Cyprus

Eighth National Communication
& Fifth Biennial Report
- under the United Nations Framework Convention on Climate Change

Department of Environment

Ministry of Agriculture,
Rural Development and Environment

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CYPRUS' EIGHTH NATIONAL COMMUNICATION

1. Introduction

This document represents the Cyprus' eighth National Communication (NC8) required under the United Nations Framework Convention on Climate Change (UNFCCC), as reaffirmed by UNFCCC decision 2/CP.17. It provides a comprehensive overview of climate change-related activity in Cyprus.

As defined in the UNFCCC reporting guidelines for National Communications[1], the information is structured into:

- National circumstances relevant to greenhouse gas emissions and removals (Chapter 2);
- Greenhouse gas inventory information (Chapter 3);
- Policies and measures (Chapter 4);
- Projections and the total effects of policies and measures (Chapter 5);
- Vulnerability assessment, climate change impacts and adaptation measures (Chapter 6);
- Financial resources and transfer of technology (Chapter 7);
- Research and systemic observation (Chapter 8) and
- Education, training and public awareness (Chapter 9).

UNFCCC decision 2/CP.17 also requires the Cyprus to submit its fifth Biennial Report (BR) by 1st January 2023. The UNFCCC reporting guidelines for National Communications content-wise overlap with the UNFCCC biennial reporting guidelines for developed country Parties (Annex I of decision 2/CP.17).

As endorsed in UNFCCC decision 2/CP.17, Cyprus has opted to submit its fourth Biennial Report as Annex 1 to this eighth National Communication. The tables as defined in the common tabular format (CTF) for the UNFCCC biennial reporting guidelines for developed country Parties (UNFCCC decision 19/CP.18) are enclosed as Appendix to Annex I. For the CTF submission to the UNFCCC, the electronic reporting facility provided by the UNFCCC secretariat has been used as required by UNFCCC decision 19/CP.18.

To avoid unnecessary duplication of information, overlapping contents were concentrated in the eighth National Communication: Those sections of the fourth Biennial report's main body which content-wise would be identical to sections of the eighth National Communication, do thus solely contain a reference to the corresponding section of eighth National Communication.

This communication focuses to the years up to which data is available; i.e. until 2021.

[1] FCCC/CP/1999/7 part II, in combination with UNFCCC decision 15/CMP.1

2. National circumstances

2.1. Introduction

This chapter reports the national circumstances of the Republic of Cyprus. It illustrates a number of key characteristics that relate directly or indirectly to the greenhouse gas emissions and include energy, transport, land use, climatic conditions and trade patterns. The chapter analyses how these various factors have influenced greenhouse gas emissions to-date and how the historic trends observed might influence emissions going forward.

The Ministry of Agriculture, Rural Development and Environment is the governmental body with the overall responsibility for the preparation, approval and submission of national communications (Contact persons: Dr Theodoulos Mesimeris and Dr Nicoletta Kythreotou, UNFCCC National Focal Points). Experts from governmental and non-governmental institutions participated in the preparation of the present national communication as information providers.

2.2. Geographic profile

Cyprus is an island country, located in the eastern end of the Mediterranean Sea, and the third largest island in the Mediterranean Sea, after the Italian islands of Sicily and Sardinia (both in terms of area and population). The total area of the island is 9,251 km^2. It measures 240 km long and 100 km wide at its widest point. It lies between latitudes 34° and 36° N, and longitudes 32° and 35° E.

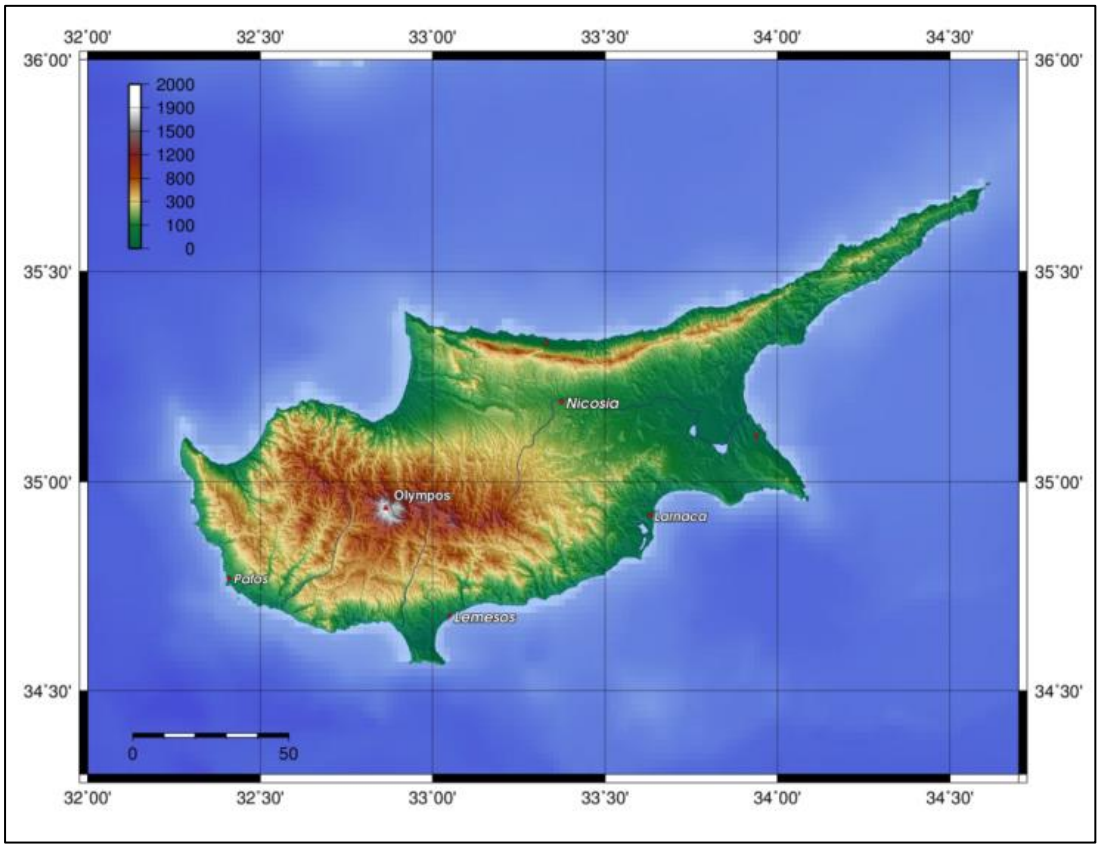

Figure 2.1. Topographic map of Cyprus

The physical relief of the island is dominated by two mountain ranges, the Troodos Mountains and the smaller Kyrenia Range, and the central plain they encompass, the Mesaoria. The Mesaoria plain is drained by the Pedieos River, the longest on the island. The Troodos Mountains cover most of the

southern and western portions of the island and account for roughly half its area. The highest point on Cyprus is Mount Olympus at 1,952 m, located in the centre of the Troodos range. The narrow Kyrenia Range, extending along the northern coastline, occupies substantially less area, and elevations are lower, reaching a maximum of 1,024 m.

2.3. Government Structure

Cyprus is an independent sovereign Republic with a presidential system of government. The constitution provides for separate executive, legislative and judicial branches of government with independent powers. The President is both Head of State and Government.

Presidency

According to the 1960 Constitution, the President is to be Greek Cypriot elected directly by the Greek Cypriot community and the Vice-President is to be Turkish Cypriot elected directly by the Turkish Cypriot community, for a five-year term of office. The Constitution provides that executive power is exercised jointly by the President and the Vice-President, through a Council of Ministers appointed by them (seven and three ministers respectively).

Both the President and the Vice-President have the right of final veto on decisions of the Council of Ministers and laws or decisions of the House of Representatives concerning foreign affairs, defence and security. In 1964, however, the Turkish Cypriot Vice-President and the three Turkish Cypriot ministers withdrew from the government and since then the government has been functioning by necessity only with Greek Cypriots in all ministries, which have been subsequently increased to eleven. The post of Vice-President remains vacant.

The ministries and deputy ministries are the following: Ministry of Defence, Ministry of Agriculture, Rural Development and Environment, Ministry of Justice and Public Order, Ministry of Energy, Commerce, Industry, Ministry of Foreign Affairs, Ministry of Labour Welfare and Social Insurance, Ministry of the Interior, Ministry of Finance, Ministry of Education, Sport and Youth, Ministry of Transport, Communications and Works, Ministry of Health, Deputy Ministry Of Research, Innovation And Digital Strategy, Deputy Ministry of Tourism, Deputy Ministry of Social Welfare, Deputy of Shipping, Deputy Ministry of Culture.

Council of Ministers

The Council of Ministers exercises executive power in all matters. Each Minister is the head of his or her Ministry and exercises executive power on all matters within that Ministry's domain. The Government Spokesman and the Deputy Minister to the President are also present at the meetings of the Council of Ministers. The Ministers are appointed by the President. The ministries mainly prepare and implement national laws.

Local Authorities

Cyprus is separated into 6 districts: Nicosia (Lefkosia), Limassol (Lemesos), Pafos, Larnaca, Ammochostos and Keryneia (Figure 2.2). Each district has a District Officer, who reports to the Minister for the Interior. Keryneia are not under the effective control of the Republic of Cyprus, whereas Ammochostos is partially under the effective control of the Republic of Cyprus.

There are two types of local authorities: Municipalities and Communities, which are governed by separate laws. In principle, Municipalities constitute the form of local government in urban and tourist centres, while Communities constitute the local structure in rural areas. Mayors and Community Presidents are elected directly by the residents for a five-year term.

Any Community may become a Municipality by local referendum subject to the approval of the Council of Ministers, provided it has either a population of more than 5,000, or has the economic resources to function as a Municipality. The main responsibilities of Municipalities are the construction, maintenance and lighting of streets, the collection, disposal and treatment of waste and environmental

protection and improvement. The functions of Communities are generally similar to those of Municipalities, although structurally different. The government provides to most Communities essential administrative and technical assistance through its District Offices.

Currently, there are 39 municipalities and 485 communities, of which 9 and 132 respectively are not under the effective control of the Republic of Cyprus.

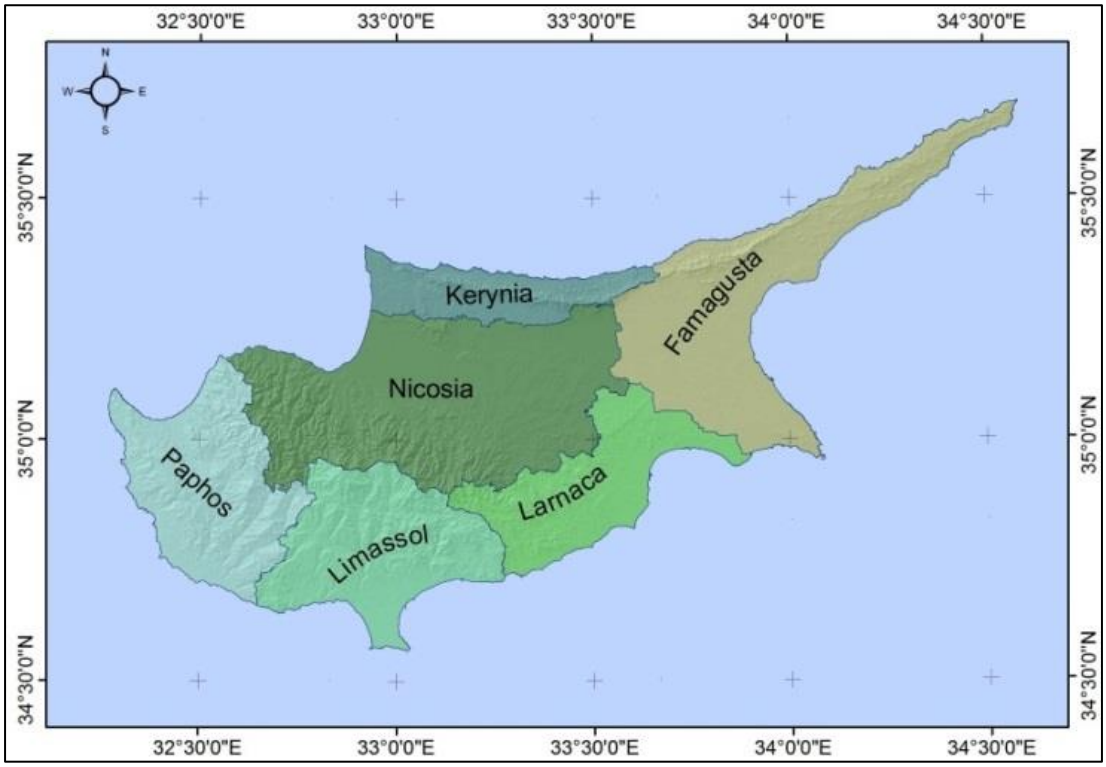

Figure 2.2. The six administrative districts of Cyprus

Legislature

House of Representatives

Legislative authority is exercised by a unicameral House of Representatives. Its members are elected for a five-year term. At the time of its establishment the House consisted of 50 members, 35 of whom were to be Greek Cypriots and 15 Turkish Cypriots. In 1985 the number of seats was increased to 80, 56 allocated to Greek Cypriot members and 24 reserved for Turkish Cypriot deputies. Following the withdrawal of the Turkish Cypriot members in 1964, the House has been functioning only with the Greek Cypriot members.

The Maronite, Armenian and Latin religious groups, which vote as part of the Greek Cypriot community, elect one additional representative each from their ranks. These non-voting representatives attend meetings, but do not participate in the House deliberations. They are consulted on issues of particular interest to their respective group.

Given the vacancy in the Vice- President's office, the House President serves as Acting President of the Republic in the case of temporary absence or temporary incapacity of the President of the Republic.

Judiciary

The administration of justice is exercised by the Republic's separate and independent judiciary. Under the 1960 Constitution and other legislation in force, the following judicial institutions have been established: The Supreme Court, The Assize Courts and District Courts.

Independent Officers and Bodies

There are also independent officers and bodies which do not come under any ministry, including the: Attorney-General and Auditor-General who head the Law Office and Audit Office respectively; Governor of the Central Bank; Ombudsman (Commissioner for Administration); Public Service Commission; Education Service Commission; Planning Bureau; Treasury; Commission for the Protection of Competition; Commissioner of Electronic Communications and Postal Regulation; Commissioner for Personal Data Protection; Commissioner for the Protection of Children's Rights; Law Commissioner; Commissioner for the Environment; Commissioner for the Reform of the Civil Service; Commissioner for Humanitarian Affairs; Commissioner for Volunteering and Nongovernmental Organisations; Tenders Review Authority; Internal Audit Service; Cyprus Radio Television Authority; Cyprus Securities and Exchange Commission.

Member of the European Union

On 1 May 2004 the Republic of Cyprus became a full member of the EU. Accession to the EU was a natural choice for Cyprus, dictated by its culture, civilisation, history, its European outlook and adherence to the ideals of democracy, freedom and justice.

The application of the EU laws and regulations (the acquis communautaire) is suspended in the area under military occupation by Turkey, pending a solution to the occupation and forcible division of the country. Meanwhile, the government, in cooperation with the EU Commission, has been promoting arrangements to facilitate increased economic transactions between the two communities and improve the standard of living of Turkish Cypriots, who are also victims of Turkey's military aggression against Cyprus.

While Cyprus has a lot to benefit from EU membership, it also has a lot to offer as a member state. Strategically situated at the crossroads of Europe, the Middle East, North Africa and Asia, Cyprus is becoming an even more important regional business centre, as well as an international communications and transport hub. It is also a prospective energy (natural gas) provider for Europe.

Given its modern infrastructure, sound legal system, tax incentives, low crime rate and well educated labour force, Cyprus is a favourite regional operations platform for European and other international companies.

Since its accession to the EU, Cyprus has undergone significant structural reforms that have transformed its economic landscape. Trade and interest rates have been liberalised, while price controls and investment restrictions have been lifted. Private financing has been introduced for the construction and operation of major infrastructure projects and monopolies have been abolished.

Cyprus held the Presidency of the Council of the European Union for the first time from July – December 2012.

2.4. Population[2]

In general, aggregate increases in population are drivers for increasing consumption, energy use and greenhouse gas emissions. The population of the Government controlled area is estimated at 918.000 at the end of 2021, compared to 875.900 at the end of 2018, recording an increase of 0,5%.

2.5. Climate[3]

Cyprus has an intense Mediterranean climate with the typical seasonal rhythm strongly marked in respect of temperature, rainfall and weather generally. Hot and dry summers from mid-May to mid-

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[3] S. Papachristodoulou, Met. officer, Department of Meteorology, Nikis 28, 1086 Nicosia; Tel.: +35722802915; e-mail: mpanayiotis@ms.moa.gov.cy

October and mild, rainy, rather changeable, winters from November to mid-March are separated by short autumn and spring seasons of rapid change in weather conditions.

The central Troodos massif, rising to 1951 metres and, to a less extent, the long narrow Kyrenia mountain range, with peaks of about 1,000 metres, play an important part in the climate of Cyprus. The predominantly clear skies and high sunshine amounts give large seasonal and daily differences between temperatures of the sea and the interior of the island which also cause considerable local effects especially near the coasts.

During the summer, the island is mainly under the influence of a trough of low pressure extending from the great continental thermal low centred over southwest Asia. It is a season of high temperatures with almost cloudless skies. Rainfall is almost negligible, but isolated thunderstorms sometimes occur which give rainfall amounting to less than 5% of the total in the average year.

In winter Cyprus is near the track of fairly frequent depressions which mainly cross the Mediterranean Sea from west to east. These depressions give periods of unsaddle weather conditions usually lasting from two to five days and produce most of the annual precipitation. Snow occurs rarely in the lowlands and on the Kyrenia range, but falls frequently every winter on ground above 1,000 metres usually occurring by the first week in December and ending by the middle of April.

Precipitation

The mean annual precipitation varies from year to year and from place to place. The lowest mean annual precipitation for Cyprus was 213mm in 1972-73 and the highest was 800mm in 1968-69. The mean annual precipitation for the period 1961-90 is 503mm. The wettest months are normally December, January and February and the driest are July, August and September.

Statistical analysis of rainfall in Cyprus reveals a decreasing trend of rainfall amounts in the last 116 years. Annual precipitation in Cyprus has on average decreased by about 100mm in the last 85 years (see Figure 2.3).

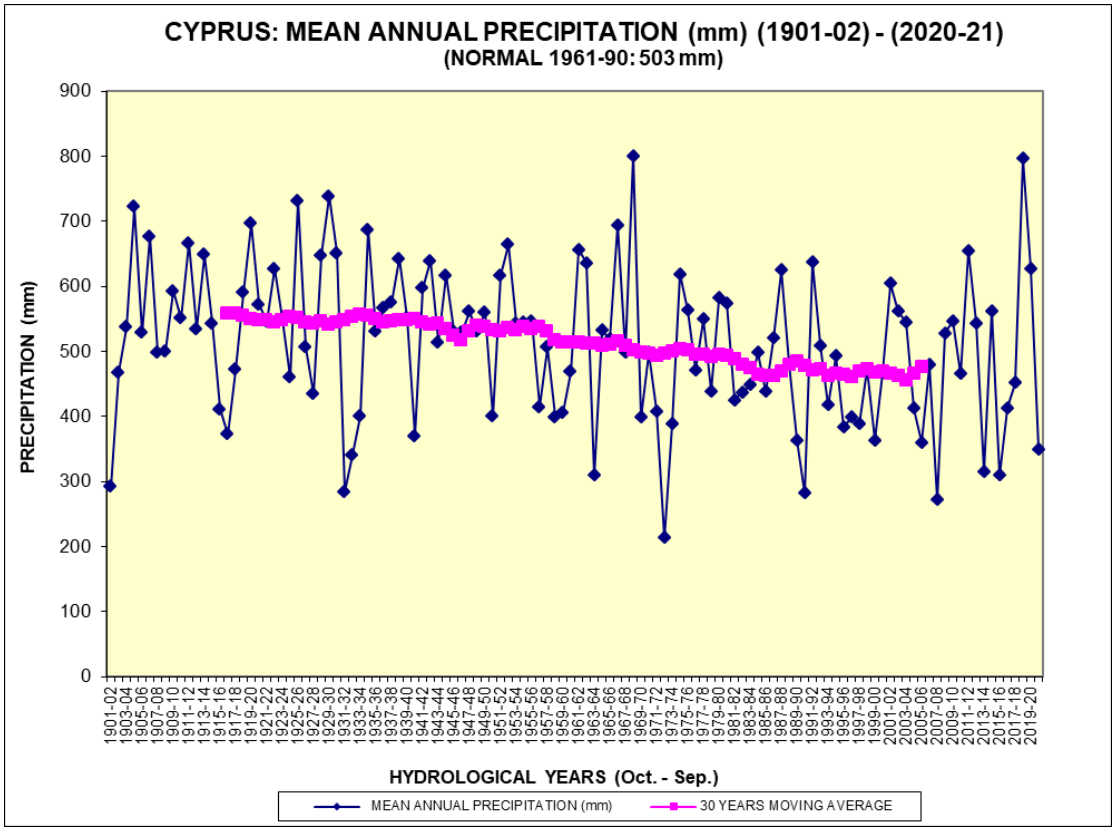

Figure 2.3. Mean annual precipitation in Cyprus 1901-02 – 2020-21 (normal 1961-90: 503 mm)

During the recent years, it has been observed that even though the total annual amount of rainfall does not change significantly, the annual distribution of rainfall has changed considerably, showing extreme rainfall years large amounts of rain alternating with periods of drought (Michaelides et al. 2009).

Temperature

Cyprus has a hot summer and mild winter, but this generalization must be modified by consideration of altitude, which lowers temperatures by about 5°C per 1,000 metres and of marine influences which give cooler summers and warmer winters near most of the coastline and especially on the west coast.

The annual mean temperature for Cyprus varies from year to year, from 16.1°C to 19.7°C, with an average of 17.5°C. The year 2010 was the warmest ever recorded in Cyprus. The years 1961, 1965 and 1967 were the coldest in the last 73 years.

The seasonal difference between mid-summer and mid-winter temperatures is quite large at 18°C inland and about 14°C on the coasts. Differences between day maximum and night minimum temperatures are also quite large especially inland in summer. These differences are in winter 8 to 10°C on the lowlands and 5 to 6°C on the mountains increasing in summer to 16°C on the central plain and 9 to 12°C elsewhere.

The average annual temperature in Cyprus, both in urban and in rural areas, presents an increasing trend. The greater increase in temperature in the towns is due to the urbanization effect, however, the fact that an increase is also observed in rural areas, it is indicative of the general increase in temperature in our area as well as globally. In Nicosia the average annual temperature increased from 18.9°C in the first 30-year period of the century to 20.9°C in the last 30-year period, an increase of 2.0 °C (see figure below).

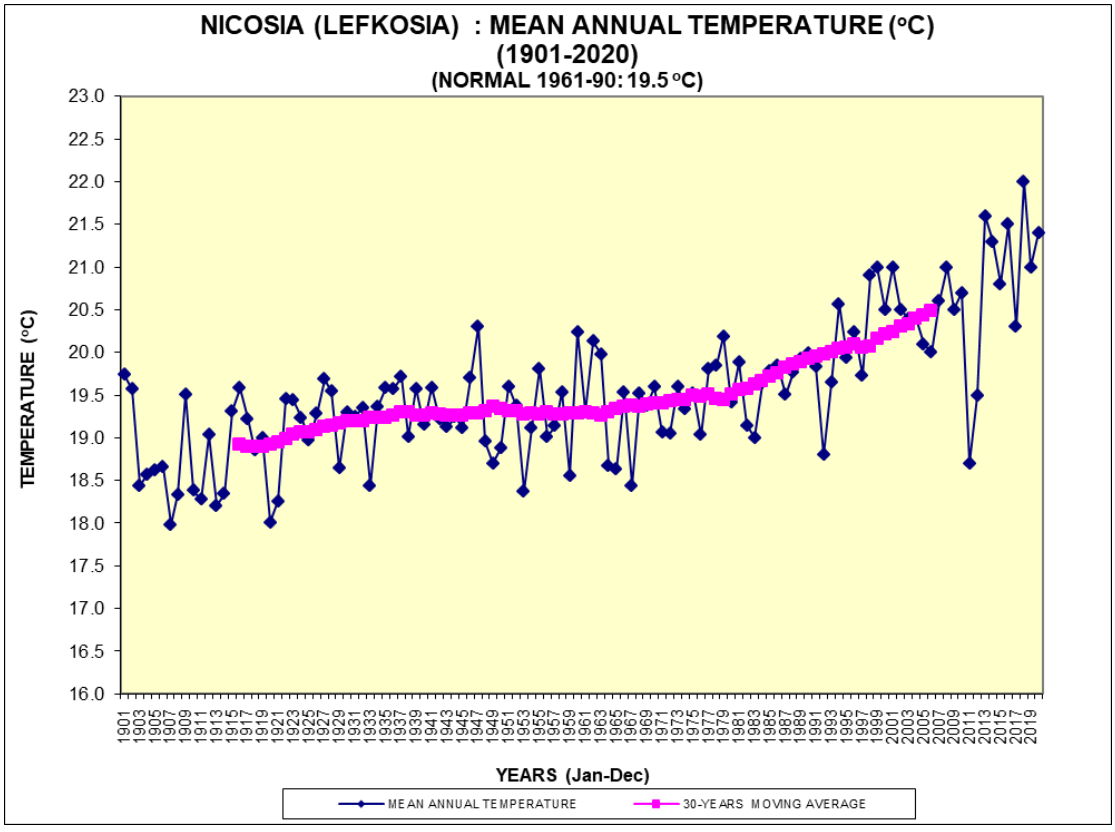

Figure 2.4. Mean annual temperature for Nicosia 1901-2020 (normal 1961-90: 19.5 °C)

Wind

Over the eastern Mediterranean generally surface winds are mostly westerly or south-westerly in winter and north-westerly or northerly in summer. Usually of light or moderate strength, they rarely reach gale force.

Over the island of Cyprus however winds are quite variable in direction with orography and local heating effects playing a large part in determination of local wind direction and strength. Temperature differences between sea and land which are built up daily in predominant periods of clear skies (mainly in summer), cause considerable sea and land breezes. Whilst these are most marked near the coasts they regularly penetrate far inland.

Gales are infrequent over Cyprus but may occur especially on exposed coasts with winter depressions. Small whirlwinds are common in summer appearing mostly near midday as "dust devils" on the hot dry central plain. Very rarely vortices, approaching a diameter of 100 metres or so and with the characteristics of water spouts at sea and of small tornadoes on land occur in a thundery type of weather. Localized damage caused by these has been reported on a few occasions but in general Cyprus suffers relatively little wind damage.

Sunshine

All parts of Cyprus enjoy a very sunny climate compared with most European countries. In the central plain and eastern lowlands the average number of hours of bright sunshine for the whole year is 75% of the time that the sun is above the horizon. Over the whole summer six months there is an average of 11,5 hours of bright sunshine per day whilst in winter this is reduced only to 5,5 hours in the cloudiest months, December and January.

Even on the high mountains the cloudiest winter months have an average of nearly 4 hours bright sunshine per day which goes up to 11 hours during June and July.

2.6. Economy[4]

The economic profile of a country has a strong link to greenhouse gas emissions, with the overall level and types of economic activity, strongly correlated to energy use. However, this is also dependent on factors such as energy efficiency and the structure of the economy.

The economy of Cyprus can generally be characterised as small, open and dynamic, with services constituting its engine power. Since the accession of the country to the European Union on 1 May 2004 the subsequent participation to the ERMII in 29 April 2005 and finally membership to the EURO area as of January 1st 2008, its economy has undergone significant economic and structural reforms that have transformed the economic landscape. Interest rates have been liberalised exchange rates and monetary policy was undertaken by the ECB, while other wide-ranging structural reforms have been promoted, covering the areas of competition, the financial sector and the business sector.

The tertiary sector (services) is the biggest contributor to GVA, accounting for about for about 83,2% in 2021. This development reflects the gradual restructuring of the Cypriot economy from an exporter of minerals and agricultural products in the period 1961-73 and an exporter of manufactured goods in the latter part of the 1970s and the early part of the 80s, to an international tourist, business and services centre during the 1980s, 1990s and the 2000s. The secondary sector (industry) accounted for around 14,9% of GVA in 2021. The primary sector (agriculture and fishing) is continuously shrinking and only reached 1,9% of GVA in 2021.

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Table 2.1. Main economic indicators

	2018	***2019***	***2020***	**2021**
GDP (in € mln)	21675	23176	21894	24018
Real GDP growth rate	5,6%	5,5%	-4,4%	6,6%
Per capita GDP in PPS, (EU-27 = 100)	91	93	90	91
Rate of Inflation HICP	0,8%	0,5%	-1,1%	2,3%
Unemployment Rate	8,4%	7,1%	7,6%	7,5%
Employment Growth	5,3%	3,8%	-1,2%	1,3%

The private sector, which is dominated by small and medium-sized enterprises, has a leading role in the production process. On the other hand, the government's role is mainly to support the private sector and regulate the markets in order to maintain conditions of macroeconomic stability and a favourable business climate, via the creation of the necessary legal and institutional framework and secure conditions of fair competition.

Before the emergence of the global economic crisis Cyprus had enjoyed a track record of satisfactory economic growth, low unemployment and relatively stable macroeconomic conditions. Over the years 2003 to 2008, real GDP rose at an annual average rate of 4,3 per cent propelled by buoyant investment and growth of private consumption and exports. Consumption was supported by annual employment growth averaging nearly 3,5 per cent over this period, attributable mainly to large inflows of migrant labour, particularly from other EU countries. During this period, per capita income in Cyprus converged rapidly with the EU-27, with GDP in euro per capita terms reaching €21.196 in 2004, or 100 per cent of the EU average in purchasing power parity terms.

The average annual growth in the five years (2008−2012) was 0.1 per cent, while inflation stood at 2,7 per cent and unemployment (as a percentage of the economically active population) at 7 per cent over that period. During that period the international economic crisis affected Cyprus indirectly mainly through lower external demand in tourism, whilst investment was also affected by lower external demand for housing by foreigners.

However, the crisis highlighted large existing imbalances in the economy stemming from the banking sector's large exposure in the Greek economy, domestic overexpansion in the property market and its overall size relative to the economy. At the same time persistent "twin deficits" in the fiscal and current account elevated the economy's vulnerability. Following the loss of market access in May 2011, the government of Cyprus requested financial assistance from its Eurozone partners and the IMF in June 2012. After a period of negotiations, a decision was taken by the Eurogroup and the Executive Board of the IMF in March and April 2013 for a 3-year Macroeconomic Adjustment Programme (the "MAP") to March 2016 of €10 billion financing via the European Stability Mechanism and the IMF.

The MAP agreed with Programme Partners addressed short- and medium-term challenges in the financial, fiscal and structural areas. The programme aimed at bringing back macroeconomic stability through the restoration of market confidence in the financial system, continuing with the ongoing fiscal consolidation process and implementing structural reforms to support competitiveness and sustainable and balanced growth, allowing for the unwinding of macroeconomic imbalances. The MAP was ambitious and addressed fundamental challenges of the Cyprus economy by promoting major reforms in the banking and fiscal areas as well in structural matters. The key programme objectives were:

- to restore the soundness of the Cypriot banking sector and rebuild depositors' and market confidence by thoroughly restructuring and downsizing financial institutions and strengthening supervision;
- to continue the on-going process of fiscal consolidation in order to correct the excessive general government deficit by 2016, in particular through measures to reduce current primary expenditure, and maintain fiscal consolidation in the medium-term, in particular through measures to increase the efficiency of public spending within a medium-term budgetary framework, enhance revenue collection and improve the functioning of the public sector; and
- to implement structural reforms to support competitiveness and sustainable and balanced growth, allowing for the unwinding of macroeconomic imbalances, in particular by reforming the wage indexation system and removing obstacles to the smooth functioning of services markets.

Cyprus authorities successfully completed the three-year macro-economic adjustment program leading to an overall transformation of the production sectors of the economy

The resilience of the Cyprus economy has been shown by the fact that economic activity contracted by 6,6% in 2013 compared to a forecast contraction of 8,7%, while in 2014, the recession was contained to approximately 1,8% compared with a projected contraction of 3,9%. The resilience of the business sector, as well as, the better than anticipated performance in the tourist sector, contributed to the containment of the severity of the contraction of the economy.

In 2015, positive growth was achieved for the first time since 2011 to about 3,4% and further accelerated in 2016 (growth of 6,6%). Growth has been broad-based, driven by very strong performance in the tourism sector, improved labour market conditions and gradual recovery in investment. The positive growth continued until 2019, when the pandemic occurred in 2020 and Cyprus economy shrank by 4,4%. In 2021 positive growth returned to 6,6%.

Unemployment also fared better than expected as it peeked to around 16,1% in 2014, despite projections of more than 20% of the labour force. Since then, unemployment has gradually decreased, with the year 2021 reaching 7,5%.

As regards public finances, targets have been met with considerable margins. In 2015, the budget deficit fell below the reference value of 3% of GDP at around 0,9%, one year ahead of the deadline set by the ECOFIN Council, allowing for the abrogation of the Excessive Deficit Procedure to commence. The nominal budget balance turned in surplus reaching 0,3% of GDP in 2016. This robust fiscal performance has supported debt sustainability, with public debt expected to drop below 100% of GDP by 2017. The reduction of public debt continued until 2020 when the pandemic took place and public debt rose to 113,5%. In 2021, debt fell again to around 101% of GDP.

In the context of the MOU, the Cypriot Banking Sector has been recapitalised and also went through significant restructuring. The supervisory framework has also been strengthened and enhanced while specific measures have been adopted in order to tackle the main challenge in this sector, that is the high level of Non-Performing Loans. These measures include, the new Foreclosure and Insolvency Laws, which introduce the right incentives for all stakeholders, including creditors and debtors, to negotiate a settlement of liabilities. They also create a safety net for vulnerable groups directly affected by the crisis.

Overall, the better than expected performance of the Cyprus economy is also reflected in the upgrades by credit rating agencies, which emphasise the successful transformation of the economy and the rapid correction of macroeconomic imbalances, as well as the impressive performance and resilience of the Cyprus economy.

In the longer term, the recent explorations for hydrocarbon reserves that have taken place in the Exclusive Economic Zone of Cyprus have revealed positive prospects for the development of the industry, which will have significant implications for the Cyprus economy. The Government has submitted a holistic legal framework regarding economic policy surrounding the exploration, discovery and exploitation of natural gas in Cyprus to the House of Representatives for their considerations and approval.

2.6.1. Trade patterns[5]

Due to the island's small domestic market and the open nature of its economy, trade and access to international markets is of utmost importance for Cyprus' well-being. The country's trade balance is traditionally in deficit because the island has to import extensively in order to satisfy domestic demand,

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while the island also depends on imports for its energy supplies. In 2016 Cyprus exported €3,286B and imported €8,531B, resulting in a negative trade balance of €5,245B.

During the last five years the total inports of Cyprus have increased by 3.6%, from €8.21B in 2017 to €8,53B in 2021. 'Agriculture, Constriction and Communication' lead the list with €2,81B followed by 'Consumer Goods' with €2,33B, 'Transport equipment and parts' with €1,73B, and 'Fuels and Lubricants' with €0,75B.

The European Union is the main source of supply of goods to Cyprus in 2021, with a share of €5,47B of total imports. Major suppliers within the Union were Greece with €2,04B, Germany with €10,53B, and Italy with €0,87B.

During the last five years the exports of Cyprus have increased by 9.6%, from €2.96B in 2017 to €3.28B in 2021. 'Industrial products of manufacturing origin' lead the list with €1,33B followed by 'Industrial products of mineral origin' with €0,95B, 'Industrial products of agricultural origin' with €0.77B and 'Agricultural products (raw)' with €0,19B.

Dispatches to the European Union accounted for €0,79B (44%) in 2021 of the total exports. The top export destination is Lebanon (€0,285B – 8%). Exports to Greece and Marshall Islands occupied the second place in importance with €0,251B (7%) and €0,250B (7%) in 2021, respectively.

2.7. Energy[6]

The energy sector in Cyprus[7]

A key challenge for Cyprus is its high dependency on fossil fuels for energy – the biggest share within the EU in fact, which makes it crucial for the country to develop both its hydrocarbon and renewable energy sources. Cyprus is reliant on fossil fuel imports for its electricity needs, and spends over 8% of its GDP to cover the costs.

The island also saw the biggest increase in energy demand among the EU28, growing 39% since 1990 from 1.6 million tonnes of oil equivalent (Mtoe) to 2.2 Mtoe in 2020. These figures may be low when compared with its larger EU partners, but a more accurate comparison would be Malta where consumption was about 0.93 Mtoe in 2020. However, Cyprus is determined to find a cleaner solution until it can exploit its own reserves.

The Renewable Energy Sources (RES) share in gross final consumption of energy was 16.88%, exceeding the national mandatory target of 13% RES in 2020, as set in the Directive 2009/28/EC. This share comes from the use of solar water heaters, the installation of PV systems, wind parks, biomass/ biogas units and biofuels for transport sector, in combination with the use of heat pumps and biomass use for heating.

Since 2013, electricity from renewable sources is no more promoted through Feed in Tariffs. In 2013 a self-consumption scheme, utilizing net-metering and net-billing methods, was initiated and is in operation until today.

Access of electricity from renewable energy sources to the grid shall be granted according to the principle of non-discrimination. With regard to the use of the grid renewable energy shall be given priority. Grid development is included in the 10-year Transmission Grid Development Plans. In addition, renewable heating and cooling (RES H&C) is promoted by support schemes offering subsidies to households.

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[7] Strategic Energy Hub, 2021, Energy: Oil and Gas, available at http://www.cyprusprofile.com/en/sectors/energy-and-environment (accessed 20/12/2021)

The country's national grid system has certain intrinsic and technical limitations affecting RES penetration and reliability of the energy system – such as the lack of interconnections to the trans-European electricity networks, a limitation to the amount of intermittent renewable energy that can be connected to the electricity system, and a lack of centralised storage capability.

To tackle these problems the country is planning to introduce smart grids in the national network and energy storage systems. Also, the EuroAsia Interconnector could bring more solutions in its wake.

The island is already one of the highest users per capita in the world of solar water heaters in households, with over 90% of households equipped with solar water heaters and over 50% of hotels using large systems of this kind. With almost year-round sunshine, Cyprus certainly has plenty of energy to harness, but competitive energy storing capabilities are crucial in order to fully tap into its solar potential and facilitate better RES penetration.

There continues to be much ground to cover in terms of renewable energy production, but international interest in developing the sector in Cyprus has been on the rise. In this respect, the production of renewable energy is expected to experience considerable growth in coming years, and significant investment is required in order for Cyprus to achieve its targets – opening the field for companies with expertise in renewables.

The Cyprus Energy Regulatory Authority (CERA) has worked towards the full opening up of the electricity market and granting consumers the right to choose their own supplier – with full liberalisation expected in the first half of 2023.

With respect to the development of the natural gas market in Cyprus, on 13 of December 2019, the tender for the engineering, construction, operation and maintenance of the "LNG Import Terminal" was awarded by ETYFA (DEFA subsidiary) to the joint venture (consortium) China Petroleum Pipeline Engineering, Metron, Hudong-Zhongua Shipbuilding and Wilhelmsen Ship Management. On 28th September 2020 ETYFA approved the revised work program which is also considered the official start date of the construction works. Due to the Covid-19 restrictions, which had several effects on the project due to an overall global impact on logistics and availability of materials and equipment, as well the price spike of certain goods, such as steel, the consortium submitted a revised wok program which indicates that project works will be completed by end H2 2023.

With respect to the supply of natural gas, on 4 June 2019, through a pre-qualification - Request for Expressions of Interest (RfEoI) process, DEFA invited prospective LNG suppliers to express an interest in supplying LNG to the LNG Import Terminal in order to be added to DEFA's list of pre-qualified LNG suppliers. DEFA intends to procure its LNG requirements through a combination of: (a) medium/ long-term supply via one or more LNG Sales and Purchase Agreements (SPAs); and (b) supplemental cargos via multiple Master Sales Agreements (MSAs) and a bidding process. The deadline for submission of EoI was the 6 September 2019, and 25 companies submitted their interest. This first stage of the above tender procedure was completed successfully in 21 December 2020. DEFA is expected to proceed to the next stage of the process within 2023 with the negotiation and execution of MSAs and with an RfP for the selection of the medium-term contract supplier of LNG.

Also, the first Open Season process for the determination of the allocation of the demand (timely, spatially and quantitatively) of natural gas/LNG by potential buyers within Cyprus (distance of 5km radius from the LNG Import Terminal as per the guidelines set by CERA) was initiated in H1 2022 and is currently ongoing.

The electrical interconnection with Israel and Greece will be the next major challenge in the country energy sector. Cyprus is promoting the «EuroAsia Interconnector» project, aiming at commissioning in 2028. The project will effectively contribute to the security of energy supply and reduction in CO2 emissions by allowing the countries in the region renewable energy sources for electricity generation.

Energy use is the largest source of GHG emissions. The following sections provide a high-level overview of the most relevant factors. Climate policy drivers have had some impact on changes in the national energy system to-date (for-example leading to improvements in energy efficiency or increases in the

share of renewables), although to a large extent these have been driven by other factors. Historic trends in GHG emissions from energy-related activities are shown in later sections. However, the impacts of future climate policy in the energy sector are likely to be far more significant, particularly as a result of the new EU Climate and Energy package. These will lead to more sizeable shifts in energy use towards renewables as well as an overall impact on primary and final energy consumption due to improvements in energy efficiency; these effects should become more noticeable within these indicators in coming years.

Total primary energy consumption in Cyprus rose over the period from 1990 despite continued efforts to improve energy efficiency. Trends in the consumption of different energy types within the total have changed significantly since 1990.

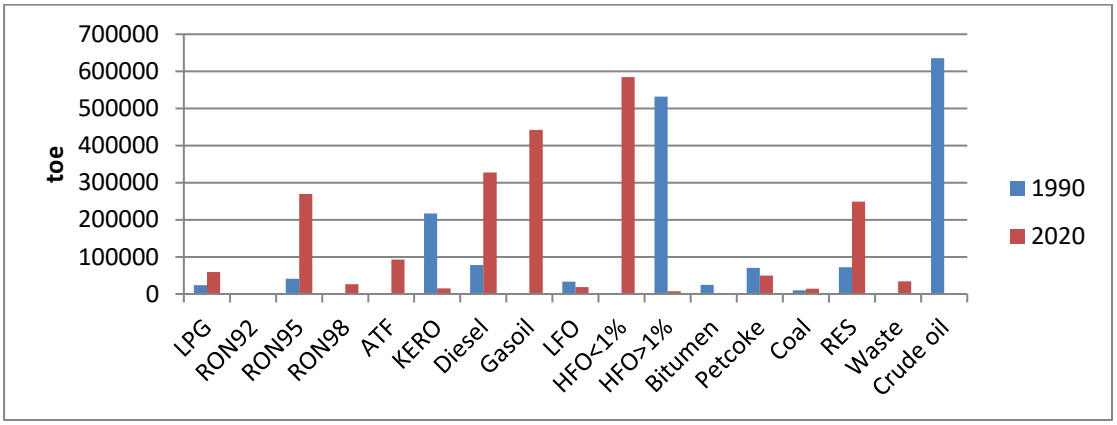

Figure 2.5. Primary energy consumption by fuel for Cyprus, 1990 and 2020

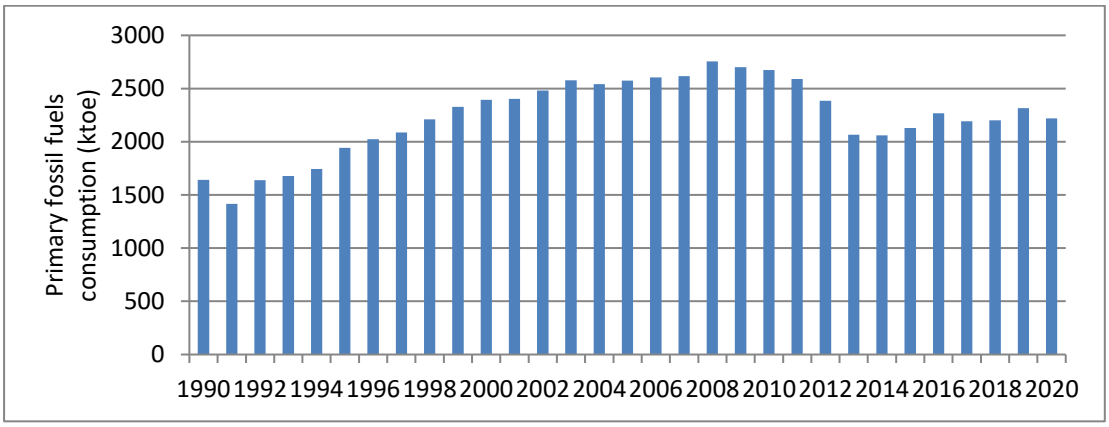

Figure 2.6. Primary consumption of fossil fuels in ktoe, 1990-2020

Renewables have the most marked increase with consumption increased approximately by 10 times from 1990 levels.

Fossil fuels continue to dominate total energy consumption and the share of renewable energy sources remains small despite the increase in use. The overall increase in total primary energy consumption has also acted to counteract some of the environmental benefits from fuel switching.

The final energy needs of the economy of Cyprus for 2020 represent 73% of the country's primary energy consumption. There are very significant energy losses linked to the transformation and distribution of useful energy (e.g. as electricity) to the end users. Energy losses broadly depend on the average efficiency of conventional thermal power stations and CHP plants and the penetration of non-thermal renewables.

2.7.1. Energy Supply

All the oil consumed is from imports and the trend, although cyclical since 1990, has been upwards of 31% in 2020 since 1990. In the case of solid fuels, overall consumption has increased by 85% between 1990 and 2004, due to the thrive of the constructing industry. From 2004 until 2008 the consumption of solid fuel was stable, while after 2008, it decreases substantially to reach 1990s levels, as renewables and alternative fuels are consumed from cement industry.

Although the absolute amount of electricity production from renewables has increased by more than 500 times since 2006 (Figure 2.7), renewable electricity still makes only a 12,6% contribution to total electricity generation in 2020. Overall, the generation mix of electricity in Cyprus has become less carbon intensive since 2008, when the first combined cycle unit for the production of electricity entered in operation and the contribution of renewable sources started to be significant. The increase in total electricity production was 270% from 1990 to 2020.

The share of primary energy met by renewables has increased steadily over time to around 12,4% of total primary energy consumption in 2020. The bulk of renewable energy consumed, about 54 %, comes from solar thermal and biomass. Energy from heat pumps is the next biggest contributor, providing 17% of total renewable energy). Biofuels has seen the biggest increase - from zero 0 in 1990 to contributing around 10% of total renewable energy in 2020.

Based on 2020 figures Cyprus, as all EU countries, has a significant challenge ahead to reach the new Renewable Energy Sources (RES) targets for 2020. The RES targets include all sources of electricity, heat and transport fuel. The RES share in gross final consumption of energy in Cyprus was 16,88% in 2020, exceeding the national mandatory target of 13%.

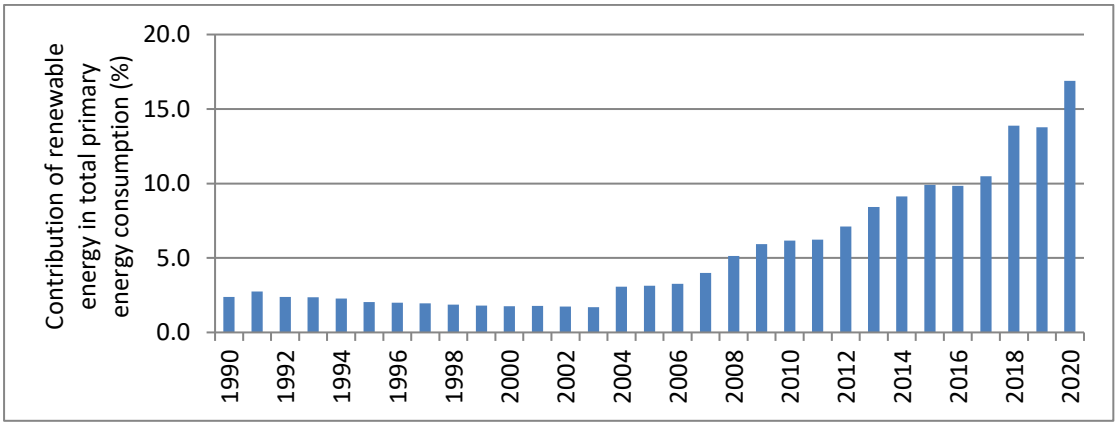

Figure 2.7. Share of renewable energy in total primary energy consumption in per cent, 1990-2020

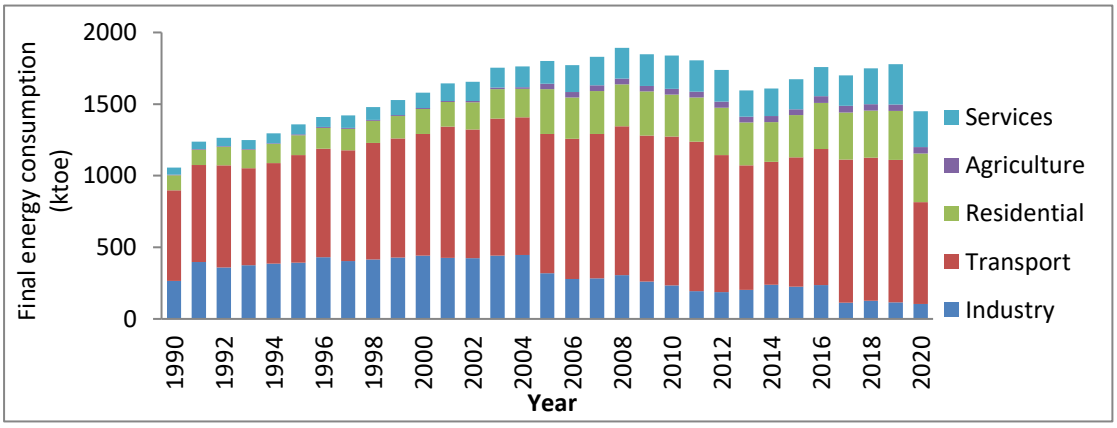

Figure 2.8. Final energy consumption by sector in ktoe, 1990-2020

2.7.2. Energy consumption in different sectors

Final energy consumption in Cyprus increased by about 38% between 1990 and 2020. The electricity sector has seen the biggest increase in overall energy consumption, increasing its consumption by over 300% since 1990. The final consumption of electricity produced from conventional fuels increased by 170% between 1990 and 2020. This is having a significant impact on GHG emissions. The Services sector has also increased its energy consumption markedly, by 358% since 1990, which correlates with an increasing share of GVA coming from this sector. Households are also one of the largest consumers of final energy in the EU. Space heating and cooling are the most significant components of household energy demand, and can vary substantially from year to year depending on climatic conditions. In very recent years, household energy consumption has declined partly as a result of higher fuel prices. Final energy consumption in industry has fallen since 1990, largely as a result of a shift towards less energy-intensive manufacturing industries, as well as the continuing transition to a more service-oriented economy.

2.7.3. Liberalisation of energy markets

As far as the electricity domestic market is concerned the new regulatory regime has been established since 2004 by liberalising 35% of the market. Cyprus has fully transposed Directive (EU) 2019/944 on common rules for the internal market for electricity into its national legislation. The Market Operator is in the process of testing the Market Management System which will allow the full implementation of a three-tiered market, i.e., an over-the-counter forward, a day-ahead and balancing tiered electricity market. At a later stage, an intra-day market will also be introduced. Until then, a transitional arrangement is in effect, which allows the bilateral trading (energy only) between independent producers (45 generation projects) and suppliers (2). At the present, 81.57% of electricity generation and 97.28% of electricity supply belongs to the incumbent.

2.7.4. Energy prices

The graph below shows how the average end-user prices of electricity have varied since 1990 for industry, commerce, households and agriculture in Cyprus.

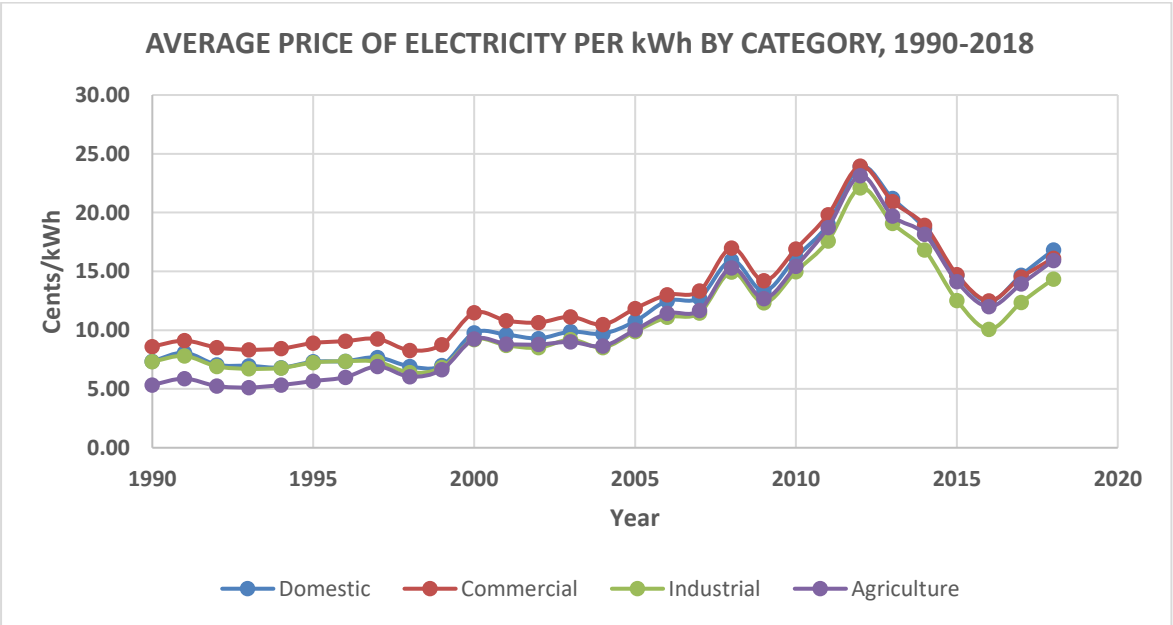

Figure 2.9. Change in average end-user energy prices in Cyprus compared to the gross disposable income for households, commerce, industry and agriculture, 1990-2018

2.8. Transport

Both freight and passenger transport, have continued to grow strongly since 1990 with continued growth in GHG emissions. According to the available information, there is no clear relation between freight or passenger transport with GDP. The transport sector is now the largest consumer of energy in Cyprus after electricity production and the issue of growing greenhouse gas emissions from this sector needs to be addressed.

2.8.1. Freight transport

Since 2002 (the year for which the first data is available) the demand for freight transport in Cyprus has decreased gradually until 2015, mainly to the changes in the economy of the country after 2008. For the period 2016-2021 the demand for freight transport has increased at a low rate. All the freight transport in Cyprus takes place via road.

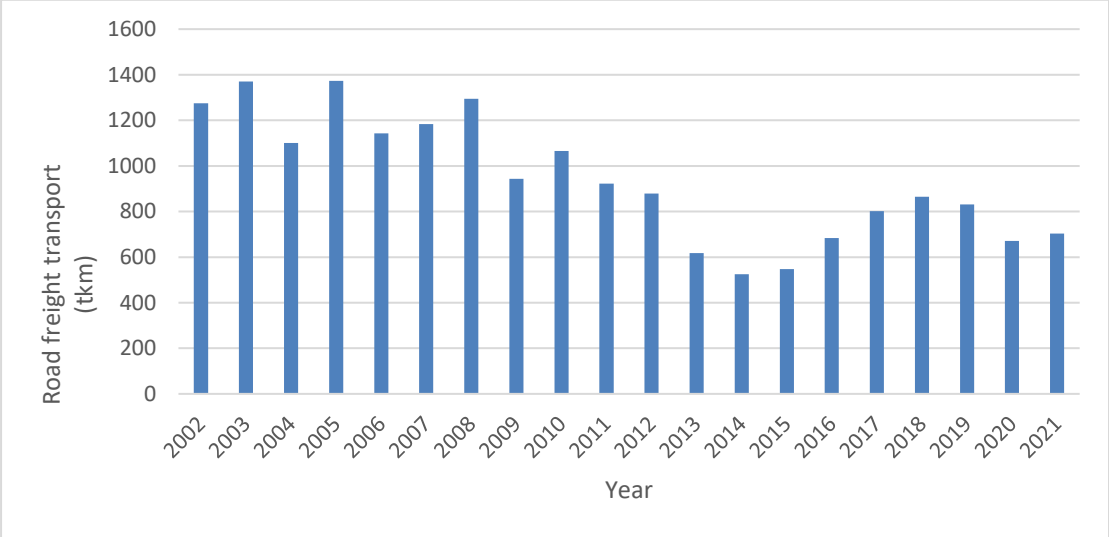

Figure 2.10. Growth in road freight transport 2002- 2021

2.8.2. Passenger transport

Since 1990 the demand for passenger transport in Cyprus has been increasing. It appears that the desired outcome, of a gradual decoupling in passenger transport from GDP, has not yet been observed. Given the continuing upward trend in demand, a reduction in absolute carbon emissions in this sector will need to come primarily via improved vehicle efficiency, modal shift to less energy intensive transport modes, and the shift to less carbon intensive transport fuels (e.g. sustainably produced biofuels or low carbon electricity).

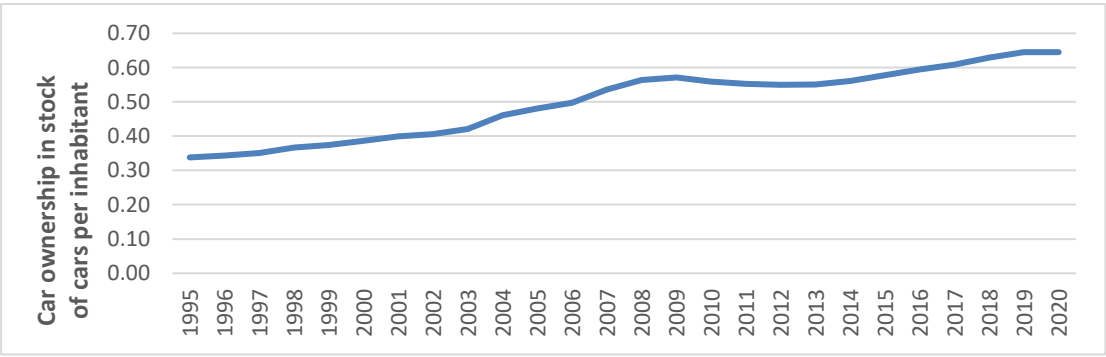

Figure 2.11. Level of car ownership in stock of cars per inhabitant, 1995 -2020

2.8.3. Prices of transport fuels[8]

Overall, the prices for both road transport fuels have increased between 1990 and 2014 due to substantial increases in oil prices and taxes. The tax on petrol increased by 274% (in 1990 €128/1000 litres and 2014 €479/1000 litres) and the tax on diesel increased from zero to €450/1000 litres over the same period. Furthermore, the VAT tax was zero in 1990 and gradually increased to19%in 2014. Also, comparison of the oil prices of transport fuels occurred between 1990 and 2014 is not possible due the different quality of the fuels, ex. in 1990 the petrol was Leaded with high sulphur content and today the petrol is unleaded and sulphur free (10 ppm). Rising prices will also help stimulate demand for more efficient vehicles. Road fuels have declined sharply from their peak in 2008 as the price of oil has declined, with (nominal) prices again similar to those in the early 2000s.

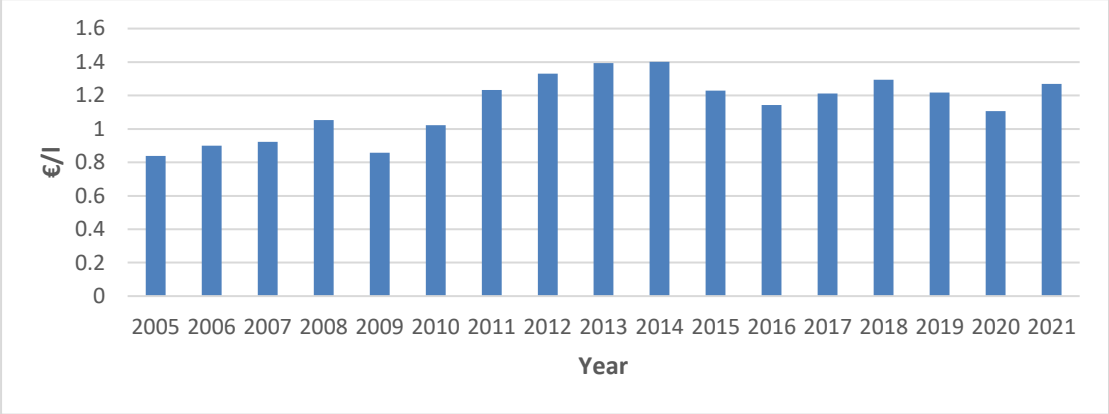

Figure 2.12. Average road transport fuel prices including taxes in €/litre, 2005-2021

2.9. Industry

Cyprus, after its independence in 1960, demonstrated a successful economic performance in terms of full employment and economic stability, apart from some isolated events. The underdeveloped rural economy inherited from colonialism was transformed into a modern economy with dynamic services, light industry, a very good agricultural sector and advanced physical and social infrastructure. From being traditionally agricultural, Cyprus embraced industrial development in the 1960s and today specializes in the manufacture of medium and high-technology products and semi-customized small-batch products. Industry grew in a sheltered environment with tariffs and quotas which have been introduced to protect local production.

Major events, that have affected the growth and structure of the economy and specifically of the industrial sector were, the Turkish invasion in 1974, accession to the World Trade Organization (WTO), the Customs Union Agreement with the EU in 1988 and eventual membership to the EU in 2004.

The Protocol for the Customs Union and Accession to the EU provided for the elimination of all restrictions to trade and increased competition in the local market. This had a major impact on the industrial sector which had to face fierce competition both from EU markets and third countries.

1990-2002

In 2002, distribution of Value Added in Manufacturing by Industry, showed Food, beverages and tobacco, as the largest group contributing 38,8% to the manufacturing value added, registered a 1,0% increase in volume of production. This was mainly due to the increase of domestic demand. Following were the subsectors of: Basic Metals and Metal Products, Machinery and Electrical and Optical Equipment and Manufacture of Transport Equipment, Other Non – Metallic Mineral Products, Refined

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Petroleum Products, Chemicals and Chemical Products and Rubber and Plastic Products, Manufacturing n.e.c, Pulp Paper and Paper Products; Publishing and Printing, Wood and Wood Products, Textiles and Textile Products and Manufacture of Leather and Leather Products. Large increases were recorded in the exports of pharmaceutical products, plastic products, dairy products and perfumes and toilet preparations. Decreases were recorded in the exports of cigarettes, wearing apparel, footwear, electricity distribution and control apparatus, kitchen furniture and jewellery and related articles.

2004-2009

On May 1st 2004, Cyprus, together with nine other countries, formally takes its place alongside the 15 member-states of the European Union. During 2004, the Cyprus economy exhibited an accelerated rate of growth, in contrast to the conditions of subdued growth observed during the previous two years. The gradual improvement of the overall confidence climate, following the accession of Cyprus to the EU, and the improved external environment of Cyprus, which positively affected the external demand for goods and services, constituted the main contributing factors towards this development. The significant increase of the oil price in international markets constituted a restraining factor towards further growth of the Cyprus economy. In summary, the Cyprus economy exhibited conditions of acceleration of economic activity in 2004, mainly due to the strengthening of domestic demand and in particular private consumption demand and investment demand in machinery and transport equipment as well as construction works.

2009-2021

In 2009, the Cypriot economy began to shrink as the economic crisis in Europe and elsewhere began to bite. The industrial sector has been hit the hardest. Local investment was negatively affected by the financial crisis in 2013 where industry found it difficult to secure funding from the local banks.

Cyprus has no heavy industry and the expansion of its light industry is limited by the lack of raw materials and the size of the domestic market. Cyprus is radically restructuring its manufacturing base and actively seeking to attract new high-tech and knowledge-based industries. Main growth industries have been in ICT sector manufacturing parts, instruments and electronics, as well as consumer products such as food and cosmetics. Cyprus' key industrial products are pharmaceuticals, food, beverages, chemicals, mineral products, machinery and equipment. Of these, only pharmaceuticals and non-metallic minerals have experienced growth in recent years. Today, manufacturing contributes approximately 5% of GDP and accounts for 9% of people in employment.

The majority of manufacturers are small and medium-sized enterprises (SMEs), which employ less than 10 workers. This makes the sector flexible and open to innovation. The government is seeking to improve SMEs' access to finance and overseas markets, and to maximize the commercial potential of local research and development in order to open up untapped areas of productivity.

Within the sphere of competencies and duties of the Ministry of Energy, Commerce and Industry (MECI) in regards to enterprises and manufacturing industry many actions are being implemented, which align with the European Union (EU), United Nations (UN) and United Nations Industrial Development Organization (UNIDO) policies, strategies and goals such as the New Industrial Policy of Cyprus 2019 and grant schemes and financial incentives/aid in different industrial areas

2.10. Waste

Municipal and Solid Waste Management

The national municipal waste Management Plant of 2015-2021 (MWMP) contained quantitative and qualitative targets and enumerates specific measures and actions to be taken in order for the EU targets to be reached. One of the quantitative targets is that no more than 95,000 tonnes of biodegradable waste to be disposed in landfills (represents the 35% target of the 1999/31/EC directive). Also, the Legal Measures will be focused on the:

- Development of local waste prevention and management schemes
- Mandatory obligation for establishing separate collection systems by local authorities,
- Establishment of extended producer responsibility (EPR) in streams other than packaging waste,
- Establishment of a landfill tax/levy,
- Banning the disposal of certain waste streams from entering into landfills (e.g. green waste, high calorific value waste, etc)

The adaptations of the strategy that are envisaged:

a) One Sanitary Landfill and one Residual Sanitary Landfill (supplementing MBT unit at Koshi) were constructed and operated (both meet the requirements of directive 99/31/EC). The MBT unit was constructed and operated from 01/04/2010 servicing Larnaca - Ammochostos districts. The Plant was designed in a way that a high separation of recycled and biodegradable material is achieved. Another I.W.M.P (Integrated Waste Management Plant) servicing Limassol district is expected to be operated by the year 2018.
b) The construction of the Green Point Network (22 collection points for the depositing of various waste streams out of households – bulky waste, green, textile, furniture, weee, etc.) is competed. The 4 Green Points, servicing Paphos district are operated.
c) Separate collection at source was promoted at households, from the existing collective system for the packing waste servicing also and all types of paper, created under the packaging directive while the competent authority promotes the separate collection from other household streams such as other organic waste eg. food and green waste.
d) The construction works for the rehabilitation/restoration of the old non approved landfills, which are closed at Paphos and Larnaca - Ammochostos districts, were completed. The preparation of studies/documents regarding the rehabilitation/restoration of the 20 non sanitary landfills of Nicosia district and the 44 sanitary landfills of Limassol district, will be completed within 2018 and after that the construction works will begin.

A comprehensive study was undertaken in 2005 for the elaboration of a Strategic Plan, an Environmental study and a Feasibility study for the restoration and management of landfills. The purpose of the study was to record all landfills, assess their status and level of risk, create a restoration priority list based on pollution risk assessments, undertake the appropriate environmental studies as well as feasibility studies for the restoration of the prioterized landfills. These studies were a necessary step for the restoration of all landfills recorded.

Two (2) landfills are still active in Cyprus but arrangements are made in order to be closed and restored. According to recent data, these two landfills are feeded with approximately 155.000 ton and 200.000 ton of municipality waste each year respectively (reference year 2012).

Sixty-two (62) non sanitary landfills are planned to be restored appropriately within the following years. According to the preliminary study contacted in 2005, these landfills contain approximately 597.269 m3 of solid waste excluding 2 major landfills that have not been closed yet.

Fifty-three (53) landfills have been restored the last five years and are being monitored. During their restoration a total of 4.902.000 m3 of solid waste were reallocated and properly buried using composite liners and leakage collection systems.

The EU landfill directive is fully harmonized in the national legislation but not fully implemented. Cyprus didn’t manage to seize of the operation of non-compliant landfills by 2009. Moreover, Cyprus has rehabilitated only 46% of its closed landfills.

2.11. Building stock and urban structure

Energy consumption for space heating or cooling within buildings forms a significant component of the country’s energy consumption. The level of energy consumption within buildings is primarily affected by: the thermal properties of the building (in terms of insulation, building type – e.g. flat/house); the efficiency of the heating or cooling system; and the stock/efficiency of the appliances used. In general, newer dwellings are likely to be more energy efficient than older buildings. The building sector has one

of the highest potentials for improved energy efficiency and measures to reduce the space heating/cooling demand in buildings represent a significant part of this potential. Many of these measures (such as improved insulation) are highly cost-effective, but a number of other barriers to their implementation exist. These are being addressed by a number of the policies related to end-use energy efficiency.

2.11.1. Building Permissions

From the data for the period 1995-2021 (as shown in Figure 2.13), it is noticeable that the maximum number of building permissions issued was in 2006 (9.794) and the minimum in 2014 (4.933). A steep upward trend is recorded during the period 2000-2006, from then on the number of building permissions issued started to decrease, reaching the minimum number recorded in 2014. From 2015, the number of building permissions issued increased slightly.

Looking at the latest data concerning the period January-July 2022, 4521 building permissions were issued, representing an increase of 4% over the corresponding period of the previous year (January - July 2021), where the number of building permissions issued was 4717. Regarding the 4521 building permissions issued, 3089 (68.3%) concerned residential buildings, 712 (15.7%) non-residential buildings, 302 (6.7%) Civil Engineering projects, 314 (6.9%) concerned the division of plots and 104 building permissions (2.3%) were issued for road construction projects.

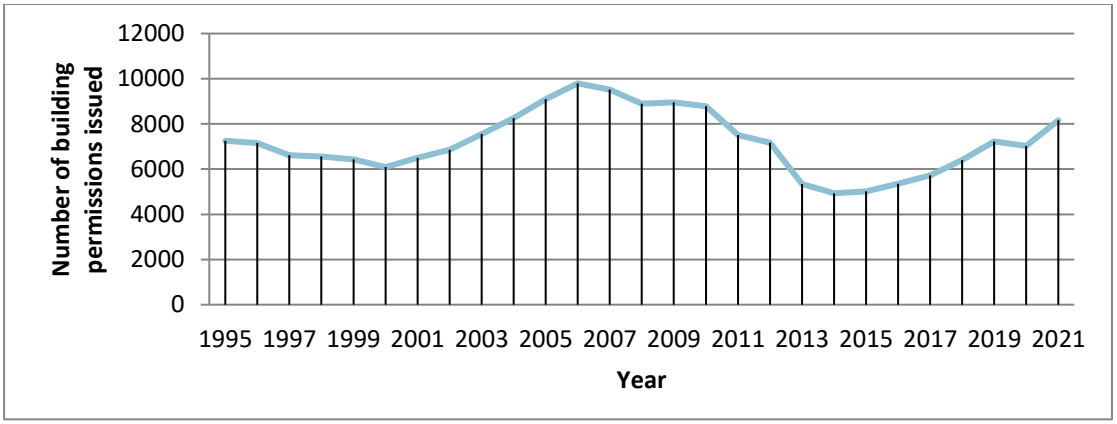

Figure 2.13. Building Permissions Authorised, 1995-2021 (Source: Construction and Housing Statistics 2022, Cyprus Statistical Service)

2.11.2. Dwelling Stock

According to the Cyprus Statistical Service (Source: Construction and Housing Statistics 2022), the dwelling stock at the end of 2020 increased by 1.2% and reached 466000units as against 460000in 2019. The following Figure presents the total dwelling stock during the period 1995-2020.

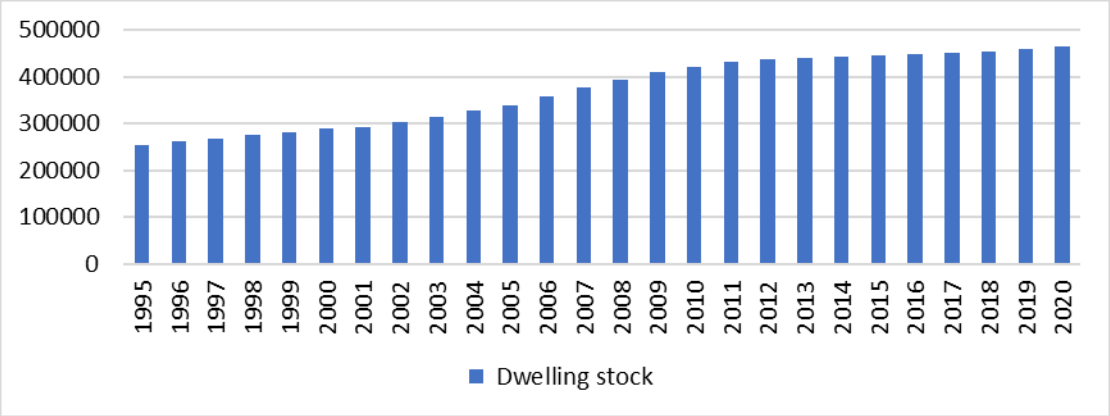

Figure 2.14. Total dwelling stock and occupied living quarters, 1995-2020 (Source: Construction and Housing Statistics 2022, Cyprus Statistical Service)

2.12. Agriculture[9]

Until 1974, the agricultural sector was considered to be one of the most important sectors of Cyprus' economy. Over the period 1960-1974 the agricultural sector had the largest contribution to Gross Domestic Product, ranging from 16% to 21%, and provided employment to more than 30% of the economically active population. Agricultural production almost doubled in the period 1960-1974 and the added value of the agricultural sector showed an average annual growth rate of about 8%.

Following the Turkish invasion (1974), the agricultural sector suffered severely since the Turkish occupying forces occupied an area that accounted for 46% of total agricultural production and 47% of livestock production. At the same time, the population that was concentrated in the less productive areas of Cyprus was displaced from the occupied areas.

Cyprus' economy, mainly from 2000 until today, is characterised by the growth of the tertiary sector (services) and the shrinking of the other two sectors of the economy (primary and secondary). Indicatively, agriculture accounts for 1.8% of GDP and employs 2.8% of the labor force.

Agricultural income, although it showed increasing trends in the period 2000-2002, with the accession of Cyprus to the EU in 2004 and the implementation of the Common Agricultural Policy (CFP) is decreasing, with the decrease being particularly pronounced in recent years, especially in small which highlights the need to redesign Cyprus' agriculture with emphasis on improving its competitiveness and exploiting its comparative advantages (high quality, early products, etc.).

The competitiveness of the agricultural sector and productivity depend to a large extent on their structural characteristics. The total utilized agricultural land decreased by 24% between 2003 and 2010. In addition, 81% had a size of less than 3 hectares and cultivated 22% of the agricultural land used, while the remaining 19% had a size of more than 3 hectares and cultivated 78% of the agricultural land used. This structural development is mainly the result of a change in the operating environment of the agricultural sector after EU accession, in particular the reduction of protectionism, the abolition of price support, the decoupling of production aid, the simultaneous reduction of prices and subsidies, rising input costs, opening markets and the functioning of the agricultural sector in a highly competitive environment. However, the impact of climate change, and more specifically drought, should not be overlooked.

The agriculture sector has shrunk considerably over the past decades, as well asits contribution to the GDP, combined with the fisheries and forestry sectors. Nevertheless, the importance of agriculture

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socially and environmentally is great, as can be seen from the amounts allocated annually by the state to support this sector. Indicatively, between 2014 and 2020, the Agricultural Payments Agency made payments of € 243,000,000 (53%from Community funds) whereas all payments made by the Agency to farmers since 2004 amounted over a€ 1 billion.

In addition to the above, the agricultural sector in Cyprus is already experiencing the impact of climate change, which has caused, among other things, the degradation of agricultural land, the reduction of agricultural production, the increase in damage caused by extreme weather events (prolonged droughts, the lack and degradation of water resources).

2.13. Forest

Wild vegetation in Cyprus is classified in two major categories: a) forest and b) Other Wooded Land (OWL, which includes maquis and garique), which are either of state or private ownership. These two categories account for 41.7 % (386,190 hectares) of the total land area. The change of forest cover is almost invariable the last 16 years. Analytical data are shown on Table 2.2. (Data taken from FRA 2020-Cyprus Country Report).

Table 2.2. Wild vegetation in Cyprus

Category of Vegetation	Forests	Other Wooded Land (OWL)	Total
1999			
Area (ha)	171610	213860	385470
%	18.5	23.1	41.7
2005			
Area (ha)	172851	213865	386716
%	18.5	23.1	41.8
2010			
Area (ha)	172841	213285	386126
%	18.7	23.1	41.7
2012			
Area (ha)	172778	213389	386167
%	18.7	23.1	41.7
2015			
Area (ha)	172700	213490	386190
%	18.7	23.1	41.7
2020			
Area (ha)	172530	213570	386100
%	18.7	23.1	41.8

3. Greenhouse gas inventory information

3.1. Introduction

This chapter provides the key points about the Cyprus' GHG inventory.

Under the Kyoto Protocol, for its second commitment period, the EU, its Member States and Iceland have agreed to fulfil their quantified emission limitation and reduction commitments jointly. The Union, its Member States and Iceland agreed to a quantified emission reduction commitment that limits their average annual emissions of greenhouse gases during the second commitment period to 80 % of the sum of their base year emissions, which is reflected in the Doha Amendment[10].

The EU's current NDC goal submitted in December 2020 within the framework of the Paris Agreement, is to reduce emissions by at least 55% below 1990 levels by 2030 (including LULUCF). Moreover, the European Council (heads of state or government of the EU Member States, the European Council President and the President of the European Commission) endorsed the objective of achieving a climate-neutral EU by 2050, in line with the Paris Agreement.

The GHG data presented in this chapter are consistent with the 2022 submission of Cyprus to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), under the Convention and the Kyoto Protocol[11].

The legal basis for the compilation of the Cyprus' inventory is the Council of Ministers' Decision adopted 15/11/2017 entitled "Structure and operation of the National Greenhouse Gases Inventory System-Roles and Responsibilities".

Summary tables of GHG emissions for Cyprus in the common reporting format are presented in Annex II for the whole of the reporting period of the NIR2022 (1990-2020) as this was submitted to the UNFCCC secretariat after the review[12].

Information related to the geographical scope

On July 20 1974, the Turkish armed forces staged a full-scale invasion against Cyprus. Turkey proceeded to occupy the northern part of the island and empty it from its Greek inhabitants. By the end of the following year, the majority of the Turkish Cypriots living in the areas left under the control of the Republic of Cyprus had also made their way to the part of Cyprus occupied by the Turkish army.

On November 15 1983 the Turkish Cypriot leadership unilaterally declared that area an independent state, by the name of "Turkish Republic of Northern Cyprus". Despite the fact that this act has been condemned by the UN and that no country other than Turkey has recognised this illegal secessionist entity, the situation continues.

For further information please refer to the website of the Ministry of Foreign Affairs of the Republic of Cyprus[13].

That area is not under the effective control of the Republic of Cyprus. Therefore, no data from official sources are available for the activities taking place in the particular areas, thus no emissions can be estimated for any activities.

[10] See https://ec.europa.eu/clima/policies/strategies/progress/kyoto_2_en
[11] Available at https://unfccc.int/ghg-inventories-annex-i-parties/2022
[12] NIR 5 April 2022, CRF 9 Sep 2022, available at https://unfccc.int/ghg-inventories-annex-i-parties/2022
[13] http://www.mfa.gov.cy/mfa/mfa2016.nsf/mfa08_en/mfa08_en?OpenDocument

This inventory estimates emissions only for areas under the effective control of the Republic of Cyprus.

3.2. Descriptive Summary of GHG Emissions Trends

This section only has a brief description of the trends in GHG emissions. For a full description of the trends, please see relevant sections in Cyprus' National Inventory Report (NIR).

3.2.1. Overall Greenhouse Gas Emissions Trends

In 2020 total GHG emissions in Cyprus, including LULUCF, were 61.68 % (3 295 Gg CO2 equivalents) above 1990, (see Figure 3.1). Between 2019 and 2020 emissions decreased by 1 % (75 Gg CO2 equivalents).

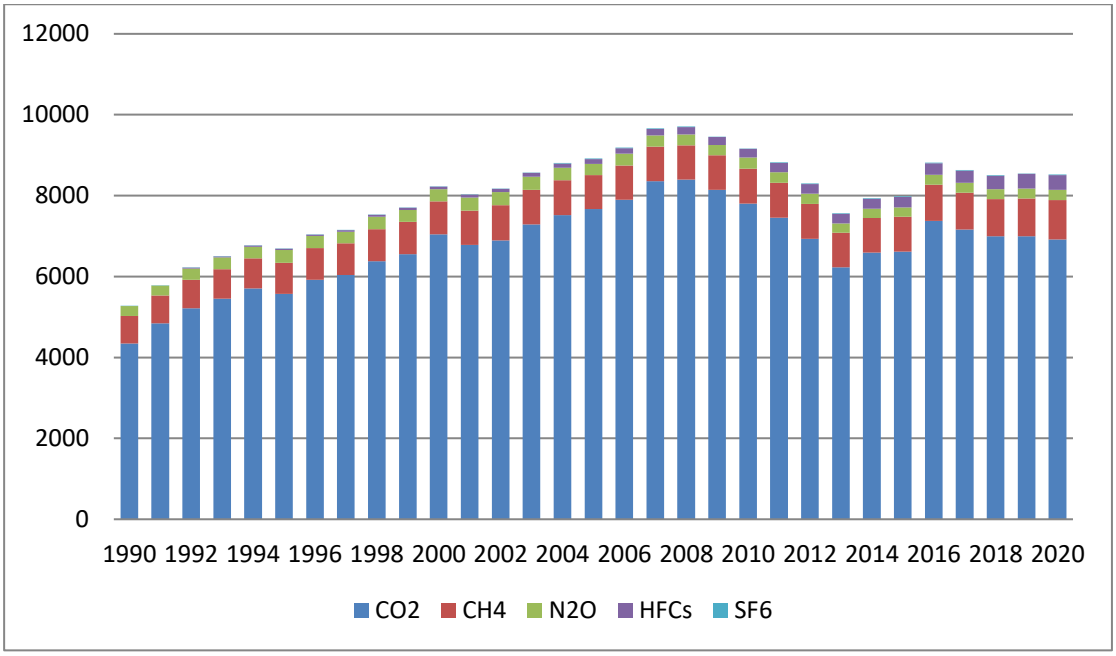

Figure 3.1. Cyprus' GHG emissions 1990 to 2015, including LULUCF.

3.2.2. Emission trends by gas

Table 3.1 provides an overview on the main trends in Cyprus GHG emissions and removals for 1990–2020. The most important GHG is CO2, accounting for 81.2 % of total emissions in 2020. In 2020, CO2 emissions including LULUCF were 6 920 Gg, which was 59.14 % above 1990 levels. CH4 and N2O emissions account for 11.36 % and 3 % of total GHG emissions respectively in 2020; both gases show increasing trends. As a group of gases, fluorinated gases (HFCs and SF6) are increasing and account for the remaining 4.4 % of total GHG emissions.

Table 3.1. Cyprus' GHG emissions 1990 to 2020, including LULUCF.

	CO2	CH4	N2O	HFCs	SF6	Total
1990	4348.18	674.23	246.47	NO	2.65	5271.52
1991	4844.33	685.24	246.9	NO	3.27	5779.74
1992	5218.8	703.55	273.22	25.35	3.89	6224.81
1993	5452.65	729.45	290.92	26.94	4.51	6504.47
1994	5710.1	744.12	281.29	28.65	5.13	6769.29
1995	5572.62	765.61	321.46	30.57	5.75	6696.02
1996	5922.82	783.49	294.15	34.62	6.37	7041.44
1997	6035.03	787.58	286.06	38.73	6.99	7154.4
1998	6378.82	791.42	308.59	46.74	7.61	7533.18
1999	6557.21	792.3	296.71	52.84	8.23	7707.3
2000	7045.49	816.44	298.31	60.38	8.86	8229.48

2001	6784.96	844.15	326.36	68.78	9.51	8033.75
2002	6895.64	866.82	327.98	77.29	10.14	8177.88
2003	7286.04	859.88	323.62	90.58	10.78	8570.9
2004	7521.93	856.83	307.97	106.77	11.41	8804.91
2005	7665.47	839.69	279.81	122.19	12.05	8919.21
2006	7900.71	842.84	291.46	140.34	11.13	9186.48
2007	8357.47	851.74	281.77	159.05	11.43	9661.46
2008	8399.18	847.25	266.31	183.4	11.73	9707.86
2009	8143.71	852.03	258.56	194.93	12.02	9461.26
2010	7805.86	861.66	274.68	214.2	12.32	9168.73
2011	7451.54	864.07	259.99	231.29	13.94	8820.83
2012	6934.32	859.27	254.94	238.49	14.52	8301.54
2013	6230.35	849.35	230.1	241.77	15.11	7566.69
2014	6596.67	853.16	223.82	248.36	15.7	7937.72
2015	6615.38	862.35	231.05	261.62	16.29	7986.7
2016	7376	897.81	243.09	284.08	15.14	8816.12
2017	7164.35	905.59	245.16	305.89	15.33	8636.32
2018	6992.89	918.1	246.91	334.87	16.39	8509.15
2019	6993.64	933.81	251.61	357.24	14.98	8551.29
2020	6919.9	968.75	258.21	357.73	18.18	8522.77

3.2.3. Trends in emissions by main source and sink categories

Table 3.2 provides an overview of Cyprus' GHG emissions in the main source categories for 1990 to 2020. Emissions from international aviation and shipping are excluded from national totals and are presented in the table as memo items.

The energy sector contributed 75.3.1 % to total GHG emissions in 2020. This sector is the largest source of emissions in Cyprus. Total GHG emissions from this sector increased by 61.4% from 3 976 in 1990 to 6417 million tonnes in 2020. The main reasons for the increasing emissions since 1990 are increase of electricity demand due to improvement of living conditions, to increase of population (by 34.6%) and increase of number of privately owned vehicles.

The industrial processes and product use sector is the second largest source of emissions, and contributed 15.1 % to total GHG emissions in 2020. Total GHG emissions from this sector increased by 77.6 % from 726 Gg CO2 equivalent in 1990 to 1 288 Gg tonnes CO2 equivalent in 2020, primarily due to the mainly due to the increase of product uses as ODS substitutes.

The agriculture sector is the third largest source of emissions in Cyprus, and contributed 6.5% to total GHG emissions in 2020. Total GHG emissions from this sector increased by 15.4% from 478 Gg tonnes CO2 equivalent in 1990 to 552 Gg tonnes CO2 equivalent in 2020, reflecting increasing animal population, reduction in fertilisers' use and improvement in waste management practices.

The remaining emissions arise from the waste sector, contributing7.2 % to total national GHG emissions in 2020. Total GHG emissions from this sector increased by 55.2 % from 396 Gg CO2 equivalent in 1990 to 616 Gg CO2 equivalent in 2020. Key factors causing this increase is increasing solid waste production per capita which is partly counterbalanced by the improvement of solid waste domestic wastewater management and the increase of population.

In addition, net removals from land use, land use change and forestry (LULUCF) increased in the EU over the same 30-year period. Based on the 2022 EU GHG inventory, net removals increased by 14.3 % between 1990 and 2020 and the net sink has decreased from 5.8 % of total net GHG emissions in 1990 to 4.1 % in 2020. In 2020, net removals from the LULUCF sector in Cyprus amounted to 349 Gg CO2 equivalent compared to 305 Gg CO2 eq. in 1990. The key driver for the increase in net removals is the prohibition of logging. Environmental policies have also resulted in less intensive agricultural practices and an increase in forest and woodland conservation areas for the purpose of preserving biodiversity and landscapes.

Table 3.2. Cyprus' GHG emissions 1990 to 2020 by source excluding indirect emissions.

	Energy	IPPU	Agriculture	LULUCF	Waste	Total (excl. LULUCF)	Total (incl. LULUCF)
1990	3976.80	725.57	478.07	-304.97	396.04	5576.49	5271.52
1991	4510.45	685.57	480.55	-298.23	401.40	6077.96	5779.74
1992	4837.10	762.08	514.97	-298.62	409.28	6523.43	6224.81
1993	5013.81	832.79	546.23	-307.71	419.35	6812.18	6504.47
1994	5224.55	868.39	535.96	-290.95	431.34	7060.23	6769.29
1995	5133.22	837.58	586.59	-300.93	439.56	6996.94	6696.02
1996	5427.31	900.34	568.48	-300.54	445.86	7341.99	7041.44
1997	5549.59	871.91	553.65	-275.72	454.97	7430.13	7154.40
1998	5891.73	837.60	567.34	-225.79	462.30	7758.97	7533.18
1999	6155.36	849.76	550.23	-318.70	470.65	8026.00	7707.30
2000	6381.29	878.48	556.42	-67.19	480.49	8296.68	8229.48
2001	6274.28	871.56	605.76	-208.36	490.51	8242.10	8033.75
2002	6432.19	913.08	624.42	-290.19	498.38	8468.07	8177.88
2003	6823.53	929.56	606.28	-290.34	501.87	8861.24	8570.90
2004	6981.88	1010.50	587.13	-280.69	506.09	9085.60	8804.91
2005	7157.94	1002.68	535.68	-291.97	514.88	9211.18	8919.21
2006	7342.06	1061.92	550.50	-284.01	516.01	9470.49	9186.48
2007	7664.32	1077.08	542.03	-140.76	518.79	9802.22	9661.46
2008	7874.86	1104.55	517.27	-317.83	529.01	10025.69	9707.86
2009	7800.03	942.31	510.18	-327.64	536.38	9788.90	9461.26
2010	7565.75	825.25	532.68	-295.32	540.36	9464.04	9168.73
2011	7268.77	825.96	518.40	-336.59	544.28	9157.42	8820.83
2012	6785.24	789.62	501.17	-328.30	553.82	8629.84	8301.54
2013	5861.46	1030.37	463.86	-353.13	564.14	7919.82	7566.69
2014	6006.82	1258.09	453.57	-354.93	574.17	8292.64	7937.72
2015	6129.30	1174.37	460.36	-357.39	580.05	8344.08	7986.70
2016	6526.60	1204.20	483.38	16.80	585.13	8799.32	8816.12
2017	6637.69	1268.50	497.63	-360.50	593.01	8996.82	8636.32
2018	6526.12	1227.88	503.79	-348.65	600.01	8857.80	8509.15
2019	6578.59	1196.90	517.82	-348.82	606.80	8900.12	8551.29
2020	6416.76	1288.35	551.87	-348.81	614.59	8871.57	8522.77
Change 1990–2020	61.35	77.56	15.44	14.37	55.18	59.09	61.68

3.2.4. Changes since the 7th National Communication

Since the publication of the 7NC, various updates and revisions to methodologies have been implemented in Cyprus' GHG inventory, which have impacted on the time-series of emissions. The 2017 GHG inventory was used in the 7NC. This means changes to the GHG inventory used in this Communication are a result of four GHG inventory updates.

Cross cutting changes that affect the GHG inventories since 7NC include:

- Implementation of the IPCC 2006 guidelines (moving from the 1996 GLs, the 2000 Good Practice Guidelines and the 2003 LULUCF Good Practice Guidance);
- Changes to the Global Warming Potentials that are used;

Because of these cross-cutting changes, direct comparisons of the changes in the magnitude of emissions between the 7NC and 8NC are not valid.

3.3. National system

3.3.1. Institutional arrangements

The Ministry of Agriculture, Rural Development and Environment (MARDE) is the governmental body responsible for the development and implementation of the majority of the environmental policy in Cyprus. The MARDE is responsible for the co-ordination of all involved ministries, as well as any relevant public or private organisation, in relation to the implementation of the provisions of the European legislation associated with climate change.

In this context, the MARDE has the overall responsibility for the national GHG inventory, and the official preparation and approval of the inventory prior to its submission. The Figure below provides an overview of the organisational structure of the National Inventory System. The entities participating are:

- The MARDE, designated as the national entity responsible for the national inventory, which keeps the overall responsibility, plays an active role in the inventory planning, preparation and management, and also compiles the annual inventory.
- Governmental ministries and agencies, and non-governmental organisations through their appointed focal persons, ensure the data provision.

At the time the 2022 GHG inventory report was prepared there was no legal framework available defining the roles-responsibilities and the co-operation between the MARDE and contact points of the involved ministries and agencies.

The legal framework defining the roles-responsibilities and the co-operation between the Inventory team at the Department of Environment and the designated contact points of the competent Ministries was formalized by Council of Ministers' Decision adopted 15/11/2017 entitled "Structure and operation of the National Greenhouse Gases Inventory System- Roles and Responsibilities". The above-mentioned Decision includes a description of each entity's responsibilities, concerning the inventory preparation, data providing or other relative information. This formal framework has improved the collaboration between the entities involved, assuring the timely collection and quality of the activity data required and solving data access restriction problems raised due to confidentiality issues.

3.3.2. Quality Assurance/Quality Control (QA/QC) Procedures

A QA/QC system is being implemented since the May 2007. The Ministry of Agriculture, Rural Development and Environment is responsible for the implementation of the QA/QC system. The system has the following objectives:

- Compliance with the IPCC guidelines and the UNFCCC reporting guidelines while estimating and reporting emissions/removals.
- Continuous improvement of GHG emissions/ removals estimates.
- Timely submission of necessary information in compliance with relevant requirements defined in international conventions, protocols and agreements

The accomplishment of the above-mentioned objectives can only be ensured by the implementation, from all the members of the Inventory Team, of the QA/QC procedures included in the plan for the following:

- Data collection and processing.
- Applying methods consistent with IPCC Good Practice Guidance and LULUCF Good Practice Guidance for calculating / recalculating emissions or removals.
- Making quantitative estimates of inventory uncertainty.
- Archiving information and record keeping.
- Compiling national inventory reports.

The QA/QC system developed covers the following processes:

- QA/QC system management: comprises of all activities that are necessary for the management and control of the inventory agency in order to ensure the accomplishment of the abovementioned quality objectives.
- Quality control: directly related to the estimation of emissions. The process includes activities related to (a) data inquiry, collection and documentation, (b) methodological choice in accordance with IPCC Good Practice Guidance, (c) quality control checks for data from secondary sources and (d) record keeping.
- Archiving inventory information: comprises of activities related to central archiving of inventory information and the compilation of the national inventory report.
- Quality assurance: comprises of activities related to the different levels of review processes including the review of input data from experts, if necessary, and comments from the public
- Estimation of uncertainties: defines procedures for estimating and documenting uncertainty estimates per source / sink category and for the whole inventory.
- Inventory improvement: related to the preparation and the justification of any recalculations made.

This QA/QC system was revised in 2017 after the adoption of the Council of Ministers' Decision (15/11/2017). Details on the QA/QC system implemented for the preparation of the 2017 GHG inventory submission are available in the 2017 inventory report, while information on the current QA/QC system is available in the 2018 submission to the European Commission for compliance with the (EU) 2018/1999 [14].

Further details on the QA/QC plan are available in the 2022 submission of the NIR.

3.3.3. The Inventory Methodology and Data

3.3.3.1. Emission factors

The estimation of GHG emissions / removals per source / sink category is predominately based on the methods described in the revised 2006 IPCC Guidelines. The emission factors used were derived from the 2006 IPCC Guidelines and special attention was paid in selecting the emission factors that are most representative of practices and conditions in Cyprus. Furthermore, emission factors were obtained from plant specific information contained in EU ETS reports. Due to data unavailability, for the estimation of the emissions of the sectors Refrigeration and Air Conditioning (2F1), Foam Blowing Agents (2F2), Fire Protection (2F3) and Metered Dose Inhalers (2F4a) the implied emission factors per capita from the average of Greece, Italy, Malta and Spain (NIR2015) have been used. For Use of Electrical Equipment (2G1) and N2O from Product Uses (2G3), the implied emission factor per capita from Greece was used. Details on the methods applied for the calculation of emissions / removals are given the chapters that follow.

The key categories analysis constitutes the basic tool for methodological choice and for the prioritisation of the necessary improvements. In addition, the results of the various review processes (at national and EU level) represent key input information for the identification of possible improvements. It should be mentioned however, that data availability as well as availability of resources (both human and financial) also have to be considered.

- Data availability could become a significant restrictive parameter when selecting an estimation methodology. The accuracy and the consistency of the emissions estimated depend on the availability of the data needed for the correct application of the selected methodology.
- Availability of resources needs also to be considered as the searching for and the collection of the necessary data in order to apply a detailed methodology for a source category should not affect the completeness and the on-time preparation of an inventory submission.

[14] Regulation Governance of the Energy Union and Climate Action (Gov. Reg.) and the related Implementing Regulation (EU) 2020/1208; available at http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0525&from=EN

3.3.3.2. Global warming potential

Emissions from anthropogenic activities affect the concentration and distribution of greenhouse gases in the atmosphere. These changes can potentially produce a radiative forcing of the Earth's surface and lower atmosphere, by changing either the reflection or absorption of solar radiation or the emissions and absorption of long-wave radiation. A simple measure of the relative radiative effects of the emissions of various greenhouse gases is the Global Warming Potential (GWP) index. This index is defined as the cumulative radiative forcing between the present and some chosen time-horizon caused by a unit mass of gas emitted now, expressed relative to that for some reference gas. The values for GWP for the greenhouse gases that are used in this inventory are according to Decision 24/CP.19[15] (Annex II).

