Reference Projections
Energy and Emissions
2005-2020

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Onderwerp : Report 'Reference Projections energy and emissions 2005-2020', revised version May 2005

Dear Sirs,

Please find enclosed the revised version of the report ' Reference Projections energy and emissions 2005-2020, which was published by ECN and MNP/RIVM in the framework of the project 'Reference Projection energy, climate and acidifying emissions'. The report offers projections of energy supply and greenhouse gas and air-polluting emissions until 2020. The report has been published by request of the ministry of Economic Affairs and the ministry of Housing, Spatial Planning and the Environment in support of the energy policy (especially the Energy report, Economic Affairs) and the national climate policy (Evaluation Paper on Climate Policy). Moreover, there will be international negotiations in the next few years on the national tasks with respect to the emission of greenhouse gases (post Kyoto) and on air-polluting emissions for the period after 2010 (2015/2020). These papers and negotiations require an actualised projection of energy consumption, energy saving, input of energy carriers and renewable energy and the emission of greenhouse gases, acidifying particles, particulate matter and VOC.

The reason for revising the report, which was published by ECN and MNP/RIVM in March 2005, is a change in data and in the conclusions with respect to the assumed allocation ceiling in the 2nd trading period and the inclusion of some process emissions. These changes will be explained below. In addition, I would like to direct your attention towards new perceptions that result from the Environmental Balance 2005, which can be important for the policy conclusions on the realisation of the Kyoto target.

Revision compared to the March version
The report includes an outlook on the possible import or export of CO_2 emission allowances of the European trading system. This is important, because the emission space that is established by the government in the 2nd allocation plan on emission trading for the period 2008-2012 (publication halfway 2006) will partly determine whether the Netherlands will meet their Kyoto target. Based on the limited available public information on the 1st allocation plan for emission trading (2005-2007), the report states that the projected emission of participating sources amounts to 93 Mton (SE) and 96 Mton (GE) in 2010.

If the emission space of the participating sources in 2010 is comparable in size to the current emission ceiling, this will leave some space in SE to sell emission credits (approximately 3 Mton), whereas in GE there is almost a trading equilibrium. The version of the report that was published in March contains different data and conclusions on this subject. Due to an allocation ceiling that was assumed to be lower and an incorrect inclusion of some process emissions, the emission that must be accounted for by the Netherlands was approximately 5 Mton lower in both scenarios. This leaves a smaller margin for achieving the Kyoto target in the revised version. The projected domestic energy balances and emissions remain unaltered in the revised version.

New perceptions resulting from the Environmental Balance 2005
According to recent perceptions, greenhouse gas emissions for 2010 and 2020 are possibly underestimated. For practical reasons, these new perceptions are not included in the current version of the Reference Projections, but are explained in this letter because of their possible importance for policy conclusions. Reasons for the underestimations are:

1. The calculations were based on the *preliminary*[1] emission figures for 2002. The definitive figures for the base year 2002 were not yet available when the calculations for this report were made. In the mean time the definitive figures have become available. In some cases the definitive figures turn out to be higher than the preliminary ones, e.g. the CO_2 emissions of refineries (0.5 Mton higher) and the CH_4 emissions of 'other sources' (0.9 Mton higher).
2. The report does not include a recent[2] projection of transport emissions. The transport emissions that were included do not include emissions from fishery and defence. It is not until 2005 that these emissions are calculated separately in the Emission Registration and are included in the national total. The emissions of these sources in 2002 amounted to 1.1 Mton and 0.5 Mton respectively.

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1 In order to comply with the international guidelines of the Climate Treaty (UNFCCC) and the Kyoto Protocol, the Emission Registration worked on a large number of adjustments in the calculation methods, activity data and emission factors that are used to calculate the historic emissions of greenhouse gases.

2 The Reference Projections use the transport emissions of the MNP report 'Actualisation of emission prognoses transport for 2010 and 2020' (November 2003). In the framework of the project 'Welfare and the physical surroundings' a new projection of transport emissions is expected this year.

Assuming equal emissions of the mentioned sources in 2010 and 2020, the greenhouse gas emissions will possibly turn out 3 Mton higher than indicated in this report. The projection of greenhouse gas emissions will amount to 216 Mton (SE) and 220 Mton (GE) in 2010 and 222 Mton (SE) and 243 Mton CO_2 equivalent (GE) in 2020. These new perceptions have a negligible effect on the projections of energy supply and air-polluting emissions until 2020.

Beside the uncertainty regarding the emission projections in years to come, the allowed emission space of the Netherlands in the framework of the Kyoto obligation is still uncertain. The Kyoto obligation, i.e. –6% compared to 1990/1995, must still be translated definitively into the emission space for the period 2008-2012 by the UNFCCC. The Environmental Balance 2005 estimates that the Kyoto obligation will amount to 200 Mton CO_2 equivalent annually in the period 2008-2012 based on the recalculation of the emission figures of 1990/1995.

Conclusion
A possibly higher inland emission and a more disadvantageous emission trading balance in 2010 result in a less optimistic conclusion than the one that was drawn in March 2005. Chances are fifty fifty that the Kyoto obligation will be met in the high economic growth scenario (GE). The main assumptions are that the intended purchase of foreign reduction and the anticipated stimulation of renewable energy are realised and that the emission space for the industry and the energy sector will not be expanded in the 2nd allocation plan period compared to the 1st period of 2005-2007.

Yours faithfully,

Dr. A.B.M. Hoff
Managing Director ECN

Prof. Dr. N.D. van Egmond
Managing Director MNP

Acknowledgement

This report presents the results of the project 'Reference projection Energy, Climate and Acidifying emissions'. The project was carried out for the Dutch Ministry of Economic Affairs (EZ) and the Netherlands Ministry of Housing, Spatial Planning and the Environment (VROM). The Supervisory Committee was composed of representatives from the Ministries of EZ, VROM, the Ministry of Agriculture, Nature and Food Quality (LNV), the Ministry of Transport, Public Works and Water Management (V&W), the Ministry of Finance, and the Netherlands Bureau for Economic Policy Analysis. All representatives are gratefully acknowledged for their critical and constructive comments. This report is registered under ECN report number ECN-C--05-089 and RIVM report number 773001035.

Beside the coordinating authors, many colleagues of ECN and MNP/RIVM have contributed to this study: L.W.M. Beurskens, Y.H.A. Boerakker, M.G. Boots, B.W. Daniëls, H.W. Harmsen, R. Harmsen, H. Jeeninga, P. Kroon, T.J. de Lange, M. Menkveld, M.J.J. Scheepers, A.J. Seebregts, C.H. Volkers and J.R. Ybema (ECN), and A. Gijsen, A. Hoen, D.S. Nijdam, C.J. Peek, M.W. van Schijndel, W.L.M. Smeets, R.A. van den Wijngaart and H. van Zeijts (MNP/RIVM). Our deepest respect goes to M. Kamp for the translation, and M. Loos and L. Pronk for the layout and editing of this report.

Petten, May 2005.

Abstract

The Reference Projection 2005-2020 covers the future development of Dutch energy use, greenhouse gas emissions and air pollution up to 2020. The Reference projection is based on assumptions regarding economic, structural, technological and policy developments. Two scenarios have been used. The Strong Europe (SE) scenario is characterized by moderate economic growth and strong public responsibility. The Global Economy (GE) scenario assumes high economic growth and has a strong orientation towards private responsibility.

Energy consumption continues to grow in both scenarios and energy intensity is declining in the GE-scenario. Gradual rise of temperature is now included in the estimates for space heating and air conditioning. Energy prices for end users will rise, due to increased imports of natural gas and rising costs of electricity generation. The share of renewables in electricity consumption increases considerably due to subsidies for wind at sea and biomass, up to the target of 9% in 2010. Emissions of non-CO_2 greenhouse gases are reduced and stabilise after 2010. The Dutch Kyoto target is probably met in both scenarios, assuming considerable emission reduction efforts abroad.

Acidifying emissions of NO_x and SO_2 stabilise after reductions, but at levels that exceed their national emission ceiling (NEC). Emissions of volatile organic compounds are projected to fall with approximately 25% between 2002 and 2010 below their NEC. Emissions of ammonia are projected to meet their NEC. The emission of particulate matter (PM_{10}) will stabilise at present levels.

Layout: 14 October 2005

SUMMARY

New Reference Projections
In view of upcoming national and international evaluations and preparations of energy, climate and air pollution policy, the developments in energy use and airborne emissions have been projected until 2020 for two economic scenarios. These economic scenarios, which have been developed by the Netherlands Bureau for Economic Policy Analysis (CPB), are the ‘Global Economy’ scenario (GE) based on high economic growth and the ‘Strong Europe’ scenario (SE) with moderate growth. With these reference projections, the Energy research Centre of the Netherlands (ECN) and the Netherlands Environmental Assessment Agency of the National Institute for Public Health and the Environment (MNP/RIVM) are creating a quantitative framework for the analysis of possible future developments. The most important developments are described below and Chapter 1 provides an overview of the results.

Energy consumption continues to increase
Compared to the last decade, the increase in energy consumption remains approximately the same in GE and decreases in SE. The main cause is the assumed lower economic growth in SE. In both scenarios, the Netherlands remains energy-intensive, compared to other countries. The energy intensity of the Dutch economy does increase slightly in the GE scenario due to the relatively higher production growth of the Services sector. The energy saving rate amounts to approximately 1% in both scenarios and is more or less similar to the last decade in the period until 2020. On the one hand, many cost-effective saving measures have been taken and a more intensive saving policy is not assumed. On the other hand, the current saving policy has a long-term effect.

As a result of temperature increase, energy consumption increases less rapidly
The relatively mild winters of the last 15 years have led to less energy consumption for space heating. The projections take into account a further increasing temperature outdoors, caused by climate change. This leads to lower energy consumption for space heating in winter but also to higher energy consumption for space cooling in summer. By assuming an increasing outdoor temperature, less energy is needed for indoor climate control in the period until 2020.

Energy prices increase slightly
The liberalisation of the energy markets persists in both scenarios. The prices of natural gas increase slightly due to increasing costs of extraction and supply and the strong market position of the limited number of suppliers of gas. Electricity prices are also increasing, caused by a gradually decreasing overcapacity and the total costs of generation that are on-charged. The European system of emission trading has only a limited increasing effect on the electricity price. The Netherlands will produce more electricity within its borders as the advantages regarding costs of production abroad are decreasing.

Oil and coal consumption increase, renewable energy grows rapidly but plays a modest role
The share of oil in energy supply increases due to the large growth of transport and the basic chemical industry. In the Global Economy scenario, the share of coal in electricity production also increases due to the construction of new coal plants. The share of renewable energy, especially wind and biomass, increases rapidly due to policy, but its role remains modest with a share of 6-8% of total inland energy consumption in 2020. Renewable electricity production attains a share in total power supply of 9% in 2010 and 16-24% in 2020.

Renewable energy continues to require extra investments
In both scenarios the incentivisation policy for long-term renewable energy remains intact. Favourable conditions are assumed for large-scale implementation of renewable energy, considering the public support, technology development and cost decrease. Along with the large increase in the implementation of renewable energy, currently anticipated annual MEP subsidies for renewable energy (subsidies for environmental quality of electricity production) are also increasing, from 0.5 billion euro in 2010 to ranging between 0.6 (SE) and 1.5 billion euro (GE) in 2020.

Absolute decoupling of economic growth and emissions will not be achieved
The government's target to increase economic growth and decrease emissions into the air at the same time will not be achieved in both scenarios under the currently implemented policy. It is true that most emissions are decreasing until 2010, but in the period of 2010-2020 the emissions stabilise in SE and increase slightly in GE. In both scenarios all emissions are so high that the ambition levels of the fourth National Environmental Policy Plan are still out of reach.

The emission of greenhouse gases continues to increase, especially CO_2
The increase of CO_2 emission is higher in the GE scenario than in the SE scenario, which is mostly related to the higher economic growth and a larger share of coal fired power plants. The increase in CO_2 emission is partly compensated by a decrease of other greenhouse gas emissions such as methane and nitrous oxide until 2010. In the period 2010-2020, however, the emissions of other greenhouse gases cease to decrease and the total emission of greenhouse gases increases in both scenarios.

The Netherlands complies with the international Kyoto obligation
The Kyoto target is probably met in both scenarios, which include currently foreseen policy. Important assumptions are that subsidies for renewable energy are continued and that CO_2 emission allowances are allocated at the current level, also after 2007. Moreover, it is assumed that the government will realise the intended purchase of foreign emission reductions via the Kyoto mechanisms. Approximately half of all policy effects in 2010 will be realised through emission reduction outside the Netherlands.

The decrease in other airborne emissions halts around 2010
Acidifying emissions of NO_x, SO_2 en NH_3 and large-scale air pollution from NMVOC en PM_{10} decrease until 2010 under the influence of air pollution policy and the reduction of the livestock due to the EU milk quotas and the increasing milk production per cow. After that, emissions stabilise in SE and increase slightly until 2010 in GE. In this period, the effect of the air pollution policy is annulled by the volume growth of economic production and consumption.

Can the Netherlands comply with the European emission obligations for acidification and large-scale air pollution?
The Netherlands cannot comply with the EU obligation to limit NO_x and SO_2 emissions to the NEC (national emission ceiling) in 2010 in either of the two scenarios. The main reason for this is the volume growth of transport and the industry. The chances of reaching the NEC for NO_x are fifty fifty if the policy measures that were announced in the White Paper on transport emissions are implemented and if the European Commission grants an exemption because of a non-representative EU emission method for heavy company vehicles. The chances of reaching the NEC for NO_x are fifty fifty if the Dutch government holds on to its position in the current negotiations with the industry, refineries and power companies.

In the cases of NH_3 and NMVOC it is yet uncertain whether the NEC obligation can be met, which, among others, depends on new insights in the NH_3 emission in manure employment and the NMVOC emission from cold starts of petrol cars.

1. RESULTS

The Reference Projections Energy and Emissions intend to support the energy, climate and air pollution policy. The projections are based on assumptions regarding economic, structural, technological and policy developments. Two scenarios have been used, i.e. Strong Europe (SE), which has a moderate growth and a strong public responsibility, and Global Economy (GE), which is based on a large growth and a strong orientation towards private responsibility. This chapter summarises the Dutch results.

1.1 Developments in energy management

Energy markets

The liberalisation of the energy markets proceeds in both scenarios. The wholesale prices of gas increase slightly with 1.2% per year as a result of increasing costs of extraction and supply and increasing import. The wholesale prices of electricity also rise with 1.5% per year, because overcapacity is gradually diminishing and total costs of generation are on-charged. The Netherlands will produce more electricity within its borders as production abroad is becoming almost equally expensive. The import balance of electricity remains an uncertain factor. The European system of emission trading has only a limited price increasing effect on energy prices for end users. Taxes are still a growing share in energy prices for small users until 2010.

Energy consumption

The Dutch energy consumption is still increasing and increases faster in the GE scenario (1.2%/yr) than in the previous Reference projection. The energy saving rate has decreased until approximately 1% per year and is maintained at that level. Structural effects after 2010 will contribute to a less energy-intensive economy. As a result, energy consumption increases less than economic growth, similar to the past. Thus, a relative decoupling is taking place, but not at such a rate that it results in a decrease in energy consumption.

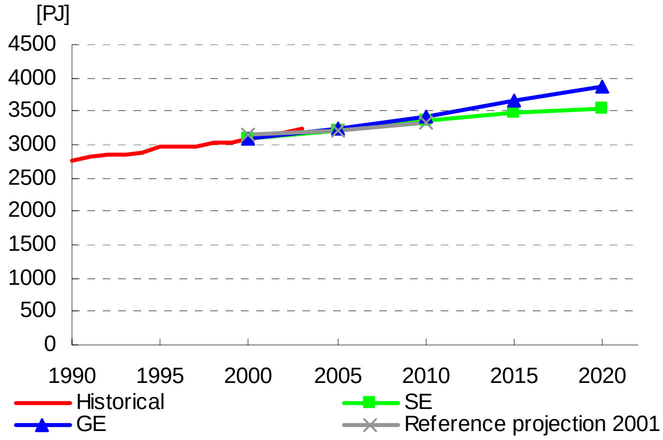

Figure 1.1.1 – Total inland consumption in PJ_{prim}, historical consumption including temperature correction

Energy saving

The energy saving rate remains almost similar at 1% per year. The main part of the saving is caused by autonomous developments and the effect of previous policy. The number of options to save much energy quickly decreases. The projections do not assume a structural intensification of saving policy.

Table 1.1.1 - Volume, structure and saving effects and total energy consumption, average [%/yr]

[%]	Historical	SE		GE	
	1995-2002	2000-2010	2010-2020	2000-2010	2010-2020
Volume	2.9	1.2	1.8	1.9	2.6
Structure	-0.9	0.3	-0.1	0.0	-0.3
Climate	-	-0.1	0.0	-0.1	0.0
Saving	-1.0	-0.9	-1.0	-1.0	-1.0
Total	1.0	0.7	0.6	1.0	1.3

Fuel mix

The relation between various energy carriers is developing towards an increase of the share of oil due to the growth in transport and the basic chemical industry. The fuel mix for electricity generation shows a major difference between GE and SE in 2020. In GE the share of coal in electricity production increases: in SE the share of coal does not increase. The share of renewable energy increases to 3-5% in 2010 and 6-8% in 2020 as a result of policy. The share of renewable energy is higher in the GE scenario than in the SE scenario.

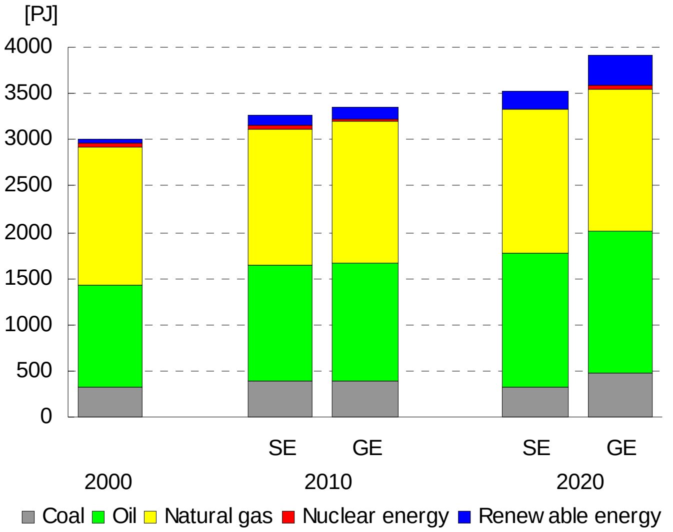

Figure 1.1.2 – Share of energy carriers in inland consumption for SE and GE, including renewable sources, expressed as avoided fossil consumption

Electricity supply

As a result of growing electricity demand, the construction of new production capacity is necessary in both scenarios. In GE new pulverised coal power plants are built after 2010. The nuclear plants also remain in operation after 2013 in the GE scenario. In the SE scenario electricity demand is less high and mostly supplied by natural gas plants. Cogeneration increases in both scenarios because of gradually improving market conditions. Renewable electricity generation is strongly stimulated in both scenarios. Especially the capacity of wind at sea is increasing significantly. The target of 9% electricity consumption from renewable sources in 2010 is achieved. In 2020 this share has increased to 16% in SE and 24% in GE.

1.2 Development of the CO_2 emission

Inland emission

The total inland emission of carbon dioxide (CO_2) increases with averagely 0.6% per year until 2015 in SE, after which it stabilises. In GE the growth between 2000 and 2020 is reasonably constant at a rate of 0.9% per year, which is slightly less than the rise in total energy consumption. The uncertainty bandwidth for SE amounts to 17 Mton in 2010.

The deviation from the base year of the previous Reference Projection is caused by adjustments to the emission registration and temperature correction.[3]

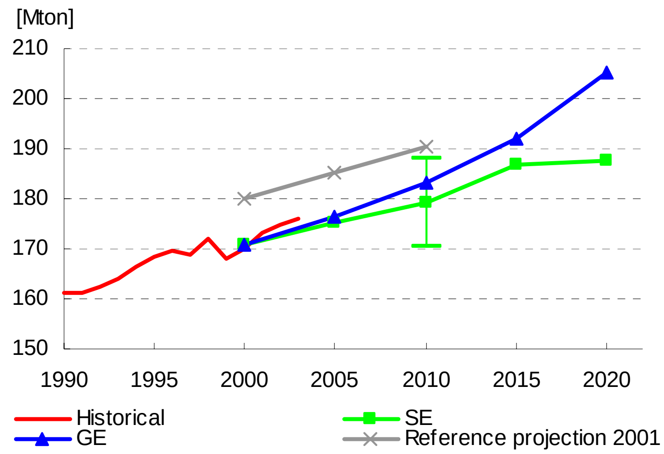

Figure 1.2.1 – Total inland CO_2 emission with uncertainty margin, historical emissions include temperature correction

Indicative targets CO_2

For 2010, indicative targets have been established per sector. These sectors are Built environment, Transport, Agriculture and Industry/Energy. The comparison shows that all sectors stay below the indicative targets (see Table 1.2.1). However, for an eventual verification, a number of important comments need to be made in relation to this table.

- The Industry/Energy sector comprises mainly sources that are subject to the European system of CO_2 emission trading. The emissions of the sources for 2010 that were projected under the trade system are somewhat lower than the emission ceiling that was allocated to the companies in the first allocation plan for 2005-2007. If the emission ceiling in the second trading period of 2008-2012 is the same as in the first trading period, then emission credits may be sold to abroad, i.e. 0-1 Mton annual in GE and 3 Mton in SE (see Paragraph 10.3). The emission of the sector that must be accounted for rises accordingly.
- The implementation of the national system of CO_2 monitoring leads to a lower projection of emissions in the sector Industry/Energy. The adjustment for this sector amounts to approximately -4 to -5 Mton in 2000-2002. One important element in the adjustment of the CO_2 monitoring is the exclusion of fixed carbon in short cycle products of the chemical industry. During the determination of the indicative target this potential emission was still included. This emission is not included in the EU trading system, however, as a result of which the emission of participating sources is not influenced (see also Paragraph 3.2).
- The sectors Built Environment and Agriculture foresee that the trend wise increase of the outdoor temperature leads to a lower natural gas consumption in the projections of -2 to -3 Mton in 2000-2002 and approximately -4 Mton in 2010 (see Paragraph 3.2).
- In July 2004 an agreement was made on political level as to the emission space of greenhouse horticulture (Dutch Lower House, 2004). It involves an increase of 5.6 Mton to

3 The deviation is approximately 9 Mton here, of which approximately 3 Mton is an adjustment to the emission registration before determination of the indicative targets (Boonekamp 2003) and 6 Mton results from recent adaptations to temperature correction and emission registration in sept-dec 2004 (see Paragraph 3.2).

6.5 Mton and in case of an area larger than 11.500 hectares an increase to 7.1 Mton (see also Paragraph 6.5).

- For Transport[4], the projections are in conformity with calculations made for the indicative targets and therefore new information has not been included (see also Paragraph 6.2).

Table 1.2.1 – Comparison of CO_2 indicative targets with inland CO_2 emissions per sector for SE and GE, i.e. excl. emission trade balance

[Mton]	2002	Projection 2001-2010	Indicative target 2010	SE 2010	GE 2010	Bandwidth SE 2010
Agriculture	6.8	8.3	7	6.8	7.7	6.0-7.4
Built Environment	31.0	30.5	29	27.1	28.3	25.2-28.7
Transport	37.6	36.4	38	38.1	38.1	33.9-42.3
Industry/energy	99.6	115.3	112	107.2	109.2	101.4-115.0
Total	174.9	190.5	186	179.2	183.2	170.5-187.9

Figure 1.2.2 shows the CO_2 emissions of the various indicative target sectors for both scenarios, compared to the indicative target

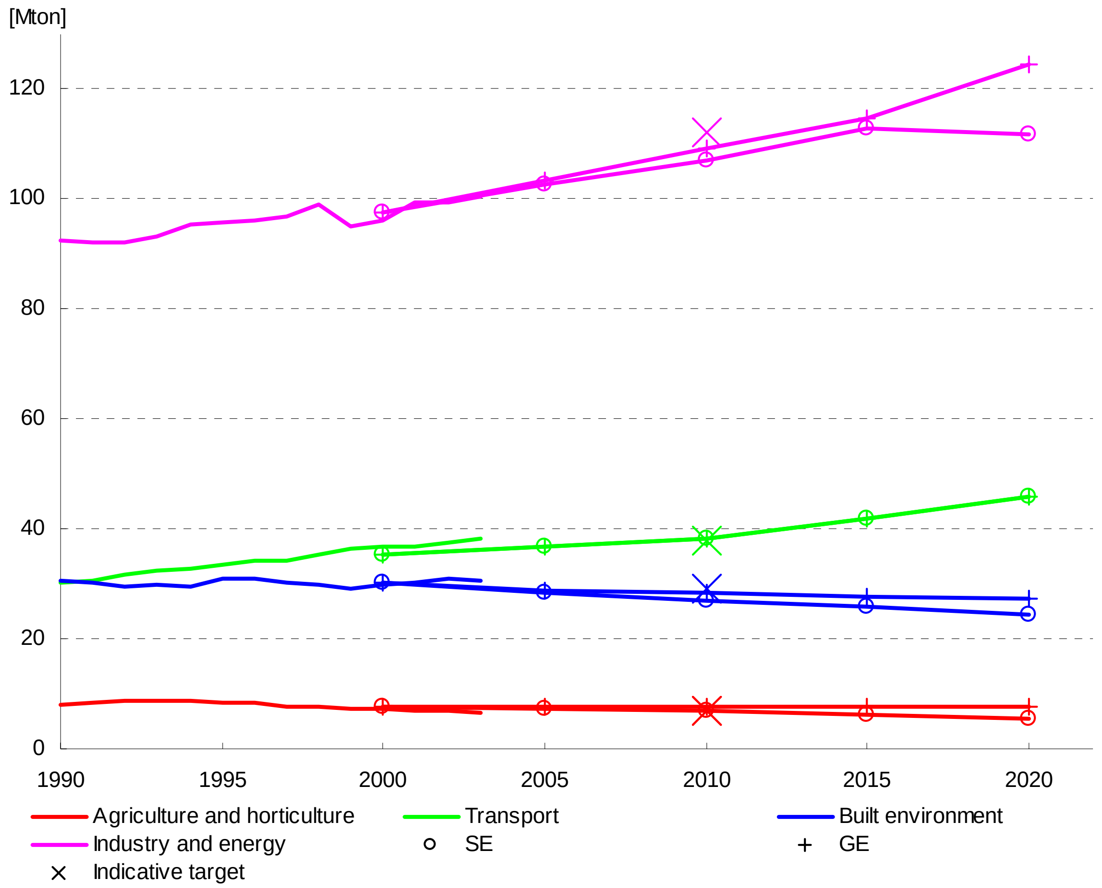

Figure 1.2.2 - CO_2-emissions in SE and GE and sectoral indicative targets per sector

4 The projection for the sector Transport is derived from (van den Brink, 2003) and is assumed to be equal in SE and GE. The emissions of mobile equipment, including agricultural tractors, have been allocated to Transport.

1.3 Development of the greenhouse gas emissions

Other greenhouse gases
The emissions of other (non CO_2) greenhouse gas emissions decrease in both scenarios from 38 Mton $CO_{2\ eq.}$ in 2002 to approximately 34 Mton $CO_{2\ eq.}$ in 2010. The current projections are thus almost equal to the projections in the Reference projection non-CO_2 greenhouse gas emissions from 2002 (Beker, 2002).

The emission in 2010 is approximately 1 Mton above the indicative target of 33 Mton $CO_{2\ eq.}$

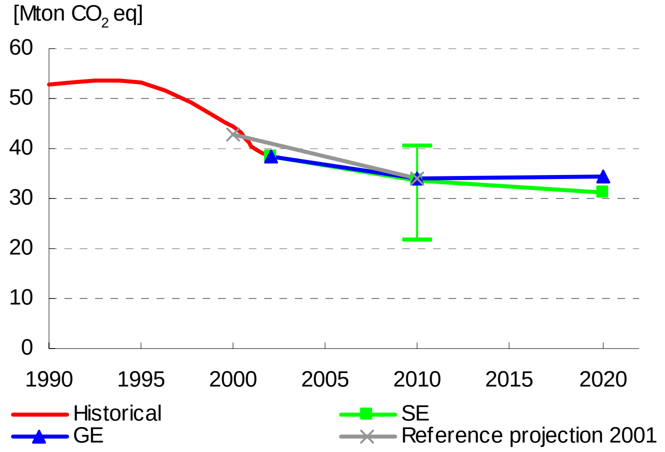

Figure 1.3.1 – Total inland emissions of other greenhouse gases, including uncertainty margin

The other greenhouse gases are methane (CH_4), nitrous oxide (N_2O) and fluorinated gases (HFCs, PFCs and SF_6). The most important developments up to 2010 are the decrease in methane emissions of landfills and in offshore gas extraction as well as measures taken in industry with respect to the emissions of F-gases. In agriculture, the emissions of other greenhouse gases (nitrous oxide and methane) are also decreasing. The more diffuse emissions, as emitted in the use of F-gases for cooling, increase slightly. After 2010, the emissions in the SE scenario decrease further to 31 Mton $CO_{2\ eq.}$ in 2020. In the GE scenario the emissions remain more or less at the level of 2010.

Target for climate policy for 2008-2012

Via the Kyoto Protocol, the European Union has committed itself to an emission reduction of greenhouse gases of averagely 9% over the period 2008-2012, compared to 1990. In the so-called Burden Sharing Agreement this target was translated for the Netherlands into an emission reduction of 6%. Although adjustments of historical emissions are still taking place, the target of the Netherlands in 2008-2010 has been calculated at 199 Mton CO_2 eq. for the moment. Flexible mechanisms from the Kyoto Protocol can be used to reach this target. It is assumed that the Dutch government will purchase 20 Mton of emission reduction annually through JI and CDM (VROM, 2002a). Moreover, the industry or the energy sector can purchase or sell emission allowances abroad. This depends on the Dutch government's allocation of allowances for the European CO_2 emission trading system and the price of these allowances on the European market. Assuming that an equal quantity of emission allowances is allocated annually as in 2005-2007, the Dutch companies will sell 0-3 Mton of emission allowances in the European emission trading system.

The uncertainty margin for inland emissions amounts to 24 Mton for SE. The uncertainty surrounding assumptions concerning JI, CDM, allocation or purchase of emission rights and the Kyoto Protocol are not further quantified in these Reference projections. As for the sources that are covered by the CO_2 emission trade system, the uncertainty surrounding their ability to reach the Kyoto target is reduced by setting an emission ceiling. Figure 1.3.2 illustrates the inland emissions of greenhouse gases, the uncertainty margin, the assumed emission reductions abroad and the Kyoto Protocol.

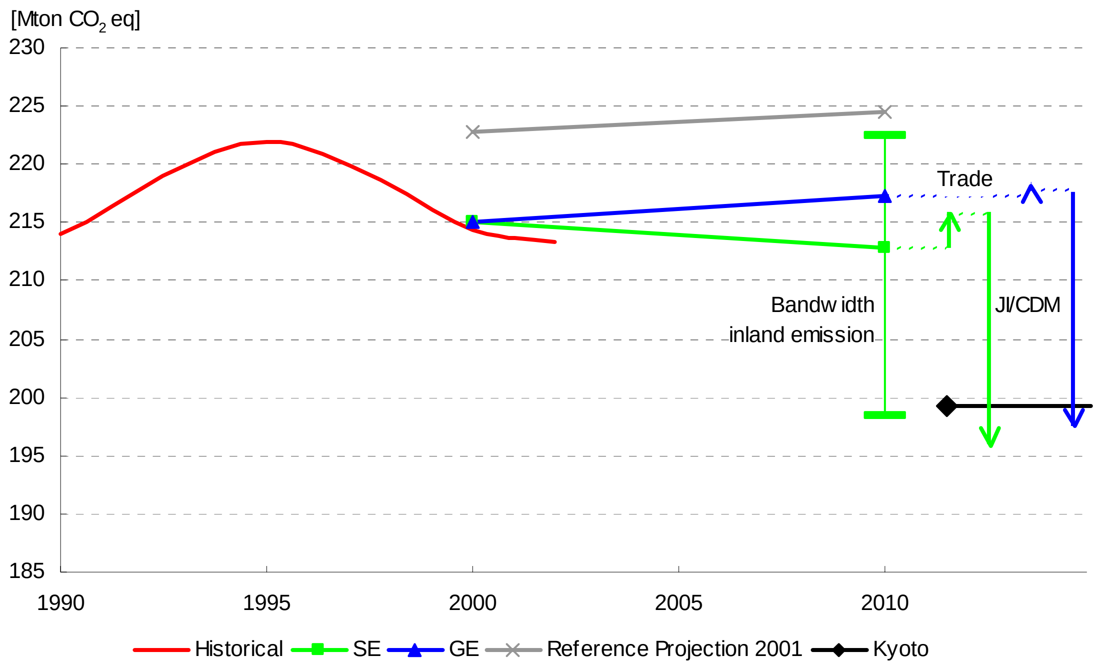

Figure 1.3.2 – Total inland emission of greenhouse gases, assumed utilisation of flexible mechanisms and the Kyoto target

Based on the projected inland emissions and the assumed emission reduction abroad, the figure shows that the Netherlands more or less adheres to its obligation. In SE there is more latitude than in GE.

1.4 Air-polluting emissions

Nitrogenous oxides

The Dutch emission of nitrogenous oxides (NO_x) decreases in the period 2001-2010 from 396 kton to 284 (SE)/288 kton (GE). The NEC target for 2010 (260 kton) is thus exceeded by 24-28 kton.

The policy intentions that are announced in the White paper on transport emissions were not included in the calculation of these data, which entails the request to the European Commission for an exemption of 19 kton, due to the non-representative EU emission testing method for heavy company vehicles.

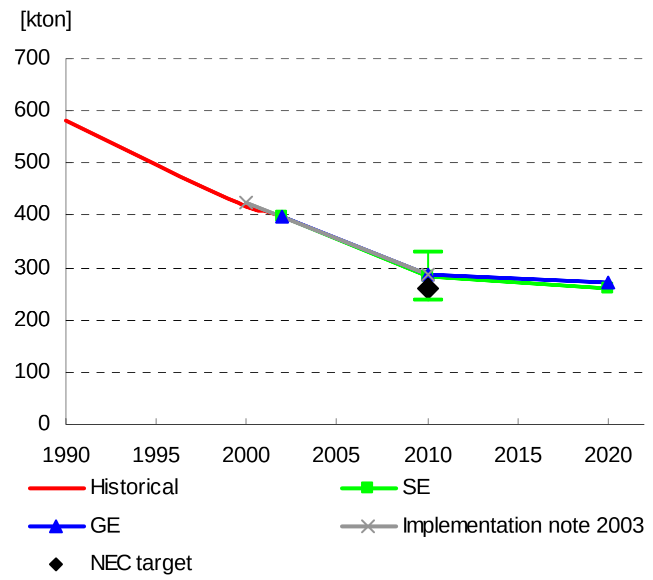

Figure 1.4.1 – Development of NO_x emission in the Netherlands

Moreover, a basic package of extra transport measures is included, which decreases the emission by 2 to 12 kiloton compared to the current projection. These measures are not fully financed as of yet and the method of implementation is still unclear, too. The measures involve the financial incentivisation of clean freight and passenger transport and a subsidy arrangement for cleaner engines in inland shipping.

The projected emission is 4 kiloton lower in SE and equal in GE compared to the 2003 projection that was carried out for the implementation memorandum 'Erop of eronder' (Smeets, 2004). In SE, especially the agricultural and domestic emissions were estimated to be lower. The emissions of industry and the energy sector are higher in both scenarios than in the previous projection. This is mainly caused by a larger energy consumption of the companies that will become involved in NO_x emission trade this year.

In the period 2010-2020, the emission further decreases to 262 (SE) or 272 kton (GE). This decrease is mainly caused by an ongoing decrease of the emission factors in transport, agriculture, trade, services and government, construction and consumers. No further decrease of the emission standard of 40 g/GJ for 2010 is assumed for the participants in NO_x emission trading.

Sulphur dioxide

The emission of sulphur dioxide (SO_2) barely decreases between 2002 and 2010. In the projections, one large reduction (approximately 10 kton), which is the result of a switch from oil to gas-firing in a refinery, is included. However, this reduction is annulled by a growth in production in the industrial and energy sector. Negotiations are currently taking place with the industry, refineries and the electricity sector to reduce their emissions. If these negotiations are successful, the emission could be 14 kton lower in 2010 than currently projected.

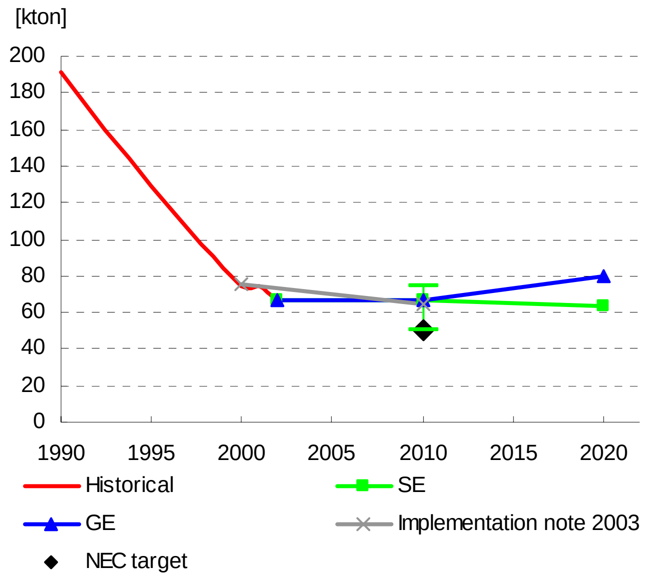

Figure 1.4.2 – Development of SO_2 emission in the Netherlands

The projected emission for 2010 amounts to 66 (SE) and 67 Kton (GE) respectively. The NEC target for 2010 (50 kton) is thus exceeded by 16 to 17 kton. The current projections are 2 kton higher than the projection that RIVM carried out for the implementation memorandum 'Erop of eronder' in 2003. The main reason is that the previous projection did not take the volume growth of the refineries into account. In these projections it has been included.

In 2020 the emission in GE is significantly higher than in SE (80 and 64 kton respectively). This difference is mainly due to the fact that fuel input in coal plants in 2020 is almost twice as high in the GE scenario as in the SE scenario.

Volatile organic compounds

The emission of volatile organic compounds (NMVOC) in 2010 will probably amount to 173 (SE) to 176 kton (GE), which is 22 to 19 kton lower than projected in the 2004 MNP-RIVM assessment 'Erop of eronder' (Beck, 2004). The main reason is that in many cases the policy that was still only proposed early 2004 meanwhile has been implemented and has thus been included here. This is particularly the case in the industry and to a lesser extent for consumers, trade, services, government and construction.

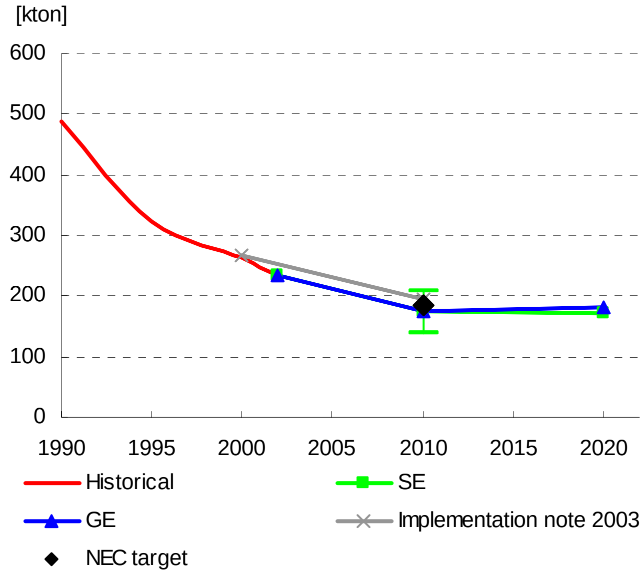

Figure 1.4.3 – Development of the NMVOC emission in the Netherlands

In the current projections, the emission stays 10 kton below the NEC target of 185 kton. However, this figure does not account for new insights regarding the NMVOC emission from cold starts of petrol cars. These illustrate that the emission has been underestimated by 5 to 20 kton so far.

In the period 2010 to 2020, the emission increases slightly in GE, which is mostly the result of the growth of industrial production as well as a number of domestic activities. In SE the emission remains almost the same after 2010.

Ammonia

Between 2002 and 2010 the emission of ammonia (NH_3) decreases with approximately 10 kton in both scenarios to the level of 125 kton. The emission thus stays just below the NEC target (128 kton).

Especially in agriculture higher emissions are projected than in 2003/2004. The higher projections are based on different assumptions regarding the manure application techniques and the number of cows.

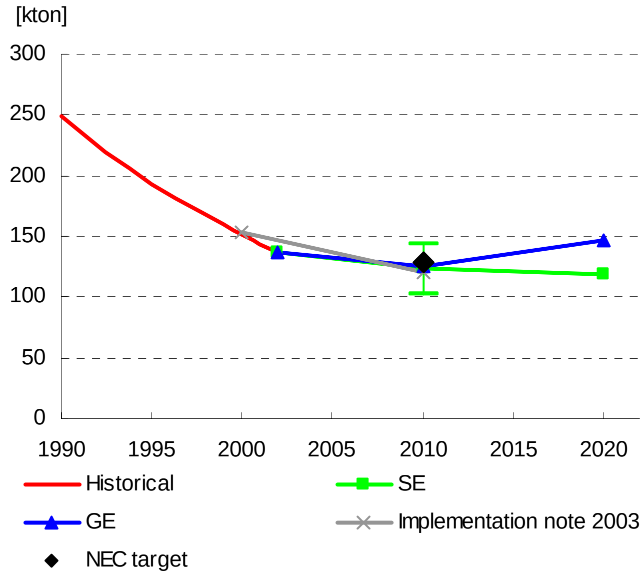

Figure 1.4.4 – Development of the NH_3 emission in the Netherlands

The results of a recent measuring project in the Achterhoek region (VELD project) point out that the emission from manure application in the spring is higher than previously assumed. As a result the total emission in 2010 could turn out 3 to 23 kton of NH_3 higher than in current projections.

Between 2010 and 2020, the NH_3 emissions decrease further to a level of 119 kton in SE; in GE the emissions increase significantly to 147 kton. The developments after 2010 are mainly influenced by changes in the livestock, as a result of changes in the Common Agricultural Policy (CAP) and market developments.

Particulate matter

The total emissions of particulate matter (PM_{10}) amounts to 42 (SE) to 44 kton (GE) in 2010, which is 1 to 3 kton lower than estimated in the previous projection (Smeets, 2004). Compared to 2002, the emission in 2010 has barely decreased: the reduction speed is stagnating. In refineries the emission decreases as a result of a switch to gas-firing.

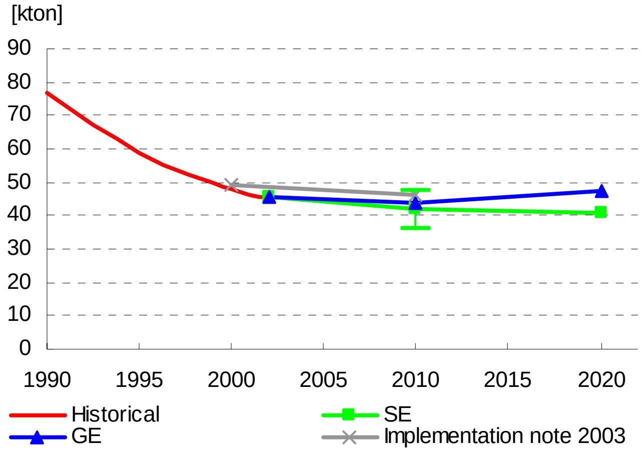

Figure 1.4.5 – Development of the PM_{10} emission in the Netherlands

In road transport, the emission decreases as a result of the European emission regulation for motor vehicles. The decrease is partly annulled by the increase in emission in other sectors. In SE the emission decreases to 41 kiloton between 2010 and 2020; in GE the emission increases to 47 kiloton. The differences between the scenarios are mainly caused by differences in economic developments in agriculture and industry.

There is no NEC target for particulate matter. The particulate matter concentration in the Netherlands and the accompanying health risks are among the highest in Europe at the moment. This is also caused by the large contribution from abroad.

1.5 Decoupling of economy and emissions

The memorandum 'Vaste waarden, Nieuwe vormen' on environmental policy 2002-2006 (VROM, 2002b) expresses the ambition to realise an absolute decoupling between economy and emissions in the longer term. Absolute decoupling means that emissions decrease while the economy grows.

The relation between gross domestic product and emissions is illustrated in Figures 1.5.1. and 1.5.2. Remarkable is the emission of CO_2 that clearly increases over the period 1990-2020, thus deviating from the other emissions.

The target to reach an absolute decoupling between airborne emissions and the economy will not be reached under the current policy. It is true that most emissions decrease until 2010, but there is a large chance that the emissions will stabilise in the period 2010-2020 (SE) or increase (GE). In both scenario's all emissions are so high that the ambition levels of the fourth National Environmental Policy Plan are still out of reach.

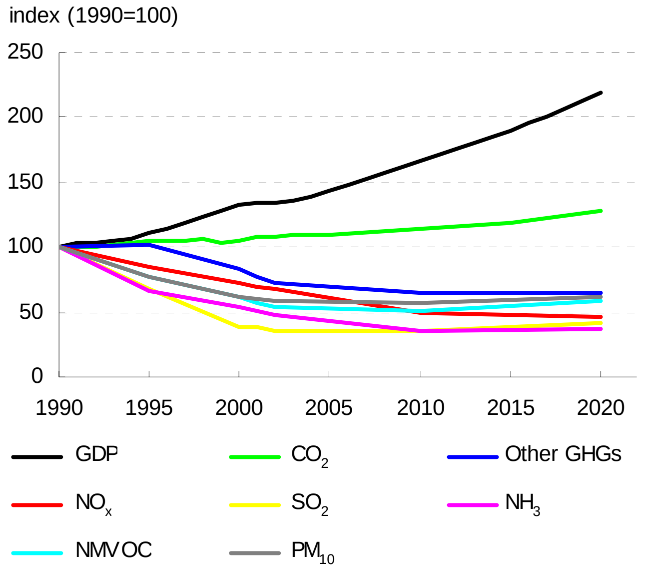

Figure 1.5.1 - Relation between the development of GDP and emissions, GE

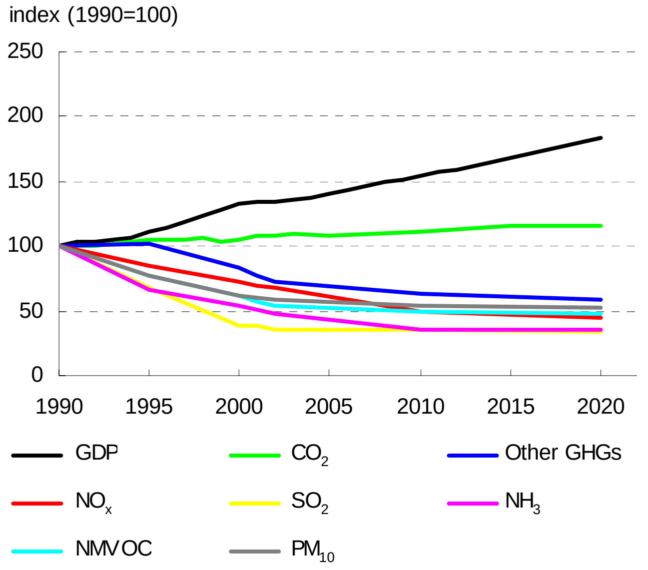

Figure 1.5.2 – Relation between the development of GDP and emissions, SE

2. OBJECTIVE AND READING GUIDE

This introductory chapter describes the objective and the functions of the Reference Projections and positions the Reference Projections in policy developments. In 2001, ECN and RIVM published the Reference Projection Energy and Greenhouse Gas Emissions 2001-2010. This projection was carried out as a joint assignment from the Dutch Ministries of Economic Affairs and the Netherlands Ministry of Housing, Spatial Planning and the Environment and is used as a starting point for energy, climate and acidification policy. The Reference Projection has delivered a major contribution to the Energy Report 2002, the Evaluation White Paper on Climate Policy 2002, the CO_2 indicative targets and the White paper on transport emissions and various other documents. This report entails two new Reference Projections with a broader and longer range. Below are a number of considerations that lie at the basis of these new projections.

Reasons for new Reference Projections

Many of the starting points of the projections for 2001-2020 have changed. The economic growth is not as strong, the saving rate appears to have dropped recently and the European climate and acidification policy plays an increasingly important role.

On February 16th 2005, the Kyoto Protocol came into effect. Meanwhile the focus of the negotiations lies with more drastic emission reductions after the first budget period. More drastic targets in the longer term for airborne emissions are examined, as well as the necessary technology, means and policy instruments.

In the near future, a number of important White Papers will be prepared by the ministries. The Ministry of Economic Affairs is planning to publish a new Energy Report in the summer of 2005 and the Netherlands Ministry of Housing, Spatial Planning and the Environment will publish a new Evaluation White Paper on Climate Policy in the autumn of 2005. Moreover, international negotiations will be held next year to establish the national targets for the emission of greenhouse gases. The final burden sharing arrangement within Europe for the Kyoto obligation in 2006 will be determined as well as the post-Kyoto efforts and NEC compounds for the period after 2010 (i.e. 2015/2020). For these negotiations it is important to have updated projections on energy consumption, energy prices, employment of renewable energy, energy saving and the emission of greenhouse gases, acidifying compounds, particulate matter and volatile organic compounds.

Objective of the Reference Projections

In order to support the above-mentioned White Papers and negotiations, the ministries have requested ECN and RIVM to provide a proposition for a new Reference Projection covering the period until 2020. A Reference Projection has two functions for the ministries:

- *A calibration function*. The projection will help to determine whether the target for 2010 and the ambitions for 2020 can be achieved. The influence of external factors will be charted.

- *A reference function*. By means of the projection, references will be developed that can play a role in the preparation and evaluation of policy. Comparing the projection against the desired developments will make clear which possibilities and obstacles can be expected. Against the background of the Reference Projections, the Document of Options for Energy and Emissions[5] will be used to explore the options for reducing emissions after 2010. In addition, the Reference Projections can contribute to the Dutch obligation towards the UNFCCC and the EC to report on emission projections.

Reading guide

Chapter 1 summarises the most important results. Chapter 2 and 3 provide an introduction on methodological and policy starting points. The starting points regarding economy and demography are discussed in Chapter 4. The actual analysis starts in Chapter 5 with an analysis of the international gas and electricity market and their influence on the Netherlands. Chapter 6 examines the energy demand of consuming sectors. Chapter 7 provides an overview of the manner in which this energy demand is fulfilled. Chapter 8 discusses the other greenhouse gases per sector. Chapter 9 focuses on the airborne emissions. Chapter 10 entails a verification with the policy targets as well as an integral analysis of the effects of policy.

The division into sectors and target groups is not similar for all types of emission. Table 2.1.1 provides an overview of the various emissions and their accompanying paragraphs.

Table 2.1.1 – Overview of emissions, sectors and paragraph indication*

	Energy and CO_2	Other greenhouse gases**	NO_x	SO_2	NMVOC	NH_3	Particulate matter
	Chapter 6 and 7	Chapter 8			Chapter 9		
Electricity production	7.1						
Cogeneration	7.2***						
Renewable energy	7.3***	8.6 and 8.7					
Refineries	7.4		9.1	9.2	9.3	9.4	9.5
Natural gas and oil extraction	7.5						
Waste	7.1	8.3					
Industry Construction	6.1	8.4 and 8.7					
Agriculture	6.5	8.2	9.1	9.2	9.3	9.4	9.5
Households	6.3	8.7					
Trade, Services and the government	6.4						
Transport	6.2	8.5	9.1	9.2	9.3	9.4	9.5

* Agriculture, trade, services, government and the construction sector, excluding mobile equipment, transport including mobile equipment.

** CH_4, N_2O, HFCs, PFCs, SF_6.

*** 7.2 en 7.3 provide a total overview of cogeneration and renewables respectively. These types of power generation have also been processed in the other sectors though, especially in 7.1.

[5] This document of Options is drafted together with the Reference projections and will also be published in 2005.

3. METHOD

This chapter discusses the methodological starting points, i.e. first of all the choice of scenarios. Secondly, the method of calculation is discussed and a number of important methodological choices are explained. The third part of this chapter is dedicated to some generic policy topics.

3.1 Scenarios

A new long-term outlook

This Reference Projection uses scenario images from the new long-term outlook 'Welvaart en Leefomgeving 2002-2040' (Welfare and Physical Surroundings 2002-2040), in short 'WLO' (CPB, RPB, MNP, 2005). Figure 3.1.1 provides a schematic overview of the scenarios.

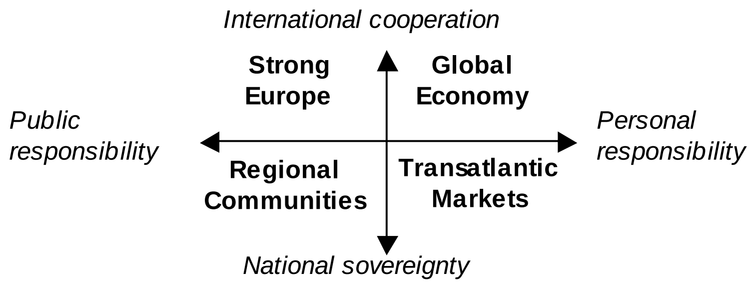

Figure 3.1.1 – Overview of the WLO scenarios

Choice of scenario

Two scenarios have been chosen for the Reference projection, i.e. Strong Europe and Global Economy. Both scenarios are oriented towards international cooperation. The Gross Domestic Product grows with 1.7% per year in SE and 2.7% in GE between 2002 and 2020. Both scenarios have the same energy, climate and air pollution policy until 2020.

SE

International cooperation in SE is linked to a public responsibility. European institutions are reformed and Europe is growing towards a strong economic and political entity. In time it will also succeed in involving the United States in a successful worldwide climate policy that relies heavily on flexible Kyoto instruments. The public responsibility leads to a relatively equal division of income and more social security as well as investments in education and research. Still the larger market will lead to a reasonable economic growth.

GE

Global Economy is the scenario that has a strong orientation towards free trade, but very little political cooperation. A strong appeal to personal responsibility for civilians and companies leads to a relatively large economic growth and material prosperity. The increase in population is also the largest in GE. Environmental consciousness is not supported by strong regulations and the international climate policy is doomed to fail in time. However, until 2020 climate policy will be maintained in Western Europe.

Policy variants

In order to establish the effect of policy several variants of GE have been determined in which energy and climate policy are partly or completely omitted. By comparing GE with a policy free variant, the total effect of energy saving and climate policy will be charted. This is based on the assumption that all climate policy will cease after 2000. Moreover, a variant has been created without the policy intensifications from the Implementation Memorandum Climate Policy 1999 and the subsequent policy adjustments. This variant links up to the UK-1 variant from the previous Reference Projection. A third variant is the SE variant in which policy is omitted that focuses on emissions that are covered by the European Emission trading system for CO_2. Finally, some analyses have been performed for possible new policy (pipeline policy), yet not in the shape of an integral variant. The policy variants are discussed in Chapter 10. The developments for the transport sector have been derived from the MNP/RIVM report ‘Actualisatie Emissieprognoses verkeer en vervoer 2003’ (Actualisation emission prognosis transport) (van den Brink, 2003) because these WLO-related developments were not yet available when these Reference Projections were published.

3.2 Method of calculation

Starting points for the calculations

The starting points for the Reference Projections can be divided in four categories, which are the main driving forces:

- First of all, the general demographic and economic starting points, as elaborated in the chosen WLO scenarios on the basis of fundamental policy choices from Figure 3.1. These will be elaborated in Chapter 4.
- Secondly, developments in international energy markets, especially natural gas and electricity, will be elaborated in Chapter 5.
- Thirdly, structural, physical and technological developments that can be expected relatively independent from the scenarios. These developments will be discussed in Chapters 6 and 7.
- Fourth, the policy developments concerning energy and emissions, as known per December 1st 2004, which are continued in a plausible manner until 2020. This chapter includes an overview of cross cutting policy topics. Further elaboration of policies can also be found in the other chapters. A complete overview can be found in Appendix A.

These starting points and elaborations have been processed in the model systems of ECN and MNP/RIVM[6]. With these instruments integral images are composed of the national energy system and emissions in the next years to come.

What is new in these Reference Projections?

Some matters deviate from the Reference projection 2001-2010 in a methodological sense. First, there is the representation of the CO_2 emission for the various sectors. For this purpose, the subdivision of the indicative target sectors has been adopted (Boonekamp, 2003). This means that industrial cogeneration that is managed as joint venture will be allocated to the electricity sector and thus no longer to the sector that receives the heat from the plant. Mobile equipment such as tractors and equipment used for civil engineering are now allocated to the Transport sector and no longer to the Agriculture, Construction and Services sector where this equipment is applied.

A complete overview of the effects of previous definition and policy adjustments until halfway 2003 can be found in ‘Sectoral CO_2 Emissions In The Netherlands up to 2010: Update of the Reference Projection for Policy-making on Indicative Targets’ (Boonekamp, 2003), especially in Appendix 2.

[6] The operation of the model systems is described in various publications. The best way to access this information is through the websites www.ecn.nl and www.rivm.nl.

The second deviation can be found in the interpretation of changes in the average outdoor temperature. Realisations of the energy consumption in recent years are the quantitative basis of the projections. In order to ensure a representative starting point for the projections, coincidental deviating circumstances are also taken into account in these realisations. For example, a correction is applied to the measured outdoor temperature, because it influences the energy consumption of space heating. What is new in these projections is that the representative outdoor temperature that was used in historic years is no longer based on the average of the last 30 years, but instead links up to the observed increasing trend of the last years. In addition, the representative outdoor temperature in the future is no longer kept equal to the temperature of recent years in these projections; instead the observed increasing trend is also extrapolated to the future. This increase of the average temperature is based on a trend analysis of observations since 1900 (Visser, 2005) and became visible from 1970 onwards. The implementation of this trend both in historic and in future results in important effects on future natural gas consumption and CO_2 emissions. For 2010 and 2020 the effect of this adjustment in climate correction amounts to approximately 4 Mton CO_2, whereas the correction of the realised CO_2 emissions in recent years is approximately 3 Mton less compared to the former method of correction.

Reasons for application of a structural climate correction

With the approval of the Royal Dutch Meteorological Institute (KNMI), RIVM has decided to include climate change in the projections. With this new method for temperature correction, the projections are improved. For the last 30 years, winters have been much warmer on average compared to earlier years in the previous century. This structural climate change has never been taken into account in previous projections. The determination of future energy consumption was based on an ‘old-fashioned’ winter season. In the previous Reference projection 2001-2010, energy consumption in the relatively warm base year 2000 was corrected on the basis of the 30-year progressing average, i.e. the period 1971-2000. The recent warmer winters have already been included in this average. Higher temperatures were thus taken into account with delay, and not directly according to the trend in this period. Furthermore, the average temperature that was used for the base year was also used for all future years. This implies that the trend was not assumed to persevere. Presently, both a model-based and statistical basis of the trend is available, supported by the KNMI (Visser, 2005). This statistical trend analysis is also closely consistent with the local temperature trends calculated with global climate models, thus providing a solid basis for extending the increasing trend into the future, see Figure 3.2.1.

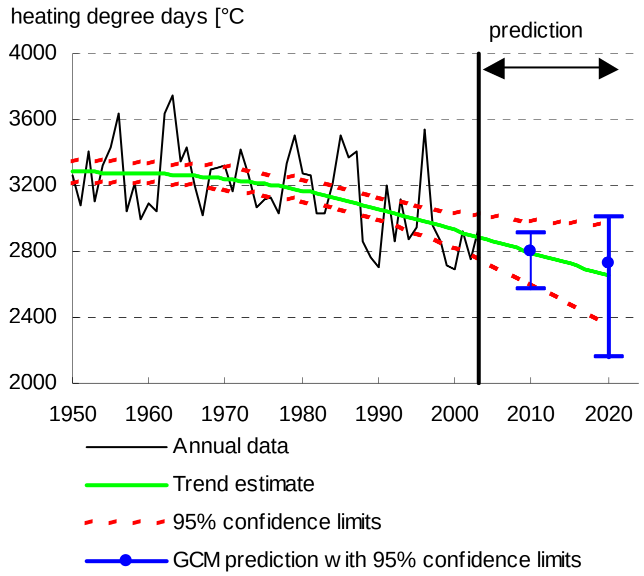

Figure 3.2.1 – Development of the trend in degree days[7], reliability interval and projections with climate models (RIVM, Visser, 2005)

The new projections are thus based on a higher standard winter temperature for the base year as well as on the expectation that future winter seasons will continually become a bit warmer on average. Apart from the winters, the summers are also expected to become warmer. Beside the energy consumption for heating, the consumption for cooling can also change. This last aspect had not been taken into account either up to now.

The new assumptions about temperature have a number of effects on the results of the projections. The important effects have been calculated and processed in the results. Other smaller effects have been listed and quantified roughly. The effects are:

- Decreased use of space heating equipment, especially in households, services and greenhouse horticulture. This effect has already occurred and results in adjustments even for historic years.
- More investments in space cooling equipment. This effect is relatively uncertain. Beside the purchase of ready-to-use cooling equipment, heat pumps in new houses also play a role.
- More intensive use of cooling equipment for buildings. The effect mainly occurs in commercial and industrial building, where much cooling equipment is already in use.
- Less investment in building isolation and efficient boilers, because these investments are less advantageous. This has a limited impact on energy saving in existing housing[8].
- More and more intensive use of air-conditioning in cars. This effect is estimated at a maximum of 0.1 Mton in 2010.
- Other effects, such as more product cooling, changed consumption patterns, effects on the efficiency of power plants, etcetera, are of negligible consequence compared to the effects of space heating and cooling.

In Table 3.2.1. the effects of the new climate correction have been quantified and compared to the method of the previous Reference Projection. The effects are expressed in Mton CO_2 emis-

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7 The number of degree days here is an indicator of the need for space heating, i.e. the number of degrees that the average outdoor temperature stays below 18ºC, summed over all days in a year.

8 New houses face EPC requirements that relate to the heat losses of buildings. These losses are calculated based on a fixed and fictitious outdoor temperature. The requirement for new buildings are not becoming less strict because of the actual higher average outdoor temperature.

sion, including the extra emission from power generation for cooling equipment. The most important effects have been included in the projections.

Table 3.2.1 – Effect of application of climate correction in Mton CO_2 emission, including indirect emissions from cooling. Difference between old and new method

[Mton]		Strong Europe		Global Economy	
	2000	2010	2020	2010	2020
Direct effect on the use of equipment for space heating	-3.0	-4.3	-5.4	-4.3	-5.5
More investments in new equipment for space cooling and more use of cooling	0.0	0.6	1.6	0.7	1.8
Processed in the scenarios	-3.0	-3.7	-3.9	-3.6	-3.7
Estimates less investments in building isolation, etcetera	0	0 to +0.1	0 to +0.2	0 to +0.1	0 to +0.2
Estimate car aircos and other effects	0	-0.2 to +0.2	-0.5 to +0.5	-0.2 to +0.2	-0.7 to +0.7

The effect of climate correction per sector is roughly the following for GE 2010:
- Households, heating -1.8 Mton, cooling +0.1 Mton
- Services, heating -1.1 Mton, cooling +0.5 Mton
- Agriculture: heating -0.5 Mton[9]
- Industry: heating -0.6 Mton.

The effects of these climate corrections are especially significant in the longer term. Next to space heating, the importance of space cooling will increase. Does this mean that the greenhouse effect has a feedback mechanism in energy consumption for space heating and that the climate problem will solve itself? This is only the case to a very limited extent. The development of energy consumption for space cooling can neutralise or even surpass the decreased gas demand. Moreover, the energy consumption for transport, industry and power generation is growing, which is a development that is not influenced by the outside temperature.

National system for monitoring greenhouse gas emissions

A third topic involves the implementation of the 'national system' for the calculation and establishment of greenhouse gas emissions. New monitoring methods have been developed for this purpose the last few years and are currently implemented in the Emission Registration. As a result, some extensive recalculations have recently been done for the entire period of 1990-2003.

The most important changes are:
- The CO_2 emissions of the industry and energy sectors are no longer primarily based on the individual emission reports from the large Dutch companies (Environmental Annual Reports) but on the energy statistics (CBS, Dutch Energy Management, NEH). As a result more complete and consistent time series can be produced as of 1990. Moreover, a more consistent distinction can be made between process and combustion emissions. The new method is more transparent and thus fits in better with the demands of 'Good Practise' as formulated by the IPCC.
- The NEH has been retrospectively adjusted for the years 1990 and 1995-2002. The changes are the result of an improved understanding that was gained by the CBS over the last years. The changes are especially related to the residual gas production and the non-energetic consumption in the industry.

[9] In addition, 0.3 Mton correction in Agriculture is the result of adjustment of the outdoor temperature sensitive share in energy consumption.

- A new list of fuels has been compiled, including the emission factors for the various types of fuel that are better attuned to the most recent scientific insights.
- Beside the changes from the NEH, two new sources have been identified (defence and fishery) in relation to the IPCC guidelines and transport emissions for aviation and inland shipping have been adjusted downwards. These changes have been implemented in historic figures but not yet in the projections.
- The CO_2 emissions of short-cycle chemical products (e.g. solvents) are based on its consumption rather than on the production. This is applied in these Reference projections in accordance with the IPCC guidelines.
- The methods for calculating the emissions from land use have been renewed. The outcome is still too uncertain and will be further examined. The emissions of land use are not included in the Reference projections.
- Especially for the agricultural sector various new methods have been developed. The emissions of other greenhouse gases, especially N_2O in agriculture, have been adjusted considerably as a result.

The emission values that arise from these adjustments are preliminary for the moment. The NIR (National Inventory Reports) of March 2005 will publish the final data. In these Reference projections the preliminary observation is made that the total emissions of greenhouse gases in the base year do not or barely change compared to the old calculation method. A shift however does occur: CO_2 emissions are probably lower than before, whereas the emissions of other greenhouse gases increase. Further details on the shifts and the quantification of the adjustments can be found in the NIR 2005.

What are the consequences for the national target in the budget period of the Kyoto protocol? The previous Reference Projection assumed a target of 199 Mton CO_2 equivalents per year for the period 2008-2012. Based on the revisions in the recalculation of the emissions of greenhouse gases in the previous years (Klein Goldewijk et al, 2004), and the most recent perceptions (February 2005) the national target for the period 2008-2012 remains 199 Mton CO_2 equivalents per year for the moment. As indicated above, it is not likely that the new perceptions necessitate a further adjustment of the target. Some comments must be made though:

- The emission data based on recalculations are still preliminary. Some adjustments may still occur that lead to other perceptions regarding the emissions in the base year.
- The calculation of the base year for Kyoto will also take land use changes into account. Which aspects of land use change should be given due weight is a point of further political consideration. As a result, the effects of this category cannot be processed in the calculation of the base year and the final obligation of the Netherlands.
- In 1998, a preliminary division of reduction obligations was made among the Member States in the EU15. This was based on the emission data of the Member States that were known for the base year at that time. In the mean time, similar to the Netherlands, most Member States have adjusted their methods for calculating their greenhouse gas emissions considerably. In 2005, all Member States will establish their methods for monitoring greenhouse gases in the first budget period (2008-2012) for their 'national system'. After that, the EU will have to see if the preliminary burden sharing can be maintained or if technical adjustments are necessary to attain an 8% reduction for the EU15 in total.

3.3 Uncertainty analysis

In outlooks for the medium and long-term, the nature and amount of uncertainty provide very important information for determining the robustness of the results. In these Reference Projections, the uncertainties are approached in two ways: by working with two scenarios and through a bottom-up analysis of sectoral uncertainties.

