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INDICATORS OF DOMESTIC EFFORTS TO REDUCE CO_2 EMISSIONS IN THE NETHERLANDS

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Acknowledgement/Preface

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Abstract

An overview of efforts on domestic CO_2 emission reduction has been composed for the Netherlands. It will serve as background information for international reporting on progress in national climate policy. The results could contribute to the discussion on supplementarity of domestic reductions as part of total avoided emissions. The term 'effort' covers all activities related to domestic reduction, and their consequences, compared to a situation without a greenhouse problem. The overview regards both past and future efforts in the period 1990-2010 of all parties involved, such as households, companies and government. Next to the indicators avoided emission, cost of emission reduction and government expenditures, also other non-monetary effort indicators have been investigated.

Main results regard the following. In 2010 emissions would be 32% higher without all reduction activities, mainly due to energy savings and about half of it due to policy. Total expenditures related to emission reduction peak around 2002 at 1.3% of government expenditures. The fraction spent on renewable energy increases up to three-quarters of total expenditures in 2010. Average total investments for emission reduction in the period 1990-2010 equal 3% of total investments. Total net costs are equal to 0.2% of GDP in 2000 and 0.6% in 2010. Finally, it proves to be impossible to provide for a systematic overview of non-financial efforts, both for reasons of definitions and data availability. From a pragmatically chosen set of indicators it shows that the score of the Netherlands compared to the EU in total is mixed.

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SUMMARY

Efforts for reduction of CO_2 emission

An overview of efforts on domestic emission reduction has been compiled for the Ministry of VROM. It will serve as background information for EU and UN reporting on progress in national climate policy. Results could also contribute to the discussion on supplementarity of domestic reductions as part of total emission reductions. For practical reasons the term 'effort' has been interpreted as all reduction activities mentioned in policy evaluations, including activities with another goal or reduction as secondarily goal. The overview presented here regards both past and future efforts in the period 1990-2010 of households, companies and government. Next to the obvious indicators emission reduction, cost of reduction and related government expenditures, also other effort indicators have been investigated.

Indicators on emission reduction and costs

The first indicator 'total emission reduction' has been calculated from (realised or projected) values for energy savings, renewable energy production and forced substitution between fossil energy carriers (see Figure S.1). The indicator 'policy-induced reduction' has been estimated on the basis of other evaluation studies and scenario results. Government expenditures on emission reduction were determined as another effort indicator. Together with taxes (another indicator) and non-financial policy measures they constitute 'policy support' that leads to policy related investments for emission reduction in households and enterprises. Together with 'other investments', not related to policy, this provides for gross reduction costs. After subtraction of benefits from avoided energy purchases (net) reduction costs are found.

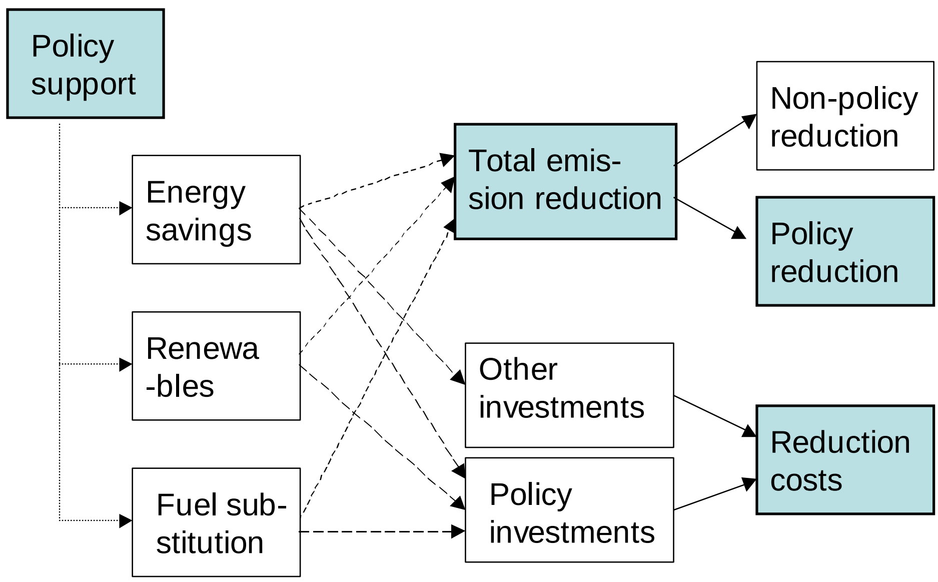

Figure S.1 *Determination of emission reduction and reduction costs and indicators*