Table 3.3. Direct Global Warming Potentials (mass basis) relative to carbon dioxide for the 100-year horizon

Gas	Chemical Compound	100-year Global Warming Potential
Carbon dioxide	CO_2	1
Methane	CH_4	25
Nitrous Oxide	N_2O	298
HFC-32	CH_2F_2	675
HFC-125	CHF_2CF_2	3500
HFC-134a	CH_2FCF_3	1430
HFC-143a	CF_3CH_3	4470
HFC-227ea	CF_3CHFCF_3	3220
HFC-245fa	$CH_2FCF_2CHF_2$	1030
HCF-365mfc	$CH_3CF_2CH_2CH_2CF_3$	794
Sulphur hexafluoride	SF_6	22800
Nitrogen trifluoride	NF_3	17200

3.3.3.3. Key categories assessment

The determination of the key categories for the Cyprus' inventory system is based on the application of the Tier 1 methodology (see Annex I for presentation of calculations) described in the IPCC Good Practice Guidance, adopting the categorization of sources that is presented in Table 7.1 of the IPCC Good Practice Guidance.

Tier 1 methodology for the identification of key categories assesses the impacts of various source categories on the level and the trend of the national emissions inventory. Key categories are those which, when summed together in descending order of magnitude, add up to over 95% of total emissions (level assessment) or the trend of the inventory in absolute terms.

In line with the specifications and options set out in the Kyoto Protocol and it´s follow up procedures, Cyprus identifies 1990 as its base year for carbon dioxide, methane and nitrous oxide and 1995 as its base year for hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride and nitrogen trifluoride.

The key categories for Cyprus' inventory system (without LULUCF) for the year 2020 are presented in Table 3.4.

Table 3.4. Key categories for Cyprus' inventory system with LULUCF for 2020

IPCC Source category	Direct GHG	Level	Trend
1A1a. Public electricity and heat production	CO_2	✓	✓
1A2e. Food processing, beverages and tobacco	CO_2	✓	✓
1A2f. Non-metallic minerals	CO_2	✓	✓
1A2g. Other (please specify)	CO_2	✓	✓
1A3a. Domestic aviation	CO_2		✓

[15] Decision 24/CP.19 Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention

IPCC Source category	Direct GHG	Level	Trend
1A3b. Road transportation	CO_2	✓	✓
1A3b. Road transportation	N_2O		✓
1A4a. Commercial/institutional	CO_2	✓	✓
1A4b. Residential	CO_2	✓	✓
1A4c. Agriculture/forestry/fishing	CO_2	✓	
2A1. Cement production	CO_2	✓	✓
2A4. Other process uses of carbonates	CO_2		✓
2F1. Refrigeration and air conditioning	HFCs	✓	✓
2F3. Fire protection	HFCs		✓
2G1. Electrical equipment	SF_6		✓
3A1a. Dairy cattle	CH_4	✓	✓
3A1b. Non-dairy cattle	CH_4	✓	✓
3A2. Sheep	CH_4	✓	✓
3A4b. Horses	CH_4		✓
3B3. Swine	CH_4		✓
3B5. Indirect N2O emission	N_2O		✓
3D. Agricultural soils	N_2O	✓	✓
4A1. Forest land remaining forest land	CO_2	✓	✓
4A2. Land converted to forest land	CO_2		✓
4B1. Cropland remaining cropland	CO_2	✓	✓
4C1. Grassland remaining grassland	CO_2	✓	✓
4E2. Land converted to settlements	CO_2		✓
4G. Harvested wood products	CO_2		✓
5A1. Managed waste disposal sites	CH_4	✓	✓
5A2. Unmanaged waste disposal sites	CH_4	✓	✓
5D1. Domestic wastewater	CH_4		✓

3.4. National registry

This section of the National Communication summarises the national registry of Cyprus. Further details can be found in Chapter 14 of the NIR.

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (26) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and Decision 24/CP.8.

According to the latest update we received from the ITL, the national registry of Cyprus is fully connected to the ITL. This update will be presented accordingly in the NIR2023.

4. Policies and measures

4.1. National Policies

4.1.1 Introduction

The majority of scholars today agree on the growing influence of the economy and society on the earth's climate through activities such as fossil fuel burning, rainforest deforestation and livestock farming. Recognizing the impact of human activities on the climate, the international community agreed at the Rio Summit in Rio de Janeiro in 1992 with the United Nations Framework Convention on Climate Change. Cyprus ratified the Convention in 1997. The objective of the Convention is to stabilize concentrations of greenhouse gases in the atmosphere at levels that prevent dangerous impacts on the climate from human activities.

In 1997 the Kyoto Protocol was adopted, which set legally binding greenhouse gas emission limit values for the period 2008–2012. Cyprus has ratified the Kyoto Protocol as a state without obligations to reduce or limit emissions. In 2012, at the Climate Change Summit held in Doha, Qatar, the second binding period of the Protocol (2013–2020) was agreed. As part of the EU's commitments (20% reduction in greenhouse gas emissions by 2020 compared to 1990), the Republic of Cyprus also assumed the national targets for a 21% reduction in greenhouse gas emissions by 2020 relative to 2020 with 2005 from electricity, cement and ceramics, and 5% in other sectors such as agriculture, transport, waste, etc., compared to 2005 levels.

Wanting to prepare for the post-2020 international negotiations, EU leaders agreed in October 2014 to reduce greenhouse gas emissions by at least 40% by 2030 compared to 1990. This target for Cyprus corresponds to a reduction of greenhouse gas emissions by 42% by 2030 compared to 2005 by electricity, cement and ceramics industries (ETS sectors), and 24% in other sectors such as agriculture, transport, waste, etc. (non-ETS sectors), compared to 2005 levels.

The culmination of the collective efforts that took place in recent years to reduce greenhouse gas emissions and hence to tackle climate change effectively by the global community is the historic agreement reached in Paris in December 2015 at the 21st Session of the Parties to the United Nations Framework Convention on Climate Change. The Paris Agreement entered into force on 4 November 2016. Cyprus completed the ratification process of the Paris Agreement on 4 January 2017. The effects of climate change are becoming increasingly felt both in Europe and globally. These are expected to be particularly serious for Cyprus, as climate change is already evident; over the last 100 years there has been an increase in average temperature and a decrease in average annual rainfall. The effects of climate change will not only continue but will also increase over the next decades.

In view of the above, Cyprus is faced with the challenge of developing its economy in a way that reduces greenhouse gas emissions, while taking appropriate measures and actions to adapt to climate change.

Climate change is a horizontal issue requiring the involvement and activation of almost all Ministries of Cyprus, including the Ministry of Agriculture, Rural Development and Environment, the Ministry of Energy, Trade, Industry and Tourism, the Ministry of Foreign Affairs, the Ministry of Transport, Communications and Works, the Ministry of Labour, Welfare and Social Insurance, the Energy Regulatory Authority and the Local Authorities. As a result, the role of the Environment Department of the Ministry of Agriculture, Rural Development and Environment as a national coordinator is upgraded and strengthened. Additionally, an important factor in the effort is the continuous improvement of the institutional framework.

Climate change mitigation is one of the main targets identified in the Cypriot strategy for sustainable development launched by MARDE in 2007[16]. The objective of the strategy is the development of a set

[16] http://www.un.org/esa/agenda21/natlinfo/countr/cyprus/nsds_2007en.pdf

of principles for the formulation of an action plan in line with international challenges, and in accordance with EU policy directions and adjusted to the specific national circumstances.

Strategic planning
In February 2014, the House of Parliament voted the Law on Fiscal Responsibility and Budget Systems (FRBSL) no. 20(I)/2014, which covers a wide range of issues related to Management of Public Finance. The goal was to introduce new principles for budgeting that strengthen the flexibility of economic operators and the transparency of the use of state resources, achieving measurable results. In this context, ministries have been asked to implement new procedures for the preparation of a medium-term strategy plan and budgeting on the basis of those activities to achieve their objectives.
The importance of climate change mitigation (and adaptation) for Cyprus is highlighted through its inclusion as the first target of the strategic plan of the Department of Environment and as one of the strategic goals of the Ministry of Agriculture, Rural Development and Environment[17].

National Policies and measures
Given that Cyprus was a non-Annex I party to the UNFCCC until 2013, national policies and measures for the reduction of greenhouse gas emissions were developed for the first time in 2007 for the implementation of EU Decision 280/2004[18]. Ever since, policies and measures are reviewed, revised and updated every 2 years. The involved ministries are presented in Table 4.1. The sections that follow present the policies and measures by sector.

Table 4.1. Involved ministries to climate change mitigation policies and measures

Ministry	Issues
Ministry of Agriculture, Rural Development and Environment	Agriculture Forestry Land use
Ministry of Energy, Trade, Industry and Tourism	Energy
Ministry of Transport, Communications and Works	Transport
Ministry of Finance	National budgets
Ministry of Interior	Land use

The National Energy and Climate Plan (NECP), which was recently adopted by Cyprus and submitted to the European Commission, constitutes a strategic plan for Cyprus on Climate and Energy issues and comprises a detailed roadmap for achieving concrete Energy and Climate Goals by 2030. The NECP presents and analyzes Policy priorities and Measures in a wide range of economic and development activities and constitutes a reference document for the next decade.

The strategic objective is the energy and climate goals set by the NECP until 2030 to make a decisive contribution to achieve a drastic reduction in greenhouse gas emissions while achieving the necessary energy transition in the most economically competitive way for the national economy.

4.1.2 Overview of Policy-making process

The Department of Environment (DoE), of the Ministry of Agriculture, Rural Development and Environment is the main governmental body entrusted with the development and implementation of environmental and climate policy in Cyprus. DoE is responsible, among others, for the formulation of policies concerning environmental protection and climate change, for the coordination of implementation efforts and to ensure compliance with the current EU and national legislative

[17] http://www.moa.gov.cy/moa/agriculture.nsf/Stratigikos%20Sxediasmos%202016-2018%20EL%20-%20YpOik%20150901.pdf
[18] Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol

framework. Other entities responsible for integrating climate policy within their respective fields are the following:

- Energy Service, Ministry of Energy, Commerce and Industry (fuels, RES, Energy efficiency)
- Department of Public Works, Ministry of Transport, Communication and Works (sustainable mobility)
- Department of Electromechanical Services, Ministry of Transport, Communication and Works (electro-mobility (alternative fuels) infrastructure)
- Department of Agriculture, Ministry of Agriculture, Rural Development and Environment (agricultural policy)
- Department of Forests, Ministry of Agriculture, Rural Development and Environment (forests policy)
- Department of Environment, Ministry of Agriculture, Rural Development and Environment (waste management, animal waste management)
- Local authorities

Policies and measures, as well as all other issues and actions regarding mitigation were discussed within the framework of an inter-ministerial committee, comprising representatives from all competent Ministries. Final approval of policies and measures related to climate change mitigation rested with the Council of Ministers.

In January 2020, MARDE and the Ministry of Energy, Commerce and Industry published Cyprus' National Energy and Climate Plan pursuant to article 3 of Regulation (EU) 2018/1999. The National Energy and Climate Plan (NECP) is Cyprus' government's strategic plan for climate and energy issues, setting out a detailed roadmap regarding the attainment of specific energy and climate objectives by 2030. The NECP stresses Cyprus' priorities and development potential in terms of energy and climate change issues, and aims to serve as the key tool for drawing up the national energy and climate policy in the next decade, taking into account the Commission's recommendations.

4.1.3 Legislative arrangements and administrative procedures for the implementation of climate change policies

In response to the emerging evidence that climate change could have a major global impact, the United Nations Framework Convention on Climate Change (henceforth the Convention) was adopted on 9 May 1992 and was opened for signature in Rio de Janeiro in June 1992.

Cyprus ratified the Convention as a non-Annex I Party in 1997 (Law No. 19(III)/97).

In that framework, the third meeting of the Conference of the Parties (COP) to the Convention, held in Kyoto (1-11 December 1997), finalised the negotiations related to the establishment of a legal instrument; the Kyoto Protocol on Climate Change. The Protocol provides a foundation upon which future action can be intensified and introduced, for the first time, legally binding commitments for developed countries to reduce emissions of greenhouse gases. Detailed rules for the implementation of the Protocol were set out at the 7th Conference of the Parties (in Marrakech) and are described in the Marrakech Accords adopted in 2001.

The Protocol entered into force on 16 February 2005, after its ratification from 141 Parties (with the exception of USA and Australia) including developed countries with a contribution of more than 55% to global CO2 emissions in 1990. Cyprus ratified the Kyoto Protocol in 2003 (Law 29(III)/2003).

With respect to the EU target under the 1st commitment period of the Kyoto Protocol (i.e. reduction of emissions at 8% for the period 2008–2012), the EU has stated that this will be achieved jointly by EU Member-States under the provisions of Article 4 of the Protocol. The Burden-Sharing agreement between all Member States was finalized during the Environment Council in June 1998 and entered into force with Decision 2002/358/EC concerning the approval, on behalf of the European Community, of the Kyoto Protocol. Cyprus was not a Member State of the EU at the time and therefore did not undertake any commitment at EU level.

In 2011 however, Cyprus requested to change its status under the UNFCCC and join Annex I, which was approved in 2012.

In Doha, Qatar, on 8 December 2012, the "Doha Amendment to the Kyoto Protocol" was adopted. The amendment includes:

- New commitments for Annex I Parties to the Kyoto Protocol who agreed to take on commitments in a second commitment period from 1 January 2013 to 31 December 2020;
- A revised list of greenhouse gases (GHG) to be reported on by Parties in the second commitment period; and
- Amendments to several articles of the Kyoto Protocol which specifically referenced issues pertaining to the first commitment period and which needed to be updated for the second commitment period.

Cyprus ratified the Doha Amendment in 2015 (Law 16(III)/2015).

The Paris Agreement which was agreed in 2015, builds upon the Convention and–for the first time–brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. As such, it charts a new course in the global climate effort. Its central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2^{o}C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5^{o}C.

Cyprus ratified the Paris Agreement in 2016 with Law 30(III)/2016.

The Paris Agreement requires all Parties to put forward their best efforts through “nationally determined contributions” (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts.

The EU and its Member States committed to a binding target of an at least 40% domestic reduction in greenhouse gas emissions by 2030 compared to 1990, to be fulfilled jointly, as set out in the conclusions by the European Council of October 2014.

As stated in chapters 3 and 4, the EU and its Member States committed to achieving a joint quantified economy-wide greenhouse gas emission reduction target of 20 per cent below the 1990 level by 2020, and has substantially overachieved this reduction target, rendering the emission reduction obligations fulfilled.

In December 2020, as part of the European Green Deal EU leaders agreed on a more ambitious goal for cutting greenhouse gases—reducing them by 55% by 2030, rather than 40% and the EU and its member states submitted an updated NDC to the UNFCCC secretariat.

The general framework for monitoring and evaluation of policies and measures till 2020 was based on the Monitoring Mechanism Regulation of the EU (MMR, no. 525/2013). This Regulation aims in the improvement of the quality of the data reported and assist the EU and Member States with the tracking of their progress towards emission targets for 2013 - 2020.

The MMR was replaced by the Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action for the period 2021–2030. Regulation (EU) 2018/1999 contains provisions about the tracking of the progress accomplished towards reaching mitigation targets, including specific templates for the monitoring and evaluation of policies and measures, the reporting of GHG projections, projection parameters and indicators, etc. In addition, it contains provisions for progress reports about the status of integrated national energy and climate plans, national adaptation actions, financial and technology support provided to developing countries, energy security, energy market, energy poverty, research, innovation and competitiveness; and about the monitoring and evaluation of policies and respective targets on renewable energy and energy efficiency.

The formulation of climate policy in Cyprus follows EU policy. A key step towards the formulation and implementation of any EU policy is to carry out an Impact Assessment of the proposed policy or key

policy changes. The Impact Assessment outlines a process that prepares evidence for political decision-makers on the advantages and disadvantages of possible policy options. The Impact Assessment is carried out by the Directorate General who takes the lead on a particular policy. The Impact Assessment process is an important element of implementing the EU's commitments under Article 4.2(e) (ii) of the UNFCCC to "identify and periodically review its own policies and practices which encourage activities that lead to greater levels of anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol than would otherwise occur".

Information about policies and measures for the reduction of GHG emissions, GHG inventory and projections, legislative arrangements and enforcement and administrative procedures that are in place to meet the national commitments under the Kyoto Protocol are publicly accessible through the following websites:

- www.moa.gov.cy/environment (official website of the Department of Environment, containing information about national GHG inventories, legislation, emission trading system, national allocation plans, etc., available in greek language)
- www.meci.gov.cy (official website of Ministry of Energy, Commerce and Industry, containing information about national strategy and policies about energy, renewable energy sources, biofuels, etc., available in greek language).
- https://unfccc.int/ghg-inventories-annex-i-parties/2020 (UNFCCC website, containing GHG inventories); https://unfccc.int/NC7 (UNFCCC website, containing latest national communications)
- Information provided through EU's websites as http://cdr.eionet.europa.eu/cy/eu and http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=475.

4.1.4 A description of the national system for reporting on policies and measures and for reporting on projections pursuant to Article 13(1a) of Regulation (EU) 525/2013

For the purposes of implementing the Regulation on the Governance of the Energy Union and Climate Action (No. 2018/1999) and in particular to set out the necessary foundation for a reliable, inclusive, cost-efficient, transparent and predictable Governance that ensures the achievement of the 2030 and long-term objectives and targets of the Energy Union in line with the 2015 Paris Agreement on climate change following the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change through complementary, coherent, and ambitious efforts by the Union and its Member States, while limiting administrative complexity, a new structure for national climate and energy governance has been approved by the Council of Ministers (15/11/2017 decision no. 83.709).

The core of this structure (Figure 4.1), the "National Governance System for Climate and Energy", is a Ministerial Committee, consisting of the Minister of Agriculture, Rural Development and Environment, the Minister of Energy, Commerce and Industry, the Minister of Finance and the Minister of Transport, Communications and Works. The Ministerial Committee is co-chaired by the Minister of Agriculture, Rural Development and Environment and the Minister of Energy, Commerce and Industry. This committee has to propose the National Energy and Climate Plan to the Council of Ministers which takes the final decision. The proposal of the NECP is prepared by the Technical Committee, which consists of the Permanent Secretaries of the same Ministries. The Technical Committee also monitors the implementation of the NECP and makes proposals for its revisions when necessary. The Technical Committee is co-chaired by the Permanent Secretary of the Ministry of Agriculture, Rural Development and Environment and the Permanent Secretary of the Ministry of Energy, Commerce and Industry. The Technical Committee is consulted by the following seven Expert Working Groups: Decarbonisation, Energy Efficiency, Energy Security, Internal Energy Market, Research, Innovation and Competitiveness, Renewable Energy and Transport. Transport is an additional working group created due to the significant contribution of the sector to the national emissions. Each Working Group has a coordinator. All working groups with the exception of decarbonisation are the responsibility of the Ministry of Energy, Commerce and Industry; Decarbonisation is the responsibility of the Department of Environment of the Ministry of Agriculture, Rural Development and Environment. The secretariat of the National Governance System for Climate and Energy is held by the Department of Environment.

This structure evolved after the publication of the Green Deal, to the National Governance System for Development Strategy in relation to the European Green Agreement, with a Council of Ministers' Decision (13/11/2020 no. 90.370) The new governance system incorporated in its structure in addition to the climate and energy issues, all the organisations involved in the implementation of the issues included in the green deal. The new structure is presented in Figure 4.2. All the working groups associated with climate and energy continue the same manner of operation as presented above.

4.1.5 Legal arrangements in place for preparation of reports on policies and measures and of projections

No legal arrangements in place for preparation of reports on policies and measures and of projections other than the Council of Ministers Decisions no. 83.709 of 15/11/2017 and no. 90.370 of 13/11/2020.

4.1.6 Procedural and administrative arrangements and timescales in place for the preparation of reports on policies and measures and of projections, to ensure the timeliness, transparency, accuracy, consistency, comparability and completeness of the information reported

The Department of Environment of the Ministry of the Agriculture, Rural Development and Environment is responsible for ensuring the timeliness of the Reporting. No later than six months before the deadline of the Reporting, a kick-off meeting between the decarbonisation working group members is organized to launch the work. A date is set by which the decarbonisation working group members provide a list of their respective policies and measures to be included in the Reporting, along with a distinction between the WEM (With Existing Measures) and WAM (With Additional Measures) scenarios. The Department of Environment then checks the lists to ensure completeness and that there are no overlaps.

Two to three months before the deadline of the Reporting, the decarbonisation working group members provide their respective information concerning the policies and measures and projections to the Department of Environment, which compiles all the information into the reporting tools and a single paper report. This schedule leaves enough time to perform the remaining QA/QC activities. The Reporting is prepared in a transparent manner. The Reporting is based on the latest version of National Energy and Climate Plan. Key assumptions and policy measures are described and published in a background report to the projections. Furthermore, the Reporting uses publicly available data to a large extent. Not all data can be published, however, due to being confidentially reported by companies. Out of the assumptions, methods and models used by expert organizations in evaluating policies and measures or used in making the projections, many are publicly available or have been described in public sources.

Accuracy is ensured through several measures. First, all the expert organizations providing information are to as large an extent as possible, and most of the methods and models have been used before in national and international reporting. Third, projections follow the greenhouse gas source and sink categorization recommended by the European Commission on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and revised UNFCCC CRF tables for inventory reporting; Fourth, effect on mitigation of climate change as well as costs and benefits are assessed for such individual or groups of policies and measures that the assessments can be done in an accurate manner giving practical information, taking into account the reasonable amount of work and available data. Furthermore, the QA/QC procedures are strictly followed.

Consistency and comparability are ensured through several measures. The Reporting is based on the National Climate and Energy Plan and its scenarios. At an early stage of preparing the PaMs (Policies and Measures), a common framework is determined for the baseline scenario. The framework is determined in a collaborative manner between the ministries mentioned in previous sections and it is approved by the ministerial committee of the national energy and climate governance system. The framework comprises several parameters related to economic growth, population growth, international climate policy, and price of energy. The framework also includes assumptions on the future use of different sources of energy and waste treatment. All ministries use the common framework while contributing to the Plan and its baseline scenario. Furthermore, under the

coordination of Department of Environment, interrelated assumptions are discussed and decided between the relevant ministries and government agencies. These procedures ensure the consistency and comparability of the assumptions and results between the different sectors in the Strategy.

Common parameters provided by the European Commission for the Reporting are used whenever applicable. As the Reporting also strongly relies on the latest version of the National Energy and Climate Plan, the above-mentioned PaMs making process improves the consistency and comparability of the information used in the Reporting. In the case that the Reporting requires extending or updating assumptions affecting several sectors, the decarbonisation working group members agree on these together. Sector-specific assumptions that are not available in the above-mentioned sources are selected based on the expertise of the decarbonisation working group members or the expert organizations and rely on other relevant strategies, plans and research reports as much as possible. To classify policies and measures under the WEM and WAM projections, a cut-off date is agreed by the decarbonisation working group. Across the different sectors, the reported policies and measures that are implemented on or before the cut-off date belong to the WEM projection and those implemented after the cut-off date or being in planning phase to the WAM projection.

The Department of Environment then checks the lists to ensure completeness and that there are no overlaps. Furthermore, the projections follow the greenhouse gas source and sink categorization recommended by the European Commission on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and revised UNFCCC CRF tables for inventory reporting).

4.1.7 Description of the links to arrangements on integrated national energy and climate reports pursuant to Art. 17 of Regulation (EU) 2018/1999

To collect data related to policies and measures and projections, the structure prepared for the preparation of the NECP and reporting on progress other dimensions of the Energy Union, e.g. processes to foster consistent use of energy-related data for the development of policies and measures and projections and for integrated progress reporting are applied.

4.1.8 Description of the process for selecting assumptions, methodologies and models for making projections of anthropogenic greenhouse gas emissions

Sectoral experts from the Department of Environment and other key agencies are responsible for selecting the assumptions, methods and models to use for the projections. The Department of Environment experts work closely and interact regularly with other key experts on energy, agriculture, industrial processes, forestry and land use change and waste modelling in order to establish an appropriate set of assumptions and methods. The experts document the data sources, methods and assumptions. Improvement opportunities are regularly identified and documented which includes input from external experts. The Department of Environment manages a list of improvements which is reviewed and prioritised on a regular basis for implementation. Changes to processes are documented in the methodology report.

4.1.9 Description of procedures for the official consideration and approval of the Member States national system for policies and measures and projections

All the involved institutions participating to the decarbonisation technical committee of the national governance system for climate and energy have nominated an expert for every reporting preparation period whose responsibility is to provide the necessary data for the report. Institutional experts take part in the quality assessment process and give the final approval concerning the information in the reporting tools and final report to be submitted.

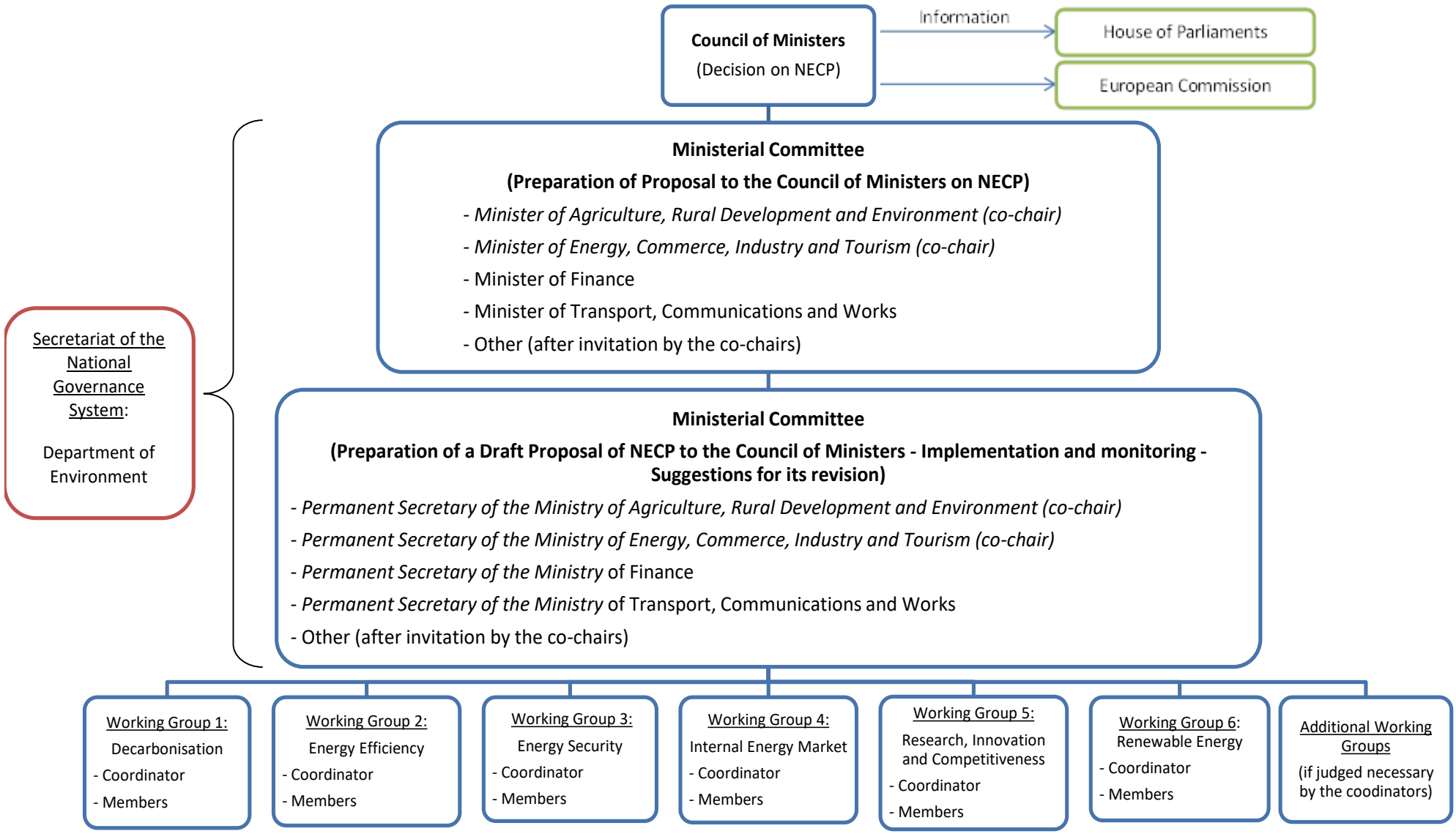

Figure 4.1. Structure of the national governance system for Climate and Energy

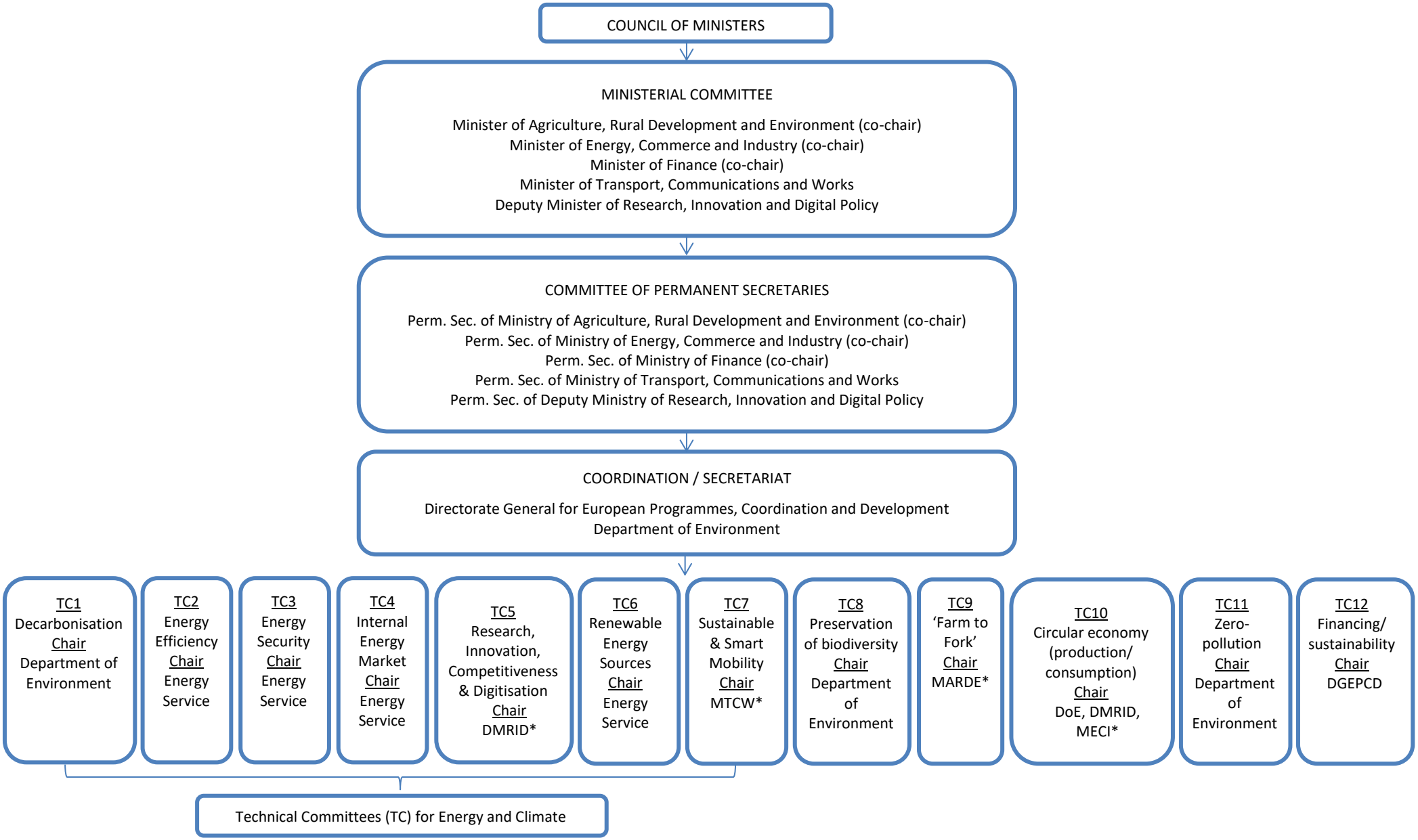

Figure 4.2. Structure of the National Governance System for Development Strategy in relation to the European Green Agreement

4.1.10 Information on relevant institutional administrative and procedural arrangements for domestic implementation of the EU's nationally determined contribution, or changes to such arrangements

The domestic implementation of the EU's nationally determined contribution is monitored through regular meetings of the Decarbonisation Working group of the national governance system. Issues, such as budgets, proposals to EU funds are discussed along with different practical issues that may come up during the implementation of the measures.

4.1.11 Description of the stakeholder engagement undertaken in relation to the preparation of policies and measures and projections

All the relevant stakeholders are kept informed through participation in the meetings of the relevant working group of the governance system that will contribute later to the decarbonisation working group.

4.1.12 Information pursuant to article 37(2)(b) of IR (EU) 2020/1208

According to article 37(2)(b) of IR (EU) 2020/1208, Member States shall report information on planned additional national policies and measures, or groups of measures, envisaged with a view to limiting GHG emissions beyond their commitments under Regulation (EU) 2018/842 and Regulation (EU) 2018/841.

At the moment there are no policies and measures that have been adopted or planned that are envisaged with a view to limiting GHG emissions beyond national commitments under Regulation (EU) 2018/842 and Regulation (EU) 2018/841.

4.1.13 National Long-Term Low GHG Development Strategy

The Long-Term Low Greenhouse Gas emission (GHG) Development Strategy for 2050 is a Roadmap for the Republic of Cyprus on Climate and Energy, as part of the country's participation in the collective European goal of a successful and sustainable transition to a climate-neutral economy by 2050.

The Long-term strategy for Cyprus is not yet available to the public. The strategic goal is to participate in the commitment towards a climate-neutral economy at EU level and to contribute to the European Green Deal promoted by the European Commission.

With the completion of the elaboration and adoption of the National Energy and Climate Plan (NECP), which analyses the energy and climate goals set by the country as well as the Policy Priorities and the measures for their implementation, the Government is also investigating the optimal policies and measures towards the year 2050 for the achievement of specific climate goals in order to determine the framework for the long-term climate strategy of the country for the year 2050.

Adopting and participating in the European Commission's strategic long-term vision for a prosperous, modern, competitive and climate-neutral economy by 2050, the Government aligns itself with the Climate Neutrality Strategy, planning the implementation of innovative but realistic technology applications, funding and research, while ensuring social justice in the context of a fair transition.

It is clear that the long-term strategy is complementary to the NECP, which is the central strategic plan under which specific energy and climate policy measures are implemented. In this context, the long-term strategy presupposes the achievement of the relevant objectives of the NECP.

The 2030–2040 decade should be a decade of choosing the appropriate technological solutions for adoption that are mature at the time, but also of continuing successful policies and measures that will contribute to achieving the goals of 2050, with even greater intensity and rate of implementation. New energy technologies or even fuels that will be available on competitive market terms are, in any case, a technical condition for the period after 2030, which will ultimately determine the relative rates of transition to 2050. The goal is to achieve climate neutrality mainly through further exploitation of existing policies, deployment of new technologies and utilisation of local and international progress on Research & Technology.

4.2. Sectoral Policies and Measures

4.2.1 Sectoral policies and measures: Energy

The emissions of the energy sector excluding transport increased from 2,641 Gg CO_2 eq. in 1990 to 4,143 Gg CO_2 eq. in 2020, corresponding to a 57% increase. As it accounts for the largest portion of emissions, the energy sector must contribute the most to the reduction of greenhouse gases of Cyprus. The import of natural gas, and its initial use for electricity production, is expected to contribute considerable reductions of emissions.

Cyprus is the southernmost region of the European Union at the crossroads of three continents, with a dominant position in the Mediterranean and South East. In general Cyprus presents the energy problems common to most islands:

(a) Isolated energy system.
(b) High rates of economic and social development involving high rates of growth in energy demand.
(c) High cost of energy supply.
(d) High dependence on petroleum products - small supply security.
(e) Seasonal variations in energy demand.
(f) Maximum operation of the system of production and distribution of electricity in peak load demand.
(g) Strict limitations of protection and promotion of the island environment that act as a disincentive to develop initiatives in energy investments.

Since its independence in 1960, Cyprus has relied on oil for all of its energy related needs: electricity generation, transport, and heating and cooling. In the absence of any domestic oil production, there has been high vulnerability to fluctuating oil prices. There was widespread use of solar water heaters for several decades throughout the island, with additional renewable energy technologies for electricity generation implemented in recent years. By the end of 2020 renewable energy corresponded to roughly 12.9% of supply[19].

The traditional system of electricity generation has dominated for over the past 40 years and has been based on monopolised ownership of a few, large, centralised and inflexible generation plants. Even though it has served well historically, recent years have increasingly exposed its vulnerability, be it from the risk of consequences of generation incidents, be it from the emergence of rather high swing load during the day and year due to the lack of base consumption and the high tertiary activity during the day in summer months, or be it simply to volatility to global oil price fluctuations.

A key challenge for Cyprus is therefore its high dependency on fossil fuels for energy. In 2020, Cyprus imported 93% of its gross available energy[20], as compared to the EU import average of 57.5%[21]. Behind Malta, this is the highest imported share in the EU, which makes it crucial for the country to develop both its hydrocarbon and renewable energy sources. Cyprus is reliant on fossil fuel imports for its electricity needs, and spends over 8% of its GDP to cover the costs[22]. Final consumption in 2020 amounted to approximately 79.9 PJ, with 97.4% of the consumption coming from liquid fuels, 0.7% from solid fuels and 1.8% from biomass. In comparison with 1990, total fuel consumption in 2020 (including biomass) increased by 41%[23].

[19] Cyprus Energy Balance, 2020.
[20] Cyprus Energy Balance, 2020.
[21] "EU Energy mix and import dependency," Eurostat, 04 March 2022, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=EU_energy_mix_and_import_dependency.
[22] "The Green Transition," CyprusProfile, December 2021, https://www.cyprusprofile.com/sectors/energy-renewables.
[23] "Cyprus 2022 National Inventory Report (NIR)." Department of Environment, Ministry of Agriculture, Rural Development and Environment, 06 Apr 2022.

Gross inland consumption in 2020 is also significantly higher as compared to 1990, with an increase from 1618.36 ktoe to 2285.77[24]. Although this consumption is relatively low compared to other EU-countries, Cyprus had the fourth highest greenhouse gas emissions per capita in 2019 and 2020[25]. Renewables and other measures to decrease fossil fuel reliance and the resultant high per capita emissions are thus of prominent interest for Cyprus.

In 2020 the Renewable Energy Sources (RES) share in gross final consumption of energy in Cyprus was 16.9%[26], exceeding the national mandatory target of 13% RES in 2020, as set in the Directive 2009/28/EC[27]. According to preliminary data the share of RES in 2020 rose to 17.08%. This share comes from the use of solar water heaters, the installation of PV systems, wind parks, biomass/ biogas units and biofuels for transport sector, in combination with the use of heat pumps and biomass use for heating.

Additionally, RES accounted for 10.16% of electricity production in 2019[28]. RES power production rose 15.5% in 2019, compared to 2018, mainly due to an increase 23.41 % in the electricity production from photovoltaic systems. However, wind farms generated almost 43.9% of electricity from RES in 2019.

In Cyprus, electricity from renewable sources is no longer promoted through feed-in-tariff schemes since 2015, given that as of 2013 a net metering, net-billing and self-consumption scheme has been put in place. Moreover, in the period 2018–2019, two schemes operated regarding the installation or RES units mainly PV parks that will participate in the competitive electricity market.

Access of electricity from renewable energy sources to the grid shall be granted according to the principle of non-discrimination. Grid development is a matter of central planning (Transmission Grid Development Plan 2021-2030 by the Cyprus TSO). In addition, renewable heating and cooling (RES H&C) is promoted by support schemes offering subsidies to households for the installation of solar thermal systems.

However, the country's national grid system has certain intrinsic and technical limitations affecting RES penetration, and reliability of the energy system. The lack of electricity interconnections to the trans-European electricity networks, limits the amount of intermittent renewable energy that can be connected to the electricity system, and the lack of natural gas interconnections does not allow the supply of Cyprus with electricity produced from natural gas, a fuel that significantly contributes to the reduction of greenhouse gas emissions. In addition, there is a lack of centralised storage capability.

To tackle these problems the country is exploring ways to introduce smart grids in the national network and is on the look-out for projects that could facilitate energy storage, and ventures that have production on a 24-hour basis. Also, the EuroAsia Interconnector could bring more solutions in its wake.

The island is already one of the highest users per capita in the world of solar water heaters in households, with over 90% of households equipped with solar water heaters and over 50% of hotels using large systems of this kind. With almost year-round sunshine, Cyprus certainly has plenty of energy to harness, but competitive energy storing capabilities are crucial in order to fully tap into its solar potential and facilitate better RES penetration.

There continues to be much ground to cover in terms of renewable energy production, but international interest in developing the sector in Cyprus has been on the rise. In this respect, the production of

[24] Cyprus Energy Balance, 2020.
[25] "Greenhouse Gas Emissions per Capita." Compiling Agency: Eurostat, 11 July 2022, https://ec.europa.eu/eurostat/databrowser/bookmark/a599cac8-3bc9-424c-86e3-8b03366e71fc?lang=en. Accessed 27 Oct. 2022. Online data code: T2020_RD300. Source of data: European Environment Agency (EEA).
[26] Cyprus Energy Balance, 2020.
[27] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance), OJ L 140, 5.6.2009, p. 16–62
[28] "Cyprus 2022 National Inventory Report (NIR)." Department of Environment, Ministry of Agriculture, Rural Development and Environment, 06 Apr 2022.

renewable energy is expected to experience considerable growth in coming years, and significant investment is required in order for Cyprus to achieve its targets–opening the field for companies with expertise in renewables.

The Cyprus Energy Regulatory Authority (CERA) has worked towards the full opening of the electricity market and enabling the consumers in exercising their right to choose their own supplier – with expectations of a full liberalisation by Q4 2022. CERA has approved the Trade and Settlement Rules which are based on a 'net pool' model. In addition, CERA has issued Regulatory Decisions with respect to the functional and accounting unbundling of the vertically integrated Electricity Authority of Cyprus.

In respect to the supply of natural gas to Cyprus, on 22/6/2016 the Council of Ministers decided to approve the import of Liquefied Natural Gas (LNG) to Cyprus. For the purpose of implementing the Decision, the Cyprus Natural Gas Company (DEFA) was mandated to carry out a study which concluded that the preferred LNG supply option project is through the use of a floating infrastructure with the development of the necessary mooring facilities and pipeline connection to the natural gas receiving point at Vassilikos.

On the basis of the results of the study the Council of Ministers, on May 18th 2017 decided to mandate DEFA to issue, as soon as possible, an invitation for tenders regarding the long-term supply of LNG to Cyprus to satisfy electricity requirements and an invitation for tenders for the construction and operation of the necessary infrastructure. In parallel to the above mentioned, DEFA was also mandated to proceed with the FEED study for the internal natural gas pipeline network.

On 13 of December 2019, the tender for the construction, operation and maintenance of the infrastructure was awarded by ETYFA (DEFA subsidiary) to the joint venture China Petroleum Pipeline Engineering, Metron, Hudong-Zhongua Shipbuilding and Wilhelmsen Ship Management. On 28th September 2020 ETYFA approved the revised work program for the project. This is also the official start date of the construction works. The project is expected to be completed by H1 2023.

With respect to the supply of natural gas, on 4 June 2019, through a pre-qualification - Request for Expressions of Interest (RfEoI) process, DEFA invited prospective LNG suppliers to express an interest in supplying LNG to the LNG Import Terminal in order to be added to DEFA's list of pre-qualified LNG suppliers. DEFA intends to procure its LNG requirements through a combination of: (a) medium and long-term supply via one or more LNG Sales and Purchase Agreements (SPAs); and (b) supplemental cargos via multiple Master Sales Agreements (MSAs) and a bidding process. The deadline for submission of EoI was the 6 September 2019, and 25 companies submitted their interest. This first stage of the above tender procedure was completed successfully in 21 December 2020. DEFA is expected to proceed to the next stage of the process in Q1 2022, with the negotiation and execution of MSAs and with an RfP for the selection of the medium-term contract supplier of LNG.

Cyprus is promoting the project of common interest «EuroAsia Interconnector», an electricity interconnection which is aiming to start commissioning in Q4 2025, and the electricity interconnection between Cyprus, Egypt and Greece, following the trilateral MOU that has been signed in October 2021. In addition, the promotion of the project of common interest «EastMed Pipeline», an offshore/onshore natural gas pipeline connecting East Mediterranean resources to Greece via Cyprus and Crete is aiming to start commissioning in Q4 2025. These projects will effectively contribute to the internal energy market integration, security of energy supply by enhancing diversification of sources and routes and reduction of GHG emissions by allowing the countries in the region to use natural gas deposits and increase the RES electricity production, in the case of EuroAsia Interconnector.

After robust growth rates in the 1980s (average annual growth was 6.1%), economic performance in the 1990s was mixed: real GDP growth was 9.7% in 1992, 1.7% in 1993, 6.0% in 1994, 6.0% in 1995, 1.9% in 1996 and 2.3% in 1997. This pattern underlined the economy's vulnerability to swings in tourist arrivals (i.e., to economic and political conditions in Cyprus, Western Europe, and the Middle East) and the need to diversify the economy. Declining competitiveness in tourism and especially in manufacturing acted as a drag on growth prior to actualization of structural changes. This greatly affected the energy sector.

The emissions from the energy sector in Cyprus increased by 61.3% during the period 1990–2020. The greatest increase in emissions was between 1990 and 2008 (97%), when the emissions reached their peak (7874 Gg CO_2 eq.). All the emissions in 2020 are from fuel combustion. The contribution of the emissions from the energy sector to the total without LULUCF in 2020 was 75.3% compared to 74.0% in 1990.

While energy is mainly responsible for carbon dioxide emissions, it also contributes to methane and nitrous oxide emissions. Fugitive emissions from fuels have not been estimated since 2004 when the refining activities stopped in Cyprus.

The competent authority in relation to energy policies is the Energy Service of the Ministry of Energy, Commerce, Industry and Tourism.

4.2.1.1 Introduction and use of Natural gas in the internal market for electricity production (PaM 5)

The Government of Cyprus, recognizing the positive contribution that the introduction and use of natural gas will have on the economy and the environment of Cyprus, is considering the introduction of natural gas initially for use for electricity generation. It is however expected that after its arrival, natural gas will also be used in other sectors of the economy (commercial, industrial and transport).

In the view of the fact that the interim solution tender process was terminated by DEFA without conclusion with a gas supply agreement, the Ministry of Energy, Commerce, Industry and Tourism, in collaboration with the Cyprus Energy Regulatory Authority (CERA), are examining all available options for the introduction of LNG in Cyprus as soon as possible and complementary to the supply of natural gas from indigenous reserves.

By importing natural gas, apart from the reduction of emissions from the actual use of the natural gas, there would also be a positive contribution to emission reductions through the increased efficiency of the newer technologies used.

The development of natural gas market in Cyprus will be based on the provisions of the relevant EU Directives including the making use of relevant derogations provided in the Directive 2009/73/EC concerning isolated and emergent markets.

Box 4.1. Key information

Competent authority
Energy Service, Ministry of Energy, Commerce, Industry and Tourism

Other involved authorities
- Cyprus Energy Regulatory Authority
- Public Natural Gas Company (DEFA)
- Electricity Authority of Cyprus
- Department of Environment

Type
Political, legislative

National legislation
- Κ.Δ.Π. 115/2006
- Ν. 183(Ι)/2004 as amended

Measures towards attainment
- Introduction and use of natural gas for electricity production
- Installation of combined cycle electricity production units using natural gas as fuel
- Decommissioning or conversion of existing electricity production units

4.2.1.2. Promotion of Renewable energy sources (PaMs 1, 2)

The energy policy of Cyprus is harmonized with the European Union goal of promoting the use of energy from renewable sources, as a major step towards the reduction of global warming and climate change phenomena[29].

The EU RES Directive[30] sets out specific national targets to be achieved by each individual Member State, regarding the share of RES generated in each Member State by the year 2020. For Cyprus, the national target states that the share of energy produced from RES were to be at least 13% out of the gross national final consumption of energy in 2020. According to preliminary data the share of RES in 2020 rose to 17.08%, an exceedance of the targets.

The main types of RES technologies promoted under these measures for integration in the Cyprus power system are solar energy, wind energy and biomass. Cyprus ranks first in the world in solar energy use for water heating in households, and has achieved significant progress in the production of energy from Renewable Energy Sources (RES).

Currently there is no policy related to RES for the period after 2020.

The most important projects relating to power generation from RES concern wind parks and photovoltaic (PV) parks, concentrated solar thermal plants and biomass and biogas utilisation plants.

Measures are separated into two key categories: Renewable energy sources in electricity production and renewable energy sources for heating and cooling.

4.2.1.2.1. Renewable energy sources in electricity production

The consumption of fossil fuels by energy industries in 2020 (39.4 PJ) increased by 40.1% compared to 1990 (23.3 PJ)[31]. Since 2005, when the refinery stopped its operations, the emissions from energy industries are entirely caused by the production of electricity (1A1a). Emissions from energy industries accounted for 35.6% of total national emissions without LULUCF for 2020, while in 1990 the contribution was 30.3%. The total GHG emissions from energy industries in 2020 (3.0 Tg CO2 eq.) increased by 71.6% compared to 1990 (1.8 Tg CO2 eq). During the period 2009–2013, a decreasing trend of emissions was observed, attributed to the penetration of renewable energy technologies to the energy mix, and to the economic recession that the country is facing since 2010. The trend changes in 2014 to an increasing trend with an annual average of 4%. All units producing electricity in Cyprus for public use running on conventional fuels are operated by the Electricity Authority of Cyprus. The main fuel used for the generation of electricity is HFO, followed gas oil. The renewable energy share in final demand amounted to 14.4% in 2020. Electricity production is regulated by the Emissions Trading System.

Box 4.2. Key information

Competent authority
Energy Service, Ministry of Energy, Commerce, Industry and Tourism
Other involved authorities
- Cyprus Energy Regulatory Authority
- Transmission System Operator
- Ministry of Finance
- Department of Town Planning and Housing, Ministry of Interior
- Department of Environment, Ministry of Agriculture, Natural Resources and Environment

Type

[29] http://www.investcyprus.org.cy/en/growth-sectors/cyprus-investment-sectors/energy-sector
[30] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance), OJ L 140, 5.6.2009, p. 16–62
[31] "Cyprus 2022 National Inventory Report (NIR)." Department of Environment, Ministry of Agriculture, Rural Development and Environment, 06 Apr 2022.

Legislative, voluntary

National legislation

- Law No. 112(I)/2013 on the promotion and encouragement of the use of renewable energy sources which has repealed the old one (N.33(I)/2013)
- Law 110(I)/2011 establishing a European emissions trading system and other relevant issues

Relevant EU legislation

- Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market (Directive 2001/77/EC is repealed by Directive 2009/28/EC from 1 January 2012. Moreover, from 1 April 2010, Article 2, paragraph 2 of Article 3 and Articles 4 to 8 will be deleted)
- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC
- Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community

Measures towards attainment

- RES support schemes
- Informational campaigns
- Implementation of relevant legislation

4.2.1.2.2. Renewable energy sources for heating and cooling

According to the latest NECP, the renewable energy share target for heating and cooling was set at 23.5%. RES in heating and cooling in 2020 was 34.2%[32]. Heating and cooling emissions for industrial, housing and tertiary sectors, contributed 7% to the emissions of the energy sector in 2020, and 5% to the total emissions of the country (excluding LULUCF)[33].

The main technologies being traditionally used in Cyprus for heating and cooling are oil-burning central heating and air-conditioning split units. The low operating cost based on cheap oil prices in the past, and clean and effective heating, provided practical advantages, far outweighing the implementation cost in the long-run. A declining trend of wood-burning biomass for home heating was observed in the recent years through 2018[34].

The measures promoted are predominately associated with the promotion of solar thermal, biomass and geothermal energy.

Box 4.3. Key information

Competent authority

Energy Service, Ministry of Energy, Commerce, Industry and Tourism

Other involved authorities

- Department of Town Planning and Housing, Ministry of Interior
- Department of Environment, Ministry of Agriculture, Natural Resources and Environment
- Department of Labour Inspection, Ministry of Labour and Social Insurance

Type

Legislative, voluntary

National legislation

- Law No. 112(I)/2013 on the promotion and encouragement of the use of renewable energy sources, which has repealed the old one (N.33(I)/2013)
- Law No. 142(I)/2006 regulating energy efficiency in buildings
- Law No. 30(I)/2009 amending Law No. 142(I)/2006 regulating energy efficiency in buildings

[32] Cyprus Energy Balance, 2020.

[33] "Cyprus 2022 National Inventory Report (NIR)." Department of Environment, Ministry of Agriculture, Rural Development and Environment, 06 Apr 2022.

[34] Cyprus' Integrated National Energy and Climate Plan, version 1.1. Nicosia January 2020. Pg. 167.

- Law No. 56(I)/2003 on Integrated Pollution Prevention Control (with amending laws no. 15(I)/2006, 12(I)/2008)

Relevant EU legislation

- Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market (Directive 2001/77/EC is repealed by Directive 2009/28/EC from 1 January 2012. Moreover, from 1 April 2010, Article 2, paragraph 2 of Article 3 and Articles 4 to 8 will be deleted)
- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC
- Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community
- Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control and related amendments

Measures towards attainment

- RES support schemes
- Informational campaigns
- Implementation of relevant legislation

4.2.1.2.3. Promotion of energy efficiency (PaMs 3, 4)

Because of its national peculiarities, which make it a small and isolated system (an island country) without any interconnections to European or other energy networks (electricity, petroleum, natural gas) at present, Cyprus attaches great importance to energy efficiency aiming, inter alia, to improve energy supply security, increase competitiveness and ensure sustainable development/environmental protection.

Measures under the Energy Efficiency Directive (Directive 2012/27/EU) and the Energy Performance of Buildings Directive (Directive 2010/31/EU) are described in the 4th National Communication.

For the EU 2030 energy efficiency targets, Cyprus set a 17% reduction in primary reduction and a 13% reduction in final energy consumption, relative to the 2007 EU PRIMES Reference Scenario[35]. These figures come from the latest NECP, wherein policies and measures for improvement of energy efficiency were created while considering the "Energy Efficiency First Principle." Please refer to the latest NECP for further details on the impacts of this principle.

4.2.1.2.4. Energy efficiency in industry (existing companies)

A Grant Scheme for encouraging the use of Renewable Energy Sources and Energy Saving for Natural and Legal Persons as well as for Public Sector Bodies engaged in an economic activity, was in place up until the end of 2013. The investments covered by the Grant Scheme fall into two subcategories. NA - Energy Saving (SA) and NB - Renewable Energy Sources (RES).

According to the provisions of the 2013 NEEAP, energy-savings investment means an investment in systems, equipment and materials whose installation achieves at least 10% energy savings in a specific application. Eligible expenses also included the design costs, where necessary, under the restrictions set out in the relevant application documents for the different categories and subcategories of the Scheme.

Category NA1 of the grant scheme applied only to existing undertakings operating in Cyprus for at least four (4) years. Financial aid was granted to energy investments in existing holdings of the undertakings in question, under the condition that the building licence was issued by 28 December 2008. There were five (5) subcategories of investments as follows:

[35] Cyprus' Integrated National Energy and Climate Plan, version 1.1. Nicosia January 2020. pg. 68

1. Purchase/installation of new equipment for the recovery of waste energy, either directly or indirectly by recovery/recycling of discarded materials, product or employed medium.
2. Purchase/integration of new materials and equipment to reduce idle energy consumption and energy losses.
3. Purchase of new equipment for the production, transmission, distribution and use of energy.
4. Purchase/installation of a new energy management IT system and/or integration of automated direct energy regulation/switch-off devices.
5. Replacement of existing materials and/or equipment connected with the subcategories 1 to 4.

Training seminars on energy management are held on an annual basis, in cooperation with the Human Resources Development Authority of Cyprus (HRDA), the Productivity Centre and the Energy Institute. Four (4) seminars were held in 2013 in Nicosia, Limassol, Larnaca and Paphos, with a duration of 60 hours each. The seminars were addressed to unemployed engineers of all specialties and focused, inter alia, on issues related to energy saving and energy efficiency improvement technologies/systems, ways of operation, selection of an appropriate system and applications in Cyprus (industry, hotels, services, etc.). In addition, examples for drawing up a technical-financial study for the installation of energy-saving systems and other examples of studies under ES Grant Schemes were presented.

Furthermore, information days were held in Nicosia, Limassol and Paphos addressed mainly to engineers who are members of the Cyprus Scientific and Technical Chamber (ETEK), the Cyprus Employers and Industrialists Federation (OEB), the Cyprus Chamber of Commerce and Industry (KEBE), hotel owners, entrepreneurs, credit institutions, municipalities and communities, contractors and the general public. Information days focused on energy audits, the energy efficiency of buildings, energy labelling, energy-saving and RES technologies used for heating and cooling purposes.

In recent years, the Cyprus Employers and Industrialists Federation (OEB) holds an annual fair on energy saving, in cooperation with the EAC and the Energy Department. Printed information material on the different energy-saving technologies is distributed at the fairs. In addition, information is provided to the general public with regard to the provisions of the grant schemes. The most efficient energy-saving investments made by natural or legal persons under the grant scheme of the Special Fund ES are rewarded at the 'Save Energy' fair.

In 2013, the Energy Service has approved training institutes to carry out training programmes for candidate Category A and B energy auditors. Category A relates to all buildings regardless of their surface and air conditioning system and includes, inter alia, ports, airports and street lighting. Category B relates to industrial facilities, as well as agricultural activities and installations. The first category B energy auditors have been entered in the relevant registry within 2014. The first energy auditors have been included in the registry of Category A energy auditors in 2013.

In addition, Cyprus' NEEP establishes, as a measure to achieve the target under Article 7, co-financing for conducting energy audits in industries and for the implementation of the energy-saving investments proposed by the energy audit. The measure will concern approximately 10 industries per year.

These measures are expected to be renewed within the following years in view of the new EU obligations for 2030.

A 2017 study noted that there was still a theoretical maximum saving potential of 34% for electricity and 5% for oil and gas for the industry sector[36].

Box 4.4. Important information

Competent authority
Energy Service, Ministry of Energy, Commerce, Industry and Tourism
Other involved authorities
Department of Environment
Type

[36] "An energy efficiency strategy for Cyprus up to 2020, 2030 and 2050," GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit), July 2017. Pg. 2.

Legislative, compulsory
National legislation
Law No. 31/2009 on energy end-use efficiency and energy services
Relevant EU legislation
- Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.
- Decision 406/209/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

Measures towards attainment
Grant scheme for energy conservation

4.2.1.2.5. Residential buildings

According to Article 4 of Directive 2012/27/EU on energy efficiency, Member States shall establish a long-term strategy for mobilising investments in the renovation of their national stock of buildings.

In Cyprus, it is estimated that houses account for 19% of final energy consumption, whereas another 13% corresponds to commerce, hotels and services, i.e., mainly office buildings[37]. The different political, economic and social conditions over the years did not allow for the implementation of energy-saving measures during the construction of buildings. The first organised attempt to implement energy-saving measures in buildings was made in 2004 through the grant schemes of the Special Fund for RES and ES, whereas the implementation of compulsory measures in new buildings and large buildings undergoing major renovation started in 2007 with the adoption of the 2007 Decree on the 'Regulation of the Energy Efficiency of Buildings (Minimum Energy Efficiency Requirements)'. Therefore, there is currently an energy-intensive building stock, which has negative consequences for the economy and the environment. In addition, the lack of sufficient thermal insulation measures and the excessive exposure to sunlight observed in many buildings are harmful to the health of citizens, reduce the productivity of workers and diminish the quality of life. Major building renovations offer an opportunity to resolve many of these issues.

Dwellings are the majority of Cyprus' building stock, as 431 059 dwellings have been recorded (2014). However, 78 088 houses are used as weekend or tourist residences, which means that they are used less and, therefore, they consume less energy. In addition, 54 651 homes are empty.

Most dwellings of Cyprus' current building stock have been constructed in the period 2001-2008, followed by the 1980's and the 1990's, which reflect the periods of increased construction activity. In the case of 91% of dwellings, there was no obligation to apply thermal insulation or any other energy-saving measures at the time they were built. Therefore, the energy status of most buildings may be characterised from poor to average, given that, as a rule, building owners did not take any measures during the building's construction, whereas some home owners have taken energy-saving measures at a subsequent stage, mainly under grant schemes of the Special Fund for RES and ES. According to the available statistics, 49% of dwellings have not taken any energy efficiency measures, whereas only 12% have applied some sort of thermal insulation at the building's envelope. The situation is better in the case of window frames, where over 38% have double-glazing.

The main energy product used in the residential sector is electricity coming from the grid, as it is responsible for almost half the final energy consumption, followed by fuel oil and LPG, which are the most important energy products after electricity. In 2020 solar energy accounted for almost 18%, whereas other renewable energy sources, such as PV systems, geothermal heat pumps and biomass have a smaller contribution. The highest primary energy consumption rates are due to air conditioning and heating. Solar thermal systems for domestic hot water production have an increased penetration in the residential sector as they are installed in 91% of dwellings.

[37] Energy Service, 2014, Strategy for encouraging investments in the renovation of buildings Under Article 4 of Directive 2012/27/EU on energy efficiency; Annex F of 3rd National Energy Efficiency Action Plan (NEEAP) of Cyprus available at https://ec.europa.eu/energy/sites/ener/files/documents/CuprusArt42014.pdf

The measures implemented in the residential sector taken into consideration are the following:

- Residential new buildings
- Residential buildings energy upgrade
- Residential solar panels replacement

The policies and measures that will stimulate investments in the renovation of existing buildings may be divided into: legislative measures and policies, incentives, training measures and awareness raising measures. Details on the measures implemented are available in Strategy for encouraging investments in the renovation of buildings Under Article 4 of Directive 2012/27/EU on energy efficiency (2014)[38].

Box 4.5. Key information

Competent authority
Energy Service, Ministry of Energy, Commerce, Industry and Tourism
Other involved authorities
- Ministry of Interior
- Municipalities
- Department of Environment

Type
Legislative, compulsory
National legislation
Law No. 142 (I)/2006 regulating energy efficiency of buildings and amending Laws N. 30(I)2009, N. 210 (I)2012, N. 15 (I)2017
Relevant EU legislation
Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings
Decision 406/209/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020
Measures towards attainment
- Implementation of national action plan on energy efficiency
- Implementation of national legislation

4.2.1.2.6. Non-residential buildings

Non-residential buildings include various types of buildings, the most important of which are offices, retail shops, restaurants, hotels and hospitals. There are no statistics on this building category. However, in 2012 the Electricity Authority of Cyprus (EAC) had 85,198 commercial customers, i.e., buildings and building units owned by enterprises and organisations. Table 4.4 provides an analysis of EAC's commercial customers per category of use, which reflects to a great extent the relevant number of buildings and building units per type.

Table 4.2. Electricity consumers per category

Type of consumer	Number of consumers
Wholesale and retail sale, repair of vehicles	24,788
Accommodation premises and establishments serving food	10,097
Public administration and defense	1,671
Education	2,454
Human health and social work activities	2,143
Culture, entertainment and recreation	2,907
Other services	41,138

The vast majority of customers under category 'other services' represent buildings and building units used as offices, which rank first in terms of number followed by retail shops. Despite the fact that there

[38] Energy Service, 2014, Strategy for encouraging investments in the renovation of buildings Under Article 4 of Directive 2012/27/EU on energy efficiency; Annex F of 3rd National Energy Efficiency Action Plan (NEEAP) of Cyprus available at https://ec.europa.eu/energy/sites/ener/files/documents/CuprusArt42014.pdf

are no statistics on the age of these buildings, it may be assumed that they have a distribution over time which is similar to the one of dwellings, as commercial and other buildings had the same peak period as dwellings. Both in the case of dwellings and other buildings, there was no obligation to apply thermal insulation or any other energy-saving measures at the time they were built. Approaches to envelope construction were the same for all building categories.

The sector of non-residential buildings uses two-thirds of total final consumption of electricity from the grid. The use of RES is reduced as compared to households, with solar energy showing the highest penetration. In some building types, such as hotels, where 50% uses solar energy for hot water production, there is an increased penetration of RES, as compared to the average penetration in buildings of the tertiary sector. One- to five-star hotels in Cyprus number 224, of which 20 are located in mountainous regions.

The measures implemented in the non-residential (tertiary) sector taken into consideration are the following:

- Tertiary new buildings
- Tertiary buildings energy upgrade

The policies and measures that will stimulate investments in the renovation of existing buildings may be divided into: legislative measures and policies, incentives, training measures and awareness raising measures. Details on the measures implemented are available in Strategy for encouraging investments in the renovation of buildings Under Article 4 of Directive 2012/27/EU on energy efficiency (2014)[39].

Box 4.6. Key information

Competent authority
Energy Service, Ministry of Energy, Commerce, Industry and Tourism
Other involved authorities
- Ministry of Interior
- Municipalities
- Department of Environment

Type
Legislative, compulsory
National legislation
Law No. 142 (I)/2006 regulating energy efficiency of buildings and amending Laws N. 30(I)2009, N. 210 (I)2012, N. 15 (I)2017
Relevant EU legislation
Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010
on the energy performance of buildings
Decision 406/209/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020
Measures towards attainment
- Implementation of national action plan on energy efficiency
- Implementation of national legislation

4.2.1.2.7. Public buildings

The term "public buildings", means buildings used by:

- Central government authorities such as Ministries, the Police and the General Prosecutor's Office;
- Local Administration, such as Municipalities and Communities
- Public schools, public universities and other public educational institutions;

[39] Energy Service, 2014, Strategy for encouraging investments in the renovation of buildings Under Article 4 of Directive 2012/27/EU on energy efficiency; Annex F of 3rd National Energy Efficiency Action Plan (NEEAP) of Cyprus available at https://ec.europa.eu/energy/sites/ener/files/documents /CuprusArt42014.pdf

- The military.

Central governmental authorities means all administrative services whose competence extends to the whole territory of the Republic of Cyprus, which are laid down in Annex IV to the 2006 Coordination of the Public Procurement, Works and Services Contracting Procedures and Relevant Matters Act. These authorities use 1,066 buildings and building units of which only 572 are property of the public sector. As a rule, they use only electricity to cover their energy needs.

In the areas under the effective control of the Republic of Cyprus, Local Administration consists of 30 Municipalities and 350 Communities. Most Municipalities and large communities have only one building, used for administrative purposes and events. However, large Municipalities own more buildings which are being used to serve the public, as well as other building types, such as libraries and sports centres.

In Cyprus there are 833 public schools of primary and secondary education. The Technical Department of the Ministry of Education and Culture is responsible for the implementation of projects related to the construction of new school units and the maintenance and extension of already existing ones. Regarding public universities, the University of Cyprus, which is the largest public university, owns most of the buildings that have been constructed in recent years within the Campus. The Technological University of Cyprus uses mainly historical buildings and leased buildings in the historical center of Limassol, whereas the Open University of Cyprus uses a building in Nicosia. Public universities have technical departments which are responsible for the maintenance and the smooth operation of their building infrastructures.

The period 2021–2030 will apply the same approach as dictated by Article 5 of Directive 2012/27/EU, namely that Member States should annually renovate 3% of the total area of buildings owned and used by central government authorities, or engage in an alternative approach that achieves equivalent energy savings[40].

Box 4.6. Key information

Competent authority
Energy Service, Ministry of Energy, Commerce, Industry and Tourism
Other involved authorities
-
Type
Legislative, Compulsory
National legislation
Law No. 142 (I)/2006 regulating energy efficiency of buildings and amending Laws N. 30(I)2009, N. 210 (I)2012, N. 15 (I)2017
Relevant EU legislation
Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings
Measures towards attainment
-

4.2.1.3 Promotion of biomass and alternative fuels in industry

Cement is considered one of the most important building materials around the world. Cement production is an energy-intensive process consuming considerable amounts of thermal energy. Globally, historically, the primary fuel used in cement industry is coal[41]. A wide range of other fuels such as gas, oil, liquid waste materials, solid waste materials and petroleum coke have all been successfully used as sources of energy for firing cement-making kilns, either on their own or in various combinations. In Cyprus the predominant fuel used in cement production is pet-coke, while biomass and the non-

[40] Cyprus' Integrated National Energy and Climate Plan, version 1.1. Nicosia January 2020. Pg. 78.
[41] Chinyama, 2011, Alternative Fuels in Cement Manufacturing, available at https://www.intechopen.com/books/alternative-fuel/alternative-fuels-in-cement-manufacturing

biomass fraction of waste are also used. Cement production continues to dominate the emissions from mineral products, accounting for 97.8% of this category in 2020[42].

The new cement producing installation in Cyprus installed in 2011 has the capability of using considerable amounts of alternative fuels and biomass. This advantage should be exploited by encouraging the installation to use non-conventional fuels.

Non-renewable waste is consumed by only one cement-producing installation, which has been submitting an annual emissions report since 2005, in accordance with the requirements of the ETS law 110(I)2011. In the industrial waste category, we report the non-biomass fraction of biomass incinerated; i.e., sewage sludge, tires, ASF, MBM and compost. The waste is incinerated for production of thermal energy in the furnace which burns the raw material to produce the cement. In 2020, 289 TJ of non-renewable industrial waste and 1168 TJ of non-renewable municipal waste were incinerated. Municipal waste incinerated increased from 24 TJ in 2012, which was the first year of use of this source. Industrial waste incineration increased from 18 TJ in 2001.

4.2.2 Sectoral policies and measures: Transport

The 2020 road transport emissions contributed 22% of the total national emissions, and 24% of 2019 total national emissions, excluding LULUCF. The emissions of road transport in 2020 increased by 58% compared to 1990, while the 2019 emissions increased by 77% from 1990. The lower number from 2020 is attributed to the lockdowns and movements in restriction brought about by the COVID-19 pandemic, as detailed in Table 3.14 of the 2022 NIR. The substantial increase of GHG emissions from road transport since 1990 is directly linked to the increase of the vehicle fleet and the increase of transportation activity. Cyprus is heavily reliant on passenger car transport, and had the fifth highest number of cars per capita in the EU-27 in 2020[43].

In addition to the importance for emissions, transport has been an issue of particularly great interest to the society of Cyprus, due to the very large growth of the number of privately owned cars and the associated problems in traffic that are experienced, especially in the capital, Nicosia. Even though many studies have been completed since the 1990s on how to deal with traffic in the urban areas of Cyprus and especially Nicosia, it was not until about a decade ago that action was initiated and measures implemented.

The energy intensity in the transport sector is among the highest in the EU, mainly due to the large percentage of road transport operations. However, there has been a remarkable improvement in this sector in recent years. The increase in the energy efficiency of private vehicles and the import of smaller and more efficient cars have led to better results although public transport in Cyprus are not adequately developed. The transport sector, along with the electricity generation and building sectors, is one of those sectors that offer a significant potential for energy efficiency improvement.

According to the 2013 (Amending) Law on Motor Vehicles and Road Traffic, which entered into force on 1 January 2014, the annual circulation tax for each category M1 motor vehicle and the annual circulation tax for each category N1 motor vehicle, resulting from a category M1 motor vehicle and classified under the category of light lorry (VAN type), is calculated on the basis of the carbon dioxide emissions of the vehicle's engine. In addition, as from 1 January 2014, category N2 and N3 vehicles (lorries) and M2 and M3 vehicles (buses) are registered in so far as they have been proven to comply with the 'EURO VI' requirements on the emission of pollutants.

The launch of the 4th Old Vehicle Scrapping and Replacement Scheme was announced on 11 October 2010, whereas the scheme was implemented in 2011. Applications were admitted for a period of 2 months with final date on 13 December 2010. The 4th Scheme related to the payment of a grant equal

[42] "Cyprus 2022 National Inventory Report (NIR)." Department of Environment, Ministry of Agriculture, Rural Development and Environment, 06 Apr 2022.
[43] "Table 2: Passenger cars, 2015-2020". Passenger Cars in the EU, Eurostat, 05 Aug. 2022, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Passenger_cars_in_the_EU.

to EUR 1 800 and covered the scrapping of M1 category motor vehicles, older than 15 years old, under the condition that a new car with CO2 mass emissions lower or equal to 165gr/km would be purchased.

The new public transportation system was put in force in the second half of 2010. The new public transportation bodies replaced part of their vehicles with new ones that have low fuel consumption and pollutant emissions, as compared to the old vehicles that were replaced. Provincial urban companies have re-organised their routes, aiming to optimise their efficiency in this sector. Their websites contain a detailed map of the routes and the timetable of buses in order to facilitate passengers.

Before the end of 2011, the widening of the motorway linking the Alambra and the GSP intersections (entry to Nicosia) from four to six circulation lanes was completed. Works started on 11 January 2010 against the amount of EUR 32.4 million + VAT and were co-financed by the Trans-European Transport Networks Fund.

In the context of the implementation of EU Regulation (EC) No 1222/2009 on the labelling of tyres with respect to fuel efficiency and other essential parameters, delegated inspectors of the Energy Department perform market surveillance checks in order to identify cases of noncompliance with these provisions. In addition, presentations on energy savings in the transport sector and on eco-driving are made in the context of the seminars addressed to unemployed engineers of all specialisations organised by the Energy Department and the Productivity Centre, with the support of the Human Resources Development Authority of Cyprus.

The municipalities of Nicosia have founded the Inter-municipal Bicycle Company of Nicosia (DEPL), aiming to change the way things work on Cypriot roads via an automated 3rd generation bike rental system. The installation of this innovative system will be combined with the design of new bicycle lanes, which will be used by a large part of the population and by tourists to commute from and to the city centre. In particular, the Nicosia Municipality has installed 100 bicycles in 5 stations, the Aglantzia Municipality, 50 bicycles in 4 stations, the Strovolos Municipality, 80 bicycles in 8 stations, the Dali Municipality, 20 bicycles in 3 stations, the Aghios Dometios Municipality, 20 bicycles in 2 stations, the Latsia Municipality, 15 bicycles in 2 stations and the Engomi Municipality, 30 bicycles in 3 stations. There is one single system for all municipalities that participate in the programme, whereas each user can take a bicycle from the station of one municipality and return it to the station of another municipality. The programme aims to promote the use of bicycles among citizens as an alternative means of transport in the city.

Furthermore, a Grant Scheme for energy saving in the transport sector (purchase of hybrid vehicles, electric vehicles and low-pollutant vehicles), was in force in the period 2004-2009.

The European Directive 2014/94 / EU on the Development of Rural Renewables Infrastructures establishes a common framework for measures to develop the market for alternative fuels in the transport sector and the implementation of relevant infrastructure within the Union in order to minimize dependence on liquid minerals to reduce the environmental impact in the transport sector. Within the framework of the directive, which sets practical goals, the development of the market and related infrastructure for the use of electricity, liquefied natural gas (LNG), compressed natural gas (CNG) and hydrogen in transport is specifically promoted. Directive 2014/94 / EC is a tool to meet the mandatory 2020 target for road transport, i.e. (a) 10% energy from RES in transport (Directive 2009/28 / EC) and b) 6 % reduction in greenhouse gas emission intensity in the life cycle of road transport fuels (Directive 2009/30/EC) the competent authority is the Ministry of Energy, Trade, Industry and Tourism. A National Policy Framework describing national targets and targets, guidelines, support actions and policies for the development of alternative fuels and developing the necessary infrastructures was prepared by the Ministry of Transport, Communications and Works in cooperation with the Ministry of Energy, Commerce, Industry and Tourism.

Charging points and infrastructures for electric vehicles have been installed in public buildings and in public roads, whereas installation costs in private buildings, single-family houses and undertakings will be subsidised under specific criteria and specifications. There are currently 20 charging stations in Cyprus: 7 charging stations in Nicosia, 6 in Limassol, 2 in Larnaca, 2 in Ammochostos and 3 in Paphos.

The Department of Electromechanical Services is undertaking installation of 10 fast charging stations[44]. Although the numbers are still very small, the expectation is that the registration of electric cars will increase considerably, so that they comprise the majority of on-road vehicles by 2030[45].

The installation of LPG systems in vehicles has also started in 2017 and will reduce the emission of pollutants and fuel consumption in old vehicles.

For the reduction of emissions from road transport the competent authorities are considering the implementation in the immediate future of further measures in the fields of Traffic demand management, Improvement of road traffic flow, Reduction in transport demand, Switch in transport modes and Alternative fuels and technologies.

The continuation and further development of measures such as the above and additional measures such as improvement of infrastructure for further encouragement of use of public transport, cycling and walking and financial incentives to encourage new vehicles with low to zero emissions and discourage vehicles with high emissions, can reduce the emissions of one of the most important sectors in Cyprus with respect to mitigation.

Biofuels

Biofuels are liquid or gaseous transport fuels such as biodiesel and bioethanol which are made from biomass. They serve as a renewable alternative to fossil fuels in the EU's transport sector, helping to reduce greenhouse gas emissions and improve the EU's security of supply. The EU aimed to have 10% of the transport fuel of every EU country come from renewable sources such as biofuels by 2020. GIZ GmbH conducted a study, 'Penetration of alternative fuels in Cyprus road and maritime sectors,' to analyse this goal for Cyprus[46]. Among the conclusions was that the 10% target was neither cost-effective nor easily feasible for Cyprus, but the overall target was met in a more cost-effective manner with greater contribution from other sectors. While the share of 2nd biofuels was 2.58% for 2020, this is projected to increase over the next two decades.

Box 4.7. Key information

Competent authority
Energy Service, Ministry of Energy, Commerce, Industry and Tourism
Other involved authorities
-
Type
Legislative, Compulsory

National legislation
Law N. 112 (I)/2013 – 2015(transposition of EU Directive 2009/28/EC)
Relevant EU legislation
Directive 2009/28/EC of the European Parliament and the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC
Measures towards attainment
-

4.2.3. Sectoral policies and measures: Industry (PaM 6)

The New EU F-gas Regulation adopted in 2014 and applied from 1 January 2015, aims among others in preventing emissions of F-gases from existing equipment by requiring leakage checks, proper serving and recovery of the gases at the end of the equipment's life. For the full implementation of this

[44] Cyprus' Integrated National Energy and Climate Plan, version 1.1. Nicosia January 2020. pg. 116
[45] Cyprus' Integrated National Energy and Climate Plan, version 1.1. Nicosia January 2020. pg. 116
[46] "Penetration of alternative fuels in Cyprus road and maritime sectors," Deutsche Gesellschaft für Internationale Zusammenarbeit, June 2017.

regulation in Cyprus a proper recovery system needs to be setup and used in Cyprus. Given the high GWP of the F-gases, and their increasing contribution to the national emissions, it is considered crucial for proper recovery to be implemented within the following years.

Under provisions of Art. 9 of Regulation 517/2014/EC, on fluorinated greenhouse gases, without prejudice to existing Union legislation, Member States shall encourage the development of producer responsibility schemes for the recovery of fluorinated greenhouse gases and their recycling, reclamation or destruction. Cyprus has adopted and harmonized the above Regulation into Cypriot Law 62(I)/2016 and 46(I)/2017. The next step is to forward a national Law regarding a producer's responsibility scheme. The main provision of this Law will follow the "polluter pays" principle and each producer will have to participate in an appropriate scheme for management of f-gases that have been recovered for any reason.

At the same time, under the provisions of the same scheme, certified technicians will be encouraged to return to the scheme any fluorinated gases the have recovered, for a pre-decided profit.

Box 4.8. Key information

Competent authority
Department of Environment, Ministry of Agriculture, Rural Development and Environment
Other involved authorities
-
Type
Legislative, compulsory
National legislation
Fluorinated greenhouse gases Law (No. 62(I)/2016 and 46(I)/2017)
Relevant EU legislation
Regulation on fluorinated greenhouse gases 517/2014
Measures towards attainment
- Implementation of "polluter pays" principle; each producer will have to participate in an appropriate scheme for management of f-gases that have been recovered

4.2.4. Sectoral policies and measures: Agriculture (PaMs 7, 8)

Anaerobic digestion technology may help to address two congressional concerns that have some measure of interdependence: development of clean energy sources and reduction of greenhouse gas emissions. Anaerobic digestion, as a way of converting biomass to energy, has been practiced for hundreds of years. It is a technology that helps to reduce waste, generate energy and cut down on carbon emissions. The general performance of anaerobic digesters and the diversity of wastes which they can treat have been increasing steadily as a result of new reactor design, operating conditions, or the use of specialised microbial consortia, during the last decades.

Most small-scale pig farms in Cyprus use mechanical separation for the treatment of their waste. The separated liquid is sent to evaporation lagoons or is used for irrigation, and the solid fraction is used as soil improver. Nine large pig farms have installed a combination of anaerobic/aerobic treatment plants (Anaerobic digestion). The treated liquid fraction is used for irrigation, washing the housing areas or is placed in evaporation lagoons. The produced biogas is combusted onsite by Combined Heat Power generators for the production of heat and electricity. Both heat and electricity are consumed at the farms. Any excess electricity is sold to the electricity provider and directed to the electricity distribution network. Heat is not distributed outside the farm because there is no heat distribution network in Cyprus. The emissions from the electrical energy from the biogas used onsite and offsite has been taken into account in the energy sector according to the national energy balance. In the 2022 NIR, anaerobic digestion was calculated at 60% of waste management for 2020.

Anaerobic digestion is also practiced at cattle farms, calculated at a percentage of 5.0% in the NIR in 2020. The waste from sheep, goats, horses, mules and asses are collected and left to dry before being applied on land for soil improver (Solid storage and dry lot). Poultry waste is characterised by high

content of solids (almost dry) and it is collected, left to dry and then used as soil improver (Solid storage and dry lot).

Manure management is responsible for methane and nitrous oxide emissions. Methane is produced during the anaerobic decomposition of manure, while nitrous oxide is produced during the storage and treatment of manure before its use as fertilizer. Emissions from manure management in 2020 accounted for 24.1% of the total agriculture emissions without LULUCF. CH_4 and N_2O from manure management in 2020 accounted for 17.2% and 37.1% of GHG emissions from Agriculture respectively. Total emissions in 2020 decreased by 13% compared to 1990 levels because of the improvement of waste management practices. All available studies show that there is a great potential in Cyprus to further promote anaerobic digestion for the treatment of waste with high organic content.

Even though anaerobic digestion is not clearly stated in the European or national legislation, the technology is preferred by large animal farms to comply with the terms stated on the wastewater and air emissions permits. The technology is strongly promoted by the Department of Environment, especially for the large installations that fall under the Industrial Emissions directive. Relevant national legislation that encourages the promotion of anaerobic digestion is (a) the Control of Water Pollution (Waste Water Disposal) Regulations 2003, Κ.Δ.Π. 772/2003; (b) the Control of Water Pollution (Sensitive Areas for urban waste water discharges) Κ.Δ.Π. 111/2004. It is a voluntary measure which is expected to increase. Therefore, it is considered important to further promote the use of anaerobic digestion for the treatment of animal waste.

4.2.5. Sectoral policies and measures: Waste (PaMs 9, 10)

Emissions from the Waste Sector in 2020 contributed 7% of the total emissions without LULUCF, 61% to the total methane emissions of the country without LULUCF and 7% to the total N_2O emissions without LULUCF. In 2020, 87% of the waste sector emissions are from solid waste disposal, 2% from biological treatment of solid waste and 11% from waste water treatment and discharge. The emissions from waste have changed considerably between 1990 and 2020 due to changes that are taking place in the waste and wastewater management practices of the country. For example, the emissions from Wastewater treatment and discharge between 1990 and 2020 decreased 44%, mainly due to the shift from septic tanks to centralised aerobic treatment systems for the treatment of domestic wastewater. Recycling and composting have been reducing the amount of waste disposal on land since 2010. Due to its dominance, the greatest emphasis of the policies and measures in the waste sector is reduction of emissions from solid waste disposal. A brief description of the situation of Cyprus' landfill follows, with full details on the trends in the waste sectors are available in the 2022 NIR.

A comprehensive study was undertaken in 2005 for the elaboration of a Strategic Plan, an Environmental study and a Feasibility study for the restoration and management of landfills. The purpose of the study was to record all landfills, assess their status and level of risk, create a restoration priority list based on pollution risk assessments, and undertake the appropriate environmental studies as well as feasibility studies for the restoration of the prioritized landfills. These studies were a necessary step for the restoration of all landfills recorded.

Two (2) landfills are still active in Cyprus but arrangements have been made in order for them to be closed and restored. According to recent data, these two landfills are fed with approximately 155,000 tonnes and 200,000 tonnes of municipality waste each year, respectively (reference year 2012).

Sixty-two (62) non sanitary landfills are planned to be restored appropriately within the following years. According to the preliminary study contacted in 2005, these landfills contain approximately 597,269 m^3 of solid waste, excluding 2 major landfills that have not been closed yet.

Fifty-three (53) landfills have been restored the last five years and are being monitored. During their restoration a total of 4,902,000 m^3 of solid waste were reallocated and properly buried using composite liners and leakage collection systems.

The EU landfill directive is fully harmonized in the national legislation but not fully implemented. Cyprus didn't manage to seize the operation of non-compliant landfills by 2009. Also, Cyprus has rehabilitated only 46% of its closed landfills.

With the EU Landfill Directive being the main guiding force, in combination to the improvement of the infrastructure of the country, Cyprus has developed and implementing during the recent years the revised strategy for municipal solid waste management. The implementation of the strategy is the responsibility of the Department of Environment.

The National Municipal Waste Management Plan of 2015-2021 (MWMP) contained quantitative and qualitative targets and enumerated specific measures and actions to be taken in order for the EU targets to be reached. One of the quantitative targets was that no more than 95,000 tonnes of biodegradable waste to be disposed in landfills (represents the 35% target of the 1999/31/EC directive). Also, the Legal Measures focused on the:

- Development of local waste prevention and management schemes
- Mandatory obligation for establishing separate collection systems by local authorities,
- Establishment of extended producer responsibility (EPR) in streams other than packaging waste,
- Establishment of a landfill tax/levy,
- Banning the disposal of certain waste streams from entering into landfills (e.g., green waste, high calorific value waste, etc.)

The adaptations of the strategy that were envisaged:

a) One Sanitary Landfill and one Residual Sanitary Landfill (supplementing MBT unit at Koshi) were constructed and operated (both meet the requirements of directive 99/31/EC). The MBT unit was constructed and operated from 01/04/2010 serving Larnaca - Ammochostos districts. The Plant was designed in a way that a high separation of recycled and biodegradable material is achieved. Another I.W.M.P (Integrated Waste Management Plant) serving Limassol district is expected to be operated by the year 2018.
b) The construction of the Green Point Network (22 collection points for the depositing of various waste streams out of households – bulky waste, green, textile, furniture, WEEE, etc.) is competed. The 4 Green Points, serving Paphos district are operated and the rest expected to be operated by 2018.
c) Separate collection at source was promoted at households, from the existing collective system for the packing waste serving also and all types of paper, created under the packaging directive while the competent authority promotes the separate collection from other household streams such as other organic waste e.g. food and green waste.
d) The construction works for the rehabilitation/restoration of the old non approved landfills, which are closed at Paphos and Larnaca - Ammochostos districts, were completed. The preparation of studies/documents regarding the rehabilitation/ restoration of the 20 non sanitary landfills of Nicosia district and the 44 sanitary landfills of Limassol district will be completed within 2018 and after that the construction works will begin.

The National Municipal Waste Management Plan of 2015–2021 (MWMP) has been updated with the new National Municipal Waste Manage Plan of 2022–2028. The latest plan includes further measures, actions and procedures to enable Cyprus' transition to a zero-waste economy. It contains quantitative and qualitative targets and enumerates specific measures and actions to be taken in order for the EU targets to be reached. One of the quantitative targets is that no more than 95,000 tonnes of biodegradable waste to be disposed in landfills (represents the 35% target of the 1999/31/EC directive). The measures accounted for the impacts from tourism, financial projections, separate collection and assumptions, limitations on the capacity of available infrastructure, and utilization/enhancement of existing infrastructure. The responsible authorities for the implementation of the SDDA are listed below, according to how they are detailed in the plan itself[47].

- The Environment Department of the Ministry of Agriculture, Rural Development and Environment acts as the competent authority for waste management.

[47]Ministry of Agriculture, Rural Development and Environment. Municipal Waste Management Plan 2022–2028. Pg. 7.

- The Department of Water Development, of the Ministry of Agriculture, Rural Development and Environment coordinates the construction of the Green Points and the OEDA units and the restoration of the HADA.
- The Provincial Councils for Exploitation of Domestic Waste Disposal or Utilization Sites are the operators of waste disposal or utilization sites and, among other things, are responsible for the receipt, separation and treatment of municipal solid waste, including the management of treatment sites and transshipment stations.
- The Local Government Authorities, as responsible for the implementation of separate collection systems for municipal waste and Pay As You Go (POP). With the relevant clustering of Municipalities and Communities, ATA is expected to have increased responsibilities and powers in a wide range of issues, including municipal waste management, thus providing quality services to the citizen, separate collection and integrated management of their municipal waste.
- Obliged product producers and collective schemes of extended producer responsibility that fulfill the producer's obligations under the relevant legislation.
- Private sector waste treatment facilities and collectors/transporters of waste.

The legal measures, envisaged adaptation strategies, and details on the outcomes of the strategic plan for restoration and management of landfills are outlined in the previous national communication. The Waste Framework Directive, 2008/98/EC, was amended in 2018 to strengthen waste prevention and management, with the main Cyprus legislation for waste management consisting of Waste Law N. 185(I)/2011 and its amendments[48].

The new municipal waste plan also provides an update of waste sent to landfills, and the general operating status of Cyprus landfills[49]. Out of the total 542,840 tons of municipal waste generated in 2020, 364,140 tons were sent to landfills. Operations for the last two illegal uncontrolled waste disposal sites ended in February 2019. The OEDA Limassol in Pentakomos has been in operation since 2017, while the OEDA Larnaca-Famagusta in Kosi has been in operation since 2010. With the closure of the Kosiatis site, the Kosi site has been accepting the mixed municipal waste from the Nicosia District since November 2018. Municpal waste from Limassol, Larnaca-Ammochostos and Nicosia are transferred to the Integrated Waste Management Facilities in Pentakomos and Kosi, while Paphos mixed waste is transferred to the landfill site in Paphos without pre-treatment. While it was determined that construction of additional mechanical-biological treatment units in Paphos and Nicosia are not necessary, the possibility of transferring the mixed waste of Paphos is under consideration.

Cyprus has no hazardous waste landfill. Some hazardous waste is collected and exported for further processing, while some is used for energy recovery at the Vasilikos Cement Plant. The Cement plant uses some tires and sludge as alternative fuels, along with municipal waste streams.

The key features of the strategy that have been included in the GHG reduction Policies and Measures are the following:

- Reduction of waste to solid waste disposal sites from sorting at production level, with recycling of at least 55%, 60%, and 65% of municipal waste by weight by 2025, 2030, and 2035
- Reduction of organics to landfills
- Increase of amount of organic wastes treated by composting
- Promotion of anaerobic digestion for the treatment of the organic fraction of the municipal solid waste and industrial solid waste

Biogas recovery from old landfills during their restoration is also considered.

[48] Ministry of Agriculture, Rural Development and Environment. Municipal Waste Management Plan 2022–2028. Pg. 11.

[49] Ministry of Agriculture, Rural Development and Environment. Municipal Waste Management Plan 2022–2028. Pg. 13.

4.2.6. Sectoral policies and measures: LULUCF mitigation activities

The Department of Forests (Ministry of Agriculture, Rural Development and Environment) is implementing a plan to increase forest tree production from its nurseries for planting in now non-forested lands. The campaign is titled "I plant for Climate" and is directed towards public or private organizations such as municipalities, churches, schools, NGOS and firms who wish to forest public or privately owned lands and who will agree to be responsible to provide the funds and care (i.e. water) of these areas for a minimum of three years. The Department of Forests, after evaluating the applications, will be providing the trees for free, taking into account the area of the plot and the specificities of the location, i.e. elevation. The plants supplied will be selected from a specific list of mostly indigenous, non-invasive species that are suited to the climatic conditions of Cyprus such as: *Pinus brutia, Cupressus semperivines, Quercus spp., Juniperus spp., Tamarix spp., Laurus nobilis, Ceratonia silique, Myrtus nobilis, Nerium oleander* and *Rosmarinus officinalis*. The scheme starts from around 70,000 trees in 2020 and is planned to reach 300,000 trees planted per year in 2030.

Moreover, the Ministry of Transport, Communications and Works (MCTW) is examining a project for planting of trees along urban and inter-urban roads of Cyprus. According to MCTW, up to one million trees can be planted next to roads by 2030. MCTW's proposal estimates a cost of 72 million Euros for creation of the infrastructure for the one million trees (not including watering and maintenance costs).

In addition, the policies included in the national adaptation strategy, such as addressing the increased risk of forest fires and installation of a monitoring system for pest populations with the ultimate aim of identifying a potential outbreak/ monitoring of pest populations in a timely manner are expected to contribute to the maintenance of forested areas and therefore maintain the CO2 absorption rate by the national forests.

4.3. EU policy on climate change[50]

This section describes some of the key over-arching strategies and programmes that guide the EU policy-making process on climate change. Further details on these are available in the National Communication of the European Union[51].

4.3.1. Key developments

The cornerstones of the EU climate change mitigation policies are the following:

• The EU ETS was one of the main instruments that helped reduce GHG emissions in the period from 2013 to 2020. For the period up to 2030, the annual reduction of the emissions cap was strengthened and the market stability reserve (the mechanism to reduce the surplus of emission allowances in the carbon market) was reinforced. The EU ETS is currently under revision to ensure that it will contribute substantially to the EU's new 2030 target.

• The Effort Sharing Decision provided emission target paths for EU Member States which they had to follow in the period 2013-2020. Most EU Member States overachieved their targets, while some made use of flexibilities provided by the system to achieve their targets. For the period up to 2030, the Effort Sharing Regulation provides new target paths with more ambitious emission reductions. This Regulation is also under revision to ensure that it will be in line with the EU's new 2030 target.

[50] C(2022) 6298 REPORT FROM THE COMMISSION Eighth National Communication and Fifth Biennial Report from the European Union under the UN Framework Convention on Climate Change (UNFCCC) (required under the UNFCCC and the Kyoto Protocol); available at hthttps://unfccc.int/documents/624694

[51] C(2022) 6298 REPORT FROM THE COMMISSION Eighth National Communication and Fifth Biennial Report from the European Union under the UN Framework Convention on Climate Change (UNFCCC) (required under the UNFCCC and the Kyoto Protocol); available at hthttps://unfccc.int/documents/624694

Other cross-sectorial policies are the following:

• The Methane Strategy sets out measures to cut methane emissions, including in Europe. It presents legislative and non-legislative actions in the energy, agriculture and waste sectors, which account for around 95% of methane emissions associated with human activity worldwide.

• Policies for sustainable carbon cycles are being implemented, setting out how to increase removals of carbon from the atmosphere. Short- to medium-term actions are set out to support carbon farming and upscale green business model to better reward land managers for carbon sequestration and biodiversity protection. By 2030, carbon farming initiatives should contribute 42Mt of CO2 storage to Europe's natural carbon sinks. New industrial value chains for sustainable capture, use, transport and storage of carbon are also promoted, including through the creation of a market for capture, use and storage of CO2. A robust certification system to reward carbon removals has been announced for 2022.

In the various sectors, the following key developments took place in recent years:

Energy:

• The amended Energy Efficiency Directive is the main legal provision addressing energy efficiency in the EU. The amendment introduced a new headline EU energy efficiency target for 2030 of at least 32.5% (relative to the 2007 consumption projections). The Directive is under revision and, among other things, a higher target for reducing primary and final (energy consumption has been introduced for 2030.

• The EU Energy Performance of Buildings Directive is the main legal provision addressing energy efficiency increases in buildings. A major goal of the amended directive is to accelerate the renovation of the existing building stock through strengthened long-term renovation strategies and the mobilisation of related investments. The European Commission proposed a revision of this Directive which aims at contributing to meeting the target of at least -60 % emission reductions by 2030 in the building sector in comparison to 2015 and sets out how Europe can achieve a zero-emission and fully decarbonised building stock by 2050.

• The recast Renewable Energy Directive is the main legal provision addressing the use of renewable energies in the EU. It includes a binding renewable energy target for the EU for 2030 of at least 32 % for the overall share of energy from renewable sources in the EU's gross final consumption of energy in 2030. To meet the higher climate ambition, the European Commission proposed a revision of the Renewable Energy Directive, which seeks to increase the current target to at least 40 % renewable energy sources in the EU’s overall energy mix by 2030.

• The EU Methane Strategy adopted in 2020 outlines a comprehensive policy framework addressing methane emissions in the energy, agriculture and waste sectors. The EU also promotes the mitigation of methane emissions internationally, e.g. under the Global Methane Pledge. To reduce methane emissions in the energy sector, a proposal provides for improved measurement, reporting and verification of energy sector methane emissions and for immediate reduction of emissions through mandatory leak detection and repair and a ban on venting and flaring.

