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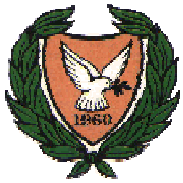

MINISTRY OF AGRICULTURE,
NATURAL RESOURCES AND
ENVIRONMENT

Environment Service

POLICIES & EMISSIONS' PROJECTIONS

Decision No 280/2004/EC Article 3(2):
Reporting by Member States

Nicosia, March 2007

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1. Introduction

Decision No 280/2004/EC of the European Parliament and of the Council concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol

Article 3(2)

Member States shall, for the assessment of projected progress, report to the Commission, by 15 March 2005 and every two years thereafter:

(a) information on national policies and measures which limit and/or reduce greenhouse gas emissions by sources or enhance removals by sinks, presented on a sectoral basis for each greenhouse gas, including:

(i) the objective of policies and measure;

(ii) the type of policy instrument;

(iii) the status of implementation of the policy or measure;

(iv) indicators to monitor and evaluate progress with policies and measures over time, including, inter alia, those indicators specified in the implementing provisions adopted pursuant to paragraph 3;

(v) quantitative estimates of the effect of policies and measures on emissions by sources and removals by sinks of greenhouse gases between the base year and subsequent years, including 2005, 2010 and 2015, including their economic impacts to the extent feasible; and

(vi) the extent to which domestic action actually constitutes a significant element of the efforts undertaken at national level as well as the extent to which the use of joint implementation and the clean development mechanism and international emissions trading, pursuant to Articles 6, 12 and 17 of the Kyoto Protocol, is actually supplemental to domestic actions, in accordance with the relevant provisions of the Kyoto Protocol and the Marrakech Accords;

(b) national projections of greenhouse gas emissions by sources and their removal by sinks as a minimum for the years 2005, 2010, 2015 and 2020, organised by gas and by sector, including:

(i) 'with measures' and 'with additional measures' projections such as mentioned in the guidelines of the UNFCCC and further specified in the implementing provisions adopted pursuant to paragraph 3;

(ii) clear identification of the policies and measures included in the projections;

(iii) results of sensitivity analysis performed for the projections; and descriptions of methodologies, models, underlying assumptions and key input and output parameters.

(c) information on measures being taken or planned for the implementation of relevant Community legislation and policies, and information on legal and institutional steps to prepare to implement commitments under the Kyoto Protocol and information on arrangements for, and national implementation of, compliance and enforcement procedures;

(d) information on institutional and financial arrangements and decision making procedures to coordinate and support activities related to participation in the mechanisms under Articles 6, 12 and 17 of the Kyoto Protocol, including the participation of legal entities.

This report has been prepared by the Environment Service of the Ministry of Agriculture, Natural Resources and Environment on behalf of the Republic of Cyprus, as required by the *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*.

After the Turkish invasion in 1974, approximately 40% of the island territory is under Turkish occupation. The data presented in this chapter concerns the areas under the effective control of the Government of the Republic of Cyprus.

2. Article 3(2)a: National Policies and Measures

2.1. Introduction

The policies associated with reduction of GHG emissions are primarily associated with energy, and involve developments in all sectors (industrial, tertiary etc.): Promotion of Renewable Energy sources, Promotion of new, less polluting fuels and Promotion of Rational Energy Use.

2.2. Energy

Objective

The objective of the policy is to promote the use of renewable energy, and investments in utilization of renewable energy sources. The indicative target set for this policy in the following years is an increase of electricity generation from RES, to reach 6% of the total electricity consumption in 2010, 9% in 2015 and 12% in 2020.

Policy instrument

The main policy instruments are financial incentives. The renewable energy sources being targeted for further development in Cyprus are solar collectors (for thermal and electricity applications), wind farms (small and large) and biomass utilization. Similarly, energy saving measures are encouraged and promoted.

Measures

Measures and actions taken (but not yet fully implemented) at national level for the promotion of RES and RUE, include 'SAVEnergy' exhibition, organising public hearings and RES info days, school presentations to promote "energy awareness", introduction of awards for the households with the best record in energy saving and promotion of the creation of a theme park. Additional measures that have been approved include:

- Introduction of simpler and faster procedures for submitting and evaluating applications;
- In order to facilitate applications and speed up the procedures for licenses and applications the Council of Ministers has recently approved the introduction of the "ONE STOP SHOP" for large investments in RES.
- Increase in the subsidy intensity and the maximum amount of grant in many categories of the scheme.
- Broadening the range of eligible applicants for thermal insulation (Construction companies are now eligible applicants)

- Provision of numerous benefits to low-energy vehicle owners like free parking and “charging stations” for electric vehicles.
- Purchasing of clean vehicles for the needs of the civil service.
- Promotion of legislation concerning the use of LPG and compressed natural gas in the transport sector.
- Evaluation of the optimal use of public transport within the local development plans.
- Improvement of driving behaviour by the evaluation of different indices like fuel consumption per vehicle, passenger number per vehicle and load per vehicle.
- A large-scale informative campaign was scheduled, to promote the use of RES and to encourage energy conservation.

As of 2006, a five year programme promoting energy saving has started. The programme is mainly financed from the special fund for energy conservation and the promotion of renewable resources. It includes undertaking of an intensive campaign on energy saving; energy saving through relevant investment expenditure in public buildings; the construction of new buildings of the broader public sector, the relevant provisions on energy saving should be complied with; and public procurement – the energy performance was introduced as a criterion in the purchases of electrical equipment and by the Government. Examples of the measures proposed include:

- placement of photovoltaic cells on the roof of public buildings ;
- use of recycled paper, files, ball pens;
- public lighting and public office lighting, all lamps will be replaced by low energy consumption lamps and all lamps used will be high pressure sodium lamps;
- central heating of public schools from solar energy, and
- six military camps will be prepared to use LPG (liquid petroleum gas) instead of diesel petrol, funded by the Ministry of Defence, and all the new installations will be using LPG.

Status of implementation

The first formulation of Renewable Energy and Energy Conservation Action Plan was completed in 1985 and revised in 1998. This included the first energy support Scheme for the sectors of manufacturing industry, hotels and agriculture. The second Action Plan for 2002 – 2010 was formulated and implemented. Cyprus is now at the stage that the new action plan is being designed.

Monitoring indicators and evaluation, and impact on future GHG emissions

Monitoring indicators include:

- the number of applications made to the Cyprus Energy Regulator for development of RES for the production of electricity

- the number of applications made to the Energy Service (Ministry of Commerce, Industry and Tourism) for financial benefits from the installation of RE utilisation systems
- the amount of energy produced and is added to the networks of the Electricity Authority

Public participation

This policy fully depends on the initiatives that are taken by individuals.

Main measure: Use of renewable energy sources (RES) for electricity generation and, more specifically, installation of wind farms with total capacity at least 150 MW in 2010 and 300 MW in 2020.