Avoided emission and policy contribution

From 1990 on the amount of avoided emissions steadily increase (see Table S.1). In 2010, using the Global Economy scenario, emissions would have been 32-33% higher without reduction activities. The main part of avoided emissions is due to energy savings. But after 2003 renewable energy contributes significantly. A substantial part of total reduction would have been realised too in absence of greenhouse policy. On average for 1990-2010 avoided emissions due to policy amount to 50% of total emission reduction. Virtually all avoided emissions due to renewables are policy induced. Policy induced substitution does not contribute in the chosen scenario. The figures for 1999-2010 (see last column) show the avoided emissions after the intensification of reduction policy. Taking account of the different length of periods it shows that speed of emission reduction has increased compared to the period 1990-1998.

Table S.1 *Breakdown of avoided emission of CO_2 in selected years after 1990*

[Mton]	1995	1998	2000	2003	2010[1]	1999-2010
Energy savings	13	22	28	30	*52*	*30*
Renewable energy	0.5	1.1	1.6	2.8	*7.6*	*6.4*
Substitution	0	0	0	0	*0*	*0*
Total avoided	13	23	30	33	*60*	*37*
Fraction of emissions [%]	8	14	18	19	*33*	
Policy induced	5	10	15	20	*28*	*18*
Fraction of total avoided [%]	40	45	50	60	*48*	

[1]Reference Outlook, scenario Global Economy.

Government expenditures for emission reduction

An overview of all government expenditures related to emission reduction is given in Figure S.2 (see further details in Chapter 3). Expenditures comprise both direct support to implementation of energy saving measures or renewable options, indirect support through R&D-activities and organizational costs of support schemes. Financial flows that do not show up in government budgets, for instance financial support in the new MEP-scheme, are also incorporated. The peak around 2002, due to substantial subsidies for renewable electricity imports, corresponds to 1.3% of total government expenditures. Until 2000 almost three-quarters of total expenditures regarded energy savings; after 2000 this changes rapidly and in 2010 the opposite is true.