The WLO scenarios reflect the possible effect of policy choices concerning internationalisation and public responsibility. These choices do not embody all major uncertainties that influence energy consumption and emissions, though. Especially uncertainties concerning energy markets and structural physical and technological developments affect energy consumption and emissions importantly. These uncertainties require a separate analysis. Therefore, separate analyses have been made per sector, or assessments have been made based on expert opinions of ECN and RIVM/MNP specialists for the sectors in question.

The approach of uncertainties is based on RIVM/MNP's 'Guidance for Uncertainty Assessment and Communication' (RIVM/MNP 2003) and the ECN guideline for dealing with uncertainty (Seebregts et al., 2003). The objectives of the uncertainty analysis in the Reference projections are:

- To provide insight in the uncertainty surrounding the attainability of the policy targets in 2010 (see Chapter 1).
- To determine the degree in which the various sources of uncertainty and uncertain factors contribute to the total uncertainty.

Four different sources are distinguished:

- *Monitoring and historical data*. Uncertainties in the monitoring data affect the prognosis. This may involve incomplete or incorrect information on the historical starting point or on emission factors. The NIR (RIVM, 2004), for example, includes an overview of this source of uncertainties regarding greenhouse gases.
- *Model instruments*. Models (see Paragraph 3.2) always provide a limited reflection of a complex reality. Therefore, models inevitably contain relations and parameters that do not always reflect that complex reality in a correct manner.
- *Future economic, social and technological developments*. This mainly involves the driving forces that are indicated in Paragraph 3.2, entailing uncertainties in the developments of the international energy prices, the growth of global trade, the development of the behaviour of market players, technological developments and effectiveness of policy.
- *Policy*. Policy changes over time and under the influence of developments in the EU policy, political preferences and new perceptions.

The third source is the main focus of this report, as this source generally represents the uncertainties with the largest effects. An inventory has been made of the main uncertain developments. Sector specialists of ECN and RIVM/MNP have made assessments concerning the possible effect of these uncertainties on the sectoral emissions and indirect energy consumption. As an indication, chapters 6 and 7 provide a bandwidth compared to the SE scenario for these sectors in terms of the effect of the main uncertain factors on sectoral emissions and on total emissions in 2010. Uncertain developments with the largest effect on emissions in 2010 are given below in order of importance. Table 3.3.1 illustrates the main uncertain factors for CO_2 emissions in 2010.

Bandwidths

For the SE scenario, the inventory of uncertainties was used for establishing a bandwidth of emissions for which policy objectives were formulated for 2010. In this process, methods were used that are also applied by the IPCC (IPCC, 2004). By means of a statistical uncertainty analysis, this results in a bandwidth for the SE scenario containing the emissions with a very large certainty (95% chance). Details on this approach and the results are described in (Gijsen and Seebregts, 2005).

Results

Chapter 1 has already presented the bandwidths for the SE scenario, including a probability with which the policy targets will be attained, if possible. Below, the most important uncertain factors will be indicated per emission. The correlation indicates the degree in which the bandwidth in the uncertain factor contributes to the bandwidth of the total emission. The larger the correlation is, the more the uncertain factor contributes to the uncertainty in the total emission. Table 3.3.1 indicates the main uncertain factors for the total of national CO_2 emissions, i.e. the total of uncertainties, including monitoring uncertainties. Table 3.3.2 presents the main uncertain factors for the other greenhouse gases. Table 3.3.3. indicates the most important factors for the total greenhouse gas emissions. Table 3.3.4, finally, contains the most important uncertain factors for the other emissions.

Table 3.3.1 – Main uncertain factors for CO_2 emissions, SE, 2010

	Description	Correlation
1	Monitoring uncertainty[1], total CO_2 (NIR)	0.58
2	Transport[1]	0.51
3	Development heat/steam demand (cogeneration)	0.28
4	Final demand for electricity	0.26
5	Import balance electricity and price ratio compared to abroad	0.26
6	Industry: Economic growth, choice of location and division of growth over activities	0.17
6	Coal-fired power capacity: input and volume	0.16
8	Lifestyle/behaviour households	0.14
9	Fuel and energy prices, including natural gas and coal price ratio	0.14
10	Price differences oil market	0.13

[1] As total, no further differentiation into sectors. If there were a division into sectors, the individual contributions would be much smaller.

Table 3.3.2 – Main uncertain factors other greenhouse gases (OGHG), SE, 2010

	Description	Correlation
1	N_2O Measure in nitric acid industry from the back-up policy package	0.53
2	N_2O Agriculture Monitoring (direct emissions)	0.51
3	N_2O Demand for N-fertilizer (industry)	0.21
4	F-gases projection uncertainty	0.19
5	CH_4 Waste disposal companies monitoring	0.17
6	CH_4 Projection uncertainty waste disposal companies	0.16
7	N_2O Agriculture monitoring (indirect emissions)	0.16
8	N_2O from fertilizer	0.15
9	HFC Monitoring	0.15

Table 3.3.3 – Main uncertain factors total greenhouse gases (GHG), SE, 2010

	Description	Correlation
1	N_2O Measure in nitric acid industry from the back-up policy package	0.40
2	N_2O Agriculture monitoring (direct emissions)	0.37
3	CO_2 Transport	0.36
4	CO_2 Import balance electricity and price ratio compared to abroad	0.19
5	CO_2 Development heat/steam demand (cogeneration)	0.19
6	CO_2 Final demand for electricity	0.18
7	N_2O Demand for N-fertilizer (industry)	0.15
8	F-gases projection uncertainty	0.15
9	CO_2 Industry: Economic growth, choice of location and division of growth over activities	0.13
10	CH_4 Projection uncertainty waste disposal companies	0.12
11	CH_4 Waste disposal companies monitoring	0.12
12	CO_2 Lifestyle/behaviour households	0.12

Table 3.3.4 – Main uncertain factors other emissions, SE, 2010

Particle	Description	Correlation
NO_x	1 Transport	0.8
	2 Industry - emission factor NO_x emission trading companies	0.5
SO_2	1 Refineries - results negotiations with industry	0.8

	2 Refineries - shift of Shell oil to gas-firing	0.4
NH_3	1 Agriculture - monitoring	0.9
	2 Consumers - monitoring	0.3
NMVOC	1 Industry and energy	0.8
	2 Transport	0.4
PM_{10}	1 Industry and energy	0.9
	2 Transport	0.3

3.4 Policy overview

In the SE and GE scenarios, current Dutch energy saving, climate and air pollution policy are continued for the duration of the Reference Projections. European policy is also assumed to continue. The global development of climate policy differs between SE and GE. When national policies come to an end, as is the case with Covenants, a logical continuation of pressure from policy is assumed. When a policy is still under development, as is the case with CO_2 emission trading, a plausible development of that policy is anticipated. Policy that involves energy markets can differ between SE and GE, as for example the small fields policy for natural gas extraction and the considered closing the nuclear plant in Borssele. Appendix A contains an overview of the assumptions for the most important policy instruments. In this paragraph several important generic policy instruments will be further explained. Specific instruments, such as covenants and emission guidelines are further explained in the separate sector and category sections.

CO_2 emission trading

Until 2020, the policy that arises from the Kyoto Protocol will be continued in both scenarios. Emission trading, JI and CDM are applied in both scenarios to attain the national target. The European CO_2 emission trading system has become effective as of 1-1-2005. It entails the electricity production, petroleum refining and the most energy intensive industry and oil and natural gas extraction. The investment climate for emission reducing measures is favourable in SE. According to general expectations, emission reduction will be continued after 2012 and more countries outside Europe will take on targets and participate. Companies maintain a strong preference towards investing in reduction within the company itself instead of buying emission allowances, because the future price level is uncertain, but will most likely rise. In GE some doubts arise after the first budget period about worldwide participation and investment behaviour that also takes into account the possibility that prices of emission allowances will remain low.

In the first period of 2005-2007 the allocation is generous and the price is low at 2 € per ton CO_2 and there is relatively little trading. Many companies use this period to straighten out their CO_2 monitoring system, to make CO_2 reduction plans and to stay below the allocated amount of allowances with their emissions. Banking is not allowed in the first period for complying in the second period.

The second period of 2008-2012 will become the real test: a number of countries will have to adhere to their national obligations with JI and CDM. Cost considerations in participating countries lead to a stricter allocation of allowances to the national industries and electricity sector. The price of emission allowances in this period increases up to 8 € in 2012, averagely 7 €per ton CO_2. All larger sources of the chemical industry are now covered by this system; the small sources are not included. Starting point of the national allocation in this period is the same absolute amount as in the first period. As a result of production growth of the participating sectors, the demand for emission allowances increases so this allocation is also experienced as less generous.

The average price in the period 2013-2020 amounts to 11 € per ton CO_2. Moreover, a large range of emission reducing options has been developed worldwide. In the SE scenario, the expectation prevails that climate policy will also be continued after 2020 and that CO_2 prices will increase strongly. In the GE scenario, according to expectations CO_2 policy will not be continued after 2020. The allocation also remains at the same absolute level as in the first and second period in both scenarios.

Emission trading affects the product prices of energy intensive sectors, especially the electricity production. In theory, the eventual marginal CO_2 price will be fully oncharged in the marginal production costs and in the product price. There are two reasons why this will not be fully implemented in the current trading system.

- Competition with producers outside the trading system, especially involving goods that are traded worldwide such as aluminium, steel and base chemicals. The SE scenario does assume a worldwide CO_2 emission price in time. However, in the period up to 2012 this is not the case. Moreover, competition remains to exist from aluminium produced from hydropower and small-scale greenhouse horticulture, for example.
- Competition with producers within the trading system. New capacity may be largely supplied with free emission allowances in the future. As a result, capacity and production growth is not curbed and the product price remains low. Extensive free allocation of emission allowances maintains the possibility to compete in market shares instead of return on investment.

Based on the market position of various processes and subsectors, oncharging factors are estimated. The assumed input and the transfer of emission costs are included in Table 3.4.1. The assumed effect of emission trade on energy prices is included in Table 3.4.2.

Table 3.4.1 - Oncharging factors under emission trading (full oncharging = 1) and product price increase [%]

	2005-2007		2008-2012		2013-2020	
European trading price CO_2, euro/ton	2		7		11	
	of	price	of	price	of	price
Greenhouse horticulture*	0.2	0.1%	0.3	0.4%	0.4	0.8%
Primary aluminium**	0.3	0.2%	0.3	0.6%	0.4	1.6%
Corus	0.2	0.2%	0.3	1.1%	0.7	3.9%
Ammonia/nitrogen fertilizer	0.2	0.2%	0.2	0.9%	0.8	5.5%
petrochemistry (ethene complexes)	0.2	0.0%	0.2	0.0%	0.6	0.0%
Petroleum refinery	0.2	0.0%	0.2	0.1%	0.6	0.6%
Pulp, paper and card board industry	0.2	0.0%	0.5	0.2%	0.7	0.5%
Starch and sugar refinery	0.2	0.0%	0.3	0.1%	0.3	0.2%
Cement	0.2	0.4%	0.3	2.0%	0.3	3.1%
Electricity producers	0.6	1.5%	0.6	5.1%	0.8	10.8%

*in as far as participant

**especially effect electricity price

Energy tax

The Regulating Energy Taxes (REB) and Fuel Tax (BSB) have merged into the Energy Tax (EB). The SE and GE scenarios include the energy tax rates as indicated in Table 3.4.2. The energy tax is retained as tax measure under the system of CO_2 emission trading, the effect of emission trading on electricity prices is not compensated by tax reductions. Large consumers of natural gas, who are not included in the emission trading system and have low marginal tariffs, face an increase in Energy Tax, as a result of which there is no advantage in costs compared to participants anymore. Table 3.4.2 also indicates the total policy pressure as a result of the Energy tax and emission trading together (expressed in €/ton CO_2). The brackets of 1 million m^3 gas and more include the emission trading prices. In greenhouse horticulture, the Energy Tax below 1 million m^3 gas is raised as of 2010, leading to equal marginal costs for participants and non-participants.

Table 3.4.2 – Tariffs of Energy Tax as established per 1-1-2005 in cent per m^3 or kWh and the Energy tax plus the influence of emission trading as a total policy effect on the marginal costs (in €/ton CO_2)[10]

	2004	2005	2006	2007	2010	2020	2004	2005	2006	2007	2010	2020
Natural gas	cent per m^3						euro/ton CO_2					
0 - 5,000 m^3	14.29	14.94	14.94	14.94	14.94	14.94	80	84	84	84	84	84
5,000 - 170,000 m^3	7.27	11.45	12.29	13.11	13.11	13.11	41	64	69	74	74	74
170,000 - 1,000,000 m^3	2.27	3.11	3.37	3.63	3.63	3.63	13	18	19	20	20	20
1,000,000 - 10,000,000 m^3	1.13	1.15	1.15	1.15	1.15	1.15	6	8	8	8	14	17
? 10.000.000 m^3 commercial consumption	0.75	0.76	0.76	0.76	0.76	0.76	4	6	6	6	12	15
Greenhouse horticulture												
0 - 5,000 m^3	1.295	1.378	1.378	1.378	1.378	1.378	7	8	8	8	8	8
5,000 - 170,000 m^3	1.207	1.917	2.058	2.195	2.195	2.195	7	11	12	12	12	12
170,000 - 1,000,000 m^3	1.144	1.573	1.704	1.835	1.835	1.835	6	9	10	10	14	17
1,000,000 - 10,000,000 m^3	1.13	1.15	1.15	1.15	1.15	1.15	6	8	8	8	14	17
? 10.000.000 m^3 commercial consumption	0.75	0.76	0.76	0.76	0.76	0.76	4	6	6	6	12	15
Electricity	cent per kWh											
0 - 10,000 kWh	6.54	6.99	6.99	6.99	6.99	6.99	130	139	139	139	142	145
10,000 - 50,000 kWh	2.12	3.2	3.41	3.61	3.61	3.61	42	64	69	72	75	78
50,000 - 10,000,000 kWh	0.65	0.86	0.93	0.99	0.99	0.99	13	18	19	21	24	27
? 10.000.000 kWh commercial consumption	0.05	0.05	0.05	0.05	0.05	0.05	1	2	2	2	5	8

EPBD, EPN and EPA

Beside the Energy tax, regulations are especially important for housing and commercial and industrial buildings. The European Energy Performance Building Directive (EPBD) requires EU Member States to have a method for the calculation of the energy performance of buildings and to have minimum requirements for the energy performance of new buildings by January 1st 2006. Moreover, the energy certification of existing buildings must have been taken care of: an owner must submit an energy certificate if he sells or lets out his house. The Netherlands adhere to these requirements by using the existing instruments EPN and EPA. The implementation of EPBD is included in calculations. By means of EPN, minimum requirements are demanded from energy consumption for space heating and cooling, the production of hot tap water, ventilation and lighting in new housing. The EPN will be increased to 0.8 as of January 1st 2006. After 2007, the scenarios do not assume any more increases. The Energy Performance Advice (EPA) is used for existing houses and provides insight in the energy performance of a house as well as the necessary measures for improvement of the energy performance. In the course of 2006, but no later than January 1st 2007, EPA will be used in the framework of the EPBD. The voluntary character of an EPA when selling or letting out a house will disappear as the results of the EPA are registered in an energy certificate. Whether or not to implement saving measures remains the choice of the owner, but the advice comes at a natural moment.

EIA

The Energy Investment Deduction EIA is a generic subsidy instrument for companies. It is assumed that the EIA will remain effective, but this fiscal arrangement has been purified and lowered to 44% compared to the Reference Projection 2001. This percentage can be deducted fiscally on top of the normal deductions when investing in energy saving and renewable electricity generation. The effective subsidy on investments thus amounts to 13-14%. The Early Depreciation Environment Investment (VAMIL) and the Energy Investment regulation Non-Profit (EINP), which were part of the Reference Projection 2001, were terminated at the end of 2002.

MEP

10 Especially with respect to electricity, this policy effect is uncertain as a result of the composition of the marginal production park and the effect of emission trading on the electricity price. Here, a CO_2 emission of 0.5 ton/MWh and effect cf. Table 3.1.1 have been assumed.

MEP refers to Environmental Quality of Electricity Production and is intended for producers of renewable/sustainable electricity and electricity from cogeneration. The MEP started in July 2003 and replaces the former producer compensation of the Regulating Energy Tax (REB 36o). The reduction of the fiscal advantage for consumers of renewable electricity (REB 36i) is compensated by an equal rise of the MEP feed in subsidies. The MEP is financed with a levy for all consumers, which is a fixed amount of € 52 in 2005. In the case of cogeneration, a MEP subsidy is provided based on the CO_2 reduction. The amount depends on market conditions for cogeneration; in 2005 it amounts to 2.2 ct per CO_2 free kWh. The regulation is tested against the European environmental support framework and will be revised per January 1st 2006. In the case of renewable energy sources, the MEP covers the average additional costs of renewable electricity compared to regular 'grey electricity', the Financial Gap (FG). The FG varies per method of generation because the cost prices of the various renewable techniques differ significantly. Moreover, the FG also varies in time: renewable electricity generation becomes more efficient, among others as a result of technological development. Despite the changes in FG every year, the MEP subsidy offers certainty to investors, as the subsidy is fixed for a maximum of 10 year from the moment that it is applied for. Table 3.4.3 shows the MEP subsidy rates for renewable electricity.

Table 3.4.3 – Overview MEP subsidy rates for renewable electricity generation

[ct/kWh]	2003	2004 until 1 juli	2004 after 1 juli	2005	2006 until 1 juli	2006 after 1 juli	2007
REB-exemption (36i)	2.9	2.9	1.5	0.0	0.0	0.0	0.0
RWZI/AWZI	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Landfill gas	0.0	0.0	0.6	2.1	2.1	1.3	1.3
Mixed waste streams[1]	2.9	2.9	2.9	2.9	2.9	3.6	3.6
Animal flour	-	0.0	0.6	2.1	2.1	3.0	3.0
Pure biomass	4.8	4.1	5.5	7.0	7.0	6.6	6.6
Onshore wind[2]	4.9	4.9	6.3	7.7	7.7	6.5	6.5
Offshore wind	6.8	6.8	8.2	9.7	9.7	9.7	9.7
Independent bioenergy plants	6.8	6.8	8.2	9.7	9.7	9.7	9.7
Hydropower	6.8	6.8	8.2	9.7	9.7	9.7	9.7
PV, wave and tidal energy	6.8	6.8	8.2	9.7	9.7	9.7	9.7

1 In proportion to the share of biogenic material.

2 During a maximum of 10 years up to a maximum of 18,000 maximal capacity equivalent hours until June 30th 2006 and up to a maximum of 20,000 maximal capacity equivalent hours as of July 1st 2006.

CO_2 reduction plan

The CO_2 reduction plan aims at projects that reduce CO_2 or other greenhouse gases. New tenders are not submitted, but budgets are still available for projects that comply with the conditions of the tender arrangement. Under these conditions, the subsidy level amounts to approximately 15 € per ton CO_2.

4. DEMOGRAPHIC AND ECONOMIC DEVELOPMENTS

In this chapter, the economic and demographic starting points of the Reference Projection are explained. These starting points are the result of the European Outlook 'Four Futures of Europe' (de Mooij and Tang, 2003), the demographic elaboration for the Netherlands (de Jong and Hilderink, 2003) and the economic elaboration for the Netherlands (Huizinga and Smid, 2004).

4.1 Demographic development

he growth of the population decreases in all scenarios compared to the average over the period 1971-2001 (see De Jong and Hilderink, 2004). The baby boom generation is greying and the death rate increases in all scenarios. The differences between the scenarios lie mainly in the differences in migration and fertility. In Strong Europe, the population growth is large mainly because of the free migration policy and a high birth rate. In Global Economy the migration rate is also high as a result of a relatively open migration policy. Together with the high amount of births, this leads to the largest population growth of the four scenarios.

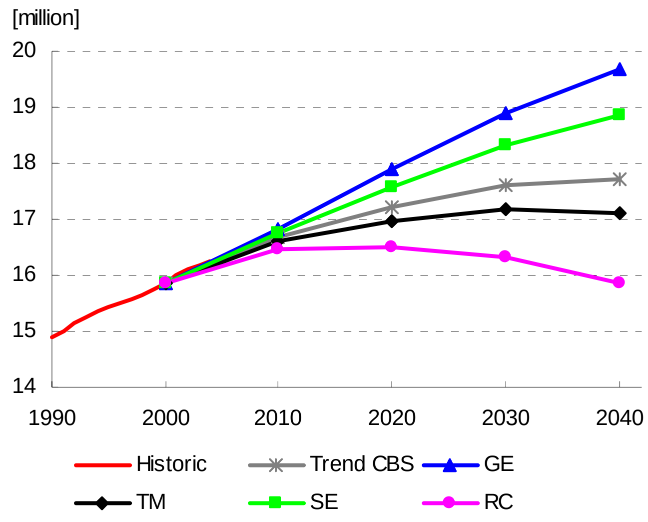

Figure 4.1.1 - Population growth in the four WLO scenarios

In all scenarios the migration rate is higher than the natural population growth. The scenarios Transatlantic Markets and Regional Communities, which are not incorporated in the Reference Projections, have a relatively strict migration policy as a result of which the population growth is lower. In 2020, the population increases to 17.6 million in Strong Europe and 17.9 million in Global Economy. Both scenarios indicate a larger growth than the trend development of the CBS, which increases to 17.2 million in 2020. Transatlantic markets and Regional Communities arrive at lower numbers, i.e. 17.0 and 16.5 million respectively. The relatively high population growth also affects the number of households. Both population and the number of households are starting points for the calculations of energy consumption of the household sector.

Table 4.1.1 - Population and households

		Strong Europe		Global Economy	
	2002	2010	2020	2010	2020
Population million	16.1	16.8	17.6	16.8	17.9
Households million	6.9	7.5	8.2	7.6	8.6
Persons per household	2.29	2.2	2.11	2.19	2.05

4.2 Economic development

The economic growth in the scenarios strongly depends on the labour market in the long run. The labour market is determined by the population growth, the share of working population and the degree of participation within this group. In GE the degree of participation is higher than in SE, because in GE social services are more directed to personal responsibility. As a result of less collective pension arrangements and social insurances, people remain longer active in the labour market in GE. Labour productivity is also of prime importance for economic performance. In SE, the development of labour productivity is more or less equal to the productivity of previous decades. In GE, the increase in world trade is the main reason for the higher productivity figure. Especially technological development is an important structural determinant of the growth of labour productivity. In GE, less interference from government is assumed to lead to a better innovation climate and better social acceptance of new technology than in SE. Table 4.2.1 summarizes the core data for the structural economic development in the scenarios. Labour productivity and employment together determine the GDP growth in the long term.

Table 4.2.1 - Economic core date scenarios

	Mutations in % per year 2002-2020	
	Strong Europe	Global Economy
Population	0.5	0.6
Effect age structure (ageing)	-0.5	-0.5
Effect degree of participation	0.4	0.7
Labour market (persons)	0.3	0.8
Labour productivity	1.6	2.1
Employment labour years	0.2	0.8
Gross Domestic Product	1.8	2.9
Private consumption	2.2	3.4

Sectors

The sector structure develops more or less similarly in both scenarios. The shift of labour from industry and agriculture to services proceeds. In SE the main focus is put on government and social services. Energy companies contribute to a lesser extent to the domestic product as a result of decreasing natural gas extraction. Within industry, some shifts occur as well. An overview of separate industrial sectors has been included in Paragraph 6.1.

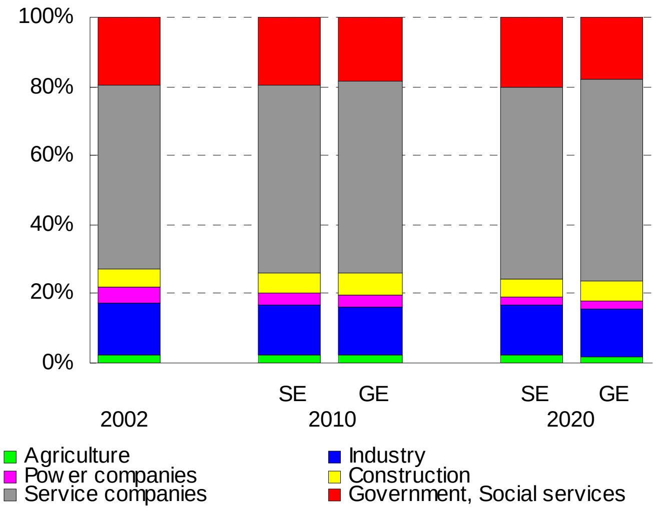

Figure 4.2.1 - Development of sector structure in SE and GE

Table 4.2.2 - Added value of main sectors [%/yr]

[%]	History	RR2001	Strong Europe		Global Economy	
	1995-2002	2000-2010	2002-2010	2010-2020	2002-2010	2010-2020
Industry	1.6	2.6	1.3	1.9	2.0	2.3
Trade, Services, Government	3.6	2.6	1.9	2.0	2.9	3.1
Service companies	4.1	2.9	2.0	2.0	3.3	3.3
Government, Social services	2.4	1.7	1.8	1.9	2.0	2.4
Agriculture and Fishery	0.2	1.8	1.4	0.2	1.5	1.3
Construction	2.1	2.1	1.7	0.7	3.7	2.6
Total	2.9	2.5	1.7	1.7	2.7	2.8

The data show that the previous Reference Projection assumed a high economic growth, based on the optimistic scenario of the Medium-term Outlook and the Macro Economic Outlook (MEV) 2002. Most striking is the fact that industry experiences a lower growth both in GE and in SE. On the other hand, the social sector and the public sector remain relatively strong, even in the GE scenario, which has a small and efficient government. This is due to the ageing population as a result of which a larger appeal on the social services becomes necessary.

5. DEVELOPMENT OF ENERGY MARKETS

In this chapter, important starting points for the projections are derived. Developments in the international energy markets determine to a large extent the conditions for the national markets. The main results of this chapter are the energy prices for the various sectors and target groups.

5.1 Natural gas market

The price that end users have to pay for natural gas is determined by a combination of expectations with respect to oil price developments, the degree of competition and import, the tariff system of Gas transport Services (GtS), margins in transport and distribution and levies.

The gas price for small users is largely determined by the Energy Tax (ET) and the Value Added tax (VAT). As of 2005, the ET was raised to 14.94 €ct/m^3 for households that consume less than 5000 m^3 per year. In the Budget for 2005 more raises are announced for the coming years. Especially the small and medium-sized businesses can expect major tax raises: the ET for consumption under 170,000 m^3 will be 13.11 €ct/m^3, which is nearly twice the amount of 2004. For large users, the commodity price mostly determines the final price. In addition, costs for transport, distribution and similar services also play a part.

Commodity price

The future development of the commodity price of gas in the Netherlands is driven by various factors. The demand for gas is increasing because high conversion efficiency can be reached, the carbon content is low and the combustion is relatively clean. This leads to a higher growth of the gas prices compared to the oil prices. Yet, there is a shift from local or regional markets to a more European or global gas market. Regional gas prices will converge as a result of increased arbitration options.

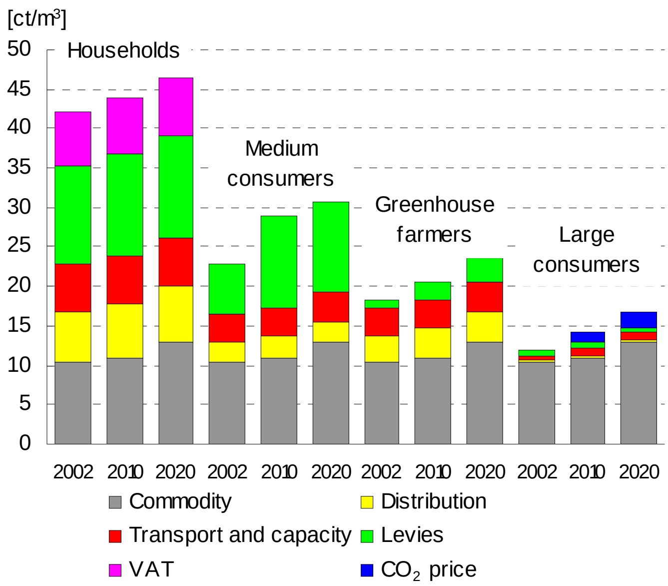

Figure 5.1.1 - Composition of average gas price for households (annual consumption <5000 m^3), medium users (annual consumption < 170000 m^3, operation hours 3000), greenhouse horticulturists (annual consumption < 1 mln m^3, operation hours 3000) and large users (annual consumption > 10 mln m^3, operation hours 7000) [€$_{2000}$ct/m^3]

Gas-to-gas competition is becoming more important, which results in an ongoing decoupling of gas and oil prices. Gas-to-gas competition has a reducing effect on the price. Most dominant, however, is the increase of production costs and the larger distances for transporting gas to the European market.

Until 2010, the gas price remains strongly linked to the oil price. The expected development of the oil price according to the 'International Energy Outlook' of the Energy Information Administration, Department of Energy of the United States, serves as starting point. This oil price is relatively high until 2012, compared to other international scenario studies. The oil price increases averagely 0.7% per year from 24.5 €/barrel in 2010 to 27.1 €/barrel in 2020.

Recently, the oil price broke one record after another, leading to peak prices of about 50 dollar per barrel. The forward contracts increase less rapidly though, which implies that the market expects that the price of crude oil will decrease again in the longer term. This has a direct effect on the gas price. Gradually, though, the influence of imported gas and market mechanisms will gain strength, whereas the inland gas production decreases. As a result, the commodity price will mainly be determined by the increasing import price after 2010. The development of the commodity price until 2020 is the same in the GE and the SE scenario.

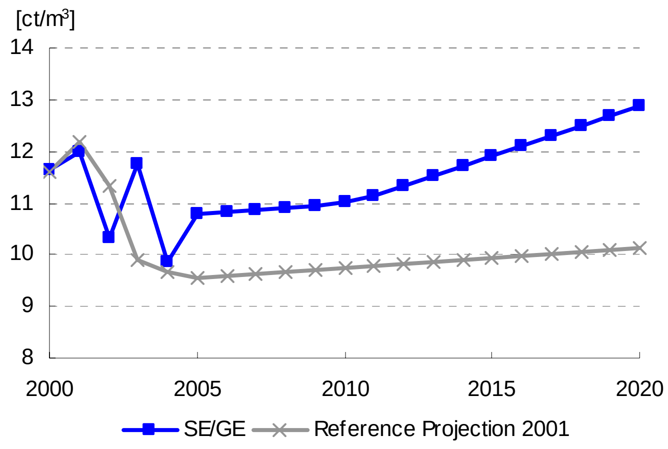

Figure 5.1.2 - Development of the commodity price for natural gas in the reference scenario (SE and GE - until 2004 is realisation) compared to the old reference scenario (RR2001) [$€_{2000}$ct/m^3]

Transport and distribution

The tariffs for gas transport and distribution remain regulated, i.e. they will continue to require approval of the Dutch Office of Energy Regulation (DTe). Even after the market was fully open in July 2004, the grid tariffs for small users (<170,000 m^3/year) remain under supervision. DTe has developed a new method for establishing the regional grid tariffs for the period 2005-2007. The starting point of this method is that customers start paying for the actual costs. Tariffs are established on the basis of the average productivity improvement in the sector, as opposed to productivity improvements per company, like before. Regional distribution tariffs for grid administration and supply of gas will not change significantly in the future. However, should the gas demand per connection decrease significantly in the future, especially among small users, then the regional grid administration costs per m^3 will increase.

The prices and conditions of gas transport through the national high-pressure grid and corresponding services are established by Gas transport Services annually for the next year. This is based on the entry-exit system, in which separate tariffs apply to contracted entry capacity and exit capacity. The transport price thus strongly depends on the operating hours: the lower the operating hours, the more additional capacity and transport are needed. The transport and capacity tariffs and the method based on operating hours will probably hardly change in the future. Tariffs for capacity services can increase, though, depending on the developments that will be discussed next.

The good physical infrastructural connections will not change significantly. According to expectations, the underground storage capacity (UGS) will expand, because gas import increases and the required flexibility can be decreasingly offered by the Groningen field. Also important is the accessibility to the infrastructure. Regulation, the role of supervisors, and the degree of harmonization between countries affect the accessibility. In the SE scenario, there is less strong policy with respect to unbundling and third party access (maintaining administrative unbundling and negotiated TPA). In the GE scenario, access to the infrastructure is left to the market. This results in relatively strong market positions for the existing gas companies in both scenarios. Although decreasing demand in the longer term and a good gas supply will lead to relatively low gas prices, gas companies can still calculate significant margins due to moderate competition. In SE, the Netherlands hold a strong market position as trading junction and supplier of flexibility services for other countries. A relatively cheap infrastructure is available as a result of a limited domestic demand. This infrastructure is also used for trading activities. Access to the infrastructure cannot be guaranteed though, as a result of less effective regulation.

Uncertainties

The commodity price of gas is uncertain. Sectors and end users of gas who participate in the system of CO_2 emission trading must purchase emission rights if they emit more than allowed. They have to deal with a CO_2 market and price that are still quite uncertain.

5.2 Electricity market

This paragraph discusses the market conditions that apply to the Dutch electricity supply in the SE and GE scenario and that play a decisive role in the projections of wholesale prices for electricity. The wholesale prices are determined by the variable production costs. These costs mainly consist of fuel costs and the costs of CO_2 emission credits and the levy of producers (mark-up). The wholesale prices are also the result of the development of the Dutch electricity production sector, which will be discussed in Chapter 7. In addition to the analysis of the development of the wholesale prices, the end user prices for the Dutch market have also been derived.

Variable production costs

The variable production costs are mainly determined by fuel costs, but also by policy with respect to CO_2 emission reduction. In the previous paragraph the development of the price of natural gas was discussed. For the electricity market the price of coal is also important. There is assumed to be no difference in coal price between the two scenarios. The coal price amounts to 1.7 €/GJ as of 2004 (an import price of approximately 1.5 €/GJ and 0.2 €/GJ for transport and transfer costs). This coal price is based on recent EU scenario studies (EC, 2003a; EC, 2003b). The coal price lies between the projections from these two studies, and is somewhat higher than the average of historical prices in the period 1990-2003 (CBS, 2004). Although recent forward prices for coal show an increasing trend (EBB, 2004), which equals the import price of approximately 2 €/GJ, the long term expectation within the scenarios is maintained at the earlier mentioned lower level. The recent high coal prices are caused by a temporary limitation in capacity of transport by sea.

Mark-up

The producers' levy on variable costs depends on the degree of competition, both within the Netherlands and abroad in neighbouring countries. The SE scenario assumes a mediocre competitive electricity market. The difference between the marginal variable production costs and the market prices, i.e. the mark-up, does not change in this scenario compared to the current one. In the GE scenario, on the other hand, the competition in the electricity market does increase, which results in a decrease of the average mark-up in the medium term.

The degree of competition and thus the mark-up is related to the strategies of the producers that are active in the Dutch electricity market. The amount of suppliers also matters: next to the amount of large-scale Dutch producers this involves foreign suppliers, small-scale decentral products and independent traders.

Market behaviour

The commodity price of electricity on the wholesale market stems from the manner in which producers meet electricity demand. The height of the electricity price is basically determined by the producing plant with the highest variable costs. Which plant this is depends on the height of the demand but also on the available supply of plants. Foreign plants also play a role but the import of electricity is limited by restraints in the capacity of the high voltage grids. Paragraph 7.1 examines the expected developments of electricity demand.

The actual market prices are often higher than the marginal variable production costs. This is due to the fact that producers often behave less competitive, either consciously or unconsciously. This is also the result of the limited number of producers in the Dutch electricity market. In peak periods, when the number of available plants is limited, the market price can be much higher than the marginal variable production costs. In this case, one can no longer speak of competitive behaviour, because the extra yields for the producers (so-called scarcity rents) are the result of scarcity on the market. These yields are needed to cover the fixed costs, especially the costs of peak capacity.

The difference between marginal variable production costs and the market prices, the so-called mark-up, can be determined by comparing the market price with the spot market prices that have been realized in the previous years in model simulations. [11] The mark-up of foreign markets can be determined in the same manner. Due to capacity limitations on the high voltage grid between the various countries (interconnectors) and because of a different composition of the production park, every country has a different market price.

Development of production capacity

In the coming years electricity demand can be covered by existing power plants. As a result of an increase in demand the market will tighten. This tightness occurs in times when peak demand coincides with a limitation in production capacity, for example as a result of failures or because the temperature of surface water that is used for the cooling of plants is too high. Under those circumstances market prices can rise sky-high and the amount of back-up capacity will decrease rapidly. A similar situation occurred in the summer of 2003.

Market power in the electricity market will have to ensure timely investments in new production capacity, in order to meet increasing demand and to replace technically aged production units. A reduction in existing production capacity can also be postponed by investing in lifetime extensions or by putting into operation old power plants that were closed down. Electrabel, for example, has decided to extend the lifetime of the Bergum, Harculo, and Gelderland plants. Essent is considering putting the Amer-71 back into operation.

Investment behaviour

In principle, the electricity price is an important indicator for investment decisions. Realisation of new production capacity becomes attractive when the average price level surpasses the integral costs of electricity production. In reality, the investment decisions will mostly be based on the analyses of the development of electricity demand and production supply.

This is because the realization of new production capacity requires a long period of preparation and construction. The slow process of tuning production supply to future demand can lead to so-called cyclic investment behaviour. Various producers decide to expand their production capacity at the same time, which results in a surplus after a few years. As a result, the average

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[11] The electricity market model POWERS has been used for the simulation of the Dutch electricity market (Rijkers et al., 2001; Seebregts et al., 2004).

market price is sometimes higher than the integral cost price for a while, after which the price decreases to below the integral cost price again.

In a market simulation model, the moment that new capacity is needed can be predicted. New capacity is installed when the average electricity price (baseload) surpasses a certain price level in a certain period. Depending on the perceived market risk, this level will be lower or higher. And cyclic investment behaviour is assumed for a more competitive market environment, such as in the GE scenario. In the SE scenario, expansion of capacity will occur more gradually. As a result of increasing CO_2 prices or natural gas prices, a price decrease does not have to take place. Instead, the price may even rise more, despite the investments in new capacity.

Beside increasing peak prices, an increasing import balance and a decreasing back-up actor are indicators of an increasing lack of production capacity. Realising new production capacity is not only restricted to the current Dutch electricity producers. In a liberalized electricity market, new power plants can also be realized by other parties. New parties in the market can specialize in certain types of production capacity and do not have to take existing production plants into account. Existing electricity producers do take their plants into account. Their choice for a new plant will be tuned to their current capacity and they will thus spread volume and price risks over all their plants.

Policy developments

Next to the Energy tax, the price of emission credits is also important for the end user prices. The price of CO_2 emission credits belongs to the variable production costs of fossil fuel-fired plants. In Dutch and many foreign electricity markets, the plant that covers the marginal demand is a thermic plant based on fossil fuels[12.] The introduction of the CO_2 emission trading system in 2005 will therefore affect the commodity price of electricity. At first the electricity producers, similar to all participating parties, received free emission credits. These credits do not require any costs, but since the CO_2 credit can potentially yield money, it is included in the marginal production costs (opportunity cost). It remains to be seen though if producers are able to increase market prices with the full CO_2 price for the larger strategic contracts. This will probably occur at the expense of part of the mark-up. It is assumed that only 60% of the CO_2 price will be included in the electricity price at first. If more credits need to be purchased in the longer time in 2020 or emission-reducing measures must be taken, this percentage will increase to 80% (see also Chapter 3).

Choice of technology

New coal capacity may seem attractive given the relatively low and reasonably stable fuel costs, especially in view of the competition with foreign production. However, it is unlikely that new plants for coal-fired electricity production will be realized in the short term. The permit procedure takes a long time and the investment cost is relatively high. Moreover, the fuel cost advantage over natural gas decreases when the price of CO_2 emission credits rises. The oldest two coal-fired plants, Gelderland-13 and Amer-17, are assumed to remain in operation until 2018. In the SE scenario, new pulverised coal-fired or coal gasification plants will not be put into operation in view of the expected strong price increase of CO_2 emission credits after 2020. As a result, the input of coal increases strongly in SE. In GE, the input of coal for electricity production increases mainly in the period until 2015/2020. The GE scenario assumes that the emission trad-

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[12] If the marginal plant is a natural gas-fired combined cycle with an efficiency of 58%, then 1 €/ton CO_2 will lead to 0.35 €/MWh extra variable costs. If the marginal plant is a pulverised coal unit with an efficiency of 45%, then 1 €/ton CO_2 leads to 0.76 of extra variable costs, which is more than double the amount of the natural gas-fired combined cycle. In terms of CO_2 emissions per kWh, this is 0.35 and 0.76 kg/kWh for natural gas-fired combined cycle and pulverised coal plant. Per kWh, a pulverised coal plant emits twice as much CO_2 as a natural gas-fired combined cycle.

ing system will cease to exist after 2020, as a result of which coal-fired plants are cheaper than natural gas-fired combined cycles. Moreover, it offers a better portfolio in which price risks of natural gas are covered better. Pulverised coal-fired plants remain attractive, despite the higher CO_2 emissions compared to natural gas-fired plants. The oldest two coal-fired plants remain in operation until after 2020. In addition, there are investments in new pulverized coal-fired plants with a total volume of 2000 MW_e.

Investing in renewable electricity production and gas plants, with or without heat utilization, is attractive in SE. New gas-fired plants are more attractive in the short term due to the relatively low investment cost and short construction period. This type of plant does face significant fuel price risks and thus volume risks due to the number of operation hours. In the short term, the new gas-fired capacity will come from combined cycles such as the recent Rijnmond Energy plant (Intergen, 790 MW) and the Sloe plant (820 MW), which is expected to start supplying electricity as of 2008. In the SE scenario, the combined cycles remain the preferred option for new investments. Paragraph 7.2 discusses the increase in cogeneration capacity and Paragraph 7.3 examines the increase in renewable capacity.

Costs of new technology

The choice of a certain technology coheres with the expected costs, output and risks. The output is determined by the electricity market price. Both in SE and in GE most investments take place in the period after 2010. To give an indication, the costs of various generation options have been determined, which are provided in Figure 5.2.1. The starting values for fossil and nuclear options are largely based on the scenario staring points of SE and GE and the fact sheets for the VROM raad/AER study (Menkveld, 2004) and have been summarized in Table 5.2.1. In SE and GE these options have the same starting points until 2020.

Figure 5.2.1 shows the integral costs of various electricity production options in 2020. The integral costs consist of variable costs and fixed costs (especially capital costs). The costs are presented with a certain bandwidth. In SE and GE (at a CO_2 price of 11 €/ton) the integral costs of a gas-fired combined cycle (44 €/MWh) are slightly lower but comparable to the costs of a pulverised coal-fired plant (45 €/MWh) and a nuclear plant (46 €/MWh). The integral costs of a coal gasification combined cycle (CG CC) and a natural gas-fired combined cycle with CO_2 capture are higher, i.e. 50 €/MWh and 51 €/MWh respectively.

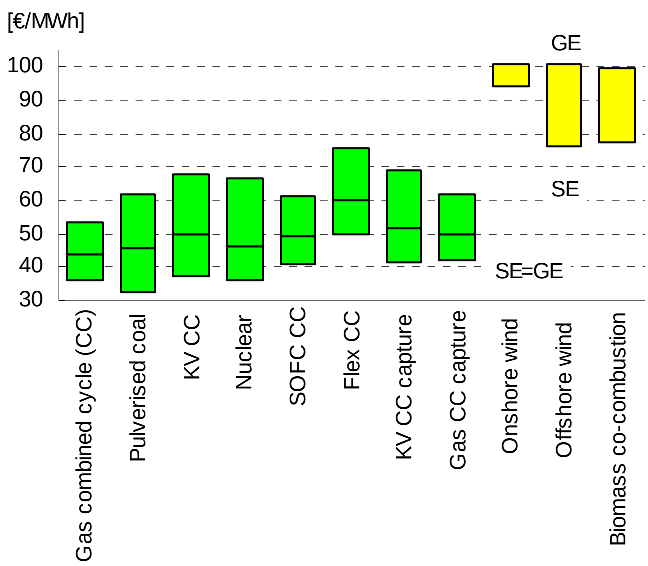

Figure 5.2.1 - Indication of integral costs generation options, SE and GE, 2020

The starting points for determining the integral costs have been indicated in Table 5.2.1. The bandwidths of coal-fired plans and nuclear plants are relatively large because, at the top of the bandwidth, a cost-of-capital rate of 15% has a large effect on the fixed costs of this type of plant with relatively high investment costs. If the upper limit of the CO_2 price is raised this could lead to a large increase of the upper limits of the fossil fuel-fired options. The production costs of offshore wind, onshore wind, biomass co-firing in coal-fired plants and photovoltaic capacity (PV) have been calculated based on other business economical assumptions (see Paragraph 7.3).

The bandwidths for the three renewable options, which have been illustrated on the right side of the figure, are based on the SE scenario (lower limit) and GE scenario (upper limit) and thus not entirely comparable to the bandwidths of the fossil and nuclear options. Biomass co-firing is assumed in pulverized coal plants. The additional costs of co-firing have been added to the costs of pulverized coal. PV is situated in a bandwidth of 370 €/MWh (SE) and 520 €/MWh (GE) and had not been included in the figure.

Investors do not only consider the costs but also the risks. Every electricity production technology has its own risks. In gas-fired plants, for example, the risks of gas price fluctuations are important; in coal-fired plants, the risk of the increasing CO_2 price plays a role and in nuclear plants the social and political support is a risk. Electricity producers usually choose the portfolio strategy, in which a certain diversification of risks can be attained. Within such a strategy, it may be rational to choose electricity production options that are not the lowest in costs as well. As mentioned earlier, the possible increase of the CO_2 price plays a larger role in the SE scenario than in the GE scenario.

Table 5.2.1 - Used parameters in the determination of integral costs of generation options in SE and GE, 2020 (fossil and nuclear)

Parameter	SE and GE value	Uncertainty margin
'Scenario'		
CO_2 price	11 €/ton CO_2	0 - 20
Fuel prices	4.7 €/GJ natural gas 1.7 €/GJ coal	4.0 - 5.4 (± 15% compared to SE/GE) 1.4 - 2.0 (± 20% compared to SE/GE)
Investment costs [€/kW]		
Natural gas combined cycle	525	450-600
Pulverised coal	1150	1000-1300
CG combined cycle	1550	1400-1700
Nuclear plant	2000	1700-2300
Fuel cell combined cycle (SOFC)	1025	900-1150
Flex combined cycle (gas)	+20% compared to natural gas combined cycle	
CG combined cycle with CO_2 capture (90% capture)	1800	1625-1975
Natural gas combined cycle with CO_2 capture (90% capture)	790	680-900
Operation and maintenance (O&M) costs [€/kW/year]		(±15% compared to SE/GE)
Natural gas combined cycle	20	
Pulverised coal	46	
CG combined cycle	47	
Nuclear plant (€ per MWh out incl. fuel front end)	15	
Fuel cell combined cycle (SOFC)	48	
Flex combined cycle (gas)	40	
CG combined cycle with CO_2 capture	55	
Natural gas combined cycle with CO_2 capture	26	

Parameter	SE and GE value	Uncertainty margin
Efficiency		-1% +3% absolute, compared to SE/GE value
Natural gas combined cycle	58%	
Pulverised coal	45%	
CG combined cycle	49%	
Nuclear plant	-	
Fuel cell combined cycle (SOFC)	70%	
Flex combined cycle (gas)	50%	
CG combined cycle with CO_2 capture	41%	
Natural gas combined cycle with CO_2 capture	50%	
Availability	85% for baseload options (7500 hours). 5000 for flex COMBINED CYCLE	SE-/GE value ±500 hours
Business economical		
Economical lifespan	20 year	15-25 year
Cost-of-capital rate	10%	8-15%

Note: In this overview, capital costs have been determined on the basis of annuitary depreciation, without taking construction interest into account.

In the price projections, which are presented below, it is assumed that the influence of the fluctuating supply of the production capacity of wind energy, as foreseen in SE and GE, will be limited. The effects on the wind supply on the market price as well as the market response are still uncertain.

In the SE scenario the nuclear plant Borssele will be closed down by the end of 2013. The public acceptance of this technology remains low in SE. In GE, on the other hand, investments are made in lifetime extension as a result of which the nuclear plant can remain in operation after 2013.

Development of foreign supply

Through the relatively large interconnectors with foreign electricity markets, the Netherlands can import or export electricity, depending on the price differences between the national markets. In both scenarios it is assumed that the Netherlands exchanges electricity with five countries, i.e. Belgium, France, Germany, the United Kingdom and Norway.[13] Similar to the Netherlands, these countries also experience changes in the composition of the production park, the development of the composition of the foreign production park is based on a recent EU scenario (EC, 2003a) and does not vary between GE and SE.

Because gas plants are built in all mentioned countries, there are no longer large price differences in peak periods. In the off-peak hours there will be structural price differences because some countries still have plants that have low variable costs (nuclear, hydropower) that are not available in other countries. The inland electricity demand is covered for the largest part by re-

[13] This does not exclude supply contracts with products and producers from other European countries. Germany and France are the largest national markets in Europe and the Netherlands and Belgium are directly connected to these markets. As a result the imports from other countries will run via Germany and France and the market price of these countries will determine the electricity price on the European continent.

newable sources with very low or no production costs or by cogeneration plants that have to remain in operation because of heat demand (so-called must run capacity).

Use of interconnectors

With respect to the interconnector capacity, it is assumed that there are no differences between the scenarios. It is assumed that the 700 MW connection with Norway will be ready in 2008. This was decided by TenneT at the end of 2004, after it was approved by DTe (Office of Energy Regulation). In addition, there are plans for a 1300 MW connection with the United Kingdom. According to plans, this connection will be realized in 2008/2009 (TenneT, 2004). In SE and GE, however, it is assumed that this connection will be realized much later, between 2011 and 2012. To illustrate this, the total interconnector capacity for off-peak periods is provided until 2020 in Figure 5.2.2. The interconnector capacity in peak periods is 500 to 700 MW lower for the interconnections with Germany and Belgium.[14].

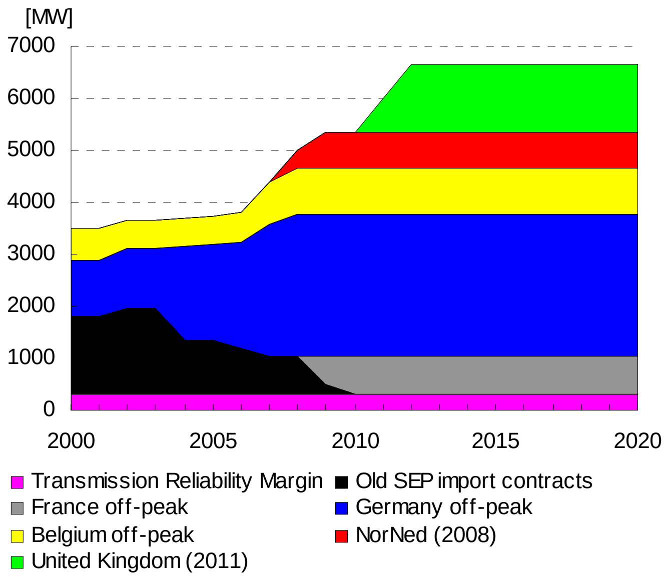

Figure 5.2.2 - Development of interconnector capacity in off-peak periods in SE and GE

Contrary to the connections with Belgium and Germany, the exchange of power through these direct current connections with Norway and England are not influenced by power transport on other high voltage connections.

Although these sea cable connections are more costly, they will encounter less social and planning problems than new connections via land. Because Norwegian hydropower plants are expanded with pumps, power can be supplied to the Netherlands in peak periods, and in off-peak periods power can be derived from the Dutch grid to pump back water into the storage reservoir. There will be power exchange with England because of the differences in natural gas prices (both countries have a relatively large number of gas-fired plants) but also because of the different peak demand moments due to the one-hour time difference.

Development of grid costs

The grid tariffs, which are composed of a connection, transport and system tariff, have been regulated. Regulation encourages the grid managers to keep the costs at a low level but at the same time deliver a qualitatively good performance. An increase in electricity supply from renewable sources and decentral electricity production could lead to extra investments in the grid, both in the SE and in the GE scenario. On the other hand, the transport of electricity via the grid will also increase as a result of the increased electricity demand. On balance, it has been assumed that the grid tariffs in both scenarios do not essentially differ from current tariffs.

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[14] Because of increased exchange on the European continent there is less capacity available for the market during peak periods than in off-peak periods, taking into account the reliability criterion.

Results

Market prices of electricity

The commodity prices of electricity on the wholesale market for the SE and GE scenario are illustrated in Figure 5.2.3. The prices that are shown represent the prices at the moment of supply. These prices are therefore nearly similar to the prices on the day ahead market of the APX. The figure illustrates some yearly averages of day-ahead prices for the period 2000-2003 for comparison (APX, 2004). It should be noted that special situations do occur sometimes in reality, which lead to strongly deviating and volatile prices. In 2003, the average APX prices were quite higher, for example, due to the cooling water problems in August of that year.

A large share of electricity is traded via forward contracts. Due to the risks involved for the supplier, the price is a bit higher in theory. As a result of the volatility of prices on the APX and contracts market, this margin of risk is difficult to establish empirically and therefore it is not included in the price projections of Figure 5.2.3.

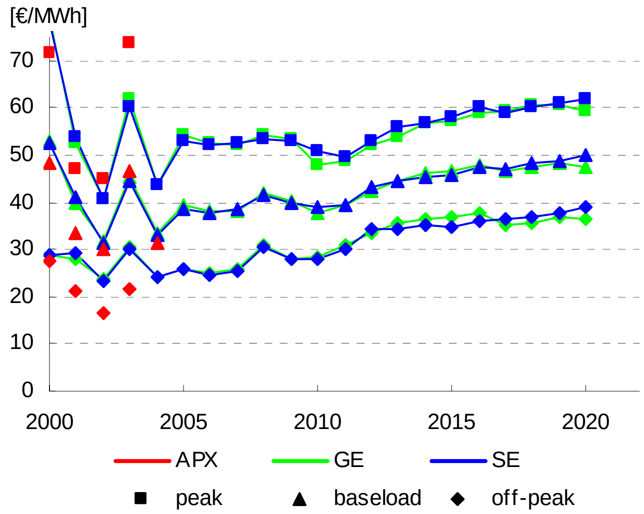

Figure 5.2.3 - Electricity prices wholesale market

Both scenarios show a trendwise increase of the baseload price as of 2005. This can be explained by the fact that the supply from currently relatively cheap baseload plants and import from Germany and France is no longer large enough for a stabile low price during off-peak periods.

This demand must be increasingly covered by gas-fired plants, as a result of which the price in off-peak period is increasingly determined by the also increasing gas price. This also leads to an increase in the baseload price.

The peak prices increase less rapidly until 2008. Increasing natural gas prices and CO_2 prices (11 €/ton CO_2 in 2020) cause the price to rise to a level of 47 to 50 €/MWh in 2020. The projections of future market prices show a temporary decrease at certain moments. This occurs shortly after new production capacity becomes operational.

The differences in scenarios are explained by:

- the difference in electricity demand as a result of differences in economic growth. The combination of the NorNed connection (700 MW) and the Sloe plant (820 MW) halfway 2008 have a lowering effect on peak and off-peak prices afterwards. As of 2010 an increasing trend will become visible.
- the moment when new investments take place and the type of plant that is chosen to expand production capacity. In GE new pulverised coal units will be added with relatively low fuel costs after 2015. In SE new investments will me made with respect to new gas-fired combined cycles with higher fuel costs as of 2013. For SE this results in an increasing electricity price because of the further increasing price of natural gas.
- the higher electricity prices until 2010, compared to the previous Reference Projection 2001. The main explanation can be found in the higher fuel prices of especially natural gas but also of coal. Moreover, the CO_2 emission trading price has a price-increasing effect, especially after 2010.

Import of electricity

The share of electricity import was high in the Netherlands, compared to surrounding countries. The balance lay somewhere between 19 TWh in 2000 and 17 MWh in 2003, 60-70 PJ. The volume of electricity import is determined by price differences of electricity compared to abroad and by the available capacity for electricity transport. Due to the relatively large share of gas-fired plants in the Dutch electricity production and the accompanying higher prices, import occurs most, but at other times electricity is also exported. In SE and GE a significant share of import occurs in the coming years. As a result of decreasing price differences the import balance with Germany decreases structurally after 2008. At the same time, the exchange with Norway is starting up as well as with England a few years later. Both in SE and in GE an import balance of 7 TWh and 3 TWh respectively remains in 2020. The course of events is a bit more volatile in GE. In 2020 there is a large decrease in import balance in GE due to a new wave of investments in efficient capacity in 2019 and 2020. Small differences in production capacity and costs can have relatively large effects on the trading streams of electricity. These trading streams also have a large effect on the nation CO_2 emission, as was established in the previous Reference Projection 2001.

Separate sensitivity analyses have been performed for the period 2010-2020 in the SE scenario in view of assumptions regarding the connection with England, mark-ups in the countries involved, natural gas prices and the lack of investments in the Netherlands. Based on these analyses, a bandwidth has been established for the import balance for 2010 and 2020. These bandwidths are illustrated in Figure 5.2.4.

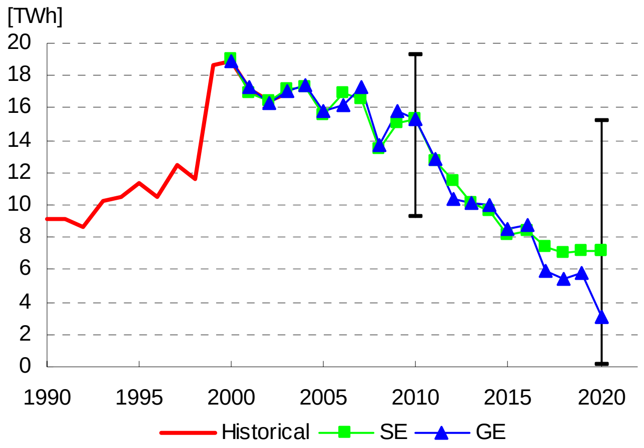

Figure 5.2.4 - Development of import balance electricity, with a bandwidth for the SE scenario

End user prices of electricity

The end user prices are composed by three components: the wholesale price plus retail margin (together they constitute the commodity price), distribution and levies (energy tax and VAT). The development of the energy tax has been discussed in Chapter 3. Figure 5.2.5 shows the development of end user prices for three groups of end user: households, medium-sized commercial and large industrial consumers. These end user prices apply to both scenarios. The commodity prices do not differ essentially (see Figure 5.2.3).

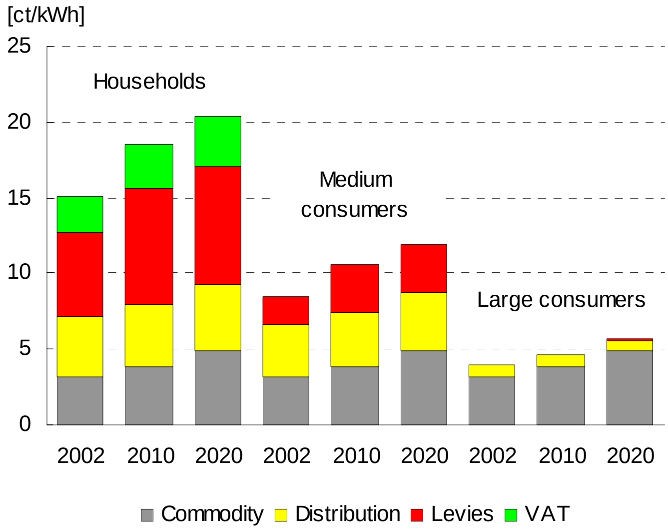

Figure 5.2.5 - End user prices for electricity, SE and GE

Uncertain factors and effects on the electricity price

A number of uncertain factors that influence the wholesale prices have already been mentioned, i.e. fuel prices, CO_2 price, price comparison with abroad and choice of technology. The uncertain factors that eventually affect the CO_2 emissions of electricity production are discussed in Paragraph 7.1. The fuel prices and the CO_2 price are identical in both scenarios (see Paragraph 5.1 and 3.4). The electricity prices therefore do not essentially differ between the two scenarios.

Because the development of the fuel prices and the CO_2 price is quite uncertain in reality, several sensitivity analyses have been performed in the SE scenario. These analyses have been restricted to the central electricity generation and indicate the effect on the electricity price and also on the import balance and the CO_2 emissions of power plants. The effect on the import balances and on the CO_2 emissions have been included in 'Uncertain factors' and in the uncertainty analysis (see Paragraph 3.3). The gas price and the CO_2 price vary in the sensitivity analyses.

The natural gas price and thus also the relation to the coal price and the CO_2 price have been set at 1.5 €ct/m^3 higher or lower for the period 2010-2020. The CO_2 prices, which were 7 €/ton in 2010 and 11 €/ton as of 2013, are raised to 14 €/ton in 2010 and 20 or 30 €/ton in 2020, or lowered to 2 €/ton.

Figure 5.2.6 illustrates the effect on the baseload electricity price in the SE scenario for the period 2010-2020 in the indicated sensitivity analyses. A bandwidth for the baseload electricity price can be derived from this. In the case of a lower natural gas price or CO_2 price the prices are up to 7 €/MWh lower and with a higher natural gas price or CO_2 price it is up to 9 €/MWh higher. This does not account for a combined occurrence of effects.

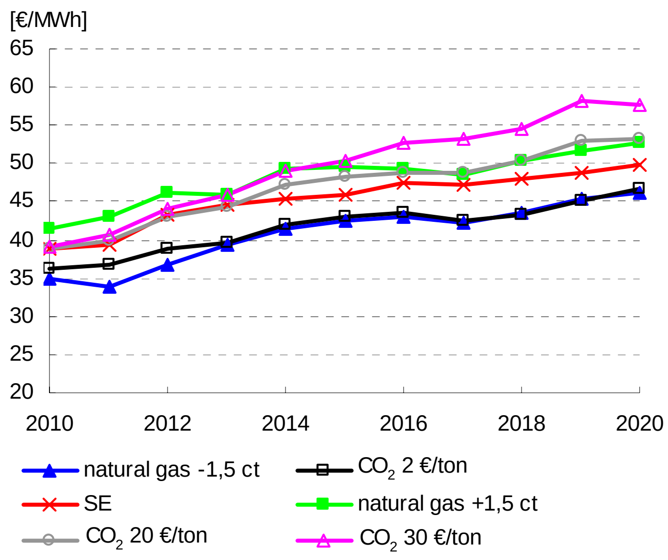

Figure 5.2.6 - Effects on baseload electricity price, SE, 2010-2010, with different natural gas and CO_2 prices

6. SECTOR DEVELOPMENTS: ENERGY DEMAND AND CO_2 EMISSIONS

This chapter describes the development of the energy demand on the basis of the economic and demographic developments outlined in Chapter 4. Taking into account the developments in the energy markets described in Chapter 5, the energy demand has been divided into five sectors: industry, transport, households, services (trade, services and government) and agriculture. The overall results for the Netherlands are given in Section 1.1. In addition, the development of CO_2 emissions is given for the various sectors, based on a preliminary adjustment of historical emissions as described in Section 3.2. The chapter ends with an analysis of volume, structure and saving effects in the various sectors, as well as a section on bunkering.

6.1 Industry

With a share of 40% of primary energy consumption, industry is the largest energy-consuming sector.[15] In addition to energetic applications of energy carriers, the industry sector also has important non-energetic applications that use the energy carrier as a raw material or catalyst. This applies to, for example, the production of synthetic materials, fertiliser and iron. Within the industry sector, the chemical industry is the major user of energy (> 50%).

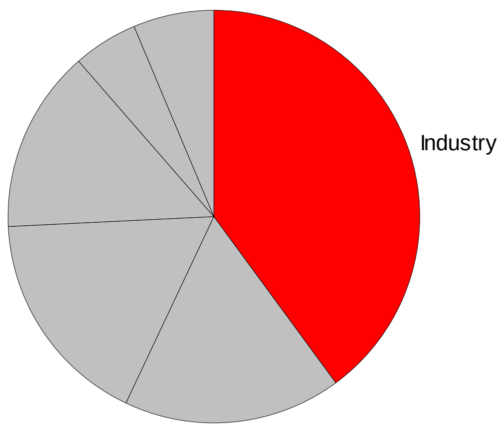

Figure 6.1.1 - Share of industry (excluding oil refining) in total primary energy consumption

The base metals and the food industry each have a share of just over 10%. Industry accounts for more than 20% of the electricity produced in the Netherlands by cogeneration.

Economic developments

In the period 2000-2020, the industry sector, as part of the strongly service-dependent Dutch economy, realises an annual growth of 1.3% in SE and 1.8% in GE. The moderate growth in the period up to 2010 is mainly due to stagnation in the years up to 2004. The 2001 Reference Projection predicted a growth of 2.5% in the period up to 2010, predominantly in the other metals industry. In both the SE and the GE scenario, growth takes place mainly in the energy-intensive sectors, with the chemical industry as the absolute number one.

The development of energy demand in the industry sector depends on the general economic development and on specific factors in the energy-intensive sectors. There is hardly any differ-

15 The refining sector is not covered in this chapter, but in the chapter on energy supply (Paragraph 7.4).

ence between SE and GE in the way growth is spread across the various subsectors; however, growth in GE is higher across the board.

Table 6.1.1 - Added value, growth in % per year, compared to the Reference projection 2010, SE, GE

[%]	History	RR2001	SE		GE	
	1995-2002	2000-2010	2002-2010	2010-2020	2002-2010	2010-2020
Base metal industry	0.8	1.9	2.0	1.9	2.1	0.9
Paper industry	1.4	2.1	1.3	1.3	1.6	1.0
Chemical industry	2.5	2.2	2.7	3.3	3.3	4.1
Food industry	0.8	2.2	1.7	1.7	2.9	3.6
Other industry	1.2	2.1	0.9	1.4	1.9	0.8
Non-metals minerals industry	1.8	1.5	1.4	1.4	1.8	1.9
Other metal industry	1.9	3.1	0.3	1.6	0.7	1.7
Industry (excl. construction)	1.6	2.5	1.3	1.9	2.0	2.3
Construction	2.1	2.0	1.7	0.7	3.7	2.6
Industry (incl. construction)	1.7	2.4	1.4	1.6	2.5	2.4

Capacity developments

In the coming years, capacity expansion is expected in the chemical industry, as is increased production at the existing locations. The location and agglomeration benefits of the base chemical industry in the Netherlands are likely to trigger further growth in this sector, relatively independent from the development of the sector at a European level. Growth in the base metals industry will result mainly from a more efficient use of existing capacity (de-bottlenecking). As a labour-intensive sector, the metals industry (metallurgical, electro-technical, machine and vehicle industry) will be hit by the competition from low-wage countries. Not surprisingly, diminished growth is expected in this sector, in contrast to the forecasts in the 2001 Reference Projection. A major part of the food industry depends strongly on developments in the Dutch agricultural sector, which supplies the raw materials. Stagnation and reduction in the dairy industry and parts of arable farming will severely hamper the growth of these subsectors. The rest of the food industry will manage to sustain reasonable growth. This general image applies to both the GE and the SE scenario, but overall the growth in GE will be somewhat higher.

Policy developments

In the 2001 Reference Projection, the Benchmarking Covenant was the most important instrument for energy-intensive sectors, such as the chemical and base metals industries. The covenant was also signed by refineries and the electricity generation sector. The objective is to achieve and retain the highest possible standards for energy efficiency. These standards are determined using a benchmark. Any shortfall will require measures with an internal efficiency base of 15% after tax before the end of 2005. If the highest standards remain out of reach, less efficient measures may also be taken before 2008, or other measures, including emissions trading, may be used. The highest standards will be reviewed every four years. In SE and GE the Benchmarking Covenant remains in full force, but the importance is gradually fading thanks to the growing role of CO_2 emissions trading. In addition, the covenant is the basis for the allocation of CO_2 emission rights and companies can meet their Benchmark obligations via purchases of such rights. Both in SE and GE, the CO_2 price increases from € 2 per ton of CO_2 for the period 2005-2007, to € 7 per ton during 2008-2012 and to € 11 per ton from 2013.