Transport:

• Regarding passenger cars, the most important legal provision is the regulation which sets CO2 emission performance standards for cars and vans. This regulation sets EU fleet-wide CO2 emission targets that apply from 2020, 2025 and 2030 and includes a mechanism to incentivise the uptake of zero- and low-emission vehicles. This regulation is currently under revision with a view to a 100 % CO2 reduction for new cars and vans from 2035 onwards.

• As for freight transport, the regulation setting CO2 emission performance standards for heavy duty vehicles is the most significant legislation. This regulation sets CO2 reduction targets of 15 % in 2025 and 30 % in 2030 compared to the EU average in the reference period (July 2019 to June 2020).

• The Renewable Energy Directive is also relevant for transport. The current Directive aims to accelerate the uptake of renewable energy in the transport sector with the aim of achieving a 14 % share of renewable energy in transport by 2030. A proposal of the European Commission introduced a target for reducing the greenhouse gas intensity of transport fuels by 13 % by 2030. Moreover, the proposal includes additional sub-targets for advanced biofuels and for renewable fuels from non-biological origin.

Industry:

• The Industrial Emissions Directive is the main EU instrument for preventing and reducing pollution from over 30 000 large industrial plants and over 20 000 intensive livestock farms in Europe. The IED is also relevant for greenhouse gas emissions abatement as it regulates industrial emissions to the extent that they are not covered by the EU ETS, methane emissions from livestock installations, and indirect greenhouse gases and short-lived climate forcers. In April 2022, a revised Directive was proposed with several main elements related to decarbonisation: Inclusion of energy efficiency requirements as integral part of permits; inclusion of the largest livestock farms representing 43% of the EU's livestock methane emissions; and more transparent reporting of fluorinated gas emissions. The REPowerEU Plan presented by the European Commission in 2022 in response to the global energy market disruption caused by the Russian Federation's invasion of Ukraine proposes measures to bring down emissions and energy costs for consumers and industry including by accelerating the roll out of renewable energy projects.

• The main legal provision for reducing fluorinated gas (F-gas) emissions in the EU is the Fgas Regulation. This regulation limits the total amount of the most important F-gases that can be sold in the EU from 2015 onwards and phases them down in steps to one-fifth of the baseline in 2030. In April 2022, a proposal was made to update the F-gas Regulation with a view to reducing the amount of hydrofluorocarbons placed on the market by 98 % by 2050 (compared to 2015).

Agriculture:

• Under the previous CAP period which ended in 2020, the EU already promoted several climate relevant actions. However, an evaluation in 2021 showed that the mitigation effects are very difficult to quantify due to limited data availability and the complexity of the implementation architecture.

• The new CAP period will start in 2023 and will increase the emphasis on climate action. 40 % of the total budget will be dedicated to climate-related measures, including improved rules and monitoring requirements.

• In the context of the Green Deal, the EU has put in place several strategies and plans to reduce emissions in the agriculture sector with concrete targets to reduce nutrient losses and fertilizer application and to increase the area of organic farming.

• The Methane Strategy includes measures to improve reporting of emissions from agriculture through better data collection, and to promote opportunities to reduce emissions with support from the Common Agricultural Policy. The main focus is put on best practice sharing for innovative methane-reducing technologies, animal diets, and breeding management.

LULUCF:

• The LULUCF sector has become increasingly important in the context of the EU climate targets and the Green Deal. In recent years, the EU prepared for a robust monitoring and accounting framework of the LULUCF sector which is applied from 2021 onwards. The current legislative proposal foresees an EU-wide mitigation target of -310 million tonnes of carbon dioxide equivalent (Mt CO2eq) in 2030, the implementation of national LULUCF targets for Member States for 2030 and a better integration better integration of mitigation, adaptation and nature restoration measures in land monitoring systems.

• In addition, the EU has launched several initiatives and strategies to increase carbon removals on the one hand and to improve land management on the other hand in the decades ahead, e.g., through carbon farming practices and new forestry, soil and biodiversity strategies.

Waste:

• The waste policy framework of the EU has been continuously extended and elaborated to address different waste streams. The EU aims to further strengthen the circular economy to reduce material use rate and to significantly reduce waste generation in the EU. To achieve these objectives, new strategies targeting plastic waste and textiles have been published recently; existing waste legislation was or is going to be amended; and, in the context of the Waste Framework Directive, separate waste collection will be enforced (e.g. for biowaste, textiles, hazardous waste and plastic bottles).

• The Methane Strategy includes action to improve the management of landfill gas, harnessing its potential for energy use while reducing emissions, and aims to minimize the disposal of biodegradable waste in landfills to avoid methane formation.

4.3.2. 2020 Climate and Energy Package

The 2020 Climate and Energy Package was formally adopted in 2009 and for the first time provided an integrated and ambitious package of policies and measures to tackle climate change. It includes the 20-20-20 targets, which set the following key objectives:

- To reduce greenhouse gas emissions by at least 20% compared to 1990 by 2020, with a firm commitment to increase this target to 30 % in the event of a satisfactory international agreement being reached;
- To achieve 20% of energy from renewable sources by 2020 (as a share of total EU gross final energy consumption), supplemented by a target to achieve a minimum of 10 % renewable transport fuel;
- To save 20% of total primary energy consumption by 2020 compared to a business-as-usual baseline.

These are also headline targets of the Europe 2020 strategy for smart, sustainable and inclusive growth[52]. In order to meet these key objectives, the Climate and Energy Package comprises four pieces of complementary legislation:

- A Directive revising the EU Emissions Trading System;
- An Effort-Sharing Decision setting binding national targets for emissions from sectors not covered by the EU ETS;
- A Directive setting binding national targets for increasing the share of renewable energy sources in the energy mix;
- A Directive creating a legal framework for the safe and environmentally sound use of carbon capture and storage technologies.

The package was complemented by two further legislative acts that were agreed at the same time: A regulation requiring a reduction in CO2 emissions from new cars and a revision of the Fuel Quality Directive. The Energy Efficiency Directive was adopted in 2012 to help achieve the energy efficiency target.

4.3.3. 2030 Climate and Energy Framework

The European Union's 2030 Climate and Energy Framework was put in place to ensure that the EU and its Member States achieve their climate change mitigation commitments under the Paris Agreement, as communicated in the EU's NDC. The main elements of the 2030 Climate and Energy Framework are the EU ETS, the Effort Sharing Regulation and the LULUCF Regulation.

The 2030 Climate and Energy Framework was first established in line with the EU's original NDC of 2015, which stipulated a 40 % reduction of GHG emissions by 2030 compared to 1990[53]. In 2020, the EU and its Member States updated their NDC and committed to a net GHG emission reduction of at least 55 %

[52] http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A52010DC2020
[53] Intended Nationally Determined Contribution of the EU and its Member States, https://unfccc.int/sites/default/files/LV-03-06-EU%20INDC.pdf

by 2030 compared to 1990[54]. While the policies and measures currently in place were developed in line with the target of the first NDC of the EU, they are now in the process of a revision to make them fit for the -55 % target communicated in the updated NDC. A comprehensive set of proposals was presented by the European Commission in July 2021[55].

The key elements of these proposals are:

• more rapid emission reductions in the period up to 2030 under the EU ETS;

• a strengthening of the emission reductions to be achieved by EU Member States by 2030 under the Effort Sharing Regulation;

• strengthened renewable energy and energy efficiency targets;

• various updates to existing legislation, such as stricter CO2 emission standards for cars and

• new proposals, including a carbon border adjustment mechanism and a social climate fund. Based on these proposals, major new legislation is in the process of being finalised by the European Parliament and the Council.

These polices and measures show various interactions. As an example, transport policies such as CO2 emission standards contribute to the reduction of greenhouse gas emissions in the transport sector and hence help Member States achieve their overall emission reduction targets under the Effort Sharing Regulation. As another example, the EU ETS provides an incentive to switch from fossil fuels to renewable electricity generation. Hence, it contributes to the achievement of the renewable energy target. The monitoring and evaluation of progress constitutes an important aspect of the 2030 climate and energy framework. With the Regulation on the Governance of the Energy Union and Climate Action ('Governance Regulation')[56], the EU has adopted integrated rules to ensure planning, monitoring and reporting of progress towards its 2030 climate and energy targets and its international commitments under the Paris Agreement. The Governance Regulation requires EU Member States to communicate and implement Integrated National Energy and Climate Plans and to regularly report on their progress in implementing them. The Governance Regulation also lays out the detailed reporting obligations on GHG emissions, policies and measures, projections, adaptation and support provided to developing countries.

4.3.3. The EU's long-term strategy and the climate law

In addition to the 2030 target, the EU and its Member States committed to the objective of a climate-neutral EU by 2050. This objective was agreed by the European Council in December 2019 and communicated as the EU's long-term low greenhouse gas emission development strategy under the Paris Agreement in March 202042. With the submission of its long-term strategy, the EU became the first large economy that committed to climate neutrality. Besides the EU as a whole, several Member States communicated their own long-term strategies under the Paris Agreement[57]. The binding objective of climate neutrality by 2050 is enshrined in the European Climate Law[58], which entered into force in July 2021. The European Climate Law also contains the 2030 climate target of reducing domestic emissions by at least 55 % compared to 1990. It constitutes a net target, i.e. removals of CO2 from the

[54] The update of the nationally determined contribution of the European Union and its Member States, https://unfccc.int/sites/default/files/NDC/2022-06/EU_NDC_Submission_December%202020.pdf

[55] Delivering the European Green Deal, https://ec.europa.eu/info/strategy/priorities-2019-2024/european-greendeal/delivering-european-green-deal_en

[56] Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, http://data.europa.eu/eli/reg/2018/1999/oj

[57] Communication of long-term strategies, https://unfccc.int/process/the-paris-agreement/long-term-strategies

[58] Regulation (EU) 2021/1119 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law'), http://data.europa.eu/eli/reg/2021/1119/oj.

atmosphere are taken into account. However, the total amount of removals which can be counted towards the achievement of the target is limited to a maximum of 225 Mt CO2eq. The European Climate Law also lays out the process for developing the 2040 climate target, which will take into account an indicative greenhouse gas budget for the period 2030 to 2050. Finally, the European Climate Law establishes a European Scientific Advisory Board on Climate Change, requires the adoption of adaptation strategies and lays out the rules for assessing the progress towards the climate targets.

4.3.4. The Environment Action Programmes

The overall environmental policy of the European Union is guided by Environment Action Programmes. The 7th Environment Action Programme addressed the period up to 2020. It identified the key objectives to protect, conserve and enhance the EU's natural capital, to turn the EU into a resource-efficient, green and competitive low-carbon economy and to safeguard the Union's citizens from environment-related pressures.

An evaluation of the action programme in 2019 found that it has been an important governance tool and has facilitated a shift in policymaking by recognising that climate and environmental protection is a driver for green growth, a healthy planet and improved wellbeing for individuals.

The 8th Environment Action Programme, which entered into force in May 2022, constitutes the EU's legally agreed common agenda for environment policy up to 2030. It contains six priority objectives, several of which are directly related to climate action:

• to achieve the 2030 GHG emission reduction target and climate neutrality by 2050;

• to enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change;

• to advance towards a regenerative growth model, decoupling economic growth from resource use and environmental degradation, and accelerating the transition to a circular economy;

• to pursue a zero-pollution ambition, including for air, water and soil and protecting the health and well-being of citizens;

• to protect, preserve and restore biodiversity, and enhance natural capital; and

• to reduce environmental and climate pressures related to production and consumption.

The European Commission, supported by the European Environment Agency and the European Chemicals Agency, monitors, assesses and reports annually on progress on these priority objectives. A mid-term evaluation will be completed by 2024, and a full evaluation by 2029.

4.5. Summary of National Policies and Measures and Mitigation Impacts

This chapter concludes with the following three tables, which provide a summary of the policies and measures. Table 4.3 provides a brief description of each policy and measure. Table 4.4 provides a quantitative summary of the policy and measures included in all three scenarios, organized by sector and aggregated as necessary. Table 4.5 provides the estimated impact of the policies and measures on the reduction of GHGs for the WEM and WAM scenarios, aggregated as necessary.

Table 4.3 Brief description of policies and measures

PaM No.	Title	Brief description	Sector & Gas affected	Type of policy	Responsible entity
Implemented / adopted policies and measures (included in the "with existing measures" scenario)					
1	Implemented & adopted policies and measures for the promotion of renewable energy sources	This policy concerns the promotion of renewable energy sources through a series of actions such as support schemes and financial assistance for the production of electricity from renewable energy sources, incentives for encouraging the use of RES in different types of developments & RES communities, replacement of the conventional transport fuels with biofuels etc.	Energy; CO2	Economic; Education; Planning; Regulatory	Ministry of Energy, Commerce and Industry
3	Implemented & adopted policies and measures for the promotion of energy efficiency	This policy concerns the promotion of renewable energy sources through a series of actions such as support schemes and financial assistance for energy efficiency investments, implementation of measures aimed at attaining energy savings in existing public buildings, minimum energy performance requirements for new and existing buildings, requirements for technical building systems installed in existing buildings, inspections for heating systems and a/c systems, Implementation of soft measures such as information campaigns, trainings and workshops, energy efficiency in electricity infrastructure, excise tax on road transport fuels, old vehicle scraping scheme and financial incentives for the purchase of electric vehicles, Installation of charging points and infrastructures for electric vehicles, etc.	Energy; CO2	Economic; Education; Information; Planning; Regulatory	Ministry of Energy, Commerce and Industry
5	Introduction of natural gas in the energy market of Cyprus through the implementation of the Project "LNG Import Terminal"	This policy is associated with the design and construction of the LNG import terminal for 20 years operations and maintenance in addition to all necessary infrastructure that will allow the use of natural gas (initially) for electricity production in Cyprus.	Energy; CO2	Fiscal; Planning; Regulatory	Ministry of Energy, Commerce and Industry
6	Implemented & adopted policies	Preparation of the proper recovery system for F-gases in equipment; This is an obligation according to EU and national legislation. It is however still not properly	Industry; HFCs, SF6	Fiscal; Information;	Ministry of Agriculture,

PaM No.	Title	Brief description	Sector & Gas affected	Type of policy	Responsible entity
	and measures for proper recovery system for Fluorinated greenhouse gases in equipment	implemented. This policy considers that the necessary implementing measures will be taken so that in 2020 proper recovery of F-gases in old equipment is performed. A financial support scheme is under preparation by the Department of Environment to provide an award for the recovery of the gases. It is anticipated that the first supporting scheme will be in place in 2021.		Regulatory; Voluntary/ negotiated agreements	Rural Development and Environment
7	Implemented & adopted policies and measures for the promotion of anaerobic digestion for the treatment of animal waste	Promotion of anaerobic digestion for the treatment and management of animal waste; Promotion of anaerobic digestion in existing biogas plants; Encouragement of new biogas plants to exploit organic waste from livestock breeding. A financial support scheme is under preparation by the Department of Environment to provide an award for the recovery of the gases. It is anticipated that the first supporting scheme will be in place in 2021.	Agriculture; CH4, N2O	Education; Information; Regulatory; Voluntary/ negotiated agreements	Ministry of Agriculture, Rural Development and Environment
9	Promotion of mitigation actions in the sector of waste	A series of policies and measures are implemented in the waste sector to reduce greenhouse gas emissions such as reduction of the amount of waste that are sent to solid waste disposal sites, reduction of the amount of organics going to landfills, promotion of alternatives for the treatment of the organic fraction of solid waste (anaerobic digestion) and biogas recovery from old landfills.	Waste; CH4	Education; Fiscal; Information; Planning; Regulatory	Ministry of Agriculture, Rural Development and Environment
11	Reduction of emissions from the businesses	Business4Climate is an innovative idea developed in 2017-2018 by Cyprus Employers and Industrialist Federation, in collaboration with the Cyprus University of Technology (scientific advisor) and the Department of the Environment. Climate4Climate initiative was developed as a pilot project to demonstrate how Cypriot enterprises can voluntarily commit and take action against climate change. Enterprises (other than those involved in the ETS) participating in the project have to sign of a voluntary declaration, to reduce greenhouse gas emissions by more than 8% by 2030. For mobilizing the enterprises, a support scheme is under	Horizontal; CO2, CH4, N2O, HFCs, SF6	Fiscal; Information; Voluntary/ negotiated agreements	Ministry of Agriculture, Rural Development and Environment

PaM No.	Title	Brief description	Sector & Gas affected	Type of policy	Responsible entity
		preparation from the Department of Environment, utilising national funds. It is anticipated that the first supporting scheme will be in place in 2021.			
Planned policies and measures (included in the "with additional measures" scenario)					
2	Planned policies and measures for the promotion of renewable energy sources	Additional measures are considered for the promotion of production of energy from renewable sources such as support schemes for storage units, implementation of an enabling framework to promote and facilitate the development of Renewable Energy Communities, installation of PV Systems in Governmental buildings with the net-billing scheme, etc.	Energy; CO2	Economic; Education; Planning; Regulatory	Ministry of Energy, Commerce and Industry
4	Planned policies and measures for the promotion of energy efficiency	Additional measures are considered for the promotion of energy efficiency, such as promotion of measures in the water sector, Shift of modal share from car trips to sustainable modes of transport – Implementation of Sustainable Urban Mobility Plans, promotion of zero emission vehicles etc.	Energy; CO2	Economic; Education; Information; Planning; Regulatory	Ministry of Energy, Commerce and Industry
8	Further promotion of anaerobic digestion for the treatment of animal waste	Promotion of anaerobic digestion for the treatment and management of animal waste; Promotion of anaerobic digestion in existing biogas plants; Encouragement of new biogas plants to exploit organic waste from livestock breeding. A financial support scheme is under preparation by the Department of Environment to provide an award for the recovery of the gases. It is anticipated that the first supporting scheme will be in place in 2021. This policy assumes further deployment/acceptance of the support scheme.	Agriculture; CH4, N2O	Education; Information; Regulatory; Voluntary/ negotiated agreements	Ministry of Agriculture, Rural Development and Environment
10	Promotion of additional mitigation actions in the sector of waste	A series of policies and measures are implemented in the waste sector to reduce greenhouse gas emissions such as reduction of the amount of waste that are sent to solid waste disposal sites, reduction of the amount of organics going to landfills, promotion of alternatives for the treatment of the organic fraction of solid waste (anaerobic digestion) and further biogas recovery from old landfills.	Waste; CH4	Education; Fiscal; Information; Planning; Regulatory	Ministry of Agriculture, Rural Development and Environment

Table 4.4 Summary of Policies and Measures included in each scenario

	BaU				WEM				WAM			
Name of Policy or Measure	**2025**	**2030**	**2035**	**2040**	**2025**	**2030**	**2035**	**2040**	**2025**	**2030**	**2035**	**2040**
Energy												
Natural Gas	Start 2024				Start 2024				Start 2024			
RES in electricity	29%	39%	73%	82%	31%	41%	71%	82%	32%	44%	68%	82%
*EE in Other Industries (TJ)					391	909	935	1013	371	1002	1016	1084
EE in Residential (TJ)					929	2226	2563	2312	1772	4534	5407	6065
EE in Services (TJ)					621	1522	1597	1700	1932	4536	4625	4890
EE in Agriculture (TJ)					30	69	72	77	23	80	83	76
RES in Residential					38%	43%	57%	65%	38%	43%	56%	65%
RES in Commercial					34%	42%	63%	73%	33%	43%	62%	74%
Transport												
Biofuels	4.0%	3.7%	2.9%	1.8%	4.0%	3.6%	2.9%	1.8%	4.1%	3.8%	3.0%	2.0%
RES	5%	7%	22%	47%	5%	8%	22%	48%	5%	8%	22%	46%
Electricity Share	2.1%	10.4%	27.9%	58.1%	2.1%	10.8%	28.6%	59.3%	1.8%	9.1%	28.6%	57.3%
Natural Gas Share	0.9%	1.1%	1.5%	1.2%	0.9%	1.1%	1.5%	1.2%	1.0%	1.3%	1.8%	0.1%
IPPU												
Recovery of F-gases from old equipment					1.4%	5%	7.5%	10%	5%	10%	15%	20%
Agriculture												
Promotion of anaerobic digestion for treatment of animal waste												
Cattle	7.5%	10.0%	12.5%	15.0%	7.5%	10.0%	12.5%	15.0%	10.0%	15.0%	22.5%	30.0%
Swine	62.5%	65.0%	67.5%	70.0%	62.5%	65.0%	70.0%	75.0%	65.0%	70.0%	75.0%	80.0%
Poultry	22.5%	25.0%	27.5%	30.0%	22.5%	25.0%	27.5%	30.0%	25.0%	30.0%	35.0%	40.0%
Inorganic N Fertilisers				-5%				-5%				-5%
Urea Application				-5%				-5%				-5%
Waste												
Solid Waste												
Sorting at Source					40% (from 2022); 55% (from 2025); 65% (from 2030)							
Organics to Landfill					24% constant from 2022				24% constant from 2022			

Recovery from Deep Managed and Unmanaged Landfills					20%	20%	20%	20%	30%	30%	30%	30%
Anaerobic Digestion at Biogas Plants					4%	9%	14%	19%	4%	9%	14%	19%
Wastewater												
Percent of Population Connected to Central System	84.5%	84.5%	84.5%	84.5%	84.5%	89.8%	100%	100%	84.5%	89.8%	100%	100%
Industrial Wastewater: Increase Anaerobic Treatment												
Alcohol					3%	5%	5%	5%	3%	5%	5%	5%
Beer					14%	20%	20%	20%	14%	20%	20%	20%
Soft Drinks					3%	5%	5%	5%	3%	5%	5%	5%
Dairy					3%	7%	7%	7%	3%	7%	7%	7%
Meat and Poultry					4%	10%	10%	10%	4%	10%	10%	10%
Vegetables, Fruits, Juices					3%	5%	5%	5%	3%	5%	5%	5%

*Energy Efficiency

Table 4.5. Estimated Mitigation Impact by Policy and Measure (Gg CO_2 Equivalent)

		WEM				WAM			
	Gg CO2 Equivalent	**2025**	**2030**	**2035**	**2040**	**2025**	**2030**	**2035**	**2040**
Energy									
	Natural Gas, RES in electricity	159	314	65	139	213	545	97	192
	EE in Other Industries (TJ)	11	22	21	11	11	24	22	11
	EE in Households (TJ)	16	34	38	16	48	101	117	48
	EE in Services (TJ)	2	5	4	2	32	66	65	32
	EE in Agriculture (TJ)	-0.03	-0.13	-0.22	-0.31	-0.01	-0.12	-0.26	-0.93
Transport									
	RES, Biofuels, Natural Gas, Electricity	0	14	14	13	107	125	122	34
IPPU									
	Recovery of F-gases from old equipment	6	20	29	39	19	39	59	78
Agriculture									
	Promotion of anaerobic digestion for treatment of animal waste (3B only)	0.12	0.07	2.70	5.27	5.15	9.48	13.18	16.82

	Inorganic Nitrogen Fertilisers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Urea Application	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste									
	Solid Waste: Sorting at Source and Organic	-1.0	-4.1	-4.1	-4.1	-1.0	-4.1	-4.1	-4.1
	Solid Waste: Recovery of Deep Unmanaged and Managed	103	107	107	107	154	160	160	160
	Anaerobic Digestion at Biogas Facilities	-0.01	-0.04	-0.11	-0.32	-0.01	-0.04	-0.11	-0.32
	Wastewater Treatment and Discharge: Population connected to central systems	9	24	24	24	9	24	24	24
	Industrial Wastewater: Increase anaerobic treatment, and 1% recovery from 2025, increasing by 1% a year	0.4	-0.6	1.6	4.4	0.7	2.1	7.0	13.2
Aggregate Impact		305	305	537	304	362	604	1102	695

5. Projections and the total effects of policies and measures

5.1. Introduction

This Chapter describes a "with measures" (WM) or "with existing measures" (WEM) scenario concerning the national projections of greenhouse gas emissions by sources and their removal by sinks for the years 2020, 2025, 2030, 2035 and 2040. The "with measures" scenario assumes that no additional emission reduction policies and measures are adopted than the existing ones (implemented and adopted).

A "with additional measures" (WAM) scenario is also reported, which reflects the effect of all implemented / adopted and planned policies and measures. This scenario includes the additional policies and measures as specified in detail in the National Energy and Climate Plan (NECP), which was adopted by Cyprus in January 2021.

A "Business as usual" (BaU) or "Without measures" (WOM) scenario is also presented in this chapter, which reflects the expected emissions that exclude the effects of all policies and measures which are planned, adopted or implemented after the year chosen as the starting point for the relevant projection.

The NECP constitutes a strategic plan for the Cyprus on Climate and Energy issues and comprises a detailed roadmap for achieving concrete Energy and Climate Goals by 2030. The NECP highlights our country's energy and climate priorities and development opportunities and aims to be the key tool for shaping/mainstreaming the national energy and climate policy over the next decade.

The GHG emission projections presented in this chapter are based on the latest energy projection scenarios that are developed for the Ministry of Agriculture, Rural Development and Environment by the Cyprus Institute[59] and the October 2020 GDP projections provided by the Ministry of Finance[60]. Further details are provided in the sections that follow.

The projections of total GHG emissions are presented in Figure 5.1, while Table 5.1 presents the sectoral emissions from 1990–2040.

5.2. Projections

The policies and measures included in each scenario are presented in Tables 4.3–4.5 in the previous chapter. The resulting impact is presented below in Figure 5.1 and Table 5.1. The sudden drop in 2024 across all scenarios is due to the introduction of natural gas.

[59] Prof. Theodoros Zachariades; Energy, Environment and Water Research Centre; The Cyprus Institute; t.zachariadis@cyi.ac.cy; Tel. +357 22 208 720; https://www.cyi.ac.cy/index.php/eewrc/about-the-center/eewrc-our-people/author/1103-theodoros-zachariadis.html

[60] Mrs. Maria Matsi; Economic Officer A'; Directorate on Economic Policy, European and International Affairs; Ministry of Finance; mmatsi@mof.gov.cy; Tel. +357 22 601 231; www.mof.gov.cy

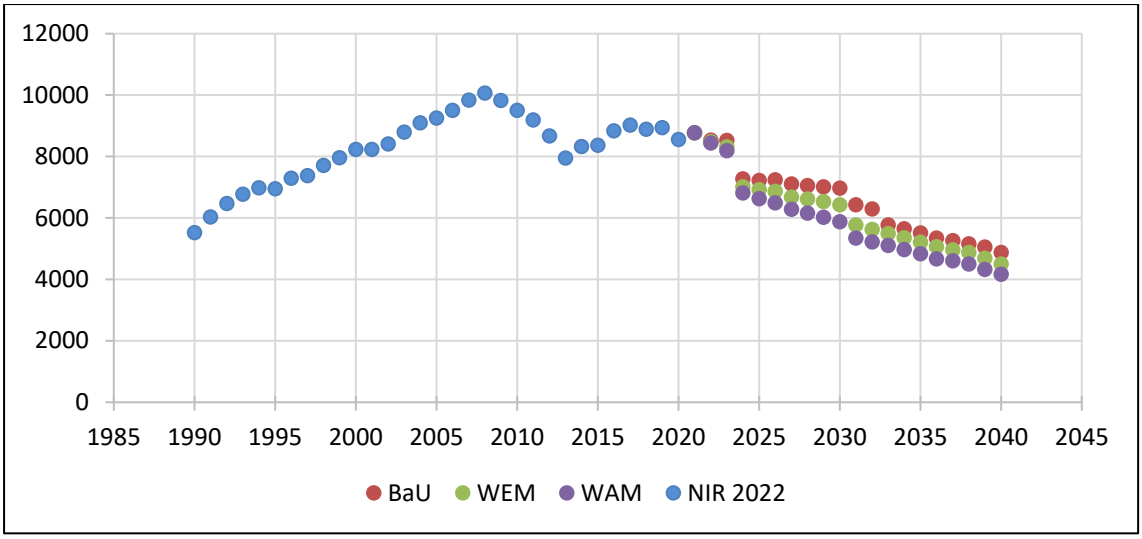

Figure 5.1. BaU, WEM and WAM Projections of total national GHG emissions (excluding LULUCF)

Three important things that should be noted for these projections are the following:

(a) The emissions from the possible exploitation of natural gas in the Exclusive Economic Zone are not taken into account due to the high uncertainty associated to any prediction of such changes.
(b) The projections presented here take into account the latest microeconomic forecasts, encompassing impacts from the COVID-19 pandemic and the war in Ukraine.
(c) The organic fraction of solid waste not going to the landfill is treated by composting, anaerobic digestion and incinerated for energy. The additional organics for incineration at the cement installation have not been accounted for.

Table 5.1. Projections of national GHG emissions disaggregated by sector (excluding LULUCF)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
BaU											
Energy	2641	3482	4434	5023	5170	4194	4143	2782	2971	2038	1838
Transport	1241	1549	1829	2122	2389	1932	1922	1780	1300	778	342
IPPU	726	838	878	1003	825	1174	1288	1449	1485	1485	1483
Agriculture	521	638	613	586	580	493	583	568	553	548	543
Waste	396	440	480	515	540	580	623	643	659	666	673
TOTAL (Excl. LULUCF)	**5525**	**6946**	**8234**	**9249**	**9504**	**8373**	**8560**	**7222**	**6967**	**5515**	**4879**
Gas (Excl. LULUCF)											
CO2	4566	5783	7017	7955	8100	6972	6920	5540	5294	3857	3238
CH4	698	799	848	871	886	875	986	998	996	991	988
N2O	258	328	301	288	292	248	277	296	286	274	263
HFCs	NO, NE	31	60	122	214	262	358	370	373	374	371
PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF6	3	6	9	12	12	16	18	19	19	19	19
WEM											
Energy	2641	3482	4434	5023	5170	4194	4143	2593	2594	1911	1648
Transport	1241	1549	1829	2122	2389	1932	1922	1780	1286	764	329
IPPU	726	838	878	1003	825	1174	1288	1443	1465	1456	1444
Agriculture	521	638	613	586	580	493	583	568	553	545	538
Waste	396	440	480	515	540	580	623	533	533	537	542
TOTAL (Excl. LULUCF)	**5525**	**6946**	**8234**	**9249**	**9504**	**8373**	**8560**	**6917**	**6431**	**5213**	**4501**

Gas (Excl. LULUCF)											
CO2	4566	5783	7017	7955	8100	6972	6920	5352	4905	3718	3036
CH4	698	799	848	871	886	875	986	888	869	860	852
N2O	258	328	301	288	292	248	277	295	285	272	261
HFCs	NO, NE	31	60	122	214	262	358	364	354	346	334
PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF6	3	6	9	12	12	16	18	19	18	18	17
WAM											
Energy	2641	3482	4434	5023	5170	4194	4143	2478	2235	1737	1446
Transport	1241	1549	1829	2122	2389	1932	1922	1673	1175	656	308
IPPU	726	838	878	1003	825	1174	1288	1429	1446	1426	1405
Agriculture	521	638	613	586	580	493	583	563	543	535	526
Waste	396	440	480	515	540	580	623	481	477	478	480
TOTAL (Excl. LULUCF)	**5525**	**6946**	**8234**	**9249**	**9504**	**8373**	**8560**	**6623**	**5875**	**4832**	**4165**
Gas (Excl. LULUCF)											
CO2	4566	5783	7017	7955	8100	6972	6920	5135	4443	3445	2819
CH4	698	799	848	871	886	875	986	829	800	788	776
N2O	258	328	301	288	292	248	277	291	279	266	258
HFCs	NO, NE	31	60	122	214	262	358	351	336	318	297
PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF6	3	6	9	12	12	16	18	18	17	16	15

5.2.1 Without measures (BaU)

The BaU emissions by sector for years 1990–2040 are presented above in Table 5.1, and are depicted below in Figure 5.2. The activity data for this scenario is presented in Annex III. The latest inventory year used as reference is 2020. This scenario assumes a considerable slow improvement in energy intensity across all end-use sectors. It also assumes that the sustainable mobility assumptions of the NECP are not effective and hence there is no modal shift away from private vehicles. These result in very high final energy demand projections, with an equivalent effect in emissions. This scenario resembles the evolution of energy intensity of the EU Reference Scenario 2020. BaU emissions are projected to decrease by 12% in 2040 compared to 1990 and by 47% compared to 2005.

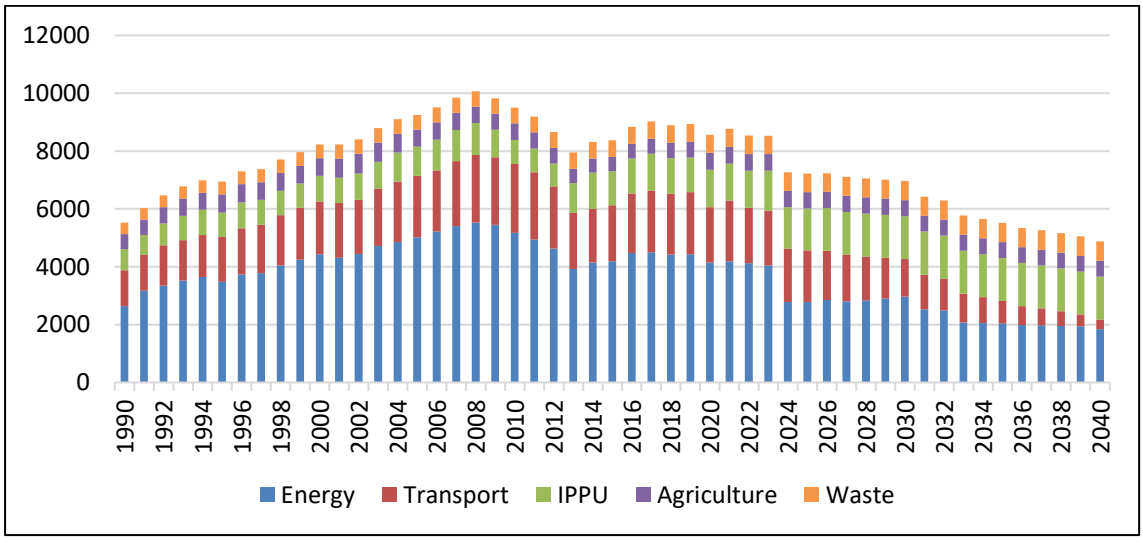

Figure 5.2. Total BaU GHG emissions by sector (Gg CO2 eq.) 1990–2040

The methodologies applied are the same as those used for the preparation of the 2020 submission of National Greenhouse Gas emissions inventory of Cyprus to the UNFCCC [61] and projected activity data.

Energy demand projections are largely based on recommended harmonized values from the European Commission as provided under Annex I, Part 2 of Regulation (EU) 2018/1999, and pursuant to Article 18(I) of the Governance Regulation[62]. For certain sectors (manufacture of solid fuels, other energy industries, aviation, water-borne navigation, non-specified stationary and mobile), the latest GDP forecast has been used[63]. Other key assumptions for energy are the introduction of natural gas in 2024 and 21% RES in 2025, 29% in 2030, 47% in 2035 and 58% in 2040. Higher fuel prices have increased the competitiveness of renewable energy, especially in the long run. Alongside decreased costs for renewable energy sources, this has resulted in higher renewable energy shares.

5.2.2. With existing measures (WEM)

The WEM emissions by sector for years 1990–2040 are presented above in Table 5.1, and are depicted below in Figure 5.3. The activity data used for the calculations is presented in Annex IV. Reduction in the emissions caused by each measure was presented previously in Table 5.4.

The methodologies applied are the same as those used for the preparation of the 2022 submission of National Greenhouse Gas emissions inventory of Cyprus to the UNFCCC[64]. Similar to the BaU scenario, the energy consumption in end-use sectors resembles that of the EU Reference Scenario 2020. Whereas the BaU scenario resembles the evolution of energy intensity of the EU Reference Scenario 2020, this scenario resembles the evolution of final energy demand of the EU Reference Scenario 2020. The same assumptions regarding transport as the BaU scenario are kept.

The difference in the total emissions between the BaU and the WEM scenario are presented in Figure 5.4. Emissions based on the WEM scenario are projected to decrease by 19% in 2040 compared to 1990 and by 51% compared to 2005. In 2040 the difference between WEM and BaU is -8%.

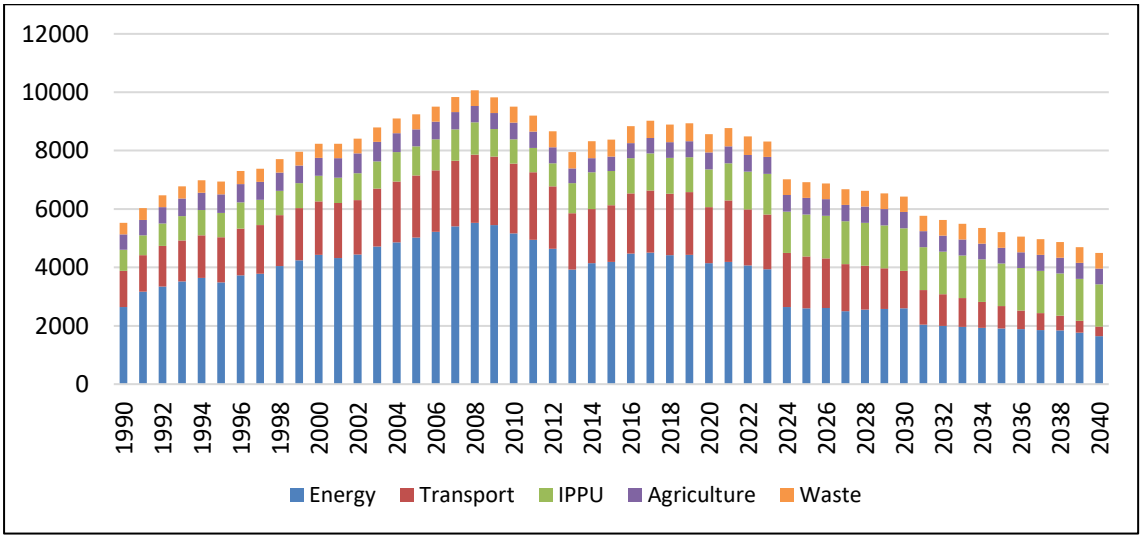

Figure 5.3. Total WEM GHG emissions by sector (Gg CO2 eq.) 1990–2040

[61] https://unfccc.int/documents/461671

[62] Annex I, Part 2 of the Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action; Article 38(3) of the Implementing Regulation; Article 18(1) of the Governance Regulation.

GDP forecast as prepared by the Ministry of Finance in October 2022; Maria Matsi, Economic Officer, Directorate of Economic Research and EU Affairs, Ministry of Finance, 1439 Nicosia – Cyprus, Tel. no.: +35722601231, Email: mmatsi@mof.gov.cy

[64] https://unfccc.int/documents/461671

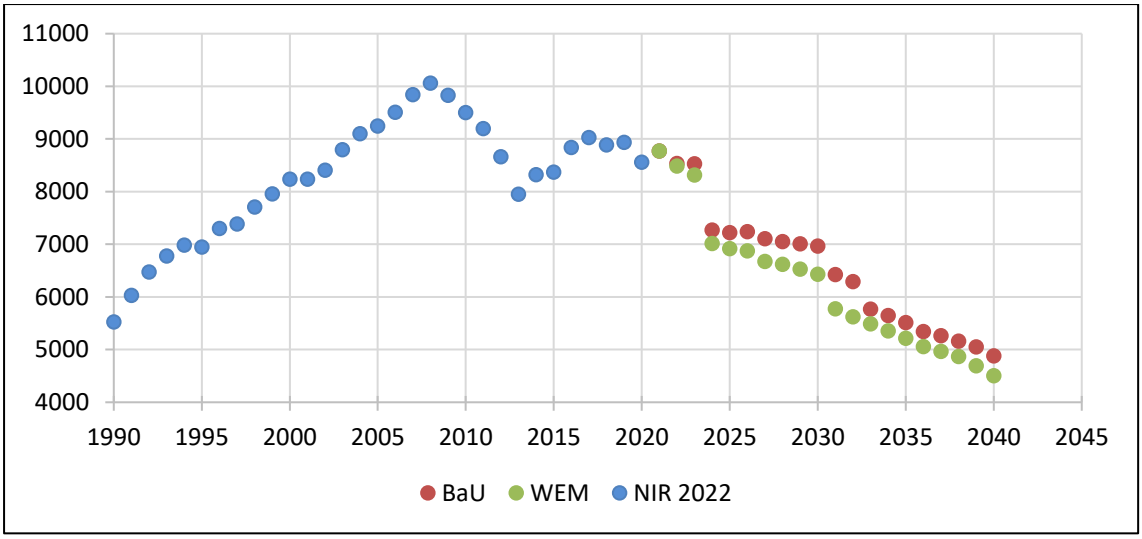

Figure 5.4. Total WEM GHG emissions compared to BaU (Gg CO2 eq.) 1990–2040

The effect of currently implemented and adopted policies and measures (that are incorporated in the WEM projections scenario) are presented in Table 5.2 in terms of GHG emissions avoided on a CO_2 equivalent basis. The aggregate impact is not equal to the sum of the reductions from each measure, as when combined they produce different results.

Table 5.2. Reductions for WEM by Sector and Gas (Gg CO2 eq.)

Gg CO2 eq.	**2025**	**2030**	**2035**	**2040**
Energy	189	376	127	190
Transport	0	14	14	13
IPPU	5	20	29	39
Agriculture	0	0	3	5
Waste	111	126	129	131
Total (Excluding LULUCF)	**305**	**537**	**301**	**378**
Gas (Excluding LULUCF)				
CO2	188	389	139	202
CH4	111	127	132	136
N2O	1	1	1	2
HFCs	5	19	28	37
PFCs	NO	NO	NO	NO
SF6	0	1	1	2

The total estimated GHG emissions reduction potential from the implemented and adopted policies and measures (without LULUCF) was estimated to be 305 Gg CO2eq for 2025 (159 Gg under EU-ETS and 146 Gg under ESR sectors); and 537 Gg CO2eq for 2030 (314 Gg under EU-ETS and 223 Gg under ESR sectors).

5.2.2.1. WEM sensitivity analysis

A quantitative sensitivity analysis was not performed due to unavailability of emission reductions per policy or measure for all policies and measures

5.2.3. With additional measures (WAM)

The WAM emissions by sector for years 1990–2040 are presented above in Table 5.1, and are depicted below in Figure 5.6. The activity data used for the calculations is presented in Annex V.

The methodologies applied are the same as those used for the preparation of the 2022 submission of National Greenhouse Gas emissions inventory of Cyprus to the UNFCCC[65]. The impact in the emissions is presented in Table 5.3 and Figure 5.8. This scenario is based on the official National Energy and Climate Plan (NECP) of January 2020, updated with published technoeconomic data, macroeconomic and fuel price assumptions. In the transport sector, a degree of modal shift is achieved through considerable investments in sustainable modes of transport.

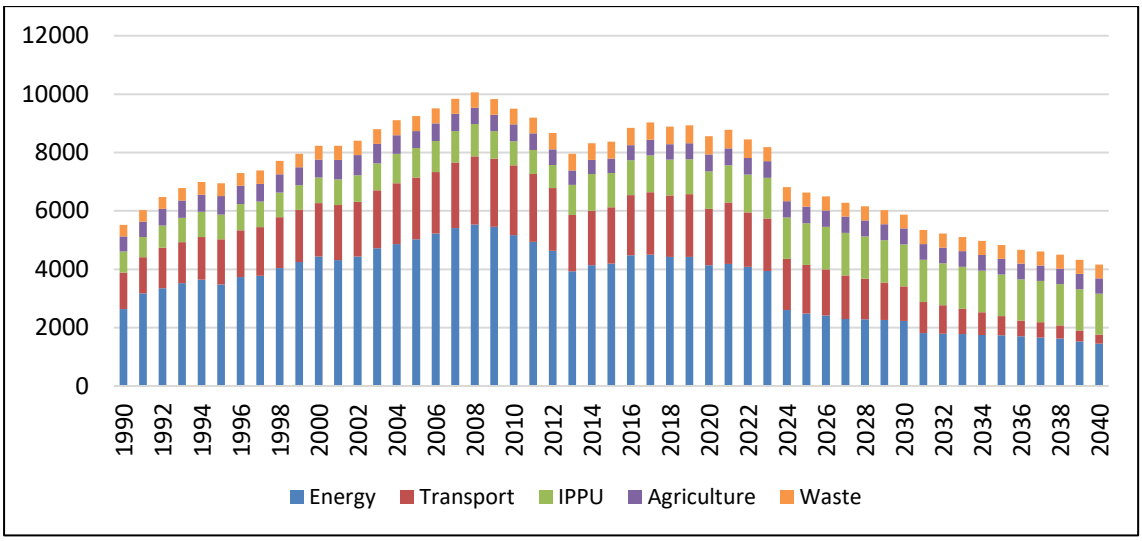

Figure 5.5. Total WAM GHG emissions by sector (Gg CO2 eq.) 1990–2040

Emissions based on the WAM scenario are projected to decrease by 25% in 2040 compared to 1990 and decrease by 55% compared to 2005. In 2040 the difference between WAM and BaU is -15%, while the difference between WAM and WEM is -7%. Reductions from the WAM scenario as compared to the BaU scenario are presented below in Figure 5.6 and Table 5.3.

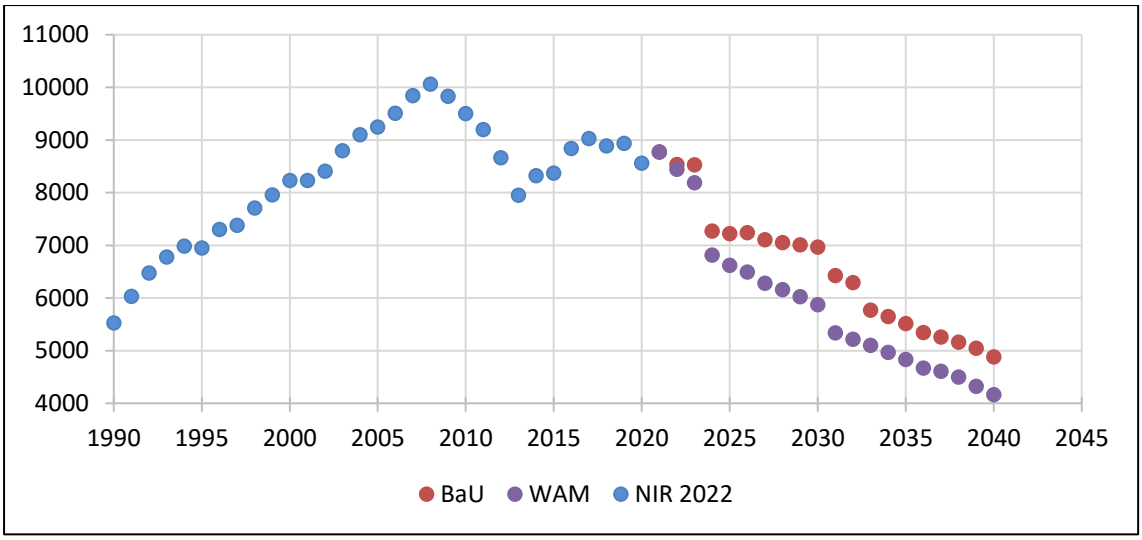

Figure 5.6. Total WAM GHG emissions compared to BaU (Gg CO2 eq.) 1990–2040

The effect of currently implemented and adopted policies and measures (that are incorporated in the WAM projections scenario) are presented in Table 5.3 in terms of GHG emissions avoided on a CO_2 equivalent basis. The aggregate impact is not equal to the sum of the reductions from each measure, as when combined they produce different results.

[65] https://unfccc.int/documents/461671

Table 5.3. Reductions for WAM by Sector and Gas (Gg CO2 eq.)

Gg CO2 eq.	2025	2030	2035	2040
Energy	304	736	301	392
Transport	107	125	122	34
IPPU	19	39	59	78
Agriculture	5	9	13	17
Waste	163	183	188	193
Total (Excluding LULUCF)	**599**	**1093**	**682**	**714**
Gas (Excluding LULUCF)				
CO2	405	851	412	419
CH4	169	196	204	212
N2O	5	7	7	5
HFCs	18	37	56	74
PFCs	NO	NO	NO	NO
SF6	1	2	3	4

The total estimated GHG emissions reduction potential from the planned policies and measures (without LULUCF) was estimated to be 599 Gg CO2eq for 2025 (213 Gg under EU-ETS and 386 Gg under ESR sectors); and 1093 Gg CO2eq for 2030 (544 Gg under EU-ETS and 548 Gg under ESR sectors).

5.2.3.1. WAM sensitivity analysis

A quantitative sensitivity analysis was not performed due to unavailability of emission reductions per policy or measure for all policies and measures

5.2.4 LULUCF projections

The absorptions from the LULUCF sector are expected to increase in the coming years, mainly due to the growth of trees in the forested areas and implementation of the national policies and measures on forestation and reforestation. Table 5.4 and Figure 5.7 present the projected absorptions by the LULUCF sector until 2040 compared to previous years.

Table 5.4. 1990–2040 LULUCF emissions

Gg CO2 eq.	NIR2022	BaU	WEM	WAM
1990	-304.97			
1995	-300.93			
2000	-67.19			
2005	-291.97			
2010	-295.32			
2015	-357.39			
2020	-348.81	-348.81	-348.81	-348.81
2025		-403.99	-403.99	-403.99
2030		-439.93	-439.93	-439.93
2035		-475.87	-523.77	-687.00
2040		-511.81	-578.44	-793.94

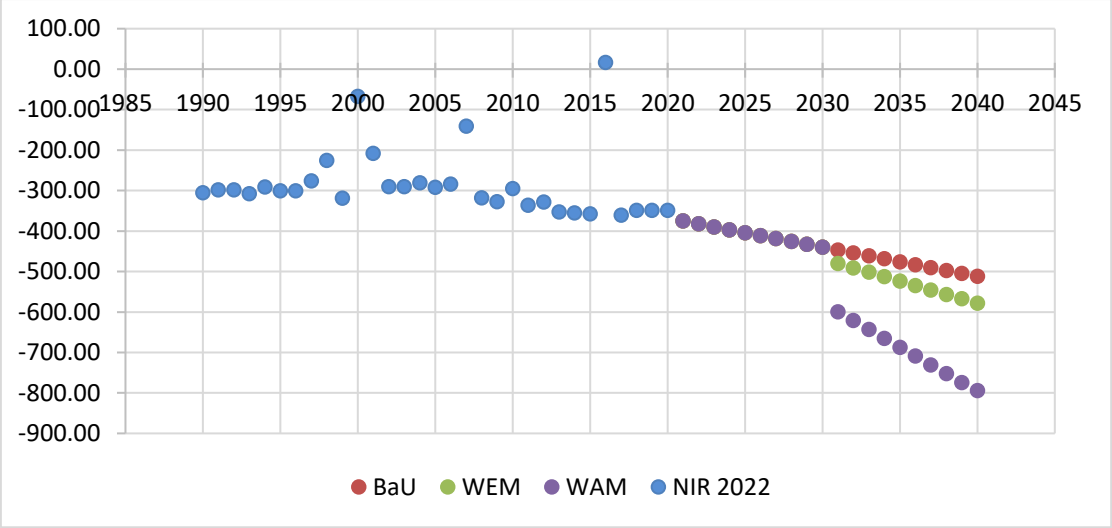

Figure 5.7. Projected LULUCF emissions by 2040, where "NIR2022" are the GHG historical emissions according to the May 2022 submission to the UNFCCC secretariat; BaU is the "Business as Usual" scenario; WEM is the "With existing measures" scenario; WAM is the "With additional measures" scenario

5.3. Methodology used for the presented GHG emission projections

5.3.1 Description of the information collection process

The methodology applied for the estimation of the projected GHG emissions has taken into consideration the following:

(a) At the time the projections were estimated, the 2022 GHG emissions inventory was available. Therefore, all data presented for 2020 and prior is based on the 2022 GHG inventory submitted to the UNFCCC in April 2022 for the purposes of compliance with Regulation (EU) 525/2013. The projection calculations reflect the inventory data for the historical years 1990–2020, revised to reflect the feedback from the latest UNFCCC review of this data.
(b) For the energy sector two models have been utilised by the Cyprus Institute for the preparation energy projections: OSeMOSYS-Cyprus and Final energy demand projection model.
(c) For the activities that are included in the EU-ETS data for 2021 was available from the annual reports of the installations. This concerns the sectors of electricity generation (1A1a(i)) and cement and ceramics production (1A2f, 2A1 and 2A4a).
(d) GDP and population projections from the energy models were used where GDP and population data was needed.
(e) The projections of activity data were converted to GHG emissions through the application of the 2006 IPCC Guidelines and by applying global warming potential values from the fourth IPCC assessment report, in line with the latest national GHG inventory submission (2022). Emission factors are derived from expert assessments based on the 2006 IPCC guidelines and country specific information.

The main steps of the methodology applied for all sectors were the following: (a) Scenario definition, (b) Activity data projection, (c) Estimation of GHG emissions. Further details on each sector and the specific assumptions applied are given in the sections that follow.

The base year for projections is the latest year reviewed inventory year of the national GHG emission inventory. Measures which have been introduced before the time of projection preparation are considered as existing measures. Measures expected to be approved later are considered as additional. Predictions of the number of inhabitants are based on information from the Statistical Service. These data are used for the energy models and waste projections. The scenarios of trends in the GDP used in projections are based on predictions provided by Ministry of Finance. These data are used for the energy models and for Waste sector projections. The prices of fuels on the global market and carbon

prices are taken from the European Commission harmonised parameter values where national estimates are not available. The prices of domestic energy sources are based on the costs of their acquisition and are also affected by the competitive energy sources. Energy production projection data and energy consumption development are obtained by the relevant bodies (System Operators, Cyprus Energy Regulatory Authority and Energy Service) as well as from projections made by external collaborators. The decision on the projections to be used is taken by the Ministry of Energy. Calculation of GHG emissions from fuel combustion is based on energy balances obtained from the scenarios developed by the model of external collaborators. The projections of GHG emissions in Agriculture are based on trends in the activity data used in the emission inventory calculation. The most important activity data are animal population cattle and swine population, amount of fertilizers applied to agricultural soils, and annual harvest and production. The development of animal numbers is taken from the Department of Agriculture.

The activity data for the base year are taken from the Statistical Service.

The emission estimates in the LULUCF sector are to a large degree determined by development of land areas categorized by their use. Therefore, the LULUCF emission estimates and their projections must primarily methodologically solve the issue of land areas. The actual development of six major IPCC land use categories as reported in the latest emission inventory is used. The projections are based are on the observed trends and anticipation of gradually less intensive land use changes until 2040. The specific attention is given to forest land, which always represents one of the key absorption categories in the emission inventory.

A waste sector projection contains three source categories - emissions from landfills, emissions from wastewater handling and emissions from biological treatment of waste. For the landfill estimation first order decay model is used based on the IPCC waste model template and for the other three sectors tier 1 methodology for the particular source sectors is applied. Activity data for the projections are various. Main socioeconomic drivers used for quantifications and GDP are obtained from the Ministry of Finance.

Subsequent activity data are estimated in accordance with scenarios description and particular policy.

Different annual reports often provide information regarding costs and energy savings achieved by different programmes and subsidy schemes. Nevertheless, further calculations are needed to evaluate the effect of emission savings in detail.

5.3.2 Description of the alignment with the national inventory system

There are certain parameters that ensure the alignment of projections with the national inventory:

- Data sources: the data sources are the same for both the inventory and the projections
- Methodology: the methodology applied for projections is the latest reviewed inventory methodology
- Experts: the experts involved in the preparation of the inventory are the same as the experts involved in the preparation of the projections

In case discrepancies are identified between the inventory and the projections, QA/QC procedures are applied to achieve the best possible calibration between the two data sets.

5.3.3 Description of the links to arrangements on integrated national energy and climate reports pursuant to Art. 17 of Regulation (EU) 2018/1999

To collect data related to policies and measures and projections, the structure prepared for the preparation of the NECP and reporting on progress other dimensions of the Energy Union, e.g. processes to foster consistent use of energy-related data for the development of policies and measures and projections and for integrated progress reporting are applied.

5.3.4 Description of the quality assurance and quality control activities for reporting of policies and measures and projections

All the expert organizations providing information for the reporting are well-established and have their own QA/QC procedures. Furthermore, the ministries are responsible for the quality of information on their respective policies and measures and projections and perform further checks where applicable, such as comparison to other estimates. The Department of Environment is responsible for collecting and combining all the information and for performing further quality checks. For example, the Department of Environment compares the sectoral projections to the scenarios of the latest Energy and Climate Plan as well as compares the compatibility of the WEM and WAM projections with the effects of policies and measures. The Department of Environment also checks the completeness and that the reporting requirements are met. Sensitivity analyses for projections are carried out for factors being especially significant in terms of greenhouse gas emissions, and they are described in detail in the report accompanying each round of the Reporting. After the reporting tools and paper report have been compiled by the Department of Environment, they are sent to the decarbonisation working group for approval and afterwards to the network of officials for final approval.

5.3.5 Description of the process for selecting assumptions, methodologies and models for making projections of anthropogenic greenhouse gas emissions

Sector experts from the Department of Environment and other key agencies are responsible for selecting the assumptions, methods and models to use for the projections. The Department of Environment experts work closely and interact regularly with other key experts on energy, agriculture, industrial processes, forestry and land use change and waste modelling in order to establish an appropriate set of assumptions and methods. The experts document the data sources, methods and assumptions. Improvement opportunities are regularly identified and documented which includes input from external experts. The Department of Environment manages a list of improvements which is reviewed and prioritised on a regular basis for implementation. Changes to processes are documented in the methodology report.

5.3.6 Description of procedures for the official consideration and approval of the Member States national system for policies and measures and projections

All the involved institutions participating to the decarbonisation technical committee of the national governance system for climate and energy have nominated an expert for every reporting preparation period whose responsibility is to provide the necessary data for the report. Institutional experts take part in the quality assessment process and give the final approval concerning the information in the reporting tools and final report to be submitted.

5.3.7 Information on relevant institutional administrative and procedural arrangements for domestic implementation of the EU's nationally determined contribution, or changes to such arrangements

The domestic implementation of the EU’s nationally determined contribution is monitored through regular meetings of the Decarbonisation Working group of the national governance system. Issues, such as budgets, proposals to EU funds are discussed along with different practical issues that may come up during the implementation of the measures.

5.3.8 Description of the stakeholder engagement undertaken in relation to the preparation of policies and measures and projections

All the relevant stakeholders are kept informed through participation in the meetings of the relevant working group of the governance system that will contribute later to the decarbonisation working group.

5.3.9. Energy Sector

5.3.9.1 Information on Models Used

Energy demand and production data for the sectors of energy were obtained mainly from the Cyprus Institute, where OSeMOSYS-Cyprus and Final energy demand projection model. The use of these models leads to the conduction of analytical quantitative targets per technology, such as the demanded power for wind turbines, small-scale biomass or the quantification of energy savings in the industrial and residential sectors, etc.

The existing model of the Cypriot energy system, developed in OSeMOSYS is updated to support the formulation of the National Energy and Climate Plan of the Republic of Cyprus. OSeMOSYS is a demand-driven cost-optimisation model, the objective function of which is to satisfy an exogenously defined final energy demand at the least possible cost. Taking into account a range of assumptions with regards to techno-economic characteristics of technologies, fuel prices, emission limits and other system constraints, the model identifies a cost-optimal technology and energy mix.

The Final energy demand projection model was initially developed in 2008 in order to suit the planning needs of Cypriot energy and environmental authorities. It has been adopted since 2009 for the preparation of consecutive Renewable Energy and Energy Efficiency Actions Plans that were submitted by the Republic of Cyprus to the European Commission; for the development of a renewable energy roadmap for Cyprus with the aid of the International Renewable Energy Agency; for the national building renovation strategy; for the assessment of the energy efficiency potential in the Cypriot economy; and for various reporting needs to assess the compliance of Cyprus with the Energy Efficiency Directive. Since 2018 it has been used in combination with the OSeMOSYs model in the preparation of diverse national plans, such as the impact assessment of the National Energy and Climate Plan, the greenhouse gas and air pollutant emission projections used by climate change and air quality authorities, the economic impact assessment of the National Recovery and Resilience Plan, the long-term low GHG development strategy, and the preparation of a proposal for a green tax reform including a carbon tax in non-ETS sectors of the economy. The models run for the energy projections were updated with the harmonised key parameters provided by the European Commission in May 2022, in order to reflect the impact of the COVID-19 pandemic and the war on Ukraine. They also include the latest

5.3.10 Non-Energy sectors

GHG emissions in the non-energy sectors are calculated using spreadsheet models that calculate emissions based on projected activity data, emission factors and sector specific assumptions. Activity data is projected on the basis of expert judgement of sectoral experts and where necessary involvement of the private sector.

5.3.11 Scenario Definition

The tables that follow summarise the main assumptions of each scenario applied for the estimation of the GHG emissions up to 2040 for the IPPU, Agriculture and Waste sectors, based on the policies and measures presented in previous sections. Tables 5.5 and 5.6 summarise the main assumptions for the Energy sectors, while Table 5.7 summarises the main assumptions for the non-energy sectors. Assumptions for changes in animal population are presented in Table 5.8. For the complete 2020 data, please refer to the 2021 National Greenhouse Gas Inventory Report. Details on the activity data by sector for energy and non-energy sectors are provided in section 5.5.4.

Table 5.5. Main assumptions and parameters used for the three projections' scenarios (BaU, WEM and WAM)

Energy sub-sector	BaU	WEM	WAM
1A1a i Electricity Generation	Table 4.6	Table 4.6	Table 4.6
1A1c Manufacture of solid fuels and other energy industries 1A1cii Other Energy Industries	GDP*	Same as BaU	Same as BaU

1A3a ii Domestic Aviation 1A3d i International water-borne navigation 1A5 Non-Specified			
1A2 Manufacturing Industries and Construction excluding 1A2f 1A4 Other Sectors	Energy models	Energy models	Energy models
1A2f Non-Metallic Minerals 2A1 Cement production	Full capacity from 2021; 80% alternative fuel by 2024 of which 30% biomass	Same as BaU	Same as BaU
1A3a i International Aviation	2021: percent change compared to 2020 based on tourists' arrivals; 2022 onward: GDP	Same as BaU	Same as BaU
1A3b Road Transport	Energy models	Energy models	Energy models
1A3d ii Domestic water-borne navigation	2021: 2019 value; 2022 onward: GDP	Same as BaU	Same as BaU
1A5 Other	GDP	Same as BaU	Same as BaU

Table 5.6. Assumptions for the energy mix to cover the electricity demand for each scenario (BaU, WEM and WAM)

	BaU	**WEM**	**WAM**
RES (in final energy demand)	14.3% (2021), 15.3% (2022), 17.7% (2023), 19.3% (2024), **21.4% (2025),** 22.8% (2026), 25.3% (2027), 26.8% (2028), 27.9% (2029), **28.7% (2030)**. Followed by faster increase to **47.0% (2035)** and **58.2% (2040**)	21.7% (2025),29.0% (2030), 45.3% (2035),58.3% (2040)	21.5% (2025), 29.0% (2030), 44.3% (2035), 57.4% (2040)
Biomass	3.3% (2021-2022), 4.0% (2023),4.2% (2024), **4.3% (2025**), 4.4% (2026), 4.5% (2027), **4.6%** (2028-**2030**), then approximate decrease of 0.1% a year; **4.4% (2035), 4.1% (2040**)	4.4% (2025), 4.7% (2030), 4.6% (2035), 4.3% (2040)	4.2% (2025), 4.4% (2030), 4.2% (2035), 3.9% (2040)
Natural gas	Starts from 2024	Starts from 2024	Starts from 2024

Table 5.7. Main assumptions and parameters used for the three projections' scenarios (BaU, WEM and WAM)

Sector	**BaU**	**WEM**	**WAM**
2A2 Lime Production	Reach 8000 t in 2030 linearly; then constant	Same as BaU	Same as BaU
2A4 Other Process Uses of Carbonates 2D1: Lubricant Use 2D2: Paraffin Wax Use	Maintain 2020 constant	Same as BaU	Same as BaU
2D3 Other - Solvent Use	Use 2020 per capita emissions with population projections	Same as BaU	Same as BaU
2F Product Uses as Substitutes for Ozone Depleting Substances 2G Other Product Manufacture and Use	Use 2020 per capita emissions with population projections	Start recovery from 2024, increase linearly to reach 5% recovery in 2030; 10% recovery in 2040	Start recovery from 2024, increase linearly to reach 5% recovery in 2025; 10% recovery in 2030; 20% recovery in 2040

2D3 Other - Urea-based catalysts	Use diesel projection from road transport	Use WEM diesel projection from road transport	Use WAM diesel projection from road transport
3A1a Dairy cattle	Lactation/ GE (gross energy intake): extrapolate 1990-2020 linear trend Pregnancy (NEp): assume constant 2020	Same as BaU	Same as BaU
3B Dairy cattle 3B Other cattle	Anaerobic digestion: linear increase from 2020 to reach 15% in 2040	Anaerobic digestion: linear increase from 2020 to reach 10% in 2030; 15% in 2040	Anaerobic digestion: linear increase from 2021 to reach 15% in 2030; 30% in 2040
3B Swine	Anaerobic digestion: linear increase from 2020 to reach 70% in 2040	Anaerobic digestion: linear increase from 2021 to reach 65% in 2030; 75% in 2040	Anaerobic digestion: linear increase from 2021 to reach 70% in 2030; 80% in 2040
3B Poultry	Anaerobic digestion: linear increase from 2019 to reach 30% in 2040	Anaerobic digestion: linear increase from 2021 to reach 25% in 2030; 30% in 2040	Anaerobic digestion: linear increase from 2021 to reach 30% in 2030; 40% in 2040
3D1.1 Inorganic N fertilisers	Linear decrease from 2019 to reach -5% in 2040	Same as BaU	Same as BaU
3H Urea application	Linear decrease from 2019 to reach -5% in 2040	Same as BaU	Same as BaU
5A Solid Waste	per capita production 2020: change with GDP - no tourists - > lower waste production 2021-2040: same as 2019 composition of waste to disposal sites: same as 2019	40% sorting at source from 2022; 55% 2025; 60% 2030; 65% 2035[1] 24% of organics to landfill from 2022; 24% in 2030; 24% in 2035[2] 20% recovery of deep unmanaged and managed from 2023	40% sorting at source from 2022; 55% 2025; 60% 2030; 65% 2035 24% of organics to landfill from 2022; 24% in 2030; 24% in 2035[3] 30% recovery of deep unmanaged and managed from 2023
5B1. Composting	Waste composted: Assume same portion of waste going to compost as 2020 (9.5%)	Same as BaU	Same as BaU
5B2. Anaerobic Digestion at Biogas Facilities	Waste digested: Assume constant as 2020	Annual increase of 1% from 2022	Same as WEM
5D Wastewater Treatment and Discharge	Population connected to central systems: assumed constant as 2020	84.5% (2020-2022), 84.8% (2023), 89.8% (2024-2026), 92.9% (2027), 94.0% (2028), 94.7% (2029), 100.0% (2030-2040)	Same as WEM
5D2 Industrial Wastewater Treatment and Discharge	Industrial production: assuming growth proportional to GDP	Increase anaerobic from 2025 (5% alcohol, 20% beer, 5% soft drinks, 7% dairy products, 10% meat and poultry, 5% vegetables, fruits and juices); constant after 2030	Same as WEM

Table 5.8. Assumptions for change in animal population

Animal Specie	2019-2030	2030-2040
Dairy & Other cattle	Linear reduction to reach -3.5% of 2019	Linear reduction to reach -2.5% of 2019
Sheep and goats	Linear increase to reach +10% of 2019	Stable from 2020
Swine	Linear reduction to reach -3% of 2019	Linear reduction to reach -2% of 2019
Horses	Stable from 2020	Stable from 2020
Mules & asses	Extrapolate 2011-2020 linear trend, continue	Continue trend
Poultry	Stable from 2020	Linear increase to reach +10% of 2019

5.3.12. LULUCF sector

For the LULUCF sector it was assumed that the scenario WEM will include the "I plan for climate" mitigation measure that was introduced in 2018 in addition to the fire prevention measures as presented above. The implementation of the "I plant for climate'' campaign, is directed towards forestation of areas that were not Forest Land before. It is assumed that this measure will lead to the conversion of Annual Cropland to Coniferous Forest. For the rest categories (Cropland, Grassland, Wetlands, Settlements, Other Land & HWP) it was assumed that a linear projection of the current activity data/ trend will take place till 2050. For Forest Land remaining Forest Land, the average values for harvesting and forest fires for the period 2012-2018 was used as a constant for the projection. This approach leads to an abrupt drop in removals between 2018 and 2019. The starting point for the projections was 2018 and the inventory submitted in 2020 to the UNFCCC was utilized.

The BaU assumes that the policies and measures are not implemented and the WAM assumes that additional absorptions are achieved.

Mitigation potential & projections for LULUCF mitigation measure "I plant for Climate"
For the projections it was assumed that 200 trees will be planted per hectare. As the starting year 2018 was utilized and the number of trees produced was estimated as presented below (estimated numbers were provided by the Department of Forests). It is assumed that the area planted was previously utilized as Annual Cropland and that the reforestation is all coniferous forest. The transition period is 20 years.

Table 5.9. Main assumptions and parameters used for the LULUCF WEM

Year	No of trees produced	Hectares planted (200 trees/ ha) per year	Additional Annual Cropland to Coniferous Forest in ha (total area)	Additional Coniferous Forest to Coniferous Forest (20-year transition period) in ha
2019	9000	45	45	0
2020	70000	350	395	0
2021	150000	750	1145	0
2022	150000	750	1895	0
2023	150000	750	2645	0
2024	150000	750	3395	0
2025	150000	750	4145	0
2026	300000	1500	5645	0
2027	300000	1500	7145	0
2028	300000	1500	8645	0
2029	300000	1500	10145	0
2030	300000	1500	11645	0
2031	300000	1500	13145	0
2032	300000	1500	14645	0
2033	300000	1500	16145	0
2034	300000	1500	17645	0
2035	300000	1500	19145	0
2036	300000	1500	20645	0
2037	300000	1500	22145	0
2038	300000	1500	23645	0

Year	No of trees produced	Hectares planted (200 trees/ ha) per year	Additional Annual Cropland to Coniferous Forest in ha (total area)	Additional Coniferous Forest to Coniferous Forest (20-year transition period) in ha
2039	300000	1500	25100	45
2040	300000	1500	26250	395

There were two projections calculated, one for Annual Cropland to Coniferous Forest and the other for Coniferous Forest remaining Coniferous Forest for the period 2019–2050 for the specific mitigation measure.

Table 5.10. Total increase in removals between land categories for LULUCF WEM

Year	Total increase in removals with specific measure "I plant for Climate" for CL to F	Total increase in removals with specific measure "I plant for Climate" for F to F	Total Projected emissions for the LULUCF sector (WEM)
2019	-1	0	-379
2020	-8	0	-381
2021	-20	0	-388
2022	-25	0	-388
2023	-31	0	-388
2024	-36	0	-389
2025	-42	0	-389
2026	-64	0	-414
2027	-75	0	-427
2028	-86	0	-440
2029	-97	0	-453
2030	-108	0	-466
2031	-119	0	-479
2032	-130	0	-493
2033	-141	0	-507
2034	-152	0	-520
2035	-163	0	-534
2036	-174	0	-548
2037	-185	0	-560
2038	-196	0	-573
2039	-207	-0.05	-585
2040	-215	-0.46	-595

5.3.13. Main Differences in Assumptions, Methods Employed, and Results Between Current and Previous National Communication Submissions

As detailed in Chapter 4, the policy and measures for projections are aligned with the National Energy and Climate Plan for the period 2021–2030 (NECP) which is the overarching mitigation action plan of Cyprus for the particular period, along with the National Long-term Strategy pursuant to Article 15 of the Regulation 2018/1999. However, major events have transpired between the adoption of the initial NECP and the current submission, including the COVID-19 pandemic, the war in Ukraine, and the EU's commitment to Fit-for-55 package. The impacts from COVID-19 and the war in Ukraine result in lower economic growth that impacts the final energy demand. In addition, the projection for fuel prices is

also very different. Higher fuel prices means that renewable energy is more competitive, especially in the long run, resulting in higher renewable energy shares.

Also impacting transport projections are updated technoeconomic assumptions of vehicles, namely cost assumptions and fuel efficiencies of vehicles. The NECP policies and measures will be updated in 2023. While projection parameters in previous projection reports to the EU were based in these NECP policies and measures, policies and measures for energy and transport sectors in this national communication were more closely aligned with the recommended harmonised values provided by the European Commission in May 2022. This ensures that projections presented in this report better reflect current economics and technology.

Essentially, the WAM scenario for energy follows the NECP PaMs with revised inputs. The WEM scenario is the replicate of the final reference projection scenario of EU 2020. The BaU scenario is similar to WEM, but replicates intensity by sector, and also reflects that the microeconomic parameters from Cyprus are higher than those from the EU Commission. For the non-energy sector, the BaU, WEM and WAM scenarios are based on assumptions from the appropriate ministries, as summarised previously in Tables 5.5–5.8.

The updated NECP parameters will serve as the guide for future projection reporting. Quantitative targets as they stood in the previous NECP submission are shown below in Table 5.11, while the key policy priorities deemed necessary for obtaining these targets are outlined below in Table 5.12. These will be adjusted as necessary and reflected in subsequent submissions.

Table 5.11. National energy and environmental objectives for the period 2021-2030 in the context of EU policies

Reducing greenhouse gas emissions and environmental objectives
• Emissions in the non-ETS sectors to be reduced by 20.9% compared to 2005. The non-ETS national target is going to be achieved by the use of flexible mechanisms provided by the ESR. • Emissions from land use, land use change or forestry are offset by at least an equivalent removal of CO_2 from the atmosphere • Emissions in ETS sectors to be reduced by 24.9% compared to 2005 • Attaining quantitative targets for reducing national emissions of specific air pollutants
Increasing the share of RES in energy consumption
• Share of RES in gross final energy consumption to reach 23% • Share of RES in gross final electricity consumption can reach at least 26% • Share of RES in heating and cooling to reach 39% • Share of RES in the transport sector to reach 14%
Improving Energy Efficiency
• Final Energy Consumption of 2.0 Mtoe in 2030, representing 13% reduction in final energy consumption compared to the respective projection for Cyprus in the 2007 in the EU PRIMES 2007 Reference Scenario • Primary Energy Consumption of 2.4 Mtoe in 2030, representing 17% reduction in primary energy consumption compared to the respective projection for Cyprus in the 2007 in the EU PRIMES 2007 Reference Scenario • Achieving cumulative energy saving of 243.04 ktoe during 2021-2030

Table 5.12. Key policy measures planning priorities

PILAR	**Key policy planning priorities**
GHG emissions and removals	• Promotion of natural gas as intermediate fuels for the decarbonisation of the energy system • Promotion of renewable energy sources • Improvement of energy efficiency in buildings, industry and infrastructure • Reduction of emissions in the transport sector • Reduction of fluorinated gas emissions • Reduction of emissions from agricultural sector

PILAR	Key policy planning priorities
	• Reduction of emissions from waste sector • Increase carbon sinks
Renewable energy sources	• Various RES Support schemes for Self-Consumption • Synergies with other sectors (Energy Efficiency, Waste, Security of supply and Internal Energy Market) to promote RES in all energy sectors • Support schemes for RES to participate in the Electricity Market • Replacement of old Solar Collectors for households • Replacement of Solar Collectors for Commercial purposes and use of Solar Technologies for High process heat and/or Solar Cooling • Old vehicle scrapping scheme and financial incentives for the purchase of electric vehicles (both new and used) • Promotion of the open loop Geothermal Energy • Installation of RES and Energy Efficiency technologies in Public Buildings. • Electricity Storage Installations, Framework development and possible financial incentives. • Various other measures for RES in Transport (New bus contracts (using alternative fuels, electricity, gas, and biofuels B100), Use of Biofuels (and biogas) in Transport Sector • Other indirect measures that will help to increase energy efficiency and thus the RES Share in transport. • Statistical Transfer of Energy to be examined (exporting Energy in case of Electricity Interconnector)
Energy efficiency	• Energy efficiency obligation scheme for energy distributors • Energy Fund of Funds providing soft loans for energy efficiency • Individual energy efficiency interventions and energy efficiency retrofits in governmental buildings • Implementation of information and education measures • Support schemes/incentives for promoting energy efficiency in households, enterprises and wider public • Energy efficient street lighting. • Additional floor space “allowance” for buildings exceeded the minimum energy efficiency requirements set by national law • Advanced Metering Infrastructure Plan. • Promotion of energy efficiency in enterprises, through voluntary agreements • Action plan for increasing energy efficiency the road transport. • Energy efficiency in water sector • Vehicle excise duty based on CO2 emissions • Energy consumption fee for Res and energy efficiency applied on electricity bills. • Excise tax on road transport fuels exceeding the minimum levels by EU legislation
Security of supply	• Introduction of natural gas via LNG imports and the development of the necessary infrastructure • Increasing the flexibility of the national energy system
Internal Energy market	• Promotion of electricity interconnectivity of Cyprus via the project of common interest EuroAsia Interconnector • Development of internal natural gas network pipeline infrastructure • Investments for development and secure operation of the transmission electricity system • Promotion of the necessary regulatory framework and projects for the operation of the competitive electricity market • Promotion of the EastMed pipeline project

PILAR	Key policy planning priorities
Research, innovation and competitiveness	• Fund of funds • New Industrial Policy • Establishment of the Deputy Ministry of Innovation and Digital Transformation • European Structural and Investment Funds in the new Programming Period 2021 – 2027 • Revision of national funds regarding research and innovation with the aim to boost climate and energy priorities

5.3.14. Non-Sectoral Key Underlying Parameters

The GHG emission projections presented in this chapter are based on the October 2022 GDP projections provided by the Ministry of Finance[66], and are shown below in Table 5.13.

Table 5.13. Summary of Population and GDP Parameters

	2020	2021	2022	2023	2024	2025	2026
Population	896000	913954	916899	919844	922789	925734	928679
GDP (%)	-5.23	5.51	2.71	3.78	3.39	2.99	2.50
	2027	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
Population	930073	931466	932860	934254	935647	935635	935622
GDP (%)	2.30	2.00	1.69	1.70	1.74	1.76	1.83
	2034	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
Population	935610	935598	935586	934272	932959	931646	930333
GDP (%)	1.93	2.09	2.23	2.39	2.39	2.39	2.39

5.4. Factors and Activities Per Sector

The tables in Annexes III-V show the trends for activity data from 1990–2040. For WEM and WAM scenarios, activity data is only presented for the projected years 2021–2040, as the historical activity data is the same with BaU. Biomass and biofuels are included, but in line with UNFCCC reporting procedures, CO_2 emissions from biomass are not included in sectoral and inventory totals, but rather reported as a memo item in the 2022 National Inventory. Emissions from solvent use are likewise excluded, and reported as indirect emissions in the 2022 National Inventory.

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6. Vulnerability assessment, climate change impacts and adaptation measures

6.1. Introduction

The information presented in this Chapter has been initially collected through the project "Development of a national strategy for adaptation to climate change adverse impacts in Cyprus" or CYPADAPT and has been further enhanced with new research work published after the end of the project. CYPADAPT is co-financed (50:50) by the government of Cyprus and the European Union through the programme LIFE+ (LIFE10ENV/CY/000723). The CYPADAPT main aim is to strengthen and increase Cyprus adaptive capacity to climate change impacts through the development of a National Adaptation Strategy. Further information is available at the website of the project http://uest.ntua.gr/cypadapt/.

6.2. Observed patterns of climate change across and projections for the future

Cyprus lies at the south-eastern end of the Mediterranean Sea and Europe, which is one of the most sensitive hot-spots and most vulnerable regions in the world regarding climate change

Climate in Cyprus is generally characterized by mild rainy winters, occasional droughts, and long, hot and dry summers. In winter, the average daytime temperature ranges from 12–15°C while the wet season extends from November to March, with most (approx. 60%) of the rain falling between December and February (Pashiardis, 2002). Precipitation is generally associated with the movement of moist maritime flows to the North, occurring particularly over areas of high elevation (Kostopoulou and Jones, 2007a). Winter precipitation is closely related to cyclogenesis in the region (Maheras et al., 2001). In summer, the average maximum temperature in coastal regions is 32oC and often reaches 40oC in lowland continental areas. This is attributed to the extension of the summer Asian Thermal Low which is evident throughout the eastern Mediterranean in all seasonal circulation patterns (Kostopoulou and Jones, 2007a,b) and associated high temperatures and abundant sunshine. The characteristic summer aridity of the region has significant implications in several socio-economic sectors (Giannakopoulos et al., 2010).

Recent studies on present and future climate have shown that this semi-arid island has been affected and is expected to be relatively strongly affected by the projected warming and related changes (Christensen et al. 2007, Michaelides et al., 2009). The already observed shift of the mean synoptic weather patterns in Europe (Michaelides et al., 2010) and in the close area (Tyrlis et al., 2015) has been connected with increase in appearance of heavy rainfall events (Hatzaki et al., 2008; Tymvios et al., 2010), rainfall (Lingis and Michaelides, 2009), heat events (Tymvios et al., 2013) and severe dust events (Michaelides et al., 2013). Therefore, Cyprus, where diverse and extreme climate conditions are already common, is likely to face increases in the frequency and intensity of droughts and hot weather conditions in the near future, with probably disproportional impacts.

Some of the future climate changes were projected by using PRECIS as the main Regional Climate Model and the A1B scenario of the Special Report on Emissions Scenarios (SRES) of the Intergovernmental Panel on Climate Change (Nakićenović and Swart 2000) which provides a good mid-line scenario for carbon dioxide emissions and economic grow.

The predictions of future climate change were examined in two future periods i.e. the near future period 2021-2050 and the distant future period 2071-2100. The derived values of various climatic parameters in Cyprus for both future stages were compared to the reference values during the period 1960-1990 (control period). The projected climate changes for the 2021- 2050 period were made by

using six additional simulation models of the ENSEMBLES prediction system[67] beside PRECIS, whereas for the 2071-2100 period the emissions scenarios A2 and B2 were use in addition to the A1B.

The future period 2021-2050 has been chosen specifically and examined in detail for the needs of stakeholders and policy makers, in order to assist their planning in relation to adaptation measures, impacts and vulnerability assessment.

In general, regional climate models consistently predict an overall warming and drying of Cyprus with significant impacts in human health, energy use, water resources and other socio-economic sectors Pronounced warming and precipitation reductions are also detected from time series of temperature and precipitation parameters, regarding representative locations of Cyprus during the period 1951-2100.

6.2.1. Observed changes

6.2.1.1. Observed changes in temperature

Temperature records and long-term changes in diurnal temperature range have been studied by Collins Price (Price et al., 1999) and more recently, for the period 1892 – 2010 from the Department of Meteorology (Papachristodoulou, 2022) and the Cyprus Institute (Hadjinicolaou et al. 2011). These studies show an increase in the annual mean air temperature of the atmosphere of the order of 1.8°C in Nicosia (Figure 6.1) and 2.9°C in Lemesos (Figure 6.2). This increase is higher than the rise in the global mean surface temperature, which was ranging between 0.74°C ± 0.18°C over the last 100 years (1906 – 2005), according to the Intergovernmental Panel on Climate Change (IPCC, 2007).

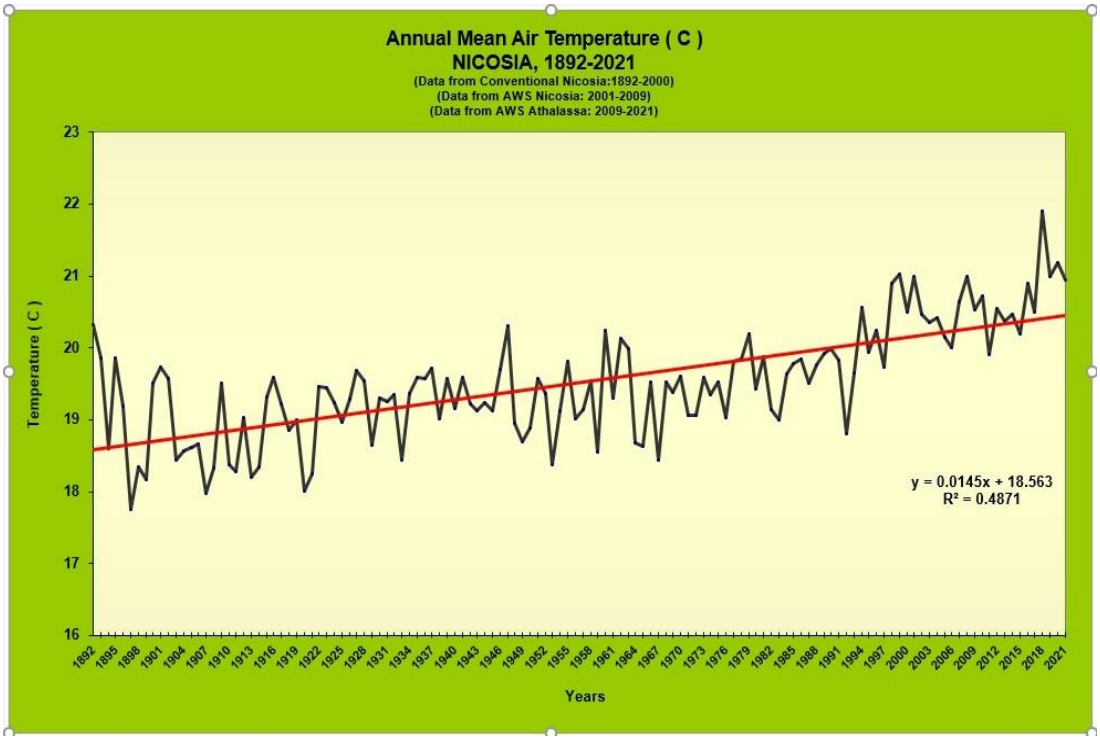


Figure 6.1. Observed changes in the annual mean air temperature (°C) from 1892 till 2021 in Nicosia

Moreover, as regards the annual mean air maximum and minimum temperature, the former varies depending on the location, while the later show an increase for the whole area have found a less rapid warming In Tmin over the mountains compared to inland and coastal areas.

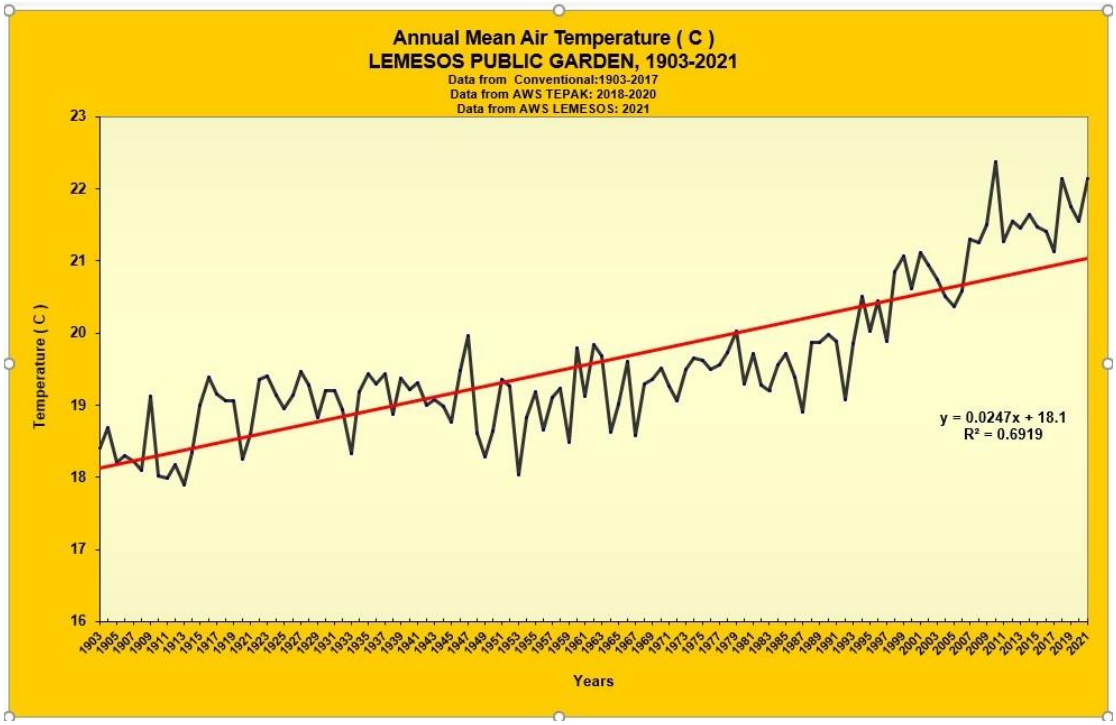


Figure 6.2. Observed changes in the annual mean air temperature (°C) from 1903 till 2021 in Lemesos

The 1961-1990 reference temperature patterns generally illustrate the different climatic zones within Cyprus, from the cool higher elevation regions to the hot and dry lowlands and the warm and humid coasts. Regarding this reference period, the average maximum temperature range is 10-16°C in winter and 25-35°C in summer. The summertime maximum TX in coastal regions is about 33°C, while further inland it often exceeds 40°C.

The average minimum temperature (TN) during winter (DJF) ranges between 2-14°C and in summer ranges between 15-25°C, showing the contrast between the coastal and the continental areas. Winter average TN does not fall below 2°C, even in continental parts of the country, whereas minimum temperatures above 7°C are typical of the Cyprus milder coastal climate.

6.2.1.2. Observed changes in precipitation

From the data of the Department of Meteorology (S. Papachristodoulou, 2022), in Figure 6.3 it can be seen that the annual average of the total precipitation has decreased from 559 mm (climate period 1901 - 1930) to 463 mm (climate period 1971 - 2000) which amounts to a decrease of 18%. The difference of the average precipitation of the climatic period 1941-1970 (pink line) with the average precipitation of the climatic period 1951-1980 (brown line) as well as with the average annual precipitation values of the following climatic periods of the line (1961-1990 and 1971- 2000, red line) depicts the decline in precipitation. The average precipitation of the climate period 1981-2010 (black line) is 464 mm, so it remains at the same level as the previous climate period 1971-2000, while the average precipitation of the climate period 1991-2020 (blue line) is 475 mm, which means that there is also a small increase compared to the 2 previous climate periods. According to Lange (2009) the decrease in precipitation for the period 1905 to 2005 was about 170 mm, while in 2008 precipitation was 45% below the 2000-2007 average, leading to severe drought.

The problem of the rainfall reduction in Cyprus till 2010 is also depicted in Figure 6.4 which shows the water stress index in other words the availability of water. Cyprus ranks first among the European countries in terms of water stress index (Wintgens and Hochstrat, 2006).

The total annual precipitation is presented in Figure 6.5. The large east–west contrast is evident in both annual and seasonal precipitation patterns. The maximum annual total precipitation occurs at the

western coasts and most precipitation occurs in winter and autumn, in similar patterns. The winter total precipitation ranges from about 75mm in the lowlands of central Cyprus to 270mm in the western higher elevation areas, woodlands and wetlands.

The frequency distribution of the annual precipitation per climatic period (30 years) was investigated by Michaelides et al. (2009). The analysis revealed that although the mean precipitation value of each climatic period had minor variation, the statistical distribution characteristics of the annual precipitation between climatological periods diversified significantly with an increase of years with high and low precipitation at the expense of years with average precipitation during consequent climatological periods. These findings are in agreement with the findings of Alpert Pinhas (Pinhas et al., 2002) who studied the paradoxical increase of Mediterranean extreme daily rainfall in spite of decrease in total annual values.

Another important parameter for Cyprus is the increase in evapotranspiration. As shown in Figure 6.6, evapotranspiration has increased by 60-80 mm in the period 1976 - 2006. This, combined with temperature rise and rainfall decrease, intensifies the drying of soils and leads gradually to their desertification.

The 1961-1990 precipitation patterns in Cyprus do not depend only upon the synoptic weather conditions but also on the pronounced topography. The dominance of local topography is also evident from the seasonal total precipitations. For example, winter total precipitation ranges from about 75mm in the lowlands of central Cyprus to 270mm in the western higher elevation areas, woodlands and wetlands.

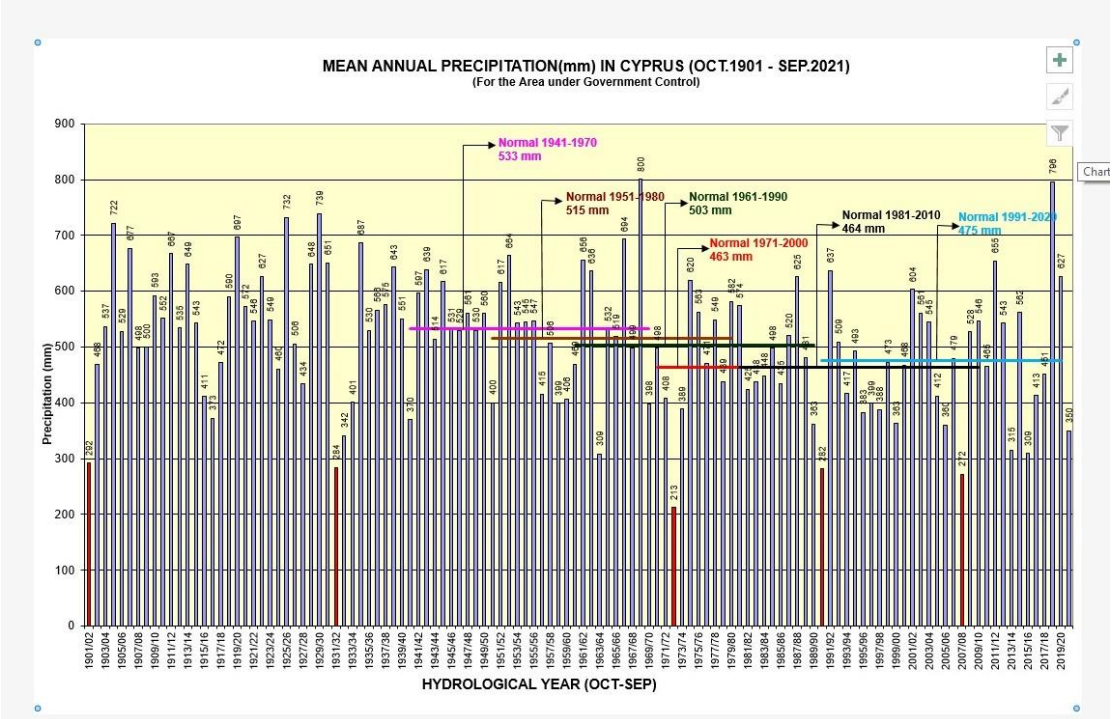


Figure 6.3. Annual average precipitation (mm) in Cyprus from hydrological year 1901-02 till 2020-21 Mean 1901-1930 559mm, mean 1971-2000 463mm, decrease 559-463 = 96mm (17%)

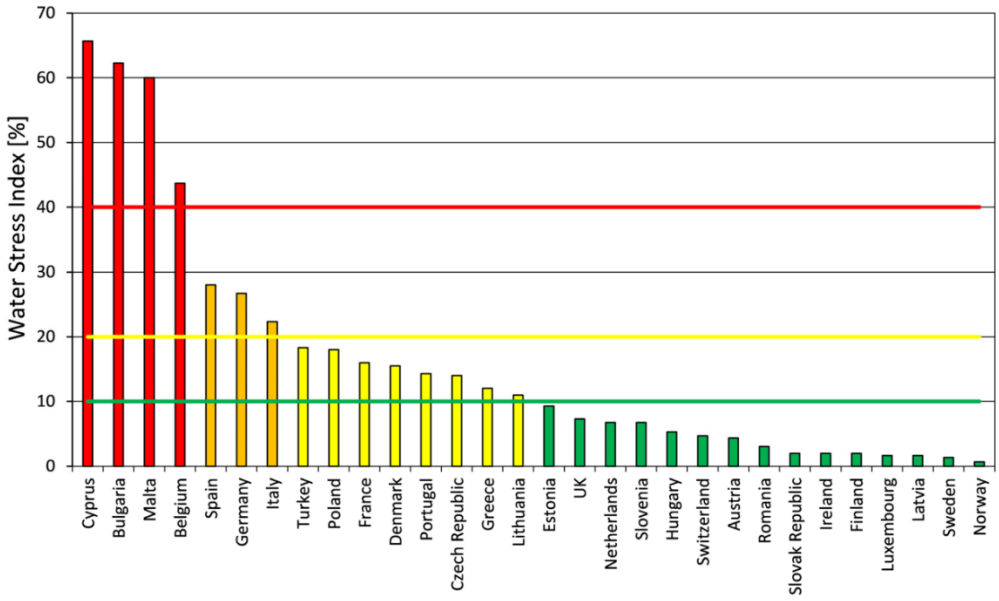


Figure 6.4. Water Stress Index among European countries. Cyprus ranks first (Sofroniou and Bishop, 2014)

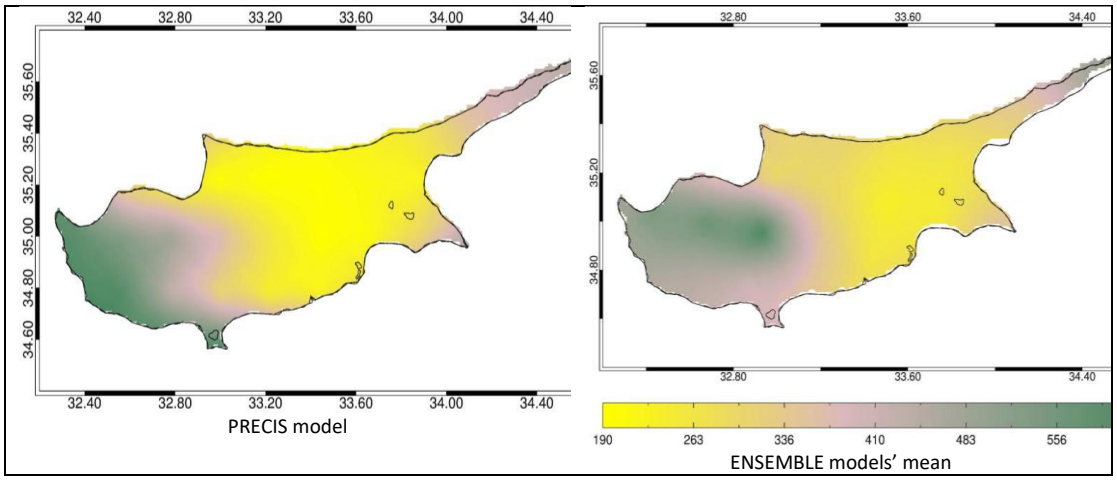


Figure 6.5. Annual total precipitation for the years 1961-1990 (control period)

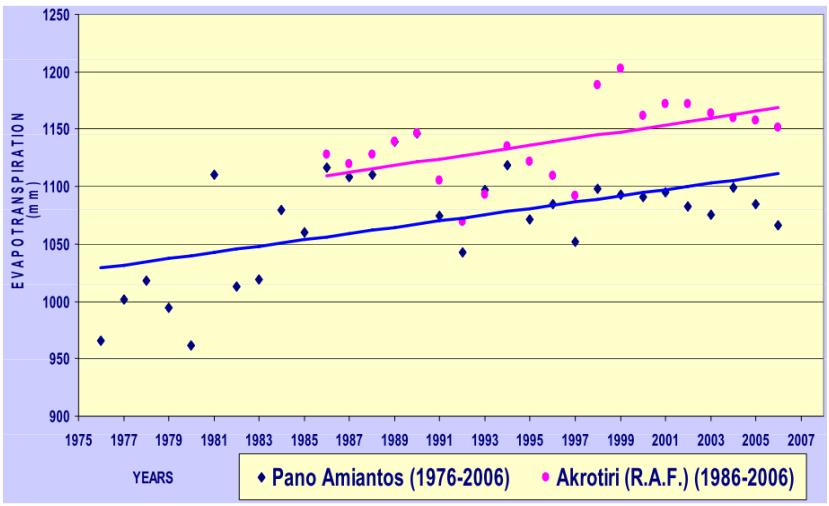


Figure 6.6. Increasing trend in annual evapotranspiration as it testified by records at Pano Amiantos station (1976 – 2006) and Akrotiri station (1986 – 2006) of the Penman-Monteith evapotranspiration

6.2.1.3. Observed changes in Extreme weather events: heat wave, drought, flood, dust

Since 1950 an increasing number of heat wave events have been observed in many regions around the world. An increase in the number of hot nights has also been recorded (IPCC, 2007, IPCC 2013). In addition, larger parts of the world have been affected by droughts as a combined effect of rainfall decline and evapotranspiration increase. Still, heavy rainfall events which lead to flooding have been intensified but this does not characterize a global trend. Finally, the number of tropical storms affecting the Eastern Mediterranean (although varying from year to year) has generally increased in terms of their intensity and duration since the 70s (IPCC 2007, IPCC 2013). However, studies for the Eastern Mediterranean and the Middle East have presented mixed results (Kostopoulou et al., 2005; Tanarhte et al., 2015).