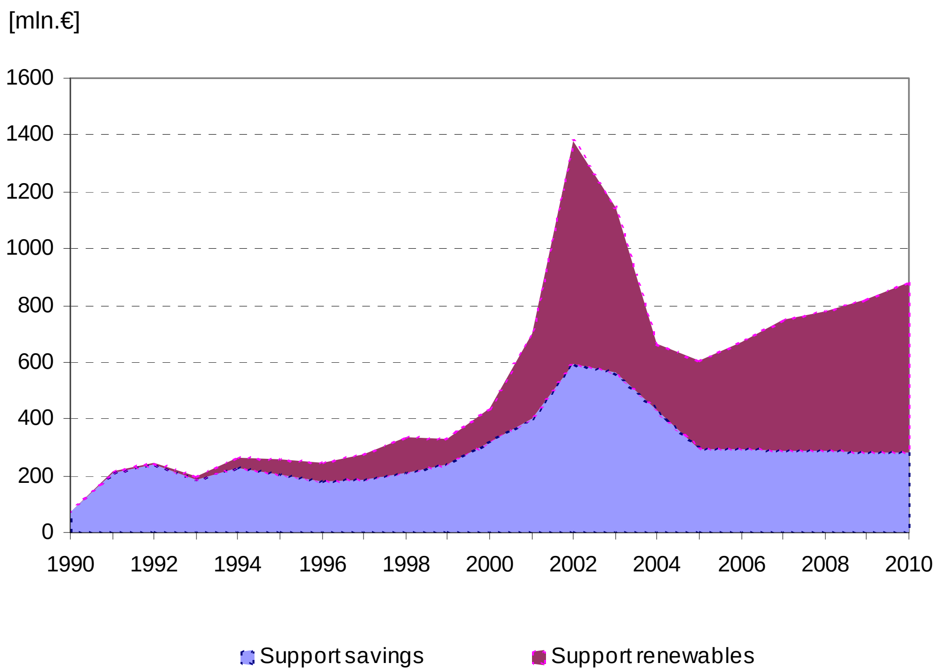

Figure S.2 *Yearly financial support for energy savings and renewable energy*

Investments related to emission reduction
For renewables this regards total investments and for savings extra investments compared to conventional systems. Most policy-related investments have been calculated from expenditures per support scheme and known ratios between financial support and investment. For non-financial policy measures, such as standards for new dwellings, investments were determined too. In Figure S.3 total yearly investments are shown for savings and renewables separately. The peak in investments in 2002 corresponds to 3% of all investments in that year. This peak is far less outspoken than that for government expenditures because substantial expenditures around 2002 did not generate inland investments.

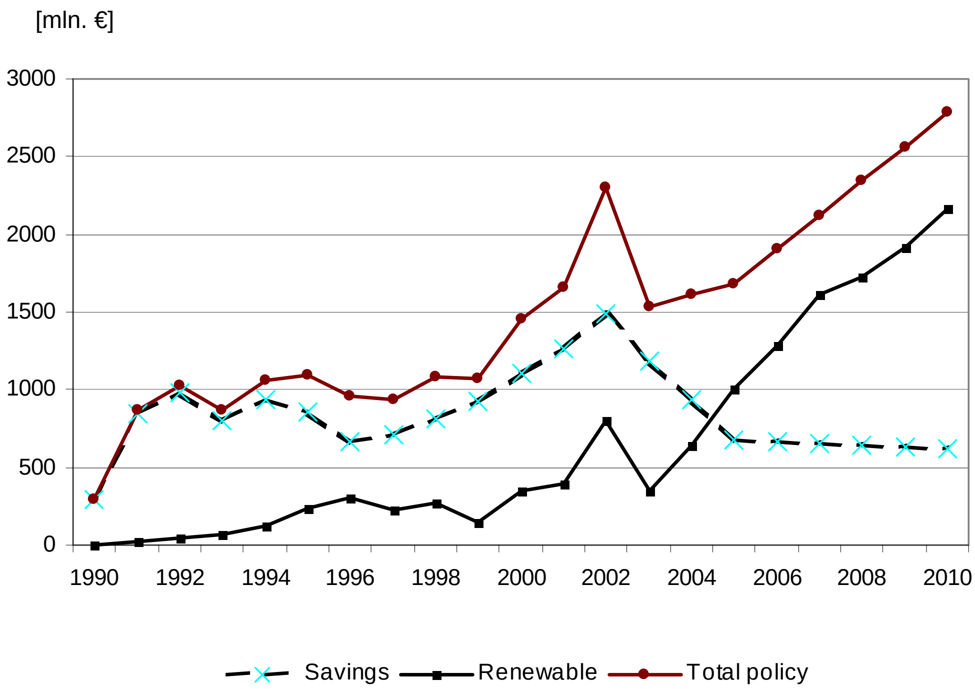

Figure S.3 *Yearly policy related investments for savings, renewables and total*

Cumulative investments over the period 1990-2010, including estimated autonomous investments, equal 57 € billion. About 14 billion are for renewable energy and 44 billion for energy savings (including cogeneration). The sectors households and electricity production contribute most to total investments.

Emission reduction costs
These have been calculated according to the 'national costing approach'. Gross yearly costs follow from investments using an annuity factor based on a 4% interest rate (see Table S.2).