2.3. Introduction of new fuels to the energy market of Cyprus

2.3.1. Natural Gas

One important issue for Cyprus is the market liberalization, opening up Electricity Authority of Cyprus to competition and promoting wider developments within the Cyprus electricity market. In particular, the following are currently studied:

- Plans to construct an Energy Centre that would allow the import of liquefied natural gas (LNG). The planned Energy Centre (through which liquefied natural gas will be available to the energy sector and more widely) may result in a significant reduction in CO_2 emissions, but these developments are too uncertain to quantify at present.
- Plans by Electricity Authority of Cyprus to construct additional combined cycle gas turbine (CCGT) units to be fuelled by natural gas;
- Plans by other companies to construct generation plants that would compete with Electricity Authority of Cyprus, again using natural gas as a fuel.

The construction of a receiving / re-gasification terminal for the Liquefied Natural Gas (LNG) would make possible the importation of natural gas.

Measures overview

- All power plants to be constructed after 2012 will be using natural gas.
- The 4th unit of Vassiliko power station whose construction has started will be using natural gas.
- Decommissioning of Moni and Dekelia power units (after 2012) and replacement by units using natural gas.

2.3.2. Biomass

The promotion of utilization of biomass is included in the National Action Plan for the promotion of RES (2002-2010). For the promotion of biomass for heating /cooling and electricity production, Cyprus has introduced the following measures:

1. A Support Scheme for the promotion of RES and Energy Conservation, which includes the provision of grants on the investment for production of biofuels, utilization of biomass for heating/cooling, tele-heating/ tele-cooling and the co-generation from biomass.
2. A new support scheme for electricity generation from biomass has just been approved. The scheme for electricity generation from biomass is more generous and provides operational grant (Feed-in purchase price per KWh) up to 12.38 euro cents per KWh depending upon the technology used and raw biomass.

2.4. Energy Efficiency

Main instruments of the energy efficiency governmental policy are the energy pricing, the formulation and implementation of energy efficiency programmes for the various sectors of the economy and the promotion of renewable energy sources.

The new 2004 grant scheme includes two categories of which Category A is Energy conservation, and refers to investments which aim at energy conservation as well as the installation of combined heat and power. Energy conservation investments are defined as investments on energy conservation systems which can achieve at least 10% energy saving out of the total energy consumption.

Indicative targets for energy conservation include the reduction of the total energy consumption by 1% per annum. Energy efficiency is enhanced by measures such as introduction of new technologies and promotion of proper maintenance of the systems used in industries. Up to June 2006, 1747 applications of thermal insulations have been approved, corresponding to an investment (on behalf of the Republic of Cyprus) of CYP£1.5 million. The corresponding annual reduction in conventional fuel consumption corresponds to 2800 tonnes (0.035%). According to data of the Energy Service (June 2006), energy saving projects have been granted ranging from 15.5% to 63% reduction in energy consumption.

Main measure: Reduction of losses from the transfer and distribution system

2.4.1. Residential and Tertiary Sector

The energy consumption in the residential and tertiary sector is expected to increase significantly (approximately 3% annually in the residential sector and 4.5% annually in the tertiary sector, for the period 2007 - 2020). The high increase in the tertiary sector is due mainly to the high development of the sector of services, commerce and tourism. Similarly, the contribution of these sectors in CO_2 emissions is significant and exceeds 45% (with the allocation of electricity consumption in end-users).

MEASURES

- Improvement of the thermal behaviour of buildings in the residential sector. This measure implies: (a) formulation and mandatory - after 2007 - implementation of a space heating regulation for all new buildings in the residential sector and (b) roof insulation in buildings constructed before 2007, so that 50% of those buildings in 2010 and 100% of those buildings in 2020 end-up in having such an insulation.
- Improvement of the thermal behaviour of buildings in the tertiary sector. This measure implies formulation and mandatory - after 2007 - implementation of a space heating regulation for all new buildings in the tertiary sector and the insulation of roof/openings in buildings constructed before 2007. The penetration rate of the measure is 60% of buildings in the public sector and 50% of buildings in the sector of services by 2010, while in 2020 the measure will cover all buildings.
- Maintenance of central heating boilers. The maintenance of central heating boilers on an annual basis could lead to an improvement of their performance up to 10%, depending on the boiler's condition before its maintenance. The penetration rate of the measure is 60% (in 2010) and 100% (in 2020) of the existing. boilers of the residential and tertiary sector.
- Replacement of central heating boilers. Replacement of old boilers with new ones with a high-energy performance. The penetration rate of the measure is 25% for 2010 and to 50% for 2020 of the existing central heating boilers in the residential sector, while the penetration rate in the public sector is 50% and 75% respectively.
- Use of high efficiency air conditioning systems. The energy conservation by unit is estimated approximately to 20%. The penetration rate of new, energy-efficient units, is 75% in 2010 and 100% in 2020 of the total installed units in the residential and tertiary sector.
- Use of high efficiency electric appliances. The penetration of energy-efficient electric appliances (note: this measure applies to the residential sector only) is 75% in 2010 and 100% in 2020 of the total appliances.
- Use of energy-efficient lighting bulbs. The penetration rate is 80% (in 2010) and 100% (in 2020) of the conventional lighting bulbs in the residential and tertiary sector.
- Automations in lighting. The conservation of electricity that can be achieved through this measure is on the order of 20% per automation installation, and the penetration rate is 50% (in 2010) and 80% (in 2020) of the total buildings of the tertiary sector.
- Solar collectors for water heating. Use of solar collectors for water heating. The target set is covering 50% of the energy demand for water heating in the tertiary sector from solar collectors in 2010 and 75% in 2020.
- Roof-top photovoltaic systems connected to the electricity grid. Installation of roof-top systems with total capacity of 3 MW (in 2020).

2.4.2. Industry

MEASURES

- Promotion of co-generation. It is estimated that 50 MW of co-generation systems with steam generators will be installed in 2010 and 100 MW in 2020.
- Promotion of natural gas for thermal uses. It is estimated that natural gas will replace 100 ktoe of crude oil in 2010 and 150 ktoe of crude oil in 2020.
- Promotion of solar energy. Substitution of crude oil and diesel by solar collectors for production of steam of low temperatures (covering 50% of the relevant thermal needs) and mean temperatures (covering 20% of the relevant thermal needs) can lead to a thermal profit up to 24 ktoe.
- Various energy conservation measures. Moderate energy conservation interventions aiming at the reduction of losses from the steam production system and the exploitation of the rejected heat from furnaces. Interventions for the improvement of performance of the space heating and lighting installations.