The connection of specific atmospheric circulation patterns with heat events (Tymvios et al., 2013) and the differentiation of the frequency of occurrences of the patterns in the recent climatological periods (Michaelides et al., 2010) confirm the shift of the general climate mean of the area towards drier and warmer conditions with prolonged summertime periods with increasingly frequent occurrence of extreme and lengthier heat events.

In Cyprus, during the last decades the number of hot days and warm nights has increased, whereas the number of days with temperatures less than or equal to 0°C has greatly declined. There has been reported an increasing trend in the minimum temperatures in the island, as indicated form the increase in the number of days with temperature 40°C or higher (Figure 6.7) and the great reduction the number of days with temperatures less than or equal to 0°C (Figure 6.8).

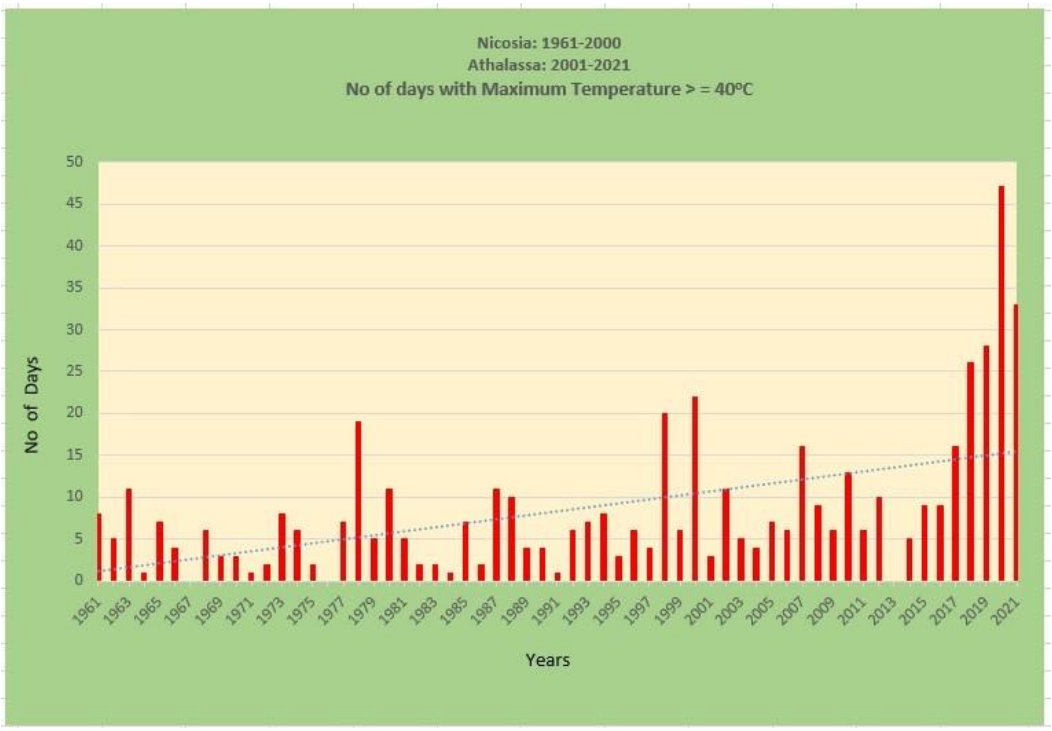


Figure 6.7. Number of days with temperature 40°C or higher from Nicosia station for the period 1961 - 2021

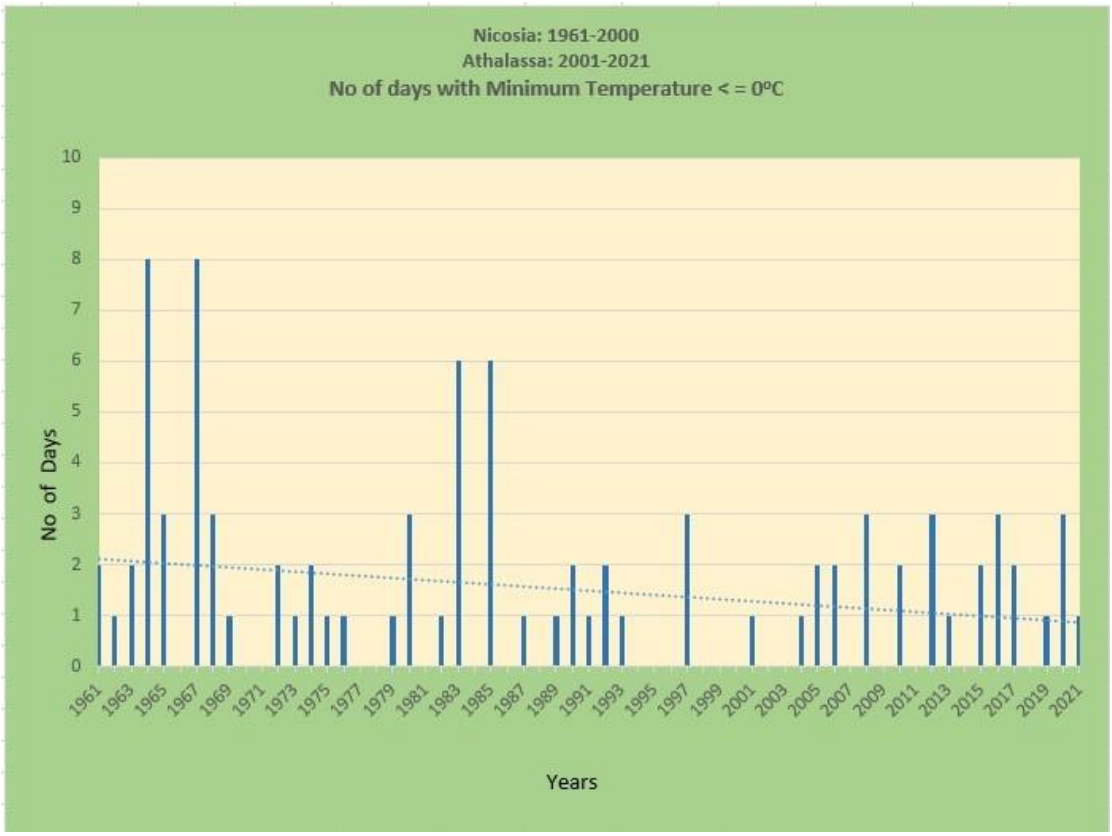
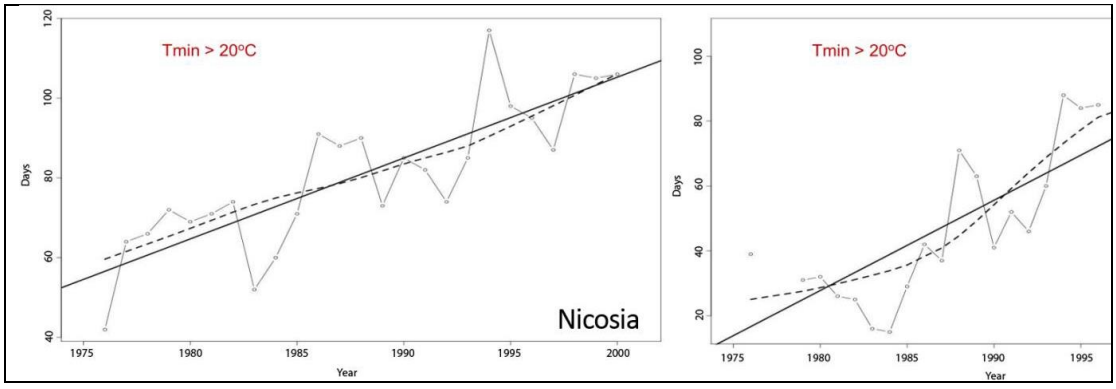


Figure 6.8. Number of days with temperatures less than or equal to 0oC from Nicosia station for the period 1961 - 2021

Furthermore, very important is the increase in the number of warm nights in almost all of Cyprus as evidenced in Figure 6.9 (Hadjinicolaou et al., 2011) and the annual mean temperature distributions present the temperature changes between the periods 1981-1990 and 2001-2008 (Figure 6.10). Over the last decade the greatest part of Cyprus has suffered from high temperatures and the largest part of the population residing in the three major cities, suffered high discomfort and serious socioeconomic problems such as increase in energy for cooling, water consumption and forest fire risk.



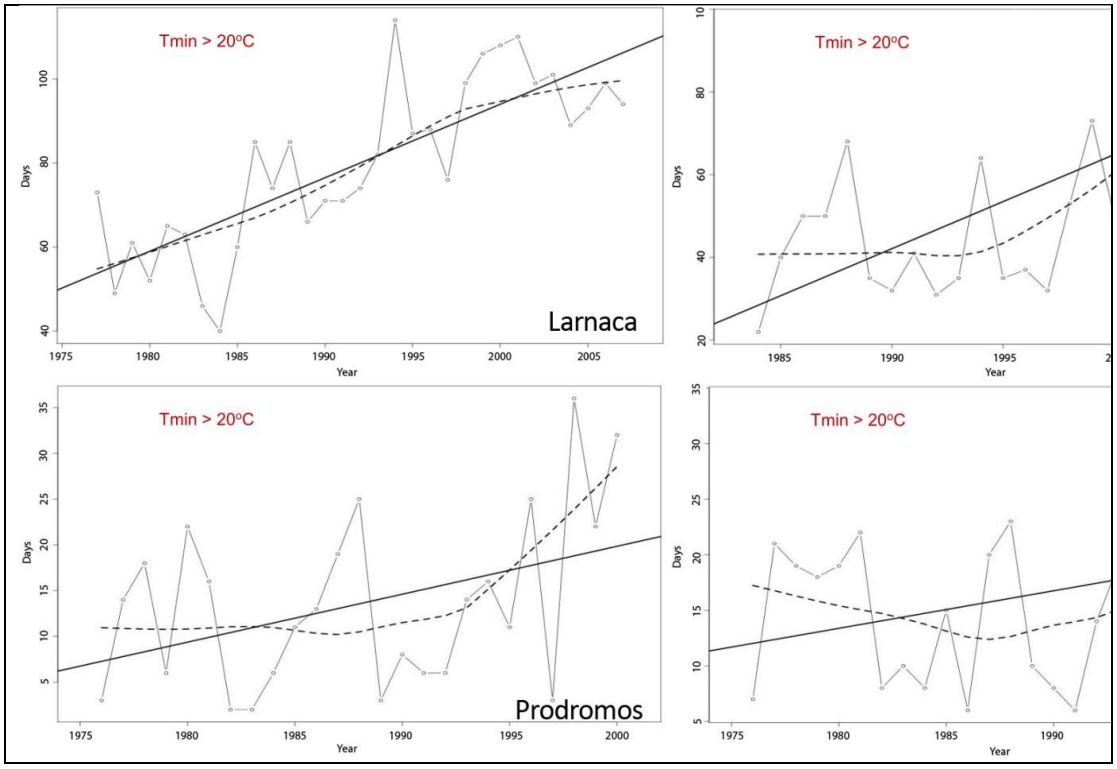


Figure 6.9. Increase in the number of warm nights in Cyprus as it testified by stations' records at Nicosia (1976 – 2000), Lemesos (1976 – 2006), Larnaca (1977 – 2007), Pafos (1983 – 2007), Prodromos (1976 –2000) and Saittas (1976 – 2000)

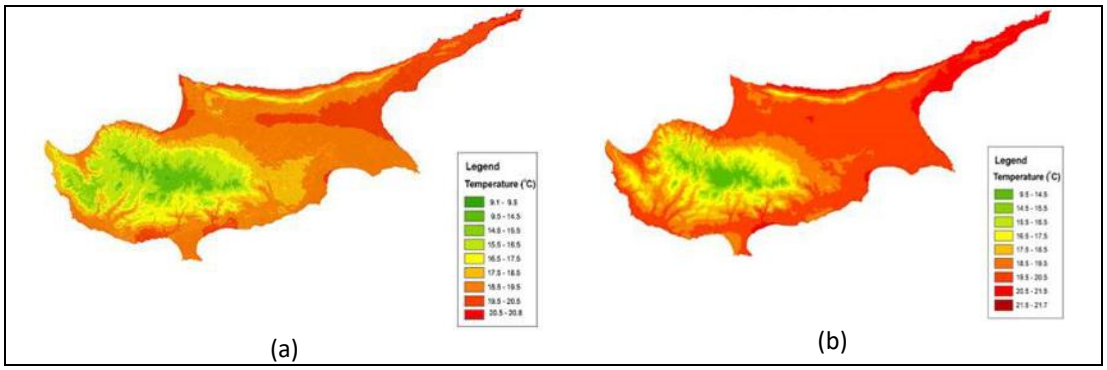


Figure 6.10. Spatial mean annual temperature distribution for period 1981 – 1990 (a) in contrast with the respective for period 2001 – 2008 (b)

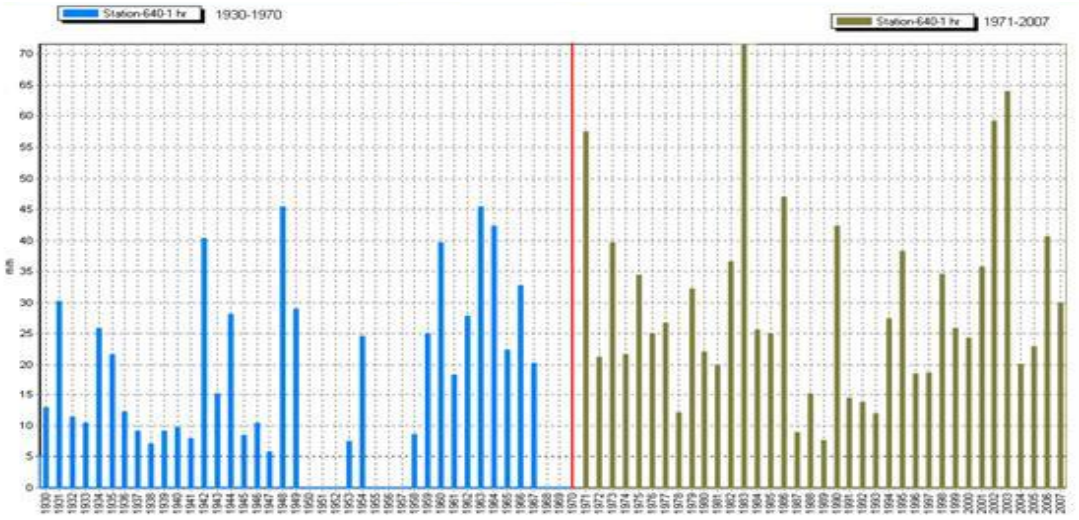


Figure 6.11. Increase in the highest amounts of rainfall in 1 hour for the period 1971 – 2007 in contrast with the respective for the period 1930 – 1970

As mentioned above, Cyprus experienced periodically severe droughts due to the declining precipitation, the worst of which was in 2008. During that event the water reservoirs were filled in only 3% of their capacity, prompting the Cyprus government to spend millions of Euros for water import from Greece (Davenport, 2008). Figure 6.11 shows the observed increase in heavy rainfall which falls in 1 hour for the period 1930-2007 despite the decrease in the mean precipitation. These extreme rainfall events may potentially cause localized flooding phenomena with devastating impacts. Nevertheless, it is not uncommon for isolated summer thunderstorms to occur, which however contribute to less than 5% to the total annual precipitation amount (Pashiardis, 2002).

6.2.2 Projected changes

6.2.2.1 Projected changes in temperature

Since the previous UNFCCC communication, the Climate and Atmosphere Research Center (CARE-C) of the Cyprus Institute has developed updated climate projections for the region and Cyprus (Zittis et al., 2019; Zittis et al., 2020; Zittis et al., 2022). These regional projections are based on in-house projections and analysis of publicly available multi-model ensembles (e.g., Diez-Sierra et al., 2022). In terms of scenarios, they are based on the Representative Concentration Pathways (RCPs), while downscaling using the Shared Socioeconomic Pathways (SSPs) is currently being developed. A scenario close to meeting the Paris Agreement's main targets (e.g., RCP2.6) implies that regional warming will continue at current rates in this decade and then will be stabilized to near 1 °C with respect to the end of the previous century or at about 2 °C since the preindustrial (Figure 6.12). On the contrary, under a business-as-usual pathway (e.g., RCP8.5), the observed warming will continue almost linearly for the rest of the century and will likely reach 4.5 °C. This warming is projected to be more pronounced in the inland parts of the island, including the capital city of Nicosia (Figure 6.13). In addition, it is expected to be stronger during the summer months (e.g., Figure 6.15 – right panel).

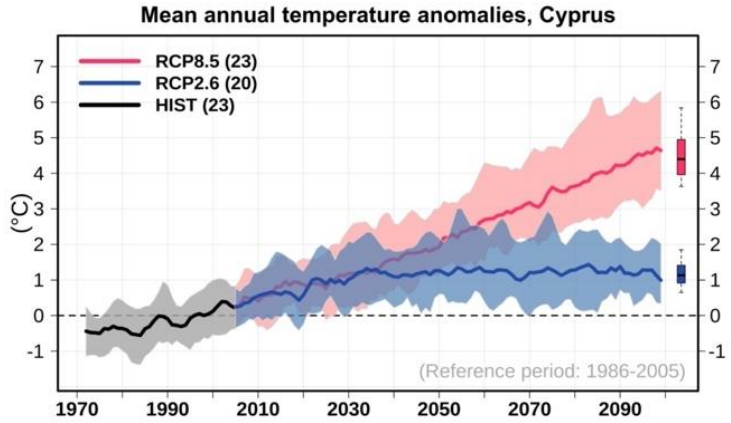


Figure 6.12. Projections of mean annual temperature anomalies for Cyprus based on the CORDEX-CORE ensemble (see Zittis et al., 2022).

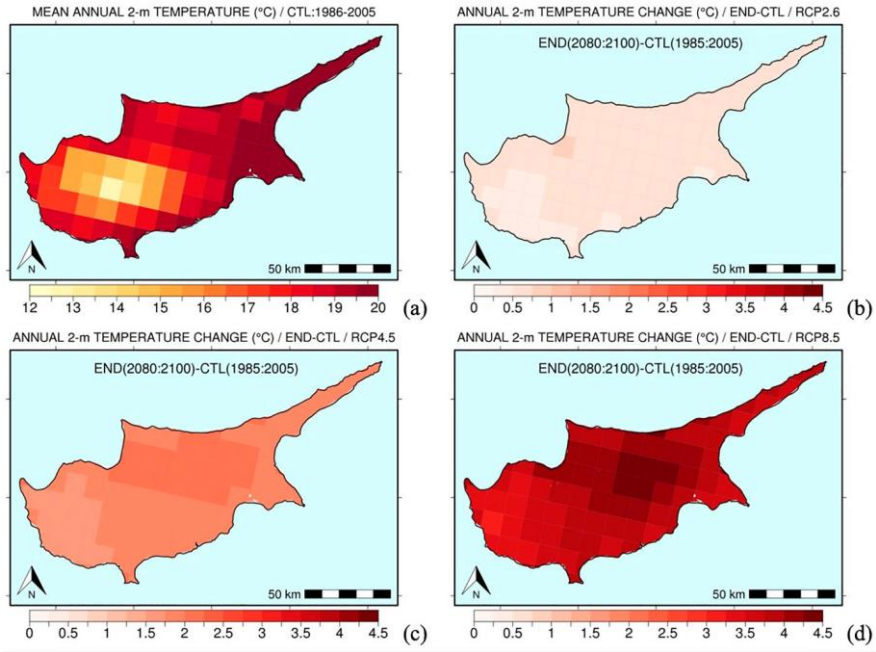


Figure 6.13. Mean annual 2-m temperature over Cyprus for the reference period 1986–2005 (a), and projected changes for the end of the twenty-first century (2080–2100) for three future pathways (b, c, d). (Source: Giannakis et al., 2020)

6.2.2.2. Projected changes in precipitation

The projected precipitation changes for Cyprus are quite variable among models and scenarios. Therefore, Cyprus precipitation patterns must be interpreted with caution, owing to the large temporal variability of rainfall and the inherent limitations of climate models to simulate accurately the hydrological cycle and the large variations of future projected changes among models. Changes in annual precipitation provide important information about occurrences of droughts and subsequent water shortages in Cyprus, expected in the near future.

Regarding precipitation (Figure 6.14), the interannual variability and model spread are significantly higher. Nevertheless, under pathway RCP8.5, the annual rainfall will be decreased by 20-30% of the reference values. This is expected to be most significant during the wet part of the year, which is also more critical for replenishing the water resources of the island (Zittis et al., 2019).

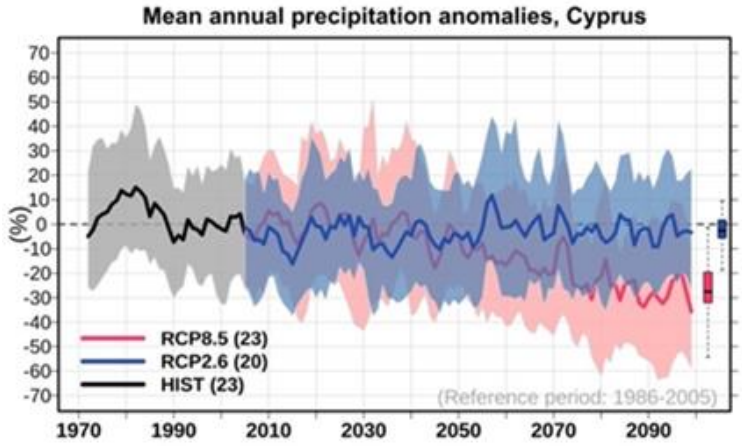


Figure 6.14. Projections of mean annual precipitation anomalies for Cyprus based on the CORDEX-CORE ensemble (see Zittis et al., 2022).

Under RCP2.6, the expected precipitation changes are less pronounced and comparable to the natural climate variability. Moreover, a high-emission scenario suggests a significant expansion of the dry season (red-shaded area in Figure 6.15). According to this scenario, because of the combination of increased temperature and precipitation declines, the wet part of the year will be mostly limited to the winter months of December and January. A comparison between the left and middle panels of Figure 6.15 highlights the benefits of adopting efficient and timely mitigation measures. In such a pathway, the climate characteristics of Cyprus will remain similar to the present-day conditions.

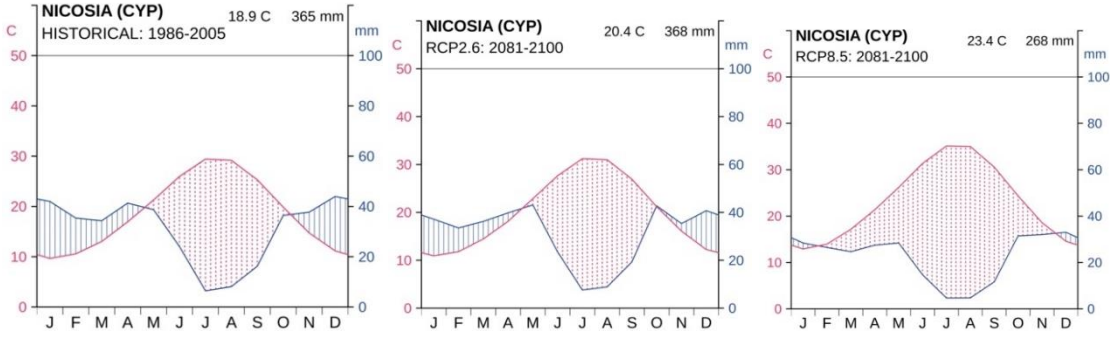


Figure 6.15 Walter-Lieth (ombrothermic) climate diagrams for Nicosia, Cyprus for historical conditions (left panel), and end-of-century projections under RCP2.6 (middle panel) and RCP8.5 (right panel). (Data source: CORDEX-CORE, Zittis et al., 2022).

6.2.2.3. Projected changes in Extreme weather events: heat wave, drought, flood, dust

Extreme weather events in the broader region are expected to intensify in terms of frequency and duration (Hochman et al., 2022). Such events relevant for Cyprus include heatwaves, droughts and, more rarely, extreme precipitation events that can lead to flooding. Heatwaves in the region are expected to occur more often, last longer, and have higher peak temperatures (Zittis et al., 2021a). This is consistent for all scenarios and time horizons; however, particularly for business-as-usual pathways, so far, unprecedented events are expected to become commonplace within the next couple of decades. Such events will persist for several weeks, while their peak temperatures will likely exceed 50 °C, even in moderate climate scenarios (Zittis et al., 2021a). The discomfort during future heatwaves will be exacerbated in the cities due to the urban heat island phenomenon and increased air pollution levels (Pyrgou et al., 2020; Zittis et al., 2022). Observed and projected temperature climate extremes at regional to urban scales have been assessed also in the framework of the CELSIUS research project, coordinated by the Cyprus Institute (https://celsius.cyi.ac.cy/). An example of projected temperature changes in simulations that resolve urban scales is presented in Figure 6.16).

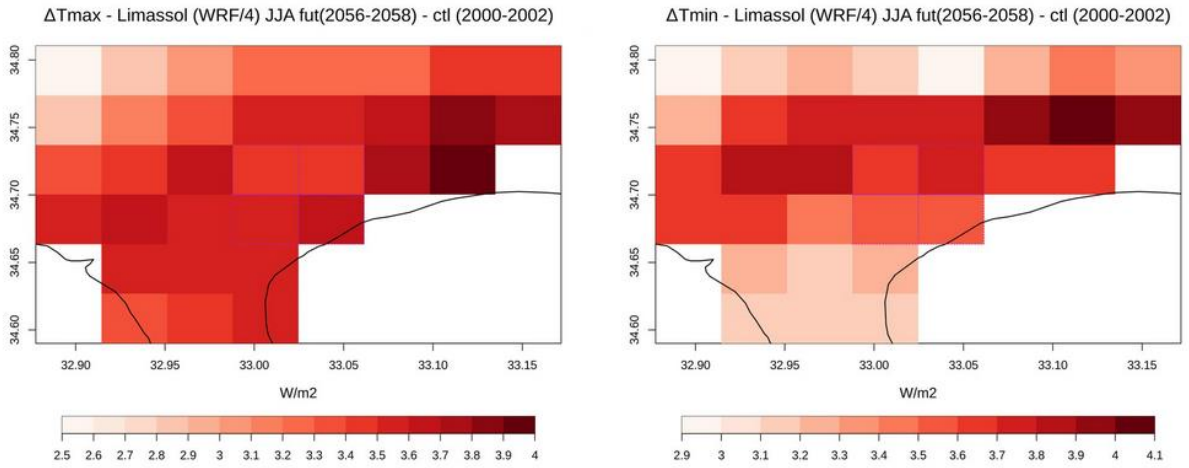


Figure 6.16. Projected change in summer maximum (ΔTmax) and minimum temperature (ΔTmin) in Limassol, Cyprus, calculated as the difference between a period (2056-2058) under the 3°C global warming level and the reference period (2000-2002), simulated by the WRF model over 4 km horizontal resolution (source: https://celsius.cyi.ac.cy/).

Future droughts constitute a significant challenge in the Mediterranean region which is projected to be a global drought hot spot (Spinoni et al., 2020; 2021). This results from the combined effect of temperature increase, precipitation decline and changes in precipitation characteristics (e.g., seasonality). For example, the number of rainy days in Cyprus is expected to decrease significantly (Figure 6.17 – left panel). Particularly in the west of the island and the Troodos mountains peaks, this decline is projected to reach or exceed 20 days per year on average. In addition, the maximum length of dry spells is projected to increase throughout the island (Figure 6.17 – right panel). Drought events will be prolonged by 30 to 40 days, particularly in the southeast territories.

Besides the overall decrease in precipitation, in a warmer world, individual precipitation events could be of unprecedented intensity, posing additional risks for flooding (Zittis et al., 2021b). This is also expected for Cyprus (Zittis et al., 2020). Nevertheless, due to their local nature and the short time scales involved, the predictability skill for such events in the current state-of-the-art climate models is relatively low.

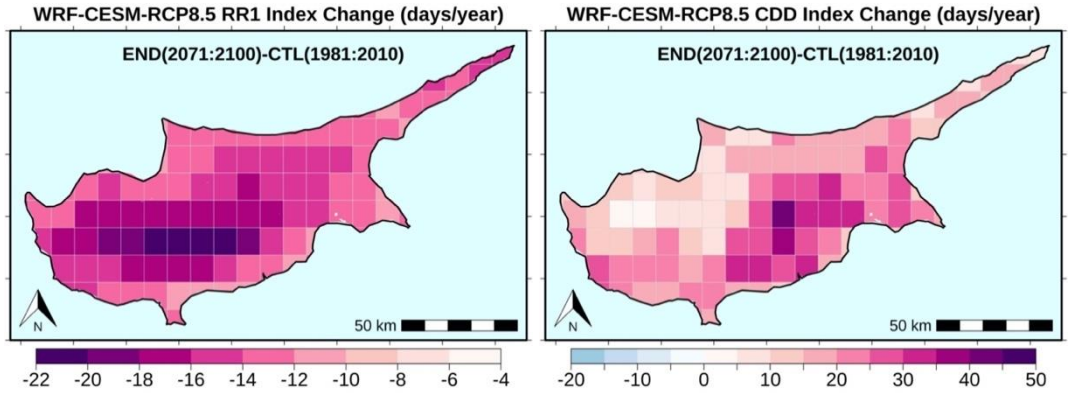


Figure 6.17. Projected changes in the average number of rainy days (left panel) and consecutive dry days (left panel) under a business-as-usual pathway for the end of the 21st century (Source: Zittis et al., 2020).

6.3. Expected impacts and vulnerabilities of climate change in Cyprus

The following sections present the expected impacts and vulnerabilities of climate change in Cyprus for biodiversity, infrastructure, energy, health, forestry, agriculture and water.

6.3.1. Biodiversity

Climate change is likely to become one of the most significant drivers of biodiversity loss by the end of the century, as already evidenced from the very rapid increase over the last century, especially in dry lands, mountains and Polar Regions (Millennium Ecosystem Assessment- MA, 2005)

Projected changes in climate, combined with land use change and the spread of exotic or alien species are likely to limit the capability of some species to migrate and therefore will accelerate species loss (CBD, 2007).

Cyprus due to its geographical position in the eastern part of the Mediterranean Sea bears all the characteristics of a semi-arid climate and some of the deficits of the global climate change. The rich biodiversity of Cyprus is the result of the combination of the geographical structure, landscape isolation due to its insular character, surrounding sea, topographic relief, geological structure and of course climatic conditions. The flora and fauna of the island are adapted to the various natural biotopes and climatic conditions, resulting in a large number of endemic and rare species (DoE, 2000).

Direct impacts of climate change on Cyprus biodiversity arise mainly from decreased rainfall and increased temperature, droughts, fluctuations in intensified precipitation, sea level rise and increased atmospheric CO_2. These impacts are expected to worsen in future period (2021–2050) as already projected PRECIS and ENSEMBLES prediction system.

Biodiversity is affected by numerous factors concerning the climate, ecology, society, culture, economy and technology (United Nations University, 2005). In terms of climate, the main factors affecting the biodiversity of Cyprus are among others the following: Variability (uneven geographic distribution and temporality of precipitation) - Reduction of frequency of precipitation -Increase of frequency of rainfall's intensity -Increase of temperature (and certain variables of temperature) -Heat-wave - Reduction of snow cover in Troodos -Increase of evapotranspiration (contributes to the intensification of soil drying).

The above-mentioned pressures in combination with other factors such as the island's landscape fragmentations, the intrusion of harmful invasive alien species and the deteriorated freshwater quality, are expected to threaten further and in more complicated way, mainly the terrestrial, marine and freshwater biodiversity of Cyprus.

6.3.1.1. Future Impact assessment

The climatic factors that may have an impact on the biodiversity of Cyprus include the decreased rainfall and increased temperature, droughts, fluctuations in intense precipitation events, sea level rise, increased atmospheric CO_2 and changes in fire regimes. According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1-2^{o}C, precipitation to decrease in seasonal level and in minor degree in annual level, the maximum length of dry spells (precipitation<0.5mm) is expected to increase 10 to 12 days on average, heat wave days (temperature >35^{o}C) will be increased averagely about 10-30 days on annual basis, depending on the region. Concerning future changes of annual max total rainfall over 1 day, PRECIS projections show that a slight increase of about 1-4 mm is anticipated. Finally, regarding the highest annual total precipitation, falling in 3 consecutive days, a negligible increase of about 1-2 mm of rainfall is expected. For the purpose of this report, the future impacts of climate change are grouped in categories and assessed in the sections that follow.

- Terrestrial ecosystems
  - Distribution of plant species in terrestrial ecosystems
  - Plant phenology of terrestrial ecosystems
  - Distribution of animal species in terrestrial ecosystems
  - Animal phenology of terrestrial ecosystems
- Aquatic ecosystems
  - Marine biodiversity
  - Freshwater biodiversity
  - Phenology of aquatic ecosystems

Impacts on terrestrial ecosystems

The distribution of plant species in terrestrial ecosystems, in terms of number of species, services of plants and plant communities, is expected to be affected even more with the projected milder winters in future. So far northward and uphill movements of plants and extinctions of species have been observed, emerging the concern about the resilience of wild plants to the rate of climate change. Another impact that is expected to be exacerbated is the invasion of alien species, having caused ecological changes throughout the world in the past few hundred years (Clout and Lowie, 1997; Unit of Environmental Studies), such as diseases of local species and alterations of keystone species. The invasive alien species alter or even extinct populations and native species in the natural ecosystems. In Cyprus the already low plants species richness will be worsening in the future period (2021-2050) where droughts are anticipated to be increased.

Changes in phenological responses of plants have been noticed in several places of Europe, including Cyprus, as mentioned in the survey "Growing Season Temperatures in Europe and Climate Forcing over the Past 1400 Years".

In the future period (2021-2050) the expected temperature increases of about 1-2°C on average, as well as the milder winters, can affect biodiversity negatively, especially in Akamas area, Troodos Mountain and Akrotiri peninsula, were the threatened plants located in a significant level. Both the winter minimum and summer maximum temperature is anticipated to have an increase of 0.8 - 1°C and 1-2°C, respectively, mainly in southern, inland and, western and mountain regions. Since there is no data available for on plant phenology, the extent of future climate impacts cannot be estimated at present.

The population and distribution of animal species in terrestrial ecosystems will be also changed with the temperature rise in the future; as a result of the decreased food availability and the expansion of invasive species and their associated diseases. The most typical example is the establishment of new pest species -such as migratory moths, butterflies, ticks and mosquitoes- due to warmer winters.

Furthermore, projections about the mammals of the Mediterranean regions- especially the threatened in terrestrial environments- suggest up to 9% risk of extinction (assuming no migration) during the 21st century (Andreou et al.).

As regard as the animal phenology of terrestrial ecosystems in Cyprus, there is no information available in relation with the increasing temperature, apart from the noticed increased populations of insects in the forests of Cyprus (DoF). However, the projected increase in temperature can affect animal phenology, due to the induced changes in the metabolic limits of animals, in the reduction of the thermoregulation capacity of warm-blooded animal species, in the length of breeding seasons and the higher reproduction of temperature-sensitive insects and others.

Impacts on aquatic ecosystems

The marine flora and fauna of Cyprus with the great diversity and low biomass are more vulnerable to climate change. Furthermore, the surrounding environment, the Levantine basin (Eastern Mediterranean Sea) is characterized by high temperature and salinity, as well as low nutrient levels, making it a challenging biological niche which constantly tests species' tolerance limits to physical components (Parari, 2009).

The temperature in Cyprus is expected to increase about 1.0 – 2.0°C in winter and about 2.0 – 2.7°C in summer, (according to PRECIS projections, for the future period 2021-2050), resulting in lower nutrient levels (phytobenthos and phytoplankton), higher salinity and acidification and, displacement of the endemic species by the invasive species, that entering the Mediterranean Sea through the Gibraltar straits and the Suez Canal.

For example, marine habitats of neuralgic importance -such as *Posidonia oceanica* meadows- are very sensitive to salinity, temperature and sedimentation alterations. The meadows produced by this marine plant function as nursery grounds for juvenile fish, reproductive fields and fisheries stock replenishment

areas are exceptionally important. A potential loss of these meadows would bring catastrophic consequences for the marine biodiversity of Cyprus and its commercial fisheries (Parari, 2009). Since there is no data available further research is required to assess the future impact on marine biodiversity due to changes in nutrient levels.

The inland aquatic biodiversity will be affected by future climate change, as they can cause enhanced phytoplankton bloom, favouring and stabilizing the dominance of harmful cyanobacteria in phytoplankton communities, resulting in increased threats to the ecological status of lakes and enhanced health risks, particularly in water bodies used for public water supply and bathing (EEA et al., 2008). The plants, fish and aquatic organisms of rivers and water storage reservoirs (dams) of Cyprus are threatened by the eutrophication, which can be deteriorated by temperature rise. One of the most important effects in aquatic phenology is the change in the size and growth of phytoplankton and the consequent influence on the light levels, surface temperature and magnitude of nutrient recycling. However, information about phytoplankton growth and bloom response to temperature rise is not available and further research is required.

6.3.1.2. Future vulnerability assessment

The future vulnerability of biodiversity to climate change impacts in terms of their sensitivity, exposure and adaptive capacity based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050 is assessed for the impact categories as follows:

1. Distribution of plant species in terrestrial ecosystems
2. Distribution of animal species in terrestrial ecosystems
3. Marine biodiversity
4. Freshwater biodiversity

Terrestrial ecosystems

It is noted that, the future vulnerability of "Plant phenology of terrestrial ecosystems", "Animal phenology of terrestrial ecosystems" and "Phenology of marine ecosystems" was not assessed due to lack of relevant research findings.

The future vulnerability of biodiversity varies substantially as it is related to the different rate and magnitude of climate change in different parts of Cyprus due to the variability of the air pollution levels, altitude, temperature and rainfall variations, meteorological conditions (e.g. wind, moisture), local geomorphology and soil characteristics.

The general characteristics of the plant distribution in Cyprus which indicate a sensitive environment to climate change plant species are the following: (i) low species richness, (ii) sensitive endemic plant species and (iii) several invasive plant species. The number of plant species in Cyprus is generally considered low in comparison with the levels in Europe, perhaps due to the semi-arid climate of the island and the more frequent presence of consecutive years of droughts according to Biosoil project (Hiederer and Durrant, 2010). Nevertheless, studies undertaken in Cyprus indicate that the percentage of endemism is 7.39% which is one of the highest in Europe (Hadjichambis and Della, 2007).

The more sensitive plant species are considered those that belong to relic populations and those that are less capable to adapt in the new environmental conditions. More specifically, according to the Red Book of Flora of Cyprus (Tsintides et al., 2007), 7% of the plant taxa in Cyprus is Regionally Extinct (RE), 14% of endemic plants of Cyprus is characterized as Critically Endangered (CR), 19.5% as Endangered (EN), 39% as Vulnerable (VU), 4,6% as Close Threatened (NT) and 2.2% as Low Danger (LC).

According to the studies of Hadjikyriakou and Hadjisterkotis (2002), 152 adventive species have been recorded. More specifically *Acacia saligna (Labill.) (H.Wendl.)* is described as the most dangerous invasive species in Cyprus, threatening many natural habitats, invading maquis, garigue, phrygana, marshy areas and agricultural land. It has been recorded as a serious threat to the habitat of the Salt Lake of Larnaca and it was considered necessary to remove a number of its population from the area (Atlantis Consulting Cyprus Ltd). Likewise, the *Robinia pseudoacacia* L. has spread in forests, maquis, garigue and phrygana vegetation. In addition, the observed for the first time *Ailantus altissimma* (Mill.)

Swingle andCasuarina cunninghamiana Miq. is also spreading, threatening natural habitats such as forests and maquis.

Considering the above, the sensitivity of the distribution of plant species (including Invasive Alien plant Species) in Cyprus for the future period (2021-2050) can be characterized high**.**

Table 6.1. List with the Critically Endangered (CR) plants of Cyprus

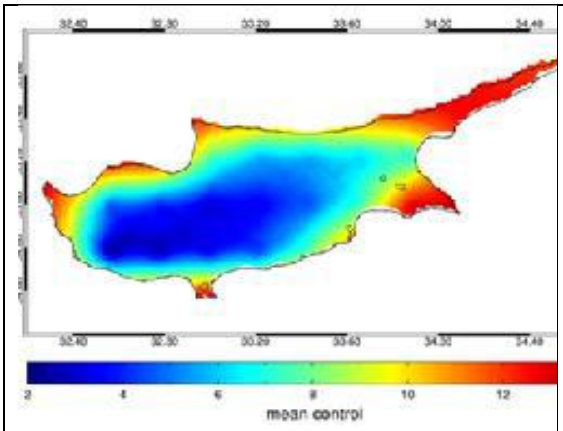
Species	*Description*
Arabis kennedyae	Troodos, Triptilos (in altitude 9001350m)
Astragalus macrocarpus subsp. lefkarensis	Only in Cyprus in Leykara, Asgata, Alaminos and Kelokedara
Centaurea akamantis	Only in Akamas of Cyprus
Delphinium caseyi	Only in Cyprus, in Pentadaktylos (tops of Saint Ilarionas and Kyparrissovouno
Scilla morrisii	Exclusively at southwest of Cyprus (Monastiri, Agia Moni, Saint Neofytos)
Salvia veneris	West of Kithreas villages
Erysimum kykkoticum	One the rarest endemic species. It is located in the valley of Xeros (Argakin of Pissokremmou

The distribution of the critically endangered plant species (Table 6.1), seems to be in many and scattered areas on the island. Though is no scientific data available concerning phenological responses of plants, these will be affected. In general, the area that the majority of threatened plants are situated will face temperature increase of about 1-2 °C in future (2021-2050), increase in maximum length of dry spell and variations in precipitation and so will threaten even more these species. Combination of density, width and dry spell increase in these areas will determine the degree of its final exposure. Taking into consideration the above findings the distribution of plant terrestrial ecosystems for the future period (2021-2050) is preliminary assessed as high.

The resilience of plants towards climate change refers to their ability to genetically adjust to changing environmental conditions as well as to their ability for uphill migration. However, more research in this field is necessary to be done.

The existing national legislative framework among which the Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (with the Law 153(I)/2003), the ratification of the Bern Convention on the conservation of European wildlife and natural habitats (with the Law 24/1988), the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the CITES (with the Law 20/1974) and the Convention on Biological Diversity (with the Law 4(III)/1996), aim mainly to reduce human pressures posed on biodiversity, while little can be done to reduce the effects from adverse climate conditions. As for example the Action Plan for the planting control and eradication of the Invasive Alien Species of *Acasia* in NATURA 2000 areas[68], was completed with great success, regarding the spreading of harmful invasive species.

[68] An ecological network of protected areas in the territory of the European Union, regulated by Directive 92/43/EEC and Directive 2009/147/EC



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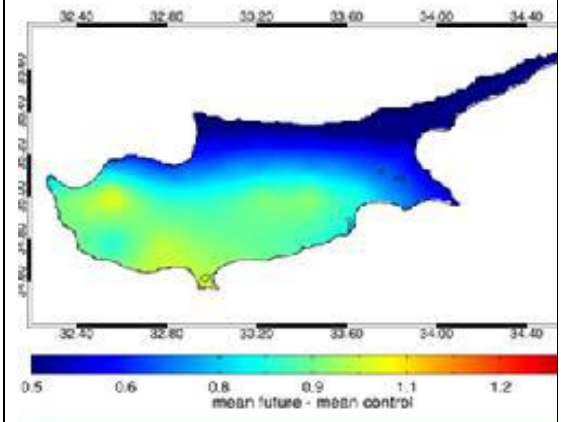

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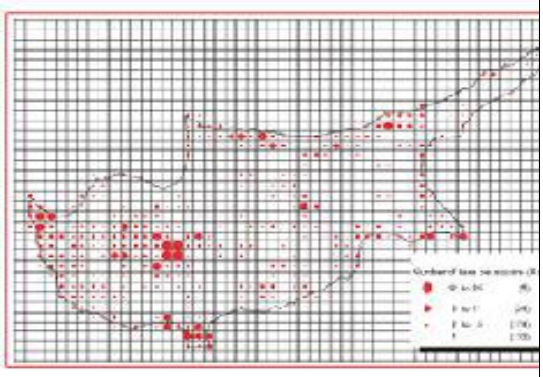
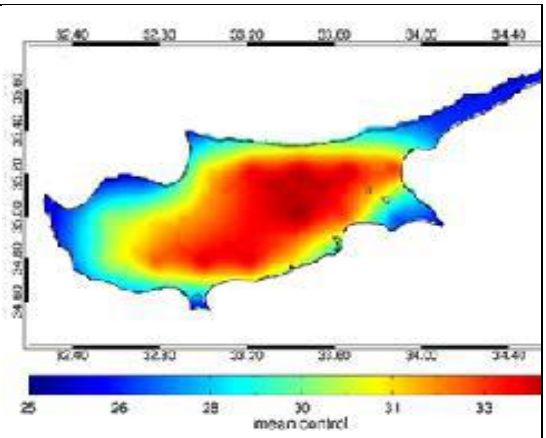


(c)

Figure 6.18a. Average winter minimum temperature for control period (a) and in the near future using PRECIS RCM model (b) and, Geographic distribution of the threatened plants of Cyprus (c)



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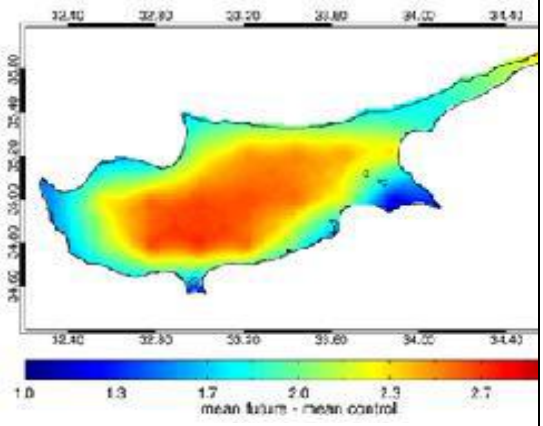

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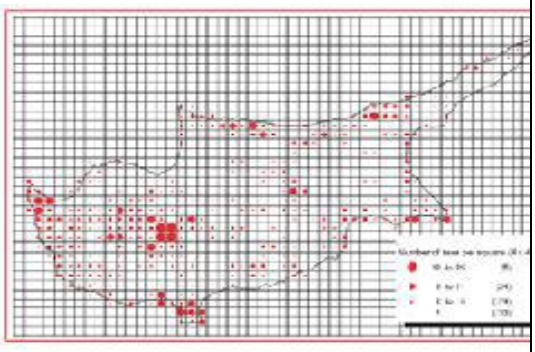


(c)

Figure 6.18b. Average summer maximum temperatures for control period (a) and in the near future using PRECIS RCM model (b) and, Geographic distribution of the threatened plants in Cyprus (c)

Consequently, the exposure for the future period (2021-2050) can be considered as high.

The resilience of animals towards climate changes refers to their ability to genetically adjust to changing environmental conditions as well as to their ability for uphill migration. There are no data available for the animal population movements in Cyprus. In addition, the extensive existing national legislative framework is protective for many animal species as shown in Table 6.2.

Nevertheless, the genetic adjustment of animals and the measures taken are not enough for combating the increasing risk of terrestrial animals towards climate change and additional adaptation measures are needed.

Aquatic ecosystems

The high Sea Surface Salinity (SSS) and Sea Surface Temperature (SST) of Cyprus, in comparison with the rest of the Mediterranean region, results in a relatively high species diversity and very low biomass. Temperature rise is the main reason for the northward movement of marine species, changing the composition of local and regional marine ecosystems. Thus, both distribution of fish and the socioeconomic situation of local fishermen are affected heavily.

The increasing intrusion of exotic fish in the Mediterranean Sea has not yet been determined whether it constitutes a serious threat for the extinction of the endemic species. The number of invasive species introduced in the coastal and offshore waters of Cyprus has grown over the last 50 years (Katsanevakis et al., 2009. Studies have shown that the rate of new biological invasions in the Mediterranean Sea is as high as 1 new species every 9 days (Zenetos et al., 2008). Considering the above, the sensitivity for the future period (2021-2050) can be characterized moderate.

The number of alien biota in the Mediterranean Sea appears to be underestimated, especially the coasts of the Levantine basin, which is one of the hot spot areas for possible species introductions (Zenetos et al., 2005).

Cyprus is located near the manmade nautical channel of Suez which favours the migration and relocation of the Lessepsian species. However, there is no data available for the anticipated effect of temperature increase on the displacement of marine biodiversity. Further research is required.

Anticipated changes in temperature, as already presented, may cause fluctuations in sea water temperatures which are responsible for changes in physiology and sex ratios of fished species, alteration in timing of spawning, migrations, and/or peak abundance and also, for the increasing of invasive species, diseases and algal blooms. These impacts are leading to reduced production of target species in marine systems. Considering the above, the exposure of marine species, for the future period (2021-2050) can be characterized high to very high.

Table **6.2. Protection status of the endangered animal species of the terrestrial ecosystems in Cyprus**

Protected fauna species	***Measures***
Reptiles	
Mauremys caspica	Protected under Annex IV of Directive 92/43/EEC, Annex II of Bern Convention
Coluber cypriensis - EN	Protected under Annex II and IV of Directive 92/43/EEC, Annex II of Bern Convention
Emys orbicularis	Annex II of Bern Convention
10 other species	Protected under Annex II of Directive 92/43/EEC
Birds	
Numenius tenuirostris	Protected under Annex II of SPA[69] protocol, Annex II of Bern Convention
Pelecanus crispus - VU	Protected under Annex II of SPA protocol
Oxyura leucocephala - EN	Protected under Annex II of Bern Convention
Branta ruficollis - VU	Protected under Annex II of Bern Convention
Crex crex - LR	Protected under Annex II of Bern Convention
Emberiza aureola	Protected under Annex II of Bern Convention
Gallinago media	Protected under Annex II of Bern Convention
Larus audouinii - LR	Protected under Annex II of Bern Convention
Emberiza cineracea	Protected under Annex II of Bern Convention

[69] Specially Protected Areas

Mammals	
Ovis orientalis ophion (Cyprus muflon) – VU	Protected under Annex II and IV of Directive 92/43/EEC
Rhinolophus Euryale - VU	Protected under Annex II and IV of Directive 92/43/EEC
Capra aegagrus (Cyprus goat) - VU	Protected under Annex II and IV of Directive 92/43/EEC, Annex II of Bern Convention
Rousettus aegyptiacus	Protected under Annex II and IV of Directive 92/43/EEC

Scientific recording of the populations of marine species reveals some of the extent of the threat for the marine host species. The genetic adjustments of the host organisms to new conditions need many reproductive cycles, and as a result the most common way of survival is the migration to other latitudes.

In addition, there are numerous institutional measures for the protection of marine ecosystems in Cyprus, including the coastal protected area of Lara-Toxeftra, which encompasses the most important breeding biotope for the sea turtles (*Chelonia mydas* and *Caretta caretta*) (Fisheries Law and related regulations, NATURA 2000 network (DoE, 2010).

The protection of aquatic species of inland and marine waters, is implemented through the provisions of national law since 1971 and its related regulations, as well as through the Law 153(I)/2003 which harmonizes Directive 92/43/EEC on the Conservation of Natural Habitats and Wild Fauna and Flora. In addition, Cyprus has ratified the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution and in particular the SPA Protocol concerning Specially Protected Areas and Biodiversity in the Mediterranean. Complementary to these are the Convention on Conservation of European Wildlife and Natural Habitats (Bern Convention), the Convention on the International Trade in Wild Fauna and Flora (CITES) and the Convention on Biological Diversity (CBD). In particular, protected marine species and habitats are those listed in the aforementioned Directives and Conventions, as well as those in the Fisheries Law and Regulations, including all species of sea turtles, dolphins, seals and a species of sand crab (DoE, 2010).

Though the important habitats along the coastal waters of Cyprus are well-preserved, could be threaten by the increased number of successful intrusions of marine species in the area (Ben Rais Lasram and Mouillot, 2009) due to climate change. Considering the above, the adaptive capacity in the future period (2021-2050) can be characterised as moderate.

The indigenous fish species richness in Cyprus is exceptionally poor and susceptible to numerous threats such as the landscape fragmentations, the environmental alterations (caused with the introduction of freshwater fish and crayfish in the artificial dams for recreation purposes) and the pollution caused by human activities. Additional stress on water quality and aquatic populations is expected as a result of further oxygen depletion and eutrophication, induced by the projected temperature increase. Based on the above facts the sensitivity for the future period (2021-2050) can be considered as moderate.

In Cyprus, the plants, fish and aquatic organisms of rivers and lake dams of Cyprus are generally in good condition, whereas the organisms of groundwater are more strained. Climatic changes will have an impact mainly on the quality of the surface waters in Cyprus and consequently on the biodiversity. The nitrogen pollution from untreated sewage effluent and agricultural run-off carrying fertilisers is responsible for the phenomenon of eutrophication, which can possibly be deteriorated by climate change.

There is no data available to correlate the effect of water quality with the change of biodiversity in freshwater bodies. Nevertheless, significant reduction in precipitation which is anticipated for the autumn period, may affect ecosystems of perennial rivers due to delayed flow and the intense reduction in recharge rates. Another factor influencing the water quality and thus the biodiversity in freshwater bodies is the number of heavy rain events due to drifting of fertilizers, sediments and other pollutants. Considering the above, the exposure of freshwater biodiversity and quality in Cyprus is considered as moderate

The resilience of the organisms of these habitats to climate change refers to their ability to genetically adjust to changing environmental conditions. Nevertheless, most of the times, due to landscape deterioration of this kind of habitats, the phenomena of extinction are inevitable.

Further to the needed adaptation measures, a limitation of the extinction phenomena is also achieved my means of several measures implemented for the protecting water resources and inland aquatic species, such as the Laws:13(I)/2004 on the protection and management of water, 34/2002 on the nitrogen pollution of waters (based on the European Directive 91/676/EEC), 42/2004 on the control of nitrogen polluted waters, 41/2004 on the control of water pollution, 517/2002 on the control of water pollution, 56(I)/2003 on waste management,1/1971 on sewerage systems, 108(I)/2004 about sewerage systems,772/2003 about urban wastewater, 254/2003 about the nitrogen pollution of water bodies, 106(I)/2002 about the control of the water and soil pollution,45/1996 about the control of the water and soil pollution.

Consequently, the adaptive capacity of Cyprus' freshwater biodiversity and quality to climate changes is considered to be moderate.

Assessment of overall future vulnerability

The overall future vulnerability of biodiversity against a climatic change impact, in terms of sensitivity, exposure, adaptive capacity on the based on the available data for the above-mentioned indicators are quantified as shown in Table 6.3.

The main indicator for assessing the vulnerability of the terrestrial biodiversity towards climate changes appears to be the landscape fragmentations of the island, as species cannot move neither northern nor higher after a certain point. Instead, the main advantage of the marine biodiversity is the ability of migration, which can also be counted as a disadvantage due to the intrusion of harmful invasive alien species. On the other hand, freshwater biodiversity is not threatened. Considering the above, it is assumed that the first vulnerability priority of the biodiversity in Cyprus to climate changes is the distribution of species in terrestrial ecosystems while the second priority is the biodiversity of aquatic ecosystems.

Table 6.3. Overall vulnerability assessment of biodiversity in Cyprus to climate changes

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Distribution of plant species in terrestrial ecosystems	High (5)	High (5)	Limited to Moderate (2)	Moderate (3)
Distribution of animal species in terrestrial ecosystems	High (5)	High (5)	Limited to Moderate (2	Moderate (3)
Marine biodiversity	Moderate (3)	High to Very high (6)	Moderate (3)	Limited to Moderate (1.2)
Freshwater biodiversity	Moderate (3)	Moderate (3)	Moderate (3)	None (0)

6.3.2. Infrastructure

The island of Cyprus is situated in the south-eastern part of the Mediterranean Sea. Administratively, Cyprus is divided into the following six districts: (a) Lefkosia (capital), (b) Limassol, (c) Larnaca, (d) Paphos, (e) Famagusta and (f) Kyrenia. It has a total of 772 km of shoreline, of which: (a) 404 km in the occupied zone after the Turkish invasion in 1974; (b) 72 km within the British Military Bases; and (c) 296 km under Government control. The critical infrastructure of Cyprus has been developed near the coastal area, except for Lefkosia which is located near the centre of the island.

In general, the infrastructures in Cyprus are not considered very vulnerable to climate changes, which arise mainly from decreased rainfall and increased temperature, droughts, fluctuations in intense precipitation events, sea level rise, increased atmospheric CO_2 and changes in fire regimes.

The future impact, vulnerability and adaptation measures for the infrastructure sector in Cyprus regarding climatic changes were also assessed as part of the Life+ CYPADAPT project, by using PRECIS and six other regional of the ENSEMBLES prediction system and, the future period (2021–2050) against the control period (1961–1990).

The main vulnerability priority of the sector to climate changes observed until now has been related to the damages caused by urban floods and sea floods. It has to be noted that specific measures have been undertaken the last decades to reduce the severity of this impact (drainage works, town plans, SUDS etc.) and that Cyprus has not experienced any severe floods from the sea in the past. The point of this consideration is the great number of tourist units and other infrastructures, important to Cyprus economy are located in the coastal areas.

According to the Intergovernmental Panel on Climate Change (IPCC), the infrastructure is defined as 'the basic equipment, utilities, productive enterprises, installations and services essential for the development, operation and growth of a city or nation'. Thus:

- Utility services; (Water supply; Energy supply (power plant and electricity networks); Wastewater and waste collection, treatment and disposal)
- Transport;
- Information and Communications Technology (ICT) infrastructure;
- Industry; and
- Buildings (residential and tourist accommodation units).

Focusing on a local scale, natural hazards such as a rise in sea levels, dry spells, heatwaves and floods are expected to occur more frequently and with greater intensity, endangering cities in vulnerable geographic locations (Romero and Gnatz 2011). Natural hazards and extreme events can destroy livelihoods, dwellings and businesses, as well as public infrastructure such as roads and bridges. Many of the world's largest urban centres are faced with harsh repercussions from such events because of their proximity to low-elevation coastal zones, where more frequent and more intense events would augment the destruction of public and private property. For instance, flood events in urban centres, which are expected to increase in frequency and severity, can be extremely destructive and costly, both in terms of material and human health damages. Of all urban centres, coastal ones are at high risk due to their exposure to the elements of nature. Historically, coastal sites developed as trading by sea led to the creation of economic hubs and cities. Their increasing industrial activity, local economic growth and wealth attracted rural and immigrant labour populations, ultimately fuelling uncontrolled development. The main climate change impacts on the infrastructure sector include: (i) material damages to infrastructure, possibly linked with extreme events and flooding, (ii) disturbances in normal community function such as interruption and obstruction of passenger or freight transport, (iii) human safety.

6.3.2.1. Future Impact assessment

The climatic factors that are likely to induce impact on Cyprus infrastructure system in the future are the extreme events, mainly the heavy rain, sea level rise, flooding and wind speed. Heavy rain may affect all types of infrastructure due to the risk of flooding, land sliding and collapsing. The relationship between potential climate changes and impacts on infrastructure is shown in Table 6.4.

Heavy rain is anticipated to have an impact on infrastructure. PRECIS predictions show that future changes of annual max total rainfall over 1 day, have a minor increase of about 2-4 mm in western and higher-level regions. The heavy rain events have been monitored since 1917 by the Department of Meteorology and as shown in Figure 6.19 they follow a rising trend. There is evidence that this rising trend is related with climate change.

Flooding which is associated with heavy rain also follows the same pattern, thus an increase, both in terms of frequency and magnitude.

As mentioned above, the infrastructure system is expected to be affected mainly by the following two main categories of impacts: material damages; and disruptive operation.

Table 6.4. Relationship between potential climate changes and impacts on the infrastructure sector

Potential climate change in Cyprus	Type of Infrastructure	Future impacts on infrastructure	Selected Indicators
Heavy rain	All types	- Flood - Landslides	Severity of material damages to infrastructure
	Water infrastructure (water treatment, wastewater collection and treatment)	- Risk for flooding of Sewerage Treatment Plants - Risk for sewer flooding	
	Transport infrastructure	- Increased demand for car use - Flooding of underground networks - Flood damage - Bridge collapse and associated implications	
	Communications	- Reliability of the signal - Disturbances to overhead networks	- Disruption frequency - Duration of disruption
Storm surge	(located at coast)	- Flood - Periodic flooding of coastal infrastructure	- Percentage of critical infrastructure located in or near coastal areas - Disruption frequency in daily operations (social activity and trade) - Duration of disruption
Sea Level Rise	All types (located at coast)	Permanent asset loss at coastal sites	Percentage of critical infrastructure located in or near coastal areas
	Transport infrastructure (ports)	- Limited access to ports - Threat to port operation	Coastal infrastructure asset losses due to Sea Level Rise
High winds	Transport	- Transport disruption (caused by blown down trees etc.) - Impede aircraft operation	- Disruption frequency in daily operations (social activity and trade) - Duration of disruption
Temperature increase	Transport	- Deformation of road and airport asphalt surfaces - Passenger discomfort	
	Communications	Decreased wireless transmission signal	
Extreme events	All types	Risks for human safety	- Number of accidents related to extreme weather events - Population living in disaster prone areas (areas prone to flooding and landslides) - Changes in the proportion of built-over land in disaster prone areas

Potential climate change in Cyprus	Type of Infrastructure	Future impacts on infrastructure	Selected Indicators
	Transport infrastructure	- Asset failure due to long, hot, dry periods followed by intense rain causing flash floods. - Stability of foundations of transmission masts and towers, mostly attributable to increased risk of subsidence (more susceptible during drier summers and wetter winters) - Damage to underground cables(more susceptible during drier summers and wetter winters)	

For the case of Cyprus, the above-mentioned impacts are related with flooding events induced by heavy rain (flash floods). However, there is no evidence that these events are directly connected with climate change and as a result the impacts due to climate change on the infrastructure sector are limited to uncertain. The available data were not conclusive and could not be used as a basis for measuring the future impact of climate change on infrastructure. It is worth saying, however, that there is an increasing trend in the appearance of flooding events, the intensity of which, both in terms of frequency and severity, is likely to exacerbate due to climate change. In general, it must be noticed that sensitivity of the sector is increasing in flood and landslide prone areas (MoE, 2011).

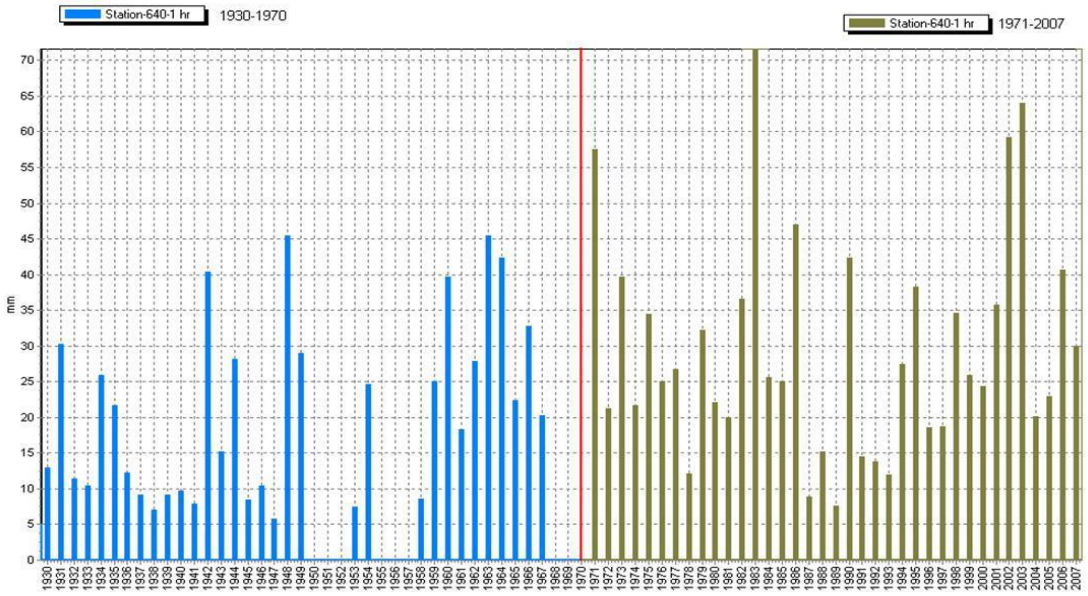


Figure 6.19. Highest amounts of rainfall in 1 hour, in Cyprus (Pashiardis, 2011)

6.3.2.2. Future vulnerability assessment

The future vulnerability of the infrastructure sector is assessed in terms of its sensitivity, exposure and adaptive capacity based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021-2050, presented in the CYPADAPT project.

It must be noted that, there are no sufficient scientific evidence and data to evaluate or correlate all impacts and indicators to future climate changes. Consequently, further research is required in order to provide concrete information for a more detailed and descriptive assessment of the future vulnerability of the sector. Nevertheless, an attempt was made to provide a preliminary assessment of the vulnerability for the following impacts: Infrastructure damage due to floods (urban and sea floods); and Infrastructure damage due to landslides.

Damages of infrastructure due to floods

The vulnerability of the Cypriot infrastructure was assessed regarding the sea floods and urban floods. The former type is caused by storm surge or sea-level and affects mainly the highly developed coastal infrastructure of the island. However, no significant sea flood events have been recorded while for future projections further research is required. The urban floods are directly connected with heavy rain and the consequent damages. According to the records of the flood events observed in Cyprus between 1859 and 2011, over 200 floods caused implications in multiple levels such as damages to road infrastructure, disruption of economic, social and cultural activities and in turn financial losses (WDD, 2011). To sum up, taking into account the current situation as well as the relative future climate changes the sensitivity of infrastructure due to floods was ranked as moderate to high.

The exposure to future sea floods depends on the importance of infrastructure which is located on or near the coastline. In Cyprus this infrastructure includes:

- Electricity supply (three power stations and the Energy centre)
- Water supply (Water treatment plants, Wastewater treatment plants, Desalination plants)
- The international airports of Larnaca and Pafos.
- Seaports;
- Marinas and fishing shelters;
- Industries (two cement plants)
- Buildings (hotels, tourist and residential accommodation units)

Sea-level rise, generally, may affect infrastructure located in or near coastal areas. For the case of Cyprus, however, sea level rise is expected to be moderate. Furthermore, it must be added that, based on archaeological data, Cyprus appears to be experiencing long-term uplift of between 0 and 1 mm per year. This uplift is expected to counteract sea-level rise and given a global rise in sea level of 0.5m by 2100, relative sea-level rise in Cyprus will be in the range 0.4-0.5m (Nicholls and Hoozemans, 1996)

The general assessment of the effects of storminess changes on storm surge is not possible due to the limited geographical coverage of studies and the associated uncertainties (IPCC, 2012). However, according to the projections of the PRECIS climate model, the mean wind speed greater than 5 m/s in Cyprus during the future period 2021-2050 is not expected to present substantial changes, on the contrary, it presents minor decreases in general of the order of about 5-12 days for the number of days with mean wind speed greater than 5 m/s.

The urban centres of Larnaca, Limassol and Lefkosia are sensitive to flood risks mainly due to their dense structuring and the restriction of green space, the elimination of natural waterways for the construction of roads, the deficient or even absent storm-water drainage system and, the covering of waterways and drain entrances with garbage. On the other hand, mountain areas are less sensitive to floods, given that the inclination of terrain together with the infiltration capacity of forested areas do not allow for flooding events to take place.

The climate projection model used for the case of Cyprus does not provide estimates for the frequency and intensity of floods in the future. Nevertheless, there is an indicator referring to the annual maximum total precipitation over one day indicating heavy rainfall, which could also be associated with flood risk.

In compliance with the Floods Directive 2007/60/EC, the Water Development Department of Ministry of Agriculture, Rural Development and Environment (MARDE) through its report “Preliminary Flood Risk Assessment” identified 19 areas around the island as “Areas with Potential Significant Flood Risk” which are monitored.

In relation to the exposure of the infrastructure to flood events, future changes in land use and their implications should be considered. Land use changes can induce significant flood risk through changes in the runoff coefficient, (influenced by the percentage of precipitation, the ground cover of an area, ground slope).

To sum up, the exposure of the infrastructure sector to urban floods as the relative future climate changes the future exposure is ranked as high.

In order to reduce the impact of floods, the Cyprus Government has undertaken a series of flood protective measures including but not limited to the following:

(a) Hard coastal defence works (for sea flood protection),
(b) Fishing shelters and artificial reefs (for sea flood protection),
(c) Dams (for urban flood protection)
(d) Sustainable Urban Drainage systems (for urban flood protection).

Due to lack of sufficient data on the future impacts of climate change on the infrastructures of Cyprus, the analysis on the effectiveness of the already applied measures as well on the necessity for additional measures for the protection of infrastructure could not be conducted. Further research is suggested to take place on the subject. Taking everything into account, the adaptive capacity for urban floods was considered to be moderate.

Damages of infrastructure due to landslide damage

Cyprus is well-known for its interesting and often complex geology, particularly in the south-west part of the island. The reason for the increased susceptibility of this area to landslides is the remains of former sea-floor deposits and massive submarine slides, which tend to be heavily deformed and are rich in the types of clay minerals that are prone to land sliding. This tendency is exacerbated by the steep terrain and the long history of powerful earthquakes in the region. In addition, climate change increases the likelihood for land displacements. More specifically changes in temperature and precipitation could be relevant for more landslides. In this regard the sensitivity was ranked as limited. However further research is required in order to provide concrete information for the future.

Variations in precipitation, temperature, heavy rain and heat wave days changes, can have an impact on landslide occurrence (Crozier, 2009) and therefore pose risk of infrastructure. However, due to the lack of data landslides in Cyprus and the issue should be investigated further.

A research project entitled 'Study of landslides in areas of Pafos District', has being undertaken aiming to minimize the landslide risk and, to promote a more efficient and secure urban development. It must be emphasized that it is appropriate such studies to be elaborated in order to allow the adaptive capacity to increase.

As few landslide protection measures have been undertaken such as road protection measures, retention walls and terraces and further research is suggested to take place on the subject. Considering the above, both the exposure and adaptive capacity of infrastructure to landslide damages for the future period (2021-2050) can be characterized as limited.

6.3.2.3. Assessment of overall vulnerability

The overall future vulnerability of the infrastructure system against climatic change impacts, in terms of sensitivity, exposure, adaptive capacity, based on the available data is presented in Table 6.5.

In general, the infrastructures in Cyprus are not considered very vulnerable to future climate changes. In specific, the first vulnerability priority of the sector to climate changes is related to the damages caused by urban floods. However, it must be noticed that specific measures have been undertaken in order to reduce the severity of this impact (drainage works, SUDS etc.). The second vulnerability priority is related to the damages to infrastructure caused by sea floods. Considering that a great number of infrastructures important for Cyprus is located in the coastal areas of the island and that Cyprus has not experienced any severe floods from the sea in the past, the vulnerability towards this impact is considered limited. The vulnerability of infrastructure systems to landslide cannot be evaluated due to limited availability of data.

Table 6.5. Overall vulnerability assessment of the infrastructure sector in Cyprus to climate changes

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Damage from urban floods	Moderate to High (4)	High (5)	Moderate (3)	Limited to Moderate (1.5)
Damage from sea floods	Limited (1)	Very High (7)	Limited to Moderate (2)	Limited (0.6)
Damage from landslides	Limited (1)	Limited (1)	Limited (1)	None (0)

6.3.3. Energy

Cyprus, as an island situated in the south-eastern part of the Mediterranean Sea, constitutes an isolated energy system. The energy requirements are covered mostly by oil imports, making Cyprus a highly energy dependent island (Koroneos et al., 2005; Zachariadis 2010). Until recently, renewable energy was considered as the sole indigenous form of energy, before the discovery of natural gas resources in its Exclusive Economic Zone (EEZ) – which is expected to change the energy mix and consequently improve the energy sufficiency of the island. As indicated, the energy sector of Cyprus is not considered very vulnerable to climate changes. In particular, the main vulnerability priority identified for the sector is related to increased energy demand for cooling and desalination. However, given that there is

potential for increasing energy supply in Cyprus to meet the increasing energy demand, the vulnerability towards this impact is characterized as limited to moderate. The impact of climate changes on the efficiency of thermal power plants is not expected to be significant, while very limited vulnerability was identified on the potential for RES generation.

On a global basis, it is expected that the energy sector will experience different impacts due to climate change, including change of the heating/cooling degree days over year, reduction of the overall efficiency of the power stations associated with the increase in temperature of the cooling medium used in the energy production process, reduction in hydropower production etc.

According to EEA the Mediterranean basin has already been subjected to decrease precipitation something that is going to exacerbate as the climate change continues to persist and intensify. The decreased precipitation and stream flows will lead apart from low water availability, to decreased energy yield (regarding hydroelectricity). However, hydropower is not used in Cyprus and is not projected to be introduced to the energy mix of the island in the coming years, due to limited water resources and intermittent river flows.

The main vulnerability priorities identified for the sector are related to the energy demand for cooling and heating, which is directly affected by climate changes and, to the efficiency of thermal power plants, which is not expected to be significantly affected by climate changes. With regard to the impact of climate changes on the various types of RES generation -except hydropower which is not exploited in Cyprus - this is minor.

The impacts of future climate change on the energy sector based on the climate projections output produced by the PRECIS and six other ENSEMBLES regional climate models, as well as on other socioeconomic projections for the period 2021-2050. The future period 2021-2050 has been chosen, instead of the end of the twenty-first century as frequently used in other climate impact studies, in order to assist investors and policy makers to develop near future plans.

The main pressure on the sector is the energy production cost. Cyprus shows particular vulnerability on the energy sector stemming from oil prices as the total amount of oil used is imported. Additional pressures -especially during the summer- are the energy demand for drinking water production from seawater desalination plants (to reduce the dependence of drinking water on rainfall) and for irrigation (for longer periods through pressurized irrigation systems and long conveyance pipe works) due to decreasing precipitation.

Climate change will affect both the supply and demand of energy profile in different ways.

Table 6.6. Relationship between climate changes and impacts on the energy sector

Potential climate changes	Impacts
Increase in temperature and relative humidity	- Increased cooling demand and decreased heating demand
	- Decreased thermal efficiency in thermal power plants
Precipitation	Change in Bio-power generation
Wind speed	Change in Wind power generation
Cloud cover	Change in Solar power generation

6.3.3.1. Future impact assessment

On a worldwide basis, it is expected that the energy sector will experience different impacts due to climate change, including alterations of the heating/cooling demand, reduction of the overall efficiency of thermal power stations, reduction in hydropower production etc. According to the PESETA IV study (European Commission, 2020), the Mediterranean basin has already been subjected to decreased precipitation, which is going to deteriorate as climate change grows. The reduced precipitation and stream flows will lead, apart from low water availability, to decreased energy yield (regarding hydroelectricity). However, hydropower is not used in Cyprus and is not projected to be introduced to the energy mix of the island in the coming years due to limited water resources and intermittent river

flows. Therefore, the main impacts identified for the sector are related to the increased energy demand for cooling, increasing needs for desalination and the efficiency of thermal power plants. Regarding the impact of climate change on the various types of RES generation -except hydropower which is not exploited in Cyprus- this is expected to be minor.

Climate change impacts on the energy sector as these have been identified and assessed in light of the climate projections for the future (2021-2050) are mainly associated with the change in the heating and cooling loads. The climatic factors that are likely to induce impacts on the energy sector are temperature and relative humidity, precipitation, wind, and cloud cover. The future impacts of climate change on the energy sector are summarized below.

1. Renewable energy yield

In the case of Cyprus, the renewable energy sources most likely to be affected by climate change are wind and solar power. Wind power, introduced to the Cypriot energy system in 2010, is affected by wind speed and changes in wind variability. There are limited assessments for estimating the impact of climate change on wind power production in Cyprus. However, the mean wind speeds are projected to decrease slightly (0.20 m/s) in the western, south-eastern and inland regions where the majority of wind turbines are installed. The projected decrease in the potential for wind energy production ranges from 3 to 10% according to the scenario and period. Solar energy is influenced by cloudiness and atmospheric aerosols, but the magnitude of the potential impact is unknown due to complex relationships between these climate factors (Kirkinen, 2005). The energy production efficiency of photovoltaics or solar panels varies with the temperature and level of solar irradiation. According to projections for the period 2021-2050, the solar energy potential of Cyprus will increase due to the increase in annual sunshine duration (additional 60-160 hours) but will be hindered to some extent by the potential increased number of hot days per year (additional 17 to 24 days per year).

2. Efficiency of thermal power plants

Regarding the efficiency of thermal power plants, future changes in temperature may be used as an indicator. According to regional climate projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1-2°C compared to the reference period 1960-1990. However, it is not known whether a change in temperature of this magnitude will have an impact on the efficiency of thermal power plants.

3. Energy demand

Energy consumption is particularly sensitive to weather (mainly air temperature). In the Mediterranean basin, the expected change in energy demand is expected to change by 2050 as follows: 2 to 3 fewer weeks per year will require heating; and additional 2 to 5 weeks will require cooling (Alcamo, 2007). According to PRECIS a further increase in the maximum and minimum temperature (by 1.3-1.9 °C and 1.3- 1.8 °C, respectively) is expected in Cyprus during the period 2021- 2050. Consequently, an increase in cooling demand and a decrease in heating demand are expected. This is expected to results in annual welfare losses in Cyprus of more than 100 million Euros (at constant prices of year 2010) (Zachariadis and Hadjinicolaou, 2014). According to more recent estimations (León et al., 2021), by the end of the century, under a business-as-usual pathway, the cooling demand for Cyprus will be nearly three times higher than the 1986-2005 reference. A pathway close to meeting the Paris Accord main targets, still implies a nearly 50% increase in the cooling demand. The increasing energy demand for seawater desalination due to the combined warming and drying in the future is also relevant for Cyprus. This demand is expected to increase by 159% by the end of the century in a high-emission scenario (León et al., 2021). On the contrary, a more optimistic scenario (RCP2.6) will limit this increase to 32% (Figure 9).

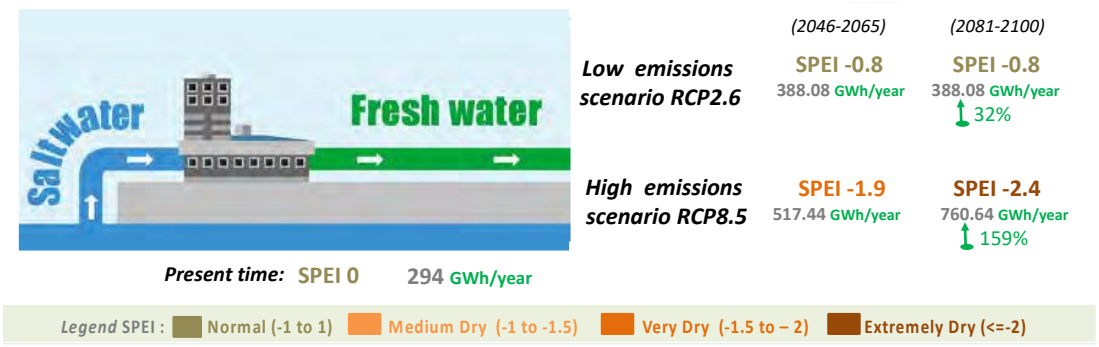


Figure 20. Estimations of increased energy demand for desalination in Cyprus under different scenarios of climate change (Adopted from León et al., 2021, https://soclimpact.net/).

6.3.3.2. Future Impact assessment

The future vulnerability of the energy sector to climate change impacts is assessed in terms of its sensitivity, exposure and adaptive capacity based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050, presented in the CYPADAPT project.

Due to the lack of sufficient scientific evidence and data, a preliminary assessment of the vulnerability of the following impacts on the energy sector, is attempted: 1. Renewable energy yield; 2. Efficiency of thermal power plants; 3. Energy demand.

1. Renewable energy yield

Renewable power production is considered sensitive to climate changes due to the reduction in renewable energy potential such as wind, solar and biomass. Given that the wind power is considered particularly sensitive to changes in wind speed and that solar energy potential is sensitive to changes in sunshine duration and higher temperatures and, that the use of biomass is limited, the sensitivity of RES energy production to climate changes can be characterised as limited to moderate.

The future exposure of RES energy potential and production to projected climate changes, rely mainly on the variations of wind and solar power potential. The annual mean wind speed changes will be slightly decreased of about 0.20 m/s in western, south-eastern and inland regions, where the majority of wind parks are installed. Therefore, the wind production is also expected to decrease in the near future. The solar energy yields are expected to be slightly increased in the future due to the projected increase in annual total sunshine duration (ranging between 60-75 hours for most of the domains and between 100-140 hours for the mountain areas).

The high temperatures, which are considered to be associated with reduced solar power potential in photovoltaics, or solar panels, will increase throughout Cyprus. According to PRECIS projections the hot day index (number of days with maximum temperature >30°C) seems to increase by 5–12 days over the northwestern and south-western coasts, by 20–24 days in continental lowlands, and by 26-28 days over Troodos mountains. Considering that the renewable energy potential in Cyprus is not significant, the future exposure of RES yield is ranked as limited.

The main policy action related to renewable energy deployment in Cyprus is the Directive 2009/28/EC on the promotion of the use of energy from renewable sources. The variety of measures taken for fostering renewable power penetration to the energy production sector, make the adaptive capacity to be considered as moderate.

2. Efficiency of thermal power plants

Though the required condensing power is sensitive to temperature increase (air and water) and is expected to reduce the thermal efficiency of power plants, no such evidence is found (Electricity Authority of Cyprus).

Considering that the energy produced and delivered to balance the energy demand would slightly be affected, the sensitivity was ranked as limited, while the exposure of power plants to future increases in temperature is moderate. On the other hand, the modernization and replacement of old equipment and the implementation of the necessary maintenance activities are expected to increase or stabilize thermal efficiency of the plants and ranked its adaptive capacity as limited to moderate.

3. Energy demand

The energy consumption is sensitive to climatic conditions and it is expected to decrease in warmer winter, and to increase in summer. Moreover, peak energy demand will be considerably greater than net consumption due higher temperatures in summer, imposing the installation of additional generating capacity over and above that needed to cater for underlying economic growth.

Energy consumption shows a clearer upward trend compared to air temperature. The energy load variations are seasonal and yearly, as it reflects both the economic growth and the greater usage of air conditioners in residential and commercial situations. The former is mainly influenced by the prevailing weather conditions and the latter by economic, social and demographic factors. Conclusively, the sensitivity of power demand towards temperature changes is considered very high.

The exposure of energy demand to future climate changes, as indicated by the overall energy consumption variation, as well as the changes in the heating and cooling demand, due to temperature changes, is ranked as very high.

According to a study combining econometric models of electricity demand with climate projections of the regionally focused PRECIS model (Zachariadis and Hadjinicolaou, 2012), by the mid-21st century annual electricity demand is projected to rise by 5.6% due to climate change, causing annual welfare losses in Cyprus of more than 100 million Euros (at constant prices of year 2010). Although additional power requirements are not very remarkable on an annual basis, climate change is expected to exacerbate the already existing imbalance between winter and summer electricity demand in the country. This outlook indicates that a reasonable and cost-effective future energy path in regions with Mediterranean climate would involve substantial deployment of solar-powered electricity generation, a zero-carbon energy source that can meet peak load requirements without increasing the country's dependency on imported fossil fuels. Moreover, this forecast highlights the need for adaptation to climate change through substantial investments in the improvement of the energy performance of the Mediterranean building stock.

The adaptive capacity of the sector to changing demand for electricity and heat is built up by means of the following:

- Installation of new power plants to satisfy future energy demand: The EAC's plan includes the installation of new power plants and the replacement of the old ones.
- Energy efficiency measures undertaken or underway: The established National Energy Efficiency Action Plan involves the implementation of measures for improving energy efficiency until 2020.
- Use of solar energy for heating and cooling. In Cyprus, solar thermal systems are widely used for the needs for hot water, while photovoltaic systems are increasingly used at household level reducing therefore the pressure on the energy supply sector; and
- Introduction of natural gas in the energy supply portfolio. The upcoming introduction of natural gas is a policy measure aiming to diversify the energy supply mix.

Based on the measures taken so far and those under way, the adaptive capacity of the cooling/heating energy demand was ranked as high.

6.3.3.3. Future vulnerability assessment

The overall vulnerability of the energy sector to climate changes, in terms of sensitivity, exposure and adaptive capacity is presented in Table 6.7.

As indicated, the energy sector of Cyprus is not considered very vulnerable to climate changes. In particular, the main vulnerability priority identified for the sector is related to the energy demand for cooling and heating, since it is directly affected by climate changes. However, given that there is

potential for increasing energy supply in Cyprus to meet the increasing energy demand, the vulnerability towards this impact is characterized as limited to moderate. The impact of climate changes on the efficiency of thermal power plants is not expected to be significant, while no vulnerability was identified on RES generation. The reason for this is that hydropower, which is the only type of RES being be significantly affected by climate changes, is not exploited in Cyprus due to the already limited water resources, while the impact of climate changes on the other types of RES is minor.

Table 6.7. Overall vulnerability assessment of the energy sector in Cyprus to climate changes

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Renewable energy yield	Limited to Moderate (2)	Limited (1)	Moderate (3)	None (-1.6)
Efficiency of thermal power plants	Limited (1)	Moderate (3)	Limited to Moderate (2)	None (-0.3)
Energy demand	Very High (7)	Very High (7)	High (5)	Limited to Moderate (2)

6.3.4. Health

6.3.4.1. Climate change and public health

In case of a continuous increase of current emissions, the next generations will face more diseases, deaths related to heat waves and natural disasters, higher rates of climate-related infections and morbidity /mortality associated with allergic and air pollution diseases. There is high possibility according to the IPCC (80% confidence) that in the future the increase in cardio-respiratory morbidity and mortality will be attributed to ground-level ozone. There is significant evidence that the Mediterranean Basin is already experiencing some of the impacts of climate change including those on public health. The main climate change related phenomena that have been recorded in Cyprus are temperature increase (especially during the summer months), an enhance in the frequency and intensity of heat waves, a reduction in the total precipitation amounts in parallel with increasing rainfall intensity and enhanced drought.

Vulnerable populations that include the elderly, children, pregnant women, and people with chronic or pre-existing medical conditions are expected to be the most affected by extreme heat (Zittis et al., 2022). The extreme environmental conditions are also expected to augment differences and inequalities between the more affluent and impoverished populations of the country. The increasing temperatures may affect cities more than other locations, with different adaptive capacities to cope with hot weather. Outdoor labour activities, such as construction and agriculture, will be challenged, particularly during the warm part of the year. In a recent review of the effects of climate change on human health in the EMME, Neira et al (2022) have proposed a set of policy suggestions which, if implemented, could improve the resilience of health systems against climate change for all countries in the region, including Cyprus. These policy suggestions, include a decisive region-wide decarbonisation, the integration of environmentally driven morbidity and mortality data throughout the region, advancing the development and widespread use of affordable technologies for the production and management of drinking water by non-traditional means, the development of comprehensive strategies to improve the health status of displaced populations, and fostering regional networks for monitoring and controlling the spread of infectious diseases and disease vectors. This review, as well as the reports of other Task Forces working in the context of the Cyprus-led 'Eastern Mediterranean and Middle East Climate Change Initiative' (EMME-CCI) can be found at: https://emme-cci.org/. Research on the climate change effects upon public health in Cyprus is performed by institutions and government departments in Cyprus concerning the study of climatological data and their possible health effects (CDC, 2009). Cyprus also participates in MedCLIVAR, which is an international network, aiming to study the climate change impacts and challenges pose to public health, as well as the occurrence of extreme events -closely related to climate variability in the Mediterranean and other regions around the world.

6.3.4.2. Future impact assessment

Human beings are exposed to climate change both directly through changing weather patterns and indirectly through changes in the ecological and social systems (Confalonieri et al., 2007)

Changes in the frequency and severity of extreme events, particularly heatwaves, floods, droughts and intense rainfall, result in local air pollution and more aeroallergens affecting health directly. Other indirect health impacts may result from the effects of climate change on ecological and social systems, such as changes in the occurrence of infectious diseases, local food production and under-nutrition, and various health consequences of population displacement and economic disruption.

A summary of the potential impacts of climate change on human health in Cyprus per climate change factor is presented in Table 6.8.

Table 6.8. Relationship between climate changes and impacts on the public health sector

Potential climate changes	Direct Impacts	Indirect Impacts
High temperatures and heat waves	- Heat related stresses - Deaths due to heat strokes - Cardiovascular diseases - Respiratory and metabolic disorders	- Water-borne diseases due to increased algal blooms - Food-borne diseases due to food contamination - Vector-borne diseases due to the higher risk of transmission, geographical and seasonal distribution
Increase in the intensity and frequency of extreme events (floods, storms)	- Deaths and injuries from floods, storms, landslides and fires - Psychological morbidity (mental disorders) from floods, storms, landslides and fires	- Water-borne diseases caused by water contamination and poor sanitation - Vector-borne diseases (malaria, Leishmaniasis, Mosquitos) due to stagnant waters - Diarrhoea diseases (including cholera) - Reduced nutritional status
Droughts	- Deaths and injuries from fires caused by high temperatures combined by strong winds and drought	- Vector-borne diseases due to contamination of small rivers and drainage canals - Water-borne diseases - Respiratory diseases due to increased air-borne particulate matter - Child malnutrition and under-nutrition, due to loss of agricultural production
Air pollution		- Eye irritation - Respiratory tract irritation - Exacerbation of respiratory diseases - Exacerbation of asthma and irritation of bronchi - Exacerbation of allergic rhinitis, asthma and other atopic diseases

There is increasing evidence of the importance of mental disorders as an impact of disasters (Ahern et al., 2005). A systematic review of post-traumatic stress disorder in high income countries found a small but significant effect following disasters, such as medium to long-term impactson behavioural disorders in young children (Durkin et al., 1993; Becht et al., 1998; Bokszczanin, 2000).

However, the effects of climate change on existing environmental and public health problems are difficult to discern. The challenge is to identify their 'additional' effect, i.e., the increase in health problems that can be attributed to climate change as an additional risk factor.

The climate change impacts on the public health sector in Cyprus were assessed on the base of PRESIS projections for the future (2021-2050) within the CYPADAPT project, under the following categories:

I. Direct impacts

1. Deaths and health problems related to heat waves and high temperatures,
2. Deaths /injuries from floods,

3. Deaths /injuries from landslides,
4. Deaths /injuries from fires.

II. Indirect impacts
1. Vector-borne and rodent-borne diseases
2. Water- borne and food-borne diseases,
3. Climate-related effects upon nutrition,
4. Air pollution related diseases.

I. Direct impacts

Deaths and health problems related to heat waves and high temperatures are of primary concern in Cyprus, although these issues are also influenced by socio-economic changes such as population growth, the increased average age and migration. General predictions and observations in Mediterranean cities have shown that heat waves can have very strong effects on mortality, reporting an increase of 1-4% for each 1^{o}C rise (IPCC 2007). In addition, mortality is associated to the timing of heat waves as indicated by the higher mortality found early in the summer than the mortality in late season.

Exposure to extreme and prolonged heat is associated with heat cramps, heat syncope, heat exhaustion and heat stroke (Faunt et al., 1995) and occupational health implications.

According to PRECIS projections, the annual number of hot days (Tmax exceeds 30^{o}C) and the annual number of tropical nights (TNmax exceeds 20^{o}C) are expected to increase all over Cyprus in the future, by 17 -24 days and by 20-45 days per year, respectively. While the number of heat wave days per year (days with Tmax over 35^{o}C), is expected to present a wider range of changes from 2 to 34 days. In addition, humidity during summer in the coastal cities of Cyprus could reaches high levels which in conjunction with high temperatures, cause great discomfort to people. However, there are no sufficient data for estimating heat related deaths and health problems which could be associated with climate changes in Cyprus.

Flood-related deaths and injuries are expected to increase with the anticipated increase in the frequency and intensity of extreme weather events such as heavy rainfall, storms and floods. Generally, the exposure to high-frequency flooding events can result in long-term problems such as increased rates of anxiety and depression stemming from the experience itself, troubles brought about by geographic displacement, damage to the home or loss of family possessions. Moreover, the persistence of flood-related health effects is directly related to flood intensity. The number floods with recorded victims in Cyprus between 1970-2011 shows an increasing trend (WDD, 2011), but the data were not sufficient to assess the deaths and injuries from floods.

Landslide-related deaths and injuries are expected to increase with increasing extreme rainfall events (Confaloniery et al., 2007) and may also result in the displacement of communities and migration. However, there is no official record in Cyprus of victims affected.

The impacts of future climate changes on both the frequency and intensity of floods and the occurrence of landslides in Cyprus, could not be assed as the only related indicator provided by PRECIS was the annual maximum total precipitation over one day, which is expected to have minor changes in the future period (2021-2050) ranging from 2 to 5 mm.

Fire- related deaths and injuries are expected to increase with increasing the risk of forest and rural fires due to climate change. Forest and bush fires may cause deaths of people trapped in them, burns and other injuries. Large fires are also accompanied by an increased number of patients seeking emergency services. In particular, forest fires in Cyprus are considered a major and permanent threat, causing enormous damage to forest ecosystems and in some cases threaten residential regions (Alker, 2009), taking into account, the high temperatures, prolonged and severe drought periods, strong winds and the configuration of the ground and extremely flammable vegetation.

The future risk of fires in Cyprus, as assessed by means of the Fire Weather Index (FWI) and, the PRECIS climate model is high. In specific, there will be an increase in the number of days with high fire risk of 5-15 days/year, as well as an increase in the number of days with extreme fire risk of 1-10 days/year in the future period (2021-2050) compared to control period (1960-1990).

However, there are no sufficient data for estimating whether there is an increasing trend on the incidents of fire-related deaths and injuries which could be associated with the trend in fires in Cyprus.