Table S.2 *Gross costs, benefits and net costs of emission reduction activities*

[Billion €]	2000			2010[1]		
	Gross costs	Benefits	Net costs	Gross costs	Benefits	Net costs
Households	0.7	0.3	0.4	*1.7*	*0.6*	*1.1*
Industry/refineries	0.6	0.7	-0.1	*0.9*	*1.3*	*-0.4*
Agriculture	0.1	0.1	0	*0.3*	*0.2*	*0.1*
Services	0.2	0.1	0.1	*0.6*	*0.2*	*0.4*
Transportation	0.1	0.1	0	*0.6*	*0.3*	*0.3*
Electricity supply	0.4	0.2	0.2	*1.7*	*0.4*	*1.3*
National	2.1	1.4	0.6	*5.8*	*2.9*	*2.9*

[1]Reference Outlook, scenario Global Economy.

Benefits from avoided use of fossil energy carriers are determined with energy prices that regard marginal costs for the country as a whole. Gross costs minus benefits lead to national net costs that are equal to 0.2% of GDP in 2000 and 0.6% in 2010. It must be remarked that the figures will often depart from cost and benefit figures that energy users experience.

Taxes related to emission reduction
Compared to total income of government the amount of taxes has increased from 9% in 1990 to 13% in 2002. Next to higher existing taxes in transportation and general fuel use, this increase is due to the introduction of the regulatory energy tax (REB) in 1996.

Effect of intensification of climate policy
The increase in total yearly-avoided emissions accelerates somewhat after the intensification of climate policy in 1998. For policy induced avoided emissions the effect is stronger. However, the cumulative avoided emissions in 2010 are still dominated by the reduction activities that took place before the start of intensification of climate policy.

Inventory of other effort indicators
Examples of other, non-financial, efforts are:
- Time spent by households to gather information on saving options or activities that lead to emission reduction, such as recycling of glass and paper and driving slower.
- Voluntary efforts of companies to reduce emissions beyond economic criteria.
- Contribution of societal organizations (environmental, retail branches, municipalities, social housing corporations, energy suppliers, education, etc.).

The last example has already been covered partly under non-financial policy measures. But in general it proves to be impossible to provide for a systematic overview of these societal activities, let alone to quantify these efforts. Instead, it has been decided to concentrate on a set of indicators that:
- may be useful to broaden the picture of Dutch efforts on CO_2 emission reduction,
- can be quantified to a satisfactory extent for the Netherlands,
- are also available in the same format for other (European) countries.

In Table S.3 an overview is given of a number of indicators and the score of the Netherlands compared to EU in total. As this regards a limited number of indicators no strong conclusions on relative Dutch efforts can be drawn from this set.

Table S.3 *Overview of 'other' indicators regarding emission reduction*

Sector	Name	Unit	Result NL
H	Label A for cold appliances	[%]	Highest in Europe
H	Organic products market share	[%]	Below average Europe
H	Paper recycling	[%]	3rd out of 4 EU countries
H	Glass recycling	[%]	Above average EU-15
H	Waste generation	[Kg/cap*yr]	Above average EU-15 (neg)
T	Public transport	[% pkm]	Above average EU-15
T	Bicycle travel	[% pkm]	Highest across 5 countries
I	Recycled materials use		
	* Pulp and paper	[%]	2nd EU-15
	* Steel	[%]	Lowest EU-15
	* Aluminium	[%]	Below average EU-15
R	Increase of renewables in national power production since 1990	[%-point]	Average OECD
T	Maximum highway speed	[km/hr]	Average

1. INTRODUCTION

Goal of report

Since publication of the Brundtland report on sustainable development in 1987, Dutch activities with respect to energy savings and renewable energy production have also become part of policy to reduce CO_2 emissions. In 1999, the Netherlands Climate Policy Implementation Plan (VROM, 1999) defined the framework for future emission reduction until 2010 and beyond. The Netherlands will report in 2005 and 2006 on progress in national climate policy, both as EU-member and as party to the Climate Treaty and the Kyoto Protocol of UNFCCC. The protocol states that use of JI or CDM must be supplemental to domestic actions to reduce emissions. The EU and UN request reporting countries to provide information on the proportion of domestic efforts, without a clear definition of 'effort'. Therefore the ministry of VROM has formulated the need for a broad overview of efforts to reduce domestic emissions. The overview should look at past and future efforts of all parties involved (households, companies, government, etc.), regardless of actual success of efforts.