2.5. Transport

The transport sector accounts for a significant percentage of the total energy consumption. The only public transport system in Cyprus is the bus system, which was characterised "not well developed". As of November 2004, the following measures were adopted for the encouragement of the sustainable use of energy:

- A significant reduction of the excise duty for small and middle class volume engine vehicles;
- A 15% discount for the purpose of the excise duty for cars with CO_2 emissions of 150 g/km or less and, at the same time, a 10% penalty on cars with CO_2 emissions of 200 g/km or more;
- Excise duty and registration fees on electric cars were abolished, whereas dual propulsion cars (hybrids) are now subject to half the registration and circulation fee;
- An incentive for scrapping of vehicles older than 15 years, was introduced;
- The discount in the form of a lower circulation license that benefited older cars was abolished;
- Finally, a provision was introduced for a small fee, paid for each saloon and light commercial vehicle before being cleared by the Customs (one cent per cc of engine – e.g. for a 1600 cc car EURO 27 is paid). The total amount so collected is earmarked for the development and enhancement of public transport, and is considered as an innovative measure to Cyprus budgetary practice.

Hybrid vehicles, Dual propulsion / Fuel flexible vehicles, Electric vehicles, Low CO_2 emission vehicles ($\leq$120g/Km CO_2) are already in the market and streets of Cyprus, with the owners receiving economical support by the Ministry of Commerce, Industry and Tourism. This was initiated in beginning of 2006, through a five year programme promoting energy saving. The programme that is mainly financed from the special fund for energy conservation and the promotion of renewable resources includes:

- The provision of a subsidy on the excise duty of hybrid cars;

- Promotion of the use of biofuels through the imposition of a zero excise duty on biofuels;
- Expansion of the use of the school bus;
- Public procurement – The energy performance will be introduced as a criterion in the purchases of electrical equipment and motor vehicles by the Government

Measures concerning vehicles:

- Maintenance of cars and trucks. The estimation of energy conservation and the implied emissions reduction is based on the consideration that for 50% of private vehicles and for 70% of trucks there is a possibility of small improvements of their performance through the implementation of this measure.
- Promotion of small cars in urban transport. The increase of the share of small cars in urban transport by 20% is expected to lead to a thermal profit up to 17 ktoe.
- Fuel switching from diesel to LPG in taxis. The measure concerns the conversion of diesel engines in taxis into engines that can use LPG. This conversion does not present technical difficulties, but attention must be paid regarding sitting of replenishment stations and related security issues. The penetration rate is set to 30% of the relevant passenger-kms after 2012 and 40% in 2020.

Measures concerning the management of transport:

- Promotion of public transport. It is estimated that the contribution of public transport into the total transport work by 30% in 2010 and by 50% in 2020 can lead to an energy profit up to 76.5 ktoe.
- Development of non-urban public transport. The improvement and further development of the existing network can lead to a thermal profit up to 23 ktoe, (in case that the relevant transport work is doubled).
- Improvements in road signalling. The measure can lead to energy conservation in the order of 0.8 - 3.5% in the signalling nodes that will be implemented. It is estimated that a full implementation of the measure after 2010 can lead to an energy profit up to 11 ktoe.

2.5.1. Alternative fuels for transport

In the framework of the EU strategy for biofuels and the review of the Directive 2003/30/EC, the Minister of Commerce, Industry & Tourism is also considering the possibility to set “biofuel obligations” under which every litre of diesel sold by the oil marketing companies will contain a given proportion of biodiesel (e.g. 3% (V/V)). Four companies have already applied for financial support of biofuel production. The estimated production of those companies is 8,238 m^3 (7,513 tones) biodiesel per year from oil seeds, which corresponds to 1.16% of the transport fuels. Excise tax exception of biofuels for transport.

The potential of biofuels from the domestic biomass is limited. There is however, the possibility of the production of certain quantities of bio-fuels from imported raw materials and especially from seed oils.

The projected increase of energy consumption in transport is significant (+80% in 2020 with respect to 2000). Consequently, there is also a significant increase of greenhouse gases emissions. It is expected that

emissions will increase with an annual average rate in the order of 3% for the period 2000 – 2020 (from 1466 ktn in 2000 to 2658 ktn in 2020). The major pollutants emitted, regarding the greenhouse effect, are CO_2 and N_2O and their contribution is expected to increase because of the penetration of catalytic vehicles.

Measures concerning the use of alternative fuels: Use of natural gas in urban public transport. The introduction of 150 buses in to 2012 using natural gas and 150 additional buses up to 2020.

2.6. Other Measures

Recycling. Recycling of paper and reuse of the materials collected in the printing industry.

Methane recovery. Collection of methane generated from managed disposal sites and conversion into CO_2 through combustion in flares. The penetration rate is 25% of methane generated from these sites in 2010 and 50% in 2020.

3. Article 3(2)b: National projections of GHG emissions

(b) national projections of greenhouse gas emissions by sources and their removal by sinks as a minimum for the years 2005, 2010, 2015 and 2020, organised by gas and by sector, including:

(i) 'with measures' and 'with additional measures' projections such as mentioned in the guidelines of the UNFCCC and further specified in the implementing provisions adopted pursuant to paragraph 3;

(ii) clear identification of the policies and measures included in the projections;

(iii) results of sensitivity analysis performed for the projections; and descriptions of methodologies, models, underlying assumptions and key input and output parameters.

Four scenarios have been considered for the projection of GHG emission:

(1) business as usual (BaU), i.e. no changes are made to the way energy is produced and managed in Cyprus;

(2) the scenario that renewable energy sources and rational energy use schemes are introduced for the production and management of energy - "with measures" projections;

(3) the addition of natural gas in the energy production, replacing other fuels used so far - "with measures" projections; and

(4) the addition of the other measures for the minimisations of GHG emissions - "with additional measures" projections.

Figure 3.1 summarises the projections of GHG emissions for the above four different scenarios, whereas Table 3.1. quantifies the projections made by the four scenarios.

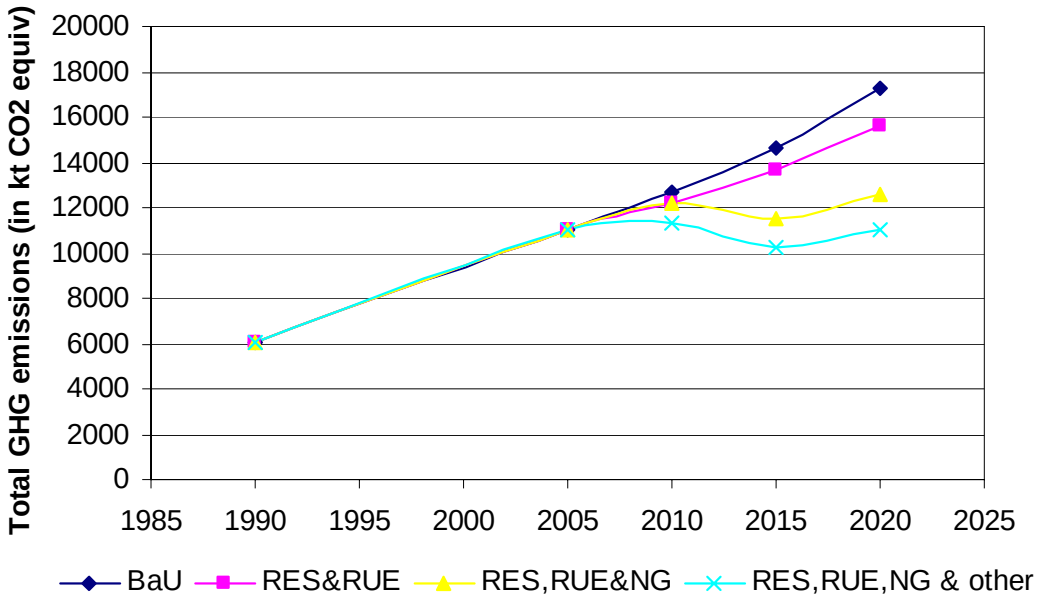

Figure 3.1. The impact of introduction of all measures on the GHG emissions in CO_2 equivalents