The CO_2 price increase is the reason why the CO_2 effect triggers further economy measures, also because most companies are already meeting, or almost meeting, the benchmark figures. To a large extent, the companies taking part in the continued Long-term Energy Efficiency Agreements (LTA2) also participate in the emissions trading system.

The energy tax for non-trading sectors is at least as high as the energy tax for trading sectors, plus any continued effect of the CO_2 price (see also Section 3.4). In addition, there are obligations that are comparable to the Benchmark, namely applying the best techniques ('best practices') by way of a Long-term Energy Efficiency Agreement (LTA) or environmental permit. The 2001 Reference Projection had a fiscal incentive via both the Energy Investment Deduction

(EIA) and the VAMIL (Early Depreciation on Environmental Investments), with an average effective subsidy of 24% on investments. In SE and GE, the VAMIL no longer applies; the effective subsidy on investments up to 2004 is 18%. In 2005 the deduction for EIA amounts to 44% (down from 55%). In combination with the gradual reduction of corporation tax from 34.5% in 2004 to 30% in 2007, this brings the effective subsidy on investments down to 13%. This does not assume a budget limit for subsidies. Additional policies relating to technology development and application, Small and Medium-size Enterprises (MKB) and building regulations remain at the same level. Specific projects may be financed up to 40% via the CO_2 reduction plan or comparable incentive schemes. This has an effect of approximately 5 PJ on heat utilisation. Via the Long-term Energy Efficiency Agreements (LTA) a start has been made on the broadening themes for energy saving (such as the energy efficient product design).

Results

Primary energy consumption

Figure 6.1.2 shows a slight increase in the primary energetic consumption.[16] In SE the increase is up to 1380 PJ in 2010 and up to 1500 in 2020. In GE the growth is a little higher, that is, up to 1411 PJ in 2010 and up to 1597 in 2020.

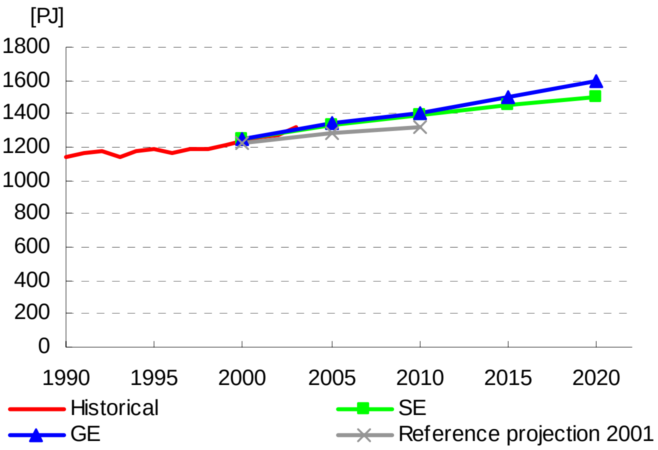

Figure 6.1.2 - Primary energy consumption of the industrial sector (excl. refineries)

Final energy consumption

The final energy consumption in the industry consists of the final demand for heat, electricity and the use for non-energetic purposes (feedstock). Compared to other sectors, the last-mentioned category is very large in the industry sector. The growth of the final electricity consumption up to 2010 is below the levels shown in the 2001 Reference Projection, for both GE and SE. To a large extent, this is due to a stagnation of economic growth in the period 2000-2004.

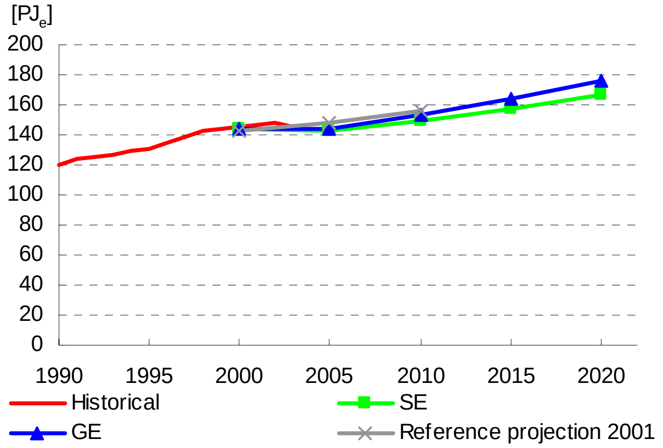

Figure 6.1.3 - Final electricity consumption of the industrial sector (excl. refineries)

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16 The energy consumption of industrial CHP in joint venture operation is attributed to the sector electricity production. In the Reference Projection 2001, this energy consumption is attributed to the industry. Because some results of the current projections cannot be compared to the results of the projection of 2001 as a consequence, the projection of 2001 has been left out in several graphs.

After 2005, the growth of energy consumption is comparable with the growth in the 2001 Reference Projection, with a slightly faster growth in GE. The demand for electricity in the industry keeps rising steadily, but the speed at which new applications for electricity are introduced is likely to be slow. Besides, many new applications offer new saving opportunities after they have been implemented.

The final thermal use is expected to show a pattern comparable to the consumption of electricity. The increase in the final thermal use from 2005 in relation to the stagnation and decrease in the 1990s is striking. This is the result of the relatively stronger growth of the base chemical industry in SE and GE. The differences between the 2001 Reference Projection on the one hand and SE and GE on the other are relatively small, both in thermal and in electrical use.

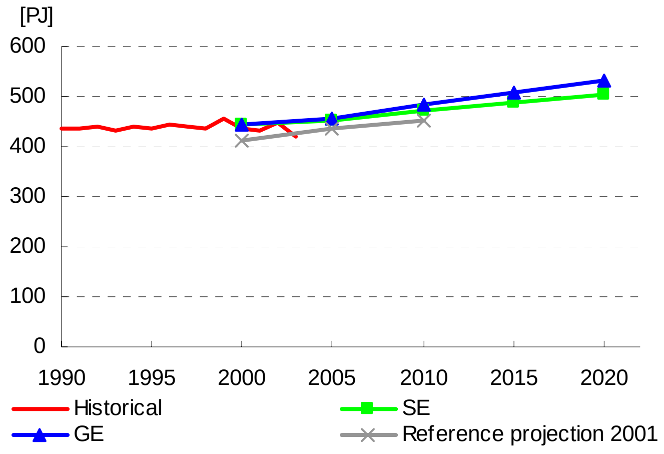

Figure 6.1.4 - Final thermal consumption of the industrial sector (excl. refineries)

This ensues from the lower economic growth in SE and to a smaller extent in GE, in combination with a much stronger concentration of such growth in the energy-intensive sectors, such as the base chemical industry. Figure 6.1.5 shows the various components of the final use of energy carriers in the industry. The rapid growth of the non-energetic use in the period 1999-2003 is striking.

It is not entirely clear to what extent this is connected with the method by which the energy consumption is calculated (see 3.2), and to what extent this can be traced back to actual activity changes within the industry, particularly in chemicals. Until 2020, all components grow more rapidly in GE than in SE, but the difference is most obvious in the final thermal use.

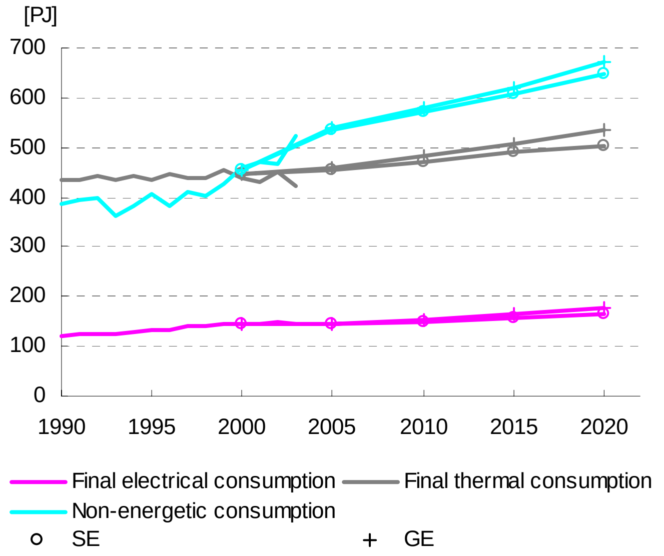

Figure 6.1.5 - Final thermal, electrical and non energetic fuel consumption of the industrial sector (excl. refineries)

CO_2 emissions

In 2000 the direct CO_2 emissions[17] from the industry sector, including process emissions, amounted to 32.5 Mton. This figure relates to the industry sector, including the construction sector and excluding the joint venture CHP systems[18]. Emissions in SE increase to 34.6 Mton by 2010 and to 34.9 Mton by 2020; in GE the forecast is 34.1 and 37.4 Mton, respectively.

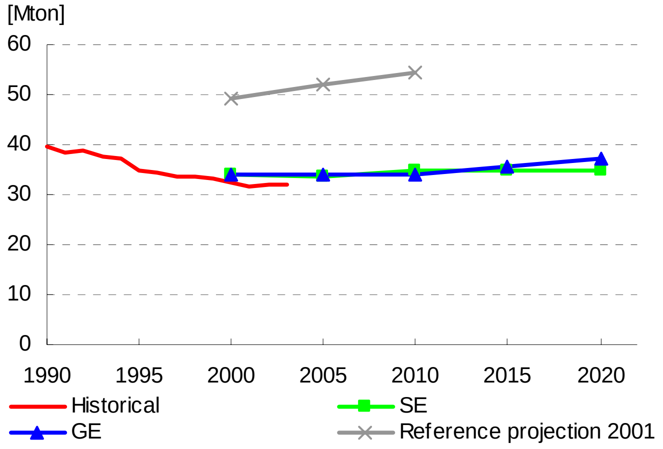

Figure 6.1.6 - Development of CO_2 emissions of industry (excl. refineries)[19]

The slight decrease in the period 1995 – 2000 is connected with the rapid increase of joint venture CHP in the industry sector, the emissions of which fall outside the sector. Even after 2000 the capacity of joint venture CHP continues to increase, in both SE and GE. This however does not cause a decrease in CO_2 emissions, as the CHP share remains relatively constant.

Effect of climate policy

The climate policy for the industry sector includes CO_2 emissions trading, the Benchmarking Covenant, the Long-term Energy Efficiency Agreement (LTA2), stimulating the residual heat utilisation via the CO_2 reduction plan, the EIA (Energy Investment Deduction) and stimulating cogeneration via the Environmental Quality of Electricity Production (MEP) scheme. In the GE scenario the policy reduces the emissions by decreasing the demand by 1.3 Mton in 2010 and by 1.9 Mton in 2020. To this the Climate Policy Implementation Memorandum (UK1) policy contributes approximately 0.3 Mton in both 2010 and 2020. However, with the policy all emissions combined are even smaller in 2010. This is because the growth in cogeneration takes place almost exclusively in joint ventures, while private cogeneration is on the decrease. On balance, this means a shift of emissions from the industry sector to decentralised generation. The overall policy-related decrease of emissions from the industry sector will therefore be approximately 2 Mton by 2010.

17 In line with the approach that was used for the determination of the indicative targets (Boonekamp, 2003), the CO_2 emissions per sector have been determined based on the direct CO_2 emissions. In that process, the emissions resulting from the generation of electricity and heat for the sector are not attributed to the sectors. A sector that experiences an increase in electricity demand and a decrease in gas consumption, such as the Services sector, will have a decrease in direct sectoral CO_2 emissions, whereas the total CO_2 emissions resulting from the developments in the sector will increase.

18 The development of CHP may have a strong influence on the development of the direct CO_2 emissions and distort the CO_2 effect of policy . CHP reduces the reduces the total CO_2 emissions, but the sector in which CHP is included shows an increase of direct emissions. CHP in joint venture systems are considered part of the electricity production sector. The installation of joint venture CHP therefore reduces the emissions of the sector to which the heat is supplied. Although intensification of policy will result in a decrease of total CO_2 emissions, this decrease cannot be clearly portrayed through the individual sectors. -

19 The emissions of the scenarios do not link up entirely with the historical emissions. This is the result of a calibration problem in 2000 in cokes gas and in heat production, as a result of which the projection for industry is too high. As of 2005, the emissions in the scenarios do link up to the historical emissions.

Uncertain factors

The market for many energy-intensive products is often at a European or world scale, which is why domestic and foreign economic developments set the physical demand in the industry. In addition, the CO_2 emissions from Dutch industry depend much on the choice of location by international companies in terms of investments in production capacity.

Furthermore, statistical observation is not always perfect, making even the points of departure for projections uncertain. As well as the total energy consumption, the division of energy consumption into energetic and non-energetic applications is uncertain.

The extent of applications and performances of new processing and energy techniques is shrouded in uncertainties, particularly in terms of new electricity applications. An important factor in this respect is that estimates assume the gradual introduction of new processes, but in reality the steps are much larger. The uncertainties are relatively limited until 2010; much of what will turn out to be different from the expectations in energy consumption CO_2 emissions does not become evident until after 2010.

Post-Kyoto refers to the degree to which companies anticipate future policies, in connection with the objectives laid down in the Kyoto Protocol. With a strong successor after Kyoto, companies will anticipate by investing in capacity at an early stage, and leaving them in place for a long period of time.

Table 6.1.2 - Bandwidth in CO_2 emissions in SE

[Mton]	2010		2020	
Directe emissions	34.6		34.9	
	Low	High	Low	High
Economic growth, choice of location of companies and division growth over activities	-1.0	1.0	-6.0	5.0
Fuel prices	-0.5	0.3	-2.2	1.2
CO_2 prices	-0.3	0.2	-3.0	0.6
Statistics	-0.5	3.0	-0.5	3.0
Costs and potential saving measures	-0.4	0.3	-1.0	0.8
Post-Kyoto	0.0	0.0	-3.0	3.0

Table 6.1.3 - Bandwidth in final electricity consumption in SE

[Mton]	2010		2020	
Indirect emissions from supplied electricity	16.8		19.3	
	Low	High	Low	High
Economic growth, choice of location of	-0.5	0.8	-2.8	3.0
Electricity prices	-0.3	0.1	-0.7	0.2
Statistics	-0.3	0.3	-0.2	0.2
Costs and potential saving measures	-0.3	0.3	-0.6	0.6

6.2 Transport

Unlike for the other sectors, the prognoses for transport are not linked to the WLO scenarios SE and GE, but to the Actualisation Report Transport 2010 and 2020 (van den Brink, 2003) made for the Implementation Memo 'Erop of eronder' (VROM, 2004a) and the Transport Emissions Memorandum (VROM, 2004b).

In the 2001-2010 Reference Projection (ECN/RIVM, 2002), the emission prognoses for transport were derived by way of a correction of the 'Milieu Verkenningen 5' (EC scenario) using what at the time were the most recent medium long-term prognoses of the CPB. The correction was related to the growth figures of the GDP, real disposable income and the oil price.

However, following the release of this Reference Projection a number of changes have occurred, calling for the Reference Projection to be brought up to date. It requires:
- Adjustment of the definition of ‘national emissions’,
- Newly specified policy and a new ‘pipeline policy’,
- New opinions as regards emission factors of inland vessels, heavy diesel trucks, and private cars,
- New opinions as regards the fuel mix for private cars and delivery vans.

The update has resulted in the above-mentioned Actualisation Emission Report Transport 2010 and 2020 (v.d. Brink, 2003).[20].

With a share of 17% of the primary energy consumption in 2000[21], the transport sector is a major energy-consuming sector. Road transport has by far the biggest share in energy demand (87%) in this sector. The use of private cars accounts for about 52%, and freight transport for around 32%.

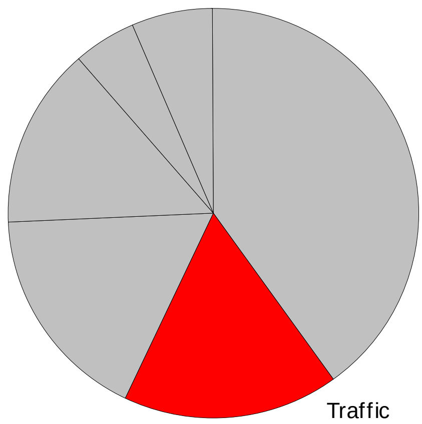

Figure 6.2.1 - Share of transport in total primary energy consumption in the Netherlands

Economic developments

The economic development is an important explanatory variable for mobility development. As mentioned, the economic growth figures quoted in the 2003 Actualisation Report are in line with the 2001-2010 Reference Projection (ECN/RIVM, 2002). For the period from 2000 to 2010, the oil price has been assumed at US$ 22 per barrel, and the average annual growth of the GDP and the real disposable income by 2.5% and 2.1%, respectively.

Volume developments

Further growth of the transport sector is expected in the years to come. Road mileage will increase from 133 billion kilometres in 2003 to 148 billion kilometres in 2010 and 175 billion kilometres in 2020. The capacity development of the infrastructure (extending the railway, waterway and road network) is based on the Medium-term Transport Infrastructure Plan (MIT) and its impact on the transport demand has, under the terms of the Fifth Exploration of the Environment (MV5), been taken into account in the National Model System (LMS). The 2003 Actualisation Report has adopted these model calculations.

Table 6.2.1 shows the contribution from the various vehicle categories to the CO_2 emission from the transport sector, as well as the annual growth in fuel sales. A shift in the fuel mix of private cars (more diesel, less petrol) is forecast for the period up to 2020. This will be good for CO_2

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[20] The background of this reference projection can be read in the MNP letter report (v.d. Brink, 2003). Actualisation of emission prognoses transport for 2010 and 2020, Bilthoven, MNP.

[21] These are the data that were published in the NIR 2005. The emissions of the base year (2000) of the Actualisation Report 2003 deviates from the emissions in 2000 according to NIR 2005.

emissions since diesel cars have a lower CO_2 emission per kilometre than do cars running on petrol. The shift in the fuel mix will also have a favourable effect on the emissions of NMVOCs, but not on the emissions of NO_x. The effect on the emissions of SO_2 is negligible. Further explanation is given in Chapter 9.

Table 6.2.1- Contribution vehicle categories to CO_2 emission of transport sector in 2000 and annual growth in % of fuel sales

	share in total CO_2 emissions 2000	2000-2010	2010-2020
passenger cars	53%	-0.2	0.5
petrol		-1.8	-1.7
diesel		3.2	2.7
LPG		-1.5	3.5
delivery vans	14%	1.1	2.6
lorries and tractors	19%	3.5	4.2
autobussen en speciale voertuigen	3%	-0.3	0.3
motor two-wheelers and mopeds	1%	0.1	0.0
rail transport (diesel)	0%	0.6	3.2
inland shipping and recreational shipping	3%	0.2	0.4

Policy developments

The 1998 EU covenants with European, Japanese and Korean car manufacturers (united in ACEA, JAMA and KAMA, respectively) appear to have led to significant reductions in the average CO_2 emission per kilometre driven by new private cars sold in the EU. The annual reduction by JAMA and KAMA will have to be increased in the years to come in order to achieve the target (140 g/km in 2009). ACEA's chances of achieving its target (140 g/km in 2008) are greater than those of the others. However, such achievements are still a few years away and it is far from sure that manufacturers will be able to further increase or even maintain the annual reductions. Meanwhile, the effects of the transition from indirect to direct fuel injection in diesel motors have been virtually exhausted. Also the upcoming tightening of emission standards in 2005 (Euro4) for NO_x and PM10 will make it more difficult to reduce the amount of fuel consumed by diesel cars.

Further, the recent demand for large, heavy MPVs and SUVs is making it harder for car manufacturers to keep reducing the annual average fuel consumption. In addition, the shift from petrol cars to diesel cars in the Netherlands is likely to remain below the EU average in 2008/2009. This is why in 2008/2009 the reduction of the average CO_2 emission of new private cars in the Netherlands will lag somewhat behind the results of the covenants with the car industry.

In updating the Reference Projection, it is therefore assumed that ACEA, JAMA and KAMA will not fully comply with the respective CO_2 covenants in 2008/2009, and that the average CO_2 emission from newly sold private cars in the EU will be 145 g/km. The assumption is made that from 2010 onwards, the covenants are continued at the 140g/km standard.

The new driving force (Het Nieuwe Rijden) is a long-term programme focused on improving driving skills (changing up a gear up at low RPMs, checking the pressure of tyres, etc.) and introducing tax incentives for in-car instruments (cruise control, board computer) in order to save on fuel, and thus lower CO_2 emissions.

Inconsistency between NIR 2005 and the Actualisation Report 2003

Before discussing the trends in energy consumption and CO_2 emissions, differences have to be noted between the National Inventory Report (NIR) 2005 and the previous NIRs upon which the

Actualisation Report 2003 is based. In earlier NIRs the emissions from mobile equipment was listed under Transport (CRF category 1A3). Such classification appeared to be incorrect and has been changed in the NIR 2005. Emissions from mobile equipment are now listed under the agriculture (1A4) and industrial (1A2) sectors. In other words, these emissions should be discounted when reporting on the transport sector (1A3) in accordance with the IPCC definitions.

However, since the Actualisation Report 2003 is based upon the old sector classification (which included mobile equipment), this section also quotes the historical emissions on the basis of the former classification. The NIR 2005 also defines new sources for which emissions have been calculated for the first time. According to the IPCC definitions, the emissions from these sources should not be part of the transport sector (1A3). These newly identified sources include fisheries (1.1 Mton CO_2 in 2003) and defence (0.4 Mton CO_2 in 2003), which were listed in the NIR under agriculture (1A4) and military activities (1A5), respectively. No prognosis estimates are available for these sources.

Results

Fuel sales[22]

Figure 6.2.2 shows an increase in fuel sales from 485 PJ in 2000 to 528 PJ in 2010 and to 638 PJ in 2020.

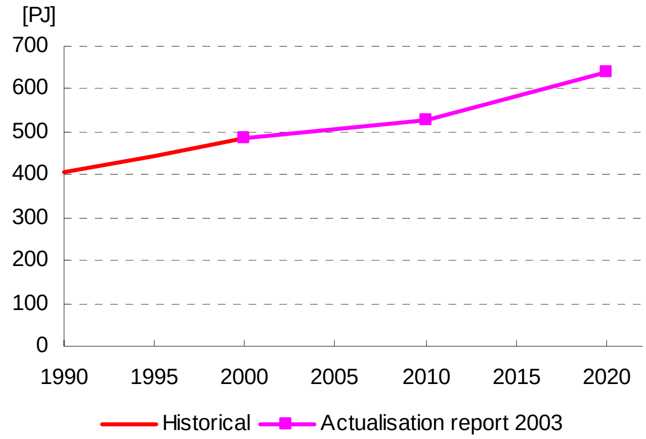

Figure 6.2.2 - Fuel sales in transport sector

CO_2 emissions

The direct CO_2 emissions[23] from the transport sector amounted to 35.2 Mton[24] in 2000. The emissions increase to 38.1 Mton by 2010 and to 45.8 Mton by 2020. The CO_2 emissions from private cars decrease to 18.0 Mton until 2010 but return to the level of 2000 in 2020. The decrease is mainly thanks to more economical new private cars and the larger share of diesel cars in total car sales.

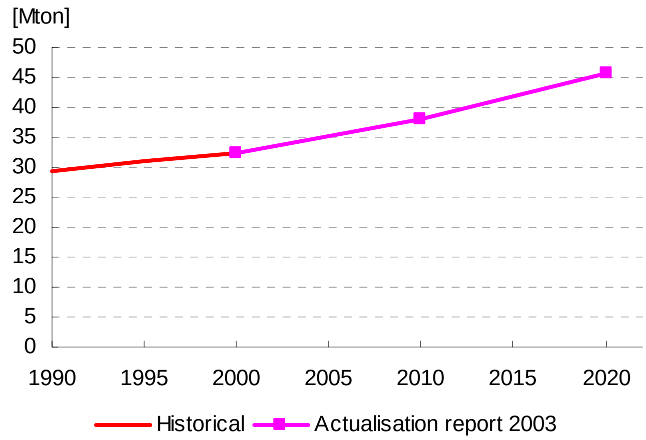

Figure 6.2.3 - Development of CO_2 emissions (IPCC) of transport sector

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[22] The calculation of CO_2 emissions is based on data concerning fuel sales, in accordance with IPCC definitions. The emission data of NEC particles of transport (NO_x, SO_2 en NMVOC), which are presented in Chapter 9, are based on fuel consumption.

[23] According to IPCC definitions.

[24] As reported in the NIR 2003, where mobile equipment has been reported under Transport.

The CO_2 emissions from heavy vehicles will see a sharp increase because of the growth in road haulage. In 2000 the emissions were 6.8 Mton; in 2010 and 2020 this figure will be 9.6 and 14.6 Mton, respectively.

Effect of climate policy

The UK1 climate policy for the transport sector consists of the covenants with the car industry (ACEA, JAMA, KAMA) and 'The new driving force II (Het Nieuwe Rijden II - HNRII) including the car and motorcycle tax (BPM) relief for in-car instruments such as on-board computers and cruise control. There is also still a minor effect as a result of taxation measures and the enforcement of speed limits. Beeldman et al. (1999) have worked out the effects of such measures for 2010. Below is shown how much higher the CO_2 emissions from transport would be in 2010 without these measures.

- ACEA covenant: 0 to 0.4 Mton
- The new driving force (in-car instruments, tyre pressure): 0.8 Mton
- Taxation measures: 0.1 Mton
- More enforcement of speed limits: 0.1 Mton.

In all, without these measures the emissions would have been approx. 1.0 to 1.4 Mton higher in 2010. On 1 January 2005, the BPM exemption for in-car instruments was abolished, which is why the effect of the new driving force will be approx. 0.05 Mton lower than the 0.8 Mton Beeldman et al. (1999) estimate. This has been included in Chapter 10 as part of the emission-increasing pipeline policy.

Uncertain factors

Uncertainties that have most impact on energy consumption and CO_2 emissions from transport include economic growth and oil prices, the fuel mix (petrol, diesel and LPG components) and the effect of the ACEA covenant.

To quantify the uncertainty regarding CO_2 emissions, one cannot rely on the report that is the source for the emission projections presented here (Actualisation Emission Prognoses 2003). Although the 2010 estimate allows for an error margin of plus or minus 2.4% from the 38.1 Mton, this margin was not estimated in accordance with the definition of a 95% confidence interval.

For that reason we go along with the 2001-2010 Reference Projection (ECN/RIVM, 2002), which has been made in accordance with this definition. In the 2010 Reference Projection, the overall uncertainty of the CO_2 emissions from the transport sector was estimated at 10%. The uncertainty in the estimates drafted as part of the WLO study may paint a different picture, of course.

6.3 Households

17% of all primary energy consumption is attributed to the household sector. The sector demands natural gas and electricity in particular, as well as heat and domestic fuel oil, although to a much lesser extent. Natural gas is mainly used for heating residential properties and for powering hot water systems.

The temperature-adjusted consumption of natural gas decreased from 362 PJ in 1990 to 331 PJ in 2003.[25]

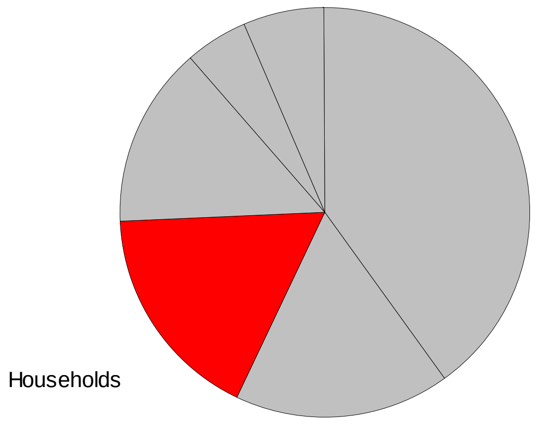

Figure 6.3.1 - Share of sector households in total energy consumption in 2003

The impact of the increased number of residential properties on the overall gas consumption in this period was smaller than the effects of improved insulation and the use of more efficient hot water systems.

Between 1990 and 2003, electricity consumption continuously increased (from 59 PJ_e to approximately 84 PJ_e). In this period the increase in the number of appliances and the change in their average lifespan had more impact on the energy consumption than the appliances themselves.

Economic and demographic developments

The energy demand from households depends mainly on the increase in population and economic growth. The increase in population and the average family size are defining factors for the housing supply. Both in the SE and in the GE scenario the population of the Netherlands undergoes a sharp increase, while the average number of persons per household drops considerably. Hence the rise in the number of households in GE and SE.

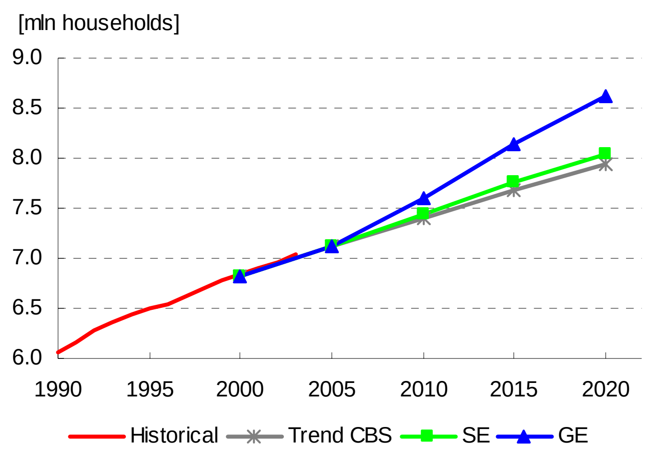

Figure 6.3.2 - Expected growth of the number of households (in millions) between 2000 and 2020

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25 The natural gas consumption not adjusted for temperature has increased in the period 1990-2003 from 329 PJ to 336 PJ (CBS).

The rise in GE is considerably higher than the rise according to the trend-related development[26]. The increase in the number of households in SE is also higher than the trend-related development.[27].

The economic growth has an impact especially on the number of appliances per household. The impact parallels the development of private consumption. From 2000 to 2020 the volume of private consumption per household in SE increases by 26%, and in GE by 49% (see figure 6.3.3).

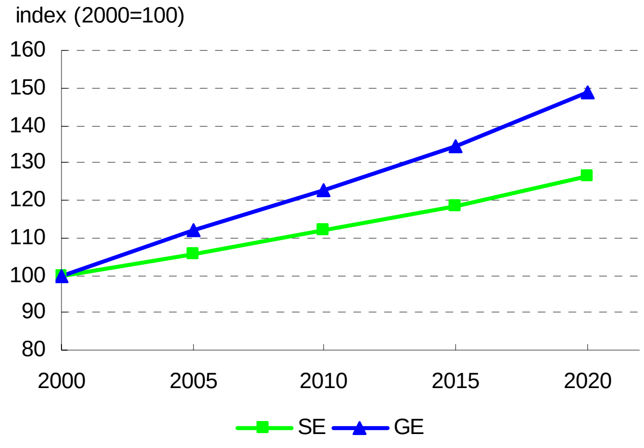

Figure 6.3.3 - Development volume private consumption per household

Policy developments

The Reference Projections in the household sector assume the following policy instruments:

- Energy Tax (EB)
  The EB is a levy on the use of energy carriers, including natural gas and electricity. The energy tax rose from 2000 to 2004 for both gas and electricity; from 2005 onwards the tax will remain at the same level.
- The European Energy Performance Building Directive (EPBD)
  The Energy Performance Advice (EPA) for existing homes and the Energy Performance Standard (EPN) for new homes. The EPN will be tightened in 2006. The calculations assume that no further tightening will take place in subsequent years. See Section 3.4 for a full description of these instruments.
- Energy labels
  With regard to tumble dryers, dishwashers and washing machines, it is assumed that no further tightening up on energy labels will take place until 2020.
- Energy Premium Scheme (EPR)
  The EPR used to provide subsidies for, for example, home insulation, super-efficient hot water cylinders, solar boilers and photovoltaic capacity (PV) systems, as well as for efficient white goods. The scheme was abandoned on 14 October 2003. The EPR is likely to be continued in 2005 in the form of a CO_2 tender scheme for built-up areas. Unlike under the EPR, the new scheme will not subsidise a large number of individual measures, but make a budget available for saving measures in large-scale projects. The introduction of a CO_2 tender scheme has not yet been included in the projections.

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[26] CBS statline.

[27] If the trendwise development of the number of households is taken as starting point for the calculation of energy consumption, the CO_2 emission in 2020 resulting from direct and indirect emissions are 0.2 Mton and 0.1 Mton lower than in SE (see Figure 6.3.7)

Results

Primary energy consumption
The growth of the primary energy consumption from 1990 to 2003 is entirely due to the growth of electricity consumption. In 2000 the primary energy consumption was 545 PJ. In SE the primary energy consumption in 2010 is at around the same level as the consumption in 2000 (548 PJ). In subsequent years, the primary energy consumption decreases, to 537 PJ in 2020.

The decrease in the primary energy consumption in SE is caused by a large decrease in gas consumption. In GE the gas consumption also comes down, but this is offset by an increased use of electricity, resulting in a steady increase in the overall primary energy consumption from 2000. In 2010 and 2020 the primary energy consumption amounts to 577 PJ and 628 PJ, respectively.

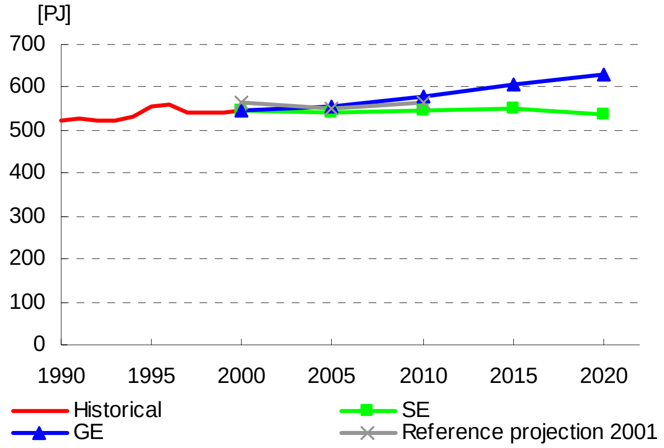

Figure 6.3.4 - Primary energy consumption of the households sector

Natural gas consumption
In the household sector, natural gas is used mainly to heat water cylinders and the home. The use of hot water by individuals undergoes little change in the 2000-2020 period (Vewin, 2002). However, as families are getting smaller, the hot water consumption per dwelling decreases by 9% in the period 2000-2020. The average gas consumption for space heating per dwelling also decreases. This is because of energy saving new houses/dwellings, the increased popularity of high-efficiency boilers and the insulation of existing boilers, and the increasing average outside temperature. Savings are partly offset by changing heating behaviour (more rooms being heated and higher heat settings) and the ever-increasing size of new homes.

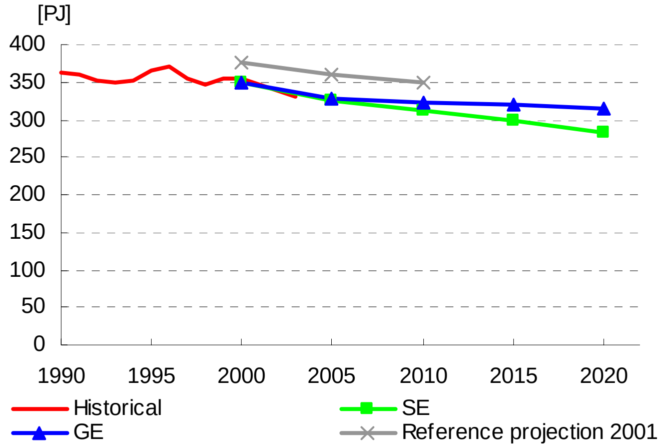

Figure 6.3.5 - Natural gas consumption in the households sector

The development of the total demand for gas depends on the development of the average demand for gas for each home as well as on the development of the number of households. In both SE and GE, the overall demand for gas decreases in relation to the reference year 2000 (349 PJ). In SE the decrease is more substantial (311 PJ in 2010 and 283 PJ in 2020) than in GE (324 PJ in 2010 and 315 PJ in 2020).

The decreasing demand for gas is partly a result of the warmer climate, which reduces the need for home heating. The less substantial decrease in GE is the result of the averagely higher demand for heating per dwelling and the larger number of households under this scenario.

Final electricity consumption

The energy consumption of households shows a rising trend in both SE and GE. In GE the energy consumption rises from 79 PJ_e in 2000 to 106 PJ_e in 2010 and 135 PJ_e in 2020. The rise in SE is less substantial (98 PJ_e in 2010 and 114 PJ_e in 2020). The increase in energy consumption is caused by a rise in the average use per household as a result of more appliances being purchased and used on the one hand, and an increase of the number of households on the other hand.

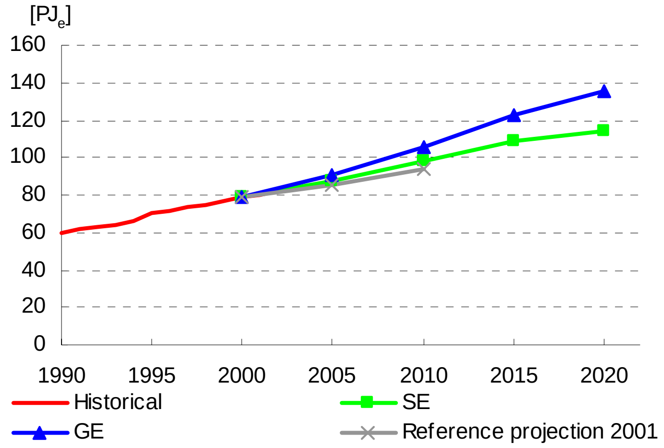

Figure 6.3.6 - Final electricity consumption in the households sector

New electricity applications

The appliances responsible for a substantial increase in electricity consumption over the last 10 years will not be the main culprits for increased consumption in the long term. Up to 2010, but in all likelihood also thereafter, the saturation effects in terms of ownership and use will play an important role. However, there are a number of trends that may cause a substantial increase in electricity consumption in the long term: home security (with links to other applications such as heating, lighting and intruder detection), kitchen renovations (increasing popularity of electric cookers) and bathrooms (pulsating, wall-mounted shower-heads and electric floor heating). Increased consumption in the area of audio/video and telecommunication is likely, due to multiple devices per household and the functions they are used for. Currently, there is also a sharp increase in the number of personal computers being left on almost all day and night (e.g. because of broadband connections) and particularly in GE we expect many consumers to be almost continuously online.

The electricity consumption for cooling will undergo a sharp increase. In 2020 the energy consumption for cooling in SE increases almost tenfold compared with 2000, while in GE the use is more than 25 times as high. However, the contribution of cooling to the overall household energy consumption will remain limited; in SE the use for cooling is only 1% of the electricity energy consumption, and in GE only 2%.

CO_2 emissions

In 2000, the direct CO_2 emissions linked to the consumption of natural gas for the household sector was around 20 Mton. This CO_2 emission is directly attributable to the sector.

After 2000, the direct emissions decrease continuously. The CO_2 emission in the SE scenario (17.7 Mton in 2010 and 16.2 Mton in 2020) drops further than in the GE scenario (18.4 Mton in 2010 and 17.9 Mton in 2020).[28]

Indirect CO_2 emissions resulting from electricity consumption amounted to 9.4 Mton in 2000. Such emissions are not directly attributed to households sector but to the electricity sector. By 2010, the indirect CO_2 emissions in SE will have increased to 12.7 Mton, in GE to 13.7 Mton. By 2020 these emissions will have increased further to 13.7 Mton in SE and to 16.1 Mton in GE.[29].

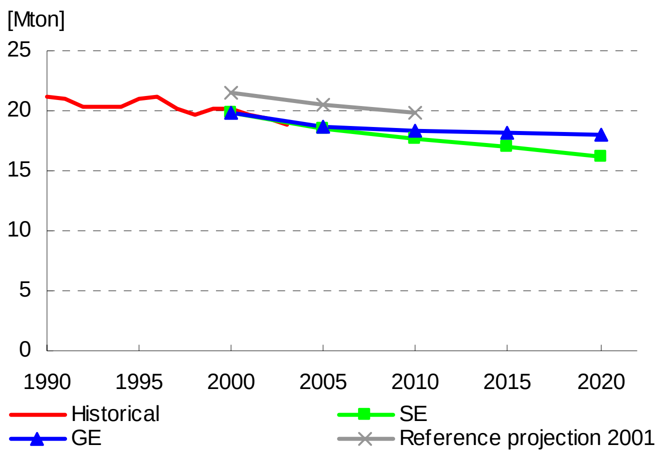

Figure 6.3.7 - Development of direct CO_2 emissions of the households sector

Effect of climate policy

The effect of the climate policy is shown in figures 6.3.8 and 6.3.9. In these illustrations, 'no new climate policy after Climate Policy Implementation Paper (UK1)' reflects the situation in which the policy from the Climate Policy Implementation Memorandum has been abandoned; in other words, the EPA and the EPR have not been introduced and the EPN and the EB are at the 1998 level. In the illustrations, 'Policy-free' reflects the situation in which the EPN, EPA, EPR and EB are abandoned after 2000.

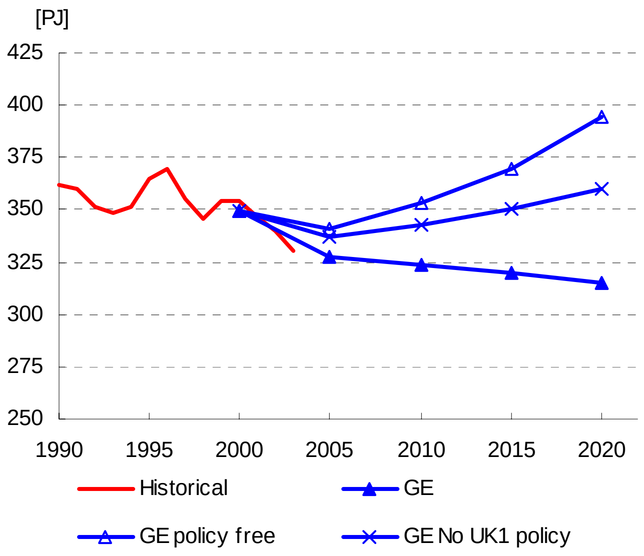

Figure 6.3.8 - Development of natural gas consumption of the households sector in GE, with and without policy

Without the policy from the Climate Policy Implementation Paper, the consumption of natural gas is 19 PJ higher in 2010 and 45 PJ higher in 2020 than in GE. The corresponding extra CO_2 emission is 1.1 Mton and 2.5 Mton, respectively. The extra emission is caused by the EPN (25% in 2010 and 40% in 2020). The remaining

28 If no temperature increase is assumed between 2000 and 2020, the CO_2 emission in GE resulting from gas consumption will be approximately 0.6 Mton higher in 2010 and 1.2 Mton higher in 2020.

29 If no temperature increase is assumed between 2000 and 2020, the CO_2 emission in GE resulting from electricity consumption will be approximately 0.1 Mton higher in 2010 and 0.3 Mton higher in 2020

effect is the result of the EPA as part of the EPBD.
In the policy-free variant the gas consumption is 29 PJ higher in 2010 and 80 PJ higher in 2020 than in GE. The effect on the CO_2 emission is 1.6 Mton and 4.5 Mton, respectively. Of this amount, 45% will be caused by the EPN in 2010 and 60% in 2020. Here, too, the remaining effect is the result of the EPA as part of the EPBD. Without the policy from the Climate Policy Implementation Memorandum, the electricity consumption is 1 PJ higher in 2010 and 3 PJ higher in 2020. The effect on the CO_2 emission is 0.2 Mton and 0.3 Mton, respectively. In the policy-free variant, the energy consumption is 5 PJ higher in 2010 and 9 PJ higher in 2020. The effect on the CO_2 emission is 0.6 Mton and 1.0 Mton, respectively. This is the combined effect of energy tax and the EPR.

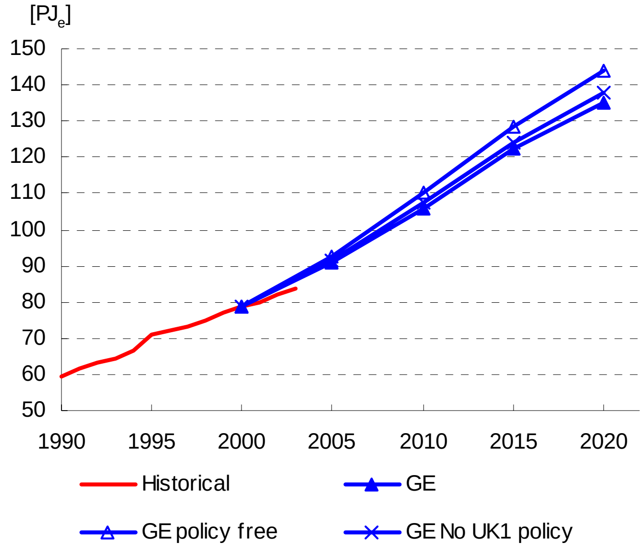

Figure 6.3.9 - Development of final electricity consumption of the households sector in GE with and without policy

Uncertain factors

- The energy consumption as it has been presented has an number of uncertainties. A summary of the major uncertainties is presented below. A summary of all the uncertainties is given in Tables 6.3.1 and 6.3.2.
- Historical data on energy consumption contain uncertainties and gaps. In the decade from 1990 to 2000 the consumption of natural gas showed a number of ups and downs that are inexplicable and therefore improbable. For instance, from 1996 to1998 the consumption of natural gas decreased by 22 PJ, only to increase by 10 PJ in 1999. During 2001-2003 the consumption of natural gas decreased. But it is far from clear whether it was a matter of an actual decrease or just a fluctuation around the average. This is why the following approach has been used as a reference point for the calculation in the scenarios. The consumption of natural gas in 2000 was established on the basis of a trend line for the consumption of natural gas in the 1985-2000 period. That is 5 PJ lower than the consumption of natural gas according to the statistics.
- The increase in population is a scenario invariable. The actual increase in population – and consequently in the number of households – may differ from the assumptions made in both scenarios.
- Economic growth has an impact on the purchase and use of appliances. Estimates for future developments are based on the observed historical shifts in owning appliances. Economic growth is one of the decisive factors for faster or slower changes.
- The calculations assume the trend of the number of so-called cooling degree days calculated by the RIVM (Visser, 2005). The uncertainties in terms of the temperature trend, shown in table 6.3.1, reflect the difference in CO_2 emission if the temperature trend were to differ slightly from the temperature trend calculated by the RIVM.
- The trends in lifestyle and behaviour influence the gas and energy consumption. Examples of factors that have an effect on gas consumption include the occupation rate in the home, the thermostat setting and the shower frequency. Factors that have an effect on electricity consumption include the purchase of appliances and the lifespan of appliances. There are uncertainties regarding the trends in lifestyle and behaviour.

- The calculations assume the EPBD is hardly a policy-intensifying factor with regard to the EPA in combination with the EPR. The effect of the EPBD on the existing buildings is hard to predict. The number of EPAs will increase under the influence of the EPBD; the EPAs are also carried out at a more natural time. However, the EPR that used to make the implementation of measures more attractive has been abolished. In addition, because of the compulsory element, more and more EPAs will be carried out for parties who are not so interested in saving energy and are less prepared to take saving measures than before. In practice, the effect of the EPBD (for existing buildings) may turn out to be different from what was assumed through calculations.
- For new buildings, the EPN is the decisive factor for energy consumption. In the calculations the effects of maintaining the EPN have been included in the realised energy consumption. Possible changes in maintaining the EPN are shown in table 6.3.1
- Newly developed properties are built because of the increasing number of households and to replace existing properties. The rate at which the replacement is taking place affects the total energy consumption, since new homes (assuming an equal floor surface) require less energy than existing residential properties. The scenario calculations assume a certain rate for replacement. Any variance will have an effect on the gas consumption.
- The current direct energy consumption in the household sector consists almost entirely of natural gas. If part of the natural gas supply is replaced by, for instance, SNG (synthetic natural gas), it will have an effect on the direct CO_2 emissions of the sector. Also the substitution of natural gas by electricity (e.g. via electric heat-pumps) will influence the direct CO_2 emissions.
- When calculating the energy consumption, assumptions have been made for each appliance in terms of improved efficiency/energy conservation. The EU saving policy will have an effect on this. In the event that future improved efficiencies are different from the calculated values, it will have an effect on the energy consumption.
- The calculation includes a 'new/unknown' appliances category. The unknown element is also a source of uncertainties.

Table 6.3.1 - Uncertainties in natural gas consumption for the households sector in the SE scenario

[Mton]	2010		2020	
Direct emissions	17.7		16.2	
	Low	High	Low	High
Statistics	-0.5	0.5	-0.5	0.5
Population growth	-0.6	0.4	-1.4	1.2
Climate development	-0.3	0.2	-0.3	0.3
Lifestyle/behaviour (heating/ventilation behaviour)	-0.6	0.6	-0.6	0.6
Replacement speed buildings	-0.1	0.1	-0.2	0.2
Effectivity policy existing buildings	-0.4	0.2	-0.7	0.4
Effectivity EPN sharpening	0.0	0.1	0.0	0.2
Fuel substitution (EWP/SNG)	-0.1	0.1	-0.8	0.8

Table 6.3.2 - Uncertainties in electricity consumption for the households sector in the SE scenario

[Mton]	2010		2020	
Indirect emissions from supplied electricity	12.7		13.7	
	Low	High	Low	High
Population growth	-0.3	0.4	-1.0	1.2
Income trends	-0.4	0.4	-1.4	1.4
Climate development	0.0	0.3	-0.1	0.5
Lifestyle/behaviour	-0.4	0.4	-1.4	1.4
EU saving technology appliances	-0.3	0.3	-0.7	0.7
Technology supply	-0.3	0.3	-0.7	0.7

6.4 Trade, services and government

The service sector, which comprises trade, services and government, is ranked only fourth in terms of energy consumption in spite of its large economic importance. Most of the energy is consumed by space heating and electrical appliances. This is why the sector consumes mainly natural gas and electricity, as well as a small amount of oil products.

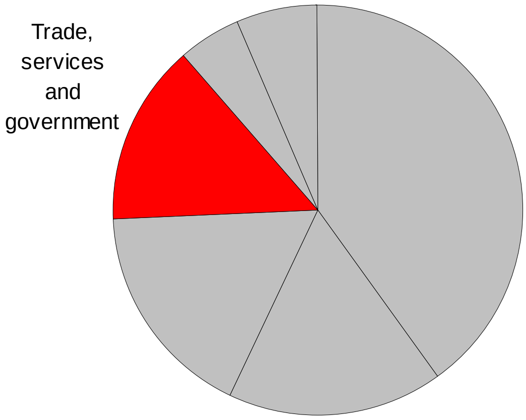

Figure 6.4.1 - Share of TSG in total energy consumption

The temperature-adjusted consumption of natural gas was 150 PJ in 1990 and rose to 203 PJ in 2003[30]. The increase of the total floor space had more impact on the overall gas consumption in this period than the improvement of the average heat insulation and the application of more efficient central heating boilers.

The final electricity consumption in the period 1990-2003 underwent a continuous increase (from 69 PJ_e to around 108 PJ_e). The increase in the number of appliances and changes in the average lifespan had more impact on the energy consumption than did the improved efficiency of appliances in this period.

Development of employment

The development of the number of employees and the corresponding floor space in buildings also has a great impact on the overall energy consumption. In some subsectors, other factors play a role, namely the number of patients in nursing homes, the type and volume of treatments in hospitals, and the number of students in the education system.

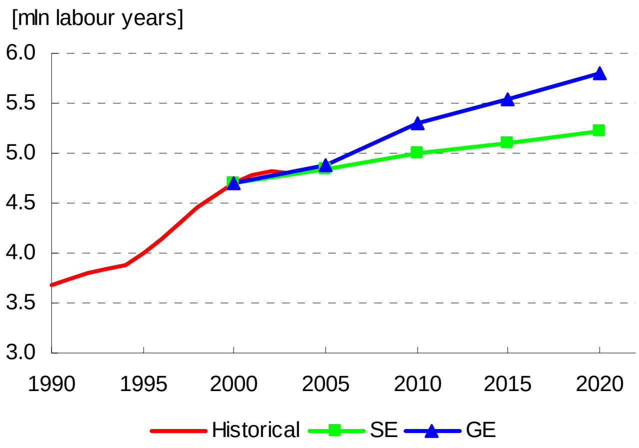

Figure 6.4.2 - Growth of labour years for SE and GE in TSG between 1995 and 2020

Both scenarios differ widely in terms of development of the total number of years of employment (see Figure 6.4.2). In the SE scenario, the growth decreases substantially after 2000; also in the GE scenario, the average growth after 2000 is lower than in the previous period. The slow-down in growth is a result of the ageing population, as ageing limits the supply of labour. Nevertheless, labour productivity increases in order to realise economic growth (Huizinga, 2004).

30 The natural gas consumption not adjusted for temperature in the period 1990-2003 increased from 135 PJ to 206 PJ (CBS).

The energy consumption is relatively indifferent to energy prices because of the small contribution of energy to the overall costs of running a business.

Policy developments
The Reference Projections assume the following policy instruments for trade, services and government:

- Energy Tax (EB). The EB is a levy on the use of energy carriers, including natural gas and electricity. The amount of energy tax payable depends on the consumption. The energy tax for natural gas and electricity increased through to 2004. The tax will be at the same level from 2005 onwards.
- The Energy Performance Building Directive (EPBD)/European Energy Performance Building Directive, the Energy Performance Advice (EPA) for existing buildings and the Energy Performance Standard (EPN) for new developments. See Section 3.4 for a full description of these instruments.
- Energy Investment Deduction (EIA). It is assumed the EIA will remain in force, but in relation to the 2001 Reference Projection this fiscal incentive has been updated. The Early Depreciation Environment Investment (VAMIL) and the Energy Investment regulation Non-profit and Special Sectors (EINP), which were still playing a role in the 2001 Reference Projection, were terminated at the end of 2002.

Results

Primary energy consumption
The growth of the primary energy consumption from 1990 to 2003 is mainly a result of the growth in energy consumption. In both the SE and the GE scenario, the primary energy consumption rises further until 2010, though not as fast as in the past. In 2010 the primary energy consumption is 456 PJ in SE and 479 PJ in GE.

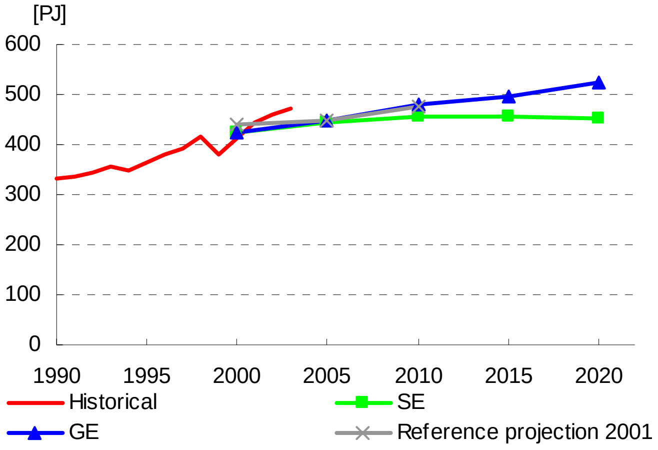

Figure 6.4.3 - Primary energy consumption of TSG

In the GE scenario, the growth continues after 2010, while in the SE scenario the total primary use is all but constant after 2010. The primary energy consumption in SE levels off as a result of the drop in the consumption of natural gas after 2000. In GE the gas consumption drops as well, but not as substantially as in SE. The difference in the development of the primary energy consumption is a result of differences in physical growth (e.g. the number of staff and the floor surface) in both scenarios. In 2020 the total primary energy consumption for SE and GE is 453 PJ and 524 PJ, respectively.

Consumption of natural gas
What is striking is the decrease in the consumption of natural gas in relation to 2000. In 2000, the consumption of natural gas was around 185 PJ, while in 2010 the figure is 165 PJ in SE and 173 PJ in GE. In 2020 the consumption of natural gas decreases further to 146 PJ in SE and to 164 PJ in GE.

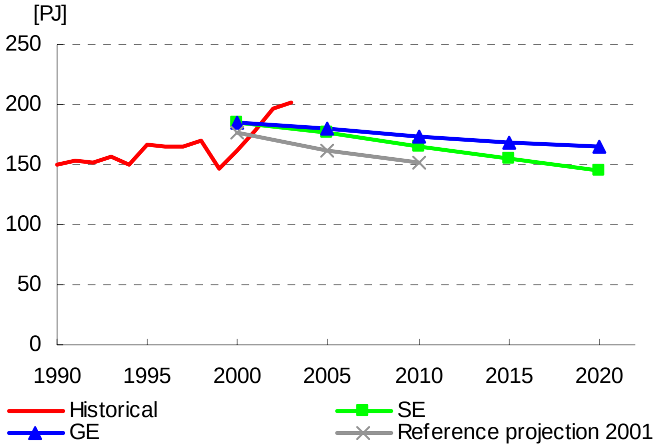

Figure 6.4.4 - Natural gas consumption of TSG[31]

The expected decrease in the Reference Projections is a result of much improved insulation in the outer walls of new buildings, the use of more efficient boilers and the increase in the average outside temperature.

Final electricity consumption
In the Reference Projections, the final energy consumption of the service sector increases from approximately 97 PJ in 2000 to 126 PJ in 2010 for SE and to 133 PJ in GE. In 2020, the energy consumption continues to rise to 142 PJ in SE and to 159 PJ in GE. The growth in these electrical applications until 2000 occurs mainly in ICT-related office applications, such as computers and peripherals.

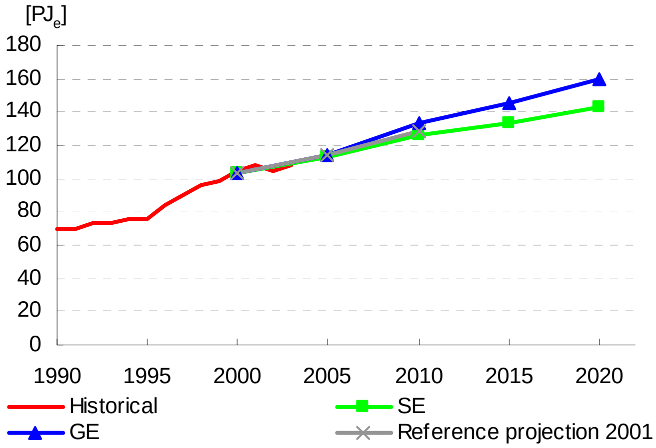

Figure 6.4.5 - Final electricity consumption of TSG

However, after 2000 the emphasis is on a rather invisible growth of ICT applications, such as the infrastructure for the Internet and mobile telephony. The increased cooling of buildings also contributes to the increased energy consumption.

[31] Statistics show an inexplicable decrease of natural gas consumption in 1998, which is probably the result of the manner in which natural gas consumption is calculated for TSG (see also ‘uncertain factors’). For the year 2000, the starting year of the scenarios, a representative value is chosen that deviates from natural gas consumption according to statistics.

CO_2 emissions

In 2000, the direct CO_2 emissions from trade, services and government amounted to around 10.5 Mton. In 2010 the CO_2 emission in SE is down to 9.4 Mton and in GE to 9.8 Mton. In 2020 the CO_2 emission is 8.3 Mton in SE and 9.4 Mton in GE.[32].

Indirect CO_2 emission resulting from electricity consumption amounted to around 11.7 Mton in 2000.

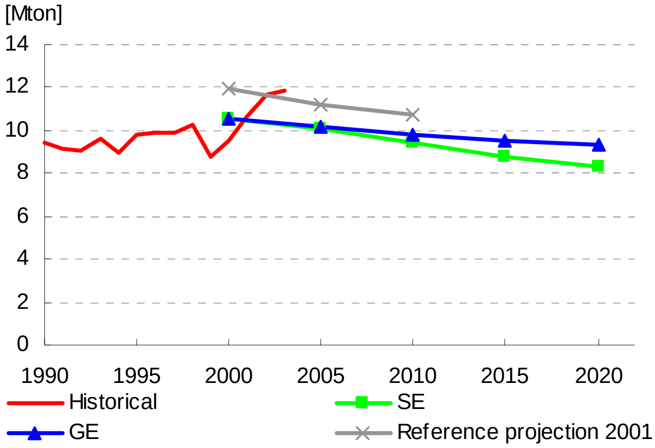

Figure 6.4.6 - Development of direct CO_2 emissions of TSG

Such emission is not directly attributed to the trades, services and government sector but to the electricity sector. In 2010 the indirect CO_2 emission in SE increases to 15.7 Mton, and in GE to 16.6 Mton. In 2020, the CO_2 emission increases even further to 16.8 Mton and 18.6 Mton in SE and GE, respectively.[33].

Effect of climate policy

The effect of the climate policy is shown in figures 6.4.7 and 6.4.8. In these illustrations, 'No UK1 policy' reflects the situation in which the policy from the Climate Policy Implementation Memorandum has been abandoned; in other words, the EPA is not introduced and the EPN, EIA and the EB are at the 1998 level. In the illustrations, 'Policy-free' reflects the situation in which the EPN, EPA, EB and EIA are abandoned after 2000.

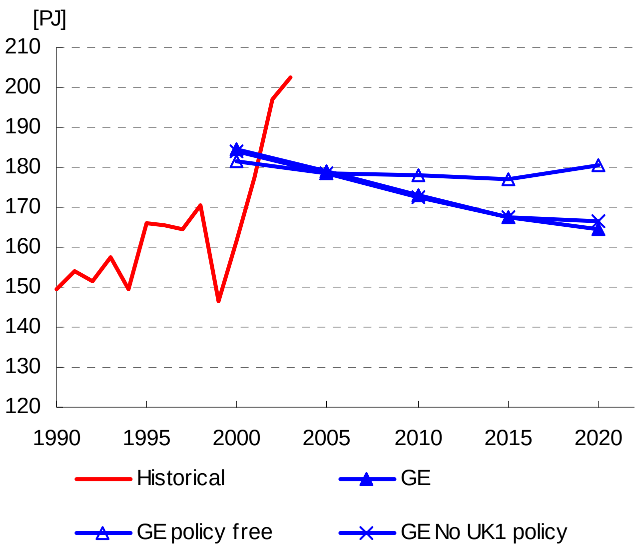

Figure 6.4.7 - Development of natural gas consumption in TSG in GE with and without policy

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[32] If no temperature adjustment is assumed between 2000 and 2020 the CO_2 emission in GE resulting from natural gas consumption will be approximately 0.4 Mton higher in 2010 and 0.7 Mton higher in 2020.

[33] If no temperature adjustment is assumed between 2000 and 2020 the CO_2 emission in GE resulting from electricity consumption will be approximately 0.4 Mton higher in 2010 and 1.0 Mton higher in 2020.

Without the policy from the Climate Policy Implementation Memorandum, the consumption of natural gas is less than 1 PJ higher in GE in 2010. In 2020 the consumption of natural gas is 2 PJ higher than in GE. The effect on CO_2 is negligible until 2010. In 2020 the effect is 0.1 Mton.

In the policy-free variant, gas consumption in GE is 5 PJ and 16PJ higher in 2010 and 2020, respectively. The effect on the CO_2 emission is 0.3 and 0.9 Mton, respectively. These policy effects are mainly caused by the EPN. The effect of the other instruments (EB, EPBD, EPA, EIA) on the consumption of natural gas is limited.

The electricity consumption also increases in the absence of policy. Without the policy from the Climate Policy Implementation Memorandum, the electricity consumption is not even 1 PJ higher in 2010 and is only 1 PJ higher in 2020. The effect on the CO_2 emission in 2010 is negligible, and in 2020 the effect is 0.1 Mton. This is a combined effect of EB, EPBD, EPN, EPA and EIA. The policy-free variant provides no extra increase in energy consumption in relation to 'No UK1 policy'

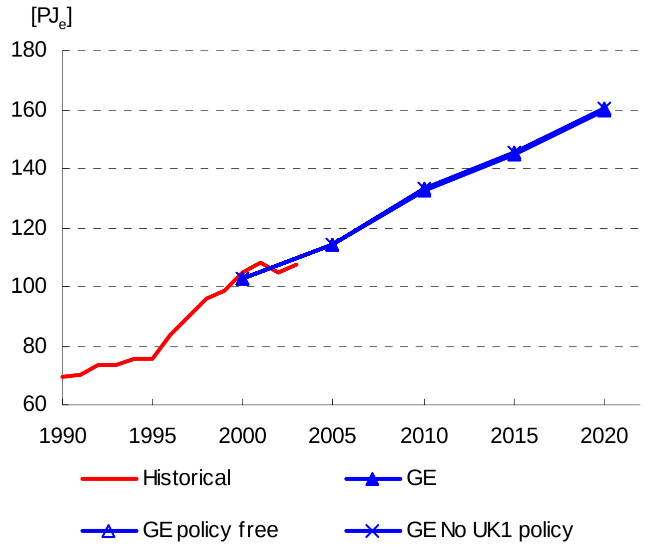

Figure 6.4.8 - Development of final electricity consumption of TSG with and without policy

It should be noted that regulations and financial instruments are partly triggering the same effects. On the basis of such overlapping, the policy effects of the overall policy will be smaller than may be expected on the basis of the individual instruments.

Uncertain factors

The energy consumption presented has a number of uncertainties. A summary of the major developments affecting the energy consumption is given below. The quantitative effects are presented in Tables 6.4.1 and 6.4.2.

- The uncertainties in terms of historical data for the service sector are large, since this sector is not separately observed in the energy statistics. The natural gas and electricity consumption of the service sector is established by subtracting the use in the various sectors from the overall national consumption. All uncertainties in the consumption by the other sectors therefore leak through in the service sector consumption.
- The employment growth is a scenario fact. The future development of the population in structure and size may differ from the picture painted in the scenarios. Also the economic growth is a scenario fact. The future economic growth may differ from the growth as outlined in the scenarios.·
- The calculations assume the trend in the number of so-called cooling degree days calculated by the RIVM (Visser, 2005). The future temperature trend may differ from the temperature trend as assumed in the calculations.

- Newly developed properties are built because of the larger space demand and to replace existing properties. The rate at which the replacement takes place affects the total energy consumption, since new homes require less energy than existing residential properties. If the actual rate of replacement differs from the rate assumed in the calculations, it will have an effect on the energy consumption.
- The future energy consumption is determined using physical units, that is, the number of staff and the floor surface, the number of patients in care, and the number of students in education. The development of these physical units is partly linked to the development of the population. The exact link is shrouded in uncertainties.
- Effectiveness of new policy measures (EPBD). In the calculations it has been assumed that the EPBD hardly means a more intensive policy in relation to the current policy. For new developments, the EPN is decisive for the energy consumption. It is harder to forecast the effect of the EPBD on existing buildings. The number of EPAs will increase through the effects of the EPBD. In the calculations it has been assumed that only a few of the advised saving measures are in fact realised. On the one hand, this is because the costs of energy are often just a marginal part of the overall costs, and on the other hand because in the event of renting out, the costs and benefits of saving measures do not fall to the same actor. The percentage of measures from the EPA put in place even declines under the influence of the EPBD. EPA of a voluntary character would especially be popular with actors interested in energy saving who are also prepared to take saving measures. The compulsory character of the EPA under the EPBD will mean that some of the EPAs will be executed for actors who are not or are hardly prepared to take saving measures. In practice, the effect of the EPBD (for existing buildings) may turn out to be different from the assumptions made in the calculations.
- Little is known about the energy consumption per physical unit at this point in time. This may result in the future development of the units also being shrouded in huge uncertainties.

Table 6.4.1 - Uncertainties in natural gas consumption for TSG (SE scenario)

[Mton]	2010		2020	
Direct emissions	9.4		8.3	
	Low	High	Low	High
Statistics	-1.0	1.0	-0.9	0.9
Population growth	-0.1	0.1	-0.2	0.2
Economic development	-0.2	0.4	-0.5	0.5
Climate development	-0.2	0.2	-0.2	0.2
Replacement speed buildings	-0.1	0.1	-0.2	0.2
Effectivity policy existing buildings	-0.2	0.2	-0.2	0.2
Development of physical units	-0.2	0.2	-0.4	0.4
Demand energy services/employee	-0.1	0.1	-0.3	0.3

Table 6.4.2 - Uncertainties in electricity consumption for TSG (SE scenario)

[Mton]	2010		2020	
Indirect emissions from supplied electricity	15.7		16.8	
	Low	High	Low	High
Statistics	-0.8	0.8	-0.8	0.8
Population growth	-0.2	0.2	-0.3	0.3
Economic development	-0.5	0.5	-1.5	1.0
Climate development	-0.3	0.3	-0.8	0.8
Replacement speed buildings	0.0	0.0	-0.1	0.1
Development of physical units	-0.3	0.3	-0.8	0.8
Demand energy services/employee	-0.3	0.3	-0.8	0.8

6.5 Agriculture

Agriculture has a 5% share in the primary energy consumption. Greenhouse horticulture is the largest user by far, accounting for 4% of the national energy consumption.