II. Indirect impacts

Vector-borne and rodent-borne diseases are among the well-studied diseases associated with climate change, due to their widespread occurrence and sensitivity to climatic factors. The former are transmitted by infected mosquitoes and other arthropod species, mainly during droughts, whereas the other are transmitted directly to humans by contact with rodent urine or other body fluids, mainly during floods or high rainfall events, droughts and introduction of exotic plant species

According to PRECIS climate projections in Cyprus for the period 2021-2050, the length of drought periods which is associated with the occurrence of both vector- and rodent- borne diseases is projected to increase up to 13 days/year on average. As for the heavy rainfall events, the most relative indicator provided by PRECIS refers to the annual maximum total precipitation over one day, which is expected to have minor increase.

In general, water-borne diseases are likely to increase with climate changes such as reduced rainfall, increased temperature, increase in the frequency of extreme weather events (droughts, heavy rainfall, floods), due to the possible risk of water deterioration and lack of good hygiene. Higher water temperatures and flooding may also lead to contamination of water with harmful algal blooms or runoff pollutants. Contamination of food may be induced by higher temperatures (surface and ocean) due to enhance the survival and proliferation of viruses, bacteria and pathogens in foodstuffs.

However, in Cyprus there many measures in place such as effective water and food legislation, high quality of health services, sanitation standards and drainage systems, to safeguard public health.

The future climate changes projected for Cyprus include minor changes in the annual average precipitation while the length of drought periods is projected to present an increase up to 13 days/year on average. It must be noted that although Cyprus is considered a dry region, the water availability is satisfactory, with the substantial contribution of desalinated water to drinking water supply and the extensive waste water drainage system.

The causal chains through which climate variability and extreme weather influence human nutrition are complex and involve different pathways such as water scarcity, salinisation of agricultural lands, destruction of crops through flood events, wind storms, frosts and hail, disruption of food logistics through disasters, and increased burden of plant infectious diseases or pests (Confalonieri et al., 2007). Reduced food production may lead in diminished dietary diversity, reduction in overall food consumption and in malnutrition, especially in low-income countries.

In Cyprus the greatest climatic threats for the agricultural production (especially seasonal) and food availability, are droughts (through cuts in irrigation water) and frosts. Other extreme weather events such, heat waves, wind storms, hail and floods are, also related to damaged crop yields and have impacts upon nutrition.

According to PRECIS climate projections in Cyprus for the period 2021-2050, the length of drought periods (precipitation<0,5mm) is projected to increase up to 13 days per year on average. However, as drinking water supply will be satisfied by desalinated water in a great extent (except for the areas not connected to government water works), the irrigation water availability will increase compared to the control period. Furthermore, the mean number of heat wave days per year (temperature >35^{o}C) is expected to increase from +2 to +34 days per year and the number of heavy rainfall events, as indicated by the annual maximum total precipitation over one day, is expected to have minor changes, ranging from 2 to 5 mm on average. Finally, the frequency of damages to crops due to frosts and wind storms

will decrease while as regards the damages due to heat waves it is expected that they will increase. Concerning the frequency of damages by droughts and floods, it is not clear whether the effect will be negative, positive or none.

The diseases related to air pollution include exacerbation of respiratory diseases, tract irritation, exacerbation of asthma, irritation of bronchi, atopic diseases, exacerbation of allergic rhinitis, eye irritation. The air pollution health risks related to climate change are caused primarily from the increased concentrations in the atmosphere of particulate matter and ozone, related to forest fires, heat-waves, Sahara dust events, re-suspension from soils and other surfaces, as well as from traffic and other anthropogenic activities.

The future climate changes in Cyprus that are considered to be associated with the impact of air pollution-related diseases are according to PRECIS climate projections in Cyprus for the period 2021-2050: the mean number of heat wave days per year (temperature >35^{o}C) which is associated with increases of tropospheric ozone and particulates, is expected to increase from +2 to +34 days per year. In addition, it is expected that the already dry climate in Cyprus which contributes to the suspension of PM10 will be further intensified with the prolongation of drought periods (precipitation <0,5mm) up to 13 days/year on average. However, wind speed which also associated with this effect is expected to decrease. As for the changes in the mean annual maximum temperature in Cyprus which is related to increased pathogen prevalence in air, this is expected to increase by 1 - 2^{o}C with respect to the control period. 1960-1990. In general, it can be said that climate changes will have a negative impact on the air pollution related diseases in Cyprus.

6.3.4.3. Future vulnerability assessment

The future vulnerability of public health to climate change impacts is assessed in terms of its sensitivity, exposure and adaptive capacity, based on selected indicators and on the available quantitative and qualitative data for Cyprus as well as on the climate projections for the period 2021-2050 and presented in the CYPADAPT project.

The vulnerability of public health is assessed for each of the following impacts:
- Deaths and health problems related to heat waves and high temperatures
- Deaths and injuries from floods/storms
- Landslide-related deaths and injuries
- Fire- related deaths and injuries
- Vector-borne and Rodent-borne diseases
- Water-borne and food-borne diseases
- Climate-related effects upon nutrition
- Air pollution-related diseases

It must be noted that, there are no sufficient scientific evidence and data to evaluate or correlate all impacts and indicators to future climate changes. Consequently, further research is required in order to provide concrete information for a more detailed and descriptive assessment of the future vulnerability of the sector.

1. Deaths and health problems related to heat waves and high temperatures

Excessive heat is a well-known cause of heat stress, exacerbated illness and mortality. Heat waves have readily discernible health outcomes because they result in a large number of deaths and affect relatively large, heterogeneous areas simultaneously. However, not all heat waves have a similar impact on mortality. In addition to the intensity of a heat wave, the duration and the timing of the event are particularly important. Illnesses recognisable as the direct results of exposure to prolonged periods of high environmental temperature are heatstroke, heat exhaustion, and heat cramps.

Empirical-statistical models for heat stress are constructed for Cyprus during summer (June-August) for the period 2004-2011, in order to investigate the relationship between hot weather conditions and mortality for Cyprus since excessive heat is a well-known cause of heat stress, exacerbated illness and mortality. The calculated summer excess deaths (or the heat related mortality) per day for each

maximum air temperature interval, as well as the frequency of occurrence of the temperature intervals during this period are presented in Figure 6.21.

A fairly linear increase of mortality with increasing temperature and thus high sensitivity is observed - with hotter days associated with greater morality risk. Heat-related deaths start to be discernible when the maximum temperature is 38^{o}C or above.

In addition, local factors, apart from climate, such as topography, urban heat-island magnitude, income, and the proportion of elderly people, are also important in determining the underlying temperature–mortality relationship in a population (Curriero et al., 2002). The population groups that are most vulnerable to heat waves are the elderly, persons with pre-existing chronic diseases, people confined to bed, children, population groups with low socio-economic status, workers in outdoor environments. Moreover, heat waves have a much bigger health impact in cities than in surrounding suburban and rural areas.

Generally, the risk period for heat waves in Cyprus is identified during the whole summer, that is, from June to August (three months). According to the WHO (2010), the 98.8% of Cyprus population is exposed to moderate heat wave hazard (32- 41^{o}C). The heat-related mortality, as projected to the future climate of 2021-2050 using temperature output from the PRECIS and ENSEMBLES climate model simulations under the A1B emissions scenario, is expected to increase up to 10 excess deaths per day under very hot weather conditions (Figure 6.22).

To investigate the potential negative impacts of climate warming on human life, the humidity index or "Humidex" (Masterton and Richardson, 1979) was employed to express the temperature perceived by people (Figure 6.23).

The public health response of Cyprus in heat waves is based at forecasting heat waves, issuing warnings and providing advices for self-protection from heat waves, through the mass media (television, radio, newspapers, and public websites). Furthermore, to the sufficient ability of the health care system of Cyprus to respond to heat related incidents, there are working regulations prohibiting outdoor labour work when temperature exceeds 40^{o}C and, though the majority of houses and buildings are fully air-conditioned, communal centres have been established to accommodate people with no access to an air-conditioned environment. Considering the above-mentioned indicators, the adaptive capacity of Cyprus' public health to heat waves is characterized as limited to moderate.

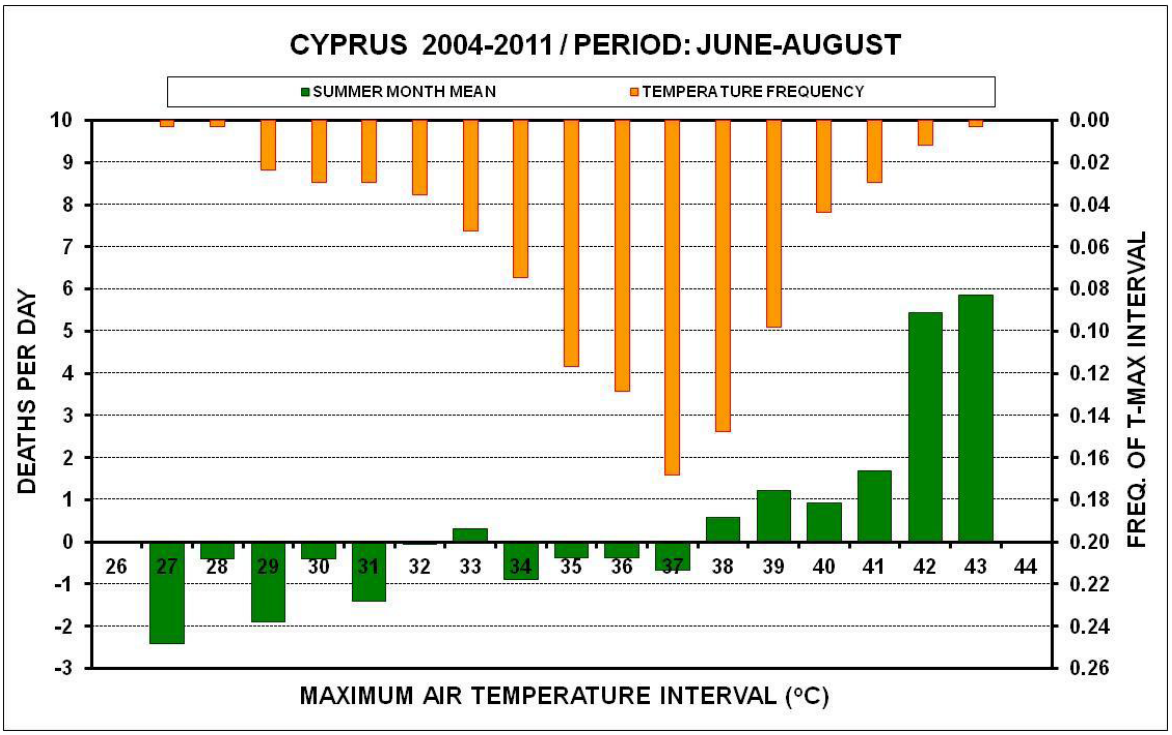


Figure 6.21. Daily excess summer deaths (green bars, left-hand axis) in Cyprus by maximum air temperature interval for the years 2004-2011. The frequency of occurrence of each temperature interval (right-hand axis) is shown using orange bars

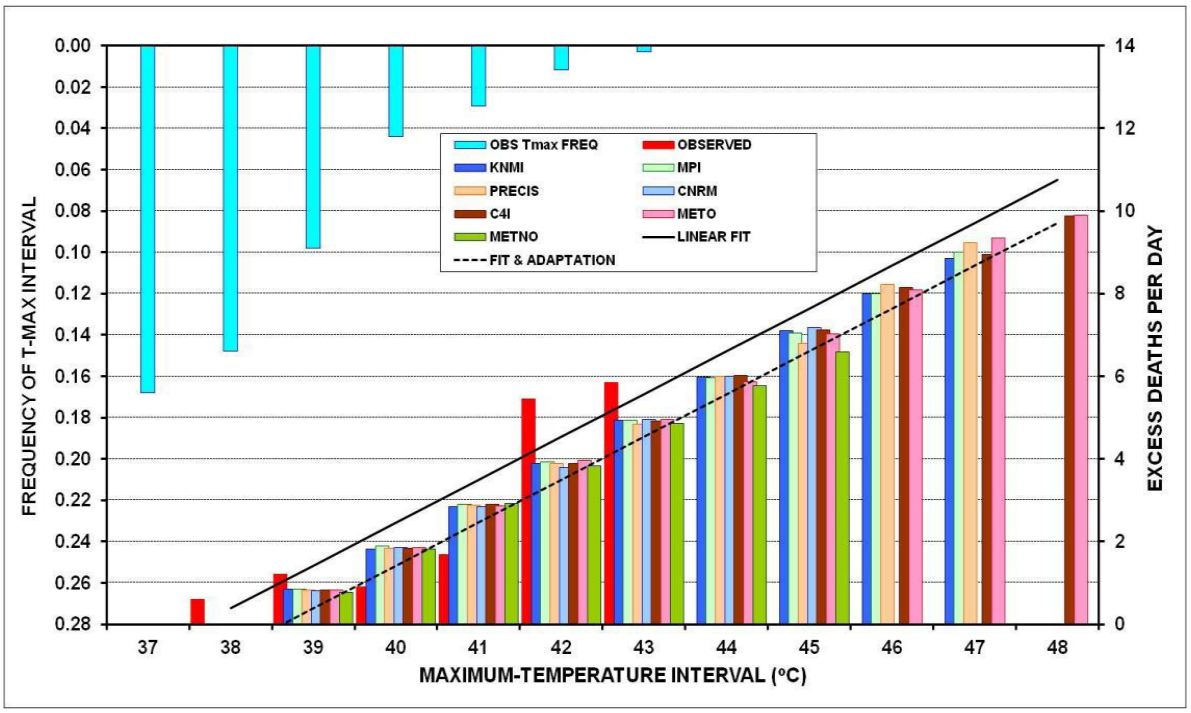


Figure 6.22. Excess deaths (right axis; model and observation bars for present and future climate with adaptation) and daily temperature frequencies (left axis; light blue bars) in Cyprus for the future period 2021-2050

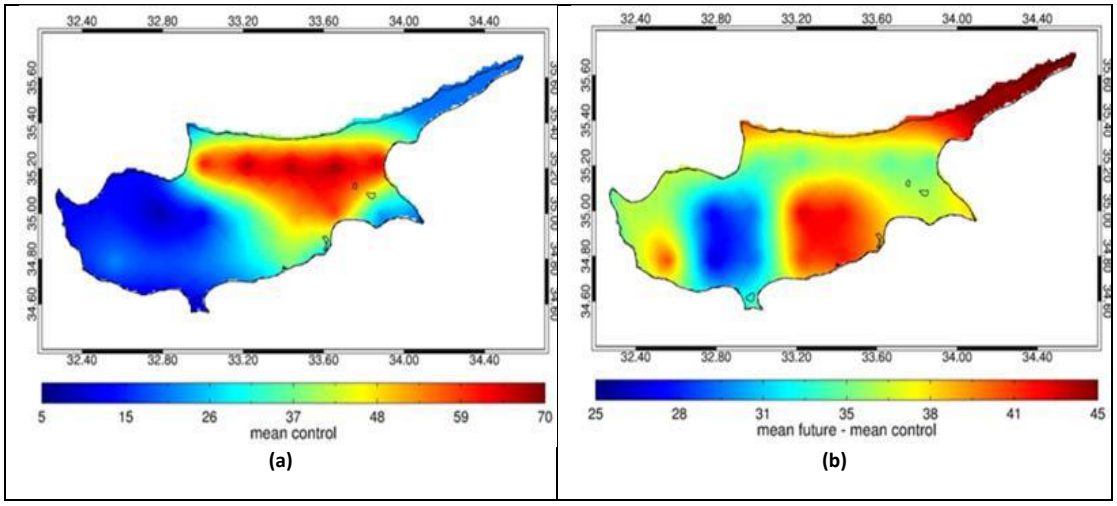


Figure 6.23. Maximum length of Humidex > 38°C (a) for the control period (1960-1990) and (b) the near future (Future – Control period), PRECIS RCM model

i. Heat-related health effects

Studies in Cyprus have found an increase in mortality risk due to cardiovascular disease associated with increased average daily temperatures (Lubczyńska et al., 2015). In this study, the evidence suggests that the increments in relative risk observed immediately after spikes in ambient temperature are the highest for ischaemic heart disease, followed by cerebrovascular disease. Furthermore, the authors suggest that the frequent presence of air conditioning (AC) units in homes in Cyprus (with up to 80% of households reportedly having at least one AC unit) might help reducing some of the negative health effects associated with heat waves (Lubczyńska et al., 2015; Zachariades and Hadjinicolaou, 2015). A 1°C increase above baseline in daily maximum temperature in Cyprus would result in doubling heat-related mortality, whereas a temperature increment of 5°C would increase mortality by almost 8-fold (Heaviside et al., 2015). Because of the urban heat island effect, this risk is reportedly higher in Cyprus's capital, Nicosia (Heaviside et al., 2015; Pyrgou and Santamouris, 2018). Increased temperatures have also been associated with increased morbidity in Cyprus (Pantavou et al., 2021). Data for the period 2009 – 2018, highlight that hospital admissions are likely to start increasing when mean daily temperatures rise above 26.1°C. Furthermore, for each 1 °C increase in mean daily temperature, hospital admissions in Cyprus increase by 0.6%. For the future, heat discomfort is expected to increase significantly due to the combined effect of strong summer warming and increased atmospheric humidity levels. In a business-as-usual scenario (RCP8.5) this discomfort conditions are expected to last more than 160 days per year and expand beyond the summer season (Figure 6.24). Besides daytime extremes, night-time temperatures are also expected to significantly increase in the region (Ntoumos et a., 2022).

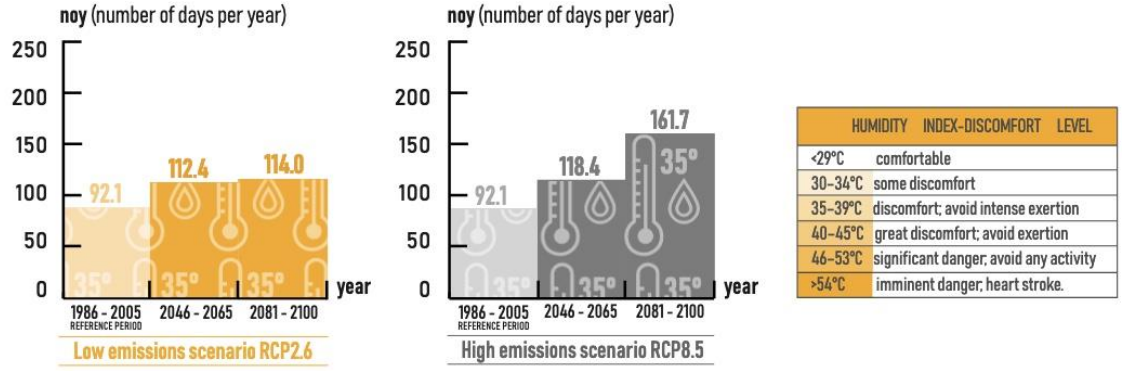


Figure 6.24. The number of days per year with Humidex greater than 35°C. A day with Humidex above 35°C describes conditions from discomfort to imminent danger for humans (Adopted from León et al., 2021, https://soclimpact.net/).

2. Deaths and injuries from floods/storms

The main population groups that are considered sensitive to deaths and injuries from floods and storms are (i) the elderly over 65 (13.3%) which cannot move easily and fast in case of a flooding event and (ii) infants and young children (16.1%) especially if they are not under the protection of an adult. The following figures illustrate the level of severity for public health of recorded flooding events in Cyprus during the period 1859-2011.

The flood hazard distribution map of Cyprus (Figure 6.26) indicates that the risk ranges from very high levels (Lefkosia) to very low (Troodos) depending on the regions.

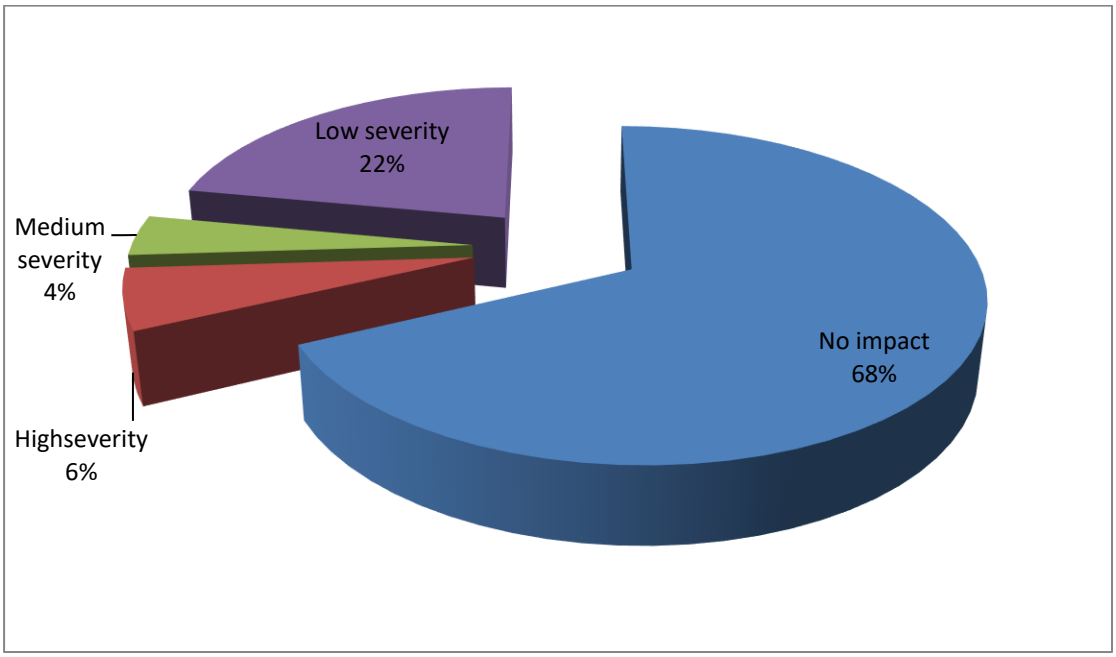


Figure 6.25. Impact of flooding events on public health (1859-2011) (WDD, 2011)

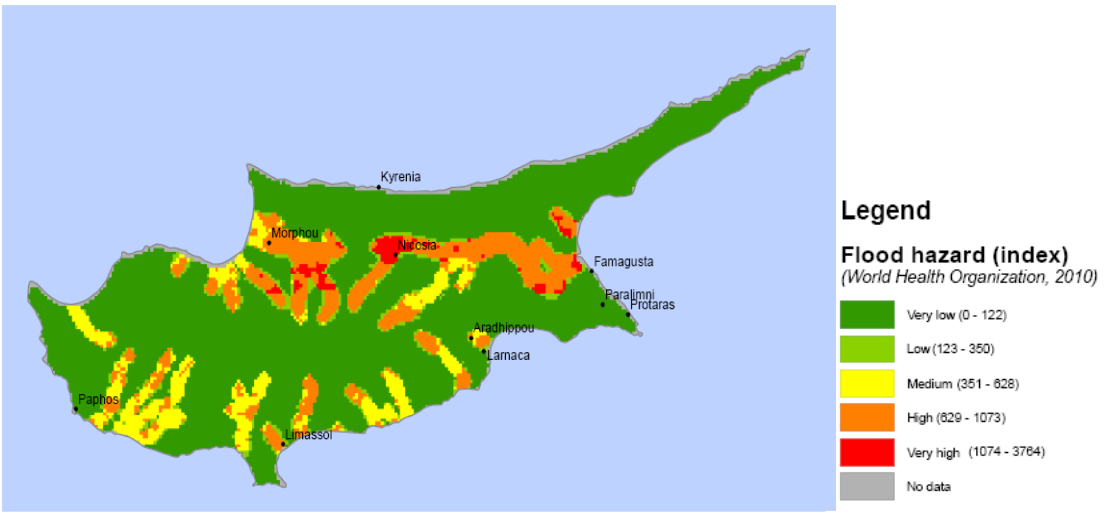


Figure 6.26. Flood hazard distribution map of Cyprus (WHO, 2010)

For the protection of people during a severe flooding event, the civil preparedness and defence service of Cyprus is in place and the health care system of Cyprus cherishes injured people. To prevent the occurrence of flooding events in Cyprus, a separate drainage system is being developed and expanded the last two decades in order to collect stormwater. Furthermore, it is expected that through the implementation of the Flood Risk Management Plans by the end of 2015 and the associated flood protection works, public health will be substantially safeguarded by the adverse effects of floods.

Taking into account the above, the sensitivity, exposure and the adaptive capacity of public health in Cyprus to floods and storms is considered limited to moderate, for the former and moderate for the rest aspects.

3. Landslide-related deaths and injuries

The main population groups that are considered sensitive to deaths and injuries from landslides are the elderly people and the young children, same as mentioned above. According to the landslide hazard map produced by the World Health Organization (2010) (Figure 6.27), Cyprus population is not at risk from landslides. Similarly, is the risk regarding future climate changes as the related the related indicator, the annual maximum total precipitation over one day, show a slight increase.

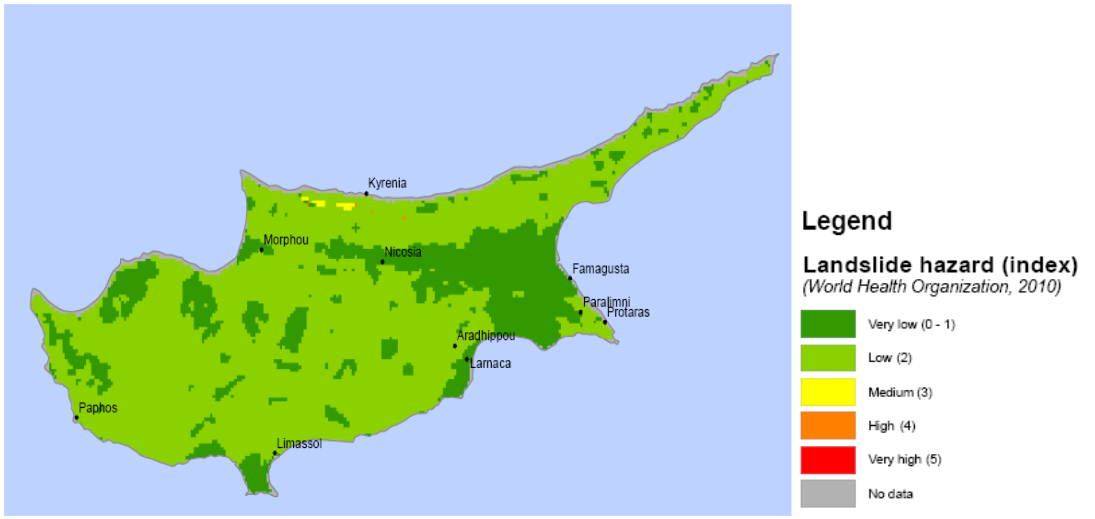


Figure 6.27. Landslide hazard distribution map of Cyprus (WHO, 2010)

Taking into account that above, the sensitivity and the exposure of public health in Cyprus to landslides is considered limited to moderate and, limited respectively.

Further to the preparedness of all responsible governmental departments for the protection of citizens living in landslide prone areas from future landslides, entire settlements have been relocated to safer places and technical structures were built. Research has been also undertaken to promote a more secure urban development

Considering the magnitude of the impact of landslides on public health which is estimated as limited to moderate, the developed adaptive capacity to cope with the impact, is characterized as moderate.

4. Fire-related deaths and injuries

Given that there are no data on the number of people killed or injured during fire events in Cyprus, the vulnerability of public health to fires is based on the fire risk areas in conjunction with the population density in these areas

According to PRECIS near future (2021-2050) the Fire Weather Index (FWI) projections rich the highest values during summer and is higher at the elevated forested areas, mainly at Troodos Mountain which are not densely populated (Figures 6.30 and 6.31).

Considering that the total share of population, which is sensitive to fires is 29% (the elderly over 65 and infants and young children), the geographic distribution of high fire risk and the low population density of these areas, the sensitivity and exposure of the population in Cyprus to fire-related deaths and injuries, are characterized as moderate and, as limited to moderate, respectively.

Several measures for fires, even though no specific adaptive measures to public health, are taken by the Forestry Department of Cyprus aiming to eliminate forest fires including prevention, pre-suppression, detection and suppression measures. Among the measures concerning public health are

the information campaigns on fire prevention and protection, fire danger mapping, installation of fire protection systems in areas where large numbers of people may concentrate. In addition, relative legislation and action plans have are applied by the Fire Brigade, the Civil Defence Service and the Health Care System to protect the population from fires.

Therefore, the adaptive capacity of Cyprus public health to fire-related deaths and injuries can be characterized as moderate.

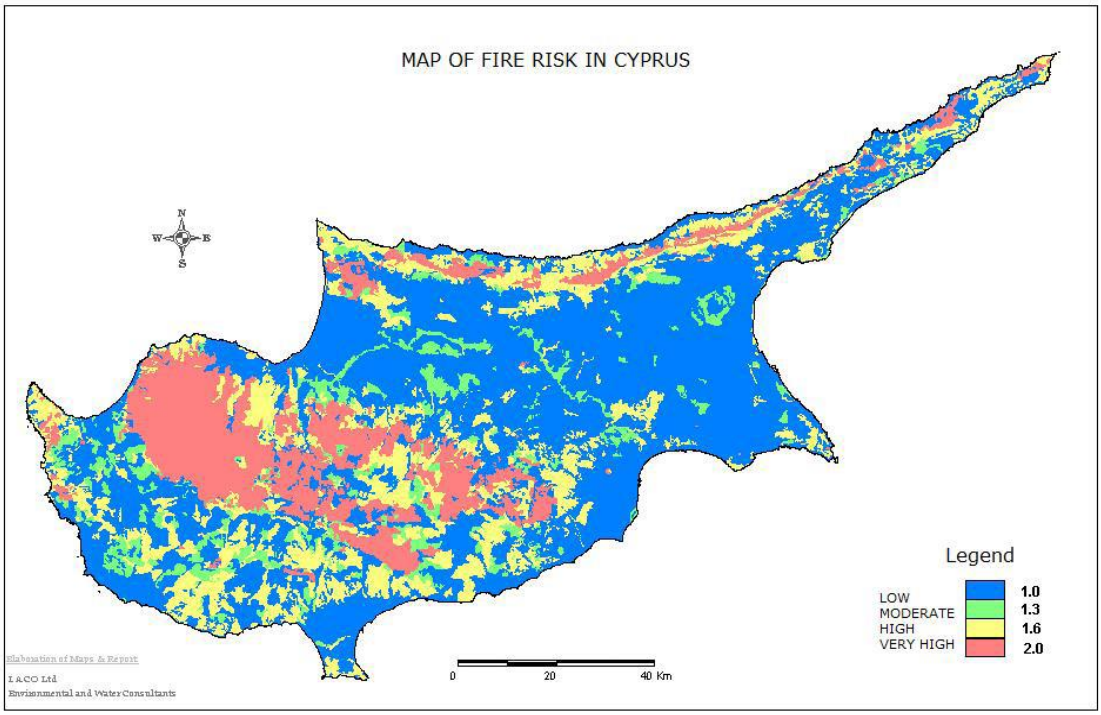


Figure 6.28. Map of fire risk in Cyprus (Department of Environment), 2007

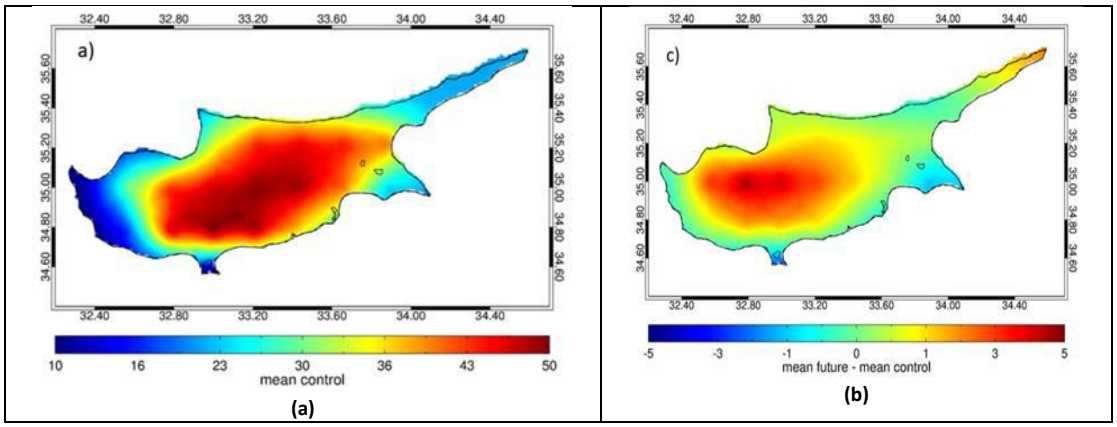


Figure 6.29. July average FWI in (a) the control period (1960-1990) and (b) the near future (Future – Control period)

5. Vector-borne and Rodent-borne diseases

All citizens in Cyprus, living either in urban or rural areas, have direct access to clean and safe water and are served with an efficient sanitation system (public wastewater network, septic tanks, waste disposal system) (Figure 6.30). According to data provided by the United Nations Environment Programme (UNEP), Cyprus presents the lowest rate for vector-borne diseases among other countries (Cosmatos, 2009).

The epidemiology of many infectious diseases is heavily influenced by climate. In a review of the effects of climate change on infectious disease transmission in the Eastern Mediterranean and Middle East

(EMME), Paz et al. (2021) identified West Nile fever, leishmaniasis and campylobacteriosis among the infectious diseases most sensitive to climate change in Cyprus. Although malaria has been eradicated from Europe since the late 1970s (Reiter 2001; Piperaki and Daikos 2016), local transmission of this disease has occurred sporadically in several countries of the region during the past decade, including in Greece and Cyprus (Piperaki and Daikos, 2016; EUDC, Emms et al., 2020). Due to the presence of competent vectors in the region, this disease has been identified as one which could re-emerge if future environmental conditions become favourable (Neira et al., 2022). Climate change can influence the transmission of vector-borne diseases (VBDs) through altering the habitat suitability of insect vectors (León et al., 2021). This is mainly controlled by increases of ambient air temperature and changes in the hydrological cycle. Asian tiger mosquito is native to the tropical and subtropical areas of Southeast Asia; however, in the past few decades, this species has spread to many countries through the international transport of goods and increased travel. It is of great epidemiological importance since it can transmit viral pathogens and infectious agents that cause chikungunya, dengue fever, yellow fever and various encephalitides.

In Cyprus, the simulated climate conditions indicate a medium suitability (historical). This is expected to slightly increase in a future of strong climate change mitigation (pathway RCP2.6). On the contrary under high mitigation RCP8.5 the suitability is expected to decrease. For a large part of the island (mainly inland) the future climatic conditions will likely be unfavorable for the Asian tiger mosquito, while high suitability is mostly simulated over the mountainous areas of Troodos where summer temperatures are not expected to exceed the 40°C threshold. These estimations are in agreement with previous studies based on different climate datasets (e.g.., Proestos et al., 2015)

The exposure of public health to vector-borne and rodent-borne diseases is more possible during periods of increased temperatures, prolonged droughts or after floods. Projections for the period 2021-2050 according to the PRECIS model, indicate that the average annual maximum temperature (TX) will increase by 1.0 to 2.0 °C, while the increase of the maximum length of dry spell will be about 15 to 20 days/year and, the annual maximum total precipitation over one day will be slightly increased by about 2-5 mm. (Figure 6.31).

Taking into consideration the above, both the sensitivity and the exposure of public health in Cyprus to vector-borne and rodent-borne diseases is characterized as limited and as limited to moderate, respectively.

The measures currently available to control vector-and rodent-borne diseases are disease specific include diagnosis and treatment, vaccination, vector control, reservoir host control (spaying stagnant waters especially during summer), information and health education as well as disease surveillance and monitoring. Considering the above, the adaptive capacity of Cyprus public health to vector-borne and rodent-borne diseases can be characterized as moderate.

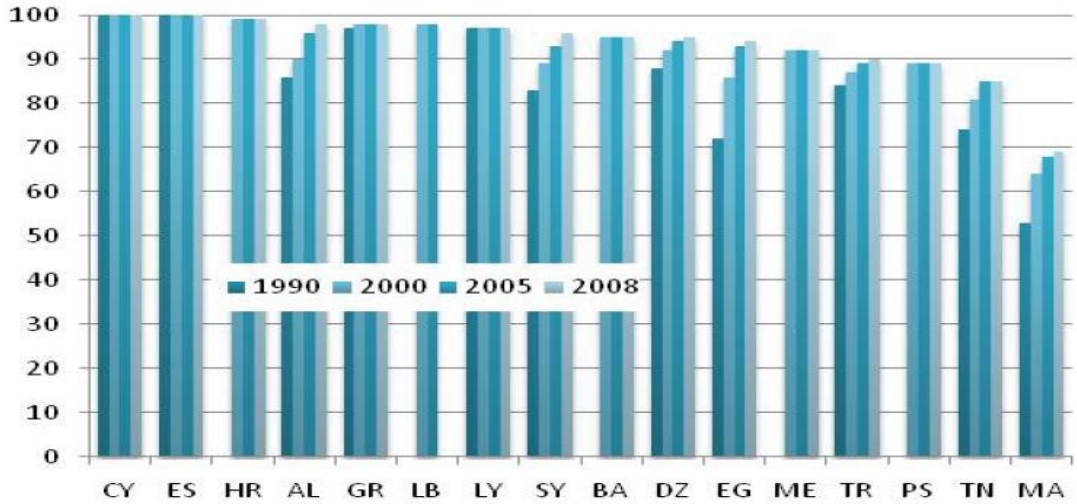


Figure 6.30. Share of population with access to an improved sanitation system, 1990 – 2008 (%)

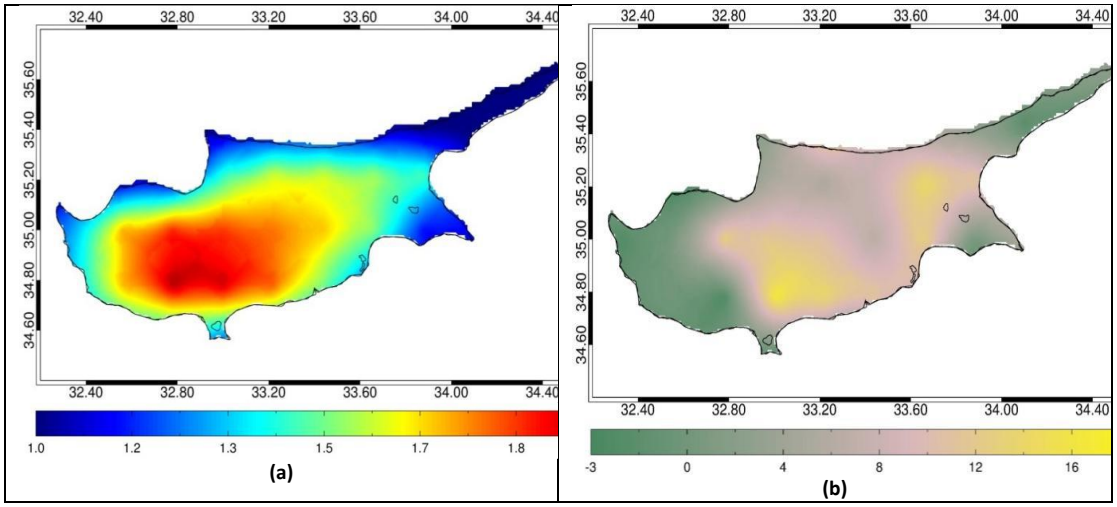


Figure 6.31. Changes in (a) average annual maximum temperature and (b) maximum length of dry spell (RR<0.5mm) between the future (2021-2050) and the control period (1961-1990)

6. Water-borne and food-borne diseases

Provided that many waterborne diseases are associated either directly or indirectly, to the quantity and quality of the water supply, it is noted that all people leaving in Cyprus have direct access to clean and safe water and to adequate sanitation facilities.

The following facts are indicative of the exposure status of public health in Cyprus to water-borne and food-borne diseases:

- The estimated number of "healthy" life years lost (DALYs) attributable to water, sanitation and hygiene for 16 Member States of the EU27, shows that Cyprus is in the first place (reference year 2002)
- The recorded incidents of salmonellosis in Cyprus for the period 1984-2007 present a general increasing trend, although they remain quite below the average respective values in the EU
- The incidents of Hepatitis A in Cyprus are quite low (less than 1 incident/100,000 capita per year) for the period 1980-2007 while the respective value for the EU was significantly higher until recently when it declined the current exposure level of population to water and food-borne diseases can be characterized as limited to moderate.

The expected changes of the climate factors influencing the exposure of public health in water-borne and food –borne diseases through drinking water contamination, according to the PRESIS model for the future period 2021-2050 are: the decreased rainfall, the increased temperature, the increase in the frequency and intensity of droughts.

Thus, the future sensitivity and exposure of population to water and food-borne diseases e can be characterized as limited and, as limited to moderate respectively.

The Ministry of Health, the Ministry of Agriculture, Natural Resources and Environment and the Ministry of Labour and Social Insurance jointly are responsible for environmental health. They apply and manage continuous control and monitoring programmes i) the food chains and drinking water supplies for ensuring quality and safety ii) the environmental pollution level of the water bodies, the wastewater solid waste systems.

There are also National Councils for Food and Water, for the effective implementation of the food-borne surveillance system, the food and drinking water safety and quality, in addition to the national legislation, which is in full compliance with all relevant international and European regulations, therefore the adaptive capacity of Cyprus to water-borne and food-borne diseases is considered as moderate to high.

7. Climate-related effects upon nutrition

Incidents of malnutrition are more likely to be detected in population groups with lower socio-economic status as well as to infants and young children. The population groups characterized by high risk of poverty in Cyprus amounted to 16% of the total population in the period 2005-2008 and the percentage of infants and young children amounts to 16.2% of the total population.

The agricultural sector is the first to suffer from the consequences of extreme climatic phenomena and their impact in farmers' seasonal yields as well as the availability of food. In Cyprus, nutrition is based on both agriculture and livestock national production but also on a great extent on imports.

Consequently, the sensitivity and exposure of public health in Cyprus to climate-related effects upon nutrition are considered as limited to moderate and, limited respectively.

The measures to protect public health from under-nutrition are associated with the measures to secure water availability for irrigation in periods of droughts (e.g. use of recycled water, increase water storage capacity, satisfaction of drinking water supply by desalination plants etc.) and the measures for the protection of crops from extreme climatic events (e.g. installation of hedgerows, green houses etc.). Last but not least, the economic ability of Cyprus to secure food availability even when national productivity is reduced through imports of agricultural, meat and dairy products substantially enhances the adaptive capacity of Cyprus. It must also be noted that, the National Committee for Nutrition, is responsible inter alia for safeguarding the production and distribution of food prod

Consequently, the adaptive capacity of Cyprus public health to the climate-related effects upon nutrition can be characterized as high.

8. Air pollution-related diseases

Certain groups are potentially more vulnerable than others to air pollution, such as the children, pregnant women, people over 65 years of age, and persons suffering from cardiovascular and respiratory diseases (e.g. asthma). The data available on these groups in Cyprus show that comprise the 30% of the total population. Therefore, the sensitivity of Cyprus public health to air pollution is considered moderate.

The ground-level ozone in Cyprus constitutes an overall transboundary problem, being lower in the cities than high elevated background areas, because of the depletion by the primary emitted pollutants there. (Figure 6.32) Considering the fact that population density in those areas is low, the exposure of population to ozone is limited.

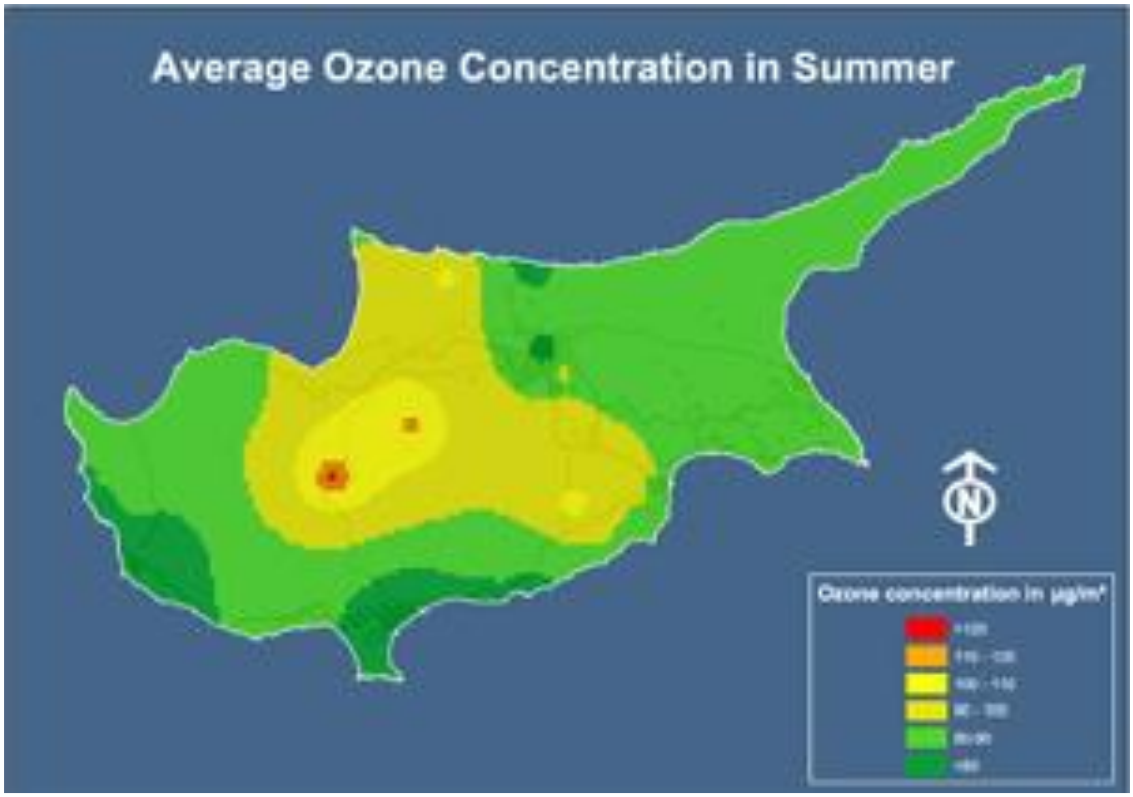


Figure 6.32. Average Ozone Concentration in Cyprus (Department of Labour Inspection, Cyprus)

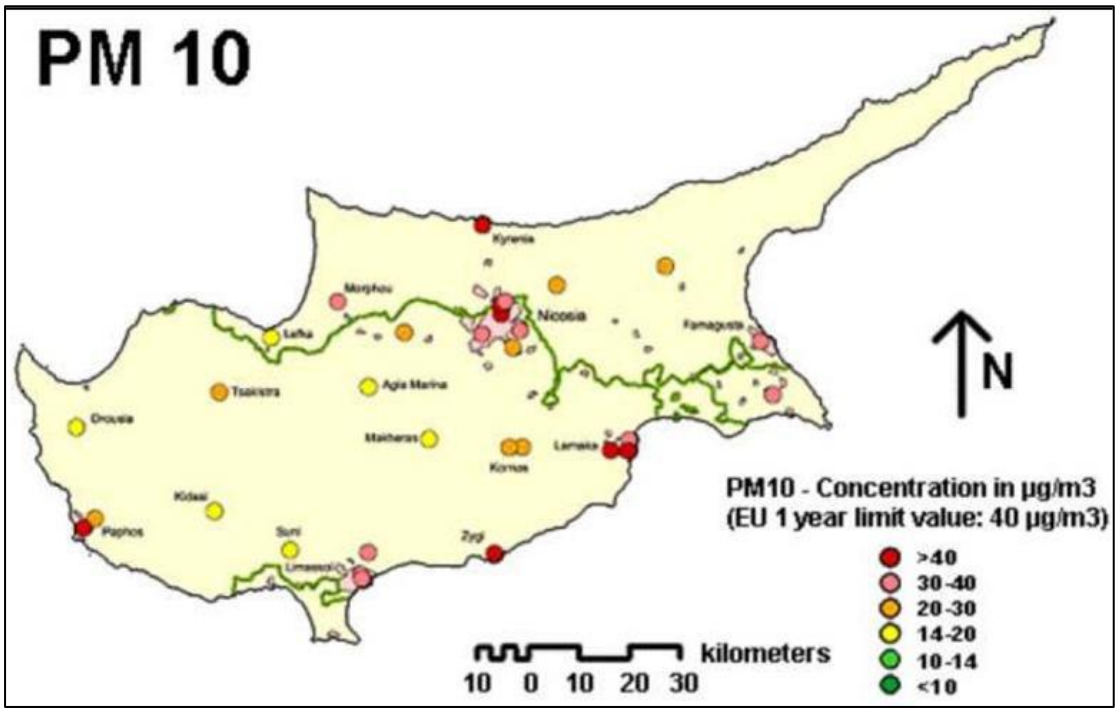


Figure 6.33. Annual PM10 concentrations in Cyprus including Sahara dust events (Department of Labour Inspection, 2007)

In addition, the results of the “Preliminary Assessment of Ambient Air Quality and Drawing up of Zones of Pollution in Cyprus" indicate that the particulate matter (PM10) in Cyprus primarily originate from Sahara dust events and anthropogenic activities such as traffic and secondarily industrial activities.

As it can be seen from Figure 6.31, the higher values of PM10 have been recorded in the main urban centres (reaching the EU limit values), where approximately 70% of the population leaves.

Additionally, reporting on a 10-year data set (1995 to 2004) for Cyprus' capital city, Nicosia, Middleton et al (2008) found a 1.2% increase in hospital admissions for cardiovascular disease per each 10 μg/m^3 increase in daily average PM10 concentration. Furthermore, the same study proposes that hospital admissions during dust storm days in Nicosia increase by 10.4% for cardiovascular problems, and 4.8% for all causes. The mortality attributable to air pollution in Cyprus ranges between 150 and 400 excess deaths per year (Kushta et al., 2018; Paisi et al., 2022). Future assessments regarding the impact of climate change on pollution-related mortality are still limited for the region, but are currently being developed in the framework of the ACCEPT research project (https://accept.cyi.ac.cy/).

The future changes (2021-2050) in climate, according to the PRECIS model, which are associated with air-pollution related diseases are: the number of heat wave days (Tmax>35°C) will increase up to 20-35 days, the maximum length of dry spell will increase about 15-20 days/year and the average annual maximum temperature (TX) will increase by 1.0- 2.0°C. Considering the above, the exposure of the public health of Cyprus to atmospheric pollution is characterized as moderate.

The measures for controlling air-pollution related diseases are measures for the prevention of such diseases, with for the mitigation of air pollution and the provision of medical services by the health care system of Cyprus.

The measures for air pollution mitigation applied in Cyprus by the Ministry of Labour and Social Insurance include among others the enforcement of air quality EU directive, the implementation of national and regional plans for air quality and improvement of the Action Plan for the support of public transportation in Cyprus. Consequently, the adaptive capacity of Cyprus to deal with air pollution can be characterized as moderate.

6.3.4.4. Assessment of overall vulnerability

The overall future vulnerability of public health to future climate changes, in terms of sensitivity, exposure, adaptive capacity based on the available data is as presented in Table 6.9. As it can be seen from the table, the public health of Cyprus is not considered vulnerable to climate changes mainly due to the fact that it is characterized by a good adaptive capacity. The only vulnerability that was identified through the CYPADAPT project is related to the deaths and health problems from heat waves and high temperatures. Thus, the adaptive capacity should be enhanced with urgent and satisfactory measures for the effective protection of the population from heat waves.

Table 6.9. Overall vulnerability assessment of public health in Cyprus to climate changes

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Deaths and health problems related to heat waves and high temperatures	High (5)	Moderate to High (4)	Limited to moderate (2)	Moderate (2.5)
Flood-related deaths and injuries	Limited to moderate (2)	Moderate(3)	Moderate(3)	None (- 0.6)
Landslide-related deaths and injuries	Limited to moderate (2)	Limited (1)	Moderate(3)	None (-1.6)
Fire-related deaths and injuries	Moderate(3)	Limited to moderate (2)	Moderate(3)	None (-0.6)
Vector-borne and rodent-borne diseases	Limited (1)	Limited to moderate (2)	Moderate(3)	None (-1.6)
Water-borne and food-borne diseases	Limited (1)	Limited to moderate (2)	Moderate to High (4)	None (-2.6)
Climate-related effects upon nutrition	Limited to moderate (2)	Limited (1)	High (5)	None (-3.6)
Air pollution-related diseases	Moderate(3)	Moderate(3)	Moderate(3)	None (0)

6.3.5. Forestry

The total forest area in Cyprus, covering 390,944 ha, which is the 42.3% of the island, consists of forests (44.2%) and other wooded land (55.8%). The Cypriot forests are natural with the main forest species of pine (*Pinus brutia*, *Pinus nigra*), many endemic species such as the Golden oak (*Quercus alnifolia*) and Cyprus cedar (*Cedrus brevifolia*) species (DoF, 2011a).

The forest sector is highly dependent on climate. Direct impacts of climate change on Cyprus forests arise mainly from decreased rainfall and increased temperature, droughts, fluctuations in intensified precipitation and changes in fire regimes. Indirect impacts come from the interactions between changes in climatic variables and several abiotic and biotic factors (Lindner et al., 2008). Non climate related pressures are mainly associated with (i) unsustainable timber harvesting, (ii) overgrazing which causes degradation not only on the vegetation but also on the soil and water regime of the island and (iii) land development especially for tourism development and construction of holiday dwellings.

The future impact, vulnerability and adaptation measures for the forestry sector in Cyprus regarding climatic changes were also assessed as part of the Life+ CYPADAPT project, by using PRECIS and six other regional of the ENSEMBLES models and, the future period (2021–2050) against the control period (1961–1990).

The main vulnerability priorities for the forests of Cyprus as observed in the recent past, has been related to the damages caused by fires as well as insect attacks and diseases on the dieback of tree species. These impacts are expected to worsen in future.

Cyprus has formulated a forest policy and a National Forest Programme, while starting a process of updating its forest legislation, laying the stress on environmental services and recreation rather than wood production.

6.3.5.1. Future impact assessment

The magnitude of the direct impacts on Cyprus' forests is expected to increase, as the relevant climate change factors are expected to intensify.

According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1-2^{o}C with respect to the control period 1960-1990, while precipitation is expected to decrease in seasonal level and in minor degree in annual level. In addition, the maximum length of dry spells (precipitation<0.5mm) is expected to increase by 10 to 13 days on average, while heat wave days (temperature >35^{o}C) will be increased averagely about 10-30 days on annual basis. Concerning future changes of annual max total rainfall over 1 day, projections show that a slight increase of about 1-4 mm is anticipated. Finally, regarding the highest annual total precipitation, falling in 3 consecutive days, a negligible increase of about 1-2 mm of rainfall is expected.

In the context of the future impact assessment the indicators presented in Table 6.10 summarize the potential impacts of climate change on Cyprus' forests. The main direct and indirect impacts presented in the table were grouped in the following impact categories: 1. Dieback of tree species, insect attacks and diseases leading to desertification, 2. Fires, 3. Floods, wind throws and storm damages, and 4. Forest growth.

Table 6.10. Relationship between potential climate changes and impacts on the forest sector

Potential climate change in Cyprus	**Potential Forest impacts**	
	Direct Impacts	**Indirect Impacts**
Drought	Insect attacks Dieback of trees Pressure on fauna species Biodiversity loss Desertification	Reduction of forestry regeneration and growth Degradation of forest, impacts on forests' health and vitality Increase in number and severity of forest fires Soil erosion Increase of dust in the atmosphere Negative effect on reforestations and natural stands

Higher mean annual temperatures – Hot spells	Insect attacks Dieback of trees Pressure on fauna species Biodiversity loss Desertification	Increase in number and severity of forest fires Photosynthesis decrease Decrease of biomass growth and yield Decrease of forests' productivity Decrease of wood production Effect on carbon sequestration rates and net carbon balance
Decreased rainfall	Change in competition among - plant species Nutrient availability in soils Deficiency in water for fauna	
Increase of extreme events (floods, wind throws and storm damages)	Injuries Inhibition of seed germination Changes in plant anatomy Promotion of early senescence and mortality Nutrient availability in soils	
Atmospheric CO_2 increase	Increase in photosynthesis rates (varying with plant nitrogen status and species) Effects on forest growth, tree physiology Insect attacks	

1. Dieback of tree species, insect attacks and diseases leading to desertification

Climate change has an effect on insect development and diseases, which are the main harmful forest organisms in Cyprus forests. Faster development of insects due to rising temperature and low levels of soil moisture due to drought can lead to further necrosis of trees. The typical Mediterranean climate with mild winters and hot, dry summers favours the breeding of harmful forest organisms in large populations (DoF).

The anticipated increase in temperature in the island and decrease in rainfall, as well as their related changes in heat wave days and maximum length of dry spell, will have a negative impact on forest organisms in Cyprus forests. This climatic change except from dieback of the tree species due to thermal stress has secondary results such as increase in the severity of future insect attacks.

The warm and dry climate conditions make pine stands in the forests of Cyprus vulnerable to pests such as the pine processionary caterpillar and bark beetle.

Projections of PRECIS regional climate model make evident that all forested areas of Cyprus will experience, in the near future, a warming of about 0.8 – 1.1°C. In specific, winter minimum temperature is expected to reach 6°C in mountains and, 7-9°C in forested area in coastal regions. Furthermore forested regions of Troodos Mountain will experience a significant warming of about 2.0 – 2.7°C reaching summer maximum temperatures of about 32 – 35.7°C in comparison with the control period.

As a conclusion rising temperature may enable some insect species to develop faster and endanger thus the forest growth. In this frame the predicted increase in winter minimum and summer maximum temperature in the future period can worsen current situation of dieback of tree species.

Increases in maximum length of dry spell can affect negatively forest species sensitive to soil moisture content causing the drying of trees, further stress on forest ecosystems, particularly those found in lowland and hilly areas, and possible necrosis of trees due to enhanced the activity of insects. In Cyprus, the necrosis of a significant number of pines and cypress in Stavrovouni forest during the dry period 2005 – 2008 was attributed to the impact of insects (DoF, 2011b; Cyprus Institute, 2011).

Number of heatwaves days is also a very important factor since in combination with the length of dry period can cause "thermal stress" to trees leading to extended necrosis mainly during the long hot summer period.

An increase of about 20-30 days (temperature over 35°C) is expected for mountain regions and conversely 10 days for other areas. Concerning annual rainfall no increase is anticipated in the future period (2021-2050), but seasonal precipitation will decrease, inducing thermal stress on trees and increase in the severity of future insect attacks. Changes in the hydrological regime may also have serious implications for the forests' sustainability.

2. Fires

Eastern Mediterranean countries, with relatively temperate climates that favor forest and shrubland biomes, including Cyprus are among those most affected by forest fires (Zittis et al., 2022). Severe drought events can create the pre-conditions for forest fires, predominantly during the warm and dry part of the year. Summer fires frequently rage across the Mediterranean landscapes, while their impact is augmented by extraordinary high temperatures, as well as droughts that are found to regulate the fuel moisture (Turco et al., 2017). Across most forests in the Mediterranean, days of critical fire risk, the length of the fire season and the extent of burnt areas have increased significantly in the past decades and are expected to continue doing so in the 21st century, especially under business-as-usual pathways (Karali et al., 2014). Considering the prevailing dry and hot conditions during the summer month, there are areas that already belong to very high fire risk class (e.g., in the northern slopes of the Troodos Mountains) (Figure 6.34 – left panel). It seems that under RCP2.6, the Fire Weather Index (FWI) slightly increases by 5 %. On the other hand, under RCP8.5 the increase in fire danger exceeds 20 % by the end of the century. In such a scenario, the majority of the island will be under high and very high fire danger.

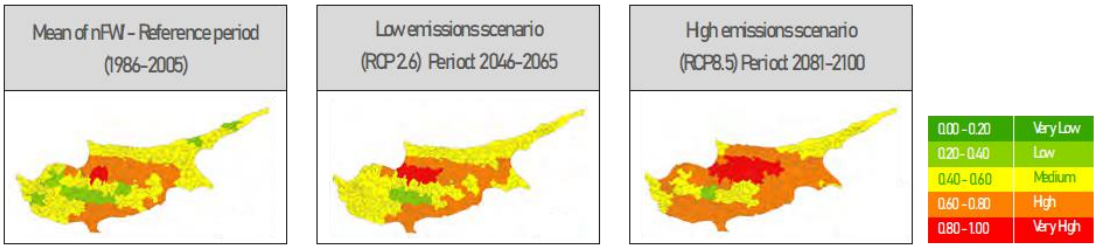


Figure 6.34. Fire Weather Index values for historical condition and two future periods based on the EURO-CORDEX with the colour associated to the level of risk. (Adopted from: León et al., 2021).

Forests of Cyprus are vulnerable to fire, primarily due to the long, hot and dry summers, mild winters, strong winds, intense relief and flammable xerophytic vegetation. These natural factors are further exacerbated by changing climatic conditions, which favour prolonged periods of drought and extreme weather events. Also, the accumulation of biomass due to the abandonment of rural areas and the increasing tourism and exodus of city residents to forested areas, are also important factors which contribute to an increased fire risk, especially during summer months.

In addition, as already mentioned above, forest fires are highly sensitive to climate change because fire behaviour responds immediately to fuel moisture, which is affected by precipitation, relative humidity, air temperature and wind speed. Thus, the projected increase in temperature will increase fuel dryness and reduce relative humidity and this effect will worsen in those regions where rainfall decreases. Accordingly, increases in climate extreme events are expected to have a great impact on forest fire vulnerability.

Mediterranean Europe, in general, has been identified as likely to suffer potentially increased fire risk. Among the climatic parameters with implication on fire risk, is the maximum length of dry spell (amount of rainfall less than 0.5 mm) because it is a parameter which not only increases fire risk but also highly influence forest species due to their sensitivity to soil moisture content. As mentioned, this parameter is expected to increase by 8 to 12 days, in comparison to the control period.

The Canadian Fire Weather Index system (FWI) is one of the most widely used indices of fire risk. Regarding PRECIS results, FWI reaches extremely high values in forested areas of about 50 (extreme high risk) in the control period, especially in summer, while a slight increase is projected for the future.

3. Floods, wind throws and storm damages

Forest damage by wind and snow are a continuing cause of economic loss in forestry throughout Europe and Cyprus (Lindner et al., 2008) because of reduction in the yield of recoverable timber, increased costs of unscheduled thinning and clear-cutting, and resulting problems in forestry planning. Despite the great severity of the particular climate change impact on forests, there are no available data for future estimation of wind throws and storm damages in Cyprus.

Flooding is harmful especially if it occurs during the growing season (Lindner et al., 2008). Extreme flooding events are expected to occur more frequently as a consequence of climate change. While the number of rain days is projected to decrease the number of days with heavy rain events is projected to increase (annual max total rainfall over 1 day show a slight increase of about 5mm is anticipated for forested areas and 2-4 mm is anticipated in western and inland regions).

4. Forest growth

Forest growth and productivity may be affected by projected climate change aspects such as increases in temperature, changes in precipitation and increases in air pollution. More specifically all forested areas of Cyprus will experience, in the near future, a warming of about 0.8 – 1.1°C and minor decreases in the annual total precipitation. Higher mean annual temperatures, decreases photosynthesis affecting thus the biomass growth and yield (Linder et al., 2010). Future changes in precipitation, in terms of frequency and availability, will have a significant effect on plant and forests' growth, as well on forestry species.

It is recognized that, rising concentrations of CO_2 in the atmosphere is believed to act as a fertilizer and increase photosynthesis rate, while higher ozone and nitrogen deposition affect tree physiology, carbon allocation and plant interactions, resulting in complex interactions with other climatic impact factors such as drought (Lindner et al., 2008).

In general, Cyprus, a region with already warm and dry conditions especially during summer, is likely to experience decrease in forest growth while the projected climate conditions will magnify the already intense water stress circumstances provoking forest growth failure.

6.3.5.2. Future vulnerability assessment

The future vulnerability of forestry sector to climate change impacts in terms of their sensitivity, exposure and adaptive capacity based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050 is assessed for the impact categories as follows: (1) Dieback of tree species, insect attacks and diseases, (2) Fires, (3) Floods, wind throws and storm damages, and (4) Forest growth.

1. Dieback of tree species, insect attacks and diseases

Increase in temperature is significant for the health of the forest ecosystem, enabling some insect species to develop faster and endanger thus the forest growth. Studies showed that the increased incidents of dieback of forest species in Cyprus are attributed to the adverse environmental conditions that prevailed and particularly the decrease in rainfall and increase in air temperature (Christou et al., 2001). A large number of tree species are affected by indigenous insects.

The summer maximum temperature is anticipated to increase about 2-2.7 °C in forested regions reaching 30-32 °C which may also lead to extinction of certain species in their current geographical range. Furthermore, PRECIS predicts duplication of heat wave days in forested areas for the future period reaching 40-60 days. Increases in maximum length of dry spell can affect negatively forest species sensitive to soil moisture content.

The number of heatwaves days is a very important factor since in combination with the length of dry period can cause "thermal stress" to trees leading to extended necrosis mainly during the long hot summer period. As PRECIS predictions show, an increase of about 20-30 days is expected for Troodos mountain regions and conversely 10 days for western areas, in comparison to the control period.

Precipitation is being geographically and seasonally, unevenly distributed, with maximum precipitation falling on the island's two mountainous masses during November and March. The overall decrease in precipitation for the future period is not significant, but it is most evident for winter and autumn seasons. The projected decrease of about 20mm in winter precipitation in combination with higher predicted temperatures in all forested areas may enhance the dieback of forest species.

Thus, both the sensitivity and exposure of Cyprus' forests to increased diebacks and insect outbreaks is expected to be very high.

The Department of Forests in Cyprus has taken action considering the implications of droughts and high temperatures and prepared a "Short-term Action Plan for the Confrontation of the Implications of Drought in Cyprus state forests (2009-2010)". The measures and actions of the Plan address the dieback of tree species, insect attacks, biodiversity loss as well as fires (DoF, 2009b). Despite the numerous measures that are implemented in Cyprus for combating dieback of forests and insect attacks as well as for the protection of biodiversity, the effect can only be alleviated but not eliminated. Additional adaptation measures are needed to further enhance adaptive capacity towards this impact.

Thus, the adaptive capacity of Cyprus' forests to increased diebacks is characterized as moderate.

2. Fires

Forests in Cyprus are sensitive to fires because of their composition which is dominated by flammable vegetation and the topography of the forested areas, which is mostly mountainous (DoF).

In Cyprus for the future period, it is expected to have increase in temperature, decrease in total rainfall and increase in dry spell days. Nevertheless, the overall Fire Weather Index is expected to have a small increase.

The Fire Weather Index for the control period has an extremely high value (about 50: extreme high risk), especially during July and August and will be higher in future of about 2-3 in all the forestry areas of Cyprus. The overall findings of the analysis (FWI) suggest that number of days with fire risk (FWI>15) will be increased from 5 to 15 days and number of days with extreme fire risk (FWI>30) will have an increase of 1 to 5day for the future period. It was also found, that future exposure of almost all forested areas in Cyprus to fire risk is expected to be medium to high in spring period, whereas in autumn period is expected to be high.

Wind speed in summer, which is also a dominant factor of fire behaviour, is expected have a slight decrease of about 0.018-0.23 m/sec in the future period (2021-2050).

Considering the above, both the sensitivity and exposure of Cyprus' forests to fires are characterized as very high.

As far as concern the adaptive capacity of Cyprus forests to fires can be characterized as moderate, due to the several measures which are taken by the Forestry Department of Cyprus aiming to eliminate forest fires. Particularly, these are (a) prevention, (b) pre-suppression, (c) detection and suppression measures.

In addition, under the framework of the Rural Development Programme 2007-2013 of Cyprus, various economic incentives were provided to individuals to apply measures in order to improve the existing protection system of forests from fire as well as the restoration of burned areas. Despite the great efforts and the good results of recent years, the problem of fires still exists and will always constitute a permanent threat for the forests of Cyprus. However further measures can increase the adaptive capacity.

3. Floods, wind throws and storm damages

The factors affecting the sensitivity of forests to floods are the slope of the area, the age of the plant species, their anatomy, the type of soils and others. In Cyprus slopes in excess of 18% and 12% cover 10% and 22% of the island (Geological Survey Department; I.A.CO Ltd, 2007). Maquis and garique

vegetation, which consist 56% of the total forest and OWL area in Cyprus, are more generally sensitive to floods due to their lower height. However, are located in areas with inclination, thus they are not considered sensitive to flooding.

The Water Development Department of MARDE through its report "Preliminary Flood Risk Assessment" identified 19 areas around the island as "Areas with Potential Significant Flood Risk", which are mainly the urban centres. In the future period (2021-2050), annual max total rainfall over 1 day is anticipated to have a slight increase of about 2-4 mm in western, inland and mountain regions and the risk of floods will not be increased significantly Consequently, both the sensitivity and exposure of Cyprus' forests to floods are considered to be limited.

The fact that there are limited flooding events in Cyprus forests without any human intervention for their protection, indicates that the forests themselves due to their topography (mountain areas) have the capacity to be self-protected from floods (autonomous adaptive capacity), as water run-off finds its way to the plains.

Therefore, the adaptive capacity of Cyprus can be characterized as high.

4. Forest growth

Forest growth and productivity may be affected by projected climate change aspects such as increases in temperature, decrease in precipitation and increases in air pollution.

According to PRECIS forested regions of Troodos Mountain (Troodos and Paphos forest) will experience a significant warming of about 2.0 – 2.7°C in comparison with the current situation (control period). Future increase in winter temperature will affect the biggest part of Cyprus and forested areas. However, the impact on forest growth and productivity cannot be evaluated. Considering the fact that summer temperatures are already high, a further increase may result in increasing the risk of halting of forest growth in forested areas in the future. The most significant increase in number of heat wave days, of about 20-30 days, appears in the central part of Cyprus affecting significantly Troodos forest and increasing the risk of forest growth.

Decrease in precipitation for the future period are not significant however they are most evident for winter and autumn seasons. PRECIS results indicate that all forested areas in Cyprus will experience a decrease in rainfall during autumn season. The decrease in autumn rainfall may have an effect on forest growth since it follows a prolonged dry summer period which may put forested areas under stress.

6.3.5.3. Assessment of overall vulnerability

The overall future vulnerability of forests to climate changes, in terms of sensitivity, exposure, adaptive capacity on the based on the available data for the above mentioned indicators are quantified as shown in Table 6.11. As it can be seen from the table, the main future vulnerability priorities for the forests of Cyprus are the impact of climate changes on the dieback of tree species, insect attacks and diseases as a significant part of Cyprus' forests has already been affected and the effect of increased frequency and intensity of forest fires as the latter cause severe and extended damages on forests.

Table 6.11. Overall vulnerability assessment of forests in Cyprus to climate changes Impact

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Dieback of tree species, insect attacks and diseases	Very high (7)	Very high (7)	Moderate (3)	Moderate to high (4)
Fires	Very high (7)	Very high (7)	Moderate (3)	Moderate to high (4)
Floods	Limited (1)	Limited (1)	High (5)	None (-5)
Forest growth	Not evaluated	Very high (7)	Moderate (3)	Not evaluated

6.3.6. Agriculture

Agriculture has always been an economic activity of great importance in the Mediterranean basin and a major source of employment and income for the countries of the region, including Cyprus. Agriculture serves for the direct supply of safe, nutritious and affordable food to society and plays an important role in landscape preservation and prevention of desertification (Demetriou, 2005).

According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2014), climatic condition patterns have brought and will bring about numerous changes concerning agricultural activities on a global scale and consequently will influence the world's food supply.

The agricultural sector is highly dependent on climate since temperature, sunlight and water sources are the key factors for plant growth. Although certain impacts of climate change may be beneficial, as for instance prolonged growing seasons and rise of temperatures, there will be also severe consequences that can put agricultural activities at significant risk, as well. Shifting weather conditions can cause variations in the sowing and harvest time of various crops. Moreover, extreme weather phenomena, such as heatwaves, droughts or hail can damage arable cultivations and reduce crop yields (IPCC, 2014).

At present, agriculture is still considered to be one of the major economic sectors of Cyprus due to the island's favourable climate and location near by its leading market, Europe. Additionally, it contributes to the social cohesion, the employment, the protection of the environment, as well as the general welfare of the society (Bruggeman et al., 2011a).

The main components of the agricultural sector, is agriculture and livestock. The most important crops in terms of production value are wheat, potatoes, grapes, citrus, vegetables and olives (Figure 6.34). The subsectors of the animal husbandry industry are mainly cattle, sheep and goats, pigs and poultry, while ostrich farming has been also recently established for commercial uses (Figure 6.34).

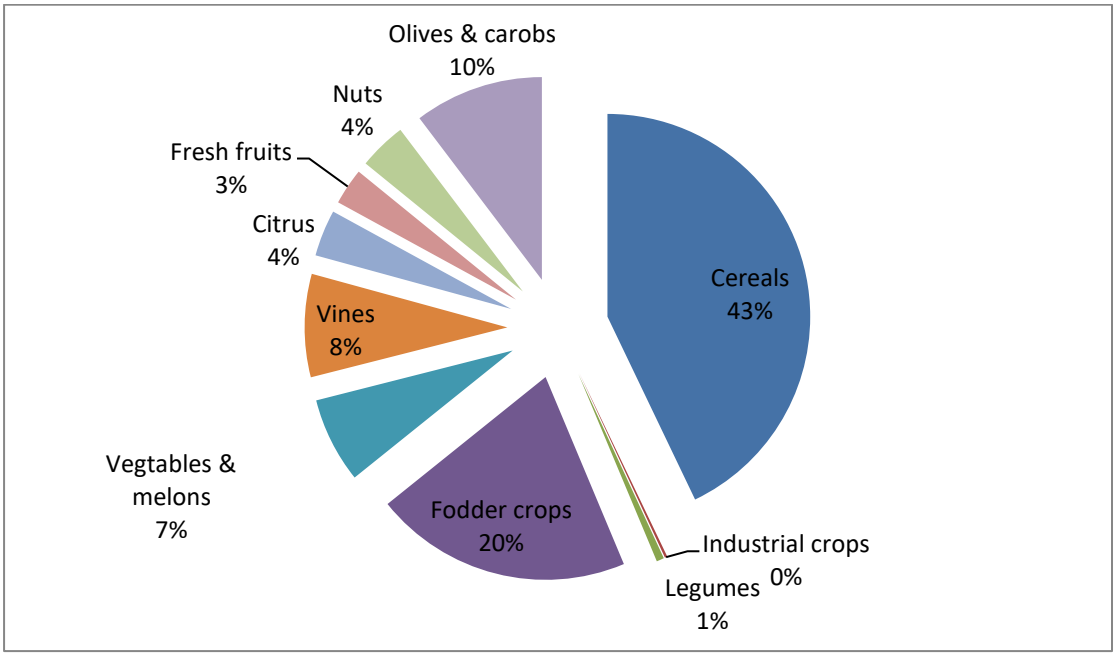


Figure 6.34. Area covered by type of crop as a per cent of total crop area, 2002-2008 (CYSTAT, 2010)

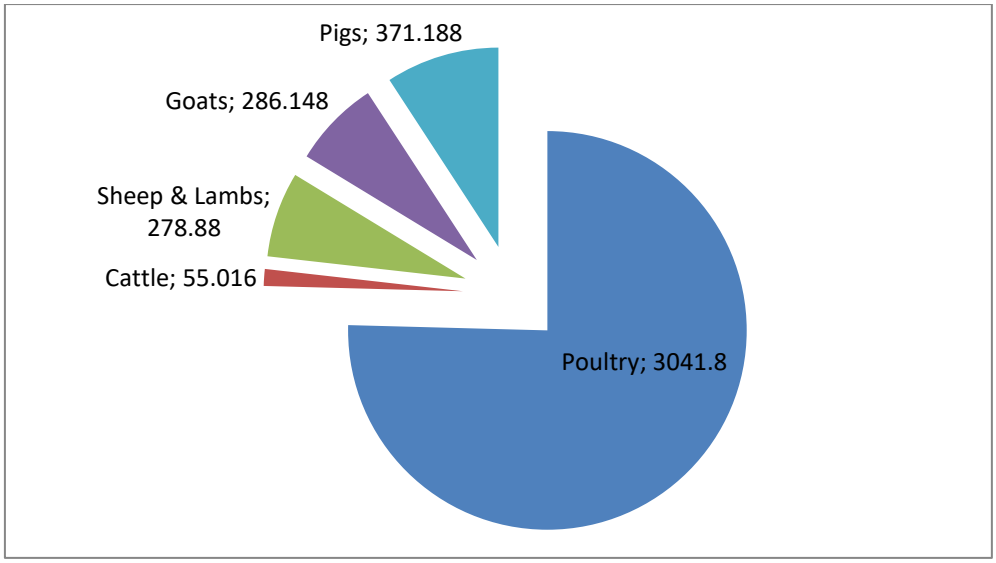


Figure 6.35. Animal population in husbandry (in thousands), average 1984-2008 (CYSTAT, 2010)

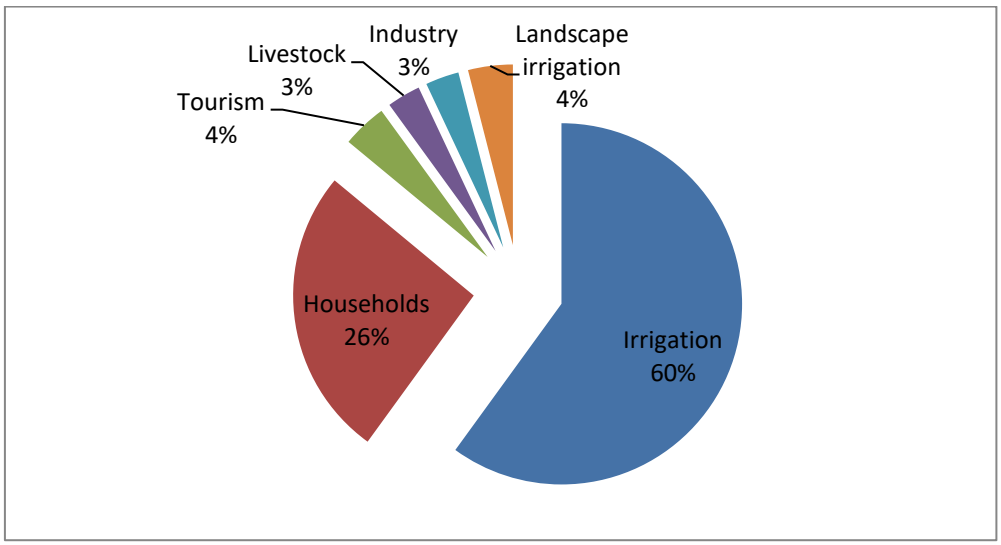


Figure 6.36. Allocation of total water consumption per sector for 2011 (WDD, 2011a)

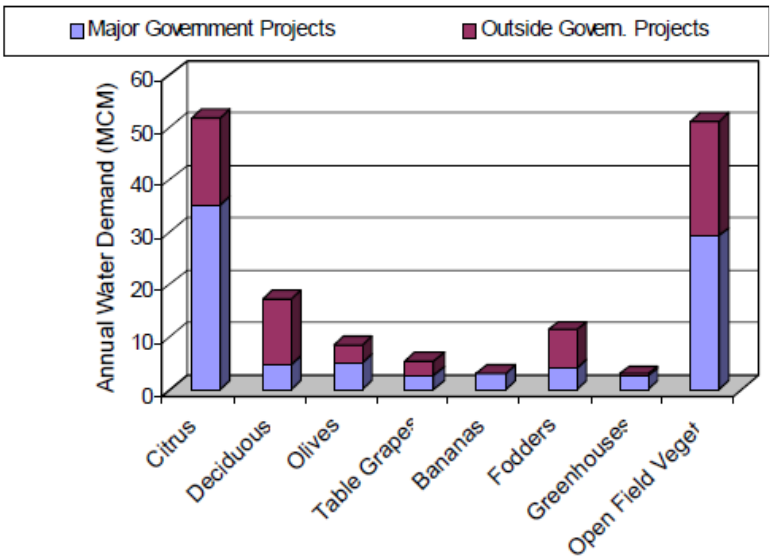


Figure 6.37. Annual water demand data for various crops (WDD – FAO, 2001)

The water consumption in agriculture and livestock represents the 60% and 3% of the total water demand in Cyprus respectively (Figure 6.36). As it can be seen in Figure 6.37 the most water-intensive crops are citrus and open-field vegetables.

In general, 24% of the total crop area is irrigated (mainly for vegetables, citrus, potatoes, melons, table grapes, deciduous fruit, bananas), while the remaining 76% is non-irrigated (rain fed for cereals, fodders, olives, carobs, wine grapes, almonds) (CYSTAT, 2010). The irrigation water supply is provided by 73% of the demand, from non-Governmental Water Works (GWW), mainly private boreholes, and the remaining 27% from GWW, mainly surface water (WDD, 2009).

The water demand for livestock varies significantly among animal species (e.g. animal's size and growth) and is being influenced by environmental and other factors, such as air temperature, relative humidity and the level of animal exertion or production, the water content of the animal's feed or dietary needs etc. (OMAFRA, 2007).

The main vulnerability priorities for the agricultural sector of Cyprus as observed in the recent past, that have been related to impact of climate changes are the reduced crop yield/ productivity due to the limited water resources, the damages caused to crops due to extreme weather events, and the declining soil fertility.

The future impact, vulnerability and adaptation measures for the agricultural sector in Cyprus regarding climatic changes were also assessed as part of the Life+ CYPADAPT project, by using PRECIS and six other regional of the ENSEMBLES models and, the future period (2021–2050) against the control period (1961–1990).

6.3.6.1. Future impact assessment

The magnitude of the impacts on Cyprus' agricultural sector is expected to increase, as the relevant climate change factors are expected to intensify.

According to PRECIS projections for the future period 2021-2050, with respect to the control period 1960-1990: the average annual temperature in Cyprus is expected to increase by 1-2^{o}C, while precipitation is expected to decrease in seasonal level and in minor degree in annual level. In addition, the maximum length of dry spells (precipitation<0.5mm) is expected to increase by 10 to 13 days on average, while heat wave days (temperature >35^{o}C) will be increased averagely about 10-30 days on annual basis. Concerning future changes of annual max total rainfall over 1 day, projections show that a slight increase of about 1-4 mm is anticipated. Finally, regarding the highest annual total precipitation, falling in 3 consecutive days, a negligible increase of about 1-2 mm of rainfall is expected.

Even though the effects of climate change on the primary sector are generally difficult to be distinguished from non-climatic impacts associated with the management of natural resources, there are some basic impacts identified which are related to global change (IPCC, 2007).

According to FAO (2007), the principal climate change impacts on agriculture can be roughly divided into two categories, namely the biophysical impacts and the socio-economic impacts, as shown in Table 6.12. The potential changes in climate and their respective impacts on the agricultural sector for the case of Cyprus are presented in Table 6.13.

Table 6.12. Climate change impacts on the agricultural sector

Biophysical impacts	**Socio-economic impacts**
Physiological effects on crops, pasture, forests and livestock (quantity, quality)	Decline in yields and production
Changes in land, soil, water resources (quantity, quality)	Reduced marginal GDP from agriculture
Increased weed and pest challenges	Fluctuations in world market prices
Shifts in spatial and temporal distribution of impacts	Changes in geographical distribution of trade regimes

Sea level rise, changes to ocean salinity	Increased number of people at risk of hunger and food insecurity; Migration and civil unrest

Table 6.13. Potential changes in climate and their respective impacts on the agricultural sector in Cyprus

Potential climate changes	Impacts
Increased Temperature	- Reduction of crop suitability and productivity - Changes in crop quality - Increased challenges of weeds, crop pests and diseases - Increased water requirements for irrigation - Water scarcity intensification - Water quality deterioration - Intensification of desertification
Decreased Precipitation	- Decreased crop productivity - Intensification of desertification - Decreased soil fertility
Increase of atmospheric CO_2	- Increased biomass production and increased potential efficiency of physiological water use in crops and weeds - Modified hydrologic balance of soils due to C/N ratio modification - Changed weed ecology with potential for increased weed competitive crops - Increased water use efficiency of some plants and as a result altered competitive interactions of species - Changes in the distribution of animal species
Increase of atmospheric O_3	- Crop yield decrease
Sea level rise	- Loss of arable land in coastal agricultural areas - Soil salinization in coastal agricultural areas - Salinization of groundwater aquifers resulting in low water quality for irrigation
Increased frequency of extreme weather events (heat waves, droughts, hail, floods)	- Crop failure - Damages to crops - Decrease in crop yield - Competition for water between different sectors (irrigation, tourism, domestic etc.) due to extended drought periods - Damage to grain formation - Increase in pests - Heat stress for animals

The extent of climate change impacts varies upon different ecosystems, regions and countries. In warmer regions like the Mediterranean basin, the majority of impacts are likely to have a negative influence, resulting in economic losses, especially significant in areas which are already under pressure due to socio-economic and other environmental problems, for instance water scarcity (EEA, 2008b).

The main direct and indirect impacts presented in the table above were grouped in the following impact categories and analysed in brief below: 1. Crop yield alterations, 2. Soil fertility alteration, 3. Increase in pests and diseases, 4. Damages to crops from extreme weather events, 5. Alterations in livestock productivity, 6. Increase in costs for livestock catering.

1. Crop yield alterations

The increases in ambient CO_2 seem to have positive impacts on plant growth and lengthening of the growing season, trough the enhancement of photosynthesis and plant respiration (EAA, 2008a). However, these potential positive impacts, in southern and warmer latitudes are less significant than the potential negative impacts, which include reduced crop yields due to high temperatures, increased

water demand for irrigation and reduced water availability due to periods of prolonged droughts, water scarcity, rainfall decrease and increased competition for water between sectors, which will in turn be much more intense (Behrens et al., 2010).

In Cyprus, the anticipated increase in temperature and evapotranspiration, and the decrease in rainfall, as well as their related changes in heat wave days and maximum length of dry spell, will decrease the crop yield.

Furthermore, the projected climate conditions will magnify the already intense water stress circumstances (drought, water shortage problems) on the agricultural sector, provoking crop failure (Bruggeman et al, 2011c). The combination of decreased rainfall and increased drought periods are expected to decrease water availability for irrigation and to increase crop moisture stress and thus further decrease crop yields. In particular, the traditional irrigated farming is the first to receive water cuts during drought years, leading to a significant decrease of the lands covered with annual crops such as vegetables and potatoes.

Bruggeman et al. (2015) used a daily water balance model to estimate agricultural water demand, water productivity and economic returns for all agricultural crop fields in Cyprus, under different policy, economic and climate scenarios. High-resolution gridded meteorological observational data sets (Camera et al., 2014) were used for the 1980-2010 reference period. Statistically downscaled projections of three Regional Climate Models for the medium emission A1B scenario indicated a 1.5–12% decrease in the mean annual rainfall over Cyprus for 2020–2050, relative to 1980-2010 (Camera et al., 2017). Crop plot data for the year 2010 were derived from applications for the Single Area Payment Scheme (Cyprus Agricultural Payment Organization), which is estimated to represent 95% of the crop area in Cyprus. The data set (excluding fallow) had 333,216 plots, covering 124,568 ha. Average annual irrigation water demand for this area increased from 154.9 Mm3 in 1980-2010 to between 160.1 and 163.6 Mm3 for the three models in 2020-2050 (3 - 6% increase). Total rainfed crop production decreased for 2020-2050, as a result of increased water stress, by 1% by 5%, relative to 1980-2010. Index prices were developed for three policy and economic scenarios (optimistic, medium, pessimistic) for crop prices (0.93 – 1.56), fuel (1.2 -1.6) and fertilizer (1.02-1.28), based on 10 global economic models, trends in global crude oil prices and the 2012 World Energy Outlook of the International Energy Agency. Net profits for the medium and optimistic policy and economic scenario for the future were higher than for 1980-2010 for all three climate models. However, the pessimistic scenario showed a 40% reduction in net profits of crop production for all three climate projections. The losses in profit were most severe for the rainfed crops, most of which would become non-profitable.

2. Soil fertility alteration

The principal soil aspects that affect soil fertility and are susceptible to climate change are soil biodiversity, organic carbon content, available soil moisture, erosion, salinization and desertification.

Soil fertility in Cyprus experiences a declining trend in recent years, mainly due to the erosion which has affected specifically the arable land and the land used for permanent crops (MANRE, 2007).

The expected higher temperature and lower precipitation may intensify the loss in soil organic carbon and soil moisture, the reduced water availability and the increase and variations in fires and desertification. It has been shown that the occurred desertification and loss of productive land in Cyprus are being exacerbated in recent past, because of the deterioration of soil quality with the expansion of droughts (IACO Ltd, 2007).

Regarding the fire risk in Cyprus, it is expected to be higher in forested areas, increasing so the risk for extended land erosion and the loss of cultivated areas (Behrens et al., 2010).

A further reduction in surface water availability may lead to the overexploitation and depletion of aquifers, which will result in sea intrusion to coastal aquifers, extended soil salinization and erosion, reducing so the fertility of agricultural land in particular the irrigated farms.

The effects of the degradation and abandonment of agricultural mountain terraces were investigated by Camera et al. (2018) and Djuma et al. (2020). Camera et al. (2018) monitored soil erosion using seven 1-m wide sediment traps, three on standing sections of a drystone terrace wall and four on collapsed sections, in a vineyard in the Troodos Mountains, from December 2015 to November 2017. Nearly half of the soil erosion (43%) occurred during two very intense rainfall events (maximum 30-min intensity exceeding 35 mm/hr), out of the 34 monitored events. Erosion from standing terrace sections was 3.8 less than the erosion from the collapsed sections. The average soil erosion rate was computed to range between 2.4 to 3.2 Mg/ha per year. The results indicate that the projected changes in rainfall extremes can have important implications for soil erosion in the Troodos Mountains.

Djuma et al. (2020) sampled and analysed soil organic carbon (SOC) up to 80-cm depth in 24 paired sites, representing a productive and a neighbouring abandoned terraced vineyard in the Troodos Mountains. The time period of abandonment was derived from aerial imagery of 1963 and 1993. In the top soil (0–10-cm, SOC concentrations were higher in abandoned (1.4% SOC) than in productive sites (0.9% SOC), with a statistical significance level<0.05. Concentrations were highest (1.6% SOC) in fields abandoned before 1963. However, mean SOC stocks, with coarse fragment correction, were slightly higher for the productive sites (22 Mg/ha) than for the abandoned sites (21 Mg/ha) and were not affected by the time of abandonment (p-value: 0.85). The study indicated that soil erosion processes are likely to reduce SOC stocks in the early stages after terrace abandonment, while recolonization of terraces by natural vegetation can improve SOC concentrations over time.

3. Increase in pests and diseases

Additional risk for crop production, as secondary effects induced by higher temperatures and prolonged growing season, will be posed by pest outbreaks, emergence of new pests and pathogens, weeds cycle acceleration and an increase in the frequency of diseases. There are no sufficient data to asset this issue and further research is needed.

4. Damages to crops from extreme weather events

The increasing trend in the occurrence of extreme weather phenomena will be more frequent and intense in the future, causing more damages to crops yields. In addition, the magnitude of damage caused to crops depends highly on the timing of the cycle of crops when the extreme weather events take place. More frequent, occurrence of dry spells, heat waves, and frost and hail incidents will potentially damage agriculture more than changes in the annual average temperature (Behrens et al., 2010).

Considering the above, damages to crops due to extreme weather events in Cyprus are expected to be further intensified in the future, mainly due to the increase in the number of heat wave days and to a lesser extent due to the increase in drought periods, while the damages to crops due to frosts, are expected to be reduced.

As mentioned earlier, the PRECIS climate projections in Cyprus for the period 2021-2050, indicate increases in the mean number of heat wave days per year (temperature>35^{o}C) up to 34 days, and up to 12 days per year on average in the length of drought periods (precipitation<0,5mm). On the other hand, the mean number of frost nights per year (temperature<0^{o}C) is expected to decrease up to 8 days on average, while the heavy rainfall and flooding events, will slightly decrease as the annual maximum total precipitation over one day shows minor changes in the future.

5. Alterations in livestock productivity

The projected increase in temperatures and heat waves are expected to reduce livestock productivity due to diseases outbreaks and heat stress suffered by animals, causing among others reduction in the feed intake, conception, growth and productivity rates.

In addition, warmer and drier climate conditions may reduce forage production resulting in shortage of animal feed which could modify animal diets and reduce growth and reproduction rates.

Changes in precipitation patterns and in particular the increase in flooding events may also cause the spreading of animal diseases, thus putting additional constraints to livestock productivity (IFAD, 2009).

The most important constraints of the livestock sector in Cyprus encompass the insufficient production of animal feed, as the reduced rainfall and increased drought periods in Cyprus will have also a negative effect on livestock feed productivity.

6. Increase in costs for livestock catering

The livestock sector in Cyprus depends mainly on imports due to the insufficient production of animal feed.

Rising temperatures and decreasing rainfall, resulting in reduced yields of forage crops and increased costs for farmers for providing other sources of feeding.

Increased risk for heat stress and unproductive grazing land during the summer months, as well as, the increase in extreme weather events may lead to increased housing requirements. Increased mechanical ventilation of both housing and transportation for livestock in order to reduce the risk of thermal discomfort in animals and, the risk of spreading of diseases is also expected to increase the cost for livestock catering. Additional research is needed to gather information and data regarding the climate change impact in the sector.

6.3.6.2. Future vulnerability assessment

e future vulnerability of the agricultural sector to climate change impacts is assessed in terms of its sensitivity, exposure and adaptive capacity, based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050, as follows: 1. Crop yield alterations, 2. Soil fertility alteration, 3. Increase in pests and diseases, 4. Damages to crops from extreme weather events, 5. Alterations in livestock productivity, 6. Increase in costs for livestock catering

1. Crop yield

In general, crop yield is favoured by the positive effect of increased CO_2 concentrations for the majority plants. However, this is counterbalanced by the negative effects, such as the decreased photosynthetic and water use efficiency, induced by the hot and dry conditions as in Cyprus. Crop production, both rainfed and irrigated, is highly sensitive to precipitation as crops, as shown in Figure 6.38.

During the studied period 1988-208, the lack of water caused an extensive reduction of crop production, with rainfed crops such as cereals, straw and green fodder being mostly affected, with a reduction of 90%, 85% and 87.6% respectively (CYSTAT, 2010).

Considering the percentage of rainfed crops in the total crop production, the exposure of crop yields regarding this indicator, is characterized as moderate.

In addition, the sensitivity of crop production to water availability especially for irrigated crops depends on the water allocation policy of Cyprus under drought conditions (water rationing) and the prioritization of water uses, as their water requirements are the last to be satisfied (WDD, 2011b). In addition, which the loss in irrigated production is mainly due to the reduction in irrigation water supply, whereas the loss in rainfed production is both due to climate change and an overall decrease in agricultural land use (Bruggeman et al, 2011c).