Table 3.1. The impact of introduction of all measures on the GHG emissions in CO_2 equivalents

	(kt CO_2 equiv)	1990	2005	2010	2015	2020
Scenario 1: BaU	Total GHG emissions	6010.6	11013.5	12710.4	14627.2	17223.6
Scenario 2: RES&RUE	RUE impact on emissions			-254.839	-457.779	-713.444
	RES impact on emissions			-305.807	-549.335	-856.133
	OVERALL IMPACT	**6010.6**	**11013.5**	**12149.7**	**13620.1**	**15654.1**
Scenario 3: RES, RUE& NG	RES & RUE impact on emissions			-560.646	-1007.11	-1569.58
	NG impact on emissions				-2147.5	-3048.79
	OVERALL IMPACT	**6010.6**	**11013.5**	**12149.7**	**11472.6**	**12605.3**
Scenario 4: RES, RUE, NG & other	RES, RUE & NG impact on emissions			-560.646	-3154.61	-4618.37
	Other measures			-824.0	-1188.5	-1553.0
	OVERALL IMPACT	**6010.6**	**11013.5**	**11325.7**	**10284.1**	**11052.3**

3.1. Scenario 1: BaU

3.1.1. Assumptions

The assumptions used for the calculations and projections performed for the scenarios of "Business as Usual" are Demographic characteristics, Weather conditions and Macroeconomic rates.

[1] Demographic characteristics

It is estimated that the increasing trend of population, which was registered during the decade 1990-2000 (approximately 1.6% annually), will continue but with lower rates (approximately 1% annually for the period

2000-2010 and 0.6% for the period 2010-2020). During the same time period, the average size of households (number of persons per household) decreases by approximately 0.7% annually, leading (together with the evolution of population) to an increase of the number of households. The evolution of population and number of households represents a crucial defining parameter of energy needs in the residential and tertiary sector, as well as in the transport sector.

Furthermore, a crucial parameter affecting the energy consumption in the tertiary sector is also the total area of buildings used in the sector of services, which depends on the population's density, the prosperity rate, the size the sector of services etc. The total area of buildings in the tertiary sector was estimated by using appropriate area indices per employee. It was assumed that this index (square meters per employee) would increase with an average rate of 0.2% until 2010 and 0.1% until 2020.

[2] Weather conditions

It was assumed that weather conditions remain unchanged, as they were in 1995. An assumption that climate conditions will be closer to the historical average would ignore the increase of the annual average temperature and would lead to a sudden, non-justifiable increase of energy demand for space heating after the year 2000. However, it is pointed out that if future weather conditions get closer to the historical average, then the energy consumption (primary and final) will be different from the projected one. On the basis of these assumptions, it was estimated that the number of degree-days for heating in Cyprus for 1995 mounted to 1050, while the operation of air-conditioning units expands over a time period of 5 months annually.

[3] Macroeconomic rates

BaU is based on the assumption that the intensive rate of economy growth in Cyprus will continue. Thus, for the whole decade 2000-2010, it is assumed that the average annual rate of GDP growth will be 4%, while it decreases slightly towards the end of the period examined by, 3.5% for the years 2010-2015 and 3% for the years 2015-2020.

The basic assumptions that are used for all three scenarios described next are summarised in Table 3.2.

Table 3.2. Summary of parameters and assumptions for emissions projections in the energy sector

Parameters	1990	2000	2005	2010	2015	2020
Increase of GDP	4.5%	4.5%	4.5%	4%	3.5%	3%
Added value INDUSTRY/year	+2.65%	+2.65%	+2.65%	+2.65%	+1.45%	+1.45%
Added value SERVICES/year	+5%	+5%	+5%	+5%	+5%	+5%
Added value AGRICULTURAL SECTOR/year	+2.45%	+2.45%	+2.45%	+2.45%	+2%	+2%
Annual increase of population	1.6%	1.6%	1%	1%	0.6%	0.6%
Persons/household/year	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%	-0.7%
Area /employee/year	+0.2%	+0.2%	+0.2%	+0.2%	+0.1%	+0.1%
Annual degree-days for space heating		1050	1050	1050	1050	1050
Operation of air-conditioning units (months)	5	5	5	5	5	5

[4] Other assumptions

Considering that Cyprus does not have a specific quantitative target for emissions reduction within the framework of the Kyoto Protocol for the 1st commitment period, it was assumed that in the BaU Scenario no specific measures for the limitation of greenhouse gases would be taken. In addition, it is assumed that all decisions regarding investments on energy technologies and equipment in the various economic sectors will be made by considering a 6% interest rate.

Finally, the agreement between EU and car manufacturing industries (ACEA, KAMA, JAMA) for the decrease of fuel consumption in new cars (aiming to achieve an average carbon dioxide emission factor of 140 g/km in 2008).

3.1.2. Methodology

ENERGY SECTORS

For the projection of emissions from the energy sector, the ENPEP (Energy and Power Evaluation Program) model was used. ENPEP was developed by the Argonne National Laboratory (ANL, USA) and comprises several distinctive models, which have as target the full analysis/simulation of the energy/electricity system, with parallel quantification of its environmental and social consequences. The ENPEP model, through the use of its basic module BALANCE achieves the following:

- Simulation of energy flows in an energy system, from the level of energy supply (crude oil imports, carbon mining etc.), through the conversion into other energy forms (liquid fuels, electricity), and up to the final energy demand (hot water in the residential sector, steam in industrial processes etc.).
- Projection of future energy balances on the basis of a non-linear algorithm for the simulation of the energy system, considering different decision-makers.
- Projection of the shares of alternative technologies in the energy market (e.g. electricity generation technologies) on the basis of the cost of these technologies, as well as of the fuels that they use.
- Estimation of the cost and the environmental burdens, which are associated with the projected development of the energy system under consideration.