Definition of 'effort'

With respect to definition of 'effort' the following approach has been used:

- The term efforts relates to *activities* deployed, but in some cases people bear a burden or suffer some loss in quality of life for the benefit of emission reduction. For instance, people must accept that their landscape view is affected in order to reduce emissions with wind power. However, this burden is not quantified here.
- Figure 1.1 shows that efforts regard activities that directly lead to avoided emissions (CO_2 storage), indirect activities (GHG policy building), activities also done for other policy reasons (energy savings, renewables and fuel substitution that contribute to less import dependence or acidification), activities where reduction is an ancillary benefit (lower speed limits) and activities of households and companies that are only partly related to policy (e.g. life style changes). All activities that are (partly) in the green area are within the scope of this study on 'efforts'.

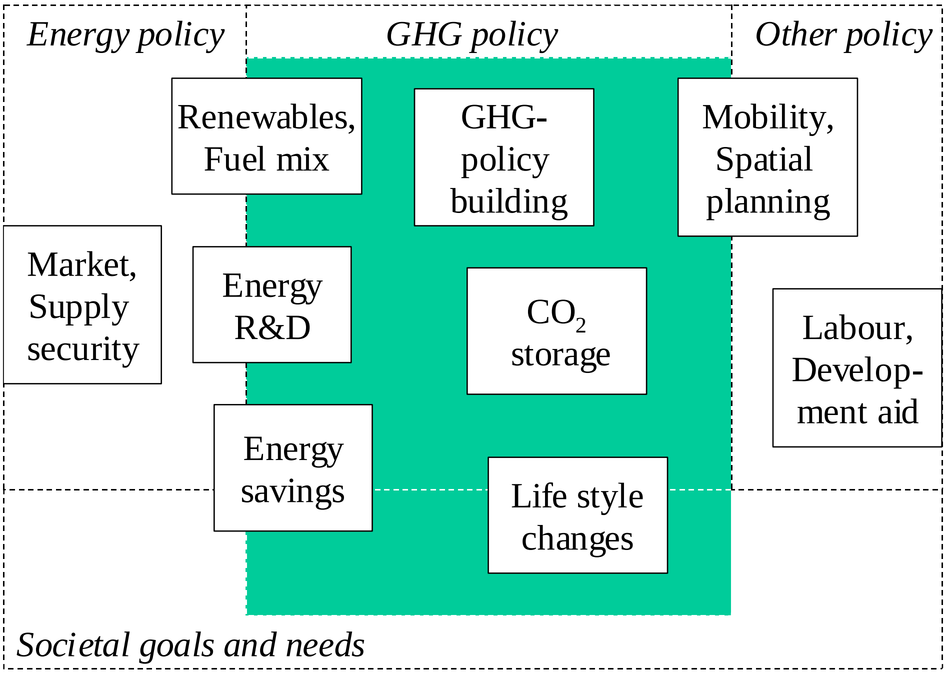

Figure 1.1 *Relation of activities to CO_2 reduction goal and other goals*

- Efforts regard the *extra* contribution because of the greenhouse problem. For instance, only supplemental investments on top of investment for conventional energy systems have been looked at. Benefits from savings on energy purchases or selling of renewable production are subtracted from gross costs; if net costs are negative investments do not count as effort.

- Double counting of efforts is also avoided. If the (small) effort to formulate insulation standards or minimum fractions for renewable electricity leads to substantial efforts of other parties, these last activities count. R&D expenditures form an effort of government but the resulting R&D-activities are not an effort of research institutes.
- As a practical approach, all policy measures that were part of policy evaluations, and the resulting activities, have been taken here as reduction measures.
- A great number of initiatives to support emission reduction have been taken by societal parties: branch organizations, municipalities, environmental organizations, scientific community, etcetera. However, emphasis lies here on related expenditures or realised reduction, and not on the initiatives themselves.