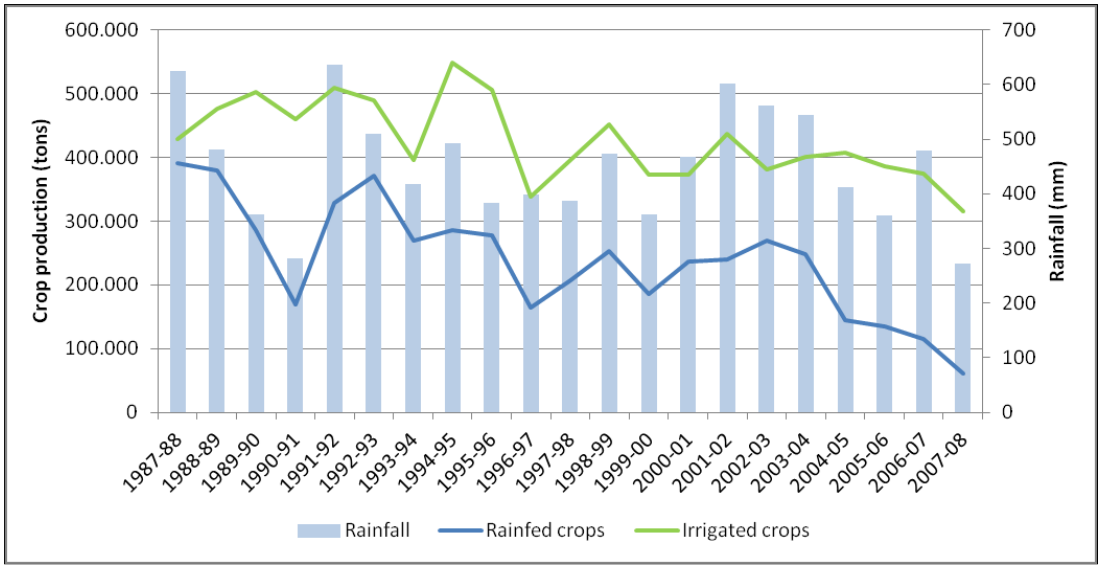


Figure 6.38. Rainfed and irrigated crop production and precipitation during the period 1987/88-2007/8 (CYSTAT, 2010; MSC, 2012)

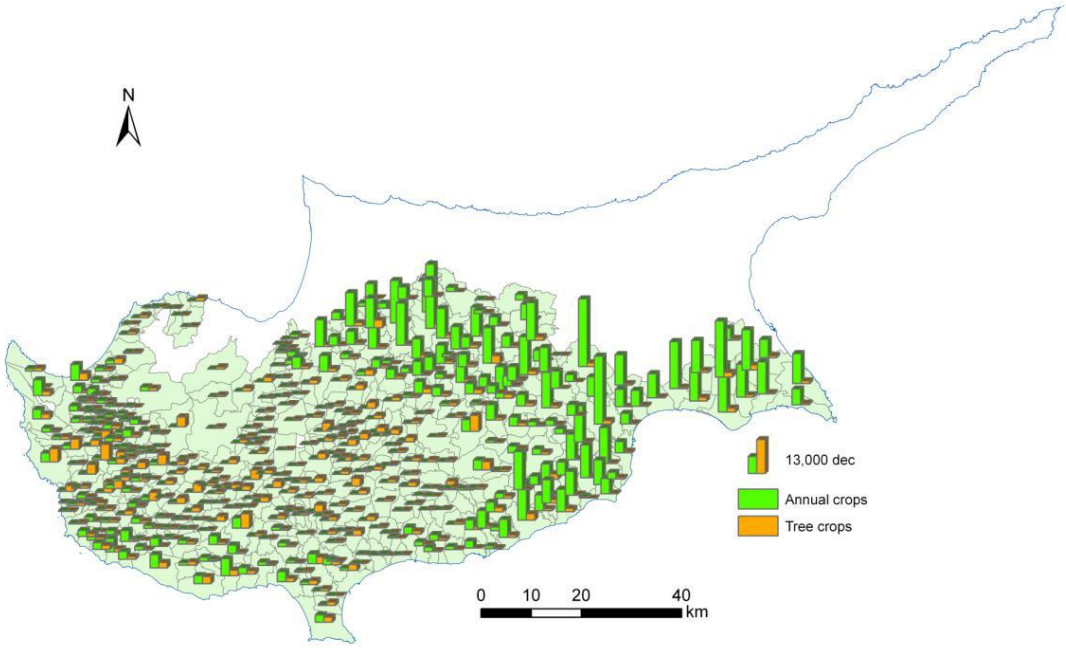


Figure 6.39. Distribution of the annual and tree crops (Bruggeman et al., 2011d)

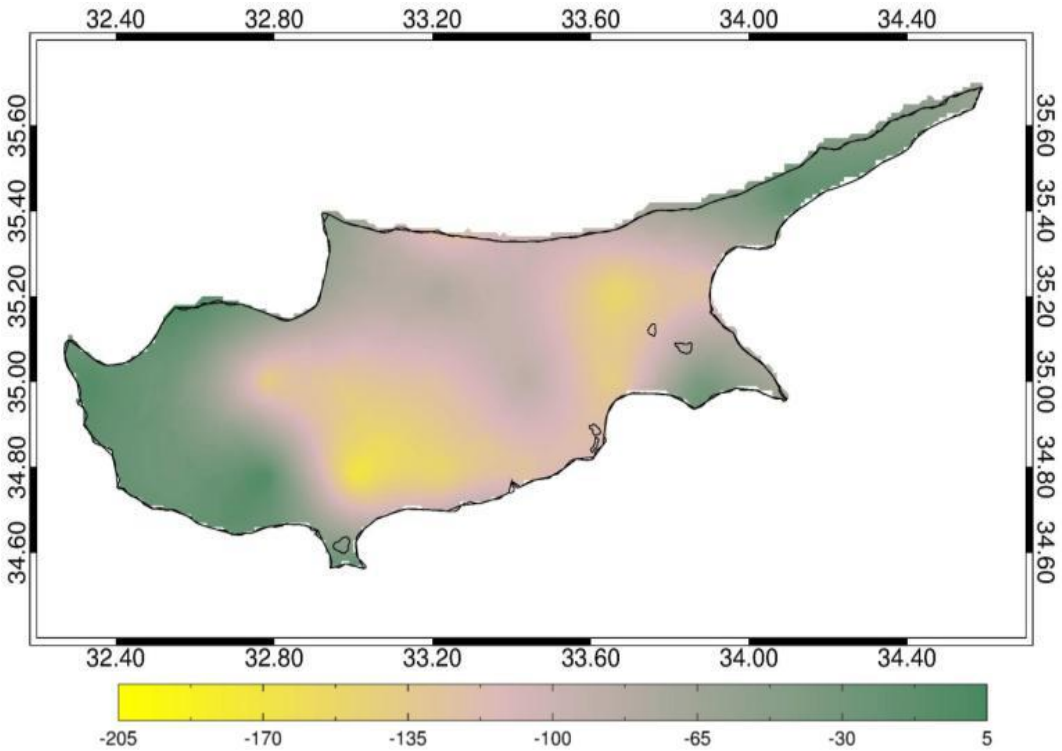


Figure 6.40. Changes in maximum length of dry spell (RR<0.5mm) between the future (2021-2050) and the control period (1961-1990)

Consequently, irrigated temporary crops are more exposed to the reduced water availability under drought conditions, and considering their percentage in the total crop production, the exposure of crops to reduced water availability, is characterized as high to very high.
The geographical distribution of crops is also linked with reduced water availability and crop yields under climate changes (Figure 6.39).

The crops located in the mountain areas, although at limited extent, are irrigated only from groundwater resources. Thus, apart from the risk of their overexploitation, they depend on climate parameters such as precipitation and evapotranspiration, as well as on climate-related parameters such as soil moisture and run-off. Therefore, the crops located in the mountain areas very sensitive to climate changes, especially during prolonged drought periods (>1year).

On the other hand, although flat plain areas and coastal regions have less precipitation than mountainous regions, they are irrigated mainly by the Government Water Works, which are also connected to desalination plants. It must be noted that some coastal areas are irrigated with low quality (saline) water from private boreholes.

With climate changes, the aforementioned effects on the crops located at the mountain and coastal areas are expected to be exacerbated, thus making them highly sensitive to climate changes.

Another factor associated with crop yields is the water availability. Although a minor reduction in precipitation of 5% is estimated based on the PRECIS model, the future total dam inflow will be decreased by 23% while the available groundwater resources are estimated to be reduced by approximately 29%.

As far as the length of drought periods in the future (2021-2050) is concerned, the central part of Cyprus will face an increase in the maximum length of dry spell, between 15 -20 days/year in the continental agricultural areas in the eastern part of Troodos Mountain, respectively (Figure 6.40).

The length of the growing season will be influenced mainly by the increase in temperatures in autumn and spring (Ainsworth and Long, 2005) and the decrease in the number of frost days. According to the PRECIS projections in the future period 2021-2050 (Figure 6.41), the expected increase in the average

autumn maximum temperature (TX) ranges between 1.0-2.0°C in the northern coasts and south-eastern area, and the in the area around southern Troodos, respectively. A similar pattern is also projected for the spring season, where TX increase is between 1.0-1.8°C. Furthermore, the number of frost nights (temperature<0°C), is expected to decrease up to the maximum 6-9 days in the greater area around central and southern Troodos.

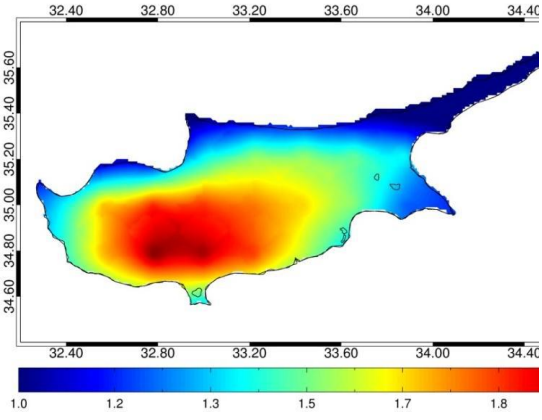


Figure 6.41. Changes in average autumn maximum temperature between the future (2021-2050) and the control period (1961-1990)

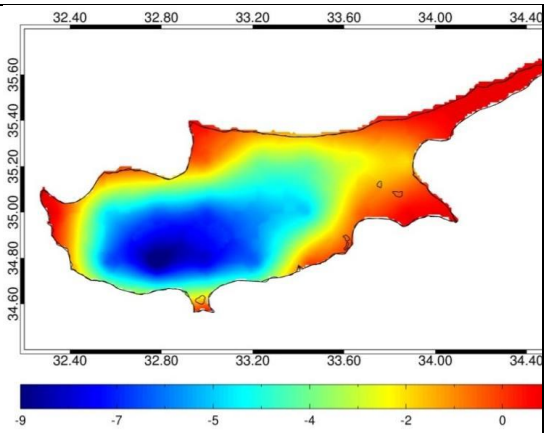


Figure 6.42. Changes in the annual number of frost nights (TN<0oC) between the future (2021-2050) and the control period (1961-1990)

Considering the above, it is highly likely that the length of the growing season will be extended and crops yield on mountains is expected to increase. Therefore, the sensitivity of crop yields to climate change is characterized as very high and the exposure as high.

Assessment of adaptive capacity

The practices applied in Cyprus in order to reduce the impact of reduced crop yields are:

(a) increasing water availability for irrigation. This is achieved by increasing water availability from Government Water Works, and by applying on-farm practices.
(b) reducing water demand for irrigation This is achieved through (i) increasing water use efficiency in irrigation (Redistribution of irrigated land, Use of advanced irrigation system, Irrigation scheduling, (ii) reducing run-off (Minimum soil cover, Minimum land management reflecting site-specific conditions, Terracing) and (iii) using less water intensive crops
(c) increasing crop productivity. The increase in crop productivity is achieved through (i) the application of crop rotation, (ii) fertilization and (iii) using crops more resistant to hot and dry climates.

2. Soil fertility

Soil fertility is sensitive to increasing temperatures as they intensify the loss of soil organic carbon and soil moisture and increase wildfires and desertification. According to the PRECIS model, the change in the average annual maximum temperature (TX) for the period 2021-2050 will increase by 1.0 –2.0°C at the eastern and western coastal agricultural area, and in higher elevation areas, respectively.

To sum up, all agricultural areas are expected to be exposed to increased temperatures and especially the mountain areas, followed by the continental lowland agricultural areas and the coastal agricultural areas.

Soils are sensitive to long dry periods along with regular strong seasonal winds as they causes wind erosion. In addition, soil erosion by rain is caused by intense precipitation and river flooding. However, the agricultural land in Cyprus and especially arable land and land used for permanent crops which constitutes approximately 70% of the total agricultural land, is sensitive to erosion mainly due to the intensive cultivation and overexploitation of land resources, which overburden the soil and reduce its productivity.

As for the future changes in droughts and strong winds, affecting the exposure of soils to wind erosion it is mentioned that the maximum increase in the length of dry spell, will be between 15 -20 days/year in the central part of Cyprus (Figure 6.42), while the number of days with mean wind speed greater than 5 m/s will decrease up to 12 days/year. In general, all agricultural areas are characterized by decreases in strong winds and the exposure to soil erosion by wind in the future due to climate changes will not further intensify.

As regards the future exposure of agricultural land to erosion by rain, since the future changes in the maximum amount of rainwater that falls in a short period of time (1 day in this case) within the year is insignificant, it is expected that the exposure to soil erosion by rain in the future due to climate changes will not be further intensified. The agricultural land located at the coasts, which represents the higher percentage of cultivated land, is mainly irrigated with good water quality from Government Water Works and in lesser degree from private boreholes, becoming so more sensitive to soil salinization due to overexploitation and sea intrusion.

The future changes in precipitation and in the periods of drought, which are associated with the salinization of coastal agricultural land, are expected to be minor and thus the future exposure of crops to the risk of soil salinization is moderate.

Desertification is a result of erosion by wind and rain, reduced soil moisture and chemical degradation of land (e.g. salinization) (IACO, 2007).The combined evaluation of Figure 6.43 and Figure 6.39, showed that the majority of crops cultivated in Cyprus are located in areas which

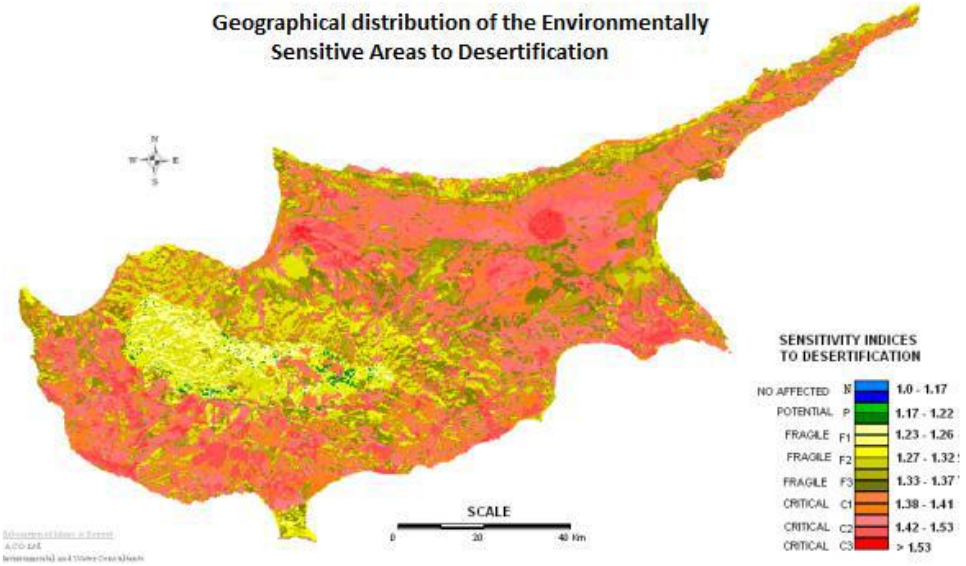


Figure 6.43. Geographical distribution of the Environmentally Sensitive Areas to Desertification (IACO, 2007)

are considered as fragile or critical to desertification, and therefore their current exposure to desertification is characterized as high.

Considering the abovementioned climate change impact indicators on soil fertility, it is concluded that the agricultural sector of Cyprus has moderate sensitivity and high exposure to climate changes.

Assessment of adaptive capacity

Measures to minimize the degradation of arable land are provided, including economic incentives under the Rural Development Programme of Cyprus (2007-2013) such as for the use (i) mechanical instead of chemical destruction of weeds, (ii) integrated production management and (iii) organic production.

Additionally, guidance and technical support is provided to farmers regarding salinity and infiltration problems, irrigation management methods for overcoming them, as well as a plethora of measures and different approaches which could be employed by farmers for mitigating risk of reduced soil fertility. Thus, the current adaptive capacity of Cyprus' agriculture towards this impact is considered as limited to moderate.

3. Pests and diseases

The assessment of the sensitivity and exposure of the agriculture in Cyprus to pests and diseases due to climate changes is not yet possible, because of the lack of data. Further research is needed regarding the number of pest outbreaks, the areas covered by weeds, the recorded incidents of plant diseases as well as the exposure of crops to climate changes and other aspects.

Assessment of adaptive capacity

The measures that have been undertaken in Cyprus to support farmers in order to reduce the proliferation of new pests and diseases are categorized into four groups: (a) promotion of indigenous and locally adapted plants and animals, (b) development of an Integrated Pest Management Strategy, (c) application of crop rotation and (d) resistance enhancement of existing plants and animals against pests and diseases.

However, in absence of data on the magnitude of the impact of climate changes on pests and diseases on crops, the adaptive capacity towards this impact cannot be evaluated.

4. Damages to crops from extreme weather events

The sensitivity of crops to extreme weather events is evaluated based on the extent of the damage caused in the recent past, in terms of crop species and type of extreme event, while the exposure is assessed based on the current and future frequency of the extreme climatic events causing damages to crops in Cyprus. The major losses to crops, because of these damages, for the period 1978-2009 is possessed by cereal and dry fodder crops, followed by potato crops deciduous crops, vines with 9.2% and citrus as illustrated in Figure 6.44. The common damaging extreme climatic event is hail, since when it occurs almost all crops are affected with extensive damages (Ioannou, 2010).

Therefore, it is estimated that the sensitivity of crops cultivated in Cyprus to extreme climatic events is high.

With regard to exposure it was observed that compensations for damages by hail events were paid every year from the establishment of the Agriculture Insurance Organisation in 1978 until 2007 with a frequency of occurrence 100%, followed by compensations for frosts with a frequency of occurrence 83%, droughts with 70%, heatwaves and windstorms with 53% each and floods with 47%.

Considering the above and their related future climate changes was mentioned earlier, the exposure of the agricultural sector of Cyprus to extreme climatic events is characterized as moderate to high.

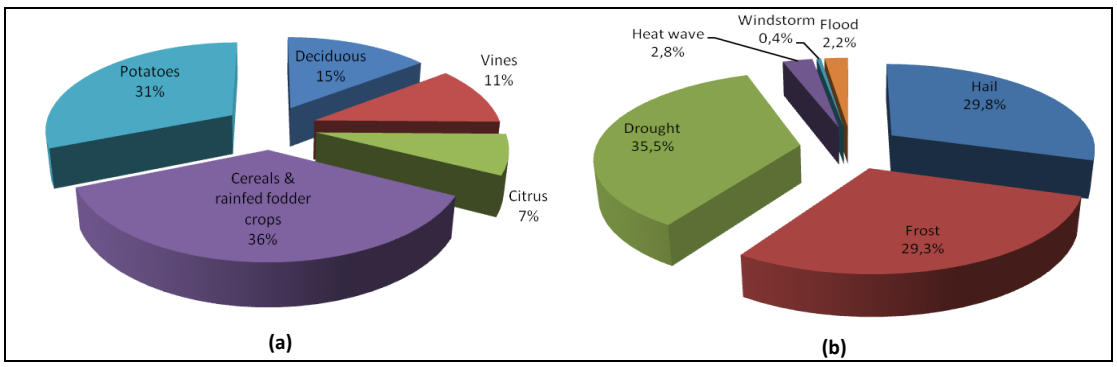


Figure 6.44. Contribution of the compensations (a) paid to main crops affected and (b) paid for the main extreme weather events to the total compensations provided in Cyprus during the period 1987-2007 (AIO, 2008a)

Assessment of adaptive capacity

For the protection of crops against droughts, a plethora of measures have been undertaken or promoted, in order to increase water availability for irrigation and reduce run-off. However, in spite of the measures, water demand for irrigation during drought events is not fully met in most cases, and thus the adaptive capacity of crops to droughts is considered limited to moderate.

In general, the abovementioned measures for the protection of crops from extreme events are applied on farm level and hence their implementation depends on the private initiative of farmers. Considering the above the adaptive capacity to this impact is characterized as limited to moderate.

5. Livestock productivity

There are no available data for the determination of the sensitivity and exposure of livestock productivity in Cyprus to climate changes. Further research is needed concerning for example, the animal species which are more resilience to increased temperatures and heat waves, production of animal feed, the reduction of incidents of diseases outbreaks etc.

Assessment of adaptive capacity

Catering for animal welfare under adverse weather conditions can be enhanced by increasing the amount of shade and shelter or by keeping livestock indoors, such as shelterbelts, planting tall, fast-growing, trees on the southern edge of pastures. The implementation of this measure is promoted through the Rural Development Programme with the provision of economic incentives for the plantation of hedgerows of forest trees.

Another measure adopted, which also contributes to the increase of the sector's adaptive capacity, is the establishment of a gene bank for animal species in order to protect genetic diversity. Guidance and advice is also provided by the Ministry of Agriculture, Natural Resources and Environment of Cyprus to farmers, in increasing of animal productivity by promoting improved breeding and management methods, improving veterinary services for animal disease control and treatment, local production of animal feed, and upgrading of farm units through mechanization and enhancing their management skills.

However, in absence of data on the magnitude of the impact of climate changes on livestock productivity, the adaptive capacity towards this impact cannot be evaluated.

6. Costs for livestock catering

There are no available data for the determination of the sensitivity and exposure of costs for livestock catering in Cyprus to climate change. Further research is needed concerning the increase in costs for livestock catering during extended warm periods in Cyprus, the deficit in local animal feed production and the excess costs for importing animal feed, for providing housing, ventilation, etc.

Assessment of adaptive capacity

The measures for enhancing adaptive capacity to increased costs for livestock catering are related mainly to the financial support provided by the Rural Development Programme of Cyprus for improving outdoor and indoor conditions for livestock.

In absence of data on the magnitude of the impact of climate changes on the costs for livestock catering, the adaptive capacity towards this impact cannot be evaluated.

6.3.6.3. Assessment of overall vulnerability

The overall future vulnerability of the agricultural sector of Cyprus to future to climate changes, in terms of sensitivity, exposure, adaptive capacity on the based on the available data for the above-mentioned indicators are quantified as shown in Table 6.14. The first vulnerability priority of the sector is the impact of climate changes on crop yield, which is expected to be significantly reduced. The second

priority of the sector regarding its vulnerability to climate changes is related to the damages caused to crops due to extreme weather events, taking into account the magnitude, frequency and intensity of these effects on crops, especially of droughts and heat waves. The last priority refers to the impact of climate changes on soil fertility, is expected to magnify the existing deterioration. For the rest of the identified impacts, no evaluation took place due to lack of sufficient data.

Table 6.14. Overall vulnerability assessment of the agricultural sector in Cyprus to climate changes

Impact	Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Crop yield alterations	Very high (7)	High (5)	Limited to Moderate (2)	Moderate to high (3.9)
Soil fertility alterations	Moderate (3)	High (5)	Limited to Moderate (2)	Limited to Moderate (1.9)
Increase in pests and diseases	Not evaluated	Not evaluated	Not evaluated	---
Damages to crops from extreme weather events	High (5)	Moderate to high (4)	Limited to Moderate (2)	Moderate (2.5)
Alterations in livestock productivity	Not evaluated	Not evaluated	Not evaluated	---
Increase in costs for livestock catering	Not evaluated	Not evaluated	Not evaluated	---

6.3.7. Water resources

Freshwater resources, their systems and management are strongly depended on climate changes such as increases in temperature, sea level and precipitation variability (Kundzewicz et al., 2007), with a potential of high vulnerability not only for water resources but also to human societies and ecosystems as a consequence (Bates et al., 2008).

Water resources are closely interrelated with climate as the physical processes, through which the water cycle takes place, strongly depends on climate factors. Thus, the processes of evaporation, condensation, precipitation, infiltration, runoff, and subsurface flow strongly dependant on climatic factors such as temperature, radiation, sea level rise, vapour pressure and wind. In addition, climate affects the soil moisture and consequently the infiltration of water to groundwater bodies. Extreme climatic events such as droughts, heavy rainfall and flooding hamper water storage, resulting in significant water losses and deterioration of water quality. Increased temperatures and decreased precipitation lead to increased evapotranspiration, condensation and eutrophication, while sea level rise threatens coastal groundwater bodies with salinization.

Cyprus is already below the water scarcity threshold of 1,000 m^3/year per capita (Bruggeman et al., 2022). The combined effect of precipitation declines and higher temperatures will further challenge the already limited water resources of Cyprus. The increasing population, changes in the standards of living, and tourist flows, especially during summer, will have a strong impact on the demand for water and food. Therefore, the water resources and agriculture sectors are considered to be highly vulnerable to the impacts of climate change. This is the case for both surface and groundwater resources in most of the region that are projected to be further limited under climate change conditions and particularly when considering pathways of strong radiative forcing (Chenoweth et al., 2011). Climate change and heat extremes will mainly affect mainly tomato, grapevine, and olive tree, whose growing cycle takes place during summer (Papadaskalopoulou et al., 2020). By contrast, crops covering autumn-winter season, such as potato, barley, and wheat, are expected to partially avoid the harsh summer conditions, but still be impacted significantly by rainfall deficits.

The water resources of Cyprus are considered vulnerable to climate changes, since they are limited due to the semi-arid climate that characterizes this Mediterranean island. Freshwater availability depends almost entirely on rainfall which is highly variable with frequent prolonged periods of drought. The Republic of Cyprus in order to satisfy drinking water and irrigation demand, continue deliver a number of water works for the exploitation of the available freshwater resources (both surface and groundwater) and no- freshwater resources (sea water, recycled water). According to the standards of

the International Commission of Large Dams (ICOLD), Cyprus is the first in Europe regarding the number of dams per square kilometre, having 108 dams and reservoirs with a combined storage capacity of 332 Mm^3 (WDD, 2011a).

The water sector currently experiences both quantitative and qualitative pressures from several environmental and socio-economic activities and practices. In specific, the impact, vulnerability and adaptation assessment for water resources in Cyprus, regarding the observed climate changes in recent past, showed the following key vulnerabilities: i) Water availability for irrigation, ii) Frequent occurrence of droughts, iii) Groundwater quality, and iv) Water availability for domestic water supply.

These impacts are expected to worsen in future period 2021–2050 as already projected by the PRECIS and ENSEMBLES regional climate models with respect to the control period 1960-1990.

6.3.7.1. Future impact assessment

The climatic factors that may have an impact on the water resources of Cyprus include the decreased rainfall and increased temperature, droughts, fluctuations in intense precipitation events.

According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1-2°C, while the average annual total precipitation will be slightly decreased with seasonal variations. The maximum length of dry spells (precipitation<0.5mm) is expected to increase by 10 to 12 days on average, while the heat wave days (temperature >35°C) will be increased averagely by 10-30 days on annual basis, depending on the region. Concerning future changes of annual max total rainfall over 1 day, PRECIS projections show that a slight increase of about 1-4 mm is anticipated. Finally, regarding the highest annual total precipitation, falling in 3 consecutive days, a negligible increase of about 1-2 mm of rainfall is expected.

The potential changes in climate and their respective impacts on water resources for the case of Cyprus are presented in Table 6.15.

Table 6.15. Relationship between climate changes and impacts on the water sector

Potential climate changes	Impact
Increased temperature	- Increased water temperatures - Increase in evaporation
Increased evapotranspiration	- Water availability reduction - Lower replenishments rates (lower groundwater levels) - Salinisation of water resources
Decreased precipitation, including increased droughts	- Decrease in runoff - More widespread water stress - Increased water pollution and deterioration of water quality due to lower dissolution of sediments, nutrients, dissolved organic carbon, pathogens, pesticides and salt - Decreased rates of groundwater recharge - Salinisation of coastal aquifers due to overpumping motivated by insufficient water supply
Increase in interannual precipitation variability	- Increase in the difficulty of flood control and reservoir utilization during the flooding season
Increase in heavy precipitation events	- Flooding - Adverse effects in quality of surface water and groundwater - Contamination of water supply - Lower replenishment rates in the aquifers of the mountain areas due to steep slopes

Increase in surface water temperature	- Increased algae growth and reduced dissolved oxygen levels in water bodies which may lead to eutrophication and loss of fish - Prolonged lake stratification with decreases in surface layer nutrient concentration and prolonged depletion of oxygen in deeper layers - Changes in mixing patterns and self-purification capacity - Salinisation of water resources
Sea level rise	- Salinisation of coastal aquifers (minor effect)

The future impacts of climate change on water resources are analysed in brief under the following categories: 1. Decrease in water availability, 2. Deterioration of water quality, 3. Increase in flood frequency and intensity, and 4. Increase in drought frequency and severity.

1. Decrease in water availability

Climate changes such as changes in temperature, precipitation patterns and snowmelt is projected to lead to major changes in yearly and seasonal water availability across Europe. More specifically, southern and south-eastern regions, which already suffer most from water stress, will be particularly exposed to reductions in water resources. Decreased summer precipitation results to a reduction of water stored in reservoirs fed with seasonal rivers. There is very high probability (80% confidence) that many regions in the Mediterranean basin will suffer a decrease in surface and groundwater resources due to climate change (Kundzewicz et al., 2007).

According to PRECIS projections for the future period 2021-2050, the average annual temperature in Cyprus is expected to increase by 1 - 2^{o}C, while annual precipitation will have minor changes and discerned seasonal changes in precipitation. The total winter and autumn precipitation present decrease of 10-20mm per year and, a minor increase in summer precipitation reaching 5 mm on average. Considering this, increased temperatures play a more significant role in potential future changes in water availability.

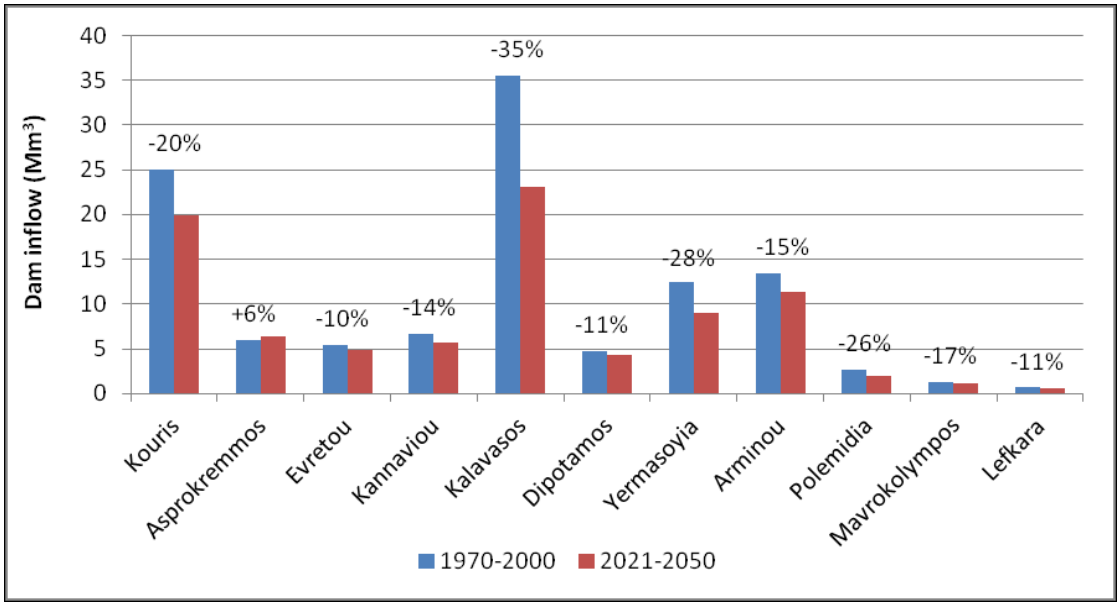
The main natural source of water in Cyprus is rainfall. The rainfall is unevenly distributed geographically with the highest in the two mountain ranges and the lowest in the eastern lowlands and coastal areas.

The climate changes are anticipated to have also an effect on evapotranspiration as well as on soil moisture, infiltration and runoff, together with the increase in water demand will in turn have a significant effect on water availability.

In general, evapotranspiration tends to decrease with reduced precipitation, but it increases with higher temperatures. It is estimated that during the period 1971-2000, 86% of rainfall returned to the atmosphere as evapotranspiration. The KNMI model predicted a general decrease in annual evapotranspiration ranging from -3% to -7% for the period 2021-2050 compared to the period 1970-2000 (CYPADAPT project).

As mentioned above, the changes in evapotranspiration and in the heavy rain events are expected to have an additional impact on river flows and thus the quantity and quality of surface water, inbounded in dams and reservoirs.

The average annual inflow to the dams during the period 1971-2000 was approximately 130Mm^3, while the respective future total dam inflow in the period 2021-2050 is expected to decrease by 23%, while the total average precipitation, according to PRECIS, is estimated to decrease only by 5%. In Figure 6.45 the change in the inflow to the main dams of Cyprus for the period 1970-2050 is presented.



* 1970-2000: Actual dam inflow (WDD, 2011a), 2021-2050: Projection

Figure 6.45. Change in inflow to the main dams of Cyprus for the period 1970-2050

The reduction in precipitation and the increase in evaporative demand will also lead to a reduction in groundwater levels. Also a change in the amount of effective rainfall and in the duration of the recharge season will alter recharge rates (Kundzewicz et al., 2007). In addition, high intensity precipitation favours runoff against groundwater recharge. Regarding future changes in high intensity precipitation, minor increases ranging from 2 to 5 mm in the annual maximum total precipitation over one day are expected in the future period (2021-2050) according to PRECIS.

The available groundwater resources in the future, as mentioned above, are estimated to be reduced by 23% on average. Again, it must be mentioned that this method does not account for future changes in runoff which could increase runoff and water losses and decrease water storage.

At this point, it has to be noted that, the water availability to rainfall continues, beside the substantial contribution of the desalination plants to domestic water demand, and of the recycled water to the agricultural demand. However, the existing and planned investments for the supply of non-freshwater resources are expected to minimize the future marginal difference between water supply and demand.

2. Deterioration of water quality

According to the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), it is believed that higher water temperatures, increased precipitation intensity, and longer periods of low flows exacerbate many forms of water pollution. However, there is no evidence for climate related trend in water quality (Parry et al., 2007).

Surface water bodies in Cyprus are mainly the storage reservoirs with no inflows during the summer months. As a result, there is no dilution and in combination with the high evapotranspiration rates, their quality will be deteriorated. In addition, the increasing temperatures enhance eutrophication rates, stratification and low levels of dissolved oxygen.

A trend in water quality deterioration is mainly observed in groundwater resources, due to the low recharge rate in combination with the low permeability of some sedimentary aquifers in Cyprus, which results in the dissolution of soluble salts and the increase in salinity (WDD, 2008). The rapid urbanization in various parts of Cyprus during the last 30 years, the uncontrolled waste discharge, the excessive use of fertilizers and pesticides, the overexploitation of many coastal aquifers gradually deteriorated the quality of Cyprus' groundwater.

The future climate changes that are anticipated to intensify the impact of water quality deterioration are the changes in water temperature, (related to the changes in air temperature), low flows or dry

spells. According to PRECIS projections, for the future period 2021-2050 with respect to the control period 1960-1990, the annual maximum total precipitation over one day show minor increases ranging from 2 to 5 mm on average, while the average annual temperature in Cyprus is expected to increase by 1-2^{o}C.As far as the periods of low flows or dry spells in the future (2021-2050), it is projected that there will be a range of changes from slight decreases to an increase of up to 12 days/year on average.

3. Increase in flood frequency and intensity

According to the IPCC, increases in the intensity of precipitation, may result in more frequent and hazardous flooding events. In particular, flash and urban floods, triggered by local intense precipitation events, are likely to be more frequent throughout Europe (Christensen and Christensen, 2007; Kundzewicz et al., 2006)

Cyprus in spite of the fact that is characterized by long and frequent dry periods, also suffers from flooding events. As illustrated in Figure 6.46, the frequency of flooding events has increased considerably during the period 2000-2010 with respect to the period 1970-2000, as 61% of the total flooding events refer to that period.

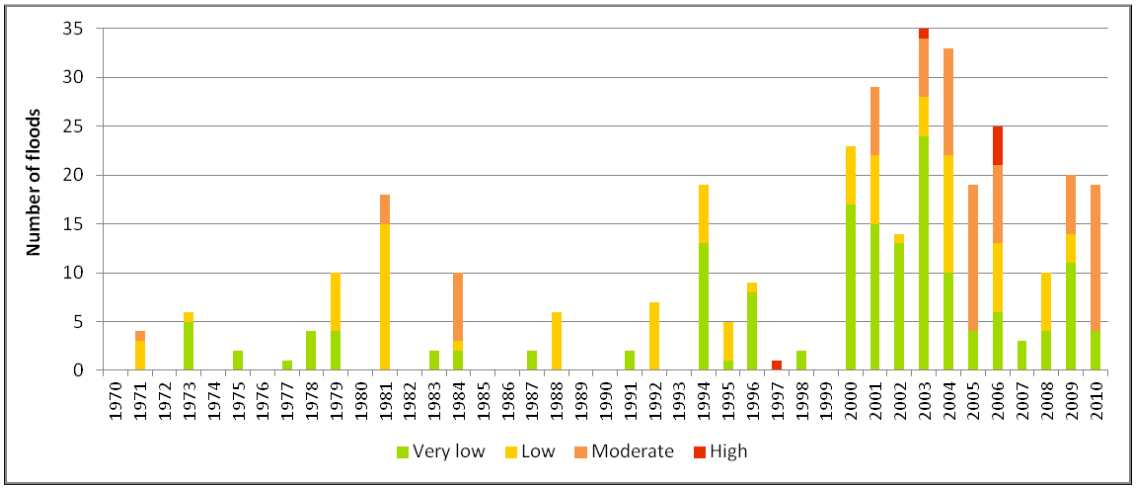


Figure 6.46. Number of flooding events per year in Cyprus (1971-2010) (WDD, 2011d)

In addition, the related hazard for each flooding event (ranked very low, low, moderate, high) in terms of adverse consequences for human health, the environment, cultural heritage and economic activity are presented.

Although a minor increase in the precipitation intensity is projected in the future, it is expected that it will further intensify the phenomenon.

4. Increase in drought frequency and severity

Droughts affect significantly both the water availability and water quality. In the future period 2021-2050, the impact of droughts will be intensified, since according to the PRECIS results the length of the drought periods is projected to increase up to 12 days/year on average.

In a study of the European Commission (2008) Cyprus is registered among the areas with highest frequencies of droughts in Europe during the period 1976 to 2006, with a large part of its territory being affected whenever droughts occurred. In Cyprus, droughts may last one or several years, the most critical of which was in the summer of 2008, with four consecutive years of low rainfall (EEA, 2010a). As can be seen in Figure 6.47, the years with precipitation above normal appear to decline, while many years with precipitation below normal were observed during the last decade with the year 2007-08 being characterized as a year of severe drought (<70% normal) and 2005-06 as a year of drought (71-80% normal).

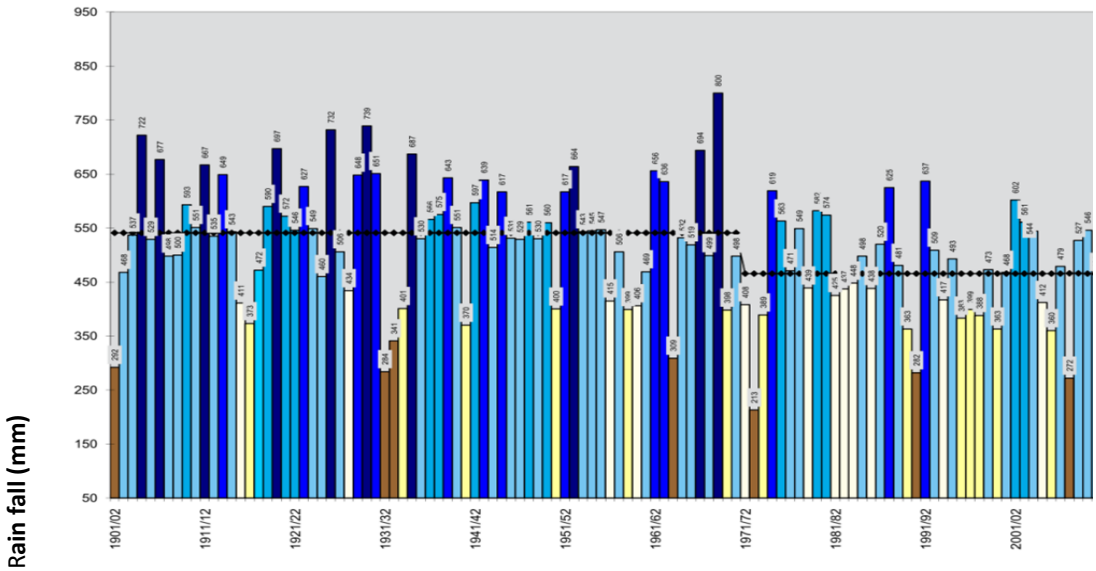


Figure 6.47. Mean annual precipitation in Cyprus (area under Government control) (WDD)

4. Baseflow

Baseflow, which is the contribution of groundwater systems to streamflow, plays an important role in maintaining aquatic ecosystems and stream water quality. Bruggeman et al. (2022b) analysed the effects of decreasing rainfall on streamflow and baseflow for 21 watersheds in Cyprus. The streams originate from the Troodos Mountain massif, which forms a complex, fractured aquifer system, consisting of mantle, plutonic, intrusive and extrusive ophiolite rocks. Daily streamflow and rainfall over the watershed areas was analysed for 35 hydrologic years, from 1980/1981 to 2014/2015. The 21 gauged watersheds, which are monitored by the Water Development Department, range in area between 5 and 110 km2. Baseflow was estimated using the USGS code PART. Baseflow indices for the past 35-years averaged 0.74 and ranged between 0.50 and 0.96, indicating that the majority of the streamflow water resources originate from baseflow. Linear and power relations between annual rainfall and streamflow and between annual rainfall and baseflow for the 21 watersheds were statistically significant, based on the F-test ($p < 0.05$). Power relations showed generally a better fit than the linear relations, but the differences in the F-statistic and the coefficient of determination (R2) were small. A 10% reduction in average annual rain resulted in an average streamflow reduction for the 21 watersheds of 27% with the use of linear relations and 44% with the use of power relations. Similarly, baseflow was, on average, reduced by 26% (linear) and by 43% (power). Under a 30% reduction in rainfall, streamflow was, on average, reduced by 80% (linear) and by 74% (power), whereas baseflow reductions averaged 78% (linear) and 72% (power). The empirical analysis showed that under our changing climate, relative reductions in streamflow and baseflow can be expected to be more than double the relative reductions in rainfall. Process-based hydrologic modelling research is ongoing to improve our understanding of these substantial decreases in our water resources under climate change.

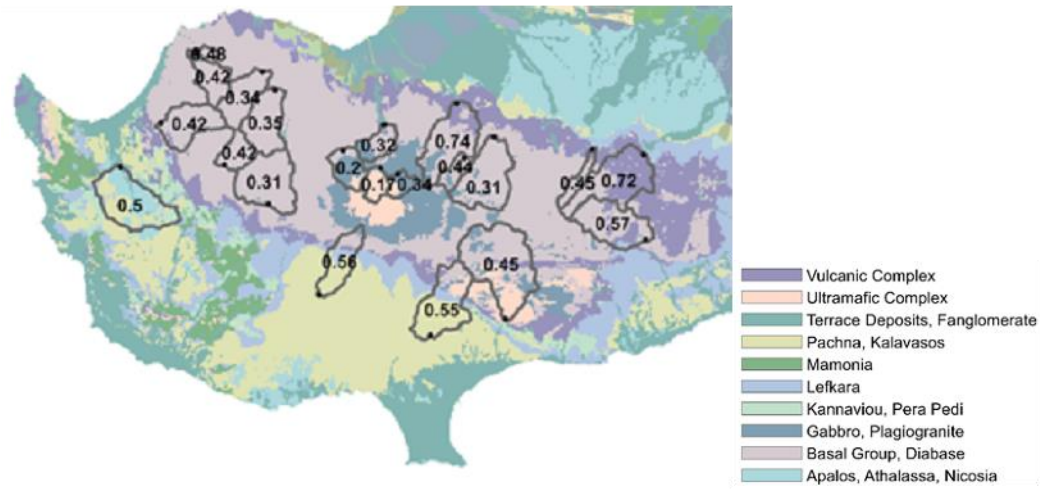


Figure 6.48 Reduction in average annual baseflow (fraction) under a 10% reduction in rainfall, derived from power relations, for 21 watersheds in Cyprus (Bruggeman et al., 2022b).

6.3.7.2. Future vulnerability assessment

The future vulnerability of water resources to climate change impacts is assessed in terms of their sensitivity, exposure and adaptive capacity, based on the available quantitative and qualitative data for Cyprus and the climate projections for the period 2021- 2050. The vulnerability is assessed for each of the follow impact categories: 1. Water availability, 2. Water quality, 3. Floods, 4. Droughts.

1. Water availability

The sensitivity and exposure of water availability to future climate changes in Cyprus is assessed by the sensitivity of runoff/ dam inflow to changes towards the rainfall and the consequent flow variability, and by the degree of exposure to limited water supply. Additional exposure to pressures, imposed on freshwater resources by non-climatic factors, such as water demand and groundwater overexploitation also increase the vulnerability of the sector.

The relationship between rainfall and dam inflow for the future period 2021-2050, based on PRECIS projections was compared to the respective data for the period 1971-2000. The results showed: i) A decrease of 23% in the future average total dam inflow, although the average precipitation decrease is only 5%. As an example, the above relation for the catchment of the Kouris dam is given in Figure 6.49, and ii) A high variability of dam inflow, indicating so a high sensitivity of Cyprus surface water resources to climate changes. The magnitude of exposure for all the 15 main dams in Cyprus ranges from -35% to +6% in the future period 2021-2050in comparison with the period 1970-2000.

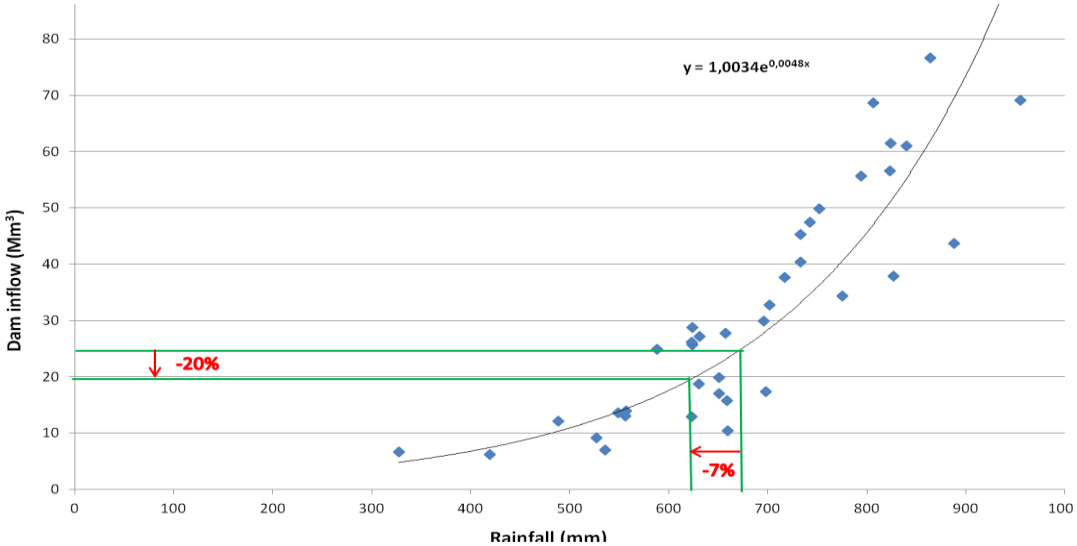


Figure 6.49. Relation between annual precipitation and annual inflow to the catchment area of the Kouris dam for the period (2021-2050)-(1970-2000)

In the recent past, the direct climate change effects observed include the diminishing precipitation and increased evapotranspiration with consecutive years of drought, which led to the depletion of surface water stored in reservoirs and the overexploitation of many aquifers especially for the irrigation of the agricultural land. The decreasing trend in ground water levels is expected to continue in future, and given that a large percent of groundwater bodies already being exposed directly or indirectly to climates changes (WDD, 2008, WDD 2011a) the Cyprus' groundwater resources exposure to climate change characterized high.

Freshwater stress, in terms of both quantity and quality, due to the decreased quantity of available freshwater resources will be worst in the future period 2021-2050 in comparison to the period 200-2010 as indicated from the following estimated indicators:

- The estimated current and future Water Stress Indicator per capita (WSI) was 284 m^3/c/y and 195 m^3/c/y respectively, both of which are considered very low, indicating that it is not possible for the case of Cyprus to rely exclusively on freshwater resources in the current situation and even more in the future
- The Water Availability Index, WAI is estimated to be approximately -0.26 and -0.1 respectively, indicating that the demand is higher than the availability of freshwater sources and that this inadequacy will be magnified in the future.
- The Water Exploitation Index (WEI) of Cyprus for the year 2007 was 64%, which is by far the highest WEI value among the European countries (EEA, 2010c). A WEI above 20 % implies that a water resource is under stress and values above 40 % indicate severe water stress and clearly unsustainable use of the water resource (Raskin et al. 1997).

Water stress is often related to the deterioration of fresh water resources in terms of both quantity and quality (Hochstrat and Kazner, 2009). Already stressed water resources are considered more vulnerable to climate changes. The difficulty facing Cyprus in order to meet water demand either for satisfying drinking water supply or for other purposes such as agriculture, tourism and industry, due to water stress, indicates the sensitivity of the sector to climate changes.

Following, the indicators used for the quantification of future water stress caused by the decreased quantity of available freshwater resources in Cyprus are presented. It is noted that, these indicators refer exclusively to the exploitation of freshwater resources, while non-freshwater resources (desalinated water, recycled water) are not taken into account

Already stressed water resources are considered more vulnerable to climate changes. The projected decreased precipitation and increased evapotranspiration due to future temperature increase will affect negatively the water availability, while the increase in demand due to population increase and the rising of living standards added an extra pressure in the already limited freshwater resources.

Taking into consideration the above, water availability is considered to have very high sensitivity and very high exposure to current and future climate changes.

Assessment of adaptive capacity

In order to combat this gap, between the increasing demands for water and the reducing water supply, due to the impacts of climate change, several adaptation measures, plans and water works have been implemented or planed by the Government. The Programme of Measures defined in the Cyprus River Basin Management Plan includes inter alia measures which are expected to reinforce Cyprus' adaptive capacity to the decreasing availability of freshwater resources and thus to climate change, are presented in Table 6.16.

Table 6.16. List of measures to adapt Cyprus' water management to climate change impacts

Adaptation measures	Implemented	Planned
Measures to increase Fresh water supply		
Reservoirs	X	
Inter-basin water transfer	X	
Artificial recharge of aquifers	X	X
Water import	X	
Diversification of water resources utilisation		
Water reuse	X	X
Desalination	X	X
Stormwater harvesting		X
Measures to decrease water consumption		
Replacement of networks	X	X
Water allocation/cuts	X	X
Use of water meters	X	X
Land consolidation	X	X
Increasing efficiency of irrigation	X	X
Control groundwater abstractions	X	
Changes in crop patterns		X
Awareness raising campaigns	X	
Economic/legal instruments		
Subsidies	X	X
Water pricing	X	X
Over consumption penalties	X	X
Other instruments		
Improving forecasting, monitoring, information -alert system	X	X

Many of the measures adopted have already alleviated the problem of water scarcity. Thus, the domestic water supply is continuous with the supplement of desalinated water. As for the future situation is concerned, the sum of the average estimated freshwater and non-freshwater resources for the period 2021-2050 (341Mm^3) is expected to fully satisfy future water demand from all sectors. However desalinated water is distributed mainly in the urban centers of Cyprus through Government Water Works (GWW), while other areas, such as the mountain communities, depend solely on freshwater resources (mainly groundwater) for meeting their drinking water needs (WDD, 2009a).

As shown in Figure 6.50a, total water use efficiency in Cyprus rose from 65% in 1995 to 82% in 2005-2010, placing the island among the first two countries as regards water use efficiency (Plan Bleu, 2011).

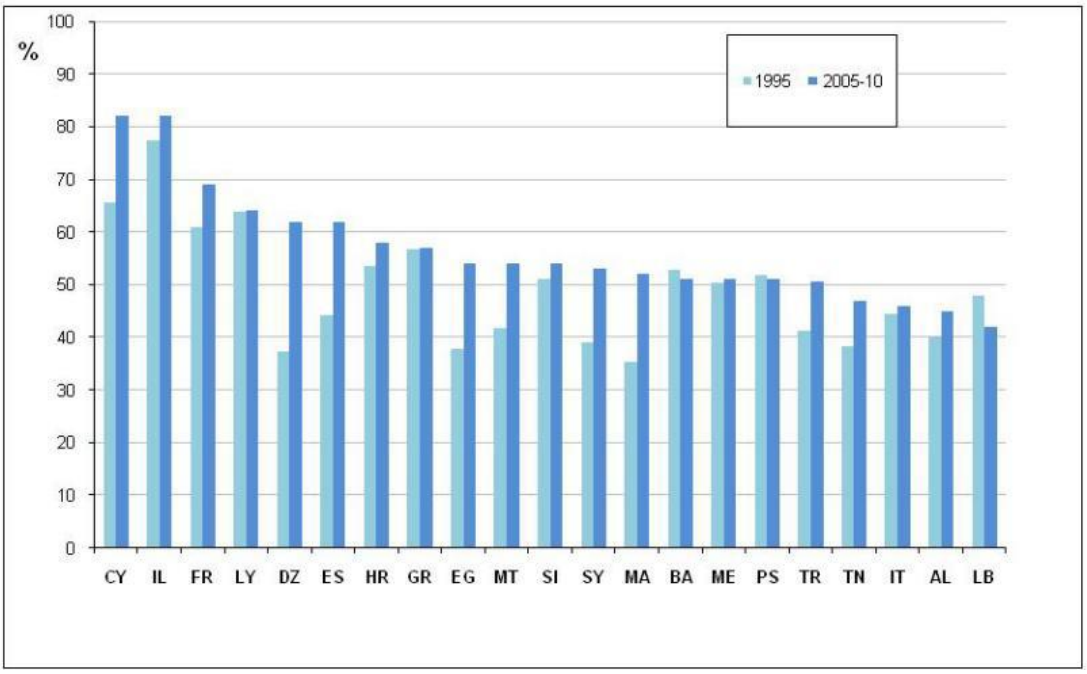


Figure 6.50a. Total water use efficiency in Mediterranean countries (1995, 2005-2010) (Plan Bleu, 2011)

The future adaptive capacity to water availability for domestic water supply in the plain and coastal areas, and in the mountain areas, is considered to be high to very high, and limited to moderate, respectively.

On the other hand, the measures applied have not yet managed to fully satisfy water demand for irrigation as agriculture constitutes the main water consumer in Cyprus. In addition, water is not evenly distributed whether it is freshwater or recycled water. In particular, recycled water for irrigation is distributed only in the plain and coastal areas. While the irrigation in mountain areas depends on the water available in the storage reservoirs which are of limited capacity and during drought periods their reserves are depleted, and on private boreholes, thus resulting in the overexploitation of aquifers.

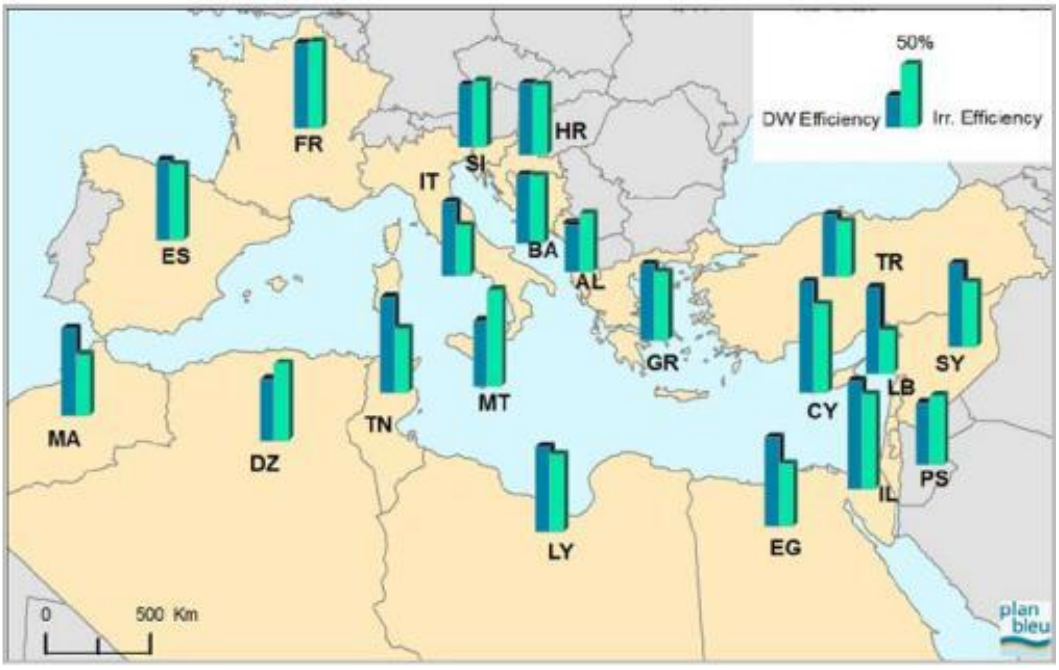


Figure 6.50b. Water use efficiency in drinking water and irrigation sectors in 2010 (Plan Bleu, 2011)

Therefore, the future adaptive capacity of Cyprus to water availability for irrigation in the plain coastal areas and in the mountain areas is considered as moderate and as limited to moderate, respectively.

Additional recommended adaptation measures (Shoukri and Zachariadis, 2012) that are considered to further enhance adaptive capacity towards this impact, include: Maintenance and repair of the water distribution systems and related infrastructure (adoption of technologies for leakage detection and control), Collection and use of rainwater, Review of the Water Policy etc.

2. Water quality

Water bodies in Cyprus are sensitive to eutrophication, stratification and low levels of dissolved oxygen as a result of increased water temperatures and decreased water flows due to reduced precipitation. In addition, heavy precipitation events and flooding adversely affect water quality. The reduction in the recharge rates due to reduced precipitation is more intense in the case of groundwater bodies, thus being more sensitive to climate changes. In addition, coastal aquifers are highly sensitive to salinization due to sea intrusion caused by their over-exploitation.

Considering the above, it was estimated that surface water bodies have moderate to high sensitivity to pollution due to climate changes while groundwater bodies have high to very high sensitivity.

The degree of water quality deterioration is mainly defined by the future climate changes, such as decreased precipitation and increased droughts, the increase in heavy precipitation events, the increase in surface water temperature and the sea level rise in Cyprus as projected in the future (2021-2050).

According to PRECIS the projections in the future period 2021-2050 (Figure 6.52), in brief are: The total annual precipitation will decrease with regional and seasonal variations. The maximum length of drought periods (consecutive days with precipitation<0.5mm) it is anticipated the central part of Cyprus by 15 days/year in the continental areas and approximately 20 days/year in the eastern part of Troodos mountain. The heavy precipitation events in the future will be without significant changes, as the annual maximum total precipitation over one day (heavy rainfall index) is expected to have a slight increase of about 2-4 mm in western, inland and mountain regions. As for changes in water temperature, these were related to the changes in air temperature. The average change in annual maximum temperature (TX) will range from +1.0°C at the eastern and northern coasts to +2.0°C in higher elevation areas and especially at the southwestern side of Troodos. Sea level changes in Cyprus are not expected to be significant.

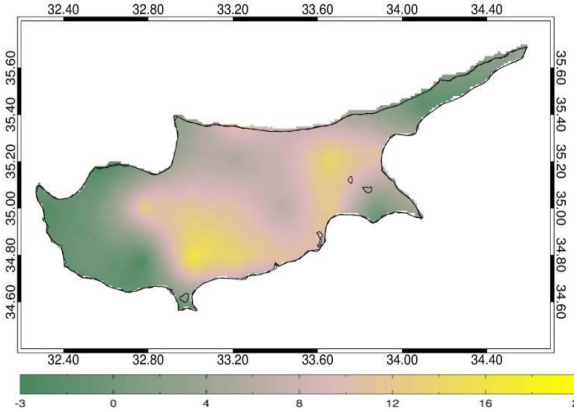


Figure 6.51. Changes in maximum length of dry spell (RR<0.5mm) between the future (2021-2050) and the control period (1961-1990)

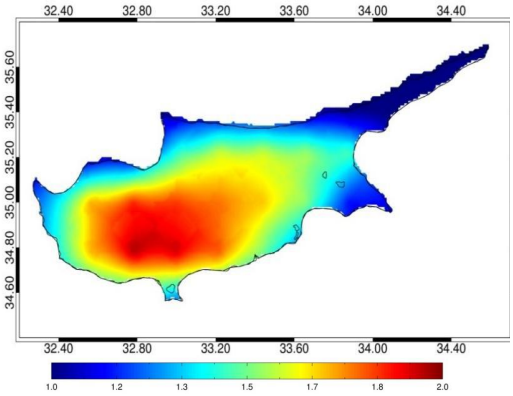


Figure 6.52. Changes in average annual maximum TX between the future (2021-2050) and the control period (1961-1990)

The exposure of the quality of water bodies in Cyprus (which, are already in bad qualitative condition) are considered more vulnerable to climate change impacts

Based on the results of the monitoring program of Cyprus' water bodies, within the implementation of the Water Frame Directive the qualitative status of the water bodies is as follows:

a) Surface water bodies: The majority of river and lake bodies of Cyprus were classified in a good or moderate ecological and chemical status (Source: WDD (7) and (8)) and all the 25 coastal water bodies were found in good or high ecological status or good ecological potential (Fisheries Department), and in good chemical status (WDD, 2011a). Furthermore, two surface water areas, in which direct or indirect disposal of urban waste water takes place, have been identified as sensitive and the surface waters with the greater relative pollution potential and thus most vulnerable are located in the central and north-western part of Cyprus (WDD, 2011a; PigWasteMan, 2007). Considering the above, it is estimated that the exposure of surface water bodies to pollution is limited to moderate.
b) Groundwater bodies: The main causes of groundwater bodies' pollution in Cyprus are agriculture, seawater intrusion, wastewater disposal and certain geological formations. From the monitoring of the 19 groundwater bodies during the period 2000-2008, 8 groundwater bodies (42%) were characterized according to the Water Framework Directive as in bad qualitative condition, based on the results of chemical analysis in the salinity levels and/or the levels of pollutants present in the groundwater bodies. In other words, the quality of groundwater bodies can be characterized as moderate to bad. Taking into account the above, the exposure of the groundwater bodies in Cyprus to deterioration of their quality is characterized as high to very high.

Assessment of adaptive capacity

To protect freshwater from pollution, a wide range of legislation which has been established in Europe, most notably the Water Framework Directive (WFD), is implemented in Cyprus.

The Programme of Measures defined in the annual report of the Cyprus River Basin Management Plan (WDD, 2011a – Annex III) includes the establishment of regulations or basic measures that should be implemented in order to achieve the objectives set out for 2015. Protected areas, Protection from point source discharges likely to cause pollution to water, Protection of groundwater bodies from salinization.

The legislation of the Cypriot Government referred as "Water Pollution Control Laws 2002- 2009" is the main tool with which all issues related to water pollution control from industrial and other activities are regulated.

Furthermore, aiming for compliance with the Urban Wastewater Treatment Directive (91/271/EEC) requirements, the wastewater collection and treatment infrastructure is being significantly expanded and upgraded.

The water policy of Cyprus on the salinization of groundwater bodies is based mainly on the prevention of seawater intrusion with the achievement of a positive balance between the abstractions and recharge, by setting proposed volumes of abstraction for each of its aquifers according to their quantitative condition. Furthermore, the measures foreseen for the achievement of a good chemical status of Cyprus groundwater bodies until 2015, in compliance with the Water Framework Directive, also contribute to this direction.

Consequently, it was estimated that the future adaptive capacity of water quality to climate changes is moderate for the case of surface water and limited to moderate for groundwater.

3. Floods

The climate projection model used for the case of Cyprus does not provide estimates for the frequency and intensity of floods in the future. Nevertheless, the annual maximum total precipitation over one day indicating heavy rainfall, which could also be associated with flood risk, will be not significantly changed, as projected the PRECIS model for the future period (2021-2050).

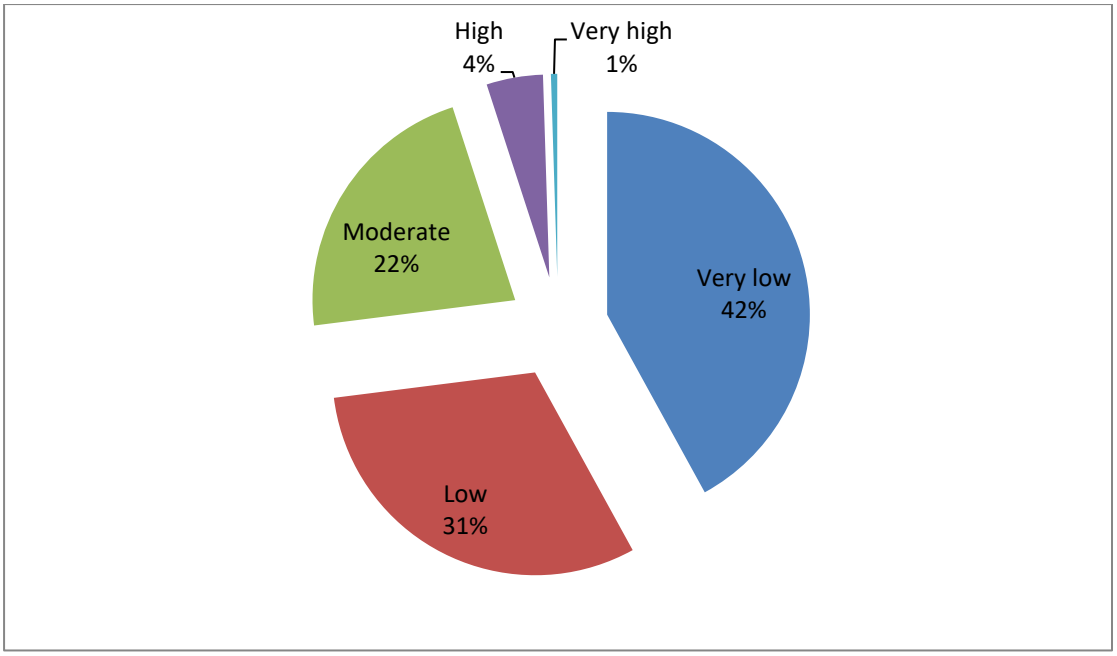


Figure 6.53. Hazard ranking of flooding events during the period 1859-2011

According to the Water Development Department (WDD), the recorded floods in Cyprus for the period 1859-2011 are characterized as urban floods (37%), flash floods (20%), river or fluvial floods (16%), pluvial floods (13%), or a combination of the above (WDD, 2011d). The distribution of floods according to their flood hazard in Cyprus in terms of adverse consequences for human health, environment, cultural heritage and economic activity for this period is presented in Figure 6.53.

The current vulnerability of Cyprus regarding flooding events will worsen with climate changes (WDD, 2011d).

The urban centers are sensitive to flood risks mainly due to their dense structuring and the restriction of green space, the elimination of natural waterways for the construction of roads, the deficient or even absent stormwater drainage system and the covering of waterways and drain entrances with garbage. On the other hand, mountain areas are less sensitive to floods, given that the inclination of terrain together with the infiltration capacity of forested areas do not allow for flooding events to take place.

This is also indicated in the "Preliminary Flood Risk Assessment" report (prepared by WDD for the compliance with the Floods Directive 2007/60/EC), where 19 areas around the island identified as "Areas with Potential Significant Flood Risk". They mainly refer to river parts that pass through built-up areas and are characterized by frequent and significant flash floods.

To sum up, it is considered that the exposure to floods of the mountain areas of Cyprus is expected to be moderate while the exposure of urban areas is considered to be limited.

Assessment of adaptive capacity

Cyprus' adaptive capacity to the increasing frequency and intensity of flooding events can be estimated by the existing flood protection works and the river protection zones as well as by the projected plans for the management of future flood risks. The last two decades, a separate drainage system is being developed In Cyprus in order to collect storm water.

In addition, it must be mentioned storage reservoirs act as a flood control measure as the water is impounded in the dam and its downstream release is regulated even in the case of an overflow.

The Law 70(I)2010 on the Flood Risk Assessment, Management and Preparedness, which harmonizes the Floods Directive 2007/60/EC with the Cypriot legislative framework states that Flood Hazard maps

and Flood Risk maps must be prepared by the end of 2013, while Flood Risk Management Plans must be prepared by the end of 2015.

Considering the above, the adaptive capacity of Cyprus to urban floods is estimated as moderate.

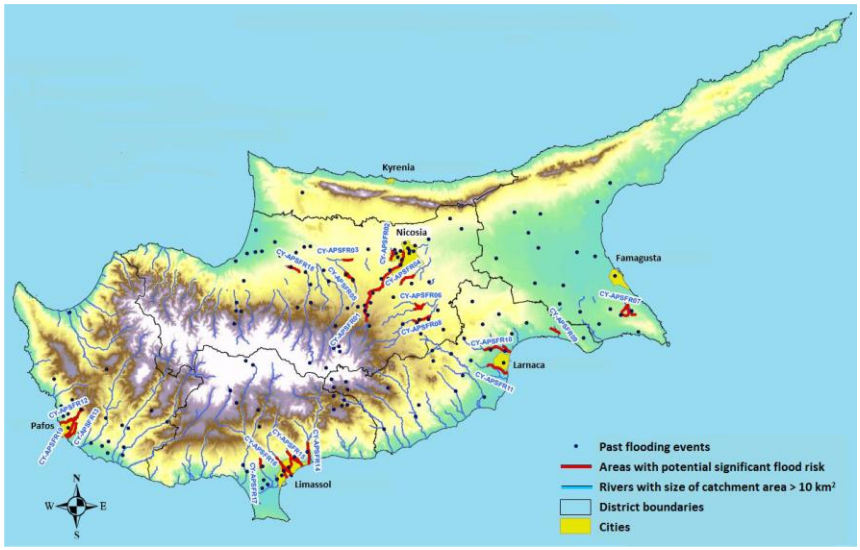


Figure 6.54. Areas with potential significant flood risk in Cyprus Source: WDD (10)

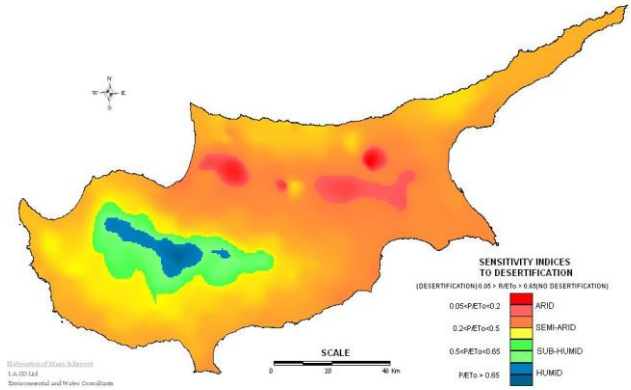


Figure 6.55. Environmentally Sensitive Areas to Desertification (IACO Ltd, 2007)

In addition, the adaptive capacity of mountain areas to floods is estimated by their inherent ability to absorb water due to the high infiltration capacity of vegetated areas and thus to prevent flooding. Thus the adaptive capacity of mountain areas to floods in mountain areas is considered high.

The maintenance and restoration of wetlands and riverbeds as natural defense against floods constitute an additional recommended adaptation measure that is considered to further enhance adaptive capacity towards this impact.

4. Droughts

Cyprus with very limited water resources is vulnerable to droughts as it has exploited most of all its natural water resources, with most of its aquifers depleted, and no perennial rivers. In order to estimate the sensitivity to droughts in Cyprus, the Department of Environment in 2007 has assigned to I.A.C.O. Ltd to define the areas threatened by desertification, by analyzing factors and processes leading to desertification and propose corrective measures. As shown in Figure 6.55 the 91% of the total area of Cyprus was characterized as critical or sensitive.

With the use of PRECIS regional climate model, the future changes (2021-2050) in the maximum length of the period with consecutive dry days (precipitation<0.5mm) per year will be increased by 10-12 days in comparison to the control period 1961-1990.

Consequently, the future exposure of Cyprus to droughts mainly is expected to be very high.

Assessment of adaptive capacity

Drought management is an essential element of water resources policy and strategies in EU but especially in drought prone areas, such as Cyprus. The Cyprus Drought Management Plan (DMP) has been prepared according to the guidelines of the European Commission (EC, 2008) Drought Management Plans (DMP), aiming to minimize the adverse impacts on the economy, social life and environment when drought appears.

Furthermore, it focuses on developing comprehensive, long-term drought preparedness policies and plans of actions that place emphasis on monitoring and managing emerging stress conditions and other hazards associated with climate variability in order to significantly reduce the risks and vulnerabilities to extreme weather events (WDD, 2011a).

Cyprus has considerably increased its adaptive capacity in coping with drought by adopting the EU guidelines on water and drought management. However, the Cyprus DMP and its Water Policy have recently implemented and have yet to be tested to prove their efficiency in achieving the abovementioned goals. For these reasons, Cyprus future adaptive capacity to droughts is considered moderate.

6.3.7.3. Assessment of overall future vulnerability

The overall future vulnerability of forests to climate changes, in terms of sensitivity, exposure, adaptive capacity is presented in Table 6.17.

As it can be seen from the table above, the main vulnerability for the water sector in Cyprus is related to the water availability for domestic water supply and irrigation in mountain areas. Water supply in mountain areas characterized by very high sensitivity and exposure to climate changes, while they have low adaptive capacity to cope with these changes mainly due to the insufficiency of government water works attributed to techno-economic reasons.

The other important vulnerabilities of the sector are related to the water availability for irrigation in plain and coastal areas, the groundwater quality and droughts. Additional adaptation measures are requested in order to eliminate all adverse consequences.

Table 6.17. Overall future vulnerability assessment of the water resources in Cyprus to climate changes

Impact		Sensitivity	Exposure	Adaptive Capacity	Vulnerability
Water availability for domestic water supply	in urban areas	Very high (7)	Very high (7)	High to Very high (6)	Limited (1)
	in mountain areas	Very high (7)	Very high (7)	Limited to Moderate (2)	High (5)
Water availability for irrigation	in plain & coastal areas	Very high (7)	Very high (7)	Moderate (3)	Moderate to High (4)
	in mountain areas	Very high (7)	Very high (7)	Limited to Moderate (2)	High (5)
Water quality	of surface water bodies	Moderate to High (4)	Limited to Moderate (2)	Moderate (3)	None (-0.2)
	of groundwater bodies	High to Very high (6)	High to Very high (6)	Limited to Moderate (2)	Moderate to High (4)
Floods	in urban areas	Moderate to High (4)	Limited (1)	Moderate (3)	None (-1)
	in mountain areas	Limited (1)	Moderate (3)	High (5)	None (-3.3)
Droughts		Very high (7)	Very high (7)	Moderate (3)	Moderate to High (4)

6.3.8. Tourism

6.3.8.1. Climate change and public health

The tourism sector is recognized as being highly vulnerable to climate change, and research is still considered scarce to support destinations to enhance resilience capacities. For example, higher temperatures could lead to a gradual decrease in tourism attractiveness during summer, caused by a higher frequency and intensity of heat waves and the decrease of thermal comfort of tourists. Other expected consequences of climate change impacting coastal destinations in Europe are sea-level rise, ocean acidification, precipitation patterns, thus leading to increased risks of beach surface loss, marine and terrestrial biodiversity degradation, forest fire events, among others (Arabadzhyan et al., 2020). In southern Europe, and particularly in Cyprus, the potential loss in overnight stay demand due to changes in climate conditions will likely reach 20% in a 2°C world (Jacob et al., 2018). This is particularly the case during the summer season, while climate conditions in higher latitudes will become milder and northern destinations will likely become more attractive.

6.3.8.2. Future impact assessment

The island of Cyprus is likely to experience several adverse climate change risks that could directly or indirectly impact the tourism industry. These include increased heat discomfort, increased risk of forest fires, the spread of vector-borne diseases, coastal erosion and more (Figure 6.56). As evaluated by tourists (León et al., 2021b), these risks will likely affect their decisions in terms of destination selection, the season of visit and the duration of stay. The reduction in tourism revenues due to changes in human comfort as captured by the hum-index, the degradation of the marine environment, the increased risk of forest fires and beach reduction will result in a decrease in tourism revenues (León et al., 2021a). According to the different scenarios and time horizons, this decrease is expected to range between -11 and -50%. Compared to other EU countries, a robust reduction in the number of overnight stays is expected in both winter and some seasons (Jacob et al., 2018). Besides the tourist flows, hotel prices and revenues will also be affected, for example, by the increasing cost of cooling and water supply.

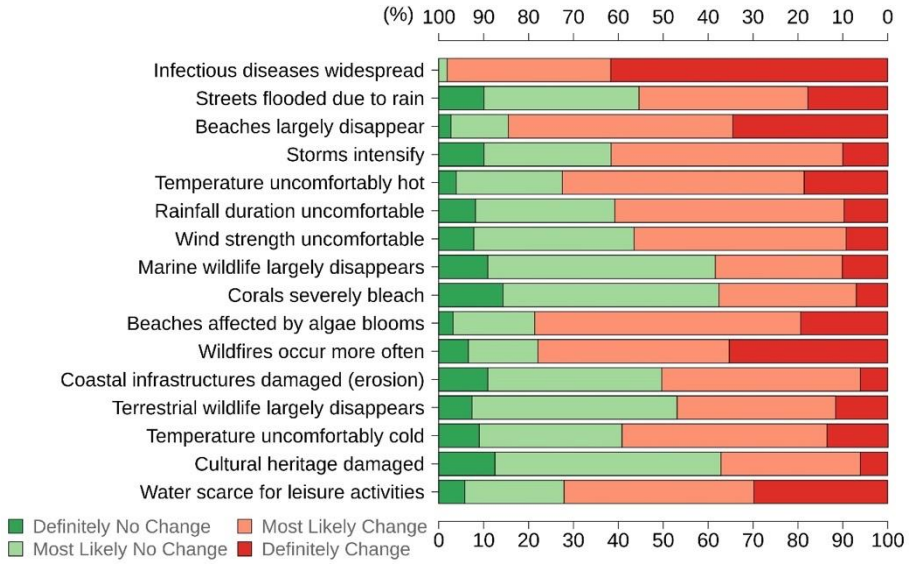


Figure 6.56. Change of travelling decisions under climate change impacts in Cyprus (Adopted from León et al., 2021b)

6.3.9. Sea-level rise

The impacts of sea-level rise (SLR) mainly include beach erosion, loss of wetlands, damage to coastal infrastructure and saltwater intrusion into coastal aquifers. These are negatively affecting ecosystems and a range of socio-economic activities such as agriculture, tourism, water and energy management, urban planning and more. Low-elevation regions, flat sandy beaches and deltaic sediments, commonly

found in the eastern Mediterranean coastal zones (incl. Cyprus), are less resistant to SLR than elevated, hard and cliffy shores (Kumar et al., 2010). Most of the critical infrastructure of the island is located near the coast (e.g., airports, ports, power and desalination plants, tourist resorts, etc.); therefore, the coastal parts of the island are highly vulnerable to mean sea-level rise and extreme storm surges. For example, under mean conditions, at the end of the century, the total beach surface loss ranges from ~30% under scenario RCP2.6 to ~54% under the business-as-usual RCP8.5 (León et al., 2021). In addition, the rising of sea levels will affect the operation and maintenance costs of critical infrastructure (e.g., ports), as new investments will be needed to keep their operability. For example, a 58 cm mean sea-level rise projected by the end of the century (RCP8.5) implies an additional cost of more than 4.3 million Euro per year (Figure 6.57).

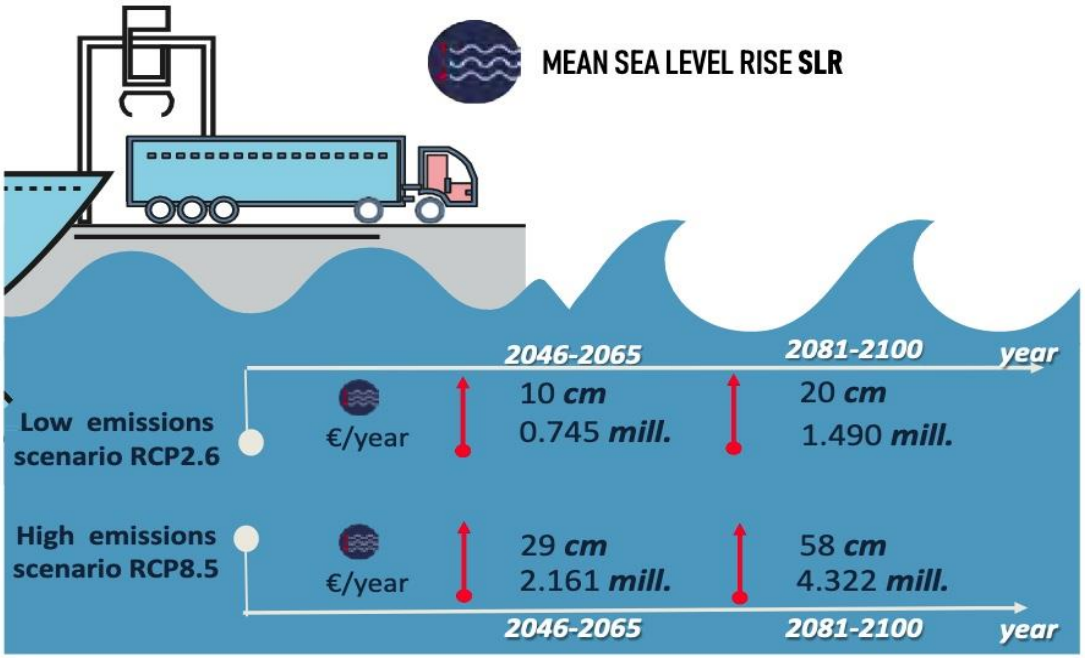


Figure 6.57. Increased costs for maintaining ports' operability in Cyprus under different scenarios of SLR caused by climate change until 2100 (Adopted from León et al., 2021, https://soclimpact.net/).

6.4. Actions for adaptation to climate change

6.4.1. National adaptation policy

Cyprus has adopted a National Adaptation Strategy and Action Plan in May 2017.

The adaptation policy process has been aided by the CYPADAPT[70] project, which was co-financed by the EU through the LIFE+ instrument. This project started in September 2011 and was completed in March 2014. The coordinator was the Department of Environment of the Ministry of Agriculture, Rural Development and Environment, the authority responsible for climate change in Cyprus. Cyprus prepared a combined National Adaptation Strategy and Action Plan in 2014[71], which was updated and formally adopted in May 2017[72].

The Ministry of Agriculture, Rural Development and Environment is the central body coordinating the adaptation policy-making process and has led the preparation and adoption of the National Adaptation Strategy and Action Plan. The responsibility for the implementation of specific sectoral actions lies with

[70] http://cypadapt.uest.gr/
[71] http://cypadapt.uest.gr/wp-content/uploads/20141219/deliverable_5.1_greek.pdf
[72] Cyprus National Adaptation Strategy 2017

the responsible authorities for each specific action (e.g. Department of Agriculture for agricultural issues). In November 2017, meetings with all the stakeholders have taken place to assess the status of implementation of the activities included in the Action Plan. The sectoral breakdown of the actions included in the strategy is presented in Table 6.18.

The contents of the National Adaptation Plan of Cyprus to climate change are the following:

- Brief presentation of the expected changes in climate worldwide and especially in Cyprus
- Brief presentation of the results of the vulnerability assessment of Cyprus to climate change for each of the eleven policy areas
- Presentation of the proposed climate change adaptation measures for each of the eleven policy areas of Cyprus

Table 6.18: Sectoral breakdown of the actions included in the strategy

	Sector	Number of actions
1	Water	7
2	Soil	4
3	Biodiversity	6
4	Agriculture	6
5	Forests	4
6	Fisheries	2
7	Health	9
8	Energy	7
9	Tourism	1
10	Coastal areas	4
11	Infrastructure	6
12	Horizontal (all sectors)	1
	TOTAL	57

Stakeholders involvement

Stakeholders are involved in a dedicated process. The active engagement of stakeholders and experts (relative ministerial departments, associations, non-governmental organizations, universities, research institutes, etc.) was recognised from the beginning of the National Adaptation Strategy development as a key element for the assessment of vulnerability, the identification and evaluation of adaptation measures and most importantly, for the development of the National Adaptation Strategy. Stakeholders were involved in several phases of the project and in particular during the following: assessment of current and future impacts, adaptation and vulnerability assessment, identification and assessment of the adaptation measures the development of the National Adaptation Strategy. The Adaptation Strategy has gone through two different consultation phases before it was finalised.

Vulnerability assessment

A first vulnerability assessment on the most important economic sectors was made within the CYPADAPT project. Key climate change risks and priority policy areas were identified. Past research had already indicated that the sectors that would require priority attention on the design and application of adaptation actions for Cyprus would be water resources, coasts, biodiversity and tourism. Cyprus's first detailed Climate Change Risk Assessment (CCRA) was published in 2016[73]. It provides an overview of potential risks and opportunities of climate change for Cyprus until 2100 and its findings will inform the development of adaptation plans by the Government and the competent authorities. The vulnerability assessment has focused on 11 priority sectors. These include water resources, land use,

73

http://www.moa.gov.cy/moa/environment/environmentnew.nsf/276491E82F8428E1C22580C30034ABF2/$file/Evidence-Report-v1_final.pdf

seaside areas, biodiversity, forestry, agriculture, fisheries, tourism, energy, infrastructure and public health.

Status of implementation

The implementation of several adaptation measures has started taking place. Some autonomous adaptation actions are being undertaken at sectoral level. For example, the Institute of Agricultural Research and the Department of Forests are undertaking projects which facilitate adaptation.

There are also a number of instances of cooperation with wider regional authorities[74], municipalities, community groups and private local enterprises, including:

CAMP-Cyprus covers a local spatial dimension at the southern peri-urban coastal area of Larnaca town by implementing activities in four fields i) biodiversity, (ii) carrying capacity assessment, (iii) strategic environmental assessment and (iv) environmental economics and economic instruments. It involves the co-operation of Larnaca municipality and the communities of Pervolia, Meneou and Kiti.

The COASTANCE project for coastal zone adaptation includes an assessment of the coastal risks and management measures for the pilot case of Mazotos area in Larnaca District.

The MAREMED project on adaptation in coastal areas, with the Larnaca District Development Agency partnering with 14 regions from five countries[75].

Monitoring & revision of the strategy

A Monitoring Strategy[76] was developed to complement the National Adaptation Strategy. In the Monitoring Strategy, and a Monitoring Team was suggested. The results of the Monitoring Strategy are expected to provide the basis for the preparation of the 2nd National Adaptation Plan. Monitoring reports are scheduled every year from 2018 to 2022. All the stakeholders have been included throughout the process and particularly monitoring of progress of implementation of adaptation measures.

Reviews involve all stakeholders coordinated by the Department of Environment, as stated in the Council of Ministers' decision that adopted the National Adaptation Strategy and the Action Plan in May 2017.

6.4.2. EU level actions

In recognition of the shared challenges and cross-border nature of climate change, the European Union has led the development of an EU-wide framework for adaptation. The European Commission started in 2007 by adopting a Green Paper "Adapting to climate change in Europe – options for EU action"106. It was followed by the White Paper "Adapting to climate change: Towards a European framework for action"[77] in 2009. These documents led to the adoption of the 'EU strategy on adaptation to climate change'108 on 16 April 2013.

The strategy predates but does not conflict with some key objectives and commitments made by the EU at the international level, including most recently the UNFCCC Paris Agreement (Article 7), the Sustainable Development Goals and the Sendai Framework on Disaster Risk Reduction109 and also the Aichi biodiversity (CBD) targets. It is also in line with the ten priorities of the Juncker Commission.

6.4.2.1. The EU Strategy on Adaptation to Climate Change

The 'EU strategy on adaptation to climate change' was adopted by the European Commission on 16 April 2013. The overall aim is to contribute to a more climate-resilient Europe. This means enhancing

[74] Each wider region (District) comprise of a number of Municipalities
[75] http://www.maremed.eu/index.php?act=1,2,3
[76] http://cypadapt.uest.gr//wp-content/uploads/20141219/deliverable_5.2_english.pdf
[77] COM(2009) 147 final WHITE PAPER Adapting to climate change: Towards a European framework for action http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0147:FIN:EN:PDF

the preparedness and capacity to respond to the impacts of climate change at local, regional, national and EU levels, developing a coherent approach and improving coordination. It sets out eight actions to meet the Strategy's three specific objectives:

Objective 1 Promoting action by Member States

- Action 1: Encourage all Member States to adopt comprehensive adaptation strategies
- Action 2: Provide LIFE funding to support capacity building and step-up adaptation action in Europe (2013-2020)
- Action 3: Introduce adaptation in the Covenant of Mayors framework (2013/2014)

Objective 2 Better informed decision-making

- Action 4: Bridge the knowledge gap
- Action 5: Further develop Climate-ADAPT as the 'one-stop shop' for adaptation information in Europe

Objective 3 Climate-proofing EU action: promoting adaptation in key vulnerable sectors

- Action 6: Facilitate the climate-proofing of the Common Agricultural Policy (CAP), the Cohesion Policy and the Common Fisheries Policy (CFP)
- Action 7: Ensuring more resilient infrastructure
- Action 8: Promote insurance and other financial products for resilient investment and business decisions

Progress and outcomes of adaptation action

Since the publication of the 6th NC in 2014, the EU and its Member States have significantly increased the number of actions for coping with the impacts of climate change at international, national and local levels as well as across sectors. These have been presented in detail in the 8th National Communication & 34th Biennial Report from the European Union under the UN Framework Convention on Climate Change (UNFCCC).

7. Financial resources and transfer of technology

7.1. Introduction

Cyprus was a non-Annex I party to the UNFCCC until 1/1/2013 and a non-Annex B party to the Kyoto Protocol. Consequently, Cyprus had no obligations to allocate financial resources for assistance to developing country parties that are particularly vulnerable to climate change. Nevertheless, in 2009, along with the rest of the member states of the EU, Cyprus committed to provide finance for climate change to developing countries.

7.2. Provision of new and additional resources

CyprusAid is the Development Cooperation Service of the Republic of Cyprus, established in its current form by the Council of Ministers in 2005. CyprusAid functions within the framework of a policy making mechanism that has been put in place in order to steer Cyprus' Official Development Assistance. This policy mechanism is one that retains a high degree of centralisation in the decision-making process, while at the same time allows for a more decentralized approach in the aid delivery arrangements. The mechanism comprises of a Coordination Body (CB) headed by the Minister of Foreign Affairs and having the Minister of Finance and the Permanent Secretary of the Planning Bureau as members. The CB is responsible for the setting of targets (quantitative, territorial and sectoral) on the basis of international obligations, EU policy recommendations and national priorities. The Planning Bureau is responsible for the preparation of policy preparation, as well as the management and implementation of the decisions of the CB while the MFA is responsible for representing the Republic abroad and also for publicizing the Republic of Cyprus ODA activities. A second body, headed by the Permanent Secretary of the Ministry of Foreign Affairs (MFA) and comprised of representatives of the Ministries of Finance, Commerce, Industry and Tourism, Agriculture, Natural Resources and Environment, Labour and Social Insurance, Education and Culture and the Planning Bureau, as well as representatives of civil society, acts in a consultative capacity to the Coordination Body.

According to the relevant EU ministerial decision and the necessary decision from the national council of ministers, Cyprus was going to provide €1.8 million as fast start finance. The amount was new and additional. The €1.8 million were going to be given in three years 2010-2011-2012, €0.6 million annually.

Funding was provided for the years 2010 and 2012. No additional funding was provided after 2012.

7.3. Assistance to developing country Parties that are particularly vulnerable to climate change

CyprusAid after studying options funds and organizations implementing projects on climate change, and with the consent of the Ministry of Finance promoted cooperation with the "Global Climate Change Alliance-GCCA", a funding mechanism coordinated by the European Commission. This mechanism acts as an intermediary / coordinator for contributions and projects to tackle climate change. The choice of "GCCA" as a means of disposing of contribution of Cyprus based on that provides recognition to donors. Furthermore, the "GCCA" is an initiative of the European Commission and the substantial and political support of Member States in this, strengthens and makes this mechanism valuable in the international arena on climate change. Moreover, GCCA focuses climate support on LDCs and SIDS.

7.3.1. Funding provided in 2010

Project name: "Building Climate Resilience in Nepal"

The estimated costs of the project amounted to €19,400,000 (European Union: €8,000,000, Development Cooperation Service of the United Kingdom €10,800,000 and Cyprus €600,000). The

project is implemented by the method of award of centralized management to the local office of the Office for Development Cooperation of the United Kingdom in Nepal.

The main objectives of the project are: (a) the development of an administrative infrastructure in Nepal, both at national and local level to enable the implementation of the National Adaptation Programme of Nepal to climate change and (b) promote the integration policy on climate change programs and projects of the government at national and local level and develop mechanisms to promote initiatives for climate adaptation.

The institutionalization of cooperation has been the signing of a Credit "Transfer Agreement" between the Cyprus and the European Union represented by the European Commission.

7.3.2. Funding provided in 2012

Project name: "Climate Change Adaptation and Sustainable Land Management in the Eastern Caribbean"

For 2012 the Planning Bureau has negotiated a Credit "Transfer Agreement", for funding the project in the Caribbean (Antigua & Barbuda, Dominica, Grenada, Saint Lucia, St. Christopher (St. Kitts) & Nevis St. Vincent, Grenadines, Montserrat, British Virgin Islands, Anguilla).

This project was funded by the European Commission with a contribution of €10,000,000 and the Republic of Cyprus with a contribution of €600,000.

The overall project objective was to contribute to the implementation of the provisions laid down in Article 24 of the Revised Treaty of Basseterre, which makes reference to implementation by each State Party "St. George Declaration" on the Declaration of Principles for Environmental Sustainability, which aims, among others, to achieve long-term conservation and sustainable productivity of the region's natural resources and the ecosystem.

The immediate goal of the project is to improve the resilience of the natural resources base in the region to the impacts of climate change through: (a) promoting efficient and sustainable practices and frameworks of land management and (b) promoting concrete pilot projects in order to adapt the field (especially in terms of land management) to climate change.

7.4. Activities related to transfer of technology

No activities related to transfer of technology have been implemented.

8. Research and systemic observation[78]

8.1. Introduction

The R&I system in Cyprus is relatively young and is evolving with the aim to increase its efficiency and foster cooperation between the research community and the productive sector (business and industry). The current governance system was established in 2007. The main barriers of the system relate to the inflexible governance structure, the weak coordination between the various actors involved and the absence of an explicit long-term strategy for R&I. In addition, the development of the R&I system is hindered by the weak cooperation between the research and academic community with the business world, the low involvement and investments of the private sector in R&I activities and the limited extroversion of the Cyprus R&I system.

Taking into consideration the above, the government of Cyprus promoted various initiatives and studies in order to develop a concrete proposal for restructuring and upgrading the R&I governance structure in Cyprus. Due to a wider administrative reform effort which is currently under way, decisions on the specific issue are still under preparation. It should be noted however that the gap is currently filled, to some extent, by the Council of Ministers.

Currently, 2 Strategy documents approved by the Council of Ministers are under implementation, namely the Smart Specialisation Strategy and the National European Research Area Roadmap for Cyprus 2016-2020.

8.2. General policy on and funding of research and systematic observation

8.2.1. Institutional mapping, actors and roles and responsibilities

The National Research and Innovation Council (NRIC) is the political, decision-making body of the R&I System. It is composed by a cabinet of six members/ ministers (Finance, Energy-Commerce-Industry and Tourism, Education and Culture, Transport-Communications and Works, Agriculture-Rural Development and Environment and Health) and it is chaired by the President of the Republic. The NRIC is entrusted with the responsibility of formulating long term R&I strategic priorities. Also, the Cyprus Scientific Council (CSC) is an advisory scientific body comprising of 19 reputable high calibre scientists. All three Public Universities as well as Private Universities and Public Research Institutions are represented in the CSC. This Council is responsible for advising NRIC on strategy and policy R&I matters. The existing Governance system has proven however rather inflexible and has been inactive for the past few years. The gap is currently filled, to some extent, by the Council of Ministers.

The responsibility for the design of the national R&I policy, is carried out by the DG EPCD, an independent governmental body which, administratively, is under the Minister of Finance. The major policy initiative undertaken by DG EPCD was the preparation of the Smart Specialisation Strategy of Cyprus (S3Cy). This strategy is implemented through an Action Plan that is a “dynamic” document reflecting the national Framework Programmes for R&I over the period 2016-2020. Also, another policy initiative undertaken by DG EPCD was the preparation of the National European Research Area (ERA) Roadmap for Cyprus 2016-2020. The Roadmap describes the current situation related to the implementation of ERA priorities at national level and indicates the national priorities and relevant current and future actions aiming to address the individual ERA Priorities.

R&I Policy is mainly implemented by the Research Promotion Foundation (RPF), which is the main research funding agency in Cyprus. The RPF was established in 1996 as an autonomous agency under

[78] Directorate for Research, Innovation and Lifelong Learning, Directorate General for European Programmes, Coordination and Development, Republic of Cyprus, 1409 Nicosia, Cyprus, http://www.dgepcd.gov.cy

private law, supervised by a Board of Directors, chaired by the Permanent Secretary of DG EPCD. The RPF is responsible for: (a) the provision of competitive funding for the implementation of research and technological development projects and innovation activities through the development and monitoring of national programmes and grant schemes for the implementation, inter alia, of the Action Plan of the Smart Specialisation Strategy for Cyprus, (b) the management of European research and innovation projects by establishing the network of National Contact Points (NCP) for Cyprus' participation in the EU Framework Programmes, thus providing assistance to applicants for EU research competitive funding and the implementation of international agreements in R&I and (c) the implementation of bilateral and multilateral agreements between Cyprus and other countries in the field of research and technological development.

Also, The Technology Service of MECIT, is responsible for the design and implementation of specific actions/programmes related to business innovation, on the basis of the national policy and in particular the S3Cy.

The major research activity in Cyprus is performed by the Higher Education Institutes (HEIs), Research Promotion Organizations (RPOs) including departments and Institutions of the public sector, enterprises and the private non-profit organisations. the role of public universities (University of Cyprus, Central University of Technology and Open University of Cyprus) is crucial, while the major RPOs, such as the Agricultural Research Organisation, the Cyprus Institute of Neurology and Genetics, the Cyprus Institute, the State General Laboratory, the Department of Fisheries and Marine Research and the Department of Meteorology are important research performers. Research in the Business sector is dominated by a few Enterprises in the pharmaceutical sector as well as small-medium companies and start-ups mainly in the ICT sector.

8.2.2. Main instruments, policies and programmes

Research is among the key priorities measures of the Action Plan for Growth, a main strategy document that aims at accelerating the economic recovery, creating jobs, improving the competitiveness of the business environment and promoting investments.