Economic developments

In the coming years, the agriculture sector is steady or even declines in SE. This overall picture is made up of a rather strong growth in greenhouse horticulture against a decline in cattle breeding and dairy farming and a small growth in arable farming.

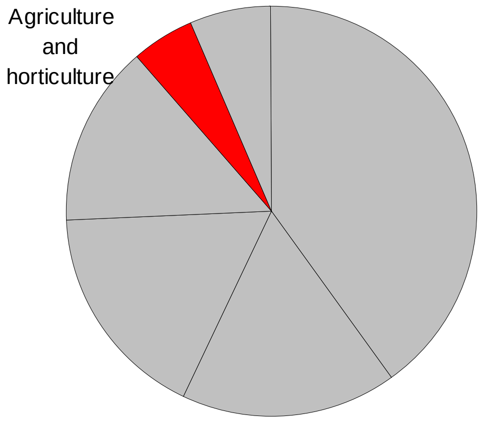

Figure 6.5.1 - Share of agricultural sector in total energy consumption

In SE, the result for the overall agriculture sector is an increase of the added value, amounting to 1.4% from 2002 to 2010, and to 0.2% from 2010 to 2020; in GE, the figures are 1.5% and 1.3%, respectively. Part of the intensification of production is a slight (SE) or strong (GE) growth in the acreage using assimilation lighting.

Table 6.5.1 - Added value, growth [%/yr]

[%]		RR 2001	SE		GE	
	1995-2002	2000-2010	2002-2010	2010-2020	2002-2010	2010-2020
Arable farming	4.5	0.7	0.7	0.1	-1.0	0.4
Greenhouse horticulture	0.5	2.4	2.8	1.3	2.4	2.1
Stock breeding	-1.6	-0.1	-0.3	-2.5	0.1	-0.8
Agriculture and fishery total	0.2	1.8	1.4	0.2	1.5	1.3

Acreage

The total greenhouse horticulture acreage decreases very slightly in SE, down to 10,300 hectares in 2010 and to just over 9800 hectares in 2020. There is a strong increase in GE, up to 11,900 hectares in 2010 and to more than 13,500 hectares in 2020. For greenhouse growers the liberalisation of the gas market is accompanied by relatively higher costs for irregular gas consumption, which is a reason for, for example, ongoing expansion and specialisation in the sector. The production per hectare continues to increase by some 1% annually on average (Ruijs 2001). The changing product package also contributes to more added value.

Policy developments

The Greenhouse Horticulture and Environment Covenant (GLAMI) and the crop standards in the greenhouse horticulture AMvB (orders in council), which is based on the Covenant, are the main instruments for the sector. For energy efficiency, the aim is an improvement of 65% by 2010 in relation to 1980. Obligations are also imposed upon individual companies via the AMvB. In 2003, the energy efficiency improvement was 50-51% in relation to 1980 (LEI 2004). The energy efficiency index is thereby behind the objective (50% in 2000, approx. 55% in 2004). To achieve the GLAMI objective, an improvement of 36% is needed in 2010 in relation to 2004, that is, 6% annually. This means that the required development to reach the objective in 2010 is even further out of reach.

Early in 2004, the CO_2 indicative target value for agriculture was set at 7 Mton for 2010. In July 2004, an agreement at the political level was reached in terms of the emission margin in greenhouse horticulture (Dutch Lower House, 2004). This concerns an increase from 5.6 to 6.5 Mton, or to 7.1 Mton for an acreage of 11,500 ha or more. The crop standards will be adjusted accordingly. This means that greenhouse horticulture emissions under SE may not exceed 6.5 and under GE 7.1 Mton.

An important element in saving is cogeneration and residual heat supply from third parties. The saving effects under GLAMI are fully attributed to horticulture. When testing against the crop standards, the saving resulting from obtaining heat from third parties is only partly attributed. Whatever the case may be, for cogeneration the MEP is an important additional instrument for the sector. The fiscal incentive via the EIA decreases and provides an effective subsidy of 13-14% on investment from 2005. Purchasing green electricity counts for both the GLAMI objective and the harvest standards. However, the EB exemption for green electricity is abandoned and the market price is uncertain (Ruijs 2004a). Additional policies are demonstration, energy transition, sustainable energy and information projects, as well as the GLAMI Energy Research Programme. Utility systems and supply equipment for CO_2 from third parties within greenhouse horticulture are eligible for a 40% fiscal incentive under the MIA/VAMIL. It has also been announced that a specific CO_2 reduction plan for primary producers in greenhouse horticulture is in the making, but this has not been included in the results (see Chapter 10).

The energy tax on both gas and electricity increases as a result of an increase in the regular tariffs in the 2005-2007 period. In addition, an extra increase is assumed for the energy tax on gas due to the increasing CO_2 price in the CO_2 emissions trading system. That is because the assumption is made that the energy tax for non-trading sectors will be at least equal to energy tax for the trading sectors plus the effect of the CO_2 price. This effect is visible from 2008 onwards, but does not play a meaningful role until 2013 (see table 3.4.2). After 2010 the GLAMI covenant will expire; it is assumed that by that time the generic energy-saving policy under the Environmental Management Act will also be effective for greenhouse horticulture.

Results

Primary energy consumption

The primary energy consumption in agriculture and horticulture decreases slightly in SE, although the decrease is smaller than foreseen in the 2001 Reference Projection. In GE, the energy consumption is unchanged. The rate of saving in both scenarios is around -1.3% annually (plus an extra -0.15% as a result of climate correction) (see Section 3.2).

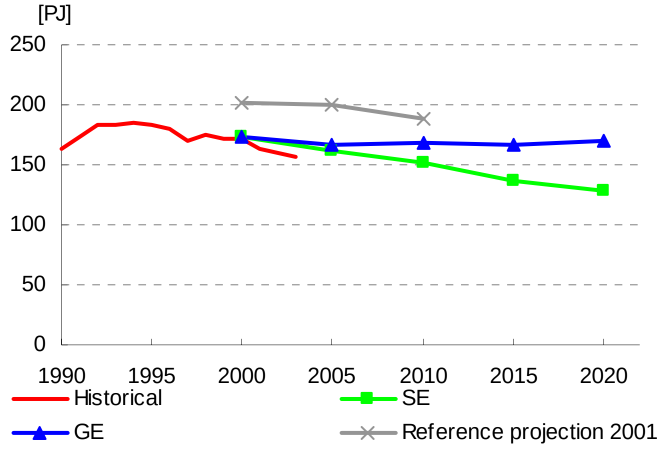

Figure 6.5.2 - Primary energy consumption in agriculture

Until 2010 the savings come mainly from cogeneration in cultivation using artificial light, heat buffers and greenhouse screens. After 2010 the advanced heating techniques, such as aquifers in combination with heat pumps, start to play a role. The more integral concepts, such as the energy-generating greenhouse, are not substantially realised until after 2020.[34]

The primary consumption in GE is higher than in SE due to the increase in the acreage and particularly in the acreage using assimilation lighting in greenhouse horticulture. The combined structural effect is 0.8% annually, against only 0.1% annually in SE. The old Reference Projection differs, particularly because mobile equipment and the climate correction are no longer included in the Projection (see 3.2). The SE scenario is most in line with the trends identified in the earlier Projection.

The energy efficiency in accordance with GLAMI is defined from the primary energy consumption and the physical production from the LEI monitoring. Assuming a bandwidth of the physical production growth per ha of 0.5-1.5% annually (Ruijs 2001), the growing acreage from -0.2 to 1.3% annually and growth of the primary use from -1% to 0% annually, the efficiency improvement is between 1% and 3% annually. The required 6% is therefore well out of reach. The saving in accordance with the Energy Saving Monitoring Protocol differs slightly from the GLAMI system, but is consistent with the above conclusion (see also Section 6.6).

Final energy consumption

The increase in growth-stimulating lighting is clearly visible in the development of the final electricity consumption, which has tripled since 1982. The trend continues in GE, while the growth eases in the Reference Projection 2001 and even more so in SE. For companies using assimilation lighting, it will be hard to meet the harvest standards from the AMVB greenhouse horticulture.

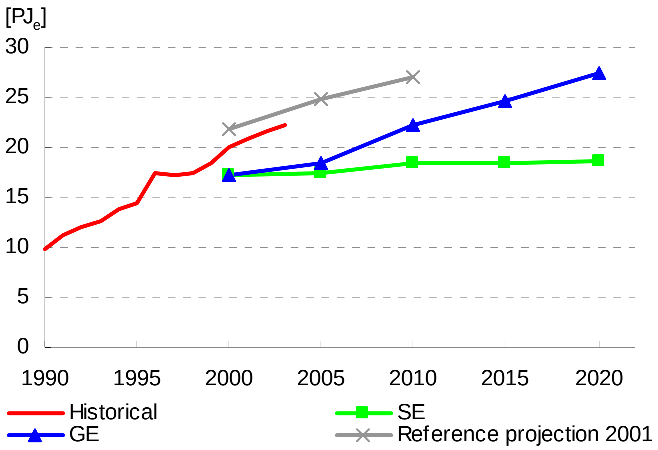

Figure 6.5.3 - Final electricity consumption in agriculture

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[34] The projection does not explicitly take into account the emergence of new greenhouse concepts due to their experimental nature. A number of options do penetrate, which will probably play an important role in these greenhouse concepts. Some examples are heating systems with heat pumps and heat storage in aquifers, either or not in combined with cogeneration. Here, too, illuminated cultivation plays an important role: in combination with assimilation lighting, such systems are usually much less profitable because the high fixed costs must be apportioned over a smaller remaining share of heat demand

The final thermal use in agriculture and horticulture further decreases in both SE and GE, mainly because of higher prices for natural gas. In GE this downward trend slows down after 2005 due to stronger growth of the sector.

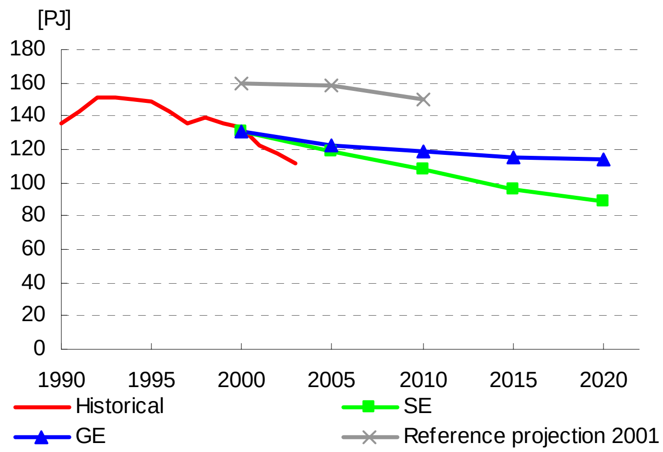

Figure 6.5.4 - Final thermal consumption in agriculture

Cogeneration

Just about all new cogeneration in agriculture is placed with businesses using assimilation lighting. Because of the larger share of the businesses' own consumption of generated electricity, it is more attractive for them to keep control over their own cogeneration rather than giving control to energy companies. Cogeneration controlled by energy companies usually occurs with businesses that use no artificial lighting. Due to the relatively high costs of overhaul and lower returns, the use of such small-scale cogeneration declines. An adjustment of figures for own cogeneration capacity using recent monitoring of gas motors leads to lower consumption compared to the previous estimate.[35].

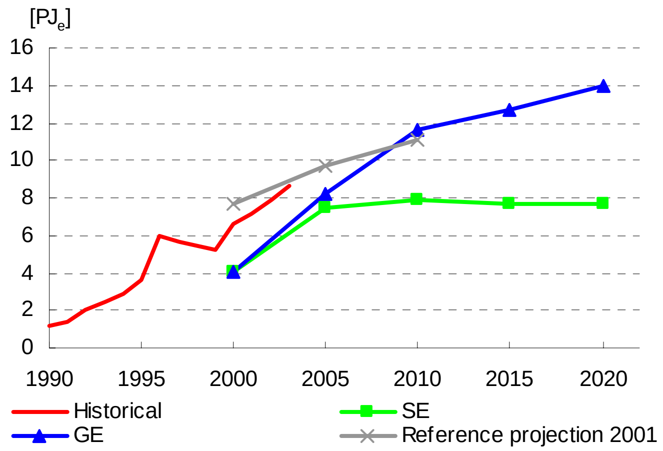

Figure 6.5.5 - Electricity production with own cogeneration in agriculture

The development of the cogeneration capacity continues in GE in line with the historical trend, while in SE stagnation occurs from 2005 onwards. Further growth of cogeneration seems to have a strong link to the application of assimilation lighting. Although cogeneration has an energy-saving effect in relation to individual generation, the growth of cogeneration goes hand in hand with energy-intensifying greenhouse horticulture.

Table 6.5.2 - Overview of indicators greenhouse horticulture

	SE		GE	
	2010	2020	2010	2020
Area [1000 ha]	10.3	9.8	12.0	13.5
Area illuminated [1000 ha]	2.9	3.1	4.2	5.7
Final elektricity demand [PJ_e]	12.4	13.3	16.0	21.4
Elektricity from private cogeneration [PJ_e]	7.8	6.8	11.6	13.9
Supplied electricity [PJ_e]	4.5	6.5	4.5	7.5
Share of autoproduced electricity	63%	51%	72%	65%
Heat from energy company cogeneration and residual heat supply [PJ]	9.4	9.3	10.4	10.3
Share of heat of third parties	10%	12%	10%	10%

[35] This adjustment has not been processed in the NEH data, as a result of which the historical and future lines apparently do not connect well in the graph.

CO_2 emissions

CO_2 emissions from the agriculture sector decrease in SE from 7.4 in 2000 to 6.8 in 2010 and to 5.6 in 2020. In GE, the CO_2 emission is about the same, at 7.7 in 2010 and 7.5 in 2020. Thus, in GE the January 2004 target value of 7 Mton is exceeded. For greenhouse horticulture, the 2010 emission is 6.9 Mton in GE and 6.0 Mton in SE. This keeps the emissions below the broadened target agreed with the government in July 2004.

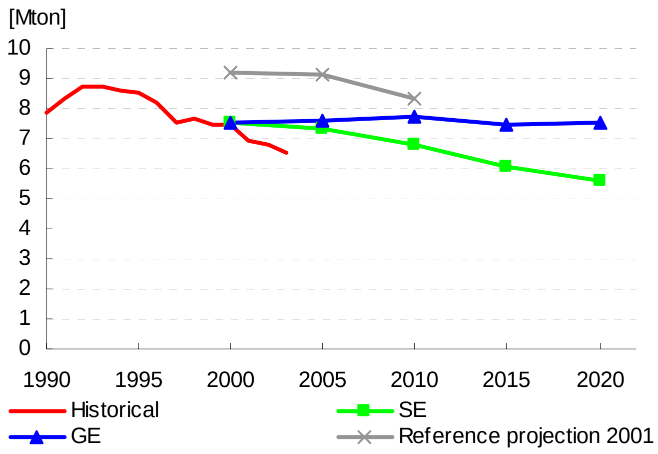

Figure 6.5.6 -Development of CO_2 emission in agriculture

The altered climate correction contributes to lower emissions by around 0.5 Mton in 2010. The remaining agricultural sector minus mobile equipment emits approximately 0.8-0.9 Mton annually in GE and SE during the entire 2000-2010 period.

Effect of climate policy

The most important element in the Climate Policy Implementation Memorandum is effectuating the GLAMI covenant. The rest of the policy consists of stimulating residual heat and CO_2 utilisation using the CO_2 reduction plan, increasing the EIA and stimulating cogeneration via the MEP. The REB on gas and electricity also rises. The GLAMI target is not realised, the required efficiency improvement rate of 6% annually is out of reach. The crop standards in the AMvB are currently not maintained. However, 2006 will probably see new and updated crop standards as well as a maintenance plan. The indicative target for greenhouse horticulture, agreed with the government in July 2004, is not exceeded in SE or GE. The updated climate correction contributes to this. Policies and measures result in both 2010 and 2020 in around 0.2 Mton lower direct emissions from agriculture. The decrease is the balance of about a 0.4 Mton reduction as a result of savings and a 0.2 Mton increase due to growing private cogeneration in the sector.

The sector is able to provide a major part of its own electricity. The share of UK1 policy in the effects is very limited. With UK1 alone, the effects of savings and the effects of cogeneration are more or less in balance; both are just under 0.1 Mton. The effect of the CO_2 price-linked increase in energy tax on gas is small: negligible in 2010 and 0.05 Mton in 2020. The overall effect of the energy tax on gas is 0.1 Mton in 2010 and 0.2 Mton in 2020.

Uncertain factors

The altered system of gas prices and higher energy bills are causing changes in the company structure. Especially the irregular use of gas is relatively costly. Growers with small profit margins or strong competition could find themselves with problems through this development. It might cause companies to relocate or close down, and result in more energy-extensive growing, as well as more capital- and energy-intensive business operations. That is because more energy-intensive growing could mean more regular and therefore relatively cheaper gas consumption. Macro-economic developments will only have a limited effect on the reorientation of the sector. No substantial changes are expected until 2010 with regard to the available technology. After 2010, new greenhouse concepts could be further introduced.

The development of assimilation lighting is very important. Recent reports indicate that such lighting is used for a much larger range of horticulture products than was assumed until recently (Ruijs 2004b). As well as for growing roses and cut-flowers, assimilation lighting is also used for growing such products as tomatoes and sweet peppers. The much larger acreage for growing these products means a much larger potential for assimilation lighting; this will also dramatically increase the uncertainty surrounding the further development of assimilation lighting. Such lighting leads to extra CO_2 emissions since the electricity generation for this purpose often occurs within the companies. Compounding two uncertainties inflates the uncertainty in the emissions from the sector more than in the previous Reference Projection.

Table 6.5.3 - Bandwidths of uncertainties for CO_2 emissions in agriculture for the SE scenario

[Mton]	2010		2020	
Direct emissions	6.8		5.6	
	Low	High	Low	High
Growth hectares greenhouse horticulture	-0.4	0.2	-1.4	1.4
Prices of fuels, including REB effect CO_2 prices	-0.3	0.2	-2.0	0.5
Statistics	-0.4	0.4	-0.4	0.4
Costs and potential energy saving measures	-0.3	0.3	-1.0	0.6

Table 6.5.4 - Bandwidths of uncertainties for final electricity consumption in agriculture for the SE scenario

[Mton]	2010		2020	
Indirect emissions from supplied electricity	1.4		1.3	
	Low	High	Low	High
Growth hectares greenhouse horticulture; division lighted non lighted	-0.1	0.7	-0.2	1.6
Electricity prices	-0.1	0.1	-0.2	0.2
Statistics	-0.1	0.1	-0.1	0.1
Costs and potential energy saving measures	-0.4	0.3	-0.6	0.4

Table 6.5.3. shows the bandwidth of uncertainties with regard to CO_2 emission in agriculture. The overall uncertainty in agriculture for SE gives a margin of error of plus or minus 15% in 2010.

6.6 Analysis of the development of energy consumption

Basic ideas of the Energy Saving Monitoring Protocol

The development of the energy consumption in the reference projections has various components. Some of these components (i.e. the volume effect, the structural effect and the savings effect) are identified on the basis of the Energy Saving Protocol approach (Boonekamp et al., 2002a). The Protocol is especially focussed on determining the savings at the national level and in the households, industry, agriculture, horticulture, transport and services sectors and the energy companies. Since the reference projections assume the continuous increase in the average outside temperature (see 3.2) and this is also included in the energy consumption, the climatological effect has also been analysed.

The volume effect is the change in consumption in accordance with the growth of the volume variable. In the industry this is the added value, in households the number of households, and in energy companies the amount of energy supplied.

The structural effect is the result of changes in the nature of production and consumption. The overall structural effect consists of, for example, the sector structural effect, dematerialisation and the effect of fuel substitution. For instance, a shift in power generation from coal to natural gas leads to a higher average yield. In the protocol this is marked as a structural effect rather than savings.

The climatological effect is the result of changing the use of installations for space heating and cooling due to changing temperatures. Fewer cool and more hot days will lead to less demand for space heating and to more for space cooling. The volume, structure and climatological effect together determine the consumption without savings, the so-called reference consumption.

Energy saving is defined as performing the same activities and providing the same functions but using less energy. In the protocol, saving is the difference between the reference consumption and the realised consumption. As well as a reduction in the demand for heat and electricity, energy saving also includes the more efficient generation of heat and electricity. Unlike the indicative target value categorisation, the protocol attributes the saving of cogeneration to the sector in which the cogeneration plant is physically present. The effect of joint venture cogeneration is therefore attributed to the end-users, rather than to decentralised generation.

An earlier and often used, broad definition of saving also comprised a part of dematerialisation and efficiency-improvement by fuel substitution and sustainable energy. These come under the structural effects in the Protocol approach. As a result, the saving is often smaller than that given in the reports dating back to before the Protocol was drawn up. The difference is approximately 0.2% annually.

Adjustments to the protocol

Since the introduction of the protocol, some small adjustments to the definitions have been made. The first version of the protocol used the Long-term Energy Efficiency Agreement (LTA) index as an indicator for the consumption without savings. As the LTA figures have not been available since 2001, an alternative measurement for the reference consumption was made on the basis of physical units. As a result, the industrial energy savings may be smaller in the current version of the protocol, although the differences are very small.

Objectives for saving

According to the definitions of the Energy Saving Protocol, the national objective of energy saving until 2020 is -1.3%/year. From 1990 to 2000, the average annual saving was -1.2%, with a bandwidth of ± 0.3%/year [36] (Boonekamp et al, 2002b); during the 1995-2002, period the saving was -1% annually. In view of the bandwidth, it is not possible to draw conclusions concerning any trends in the rate of saving.

Comparability of historical figures with projections

One must exercise some caution when comparing the saving figures for the estimates with historical figures. The indicators used to calculate the consumption before saving in the past differ somewhat from those in the future. The result is a margin of error of 0.1 to 0.2% from the correct outcome of volume, structure and saving effects in the future. Together with the uncertainty in the historical saving figures of ± 0.3%, it gives a rather large margin of error when comparing the historical figures with the estimates. In other words, only when the difference is more than 0.4% is there almost certainly an actual change in the saving figures compared with the past.

Results for the national energy consumption[37]

The results for the national energy consumption have been calculated with the exclusion of the transport sector, for which no saving figure could be established. The national energy consumption in SE will grow by 0.9 %/year from 2000 to 2010, while the growth of the GNP average amounts to 1.7%/year. The difference is made up of approximately -0.9% energy saving, just under -0.1% climatological effect and a small positive structural effect of 0.2%. Between 2010 and 2020 the national energy consumption in SE grows by 0.7%/year, and the GNP by

[36] The bandwidth is the result of a limited availability of suitable monitoring data, on which energy saving is determined. For individual sectors, this bandwidth can be much wider.

[37] The effect on energy consumption is expressed in the framework of the mentioned effects: a negative effect leads to a decrease in energy consumption, a positive effect leads to an increase.

1.8%/year. Of the total difference (-1.1%), -1.0% is the result of energy saving and 0.1% is the result of structural effects. Thus the speed of saving energy in SE falls short of the objective.

In GE, the growth of energy consumption until 2010 is 1.2%, and the growth of the GNP 2.5%; the difference is 1.3%, representing a saving of 1.0%. From 2010 to 2020, the growth of the energy consumption in GE is 1.2%, and that of the GNP 2.8%; the difference is 1.6%, representing a saving of 1.0%. Also in GE the rate of saving not only falls short of the objective but slows down. The structural effect in GE amounts to -0.3% annually until 2010, and -0.6% annually from 2010 to 2020.

The 2001 Reference Projection foresaw a 0.6% annual growth of the national energy consumption until 2010 at 2.5%/year economic growth. The difference consisted of an energy saving of 1.2%/year and a structural effect of -0.7%/year. Thus the energy saving in SE is 0.3%/year less, and in GE 0.2%/year.

Table 6.6.1 - Energy saving in conformity with the Energy Saving Monitoring Protocol

[%]	Protocol old			Protocol current			
	1990-2000	2000-2010	1995-2002	2000-2010		2010-2020	
		RR-2001	historic	SE	GE	SE	GE
Industry	-1.3	-1.1	-1.0	-0.7	-1.0	-1.0	-0.8
Transport	-0.4	-1.1	-0.4	-	-	-	-
Households	-1.5	-2.0	-1.2	-1.3	-1.3	-0.8	-1.1
Trade, services & government	-0.6	-1.1	-	-0.3	-0.4	-0.3	-0.4
Agriculture	-1.8	-1.9	-1.7	-1.5	-1.7	-1.2	-1.3
Energy companies	-0.1	-0.1	-0.1	0.0	0.0	-0.2	-0.2
National	-1.2	-1.2	-1.0	-0.9	-1.0	-1.0	-1.0

Results of the individual sectors

Households

Influenced by the EPN, at first there will be a slight increase in the rate of saving, until 2010 by -1.3% annually. Saving is mainly realised in the energy consumption in buildings. The rate of saving in households will slow down after 2010, particularly because saving in new developments will decrease. The difference in the demand for heat in existing and new homes will be smaller thanks to subsequent insulation work in existing homes. In addition, the rate of saving will ease because the rate of efficiency improvement of boilers will decline after 2010. The climatological effect in households is around -0.2% annually.

Transport

See van den Brink, 2003.

Industry

The rate of saving in SE will be approximately -0.7% until 2010, after 2010 approximately -1.0%. In GE, the figures are -1.0% and -0.8%, respectively. The rate of saving in cogeneration as part thereof (incl. joint venture cogeneration) is between -0.1 and -0.2%, in line with the historical trend. Depletion of the saving potential after 2010 is partly offset by stricter targets for emissions trading until 2020 and anticipating even higher CO_2 prices after 2020 in WLO-SE. Cogeneration in particular will give an extra boost in SE from 2015 onwards. In GE there is no such extra impulse.

Agriculture

The rate of saving until 2010 is approximately -1.5% in SE and -1.7% in GE. The substantial saving figures are connected with, for example, the growth of cogeneration for greenhouse lighting, particularly in GE. After 2010 the rate of saving slows down, in SE to -1.2% and in GE to

-1.3%. Part of the possible savings will have been realised by then, there will be little room to tighten the policy and far-reaching options will be too expensive.

The rate of saving in cogeneration also continues to slow down: the introduction of new cogeneration is mainly linked to greenhouse lighting, where the growth in SE stagnates after 2010[38]. The climatological effect in agriculture is approximately -0.1% annually.

Trade, services and government

The rate of saving until 2010 is -0.3 % annually, after 2010 -0.4% in both SE and GE. The share of cogeneration in these figures is almost negligible. Historical comparison is not possible as there are no data available in terms of the rate of saving from 1995 to 2002.

The total rate of saving is made up of a relatively substantial saving on the demand for gas, -0.9% in SE and -1.0% in GE, as well as a much smaller saving on electricity of between -0.1 and -0.2%. The rate of saving on heat is almost entirely linked to the rate of building new developments in combination with the EPN[39]. In the TSG, energy prices have only a relatively small impact on the implementation of saving measures since the price elasticity of saving in existing buildings is very low and in new buildings the EPN is the main motive behind savings, masking any effects of energy prices.

TSG is the only sector with a dissaving climatological effect: after 2010 more energy consumption will prevail because extra cooling will surpass less heating. On balance, energy consumption will increase by 0.1% annually.

Energy companies

In line with the protocol, savings in energy companies are expressed in relation to the national total balance of consumption. The saving until 2010 is minimal, less than approximately -0.1%. From 2000 to 2010 there will be hardly any investments in new power generation, limiting the possibilities to increase the average yield. Some of the effects on centralised generation have their origins in using the existing production park; at short supply producers are forced to increasingly use less efficient capacity, causing the average efficiency to decrease. On the other hand, a larger supply leads to higher efficiency and consequently also to saving. Although some savings are realised in refining[40], the dissaving structural effect at the energy companies originates partly in refining, forced to use extra energy to comply with European standards for sulphur content in transport fuels.

The scenario after 2010 remains essentially the same, although the saving is higher across the board, that is, -0.2% annually in both SE and GE. A major part of the reduction in emissions in the sector is realised through substitution (wind, biomass), in line with the definitions of the Energy Saving Protocol, visible as a structural effect. That, as well as the growth of cogeneration, will strongly reduce the potential for savings via the placement of efficient generating capacity. This is because the savings obtained by cogeneration are attributed to the sectors where the installations are physically present. However, the small savings by energy companies do not imply that the policies have no effect. With the assumed policy, energy companies often find it more attractive to make a shift in generating methods. Examples include the reduction in coal

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38 After 2010, new greenhouse concepts (closed greenhouse) could provide a new impulse for saving. Before 2020, the share grows quite slowly though, due to high costs. Moreover, the limited new construction of greenhouses as a result of the light decrease in acreage also contributes to this slow growth.

39 New construction (replacement and expansion) amount to approximately 1/40th of the total number of buildings. The EPN standard as of 2005 involves a reduction with nearly 40% in gas consumption per m^2 building space 0.4 * 1/40 = 1.0% per year.

40 Here refining is attributed to the energy companies, thus deviating from the protocol.

capacity in SE and the substantial increase in sustainable generation in SE and GE. However, such shifts do not show in the rate of saving.

6.7 Bunkering

Bunkering fuels for navigation and aviation occurs on a large scale in the Netherlands. This form of energy consumption does not come under domestic use. Nor are the CO_2 emissions resulting from this form of energy consumption counted as part of the Dutch emission, according to the Kyoto Protocol. This is why bunkering is discussed separately and concisely in this section.

With regard to calculations in the refinery sector, ECN made an estimate of bunkering oil products in the Netherlands on the basis of historical data and scenario data (figure 6.7.1). The port of Rotterdam plays an important role in providing fuel to the global shipping industry.

Development of the demand

Bunkering heavy fuel oil (bunker oil) for sea-going vessels is strongly dependent on the price of such oil in the Dutch port and has little to do with the Dutch transport sector.

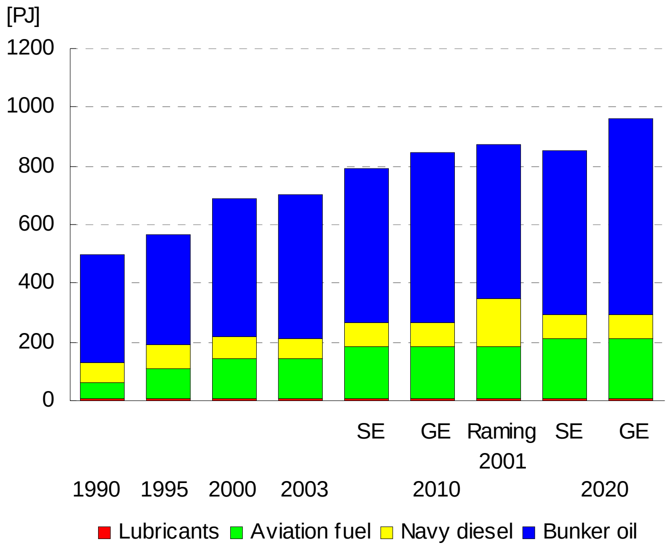

Figure 6.7.1 - Bunkering of oil in the Netherlands

Foreign countries are also exporting heavy oil to the Netherlands to be sold on to vessels. The growth in the GE scenario is in line with the spread in international projections (see e.g. MARINEK, 2000). After 2010, the SE scenario is clearly lowest.

The demand for aviation fuel is much more clearly linked to the Netherlands and is strongly dependent on the developments around Schiphol Airport. This is specifically related to aircraft departing from the Netherlands. With no Dutch figures available taking the market stabilisation from 2000 to 2003 into account, international studies have also been looked at (see e.g. Boeing, 2004). Until 2020 no distinction has been made between SE and GE. However, the exponential growth of Boeing after 2010 is not included, considering the EU baseline scenario does not include this exponential growth either (EC, 2003a).

CO_2 emissions

CO_2 emissions in connection with bunkering are considerable (figure 6.7.2). In view of the worldwide character, especially in the case of sea-going vessels, this is not a matter of purely Dutch emissions. The uncertainties in the bunkering figures are fairly large. If foreign ports competing with Rotterdam strengthen their position, the figures may remain at the level of 2000.

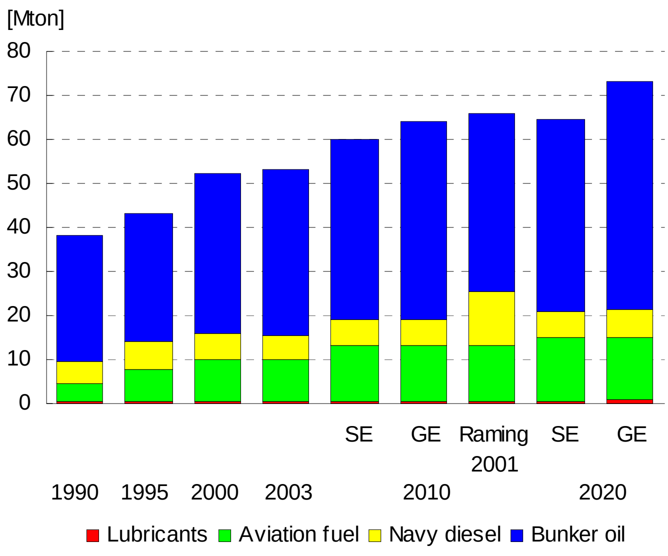

Figure 6.7.2 - CO_2 emission from bunkering in the Netherlands

Recent years have shown that growth in aviation bunkering can also be hindered by external circumstances. Here, the uncertainty lies particularly in the growth factor, which is expected to be well over the GDP. For instance, if growth from 2010 to 2020 is 2% annually, the bunker demand in 2020 will be approximately 22% higher (EC 2003a).

7. TRENDS IN ENERGY SUPPLY

This chapter describes how the demand for energy, as set out in Chapter 6, is met. Electricity supply as a whole is discussed in 7.1, based on final demand. Cogeneration and sustainable energy are examined specifically in 7.2 and 7.3. Oil refining and oil and gas extraction complete the picture regarding energy supply. The trends in CO_2 emissions in the various supply sectors are shown, now based on a provisional adjustment of historical emissions, as set out at 3.2..

7.1 Electricity production

The electricity industry consists of central production units, large-scale district heating systems and industrial companies with CHP systems, and other distributed generation. This other capacity include smaller CHP systems, waste combustion plants and small-scale renewable sources (wind and water power etc.). The Netherlands has a fairly large amount of local generating capacity, in particular CHP.

Trends in electricity demand
When planning the supply of electricity we need to know how demand for it is likely to develop. The demand for electricity has increased steadily over the past twenty years, but the growth rate is going down. The annual growth figures are shown in Figure 7.1.1. During the past ten years growth averaged 2.8% a year and the final demand in 2003 was over 111 TWh.

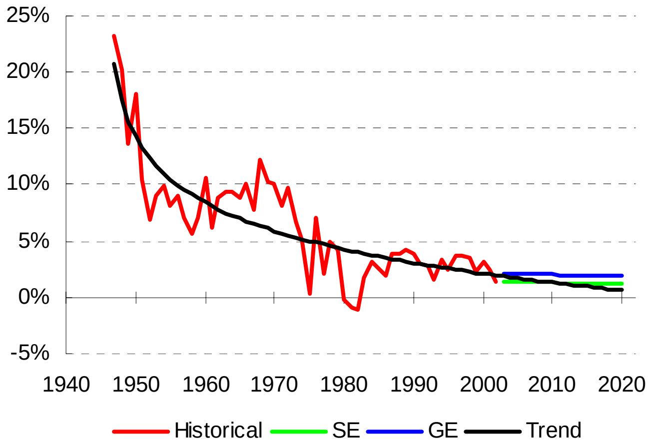

Figure 7.1.1 - Annual growth in electricity consumption, historical and SE and GE (source: CBS Statline)

Table 7.1.1 - Annual growth percentages final electricity consumption in the scenarios

[%]	SE		GE	
	2000-2010	2010-2020	2000-2010	2010-2020
Final electricity	1.4	1.3	2.0	2.0
GNP	1.5	1.7	2.3	2.8

In the SE scenario the final electricity demand[41] continues to grow in the coming years, to over 122 TWh in 2010 and just under 139 TWh in 2020. Average growth in SE is about 1.5% up to 2010, after which it falls to 1.3% a year. In GE growth is higher, rising to just under 130 TWh and over 157 TWh in 2010 and 2020 respectively, the growth rate in GE is thus 2.1% up to 2010, after which it falls to an average of 2.0% a year.

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[41] The total final demand relates to all electricity consumed, including own consumption of power auto-produced using CHP systems.

The growth in electricity consumption in GE is higher because of the higher economic growth, especially in the domestic and service sectors. In the previous Reference Projection, electricity demand was 124 TWh in 2010, virtually the same figure as now in the SE scenario.

Trends in the electricity market
The future supply of electricity will also depend on trends in the electricity market and, to a lesser extent, the gas market. These are set out at 5.2 and 5.1 respectively.

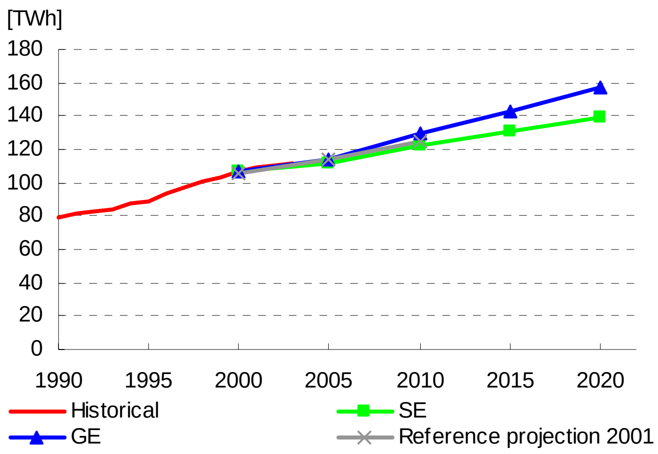

Figure 7.1.2 - Total final electricity consumption

Policy developments
Policy on electricity production includes CO_2 emissions trading, the Environmental Quality of Electricity Production (MEP) scheme, the Coal Covenant and the Benchmarking Covenant. The MEP scheme and other policies to promote sustainable energy and CHP are described in 3.4 and also mentioned in 7.2 and 7.3. The electricity industry has signed the Benchmarking Covenant, thereby expressing its aim to be among the international leaders in efficient power generation from gas and coal. The Covenant remains fully in force in both SE and GE but gradually loses its importance because of the growing effect of trading in CO_2 emissions (see 3.4). Producers are permitted to count the purchase of CO_2 emission rights in order to achieve the Benchmarking target.

Results

Electricity production
Figure 7.1.3 shows the proportions of various electricity generation and importation options for the 2000-2020 period in the SE scenario. At present power is supplied mainly by CHP, coal and gas-fired power plants and imports. Output from coal-fired plants rises to over 30 TWh in 2010 and 2015 (including co-combustion of biomass), thus continuing the rising trend of the past three years.

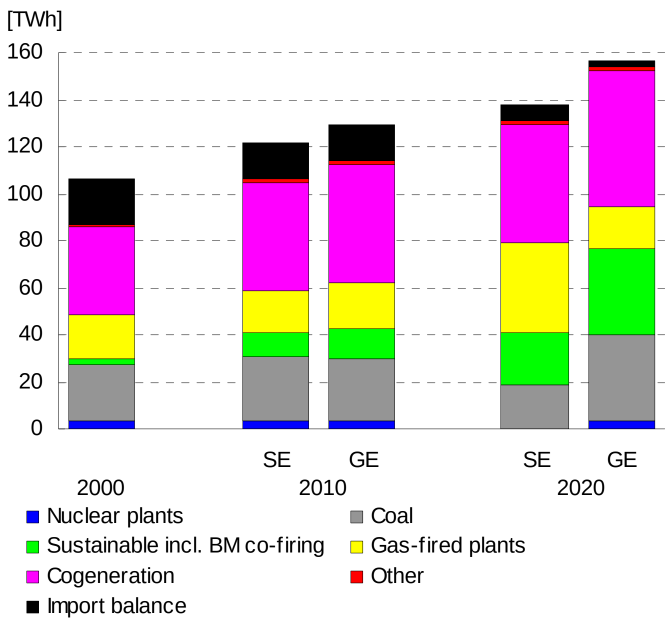

Figure 7.1.3 - Net electricity production divided in method of generation, SE and GE

In the GE scenario (see Figure 7.1.3) output from coal-fired plants continues to increase after 2015 as a result of the building of new coal-fired plants during the 2016-2020 period and the oldest coal-fired plants remaining on stream until after 2020. The Borssele nuclear power plant maintains the high output of the last five years, about 3.7 TWh (IAEA 2004).

In the SE scenario the nuclear plant closes after 2013; in GE it remains on stream until after 2020. Imports account for about 15 TWh in 2010, i.e. slightly less than in the 2000-2003 period. After that, they fall again to about 6 TWh in 2020 in the SE scenario and 3 TWh in the GE scenario (for details see 5.2). The proportion of power from renewable domestic sources increases substantially in both the SE and the GE scenario, from 3.3% in 2003 to about 10% in 2010 in both scenarios; the respective figures for 2020 are 17% (SE) and 24% (GE) (see also 7.3).

Fuel input

In 2000 about 66% of power was generated from natural gas and 25% from coal. The proportion of gas increases in the SE scenario to 68% in 2020; the proportion of coal falls to 16% and that of biomass/waste to 11%. In the GE scenario, on the other hand, the proportion of coal increases to 27% and that of gas declines to 53%; the proportion of biomass/waste goes up slightly more (to 13%), owing mainly to the greater opportunities for co-combustion because there are more coal-fired plants.

Figs. 7.1.5 and 7.1.6 show the overall consumption of coal and natural gas respectively. In the previous Reference Projection (2001) the amount of coal used was lower because of the relatively lower price of gas. Power generation from renewable sources is discussed in 7.3.

Emission factors for power generation

The average CO_2 emission factor for power generation is 9-10% lower in 2010 than in 2000 in both SE and GE (see Table 7.1.2). The average emission factors fall substantially after 2005, despite a decreasing proportion of imports, due to a substantial proportion of renewables.

Table 7.1.2 - Average CO_2 emission factors[42]

Index 2000=100	2000	2005	2010	2015	2020
SE	100	102	92	87	79
GE	100	102	91	83	85
[g/kWh]					
SE	532	541	489	465	422
GE	531	540	482	442	451

The emission factors shown here, including imports, were about 21% higher in 1990 than in 2000 (1990=121). As old coal-fired plants remain open after 2015 in the GE scenario and new ones are built, the emission factor in 2020 is ultimately higher than in the SE scenario, despite the much greater use of renewables in the GE scenario, with more wind and more use of biomass.

42 Heat-corrected and without correction for import. Calculated from [(CO_2 emissions from central generation + waste incineration + decentral production + distribution) - (CO_2 oil distribution) - (CO_2 gas loss distribution) / (Final electricity consumption + export)]. The Energy Saving Protocol definition assumes production Dutch park, i.e. with correction for import balance. The denominator then includes (Final electricity consumption Netherlands + Export - Import) = Final import balance. The emission factor of the Dutch park is 20% higher than the numbers in Table 7.2.1 in that case.

Trends in production capacity
Present-day electricity producers have the possibility of increasing the lifespan of existing power plants, and this is often a more attractive financial proposition than investing in new ones. Plants with relatively low variable costs (e.g. coal-fired and nuclear) and high enough efficiency can be (and are) kept on stream longer with limited investments in replacement - provided, that is, they comply with environmental and safety standards.

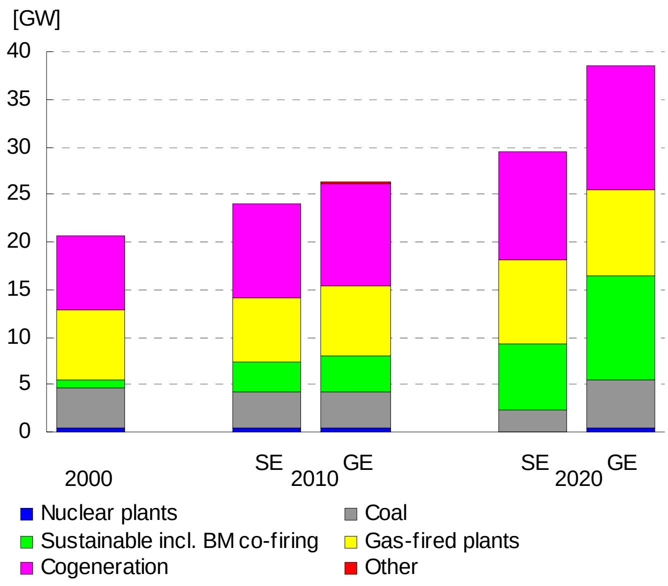

Figure 7.1.4 - Development of production capacity, 2000-2020, SE and GE

In the case of the Dutch coal-fired plants the Coal Covenant requires them to emit less CO_2, in particular as a result of biomass co-firing. The Borssele nuclear plant will in any event remain in operation until the end of 2013.

In the GE scenario Borssele's lifespan is extended. In the SE scenario a small number of relatively old and less efficient gas units are closed from 2010 onwards, but the lifespan of most units is extended, by about 50% on the original lifespan of 25 years, i.e. to about 38 years.

In the GE scenario the less efficient gas units are still on stream in 2020, as are all the coal-fired plants, so lifespan is extended still further. Increase in the demand for power and the ageing of the existing production facilities creates a need around 2008 for new generating capacity in both scenarios. This demand is met by the Sloe power plant (820 MW), offshore wind power, new CHP and the 700 MW NorNed link with Norway.

After this, in the SE scenario, there is a need for new generating capacity around 2013. New coal-fired plants are built from 2016 onwards in the GE scenario. The new types of plant are more efficient and less costly than the current generation, in line with the features of new energy technologies (Menkveld, 2004).

Coal versus gas-fired power plants
From the electricity producers' point of view it is better to keep coal-fired plants running long hours, mainly because of the relative increase in the price of natural gas compared with that of coal. On top of this, the MEP subsidy makes co-firing biomass worthwhile. In the previous Reference Projection an average of 10% of biomass was co-combusted in 2010; in the current scenarios the percentage is higher, viz. 12% in 2010 and 20% in 2020.

New coal-fired plants would seem to be attractive given the relatively low and relatively constant cost of fuel, especially as regards competition with foreign producers. It is unlikely, however, that new generating facilities of this kind will be built before 2010, because of the current uncertainty as to future CO_2 prices and the time it takes to build a coal-fired plant. The SE scenario assumes that the two oldest coal-fired plants, Gelderland 13 and Amer 17, will remain on stream until about 2018.

In SE no plans for coal-fired plants are drawn up in the coming years, nor – in view of the expected price of CO_2 – between 2010 and 2020. As a result, the amount of coal used in SE falls substantially by 2020. Investing in renewables and gas (both dedicated power plants and CHP) is more attractive to producers in SE. New gas-fired plants are atractive because of the relatively low investment cost and the short time it takes to build them. Being dependent on the price of gas, however, they do have higher price and volume risks.

In the short term the new natural gas-fired plants will consist of combined cycles (steam and gas turbine plants) such as the recently completed Rijnmond plant (Intergen, 790 MW) and the Sloe plant (820 MW), which is expected to start supplying power in 2008. In SE gas combined cycles of this kind remain the preferred option for subsequent new investments. The development of CHP is discussed in 7.2.

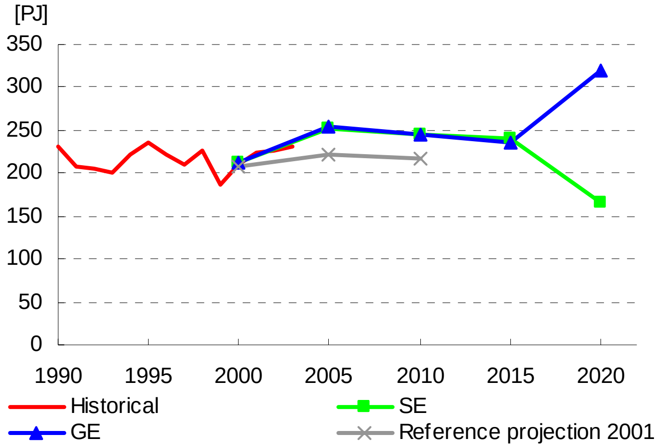

Figure 7.1.5 - Coal consumption balance, SE and GE

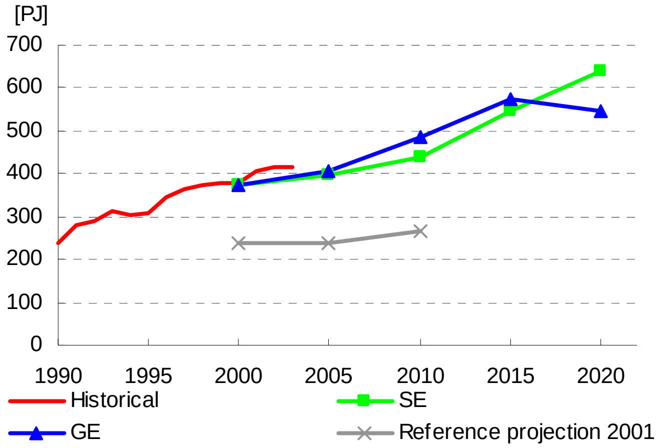

Figure 7.1.6 - Natural gas consumption balance, SE and GE

In the GE scenario the use of coal rises substantially over the period up to 2020 (see Figure 7.1.5) as a result of 2000 MW of additional capacity in plants fired by pulverised coal, and producers assume around 2010 that the emission limits will not be tightened up at some future date and the price of CO_2 will not rise much higher. Pulverised-coal plants remain attractive in spite of their higher CO_2 emissions compared with gas-fired plants. Figure 7.1.4 shows the trend in production capacity and Figure 7.1.6 the use of natural gas. The differences from the previous Reference Projection result from the classification of joint ventures in the energy sector. Consumption of natural gas in 2020 is ultimately lower in GE, owing mainly to the building of new coal-fired plants.

CO_2 emissions

Total CO_2 emissions from the electricity industry rise from 53.6 Mton in 2003 to 54.7 Mton in 2010 in the SE scenario, and 57.2 Mton in the GE scenario (see Figure 7.1.7). In the SE scenario, emissions rise from 2010 to 2020 to 58.4 Mton in spite of the closure of two coal-fired plants around 2018 and the growth in renewables, in particular co-firing of biomass and offshore wind power. In the GE scenario, emissions continue to rise up to 2020, to 67.8 Mton, owing mainly to higher demand for electricity and growth in total coal-fired capacity of 2000 MW.

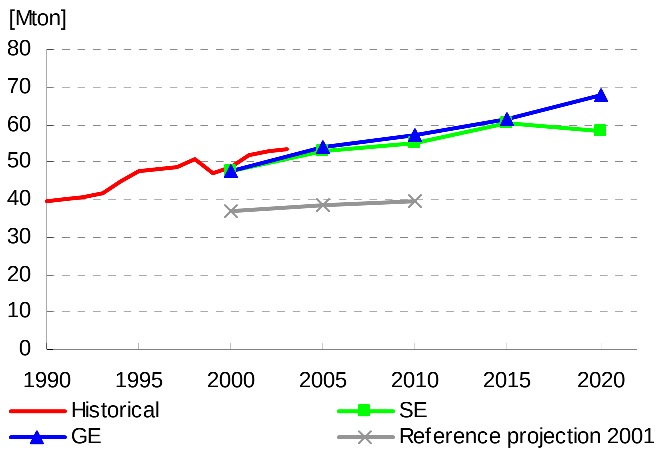

Figure 7.1.7 - CO_2 emissions electricity production, SE and GE

Effects of policy

Figure 7.1.8 shows the effect of policy on CO_2 emissions from total electricity production. Table 7.1.3 shows the differences between GE and the policy variants: the effects are relatively large in the GE scenario (taking the effects of policy on demand for electricity into account: see Chapter 10 for details).

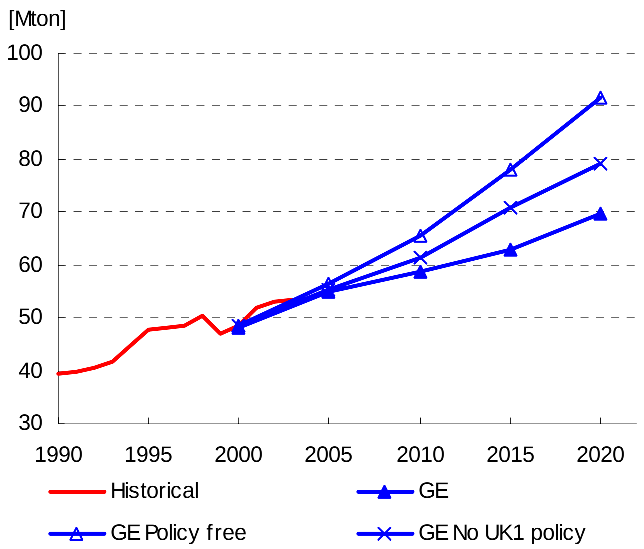

Figure 7.1.8 - CO_2 emissions electricity production , GE plus policy variants GE

Uncertain factors

The bandwidths for CO_2 emissions in the electricity industry are large, compared with those in most other sectors. The difference in emissions between SE and GE in 2020 gives a good indication of this. The uncertainties are greater for 2020 than for 2010.

Table 7.1.3 - Differences in CO_2 emissions from power generation: GE, effects of policy in Mton of CO_2

[Mton]	2000	2005	2010	2015	2020
GE no policy minus GE	0.3	1.8	6.6	15.4	22.1
GE no UK1 policy minus GE	0.3	0.5	2.6	8.2	9.5

Table 7.1.4 shows the main uncertain factors, indicating the bandwidth for CO_2 emissions from central power generation in 2010 and 2020 (the bandwidth is shown in relation to the figures in the SE scenario). The same factors are important in the GE scenario, but the bandwidths may be slightly different.

Table 7.1.4 - Uncertain factors and effect on CO_2 emissions of power plants, SE

[Mton]	2010		2020	
Direct emissions	40.9		40.2	
	Low	High	Low	High
Final demand elektricity	-0.8	1	-2.4	2.4
Import balance and price ratio with abroad	-2.5	3.7	-4.1	3.6
Coal plants: input and volume capacity	-3.0	0.0	-3.0	9.5
Emission trading and CO_2 price	negligible		-0.6	1.3
Relation between natural gas and coal price	-0.6	0.6	-0.7	1.0

Uncertainty about future CO_2 emissions is due mainly to the proportion of imports and the factors that affect this, and the use of coal-fired plants. Imports will be higher or lower depending particularly on trends in prices abroad compared with those in the Netherlands and interconnection capacity. Imports do not count towards Dutch emissions, so they have a more or less direct impact on emissions. The effects of changes in fuel prices and CO_2 prices could interact strongly with the ultimate proportions of imports.

Keeping the oldest coal-fired plants on stream until after 2020, or investing in new coal-fired plants between 2012 and 2020, has a major effect on emissions. Another decisive factor is the length of time they operate at full load, which is relatively high in SE, both in 2010 and in 2020 (7300 and 7800 hours respectively). In 2010 only time working at full load is relevant; in 2020 so are the other factors. The amount of coal used depends partly on the CO_2 price and fuel prices (natural gas versus coal).

The final demand for electricity is strongly correlated to economic growth and demographic trends. The demand for electricity in the WLO scenario with the lowest economic growth (the Regional Communities or RC scenario, see Paragraph 3.1) is taken as the lower limit for SE, with GE as the upper limit.

The resulting price for CO_2 emission rights has a major influence on the use of fossil fuel power plants and investments in certain types of new plant. With CO_2 at € 11 per ton, the effect on consumption is relatively small. At a CO_2 price of over € 30 per ton the variable costs of the old pulverised-coal plants would be too high. For 2010 a bandwidth of € 2-14 per ton is assumed, €2-20 per ton for 2020.

In both SE and GE the price of natural gas goes up substantially compared with that of coal, causing the use of coal-fired plants to rise (see also Figure 7.1.5). Prices of gas from 2010 to 2020 are assumed to be 0.15 eurocents per cubic metre higher/lower respectively so as to arrive at a bandwidth. These price changes affect both the use of gas versus coal-fired plants and competitiveness with foreign countries. A higher gas price would increase the attractiveness of both imports (relatively lower emissions) and the use of Dutch coal-fired plants (relatively higher emissions).

There can be a combination of uncertain factors, e.g. if a low gas price coincides with a much higher CO_2 price. This would result in less use of Dutch coal-fired plants (and therefore lower emissions) but also lower imports from Germany, consisting mainly of electricity from lignite plants. In this case more production would take place in the Netherlands (resulting in higher emissions for the Netherlands).

Sections 7.2 and 7.3 set out the uncertain factors for CHP and renewable sources.

7.2 Cogeneration

CHP capacity comprises industrial CHP, large-scale district heating and heat distribution units and small-scale CHP, e.g. in horticulture and the health service. The total gas-fired CHP capacity in 2003 was 7600 MW_e, which generated a total of over 37 TWh of electricity. In industry the chemical industry is by far the largest CHP sector, with just under 2500 MW_e.

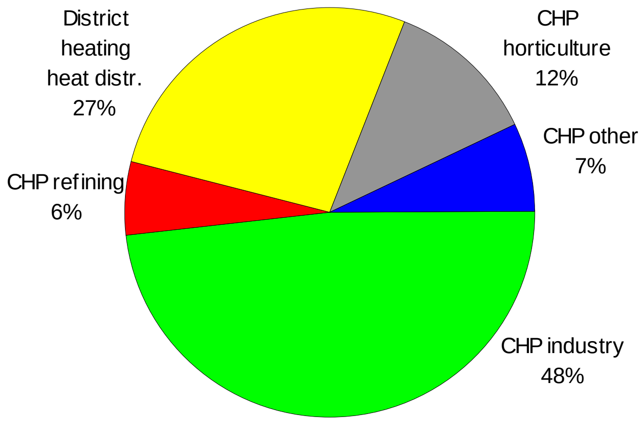

Figure 7.2.1 - Composition of cogeneration capacity according to sector [% installed capacity]

In terms of installed load, the combined cycle is the dominant technology, with 4700 MW_e, but in terms of numbers of plants the gas engine dominates, with over 340 plants (compared to over 50 combined cycles).The sharp growth in cogeneration (CHP) seen in the 1990s has come to a halt in recent years. Uncertainty as to whether CHP would be financially viable in a liberalized electricity market has made a lot of investors cautious.

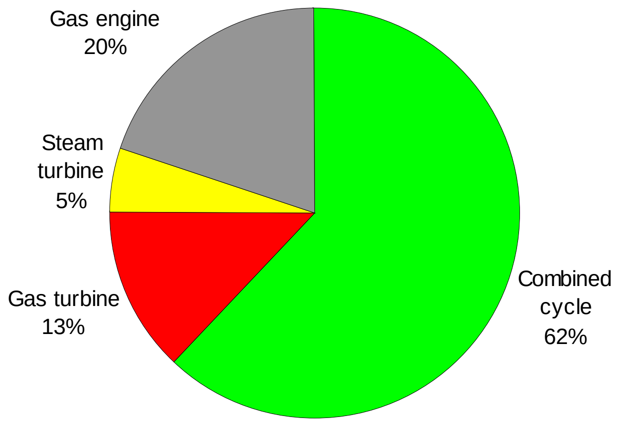

Figure 7.2.2 - Composition of cogeneration capacity, according to type of technology [% installed capacity]

The few new CHP projects are largely confined to the chemical industry and horticulture. A striking newcomer is the Rijnmond plant, which was taken into operation in 2004. This plant has a very large capacity of 800 MW_e and also supplies a small amount of steam to the nearby chemical industry. From the point of view of energy saving this is not the ideal solution.

CHP remains a particularly attractive option in horticulture using artificial lighting, as it has the advantage that producers use the electricity themselves.

For CHP the liberalization of the electricity market caused the system of fixed prices for power supplied to the grid has had to give way to one where generated power is sold at the current market price.

The relatively low price of electricity in the off-peak periods combined with the high price of gas affected the profits of many of CHP systems, resulting in the electricity companies cutting back sharply on their gas engines and postponing expensive overhauls of many plants, among other things. Wherever possible CHP operating hours have been reduced and the demand for heat/steam is being supplied by boilers.

Market trends

Prices on the electricity market will increasingly determine how CHP is used, and it will become more and more important to be able to respond flexibly to price changes. On balance the trend in gas and electricity prices in the SE scenario is favourable to CHP, owing mainly to the higher price of off-peak electricity (see 5.2). The off-peak rate rises in the GE scenario too, but less than in the SE scenario.

Policy developments

With the introduction of the MEP scheme, operating subsidies for CHP are based on a plant's CO_2 performance. Under the European environmental aid guidelines the aid may not cover more than 50% of the financial gap. Also, if the market conditions for CHP improve, the subsidy could be reduced, possibly even to zero. As a rule, then, the scheme does not make the average investment profitable. The amount of MEP aid, however, is based on the profitability of a typical system; new CHP projects that differ sufficiently, and in the right direction, from this average profitability could therefore cover their costs.

In future, trade in CO_2 emissions could also give rise to new investments in CHP if the market price of CO_2 is high enough and passed on sufficiently in the price of electricity. Until 2020 trade in emissions will have a relatively limited effect. Existing schemes for CHP such as the EIA (Energy Investment Deduction) and the energy tax exemption (on gas and electricity) will remain in force. The tax allowance for own consumption of CHP electricity is offset against income from the MEP scheme. The use of CHP will be affected by the European CHP Directive of February 2004, which is designed to harmonize methods for assessing the quality of CHP. In effect it fleshes out previous directives that obliged Member States to examine the economic feasibility of CHP in new build projects in industry and utility building.

Results

Capacity and electricity output

Figs. 7.2.3 and 7.2.4 outline the development of CHP in the scenarios. In both the SE and the GE scenario, installed CHP capacity increases until 2020 and electricity output from CHP rises accordingly. The way CHP is classified is based on CBS, but this declines in importance in view of sectoral developments. The new Rijnmond and Sloe plants are classified as Central CHP. New CHP in industry and refining falls mainly under the heading of Joint Ventures, because of the need to involve electricity companies in selling the power.

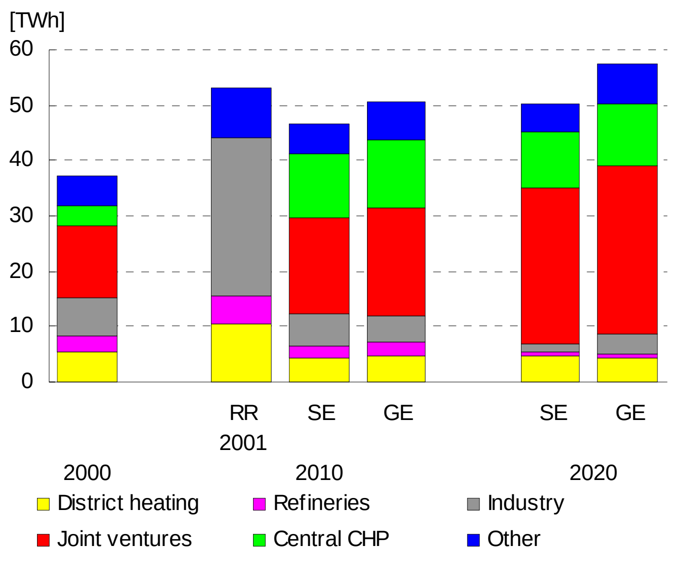

Figure 7.2.3 - Development of CHP electricity production

Compared with the previous projection the output of electricity is lower and the capacity somewhat higher: this is due to the change in operation, with less power being produced during off-peak periods in particular. In the previous projection joint ventures were classified under Industry. About two-thirds of electricity output from CHP in industry is produced by joint ventures, the remainder by companies' own CHP systems. The growth of CHP electricity over the 2000-2020 period is about +40%, the largest growth taking place in the chemical industry.

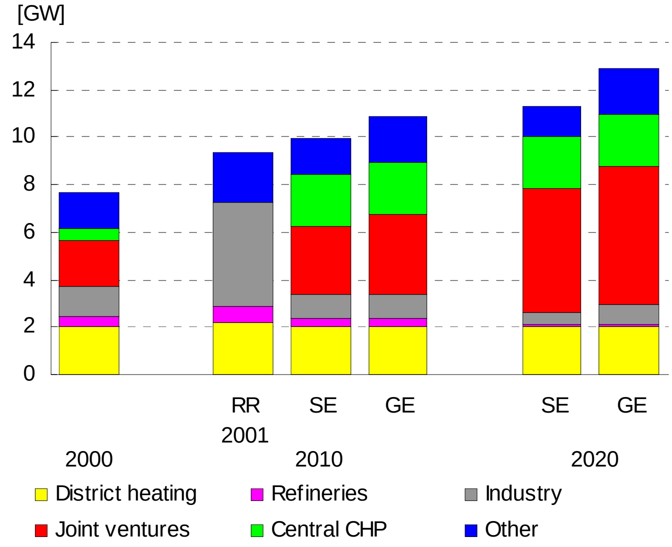

Figure 7.2.4 - Development of CHP capacity

In the refining industry, installed CHP capacity grows under both SE and GE, mainly as a result of the rejuvenation of CHP systems, with old plants with a high H/P ratio being decommissioned and replaced with combined cycles, which have an H/P ratio of about 1. In both the SE and the GE scenario, CHP capacity for district heating and large-scale heat distribution remains unchanged. The pattern as regards other customers (the greenhouse and service sectors) is more varied: in the GE scenario there is still growth, particularly in the greenhouse sector, as against a slight decline in SE owing to much lower growth in horticulture using artificial light in that scenario. Compared with the previous Reference Projection, electricity output from CHP in 2010 is slightly higher in both scenarios.

Meeting the demand for heat and steam

The growth in CHP capacity in industry is due partly to rising industrial demand for steam and partly to slightly more efficient ways of meeting that demand. In the GE scenario the first effect is somewhat more prominent, whereas in the SE scenario it is the second one, as a result of the slightly better off-peak rate. The final demand for steam in the refining industry rises. There is also an increase, however, in production processes that produce steam, e.g. hydrogen production and desulphurisation, so the demand for steam that can be met by CHP goes down. As a consequence the coverage of CHP falls considerably. The great potential of CHP to meet firing demand, e.g. for heating crude oil in refining and cracking naphtha, remains virtually unused in both scenarios: implementing this option would effectively require the building of whole new plants. Neither of the scenarios envisages large-scale district heating and heat distribution projects. The output of heat from small-scale CHP in the greenhouse and service sectors falls in absolute terms in the SE scenario, owing mainly to lower demand for heat in these sectors. In the GE scenario the heat output from CHP in the greenhouse sector rises as a result of using CHP for cultivation using artificial light. The coverage of small-scale CHP thus rises on balance in GE.

Energy saving and reduction in CO_2 emissions

The energy saving and reduction in CO_2 emissions due to CHP is highly dependent on the reference system selected. If the average efficiency of power generation (in 2020) is taken as the reference, differences between the generating industry in SE (dominated by combined cycles) and GE (a combination of coal-fired plants burning biomass separately and much sharper growth in wind power than in SE) play a major role. As the proportion of sustainable energy in overall electricity production grows, the reduction in CO_2 due to CHP is eroded, as the average emission factor of the reference system goes down.

Effects of climate policy

Climate policy has both a direct and an indirect effect on CHP. The direct effect is due to specific measures to promote investment in and operation of CHP. The indirect effect is due mainly to the way the available CHP potential is used. Without climate policy the saving on final demand for steam in industry is lower, for instance. As this ultimately increases the CHP potential, the net impact of climate policy is smaller than one would expect based only on direct effects. For the effects of policy see 10.3.