NON-ENERGY SECTORS

Projection of greenhouse gases emissions in the non-energy sector is not based on the use of a computational simulation tool, such as in the energy sector, but it depends on the projection of activity data for each source and on the definition of the suitable emission factor. The equation used for emissions projection has the following general form:

$$\begin{aligned} Em_t^g &= A_t \cdot EF_t^g \\ A_t &= A_0 \cdot (1 + r(x_i))^t \\ EF_t^g &= EF_0^g \cdot (1 + f(m,T)) \end{aligned} \quad (1)$$

where:

t, 0	:	Indices referring to a future point in time and to the base year respectively
g	:	Index referring to greenhouse gases
Em_t^g	:	Emissions of g-gas at time point t
At	:	Activity at time point t
EF_t^g	:	Emission coefficient of g-gas at time point t
xi	:	Defining parameters of activity development
r(xi)	:	Rate of activity change, estimated on the basis of the defining parameters
$f(m,T)$	:	Rate of change of emission factor, which depends on the technological evolutions (parameter T) and the adoption of policies and measures (parameter m)

Industrial processes

Projections of CO_2 emissions from cement and lime production are based on the estimation of the respective production levels up to 2020. The defining parameter for the development of cement and lime production was considered to be the added value (AV) of the sector of construction. In specific, the 3-years moving average is used, so that the time-lag in the relevant change of the two elements is taken into account.

It is estimated that AV will increase with an average annual rate of growth of 2.3% for the period 2005 until 2010 and 1% until 2015. Finally, for the period 2015-2020, it is estimated that AV will decrease with an average annual rate of 1%. The CO_2 emission factor for cement and lime production remains stable and equal to the one of the period 2000-2005, as the introduction of measures for the reduction of emissions is not foreseen in BaU.

Solvents and coherent products use

Sources examined in this sector are the use of paints and metal degreasing / dry cleaning. Activity levels are defined from the evolution of population, while no change is foreseen for the emission factor (1 kg NMVOC/capita for paints and 0.25 kg NMVOC/capita for metal degreasing / dry cleaning)

Agriculture

Emissions are projected on the basis of the number of animals, the production of agricultural products and the amount of nitrogen in synthetic fertilizers. In specific:

- The projection of the number of animals is based on the analysis of the available time series. Per category, the rates are higher until 2010, while from this point and onward the number of animals remains practically stable (the change of the number of animals per category for the period 2010-2020 is less than 1%).
- The production of agricultural products depends on the agricultural land and the productivity of cultivated lands. On the basis of data available, crop areas decrease with an average rate of 0.3% for the period 1990-2005. Adopting a linear trend model, projected areas decrease by 20% in 2020. Productivity of

agricultural areas presents significant fluctuations and this is the reason why the average of the period 1990-2005 was used.

- The amount of nitrogen in synthetic fertilizers is defined on the basis of the total crop area and the share of cereals in the total crop area. Overall, the required nitrogen decreases by 5% until 2010 and by 10% until 2020 compared to 1990.

Wastes

For solid wastes, the activity levels are defined on the basis of population (permanent and tourists) while in the case of liquid waste the industrial production is also required.

- Population. The consideration of tourists for the estimation of the equivalent population is performed through the number of overnight staying. The projection of overnight staying is based on a linear trend model, which leads to a doubling of the number of overnight staying in 2020 with respect to 2005. This result is in accordance with the estimations for the evolution of AV in the hotels/restaurants sector.
- Industrial production. The projection of industrial production is based on the analysis of the relevant time series. The average rate of increase for the industrial production of the examined sectors fluctuates up to 3.5% until 2010, while for the period 2010-2020 the average rate fluctuates up to 1.5%. It should be pointed out that the refinery does not operate from 2010 and onwards.

In the case of solid waste management, the following assumptions have been made:

- The composition of wastes is the average of the period 1990-2005.
- The amount of recycled materials increases from approximately 3% in 2005 to 20% in 2010 and to 40% in 2020
- The amount of wastes deposited in managed landfills increases gradually, so that in 2010 the total amount of wastes is deposited in managed landfills. Furthermore, it was assumed that there will be no collection of methane generated for combustion in flares or for energy recovery.

3.1.3. Emissions

The emissions calculated on the basis of sector and gas. Table 3.3 summarises the results of the sectors energy, agriculture, industry, tertiary, wastes, contributing the most to the GHG emissions.

Table 3.3. Emissions of GHG per sector in kt CO_2 equivalents, based on the BaU scenario, projected for 2010, 2015 and 2020

Sector	1990	2010	2015	2020
Energy	4452.9	10689.8	12539.7	15175.4
Industry	570.6	646.5	686.1	665.7
Solvents	2.3	3.0	3.0	3.0
Agriculture	570.6	739.0	741.1	741.1
Wastes	433.2	632.1	657.3	638.4
TOTAL	6029.6	12710.4	14627.2	17223.6
Comparison to 1990		110.8%	142.6%	185.7%

The figures above are also illustrated in the form of a diagram (Figure 3.2). As it can be seen, the emissions caused by industry, agriculture and wastes are almost stable at approximately 2000 kt CO_2 eq, while the overall increase is produced entirely by the sector of energy.

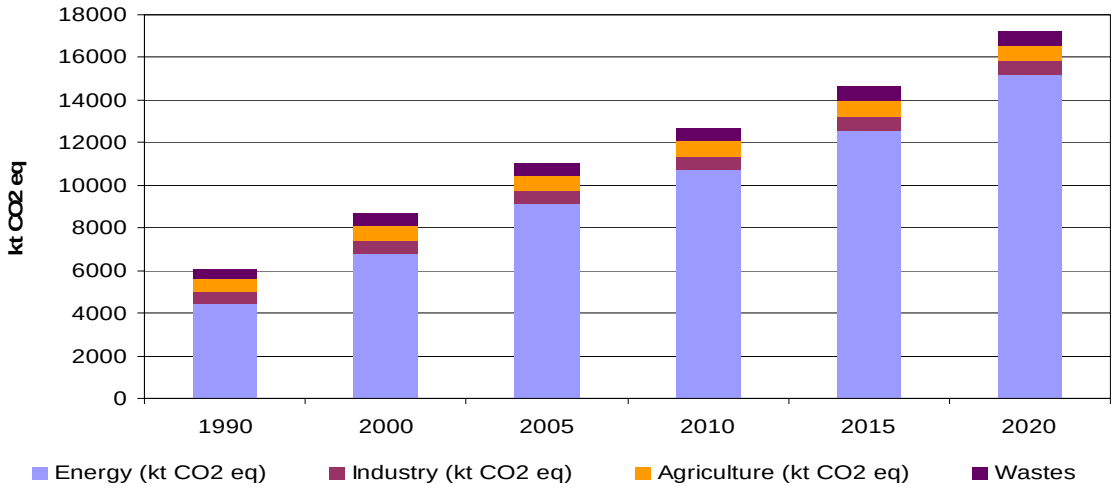

Figure 3.2. Contribution of sectors to emissions of GHG in kt CO_2 equivalents

Table 3.4. Emissions of GHG per gas and sector in kt CO_2 equivalents, based on the BaU scenario, projected for 2010, 2015 and 2020