Efforts and avoided emissions

Figure 1.2 highlights the relation between emission developments and efforts presented here. Actual emissions plus total avoided emissions constitute the emission level without any policy, this level is determined by GDP-growth and the way it leads to energy needs and emissions (called structure). Without reduction policy (but with other policy) total emissions should have been higher due to counter-active policy measures that have stimulated energy use and emissions. Examples are spatial planning, e.g. construction of new highways, and liberalization of energy markets, causing extra energy consumption (Boonekamp, 2004b). The extra emission has to be compensated by the reduction efforts. Part of avoided emissions is autonomous, as it regards profitable energy savings or market related substitution that does not constitute an effort. On the other hand part of the efforts does not lead to actual reduction. Thus the scope of total effort relates to emission reduction as given in the figure. Finally it has to be stressed that all socio-economic developments are taken as given; none is regarded as a *negative* contribution to emission reduction. Indicators on efforts with direct financial and/or policy consequences are described in Chapter 3. Indicators on other efforts are described in Chapter 4.

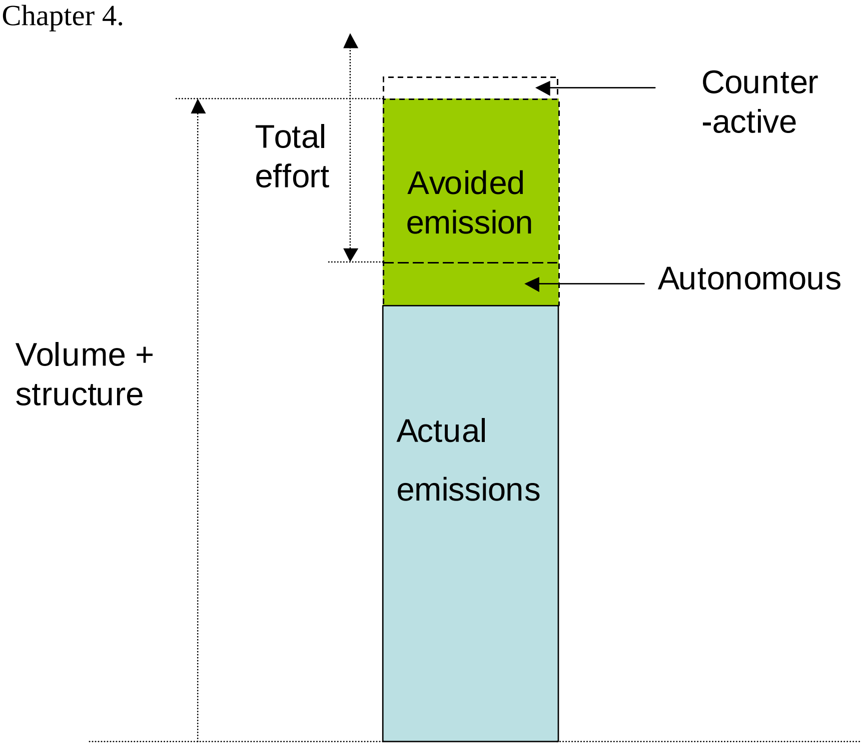

Figure 1.2 *Emission developments and emission reduction efforts*

The amount of avoided emissions connected to total efforts is unclear because autonomous emission reduction has not been quantified and emissions due to counter-active policy measures could not be quantified. The avoided emissions due to policy measures have been quantified but will not always constitute an effort, as there are free riders that should have reduced autonomously. The remaining part of calculated emission reduction will regard profitable investments for energy users without government support. However, these could constitute an effort yet, because of the different costing approach used here (see Chapter 3).