The main policy document for Research and Innovations currently in force is the Smart Specialisation Strategy for Cyprus (S3CY), which was approved by the Council of Ministers in March 2015. It includes an Action Plan, to be implemented over the period 2015 – 2022, with measures amounting to €144 mln, with co-financing from the European Structural and Investment Funds (ESIF). The Action Plan of S3CY is expected to also address the main issues of the R&I system in Cyprus such as the inclusion of SMEs in R&I activities and the attraction of private sector in R&I investments, the establishment of synergies between the research and academic community with the business world and the enhancement of extroversion of the Cyprus R&I system.

The main tool for the implementation of the S3CY Action Plan is the National Framework Programme for Research and Innovation RESTART 2016-2020, implemented by the Research Promotion Foundation that offers ample opportunities to all local stakeholders, including universities and research organisations, to establish consortia for the implementation of projects, thus nurturing closer links between them.

Also, another policy document, is the National "European Research Area (ERA)" Roadmap for Cyprus 2016-2020m, which was approved by the Council of Ministers in 19th of July 2017. The Roadmap describes the current situation related to the implementation of ERA priorities at national level and indicates the national priorities and relevant current and future actions aiming to address the individual ERA Priorities.

8.2.3. International Cooperation

The preparation and monitoring of bilateral and multilateral transnational agreements on the promotion of Science, Technology and Innovation (STI) Cooperation as well as the participation in International Organizations and initiatives for R&I is carried out by the DGEPCD.

Cyprus has concluded a number of STI Cooperation Agreements and Memoranda of Understanding with third countries (i.e. United States, Israel, Russia, Egypt, China, Cuba). The choice of partner-countries is decided on a case-by-case basis, taking into consideration Cyprus' external policy priorities and the interest of the Cypriot Research Community for cooperation in R&I with a specific country.

Furthermore, Cyprus is participating in international research organizations such as CERN (the European Organisation for Nuclear Energy), where it is an "associate member in the pre-stage to membership", providing, inter alia, the opportunity to national research organizations and scientists to participate in consortia for projects of mutual interest. Cyprus is also a founding member of SESAME and in fact, the only EU Member State participating as a full member, together with Egypt, Iran, Israel, Jordan, Pakistan, the Palestinian Authority and Turkey, providing a link between the EU and the organization, which is highly valued by the European Commission in the context of scientific diplomacy.

The implementation of bilateral and multilateral agreements between Cyprus and other countries in the field of research and technological development and the promotion of the participation of, Cyprus in European and International initiatives and organisations (COST, EUREKA, EUROSTARS, etc.) were carried out mainly by the RPF through relevant Schemes in the National Funding Programme "RESTART 2016-2020".

Specifically, the National Framework Programme "RESTART 2016-2020", under the priority "Extroversion – Open Horizons" included 4 programmes (Bilateral Cooperation, International Collaboration-Dual targeting, EUREKA Cyprus and European Initiatives) for the enhancement of the extroversion of the R&I sector.

RPF is also the responsible agency for the promotion and the facilitation of the participation of Cypriot organizations and researchers in EU Framework Programmes by establishing the network of National Contact Points (NCP) for Cyprus' participation in the EU Framework Programmes, thus providing assistance to applicants for EU research competitive funding and the international agreements programmes in R&I.

8.2.4. Funding of research and systematic observation

The national target for R&D expenditures as a percentage of GDP was set to reach 0.50% by the year 2020. This target was set taking into account the particularities of Cyprus in terms of the size of the research community, the orientation of the economy in low value-added products and services and the very small size and low involvement of Cypriot companies in R&D activities in terms of participation and expenditure in R&D.

Cyprus ranks very low in terms of R&D expenditure, as it counts only for 0.48% of GDP for 2015. The significant fluctuations of GDP determine to a large extent the evolution of Research and Development intensity as actual investments in absolute terms remain relatively stable over the years.

Expenditures (GERD) performed by the Government in 2015 (most recent available data) was accounted to 50.6%, including the expenditures of the Public Universities which were accounted to 23%. The private sector contribution accounted to 26,4% while the contribution from abroad accounted to 23%.

By sector of performance, the higher education institutions accounted in 2015 for €42,6 million or 49,9% of total R&D expenditure, the business enterprises for €19,5 million or 22,8%, the private non-profit institutions for €12,2 million or 14,3% and the government for €11,1 million or 13,0%. In the business enterprise sector, information and communication constituted the principal source of R&D activity, with a total R&D expenditure of €10,1 million, while of importance was also the contribution of the manufacturing industry (and particularly the manufacturers of basic pharmaceutical products and preparations) with €7,3 million.

The private sector contribution to Research and Development activities is low and has been identified as a major limitation factor for the development of the field. Business Enterprise Expenditure on Research and Development (BERD) also stood very low compared to the EU average in 2015. More specifically, the indicator stood at 0.11% of GDP in 2015, far below the EU average (1.3%). Businesses

performed 22.8% of GERD in 2015. In terms of R&D financing, the Cypriot private sector funded 26.4% of overall R&D expenditure in 2015 (most recent available data).

The proportions among fields of science have not changed significantly over the years. Most of the research expenditures focused on Natural sciences (€36.3 million), while Engineering sciences absorbed €19.1 million, Social sciences €13.0 million, Humanities €7.0 million, Agricultural sciences €6,7 million and Health sciences €3,1 million.

The Cyprus Government allocates institutional funding to public Higher Education Institutes (HEIs) and the Research Promotion Organisation (RPO) annually, through the state budget. HEIs have introduced mechanisms within the universities for the selection and management of research proposals.

Also, national funding schemes included in the Action Plan of the S3Cy, amounting to €144 ml and co-funded by the European Structural and Investment Funds (ESIF), are implemented mainly through the Research Promotion Foundation (RPF) and the Technology Service of the Ministry of Energy, Commerce, Industry and Tourism (MECIT).

8.3. Systematic observation

8.3.1. Atmospheric observation

Measurements of meteorological parameters[79]

The Cyprus Department of Meteorology is a Department of the Ministry of Agriculture, Rural development and Environment and handles issues concerning the weather and climate of Cyprus.

In order for the Sector of Climatology to achieve its goals of measuring all the meteorological parameters, it operates a dense network of Meteorological Stations which includes 144 rainfall stations, 17 climatological stations, 3 synoptic station, 1 upper air station, 52 automatic stations, 2 stations measuring UV radiation and 20 radiation stations.

The Department of Meteorology also was operating a Meteorological Doppler Radar in Troodos mountains (Kykkos area) until 2009. From June 2017, the Department of Meteorology operates two new x-band Weather Radar (one in Rizoelia area in Larnaka and one in Paphos).

For information regarding the network of stations, see Figure 8.1 and Table 8.1.

Table 8.1. Type of meteorological stations in Cyprus

Type of Meteorological Stations	Number of Met. Stations
Rainfall Stations	144
Conventional Climatological Stations	9
Automatic Weather Stations	52
Radiation Stations	20
UV- Radiation Stations	2
Synoptic stations	3
Upper Air stations (Radiosonde)	1

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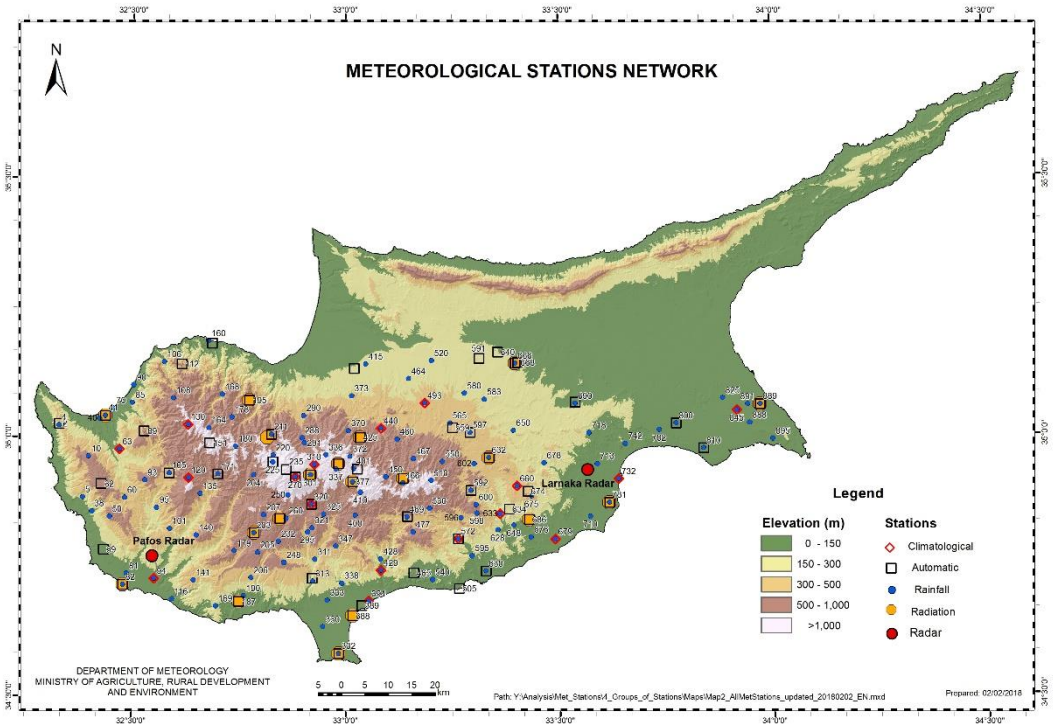

Figure 8.1. Cyprus meteorological stations network

Ground level air pollutants[80]

The Ministry of Labour &Social Security is responsible for Air Quality and Emissions Inventory in Cyprus. The Air Quality Section of the Department of Labour Inspection operates a network of 13 ambient air monitoring stations all over Cyprus as shown in Figure 8.2. The results, together with other useful information on air quality, are given to the public, on-line, through the website www.airquality.gov.cy and through indoor/outdoor information panels.

[80] Savvas Kleanthous, Senior Labour Inspection Officer, Head of Air Quality Section, Department of Labour Inspection; 12, Apelli Street, 1080 Nicosia, Cyprus; Tel: +357-22405639; e-mail: skleanthous@dli.mlsi.gov.cy

Figure 8.2. Cyprus air quality monitoring stations

Atmospheric climate observing systems (incl. measuring atmospheric constituents)

Since the previous UNFCCC communication, the Climate and Atmosphere Research Center (CARE-C) of the Cyprus Institute has further developed a comprehensive atmospheric network over Cyprus that fully complements those currently operating by 1) the Cyprus Department of Meteorology (DoM) for the monitoring of meteorological parameters (see previous UNFCCC report), and 2) the Department of Labour Inspection (DLI) for the monitoring of air quality (see previous UNFCCC report).

This atmospheric network aims to establish the first ever (open access) long-term observations of key climate forcers in the Eastern Mediterranean and Middle East region, in order to better constrain emissions of greenhouse gases and air pollutants and therefore better support the development of accurate regional (air quality) models for better prediction, mitigation, and adaptation.

8.3.1.1. Ground-based observations: The Atmospheric Network operated by the CARE-C (Cyprus Atmospheric Observatory, CAO,) consists of 4 ground-based stations which operate continuously with the objective to provide (open access) high quality long-term atmospheric observations relevant climate:

1) A **regional background station** - CAO-AMX (co-operated with DLI for Air quality) to document regional pollution (with minimal influence of Cyprus) and impact of long-range transport from Europe, Africa, and the Middle East
2) A **marine background station** – CAO-IN to document specifically greenhouse gases (CO2, CH4) with minimal influence of Cyprus (anthropogenic and biosphere emissions/sinks)
3) A **free-troposphere background station** – CAO-TRO to document atmospheric composition in the free troposphere (to complement the boundary layer observations performed at CAO-AMX and CAO-IN)
4) An **urban background station** – CAO-NIC to characterize urban pollution of the Nicosia urban area with atmospheric parameters complementary to those provided by the local air quality network,

The list of atmospheric parameters monitored at each station is accessible at the above links. They comprise Air Quality parameters (O3, CO, SO2, NOx, PM2.5/PM10), Greenhouse Gases (CO2, CH4), Aerosol properties (Chemical composition, Size-resolved number concentration, light scattering/absorption, dry/wet deposition, etc.), Reactive gases (VOCs), and further information on aerosol formation (nucleation).

For the CAO-AMX station (National Facility), these observations are part of the European Research Infrastructure ACTRIS (Aerosol, Clouds and Trace Gases Research Infrastructure) that is currently supported (for Annual Membership) by the Cyprus Deputy Ministry of Research, Innovation, and Digital Policy (DMRID). This station is also a component of the WMO-GAW (World Meteorological Organization - Global Atmospheric Watch) network (as Regional Station), and contributes to the EMEP (European Monitoring and Evaluation Programme) network. Atmospheric observations are provided in Open Access to these different networks (e.g. EBAS atmospheric database) and follow strict quality control procedures regularly checked with the support of WMO, ACTRIS, EMEP, IAEA, etc. Cyprus Atmospheric data from CAO network (The Cyprus Institute): Real-time (level 0) data display of the major CAO stations are provided in Open Access (https://emme-care.cyi.ac.cy/data/).

Figure 8.3.: Pictures of the four (4) ground-based monitoring stations of the Cyprus Atmospheric Observatory (CAO) currently operated by the Climate and Atmosphere Research Center (CARE-C) of the Cyprus Institute. (Right) Logos of the international networks under which the CAO stations are operating

8.3.1.2. Remote sensing observations: As part of the CAO network a comprehensive suite of remote sensing observations are performed continuously over Cyprus and relate to

+ Long-term vertical profiling of aerosol/cloud properties obtained by sunphotometers part of AERONET (Aerosol Robotic Network) network (CAO-NIC, CAO-AMX, LIMASSOL), and by LIDAR/ceilometers for aerosol vertically-resolved profiling. Real-time (level 0) data of sunphotomers are accessible in real-time at AERONET webpage. Remote sensing observations at Limassol are performed by the ERASTOTHENES Center of Excellence of the Cyprus University of Technology

+ Long-term Vertical (column integrated) greenhouse gas (CO2, CH4, N2O) observations through passive spectroscopy that are part of the TCCON (Total Carbon Column Observing Network) and aims (after forthcoming upgrade) to be part of the NDACC (Network for the Detection of Atmospheric Composition Change).

+ Long-term solar radiation observations that aims to become part of the WRMC-BSRN (World Radiation Monitoring Center – Baseline Surface Radiation Network

8.3.1.3. Atmospheric data availability:

Cyprus Air Quality data (DLI): https://www.airquality.dli.mlsi.gov.cy/
Cyprus Weather data (DoM):
http://www.moa.gov.cy/moa/dm/dm.nsf/home_en/home_en?openform
Cyprus Atmospheric composition data (CAO, The Cyprus Institute): see networks above.

8.3.2. Oceanic observation

Oceanic observation is performed by the following programmes of the Cyprus Oceanography Centre[81]:

Hydrochanges: The CIESM body coordinates and brings together all kinds of marine scientists from the Mediterranean and Black Seas. It has encouraged this initiative to increase the number of sensors in the very deep ocean for detecting climatic changes. Currently, it is an umbrella and networking agent for countries and institutions who wish to develop such long-term observing programs in the deep sea. In situ measurements of temperature and salinity, collected with adequate spatial and temporal resolutions, and with particular attention to sensitive, often long-neglected Mediterranean areas (straits and channels, zones of dense water formation, deeper parts of the basins), constitute a priority, particularly in the current context of global climate change. To this effect, our CIESM program is deploying/ monitoring an array of stations that could be viewed in time as the marine counterpart of meteorological stations. A station is composed of a short (~10 m high) subsurface mooring equipped with an autonomous CTD (1 to 2-hr sampling interval) and usually a current-meter. Moorings are set in place close to the seabed at depths ranging from 300 to 2,500 m, for periods of 1-2 years before recovery (for maintenance and calibration) and re-deployment, by scientific teams and/ or hydrographic services of participating countries. More than twenty stations are already in operation, plus those susceptible to be deployed soon, are indicated on the map below. The partner from Cyprus is the Oceanography centre.

MEDship: The CIESM body coordinates and brings together all kinds of marine scientists from the Mediterranean and Black Seas. It has encouraged this initiative to increase the number and quality of ship-based observations of physical, chemical, and biological in the Mediterranean. Special emphasis is given on the deepest layers and longest (climatic) time scales. A link has been made with a similar global initiative called 'GO-SHIP', in which high standards for data collection, analysis, and distribution are set for the global oceans. This program is actively seeking funding to be implemented, but already coordination between partners is taking place. The partner from Cyprus is the Oceanography centre.

8.3.3. Terrestrial observation

Observation System on quantity/quality of surface water[82]

The Water Development Department (WDD) is responsible for implementing the water policy of the Ministry of Agriculture, Natural Resources and Environment, to provide effective protection, rational development and sustainable management of water resources in Cyprus. In this context, the WDD implements the necessary measures to prevent the qualitative and quantitative deterioration of water bodies from contamination, pollution and uncontrolled exploitation. The WDD is also responsible for the feasibility studies, design, implementation, operation and maintenance of infrastructure, such as dams, ponds, irrigation, domestic water supply and sewerage schemes, water and wastewater treatment and recycling systems, as well as desalination plants.

In order to fulfil its mission, the Department systematically collects, classifies, archives, analyses and evaluates hydrological, hydro-geological, geotechnical and other data necessary for the protection and sustainable management of water resources in Cyprus.

In the field of quantitative monitoring of surface waters, continuous stream flow monitoring takes place at 52 hydrometric stations. In addition, the flows of 45 springs are measured on a regular basis.

Qualitative monitoring of surface waters, takes place at 45 river monitoring stations at a frequency of 9 times annually and 13 lake (reservoir) monitoring stations at a frequency of 4 and 6 times annually. Elements for biological monitoring: macroinvertebrates, phytobenthos, macrophytes and chlorophyll a. Parameters for chemical monitoring: Metals, VOCs, Pesticides, PCBs and PAHs. Additional monitoring

[81] www.oceanography.ucy.ac.cy
[82] Water development department website, www.moa.gov.cy/wdd

parameters are nutrients, microbiology, ecotoxicology and physico-chemical parameters (Temp., pH, EC, DO, Turbidity).

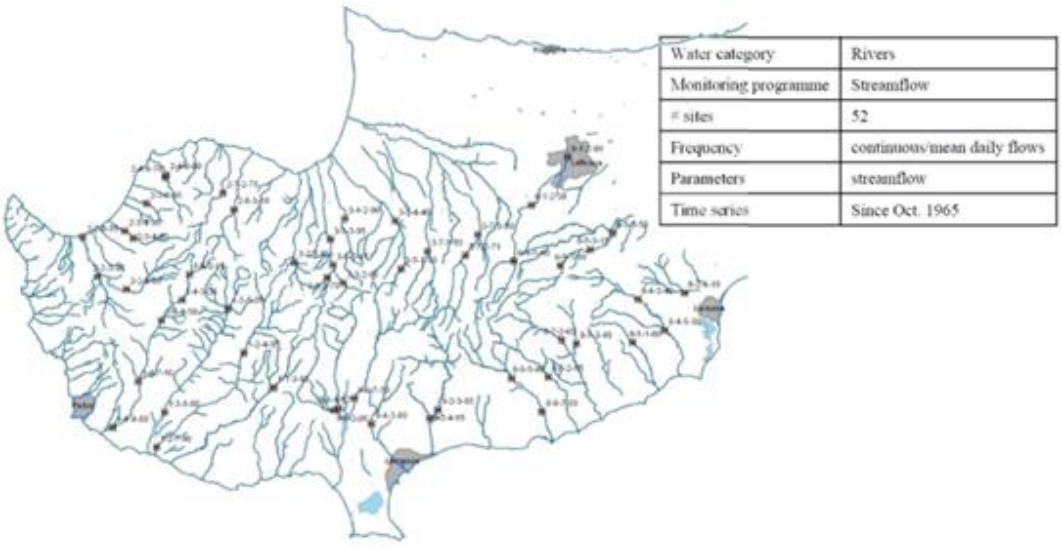

Figure 8.4. Surface waters quantitative monitoring stations[83]

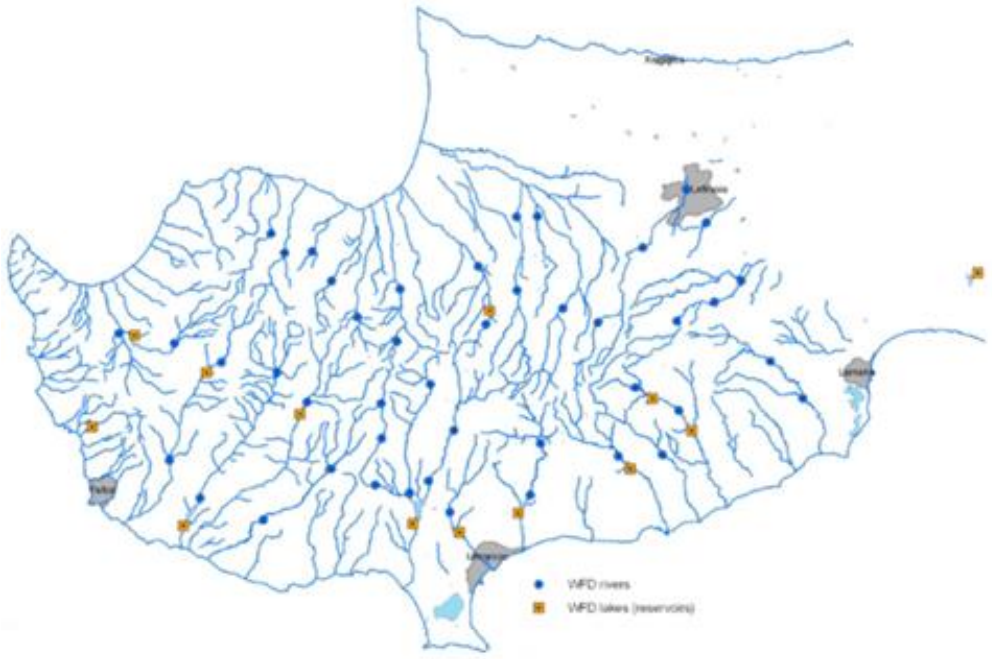

Figure 8.5. Surface waters qualitative monitoring stations

[83] Gerald Dörflinger, 2011. The Cyprus Water Development Department: Water data collection, data bases, access and utilization of data by third parties; presented at Data Repositories and Computational Infrastructure for Environmental and Climate Studies in the Eastern Mediterranean 2nd DARECLIMED Workshop; available from http://www.moa.gov.cy/moa/wdd/WDD.nsf/All/24A949CC66A15BF5C22579DB0028205E/$file/DARECLIMED_G_Dorflinger_15Dec2011.pdf

Forest ecosystem health observation[84]

Forest ecosystem health observation belongs to the responsibility of the Department of Forests. It is accomplished through the monitoring programs implemented in forest ecosystems of Cyprus. These programs are classified into three categories, depending on the agent which threats the stability of forest ecosystems:

(a) Annual surveys for quarantine harmful organisms. The survey is carried out for specific harmful organisms which are described under the Council Directive 2000/29/EC. The survey aims to the verification of the absence of pests which their introduction into the Community will cause extensive damages to forest plants and products. Surveys are carried out by plant health inspectors and the results are submitted annually to the EU.
(b) Monitoring Program for Pine Processionary Caterpillar (Thaumetopoea wilkinsonii). Pine processionary caterpillar is a very common harmful insect (defoliator) causing extensive damages to the pine ecosystems of Cyprus. Monitoring program includes the establishment of permanent plots and the annual data are very useful in application control measures.
(c) ICP Forests-Biomonitoring Program. The Department of Forests participates in the program which is one of the world's largest biomonitoring networks, where more than 40 countries are involved. Its aims are:
    - to provide a periodic overview on the spatial and temporal variation of forest condition in relation to anthropogenic and natural stress factors (in particular air pollution) by means of European-wide and national large-scale representative monitoring on a systematic network;
    - to gain a better understanding of the cause-effect relationships between the condition of forest ecosystems and anthropogenic as well as natural stress factors (in particular air pollution) by means of intensive monitoring on a number of selected permanent observation plots spread over Europe and to study the development of important forest ecosystems in Europe.

The results of the program provide information on forest health, air pollution, climate change and biodiversity.

8.3.4. Satellite Observation

8.3.4.1. GMES

The Republic of Cyprus as a European Union member state participates in the European program Copernicus (ex GMES). The "Regulation (EU) No 911/2010 of the European Parliament and of the Council of 22 September 2010 on the European Earth monitoring programme (GMES) and its initial operations (2011 to 2013)" set the framework of the programme.

The GMES programme is built on the research activities carried out under Decision No 1982/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Seventh Framework Programme of the European Community for research, technological development and demonstration activities (2007 to 2013) and the GMES Space Component Programme of ESA.

The GMES programme is comprised the following:

(a) a service component ensuring access to information in support of the following areas:
    - atmosphere monitoring,
    - climate change monitoring in support of adaptation and mitigation policies,
    - emergency management,
    - land monitoring,
    - marine environment monitoring,
    - security;

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(b) a space component ensuring sustainable spaceborne observations for the service areas referred to in point (a);
(c) an in-situ component ensuring observations through airborne, seaborne and ground-based installations for the service areas referred to in point (a).

8.3.4.2. Copernicus

The Copernicus programme is the continuation program of GMES and is a civil, user driven programme under civil control, building on the existing national and European capacities, as well as ensuring continuity with the activities achieved under the Global Monitoring for Environment and Security (GMES). The maximum amount allocated by the European Union to implement its activities shall be EUR 3.786 million at 2011 prices for the period from 1 January 2014 to 31 December 2020.

8.3.4.3. Copernicus Climate Change Service

The Copernicus Climate Change Service provides information to increase the knowledge base to support adaptation and mitigation policies. It contributes to the provision of Essential Climate Variables (ECVs), climate analyses, projections and indicators at temporal and spatial scales relevant to adaptation and mitigation strategies for the various European Union's sectorial and societal benefit areas.

The Climate Change Service (C3S) [85] is designed to increase the knowledge base in support of adaptation and mitigation policies. The Climate Change service contributes to the observations, reanalyses and projections of Essential Climate Variables (ECVs) among other quantities. Series of climate impact indicators are generated on the basis of these geophysical field and regularly updated and then feed into various types of products (maps, reports, etc.) tailored to policy applications.

The service is organized around four complementary blocks: A Consistent Climate Data store (CDS), a Sectoral Information System (SIS), an Evaluation and Quality Control (EQC) platform and, finally, an Outreach and Dissemination (OD) platform. It is established and its performance routinely assessed according to common practice for an operational service. The success of the implementation of the proposed service largely relies on the quality of the information flow and the overall coordination between the various blocks. Series of precise, well-defined and operational procedures are defined and established such that the information delivered to the end-user is fully traceable, quality controlled and disseminated within the most appropriate time. The articulation between the different public national and international institutions and the private sector that are involved in the Climate Change service through the entire production and dissemination chain is a critical element of the operations.

National Coordination

The Department of Electronic Communications (DEC) of the Ministry of Communications and Works, as the responsible department for space policy, is the national coordinator of the Copernicus programme, one of the flagship programmes for the European Space Policy sector. The role of the DEC is to coordinate the relevant governmental departments that have the knowledge and the expertise of the various services of the programme. The DEC will also contribute in the area of radiofrequencies that are related to the programme, as it is also the national frequency manager.

The services of the programme relevant to climate change issues have been allocated as follows:

- Atmosphere monitoring service: Department of Meteorology and Department of Labour Inspection
- Climate change monitoring service: Department of Environment
- Land monitoring service: Department of Lands and Surveys
- Marine environment monitoring service: Department of Fisheries and Marine Research, Department of Environment, Department of Meteorology, Cyprus Police and University of Cyprus(Cyprus Oceanography Centre)

[85] https://climate.copernicus.eu/

Support for developing countries to establish and maintain observing systems and related data and monitoring systems

Several challenges prevent many neighboring countries to initiate long-term atmospheric observations (weather, air quality, climate forcers) including the lack of scientific/technical knowledge, the absence of national/regional networks to better coordinate efforts and resources, and other issues related to open-access data, in particular in regards to greenhouse gas emissions from the oil and gas industry.
With the objective to address all these issues and build national capacities in the EMME region, the Cyprus Institute is aiming at developing a comprehensive regional collaboration network to promote the establishment of atmospheric monitoring optimally connected to international networks (incl. EU Research Infrastructure) and satellite-based observations (ESA, NASA) that still require ground-truth validation. This activity falls under the mission of the Climate & Atmosphere Research Center of the CyI which has received a total funding of 15M€ from the European Commission (through the Horizon 2020 EMME-CARE project) and 15M€ complementary funding from the Cyprus Government to address issues related to Air Pollution and Climate Change in the Eastern Mediterranean and Middle East (EMME) region.
The scientific network established by the Cyprus Institute on the topic related to air pollution and climate change is illustrated below.

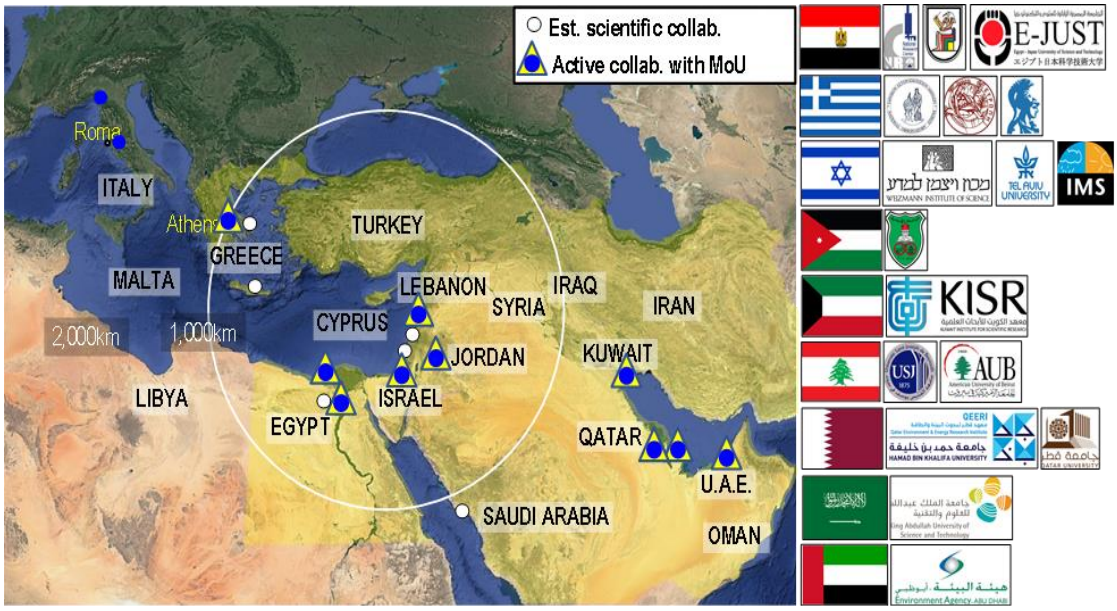

Figure 8.6. Scientific collaboration network established by the Cyprus Institute to further promote atmospheric observations to address regional/global issues related to air pollution and climate change

This regional collaboration network is actively contributing to the exchange of scientific knowledge that takes place annually through the (on-line) “Climate and Atmosphere Research & Innovation in the Eastern Mediterranean & Middle East” workshop that brings altogether over 300 scientific experts from the region. Complementary scientific/technical capacity building and scientific collaboration activities are also implemented such as Joint Scientific Publications in top journals on regional climate change projections (Zittis et al., Review of Geophysics, 2022), the “EMME-CARE Autumn school”, and the EMME Climate Change initiative (EMME-CCI) led by the President of the Republic of Cyprus which has mobilized over 220 scientific experts primarily from the Eastern Mediterranean and Middle East (EMME) region to establish 13 Scientific Tasks to establish the ever regional assessment of climate change.

8.3.4.4. European Space Agency

In October 2008 the Council of Ministers (Decision of No. 67.802) gave the political responsibility of the space policy sector to the Minister of the Communication and Works and tasked the DEC to be the Executive Body to formulate and implement the national policies. DEC was also appointed as ESA counterpart for the implementation of the ESA – Cyprus cooperation.

The ESA – Cyprus Cooperation Agreement was signed by Mr Peter Hulsroj, ESA Director of Legal Affairs and External Relations and, Mr Michael Constantinides, Permanent Secretary of the Ministry of Communications and Works of Cyprus on 27 August 2009. The said agreement was ratified by Law N. 1(III)/2010 and was published in the Official Gazette of the Republic on 5/3/2010.

In 2011 technical experts from ESA visited Cyprus in order:
- to support the creation of a database of companies/institutes/universities that are interested in participating in space activities;
- to map the existing capabilities of the country;
- to facilitate the identification of areas where a specific intervention will lead to an effective participation of the industry and academia through the European Cooperating State Agreement with the European Space Agency if so requested by Cyprus.

In their analysis report the ESA experts stated that the overall assessment following the exercise is that Cyprus is a country with intellectual infrastructure and technical capabilities pertinent to space.

Existing capabilities could be used as leverage for space related activities in the areas of Earth observation, navigation and telecommunication downstream added services, possibly in ground-based long-term testing and characterization of solar generators and niche material research and turbulent flow modelling.

The mechanism for implementing the findings of the assessment will be discussed with Cyprus in order to appropriately support the conclusion of an ECS Agreement. It is recognized by both sides that the conclusion of an ECS Agreement should take place as soon as possible. However, a smooth transition between the Cooperation Agreement and the ECS Agreement should be ensured.

8.4. Research[86]

The Research Promotion Foundation (RPF) announced in September 2016 the RESTART 2016-2020 Work Programme for Research, Technological Development and Innovation for the 2016-2020 period, which will hereinafter be referred to as “RESTART 2016-2020 Programmes”. It refered to three (3) Strategy Pillars, which reflected the strategic objectives of the RESTART 2016-2020 Programmes and to 22 specific Programmes, each having its individual specialised objectives. Moreover, it is co-funded by the Republic of Cyprus (though the RPF budget) and the European Regional Development Fund for the 2016-2020 period.

The main objectives of the RESTART 2016-2020 Programmes, which reflect on the three (3) main Strategy Pillars, were the following:
1. Smart development, with focus on selected priority sectors, through supporting the effectiveness of the RTDI System in Cyprus, its association with the productive base of the Economy, the enhancement of its extroversion and the reinforcement of its links and interoperability between its components.
2. Ensuring the sustainability and dynamics of the Research, Technological Development and Innovation (RTDI) system and to reinforce its future perspectives, focusing on excellence and on the support of human resources, especially those of the younger generation.
3. Support the operational framework of the RTDI system and production of added value resulting from research and innovation activities, through the development of supportive instruments and

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pilot measures, the encouragement for dissemination and exploitation of research results, and the cultivation and promotion of appropriate culture.

The basic layout of the RESTART 2016-2020 Programmes has three (3) levels. At a first level, three (3) main Strategy Pillars are being set, which correspond to the main objectives of the RESTART 2016-2020 Programmes, as follows:

- Pillar I "Smart Growth"
- Pillar II "Sustainable RTDI System"
- Pillar III "Transformation of RTDI System"

At a second level, each Pillar is divided into Sections, each Section particularly aiming to achieve the objectives and priorities of RESTART 2016-2020 Programmes. Finally, at a third level, each Section comprises specific Programmes which are the instruments and implementation measures used to achieve the set objectives and priorities of the RESTART 2016-2020 Programmes. The Programmes may be implemented through Competitions. The table that follows shows the structure of the RESTART 2016-2020 Programmes.

Table 8.2. Structure and budget for framework programme RESTART 2016-2020

PILLAR	SECTION	PROGRAMME	BUDGET (Euros)
PILLAR I Smart Growth	**R&I Partnerships**	Integrated Projects	20.000.000
	Infrastructures	New Strategic Infrastructure Units- Young Scientists	11.000.000[87]
	Participation of Enterprises	Research in Enterprises	9.300.000
		Research in Start-Ups	1.000.000
		Proof of Concept for Technology/Knowhow Applications	1.000.000
	Extroversion – Open Horizons	Bilateral Collaborations	1.600.000
		International Collaboration- Dual Targeting	1.200.000
		EUREKA Cyprus	1.200.000
		European Initiatives- National Development	8.000.000
PILLAR II Sustainable RTDI System	**Excellence**	Excellence Hubs	17.100.000
		EUROSTARS Cyprus	2.500.000
	New Researchers, New Ideas, New Opportunities	DIDAKTOR (Post-Doctoral Researchers)	9.400.000
		Horizon 2020 – 2nd Opportunity	5.500.000
		Social Innovation	1.500.000
PILLAR III Transformation of RTDI system	**Support Mechanisms**	Innovation Vouchers	260.000
		Industrial Property	400.000
		Participation in International Brokerage Events	140.000
		Encouragement of Project Coordination in Horizon 2020	1.000.000
	Alternative Forms of Funding	Commercial Exploitation of Research Results	Stage A: 270.000 Stage B: 1.000.000
		Commercial Exploitation of Research Results by Enterprises	Stage A: 270.000 Stage B: 1.000.000

[87] This amount can be reduced to €8.000.000 or less in case Cypriot organisations are selected for funding in the frame of the "Spreading Excellence and Widening Participation- Teaming" Programme of the Horizon 2020 Programme. The deducted amount will be used to co-fund Teaming projects, in accordance to an existing commitment of the Republic of Cyprus.

PILLAR	SECTION	PROGRAMME	BUDGET (Euros)
		Complementary Funding	4.000.000
	Culture	Nurturing an RTDI Culture	500.000

Pillar I, "Smart Growth", aims at smart development, focusing on the selected priority sectors, through the liaison of academic and research organisations with the productive base of the economy, the enhancement of the RTDI System's quality and effectiveness, the enhancement of its extroversion and the reinforcement of its links and interoperability between its components.

Pillar II, "Sustainable RTDI System", aims at ensuring the sustainability and dynamics of the RTDI System. In contrast to Pillar I which deals with the implementation of specific targeted Programmes in the Priority Sectors, Programmes of Pillar II aim at addressing the needs of the RTDI System and enhancing its prospects. The Programmes focus around "excellence", following a bottom-up approach meaning that participants may implement projects in the scientific or technological field of their choice.

Pillar III "Transformation of RTDI System", contrary to the first two Pillars, does not concern the implementation of RTDI Projects, but the application of policy measures for supporting and upgrading the complete RTDI System, the optimisation of its results exploitation, the promotion of research and innovation activities, and generally overcoming the main challenges of the System.

8.4.1. Priority Sectors of the Smart Specialisation Strategy

The Priority Sectors that have been selected through the study for Smart Specialisation Strategy for Cyprus (S3Cy) are the following:

- The Sectors of "Tourism" and "Energy" as the dominant priority sectors.
- The Sectors of "Agriculture- Food Industry[88]", "Built Environment- Construction Industry", "Transport- Shipping" and "Health", as secondary priority sectors, and
- The Sectors of "Information and Communication Technologies", "Sustainable Growth- Environment" and "Key Enabling Technologies (KET)" as important Horizontal Sectors which, beyond their intrinsic importance, deeply affect the qualitative development of the Priority Sectors.

Horizontal Priority Sectors

The emphasis of horizontal sector "Sustainable Growth- Environment" is placed upon the following areas, which present important prospects and challenges:

- Adaptation to Climate Change- Prevention and Management of Risks: Monitoring and Management Systems, Protection of Critical Infrastructures and Mitigation of Desertification
- Rational Management of Nature Resources with Emphasis on Water Resources and the Protection of Ecosystem and Biodiversity
- Conservation, Promotion and Exploitation of Cultural Heritage
- Sustainable Blue Growth

In the "Information and Communication Technologies (ICT)" horizontal priority sector, the emphasis is placed, but not limited to, on the following areas:

- Information Technologies
    - Software: innovative software, multimedia and graphics applications, knowledge and content management technologies- bigdata, language technologies, new internet applications- cloud services

[88] In the framework of "Agriculture- Food Industry" Sector only activities relating to research and development in this sector, will be funded by the Research Promotion Foundation through the European Regional Development Fund. Activities relating to the active involvement of farmers in the cultivation of cooperation culture and the adoption of innovative methods and practices in order to solve problems in the field of Agriculture, will be financed by the relevant Programmes of the Ministry of Agriculture, Rural Development and Environment, via the European Agricultural Fund for Rural Development.

    - Hardware: smart systems, optimisations of hardware and processing power, high efficiency computational systems, system interoperability, Artificial Intelligence, robotics, sensors
- Communication Technologies
    - Networks: security, high capacity, flexibility network management
    - Wireless and Satellite Communication: new generation wireless and mobile networks, mobile broadband networks, 4th generation network applications, remote sensing
    - High Speed Transmission Media: optical fibres, light wave networks
- Horizontal ICT Applications
    - Digital Tourism and Culture: tele-service, web observatories, product management and promotion, digitalisation of cultural heritage, 3D representation
    - Digital Education: e-learning, computer assisted and interactive learning
    - Digital Health and Quality of Life: health management, systems, tele-medicine, tele-examination, digital integration and assistance, ICT assisted independent living, innovative diagnostic imaging approaches
    - Promotion of Ecological Technologies: smart distribution systems, water management, environmental monitoring, smart energy applications
    - Digital Governance, Labour and Entrepreneurship: tele-working, e-commerce, citizen service systems, integrated public service management systems.

The horizontal priorities include the field of Key Enabling Technologies (KET). KETs are the technological building blocks which provide important prospects for innovation and contribute to the development and manufacturing of advanced products and the application of reforms and improvements in productivity and performance, thereby being of vital importance for the evolvement of the industry sector and for addressing significant societal challenges.

In the frame of the present Work Programme, KETs include the following fields of technology and science:

- Nanotechnology: An umbrella-term that covers the design, characterisation, production and application of structures, devices and systems by controlling shape and size at atomic, molecular and supramolecular scale. Nanotechnology holds the promise of leading to the development of smart nano- and micro- devices and systems and to radical breakthroughs in vital fields such as healthcare, energy, environment and manufacturing.
- Advanced Materials: This field refers to new reduced-cost substitutes to existing materials and to new higher added-value products and services. Advanced materials offer major improvements in a wide variety of different fields, e.g. in aerospace, transport, building and healthcare. They facilitate recycling, lowering the carbon footprint and energy demand as well as limiting the need for raw materials that are scarce.
- Advanced Manufacturing and Processing: This field is relevant to the development and supply chain of basic Key Enabling Technologies, which include nanotechnology, advanced materials, micro- and nano-electronics, photonics and industrial biotechnology. It is related to the high technology involved in manufacturing and processing, leading to the optimisation of product properties, production time, cost, energy and material consumption, efficiency of operations, waste management and environmental pollution.
- Life Sciences, Biomedical Sciences and Technology and Biotechnology: It includes the fields of life sciences, industrial biotechnology, basic and clinical medicine, biotechnology in medicine, medical engineering, environmental biotechnology, health sciences and agrosciences.
- Micro-Nanoelectronics: Deals with semiconductor components and/or highly miniaturised electronic subsystems and their integration into larger products and systems. They include the fabrication, design, packaging and testing from nano-scale transistors to micro-scale systems integrating multiple functions on a chip.
- Photonics: A multidisciplinary domain dealing with light, encompassing its generation, detection, and management. Among other things, it provides the technological basis for the economic conversion of sunlight to electricity (which is important for the production of renewable energy) and a variety of electronic components and equipment such as photodiodes, LEDs and lasers.

8.4.2. Association between Programmes and Priority Sectors

The relation between the Programmes of Pillar I with the Priority Sectors with Thematic Focus and the Horizontal Priority Sectors is shown in the Table 8.3. This is further specified in Programme descriptions.

Cyprus, through the RPF and in particular the Programme "European Initiatives – National Development", participates in the following European initiatives, which aim at coordinating the funding of research activity and the establishment of research priorities at a pan-European level, through the formulation and implementation of Joint Research Programmes:

- M.ERA-NET: Materials-Energy,
- SOLAR ERA-NET: Solar Energy
- Water Challenges for a Changing World: Environment- Tourism,
- URBAN EUROPE: Global Challenges – Local Solutions: Urban development- Construction Industry- Environment,
- Agriculture, Food Security and Climate Change (FACCE): Agriculture- Food Industry- Environment, and
- Cultural Heritage and Global Change: A New Challenge for Europe: Cultural Heritage- Tourism- ICT- Environment.

Table 8.3. Requirements for targeting of projects of pillar in priority sectors with thematic focus and/or horizontal priority sectors

SECTION	PROGRAMME	SECTORS WITH THEMATIC FOCUS						HORIZONTAL SECTORS		
		TOURISM	ENERGY	AGRICULTURE - FOOD INDUSTRY	BUILT ENVIRONMENT- CONSTRUCTION INDUSTRY	TRANSPORT- SHIPPING	HEALTH	SUSTAINABLE GROWTH- ENVIRONMENT	ICT	KET
R&I Partnerships	Integrated Projects	X	X	X	X	X	X			
Infrastructures	New Strategic Infrastructure Units- Young Scientists	*	*	*	*	*	*	*	X	X
Participation of Enterprises	Research in Enterprises	X	X	X	X	X	X	X	X	
	Research in Start-Ups	X	X	X	X	X	X	X	X	
	Proof of Concept for Technology/ Knowhow Applications	X	X	X	X	X	X	X	X	
Extroversion- Open Horizons	Bilateral Collaborations	X	X	X	X	X	X	X	X	
	International Collaboration- Dual Targeting	X	X	X	X	X	X	X	X	
	EUREKA Cyprus	X	X	X	X	X	X	X	X	
	European Initiatives- National Development	X	X	X	X	X	X	X	X	

**** The New Strategic Infrastructure Units- Young Scientists Programme anticipates the implementation of Projects in the field of ICT and KETs, with applications in the six Thematic Priority Sectors as well as the Horizontal Sector "Sustainable Growth- Environment".***

9. Education, training and public awareness

9.1. Introduction

It is generally acknowledged that combating climate change will be a success only if the danger is widely known and understood by the public and especially by those who have to undertake mitigation and adaptation measures. This can be accomplished with intensive education, awareness and training efforts at all levels.

For this purpose, as part of the programme for the implementation of the Convention and the New Delhi Programme, and the relevant provisions of the Kyoto Protocol, Cyprus has carried out a series of actions, which are presented below, aiming at the integration of climate change issues at all educational levels and disciplines, the dissemination of information and promotion of participation of youth, stakeholders, and public, as well as the enhancement of cooperation and co-ordination at regional and international level to promote capacity building.

9.2. General policy toward education, training and public awareness

Climate change in the context of formal and non - formal education is an issue of interdisciplinary investigation and interconnected with all the issues of environment and sustainable development as a matter of national, regional and international interest. The consideration of climate change in this context relies on the fact that climate change is not a mono-dimensional problem, cut off from the rest of the Sustainable Development issues, but could be the apparent cause and consequence of a chain of direct and indirect human effects on all environmental and Sustainable issues. Within this context the issue of climate change is considered an intrinsic part of the National Action Plan for Environmental Education with focus on Education for Sustainable Development (NAPEESD) (CPI 2007) which is considered the most important policy document on EE/ESD in Cyprus. It was approved and enacted by the Ministerial Board (2007). It is noted that the National Strategy on Education for Sustainable Development is under revision aiming to cover the period 2022-2030 and aims to give emphasis on green transition and Sustainable Development Goals in Education in formal, non-formal and in-formal education. In the revised National Action Plan on ESD special emphasis is given to climate change is "captured" holistically in the school process and not just an issue for teaching through curricula. More specifically through the revised action plan on ESD special emphasis given to youth empowerment on climate action, to transforming schools as learning communities for SDGs, including climate change, by promoting programs for greening school infrastructures (school yards, using of renewable resources of energy, supporting local products, strengthening sustainable mobility etc). Access of environmental information to the public is provided through the websites of the relevant Ministries and other governmental agencies. With the ratification of the Aarhus Convention, Cyprus has posed legal obligations for the access of information regarding the state of the Environment. In addition, law no. 119(I)/2004 by which Cyprus incorporated the Directive 2003/4/EC on "public access to environmental information" into national legislation, seeks to increase public access and dissemination of information, contributing to a greater public awareness in decision making and environmental protection. According to this law, "environmental information" includes information related to climate change such as: state of elements (among others air, atmosphere, water, coastal areas, biological diversity, and the interactions among them), factors (e.g., emissions, energy), policies and measures, reports, cost-benefit analyses.

The Cypriot Government gives high priority to public consultation and awareness. Draft legislation related to climate change, energy and environmental issues are open to public consultation before their adoption.

9.3. Primary, secondary and higher education

9.3.1. Curriculum on Environmental Education (EE) and Education for Sustainable Development (ESD)

Through the Curriculum of EE/ESD which is an important innovation in the educational system of Cyprus and is formatted in a uniform and systematic way in pre-primary and primary education, the issue of climate change examined through all the other related thematic units such as energy, production and consumption, urbanization, waste, water, transportation, as well as the Sustainable Development Goals. Specifically, it is aimed that students understand in a systematic and holistic way that the problem of climate change is complex, has multiple causes and effects both locally and globally. For this purpose within the education process the issue is viewed through the social, political and cultural aspects, along with the environmental. Climate change is first examined in the immediate local environment of students and then extends through various teaching techniques, applications and examples globally.

For this purpose in the learning process a variety of methodological and pedagogical approaches (experiential learning, simulations, investigations etc) applied in order to help students understand the impact of climate change on a local and global level. Also, the pedagogical principles of Environmental Education and Education for Sustainable Development as intergenerational communication, interaction with place, holistic investigation and action community are applied for studying climate changes.

Examples of issues that are approached through the curriculum of EE/ESD on climate change are:

- Study of the effects of water scarcity at local and global level and awareness of the extent and complexity of the problem across the globe.
- Correlation of water shortage with other issues such as climate change and desertification.
- A study of the factors that contributed to the intensity of the problem of climate change.
- Reflection upon our responsibility on addressing the phenomenon of climate change and suggestion of measures to alleviate the problem.
- Investigation of the measures and actions taken at national and global level to address climate change.
- Interconnection of climate change around the world with the decline of biodiversity.
- Interconnection of the greenhouse effect and global climate change through energy consumption.
- Study of the impact of the increasing use of motorized vehicles on the environment at local and global levels (air pollution, climate change, etc.).
- Awareness of the impact of climate change on social, economic and political level.
- Cooperation of students with agencies and organizations to promote information measures, information and participation in intervention programs on climate change.

It is noted that the above issues are indicative regarding the investigation of environmental issues, since as mentioned above, the twelve thematic units of the curriculum concerning all educational levels approach systematically the issue of climate change.

Additionally, in primary education, climate changes are part of the curriculum of all the distinct subjects. Indicatively through the subject of Science includes specific unit for the atmosphere pollution and the climate changes, aiming students be able to explain the green-house effects, the causes and its role to the climate change, as well as the actions and behaviours that eliminated it. According to the subject of Greek-language the oral and writing skills, as well as the development of students literacy is pursued through texts, activities, exercises as well as other educational means that consider the climate changes.

Special emphasis in the curriculum is given to Sustainable Development Issues and Climate Change through the STEM (Science, Technology, Engineering, Mathematics) pedagogical approach. Real life issues such as reducing energy from fossil fuels, creating a smart energy building, water management and school water supply are examined through STEM approach. The aim is students to investigate and analysis real life problems and through problem solving and systemic thinking to promote feasible solutions that can be applied in their context.

9.3.2. Educational tools for the study of climate change

The effective investigation of climate change in schools, prerequisite the development of the appropriate educational tools, that support the teaching of climate change in formal (school education) and non-formal education. Climate Change as a systemic issue is an intrinsic part of all the educational and pedagogical tools that produced by the Ministry of Education, Sport and Youth (Unit of Education for Environment and Sustainable Development), for Sustainable Development Issues. These tools based on synchronous and asynchronous learning. Indicatively are the educational tools "Issues in Education for Sustainable Development " and "Rational waste management". These, are supporting tools for the teacher and the student to study the issues of production and consumption, transportation, desertification, tourism, poverty, waste, where there is special emphasis on the study of climate change. Also, an education tool for energy efficiency developed aiming to introduce and support students and the school community to smart ways for reducing energy and also for using renewable resources of energy. It is noted that the study of the issue of climate change is through the application of pedagogical techniques of Environmental Education and Education for Sustainable Development such as debate, simulations, use of new technologies, moral dilemma, concept maps, experimental investigations, bibliographic research, field study, etc. The above tools concern Primary and Secondary Education as a means to support the curriculum of EE/ESD. During Covid-19 where schools closed and teaching switch on to the on-line learning a series of on-line tools developed related with the climate change. An indicative example is the series of 12 teaching lessons on food waste. The lessons raising awareness and especially educating students on issues related to food sustainable consumption and production, food safety, food waste management and reduction, composting, the adoption of sustainable practices to reduce food waste. All these lessons are closely related with the causes and impacts of climate change. The courses designed to provide unique pedagogical learning experiences through simulations, games, quizzes, learning scenarios and are used by both teachers and students. The design of the courses provides opportunities for immediate feedback in relation to the topics that each course examines and through interactive applications contributes to reflective learning. https://mepaa.moec.gov.cy/index.php/el/epimorfosi/imerides-seminaria-sinedria

Climate Change is also addressed through a series of education broadcasts on the TV web education channel. Educational broadcasts such as desertification and climate change, sustainable cities, climate change and food security, bioclimatic design are some of the issues that presented. All the broadcasts are used in teaching process in synchronous and asynchronous learning and it's an important tool for teachers, students and parents for being aware on climate change emergencies taking action now. https://elearning.schools.ac.cy/index.php/el/monada-perivallontikis-ekpaidefsis

Finally, is in process for finalizing the educational tool The "SDGs and Global Citizenship are travelling" is an educational material with the aim of conveying to the educational community and to the civic society the message that " each and everyone of us, leading by personal and collective example, can contribute to the accomplishement of the sustainable development goals". Seventeen books, one for each SDG, "travel in a suitcase", to schools, to neighborhoods, to businesses, to communities and to organizations. The "travelling SDGs Suitcase" pursues to inform, raise awareness, awaken and mobilize each one of us, to make the necessary changes and interventions that will gradually and in the long term improve the quality of life and create the conditions for healthy, prosperous and sustainable societies. Climate Change is examined through the book "SDG13: Learning and Action for Climate Change", as well as a horizontal issue that permeates the rest of the books that planned to be published in 2023.

In Secondary Education, where the curriculum on EE/ESD has not yet been introduced, the issue of climate change is examined and studied through various subjects. Students though Biology, Physics, Geography and technology describe the greenhouse effect in terms of the interaction of radiation with matter. Students learn about the urbanisation and evaluate the evidence for additional anthropogenic causes of climate change, including the correlation between change in atmospheric carbon dioxide concentration and the consumption of fossil fuels. Students describe the potential effects of increased levels of carbon dioxide and methane on the Earth's climate and how these effects may be mitigated. Students discuss why is climate change important? The impacts of climate change on different sectors of society are interrelated. Drought can harm food production and human health. Flooding can lead to

disease spread and damages to ecosystems and infrastructure. Human health issues can increase mortality, impact food availability, and limit worker productivity.

Indicatively on how climate change is integrated through various subjects in secondary education are the examples below:

In Biology and Geography.

1st Grade Biology: Activity Book

Examination of Greenhouse effect

- The importance of plants to maintain stable amounts of carbon dioxide in the atmosphere
- Relationship of photosynthesis and greenhouse
- How the increase the amount of carbon dioxide in the atmosphere causes a rise in the average temperature of the Earth
- How humans can cope with the increase in the average temperature of the Earth
- Activity which refers to changing the behaviour of mouflon in times of scarcity

2nd Grade Biology Gymnasium: Activity Book

Topics included:

- Examination of the problem of climate change
- Investigation of the increase in average temperature in Cyprus from 1893 until today
- Investigation of the reduction of average rainfall in Cyprus from 1893 until today
- Investigation the impact of climate change on species' populations, ecosystems and ecological balance
- Human's role on the environmental of the problem of climate change
- Possible solutions, actions and behaviour changes on climate change that we can take individually or collectively
- Other environmental problems caused secondarily by climate change

1st Grade Geography: Book and workbook

- "The Earth and Man "
- Emphasis in anthropogenic systems.
- The global problems and challenges to be faced by humankind as expressed by the UN.
- Understanding and interpretation of human interactions with the environment and managing the challenges facing humanity, as is climate change.

Geography, Grade B Gymnasium: Book and workbook

The curriculum of Gymnasium Grade B Geography explores locally and internationally issues related to climate change as natural, urban and rural environments, natural hazards, natural resources management energy, management waste etc. The main issues which concern the curriculum of Grade B Geography are the ways in which they relate the above influencing factors, the patterns and the changes that occur and what will be the impact on the present and future generations.

Beyond the above subjects, climate changes are part of the curriculum of all the other subjects of secondary education (Physics, Chemistry, household economy, foreign languages etc) as a horizontal issue.

9.3.3. Higher Education

Several undergraduate and postgraduate programmes in Cypriot Universities deal with diverse aspects of climate change. Undergraduate programmes in Civil & Environmental Engineering and Environmental Science & Technology as well as postgraduate and doctoral programmes in Environmental Engineering, Energy Resource Management, Environmental Science, Environmental

Management, and Education for Sustainable Development, contain numerous courses on climate change impacts, economics, mitigation and climate change education.

9.4. Public information campaigns

One of the missions of the Department of the Environment is to inform and raise public awareness on environmental issues. Among the established campaigns that the Department of Environment organises and/or co-organises are the following:

- The Department of Environment participates every year with the established cycling tour of Nicosia in the European Mobility Week campaign which provides the opportunity to present sustainable mobility alternatives to local residents;
- The Department of Environment organized a lecture open to the public on Climate Change on Wednesday 14 October 2015 at the Cleopatra Hotel. The event was held in view of the UN Climate Change Conference (COP21). The aim of the event was to raise awareness and information about the Paris conference and the exchange of views on how Cyprus contributes to the international effort to reduce greenhouse gas emissions.
- Since 2014 the Department of Environment organizes along with other authorities and organizations the Cyprus Green Public Procurement Awards (CY GPP AWARDS) – EU Ecolabel. The CY GPP Awards is an institution that appears to have a strong response from Contracting Authorities, (State Authorities - Public Sector) and the Public Law Entities and the Local Authorities. In 2017, for the first time, beyond the Public Law Entities, the prizes were also addressed to the private sector.
- In addition to the Green Public Procurement Awards, the European Ecolabel Ecolabel is awarded to Cypriot products. The Department of Environment which is also the EMAS Competent Authority, has implemented EU EMAS in its headquarters in Nicosia with the aim of protecting the environment and its own activities and staff, limiting and reducing its impact on the environment, through the day-to-day operation of the Department, hoping to follow its example other Public Authorities.
- The Department of Environment participates annually as a co-organizer at the Earth Hour celebration held at the Presidential Palace. Households, public buildings and businesses have been involved in turning off the lights for an hour, demonstrating the need to protect the environment and take action on climate change.
- Each year the Department of Environment participates in 'Let's Do it Cyprus' campaign which is part of the 'Let's Do it World' campaign that aims to clean the natural areas of the world from rubbish. The project is implemented in 94 countries all over the world. It is based on volunteer work and the goal is to clean up the waste recorded in the island in a single day. Public and local authorities, private companies, community service companies, recycling companies, non-governmental organizations, associations and schools participate in this effort in order to protect the environment and develop environmental awareness to ensure a cleaner tomorrow.

9.5. Training programmes

9.5.1. Education and training of teachers on climate change

The Ministry of Education Sports and Youth, through the responsible Unit of Education for Environment and Sustainable Development (Unit of ESSD-Pedagogical Institute), emphasizes the importance of teacher's professional development on climate change education. A series of Professional Development Courses are offered on Climate Change Education and are obligatory and optional. These courses varies on type and content, covering various aspects and elements of Climate Change Education.

A. **Obligatory Professional Development Courses** seek to strengthen teachers in the planning of actions against climate change, using the school and the community as the main field of action. The seminars are developed in four experiential workshops and promote the use of ESD teaching technics (role play, concept map, brainstorming etc). Seminars focuses on clarifying key concepts related to action, activity, and active citizenship, using examples from real life. Their aim is to help teachers in a practical way to understand the importance of planning

actions against climate change, in a collective and participatory way. At the same time through the ESD Curricula, professional development courses offered to highlight the systemic relationship that exists between climate change and other global challenges (migration, poverty, environmental justice), as well as to reveal the emergency for taking action against climate change. During the obligatory seminars special emphasis is given to the investigation of issues related to Cyprus and Climate Change and the designing of several action plans related to those issues, as part of the Schools Sustainable Environmental Education Policy (SEEEP) in pre-primary and primary education and as part of the School Unit Improvement Plan in secondary education.

At the beginning of the academic year 2022-2023, a series of new professional development courses offered for climate change education for teachers in all educational levels. A three days courses: "Empowering students against climate change: Ideas, examples, and implementation of climate change actions at school" and "Empower students against Climate Change" offered. At the end of each course, each trainee became a trainer and provided obligatory training related to Climate Change Education to his/her school aiming to support further the school community to deal with different aspects of Climate Change in school. https://mepaa.moec.gov.cy/index.php/el/epimorfosi/imerides-seminaria-sinedria.

- **Optional Professional Development Courses** seek, through experiential workshops and interactive activities in schools, outdoor learning Environment, such as the Governmental Network of Environmental Education Centers, to strengthen the school community in teaching about climate change and planning actions against climate change related to their local community. Seminars include: a) the theoretical part, which is an introduction to the global issue of the Climate Crisis and b) the planning of actions against climate change. Indicative workshops that are offered are: Consumerism and climate change, Human Stories and Climate Change, Role play: Legislation to reduce greenhouse gas emissions, Young Leaders Against Climate Change, Climate Action: Supporting the 13th Sustainable Development Goal, Causes of Climate Change: Testimonies of Consumerism in the past and the present, Climate Change: Social, Economic and Environmental Implications, Mitigation and Adaptation: Target the Heart of the Problem, Climate Change in Cyprus. Some of the workshops are utilizing digital environments to promote ESD digital skills and aim to educate and train teachers on ways to leverage Climate Change-related digital lessons in the classroom (https://view.genial.ly/616dbd3c2f11290dd53d84a5/presentation-spatalh-trofimwn-h-istoria-mias-fraoylas-klimatikh-allagh). More than 100 schools participated in these form of workshops.

Another course optional professional development course offered by the Unit of EESD, is on how to develop and implement STEAM projects in schools in order to tackle authentic word real problems including Climate Change. Through this 30-hour professional development course, three projects on various issues of climate change, designed and developed, aiming to operate as an example of good practice that can facilitate teachers to work with climate change issues more effectively in their school practice.

The Unit of EESD for supporting more effectively the teachers on climate change education created on viber a community called "Educating about Climate Change" for providing promptly educational material and tools on the topic to teachers.

9.5.2. Environmental Education Programs

All environmental education programs applied in all educational levels (Pre-primary, Primary, Secondary, Vocational and Technical Education) coordinated (Gold- Leaf, Eco Schools, Young Reporters for the Environment, Globe, Semep, Litter less, Learning about Forests) approach climate change according to the theme processed by each participating school. Climate change is approached as a separate, independent study topic or incorporated dimensions of climate change on other related issues such as for example in the study of biodiversity.

Each program has its own objectives, but the ultimate purpose of all is the development of positive attitudes and behaviors concerning the environment and sustainable development, as well as their awareness on climate change. For example **The South Eastern Mediterranean Sea Project (SEMEP) is an interdisciplinary environmental education project under the auspices of UNESCO** which focuses primarily on the South Eastern Mediterranean sea region. Twenty secondary schools are involved in the project and teachers and students are involved in activities which are designed for an inductive or 'inquiry' field work approach that incorporates the processes of field research. In this program **Climate change issues** are introduced, key questions are raised, and students select methods to investigate and develop possible solutions to these. The teachers and researchers act as supervisors and advisors, providing equipment, advice and ensuring safe working. The field experiments **enable students to:** learn about organisms and environments, environmental and sustainability issues, explain everyday and technological applications of science, evaluate associated personal, social, economic and environmental implications, make decisions based on the evaluation of evidence and arguments, use peer-reviewed literature as a foundation for communicating about climate change and living systems and use scientific vocabulary, terminology and definitions.

Additionally, the Unit of EESD developed the program "The Climate calls "S.O.S.". This program developed in collaboration with the German Embassy, the Cyprus Institute, the office of the Commissioner of the Environment, the Cyprus Cartoons Association, The Animafest Cyprus. The program pursued to support the participants to understand the complexity of the climate change, to be aware of the systemic nature and the chain effects of Climate Change at the environmental, social, economic and political level, to be informed on actions promoted in the fight against climate change at the scientific and technological level, to get familiar with policies that promoted in EU against climate change, to be aware of the role and responsibility that each of us has in the deterioration, but also in addressing the issue of Climate Change, to acquaintance with actions and campaigns to enlighten and inform the public on the issue of Climate Change at local and global level, to introduce to information and awareness techniques, such as TV spots, cartoons, caricatures, informative posters, to be aware of the role and power that everyone has as a catalyst for change in the issue of Climate Change.

More than 2000 participated and the deliverables of this action were the development of children animated films and cartoons against climate change, which is used as information, awareness and education tool for the school community and the civil society[89].

9.6. Resource or information centres

The issue of climate change in terms of non-formal education is approached systematically through the Governmental Network of Environmental Education Centers of the Cyprus Ministry of Education Sports and Youth, which operates as a complementary structure of schools, with the aim of bringing environmental issues into fields of environmental interest and of transferring the learning process in terms of the environmental issues beyond and outside the context of the classroom. Specifically the issue of climate change is studied through all the Environmental Education Centers' of the Governmental Network (Pedoulas, Akrotiri, Athalassa,Salamiou, Kavo-Greko, Koilani, Panagia) under specific environmental educational programs implemented at each center. For example, at Pedoulas Environmental Education Center climate change is discussed through environmental education programs concerning the biodiversity of the forests of the Troodos, the Amiantos mine field and desertification in the region, the degradation of soils. At the Athalassa Environmental Education Center, climate change is examined in relation to urbanization, transport and Athalassa National Forest Park. At the Akrotiri Community Environmental Education Center, climatic change is discussed in relation to the wetland and flora and fauna of the region. At the Salamiou Environmental Education Center, the issue of climate change is discussed in relation to local cultivations, at the Environmental Education Centre Kavo-Greko climate change isexamined in conjunction with the environmental degradation of the area because of the non-sustainable tourism development. At Koilani Environmental Education Center climate change is investigated though its' impacts on local cultivations and at Panagia Environmental Education Center Climate Change is examined through the programs of loss of biodiversity and the forest degradation. An important element in the study of climate change at the

[89] https://elearning.schools.ac.cy/index.php/el/monada-perivallontikis-ekpaidefsis

non - formal level is the fact that the issue is approached through field studies, where special attention is given to experimental investigation, the interaction of students with space and with local populations. Emphasis is given to the intergenerational communication and interaction aiming the students to have first-hand experiences on how the climate change, through the years, impacted on landscape and local communities life. Specifically, all the programs through which the issue of climate change is examined are presented in the website of Unit of EESD. https://mepaa.moec.gov.cy/index.php/el/#

9.7. Participation in International Activities

Ministry of Education Sport and Youth (MoESY), through the Unit of EESD, is actively involved in various international activities for climate change in education. Indicatively it is mentioned that Cyprus is chairing the UNECE ESD SC and had an intrinsic role on the preparation of the Framework for the implementation of the United Nations Economic Commission for Europe Strategy for Education for Sustainable Development from 2021 to 2030, where climate change and youth empowerment on climate action is considered as one of the key horizontal priority areas https://unece.org/environment/documents/2022/05/working-documents/framework-implementation-united-nations-economic

Additionally, Cyprus with the Ministry of Education, Sports and Youth (MoESY) is leading the Mediterranean Committee on Education for Sustainable Development (ESD) and recently, during the UNECE 9th Ministerial Meeting for Environment for Europe that hosted in Cyprus, 5-7 of October 2022, the revised Mediterranean ESD Action Plan 2030, which adopted by the Ministers of Education and Environment, addressed the emergencies for a regional cooperation on climate action. Furthermore MoESY participated actively to the EC Working Group of Environmental Sustainability where specific policy recommendations to the Member States are given including climate action[90]. Also, internationally MoESY is participating actively on the UNESCO Countries ESD2030 initiatives, where youth and climate action is a key issue. During the UNECE 9th Ministerial Meeting for EfE, Cyprus facilitated the organization of 40 side-events where Climate Change discussed in the framework of the sustainable Infrastructure, sustainable tourism and Education for Sustainable Development.

Furthermore, MoESY through bilateral and trilateral collaborations is developing with countries of Middle East and Eastern Mediterranean joint programs for empowering teachers, students and education institutions to work more actively against climate change initiatives. Indicatively, are mentioned the bilateral collaboration between Cyprus and Egypt, where Cyprus provides expertise and support at the Egyptian Schools on how to become sustainable and green schools. Also is provide a series of professional development courses to the teachers, for familiarizing them with pedagogical approaches and techniques that can use in their schools for climate change. In the framework of the regional collaboration the Unit of EESD lead the task force for Climate Change Education (CCE) and Outreach in the Easter Mediterranean and Middle East and prepared the scientific report of the task force on climate change and outreach of the climate change initiative in the EMME Region. This report is a very useful tool for CCE in the EMME Region since it identifies the trends, commonalities and gaps of CCE in the EMME region and aims to help the countries of the region to develop synergies and collaborate to accelerate and integrate CCE into their educational policies and systems https://emme-cci.org/wp-content/uploads/CC_edu_in_EMME_report.pdf

Also, MoESY is participating at various international and regional frameworks where Climate Change is considered as a key strand such as Global Education Network in Europe, Mediterranean Information Office for Environment, Culture and Sustainable Development, Union of the Mediterranean.

It is noted that MoESY participated actively in the Pre-Cop26 Conference in Milan 30 of September till 2 of October 2021 for 'Youth4Climate: Driving Ambition'. Also, in Cop27 in Egypt MoESY will participate at the side-event for Climate Change in Education, that will take place at 10th of November 2022.

[90] https://data.consilium.europa.eu/doc/document/ST-9242-2022-INIT/en/pdf

9.8. Monitoring, Review and Evaluation of the implementation of the Article 6 of the Convention

At national level the Unit of EESD operates as a permanent mechanism for the monitoring, review, implementing and evaluating the SDGs and Climate Change in formal, non-formal and informal education. The establishment of the Permanent Structure for EESD is a reference point for Cyprus because, as a permanent structure, it brings together all the actions related to ESD at the level of formal, non-formal and non-formal education for all education and civil society, which enables the interconnection of ESD policies and their complementarity. Secondly, the establishment of the Permanent Structure for EESD functions as a permanent structure for the design, monitoring, updating and evaluation of ESD at all levels of education and between Ministries, ensuring a) the institutional memory for the actions on ESD and climate change, b) its long-term and systematic implementation, c) its uniform application at all levels of education, d) the taking of immediate and corrective measures in cases where there are gaps in its implementation. Also, the fact that the staff of the EESD Unit comes from various scientific fields, such as the natural sciences, education, humanities, the social sciences, enhances the peer learning and the enhancement of interdisciplinary learning experiences within the stuff, a factor that contributes significantly to the promotion of actions and programs for climate change through which all dimensions of sustainability are highlighted.

At school level a self-assesment mechanism has been establihsed for the school as a result of the introduction of the Edication for Sustainable Development curriculum officially in pre-prmart and primary education, where climate change is parts. The ESD curriculum is connected with the development of the Sustainable Environmental Education Policy of each school (SEEP), which is based on the whole school approach, aiming for each school to become sustainable in the long term and systematically . The Ministry of Education, Sport and Youth, through the Unit of Education for Environment and Sustainable Development, in cooperation with the Departments of Education and the Universities, has designed a quality assessment system for ESD implementation in schools and for SEEP integration. It is a school self- assessment report based on qualitative criteria. It is completed by schools at the end of each year, aiming to help schools to identify the degree of achievement of their SEEP, its gaps and weaknesses and to take remedial measures the following year to make progress on ESD (climate change). The education assessment tool on ESD is for school self improvement on integrating ESD and not for ranking schools. The self-assessment tool covers the administrative, technical, pedagogical, organizational and social level of the school and examines the achievement of: a) The learning objectives on SD issues that identified as the key issue of the SEEP, b) The school subjects used, c) The activities organized, d) The pedagogic approaches and teaching techniques applied, e) The type of collaboration with the local community, the local populations, the governmental services and the non-governmental organizations, f) The utilization of the external environments and the ways in which they were utilized, g) The participation of students and the way in which they participated.

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Cyprus' Integrated national energy and climate plan for the period 2021-2030

Annex I: BIENNIAL REPORT

A1. Introduction

This report constitutes the second Biennial Report of Cyprus, as required by Decision 2/CP.17 of the Conference of the Parties under the United Nations Framework Convention on Climate Change (UNFCCC).

A2. Information on GHG emissions and trends, GHG inventory including information on national inventory system

Please refer to Chapter 2 of the National Communication.

A2.1. Introduction and summary information from the national GHG inventory

Please refer to Chapter 3 of the National Communication.

A2.2. National inventory arrangements

A2.2.1. Summary information on national inventory arrangements

Please refer to Chapter 3.3 of the National Communication.

A2.2.2. Summary information on changes to national inventory arrangements since the last National Communication or Biennial report

The national inventory arrangements and the QA/QC procedures have been restructured in 2017, to meet the requirements of CMP and COP Decisions relevant to national systems and QA/QC. The most important change is that the legal framework defining the roles-responsibilities and the co-operation between the DoE Inventory team and the designated contact points of the competent Ministries was formalized by Council of Ministers' Decision adopted 15/11/2017 entitled "Structure and operation of the National Greenhouse Gases Inventory System- Roles and Responsibilities". The above-mentioned Decision includes a description of each entity's responsibilities, concerning the inventory preparation, data providing or other relative information. This formal framework has improved the collaboration between the entities involved, assuring the timely collection and quality of the activity data required and solving data access restriction problems raised due to confidentiality issues.

A3. Quantified economy-wide emission reduction target

This section explains the EU 2030 emission reduction target under the UNFCCC and the target compliance architecture set up within the EU in order to meet that target. It also gives an overview of other EU emission reduction targets that are helping achieve the quantified economy-wide emission reduction target under the UN.

A3.1. 2030 Climate and Energy Framework

The Climate and Energy Framework was agreed by EU leaders in October 2014 and builds on the 2020 climate and energy package. It sets three key targets for the year 2030:

- At least 40% reduction in greenhouse gas emissions (from 1990 levels). To achieve this, EU ETS sectors would have to cut emissions by 43 % (compared to 2005), and the ETS will be reformed and strengthened to achieve this. Non-ETS sectors would need to cut emissions by 30 % (compared to 2005), and this will need to be translated into individual binding targets for Member States;
- At least 32% share of EU energy consumption for renewable energy;
- At least 27% improvement in energy efficiency.

The European Council asked the Commission to review the energy efficiency target by 2020 having in mind an EU level of 30%. With the Clean Energy for All Europeans package from November 2016, the Commission has already proposed to set a binding EU-wide target of 30 % for energy efficiency by 2030.

The framework is in line with the longer-term perspective set out in the Roadmap for moving to a competitive low carbon economy in 2050, the Energy Roadmap 2050 and the Transport White Paper. The framework will be underpinned by a new and transparent governance process that will the targets outlined above to be met in an effective and coherent manner. This governance process will be based on national plans for competitive, secure, and sustainable energy but will follow a common EU approach.

The European Commission has proposed a number of actions to help deliver the framework and the 2030 targets, including a reformed EU ETS (with a proposal for legislation being presented in parallel to the Communication on the 2030 framework), a new Effort Sharing Regulation, a proposal to integrate greenhouse gas emissions and removals from land use, land use-change and forestry (LULUCF) into the 2030 climate and energy framework a proposal for amending the Energy Efficiency Directive and the Energy Performance of Buildings Directive and a new set of indicators for the competitiveness and security of the energy system, such as price differences with major trading partners, diversification of supply, and interconnection capacity between EU countries.

An impact assessment for the framework was published in January 2014 and considers the costs and benefits of the proposed framework for 2030. It found that average annual additional investments are projected to be in the order of € 38 billion for the EU as a whole over the period 2011-2030, with more than half of the investments needed in the residential and tertiary sectors. However it should also be noted that fuel savings will to a large extent compensate for these investments. Crucially, costs do not differ substantially from the costs of renewing an ageing energy system, which would be necessary in any case.

The European Commission adopted "A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy" in February 2015. This strategy is made up of five closely related and mutually reinforcing dimensions–'security, solidarity and trust', 'a fully-integrated internal energy market', 'energy efficiency', 'climate action–decarbonising the economy' and 'research, innovation and competitiveness'. Every year a State of the Energy Union review is conducted to assess progress and consider areas for further strengthening. The second State of the Energy Union report was published in February 2017, noting that 2016 had been a year of delivery, translating the overall vision into "concrete legislative and non-legislative initiatives". It also looked forward to the low emission mobility strategy due to be published in late 2017.

A3.1.1. National Energy and Climate Plan

Cyprus national energy and climate plan (NECP) has been drawn up to perform the requirement laid down in Article 9(1) of Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, in accordance with which each Member State must prepare and submit to the Commission their national energy and climate plan.

The National Energy and Climate Plan (NECP), that adopted in 2020 presents the existing structure of the energy sector, the policies implemented so far, the evolution scenario of the energy system for the achievement of the national energy and climate targets for the year 2030, as well as the planned policies and measures for their achievement.

The energy and climate objectives present opportunities, benefits and advantages of the national economy, the energy system and civil society, in general, as well as the challenges that need to be overcome.

The main objective of the development of the National Energy and Climate Plan is to design and plan the cost-effective policies and measures that will help to achieve the medium- and long-term national energy and climate goals, will contribute to the economic development of the country and will also respond to the challenge of other environmental goals.

In this context, the main goals set out in the preparation of the national energy planning and the preparation of the energy and climate plan are:

• Achievement of national targets for reducing greenhouse gas emissions, to increase the participation of Renewable Energy Sources in domestic energy consumption and to achieve end use energy savings in final energy consumption;

• Enhancement of energy supply security;

• Strengthen the competitiveness of Cyprus' economy;

• Protection of consumers while strengthening their role in the energy system;

• Setup and operation of a competitive internal energy market;

In particular, as part of the energy planning, key quantitative policy targets are set for the period up to the year 2030, stemming from national priorities as well as from the climate and energy objectives developed and agreed at EU level. They also comprise 'intermediate' targets in the framework of key international and European projects and long-term strategies to reduce greenhouse gas emissions by 2050. These national targets for the year 2030 result both from specific quantitative commitments undertaken by Member States (i.e. targets for non-ETS sectors and for the reduction of national emissions of certain air pollutants), and taking into account the characteristics and specificities of the national energy system, the domestic potential for developing technologies and applications, the potential for adaptation as well as the socio-economic characteristics. This process results in the adaptation of national targets to the corresponding central European ones (i.e. the targets for sectors that are part of the Emissions Trading Schemes, RES, energy efficiency), which are finally proposed under this national plan.

It should be noted that this plan is part of the European climate change policy with specific climate targets by 2050 and the need to develop a long-term strategy by 2050. The analysis made with the present/proposed energy and climate plan focuses on measures and policies by the year 2030.

In addition, it should be stressed that improving energy efficiency is a key horizontal priority, as it leads to multiple benefits such as reducing greenhouse gas emissions, reducing energy costs, improving comfort conditions in buildings, increasing added value and employment and improving the competitiveness of businesses. Towards this, the energy efficiency first principle has been taken into account.

Specifically for the year 2030, the following targets are set:

i. 24% reduction in non-ETS greenhouse gas emissions compared to 2005.

ii. Ensure that greenhouse gas emissions from land use, land use change or forestry are offset by at least an equivalent removal of CO_2 from the atmosphere

iii.23% RES penetration into gross final energy consumption for the year 2030. Regarding the three indicative sub-targets for the promotion of RES in gross electricity consumption, (at least up to 26%, heating and cooling (up to 39%) and transport (up to 14%), by 2030 were set.

iv. National indicative key targets set for energy efficiency: Final Energy Consumption of 2.0 Mtoe in 2030 and Primary Energy Consumption of 2.4 Mtoe in 2030. National obligatory target for achieving cumulative end use energy savings of 243.04 ktoe during 2021-2030. These targets are expected to be achieved in the context of energy planning.

Reducing greenhouse gas emissions and environmental objectives

- Emissions in the non-ETS sectors to be reduced by 20.9% compared to 2005. The non-ETS national target is going to be achieved by the use of flexible mechanisms provided by the ESR.
- Emissions from land use, land use change or forestry are offset by at least an equivalent removal of CO_2 from the atmosphere
- Emissions in ETS sectors to be reduced by 24.9% compared to 2005
- Attaining quantitative targets for reducing national emissions of specific air pollutants

Increasing the share of RES in energy consumption

- Share of RES in gross final energy consumption to reach 23%
- Share of RES in gross final electricity consumption can reach at least 26%
- Share of RES in heating and cooling to reach 39%
- Share of RES in the transport sector to reach 14%

Impoving Energy Efficiency

- Final Energy Consumption of 2.0 Mtoe in 2030, representing 13% reduction in final energy consumption*
- Primary Energy Consumption of 2.4 Mtoe in 2030, representing 17% reduction in primary energy consumption*
- Achieving cumulative energy saving of 243.04 ktoe during 2021-2030

** compared to the respective projection for Cyprus in the 2007 in the EU PRIMES 2007 Reference Scenario*

Figure I3.1. National energy and environmental objectives for the period 2021-2030 in the context of EU policies

To achieve all these targets, a necessary horizontal condition is to mobilise significant investment funds from both the private and the public sectors, which will need to maintain and strengthen their role in an increasingly efficient way, especially in energy networks. A key condition is also the combined use of specialised financial mechanisms that will allow for the optimal economic and timely implementation of the planned measures and policies at the level of specific projects and interventions. The implementation of these investments is directly related to the creation of the appropriate framework for the development and implementation of the investment projects and thus to the individual regulatory, licensing and financial framework.

Table I.1. Key policy measures planning priorities

PILAR	Key policy planning priorities
GHG emissions and removals	• Promotion of natural gas as intermediate fuels for the decarbonisation of the energy system • Promotion of renewable energy sources • Improvement of energy efficiency in buildings, industry and infrastructure • Reduction of emissions in the transport sector • Reduction of fluorinated gas emissions • Reduction of emissions from agricultural sector • Reduction of emissions from waste sector • Increase carbon sinks
Renewable energy sources	• Various RES Support schemes for Self-Consumption

PILAR	Key policy planning priorities
	• Synergies with other sectors (Energy Efficiency, Waste, Security of supply and Internal Energy Market) to promote RES in all energy sectors • Support schemes for RES to participate in the Electricity Market • Replacement of old Solar Collectors for households • Replacement of Solar Collectors for Commercial purposes and use of Solar Technologies for High process heat and/or Solar Cooling • Old vehicle scrapping scheme and financial incentives for the purchase of electric vehicles (both new and used) • Promotion of the open loop Geothermal Energy • Installation of RES and Energy Efficiency technologies in Public Buildings. • Electricity Storage Installations, Framework development and possible financial incentives. • Various other measures for RES in Transport (New bus contracts (using alternative fuels, electricity, gas, and biofuels B100), Use of Biofuels (and biogas) in Transport Sector • Other indirect measures that will help to increase energy efficiency and thus the RES Share in transport. • Statistical Transfer of Energy to be examined (exporting Energy in case of Electricity Interconnector)
Energy efficiency	• Energy efficiency obligation scheme for energy distributors • Energy Fund of Funds providing soft loans for energy efficiency • Individual energy efficiency interventions and energy efficiency retrofits in governmental buildings • Implementation of information and education measures • Support schemes/incentives for promoting energy efficiency in households, enterprises and wider public • Energy efficient street lighting. • Additional floor space “allowance” for buildings exceeded the minimum energy efficiency requirements set by national law • Advanced Metering Infrastructure Plan. • Promotion of energy efficiency in enterprises, through voluntary agreements • Action plan for increasing energy efficiency the road transport. • Energy efficiency in water sector • Vehicle excise duty based on CO2 emissions • Energy consumption fee for Res and energy efficiency applied on electricity bills. • Excise tax on road transport fuels exceeding the minimum levels by EU legislation
Security of supply	• Introduction of natural gas via LNG imports and the development of the necessary infrastructure • Increasing the flexibility of the national energy system
Internal Energy market	• Promotion of electricity interconnectivity of Cyprus via the project of common interest EuroAsia Interconnector • Development of internal natural gas network pipeline infrastructure • Investments for development and secure operation of the transmission electricity system

PILAR	Key policy planning priorities
	• Promotion of the necessary regulatory framework and projects for the operation of the competitive electricity market • Promotion of the EastMed pipeline project
Research, innovation and competitiveness	• Fund of funds • New Industrial Policy • Establishment of the Deputy Ministry of Innovation and Digital Transformation • European Structural and Investment Funds in the new Programming Period 2021 – 2027 • Revision of national funds regarding research and innovation with the aim to boost climate and energy priorities

The goal of the national energy and climate plan is to achieve a reduction in sectors covered under the Effort Sharing Decision (ESD, non-ETS) of greenhouse gas emissions of 24% by 2030 compared to 2005. This will be achieved through a phase approach as presented in figure I3.1.

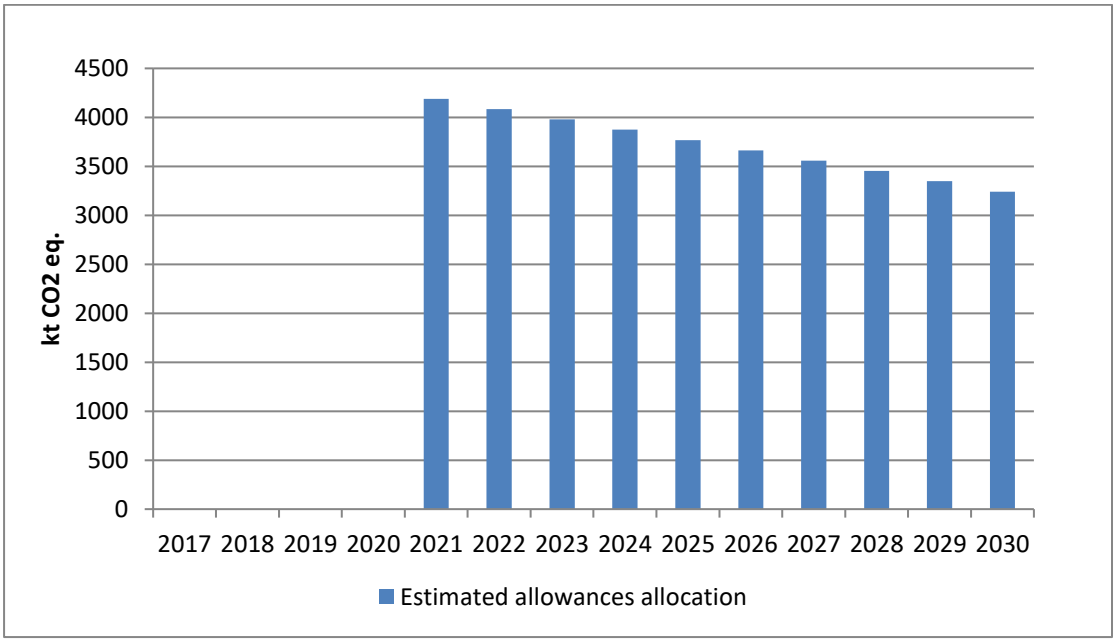

Figure I.3.2. Allowances allocation of GHG emissions of non-ETS sectors

A3.2.2. Monitoring on progress to 2020 targets

For the monitoring of GHG emissions at the EU and the Member State level, the Monitoring Mechanism Regulation has been adopted, see section 2.2.2.1 of the EU's fourth Biennial Report. Also for the effective operation of the EU ETS, robust, transparent, consistent and accurate monitoring and reporting of greenhouse gas emissions are essential, therefore an annual procedure of monitoring, reporting and verification (MRV) at the installation level is implemented. For a description of the requirements contained therein, please refer to section 2.2.2.1 of the EU's second Biennial Report. Installation and aircraft operators have to monitor, report and verify their annual emissions in accordance with two EU Regulations, the Monitoring and Reporting Regulation (MRR) and the Accreditation and Verification Regulation (AVR). For a description of the requirements contained therein, please refer to in section 2.2.2.2 of the EU's fourth Biennial Report.

Monitoring, reporting and verification of the ESD targets mainly takes place through the submission of the national GHG inventories by MS. Chapter III of the Commission Implementing Regulation 749/2014 sets out strict criteria by which MS national GHG inventories GHG emissions are reviewed annually at

the EU-level. Based on this review, the European Commission issues an implementing decision on MS ESD emissions in the given year, which might lead to MS inter alia facing penalties as described above.

A3.2.3. Accounting for Market-based Mechanisms under the 2030 Climate and Energy Framework

Please refer to Section 5.4 of the 8th National Communication.

A3.2.3. Other EU emission reduction targets

A4. Progress in achievement of the quantified economy-wide emission reduction targets

Please refer to Section 5.3.1 of the 8th National Communication.

A5. Projections

Please refer to Chapter 5 of the 8th National Communication.

A6. Provision of financial, technological and capacity building support to developing countries

Please refer to Chapter 7 of the 8th National Communication.