Agriculture	1990	2010	2015	2020
CO2	0.0	0.0	0.0	0.0
CH4	265.4	336.0	338.1	338.1
N2O	305.3	403.0	403.0	403.0
TOTAL	570.6	739.0	741.1	741.1
Comparison to 1990		29.5%	29.9%	29.9%

Wastes	1990	2010	2015	2020
CO2	0.0	0.0	0.0	0.0
CH4	433.2	632.1	657.3	638.4
N2O	0.0	0.0	0.0	0.0
TOTAL	433.2	632.1	657.3	638.4
Comparison to 1990		45.9%	51.7%	47.4%

Industry	1990	2010	2015	2020
CO2	570.5	646.5	686.1	665.7
CH4	0.0	0.0	0.0	0.0
N2O	0.0	0.0	0.0	0.0
TOTAL	570.5	646.5	686.1	665.7
Comparison to 1990		13.3%	20.3%	16.7%

Energy	1990	2010	2015	2020
CO2	4067.4	9755.8	11444.1	13849.5
CH4	10.3	22.4	26.3	31.8
N2O	375.2	910.3	1067.8	1292.2
TOTAL	4452.9	10689.78	12539.72	15175.44
Comparison to 1990		140.1%	181.6%	240.8%

The energy sector in Cyprus is divided into the sub-sectors of Energy Industries, Manufacturing Industries and Construction, Transport, Agriculture, Tertiary Sector and Residential. The Table 3.5, the emissions released per sub-sector are shown.

Table 3.5. Emissions of GHG per gas and energy sub-sector in kt CO_2 equivalents, based on the BaU scenario, projected for 2010, 2015 and 2020

Energy Industries	1990	2010	2015	2020
CO2	1664.0	4289.4	5137.0	6004.6
CH4	0.0	1.0	1.0	1.0
N2O	313.0	806.4	965.8	1128.9
TOTAL	1977.0	5096.8	6103.7	7134.4
Comparison to 1990		157.8%	208.7%	260.9%

Transport	1990	2010	2015	2020
CO2	957.0	1956.0	2232.0	2547.0
CH4	6.7	11.0	13.0	1.0
N2O	12.4	66.0	81.0	908.0
TOTAL	976.2	2033.0	2326.0	3456.0
Comparison to 1990		108.3%	138.3%	254.0%

Agriculture	1990	2010	2015	2020
CO2	218.0	511.0	576.0	642.0
CH4	0.0	1.0	2.0	2.0
N2O	25.0	61.0	69.0	77.0
TOTAL	243.0	573.0	647.0	721.0
Comparison to 1990		135.8%	166.3%	196.7%

Tertiary	1990	2010	2015	2020
CO2	182.0	485.0	574.0	671.0
CH4	0.0	0.0	0.0	0.0
N2O	0.0	1.0	1.0	1.0
TOTAL	182.0	486.0	575.0	672.0
Comparison to 1990		167.0%	215.9%	269.2%

Residential	1990	2010	2015	2020
CO2	202.0	519.0	620.0	719.0
CH4	2.0	2.0	2.0	2.0
N2O	0.0	2.0	2.0	2.0
TOTAL	204.0	523.0	624.0	723.0
Comparison to 1990		156.4%	205.9%	254.4%

Industry	1990	2010	2015	2020
CO2	770.2	1927.0	2213.0	2414.0
CH4	0.8	5.0	4.0	5.0
N2O	21.8	46.0	47.0	50.0
TOTAL	792.8	1978.0	2264.0	2469.0
Comparison to 1990		149.5%	185.6%	211.4%

The comparison between the energy sub-sectors is illustrated in Table 3.6 and Figure 3.3.

Table 3.6. Emissions of GHG per energy sub-sector in kt CO_2 equivalents, based on the BaU scenario, projected for 2010, 2015 and 2020

ENERGY SUB-SECTORS	1990	2010	2015	2020
Energy Industries	2053.6	5096.8	6103.7	7134.4
Manufacturing Industries and Construction	792.8	1978.0	2264.0	2469.0
Transport	976.2	2033.0	2326.0	3456.0
Agriculture	243.0	573.0	647.0	721.0
Tertiary Sector	182.0	486.0	575.0	672.0
Residential	204.0	523.0	624.0	723.0
TOTAL	4451.6	10689.8	12539.7	15175.4
Comparison to 1990		140.1%	181.7%	240.9%

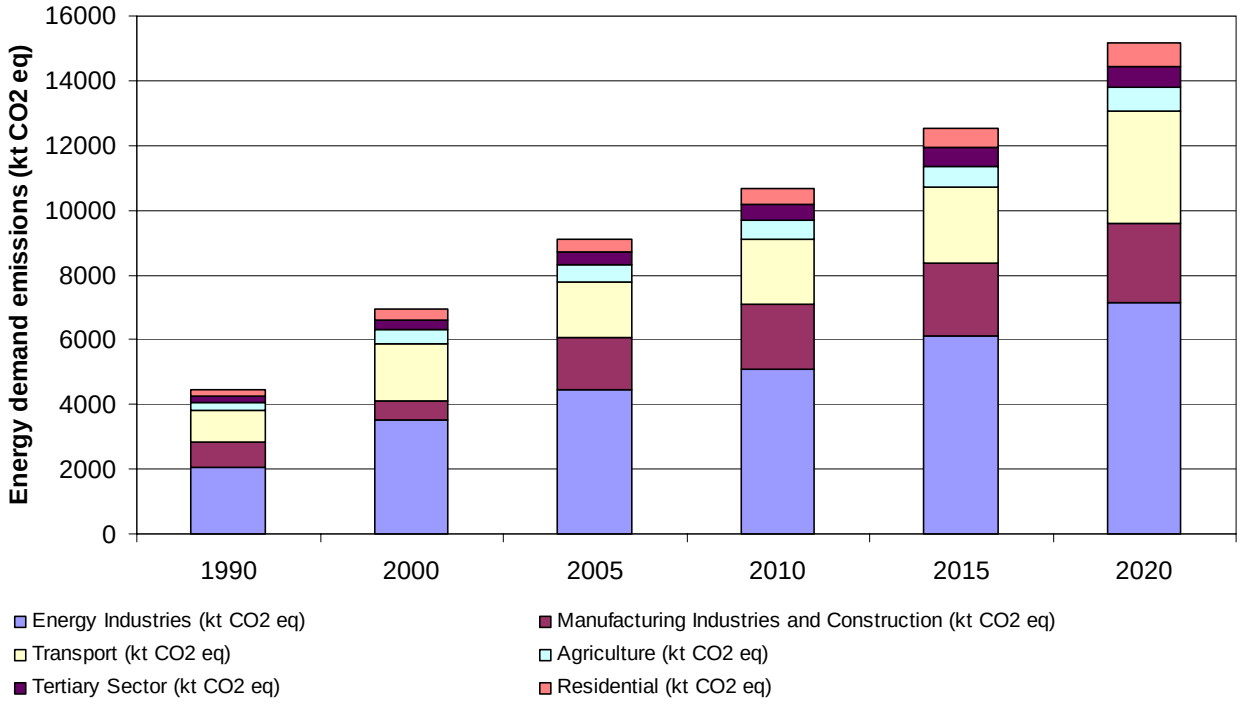

Figure 3.3. Contribution of GHG emissions of in kt CO_2 equivalents for 2000, 2005, 2010, 2015 and 2020 in comparison to 1990, for the energy sub-sectors

3.2. Scenario 2: Introduction of Renewable Energy Sources (RES) and Rational Use of Energy (RUE)

3.2.1. Assumptions

In addition to the assumptions stated for the BaU scenario, Scenario 2 assumes that:

- An increase of electricity generation from RES, to reach 6% of the total electricity consumption in 2010, 9% in 2015 and 12% in 2020.