Uncertain factors

The CHP results are highly dependent on how the demand for heat and steam develops, and thus indirectly on economic growth in particular sectors. Investments in and use of CHP are determined mainly by how competitive it is in relation to other generating capacity, and this in turn is determined by developments-to some extent uncertain-in natural gas and electricity prices.

On top of the above factors, the rate at which existing CHP systems are replaced also produces a certain degree of uncertainty. Old systems generally have a much higher heat-to-power (H/P) ratio than new ones, so replacing old capacity with new capacity results in sharp growth in generating capacity and therefore output, while steam output remains the same or rises only slightly. If the replacement of old systems is postponed in practice, capacity and power output are overestimated.

Table 7.2.1 - Uncertain factors for cogeneration, expressed in Mton CO_2

[Mton]	2010		2020	
	Low	High	Low	High
Development of heat/steam demand	-2.2	2.8	-4.5	6.5
Energy prices (incl. CO_2)	0.1	-0.1	0.3	-0.3
Replacement of existing cogeneration	0.0	0.9	0.0	2.6

7.3 Renewable energy

In 2003 renewable energy generated in the Netherlands accounted for 1.5% of the Dutch energy supply (CBS 2004). The proportion of imported electricity from renewable sources has increased rapidly since 2000 because of the sharp rise in demand for renewable electricity due to tax incentives. As a result, in 2003 renewable sources provided 127 PJ and 12% of electricity consumption was from such sources (including imports).

In 2003 the largest proportion, 62% (79 PJ), came from imported sustainable electricity. The biggest contribution to national production is from biomass and waste, which accounted for 26% (34 PJ) that year. After biomass and waste, wind power made an important contribution (8%, 11 PJ).The proportion accounted for by the other sustainable energy options, such as solar water heaters, photovoltaic solar power (PV) and heat pumps is small (less than 3%, 3.2 PJ), but there was sharp growth in most of these between 1990 and 2000.

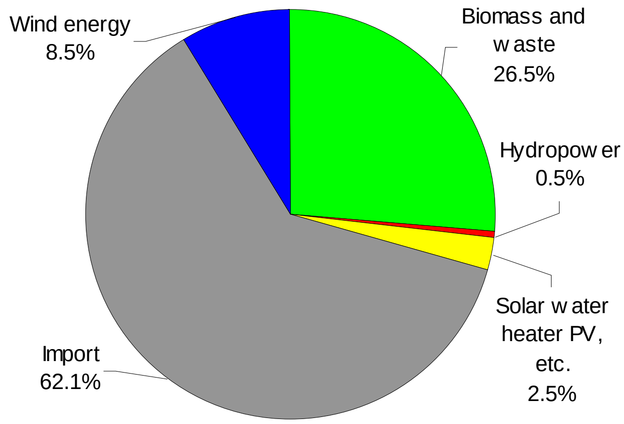

Figure 7.3.1 - Division of the renewable energy options over the various options in 2003 (avoided primary energy, total 127 PJ)

Especially PV has grown spectacularly in 2003: the contribution has more than tripled compared to 2000. In 2003, the installed capacity amounts to 46 MW_{peak}. This is mainly the result of favourable supporting measures in that period.

It is estimated that the total share of renewables in the year 2004 (the data of which will become available in the course of 2005) will have risen slightly, but drop again after that due to decreasing import of renewable electricity, which is no longer encouraged after 2004.

Policy developments

The Dutch government has set itself the target of increasing the proportion of renewable sources in the energy supply to 5% in 2010 and 10% in 2020. A European target for electricity consumption has been set, amounting to 9% in the case of the Netherlands in 2010. No EU target has yet been agreed for 2020.

There has been a major shift in Dutch policy to promote renewable electricity in recent years, from tax incentives on the demand side to a fixed output subsidy on the supply side. In 2000 the measures to promote renewable electricity consisted mainly of an exemption from REB (Regulating Energy Tax or ecotax) and a subsidy to producers from REB revenue (known as the 'REB transfer'). The REB exemption rose to 6.01 eurocents per kWh in 2002 and the REB transfer was 2.00 eurocents per kWh. Aid was also available under the CO_2 Reduction Scheme and three investment-related tax schemes, VAMIL (early depreciation on environmental investments), EIA (Energy Investment Deduction) and the Green Investment Scheme.

The market for renewable electricity was liberalized in 2001 and a system of tradable green certificates was introduced to verify, register and monitor renewable electricity. Green certificates could also be issued for imported sustainable electricity, making it eligible for tax concessions.

Because of the increasing use made of REB exemptions and transfers for imports of renewable electricity from existing plants and lack of national implementation, the REB scheme was drastically revised with effect from 2003. The REB transfer system was discontinued entirely and the exemption system gradually phased out. To take its place MEP subsidies were introduced (under the Environmental Quality of Electricity Production Act - see also 3.4). The VAMIL scheme was also abolished in 2003 and the green investment scheme cut back.

The changes in the incentive policy had a marked impact on the issue of green certificates for imported sustainable electricity. After the green certificates scheme came into effect (at the start of 2002) large numbers of these were issued for imported renewable electricity, but hardly any since the abolition of the REB scheme (Certiq 2005). The expectation is that once the remainder of the REB exemption scheme has been abolished, with effect from 2005, there will not be enough incentive to continue importing renewable electricity. Because of this and a number of other uncertain factors (see inset 'Imports of renewable electricity from neighbouring countries') these Reference Projections for the 2005-2020 period are based on the assumption that no renewably generated electricity will be imported from abroad.

The coal-fired power plants are covered by the 'Coal Covenant', which contains agreements on reducing CO_2 emissions by co-firing biomass, either mixed with coal or separately. This involves replacing 503 MW_e of coal-fired capacity, based on the current coal-fired power plants.

Import of renewable electricity from neighbouring countries

The Reference Projections assume that there will be a power link with Norway (where electricity is generated almost entirely using hydropower) from 2008. This will be beneficial to maintaining balance in the Dutch power grid for a number of reasons.

Firstly, it will enable better use to be made of Dutch capacity during off-peak periods (especially at night), as surplus power can be stored by pumping up water in Norway. During peak periods in the Netherlands imports via the power grid will help to maintain the grid balance. Secondly, the link with the Scandinavian grid will increase the scope for trading electricity, which could affect the wholesale price (see also 5.2).

The third aspect is the import of renewably generated electricity. Whether this will happen, and whether it will be possible at all administratively, remains to be seen. Electricity from large-scale hydroelectric plants does count towards the Dutch target, but there is no subsidy for it: the current MEP scheme applies only to plants in the Netherlands (guarantees of origin must be applied for in the Netherlands); furthermore, only small-scale hydroelectric plants (under 15 MW) are regarded as renewable for MEP purposes.

Whether electricity regarded as renewable will be imported in the long term is very uncertain. It is difficult to predict what the ratio between supply and demand and the prices paid on the wholesale markets will be. Use of the link will also not be free of charge: there will be transport losses and a transport charge will be levied. Whether net importing of electricity will be an attractive financial proposition will depend on potentially significant differences in wholesale prices (which will have to be larger than the transmission margin) in Norway and the Netherlands.

Apart from importing electricity physically, it can also be imported to the Netherlands purely on paper, using certificate trading. There will have to be strict rules and supervision, however, to ensure that the green value of Norwegian hydropower is not counted twice. The fact that Norway is not a member of the EU means that the mechanism cannot be taken for granted. Any flow of guarantees of origin to the Netherlands would depend, for instance, amendments to Norwegian legislation (transposing the EU Renewables Directive, 2001/77/EC, into Norwegian law, which is expected to take place in the very near future), the way the Commission interprets the Directive, and how any such new legislation is implemented in Norway.

These Reference Projections set imports of renewable electricity from Norway at 0 TWh. There is some exchange with Norway, but this is interpreted as storage of electricity as described in the 'Use of interconnectors' inset in 5.2, as electricity originally generated using fossil fuels is temporarily stored, with losses, in the form of potential energy and subsequently returns to the Netherlands. In line with the treatment of greenhouse gases, CO_2 is regarded as being emitted when this electricity is generated, whether or not it is exported. The fact that emission-free electricity subsequently returns has no significance-unless there is a certificated trading system-especially as the CO_2 associated with the imports is not shown in the books. Electricity from fossil fuels that has been 'greenwashed' in this way is thus not regarded as renewably generated electricity.

Whether there is an incentive for commercial operators to register and sell Norwegian hydropower as renewable energy in the Netherlands, then, is very uncertain, though it is quite possible, depending on the policy decisions made on trade in renewably generated electricity. In the Reference Projections it was decided not to draw any conclusions on this and to make a conservative estimate of 0 TWh in both the GE and the SE scenario.

Results

Green electricity

Since the liberalization of the market for renewably generated electricity (also known as 'green electricity') the number of customers has gone up sharply. In August 2001 there were about 650,000 consumers of renewably generated electricity; by mid-2004 the figure had risen to 2.8 million.

The number is not expected to grow any further; indeed it is likely to go down because of the abolition of demand incentives. The national supply is inadequate to supply every customer with renewable electricity, and importing it entails costs to the electricity companies that are offset by very little revenue. The expectation, then, is that providers will raise the price of renewable electricity above that of electricity of fossil origin and that the number of customers will decrease sharply.

The proportions of renewable energy in energy consumption and electricity production

Based on assumptions regarding the potential for development, cost trends and policies, conclusions are drawn on the expected proportions of national energy consumption and electricity production accounted for by renewable energy under the two scenarios, SE and GE.

The target, as mentioned above, for the proportion of renewable sources in the energy supply is 5% in 2010 and 10% in 2020. In this section examines whether they can be achieved in this period. The same is done for the specific target for power generation (9% of national electricity consumption in 2010).

The share of renewable energy generated nationally rises sharply in the Reference Projections, as can be seen from Figures. 7.3.2 (quantity of primary energy avoided) and 7.3.3 (quantity of CO_2 emissions avoided). The rise is particularly large between 2001 and 2003, owing to growth in import of renewable electricity (see also Figure 7.3.1).

As the quantity of imports falls sharply from 2004, the amount of renewable energy drops to about 64 PJ (less than 2% of total national consumption) in 2005 under both scenarios.

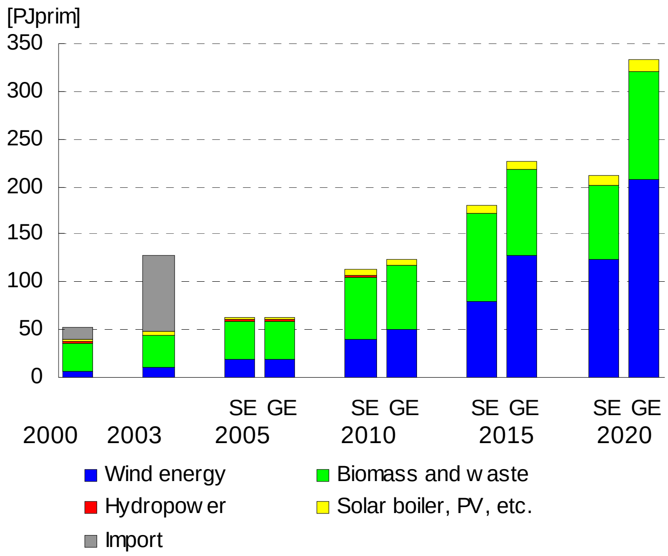

Figure 7.3.2 - Development of the share of renewable energy until 2020 (in conformity with definitions from the Renewable energy saving protocol)

No imports are found in Figure 7.3.3, as imported electricity does not count towards the CO_2 balance.

The proportions are 123 PJ (3.6%) and 112 PJ (3.4%) in 2010 in the GE and SE scenario respectively; in 2020 the proportion of renewable energy rises to 332 PJ (8.6%) and 212 PJ (6.0%) respectively.

In absolute terms the amount is fairly high in GE in 2020 - higher than the 288 PJ mentioned in the Third Energy White Paper (1995).

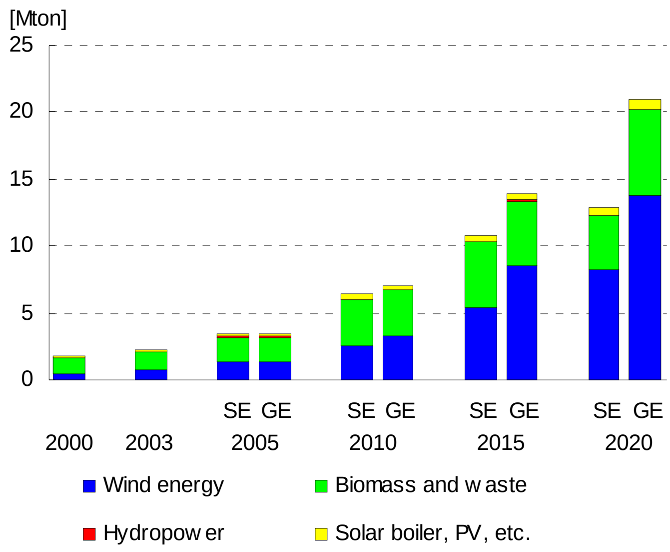

Figure 7.3.3 - Development of the amount of renewable energy until 2020, expressed as avoided CO_2 emission. Emission factors used amount to 66.2 kg CO_2/GJ for the electricity options and 56.1 kg CO_2/GJ for heat options

Biomass (in particular burned in coal-fired plants, either mixed with coal or separately) provides the biggest contribution until into 2010, after which this role is taken over by wind power. The situation for these two renewable sources will be outlined in more detail later on in this section.

By comparing the expected contribution of renewable energy with total national consumption (see also Figure. 1.1.1) we find the proportion of renewable energy. The results of this exercise are given in Table 7.3.1, which shows that the targets for both 2010 and 2020 will not be met according to the Reference Projections.

Table 7.3.1 - Share of renewable energy compared to total inland consumption

		2000	2003	2005	2010	2015	2020
Total Inland Consumption [PJ_{prim}]	Historical	3101	3249				
	GE			3244	3434	3646	3867
	SE			3216	3350	3473	3547
Renewable energy [PJ_{prim}]	Historical	52	127				
	GE			64	123	227	332
	SE			64	112	180	212
Target [%]					5.0		10.0
Share of renewables [%]	Historical	1.7	3.9				
	GE			2.0	3.6	6.2	8.6
	SE			2.0	3.4	5.2	6.0

As Figure 7.3.2 shows, these renewable electricity options account for about 95% of renewable energy generation in both scenarios (solar thermal energy, heat pumps and heat/cold storage, which are not electrical systems, together account for about 10 PJ_{prim}; see also Figure. 7.3.9).

In 2003 about 13 TWh of electricity came from renewable sources (including 9.5 TWh from imports). Because of reduced imports the amount is expected to fall to about 6 TWh in 2005, after which it will rise again to 12 TWh (GE) or 11 TWh (SE) in 2010; by 2020 it will have risen still further to 37 TWh or 23 TWh respectively.

For 2010, then, the proportion of final national electricity consumption accounted for by renewable electricity in both scenarios is above target: 9.6% in GE and 9.1% in SE. Based on the electricity consumption in the two scenarios, the shares of electricity consumption accounted for by renewably generated electricity in 2020 would be 24% in GE and 16% in SE. This is shown in graphical form in Figure 7.3.4 and in figures in Table 7.3.2.

Table 7.3.2 - Share of renewable energy compared to final inland electricity consumption (both in TWh electricity)

		2000	2003	2005	2010	2015	2020
Inland electricity consumption [TWh]	Historical	105	110				
	GE			114	130	143	157
	SE			112	122	131	139
Renewable energy [TWh]	Historical	4	13				
	GE			6	12	25	37
	SE			6	11	19	23
Target [%]					9.0		
Share renewables [%]	Historical	4.0	12.0				
	GE			5.1	9.6	17.2	23.6
	SE			5.1	9.1	14.6	16.3

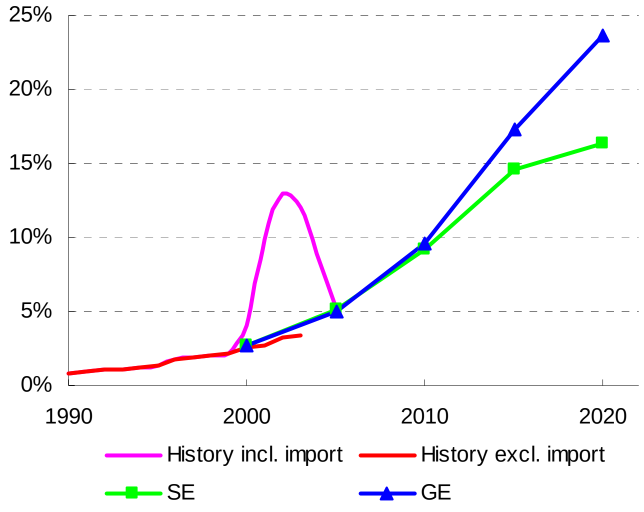

Figure 7.3.4 - Shares of the production of renewable energy in final inland electricity consumption

Wind power

The Reference Projections divide wind power into two types, i.e. onshore and offshore. At the end of 2003 the installed capacity was 884 MW, twice the amount in 2000. As regards onshore wind power, the Netherlands passed the 1,000 MW barrier in 2004, so growth continues. As for offshore wind power, the installed capacity today is still zero, apart from two wind farms in the IJsselmeer (together supplying 19 MW). Future offshore wind farms will be located in the North Sea, away from the coast and with sizes upwards of 100 MW. The Reference Projections assume that offshore wind power will develop from 2006 onwards.

In the two reference scenarios, installed onshore wind power increases, but more in GE than SE: in the latter there is relatively substantial opposition to onshore wind power, making it difficult to obtain planning permission and reducing the growth rate, so that ultimately the maximum amount of onshore wind power that can be installed is lower than in GE.

In the SE scenario the main problem is replacing the old smaller turbines with new higher-capacity ones, because of the high building height, which makes it difficult to obtain planning permission. The amount of onshore wind power still rises substantially even in this scenario: current capacity is estimated to double to 2000 MW in 2020, compared to 3000 MW in the GE scenario (see Figure 7.3.5).The growth pattern is the same for offshore wind power. In the first phase (where the first farms are built in the North Sea) it is more or less constant. The 6000 MW target is ultimately met in the GE scenario, but penetration is a good deal lower in the SE scenario, 3500 MW in 2020. This is due mainly to arguments concerning planning permission, which also clearly tie in with ideas on using the North Sea for various purposes, plus the problems of incorporating the wind farms in the grid (see Figure 7.3.6).

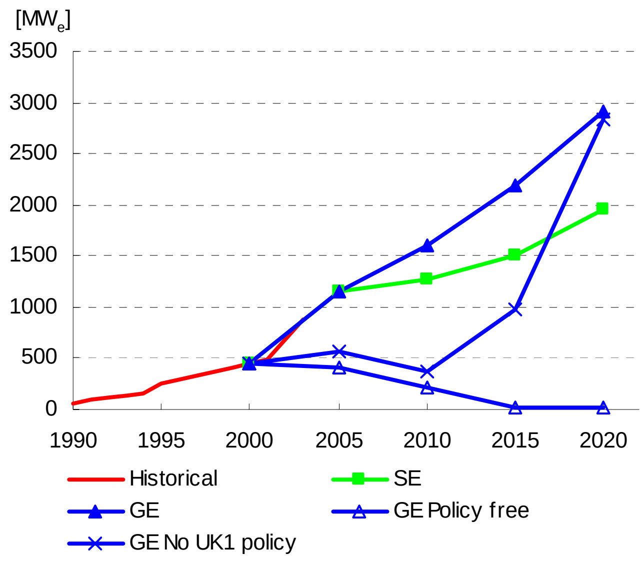

Figure 7.3.5 - The projected capacity of onshore wind for the two scenarios and the policy variants of GE

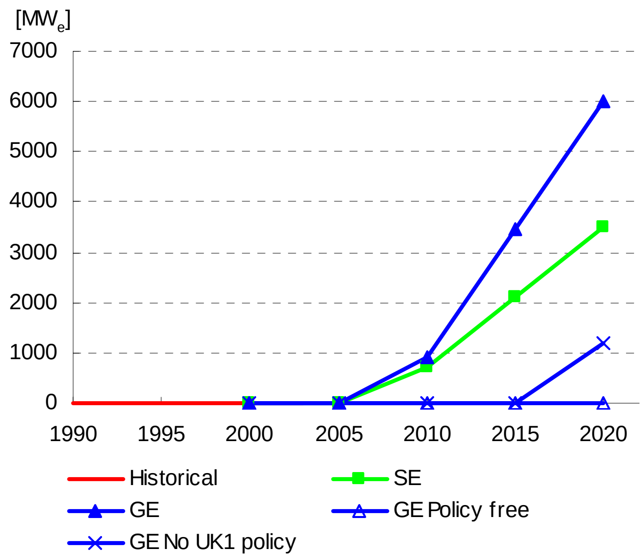

Figure 7.3.6 - The projected capacity of offshore wind for the two scenarios and the policy variants of GE

In the no-policy variant the MEP, EIA and green investment schemes are abolished after 2000, with the result that the building of both onshore and offshore wind farms is halted completely. As the wind turbines do not all reach the end of their lifespan at the same time, the installed capacity of onshore wind power decreases only gradually: in the no-policy variant all wind turbines will have disappeared by 2015. Offshore wind power remains completely absent in this variant.

In the variant without Climate Policy 1 the EIA and green investment schemes remain in force but the REB returns to take the place of the MEP scheme: this is set at the same level as in 2000, viz. 5.33 €ct/kWh (based on an REB of 3.72 €ct/kWh and a producer subsidy of 1.61 €ct/kWh). As public support for the development of wind power remains in the GE scenario, the amount of onshore wind power will continue to grow slowly, even if this method of electricity generation is not competitive under the assumed policy. Market growth in the other European countries is also assumed to be lower, so the investment cost is not likely to come down so quickly. The proportion of onshore wind power without Climate Policy 1 will go up again starting in 2010, as will the proportion of offshore wind from 2015. Growth in onshore wind is assumed to be so rapid that the installed capacity could be the same in ten years' time compared to the GE scenario; this is not possible with offshore wind, however, where the installed capacity totals 1200 MW in 2020.

Assumptions on the cost of wind power

The future cost of the technologies expected to play a substantial role will depend on various developments. Worldwide interest in using wind power will have a major influence, for instance: if it grows as it has in recent years the cost will continue to go down correspondingly. As wind power is an important technology for national generation, Figure 7.3.7 shows the costs of generation.

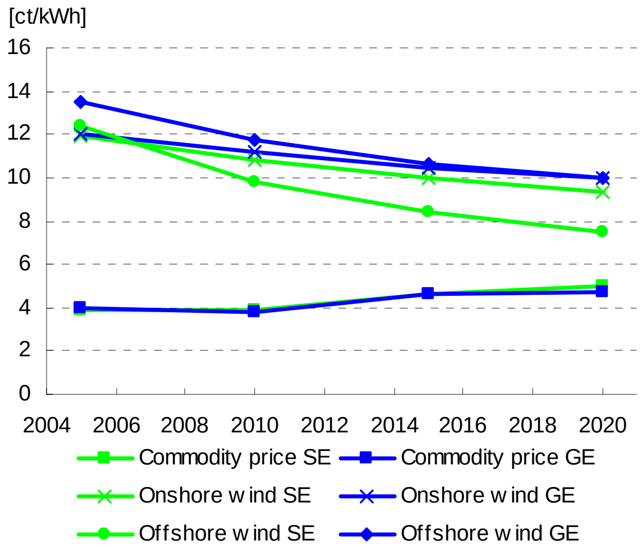

Figure 7.3.7 - Development of the production costs of electricity from wind energy and the commodity price of electricity

While the commodity price goes up in both scenarios, a marked cost reduction is found in both GE and SE. As the assumptions of cost reduction are more advantageous in the SE scenario than the GE scenario, the resulting generation costs are lower in SE than in GE. The figures for onshore wind power are based on an investment cost of € 1150 per kW in 2003. This will go down over time, based on assumptions on the progress ratio (PR), which is assumed to be 0.92 up to 2020 in the GE scenario and 0.90 in SE. Worldwide market growth during the period to 2020 is assumed to be about 15% annually in both scenarios. These assumptions result in a rapid reduction in the cost of onshore wind power over time, but they depend partly on worldwide interest in wind power: if this interest tails off, the cost reduction will be less rapid. The same applies to offshore wind power, where the PR figures are otherwise the same as in the case of onshore wind. The investment cost is assumed to be very high (€ 2600 per kW in 2000) to take account of the need to develop relatively difficult (distant and deep) offshore sites.

The assumed growth is high: worldwide growth to 2020 is set at 26% annually in GE and 37% in SE. These high growth rates are due to the fact that offshore wind is a small market with many projects planned for the next fifteen years: not just the odd turbine here and there but farms ranging from 100 to 500 MW-sharp growth in big steps. These assumptions result in low generation costs for offshore wind in particular.

Biomass

In the GE scenario the installed capacity of biomass options in 2020 is over 2000 MW. In the SE scenario the installed capacity of biomass options in 2020 is 1400 MW (see Figure 7.3.8). In the SE scenario the capacity of biomass burned with coal declines after 2015 as a result of the decommissioning of two coal-fired power plants (Gelderland 13 en Amer 8): by 2020 there will be some 2900 MW of coal-fired capacity remaining.

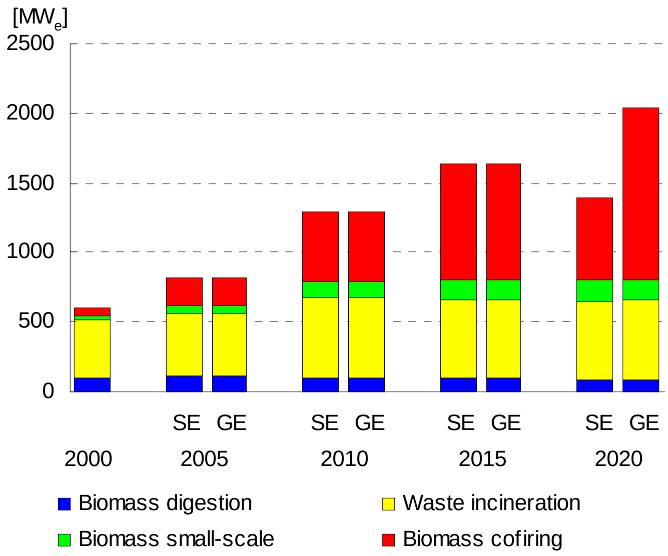

Figure 7.3.8 - Capacity of electricity generation capacity with biomass, both for GE and for SE

Co-firing biomass with coal is considered to be feasible up to about 20% of capacity. In the GE scenario new coal-fired plants are built, thus increasing the scope for firing biomass: by 2020 there will be some 6200 MW of coal-fired capacity. Given the large scope this offers for firing biomass mixed with coal, the expectation is that the more expensive approach of firing it separately in coal-fired plants (separate gasification) will not be developed, either in the GE or the SE scenario. Separate plants for gasifying biomass will not get off the ground for the same reason.

The amount of waste produced in the Netherlands does not increase significantly in either scenario. In the period up to 2020 waste prevention and recycling will offset the increase in economic growth, with the result that the proportion of waste assigned to power generation or landfill will not go up. Apart from a small increase in generating capacity into 2006 (based on already published plans), the number of waste incineration plants is thus not expected to rise in either scenario. Nor is any major increase in small-scale biomass plants expected, mainly because of the relatively large financial gap not covered by the MEP scheme.

Solar thermal energy, PV, heat pumps and heat/cold storage

The total contribution made by solar thermal energy, PV, heat pumps and heat/cold storage to avoidance of primary consumption gradually rises from 3.2 PJ in 2003 to over 5 PJ in 2010 and 10 PJ in 2020 (see Figure 7.3.9). Policy only provides incentives for the domestic use of solar water heaters and heat pumps. There were about 50,000 solar water heaters in domestic use in 2000.

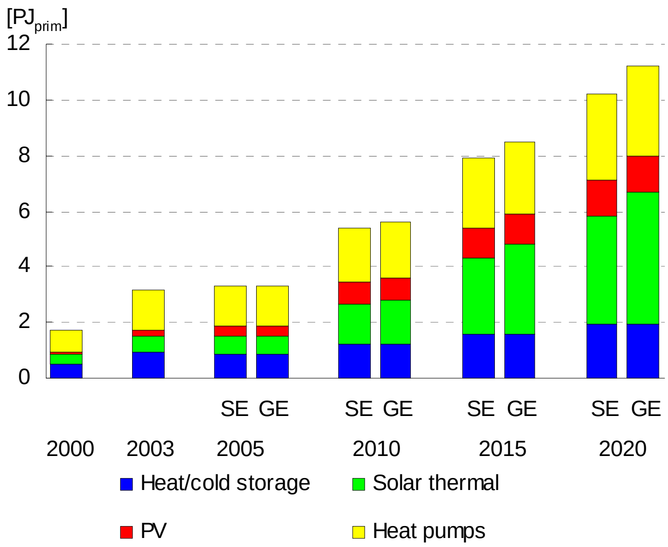

Figure 7.3.9 - Contribution of solar thermal, PV, heat pumps and heat/cold storage

There are also larger systems in multiple-family homes and for heating swimming pools. During the 1999-2001 period the number of solar water heaters rose by 8,000 a year, half of them in new housing, about 5% of houses.

Both scenarios proceed from the assumption that this proportion of new housing will rise to 35% after 2010 as a result of the tightening-up of the EPC (Energy Performance Coefficient) to 0.8. The rate at which solar water heaters are installed in existing homes halves after 2005 as a result of the ending of the EPR (Energy Premium Scheme).

The saving on natural gas from solar thermal systems rises from 0.6 PJ in 2003 to 3.8 PJ in SE and 4.7 PJ in GE in 2020. Both scenarios proceed from the assumption that the proportion of heat pumps will also rise to 6% after 2010 as a result of the tightening-up of the EPC to 0.8. The installed PV capacity grows from 46 MW peak in 2003 to 200 MW peak in 2020 in both scenarios. The estimated amount of PV is low (half the installation rate in 2003) as current policy provides hardly any incentive to invest in this technology.

Cost of MEP

Renewable electricity is eligible for subsidy under the MEP scheme. The amount of aid is based on the financial gaps for the various technologies. In the SE scenario the annual cost of the MEP scheme is much lower than in the GE scenario, partly because of the smaller financial gap but mainly because of the much lower output of renewable electricity in SE.

It is mainly the development of offshore wind power in the GE scenario that results in a substantial increase in the MEP budget. The amounts spent on MEP subsidies depend largely on the assumptions made: the Reference Projections, for instance, assume substantial growth in worldwide installed wind power capacity, combined with strong learning effects, resulting in the cost of onshore wind, and especially offshore wind, going down relatively rapidly. Figure 7.3.10 shows the estimated spending on MEP.

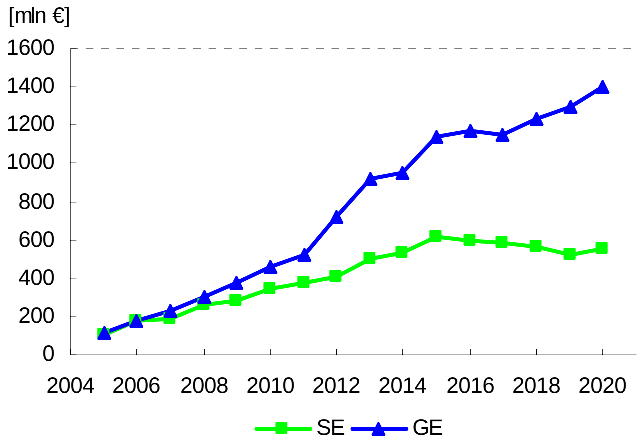

Figure 7.3.10 - Total MEP expenditure annually for renewable electricity

Effects of climate policy

Under the policy variant ‘no new climate policy after Climate Policy Implementation Paper (UK1)’ offshore wind power takes longer to get off the ground, because the REB exemptions and producer subsidies provide less of an incentive than the MEP (5.33 eurocents per kWh). The cost also goes down somewhat more slowly, as worldwide market growth is assumed to be less rapid. Onshore wind power is developed later, after 2010, for the same reason. Burning of biomass remains the same as in the original GE scenario, as the coal-fired capacity remains the same and the financial gap is covered by the REB. Under this policy variant, then, the amount of offshore wind power in particular is reduced considerably.

Table 7.3.3 - Policy effects for renewable energy in primary savings

[PJ$_{prim}$]	SE				GE			
	2005	2010	2015	2020	2005	2010	2015	2020
Avoided primary through renewables	63.8	112.3	180.1	211.6	63.9	123.3	227.3	332.5
Effect total policy as of 2000	62.1	109.6	176.7	208.0	62.2	120.9	224.0	330.1
of which UK1 policy	62.1	109.6	176.7	208.0	62.2	120.9	224.0	330.1

Table 7.3.4 - Policy effects for renewable energy in avoided CO_2 emission. Used emission factors amount to 66.2 kg CO_2/GJ for electricity options and 56.1 kg CO_2/GJ for heat options

[Mton]	SE				GE			
	2005	2010	2015	2020	2005	2010	2015	2020
Avoided primary through renewable:	3.4	6.4	10.8	12.9	3.4	7.1	14.0	20.9
Effect total policy as of 2000	1.7	4.9	9.5	11.6	1.8	5.6	12.7	19.7
of which UK1 policy	0.7	2.1	1.8	0.4	0.7	3.0	7.4	8.8

Uncertain factors

The outcomes of the scenarios mentioned in this section are based on numerous assumptions about factors that have an uncertain future. Table 7.3.5 quantifies the uncertainty for three generating technologies by making assumptions about installed capacity and length of operation.

Table 7.3.5 - Uncertainties in several generation options of renewable electricity (Mton CO_2)

[Mton]	2010		2020	
	Low	High	Low	High
The uncertainty regarding onshore wind capacity is -5% to +25% in the year 2010 and -5% to +20% for the year 2020. The uncertainty regarding operating hours is -5% to +20% in the year 2010 and -10% to +5% in the year 2020.	-0.2	0.2	-1.5	1.2
The uncertainty regarding offshore wind capacity is -10% to +10% in the year 2010 and -25% to +20% in the year 2020. The uncertainty regarding operating hours is -10% to +5% in the year 2010 and in 2010.	-0.2	0.4	-0.3	0.6
The uncertainty regaring biomass co-combustion capacity is -5% to +20% and the uncertainty regarding operating hours is -10% to +5% both in 2010 and in 2020. Moreover, if the share of co-combustion decreases then the share of coal will increase, as a result of which the amount of Mton CO_2 will increase.	1.4	-1.9	1.6	-0.8

7.4 Refineries

The Dutch refineries-owing partly to the presence of major rivers and the Port of Rotterdam-have a capacity far in excess of Dutch oil consumption. Important factors, besides national consumption, are sales to the German market and bunkering of heavy residues by ocean-going vessels.

Trends in output and capacity

Major changes took place between 1990 and 2000. One refinery was closed, another was started up again, the product mix shifted towards lighter oil products, the requirements that oil products have to meet were tightened up and substantial measures were taken to reduce emissions of CO_2 and harmful substances.

The refining industry worked at maximum throughput during the 1995-98 period. The subsequent decline was due mainly to maintenance and shutdowns for conversion and technical modifications. Intermediate products were increasingly purchased to maintain throughput in the other parts of the refineries while the work was going on. During the 2001-2003 period a large amount of money was invested in desulphurisation in particular, so as to meet the strict limits on sulphur content of petrol and diesel that were about to be introduced.

Policy developments

Strict limits on the sulphur content of petrol and diesel (50 ppm) took effect on 1 January 2005 throughout the EU. The limit for diesel used other than as a fuel for road vehicles is to be lowered from 2000 ppm to 1000 ppm in 2008. The limits on the benzene content of petrol and the aromatics content of diesel are also being tightened up constantly: Directive 98/70/EC on the quality of petrol and diesel fuel was amended again on 3 March 2003 (EU, 2003), essentially requiring both diesel and petrol with 10 ppm of sulphur to be widely on sale by 2005 and all petrol and diesel to meet this standard by 2009. The refineries are currently set up to supply ‘2009’ fuels (which are already on sale in Germany).

As regards the sulphur content of bunker oil, the assumption is that the sulphur content of a proportion of bunker oil sold will be lowered (from 2% to 1.5%) between 2005 and 2020 so as to meet European Union requirements and in line with a decision by the International Maritime Organisation on lower sulphur content for bunker oil in the Baltic and the North Sea (IMO, 2003). More hydrogen is needed if oil products are to be further desulphurised; this also involves additional process stages (including heating and gas compression), and in a few cases more energy is required to bring other properties (e.g. the octane number of petrol) back up to standard.

The refineries signed the Benchmarking Covenant a few years ago, but this has now been ‘overtaken’ by the CO_2 emissions trading system. This is not expected to result in noticeable differences until after 2010 (1-2% additional saving in 2020). As there is major expansion in GE and the oil price is higher, the saving here is greater than in SE.

Results

Net throughput

The investments have had a substantial effect on the refineries’ throughput in recent years. In the previous projection it was decided to take the change in national demand as an indicator of growth in refining industry throughput. Following discussions with the industry, among other things, the assumption is now that the refineries will not have any major expansion plans until 2010. This reduces the growth in throughput compared with the 2001 Reference Projection (see Figure 7.4.1).

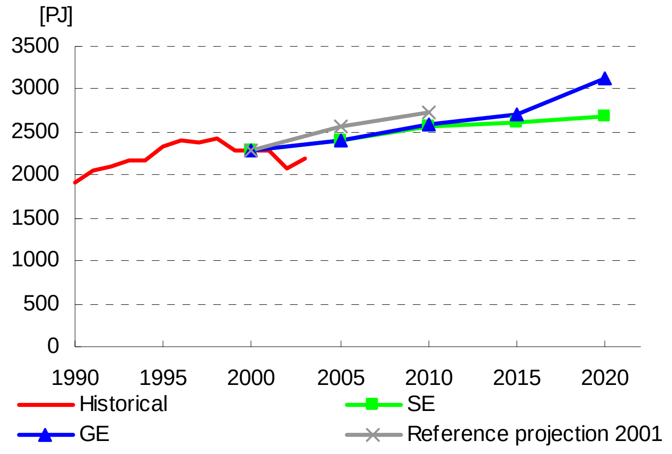

Figure 7.4.1 - Net throughput in the period 1983-2020, historical and for the RR2001, SE and GE

An important point here is that recent modifications to the statistics reduce the refineries’ throughput by about 180 PJ due to a shift towards organic chemistry in the historical period up to and including 1998. Figs. 7.4.2 and 7.4.4 show the growth factors in the 2001 Reference Projection on the same basis as GE and SE, so as to make the difference in relative terms clear.

In SE throughput gradually rises as a result of modifications to existing refineries. In GE there is substantial investment in expansion between 2015 and 2020.The net throughput in Figure 7.4.1 is based on gross output adjusted for raw materials bought in and own consumption of oil products and residual gases as fuel by the refineries themselves. Gross throughput falls far less than net throughput as a result of the increasing share of semi-manufactures purchased

Product mix

Shifts in the product mix can have major effects on the industry's energy consumption.

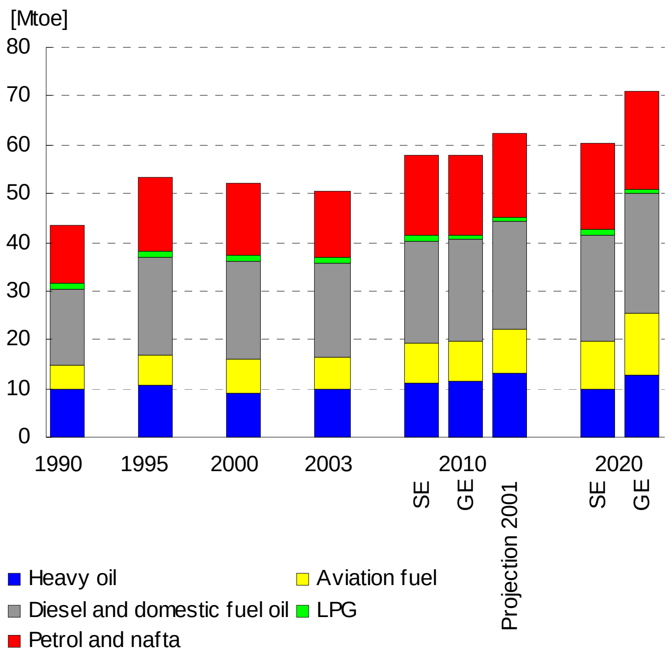

Figure 7.4.2 - Product mix in a number of reference years and reference projection 2001

Important shifts in product mix assumed here (see Figure 7.4.2) are:

- An increase in sales of diesel for road haulage
- A decline in exports of domestic fuel oil as a result of more use of natural gas and home insulation
- A substantial rise in aviation fuel as a result of growth in air traffic and the resulting increase in bunkering
- A stabilization/decline in petrol as a result of a decreasing share of petrol and more economic cars, as a result of the ACEA Covenant, among other things (ACEA = *Association des Constructeurs Européens d'Automobiles*)
- An increase in naphtha for the manufacture of plastics
- A relative decline in national output of heavy fuel oil and an increase in bunker oil; the increase in demand for the latter is met partly by imports.
- An increase in use of biofuels on the European market in both scenarios

Fuel consumption

The refining industry uses four fuels, heavy fuel oil, refinery gas, residual gas (from the cracking plants, flexicoker etc.) and natural gas. Use of heavy fuel oil is reduced as a result of environmental limits; some is still used in gasification plants to produce hydrogen and drive a CHP system.

The previous Reference Projection proceeded from the assumption that CHP would be controlled by the refineries instead of the power sector. The current projections assume an increasing role for joint ventures, which means that the industry will purchase electricity and heat, resulting in a reduction in own consumption. The industry's fuel consumption depends on such things as throughput, product mix, product requirements and the types of crude oil processed.

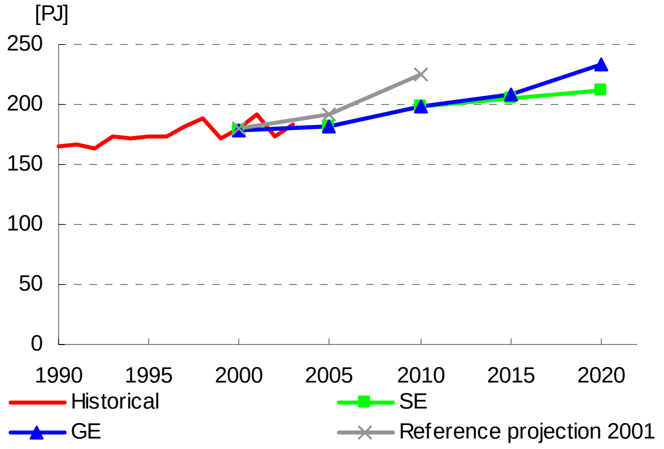

Figure 7.4.3 - Own energetic consumption of refineries

Because of increasing desulphurisation the refineries are expected to need more hydrogen than the amount produced as a by-product of the refining process, and the importance of the regional hydrogen market and the associated gas network will increase accordingly.

Own energy consumption by the refineries went up slightly between 1990 and 2000, but with dips in some years (such as 1992 and 1999). Both scenarios see slight growth after 2000, with own consumption again exceeding 200 PJ around 2010. The difference from the 2001 Reference Projection is due mainly to lower throughput and a smaller amount of electricity supplied but it is in turn reduced by the stricter standards for vehicle fuels.

CO_2 emissions

CO_2 emissions from the refining industry have fluctuated around 12 Mton for the last few years. In the scenarios they rise to 13 Mton in 2010 and 14 (SE) to 16 (GE) Mton in 2020. Economy measures are not enough to make up for increasing throughput and stricter environmental limits. CO_2 emissions in 2010 are lower than in the previous Reference Projection, and this is due only partly to lower throughput.

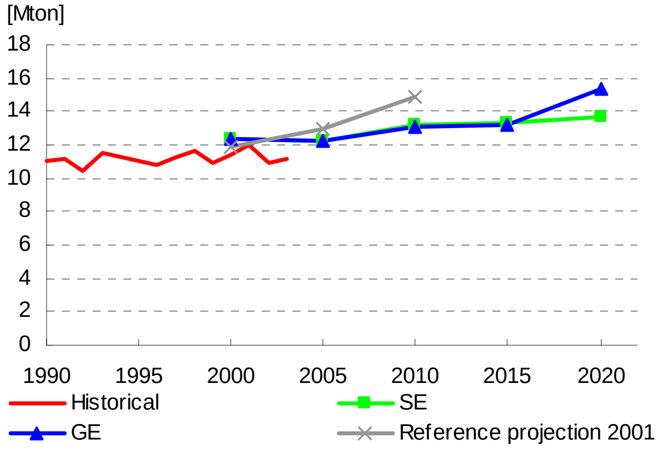

Figure 7.4.4 - CO_2 emission in the scenarios

Stricter quality standards for products are also assumed, compared with the previous Reference Projection. Changes in product mix and the types of crude oil processed also play a major role here (see also 'Uncertain factors').

Effects of policy

Energy is a major cost item in the industry, and the Dutch refining industry has already achieved high efficiency as a result. A good deal of the targets have been met under the Long-term Energy Efficiency Agreement LTA 1. Annual improvements in efficiency will gradually become smaller. Two variants have been developed to assess the effects of policy: the 'no new climate policy after Climate Policy Implementation Memorandum (UK1)' variant assumes no trade in emissions and less financial incentive from the EIA.

On top of autonomous saving, the Benchmarking Covenant has an additional effect (approx. a 1% additional saving in 2010). If the ACEA Covenant is counted as part of Climate Policy Implementation Paper (UK1), this variant would come just under the 'GE, no policy' figure in Figure 7.4.5 and higher throughput would be assumed.

The difference between this variant and GE is too small to be visible in the CO_2 emissions shown in Figure 7.4.5, as there are also shifts resulting from small changes in the price of energy (e.g. between that of electricity bought in and produced in house).

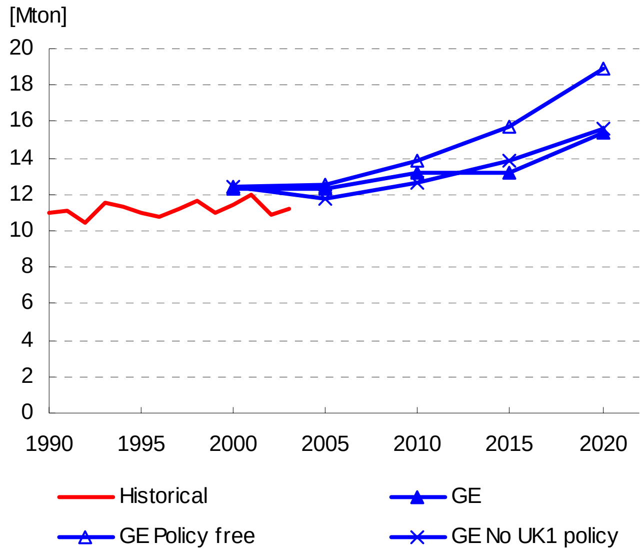

Figure 7.4.5. - Effect of policy on CO_2 emission of refineries in GE

The no-policy variant proceeds from the assumption of no Dutch or European climate policy. This means no ACEA Covenant and no promotion of biofuel for vehicles, with the result that European demand for oil would develop differently from the assumption in GE. In order to maintain throughput in the reference year 2000 it is therefore assumed, for practical reasons, that the ACEA Covenant is discontinued in 2000, when more economic car models were already being developed or manufactured, or were even on the road. This cannot be reversed immediately, so it takes a few years for the discontinuation of the covenant to have a noticeable effect. If this change is applied to the Dutch refineries, their throughput would be about 2.5% higher in 2010, and the difference rises to over 7% in 2020.

Uncertain factors

Table 7.4.1 gives an overview of the uncertain factors in the industry (the figures are for the SE scenario). An important factor affecting emissions in any particular year is the length of time that the refineries are shut down for maintenance. The situation on the crude oil market and whether energy production is farmed out (joint ventures) also play a part, as well as a host of smaller factors that could affect energy consumption and CO_2 emissions in a particular scenario.

Table 7.4.1 - Assessment of uncertainties in the calculations for Refineries

[Mton]	2010		2020	
Direct emissions	13.1		13.7	
	Low	High	Low	High
Same level of maintenance	-0.5	0.5	-0.5	0.5
Price differences oil market	-1.0	1.0	-1.0	1.0
Sharpening of product quality	-0.5	0.5	-2.5	2.5
Investments in secondary capacity	-0.5	0.5	-2.0	2.0
Investments in primary capacity	-0.5	0.5	-2.0	2.0
Fuel input energy RF	-0.5	0.5	-1.5	1.5
Product subdivision and raw material quality, statistics	-0.5	0.5	-0.5	0.5
Product subdivision and raw material quality, future	-0.5	0.5	-1.5	1.5
Properties production processes	-0.5	0.5	-1.5	1.5
Degree of energy saving depending on price of CO_2	-0.5	0.5	-1.6	1.6
Cogeneration, also for third parties	-0.7	0.7	-5.0	5.0

7.5 Natural gas and oil extraction

Dutch natural gas output in 2002 amounted to 71.2 billion cubic metres, over 40% of which was extracted from the Slochteren field, and the remainder from small onshore and offshore fields (Ministry of Economic Affairs, 2003). The total supply of just under 80 billion cubic metres was supplemented by imports, which have increased sharply since 1999, in parallel with the entrance of new providers onto the national market. To offset the loss of national market share, more Dutch gas was exported. Dutch oil output is much smaller than gas output, amounting to 2.7 million cubic metres in 2002 (Ministry of Economic Affairs, 2003).

Energy losses occur in natural gas extraction as a result of blowing off and burning off gas and, to a lesser extent, transport and distribution. Electricity and gas are used during extraction and transport for compression, drying and quality conversion, plus a relatively small amount of diesel oil, used in drilling.

Trends in supply

The amount of Dutch natural gas extracted each year depends on trends in national demand for gas, foreign demand for Dutch gas and the amount of gas imported. Trends in national gas demand are discussed in Chapter 6 and Sections 7.1, 7.2 and 7.4. As regards exports of gas, in SE these are assumed to rise slightly until 2010 and fall back to the current level by 2020. In GE exports rise until 2010 and then stabilize. Gas imports play an increasingly important role in both scenarios (see 5.1), greater than assumed in the previous Reference Projection.

Although the Dutch gas fields are large enough to still be producing gas after 2020, an increasing proportion of the total demand for gas is expected to be met from imports. In both scenarios the amount of imported gas rises above Dutch gas output after 2010-slightly later in GE than in SE (see Figure 7.5.1). In the SE scenario Wadden gas (small fields) makes a modest contribution to gas extraction after 2015; in GE these fields are only exploited insofar as they are economically viable.

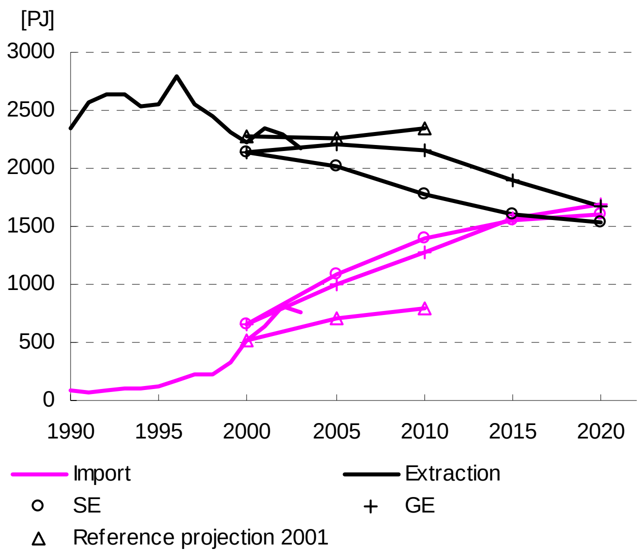

Figure 7.5.1 - Import and extraction of natural gas

Given the greater role played by imported gas, national gas extraction declines more, in both SE and GE, than in the previous Reference Projection. As regards oil extraction, both scenarios assume the reopening of the Schoonebeek oil field, which is expected to produce oil for about 20 years from 2007 (Damveld 2004).

Trends in energy consumption

Because of the fall in pressure the ‘swing’-i.e. the possibility of balancing out supply and demand for gas-exerted by the Slochteren field becomes ever smaller, with the result that there will be an increasing need in the long run for new storage capacity to cushion seasonal demand peaks. A total of 29 compressors are being installed to enable extraction of gas from the field to continue, and these developments will cause a corresponding rise in energy consumption per cubic metre of gas extracted. The growth in the proportion of imported gas increases the need for quality conversion too, as imported gas generally has a higher calorific value than Dutch gas and non-industrial consumers in particular are not able to switch to high-calorific gas. Gas quality is converted by mixing high-calorific and low-calorific gas to achieve 'Groningen quality' or by mixing high-calorific gas with nitrogen.

Policy trends

The ceiling for Dutch natural gas output in the 2003-2007 period is set at 76 billion m^3, 70 billion ^{m3} for the subsequent period up to 2013 (Ministry of Economic Affairs 2004). No ceiling has yet been set for 2013 onwards. The small fields policy is continued in the SE scenario, whereas it is abandoned after 2010 in GE. After 2010 access to and availability of the gas infrastructure for outsiders is more heavily regulated in GE. Most companies in the industry take part in trade in CO_2 emissions and Long-term Energy Efficiency Agreement LTA 2.

Results

Natural gas consumption

Although natural gas extraction falls faster in the SE scenario than the GE scenario, own consumption of gas in the gas and oil extraction industry falls faster in GE than in SE, as the expectation in GE is that less gas will be extracted from the small fields, especially after 2010.

The growth in consumption between 2005 and 2010 is due to a large CHP system for the exploitation of the Schoonebeek field coming on stream. The difference from the results in the 2001-2010 Reference Projection is due to adjustment of the prognoses for output from small gas fields.

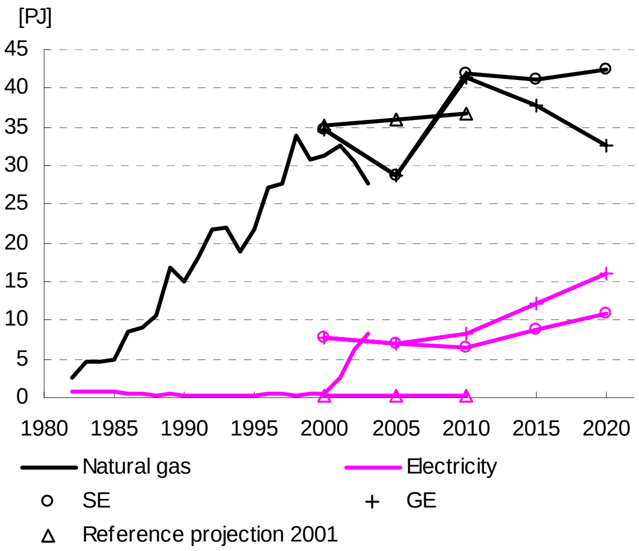

Figure 7.5.2 - Consumption balance energy natural gas and oil extraction

Electricity consumption

Since the early 1990s electric compressors have increasingly been used instead of gas-fired ones, with the result that electricity consumption has gone up steadily. This growth was not observed by the CBS until 2001, which explains the abrupt rise in historical electricity consumption in Figure 7.5.2. The forecast growth in the scenarios is based on the trends expected in national production and the need for gas storage and quality conversion. Consumption grows faster in GE than in SE mainly because of the higher production rate of the Slochteren field.

CO_2 emissions

CO_2 emissions from the extraction companies are directly linked to natural gas consumption. Total emissions were 1.9 Mton in 2002. The prognosis for 2010 is 2.4 (SE) and 2.3 (GE) Mton, and 2.4 (SE) and 1.8 (GE) Mton respectively for 2020.

Effects of climate policy

The natural gas and oil extraction industry is affected mainly by indirect effects of climate policy, compared to which the direct effects on the industry of trade in CO_2 emissions and Long-term Energy Efficiency Agreement LTA 2 are relatively small.

Uncertain factors

The uncertainties in the gas and oil extraction industry relate mainly to market trends. Only the first factor is relevant to national CO_2 emissions, and the last two are marginal compared with the others.

- National gas output (demand versus imports); the uncertainty is -0.5 to 0.5 Mton in 2010 and -1.2 to 4.7 Mton in 2020.
- The need for quality conversion (supply and demand for 'Groningen-quality' gas)
- Developments in and utilization of storage capacity (seasonal, peak and strategic)

8. OTHER GREENHOUSE GASES

8.1 The Netherlands as a whole

This chapter describes how emissions of non-CO_2 greenhouse gases (methane, nitrous oxide and the fluorinated gases: HFCs, PFCs and SF6) will evolve between now and 2020. The classification used here is the same as that given in the 'Reference Projection for non-CO_2 greenhouse gas emissions from 2002' (Beker, 2002). That is based upon the groups defined in the emissions registration system. Table 2.1.1 shows the similarities and differences between this and the classification according to target-value sectors used in describing CO_2 emissions in Chapter 6.

Results

In both scenarios, Dutch emissions of other (non-CO_2) greenhouse gases (OGGs) fall from 38 to 34 Mton CO_{2eq}. between 2002 and 2010. This makes the expected emissions virtually identical to those in the previous Reference Projection for OGGs (Beker 2002).

Because of a new calculation method, the forecast agricultural emissions of nitrous oxide are now higher (see Paragraph 8.2). But this is compensated for by lower emissions by the energy sector (Paragraph 8.6) and other sources (Paragraph 8.7), again due to new calculation methods.

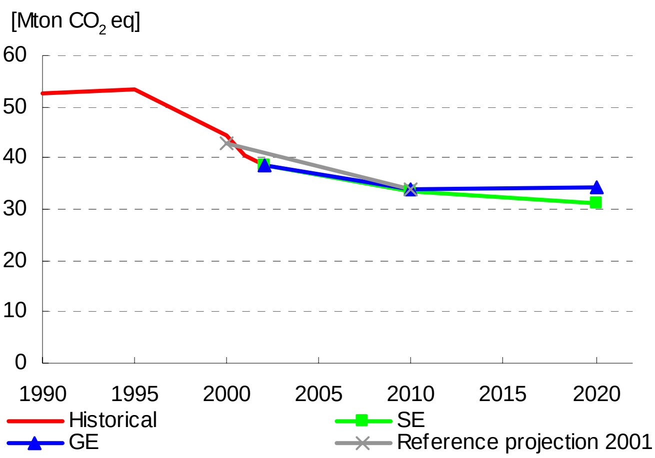

Figure 8.1.1 - Development of total emissions of other greenhouse gases in the Netherlands (preliminary results for agriculture)

The new historical figures and a very brief description of the calculation method have been published in the 2005 National Inventory Report (NIR) (Klein Goldewijk et al, 2005). Between 2010 and 2020, the emissions in the SE scenario fall to 31 Mton CO_2 eq. and those in GE remain at the 2010 level.

Target values

In both scenarios, projected emissions of OGGs in 2010 are about 1 Mton CO_2 eq. above the target value of 33 Mton CO_2 eq.

Uncertainties

The margin of error has been calculated at approximately -35 to +20 percent. The main contributory factors in this are the uncertainty of N_2O in the agricultural sector and doubts as to whether the N_2O reserve facility in potassium nitrate production will be taken up. The latter is the reason why the margin of error is skewed. The projections assume that the facility will not be taken up. However, the uncertainty analysis assumes a 50 percent chance that it will be, with an effect of 4 Mton CO_{2eq}.

8.2 Agriculture

The agricultural sector emits methane (CH_4) and nitrous oxide (N_2O). Its share in the total emissions of OGGs in the Netherlands was 48 percent, of which CH_4 made up 23 percent and N_2O 25 percent.

Methane is produced in the digestive tract of livestock, in particular cattle, and is released during the storage of manure. Nitrous oxide is mainly generated following the application of nitrogen to the soil, in the form of either artificial or animal fertiliser, where natural processes convert a small proportion of it into the gas.

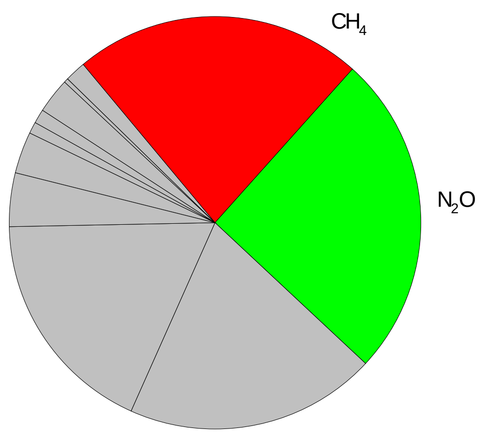

Figure 8.2.1 - Share of agriculture in total emissions of other greenhouse gases in 2002

Methane emissions are calculated by multiplying livestock numbers by an emissions factor. In the case of cattle, the amount of fodder they eat is taken into account. Forecasts for the size of the national herd over the next 15 years vary according to economic factors, including changes to EU agriculture policy and to Dutch manure and ammonia policy.

Nitrous oxide emissions are determined by multiplying the amount of nitrogen applied to the soil, particularly in the form of artificial or animal fertiliser, by a gasification percentage. This takes into account both direct emissions, which occur quite soon after the nitrogen is applied, and indirect ones related to the deposition of ammonia and the washing of nitrate out of the land. The method used to calculate agricultural methane and nitrous oxide emissions has been revised recently. This has resulted in higher figures for nitrous oxide, in particular, both historically and for future years.

Volume developments

The Dutch agricultural sector seems to have only limited long-term potential for expansion. This restricted growth has a number of causes.

- Saturation of the market for foodstuffs: supply is growing faster than demand.
- Trade liberalisation, resulting in less state support and increasing competition.
- Environmental policy, particularly that in respect of manure.
- Falling agricultural acreage due to demand for land for other uses.

The main activities that account for agricultural OGG emissions are milk production and the amount of manure and artificial fertiliser applied to the land. Milk production will be limited by quotas until 2012, but in both scenarios these are then abolished. Particularly in the GE scenario, this will lead to a sharp increase in milk production and hence to a rise in the number of dairy cattle and the amount of manure they produce. This growth in dairy farming will come at the expense of the space available for arable farming (land market) and intensive livestock farming (manure sales). The declining use of both animal and artificial fertiliser between 2000 and 2010 is a consequence of manure policy. In the SE scenario, that decline continues after 2010, but in GE both production and use of manure start to rise again (see also ‘Policy developments’).

Table 8.2.1 - Share of milk production, manure and fertiliser in total OGHG emissions of agriculture and the annual growth of these sources in %

	matter	share in total OGHG emission 2002	SE 2000-2010	SE 2010-2020	GE 2000-2010	GE 2010-2020
Milk production (national total)	CH_4	37%	0.1	0.5	0.1	2.7
Animal manure on farm land	N_2O	36%	-1.4	-0.7	-1.2	1.0
Fertilizer	N_2O	13%	-2.5	-0.9	-2.4	0.4

Policy developments

There is no legislation designed to reduce agricultural OGG emissions; instead, government policy focuses upon subsidising R&D and practical experiments. This has had no measurable effects as yet. Yet other policy has had an impact upon OGG emissions. The milk quotas imposed under the EU’s Common Agricultural Policy (CAP) restrict the size of the national dairy herd, and hence the level of methane emissions. The manure policy regulates the amount of nitrogen applied to the soil and hence livestock numbers. The restriction on the amount of manure that can be spread – 250kg N/ha on farms consisting of at least 70 percent grassland and 170kg N/ha on other agricultural land – and the limits on the overall use of nitrogen from animal and artificial fertilisers define how much nitrogen is added to the soil. The figures for 2010 are based upon these limits, with reduced emissions of nitrous oxide and – to some extent – methane being linked to their expected tightening. In the GE scenario, the restrictions will have been eased slightly in 2020 in response to increasing grass yields. That is not the case in the SE scenario, which implicitly foresees manure policy becoming stricter.

It is assumed that current policy, including definite proposals, will continue until 2010. Milk quotas combined with increasing milk production – rising by approximately 1 percent annually – will reduce the dairy herd, and with it the number of calves. Pig and chicken numbers will remain more or less unchanged. After 2010, the GE and SE scenarios diverge. Both envisage milk quotas being scrapped, but GE predicts more market opportunities for the dairy herd to grow (+16 percent, compared with -2 percent in SE) between 2002 and 2020. In this scenario, moreover, both milk production and the productivity per cow increase (+16 percent, compared with +5 percent in SE). The number of pigs falls by 4 percent in GE and 34 percent in SE, whilst the number of chickens is up 5 percent in GE and down 32 percent in SE. The larger livestock numbers in the GE scenario are able to stay within the manure limits by keeping cows in their stalls more and by processing more manure than under SE.

Results

The new method for calculating agricultural nitrous oxide emissions has raised the figure for 2010 by 3 Mton CO_2 eq. over the 2001 Reference Projection (Beker, 2002). They will then total between 8.9 (SE) and 9.2 (GE) Mton CO_2 eq. In the SE scenario, emissions will fall between 2010 and 2020, to 8.2 Mton CO_2 eq. In GE, they rise to 9.8 Mton CO_2 eq.

The new method for calculating methane emissions has also resulted in higher base-year figures, but on a smaller scale: a difference of about 0.5 Mton CO_2 eq. in 2000. That makes the new projection for 2010, 8.3 Mton CO_2 eq., higher by the same amount. In the GE scenario, these emissions then rise to 9.4 Mton CO_2 eq. between 2010 and 2020; in SE they fall slightly, to 8.0 Mton CO_2 eq.

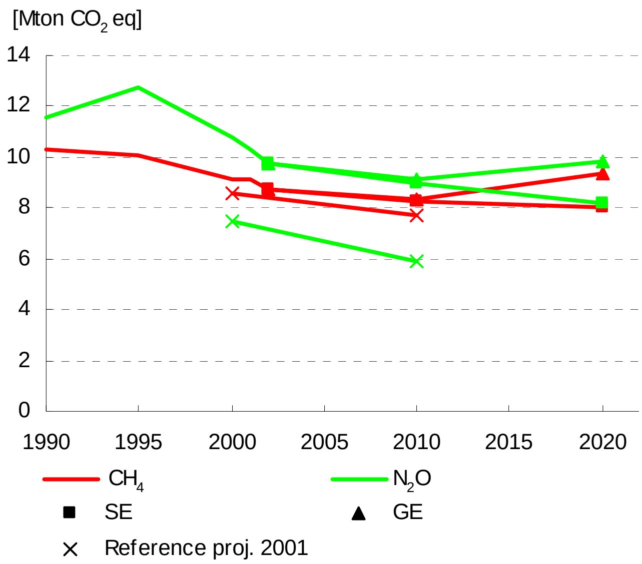

Figure 8.2.2 - Development of methane and nitrous oxide emissions in agriculture

Policy effects

There are no regulations designed to reduce agricultural OGG emissions. However, there is a clear relationship with Dutch manure and ammonia policy. Without the former, the predicted fall in pig and poultry numbers by 2010 would be less marked, much less manure would be processed for export and the use of artificial fertiliser would fall less quickly. The main impact of this is upon emissions of nitrous oxide, which as a consequence will at least be at the same level in 2010 as in 2000. Without a manure policy, they would be 1.5 Mton CO_2 eq. higher in 2010. And 0.9 Mton CO_2 eq. higher in 2020.

Without an ammonia policy, more manure would be used above ground and more ammonia emitted. However, the nitrous oxide emissions factor for surface use is lower than when the manure is worked into the soil. This is because conditions in the ground are less than perfect for nitrification (conversion of NH_4^+ into NO_3^-) and denitrification (conversion of NO_3^- into N_2), which results in more nitrous oxide being produced.

The true emissions factor remains shrouded in uncertainty, though. In fact, were all manure to be used above ground, emissions would actually be up to 1.2 Mton CO_2 eq. lower in 2010 and 2020 than in the case of 'low-emission' use. And that increases ammonia emissions by almost 60 kton! To compensate for the nitrogen, which evaporates in the form of ammonia, and so cannot be used, more artificial fertiliser will have to be applied. In the event of full compensation, the effect upon N_2O emissions is smaller. Without an ammonia policy, then, agricultural nitrous oxide emissions would be 0.9 Mton CO_2 eq. lower in 2010 and 2020.