Annex II: Summary tables of GHG emissions for Cyprus in the common reporting format for the whole of the reporting period of the NIR2022 (1990-2020)

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1990
Submission 2022 v10
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	4348,18	674,23	246,47	NO,NE	NO	2,65	NO	NO	5271,52
1. Energy	3932,90	12,62	31,28						3976,80
A. Fuel combustion (sectoral approach)	3932,90	12,21	31,28						3976,40
1. Energy industries	1761,49	1,79	4,11						1767,39
2. Manufacturing industries and construction	512,20	0,88	1,72						514,80
3. Transport	1217,82	7,04	24,45						1249,32
4. Other sectors	430,40	2,46	0,97						433,83
5. Other	10,99	0,04	0,03						11,06
B. Fugitive emissions from fuels	NO,NE	0,40	NO,NE						0,40
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,40	NO,NE						0,40
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	718,50	NO,NE,NA	4,42	NO,NE	NO	2,65	NO	NO	725,57
A. Mineral industry	717,07								717,07
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,43	NE,NA	NE,NA						1,43
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				NO,NE	NO	NO	NO	NO	NO,NE
G. Other product manufacture and use	IE	NE	4,42		NO	2,65			7,07
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	1,82	276,53	199,73						478,07
A. Enteric fermentation		196,97							196,97
B. Manure management		78,01	64,04						142,04
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	135,21						135,21
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		1,55	0,48						2,03
G. Liming	NO								NO
H. Urea application	1,82								1,82
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[(1)]	-305,04	0,05	0,02						-304,97
A. Forest land	-36,77	0,05	0,02						-36,69
B. Cropland	-135,79	NE,NO	NE						-135,79
C. Grassland	-136,24	NE,NO	NE						-136,24
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	-0,01	NO,NE	NE,NO						-0,01
F. Other land	0,49	NO,NE	NE,NO						0,49
G. Harvested wood products	3,27								3,27
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	385,03	11,02						396,04
A. Solid waste disposal	NO,NA	268,94							268,94
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		116,09	11,02						127,11
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[(2)]									
International bunkers	900,89	0,47	8,25						909,60
Aviation	718,10	0,13	5,99						724,21
Navigation	182,79	0,34	2,26						185,39
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	30,50								30,50
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2[(3)]	6,49								
Total CO_2 equivalent emissions without land use, land-use change and forestry									5576,49
Total CO_2 equivalent emissions with land use, land-use change and forestry									5271,52
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									5582,98
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									5278,01

(1) For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for
(2) See footnote 7 to table Summary 1.A.
(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 1991
Submission 2022 v10
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	4844,33	685,24	246,90	NO,NE	NO	3,27	NO	NO	5779,74
1. Energy	4463,55	12,89	34,01						4510,45
A. Fuel combustion (sectoral approach)	4463,55	12,41	34,01						4509,97
1. Energy industries	1824,04	1,84	4,42						1830,30
2. Manufacturing industries and construction	938,38	1,29	2,68						942,35
3. Transport	1218,53	6,84	25,87						1251,24
4. Other sectors	470,37	2,40	1,01						473,78
5. Other	12,23	0,04	0,03						12,30
B. Fugitive emissions from fuels	NO,NE	0,49	NO,NE						0,49
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,49	NO,NE						0,49
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	677,76	NO,NE,NA	4,54	NO,NE	NO	3,27	NO	NO	685,57
A. Mineral industry	676,21								676,21
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,54	NE,NA	NE,NA						1,54
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				NO,NE	NO	NO	NO	NO	NO,NE
G. Other product manufacture and use	IE	NE	4,54		NO	3,27			7,81
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	1,47	282,10	196,98						480,55
A. Enteric fermentation		200,41							200,41
B. Manure management		80,77	63,84						144,62
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	132,86						132,86
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,91	0,28						1,19
G. Liming	NO								NO
H. Urea application	1,47								1,47
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-298,44	0,16	0,06						-298,23
A. Forest land	-38,62	0,16	0,06						-38,41
B. Cropland	-135,81	NE,NO	NE						-135,81
C. Grassland	-135,25	NE,NO	NE						-135,25
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	-0,01	NO,NE	NE,NO						-0,01
F. Other land	0,49	NO,NE	NE,NO						0,49
G. Harvested wood products	10,75								10,75
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	390,10	11,30						401,40
A. Solid waste disposal	NO,NA	274,08							274,08
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		116,02	11,30						127,32
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1029,51	0,49	8,98						1038,98
Aviation	853,22	0,15	7,11						860,48
Navigation	176,30	0,34	1,87						178,50
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	28,00								28,00
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2[3]	5,84								
Total CO_2 equivalent emissions without land use, land-use change and forestry									6077,96
Total CO_2 equivalent emissions with land use, land-use change and forestry									5779,74
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									6083,81
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									5785,58

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	5218,80	703,55	273,22	25,35	NO	3,89	NO	NO	6224,81
1. Energy	4787,39	12,94	36,77						4837,10
A. Fuel combustion (sectoral approach)	4787,39	12,48	36,77						4836,64
1. Energy industries	2120,79	2,14	5,02						2127,96
2. Manufacturing industries and construction	726,57	0,79	1,77						729,12
3. Transport	1363,77	6,81	28,74						1399,33
4. Other sectors	561,45	2,68	1,20						565,33
5. Other	14,81	0,05	0,04						14,90
B. Fugitive emissions from fuels	NO,NE	0,46	NO,NE						0,46
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,46	NO,NE						0,46
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	728,18	NO,NE,NA	4,66	25,35	NO	3,89	NO	NO	762,08
A. Mineral industry	726,64								726,64
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,54	NE,NA	NE,NA						1,54
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				25,35	NO	NO	NO	NO	25,35
G. Other product manufacture and use	IE	NE	4,66		NO	3,89			8,55
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	1,92	292,88	220,16						514,97
A. Enteric fermentation		200,52							200,52
B. Manure management		90,02	67,44						157,46
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	152,00						152,00
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		2,34	0,72						3,07
G. Liming	NO								NO
H. Urea application	1,92								1,92
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-298,69	0,05	0,02						-298,62
A. Forest land	-40,45	0,05	0,02						-40,38
B. Cropland	-135,90	NE,NO	NE						-135,90
C. Grassland	-134,25	NE,NO	NE						-134,25
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	-0,01	NO,NE	NE,NO						-0,01
F. Other land	0,49	NO,NE	NE,NO						0,49
G. Harvested wood products	11,44								11,44
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	397,68	11,61						409,28
A. Solid waste disposal	NO,NA	279,51							279,51
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		118,16	11,61						129,77
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									
Memo items:[2]									
International bunkers	1015,78	0,50	8,88						1025,16
Aviation	830,04	0,15	6,92						837,10
Navigation	185,74	0,36	1,96						188,06
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	27,80								27,80
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	6,09								
Total CO_2 equivalent emissions without land use, land-use change and forestry									6523,43
Total CO_2 equivalent emissions with land use, land-use change and forestry									6224,81
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									6529,52
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									6230,91

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	5452,65	729,45	290,92	26,94	NO	4,51	NO	NO	6504,47
1. Energy	4962,74	12,91	38,15						5013,81
A. Fuel combustion (sectoral approach)	4962,74	12,41	38,15						5013,31
1. Energy industries	2242,99	2,26	5,31						2250,56
2. Manufacturing industries and construction	768,41	0,84	1,88						771,14
3. Transport	1377,84	6,56	29,69						1414,09
4. Other sectors	558,13	2,69	1,23						562,06
5. Other	15,37	0,05	0,04						15,46
B. Fugitive emissions from fuels	NO,NE	0,50	NO,NE						0,50
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,50	NO,NE						0,50
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	796,57	NO,NE,NA	4,77	26,94	NO	4,51	NO	NO	832,79
A. Mineral industry	795,18								795,18
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,39	NE,NA	NE,NA						1,39
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				26,94	NO	NO	NO	NO	26,94
G. Other product manufacture and use	IE	NE	4,77		NO	4,51			9,28
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	1,60	308,89	235,74						546,23
A. Enteric fermentation		209,32							209,32
B. Manure management		97,03	71,97						169,00
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	162,99						162,99
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		2,54	0,79						3,33
G. Liming	NO								NO
H. Urea application	1,60								1,60
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-308,26	0,41	0,14						-307,71
A. Forest land	-38,38	0,41	0,14						-37,82
B. Cropland	-136,00	NE,NO	NE						-136,00
C. Grassland	-133,26	NE,NO	NE						-133,26
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	-0,02	NO,NE	NE,NO						-0,02
F. Other land	0,49	NO,NE	NE,NO						0,49
G. Harvested wood products	-1,10								-1,10
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	407,24	12,11						419,35
A. Solid waste disposal	NO,NA	285,71							285,71
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		121,54	12,11						133,65
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									

Memo items:[2]									
International bunkers	863,12	0,44	7,45						871,01
Aviation	705,94	0,12	5,89						711,95
Navigation	157,18	0,31	1,57						159,06
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	27,70								27,70
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	6,11								
Total CO_2 equivalent emissions without land use, land-use change and forestry									6812,18
Total CO_2 equivalent emissions with land use, land-use change and forestry									6504,47
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									6818,29
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									6510,58

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	5710,10	744,12	281,29	28,65	NO	5,13	NO	NO	6769,29
1. Energy	5171,03	13,46	40,07						5224,55
A. Fuel combustion (sectoral approach)	5171,03	12,88	40,07						5223,97
1. Energy industries	2370,90	2,58	5,98						2379,46
2. Manufacturing industries and construction	782,00	0,84	1,89						784,73
3. Transport	1432,02	6,71	30,93						1469,66
4. Other sectors	570,29	2,70	1,22						574,22
5. Other	15,82	0,05	0,04						15,91
B. Fugitive emissions from fuels	NO,NE	0,58	NO,NE						0,58
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,58	NO,NE						0,58
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	829,75	NO,NE,NA	4,86	28,65	NO	5,13	NO	NO	868,39
A. Mineral industry	827,76								827,76
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,98	NE,NA	NE,NA						1,98
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				28,65	NO	NO	NO	NO	28,65
G. Other product manufacture and use	IE	NE	4,86		NO	5,13			9,99
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	1,70	310,64	223,61						535,96
A. Enteric fermentation		212,63							212,63
B. Manure management		96,08	71,64						167,72
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	151,38						151,38
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		1,93	0,60						2,53
G. Liming	NO								NO
H. Urea application	1,70								1,70
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-292,37	1,06	0,37						-290,95
A. Forest land	-27,35	1,06	0,37						-25,93
B. Cropland	-136,09	NE,NO	NE						-136,09
C. Grassland	-132,26	NE,NO	NE						-132,26
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	-0,02	NO,NE	NE,NO						-0,02
F. Other land	0,49	NO,NE	NE,NO						0,49
G. Harvested wood products	2,87								2,87
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	418,96	12,38						431,34
A. Solid waste disposal	NO,NA	292,06							292,06
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		126,90	12,38						139,28
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									

Memo items:[2]									
International bunkers	919,91	0,53	7,85						928,29
Aviation	725,33	0,13	6,05						731,50
Navigation	194,58	0,40	1,80						196,79
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	60,76								60,76
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	6,56								
Total CO_2 equivalent emissions without land use, land-use change and forestry									7060,23
Total CO_2 equivalent emissions with land use, land-use change and forestry									6769,29
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									7066,80
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									6775,85

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	5572,62	765,61	321,46	30,57	NO	5,75	NO	NO	6696,02
1. Energy	5076,26	13,93	43,03						5133,22
A. Fuel combustion (sectoral approach)	5076,26	13,40	43,03						5132,69
1. Energy industries	2166,14	2,38	5,37						2173,90
2. Manufacturing industries and construction	770,90	0,80	1,81						773,51
3. Transport	1519,51	6,62	34,44						1560,58
4. Other sectors	602,54	3,54	1,36						607,44
5. Other	17,17	0,06	0,04						17,26
B. Fugitive emissions from fuels	NO,NE	0,53	NO,NE						0,53
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,53	NO,NE						0,53
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	796,31	NO,NE,NA	4,94	30,57	NO	5,75	NO	NO	837,58
A. Mineral industry	794,46								794,46
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,85	NE,NA	NE,NA						1,85
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				30,57	NO	NO	NO	NO	30,57
G. Other product manufacture and use	IE	NE	4,94		NO	5,75			10,69
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	1,54	324,53	260,52						586,59
A. Enteric fermentation		221,98							221,98
B. Manure management		100,83	74,23						175,05
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	185,76						185,76
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		1,72	0,53						2,25
G. Liming	NO								NO
H. Urea application	1,54								1,54
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-301,48	0,41	0,14						-300,93
A. Forest land	-38,24	0,41	0,14						-37,69
B. Cropland	-136,19	NE,NO	NE						-136,19
C. Grassland	-131,27	NE,NO	NE						-131,27
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	-0,02	NO,NE	NE,NO						-0,02
F. Other land	0,49	NO,NE	NE,NO						0,49
G. Harvested wood products	3,75								3,75
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	426,73	12,83						439,56
A. Solid waste disposal	NO,NA	298,85							298,85
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		127,88	12,83						140,71
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									

Memo items:[2]									
International bunkers	1013,52	0,58	8,69						1022,79
Aviation	796,86	0,14	6,64						803,65
Navigation	216,65	0,44	2,05						219,15
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	76,72								76,72
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	7,30								
Total CO_2 equivalent emissions without land use, land-use change and forestry									6996,94
Total CO_2 equivalent emissions with land use, land-use change and forestry									6696,02
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									7004,25
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									6703,32

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

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SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	5922,82	783,49	294,15	34,62	NO	6,37	NO	NO	7041,44
1. Energy	5368,58	14,37	44,36						5427,31
A. Fuel combustion (sectoral approach)	5368,58	13,88	44,36						5426,83
1. Energy industries	2281,12	2,46	5,59						2289,17
2. Manufacturing industries and construction	872,26	0,88	2,03						875,17
3. Transport	1568,80	6,51	35,23						1610,54
4. Other sectors	628,34	3,97	1,47						633,78
5. Other	18,06	0,06	0,04						18,17
B. Fugitive emissions from fuels	NO,NE	0,48	NO,NE						0,48
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,48	NO,NE						0,48
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	854,33	NO,NE,NA	5,02	34,62	NO	6,37	NO	NO	900,34
A. Mineral industry	852,47								852,47
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,86	NE,NA	NE,NA						1,86
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				34,62	NO	NO	NO	NO	34,62
G. Other product manufacture and use	IE	NE	5,02		NO	6,37			11,39
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	1,38	335,59	231,51						568,48
A. Enteric fermentation		228,44							228,44
B. Manure management		105,55	77,57						183,12
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	153,44						153,44
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		1,60	0,50						2,10
G. Liming	NO								NO
H. Urea application	1,38								1,38
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-301,47	0,69	0,24						-300,54
A. Forest land	-37,50	0,69	0,24						-36,57
B. Cropland	-136,29	NE,NO	NE						-136,29
C. Grassland	-130,28	NE,NO	NE						-130,28
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	-0,03	NO,NE	NE,NO						-0,03
F. Other land	0,49	NO,NE	NE,NO						0,49
G. Harvested wood products	2,12								2,12
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	432,84	13,02						445,86
A. Solid waste disposal	NO,NA	306,91							306,91
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		125,93	13,02						138,95
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									
Memo items:[2]									
International bunkers	1047,16	0,70	9,18						1057,04
Aviation	764,25	0,13	6,37						770,75
Navigation	282,91	0,56	2,81						286,29
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	74,50								74,50
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2[3]	7,43								
Total CO_2 equivalent emissions without land use, land-use change and forestry									7341,99
Total CO_2 equivalent emissions with land use, land-use change and forestry									7041,44
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									7349,42
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									7048,88

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[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	6035,03	787,58	286,06	38,73	NO	6,99	NO	NO	7154,40
1. Energy	5489,89	14,10	45,61						5549,59
A. Fuel combustion (sectoral approach)	5489,89	13,43	45,61						5548,93
1. Energy industries	2410,95	2,55	5,83						2419,33
2. Manufacturing industries and construction	772,52	0,79	1,80						775,11
3. Transport	1634,64	6,45	36,48						1677,57
4. Other sectors	652,82	3,57	1,45						657,85
5. Other	18,96	0,06	0,05						19,07
B. Fugitive emissions from fuels	NO,NE	0,66	NO,NE						0,66
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,66	NO,NE						0,66
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	821,10	NO,NE,NA	5,08	38,73	NO	6,99	NO	NO	871,91
A. Mineral industry	819,26								819,26
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,84	NE,NA	NE,NA						1,84
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				38,73	NO	NO	NO	NO	38,73
G. Other product manufacture and use	IE	NE	5,08		NO	6,99			12,08
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	1,10	330,71	221,83						553,65
A. Enteric fermentation		223,31							223,31
B. Manure management		106,83	80,38						187,21
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	141,28						141,28
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,57	0,18						0,75
G. Liming	NO								NO
H. Urea application	1,10								1,10
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-277,06	0,99	0,35						-275,72
A. Forest land	-23,42	0,99	0,35						-22,08
B. Cropland	-136,38	NE,NO	NE						-136,38
C. Grassland	-129,28	NE,NO	NE						-129,28
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	-0,03	NO,NE	NE,NO						-0,03
F. Other land	0,49	NO,NE	NE,NO						0,49
G. Harvested wood products	11,56								11,56
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	441,79	13,19						454,97
A. Solid waste disposal	NO,NA	315,10							315,10
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		126,69	13,19						139,87
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1061,10	0,75	9,34						1071,18
Aviation	753,05	0,13	6,28						759,46
Navigation	308,04	0,62	3,06						311,72
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	63,42								63,42
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2[3]	7,38								
Total CO_2 equivalent emissions without land use, land-use change and forestry									7430,13
Total CO_2 equivalent emissions with land use, land-use change and forestry									7154,40
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									7437,51
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									7161,79

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[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	6378,82	791,42	308,59	46,74	NO	7,61	NO	NO	7533,18
1. Energy	5830,20	14,46	47,08						5891,73
A. Fuel combustion (sectoral approach)	5830,20	13,77	47,08						5891,04
1. Energy industries	2643,21	2,80	6,47						2652,48
2. Manufacturing industries and construction	776,49	0,82	1,86						779,16
3. Transport	1711,37	6,30	37,18						1754,85
4. Other sectors	678,93	3,78	1,53						684,24
5. Other	20,19	0,07	0,05						20,31
B. Fugitive emissions from fuels	NO,NE	0,69	NO,NE						0,69
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,69	NO,NE						0,69
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	778,11	NO,NE,NA	5,14	46,74	NO	7,61	NO	NO	837,60
A. Mineral industry	776,84								776,84
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,27	NE,NA	NE,NA						1,27
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				46,74	NO	NO	NO	NO	46,74
G. Other product manufacture and use	IE	NE	5,14		NO	7,61			12,76
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,84	324,74	241,76						567,34
A. Enteric fermentation		216,25							216,25
B. Manure management		107,76	80,65						188,41
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	160,88						160,88
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,73	0,23						0,95
G. Liming	NO								NO
H. Urea application	0,84								0,84
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-230,32	3,35	1,18						-225,79
A. Forest land	29,27	3,35	1,18						33,80
B. Cropland	-136,48	NE,NO	NE						-136,48
C. Grassland	-128,29	NE,NO	NE						-128,29
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	-0,03	NO,NE	NE,NO						-0,03
F. Other land	0,49	NO,NE	NE,NO						0,49
G. Harvested wood products	4,71								4,71
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	448,86	13,44						462,30
A. Solid waste disposal	NO,NA	323,51							323,51
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		125,36	13,44						138,79
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1102,67	0,73	10,34						1113,74
Aviation	794,15	0,14	6,62						800,91
Navigation	308,52	0,59	3,72						312,83
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	69,18								69,18
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	7,29								
Total CO_2 equivalent emissions without land use, land-use change and forestry									7758,97
Total CO_2 equivalent emissions with land use, land-use change and forestry									7533,18
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									7766,26
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									7540,46

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	6557,21	792,30	296,71	52,84	NO	8,23	NO	NO	7707,30
1. Energy	6091,54	14,56	49,27						6155,36
A. Fuel combustion (sectoral approach)	6091,54	13,81	49,27						6154,61
1. Energy industries	2826,94	2,96	6,74						2836,63
2. Manufacturing industries and construction	802,06	0,83	1,94						804,82
3. Transport	1755,70	6,10	38,97						1800,78
4. Other sectors	686,09	3,85	1,57						691,50
5. Other	20,76	0,07	0,05						20,88
B. Fugitive emissions from fuels	NO,NE	0,75	NO,NE						0,75
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,75	NO,NE						0,75
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	783,48	NO,NE,NA	5,20	52,84	NO	8,23	NO	NO	849,76
A. Mineral industry	782,20								782,20
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,29	NE,NA	NE,NA						1,29
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				52,84	NO	NO	NO	NO	52,84
G. Other product manufacture and use	IE	NE	5,20		NO	8,23			13,43
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,92	320,66	228,65						550,23
A. Enteric fermentation		214,73							214,73
B. Manure management		104,66	80,09						184,74
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	148,17						148,17
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		1,27	0,39						1,66
G. Liming	NO								NO
H. Urea application	0,92								0,92
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-318,73	0,02	0,01						-318,70
A. Forest land	-57,43	0,02	0,01						-57,40
B. Cropland	-136,57	NE,NO	NE						-136,57
C. Grassland	-127,30	NE,NO	NE						-127,30
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	-0,03	NO,NE	NE,NO						-0,03
F. Other land	0,49	NO,NE	NE,NO						0,49
G. Harvested wood products	2,11								2,11
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	457,06	13,59						470,65
A. Solid waste disposal	NO,NA	331,98							331,98
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		125,09	13,59						138,67
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1298,07	1,10	11,68						1310,85
Aviation	813,79	0,14	6,78						820,71
Navigation	484,28	0,96	4,90						490,14
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	64,43								64,43
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2[3]	9,14								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8026,00
Total CO_2 equivalent emissions with land use, land-use change and forestry									7707,30
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									8035,15
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									7716,45

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	7045,49	816,44	298,31	60,38	NO	8,86	NO	NO	8229,48
1. Energy	6316,75	14,29	50,24						6381,29
A. Fuel combustion (sectoral approach)	6316,75	13,55	50,24						6380,54
1. Energy industries	2954,60	3,06	6,99						2964,66
2. Manufacturing industries and construction	818,73	0,99	2,14						821,86
3. Transport	1796,60	5,83	39,44						1841,87
4. Other sectors	725,39	3,59	1,61						730,60
5. Other	21,43	0,07	0,05						21,55
B. Fugitive emissions from fuels	NO,NE	0,75	NO,NE						0,75
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,75	NO,NE						0,75
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	803,99	NO,NE,NA	5,25	60,38	NO	8,86	NO	NO	878,48
A. Mineral industry	802,75								802,75
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,24	NE,NA	NE,NA						1,24
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				60,38	NO	NO	NO	NO	60,38
G. Other product manufacture and use	IE	NE	5,25		NO	8,86			14,11
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	1,67	328,31	226,44						556,42
A. Enteric fermentation		224,21							224,21
B. Manure management		103,61	82,60						186,21
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	143,69						143,69
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,49	0,15						0,65
G. Liming	NO								NO
H. Urea application	1,67								1,67
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-76,92	7,20	2,53						-67,19
A. Forest land	168,32	7,20	2,53						178,05
B. Cropland	-136,67	NE,NO	NE						-136,67
C. Grassland	-126,30	NE,NO	NE						-126,30
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	-0,04	NO,NE	NE,NO						-0,04
F. Other land	0,49	NO,NE	NE,NO						0,49
G. Harvested wood products	17,27								17,27
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	466,63	13,85						480,49
A. Solid waste disposal	NO,NA	340,57							340,57
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		126,06	13,85						139,92
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1433,77	1,37	12,84						1447,97
Aviation	827,30	0,14	6,90						834,34
Navigation	606,47	1,22	5,94						613,63
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	56,93								56,93
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2[3]	9,12								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8296,68
Total CO_2 equivalent emissions with land use, land-use change and forestry									8229,48
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									8305,80
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									8238,60

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for
[2] See footnote 7 to table Summary 1.A.
[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2001
Submission 2022 v10
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	6784,96	844,15	326,36	68,78	NO	9,51	NO	NO	8033,75
1. Energy	6208,45	14,18	51,65						6274,28
A. Fuel combustion (sectoral approach)	6208,45	13,44	51,65						6273,55
1. Energy industries	2837,28	2,94	6,88						2847,11
2. Manufacturing industries and construction	764,83	0,99	2,10						767,91
3. Transport	1856,18	5,81	41,00						1902,99
4. Other sectors	728,51	3,63	1,62						733,76
5. Other	21,65	0,07	0,05						21,78
B. Fugitive emissions from fuels	NO,NE	0,74	NO,NE						0,74
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,74	NO,NE						0,74
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	787,96	NO,NE,NA	5,31	68,78	NO	9,51	NO	NO	871,56
A. Mineral industry	786,68								786,68
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,28	NE,NA	NE,NA						1,28
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				68,78	NO	NO	NO	NO	68,78
G. Other product manufacture and use	IE	NE	5,31		NO	9,51			14,82
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,17	351,07	254,52						605,76
A. Enteric fermentation		239,91							239,91
B. Manure management		110,02	89,18						199,20
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	165,00						165,00
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		1,13	0,35						1,48
G. Liming	NO								NO
H. Urea application	0,17								0,17
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-211,63	2,42	0,85						-208,36
A. Forest land	20,74	2,42	0,85						24,01
B. Cropland	-136,00	NE,NO	NE						-136,00
C. Grassland	-123,21	NE,NO	NE						-123,21
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	1,74	NO,NE	NE,NO						1,74
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	25,10								25,10
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	476,49	14,02						490,51
A. Solid waste disposal	NO,NA	349,44							349,44
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		127,05	14,02						141,07
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1573,85	1,39	13,93						1589,17
Aviation	970,68	0,17	8,09						978,94
Navigation	603,17	1,22	5,84						610,23
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	60,59								60,59
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	8,69								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8242,10
Total CO_2 equivalent emissions with land use, land-use change and forestry									8033,75
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									8250,79
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									8042,44

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	6895,64	866,82	327,98	77,29	NO	10,14	NO	NO	8177,88
1. Energy	6365,23	14,27	52,69						6432,19
A. Fuel combustion (sectoral approach)	6365,23	13,58	52,69						6431,50
1. Energy industries	2998,47	3,08	7,28						3008,83
2. Manufacturing industries and construction	775,29	1,00	2,12						778,42
3. Transport	1838,14	5,55	41,60						1885,29
4. Other sectors	732,57	3,88	1,64						738,09
5. Other	20,76	0,07	0,05						20,88
B. Fugitive emissions from fuels	NO,NE	0,69	NO,NE						0,69
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,69	NO,NE						0,69
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	820,27	NO,NE,NA	5,37	77,29	NO	10,14	NO	NO	913,08
A. Mineral industry	819,00								819,00
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,27	NE,NA	NE,NA						1,27
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				77,29	NO	NO	NO	NO	77,29
G. Other product manufacture and use	IE	NE	5,37		NO	10,14			15,52
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,42	368,28	255,72						624,42
A. Enteric fermentation		251,64							251,64
B. Manure management		115,44	93,60						209,05
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	161,74						161,74
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		1,20	0,37						1,57
G. Liming	NO								NO
H. Urea application	0,42								0,42
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-290,28	0,07	0,02						-290,19
A. Forest land	-62,10	0,07	0,02						-62,01
B. Cropland	-135,68	NE,NO	NE						-135,68
C. Grassland	-122,22	NE,NO	NE						-122,22
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	3,27	NO,NE	NE,NO						3,27
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	26,45								26,45
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	484,20	14,18						498,38
A. Solid waste disposal	NO,NA	359,04							359,04
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		125,16	14,18						139,34
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									
Memo items:[2]									
International bunkers	1368,40	1,04	12,73						1382,17
Aviation	934,92	0,16	7,79						942,88
Navigation	433,48	0,88	4,93						439,29
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	66,88								66,88
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2[3]	10,77								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8468,07
Total CO_2 equivalent emissions with land use, land-use change and forestry									8177,88
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									8478,84
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									8188,65

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for
[2] See footnote 7 to table Summary 1.A.
[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	7286,04	859,88	323,62	90,58	NO	10,78	NO	NO	8570,90
1. Energy	6753,32	14,73	55,49						6823,53
A. Fuel combustion (sectoral approach)	6753,32	14,11	55,49						6822,91
1. Energy industries	3224,91	3,28	7,55						3235,74
2. Manufacturing industries and construction	802,63	1,13	2,34						806,11
3. Transport	1947,12	5,74	43,87						1996,73
4. Other sectors	757,33	3,89	1,67						762,90
5. Other	21,32	0,07	0,05						21,44
B. Fugitive emissions from fuels	NO,NE	0,62	NO,NE						0,62
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,62	NO,NE						0,62
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	822,75	NO,NE,NA	5,44	90,58	NO	10,78	NO	NO	929,56
A. Mineral industry	821,47								821,47
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,29	NE,NA	NE,NA						1,29
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				90,58	NO	NO	NO	NO	90,58
G. Other product manufacture and use	IE	NE	5,44		NO	10,78			16,22
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,73	356,83	248,72						606,28
A. Enteric fermentation		244,59							244,59
B. Manure management		111,93	89,04						200,96
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	159,28						159,28
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,31	0,40						0,72
G. Liming	NO								NO
H. Urea application	0,73								0,73
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-290,76	0,31	0,11						-290,34
A. Forest land	-65,92	0,31	0,11						-65,50
B. Cropland	-135,35	NE,NO	NE						-135,35
C. Grassland	-121,23	NE,NO	NE						-121,23
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	4,79	NO,NE	NE,NO						4,79
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	26,95								26,95
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	488,01	13,86						501,87
A. Solid waste disposal	NO,NA	368,79							368,79
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		119,22	13,86						133,09
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									

Memo items:[2]									
International bunkers	1391,24	0,95	12,27						1404,45
Aviation	1001,36	0,18	8,35						1009,88
Navigation	389,88	0,77	3,92						394,57
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	75,37								75,37
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2[3]	12,65								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8861,24
Total CO_2 equivalent emissions with land use, land-use change and forestry									8570,90
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									8873,89
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									8583,55

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [1]	7521,93	856,83	307,97	106,77	NO	11,41	NO	NO	8804,91
1. Energy	6915,68	14,32	51,89						6981,88
A. Fuel combustion (sectoral approach)	6915,68	14,14	51,89						6981,71
1. Energy industries	3283,44	3,35	7,98						3294,77
2. Manufacturing industries and construction	880,45	1,19	2,49						884,13
3. Transport	2050,20	5,72	39,87						2095,78
4. Other sectors	681,20	3,73	1,50						686,43
5. Other	20,39	0,15	0,05						20,59
B. Fugitive emissions from fuels	NO,NE	0,18	NO,NE						0,18
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	0,18	NO,NE						0,18
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	886,80	NO,NE,NA	5,52	106,77	NO	11,41	NO	NO	1010,50
A. Mineral industry	884,95								884,95
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,86	NE,NA	NE,NA						1,86
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				106,77	NO	NO	NO	NO	106,77
G. Other product manufacture and use	IE	NE	5,52		NO	11,41			16,93
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,95	349,84	236,34						587,13
A. Enteric fermentation		242,82							242,82
B. Manure management		106,18	84,80						190,97
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	151,48						151,48
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,84	0,07						0,91
G. Liming	NO								NO
H. Urea application	0,95								0,95
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry [1]	-281,50	0,60	0,21						-280,69
A. Forest land	-59,67	0,60	0,21						-58,86
B. Cropland	-135,02	NE,NO	NE						-135,02
C. Grassland	-120,23	NE,NO	NE						-120,23
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	6,30	NO,NE	NE,NO						6,30
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	27,13								27,13
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	492,08	14,01						506,09
A. Solid waste disposal	NO,NA	378,95							378,95
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		113,13	14,01						127,14
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									

Memo items: [2]									
International bunkers	1086,31	0,46	9,63						1096,41
Aviation	915,85	0,16	7,63						923,65
Navigation	170,46	0,30	2,00						172,76
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	67,02								67,02
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	15,24								
Total CO_2 equivalent emissions without land use, land-use change and forestry									9085,60
Total CO_2 equivalent emissions with land use, land-use change and forestry									8804,91
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									9100,84
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									8820,15

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	7665,47	839,69	279,81	122,19	NO	12,05	NO	NO	8919,21
1. Energy	7093,91	14,28	49,74						7157,94
A. Fuel combustion (sectoral approach)	7093,91	14,28	49,74						7157,94
1. Energy industries	3471,84	3,53	8,25						3483,62
2. Manufacturing industries and construction	908,28	1,21	2,54						912,04
3. Transport	2090,16	5,61	37,56						2133,33
4. Other sectors	604,60	3,77	1,34						609,71
5. Other	19,03	0,15	0,05						19,23
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	862,84	NO,NE,NA	5,60	122,19	NO	12,05	NO	NO	1002,68
A. Mineral industry	860,47								860,47
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	2,36	NE,NA	NE,NA						2,36
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				122,19	NO	NO	NO	NO	122,19
G. Other product manufacture and use	IE	NE	5,60		NO	12,05			17,65
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,97	324,03	210,68						535,68
A. Enteric fermentation		228,47							228,47
B. Manure management		95,04	78,51						173,55
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	132,02						132,02
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,52	0,16						0,68
G. Liming	NO								NO
H. Urea application	0,97								0,97
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-292,25	0,20	0,07						-291,97
A. Forest land	-73,23	0,20	0,07						-72,96
B. Cropland	-134,69	NE,NO	NE						-134,69
C. Grassland	-119,24	NE,NO	NE						-119,24
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	7,82	NO,NE	NE,NO						7,82
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	27,10								27,10
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	501,17	13,71						514,88
A. Solid waste disposal	NO,NA	389,54							389,54
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		111,63	13,71						125,34
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									

Memo items:[2]									
International bunkers	1750,15	2,02	15,71						1767,88
Aviation	833,10	0,15	6,94						840,19
Navigation	917,05	1,87	8,77						927,69
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	63,60								63,60
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2[3]	17,74								
Total CO_2 equivalent emissions without land use, land-use change and forestry									9211,18
Total CO_2 equivalent emissions with land use, land-use change and forestry									8919,21
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									9228,91
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									8936,94

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	7900,71	842,84	291,46	140,34	NO	11,13	NO	NO	9186,48
1. Energy	7279,49	14,31	48,26						7342,06
A. Fuel combustion (sectoral approach)	7279,49	14,31	48,26						7342,06
1. Energy industries	3653,38	3,58	8,50						3665,46
2. Manufacturing industries and construction	868,32	1,13	2,37						871,82
3. Transport	2078,95	5,31	35,84						2120,09
4. Other sectors	664,90	4,12	1,51						670,52
5. Other	13,95	0,17	0,04						14,16
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	904,75	NO,NE,NA	5,71	140,34	NO	11,13	NO	NO	1061,92
A. Mineral industry	902,37								902,37
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	2,37	NE,NA	NE,NA						2,37
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				140,34	NO	NO	NO	NO	140,34
G. Other product manufacture and use	IE	NE	5,71		NO	11,13			16,84
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	1,17	325,97	223,37						550,50
A. Enteric fermentation		229,93							229,93
B. Manure management		95,59	77,18						172,77
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	146,04						146,04
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,46	0,14						0,60
G. Liming	NO								NO
H. Urea application	1,17								1,17
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-284,69	0,51	0,18						-284,01
A. Forest land	-66,98	0,51	0,18						-66,29
B. Cropland	-134,37	NE,NO	NE						-134,37
C. Grassland	-119,16	NE,NO	NE						-119,16
D. Wetlands	0,00	NE,NO	NE,NO						0,00
E. Settlements	9,31	NO,NE	NE,NO						9,31
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	26,50								26,50
H. Other	NO	NO	NO						NO
5. Waste	NO,NE,NA	502,06	13,95						516,01
A. Solid waste disposal	NO,NE,NA	400,17							400,17
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		101,89	13,95						115,84
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1771,71	1,93	18,24						1791,89
Aviation	839,84	0,15	7,00						846,99
Navigation	931,87	1,79	11,24						944,90
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	64,14								64,14
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	19,33								
Total CO_2 equivalent emissions without land use, land-use change and forestry									9470,49
Total CO_2 equivalent emissions with land use, land-use change and forestry									9186,48
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									9489,83
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									9205,82

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	8357,47	851,74	281,77	159,05	NO	11,43	NO	NO	9661,46
1. Energy	7602,92	15,07	46,33						7664,32
A. Fuel combustion (sectoral approach)	7602,92	15,07	46,33						7664,32
1. Energy industries	3801,67	3,83	8,97						3814,47
2. Manufacturing industries and construction	926,03	1,34	2,74						930,11
3. Transport	2218,88	5,04	33,08						2257,01
4. Other sectors	636,02	4,70	1,49						642,21
5. Other	20,32	0,15	0,05						20,52
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	900,75	NO,NE,NA	5,85	159,05	NO	11,43	NO	NO	1077,08
A. Mineral industry	898,32								898,32
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	2,43	NE,NA	NE,NA						2,43
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				159,05	NO	NO	NO	NO	159,05
G. Other product manufacture and use	IE	NE	5,85		NO	11,43			17,27
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	1,11	327,31	213,62						542,03
A. Enteric fermentation		234,00							234,00
B. Manure management		92,89	79,32						172,21
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	134,17						134,17
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,41	0,13						0,54
G. Liming	NO								NO
H. Urea application	1,11								1,11
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-147,31	4,85	1,70						-140,76
A. Forest land	75,62	4,85	1,70						82,17
B. Cropland	-134,11	NE,NO	NE						-134,11
C. Grassland	-119,43	NE,NO	NE						-119,43
D. Wetlands	-0,02	NE,NO	NE,NO						-0,02
E. Settlements	9,75	NO,NE	NE,NO						9,75
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	20,89								20,89
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	504,51	14,28						518,79
A. Solid waste disposal	NO,NA	411,83							411,83
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		92,69	14,28						106,96
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1693,34	1,79	16,21						1711,34
Aviation	827,25	0,14	6,90						834,29
Navigation	866,09	1,65	9,32						877,05
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	103,05								103,05
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	19,86								
Total CO_2 equivalent emissions without land use, land-use change and forestry									9802,22
Total CO_2 equivalent emissions with land use, land-use change and forestry									9661,46
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									9822,07
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									9681,31

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2[1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	8399,18	847,25	266,31	183,40	NO	11,73	NO	NO	9707,86
1. Energy	7813,29	15,12	46,45						7874,86
A. Fuel combustion (sectoral approach)	7813,29	15,12	46,45						7874,86
1. Energy industries	3967,29	3,96	9,19						3980,44
2. Manufacturing industries and construction	903,32	1,35	2,73						907,40
3. Transport	2308,36	4,85	33,00						2346,22
4. Other sectors	591,69	4,73	1,43						597,85
5. Other	42,62	0,23	0,11						42,96
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	903,42	NO,NE,NA	6,00	183,40	NO	11,73	NO	NO	1104,55
A. Mineral industry	901,00								901,00
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	2,42	NE,NA	NE,NA						2,42
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				183,40	NO	NO	NO	NO	183,40
G. Other product manufacture and use	IE	NE	6,00		NO	11,73			17,73
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,54	317,61	199,13						517,27
A. Enteric fermentation		226,19							226,19
B. Manure management		91,02	74,66						165,68
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	124,34						124,34
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,40	0,12						0,53
G. Liming	NO								NO
H. Urea application	0,54								0,54
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-318,06	0,17	0,06						-317,83
A. Forest land	-94,48	0,17	0,06						-94,25
B. Cropland	-133,95	NE,NO	NE						-133,95
C. Grassland	-119,35	NE,NO	NE						-119,35
D. Wetlands	-0,14	NE,NO	NE,NO						-0,14
E. Settlements	10,34	NO,NE	NE,NO						10,34
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	19,52								19,52
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	514,35	14,66						529,01
A. Solid waste disposal	NO,NA	423,93							423,93
B. Biological treatment of solid waste		NO	NO						NO
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		90,42	14,66						105,08
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1654,94	1,69	16,72						1673,35
Aviation	858,60	0,15	7,16						865,91
Navigation	796,34	1,54	9,56						807,44
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	156,43								156,43
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2[3]	17,36								
Total CO_2 equivalent emissions without land use, land-use change and forestry									10025,69
Total CO_2 equivalent emissions with land use, land-use change and forestry									9707,86
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									10043,05
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									9725,22

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Inventory 2009
Submission 2022 v10
CYPRUS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	8143,71	852,03	258,56	194,93	NO	12,02	NO	NO	9461,26
1. Energy	7741,41	17,21	41,41						7800,03
A. Fuel combustion (sectoral approach)	7741,41	17,21	41,41						7800,03
1. Energy industries	3992,47	3,89	9,29						4005,65
2. Manufacturing industries and construction	798,90	1,19	2,38						802,47
3. Transport	2312,96	4,63	27,76						2345,34
4. Other sectors	616,80	7,35	1,92						626,07
5. Other	20,29	0,15	0,05						20,49
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	729,19	NO,NE,NA	6,17	194,93	NO	12,02	NO	NO	942,31
A. Mineral industry	726,74								726,74
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	2,45	NE,NA	NE,NA						2,45
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				194,93	NO	NO	NO	NO	194,93
G. Other product manufacture and use	IE	NE	6,17		NO	12,02			18,19
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	1,14	313,20	195,84						510,18
A. Enteric fermentation		225,56							225,56
B. Manure management		87,29	72,52						159,81
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	123,21						123,21
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,36	0,11						0,47
G. Liming	NO								NO
H. Urea application	1,14								1,14
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-328,03	0,29	0,10						-327,64
A. Forest land	-111,53	0,29	0,10						-111,14
B. Cropland	-133,78	NE,NO	NE						-133,78
C. Grassland	-119,28	NE,NO	NE						-119,28
D. Wetlands	-0,26	NE,NO	NE,NO						-0,26
E. Settlements	10,94	NO,NE	NE,NO						10,94
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	25,88								25,88
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	521,33	15,04						536,38
A. Solid waste disposal	NO,NA	436,59							436,59
B. Biological treatment of solid waste		0,03	NO,NE						0,03
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		84,72	15,04						99,76
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									

Memo items:[2]									
International bunkers	1500,67	1,48	13,93						1516,07
Aviation	811,53	0,14	6,76						818,44
Navigation	689,14	1,34	7,16						697,64
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	182,35								182,35
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	15,42								
Total CO_2 equivalent emissions without land use, land-use change and forestry									9788,90
Total CO_2 equivalent emissions with land use, land-use change and forestry									9461,26
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									9804,32
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									9476,67

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	7805,86	861,66	274,68	214,20	NO	12,32	NO	NO	9168,73
1. Energy	7509,55	15,00	41,19						7565,75
A. Fuel combustion (sectoral approach)	7509,55	15,00	41,19						7565,75
1. Energy industries	3868,00	3,76	9,00						3880,76
2. Manufacturing industries and construction	696,58	1,17	2,29						700,03
3. Transport	2361,47	4,59	28,35						2394,40
4. Other sectors	563,22	5,33	1,51						570,06
5. Other	20,29	0,15	0,05						20,49
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	592,41	NO,NE,NA	6,32	214,20	NO	12,32	NO	NO	825,25
A. Mineral industry	589,98								589,98
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	2,43	NE,NA	NE,NA						2,43
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				214,20	NO	NO	NO	NO	214,20
G. Other product manufacture and use	IE	NE	6,32		NO	12,32			18,64
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,74	321,17	210,78						532,68
A. Enteric fermentation		235,38							235,38
B. Manure management		85,37	74,56						159,92
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	136,09						136,09
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,42	0,13						0,55
G. Liming	NO								NO
H. Urea application	0,74								0,74
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-296,84	1,13	0,39						-295,32
A. Forest land	-81,45	1,13	0,39						-79,93
B. Cropland	-133,74	NE,NO	NE						-133,74
C. Grassland	-119,20	NE,NO	NE						-119,20
D. Wetlands	-0,37	NE,NO	NE,NO						-0,37
E. Settlements	11,53	NO,NE	NE,NO						11,53
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	26,40								26,40
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	524,36	15,99						540,36
A. Solid waste disposal	NO,NA	449,11							449,11
B. Biological treatment of solid waste		0,87	0,56						1,43
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		74,39	15,43						89,82
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1416,02	1,31	13,75						1431,08
Aviation	828,13	0,14	6,90						835,18
Navigation	587,89	1,17	6,85						595,90
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	167,18								167,18
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	14,97								
Total CO_2 equivalent emissions without land use, land-use change and forestry									9464,04
Total CO_2 equivalent emissions with land use, land-use change and forestry									9168,73
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									9479,01
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									9183,70

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	7451,54	864,07	259,99	231,29	NO	13,94	NO	NO	8820,83
1. Energy	7214,24	15,13	39,40						7268,77
A. Fuel combustion (sectoral approach)	7214,24	15,13	39,40						7268,77
1. Energy industries	3710,04	3,63	8,70						3722,37
2. Manufacturing industries and construction	572,44	0,78	1,62						574,84
3. Transport	2292,02	4,26	27,30						2323,59
4. Other sectors	613,11	6,28	1,71						621,10
5. Other	26,63	0,18	0,07						26,87
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	574,25	NO,NE,NA	6,49	231,29	NO	13,94	NO	NO	825,96
A. Mineral industry	571,83								571,83
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	2,42	NE,NA	NE,NA						2,42
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				231,29	NO	NO	NO	NO	231,29
G. Other product manufacture and use	IE	NE	6,49		NO	13,94			20,43
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,91	320,64	196,85						518,40
A. Enteric fermentation		241,14							241,14
B. Manure management		79,04	72,71						151,75
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	124,00						124,00
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,46	0,14						0,60
G. Liming	NO								NO
H. Urea application	0,91								0,91
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-337,86	0,94	0,33						-336,59
A. Forest land	-123,05	0,94	0,33						-121,78
B. Cropland	-133,70	NE,NO	NE						-133,70
C. Grassland	-119,13	NE,NO	NE						-119,13
D. Wetlands	-0,48	NE,NO	NE,NO						-0,48
E. Settlements	12,12	NO,NE	NE,NO						12,12
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	26,39								26,39
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	527,36	16,92						544,28
A. Solid waste disposal	NO,NA	461,81							461,81
B. Biological treatment of solid waste		1,62	1,07						2,69
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		63,93	15,85						79,78
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									

Memo items:[2]									
International bunkers	1484,81	1,39	13,45						1499,65
Aviation	859,10	0,15	7,16						866,41
Navigation	625,71	1,24	6,29						633,24
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	188,13								188,13
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	6,76								
Total CO_2 equivalent emissions without land use, land-use change and forestry									9157,42
Total CO_2 equivalent emissions with land use, land-use change and forestry									8820,83
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									9164,18
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									8827,59

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	6934,32	859,27	254,94	238,49	NO	14,52	NO	NO	8301,54
1. Energy	6733,40	15,15	36,69						6785,24
A. Fuel combustion (sectoral approach)	6733,40	15,15	36,69						6785,24
1. Energy industries	3545,93	3,49	8,14						3557,56
2. Manufacturing industries and construction	458,92	0,50	1,10						460,52
3. Transport	2117,41	4,10	25,63						2147,14
4. Other sectors	590,86	6,91	1,77						599,53
5. Other	20,29	0,15	0,05						20,49
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	530,08	NO,NE,NA	6,52	238,49	NO	14,52	NO	NO	789,62
A. Mineral industry	527,64								527,64
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	2,44	NE,NA	NE,NA						2,44
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				238,49	NO	NO	NO	NO	238,49
G. Other product manufacture and use	IE	NE	6,52		NO	14,52			21,05
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,55	306,78	193,84						501,17
A. Enteric fermentation		235,16							235,16
B. Manure management		71,16	68,22						139,38
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	125,48						125,48
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,46	0,14						0,60
G. Liming	NO								NO
H. Urea application	0,55								0,55
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-329,72	1,05	0,37						-328,30
A. Forest land	-115,18	1,05	0,37						-113,76
B. Cropland	-133,66	NE,NO	NE						-133,66
C. Grassland	-119,05	NE,NO	NE						-119,05
D. Wetlands	-0,59	NE,NO	NE,NO						-0,59
E. Settlements	12,70	NO,NE	NE,NO						12,70
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	26,08								26,08
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	536,28	17,53						553,82
A. Solid waste disposal	NO,NA	472,67							472,67
B. Biological treatment of solid waste		2,48	1,64						4,13
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		61,13	15,89						77,02
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									

Memo items:[2]									
International bunkers	1450,80	1,34	13,45						1465,59
Aviation	830,69	0,15	6,93						837,76
Navigation	620,11	1,19	6,53						627,83
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	183,37								183,37
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2[3]	6,54								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8629,84
Total CO_2 equivalent emissions with land use, land-use change and forestry									8301,54
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									8636,38
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									8308,08

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2 the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	6230,35	849,35	230,10	241,77	NO	15,11	NO	NO	7566,69
1. Energy	5816,16	13,33	31,97						5861,46
A. Fuel combustion (sectoral approach)	5816,16	13,33	31,97						5861,46
1. Energy industries	2829,73	2,78	6,64						2839,15
2. Manufacturing industries and construction	538,27	0,62	1,32						540,21
3. Transport	1909,14	3,67	22,42						1935,22
4. Other sectors	512,60	6,10	1,53						520,22
5. Other	26,42	0,17	0,06						26,66
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	767,03	NO,NE,NA	6,46	241,77	NO	15,11	NO	NO	1030,37
A. Mineral industry	765,18								765,18
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,84	NE,NA	NE,NA						1,84
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				241,77	NO	NO	NO	NO	241,77
G. Other product manufacture and use	IE	NE	6,46		NO	15,11			21,57
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,79	288,67	174,40						463,86
A. Enteric fermentation		224,23							224,23
B. Manure management		64,10	62,55						126,66
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	111,74						111,74
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,34	0,10						0,44
G. Liming	NO								NO
H. Urea application	0,79								0,79
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-353,63	0,36	0,13						-353,13
A. Forest land	-139,45	0,36	0,13						-138,96
B. Cropland	-133,34	NE,NO	NE						-133,34
C. Grassland	-118,71	NE,NO	NE						-118,71
D. Wetlands	-0,64	NE,NO	NE,NO						-0,64
E. Settlements	12,61	NO,NE	NE,NO						12,61
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	25,91								25,91
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	546,99	17,14						564,14
A. Solid waste disposal	NO,NA	484,46							484,46
B. Biological treatment of solid waste		2,17	1,40						3,57
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		60,36	15,74						76,10
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1530,27	1,59	14,39						1546,25
Aviation	774,87	0,14	6,46						781,47
Navigation	755,40	1,46	7,93						764,78
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	178,36								178,36
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	5,54								
Total CO_2 equivalent emissions without land use, land-use change and forestry									7919,82
Total CO_2 equivalent emissions with land use, land-use change and forestry									7566,69
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									7925,36
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									7572,23

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	6596,67	853,16	223,82	248,36	NO	15,70	NO	NO	7937,72
1. Energy	5964,09	12,72	30,01						6006,82
A. Fuel combustion (sectoral approach)	5964,09	12,72	30,01						6006,82
1. Energy industries	2940,32	2,87	6,92						2950,11
2. Manufacturing industries and construction	693,24	1,06	2,11						696,41
3. Transport	1842,66	3,52	19,61						1865,79
4. Other sectors	449,91	5,14	1,28						456,33
5. Other	37,97	0,12	0,09						38,18
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	987,65	NO,NE,NA	6,38	248,36	NO	15,70	NO	NO	1258,09
A. Mineral industry	985,79								985,79
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,86	NE,NA	NE,NA						1,86
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				248,36	NO	NO	NO	NO	248,36
G. Other product manufacture and use	IE	NE	6,38		NO	15,70			22,08
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,41	283,40	169,76						453,57
A. Enteric fermentation		222,73							222,73
B. Manure management		60,60	62,67						123,27
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	107,07						107,07
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,07	0,02						0,09
G. Liming	NO								NO
H. Urea application	0,41								0,41
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-355,48	0,41	0,14						-354,93
A. Forest land	-140,61	0,41	0,14						-140,06
B. Cropland	-133,36	NE,NO	NE						-133,36
C. Grassland	-118,61	NE,NO	NE						-118,61
D. Wetlands	-0,67	NE,NO	NE,NO						-0,67
E. Settlements	12,61	NO,NE	NE,NO						12,61
F. Other land	NO,NE	NO,NE	NE,NO						NO,NE
G. Harvested wood products	25,16								25,16
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	556,64	17,53						574,17
A. Solid waste disposal	NO,NA	493,87							493,87
B. Biological treatment of solid waste		2,99	1,99						4,98
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		59,78	15,54						75,32
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1509,14	1,55	14,15						1524,84
Aviation	775,81	0,14	6,47						782,41
Navigation	733,33	1,42	7,68						742,43
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	169,12								169,12
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2[3]	5,18								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8292,64
Total CO_2 equivalent emissions with land use, land-use change and forestry									7937,72
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									8297,83
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									7942,90

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	6615,38	862,35	231,05	261,62	NO	16,29	NO	NO	7986,70
1. Energy	6082,50	15,73	31,08						6129,30
A. Fuel combustion (sectoral approach)	6082,50	15,73	31,08						6129,30
1. Energy industries	3023,00	3,00	6,97						3032,96
2. Manufacturing industries and construction	600,16	1,22	2,30						603,68
3. Transport	1912,35	3,48	19,91						1935,75
4. Other sectors	521,74	7,94	1,84						531,52
5. Other	25,26	0,08	0,06						25,39
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	890,07	NO,NE,NA	6,39	261,62	NO	16,29	NO	NO	1174,37
A. Mineral industry	888,12								888,12
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,94	NE,NA	NE,NA						1,94
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				261,62	NO	NO	NO	NO	261,62
G. Other product manufacture and use	IE	NE	6,39		NO	16,29			22,68
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,40	284,63	175,33						460,36
A. Enteric fermentation		224,39							224,39
B. Manure management		59,66	61,12						120,78
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	114,03						114,03
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,58	0,18						0,76
G. Liming	NO								NO
H. Urea application	0,40								0,40
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-357,58	0,14	0,05						-357,39
A. Forest land	-142,59	0,14	0,05						-142,40
B. Cropland	-133,36	NO,NE	NE						-133,36
C. Grassland	-118,51	NO,NE	NE						-118,51
D. Wetlands	-0,70	NO,NE	NO,NE						-0,70
E. Settlements	12,61	NO,NE	NO,NE						12,61
F. Other land	NO,NE	NO,NE	NO,NE						NO,NE
G. Harvested wood products	24,97								24,97
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	561,85	18,20						580,05
A. Solid waste disposal	NO,NA	500,92							500,92
B. Biological treatment of solid waste		3,87	2,62						6,49
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		57,06	15,58						72,64
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									

Memo items:[2]									
International bunkers	1518,32	1,64	14,08						1534,03
Aviation	750,89	0,13	6,26						757,28
Navigation	767,43	1,51	7,82						776,76
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	221,65								221,65
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	5,69								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8344,08
Total CO_2 equivalent emissions with land use, land-use change and forestry									7986,70
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									8349,77
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									7992,39

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	7376,00	897,81	243,09	284,08	NO	15,14	NO	NO	8816,12
1. Energy	6476,48	16,25	33,88						6526,60
A. Fuel combustion (sectoral approach)	6476,48	16,25	33,88						6526,60
1. Energy industries	3300,00	3,30	7,75						3311,05
2. Manufacturing industries and construction	596,03	1,35	2,63						600,01
3. Transport	2039,67	3,56	21,64						2064,88
4. Other sectors	515,52	7,96	1,80						525,28
5. Other	25,26	0,08	0,06						25,39
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	898,54	NO,NE,NA	6,44	284,08	NO	15,14	NO	NO	1204,20
A. Mineral industry	896,42								896,42
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	2,13	NE,NA	NE,NA						2,13
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				284,08	NO	NO	NO	NO	284,08
G. Other product manufacture and use	IE	NE	6,44		NO	15,14			21,58
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,39	302,89	180,10						483,38
A. Enteric fermentation		243,75							243,75
B. Manure management		59,05	63,16						122,20
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	116,91						116,91
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,09	0,03						0,12
G. Liming	NO								NO
H. Urea application	0,39								0,39
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	0,59	12,01	4,21						16,80
A. Forest land	215,74	12,01	4,21						231,95
B. Cropland	-133,38	NO,NE	NE						-133,38
C. Grassland	-118,41	NO,NE	NE						-118,41
D. Wetlands	-0,73	NO,NE	NO,NE						-0,73
E. Settlements	12,65	NO,NE	NO,NE						12,65
F. Other land	NO,NE	NO,NE	NO,NE						NO,NE
G. Harvested wood products	24,72								24,72
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	566,66	18,47						585,13
A. Solid waste disposal	NO,NA	508,91							508,91
B. Biological treatment of solid waste		4,10	2,77						6,87
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		53,65	15,70						69,35
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1783,35	1,92	16,71						1801,97
Aviation	877,15	0,15	7,31						884,62
Navigation	906,20	1,76	9,39						917,36
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	235,45								235,45
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	5,83								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8799,32
Total CO_2 equivalent emissions with land use, land-use change and forestry									8816,12
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									8805,15
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									8821,95

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [1]	7164,35	905,59	245,16	305,89	NO	15,33	NO	NO	8636,32
1. Energy	6584,18	18,01	35,50						6637,69
A. Fuel combustion (sectoral approach)	6584,18	18,01	35,50						6637,69
1. Energy industries	3287,83	3,32	7,80						3298,95
2. Manufacturing industries and construction	615,71	1,83	3,25						620,79
3. Transport	2111,64	3,46	22,36						2137,46
4. Other sectors	543,59	9,32	2,03						554,94
5. Other	25,41	0,08	0,05						25,54
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	940,77	NO,NE,NA	6,51	305,89	NO	15,33	NO	NO	1268,50
A. Mineral industry	938,91								938,91
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,85	NE,NA	NE,NA						1,85
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				305,89	NO	NO	NO	NO	305,89
G. Other product manufacture and use	IE	NE	6,51		NO	15,33			21,84
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,42	312,85	184,36						497,63
A. Enteric fermentation		255,69							255,69
B. Manure management		56,92	64,88						121,79
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	119,40						119,40
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,25	0,08						0,33
G. Liming	NO								NO
H. Urea application	0,42								0,42
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry [1]	-361,02	0,38	0,13						-360,50
A. Forest land	-145,59	0,38	0,13						-145,07
B. Cropland	-133,39	NO,NE	NE						-133,39
C. Grassland	-118,30	NO,NE	NE						-118,30
D. Wetlands	-0,77	NO,NE	NO,NE						-0,77
E. Settlements	12,69	NO,NE	NO,NE						12,69
F. Other land	NO,NE	NO,NE	NO,NE						NO,NE
G. Harvested wood products	24,34								24,34
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	574,34	18,66						593,01
A. Solid waste disposal	NO,NA	517,65							517,65
B. Biological treatment of solid waste		3,93	2,77						6,71
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		52,76	15,89						68,65
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items: [2]									
International bunkers	1802,99	1,69	17,10						1821,78
Aviation	998,33	0,17	8,32						1006,82
Navigation	804,67	1,51	8,77						814,95
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	288,44								288,44
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	7,22								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8996,82
Total CO_2 equivalent emissions with land use, land-use change and forestry									8636,32
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									9004,04
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									8643,54

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions) [1]	6992,89	918,10	246,91	334,87	NO	16,39	NO	NO	8509,15
1. Energy	6472,30	18,00	35,83						6526,12
A. Fuel combustion (sectoral approach)	6472,30	18,00	35,83						6526,12
1. Energy industries	3342,36	3,32	7,84						3353,52
2. Manufacturing industries and construction	549,60	2,21	3,80						555,60
3. Transport	2081,83	3,31	22,24						2107,37
4. Other sectors	471,92	9,08	1,89						482,89
5. Other	26,59	0,09	0,06						26,74
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	870,03	NO,NE,NA	6,60	334,87	NO	16,39	NO	NO	1227,88
A. Mineral industry	868,24								868,24
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	1,79	NE,NA	NE,NA						1,79
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				334,87	NO	NO	NO	NO	334,87
G. Other product manufacture and use	IE	NE	6,60		NO	16,39			22,99
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,22	318,97	184,60						503,79
A. Enteric fermentation		261,59							261,59
B. Manure management		57,20	65,44						122,64
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	119,11						119,11
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,18	0,05						0,23
G. Liming	NO								NO
H. Urea application	0,22								0,22
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry [1]	-349,66	0,75	0,26						-348,65
A. Forest land	-134,11	0,75	0,26						-133,10
B. Cropland	-133,40	NO,NE	NE						-133,40
C. Grassland	-118,20	NO,NE	NE						-118,20
D. Wetlands	-0,80	NO,NE	NO,NE						-0,80
E. Settlements	12,74	NO,NE	NO,NE						12,74
F. Other land	NO,NE	NO,NE	NO,NE						NO,NE
G. Harvested wood products	24,12								24,12
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	580,38	19,62						600,01
A. Solid waste disposal	NO,NA	526,19							526,19
B. Biological treatment of solid waste		4,99	3,52						8,51
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		49,21	16,10						65,31
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									

Memo items: [2]									
International bunkers	1894,30	1,76	18,24						1914,30
Aviation	1037,11	0,18	8,65						1045,94
Navigation	857,19	1,58	9,60						868,37
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	324,87								324,87
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites	NE								NE
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	6,73								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8857,80
Total CO_2 equivalent emissions with land use, land-use change and forestry									8509,15
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									8864,53
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									8515,88

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	6993,64	933,81	251,61	357,24	NO	14,98	NO	NO	8551,29
1. Energy	6524,96	18,69	34,94						6578,59
A. Fuel combustion (sectoral approach)	6524,96	18,69	34,94						6578,59
1. Energy industries	3282,06	3,24	7,68						3292,98
2. Manufacturing industries and construction	559,88	2,35	4,02						566,25
3. Transport	2127,02	3,40	21,12						2151,53
4. Other sectors	530,21	9,62	2,06						541,89
5. Other	25,80	0,08	0,06						25,94
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	817,99	NO,NE,NA	6,69	357,24	NO	14,98	NO	NO	1196,90
A. Mineral industry	814,39								814,39
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	3,60	NE,NA	NE,NA						3,60
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				357,24	NO	NO	NO	NO	357,24
G. Other product manufacture and use	IE	NE	6,69		NO	14,98			21,67
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,23	328,42	189,18						517,82
A. Enteric fermentation		270,64							270,64
B. Manure management		57,37	66,89						124,26
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	122,16						122,16
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,41	0,13						0,53
G. Liming	NO								NO
H. Urea application	0,23								0,23
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-349,53	0,53	0,18						-348,82
A. Forest land	-133,79	0,53	0,18						-133,08
B. Cropland	-133,41	NO,NE	NE						-133,41
C. Grassland	-118,10	NO,NE	NE						-118,10
D. Wetlands	-0,84	NO,NE	NO,NE						-0,84
E. Settlements	12,78	NO,NE	NO,NE						12,78
F. Other land	NO,NE	NO,NE	NO,NE						NO,NE
G. Harvested wood products	23,83								23,83
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	586,18	20,62						606,80
A. Solid waste disposal	NO,NA	533,71							533,71
B. Biological treatment of solid waste		6,06	4,29						10,35
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		46,41	16,33						62,74
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***									

Memo items:[2]									
International bunkers	1909,90	1,80	18,51						1930,21
Aviation	1027,07	0,18	8,56						1035,81
Navigation	882,83	1,62	9,95						894,40
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	320,13								320,13
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites									
Indirect N_2O			NO,NE						
Indirect CO_2[3]	6,74								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8900,12
Total CO_2 equivalent emissions with land use, land-use change and forestry									8551,29
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									8906,86
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									8558,03

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[1]	6919,90	968,75	258,21	357,73	NO	18,18	NO	NO	8522,77
1. Energy	6363,67	18,17	34,92						6416,76
A. Fuel combustion (sectoral approach)	6363,67	18,17	34,92						6416,76
1. Energy industries	3023,11	3,01	7,13						3033,25
2. Manufacturing industries and construction	915,47	2,81	4,74						923,02
3. Transport	1900,61	2,58	20,97						1924,16
4. Other sectors	498,01	9,68	2,02						509,71
5. Other	26,47	0,08	0,06						26,62
B. Fugitive emissions from fuels	NO,NE	NO,NE	NO						NO,NE
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	NO,NE	NO,NE	NO						NO,NE
C. CO_2 transport and storage	NO								NO
2. Industrial processes and product use	905,69	NO,NE,NA	6,75	357,73	NO	18,18	NO	NO	1288,35
A. Mineral industry	902,15								902,15
B. Chemical industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	3,54	NE,NA	NE,NA						3,54
E. Electronic Industry				NO	NO	NO	NO	NO	NO
F. Product uses as ODS substitutes				357,73	NO	NO	NO	NO	357,73
G. Other product manufacture and use	IE	NE	6,75		NO	18,18			24,93
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0,22	356,01	195,65						551,87
A. Enteric fermentation		294,30							294,30
B. Manure management		61,32	69,98						131,30
C. Rice cultivation		NO							NO
D. Agricultural soils		NE	125,54						125,54
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		0,39	0,12						0,52
G. Liming	NO								NO
H. Urea application	0,22								0,22
I. Other carbon-containing fertilizers	NO								NO
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[1]	-349,67	0,64	0,23						-348,81
A. Forest land	-133,29	0,64	0,23						-132,42
B. Cropland	-133,42	NO,NE	NE						-133,42
C. Grassland	-118,00	NO,NE	NE						-118,00
D. Wetlands	-0,87	NO,NE	NO,NE						-0,87
E. Settlements	12,83	NO,NE	NO,NE						12,83
F. Other land	NO,NE	NO,NE	NO,NE						NO,NE
G. Harvested wood products	23,08								23,08
H. Other	NO	NO	NO						NO
5. Waste	NO,NA	593,92	20,67						614,59
A. Solid waste disposal	NO,NA	541,46							541,46
B. Biological treatment of solid waste		5,93	4,19						10,12
C. Incineration and open burning of waste	NO	NO	NO						NO
D. Waste water treatment and discharge		46,54	16,48						63,02
E. Other	NO	NO	NO						NO
6. Other *(as specified in summary 1.A)*									

Memo items:[2]									
International bunkers	1201,10	1,68	12,49						1215,26
Aviation	326,65	0,06	2,72						329,43
Navigation	874,45	1,62	9,76						885,83
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	412,53								412,53
CO_2 captured	NO								NO
Long-term storage of C in waste disposal sites									
Indirect N_2O			NO,NE						
Indirect CO_2 [3]	6,86								
Total CO_2 equivalent emissions without land use, land-use change and forestry									8871,57
Total CO_2 equivalent emissions with land use, land-use change and forestry									8522,77
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									8878,44
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									8529,63

[1] For carbon dioxide (CO_2) from land use, land-use change and forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for

[2] See footnote 7 to table Summary 1.A.

[3] In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

Annex III: BaU scenario - activity data

Table III.1 Annual Fuel Consumption by Energy Sector per Scenario 2020–2040: BUSINESS AS USUAL

Fuel consumption (TJ)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Electricity																
Natural gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HFO	21856	22669	26073	28100	29380	26743	28413	30046	32799	34627	36421	36149	37648	40460	42149	44622
Diesel	0	0	450	149	84	351	254	246	496	897	799	158	68	217	361	699
Manufacture of Solid Fuels																
Charcoal	112	112	112	112	405	388	328	288	314	281	248	253	235	209	184	174
Other Energy Industries																
Diesel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacturing Industry (excluding cement)																
Diesel	534	594	719	747	769	834	878	921	981	1008	1041	1052	1008	1036	932	866
LPG	172	172	193	179	175	179	179	182	175	172	186	186	189	203	196	186
gas biomass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kerosene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other oil products	0.0	201	0.0	0.0	0.0	0.0	0.0	40.2	0.0	0.0	0.0	0.0	0.0	0.0	241	0.0
RFO	1059	3548	3377	2862	3148	2776	3176	2003	1946	1946	2003	1545	1574	1855	2148	1374
Solid biofuels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White spirit	0.0	0.0	0.0	40.2	0.0	40.2	40.2	40.2	0.0	40.2	0.0	40.2	0.0	0.0	0.0	40.2
1A2f Non-Metallic Minerals (cement)																
Pet-coke	1300	3023	2763	3705	3640	4063	4778	4940	4875	5005	4583	4323	4518	4453	4745	5005
RFO	374	1252	1192	1010	1111	980	1121	707	687	687	707	545	556	626	687	1495
Diesel	89	99	120	124	128	139	146	154	164	168	174	175	168	173	155	144
LPG	43	43	48	45	44	45	45	46	44	43	46	46	47	51	49	46
Other kerosene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other bituminous coal	2503	2503	671	800	697	516	464	490	671	774	1264	1367	1367	1367	1471	1632
Solid biomass	0	0	0	0	0	0	0	0	0	0	41	70	90	211	127	38
Industrial waste (non-renewable)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18	0	15	71	138
Municipal waste (non-renewable)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1A3a i International Aviation																
Jet kerosene	10043	11933	11609	9873	10144	11145	10689	10532	11107	11382	11571	13576	13076	14005	12809	11652
1A3a ii Domestic Aviation																
Jet kerosene	364	415	386	314	307	321	292	272	271	261	248	271	242	239	200	175
1A3b Road Transport																
Gasoline	7219	7529	7618	7485	7972	8105	8237	8458	8635	8989	9121	9697	10095	11157	12484	13413
Diesel	9000	8657	10543	10928	11185	12214	12771	13456	14313	14564	15024	15243	14635	15071	15192	14842
LPG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Biodiesel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fuel consumption (TJ)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1A3d i International water-borne navigation																
Diesel	1032	860	903	602	516	645	1075	1161	1505	1978	2150	2021	1419	1548	1161	2881
RFO	1374	1454	1535	1454	2020	2182	2626	2868	2545	4363	5777	5858	4242	3555	1091	9090
1A3d ii Domestic water-borne navigation																
Diesel	30	29	35	36	37	40	42	44	47	53	23	18	24	19	26	31
1A4a Commercial / Institutional																
Diesel	475	528	640	664	683	741	780	819	872	896	925	935	896	921	829	770
RFO	62	209	199	168	185	163	187	118	114	114	118	91	93	104	114	40
LPG	558	558	626	581	569	581	581	592	569	558	604	604	615	660	638	604
Other kerosene	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
solid biomass	19	15	15	15	11	12	17	9	8	11	10	10	10	9	8	7
gas biomass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Charcoal	15	15	15	15	30	103	103	103	118	103	74	74	103	103	118	148
1A4b Residential																
Other kerosene	526	526	745	701	745	745	788	876	920	876	1051	1051	1358	1358	1051	701
Diesel	2255	2509	3038	3153	3245	3521	3705	3889	4143	4258	4396	4442	4258	4373	3935	3569
LPG	1502	1502	1686	1564	1533	1564	1564	1594	1533	1502	1625	1625	1656	1778	1717	1625
solid biomass	126	105	103	102	74	79	119	61	56	77	68	70	64	58	53	51
charcoal	15	15	15	15	30	103	103	103	118	103	74	74	103	103	118	148
1A4c Agriculture / Forestry / Fishing / Fish farms - *stationary*																
Diesel	623	693	839	871	897	973	1024	1075	1145	1176	1215	1227	1176	1208	1087	1029
LPG	43	43	48	45	44	45	45	46	44	43	46	46	47	51	49	46
Gas biomass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
mobile																
Diesel	89	99	120	124	128	139	146	154	164	168	174	175	168	173	155	132
1A5a Stationary																
Diesel	148	165	200	207	213	232	244	256	273	280	289	292	280	288	259	241
LPG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1A5b Mobile																
Diesel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fuel consumption (TJ)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Electricity															
Natural gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HFO	46014	47530	49583	47448	42797	43097	36529	26371	32281	35069	35877	31609	32621	31325	24516
Diesel	294	686	975	3921	6763	4770	9135	10111	5234	3816	6406	10890	10498	11009	14584
Manufacture of Solid Fuels															
Charcoal	135	274	211	47	48	45	82	71	58	94	163	172	112	93	80
Other Energy Industries															
Diesel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	262

Fuel consumption (TJ)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Industry (excluding cement)															
Diesel	885	780	663	663	516	676	860	516	516	688	688	901	795	1025	905
LPG	237	237	189	237	189	237	284	189	237	284	237	326	340	377	346
gas biomass	0	0	0	15	30	67	70	68	67	69	68	68	66	65	66
Kerosene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	87.6	0.0	0.0	1.6	1.2	4.3	5
Other oil															0
RFO	1050	1818	1616	1212	1212	1535	570	604	768	565	647	712	640	600	592
Solid biofuels	0	0	0	0	0	0	0	0	86	59	57	72	85	117	83
White spirit	40.2	40.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
1A2f Non-Metallic Minerals (cement)															
Pet-coke	4745	4648	4940	4680	3770	3250	3055	4388	5265	4153	4007	3533	2420	1806	2038
RFO	1414	1535	1535	1212	1010	606	525	323	283	323	404	497	587	621	541
Diesel	147	123	111	111	86	98	129	43	43	43	86	70	59	78	98
LPG	47	47	47	47	47	47	47	47	47	47	47	18	19	21	34
Other kerosene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	2.1	0.8	0.9
Other bituminous coal	1620	1403	1157	613	736	313	0	0	96	155	21	130	582	714	579
Solid biomass	61	133	281	304	347	306	29	28	116	95	55	86	78	126	205
Industrial waste (non-renewable)	73	288	239	276	299	4	0	0	279	221	94	90	157	165	289
Municipal waste (non-renewable)	0.0	0.0	0.0	0.0	0.0	0.0	24	45	37	295	569	812	805	1123	1168
1A3a i International Aviation															
Jet kerosene	11746	11570	12008	11350	11582	12015	11618	10837	10850	10502	12268	13963	14505	14365	4568
1A3a ii Domestic Aviation															
Jet kerosene	147	131	125	101	107	32.6	20.8	13.4	8.4	12.6	7.9	11.5	12.4	5.24	1.33
1A3b Road Transport															
Gasoline	7219	7529	7618	7485	7972	8105	8237	8458	8635	8989	9121	9697	10095	11157	12484
Diesel	9000	8657	10543	10928	11185	12214	12771	13456	14313	14564	15024	15243	14635	15071	15192
LPG	0	0	0	0	0	0	0	0	0	0	0	0	21	23	19
Biodiesel	0	37	592	629	629	666	666	629	407	407	370	359	375	450	1037
Natural Gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1A3d i International water-borne navigation															
Diesel	4558	4472	3784	3139	2279	2494	2967	3569	3440	3225	4085	4356	5064	5322	5121
RFO	7676	6908	6666	5898	5414	5696	5171	6343	6181	6828	7797	6226	6226	6311	6395
1A3d ii Domestic water-borne navigation															
Diesel	24	27	33	64	41	38	27	20	24	27	20	29	28	38	17
1A4a Commercial / Institutional															
Diesel	817	774	860	817	989	860	688	731	559	559	645	782	702	706	505
RFO	81	81	81	81	81	81	162	162	81	121	162	170	129	146	98
LPG	615	615	662	615	615	662	662	568	520	568	520	623	650	735	526
Other kerosene	0	0	0	0	0	0	0	0	0	0	0	2	78	105	107
solid biomass	5	14	15	15	15	13	16	16	16	15	15	17	17	17	132
gas biomass	0	0	0	11	12	11	11	11	12	12	16	17	45	54	20

Fuel consumption (TJ)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Charcoal	148	207	207	177	177	177	177	177	177	207	207	209	176	166	161
1A4b Residential															
Other kerosene	701	701	613	832	613	701	745	526	394	613	613	624	407	550	560
Diesel	4214	3827	3354	3569	3010	3440	3268	2666	2451	2795	2795	2797	2298	2599	2567
LPG	1656	1703	1608	1703	1608	1797	1750	1561	1466	1608	1656	1536	1346	1521	1481
solid biomass	74	95	123	500	260	339	419	353	249	551	531	691.327	709.199	768.568	644
charcoal	148	177	177	148	148	177	177	177	177	207	236	255	256	249	300
1A4c Agriculture / Forestry / Fishing / Fish farms - *stationary*															
Diesel	1076	1073	989	860	817	946	903	903	817	946	903	957	884	945	1022
LPG	47	47	47	47	47	47	47	47	0	95	95	115	120	135	122
Gas biomass	0	15	78	209	274	448	476	466	464	460	475	419	443	464	471
mobile															
Diesel	128	131	129	172	172	129	129	86	86	86	86	80	77	82	64
1A5a Stationary															
Diesel	172	258	559	215	215	258	215	215	387	258	258	238	261	244	242
LPG	0	0	0	0	0	0	0	47	47	47	47	62	43	59	60
1A5b Mobile															
Diesel	0	0	0	44	44	88	44	88	88	44	44	54	63	56	66

Fuel consumption (TJ)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Electricity																				
Natural gas	0	0	0	30810	30872	31662	30567	30934	32300	33555	25972	25570	18214	18053	17945	17332	17190	17085	17033	15409
HFO	27684	26473	26590	728	68	122	151	241	80	0	0	0	0	0	0	0	0	0	0	0
Diesel	12339	13655	13192	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Manufacture of Solid Fuels																				
Charcoal	85	87	90	93	96	98	101	103	104	106	108	110	112	114	116	119	122	125	128	131
Other Energy Industries																				
Diesel	276	283	294	304	313	321	328	335	341	346	352	359	365	372	380	389	398	407	417	427
Industry (excluding cement)																				
Diesel	915	901	909	934	956	963	951	950	952	955	940	929	922	918	918	922	929	935	941	946
LPG	362	353	353	359	363	363	357	354	352	351	345	340	336	334	334	335	338	340	342	344
gas biomass	13.3	15.9	19.0	23.3	27.7	31.5	33.9	37.5	41.6	45.8	48.8	52.0	55.4	59.1	63.3	67.9	73.0	78.2	83.7	89.6
Kerosene	5.4	5.3	5.3	5.4	5.4	5.4	5.3	5.3	5.3	5.3	5.2	5.1	5.0	5.0	5.0	5.0	5.0	5.1	5.1	5.1
Other oil	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RFO	1113	1081	1074	1082	1086	1075	1047	1029	1012	998	969	945	924	909	898	891	887	882	878	874
Solid biofuels	17	20	24	30	35	40	43	47	53	58	62	66	70	75	80	86	92	99	106	113
White spirit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1A2f Non-Metallic Minerals (cement)																				
Pet-coke	430	342	253	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221	221

Fuel consumption (TJ)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
RFO	46	36	27	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Diesel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
LPG	9	8	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Other kerosene	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other bituminous coal	1714	1362	1010	881	881	881	881	881	881	881	881	881	881	881	881	881	881	881	881	881
Solid biomass	279	222	165	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144	144
Industrial waste (non-renewable)	266	212	157	137	137	137	137	137	137	137	137	137	137	137	137	137	137	137	137	137
Municipal waste (non-renewable)	1426	1133	840	733	733	733	733	733	733	733	733	733	733	733	733	733	733	733	733	733
1A3a i International Aviation																				
Jet kerosene	14010	14390	14933	15440	15901	16298	16673	17007	17294	17589	17895	18211	18544	18902	19297	19727	20198	20681	21175	21681
1A3a ii Domestic Aviation																				
Jet kerosene	1.40	1.44	1.50	1.55	1.59	1.63	1.67	1.70	1.73	1.76	1.79	1.82	1.86	1.89	1.93	1.98	2.02	2.07	2.12	2.17
1A3b Road Transport																				
Gasoline	13442	13282	12978	13115	12737	12364	11808	11178	10356	9532	8676	7843	7018	6191	5375	4449	3626	2782	1871	1378
Diesel	14924	12566	12304	11792	11074	10375	9707	9050	8408	7794	7226	6678	6161	5613	4859	4100	4076	3797	3293	3005
LPG	3	6	9	12	14	17	19	21	24	25	28	30	32	34	36	36	7	21	36	35
Biodiesel	802	675	1109	1087	1035	985	930	872	810	748	688	630	573	515	447	374	344	300	242	209
Natural Gas	0	0	0	0	237	236	235	234	233	232	232	231	231	230	230	237	237	236	302	140
1A3d i International water-borne navigation																				
Diesel	5403	5550	5759	5955	6133	6286	6431	6559	6670	6784	6902	7024	7152	7290	7442	7608	7790	7976	8167	8362
RFO	6748	6931	7192	7436	7658	7850	8030	8191	8329	8471	8619	8771	8931	9104	9294	9501	9728	9960	10199	10442
1A3d ii Domestic water-borne navigation																				
Diesel	38	39	40	42	43	44	45	46	47	47	48	49	50	51	52	53	54	56	57	58
1A4a Commercial / Institutional																				
Diesel	530	555	584	667	762	835	881	920	945	941	918	897	877	858	841	825	804	782	759	736
RFO	103	108	113	127	142	154	162	169	173	173	170	166	163	159	156	153	149	146	141	137
LPG	552	571	594	657	726	778	812	837	850	840	816	793	771	751	732	715	694	672	651	630
Other kerosene	101	104	108	120	132	142	148	152	155	153	149	144	140	137	133	130	126	122	119	115
solid biomass	141	149	158	188	223	251	271	289	303	306	303	299	296	294	292	291	287	282	277	271
gas biomass	22	23	24	29	34	38	41	44	46	47	46	46	45	45	45	44	44	43	42	41
Charcoal	172	182	194	229	272	307	331	353	370	374	370	366	362	359	357	355	350	345	338	332
1A4b Residential																				
Other kerosene	515	530	565	604	634	644	656	659	655	648	636	623	609	592	574	552	531	512	493	474
Diesel	2345	2412	2574	2750	2887	2932	2987	3002	2984	2951	2897	2839	2772	2696	2614	2515	2420	2330	2244	2158
LPG	1489	1556	1705	1896	2071	2152	2228	2297	2355	2397	2420	2440	2455	2469	2479	2461	2447	2436	2428	2422
solid biomass	641	641	661	678	690	689	693	691	685	678	667	658	649	640	631	617	605	594	586	578
charcoal	302	302	311	319	325	324	326	325	322	319	314	310	305	301	297	290	285	280	276	272
1A4c Agriculture / Forestry / Fishing / Fish farms - *stationary*																				

Fuel consumption (TJ)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Diesel	1029	1019	1024	1035	1040	1032	1013	996	977	958	937	919	902	888	877	868	860	851	841	823
LPG	82	81	81	81	80	79	77	75	73	71	68	66	65	63	61	60	59	58	57	55
Gas biomass	448	443	446	450	453	449	441	434	425	417	408	400	393	387	382	378	374	370	366	358
mobile																				
Diesel	61	60	60	61	61	61	60	59	57	56	55	54	53	52	52	51	51	50	49	48
1A5a Stationary																				
Diesel	256	263	273	282	290	298	304	310	316	321	327	332	339	345	352	360	369	378	387	396
LPG	63	65	68	70	72	74	76	77	78	80	81	83	84	86	87	89	92	94	96	98
1A5b Mobile																				
Diesel	70	71	74	77	79	81	83	84	86	87	89	90	92	94	96	98	100	103	105	108

Table III.2 Activity data for the non-energy sectors per Scenario 2020–2040: BUSINESS AS USUAL

Activity Data	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
2.INDUSTRIAL PROCESSES																				
2A1 Cement production																				
Clinker (t)	1650851	1844996	1892964	1940932	1988900	2000000	2000000	2000000	2000000	2000000	2000000	2000000	2000000	2000000	2000000	2000000	2000000	2000000	2000000	2000000
2A2 Lime Production																				
Slaked lime (t)	4647	5019	5392	5764	6137	6510	6882	7255	7627	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000	8000
2A4a Ceramics																				
Production (t)	177156	177156	177156	177156	177156	177156	177156	177156	177156	177156	177156	177156	177156	177156	177156	177156	177156	177156	177156	177156
2A4b Other Uses of Soda Ash	172	172	193	179	175	179	179	182	175	172	186	186	189	203	196					
Imports (t)	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154
2D1: Lubricant Use																				
Consumption (kt)	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01
2D2: Paraffin Wax Use																				
Imports (kt)	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113
2D3 Other																				
Urea-based catalysts																				
Diesel (Gg)	347	292	286	274	258	241	226	210	196	181	168	155	143	131	113	95	95	88	77	70
3. AGRICULTURE																				
3A1a Dairy cattle																				
kg milk/ day	19.6	19.6	19.6	19.7	19.7	19.7	19.7	19.7	19.8	19.8	19.8	19.8	19.8	19.9	19.9	19.9	19.9	19.9	20.0	20.0
GE MJ/head/day	287.5	288.8	290.1	291.4	292.8	294.1	295.4	296.7	298.1	299.4	300.7	302.0	303.3	304.7	306.0	307.3	308.6	309.9	311.3	312.6
population																				
Dairy cattle	38924	38353	37783	37213	36643	36072	35502	34932	34362	33791	33707	33622	33538	33453	33369	33285	33200	33116	33031	32947
Other cattle	42818	42227	41635	41044	40452	39860	39269	38677	38086	37494	37400	37307	37213	37119	37025	36932	36838	36744	36650	36557

Activity Data	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Sheep	330981	333855	336729	339602	342476	345350	348224	351098	353972	356846	356846	356846	356846	356846	356846	356846	356846	356846	356846	356846
Swine	356681	354307	351932	349558	347183	344809	342434	340060	337685	335311	334640	333969	333299	332628	331957	331287	330616	329946	329275	328604
Horses	472	472	472	472	472	472	472	472	472	472	472	472	472	472	472	472	472	472	472	472
Mules and Asses	1332	1393	1450	1504	1554	1601	1644	1684	1720	1753	1782	1808	1831	1850	1865	1877	1886	1891	1893	1893
Goats	262317	263852	265386	266921	268456	269991	271525	273060	274595	276130	276130	276130	276130	276130	276130	276130	276130	276130	276130	276130
Poultry	3578368	3581589	3584810	3588031	3591251	3594472	3597693	3600914	3604135	3578368	3614063	3649758	3685454	3721149	3756844	3792539	3828234	3863929	3899625	3935320
3D Agricultural Soils																				
FSN (kt N in fertilizer)	7.763	7.744	7.726	7.707	7.689	7.670	7.651	7.633	7.614	7.596	7.577	7.559	7.540	7.521	7.503	7.484	7.466	7.447	7.429	7.410
FAM (kt N)	16.70	16.72	16.74	16.76	16.78	16.80	16.82	16.84	16.85	16.86	16.87	16.87	16.88	16.88	16.89	16.90	16.90	16.91	16.91	16.92
N SEWSLUDGE (kt N)	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460	0.0460
N COMP (kt N)	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124	0.124
FCR (kt N)	0.760	0.760	0.760	0.760	0.760	0.760	0.760	0.760	0.760	0.760	0.760	0.760	0.760	0.760	0.760	0.760	0.760	0.760	0.760	0.760
Atmospheric deposition (kt N)	4.151	4.153	4.155	4.157	4.159	4.160	4.162	4.164	4.166	4.165	4.165	4.164	4.164	4.163	4.162	4.161	4.161	4.160	4.159	4.159
3H Urea application																				
M - kt applied	299	299	298	297	296	296	295	294	293	293	292	291	290	290	289	288	287	287	286	285
5. WASTE																				
Population (mln)	0.914	0.917	0.920	0.923	0.926	0.929	0.930	0.931	0.933	0.934	0.936	0.936	0.936	0.936	0.936	0.936	0.934	0.933	0.932	0.930
5A. Solid waste disposal																				
per capita production (kg/cap)	646	646	646	646	646	646	646	646	646	646	646	646	646	646	646	646	646	646	646	646
Waste to disposal sites (kt)	429	429	429	429	429	429	429	429	429	429	429	429	429	429	429	429	429	429	429	429
Managed, anaerobic waste management	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Composition of waste to disposal sites																				
Food	39%	39%	39%	39%	39%	39%	39%	39%	39%	39%	39%	39%	39%	39%	39%	39%	39%	39%	39%	39%
Garden	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Paper	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%	27%
Wood	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Textile	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Nappies	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Plastics, other inert	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%	19%
Other solid to landfills- Deep Unmanaged (Gg)																				

Activity Data	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Industrial effluent sludge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wood wastes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Textile wastes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Animal and vegetal wastes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other solid to landfills- Deep Managed (Gg)																				
Industrial effluent sludge	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Wood wastes	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
Textile wastes	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Animal and vegetal wastes	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
5B Biological Treatment																				
M composted (kt)	56.1	56.2	56.4	56.6	56.8	57.0	57.0	57.1	57.2	57.3	57.4	57.4	57.4	57.4	57.4	57.4	57.3	57.2	57.1	57.1
M digested (kt)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
5D Wastewater Treatment and Discharge																				
TOW septic (kt)	3.11	3.12	3.13	3.14	3.15	3.16	3.16	3.17	3.17	3.17	3.18	3.18	3.18	3.18	3.18	3.18	3.17	3.17	3.17	3.16
TOW collected (kt)	21.14	21.21	21.27	21.34	21.41	21.48	21.51	21.54	21.57	21.61	21.64	21.64	21.64	21.64	21.64	21.64	21.61	21.58	21.55	21.52
Protein, kg/person	29.81	30.81	31.81	32.81	33.81	34.81	35.81	36.81	37.81	38.81	39.81	40.81	41.81	42.81	43.81	44.81	45.81	46.81	47.81	48.81
NWWT (t)	1.861	1.867	1.873	1.879	1.885	1.891	1.894	1.897	1.900	1.902	1.905	1.905	1.905	1.905	1.905	1.905	1.903	1.900	1.897	1.894
TOW industrial (kt COD/yr)	16.86	17.31	17.97	18.58	19.13	19.61	20.06	20.46	20.81	21.16	21.53	21.91	22.31	22.74	23.22	23.73	24.30	24.88	25.48	26.09
Anaerobic																				
alcohol	3.5%	3.4%	3.3%	3.2%	3.1%	3.0%	2.9%	2.9%	2.8%	2.8%	2.7%	2.7%	2.6%	2.6%	2.5%	2.5%	2.4%	2.4%	2.3%	2.3%
beer	15.5%	15.1%	14.6%	14.1%	13.7%	13.3%	13.0%	12.8%	12.6%	12.4%	12.1%	11.9%	11.7%	11.5%	11.3%	11.0%	10.8%	10.5%	10.3%	10.0%
soft drinks	3.4%	3.3%	3.1%	3.0%	3.0%	2.9%	2.8%	2.8%	2.7%	2.7%	2.6%	2.6%	2.5%	2.5%	2.4%	2.4%	2.3%	2.3%	2.2%	2.2%
dairy products	3.8%	3.7%	3.6%	3.5%	3.4%	3.3%	3.2%	3.1%	3.1%	3.0%	3.0%	2.9%	2.9%	2.8%	2.8%	2.7%	2.6%	2.6%	2.5%	2.5%
meat & poultry	4.8%	4.7%	4.5%	4.4%	4.2%	4.1%	4.0%	4.0%	3.9%	3.8%	3.8%	3.7%	3.6%	3.6%	3.5%	3.4%	3.3%	3.3%	3.2%	3.1%
soaps & detergents	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
vegetable oils	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
vegetables, fruits & juices	0.6%	0.6%	0.6%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
wine	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Annex IV: WEM scenario - activity data

Table IV.1 Annual Fuel Consumption by Energy Sector per Scenario 2020–2040: WITH EXISTING MEASURES

Fuel consumption (TJ)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Electricity																				
Natural gas	0	0	0	28725	28106	28049	26073	27002	27541	27956	18360	17794	17418	17034	16791	16484	16150	16139	14920	12926
HFO	27684	26362	26474	689	17	28	41	56	0	0	0	0	0	0	0	0	0	0	0	0
Diesel	12339	13062	11850	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Industry (excluding cement)																				
Diesel	915	887	880	890	897	890	865	851	839	828	815	806	799	795	796	799	805	810	816	821
LPG	362	348	342	342	342	336	325	317	311	305	299	295	292	290	290	291	293	295	296	298
gas biomass	13	15	18	22	26	29	30	33	36	39	42	45	48	51	55	59	63	68	73	78
Kerosene	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4
Other oil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RFO	1113	1065	1042	1034	1022	996	955	924	895	868	842	820	802	788	779	773	769	765	762	758
Solid biofuels	17	20	23	28	32	36	38	42	46	50	53	57	60	65	69	74	80	86	92	98
White spirit	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1A3b Road Transport																				
Gasoline	13442	13282	12978	13115	12737	12364	11808	10974	10155	9333	8479	7647	6824	5998	5183	4259	3437	2595	1686	1194
Diesel	14924	12566	12304	11792	11074	10375	9707	9050	8408	7794	7226	6678	6161	5613	4864	4105	4081	3802	3298	3010
LPG	3	6	9	12	14	17	19	21	24	25	28	30	32	34	36	36	7	21	36	35
Biodiesel	802	675	1109	1087	1035	985	930	865	803	741	681	623	567	509	440	368	338	294	235	203
Natural Gas	0	0	0	0	237	236	235	234	233	232	232	231	231	230	230	237	237	236	302	140
1A4a Commercial / Institutional																				
Diesel	530	552	579	657	746	814	855	889	909	907	887	868	849	832	817	803	783	762	741	720
RFO	103	107	112	125	139	150	158	164	167	167	164	161	158	155	152	150	146	142	139	135
LPG	552	569	590	649	713	761	790	811	821	812	790	769	749	730	713	697	677	657	637	617
Other kerosene	101	104	108	118	130	139	144	148	150	148	144	140	136	133	130	127	123	120	116	112
solid biomass	141	148	157	185	218	244	262	278	290	294	291	289	286	284	283	282	278	274	270	265
gas biomass	22	23	24	28	33	37	40	42	44	45	44	44	44	43	43	43	43	42	41	40
Charcoal	172	181	192	225	266	298	320	339	355	360	356	353	350	347	346	345	340	335	330	323
1A4b Residential																				
Other kerosene	515	524	554	586	610	615	621	620	612	601	588	574	559	542	525	507	489	472	456	440
Diesel	2345	2387	2523	2671	2780	2800	2831	2824	2786	2736	2678	2616	2546	2469	2394	2308	2227	2151	2077	2004
LPG	1489	1534	1660	1825	1972	2026	2076	2119	2152	2170	2182	2192	2197	2199	2210	2205	2205	2208	2214	2223
solid biomass	641	637	652	665	671	665	664	656	645	632	620	609	597	585	577	566	557	550	544	540
charcoal	302	300	307	313	316	313	313	309	303	298	292	286	281	275	272	266	262	259	256	254
1A4c Agriculture / Forestry / Fishing / Fish farms - *stationary*																				
Diesel	1029	1019	1024	1035	1041	1033	1014	997	978	960	939	921	905	890	880	871	863	854	844	827
LPG	82	81	81	81	80	79	77	75	73	71	69	67	65	63	62	60	59	58	57	56

Fuel consumption (TJ)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Gas biomass	448	443	446	451	453	450	442	434	426	418	409	401	394	388	383	379	376	372	368	360
mobile																				
Diesel	61	60	60	61	61	61	60	59	57	56	55	54	53	52	52	51	51	50	49	48

Table IV.2 Activity data for the non-energy sectors per Scenario 2020–2040: WITH EXISTING MEASURES

Activity Data	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
2.INDUSTRIAL PROCESSES																				
Urea-based catalysts																				
Diesel (Gg)	313	309	302	305	296	288	275	255	236	217	197	178	159	139	121	99	80	60	39	28
2F Product Uses as Substitutes for Ozone Depleting Substances																				
recovery	0%	0%	0%	0.7%	1.4%	2.1%	2.9%	3.6%	4.3%	5%	5.5%	6.0%	6.5%	7.0%	7.5%	8.0%	8.5%	9.0%	9.5%	10%
2G Other Product Manufacture and Use																				
recovery	0%	0%	0%	0.7%	1.4%	2.1%	2.9%	3.6%	4.3%	5%	5.5%	6.0%	6.5%	7.0%	7.5%	8.0%	8.5%	9.0%	9.5%	10%
5. WASTE																				
5A. Solid waste disposal																				
Waste to disposal sites (kt)	375154	355390	335304	315081	269111	263968	258356	252725	247077	241411	235727	229680	223632	217585	211539	211536	211239	210942	210645	210348
Composition of waste to disposal sites																				
Food	35%	32%	28%	24%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%
Garden	6%	5%	5%	4%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Paper	29%	31%	33%	35%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%
Wood	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Textile	7%	7%	8%	8%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%
Nappies	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Plastics, other inert	20%	22%	23%	25%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%
5B Biological Treatment																				
M digested (kt)	1.281	1.294	1.320	1.359	1.414	1.484	1.573	1.684	1.818	1.982	2.180	2.420	2.710	3.063	3.491	4.015	4.657	5.449	6.430	7.652
5D Wastewater Treatment and Discharge																				
TOW septic (kt)	3.10	3.11	3.06	2.06	2.07	2.07	1.45	1.22	1.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOW collected (kt)	21.14	21.21	21.35	22.68	22.76	22.83	23.65	23.97	24.18	25.58	25.61	25.61	25.61	25.61	25.61	25.61	25.58	25.54	25.50	25.47
Protein, kg/person	28.81	29.81	30.81	31.81	32.81	33.81	34.81	35.81	36.81	37.81	38.81	39.81	40.81	41.81	42.81	43.81	44.81	45.81	46.81	47.81

Activity Data	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
NWWT (t)	1.861	1.867	1.873	1.879	1.885	1.891	1.894	1.897	1.900	1.902	1.905	1.905	1.905	1.905	1.905	1.905	1.903	1.900	1.897	1.894
Anaerobic																				
alcohol	3.5%	3.4%	3.3%	3.2%	3.1%	3.5%	3.9%	4.2%	4.6%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
beer	15.5%	15.1%	14.6%	14.1%	13.7%	14.9%	16.2%	17.5%	18.7%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
soft drinks	3.4%	3.3%	3.1%	3.0%	3.0%	3.4%	3.8%	4.2%	4.6%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
dairy products	3.8%	3.7%	3.6%	3.5%	3.4%	4.1%	4.8%	5.5%	6.3%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%
meat & poultry	4.8%	4.7%	4.5%	4.4%	4.2%	5.4%	6.5%	7.7%	8.8%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
soaps & detergents	3.5%	3.4%	3.3%	3.2%	3.1%	3.5%	3.9%	4.2%	4.6%	5.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
vegetable oils	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
vegetables, fruits & juices	0.6%	0.6%	0.6%	0.5%	0.5%	1.4%	2.3%	3.2%	4.1%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
wine	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Annex V: WAM scenario - activity data

Table V.1. Annual Fuel Consumption by Energy Sector per Scenario 2020–2040: WITH ADDITIONAL MEASURES

Fuel consumption (TJ)	2021		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Electricity																					
Natural gas	0		0	0	28689	27160	26134	24257	24346	24195	23852	16528	16497	16455	16260	16211	15830	15284	14810	13350	11985
HFO	27684		26419	26502	689	6	5	6	2	0	0	0	0	0	0	0	0	0	0	0	0
Diesel	12339		13360	12231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Industry (excluding cement)																					
Diesel	915		887	880	890	897	890	865	851	839	828	815	806	799	795	796	799	805	810	816	821
LPG	362		348	342	342	342	336	325	317	311	305	299	295	292	290	290	291	293	295	296	298
gas biomass	13		15	18	22	26	29	30	33	36	39	42	45	48	51	55	59	63	68	73	78
Kerosene	5		5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4
Other oil	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RFO	1113		1065	1042	1034	1022	996	955	924	895	868	842	820	802	788	779	773	769	765	762	758
Solid biofuels	17		20	23	28	32	36	38	42	46	50	53	57	60	65	69	74	80	86	92	98
White spirit	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1A3b Road Transport																					
Gasoline	13442		12605	11954	11727	11257	10794	10246	9422	8612	7804	6967	6153	5357	4548	3713	2763	2605	1993	1394	1001
Diesel	14924		12566	12304	11792	11074	10375	9707	9050	8408	7794	7226	6678	6161	5598	4864	4109	4085	3806	3302	3014
LPG	3		6	9	12	14	17	19	21	24	25	28	30	32	34	15	36	35	36	36	35
Biodiesel	802		675	1074	1039	984	930	876	812	749	688	629	571	516	458	390	316	310	273	226	197
Natural Gas	0		0	0	0	237	236	235	234	233	232	232	231	231	230	230	237	237	236	236	8
1A4a Commercial / Institutional																					
Diesel	530		525	523	543	557	559	547	538	528	517	497	478	459	443	428	414	397	381	365	349
RFO	103		103	103	106	108	108	107	105	103	101	97	93	90	86	83	80	77	74	71	68
LPG	552		546	543	553	556	550	535	521	505	490	467	446	426	407	390	375	358	342	326	310
Other kerosene	101		99	99	101	101	100	97	95	92	89	85	81	78	74	71	68	65	62	59	56
solid biomass	141		140	139	148	156	159	157	157	158	158	154	150	147	144	141	139	135	132	128	123
gas biomass	22		21	21	23	24	24	24	24	24	24	23	23	22	22	22	21	21	20	20	19
Charcoal	172		171	170	181	190	195	192	192	193	193	188	183	179	176	173	170	166	161	156	151
1A4b Residential																					
Other kerosene	515		524	542	559	565	554	548	536	521	507	491	475	457	439	420	400	381	364	347	331
Diesel	2345		2387	2467	2548	2573	2524	2495	2442	2372	2311	2239	2164	2084	1999	1912	1823	1737	1657	1581	1506
LPG	1489		1534	1610	1712	1778	1763	1749	1741	1733	1735	1725	1712	1695	1677	1657	1629	1604	1581	1521	1521

Fuel consumption (TJ)	2021		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
solid biomass	641		637	643	643	634	613	599	580	560	544	526	509	493	476	460	444	429	416	404	393
charcoal	302		300	303	303	298	288	282	273	263	256	248	240	232	224	217	209	202	196	190	185
1A4c Agriculture / Forestry / Fishing / Fish farms - *stationary*																					
Diesel	1029		1019	1024	1035	1041	1033	1014	997	978	960	939	921	905	891	880	871	863	855	845	835
LPG	82		81	81	81	80	79	77	75	73	71	69	67	65	63	62	60	59	58	57	56
Gas biomass	448		443	446	450	453	450	441	434	426	418	409	401	394	388	383	379	376	372	368	363
mobile																					
Diesel	61		60	60	61	61	61	60	59	58	56	55	54	53	52	52	51	51	50	50	49

Table V.2 Activity data for the non-energy sectors per Scenario 2020–2040: WITH ADDITIONAL MEASURES

Activity Data	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
2.INDUSTRIAL PROCESSES																				
Urea-based catalysts																				
Diesel (Gg)	347	292	286	274	258	241	226	210	196	181	168	155	143	130	113	96	95	89	77	70
2F Product Uses as Substitutes for Ozone Depleting Substances																				
recovery	0%	0%	0%	2.5%	5.0%	6.0%	7.0%	8.0%	9.0%	10%	11.0%	12.0%	13.0%	14.0%	15.0%	16.0%	17.0%	18.0%	19.0%	20%
2G Other Product Manufacture and Use																				
recovery	0%	0%	0%	2.5%	5.0%	6.0%	7.0%	8.0%	9.0%	10%	11.0%	12.0%	13.0%	14.0%	15.0%	16.0%	17.0%	18.0%	19.0%	20%
5. WASTE																				
5A. Solid waste disposal																				
Waste to disposal sites (kt)	375154	355390	335304	315081	269111	263968	258356	252725	247077	241411	235727	229680	223632	217585	211539	211536	211239	210942	210645	210348
Composition of waste to disposal sites																				
Food	35%	32%	28%	24%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%	21%
Garden	6%	5%	5%	4%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Paper	29%	31%	33%	35%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%	37%
Wood	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Textile	7%	7%	8%	8%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%
Nappies	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Plastics, other inert	20%	22%	23%	25%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%	26%
5B Biological Treatment																				
M digested (kt)	1.281	1.294	1.320	1.359	1.414	1.484	1.573	1.684	1.818	1.982	2.180	2.420	2.710	3.063	3.491	4.015	4.657	5.449	6.430	7.652

Activity Data	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**
5D Wastewater Treatment and Discharge																				
TOW septic (kt)	3.10	3.11	3.06	2.06	2.07	2.07	1.45	1.22	1.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOW collected (kt)	21.14	21.21	21.35	22.68	22.76	22.83	23.65	23.97	24.18	25.58	25.61	25.61	25.61	25.61	25.61	25.61	25.58	25.54	25.50	25.47
Protein, kg/person	28.81	29.81	30.81	31.81	32.81	33.81	34.81	35.81	36.81	37.81	38.81	39.81	40.81	41.81	42.81	43.81	44.81	45.81	46.81	47.81
NWWT (t)	1.86	1.87	1.87	1.88	1.89	1.89	1.89	1.90	1.90	1.90	1.91	1.91	1.91	1.91	1.91	1.91	1.90	1.90	1.90	1.89
Anaerobic																				
alcohol	3.5%	3.4%	3.3%	3.2%	3.1%	3.5%	3.9%	4.2%	4.6%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
beer	15.5%	15.1%	14.6%	14.1%	13.7%	14.9%	16.2%	17.5%	18.7%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
soft drinks	3.4%	3.3%	3.1%	3.0%	3.0%	3.4%	3.8%	4.2%	4.6%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
dairy products	3.8%	3.7%	3.6%	3.5%	3.4%	4.1%	4.8%	5.5%	6.3%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%
meat & poultry	4.8%	4.7%	4.5%	4.4%	4.2%	5.4%	6.5%	7.7%	8.8%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
soaps & detergents	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
vegetable oils	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
vegetables, fruits & juices	0.6%	0.6%	0.6%	0.5%	0.5%	1.4%	2.3%	3.2%	4.1%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
wine	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%