- The reduction of GHG emissions caused by RUE in energy consumption to reach 5% by 2010, 7.5% by 2015 and 10% by 2020.

3.2.2. Emissions

The impact of introduction of RES and RUE mainly has an impact on the sector of energy. The rest of the sectors are affected but not to the extent the sector of energy is affected. Table 3.7 and Figure 3.4 shows the impact RES and RUE will have on the total emissions.

Table 3.7. Impact of introduction of RES and REU on GHG emissions for total emissions in kt CO_2 equivalents for 2010, 2015 and 2020 in comparison to 1990

02>>>>> RES & RUE	1990	2010	2015	2020
RUE		-254.8	-457.8	-713.4
RES		-305.8	-549.3	-856.1
TOTAL CO_2 EMISSIONS	6010.6	12149.7	13620.1	15654.1

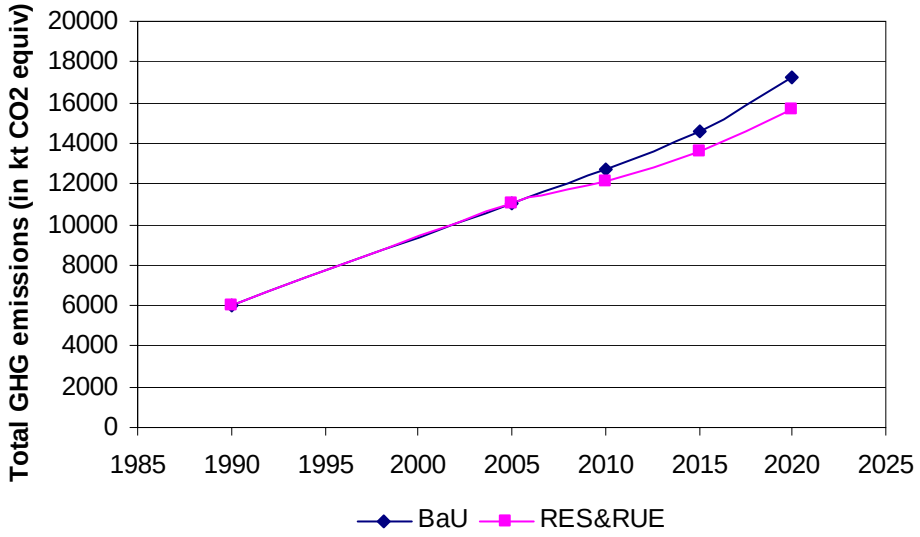

Figure 3.4. Impact of introduction of RES and RUE on GHG emissions for total emissions in kt CO_2 equivalents for 2010, 2015 and 2020 in comparison to 1990

3.3. Scenario 3: Introduction of Renewable Energy Sources (RES), Rational Use of Energy (RUE) and Natural Gas

3.3.1. Assumptions

In addition to the use of RES and RUE after 2008, at the power generating stations

- The use of Diesel is minimised
- Natural Gas is introduced in 2011 covering all the new energy demand and replacing HFO units.

3.3.2. Emissions

Table 3.8. Impact of introduction of RES, RUE and natural gas on GHG emissions for total emissions in kt CO_2 equivalents for 2010, 2015 and 2020 in comparison to 1990

03>>>>> RES, RUE & Natural Gas	1990	2010	2015	2020
RUE		-254.8	-457.8	-713.4
RES		-305.8	-549.3	-856.1
LNG (Mt)			-2147.5	-3048.8
TOTAL CO_2 EMISSIONS	6010.6	12149.7	11472.6	12605.3

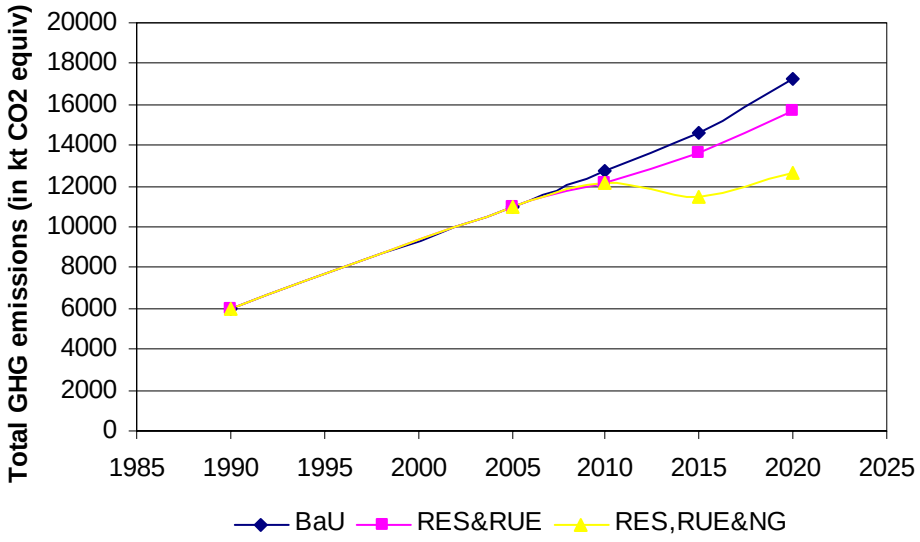

Figure 3.5. Impact of introduction of RES, RUE and natural gas on GHG emissions for total emissions in kt CO_2 equivalents for 2010, 2015 and 2020 in comparison to 1990

3.4. Scenario 4: Introduction of RES, RUE, Natural Gas and other measures in the tertiary sector

3.4.1. Assumptions

In addition to the use of RES, RUE after 2008 and natural gas this scenario considers the reductions in emissions caused by the tertiary sector:

- Improvement of the thermal behaviour of buildings in the residential sector causing energy conservation; (up-to 2,338 toe conservation in 2020)
- Maintenance of central heating boilers (up to 44,664 toe conservation in 2020);
- Replacement of central heating boilers (up to 3,218 toe conservation in 2020);

- Use of high efficiency air conditioning systems (up to 38,180 toe conservation in 2020);
- Use of high efficiency electric appliances (up to 6,476 toe conservation in 2020);
- Use of energy-efficiency lighting bulbs (up to 34,934 toe conservation in 2020);
- Automations in lighting (up to 6,892 toe conservation in 2020);
- Solar collectors for water heating (up to 11,595 toe conservation in 2020);
- Roof-top photovoltaic systems connected to grid (up to 452 toe conservation in 2020).