Then there is the effect of the CAP. Its milk quotas have had a positive impact upon the environment in the Netherlands. Without them, the national dairy herd would be larger than it is now because Dutch dairy products are in a reasonably strong market position and because dairy farmers can pay more for land than arable farmers. Assuming that the number of dairy cattle and calves would stabilise – rather than fall, as the projections indicate – without them, the milk quotas are reducing methane emissions by 0.3 Mton CO_2 eq. between 2000 and 2010. This factor has no effect between 2010 and 2020, however, since the GE scenario assumes that the quotas will have been abolished by then.

Uncertain factors

The overall margin of error for N_2O emissions is about 75 percent. Most of this, some 70 percent, is accounted for by the uncertainty in monitoring. For CH_4, the margin of error is 20 percent, with monitoring responsible for 17 percent of that. The principal uncertain factor in the projections is the evolution of livestock numbers. Until 2010, the question is how farmers are going to react to the new manure policy. An upper limit for the size of the national herd has been established, based upon the milk quotas and animal rights considerations. But with the former disappearing after 2010, what will happen then becomes more unclear. The two scenarios provide an idea of the range of future developments.

8.3 Waste disposal

In this sector, methane is produced at landfill sites. In 2002, these accounted for 20 percent of total Dutch emissions of other (non-CO_2) greenhouse gases (OGGs). Methane is generated during the biological decomposition of organic substances, a process that can take decades. The gas rises and emerges through the surface of the landfill, at which point it may be wholly or partially oxidised.

It is also possible to recover the methane while it is still underground. This is done by sinking extraction pipes. Models are used to calculate annual methane production from this source, with the main variables in this calculation being the amount of waste dumped at the site each year, its carbon content and the amount of gas recovered. The forecasts for next 20 years are shaped mainly by current waste policy.

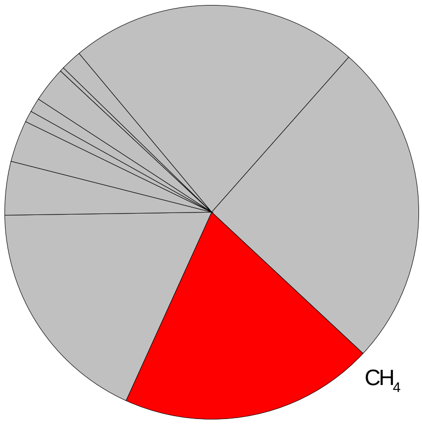

Figure 8.3.1 - Share of waste disposal in total emissions of other greenhouse gases in 2002

Evolution of waste volumes

[43] Personal communication from the Waste Consultative Body (AOO).

The evolution in the amount of waste dumped in landfills is the same in both scenarios.[43] As a result of bans, this will fall sharply between 2000 and 2020.

As far as its composition is concerned, it has been borne in mind that the dumping of domestic residual waste ended in 2004, that of organic wet fraction (OWF) will cease by 2007 and that of bulk domestic and normal commercial waste ends in 2010.

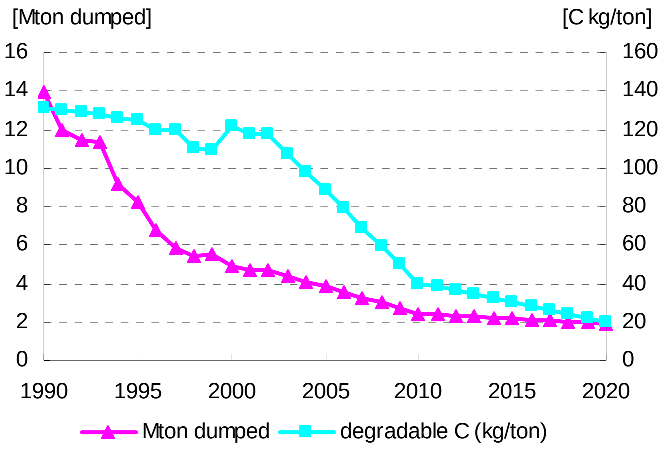

Figure 8.3.2 - The development of the composition and amount of dumped waste

The largest decline in the amount of waste dumped at landfill sites, and in the associated carbon content, will occur between now and 2010. From then on the carbon content will continue to fall slowly as a result of continuing concern about reducing the dumping of combustible waste.

Policy developments

The National Waste Management Plan (Landelijk Afvalbeheersplan, LAP) is prioritising a reduction in landfill dumping. According to the Plan, only waste that cannot be recycled or incinerated may be disposed of in this way. Over the years, bans on dumping some categories and levies for dumping others have changed both the size and the composition of the waste supply.

Results

Methane emissions from landfill sites are set to fall sharply, from 7.5 Mton CO_2 eq. in 2002 to 4.4 Mton CO_2 eq. in 2010 and 2.2 Mton CO_2 eq. in 2020. These figures are the same in both scenarios. That for 2010 is now 0.2 Mton CO_2 eq. lower than in the 2001 Reference Projection. This is the result of changes to the method used to calculate the emissions. That has adjusted the figures downwards across the board, including in the base year.

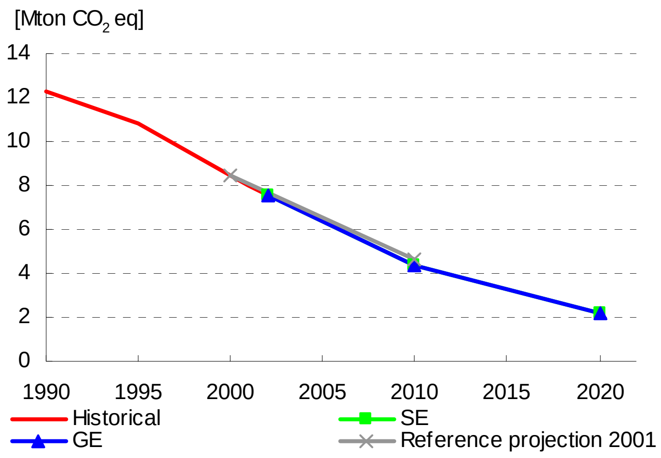

Figure 8.3.3 - Development of methane emissions in waste disposal

Policy effects

The policy being referred to here is that on dumped waste volumes in 2010 and 2020 under the LAP, not the Climate Policy Implementation Paper (UK1). If there were to be no bans, the amount of waste dumped would certainly increase. Moreover, OWF volumes could be expected to increase. Without a dumping policy, it is estimated that methane emissions in 2010 would be at the same level as in 2000. That would be almost 4 Mton CO_2 eq. higher than under the current projections, rising to 6 Mton CO_2 eq. more in 2020.

Uncertain factors

The uncertainties here lie mainly in the amount and composition of the waste being dumped. On the one hand, these are policy-based; on the other, they concern the way in which the composition – that is, the carbon content of the material being dumped – is determined. For both, a margin of error of ±1.5 Mton CO_2 eq. in 2010 has been factored in. There is actually less uncertainty about 2020, since the projected emissions then will be so low (2.2 Mton).

8.4 Industry

The main non-CO_2 greenhouse gases (OGGs) in this sector are N_2O (nitrous oxide) and the fluorinated gases: HFCs, PFCs and SF_6. In 2002, industry's share in the total emissions of OGGs in the Netherlands was 26 percent, of which N_2O made up 18 percent, HFCs 4 percent, PFCs 3 percent and SF_6 1 percent.

Most N_2O is produced during the manufacture of nitric acid and caprolactam, with lesser amounts being generated as indirect emissions from incineration processes.

To prevent fragmentation in this report, all fluorinated gas emissions have been attributed to industry. In fact, this sector accounts for only 50 percent of HFC emissions – amongst other things, from the production of caprolactam and from industrial use. The other 50 percent is accounted for by other sectors. HFCs are used as coolants in stationary refrigeration units and in-car air conditioners, as a propellant in aerosols and in sealed foams such as those in insulating tiles.

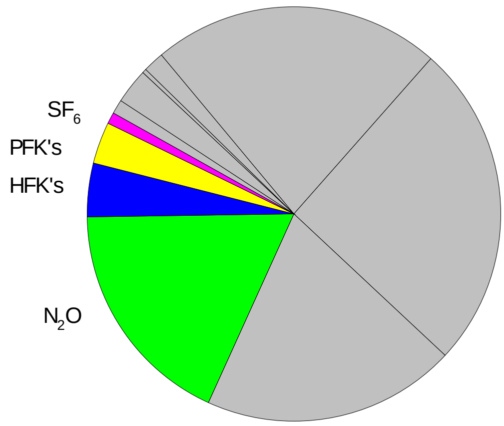

Figure 8.4.1 - Share of industry in total emissions of other greenhouse gases in 2002

HFC emissions from refrigeration units are calculated based upon leakage rates and the known volume in this application; those from aerosols are derived from annual consumption; and those from sealed foams are worked out from annual use in the Netherlands, a loss percentage during production and application and the rate of slow release from the existing stock. PFC emissions occur during the manufacture of primary aluminium and in use by the semiconductor industry. SF_6 is emitted during the testing and use of high-voltage switches, the production and use of insulating glass, use in the semiconductor industry and the manufacture of electron microscopes.

Volume developments

It has been assumed that the evolution of nitric acid production is linked to that of nitrogen-based fertilisers. This is expected to grow slightly over the next 20 years. Caprolactam and HCFC22 production has reached full capacity in the Netherlands and is not expected to increase any further.

As for liquid coolants in stationary refrigeration units, both the GE and the SE scenarios assume that current volumes will remain unchanged despite the growth in refrigeration capacity. This is based, in turn, upon the assumption that the increased capacity will be compensated for by the use of more compact units requiring less coolant to achieve the same effect. Until about 2010, though, there will be a shift away from the use of HCFC22 as a liquid coolant and towards HFCs, thus increasing their application in this field.

With respect to in-car air conditioners, the assumption is that the number of vehicles on the road will grow and that a larger proportion of them will be fitted with these units. Moreover, both scenarios assume more use of aerosols and, with the expansion of the construction industry, of hard-foam insulation materials.

The previous Reference Projection (Beker, 2002) forecast that only one of the two Dutch aluminium manufacturers would still be operational in 2010. But the expectation now is that both will stay in operation.

Table 8.4 1- Share of the most relevant processes in the total OGHG emission of industry and annual growth of these processes in %

	matter	share in total OGHG emission 2002	SE 2000-2010	SE 2010-2020	GE 2000-2010	GE 2010-2020
Nitric acid production (ton)	N_2O	49%	0.3	0.3	0.7	0.7
Caprolactam production (ton)	N_2O	19%	0	0	0	0
Coolant for stationary cooling (litre)	HFK	5%	20.6	3.9	20.6	3.9
Coolant for mobile airco (no of cars)	HFK	1%	22.3	6.3	22.3	6.3
Use of propellant in spray cans	HFK	2%	-10.6	0.0	-10.6	0.0
HCFK22 production (ton)	HFK	7%	0	0	0	0
Aluminium production (ton)	HFK	10%	0.5	0.5	1.1	1.1

Policy developments

Nitrous oxide (N_2O) emitted during nitric acid production remains on the reserve list at present, and so has not been included in the projections. However, the Dutch government has decided to implement this measure. Only two companies are affected, making the costs for each of them relatively high. The resulting reductions in emissions were expected to be 5 Mton CO_2 eq., but at the moment are only 4 Mton CO_2 eq. due to a process change at one of the firms concerned. A research project is currently investigating whether emission reductions are feasible in caprolactum production. This has already resulted in a downward adjustment in the monitoring, by 0.28 Mton CO_2 eq. As far as the fluorinated gases are concerned, agreements have been reached to limit HFC and PFC emissions resulting from their use in stationary refrigeration units, in-car air conditioners, foams, aerosols and the semiconductor industry. The implementation of the European Directive on Fluorinated Gases is being awaited, which will have repercussions for a range of applications. For SF_6 and PFCs, the semiconductor industry has a permitted ceiling of 0.44 Mton in its licence. Research is now being conducted to see how this can be reduced further. An afterburner was installed at the sole Dutch HCFC22 plant in 1998, and has since been optimised. This has led to a total reduction in HFC emissions of 7.3 Mton CO_2 eq.

Results

Scenario SE projects N_2O emissions of 7.1 Mton CO_2 eq. in 2010, whilst the GE scenario puts them at 7.3 Mton CO_2 eq. This is the same as in the previous projection (Beker, 2002). The estimated emissions from nitric acid and caprolactam production may be lower than was then calculated[44], but the recalculations under NIR 2005 have introduced a new source: N_2O emissions from incineration processes.

In both scenarios, fluorinated gas emissions are 3.4 Mton CO_2 eq. That makes then just over 1 Mton CO_2 eq. less than forecast in the previous Reference Projection.

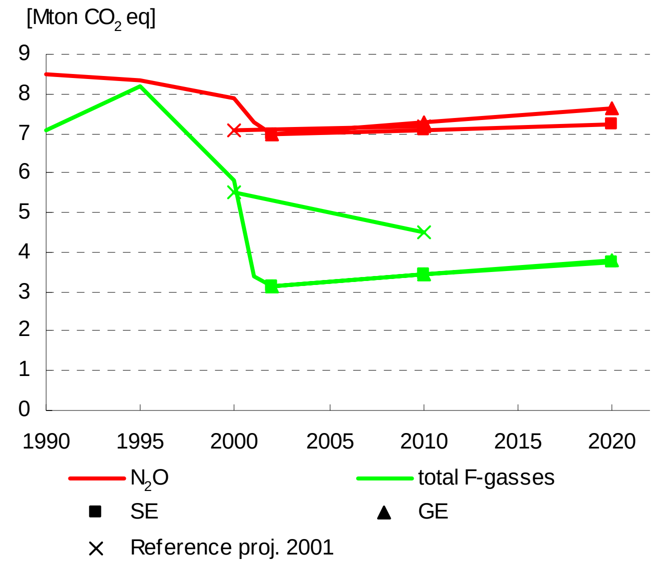

Figure 8.4.2 - Development of N_2O and F-gas emission in industry

The main reason for this is that emissions from the HCFC22 manufacturer have fallen as a result of its afterburner being optimised in 2000. That has increased its removal efficiency, reducing emissions by 0.4 Mton CO_2 eq. since the last projection. Moreover, emissions resulting from a variety of uses – although not refrigeration and air conditioning – have fallen in the base year, and hence in the projections as well. N_2O emissions will increase slightly in 2020, compared with 2010, to between 7.3 (SE) and 7.6 (GE) Mton CO_2 eq. Emissions of the fluorinated gases are up 0.4 Mton CO_2 eq., to 3.8 Mton CO_2 eq., in both scenarios.

Effects of climate policy

The effect of the Climate Policy Implementation Paper (UK1) upon industry will reduce emissions by almost 6 Mton CO_2 eq. from 2010. Of the total reduction at the manufacturer of HCFC22, some 3.6 Mton CO_2 eq. is attributable to that policy; 1.7 Mton CO_2 eq. was achieved before 2000, the remainder thereafter.

The change from side to middle input at one major aluminium manufacturing plant in 2002 and 2003 has reduced its emissions by approximately 1.1 Mton CO_2 eq. This measure is also a consequence of the UK1 policy. Combined with other policy measures to limit HFC and PFC emissions during their use in stationary refrigeration units, in-car air conditioners, foams, aerosols and the semiconductor industry, the policy will cut them by about 1 Mton CO_2 eq. from 2010.

Uncertain factors

The margin of error in respect of all the fluorinated gases is estimated at ±1.5 Mton CO_2 eq. in 2010. This is caused mainly by uncertainties in the rate at which HCFCs and CFCs in refrigeration units and sealed foams will be replaced by HFCs and other products.

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[44] This is the result of lower emissions in the base year. In the case of caprolactam production, that is due to improved monitoring. In the nitric acid industry, it was caused by process changes at one of the manufacturing companies.

The margin of error with regard to N_2O is estimated at between -90 percent and +20 percent. This extensive and skewed range is down to the lack of certainty as to whether the N_2O measure will be taken off the reserve list. In the projections it is not. If it were to be implemented, however, then emissions would be 4 Mton CO_2 eq. lower. For the purposes of the uncertainty analysis, the chance that this will happen has been put at 50 percent.

8.5 Road transport

In this sector, N_2O emissions are caused mainly by the use of three-way catalytic converters. These transform most of the NO_x in exhaust gases to N_2, but also turn a small proportion of it into N_2O. Meanwhile, fuel combustion releases a negligible amount – less than 0.1 Mton CO_2 eq. – of CH_4 as well. Road transport's share in total Dutch emissions of non-CO_2 greenhouse gases was 1 percent in 2002.

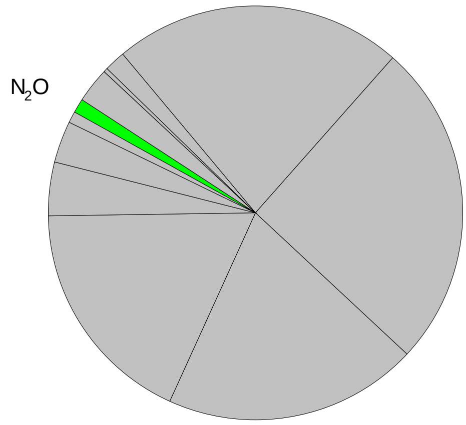

Figure 8.5.1 - Share of the road transport sector in total emissions of other greenhouse gases in 2002

Policy developments

There is no policy designed specifically to reduce N_2O emissions by road transport. But there is one to tackle NO_x emissions. That has resulted in petrol-driven vehicles being fitted with catalytic converters. These, however, increase N_2O emissions per kilometre driven. Because the proportion of cars equipped with a catalytic converter increased sharply from 1990, the average N_2O emissions factor for motor vehicles did the same – from about 9 to about 15 mg/km between 1990 and 1999. That factor fell again in 2003, to approximately 12 mg/km.

Results

The current forecast for N_2O emissions in 2010 is 0.1 Mton CO_2 eq. lower than in the previous projection (Beker, 2002), down from 0.6 Mton CO_2 eq. to 0.5 Mton CO_2 eq. This increase after 2010 is a result of more kilometres being driven, mainly by private cars and light commercial vehicles.

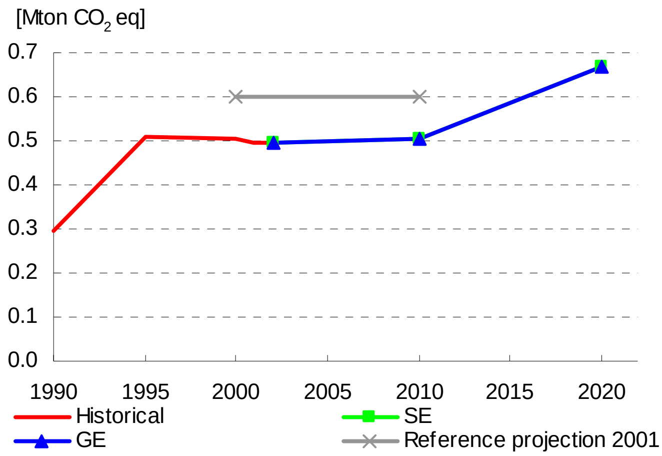

Figure 8.5.2 - Development of the N_2O emission in the transport sector

Effects of climate policy

There is no policy designed specifically to reduce N_2O emissions by road transport.

Uncertain factors

It is estimated that actual N_2O emissions by road transport in 2010 could be higher or lower than the projections by a factor of as much as 2. That puts them in the range 0.3-1.0 Mton CO_2 eq.

8.6 Energy

In this sector, methane is released during the recovery of oil and gas, as well as during the transportation of natural gas. The main sources of these emissions are the offshore drilling industry and gas distribution.

Methane release in oil and gas production occurs during the flaring and blowing off of excess gas. In distribution, it is emitted from leaks and during maintenance work. Energy's share in total Dutch emissions of non-CO_2 greenhouse gases was 3 percent in 2002.

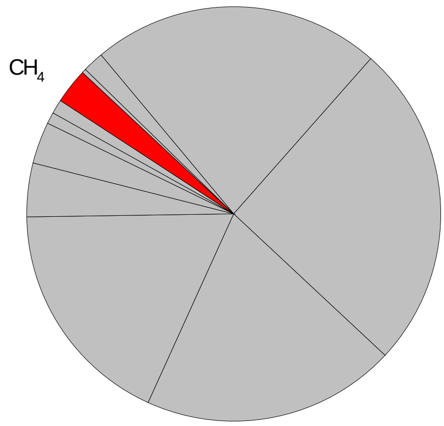

Figure 8.6.1 - Share of the sector energy in the total emissions of other greenhouse gases in 2002

Volume developments

Table 8.6.1 shows the share held by the most significant contributory processes to the total emissions of non-CO_2 greenhouse gases by the energy industry, as well as their annual growth rates as a percentage.

Table 8.6.1- Share of the most relevant processes in total OGHS emission of the energy sector and annual growth of these processes in %

		share in total OGHG	SE		GE	
	matter	emission 2002	2000-2010	2010-2020	2000-2010	2010-2020
Gas extraction sea	CH_4	42%	-3.1	-1.0	-4.1	-7.8
Gas distribution	CH_4	50%	-1.5	-1.2	-0.9	-0.3

Policy developments

It was announced in the Climate Policy Implementation Paper (UK1) that methane reduction would be included in the 2002 Netherlands Oil and Gas Exploration and Production Association (NOGEPA) Covenant, after which the measures would be included in individual corporate environmental plans (CEPs) for the period 2003-2007. This has now been done. These projections incorporate the definite measures contained in those CEPs.

Results

In both scenarios, CH_4 emissions fall to approximately 0.3 Mton CO_2 eq. in 2010. The reason for this decline is that offshore gas production will be reduced by about 30 percent between 2000 and 2010, with measures to cut emissions being taken at the same time. This, as well as the recalculations under NIR 2005, means that forecast emissions are now 1 Mton CO_2 eq. lower than in the previous Reference Projection (Beker, 2002).

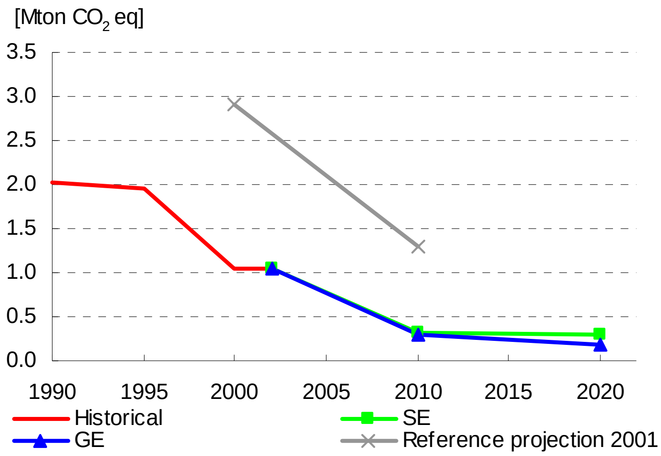

Figure 8.6.2 - Development of the CH_4 emission in the sector energy

It is notable that the GE scenario projects a much faster decline in offshore gas production after 2010 than SE does. As a result of that, CH_4 emissions fall more quickly in GE than in SE.

Effects of climate policy

Both scenarios envisage that the Climate Policy Implementation Paper (UK1) will result in a reduction of approximately 0.3 Mton CO_2 eq.

Uncertain factors

The margin of error for CH_4 emissions by the energy industry is estimated at between -95 and +40 percent. The main cause of this the high degree of uncertainty in monitoring. Another important factor is the lack of certainty about the emissions factor of the gas distribution network. This could be lower by factor of 10.

8.7 Other sources

These are mainly nitrous oxide emissions emanating from a range of sources – mainly polluted surface water but also, to a lesser extent, waste disposal, the energy sector and commerce, services and government (TSG). A negligible amount of methane – less than 0.1 Mton CO_2 eq. – is generated by households, industry and TSG. These other sources accounted for approximately 2 percent of total Dutch emissions of non-CO_2 greenhouse gases in 2002.

Results

In the absence of data regarding the evolution of these emissions, it has been assumed that they will remain constant at their 2002 levels throughout the projection period. At 0.7 Mton CO_2 eq., forecast N_2O emissions are now 0.9 Mton CO_2 eq. lower than in the previous Reference Projection where CH_4 emissions were 0.6 Mton CO_2 eq.; in this one, they have fallen to less than 0.1 Mton CO_2 eq.,

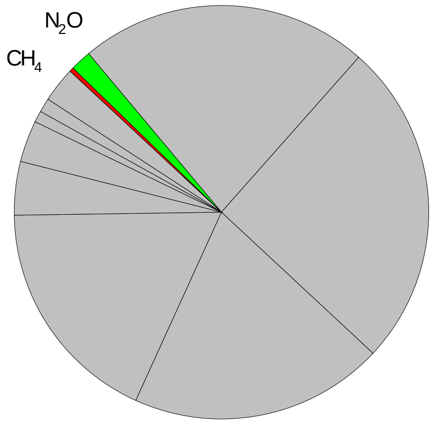

Figure 8.7.1 - Share of other sources in the total emissions of other greenhouse gases in 2002

In both cases, these reductions result from the recalculations under NIR 2005.

Uncertain factors

Little is known about it, but the level of uncertainty is probably relatively high.

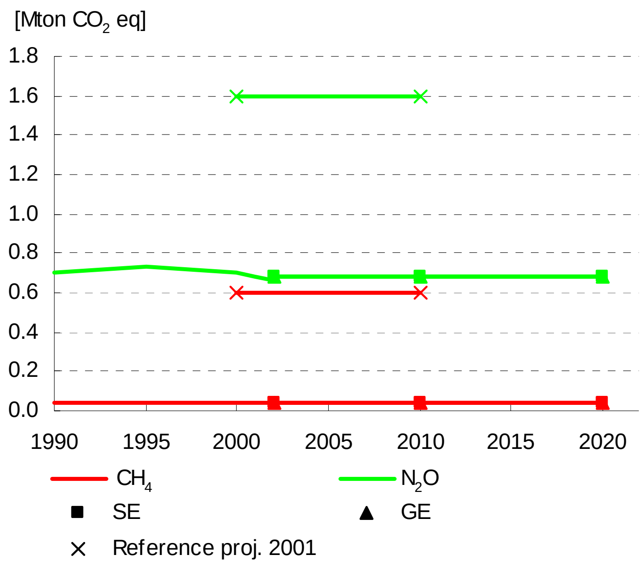

Figure 8.7.2 - Development of N_2O and CH_4 emission of other sources

9. AIR-POLLUTING EMISSIONS

This chapter describes the development of the air-polluting emissions NO_x, SO_2, NMVOC, NH_3 and PM_{10} until 2020. The sectoral division links up to the division for which NEC sectoral targets have been established. This division deviates in some aspects from the division that was used in Chapter 6 (Energy demand and CO_2) and Chapter 8 (Other greenhouse gases) (see Table 2.1.1) The projections for the Transport sector that are presented in this chapter are not from the WLO study, contrary to the projections of the other sectors, but stem from the report 'Actualisatie Emissieprognoses verkeer en vervoer 2003' (van den Brink, 2003), which was drafted by RIVM/MNP for the White Paper 'Erop of Eronder'. More information on the reasons behind this choice can be found in Paragraph 6.2. The report offers a projection with a scenario differentiation that is based on the CPB scenarios EC and GC.

9.1 Nitrous Oxides (NO_x)

The Netherlands total

The largest share of emissions is emitted in combustion processes. The transport sector has by far the largest share in total emissions (almost two-third share in 2002), followed by the industry and the energy sector (one quarter together). The remainder is emitted by the domestic sector, trade, services and the government, construction and agriculture.

Results

The Dutch NO_x emission decreases in the period 2002 to 2010 from 396 kiloton to 284 (SE) and 288 (GE) kiloton. Thus, the projected emission is 4 kiloton lower and in GE it is equal to the projection of 2003, which was done for 'Erop of eronder'. In SE the lower emissions are mainly ascribed to Trade, Services, Government, Construction and Agriculture. An explanation can be found in the Paragraph that is dedicated to these sectors. In the period 2010-2020, the emission further decreases to 262 (SE) and 272 (GE) kiloton.

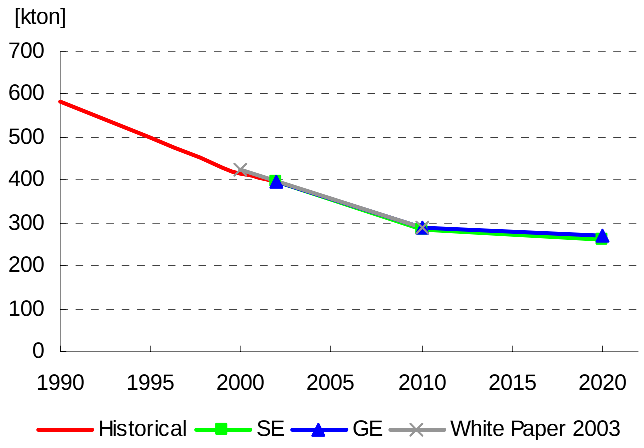

Figure 9.1.1 - Development of the NO_x emission in the Netherlands

Target compliance 2010

The NEC target amounts to 260 kiloton. Given the projected emissions in 2010, i.e. 284 (SE) and 288 (GE) kiloton, the target will most probably be exceeded with 24 kiloton in SE and 28 kiloton in GE. It is unlikely that the NEC target will be reached. If the policy intentions from the White paper on transport emissions are implemented (2 to 12 kiloton inland base package and 19 kiloton related to the non-representative EU emission test method for heavy company vehicles), then the target realisation becomes more probable, yet not completely certain.

Uncertain factors
The margin in the projected emission in SE amounts to approximately 15%. This is mainly caused by the uncertainties in the Transport sector, both with respect to monitoring and scenario uncertainty.

Industry, energy sector, refineries and waste-disposal

The sectors industry, refineries, energy sector and waste disposal held a share of 24% in the Dutch NO_x emission in 2002. This puts these sectors in second place after transport.

Contrary to CO_2 and SO_2, the NO_x emissions are not presented separately for the sectors industry, refineries and energy. The reason behind this is the fact that a large share of the companies will participate in the NO_x emission trading system as of 2005. The companies have two choices, namely to take their own measures in order to comply with the performance standard, or to purchase emission credits from companies that have a better performance than required by the standard.

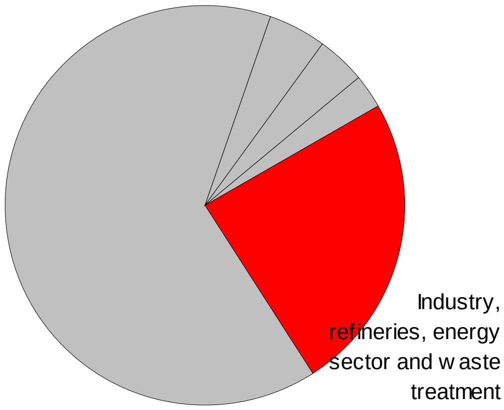

Figure 9.1.2 - Share of the sectors industry, refinery, energy and waste disposal in total NO_x emissions in 2002

At the moment it is hard to predict which choice the companies will make: to take measures or to purchase. Neither can a prediction be made as to the degree in which sectors will be net seller or purchaser of emission credits. Therefore, only the joint emissions of the participating sectors are presented.

Volume developments
The largest share of NO_x emission in this sector is caused by combustion processes, with fuel consumption being the relevant volume quantity. A smaller share is defined as process emission according to the NO_x emission trading system, as a result of which the emission volume is linked to the production volume of the processes in question[45].

Table 9.1.1 presents the development of fuel consumption in industry, refineries and the energy sector, as well as the fuel consumption of the production processes that are most relevant based on their emissions[46]. Moreover, the share of total NO_x emissions of the sectors in 2005 (the year that NO_x emission trading started) is shown.

45 The following processes are involved: iron, steel, electro steel, zinc, anode, caprolactam, carbon black, silicon carbide, aluminium, flat glass, packaging glass, special glass, rock wool, enamelling frits, glass frits, phosphorus, phosphoric acid, sodium tripolyphosphate. cement, nitric acid, nitrate, active coal or magnesium oxide.

46 Because not all processes have been mentioned, the shares do not add up to 100%.

Table 9.1.1 - Contribution to total NO_x emission of the sectors Industry, Refinery and Energy, and annual growth in % of the most relevant processes

	share in total	SE		GE	
	NO_x emission	2000-2010	2010-2020	2000-2010	2010-2020
Fuel consumption industry	24%	-0.5	-0.6	-0.8	0.7
Fuel consumption refineries	10%	0.4	-0.8	0.3	0.5
Fuel consumption energy sector	50%	2.0	1.4	2.5	1.7
Iron and steel production	4%	-0.1	-0.1	0.4	0.5
Nitric acid production	2%	0.3	0.3	0.7	0.7
Glass production	4%	1.1	0.8	1.6	0.8

Based on fuel consumption, approximately 85% of the industry and 95% of the energy sector participate in NO_x emission trading in 2010. The remaining part is covered by another policy regime, especially BEES-B (Decree on emission standards for furnace installations and NeR (Netherlands Emission Guidelines for Air). The refineries are completely covered by the trading system.

Policy Developments

Plants with a thermic capacity larger than 20 MW in total will be covered by the NO_x trading system as of June 1st 2005. It is estimated that approximately 250 installations are involved. Under this system, installations have to comply with a performance standard, which will be tightened annually between 2005 and 2010. Combustion emissions are facing a standard of 40 gr/GJ in 2010. Process must comply with a standard according to which the emission per unit of production must be 46% lower than in 1995.

The fact that companies must comply with a performance standard means that the emission depends on fuel consumption and on the production volume of a number of processes.

The installations of plants with a thermic capacity that is smaller than 20 MW in total are covered by the Decree on emission standards for furnace installations (BEES), in as far as turbines, gas engines, boilers and furnaces are involved. The emission requirements depend on the type and date of construction of the installation. BEES' requirements will be tightened in 2007, but information as to what extent is not yet available. Furnaces and dryers are covered by the Netherlands Emission Guidelines for Air.

In addition, the IPCC guideline also applies to larger plants. Companies that participate in NO_x emission trading are also covered by this guideline, which prescribes that every installation must implement emission-reducing measures that are based on the Best Available Technique (BAT). So-called sector specific BAT Reference Documents (BREF) [47] describe which techniques qualify for that sector. Often more techniques qualify, which have a broad distribution in the emission factors. The implementation of the guideline is managed by the competent authorities. They must establish what is BAT for the location in question.

This requires some consultations with the company. For existing situations this means that the authority granting the permits must ask the company to apply for a new (revision) permit first. Theoretically speaking, it is possible that companies that participate in NO_x emission trading are forced to take measures that lead to a lower emission factor than 40 gr/GJ, whereas a company itself might prefer not to take its own measures, but to purchase emission credits. Whether or not this will occur and to what extent will depend on the negotiation processes between the authority granting permits and the companies. In the calculation of emissions, it was assumed that the IPCC guideline will not lead to an averagely lower emission factor than 40 gr/GJ for companies that participate in NO_x emission trading.

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[47] BAT-Reference, BAT refers to 'best available technique'.

Results

The total emission in 2010 of industry, refinery, the energy sector and waste disposal amounts to 73 kton in the SE scenario and 75 kiloton in the GE scenario. This is 2 to 4 kiloton higher than the projection for the White Paper 'Erop of eronder' (Smeets, 2004), which amounts to 71 kiloton.

The sectors that participate in NO_x emission trading will expectedly emit 66 kiloton in SE and 67 kiloton in GE in 2010. For 'Erop of eronder' an emission of 60 kiloton was projected. The difference can mainly be explained by a higher projection of fuel consumption. Moreover, the calculation of the process emission now includes the growth of the production processes in question.

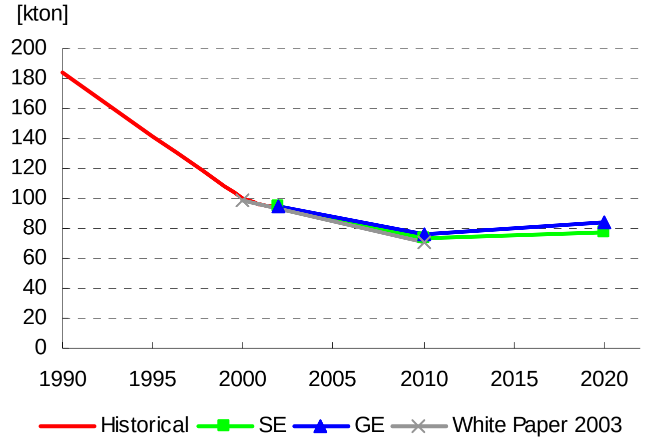

Figure 9.1.3 - Development of the NO_x emission in the sectors industry, refinery, energy sector and waste treatment

In the past, it was implicitly assumed that the production volume of these processes would remain unaltered.

In the calculation of the emissions, it was assumed that all participating companies will comply wit the performance standard (similarly to the White Paper), either through the implementation of emission reducing measures within the company, or by purchasing emission credits. For 2010, an emission factor of 40 gr/GJ has been used for combustion emissions. The same factor is also used after 2010. The increase in emission after 2010, which amounts to 71 kiloton in SE and 77 kiloton in GE, is the result of an increase in fuel consumption.

The emission of companies that are not participating in NO_x emission trading is lower than in 'Erop of eronder'. In the White Paper, an emission of 11 kton was estimated, whereas both scenarios now indicate 8 kton. The main reasons for the lower projections are a lower assessment of fuel consumption by the small-scale industry and the reorganization of gas engines of energy companies (Kroon, 2005). After 2010, the emission decreases in both scenarios to 7 kiloton in 2020. This decrease is the result of a further decrease of the average emission factor caused by the replacement of old equipment (with relatively high NO_x emissions) with new and cleaner equipment. Within the oil and gas extraction a decrease in energy consumption is occurring.

Target compliance 2010

The NEC target in 2010 amounts to 65 kiloton for these sectors, divided into 55 kiloton for the large-scale industry (>20 MW) and 10 kiloton for the small-scale industry. The ceiling for large-scale industry will most likely be exceeded with 11 kiloton (SE) to 12 kiloton (GE) as a result of which the target will probably not be reached. The small-scale industry will probably remain 2 kiloton under the 10 kiloton ceiling in both scenarios and will most likely reach its target. It is unlikely that the joint ceiling of 65 kiloton will be reached.

Uncertain factors

The uncertainty in the projections of the NO_x emission amounts to approximately 20% in 2010 and is mainly caused by uncertainties in relation to future fuel consumption and the inaccuracy in measurements which are used to determine if companies comply with the performance standard (emission trading) or emission requirements (BEES).

Transport

The transport sector held a 64% share in total NO_x emissions in the Netherlands in 2002. The data that are presented here do not stem from the WLO study, contrary to the other sectors, but come from the study ´Actualisatie Emissieprognoses verkeer en vervoer 2003´, which was drafted by MNP-RIVM for the White Paper ‘Erop of Eronder’.

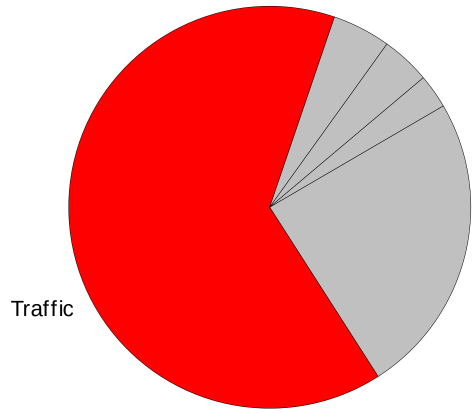

Figure 9.1.4 - Share of the Transport sector (excluding ocean shipping) in total emissions of NO_x in 2002

Volume developments

Table 9.1.2 shows the annual growth of fuel consumption of the various vehicle categories and the contribution of these categories to the total NO_x emission of the Transport sector.

Due to a shift in fuel mix (share of petrol, diesel and LPG in fuel consumption) in passenger cars and the growth of freight transport the consumption of diesel increases significantly. Because diesel cars are more economical per kilometre than petrol cars, CO_2 emissions would have been higher in 2010 without the shift in fuel consumption. The reverse is the case with NO_x emissions (and fine particle emissions), because the emissions per driven kilometre of the average diesel car is 8 times higher than the emissions of petrol cars in 2010.

Table 9.1.2 - Contribution vehicle categories to total NO_x emission of transport and annual growth of fuel consumption [%]

	share in total NO_x emission	2000-2010	2010-2020
Passenger cars	26%	-0.5	0.4
on petrol		-2.0	-1.7
on diesel		3.3	2.7
on LPG		-0.8	3.5
Delivery vans	8%	1.1	2.6
Lorries and tractors	28%	3.6	4.2
Buses and special vehicles	4%	-0.1	0.3
Motors and mopeds	0%	-0.1	0.0
Rail transport (diesel)	1%	0.4	3.2
Inland shipping and recreational shipping	13%	1.9	0.3
Fishery (incl. DCP*)	6%	-2.8	-1.8
Aviation	1%	7.6	2.6
Mobile equipment	13%	0.8	1.3

* DCP = Dutch Continental Platform

Policy developments

Below an overview is provided of the policy that was included in the calculation of, among others, the NO_x emissions in the Actualisation report. The policy that was already included in the Reference Projection 2001 is not included in this table. A more complete overview can be found in the Actualisation report.

Table 9.1.3 - Overview of policy NO_x emissions Actualisation report

Vehicle category	Instruments	Reference
Motor bikes	- phase 2 (as of 2003) and phase 3 (as of 2006)	EU:2005/51/EG
Inland vessels	- phase 1 EU (as of 2006…2008)[a)]	EU:COM (2002) 0765
Mobile equipment	- phase 3a and 3b (as of 2006…2012)[b)]	EU:COM (2002) 0765
Agricultural tractors	- phase 3a and 3b (as of 2006…2012)[b)]	EU:COM (2002) 0765
Diesel trains (<560 kW)[c)]	- phase 3a and 3b (as of 2006…2012)[b)]	EU:COM (2002) 0765

a) Phase 1 EU for inland vessels enters into operation between 1-1-2006 and 1-1-2008 for newly produced engines, depending on the category. Engines that were already manufactured before the date of commencement may be sold until two years thereafter.

b) Phase 3a enters into operation between 1-1-2006 and 1-1-2009 for newly produced engines, depending on the category. Phase 3b, in which the standard for particle emissions is tightened, enters into operation between 1-1-2011 and 1-1-2012 for newly produced engines, depending on their category. Engines that were already manufactured before the date of commencement may be sold until two years thereafter.

c) Effectively, the standard only applies to diesel engines in shunting engines and diesel-driven trains. Diesel engines generally have more motor power than the upper limit in the guideline (560 kW).

Results

Despite the increase of the number of driven kilometres, the higher share of diesel cars and the growth of freight transport, the NO_x emission decreases in the period 2002-2010 with 70 kiloton to a level of 185 kiloton. This decrease is mainly caused by a tightening of the NO_x emission standards of road vehicles in this period. The decrease between 2002 and 2010 is relatively largest for passenger cars and delivery vans.

In these categories the emission is lowered with more than 50%. In the period 2010-2020 the emission further decreases to 167 kiloton, despite the increase in fuel consumption. This is caused by the fact that the emission standards apply to newly produces vehicles, as a result of which these have fully penetrated the fleet of vehicles only after a longer period of time.

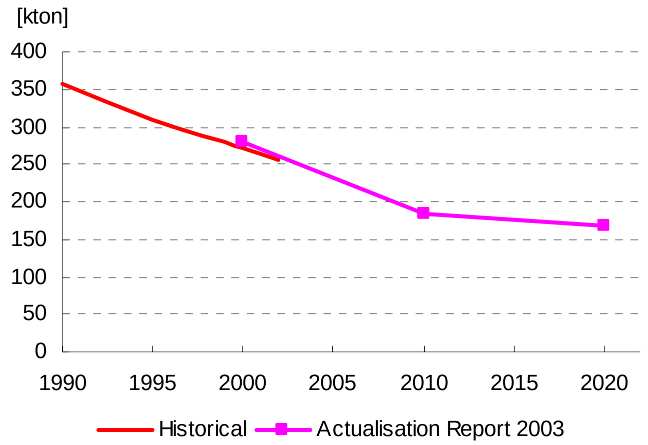

Figure 9.1.5 - Development of the NO_x emission in the transport sector (including fishery on the Dutch Continental Shelf, but excluding ocean shipping)

Target compliance 2010

The NEC sector target for NO_x in 2010 amounts to 158 kiloton. It is unlikely that this target will be reached. The measure package in the White paper on transport emissions aims to realize the policy objective by means of a 'basic package' (-8 kiloton) and by raising the matter of the EU emission testing method for heavy company vehicles (-19 kiloton) in the EU.

Recently, it became public that the NO_x emissions from heavy company vehicles has indeed decreased between consecutive Euro standards in the official EU emission test, but considerably less or even not at all during driving in practise. This practise of so-called ‘cycle bypassing’ was possible because the EU testing method is hardly representative for the actual situation.

In addition, a back-up package has been defined for additional emission reductions. The back-up package must compensate for eventual setbacks. The Netherlands should take into account that the EU will not or only partly take care of the 19 kiloton, in which case extra policy will be necessary to realize the sector target for transport (Beck et al, 2004). It is also not certain beforehand if the EU will agree with the Dutch calculation method for the calculation of the 19 kiloton setback as a result of ‘cycle bypassing’ in heavy company vehicles.

Uncertain factors

Uncertain factors that were included in the Actualisation report and are related to the NO_x emissions are:

- The volume of road transport. The uncertainty is the result of uncertainties in the growth of the GDP, disposable income and the development of the oil price.
- The development of fuel consumption in fishery at the Dutch Continental Shelf (DCS). It is assumed that in the most unfavourable situation the volume remains similar to the current level, whereas in the most favourable situation it decreases with 50%. The estimated uncertainty with respect to fuel consumption thus amounts to +/- 25%. The uncertainty in NO_x emission factors has not been included here.
- The fuel mix of passenger cars. In the most unfavourable situation for NO_x, it is assumed that the share of diesel has increased to 35% in 2010. In the most favourable situation it amounts to approximately 25%.

The final uncertainty in NO_x emissions from transport is difficult to assess due to the large complexity of the modelling of transport prognoses and the large uncertainties of monitoring. In the Actualisation report, the bandwidth in 2010 is estimated at +/- 6 kton, analogous to +/- 3%. This projection has not been done according to the definition of a 95% reliability interval, however, in which case the reliability is at least 20%.

Furthermore, it should be noted that this uncertainty is related to the projection for the White Paper ‘Erop of eronder’. New projections will be made in the framework of the WLO study. According to expectations, especially the growth of road transport can turn out differently, among other things because a different GDP growth is assumed. For ‘Erop of eronder’ the GDP growth amounted to 2.5% annually, and now that growth amounts to 1.7% (SE) and 2.7% (GE) respectively.

Households, TSG, construction and agriculture

The sectors households, trade, services & government (TSG) and agriculture held a share of respectively 5,4 and 3% in Dutch NO_x emissions in 2002. In the households sector the emission is mainly caused by CV boilers and in the sectors trade, services & government (TSG) and agriculture emissions come from heating boilers, air heaters and cogeneration gas engines.

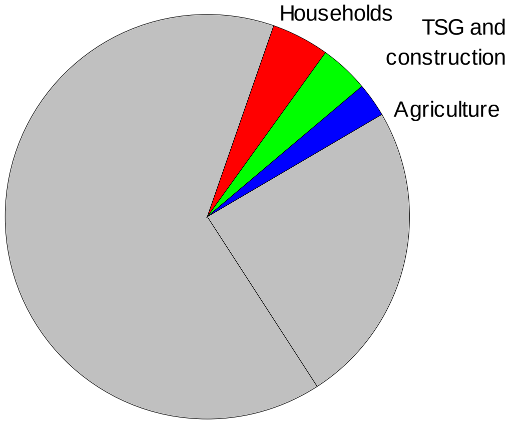

Figure 9.1.6 – Share of the sectors households, trade, services & government (TSG), construction and agriculture in the total NO_x emissions in 2002

Volume developments

Table 9.1.4 presents the development of fuel consumption in households, TSG & construction and agriculture as well as the share in total emissions of these sectors.

Table 9.1.4 – Contribution to total emissions of the sectors households, trade, services, government & construction and agriculture, and the annual growth in % of the most relevant processes

	share in total	SE		GE	
	NO_x emission	2000-2010	2010-2020	2000-2010	2010-2020
Fuel consumption households	45%	-1.1	-0.9	0.0	0.0
Fuel consumption TSG&construction	35%	-1.0	-1.1	-0.5	-0.3
Fuel consumption agriculture	20%	-0.9	-2.1	0.3	-0.9

Policy Developments

Based on fuel consumption, nearly half of the equipment is covered by BEES-B, i.e. mainly gas engines and boilers that are used in agriculture and trade, services and government & construction. A minor 40% is covered by the type test specification for CV boilers. Nearly 10% of all equipment, especially gas cookers and heaters, are not covered b y NO_x regulations.

Results

The projection for 2010 for the households sector amounts to 11kiloton (SE) and 12 kiloton (GE). For 'Erop of eronder' an emission of 13 kiloton was projected for 2010. The difference is mainly caused by an averagely somewhat lower emission factor for CV boilers than the one that is used in the projection for 'Erop of eronder'. On the one hand the percentage of clean high efficiency boilers turns out to be higher than previously assumed, but on the other hand the emission factor of old boilers has been raised.

In the period 2010-2020 the emission further decreases to 9 kiloton (SE) and 10 kiloton (GE). This decrease is caused by a decrease in energy consumption on the one hand and by an on-going replacement of old equipment by new and cleaner equipment on the other hand.

The emission of the sector TSG & Construction amounts to 8 kiloton (SE) and 9 kiloton (GE) respectively. The projection for ‘Erop of eronder’ also amounted to 9 kiloton. In the period 2010-2020 the emission further decreases to 5 kiloton (SE) and 6 kiloton (GE) for the same reasons as in the households sector.

The emission of the agricultural sector amounts to 6 kiloton (SE) to 7 kiloton (GE) in 2010, which is 3 kiloton lower than projected for ‘Erop of eronder’. The difference can mainly be explained by new perceptions on increasing use of cogeneration for CO_2 fertilisation in greenhouse horticulture. For this application, exhaust fumes are cleaned by means of exhaust fume cleansing (especially Selective Catalytic Reduction SCR). As a result, the NO_x emission of these installations is well below the current or expected emission standard at 20-30 gr/GJ. In 2020, the emission will have decreased further to 3 kiloton (SE) to 4 kiloton (GE). In this case, the decrease is also caused by a decrease in energy consumption and the ongoing replacement of old equipment with new ones.

Target compliance 2010

The NEC sector targets for 2010 of Households, TSG/Construction and Agriculture amount to 12, 7 and 5 kiloton respectively. The emission of Households in 2010 is expected to amount to 11 kiloton in the SE scenario and 12 kiloton in the GE scenario. The chances of reaching this target are fifty fifty.

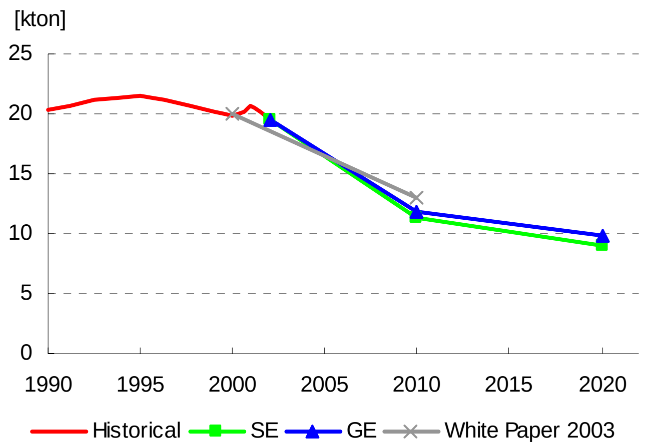

Figure 9.1.7 - Development of NO_x emission in the households sector

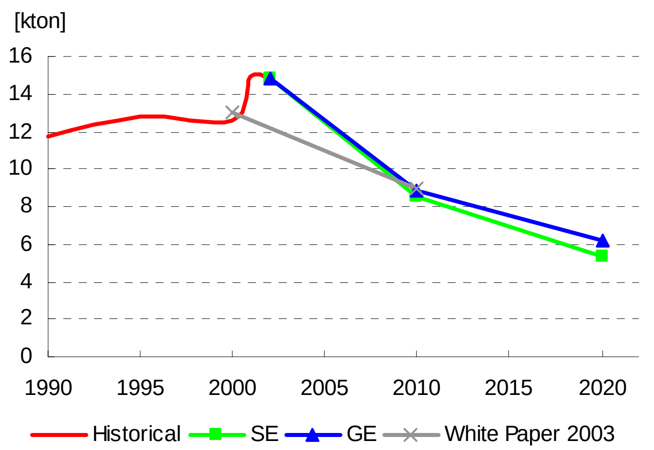

Figure 9.1.8 - Development of NO_x emission in sectors TSG and construction

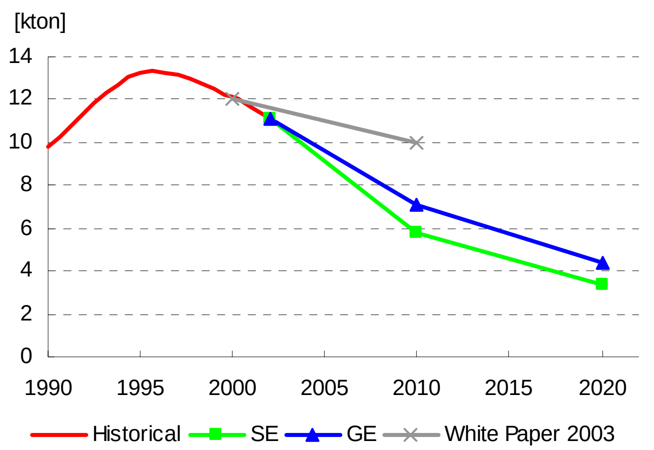

Figure 9.1.9 - Development of NO_x emission in the sector Agriculture

The emission of TSG/Construction in 2020 is expected to amount to 8 kiloton in SE and 9 kiloton in GE. It is highly unlikely that this target will be reached. The emission of Agriculture in 2010 is expected to be 6 kiloton in the SE scenario and 7 kiloton in the GE scenario. It is unlikely that this target will be reached.

Uncertain factors

The calculated margin in total emissions of 26 kiloton (SE) - 28 kiloton (GE) amounts to approximately 15% for SE. This is mainly caused by the monitoring and projection uncertainty in fuel consumption and the emission factors of the equipment in operation (especially gas engines and CV boilers).

9.2 Sulphur Dioxides (SO_2)

Netherlands total

SO_2 is mainly released during the combustion of coal (products) or oil (products). The largest share (nearly 90% in 2002) of the Dutch emission comes from industry, refinery and the energy sector (especially coal-fired plants). The transport sector held a share of approximately 7%. The other sectors emit relatively little SO_2 because they mainly burn natural gas.

Results

The projected emission for 2010 is 66 kiloton (SE) and 67 kiloton (GE) respectively, which is 2 to 3 kiloton higher than projected by RIVM last year for the White Paper ‘Erop of eronder’. The main reason is that a higher volume growth has been estimated for refineries.

Target compliance 2010

The NEC target for 2010 amounts to 50 kiloton. The target is exceeded with 16 kiloton in the SE scenario and with 17 kiloton in the GE scenario. It is highly unlikely that the target will be reached, unless policy that is currently being developed with industry, refineries and the power sector can be implemented.

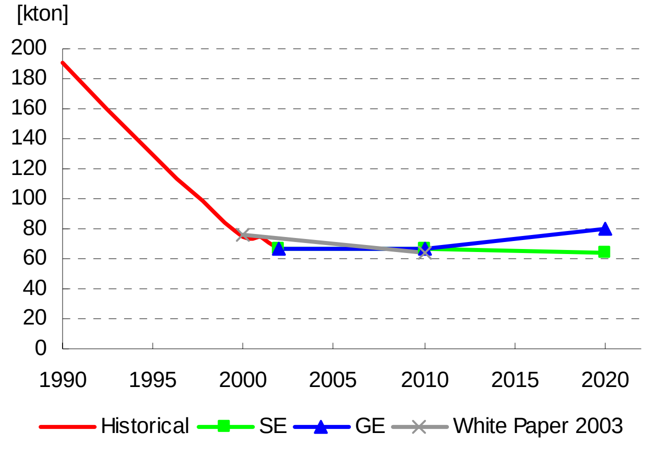

Figure 9.2.1 - Development of the SO_2 emission in the Netherlands

Uncertain factors

The uncertainty for 2010 is projected at -25% and + 11%. The fact that the downward uncertainty is larger is caused, among others, by the fact that the outcome of current SO_2 negotiations with refineries and the power sector, which have not been included in the projections, are the largest uncertain factor and this uncertainty can only have a downward effect compared to the SE scenario. If the outcome turns out positive, then the emission will be lower than projected; if the outcome is negative, then the emission will remain at the level of the current projection. A major reduction has been included in the projections, because Shell Refinery has announced a shift from oil-firing to gas-firing. The small chance that this shift will not take place has been included. Further explanation can be found in the next paragraph.

Industry, energy sector, refineries and waste treatment

The industry (incl. waste treatment), refineries and the energy sector held a share of 22, 45 and 20% respectively in total SO_2 emissions in the Netherlands. Approximately 90% of the total emissions of these sectors are emitted by only 20 companies.

Within the industry, the chemical industry and the base metal industry are the largest emittants. Involved are, among others, producers of soot, aromats, steel and aluminium. In addition. SO_2 is also emitted during the production of glass..

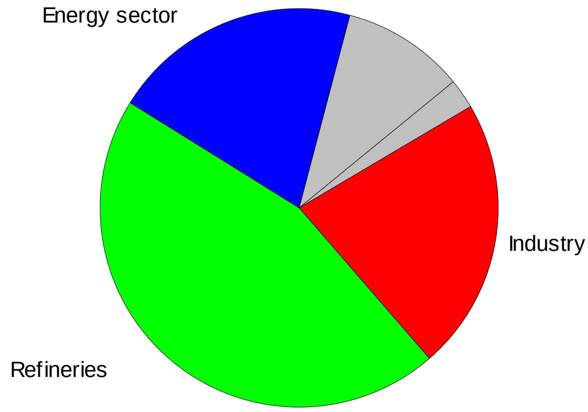

Figure 9.2.2 - Share of the sectors industry (including waste treatment), refineries and the energy sector in total SO_2 emissions in 2002

In refineries, 60% of SO_2 emissions were caused by the use of fuel oil and refinery gas for firing in 2001. Moreover, SO_2 is emitted during the burning off of the catalyst of the catalytic cracking plants, by desulphurisation plants (Claus plants) and by torches.

Within the energy sector, coal plants are the largest emitters of SO_2 emissions. SO_2 is not emitted by gas-fired plants.

Volume developments

Table 9.2.1 shows the development of the relevant processes. The development of fuel consumption in coal pants after 2010 differs significantly between SE and GE. Paragraph 7.1 explains this difference. The development of the refining production also depends on scenarios, especially after 2010.

Table 9.2.1 - Contribution to total SO_2 emissions of the sectors industry, refinery and the energy sector, as well as annual growth in % of the most relevant processes

	share in total	SE		GE	
	SO_2 emission	2000-2010	2010-2020	2000-2010	2010-2020
Fuel consumption coal plants	24%	1.5	-3.9	1.5	2.7
Net refinery production	52%	1.0	0.4	1.1	2.0
Iron and steel production	6%	-0.1	-0.1	0.2	0.2
Aluminium production	6%	0.5	0.5	1.1	1.1
Production other industry	6%	1.1	0.8	1.6	0.8

Policy developments

A number of sources within industry (cf. in soot plants and iron and steel production) are covered by BEES or NeR. For a number of important emission sources (cf. furnace house exhaust) in the aluminium industry) there is no specific regulation. Moreover, in the framework of the target group policy, the chemical and base metal industry have agreed with the government to reduce SO_2 emissions with 90% compared to 1985 (Integrated Environmental Targets target).

In the projections it has been assumed that no reduction or only limited reduction is to be expected between the present time and 2020 in the industry. Companies already comply with the requirements of BEES or NeR, or are not covered by such regulations. The chemical industry has almost fully complied with the IMT target and is not planning any additional measures. Although the base metal industry is not yet in compliance with the IMT target, it is giving priority to other environmental themes (especially water pollution). For that reason, a large aluminium producer (for example) is refusing to install gas scrubbers (reduction of approximately 2 kiloton SO_2), albeit with full approval of the proper authorities.

Negotiations are currently taking place with the industry on the reduction of SO_2 emissions before 2010. The intention is to translate the results of these negotiations into a tightening of BEES or to lay down the results in a covenant or in individual permits. However, since this is not yet existing policy, it has not yet been included in the projections. The emissions of refineries are covered by BEES-A. In that framework the bubble concept is applied for refineries, i.e. a refinery as a whole is facing a 1000 mg/m^3 standard. All refineries are currently in compliance with this standard. Despite this fact, in 2004 Shell Refining decided to switch from oil-fired to gas-fired cogeneration plants. This decision is in line with previous agreements with the government. The measure will lead to a reduction of SO_2 emission of approximately 10 kiloton (Shell Venster, 2005) [48]. This reduction has been included in the projections. Negotiations with other refineries are currently taking place on a maximal emission in 2010 of 14.5 kiloton, but this is not yet solid/firm policy and for that reason not yet included in the projections.

Coal plants are covered by BEES or the Decree on Waste incineration Directive if polluted biomass is co-fired. All coal plants have already been equipped with a flue gas desulphurisation installation (ROI). The removal efficiencies of these installations are in compliance with the current emission demands of BEES (400 mg/m^3) and the BVA (175 mg/m^3 if 20% polluted biomass is co-fired). This means that the current regulation does not provide a legal basis for enforcing additional measures. Therefore the current projections do not assume any additional reduction measures. Negotiations are taking place with cowl plants about a reduction of 13.5 kiloton in 2010. There is an agreement with EnergieNed on the NEC target of 13.5 kiloton in 2010. Wit what instrument this agreement can be fixed is a matter that needs further examination. This reduction has also not been included in the projections.

Results

The emission that is projected for the industry for 2010 amounts to almost 18 kiloton, which is equal to the projection for the White Paper 'Erop of eronder'. No new information is available that results in new perceptions.

The emission increases slowly over the period 2000 to 2020. This is the result of an increase of the production levels of SO_2 emitting processes, whereas new reduction measures are not foreseen.

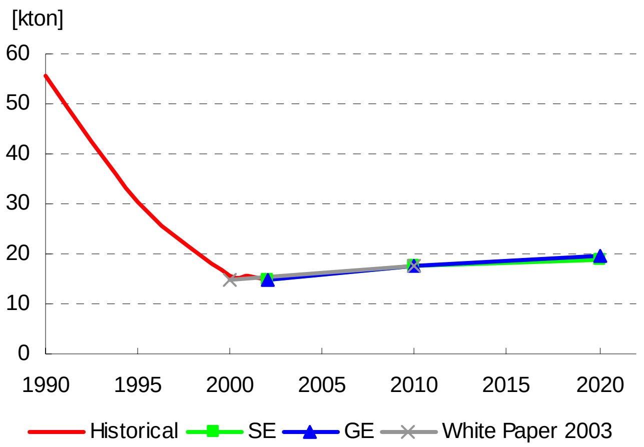

Figure 9.2.3 - Development of the SO_2 emission in the sector industry (including waste treatment)

The emission of refineries in 2010 is projected at 25 kiloton (SE) to 26 kiloton (GE). This is 3 to 4 kiloton higher than in the projection that was done for 'Erop of eronder' in 2003. The difference can be explained by the fact that in the current projection, contrary to the previous projection,

48 Pernis poetst zich verder op (Pernis is brushing up), Shell Venster January/February 2005, pp. 17-19.

takes volume growth of refineries into account and a somewhat lower reduction has been estimated for Shell.

The emission of coal plants in 2010 amounts to 17 kiloton both in SE and in GE. The projection for 'Erop of eronder' amounted to nearly 19 kiloton. This difference is caused by a lower estimate of fuel input (coal) for the current projection. Both scenarios have assumed that new measures will not be taken. In SE the emission has decreased to 12 kiloton in SE in 2020, whereas in GE it has increased to 23 kiloton. The difference can be fully explained by the fact that the input of coal in 2020 is much larger in the GE scenario than in the SE scenario.

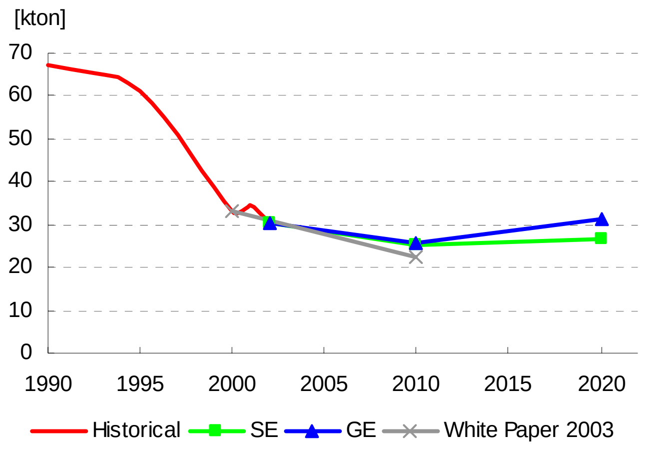

Figure 9.2.4 - Development of the SO_2 emission in the sector refineries

Target compliance 2010

The joint NEC target of the sectors industry, refinery energy and waste treatment for 2010 amounts to 39.5 kiloton. The emission of these sectors is expected to amount to 60 kiloton in both scenarios that year. The ceiling is thus exceeded with more than 20 kiloton. The target will almost certainly not be reached. If the negotiations (see policy developments) are successful, then the exceeding may end up 14 kiloton lower than currently projected.

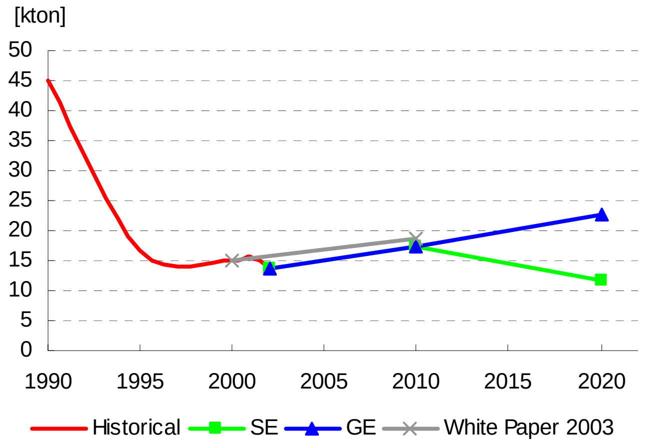

Figure 9.2.5 - Development of the SO_2 emission in the energy sector

Uncertain factors

The margin of this sector is minus 25% and plus 15%. Since these sectors together hold the largest share in the Dutch total, they are dealing with the same uncertainties as the Dutch total: the largest uncertainty is caused by the intended but not included reductions in refinery and in coal plants (see policy developments).

The uncertainties in industry are mainly related to the development of the production levels of the processes that emit SO_2. This uncertainty is estimated at 10%. Companies in the industry are currently not planning on taking any SO_2 emission reducing measures and the chances of current negotiations leading to any results are assumed to be limited in the uncertainty analysis. The uncertainty in the determination of the future emission per unit of production (emission factors) is therefore relatively limited.

In refining, the uncertainty of the projections of production in 2010 also amounts to 10%. In this sector, it was assumed that the largest emittant (Shell) will switch from oil-firing to gas-firing, resulting in an emission reduction of 10 kiloton. The choice to include this reduction is based on the fact that Shell has commissioned the construction of a gas-fired cogeneration plant. Whether or not this plant will be built, however, is only 100% certain when the actual building starts. In this projection it is estimated at 90%.