3.4.2. Emissions

Table 3.9. Impact of introduction of RES, RUE, natural gas and reductions in the total emissions in kt CO_2 equivalents for 2010, 2015 and 2020 in comparison to 1990

04>>>>> RES, RUE, NG & Tertiary sector	1990	2010	2015	2020
RUE		-254.8	-457.8	-713.4
RES		-305.8	-549.3	-856.1
LNG (Mt)			-2147.5	-3048.8
Tertiary Sector		-824.0	-1188.5	-1553.0
TOTAL CO_2 EMISSIONS	6010.6	11325.7	10284.1	11052.3

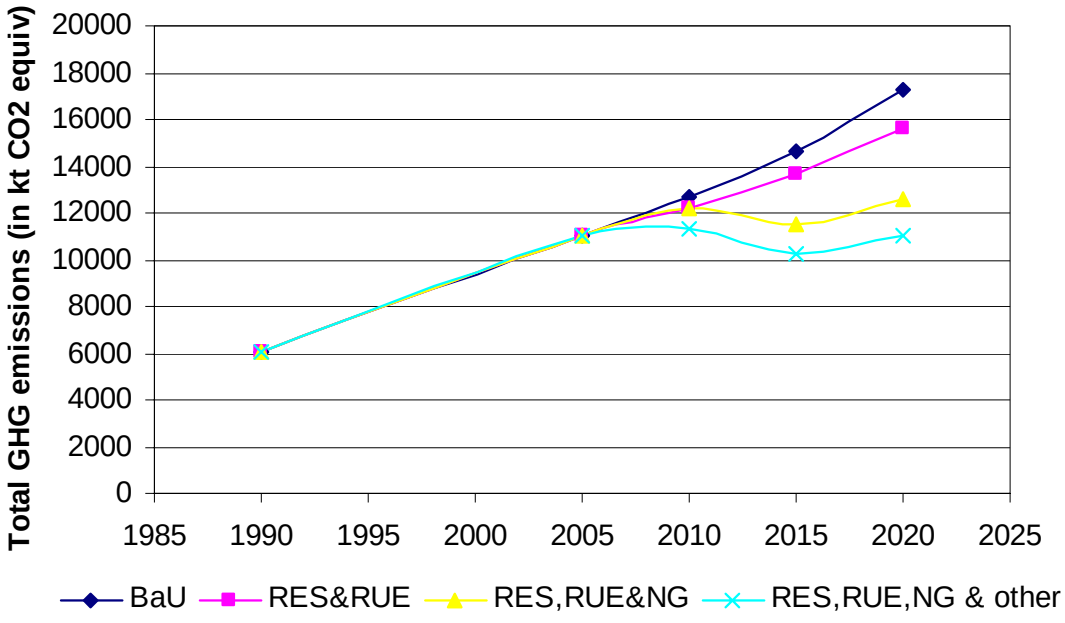

Figure 3.6. Impact of introduction of RES, RUE, natural gas and reductions in the emissions of the tertiary sector on GHG emissions for total emissions in kt CO_2 equivalents for 2010, 2015 and 2020 in comparison to 1990

3.5. Summary

Figure 3.7 and Table 3.10 summarise the results of the policies and measures in the reduction of GHG emissions under the four different Scenarios. Also, Figure 5.7 illustrates that all Scenarios (apart from BAU) will result in a significant decoupling of GHG emissions from GDP.

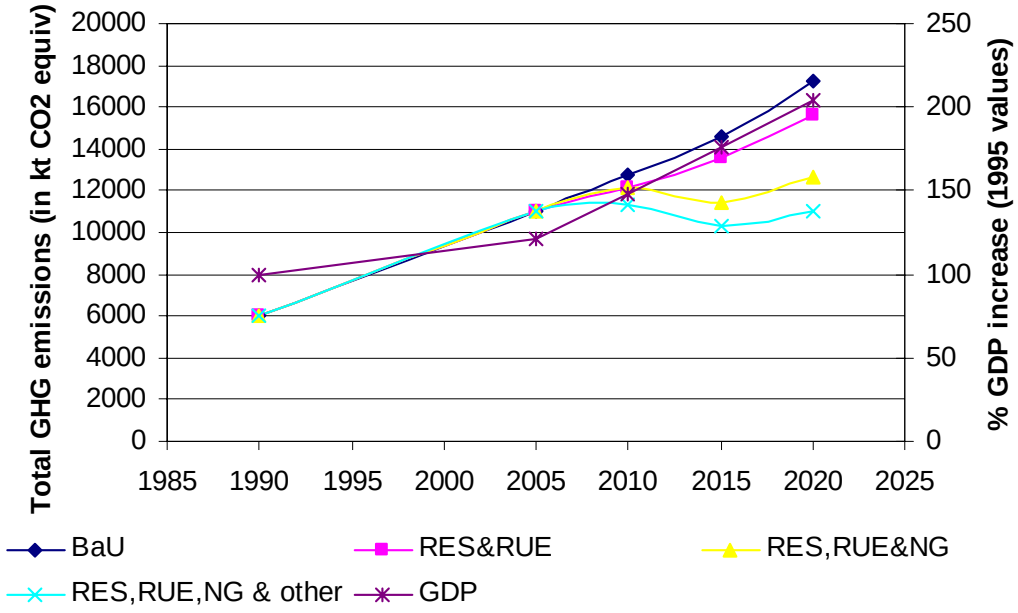

Figure 3.7. Impact of introduction of RES, RUE, natural gas and reductions in the emissions of the tertiary sector on GHG emissions for total emissions in kt CO2 equivalents for 2010, 2015 and 2020 in comparison to 1990, in comparison to the % GDP increase

Table 3.10. Impact of introduction of RES, RUE, natural gas and reductions in the total emissions in kt CO_2 equivalents for 2010, 2015 and 2020 in comparison to 1990

	1990	**2005**	**2010**	**2015**	**2020**
BaU (kt CO2 equiv)	6011	11013	12710	14627	17224
BaU (% increase from 1990 values)		*83%*	*111%*	*143%*	*187%*
RES&RUE (kt CO2 equiv)	6011	11013	12150	13620	15654
RES&RUE (% increase from 1990 values)		*83%*	*102%*	*127%*	*160%*
RES,RUE&NG (kt CO2 equiv)	6011	11013	12150	11473	12605
RES,RUE&NG (% increase from 1990 values)		*83%*	*102%*	*91%*	*110%*
RES,RUE,NG & other (kt CO2 equiv)	6011	11013	11326	10284	11052
RES,RUE,NG & other (% increase from 1990 values)		*83%*	*88%*	*71%*	*84%*
GDP (%)	100	122	148	176	204