Beside the outcome of the negotiations, especially the development of fuel consumption (coal and biomass) in coal plants is very uncertain. This uncertainty is estimated at 10%, similar to the industry and the refineries.

Transport

The transport sector held a 7% share in total SO_2 emission in the Netherlands in 2002. The data that are presented here do not stem from the WLO study, contrary to the other sectors, but come from the study ´Actualisatie Emissieprognoses verkeer en vervoer 2003´ that was drafted by MNP-RIVM for the White Paper ‘Erop of Eronder’.

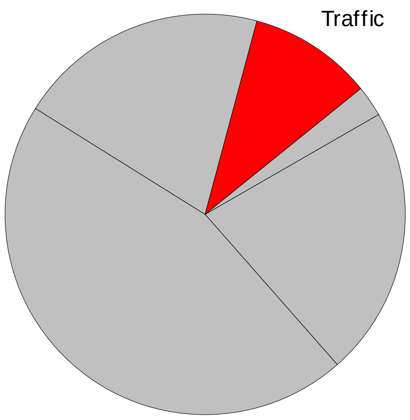

Figure 9.2.6 - Share of the sector transport (excluding ocean shipping) in total emission of SO_2 in 2002

More details on the background of this choice and the characteristics of the Actualisation report can be found in Paragraph 6.2. In the Actualisation report a middle projection is provided with a scenario differentiation based on the CPB scenarios EC and GC.

Volume developments

Table 9.2.2 shows the annual growth of fuel consumption of the various vehicle categories and the contribution of these categories to the total SO_2 emission of the sector transport. SO_2 emissions are directly related to the fuel consumption of vehicles and the sulphur content of the fuel.

Table 9.2.2 - Contribution of vehicle categories to total SO_2 emissions of transport, as well as annual growth of fuel consumption (%)

	share in total SO_2 emission	2000-2010	2010-2020
Passenger cars	14%	-0.5	0.4
on petrol		-2.0	-1.7
on diesel		3.3	2.7
on LPG		-0.8	3.5
Delivery vans	7%	1.1	2.6
Lorries and tractors	11%	3.6	4.2
Buses and special vehicles	2%	-0.1	0.3
Motors and mopeds	0%	-0.1	0.0
Rail transport (diesel)	1%	0.4	3.2
Inland shipping and recreational shipping	26%	1.9	0.3
Fishery (incl. DCP*)	10%	-2.8	-1.8
Aviation	3%	7.6	2.6
Mobile equipment	27%	0.8	1.3

* DCP = Dutch Continental Platform

Policy developments

The only new policy measure since the Reference projection of 2001 is the tightening of the standard for the maximum content of sulphur of road transport fuels to 10 ppm. This standard applies as of January 1st 2009. The tightening to 50 ppm per January 1st 2005 was already included in the Reference Projection of 2001.

Results

Despite the volume growth of road transport, the SO_2 emission decreases with 3 kiloton to a level of 4 kiloton in the period 2002-2010. This is the result of a sharpening of the standards for sulphur contents in fuels for road transport before 2010.

The standard is equal for petrol and for diesel as a result of which the shift to more diesel cars does not influence the amount of SO_2 emissions. The standards for the sulphur con tent of gas oil for non road transport purposes (e.g. mobile equipment, diesel trains) will also be tightened. Therefore the emissions in this category decrease between 2000 and 2010, despite the increase in fuel consumption.

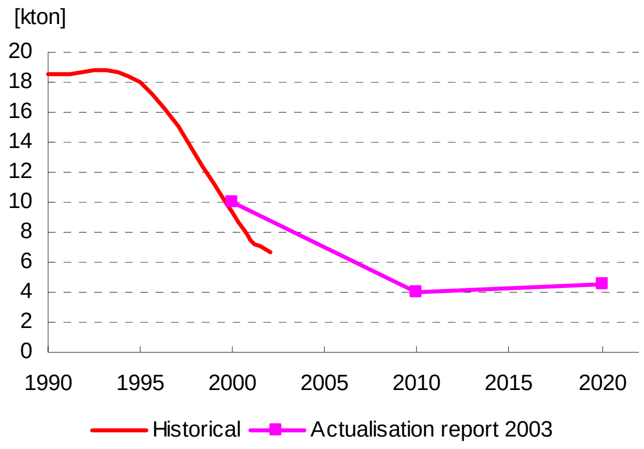

Figure 9.2.7 - Development of the SO_2 emission in the sector transport (excluding ocean shipping)

In the period 2010-2020 the SO_2 emission increases slightly to nearly 5 kiloton. Because the emission of SO_2 is directly related to fuel consumption and the sulphur content in the fuel there is no time-lag, contrary to emission standardization for new vehicles. Because fuel consumption increases in the period 2010-2020 and additional measures for tightening the sulphur standard are not taken, the SO_2 emissions increase slightly again in this period.

Target compliance 2010

The transport sector has an SO_2 ceiling of 4 kiloton. The emission that is projected for 2010 is equal to this amount. Thus there is a fifty fifty chance of reaching the ceiling.

Uncertain factors

The uncertainty factors that are included in the Actualisation emission prognoses in relation to the SO_2 emissions are the following:

Uncertainty in relation to the volume op passenger and freight transport. The uncertainty is the result of uncertainties regarding the growth of the GDP, disposable income and the development of the oil price.

Uncertainties with respect to the development of fuel consumption of fishery on the Dutch Continental shelf. It is assumed that the volume remains equal to the current level in the worst case (for SO_2 emissions), whereas under the most favourable circumstances it will decrease with 50%. The estimated uncertainty regarding fuel consumption thus amounts to +/- 25%.

The estimated final uncertainty in SO_2 emissions from transport amounts to at least 25% at a reliability interval of 95%. Half of that percentage is caused by monitoring uncertainty.

This uncertainty is related to the projection for the White paper “Erop of eronder”. New projections will be made for the WLO study.

Households, TSG, construction and agriculture

The sectors households, TSG, construction and agriculture held a mere 3% share in Dutch SO_2 emissions in 2002. In these sectors, energy is mostly generated with natural gas, which does not contain sulphur.

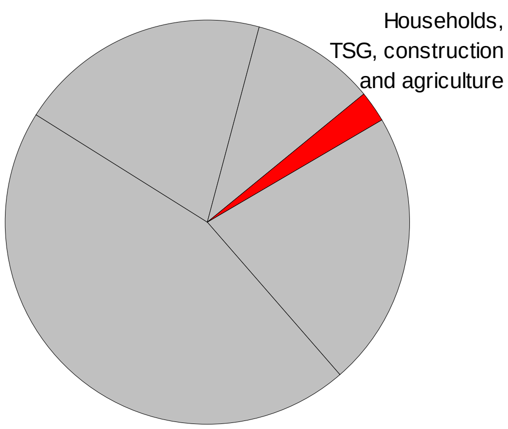

Figure 9.2.8 - Share of the sectors households, TSG, construction and agriculture in total SO_2 emissions in 2002

Volume developments

New information has not become available on the SO_2 emissions of the sectors households, TSG, construction and agriculture in 2010 since the projection for the White paper “Erop of eronder”. Therefore the same data are presented for that year. The emission for 2010 is calculated on the basis of the growth in the sectors households and construction (the emission of agriculture has decreased to 0 in 2010). Table 9.2.3 shows the share of the sectors in the emission in 2010 as well as the annual growth of the sectors in % as of 2010.

Table 9.2.3 - Contribution of the relevant sectors to the total SO_2 emission of the sectors households, TSG, construction and agriculture in 2010 and annual growth in %

	share in total SO_2 emission	SE 2010-2020	GE 2010-2020
Population size	26%	0.5	0.6
Building industry (production)	74%	0.5	1.8

Policy developments

There is no specific policy for the reduction of SO_2 emissions in these sectors.

Results

The total emission of the sectors that are discussed here amounts to approximately 2 kiloton in both scenarios in 2010, which is equal to the projection for 'Erop of eronder'. In SE, there is a limited increase of emissions after 2010 and in GE the emission increases with approximately half a kiloton.

Target compliance 2010

The NEC sector ceilings 2010 of households, TSG & construction and agriculture are 1,1 and 0 kiloton respectively. The projected emission in 2010 is also 2 kiloton (both scenarios). Chances of reaching the ceiling are fifty fifty.

Uncertain factors

As this sector holds a particularly small share in total emissions (3%), the projection uncertainty has not been estimated. The monitoring uncertainty amounts to approximately 40%.

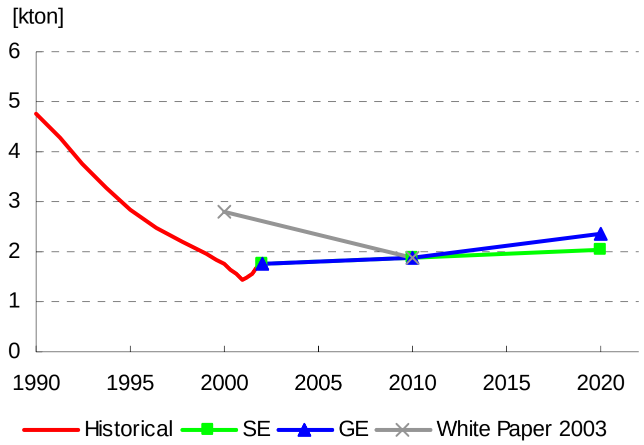

Figure 9.2.9 - Development of the SO_2 emission in the sectors households, TSG, construction and agriculture

9.3 Volatile organic compounds excl. methane (NMVOC)

The Netherlands total

NMVOC (volatile organic compounds excluding methane) is emitted by all sectors. In 2002, the sectors transport held the largest share with 41% and 22% respectively, followed by the sector households (13%), TSG and construction (12%) and the energy sector (7%). Refineries and agriculture emit very little NMVOC.

In industry and refineries, NMVOC is a process emission in the production and storage of hydrocarbon and combustion of fuels. In the energy sector, the extraction and transport of natural gas is the main source and in the transport sector petrol vehicles are the main source of NMVOC emissions. In households, TSG and construction and agriculture NMVOC-containing products such as paint, glue and cosmetics are important sources.

Results

The projected emission for 2010 is 173 kiloton (SE) to 176 kiloton (GE), which is 22 kiloton (SE) to 19 kiloton (GE) lower than the projection of MNP-RIVM in the assessment of 'Erop of eronder' (Beck et al, 2004)[49]. The main reason is that in many cases policy that was still marked as 'soft' (not established) at that time is now included as existing policy. This is especially the case for industry and to a lesser extent for households, TSG and construction.

Target compliance 2010

The NEC target for 2010 amounts to 185 kiloton. In the SE scenario, the emission is 173 kiloton and in the GE scenario it amounts to 176 kiloton. It should be noted, however, that the projected numbers for the transport sector do not include the latest perceptions on NMVOC emissions from cold starts of petrol cars. Most recent insights show that the cold start emissions have been underestimated with 5 to 20 kiloton (Beck et al, 2004). Based on these data, the realization of the emission ceiling is still possible but not certain.

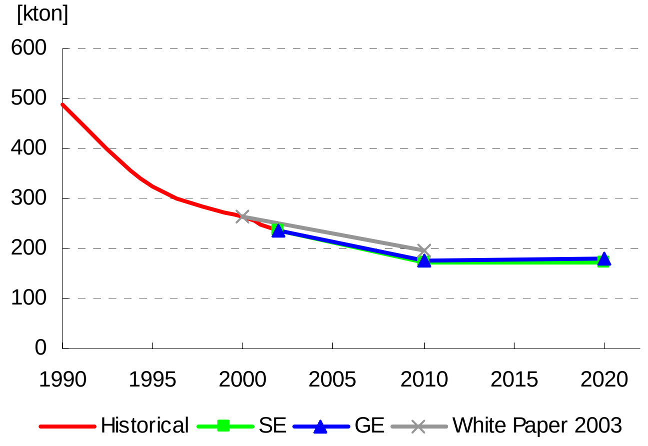

Figure 9.3.1 - Development of the NMVOC emission in the Netherlands

Uncertain factors

The uncertainty in the projections is estimated at approximately 20%. More than half of this percentage is caused by uncertainty in monitoring. The total projection uncertainty of the sectors industry and energy holds the largest share in this percentage. This uncertainty is estimated to be very high, because reliable information on the emission factors of all VOC emitting activities in this sector is not available.

Industry, energy sector, refineries and waste disposal

The industry (incl. waste disposal), refineries and the energy sector held a share of 22, 3 and 7% respectively in total NMVOC emission in the Netherlands in 2002.

49 Assessment of the White paper on Emission ceilings acidification and large-scale air pollution 2003, J.P. Beck, R.J.M. Folkert, W.L.M. Smeets (red.),RIVM report 500037003/2004.

Nearly all industrial sectors emit NMVOC emissions. NMVOC emissions arise as process emissions in various industrial processes and as combustion emission during the combustion of fuels. A significant share of the emission is the result of the use of NMVOC-containing solvents, cleaning products, paint and ink.

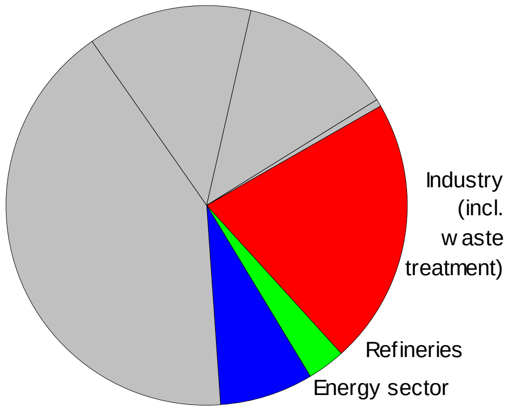

Figure 9.3.2 - Share of the sectors industry (including waste disposal), refineries and the energy sector in total emissions of NMVOC in 2002

In refineries NMVOC emissions are emitted during the production and storage of petroleum products. In the energy sector, the extraction and transport of natural gas is the main source of NMVOC emissions.

Volume developments

In Table 9.3.1 the volume developments of the main processes are indicated, as well as the contribution of these processes to the total NMVOC emission of the sectors industry, energy, refinery and waste disposal.

Table 9.3.1 - Contribution of the main processes to the total NMVOC emission of industry (incl. waste disposal), refinery and the energy sector as well as annual growth of the production (%)

	share in total	SE		GE	
	NMVOC	2000-2010	2010-2020	2000-2010	2010-2020
Oil and gas extraction	15%	-1.9	-1.3	0.0	-2.3
Gas transport / distribution	8%	-0.8	-0.2	-0.2	0.7
Chemical industry	14%	1.6	2.2	2.0	2.3
Refineries and terminals	10%	1.0	0.4	1.1	2.0
Metalectro	21%	-0.1	1.1	0.1	1.1
Printing industry	11%	0.4	0.9	1.4	0.8
Foods and luxury foods industry	7%	0.8	1.0	1.5	2.2

Policy developments

The White paper ‘Erop of eronder’ includes a hard (established) and a soft (not established) policy package. Only the hard policy package was included in calculations at the time. In the mean time the following measures have been transferred from the soft to the hard policy package:

- BMP3 measures from the chemical industry.
- Measures from the Environmental Policy Agreement (MBO) for the printing industry.

The measures from the ‘National Reduction Plan NMVOC’ for refineries and terminals have not yet been transferred to the hard policy package. The refineries and terminals are the only sectors that have established a new (higher) emission value in their sectoral reduction plans for base year 2000. Next, the possible reductions were calculated on the basis of this new starting value for the year 2000. As the new emission value has not yet been adopted in the Emission Registration and thus still lacks an official status, it is currently not possible to transfer the measures for refineries and terminals to the hard policy package.

Results

The projected emission for the industry amounts to 43 kiloton (SE) to 44 kiloton (GE) for 2010. This is 14 to 13 kiloton lower than the 57 kiloton that was projected by MNP-RIVM for the assessment of 'Erop of eronder' (Beck et al, 2004) [50]. The main reason is that a number of policy measures that were considered as 'soft' at that time are now included as hard policy (see policy developments).

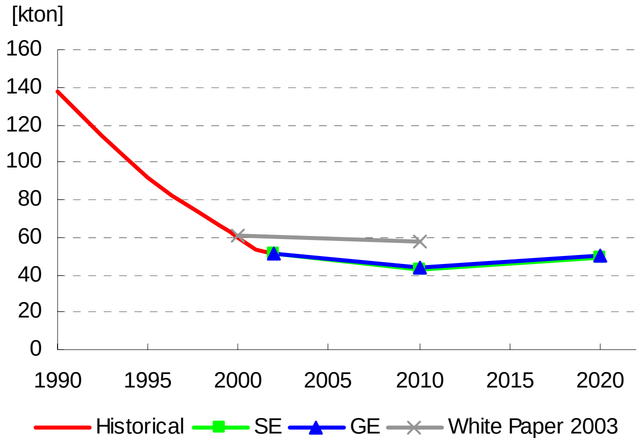

Figure 9.3.3 - Development of the NMVOC emission in the sector industry (including waste disposal)

The projected emission for 2010 for refineries amounts to 8 kiloton in both scenarios. This is 1 kiloton lower than the 9 kiloton that was projected for 'Erop of eronder'. This is the result of a lower projection of the production of refineries.[51].

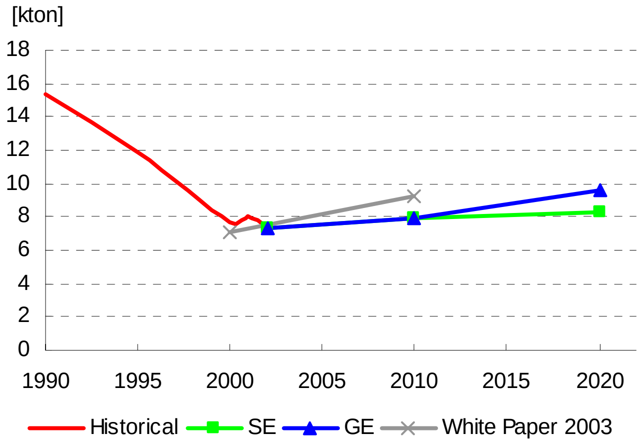

Figure 9.3.4 - Development of the NMVOC emission in the sector refinery

The projected emission for 2010 amounts to 8 kiloton in both scenarios, which is 2 kiloton lower than the emission, projected for 'Erop of eronder'. The difference is caused by the fact that in the previous projection 2000 was taken as base year, whereas now 2002 is the base

[50] Assessment of the White paper on Emission ceilings acidification and large-scale air pollution 2003, J.P. Beck, R.J.M. Folkert, W.L.M. Smeets (red.),RIVM report 500037003/2004.

[51] Contrary to the previous projection of the SO_2 emission of refineries, the previous projection of NMVOC emissions did include production growth.

whereas now 2002 is the base year. The emission of power plants in 2002 was considerably lower than in 2000.

In all three sectors the development of the emission in the period 2010 to 2020 is equal to the development of the production volume of the emitting processes. It is assumed that the emission per unit of production will not change after 2010.

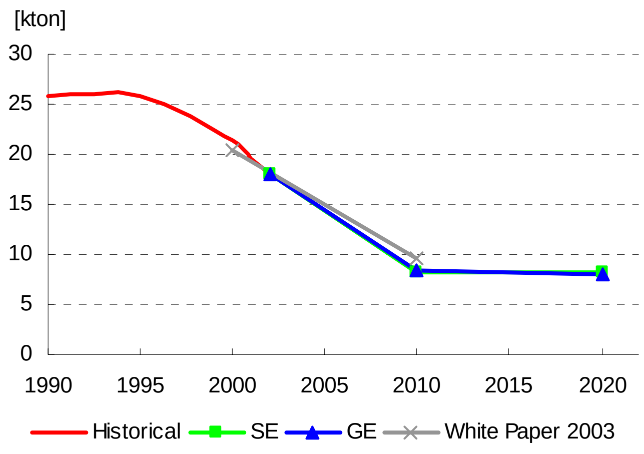

Figure 9.3.5 - Development of the NMVOC emission in the energy sector

Target compliance 2010

The joint NEC target of industry, refinery and the energy sector for 2010 amounts to 61 kiloton. The projected emission in these sectors in 2020 is 59 kiloton in the SE scenario and 60 kiloton in the GE scenario. Chances of reaching the ceiling are fifty fifty.

Uncertain factors

The uncertainty in the NMVOC emission is probably large, yet at the same time difficult to establish. In the projection of MNP-RIVM for 'Erop of eronder' the monitoring uncertainty of the total NMVOC emission in the Netherlands is estimated at 25% (95% reliability interval). It is assumed that this percentage does not only apply to the total Dutch NMVOC emissions, but also to the sectors industry, refinery and the energy sector.

In order to determine the total uncertainty in 2010, an estimate needs to be made of the uncertainty in the projections as well. Factors that play a role here are the development of the production volume of NMVOC emitting processes and the extent to which reducing measures will be taken. The projection uncertainty amounts to at least 25 % according to estimates. The total uncertainty amounts to approximately 50%. This is a rather rough estimate though.

Transport

The sector transport held a 41% share in total NMVOC emissions in the Netherlands in 2002. The data that are presented here do not stem from the WLO study, contrary to the other sectors, but come from the study ´Actualisatie Emissieprognoses verkeer en vervoer 2003´ that was drafted by MNP-RIVM for the White Paper 'Erop of Eronder'.

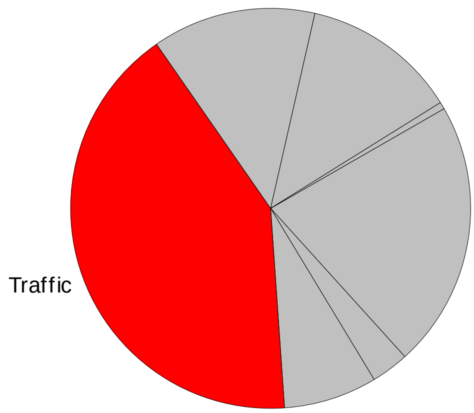

Figure 9.3.6 -Share of the sector transport (excluding ocean shipping) in total emissions of NMVOC in 2002

Volume developments

Table 9.3.2 shows the annual growth of fuel consumption in the various vehicle categories and the contribution of these categories to the total NMVOC emission of the sector transport. By far the largest contribution to the emissions comes from petrol cars. As a result of a shift in fuel mix in passenger cars, petrol consumption decreases in the period 2002 to 2020.

Table 9.3.2 - Contribution of vehicle categories tot the total NMVOC emissions of transport and annual growth of fuel consumption [%]

	share in total NMVOC	2000-2010	2010-2020
Passenger cars	60%	-0.5	0.4
on petrol		-2.0	-1.7
on diesel		3.3	2.7
on LPG		-0.8	3.5
Delivery vans	5%	1.1	2.6
Lorries and tractors	4%	3.6	4.2
Buses and special vehicles	1%	-0.1	0.3
Motors and mopeds	18%	-0.1	0.0
Rail transport (diesel)	0%	0.4	3.2
Inland shipping and recreational shipp	4%	1.9	0.3
Fishery (incl. DCP*)	1%	-2.8	-1.8
Aviation	1%	7.6	2.6
Mobile equipment	6%	0.8	1.3

* DCP = Dutch Continental Platform

Policy developments

An overview of the policy that was included in the calculations of the NMVOC emissions can be found in Paragraph 9.2 (NO_x). The policy instruments that are presented there, the European emission standard for vehicles (Euro standards) for NO_x, CO_2 and PM_{10} also apply to NMVOC emissions.

Results

The emission of NMVOC decreases in the period 2000 to 2020. The emission amounts to 55 kiloton in 2010 and 43 kiloton in 2020. Both the decrease in petrol consumption and the tightening of the NMVOC emission standard contribute to this decrease. As the tightened emission standard applies to newly produced vehicles, it also leads to a decrease of the average emission factor in the period 2010-2020.

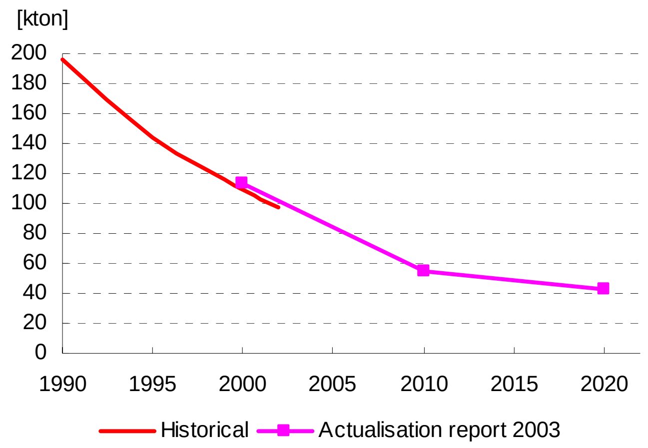

Figure 9.3.7 - Development of the NMVOC emission in the sector transport (incl. fishery on the DCP, excl. ocean shipping)

Target compliance 2010

The NEC target for 2010 amounts to 55 kiloton, which equals the projected emission for 2010. It should be noted though that the Actualisation Emission prognosis does not account for new perceptions on the NMVOC emissions of cold starts of petrol cars. According to these perceptions, the cold start emissions have been underestimated with 5 to 20 kiloton (Beck et al, 2004). As a result it is uncertain if the sector ceiling will be achieved.

Uncertain factors

The following uncertain factors have been included in the Actualisation report on emission prognoses and are related NMVOC emissions:

The volume of road transport. The uncertainty here is the result of uncertainties regarding the growth of the GDP, the disposable income and the development of the oil price. The fuel mix of passenger cars. In the best case scenario for NMVOC emissions it is assumed that the share of petrol has decreased to 60% in 2010. In the worst case scenario it will amount to approximately 70%. The degree in which mopeds comply with the standard under real circumstances. Mopeds are often tuned up, which is usually disastrous for emissions. The somewhat pragmatic assumption has been made that the emission factor has a bandwidth of 20% in 2010.

The final uncertainty in the NMVOC emissions from transport is difficult to assess due to the large complexity of the modelling of transport prognoses. In the Actualisation report, the bandwidth is estimated at +/- 4 kiloton, which corresponds with +/- 7%. This projection was not done in accordance with the 95% reliability interval though, in which case the uncertainty amounts to at least 30%. It should be noted that the uncertainty is related to the projection for the White Paper 'Erop of eronder'. New projections will be made for the WLO study.

Households, TSG, construction and agriculture

The share of households, TSG & construction and agriculture in the total NMVOC emissions in the Netherlands amounted to 13, 12 and 1% respectively in 2002. In households, the emissions mostly stem from the use of cosmetics and other personal care products, paint and cleaning products and from fireplaces and wood-burning stoves.

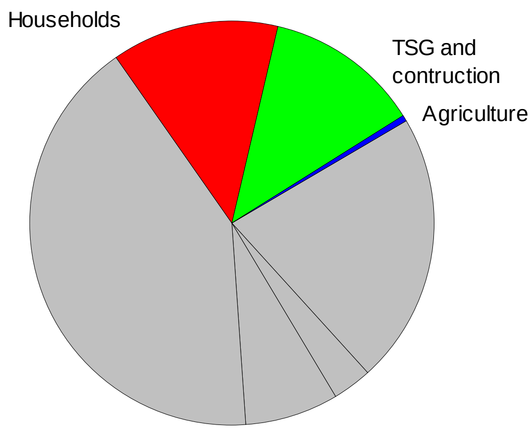

Figure 9.3.8 - Share of the sectors households, TSG, construction and agriculture in total emissions in total emissions of NMVOC in 2002

In the TSG sector, emissions come from a large number of sources. The main sources are warehouses that store VOC-containing products, petrol stations and car respraying businesses. In addition, the use of cleaning products also provide a considerable contribution. In the construction sector, the emission is largely caused by use of paint. Agriculture emits relatively little NMVOS in comparison. The emission is mainly caused by incomplete burning.

Volume developments

Table 9.3.3 provides the volume developments for the main activities in the sectors households, TSG & construction and agriculture as well as the contribution of these activities to the total NMVOC emissions of the sectors in question.

Table 9.3.3 - Contribution of the main activities to total NMVOC emissions of households, TSG & construction and agriculture, and annual volume growth of the activity (%)

	share in total	SE		GE	
	NMVOC	2000-2010	2010-2020	2000-2010	2010-2020
Cosmetics and personal care	17%	1.9	1.7	2.9	3.0
Cleaning products households	5%	0.4	0.5	0.5	0.6
Use of paint in households	10%	1.4	1.6	1.6	2.0
Hearths households	12%	-1.1	-1.2	-1.1	-1.2
Gas stove households	2%	-0.1	0.2	0.2	0.9
Storage and transfer	5%	1.5	1.9	2.9	3.3
Petrol stations	4%	-2.2	-1.6	-2.2	-1.6
Cleaning products TSG	4%	0.9	1.2	1.5	2.0
Use of paint and lacquer in car respraying businesses	5%	-1.9	0.0	-1.9	0.0
Building industry and contractors	20%	1.0	0.5	2.1	1.9

Policy developments

Policy instruments that are new compared to the projection for 'Erop of eronder' are the VOC reduction plans of the branches Association of Independent Tank Storage Companies (VOTOB), the Association of paint and printing ink manufacturers and the Association of tank cleaning companies in the Netherlands (ATCN). Policy that was already included in previous projections is for example the Occupational Health and Safety for glue and paint. As a result of this policy, VOC-containing paint and glue that are used indoors must be replaced with VOC free products.

The EU paint directive was also included in the previous projection. In this directive a maximum is fixed for the content of solvents in of paint products in order to gain admittance to the internal EU market.
Recently, the hallmark for wood-burning stoves was terminated. Since wood-burning stoves often already have a lower emission factor than prescribed in the hallmark, it is assumed that the termination of this policy instrument will not lead to a deterioration of the emission factor.

Results

The NMVOC emissions of households in 2010 is projected at 32 kiloton (SE) to 33 kiloton (GE), which is 3 to 4 kiloton higher than in RIVM's projection for 'Erop of eronder' in 2003.

The main reason is a change in allocation in the base year (2002) of the emissions of cleaning products and cosmetics. Emissions that were previously allocated to TSG are now transferred to households. In the period 2010-2020 the development of emissions follow the volume of the underlying activities.

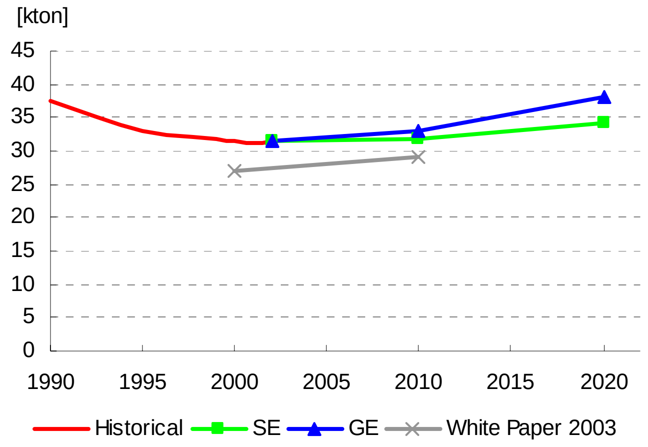

Figure 9.3.9 - Development of the NMVOC emission in the sector households

It has been assumed that the emission factor in this period remains constant. In Se the emission increases to 34 kiloton and in GE it increases to 38 kiloton.

The NMVOC emissions of TSG and construction amounts to 26 kiloton (SE) to 27 kiloton (GE), which is 8 to 7 kiloton lower than in the projection for 'Erop of eronder'. This difference is caused by a change in allocation of a number of emissions (see households) and because some VOC reduction plans of a number of branches (see policy developments, which were previously characterised as soft, are now considered hard plans.

In the period 2010 to 2020 the NMVOC emission increases to 28 kiloton (SE) to 32 kiloton (GE). Similar to households, the emission develops accordingly to the volume of the underlying activities.

The NMVOC emission of agriculture amounts to approximately 1 kiloton in both scenarios in 2010. This projection is similar to the projection for 'Erop of eronder'.

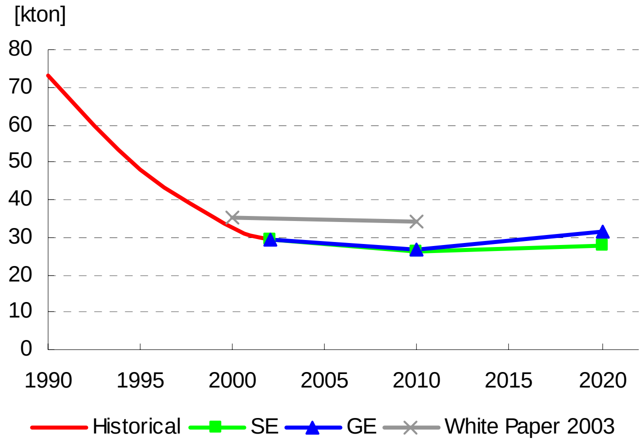

Figure 9.3.10 - Development of the NMVOC emission in the sectors TSG and construction

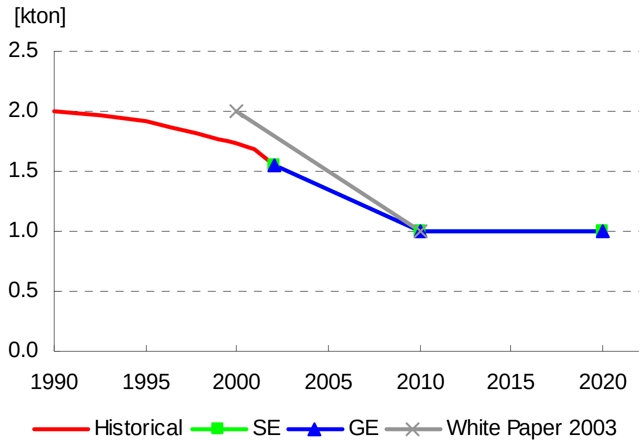

Figure 9.3.11 - Development of the NMVOC emission in the agricultural sector

Target compliance 2010

The NEC sector target of households amounts to 29 kiloton; the TSG and construction target is 33 kiloton and the target for agriculture is 1 kiloton.

In the scenario with the largest growth (GE) the projected emission of the sector households amounts to 33 kiloton, the emission of the TSG and construction sector amount to 27 kiloton and agriculture faces 1 kiloton. It is unlikely that the sector households will realize the NEC sector target. TSG and construction probably will stay below the ceiling.

Uncertain factors

The total margin of the emission in 2010 is calculated at ± 20%. The largest contribution comes from monitoring uncertainty. Without monitoring uncertainty the margin is ± 10%. The main factor is the uncertainty of the NMVOC content of products of the sectors households and TSG.

9.4 Ammonia (NH_3)

The Netherlands total

The agricultural sector has by far the largest share (90% in 2002) in the Dutch NH_3 emission. NH_3 mainly comes from animal manure. Of the other sectors, households have the largest share with 5%. The sources are mostly transpiration and pet manure.

Results

The emission of NH_3 decreases with 10 kiloton in both scenarios to a level of approximately 125 kiloton between 2002 and 2010. The emission barely stays below the NEC emission ceiling (128 kiloton). Especially in agriculture higher emissions are currently projected than in 2003/2004. The higher projection is mainly the result of new perceptions regarding manure utilization techniques and the number of cows.

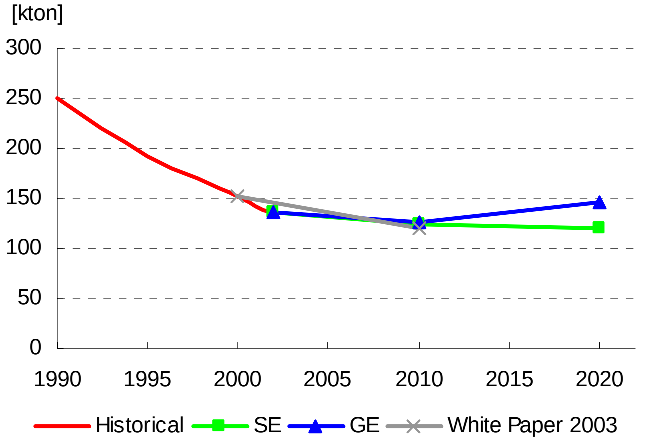

Figure 9.4.1 - Development of the NH_3 emission in the Netherlands

Target compliance 2010

The NEC emission target amounts to 128 kiloton in 2010. In 2010 the emission in the SE scenario is approximately 124 kiloton and 126 kiloton in the GE scenario. One point of interest is the emission factor of low-emission manure utilization. A few years ago there appeared to be a gap between the measured ammonia concentration in the air and the predicted concentration, based on ammonia policy. New perceptions from a measuring project, which was done in the Achterhoek region (VELD project) point out that the emission from manure utilization in the spring is higher than assumed until recently. As a result, the total emission could turn out 2 to 23 kiloton higher than stated in the projections. Realisation of the NEC target is thus possible, yet not altogether certain.

Uncertain factors

The margin is estimated at ± 17%, the largest part of which is caused by monitoring uncertainty of agriculture in particular. Without this uncertainty the margin would have amounted to ± 7%.

Agriculture

Agriculture has by far the largest share of NH_3 emission with approximately 90% of total emissions in the Netherlands (2002). Ammonia mainly comes from animal manure. Emission sources are stables, manure storage outside stables, grazing of livestock and the spreading of manure. NH_3 is also released in the application of nitrogen fertilizer.

The basis for the calculations is the manure production per animal. The ammonia emission from the stable is equal to the manure production per animal times the amount of livestock times the emission factor. The emission factor differs per stable system. A similar procedure is used for manure storage and emission from grazing. The ammonia emission in application is calculated by multiplying the amount of manure that is spread per region, type of crop and type of soil with an emission factor.

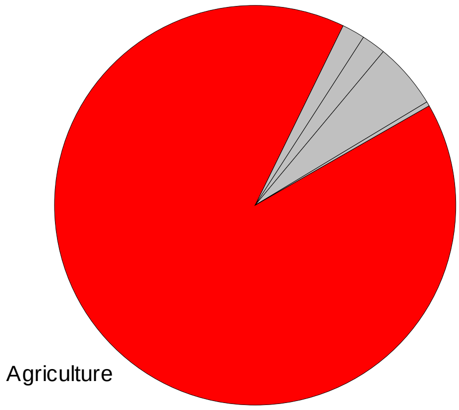

Figure 9.4.2 - Share of the sector agriculture in total emissions of NH_3 in 2002

The value of the emission factor depends on the technique of application (above the ground, injection etc.).

Volume developments

The prognosis of the livestock (and thus the manure production) for the next 15 years is influenced by economic factors, but changes in the EU agricultural policy and manure and ammonia policy also play a role. The manure production per animal is influenced by the development of technology, partly as a result of manure policy: e.g. feeding adjustments in pig and poultry farms or farms where cows are permanently stalled. The share of low emission stable systems and low emission techniques for the utilization of manure are largely steered by the policy for ammonia. Table 9.4.1 shows the development of manure production.

Table 9.4.1 - Share of manure production in total NH_3 emissions in agriculture and annual growth in %

	share in total	SE		GE	
	NH_3 emission	2000-2010	2010-2020	2000-2010	2010-2020
Manure production	93%	-1.4	-0.9	-1.2	1.1

Policy developments

The Common Agricultural Policy (CAP) and manure policy influence the volume of livestock and applied nitrogen to the soil. Without the manure policy, the manure would be processed and exported on a much smaller scale (and/or the livestock volume would increase) and the application of fertilizer would decrease less. A more complete overview of the effects on total manure production and utilization can be found in Paragraph 8.2. The ammonia policy does not influence the volume of the livestock, but it does influence the emission factors though regulations on the manner of manure application and the types of stables that are allowed. Until now the largest emission reduction was achieved through low emission application. Further tightening will be applied to farm land, whereas further tightening for grassland on sandy soil has not taken place. The less low emission drag shoe applicator is still allowed here. The Orders in Council for ammonia emissions of housing of cattle farms states that pig farmers and chicken farmers must build low emission stables during new construction or renovation and that existing stables must be low emission no later than 2008 and 2010 respectively. Large intensive cattle farms must be low emission in 2007 in conformity with IPPC.

Results

In both scenarios NH_3 emission decreases until 2010. This decrease until 2010 is linked to the obligation regarding low emission stables in the intensive cattle farming and the decreasing livestock, especially of dairy cattle. In SE the emission until 2010 amounts to 109 kiloton and in GE it is 111 kiloton. This is 3 to 5 kiloton higher than projected for “Erop of eronder”. The main reason is that the new projections assume a lower increase in milk production, as a result of which more cows are needed to reach the milk quotas (+3 to +4 kiloton). In addition, the changed manure policy is less focused on an efficient utilization of feed and fertilizers (+2 kiloton). The effect of the obligation to plough in manure (into the soil in one run (-6 to -7 kiloton) is almost completely annulled because the use of the drag-shoe applicator) on grass-land on dandy soil remains allowed (+ 4 to +6 kiloton).

After 2020, the emission decreases to 103 kiloton in 2020 in SE, but in GE the emission increases again to 130 kiloton in 2020. The developments after 2010 are mainly related to changes in livestock as a result of changes in the CAP and market developments.

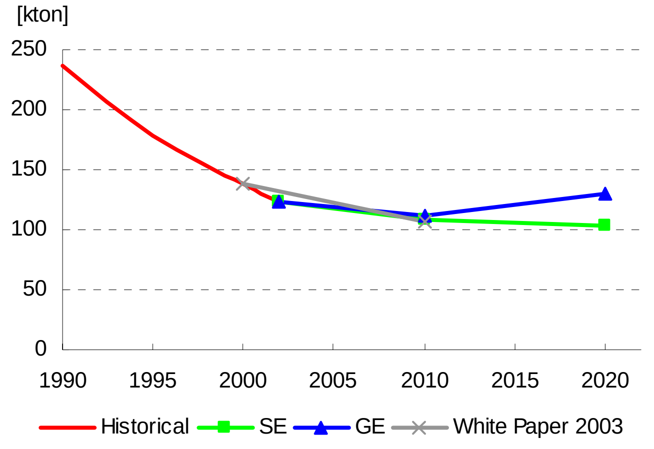

Figure 9.4.3 - Development of the NH_3 emission in the agricultural sector

Target compliance 2010

The NEC sector target for 2010 is 96 kiloton. The projected emission is 109 kiloton in SE and 111 kiloton in GE. Thus it is assumed that the sector ceiling will be exceeded with 11 to 15 kilo-ton. It is unlikely that the ceiling will be reached. The NEC target of the Netherlands anticipates an undivided emission space of 18 kiloton. Agriculture will only stay beneath the sector ceiling if this space is allocated to the agricultural sector. It should be noted that the sector ceiling, con-trary to the NEC target, is an obligation with respect to effort, not a result-oriented obligation.

One issue that is focuses upon is the emission factor of low emission manure utilisation. Some years ago, there appeared to be a gap between the measured level of ammonia in the air and the predicted level, which was based on ammonia policy. A measuring project was done in the Achterhoek (VELD project) to gain some perspective on this issue (Smits et al, 2005). The re-sults show that the emission from manure utilisation in the spring is higher than assumed up to now. As a result, the total emission could turn out 3 to 23 kiloton NH_3 higher than in the projec-tions of Figure 9.4.3.

Uncertain factors

The uncertainty is estimated at approximately 20%, but the results of the above-mentioned ma-nure project have not yet been included. The main uncertain factor, beside the monitoring un-certainty, is the development of low emission application on grassland, and especially the ques-tion to what extent farmers will use the less low emission drag-shoe applicator) on sandy soil. Another uncertain factor is the change n livestock. Until 2010 the question remains how farmers will react to the new manure policy and to what extent the number of cows and chickens will decrease or the manure export will increase. An upper limit has been established for pigs and poultry via animal rights. Moreover, there is uncertainty as to the number of cows needed to fill the milk quote. Between 2020 and 2020 the milk quote is terminated and developments are even more uncertain than ever. This uncertainty is significantly expressed by the two scenarios GE and SE. Finally, the development of nitrogen excretion per animal is also uncertain.

Industry, transport, households, TSG and construction

The data that are presented here do not stem from the WLO study, contrary to the other sectors, but come from the ´Actualisation report' (van den Brink, 2003), which was drafted by RIVM for the White Paper 'Erop of Eronder'.

The ammonia emission of the transport sector, which contributes 2% to the total Dutch emission, is caused by three-way converters in petrol cars.

The emission in households (5% of the total emission) is mainly caused by transpiration and by pet manure.

The emission in industry (2% of the total emission) is mainly released during the production of ammonia.

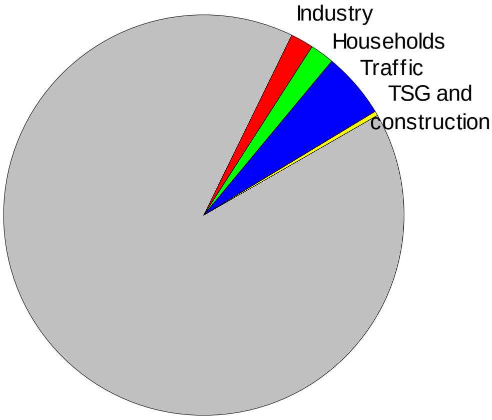

Figure 9.4.4 - Share of the sectors industry, households, TSG and construction in the total emissions of NH_3 in 2002

Volume developments

Table 9.4.2 presents the share of the most relevant factors in the NH_3 emission of the sectors industry, transport, households, TSG and construction in 2002, as well as the annual growth of these factors. The growth of the population is taken as explanatory factor for the emission of households.

Table 9.4.2 - Share of the most relevant factors in the NH_3 emission of industry, transport, households, TSG and construction in 2002 and the annual growth in % of these factors

	share in total	SE		GE	
	NH_3 emission	2000-2010	2010-2020	2000-2010	2010-2020
Number of driven km petrol cars	19%	-0.4	-0.6	-0.4	-0.6
Population size	52%	0.5	0.5	0.6	0.6
Ammonia production	21%	1.6	1.6	1.7	1.7

Policy developments

There is no specific policy for ammonia reduction in the sectors in question. Therefore it is assumed that the emission factors of the NH_3 emitting processes within the sectors that are discussed here do not change.

Results

The emission for 2010 for the sector industry amounts to 4 kiloton in both scenarios, which is equal to the emission that was projected for 'Erop of eronder'. In the period 2010 to 2020 the emission increases to 5 kiloton in both scenarios.

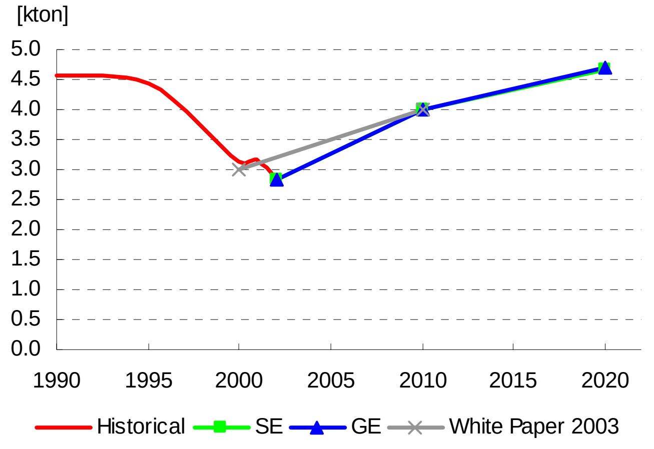

Figure 9.4.5 - Development of the NH_3 emission in the sector industry

In the transport sector the emission amounts to approximately 3 kiloton in 2010. After 2010 the emission increases slightly.

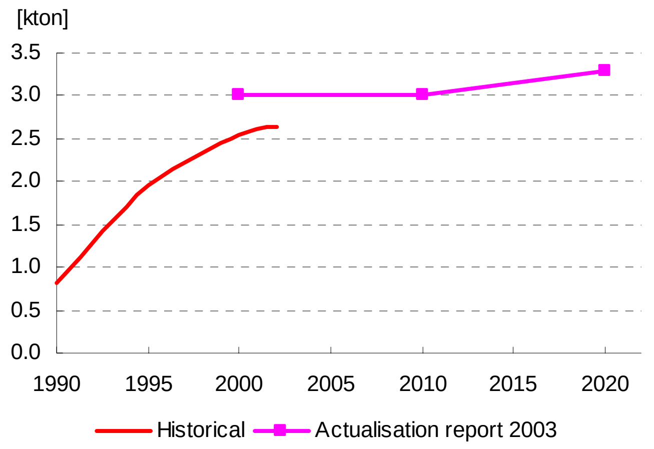

Figure 9.4.6 - Development of the NH_3 emission in the sector transport (incl. fishery on the DCP, excl. ocean shipping))

In the sector households, TSG and construction the emission amounts to approximately 8 kiloton in both scenarios in 2010, which is equal to the projection for 'Erop of eronder'. The emission of 2020 is approximately 0.5 kiloton higher compared to the emission of 2010.

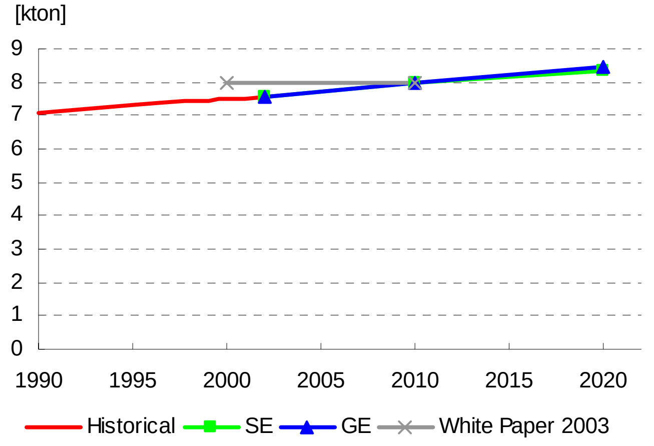

Figure 9.4.7 - Development of the NH_3 emission in the sector households, TSG and construction

Target compliance 2010

The NEC target of industry and transport amount to 3 kiloton each; for households it amounts to 7 kiloton and TSG and construction have a target of 1 kiloton. The projected emission of the sector industry amounts to 4 kiloton (both in SE and in GE), the emission of transport is estimated at 3 kiloton; 7 kiloton for households (both scenarios) and 1 kiloton for TSG and construction (both scenarios). The chances of reaching the ceiling are fifty fifty for these sectors.

Uncertain factors

The uncertainty is estimated at 50% and is nearly completely caused by monitoring uncertainty.

9.5 Particulate Matter (PM_{10})

The Netherlands total

Particulate matter has undesired effects on human health. The health risks from particulate matter in the Netherlands are among the highest in Europe. Particulate matter in the air is composed of primary and secondary particles. Primary particles are emitted directly into the air. Secondary particles are the result of conversion processes in the air from sulphur oxide, nitrous oxides and ammonia. This paragraph describes the development of the emission of particulate matter until 2020.

Particulate matter is emitted by all sectors. The main cause of particulate matter is the transport sector with a share of 35% in total Dutch emissions, followed by industry, energy, refinery and waste (28%), agriculture (21%), TSG and construction (8%) and households (8%). Emissions with natural causes and as a result of wind erosion in agricultural areas have not been included.

Particulate matter emerges from combustion processes in industry, agriculture and households (coal, oil, biomass) and also occur as a so-called process emission in varying activities in industry, transport (wear), TSG (storage and transfer) and construction.

Results

The total emission of particulate matter amounts to 42 kiloton (SE) and 44 kiloton (GE) in 2010. The projected emission is thus 3 kiloton lower in SE and 1 kiloton lower in GE than projected for 'Erop of eronder' in 2003. This difference can be explained by a new measure in refinery and new perceptions in relation to the emissions of industry, refineries and the energy sector (-2 to -3 kiloton) as well as some minor changes in the other sectors.

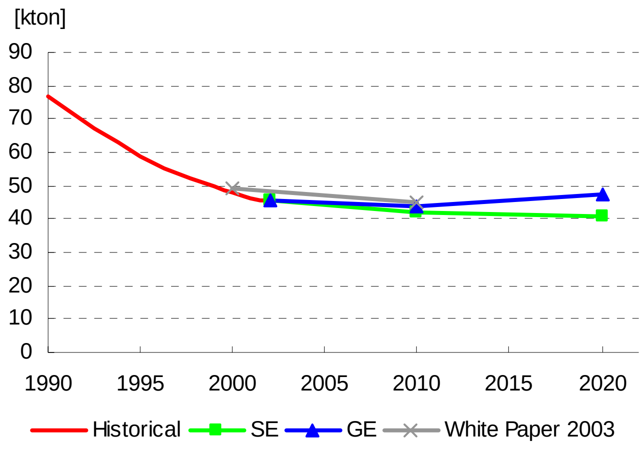

Figure 9.5.1 -Development of PM_{10} emission in the Netherlands

Between 2010 and 2020, the emission decreases further to 41 kiloton in SE and increases to 47 kiloton in GE.

Target range

There is no NEC target for particulate matter. The European programme 'Clean air for Europe' (CAFE) is working on a thematic strategy that will be brought forward by the European Commission in the middle of 2005. More proposals will be developed for tackling the fine particle problem.

Uncertain factors

The uncertainty is calculated at 15%, which is a first indicative estimate. The largest part of the 15% is caused by the uncertainty in the industrial sector, which is estimated to be very high (50%).

Industry, energy sector, waste treatment and refineries

The industry (including waste treatment), refineries and the energy sector held shares of 21, 5 and 1% respectively in the total PM_{10} emission in the Netherlands in 2002.

PM_{10} emissions are released in nearly all industrial sectors, as process emission in various industrial processes and as combustion emission from burning fuels (coal, biomass and oil). The emissions in industry are dominated by the process emissions (± 75%). The combustion emissions contribute 25%.

Combustion emissions mainly occur in refineries (burning of fuel oil) and the energy sector (burning of coal and biomass). In the other industrial sectors the combustion emissions are limited, which can be explained by the fact that the Dutch industry mainly uses natural gas as fuel.

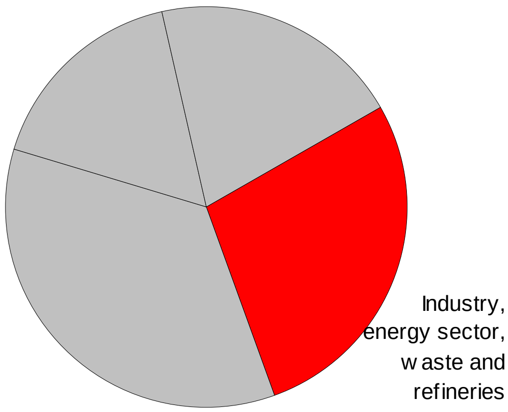

Figure 9.5.2 - Share of the sectors industry, energy, waste treatment and refineries in the total emissions of PM_{10} in 2002

Volume developments

Table 9.5.1 shows the volume developments for the main sectors, as well as the contribution of these sectors to the total PM_{10} emission of these sectors. For all sectors, the physical production has been used as volume quantity.

Table 9.5.1 - Contribution of the main processes to the total emission of particulate matter of industry (including waste treatment), refineries and the energy sector and the annual growth of the production (%)

	share in total PM_{10}	SE 2000-2010	SE 2010-2020	GE 2000-2010	GE 2010-2020
Food and luxury food industry	16%	0.8	1.0	1.5	2.2
Steel production	9%	-0.1	-0.1	0.3	0.4
Aluminium production	6%	0.4	0.5	0.9	1.1
Refinery production	19%	0.8	0.4	0.9	2.0
Chemical industry	10%	1.6	2.2	2.0	2.3
Energy sector	5%	1.5	-3.9	1.5	2.7
Metal-electro industry	6%	-0.1	1.1	0.1	1.1
Diffuse emissions	21%	assumed steady			

Policy developments

The emission of particulate matter in industry, refineries and the energy sector has decreased significantly with approximately 65% between 1990 and 2002. The abatement policy for particulate matter in industry has thus proven very successful. Emission reductions have been achieved through the Decree on emission standards for furnace installations (BEES A and B) and the Netherlands Emission Guidelines for Air (NeR), which entails the implementation of various types of filters as well as process adjustments as for example in the base metal industry. Recently, the NeR has been revised and the general emission demands for particles have been tightened.

In the period 2002-2010 the speed of fine particle reduction in the sectors industry, refineries and energy comes to a near stand-still. The emission will decrease slightly from 13 kiloton in 2002 to 12 kiloton in 2010. This slight decrease can be fully explained by the fact that Shell has decided to put into operation a new cogeneration plant in 2007 and to shift from oil to gas-firing (Shell Venster, 2005).

Early 2005 the National Air Quality Plan 2004 was published, in which it was stated that new additional policy will be needed to improve air quality with respect to particulate matter. This policy will be further elaborated and implemented in 2005. The plan contains a number of new measures and policy actions for industry, which is ‘soft’ (not established) policy that will be further examined and elaborated in the coming years. This ‘soft’ policy, which has not been included in the projections, entails the following actions:

- the possible adjustment of the NeR emission demands for firing clean biomass in small equipment,
- charting the technical state of affairs with respect to diffuse (non-canalised) emissions that are difficult to monitor,
- stimulating advanced particle reduction techniques through the VAMIL regulation (Early Depreciation Environment Investment),
- tightening of particle restrictions in plants where solid fuels are fired in the framework of the re-evaluation of BEES-A and B,
- additional emission reduction in refineries through the transfer from oil-firing to gas-firing.

Results

The projected emissions of the sectors amount to 12 kiloton in both scenarios in 2010.

The development of the emission from 2002 onwards (the base year of the projections) equals the development of the production volume of the emitting processes. The only exception are the refineries, due to the construction of a new gas-fired clean cogeneration plant, which has been taken into account, leading to an emission reduction of over 1 kiloton (Shell Venster, 2005).

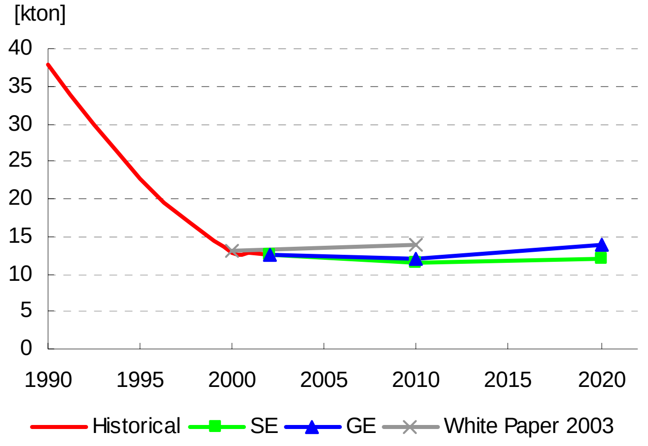

Figure 9.5.3 - Development of the PM_{10} emission in the sectors industry, energy, waste treatment and refineries

The main part of the fine particle emissions in the sectors in 2010 arises as process emissions. The share of combustion emissions in the industrial PM_{10} emissions decreases further until 2010. In 2010 approximately 10-15% of the emissions are combustion emissions (coal-fired plants ad refineries).

Uncertain factors

The total uncertainty is estimated to be very high at 50%. This is the result of limited availability of information on the emission factors of PM_{10} emitting activities of this sector.

Transport

The transport sector held a 35% share in total PM_{10} emissions in the Netherlands in 2002.

Fine particle emissions arise from the burning of diesel and petrol and from the abrasion of brakes, tyres and the road surface. The main sources are diesel cars, passenger cars and lorries, other mobile sources (e.g. agricultural equipment), inland vessels and fishing boats. The emissions of ocean vessels are not included in the reference projections, which is in line with the international reporting requirements.

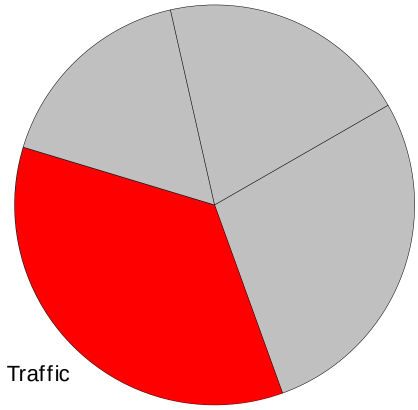

Figure 9.5.4 - Share of the sector transport (excluding ocean shipping) in total PM_{10} emissions in 2002

The data that are presented here do not stem from the WLO study, contrary to the other sectors, but come from the ´Actualisation report' (van den Brink, 2003), which was drafted by MNP-RIVM for the White Paper 'Erop of Eronder'.

Volume developments

Table 9.5.2 shows the annual growth of fuel consumption of the various vehicle categories as well as the contribution of these categories to the total PM_{10} emission of the transport sector. By far the largest share of the emissions (40%) is held by passenger cars and delivery vans.

Table 9.5.2 - Contribution of the vehicle categories to the total PM_{10} emission of transport, and the annual growth of fuel consumption (%)

	share in total PM_{10} emissions 2000	2000-2010	2010-2020
Passenger cars	24%	-0.5	0.4
on petrol		-2.0	-1.7
on diesel		3.3	2.7
on LPG		-0.8	3.5
Delivery vans	16%	1.1	2.6
Lorries and tractors	15%	3.6	4.2
Buses and special vehicles	3%	-0.1	0.3
Motors and mopeds	1%	-0.1	0.0
Rail transport (diesel)	0%	0.4	3.2
Inland shipping and recreational shipping	10%	1.9	0.3
Fishery (incl. DCP*)	2%	-2.8	-1.8
Aviation	1%	7.6	2.6
Mobile equipment	19%	0.8	1.3

* DCP = Dutch Continental Platform

Policy developments

In road transport much has been accomplished via the European emission regulations for motor vehicles. This policy will have its effect on the emissions until after 2010. The projections do not include the fiscal incentivisation of soot filters in new diesel passenger cars. Soot filters reduce the amount of PM_{10} in exhaust fumes with 90%.

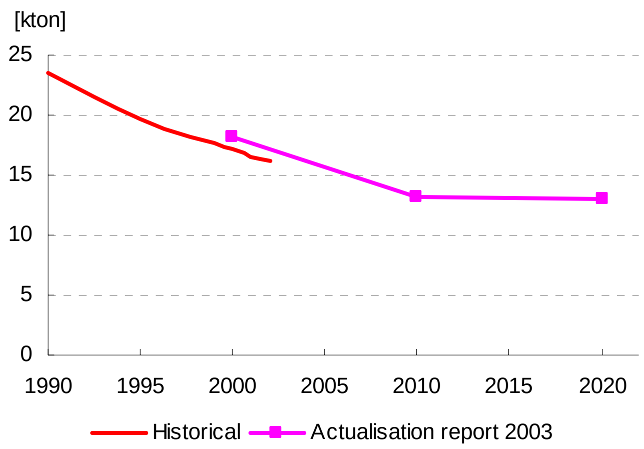

Figure 9.5.5 - Development of the PM_{10} emissions in the transport sector (including fishery on the DCP, excluding ocean shipping)

The implementation of this measure will expectedly lead to a 1 kiloton reduction in particulate matter emissions. This constitutes 6% of the total PM_{10} transport emissions in 2010 and 55% of the health-related PM_{10} combustion emissions from diesel passenger cars. In the Air Quality Plan 2004 an additional measure is announced for lorries, but this measure is not yet 'solid' and has therefore not been included in the projections. The measure entails a fiscal incentivisation of the advanced introduction of cleaner lorries and buses (Euro-4 and Euro-5).

Results

Despite the increase in passenger and freight transport and the higher share of diesel passenger cars, the PM_{10} emission decreases from 17 to 13 kiloton between 2000 and 2010. After 2010, the PM_{10} emission more or less remains at the level of 2010.

The abatement of particulate matter emissions in non-road transport (shipping and other mobile sources) is lagging behind road transport. As a result these sources will become increasingly important in the future. Particles from abrasion (brakes, road surface and tyres) will hold an increasingly larger share in total PM_{10} emissions from transport.

Uncertain factors

The uncertainty in PM_{10} emissions is mainly related to the uncertainty in the fuel mix in 2010 (share of diesel and petrol). Moreover, there is an uncertainty that correlates to the technology that car manufacturers will choose in petrol cars. Modern petrol engines (so-called direct injection otto engines) emit 2-20 times more PM_{10} than conventional petrol cars.

The final uncertainty in PM_{10} emission from transport is difficult to estimate due to the complexity of the modelling of transport prognoses and the large uncertainty of monitoring. The uncertainty is estimated at least 25%. It should be note that the uncertainty is related to the projection that was done for the White paper 'Erop of eronder'. New projections will be made for the WLO study.

Households, TSG and construction

The share of the sectors households, TSG and construction in total PM_{10} emissions in 2002 amounted to 17%.

Particulate matter is emitted during construction activities and the storage and transfer of various goods in the TSG sector. In households, particulate matter is emitted by burning wood in hearths and stoves and by the smoking of cigarettes.

Emissions from storage and transfer in industry have been included in the industrial sector.

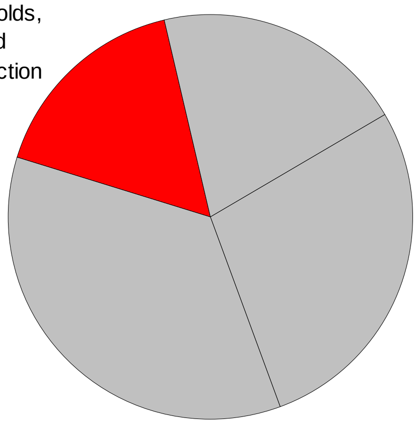

Figure 9.5.6 - Share of sectors households, TSG and construction in total PM_{10} emissions in 2002

Volume developments

Table 9.5.3 provides the share of the above-mentioned activities in the total emission of 2002, as well as the annual growth in %.

Table 9.5.3 - Share of the most relevant activities in total PM_{10} emissions of households, TSG and construction, and annual growth in % of these activities

	share in total	SE		GE	
	PM_{10} emission	2000-2010	2010-2020	2000-2010	2010-2020
Building industry and contractors	15%	1.0	0.5	2.1	1.9
Hearths (number)	24%	-1.1	-1.2	-1.1	-1.2
Cigarettes (number)	21%	0.4	0.5	0.5	0.6
Storage and transfer	33%	1.5	1.9	2.9	3.3

Policy developments

Recently the type assay for wood burning stoves has been abolished. Similar to NMVOC it has been assumed that this will not lead to a deterioration of the emission factor. Crematoriums have to adhere to the NeR (Dutch emission guideline). There is no specific fine particle policy for the other sources within the sectors households, TSG and construction.

Results

The fine particle emissions of the sectors households, TSG and construction amount to 8 kiloton (SE) to 9 kiloton (GE) in 2010. In SE the emission until 2020 remains similar to the level of 2010; in GE the emission increases to 10 kiloton.

Uncertain factors

The margin has been calculated at 25%, excluding monitoring uncertainty. The largest contribution comes from the uncertainty in the projection of the use of hearths in households. Another important factor is the uncertainty of the PM_{10} emission of storage and transfer in the TSG sector.

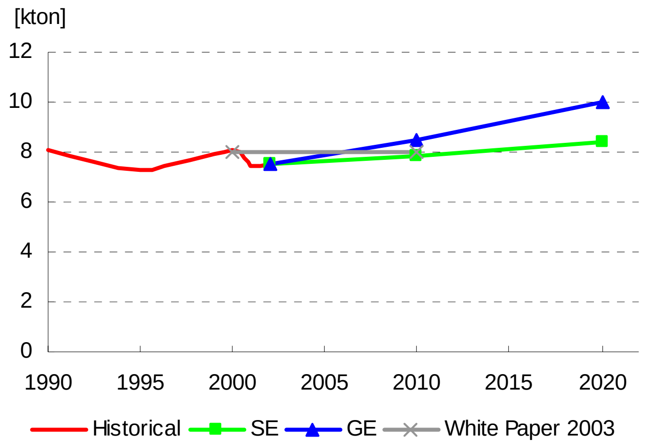

Figure 9.5.7 - Development of the PM_{10} emission in the sectors households, TSG and construction

Agriculture

The share of agriculture in total PM_{10} emissions in the Netherlands amounted to 20% in 2002.

The main sources of PM_{10} emission in agriculture are skin, manure, feed and litter particles that are blown into the air outside via the ventilation system of the stables. Poultry and pigs together provide the largest contribution.

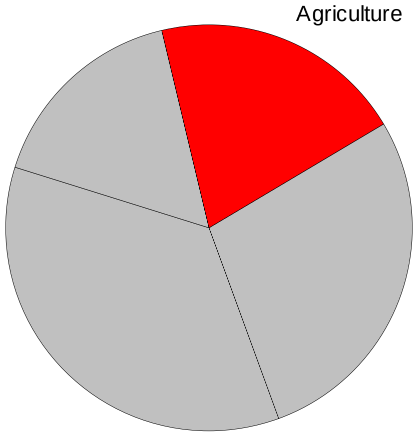

Figure 9.5.8 - Share of the sector agriculture in total PM_{10} emissions in 2002

Volume developments

In poultry, straw-based housing emits more particles than the battery system. Due to more strict regulations for animal welfare, battery systems are forbidden as of 2012 and must have been replaced with straw-based housing. This leads to an increase in emissions per animal. The slight increase of PM_{10} in 2010 can largely be explained by this shift to straw-based housing for poultry. The large reduction of the poultry and pig stock leads to lower PM_{10} emissions in SE in 2020.

Table 9.5.4 - Share of the most relevant sources in total PM_{10} emissions of agriculture and annual growth in % of these sources

	share in total	SE		GE	
	PM_{10} emission	2000-2010	2010-2020	2000-2010	2010-2020
Pigs (number)	27%	-0.5	-4.3	-0.5	-0.2
Laying poultry straw-based housing (number)	16%	4.8	-1.8	6.0	1.0
Laying poultry non straw-based housing (number)	1%	-14.0	-5.2	-13.0	-2.5
Meat poultry (number)	42%	-1.6	-2.5	0.4	0.8
Cattle (number)	9%	-1.0	0.3	-0.9	0.0

Policy developments

There is no policy for PM_{10} in agriculture. In the Air Quality Plan 2004 some measures and actions are presented, but these have an exploratory character. There will be an examination of how the reduction of fine particle emissions can be weighed in current regulations for investment deduction (VAMIL/MIA) in the building of new stables.

Results

In 2010 the fine particle emission in agriculture amounts to 9 kiloton (SE) to 10 kiloton (GE). In the projection for 'Erop of eronder' the emission was also 10 kiloton. In 2020 the emission has decreased to 7 kiloton in SE, whereas in GE the emission increases to 11 kiloton as a result of the increase of the meat poultry stock.

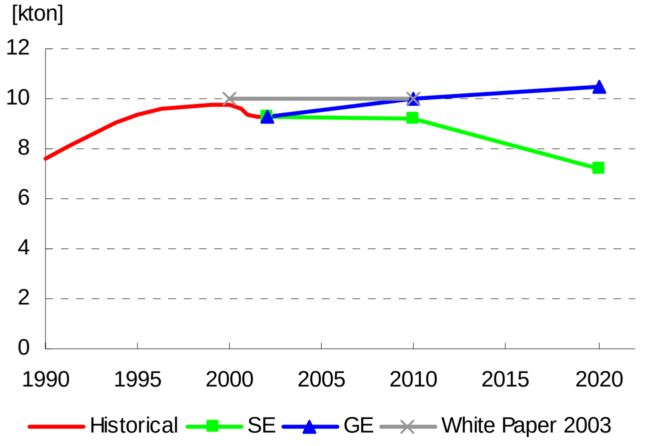

Figure 9.5.9 - Development of the PM_{10} emission in the agricultural sector

Uncertain factors

The margin is calculated at approximately 7% (excluding the monitoring uncertainty that will probably be high). This margin is mainly determined by the uncertainty in future division of housing systems in poultry and the uncertainty of the amount of pigs and poultry.

10. POLICY RESULTS

10.1 Policy variants

This chapter looks at the effects of policy and its scrutiny upon energy and greenhouse gases. As mentioned in Chapter 3, so-called 'policy-free' variants of both scenarios, GE and SE, have been developed. These reflect an imaginary situation in which all government policy in respect of energy and reducing emissions ceases to exist from 1 January 2000. The purpose of these variants is analytical. By comparing the results with SE and GE, we can establish what the overall effects of policy are. In the same way, a variant incorporating the effects of policy developments since the Climate Policy Implementation Memorandum (UK1) has been developed. A summary of the policy under each scenario and variant is given in the appendices.

In Section 10.3, the overall effects described in this chapter are broken down by causal instrument. The differences compared with the previous Reference Projection are then explained. Finally, Section 10.4 covers the effects of proposed policy.

10.2 Energy and climate policy

Policy objectives

Amongst other things, Dutch energy and climate policy is designed to save energy, make it sustainable and reduce emissions of greenhouse gases. The target for energy savings is 1.3 percent annually. The policy objective in respect of sustainable energy is that it account for 5 percent of total use by 2010, with renewably generated electricity making up 9 percent all power consumed. As for reducing greenhouse gas emissions, the policy target is the target that was agreed upon at the European level under the Kyoto Protocol (see also Chapter 1 and Section 3.2).

Energy savings

Table 10.2.1 summarises the policy objectives in respect of energy savings. The figures indicate that a significant proportion of those savings would occur even without a government policy. Nevertheless, the target saving of 1.3 percent is not achieved between 2010 and 2020. Policy has a relatively greater impact in the Households sector than elsewhere, due to the effect of building regulations and high rates of Energy Tax.

Table 10.2.1 - Savings rate in % per year in various scenarios and policy variants

Saving [%]	Historical	Projection	
	1995-2002	2000-2010	2010-2020
SE	-1.0	-0.9	-1.0
SE no UK1	-	-0.8	-1.0
SE no policy	-	-0.6	-0.8
GE	-1.0	-1.0	-1.0
GE no UK1	-	-0.9	-0.8
GE no policy	-	-0.7	-0.9

The distinction in policy effect between GE and SE is small because the same policy package has been maintained. The larger saving in 2020 for GE with no policy compared to no UK1 involves a 'catching-up effect' (cf 2000-2010)

Renewable energy
Table 10.2.2 shows the effect of policy in respect of sustainable energy. Virtually all implementation of sustainable sources results from energy and climate policy. The only exceptions are waste-fired power plants, landfill gas and fermentation gas.

Table 10.2.2 - Share of renewable energy in % in total energy consumption and electricity consumption in various scenarios and policy variants respectively

[%]	Share of renewables in 2000	2010	2020	Share of renewables in 2000	2010	2020
SE	4	9	16	2	3	6
SE No UK1	4	6	16	2	2	6
SE No policy	4	2	1	2	1	1
GE	4	10	24	2	4	9
GE No UK1	4	5	13	2	2	5
GE No policy	4	2	1	2	1	1

CO_2 emissions: the SE scenario
In the SE scenario, the overall effect of all energy and climate policy is approximately 12 Mton in 2010 and 29 Mton in 2020. And the effect of that derived from the 1999 Climate Policy Implementation Paper (UK1) is about 5 Mton in 2010 and 11 Mton in 2020.

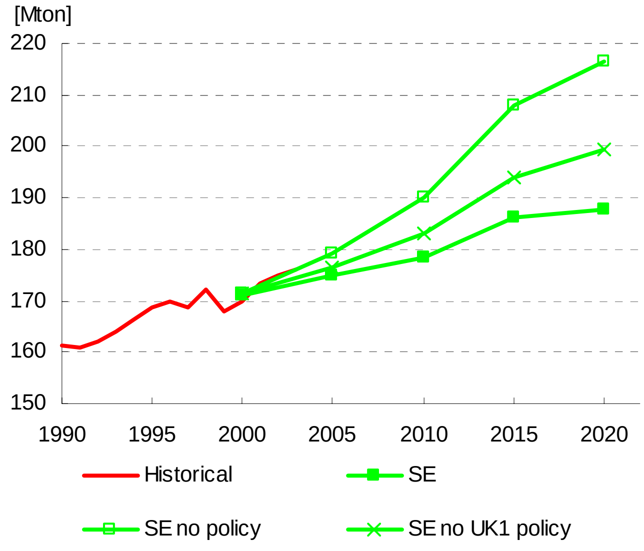

Figure 10.2.1 - Total CO_2 emission of SE under various policy variants

CO_2 emissions: the GE scenario
In the GE scenario, the overall effect of all energy and climate policy is approximately 13 Mton in 2010 and 35 Mton in 2020. And the effect of that derived from the Climate Policy Implementation Paper (UK1) is about 5 Mton in 2010 and 14 Mton in 2020.

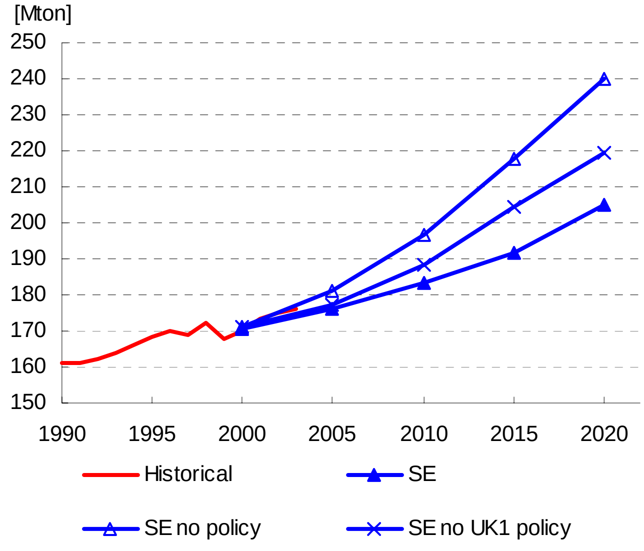

Figure 10.2.2 - Total CO_2 emission of GE under various policy variants

Emissions of other greenhouse gases

In both scenarios, the overall effect of all environmental policy from 2000 upon emissions of other (non-CO_2) greenhouse gases is a reduction of 9 Mton CO_2 eq. More than 50 percent of this reduction is the result of policy not actually designed to reduce greenhouse gas emissions, such as the agricultural ammonia and manure policy and the landfill policy. The effect derived since 2000 from the Climate Policy Implementation Memorandum (UK1) is 4 Mton CO_2 eq. in 2010, all of which in the industrial sector. In 2020 the total policy effect has increased to 10 Mton CO_2 eq., but with the impact from UK1 unchanged.

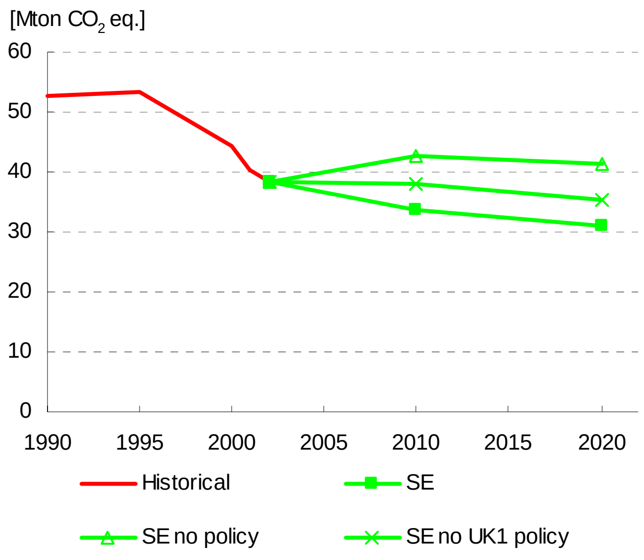

Figure 10.2.3 - Emission of other greenhouse gases of SE under various policy variants

The policy effects of other greenhouse gases are the same for SE and GE.

From Table 10.2.3, we can determine that government policy is most effective in reducing emissions of non-CO_2 greenhouse gases. In the long term, however, its impact upon CO_2 emissions increases but it becomes more difficult to achieve further reductions in the other greenhouse gases. The policy changes arising out of and subsequent to UK1 have a significant additional effect compared with those in place prior to the paper.

Table 10.2.3. - Overview of policy effects regarding inland greenhouse gas emissions

[Mton CO_2 eq.]	SE				GE			
	2005	2010	2015	2020	2005	2010	2015	2020
CO_2								
Emission base scenario	175	179	187	187	176	183	192	205
Effect total policy as of 2000	5	12	22	29	5	13	26	35
of which UK1 policy	2	5	8	11	1	5	13	14
Other greenhouse gases								
Emission base scenario	37	34	32	31	37	34	34	34
Effect total policy as of 2000	7	9	10	10	7	9	10	10
of which UK1 policy	4	4	4	4	4	4	4	4
Total greenhouse gases								
Emission base scenario	212	213	219	219	213	217	226	240
Effect total policy as of 2000	12	21	31	39	12	22	36	45
of which UK1 policy	5	9	12	16	5	9	17	18

Base scenario other greenhouse gases for 2005 and 2015 interpolated

10.3 Energy and climate policy instruments

Developments since the 2001-2010 Reference Projection

The results from the 2001 Reference Projection were incorporated into the 2002 Energy Report and the 2002 Climate Policy Evaluation Paper. A partial update of the Reference Projection has been carried out since then, when the sectoral CO_2 indicative target values were set (Boonekamp, 2003). As well as policy changes, the update included a number of accounting adjustments. Moreover, several important new expectations in respect of energy-intensive processes and developments in electricity production were included.

Domestic emissions: overall effect of policy and policy changes since the Climate Policy Implementation Memorandum (UK1

Table 10.3.1 provides a complete overview of climate policy instruments and their effect upon emissions in the Netherlands. However, it disregards the impact of flexible instruments upon domestic greenhouse gas emissions as a result of reductions abroad. The effect of the import of emission rights under the European trading system is shown in Table 10.3.2.

Table 10.3.1 - Effect on inland greenhouse gas emissions of separate policy instruments in Mton CO_2 eq. The effects have been quantified as the difference in the reference year between the actual development in GE and total abstinence from policy (Total GE) or the fixation of policy (among which UK1) as of the starting year of the indicated period

		Realisation *1*)	Projection *2*)	Policy UK1 and thereafte		Total policy GE		
		1990-2000	2000-2010	2000-2010	2000-2020	2000-2010	2000-2020	
	selection year	2000	2010	2010	2020	2010	2020	Note
Energy sector (incl. refining)								
Incentivisation cogeneration	CO_2	4.2	0.5	0.2	0.7	1.9	1.3	*3*
MEP renewable and other financial incentivisation of renewables (Green investment, EIA/VAMIL, Coal covenant, BLOW covenant, energy tax)	CO_2	1.0	2.0	1.5	8.0	4.2	18.8	*4*
Benchmarking covenant and LTA-2	CO_2	0.0		0.0	0.0	0.0	0.0	
CO_2 emission trading and other policy energy sector								
Refineries	CO_2			0.0	0.0	0.2	0.4	*5*
Electricity sproduction	CO_2			0.0	0.4	0.9	0.6	*6*
Oil and gas extraction	CO_2			>0	>0	>0	>0	*7*
CH_4 gassector	CH_4	1.5		0.3	0.3	0.3	0.3	*8*
Industry								
Covenants and subsidy industry excl cogeneration and renewabl	CO_2	3.2	1.4	0.1	0.1	1.4	2.1	*9*
Emission trading	CO_2			0.3	0.3	0.3	0.3	
HFC industry	HFC	5.4	1.5	1.9	1.9	1.9	1.9	*10*
PFC aluminium	PFC	1.1	1.2	1.1	1.1	1.1	1.1	
N_2O Nitric acid production	N_2O		0.0	0.0	0.0	0.0	0.0	*11*
Reduction programme other greenhouse gases	HFC/PFC		1.0	1.0	1.0	1.0	1.0	
Traffic								
Policy aimed at technical measures vehicles	CO_2	0.0	1.2	0.4	0.4	0.4	0.4	*12*
Policy aimed at behaviour measures vehicles	CO_2	0.0		0.9	0.9	0.9	0.9	*13*
Policy aimed at decreasing transport demand	CO_2	0.0		0.0	0.0			*14*
Other (tax, CO_2 reduction programme passenger transport)	CO_2	1.2		0.1	0.1	0.1	0.1	*15*
Agriculture								
Greenhouse horticulture policy	CO_2	0.9	0.1	0.3	0.6	0.4	0.7	
Size of cattle stock	CH_4	2.0		0.0	0.0	0.3	0.0	
Ammonia and manure policy	N_2O	-1.5		0.0	0.0	0.6	0.0	*16*
Waste								
Landfill policy	CH_4	4.0		0.0	0.0	4.0	6.0	*17*
Built environment - households								
EPN, energy tax (new housing)	CO_2	0.4	0.0	0.3	1.0	0.7	2.7	*18*
EPBD, EPA, EPR, energy tax (existing buildings)	CO_2	1.5	1.0	0.8	1.5	0.9	1.8	
Energy labelling, EPR electric appliances	CO_2	0.6	0.8	0.2	0.3	0.6	1.0	
Energy efficient lighting, MAP	CO_2	0.2	0.0	0.0	0.0	0.0	0.0	
Built environment - commercial and industrial building								
EPN, EINP (new housing)	CO_2	0.4		0.2	0.3	0.4	1.0	
EPA, EPBD, EIA/EINP (existing buildings)	CO_2	0.3	0.7	0.0	0.0	0.1	0.1	
Energy labelling, EPR electric appliances	CO_2			0.0	0.0	0.0	0.0	
Energy tax	CO_2	0.2		0.0	0.0	0.0	0.0	*19*
Total effect		26.5	11.4	9.5	18.9	22.5	42.6	
Of which CO_2		14.0	7.7	5.2	14.6	13.3	32.3	*20*
Other greenhouse gases		12.5	3.7	4.3	4.3	9.2	10.3	

Notes table 10.3.1

General *The policy effects on end user sectors, as indicated in the table, concern the final consumption, which includes the effect on the electricity sector and excludes the effects of cogeneration. The effects of cogeneration have been indicated separately and involve the comparison of cogeneration and separate generation. As a result of this viewpoint differences occur such as have been reported in Chapter 6, where direct emissions of the sector are involved.*

1 Jeeninga and Honig, 2002

2 Reference Projection 2001-2010, effects UK1 policy

3 Of the total effect on cogeneration in 2010, 1.9 Mton is policy-related and 0.2 Mton is UK1-related. In 2020, 1.3 Mton is policy-related and 0.7 Mton is UK1-related. Largest effect comes from emission trading. See alsno note 20.

4 Realisation 1990-2000: 1.3 Mton CO_2, 1 Mton of which from policy. For policy after 2000: see also table 10.3.2

5 The total effect, beside EU ETS, is also the Covenant Benchmarking. EIA and VAMIL. UK1 effect, beside EU ETS, is also the raised EIA> After the termination of th ACEA Covenant, the throughput would also be raised, which also changes the fuel mix. This leads to an increase of emissions: 2005: 0.32 Mton; 2010: 0.64 Mton; 2015; 3.30 Mton. See also note 20

6 The effect of emission trading on the import balance (decrease) is not taken as (negative) policy effect. That effect is deducted from the effects of generation from renewable sources and central generation. The effect of the Covenant Benchmarking in central generation is negligible compared to the Coal covenant and ETS.

7 Effect almost negligible

8 1990: Extraction 1.0 Mton, distribution 0.5 Mton

9 By far the largest share of policy dates back to before UK1. It entails EIA/VAMIL, LTA's etc. The Benchmark and LTA-2 are post UK1, but hardly entail an intensification compared to existing policy. Moreover, the post UK1-related increase of EIA has recently been undone for the largest part and VAMIL has been abolished. Finally, there is competition from ETS with respect to the post UK1 effect. The effect of ETS for the largest part overlaps with the effect of the Benchmark and takes over part of the effect of the BM. Moreover, it even undermines the effect of the BM to some extent, because companies may comply with their BM obligations by purchasing emission credits.

10 The report by Jeeninga estimated 5.7 Mton over het period 1990-2000. In reality, this amounted to 5.4 Mton (source: RIVM). Effect UK1: of the total UK1 effect (3.6 Mton) 1.7 Mton was realised before 2000 and 1.9 Mton after 2000.

11 In UK1 as back-up measure 4 Mton

12 First Reference Projection: 1.2 Mton from improved energy efficiency transport including the new driving force. For reference years 2010 and 2020 0.4 Mton is the maximum effect of ACEA; the minimum effect is 0.

13 Effect the new driving force is 0.8 Mton. More strict maintenance of maximum speed = 0.1 Mton

14 Effect is small and cannot be quantified.

15 Largest effect taxes 1.0 in the period 1990-2000; the rest is location policy, traffic management, parking policy

16 Ammonia policy: -0.8 Mton (2005); -0.9 to -1.2 Mton (2010-2020) plus manure policy: 1.2 Mton manure policy (2005), 1.5 Mton (2010) and 0.9 Mton (2020). Maximu joint effect 0.6 mton (2010) and 0 Mton (2020), minimal effect 0.3 Mton (2010) and -0.3 Mton (2020). Negative effect 1990-2000 through chemical conversion under anaerobic circumstances while plowing in manure into the soil.

17 No UK1 policy

18 UK1 introduction and tightening of EPN in 1998 and no further developments after that. No policy means a return to the isolation standards of 1988.

19 0.2 Mton over the period 1990-2000 as a result of MAP, after 2000 the effect is mainly accredited to the EPN.

20 Several indirect structure and volume effects in the energy sector have not been included (c.f. table 10.2.3.). These effects are (1) the effect of the ACEA covenant in the refining sector in Europeas as a result of which the throughput is much lower (larger policy effect 0.6 Mton in 2010 and 3.3 Mton in 2020) and (2) the effects of less heat demand in the electricity production sector and higher prices for cogeneration (smaller policy effect 0.9 Mton in 2010 and 2020 for cogeneration)

The first column lists the actual results of climate policy between 1990 and 2000, based upon Jeeninga and Honig (2002). The policy directed at industry and cogeneration was particularly effective during that period, when compared with the projections for 2010. On the other hand, those show that the encouragement of sustainable energy sources is likely to have a greater impact than it had in the past. The second column gives the policy effects in 2010 as forecast in the old 2001-2010 Reference Projection. Compared with what is now predicted under and following the UK1 policy, as shown in the third column, that was more optimistic. The current projection is an emissions reduction of just over 9 Mton in 2010, compared with more than 11 Mton in the old forecast. That is explained in more detail later. The fifth and sixth columns give the effect of policy as a whole – that is, including those measures already in place prior to UK1: CHP policy, the Long-term Energy Efficiency Agreement (LTA-1), building regulations, Regulatory Energy Tax (REB) and so on. In the GE scenario, the total policy effect in 2010 is just over 22 Mton. The further increase in that effect in 2020 is due primarily to sustainable sources, and to a lesser extent to energy savings. As far as the non-CO_2 greenhouse gases are concerned, only a reduction in methane emissions from landfill sites has any additional effect in 2020.

Difference in policy effect compared with the 2001 Reference Projection

Columns 2 and 3 of Table 10.3.1 concern the effect of policy arising from and subsequent to the Climate Policy Implementation Paper (UK1). The difference between those in the previous Reference Projection and those now determined under the GE scenario are summarised in Table 10.3.2, together with a brief explanation. It should be recalled that a whole series of policy developments have occurred since UK1, the effects of which have also incorporated into GE.

Table 10.3.2 - Explanation of differences with the reference projection 2001 of policy effects resulting from and starting with UK1, per instrument cluster in Mton CO_2

Instrument cluster	Difference	Explanation
Incentivisation cogeneration	-0.3	Difference is explained by the termination of VAMIL, the effect of REB tax exemption is a more effective instrument from a policy technical point of view than the MEP (REB is a fixed amount).
MEP renewable and other financial incentives renewables (green investment, EIA/VAMIL, Coal covenant, BLOW covenant, energy tax)	-0.5	Policy amendments in renewable energy policy: REB is replaced with MEP, as a result of which the import leakage has disappeared among others. Wind is facing more favourable developments. The policy effect based on the penetration if renewable energy amoutns to approximately 3 Mton (see 7.3). As a result of structure effects in electricity production approximately 1.5 Mton is left.
CH_4 gas sector	0.3	In the Reference Projection 2001 considered not existing policy, in the Reference Projection 2005 it is existing policy (measures included in industrial environmental plans)
Covenants and subsidies industry excluding cogeneration and renewables	-1.3	Part of the effect that was attributed to this policy in the Reference Projection of 2001 is currently attributed to ETS (0.1 to 0.2 Mton). In addition the VAMIL has been abolished, the EIA list cleared and the deduction percentage decreased, and the effect of EIA is smaller because the corporation tax will decrease. Moreover, a lower economic growth results in a more limited saving and more limted policy effect. Finally, the effect does not include the effects of the broadening themes that are not attributed to the sector itself in accordance with the indicative targets method. In the Reference Projection of 2001 a small effect was included.
Emission trading	0.3	The ETS has not been included in the Reference Projection of 2001. The largest part of the atributed effect is not additional compared to current policy, but is deducted from the effect that is attributed to Benchmarking. The additional effect is 0.1 to 0.2 Mton maximum.
HFC industry	0.4	The effect is larger because the production of HCFC's has increased.
PFC aluminium	-0.1	New perceptions
Policy aimed at technical measures vehicles	-0.8	The 1.2 Mton of the Reference Projection 2001 does not only entail the ACEA covenant but also the new driving force and in-car instruments.
Policy aimed at behaviour measures vehicles	0.9	See above
Other (tax, CO_2 reduction programme passenger transport)	0.1	The Reference Projection 2001 did not consider tax measures (no UK1)
Greenhouse horticulture policy	0.2	The effects of the energy tax plus the effect of emnission trading are stronger than in the Reference Projection 2001, see also table 3.4.2 and clarification.
EPN, energy tax (new housing)	0.3	EPN: tightened since UK1
EPBD, EPA, EPR, energy tax (existing buildings)	-0.2	EPR abolished after 2003, whereas the Reference Projection 2001 assumed it would exist until 2010.
Energy labeling, EPR electric appliances	-0.6	See above
EPN, EINP (new housing)	0.2	EPN commercial and industrial buildings is tightened further
EPA, EPBD, EIA/EINP (existing buildings)	-0.7	EINP and Vamil abolished, EIA decreased, less effect of EPA than assumed in the Reference Projection of 2001

Emission reductions abroad

Chapters 6 and 7 report on domestic CO_2 emissions – that is, those on Dutch territory. They may differ from the quantities permitted here under international treaties, what is called the 'assigned amount' in the Kyoto Protocol. These national emissions are calculated by subtracting the reduction through joint implementation (JI) and clean development mechanisms (CDMs) and the import balance of emission rights from domestic emissions. The JI and CDM reduction is based upon the policy proposals contained in the Climate Policy Evaluation Paper (VROM, 2002): 20 Mton annually for the period 2008-2012.

Exploring the possible effects of the emissions trade

The import balance of emission rights is determined by subtracting the allocated rights under the National Allocation Plan (NAP) from domestic emissions under the trading ceiling. This difference represents the amount that has to be purchased into order to meet the obligations of the trading system. To gain an impression of the possible extent of the import balance, assumptions have been made about the future allocation of CO_2 emission rights and their future prices (see Section 3.4), which are determined on the European market. And they are one determining factor of energy use in the projections (as shown in Table 3.4.2) and of domestic CO_2 emission reductions. The trading balance is determined by the allocation of rights by the Dutch government. The smaller that is, the more purchases abroad – or the fewer sales – there will be at the same market price[52.] Table 10.3.3 compares emissions with the allocation, as it is set out in the NAP for 2005-2007 (VROM/SenterNovem, 2004) – approximately 4 Mton – but then extrapolated to the projection years, 2010 and 2020. To this has been added a margin for emissions covered by reserves or which, as a result of opt outs or legal proceedings, do not have to be covered. That margin has been set at 4 percent of emissions, or about 4 Mton. What remains is the balance of emission rights to be imported (+) or exported (-); this has been worked into the national emissions shown in Figure 1.3.2. For the breakdown into electricity production and other trading sectors shown in Table 10.3.3, it has been assumed that 30 percent of emissions of new CHP by joint-venture structures are accounted for by industry, as are 100 percent of blast-furnace gas emissions. Joint-venture attributions are particularly uncertain, however, although these have no impact upon the overall national balance.

Table 10.3.3 - Inland emissions of sources under the CO_2 trading system, allocation of allowances and resulting import balance (- = export) of emission allowances in Mton CO_2

[Mton]	SE				GE			
	Emission	Allocation	Margin	Import	Emission	Allocation	Margin	Import
2010								
Industry, Refining								
Natural gas and oil extraction	46	48	2	-4	46	48	2	-4
Electricity production	47	44	2	1	50	44	2	3
2020								
Industry, Refining								
Natural gas and oil extraction	48	48	2	-2	51	48	2	1
Electricity production	49	44	2	3	58	44	3	11

From Table 10.3.3 it can be concluded that based on the assumptions, especially the electricity producers should purchase emission allowances. Compared to the calculations for the CO_2 indicative targets a lower import balance for electricity can be noted (see also Paragraph 7.1). The assumed growth in electricity demand in the indicative targets calculation lies somewhere between SE and GE.

[52] Because Dutch sources represent only a small proportion of the emissions under the European system, it is assumed that the Netherlands' national allocation has no direct impact upon the price of emissions in the European market.

Emissions trading versus other policy

The research then turned to the question of whether an emissions trading ceiling would make other policy targeting the sources covered by that ceiling superfluous. After all, the emissions ceiling could be simply set at the policy target level for the source concerned. If reduced emissions are stimulated by a subsidy, for example, then fewer credits need to be bought abroad. Domestic emissions may then fall, but there is an additional reduction elsewhere. On balance, there is no overall CO_2 effect upon the national obligation. In a separate policy variant, it was calculated how much domestic emissions would increase if there were to be no policy targeting sources in the trading system from 2005. This would mean the following.

- Abolition of subsidies for the environmental quality of electricity production (MEP) on co-generation, as well as the Energy Investment Tax Allowance (EIA) and other fiscal arrangements for both large and small-scale cogeneration.
- Abolition of the EIA and other fiscal arrangements for measures to reduce tradable emissions and to save electricity. The CO_2 Reduction Plan would also end.
- Freezing of the Energy Tax on electricity at its 2004 level.
- Cancellation of the Benchmarking Covenant and the second Long-term Energy Efficiency Agreement (LTA2).

In this analysis, it is assumed that policy directed at sustainable energy remains intact. Table 10.3.4 indicates that domestic emissions are indeed higher in this variant, and hence so too are the required imports of emission rights. And the higher domestic CO_2 emission also changes other emissions, such as those from power plants. The effect of this is limited.

Table 10.3.4 - Extra inland emissions of CO_2, NO_x en SO_2 in the omission of other policy as of 2005 in SE with sources under the CO_2 trading system, and extra reduction of CO_2 abroad by additional import of emission allowances

	Effect emission Netherlands			Effect abroad
	CO_2	NO_x	SO_2	CO_2
	[Mton]	[kton]	[kton]	[Mton]
2010				
Industry, Refining				
Natural gas and oil extraction	0.1	0.04	0.15	-0.1
Electricity production	0.4	0.32	0.12	-0.4
2020				
Industry, Refining				
Natural gas and oil extraction	0.0	0.04	0.17	0,0
Electricity production	1.0	0.64	0.67	-1.0

With no additional policy covering trading sectors, the rise in fuel consumption is approximately 9 PJ in 2010. In the NO_x trading system, that produces an extra 0.4 kton of emissions and, based upon average emission factors for each sector[53,] the effect upon SO_2 is about 0.3 kton. In 2020, fuel consumption has risen by approximately 17 PJ and emissions by 0.7 kton (NO_x) and 0.8 kton (SO_2) respectively. In theory, the trading system compensates for the reported additional domestic emissions of CO_2 through an equivalent reduction abroad.

[53] In the electricity sector, the effect of SO_2 is strongly dependent upon the marginal fuelling of power plants. If gas is used, there is no SO_2 effect; if coal is used, the effect is greater.

Distribution across policy instruments

Based upon Table 10.3.1 and the results of the analyses of the future emissions market, it is possible to assess the effects of various specific policy measures. Figure 10.3.1 illustrates these graphically for the different policy 'packages' in each of the projection years.

From the graph, it can be seen that the projections indicate that the impact of the policy to stimulate sustainable sources will increase in significance. And so too will that of the energy-saving policy, although not as fast as in the period 1990-2000. Flexible instruments such as JI and CDM are credited with a prominent role in 2010. In the total policy effect for 2010, the share held by emission reductions abroad[54] is a little less than 50 percent. This compares with a share of two-thirds in the impact of the policy resulting from Climate Policy Implementation Paper (UK1) and subsequent measures.

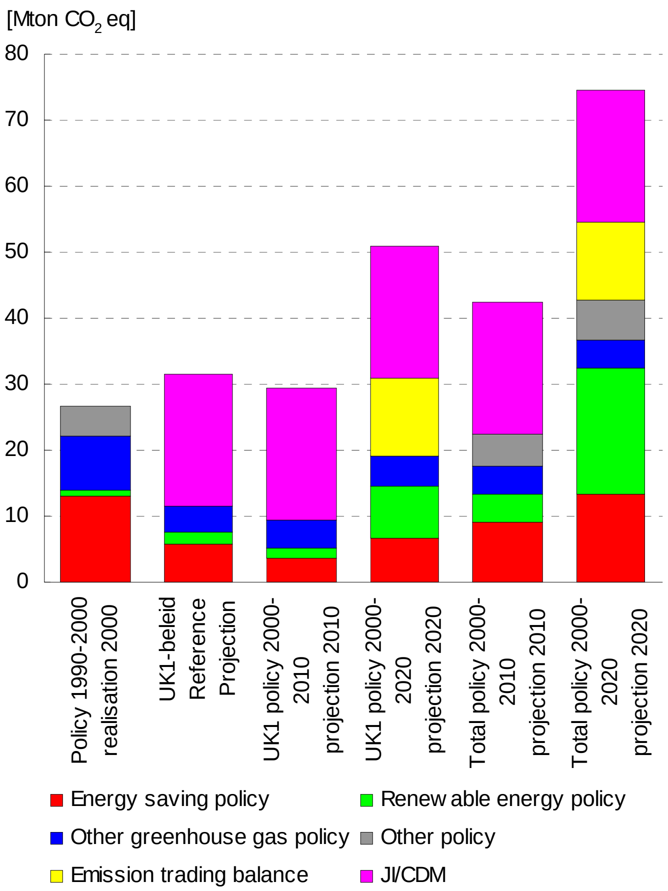

Figure 10.3.1 - Effects of climate policy and division of various categories of instruments, case positions in conformity with Table 10.3.1., historically covering 1990-2000, according to the old projection and in GE

10.4 Effects of policy not included in the projections

As well as the policy incorporated into the projection calculations, the effects of a number of other instruments and adjustments have been investigated. These are ones that have been announced but not yet finalised or clearly quantified. They are summarised in Table 10.4.1, which also includes a comment about the instrument's status and, if possible, its effects.

[54] Here, 'emission reductions abroad' refers to the emissions trading balance of Dutch companies plus purchases through JI/CDM by the national government.

Table 10.4.1 - Overview of policy that was not included in the projections

Instrument	Remarks	Effect Mton CO_2 eq.
Tender arrangement CO_2 reduction in built environment, 34.5 mln	Introduxtion depends on the results of Referencer Projection and evaluation of indicative targets	0-0,7 Mton
CO_2-reduction plan primary farmers	Volume unknown as of yet	PM
Car and motorcycle tax differentiation based on CO_2 emission	As of 1.1.2006 the car and motorcycle tax will be based on CO2 emmission: economical cars pay less and non-economical cars pay more. This	PM
Policy amendments traffic since Actualisation emission prognoses traffic [van den Brink, 2003]	This entails the negative efefct of the abolishement of policy such as the car and motorcycle tax for in-car instruments. [a)]	minus 0-0,05 Mton
Kilometer levy and road-pricing etc.	Entails two price variants (constructiom € 2.5 bln with variabilisation, and congestion levies that have been included in the Note on Mobility, which have been marked for further research. [b)]	PM
Biofuel policy	Based on 2% biofuel admixture in 2010. [c)]	PM
Policy N_2O industry		±. 4 Mton
F-gasses regulation	Autonomous improvement of leak tightness car airconditioning has already been processed in the reference Projection. Additional affect is not expected until 2015.	in 2010: nil

a) The abolishment of the BPM exemption on in-car instruments per 1-1-2005 could lead to an increase in CO_2 emissions of 0.05 Mton (Hoen and Annema, 2004)

b) The effect of this measure is considered soft and therefore included in the table as PM because it is very uncertain whether this measure will have been implemented before 2010. Depending on the chosen variant, the CO_2 emissions for road transport in 2010 will be approximately 0 to 0.9 Mton lower in 2010 (Geurs et al., 2004).

c) The effect of this measure is considered soft and therefore included in the table as PM because it is very uncertain whether this measure will have been implemented before 2010. The Note on transport emissions maintains an indicative percentage of 2% as of 2006 which is instrumented via an incentives regulation. If this percentage is achieved in 2010, the emissions from road transport will be 0.7 Mton lower. The effect of this measure is not well-to-wheel, which means that extra emissions, for example in the agricultural sector as a result of the cultivation of crops for biofuels, have not been included in this effect.

APPENDIX A POLICY OVERVIEW

	Strong Europe	Global Economy	Policy-free variant	Variant: no climate policy pursuant and subsequent to the Climate Policy Implementation Memorandum (UK1)	Variant: no policy for sources under CO_2 emissions ceiling	Policy in preparation ('pipeline') not included
Policy effect begins			2000	2000	2005	TBC
Emissions trading	Emission prices: €2/ton in 2005; €7/ ton in 2010, €11/ton in 2020. European system becomes global system.	As SE, but European system winding down in 2020.	No emissions trading.	No emissions trading.	As SE.	
Energy Tax	Rates for non-participants are at least equal to those for participants plus CO_2 price. Special arrangements for greenhouse horticulture remain in place. See also Energy Tax rate table	As SE.	Energy Tax/Regulatory Energy Tax (REB) end after 2000 for all sectors.	REB and Fuel Tax (BSB) fixed at level prior to UK1.	REB on electricity fixed at 2004 level.	
Energy Premium Scheme (EPR) and Energy Performance Advice (EPA) for existing buildings	EPR ends; EPA remains limited and is replaced in 2006 by the European Building Directive (EPPD).	As SE.	EPR and EPA are not introduced; no subsidies.	Built environment subsidies fixed at level prior to UK1.	As SE.	Possible tender as follow-up to EPR.
EPR and EPA for new buildings	Standards for homes and office buildings continue. Commercial remains at current adjusted level; housing revised to 0.8 on 01/01/2007.	As SE.	Building regulations in respect of energy savings end after 2000.	Energy-related building regulations fixed at level prior to UK1.	As SE.	
Energy labelling and EPR on electrical appliances	Labelling scheme continues; EPR ends.	As SE.	Arrangement and EPR end.	Arrangement and EPR end.	As SE.	
Non-Profit Energy Investment Regulation (EINP)	Ended in 2003.	As SE.	End after 2000.	Arrangement fixed at level prior to UK1.	As SE.	

	Strong Europe	Global Economy	Policy-free variant	Variant: no climate policy pursuant and subsequent to the Climate Policy Implementation Memorandum (UK1)	Variant: no policy for sources under CO_2 emissions ceiling	Policy in preparation ('pipeline') not included
Policy effect begins			2000	2000	2005	TBC
Energy Investment Tax Allowance (EIA)/Early Depreciation Environmental Investment (VAMIL), excluding CHP and sustainable energy	Budget is cut by €100m, of which €40m is 'structural' and €60m 'pruning''. Supplementary tax allowance reduced from 55% to 44%. Technology criteria approximately 14, sometimes up to €70 per ton of CO_2. Selection stricter due to free riders. No VAMIL.	As SE.	Arrangements end after 2000.	Arrangement fixed at level prior to UK1.	Ends for electrical appliances and for industrial, refinery and CHP participants in emissions trading, including small-scale ones.	
CO_2 reduction plan, clean fossil fuels policy	Selected technology receives temporary support. Technology criteria approximately 14, sometimes up to € 70 per CO_2 eq. ton. Limited budget.	As SE.	Arrangements end after 2000.	Arrangements end.	Ends for industrial, refinery and CHP participants in emissions trading; budget for other projects proportional.	
Benchmarking Covenant and Long-Term Energy Efficiency Agreement (LTA2)	Replaced by emissions trading, but still used for allocation.	As SE.	Benchmarking and LTA2 end after 2000.	Covenants continue: only profitable measures are taken, with signalling and facilitation in accordance with LTA-1.	Ends for participants in emissions trading.	
Environmental Management Act and LTA for Energy Tax non-participants	Standard remains that environmental investments must involve an internal interest rate of more than 15%.	As SE.	No energy requirement in the environmental licence.	Energy retained in the environmental licence; no more additional support for implementation.	As SE (European directive).	
Greenhouse horticulture policy	Greenhouse Horticulture Administrative Orders (AMvB) end in 2010, then equalised with the Environmental Management Act (WMB) to 15% internal interest rate in 2020.	As SE.	Greenhouse Horticulture Environmental Covenant (GLAMI) and AMvB end after 2000.	GLAMI and AMVB policies continue, but objectives not forced.	As SE.	CO_2 reduction plan for primary agriculturalists.

	Strong Europe	Global Economy	Policy-free variant	Variant: no climate policy pursuant and subsequent to the Climate Policy Implementation Memorandum (UK1)	Variant: no policy for sources under CO_2 emissions ceiling	Policy in preparation ('pipeline') not included
Policy effect begins			2000	2000	2005	TBC
Subsidies for environmental quality of electricity production (MEP) and other financial stimulation of total (EIA, tax exemptions)	CHP MEP continues based upon 50% average unprofitable top end, in so far as needed. See also EIA/VAMIL.	As SE.	MEP and other CHP facilities end after 2000.	Pre-UK1 CHP arrangements retained; no UK1 policy; no payment discount or other stimulation from after 1999.	MEP for large-scale CHP ends, as does MEP for small-scale CHP in order to prevent substitution effect.	
MEP and other financial stimulation of sustainable energy ('green' investment, EIA/VAMIL)	Current policy continues – that is, subsidy on unprofitable top end of technologies currently defined, so that subsidy amount declines with the falling cost of sustainable electricity but with no other budgetary restrictions. Article 36i to stimulate demand for 'green' energy and gas abolished from 01/01/05. MEP grows accordingly at the same time. See also EIA/VAMIL.	As SE.	MEP and other sustainable energy facilities end after 2000.	Pre-UK1 intensity arrangements for domestic sustainable energy retained.	As SE.	
Coal covenant	No extension after 2012, due to emissions trading. See also MEP.	As SE.	Coal covenant ends.	No coal covenant.	Ends as far as savings are concerned. Biomass agreement continues.	
Nuclear energy	In accordance with current policy, Borssele power plant closes in 2013. No new plants possible.	Borssele remains in service after 2013.	Borssele closes in 2013.	Borssele closes in 2013.	Borssele closes in 2013.	
Automobile Manufacturers Associations (ACEA, JAMA and KAMA) covenant	Current covenant is extended with the same objective: for new cars, 140 grams of CO_2/km in 2008/2009.	As SE.	No European Automobile Manufacturers Association (ACEA) covenant.	No ACEA covenant.	As SE.	
Car labelling	Energy label for passenger cars.	As SE.	Ends.	Ends.		

	Strong Europe	Global Economy	Policy-free variant	Variant: no climate policy pursuant and subsequent to the Climate Policy Implementation Memorandum (UK1)	Variant: no policy for sources under CO_2 emissions ceiling	Policy in preparation ('pipeline') not included
Policy effect begins			2000	2000	2005	TBC
Financial stimulation of fuel-efficient cars	Premium for fuel-efficient cars (abolished on 01/01/2003).	Premium abolished.	Premium abolished.	Premium abolished.	Premium abolished.	
Car and Motorcycle Tax (BPM) exemption for hybrid cars	Hybrid car is exempt from BPM.	As SE.	Ends.	Ends.	As SE.	
BPM differentiation based upon CO_2 emissions	Not implemented.	As SE.	Not implemented.	Not implemented.	Not implemented.	From 01/01/2006, BPM is linked to CO_2 emissions: more efficient cars pay less and less efficient ones pay more. This measure is budget neutral.
Road charging etc.	Not until after 2020 (is not current policy, level to be decided).	As SE.	Not implemented.	Not implemented.	Not implemented.	Two price variants are being investigated. Not yet defined.
Other fiscal policy	Maintenance of 2003 taxes and duties.	As SE.	Excise duty increases after 2000 end, but no effect projected.	Excise duties are not covered by UK-1.	As SE.	
Biofuels policy	Not until after 2020, then introduced at EU standard for 2010 (not yet implemented).	As SE.	Not implemented.	Not implemented.	Not implemented.	Starting point is 2% biofuel addition in 2010. Not yet defined.
Improved enforcement of speed limits	Fixed in the 1991 Climate Change Paper.	As SE.	Ends.	Ends.	As SE.	
'New driving' (in-car instruments, tyre pressure)	In accordance with 2003 policy.	As SE.	Ends.	Ends.	As SE.	

	Strong Europe	Global Economy	Policy-free variant	Variant: no climate policy pursuant and subsequent to the Climate Policy Implementation Memorandum (UK1)	Variant: no policy for sources under CO_2 emissions ceiling	Policy in preparation ('pipeline') not included
Policy effect begins			2000	2000	2005	TBC
CO_2 reduction plan for freight transport	Existing projects continue.	As SE.	Projects end, but no effect projected.	Projects end, but no effect projected.	As SE.	
CO_2 reduction plan for passenger transport	Existing projects continue.	As SE.	Projects end, but no effect projected.	Projects end, but no effect projected.	As SE.	
Subsidy scheme for quieter, cleaner and more economical urban transport (SSZ)	Subsidy scheme for quieter, cleaner and more economical urban transport	As SE.	Ends, but no effect projected.	Ends, but no effect projected.	As SE.	
Market regulation	No full competition as yet in the gas and electricity markets.	As SE.	As now.	As now.	As now.	
Natural gas production	Maintenance of 'small fields' policy, including limit on production in Groningen.	No additional policy.	As now.	As now.	As now.	
Electricity production	Introduction of capacity market after 2020.	No additional policy.	As now.	As now.	As now.	
Other greenhouse gases						
HFC, chemicals industry	No further efficiency improvements expected from afterburner.	As SE.	Dupont afterburner was installed in 1997, so in policy-free variant (from 2000) it is not removed. But post-2000 optimisation is not carried out.	UK-1 reduction – half of the total – from Dupont afterburner ends.	As SE.	
CH_4, gas sector	Netherlands Oil and Gas Exploration and Production Association (NOGEPA) agreement on oil and gas production.	As SE.	NOGEPA agreement ends.	NOGEPA agreement ends.	As SE.	

	Strong Europe	Global Economy	Policy-free variant	Variant: no climate policy pursuant and subsequent to the Climate Policy Implementation Memorandum (UK1)	Variant: no policy for sources under CO_2 emissions ceiling	Policy in preparation ('pipeline') not included
Policy effect begins			2000	2000	2005	TBC
CH_4, waste sector	Under National Waste Management plan (LAP), agreements on quantities dumped and their composition in 2010 and 2020.	As SE.	LAP agreements end.	As SE.	As SE.	
CH_4/N_2O, agriculture	Ammonia policy ('ploughing in' with manure), manure policy and Common Agricultural Policy (milk quotas).	As SE.	Policy ends.	As SE.	As SE.	
N_2O, nitric acid production	Not yet defined.	As SE.	Not implemented.	Not implemented.	Not implemented.	Not yet defined.
PFC, aluminium industry	Measure to reduce PFC emissions in the aluminium industry in 2005, through central input (= UK1).	As SE.	Measure ends.	Measure ends.	As SE.	
HFCs	Emissions ceiling in semiconductor industry.	As SE.	Measures end.	Measures end.	As SE.	
HFCs	Fluorinated Gases Regulations (not yet defined).	As SE.	Not implemented.	Not implemented.	Not implemented.	Not yet defined.
Acidification policy						
NO_x	NO_x emissions trading for companies larger than 20 MW_{th}; type certification for central-heating systems and emission regulations (BEES) for oil-fired systems at companies smaller than 20 MW_{th}; European emissions standards for transport.	As SE.				

	Strong Europe	Global Economy	Policy-free variant	Variant: no climate policy pursuant and subsequent to the Climate Policy Implementation Memorandum (UK1)	Variant: no policy for sources under CO_2 emissions ceiling	Policy in preparation ('pipeline') not included
Policy effect begins			2000	2000	2005	TBC
SO_2	BEES for oil-fired heating systems and refineries; Netherlands Atmospheric Emissions Guidelines (NER) for non-BEES systems; Waste Incineration Regulations for coal-fired power plants with supplementary fuelling by contaminated biomass; agreement with Shell refinery on conversion to gas firing; European Emissions standards for transport.	As SE.				
Volatile organic compounds (VOCs)	VOC reduction plans for various industries; Corporate Environmental Plan (BMP3) measures for the chemicals industry; Environmental Policy Agreement for the graphical industry; occupational health policy for adhesives and paint; EU Paint Directive, European emissions standards for transport.	As SE.				
NH_3	Ammonia policy: regulations concerning manure application methods and permissible stall types.	As SE.				
Particulate matter policy						Stimulation scheme for the fitting of particle filters to new diesel cars.

APPENDIX B ENERGY BALANCES

Table B.1 - 2002: Energy consumption per sector and sectoral CO_2 emissions

History 2002 (temperature corrected)

	Households	Industry	of which Chemical industry	Agriculture and Horticulture	Trade, services and Government	Traffic*	Total end consumption	Refineries	Electr. Production	Natural gas and oil extraction	Total energy company	TOTAL
Consumption balance [PJ]	433	1137	708	147	331	521	2569	174	400	37	611	3180
coal	0	102	8	0	1	0	103	0	250	0	250	353
oil	4	418	378	2	9	516	949	145	39	0	184	1133
natural gas	340	382	202	118	197	0	1037	38	418	30	486	1524
steam from nuclear energy	0	0	0	0	0	0	0	0	40	0	40	40
electricity	82	128	33	14	99	6	329	-1	-271	6	-265	63
heat	7	105	87	13	23	0	147	-8	-77	0	-86	62
other energy	0	1	0	0	3	0	3	0	2	0	2	5
Non-energetic consumption [PJ]	0	465	368	0	5	3	473					473
coal	0	64	4	0	0	0	64					64
oil	0	313	276	0	5	3	321					321
natural gas	0	88	88	0	0	0	88					88
Extraction [PJ]	0	9	5	0	2	0	12	0	54	0	54	66
heat	0	9	4	0	2	0	11	0	51	0	51	62
electricity	0	1	0	0	1	0	1	0	3	0	3	4
Final electricity [PJ]	82	148	43	22	105	6	362	9	19	6	34	396
Primary energy consumption [PJ]	546	1271	726	160	459	543	2980				200	3180
CO_2 emission [Mton]												
combustion	19.4	24.9	11.2	6.8	11.5	37.4	100.0	9.5	54.4	1.7	65.7	165.7
energetic process	0.0	5.3	3.1	0.0	0.0	0.1	5.4	1.4	0.0	0.0	1.4	6.8
other	0.0	1.6	0.1	0.0	0.2	0.0	1.8	0.0	0.3	0.4	0.7	2.5
total	19.4	31.8	14.4	6.8	11.6	37.6	107.2	10.9	54.7	2.1	67.7	174.9

*Including fishery and defense

Table B.2 - SE 2010: Outcome of the reference projection for 2010: energy consumption per sector and sectoral CO_2 emissions

SE 2010

	Households	Industry	of which Chemical industry	Agriculture and Horticulture	Trade, services and Government	Traffic*	Total end consumption	Refineries	Electr. Production	Natural gas and oil extraction	Total energy company	TOTAL
Consumption balance [PJ]	419	1286	818	140	303	536	2683	199	420	48	667	3350
coal	0	123	2	0	0	0	123	0	267	0	267	390
oil	4	551	489	0	0	530	1085	139	32	0	172	1257
natural gas	311	335	171	122	165	0	932	53	437	42	532	1465
steam from nuclear energy	0	0	0	0	0	0	0	0	39	0	39	39
electricity	98	129	32	11	121	6	365	3	-300	6	-290	74
heat	6	147	124	7	12	0	173	3	-56	0	-53	120
other energy	0	0	0	0	5	0	5	0	0	0	0	5
Non-energetic consumption [PJ]	0	571	450	0	0	3	574					574
coal	0	70	2	0	0	0	70					70
oil	0	403	350	0	0	3	406					406
natural gas	0	98	98	0	0	0	98					98
Extraction [PJ]	1	9	6	0	1	0	11	11	116	0	127	138
heat	1	9	6	0	1	0	10	11	99	0	110	120
electricity	0	1	0	0	0	0	1	0	18	0	18	19
Final electricity [PJ]	98	149	42	18	126	6	398	12	21	10	43	441
Primary energy consumption [PJ]	548	1394	818	152	456	560	3110				241	3350
CO_2 emission [Mton]												
combustion	17.7	27.1	10.8	6.8	9.3	37.9	98.8	12.7	56.3	2.4	71.3	170.1
energetic process	0.0	6.3	3.6	0.0	0.0	0.2	6.5	0.5	0.0	0.0	0.5	7.0
other	0.0	1.2	0.1	0.0	0.1	0.0	1.4	0.0	0.4	0.3	0.7	2.1
total	17.7	34.6	14.5	6.8	9.4	38.1	106.7	13.2	56.7	2.7	72.5	179.2

Table B.3 - SE 2020: Outcome of the reference projection for 2020: energy consumption per sector and sectoral CO_2 emissions

SE 2020

	Households	Industry	of which Chemical industry	Agriculture and Horticulture	Trade, services and Government	Traffic*	Total end consumption	Refineries	Electr. Production	Natural gas and oil extraction	Total energy company	TOTAL
Consumption balance [PJ]	409	1389	907	117	302	648	2865	211	417	53	682	3547
coal	0	135	2	0	0	0	135	0	187	0	187	322
oil	4	642	557	0	0	641	1287	137	32	0	169	1456
natural gas	283	287	164	99	146	0	815	49	640	42	731	1546
steam from nuclear energy	0	0	0	0	0	0	0	0	0	0	0	0
electricity	114	161	44	11	140	6	432	9	-369	11	-349	83
heat	7	164	139	7	13	0	192	16	-73	0	-57	135
other energy	0	1	0	0	4	0	5	0	0	0	0	5
Non-energetic consumption [PJ]	0	647	521	0	0	3	650					650
coal	0	77	2	0	0	0	77					77
oil	0	460	409	0	0	3	463					463
natural gas	0	110	110	0	0	0	110					110
Extraction [PJ]	3	9	6	0	2	0	13	16	162	0	178	191
heat	2	9	6	0	2	0	12	16	107	0	123	135
electricity	1	1	0	0	0	0	1	0	55	0	55	56
Final electricity [PJ]	114	166	46	19	142	6	448	13	24	15	52	500
Primary energy consumption [PJ]	537	1502	909	128	453	673	3293				254	3547
CO_2 emission [Mton]												
combustion	16.2	26.6	10.0	5.6	8.2	45.6	102.1	13.0	60.1	2.4	75.5	177.6
energetic process	0.0	6.9	4.0	0.0	0.0	0.2	7.1	0.8	0.0	0.0	0.8	7.9
other	0.0	1.3	0.1	0.0	0.1	0.0	1.5	0.0	0.2	0.3	0.5	2.0
total	16.2	34.9	14.2	5.6	8.3	45.8	110.7	13.7	60.4	2.7	76.8	187.4

Table B.4 - GE 2010: Outcome of the reference projection for 2010: energy consumption per sector and sectoral CO_2 emissions

GE 2010

	Households	Industry	of which Chemical industry	Agriculture and Horticulture	Trade, services and Government	Traffic*	Total end consumption	Refineries	Electr. Production	Natural gas and oil extraction	Total energy company	TOTAL
Consumption balance [PJ]	440	1298	815	157	318	536	2749	199	436	50	685	3434
coal	0	124	2	0	0	0	124	0	266	0	266	389
oil	4	560	495	0	0	530	1094	143	32	0	175	1270
natural gas	324	323	154	138	173	0	958	49	484	41	574	1532
steam from nuclear energy	0	0	0	0	0	0	0	0	39	0	39	39
electricity	106	136	35	11	128	6	386	4	-319	8	-307	79
heat	7	154	130	8	13	0	182	4	-67	0	-63	119
other energy	0	0	0	0	5	0	5	0	0	0	0	5
Non-energetic consumption [PJ]	0	580	456	0	0	3	583					583
coal	0	70	2	0	0	0	70					70
oil	0	411	356	0	0	3	414					414
natural gas	0	99	99	0	0	0	99					99
Extraction [PJ]	1	9	6	0	1	0	11	11	121	0	132	143
heat	1	9	6	0	1	0	10	11	98	0	109	119
electricity	0	1	0	0	0	0	1	0	22	0	22	23
Final electricity [PJ]	106	154	42	22	133	6	421	12	22	12	46	467
Primary energy consumption [PJ]	577	1409	816	168	479	560	3194				240	3434
CO_2 emission [Mton]												
combustion	18.4	26.5	9.8	7.7	9.7	37.9	100.3	12.6	58.8	2.3	73.7	174.0
energetic process	0.0	6.3	3.6	0.0	0.0	0.2	6.5	0.5	0.0	0.0	0.5	7.1
other	0.0	1.3	0.1	0.0	0.1	0.0	1.4	0.0	0.4	0.4	0.8	2.2
total	18.4	34.1	13.5	7.7	9.8	38.1	108.2	13.1	59.2	2.7	75.0	183.2

Table B.5 - GE 2020: Outcome of the reference projection for 2020: energy consumption per sector and sectoral CO_2 emissions

GE 2020

	Households	Industry	of which Chemical industry	Agriculture and Horticulture	Trade, services and Government	Traffic*	Total end consumption	Refineries	Electr. Production	Natural gas and oil extraction	Total energy company	TOTAL
Consumption balance [PJ]	462	1464	943	156	337	648	3067	234	518	49	800	3867
coal	0	135	2	0	0	0	135	0	341	0	341	477
oil	4	669	588	0	0	641	1314	177	32	0	209	1524
natural gas	315	326	173	134	165	0	940	26	544	33	602	1542
steam from nuclear energy	0	0	0	0	0	0	0	0	39	0	39	39
electricity	135	163	40	13	155	6	473	12	-396	16	-368	105
heat	9	169	140	8	13	0	199	20	-44	0	-24	175
other energy	0	1	0	0	4	0	5	0	0	0	0	5
Non-energetic consumption [PJ]	0	670	535	0	0	3	673					673
coal	0	77	2	0	0	0	77					77
oil	0	480	421	0	0	3	483					483
natural gas	0	112	112	0	0	0	112					112
Extraction [PJ]	3	9	6	0	2	0	14	16	237	0	253	267
heat	3	9	6	0	2	0	13	16	146	0	162	175
electricity	1	1	0	0	0	0	1	0	91	0	91	92
Final electricity [PJ]	135	176	48	27	159	6	504	15	28	20	63	567
Primary energy consumption [PJ]	628	1598	945	170	524	675	3595				272	3867
CO_2 emission [Mton]												
combustion	17.9	28.9	11.3	7.5	9.3	45.6	109.2	15.0	69.3	1.8	86.1	195.3
energetic process	0.0	7.0	4.1	0.0	0.0	0.2	7.2	0.4	0.0	0.0	0.4	7.6
other	0.0	1.4	0.2	0.0	0.1	0.0	1.6	0.0	0.5	0.3	0.8	2.4
total	17.9	37.4	15.6	7.5	9.4	45.8	118.0	15.4	69.8	2.1	87.3	205.3

APPENDIX C OVERVIEW OF EMISSIONS

The numbers for 2002 that have been included in this appendix are preliminary. The NIR 2005 will publish the definitive numbers.

Table C.1 - 2002: Emissions per sector

Greenhouse gas emissions [Mton CO_2 eq.]

	CO_2	CH_4	N_2O	HFC's	PFC's	SF_6	Total
Agriculture	6.8	8.7	9.8				25.3
Waste disposal		7.6					7.6
Industry	31.8		7.0	1.6	1.2	0.3	42.0
Traffic	37.6		0.5				38.0
Energy	67.7	1.0					68.8
Other	31.0	0.0	0.7				31.7
Total	174.9	17.3	17.9	1.6	1.2	0.3	213.3

Air-polluting emissions [kton]

<table>
<tr><th></th><th>NO_x</th><th>SO_2</th><th>NMVOC</th><th>NH_3</th><th>PM_{10}</th></tr>
<tr><td>Industry</td><td rowspan="4">95</td><td>15</td><td>51</td><td>3</td><td rowspan="4">13</td></tr>
<tr><td>Refineries</td><td>30</td><td>7</td><td></td></tr>
<tr><td>Energy sector</td><td>14</td><td>18</td><td></td></tr>
<tr><td>Waste treatment</td><td></td><td></td><td></td></tr>
<tr><td>Traffic</td><td>255</td><td>7</td><td>103</td><td>3</td><td>16</td></tr>
<tr><td>Agriculture</td><td>11</td><td rowspan="3">2</td><td>2</td><td>123</td><td>9</td></tr>
<tr><td>Households</td><td>20</td><td>32</td><td rowspan="2">8</td><td rowspan="2">8</td></tr>
<tr><td>TSG and contruction</td><td>15</td><td>29</td></tr>
<tr><td>Total</td><td>396</td><td>67</td><td>242</td><td>136</td><td>46</td></tr>
</table>

Table C.2 - SE 2010: Outcome of the reference projections for 2010: Emissions per sector

Greenhouse gas emissions [Mton CO_2 eq.]

	CO_2	CH_4	N_2O	HFC's	PFC's	SF_6	Total
Agriculture	6.8	8.3	8.9				24.0
Waste disposal		4.4					4.4
Industry	34.6		7.1	2.5	0.6	0.3	45.2
Traffic	38.1		0.5				38.6
Energy	72.5	0.3					72.8
Other	27.1	0.0	0.7				27.8
Total	179.2	13.0	17.2	2.5	0.6	0.3	212.8

Air-polluting emissions [kton]

<table>
<tr><th></th><th>NO_x</th><th>SO_2</th><th>NMVOC</th><th>NH_3</th><th>PM_{10}</th></tr>
<tr><td>Industry</td><td rowspan="4">73</td><td>18</td><td>43</td><td>4</td><td rowspan="4">12</td></tr>
<tr><td>Refineries</td><td>25</td><td>8</td><td></td></tr>
<tr><td>Energy sector</td><td>17</td><td>8</td><td></td></tr>
<tr><td>Waste treatment</td><td></td><td></td><td></td></tr>
<tr><td>Traffic</td><td>185</td><td>4</td><td>55</td><td>3</td><td>13</td></tr>
<tr><td>Agriculture</td><td>6</td><td rowspan="3">2</td><td>1</td><td>109</td><td>9</td></tr>
<tr><td>Households</td><td>11</td><td>32</td><td rowspan="2">8</td><td rowspan="2">8</td></tr>
<tr><td>TSG and contruction</td><td>8</td><td>26</td></tr>
<tr><td>Total</td><td>284</td><td>66</td><td>173</td><td>124</td><td>42</td></tr>
</table>

Table C.3 - Outcome of the reference projections for 2010: Emissions per sector

Greenhouse gas emissions [Mton CO_2 eq.]

	CO_2	CH_4	N_2O	HFC's	PFC's	SF_6	Total
Agriculture	5.6	8.0	8.2				21.8
Waste disposal		2.2					2.2
Industry	34.9		7.3	2.9	0.7	0.2	45.9
Traffic	45.8		0.7				46.5
Energy	76.8	0.3					77.1
Other	24.4	0.0	0.7				25.2
Total	187.4	10.6	16.8	2.9	0.7	0.2	218.5

Air-polluting emissions [kton]

<table>
<tr><th></th><th>NO_x</th><th>SO_2</th><th>NMVOC</th><th>NH_3</th><th>PM_{10}</th></tr>
<tr><td>Industry</td><td rowspan="4">77</td><td>19</td><td>49</td><td>5</td><td rowspan="4">12</td></tr>
<tr><td>Refineries</td><td>26</td><td>8</td><td></td></tr>
<tr><td>Energy sector</td><td>12</td><td>8</td><td></td></tr>
<tr><td>Waste treatment</td><td></td><td></td><td></td></tr>
<tr><td>Traffic</td><td>167</td><td>5</td><td>43</td><td>3</td><td>13</td></tr>
<tr><td>Agriculture</td><td>3</td><td rowspan="3">2</td><td>1</td><td>103</td><td>7</td></tr>
<tr><td>Households</td><td>9</td><td>34</td><td rowspan="2">8</td><td rowspan="2">8</td></tr>
<tr><td>TSG and contruction</td><td>5</td><td>28</td></tr>
<tr><td>Total</td><td>262</td><td>64</td><td>171</td><td>119</td><td>41</td></tr>
</table>

Table C.4 - GE 2010: Outcome of the reference projections for 2010: Emissions per sector

Greenhouse gas emissions [Mton CO_2 eq.]

	CO_2	CH_4	N_2O	HFC's	PFC's	SF_6	Total
Agriculture	7.7	8.3	9.2				25.2
Waste disposal		4.4					4.4
Industry	34.1		7.3	2.5	0.6	0.3	44.8
Traffic	38.1		0.5				38.6
Energy	75.0	0.3					75.3
Other	28.3	0.0	0.7				29.0
Total	183.2	13.0	17.6	2.5	0.6	0.3	217.3

Air-polluting emissions [kton]

<table>
<tr><th></th><th>NO_x</th><th>SO_2</th><th>NMVOC</th><th>NH_3</th><th>PM_{10}</th></tr>
<tr><td>Industry</td><td rowspan="4">75</td><td>18</td><td>44</td><td>4</td><td rowspan="4">12</td></tr>
<tr><td>Refineries</td><td>26</td><td>8</td><td></td></tr>
<tr><td>Energy sector</td><td>17</td><td>8</td><td></td></tr>
<tr><td>Waste treatment</td><td></td><td></td><td></td></tr>
<tr><td>Traffic</td><td>185</td><td>4</td><td>55</td><td>3</td><td>13</td></tr>
<tr><td>Agriculture</td><td>7</td><td rowspan="3">2</td><td>1</td><td>111</td><td>10</td></tr>
<tr><td>Households</td><td>12</td><td>33</td><td rowspan="2">8</td><td rowspan="2">9</td></tr>
<tr><td>TSG and contruction</td><td>9</td><td>27</td></tr>
<tr><td>Total</td><td>288</td><td>66</td><td>176</td><td>126</td><td>44</td></tr>
</table>

Table C.5 - GE 2020: Outcome of the reference projections for 2020: Emissions per sector

Greenhouse gas emissions [Mton CO_2 eq.]

	CO_2	CH_4	N_2O	HFC's	PFC's	SF_6	Total
Agriculture	7.5	9.4	9.8				26.7
Waste disposal		2.2					2.2
Industry	37.4		7.6	2.9	0.7	0.2	48.8
Traffic	45.8		0.7				46.5
Energy	87.3	0.2					87.5
Other	27.3	0.0	0.7				28.0
Total	205.3	11.8	18.8	2.9	0.7	0.2	239.7

Air-polluting emissions [kton]

<table>
<tr><th></th><th>NO_x</th><th>SO_2</th><th>NMVOC</th><th>NH_3</th><th>PM_{10}</th></tr>
<tr><td>Industry</td><td rowspan="4">84</td><td>20</td><td>51</td><td>5</td><td rowspan="4">14</td></tr>
<tr><td>Refineries</td><td>31</td><td>10</td><td></td></tr>
<tr><td>Energy sector</td><td>23</td><td>8</td><td></td></tr>
<tr><td>Waste treatment</td><td></td><td></td><td></td></tr>
<tr><td>Traffic</td><td>167</td><td>5</td><td>43</td><td>3</td><td>13</td></tr>
<tr><td>Agriculture</td><td>4</td><td rowspan="3">2</td><td>1</td><td>130</td><td>11</td></tr>
<tr><td>Households</td><td>10</td><td>38</td><td rowspan="2">8</td><td rowspan="2">10</td></tr>
<tr><td>TSG and contruction</td><td>6</td><td>32</td></tr>
<tr><td>Total</td><td>272</td><td>80</td><td>182</td><td>147</td><td>47</td></tr>
</table>

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