Approach followed

The analysis started with providing a current overview of realised and estimated trends for CO_2 emissions. Then total avoided emissions were calculated to provide for a first indicator of efforts to reduce emissions. These were based on given data on energy savings and renewable energy production, both historically and according to scenarios. For the second indicator the policy induced avoided emissions were estimated. For historic years use was made of existing evaluation studies; for future years the differences between results of scenario and policy free variant were used. The calculation of the indicator 'reduction costs' started with an investigation into government expenditures on emission reduction (see also Figure S.1). A major part of work comprised mapping of investments for emission reduction, both by households and enterprises, based on the relation with government support. Also investments due to non-financial policy, e.g. standards, and other investments were determined. Total investments have been converted into gross yearly costs, using an annuity factor according to the so-called national costing approach (see Section 3.2). Financial benefits of reduction activities have been calculated from realised energy savings or renewable production and energy prices. The cost savings according to the national approach were calculated with prices of primary energy carriers for the country as a whole. From gross costs and benefits the net national reduction costs follow. Next to government expenditures as indicator also the total amount of taxes related to reduction has been calculated as an indicator. Finally a first inventory has been made of possible other indicators of reduction efforts. These non-financial indicators complement the indicators mentioned here.

Uncertainty margins

With respect to the uncertainties in the results of this study the following must be remarked. The data on energy consumption and related CO_2 emissions have been recently updated, but the values for 2003 are still preliminary. The values for 2010 are dependent on the scenario chosen. Figures on avoided emissions have a margin of 10% and that for policy induced reduction even 20%. The margin for total financial support by government will be less than 10%; however, for individual policy measures the margin could be up to 30%. The margin for total investments is estimated at 20% and that for net cost figures could be 40%. Especially reduction costs presented should be interpreted cautiously as these costs are dependent on energy prices that vary from year to year.

Outline of report

In Chapter 2 emission trends, total avoided emissions and policy-induced reduction are presented. In Chapter 3 the calculation of financial effort indicators is described: government expenditures, investments for reduction, reduction costs and taxes. The newly formulated non-financial indictors are described in Chapter 4. Finally in Chapter 5 the results are put into perspective.

2. TRENDS, EMISSION REDUCTIONS AND POLICY

2.1 Development of CO_2 emissions

Scope of emission trend studied

Emission trends for greenhouse gasses are published regularly in the Environmental Balance of RIVM [RIVM-MB], the National Inventory Report [RIVM-NIR] and the National Communications [RIVM-NC]. The main part of GHG emissions consists of CO_2 emissions. This report regards CO_2 emissions of energy use only; other emissions of CO_2 are not taken into account[1]. In the NIR only historical figures are given; the Environmental Balance and National Communications also provide for estimated future emission levels. Here both historic and future emission figures are presented for 1990-2010. Finally it has to be remarked that emission figures presented regard actual domestic emissions only. If results are compared with emission targets for 2010, account has to be taken of emission trading results (see Section 2.4).

Update of historic emission trends

In 2004 CO_2 emission figures for the Netherlands 1990-2003 have been updated by Statistics Netherlands (CBS) and SenterNovem. The new historic figures will not always comply with older versions of publications mentioned above. The revised figures will be part of the new National Inventory Report, to be published in 2005 (NIR, 2005).

New scenarios on energy and emission

In 2004 new long-term scenarios on socio-economic and environmental trends have been developed (WLO, 2004). For the period until 2010 both the Strong Europe (SE) and the Global Economy scenario (GE) have been elaborated in the field of energy use and emissions (ECN, 2005). Here the GE-scenario has been chosen as relevant scenario to study Dutch efforts to reduce CO_2 emissions. In Table 2.1 some main characteristics of the GE-scenario are presented.

Table 2.1 *Characteristics Global Economy scenario for the Netherlands*

	Unit	2002	2010	2002-2010
Population	Mln.	16.1	16.8	
Households	Mln.	6.9	7.6	
GDP	[%/year]			2.8
Labour volume	[%/year]			0.8
Gas price	€ct/m^3	10.3	11.0	

Climate and temperature corrections

In national policy evaluations realised emission figures are often corrected for yearly variations in mean temperature during the heating season (heating degree days). This facilitates evaluation of trends and policy effects and their relation with socio-economic factors and policy measures. Moreover, the temperature correction for 2000, base year of the scenarios, also influences calculated emission for 2010. Recently it has been decided to suppose a *structural* downward trend for the number of heating degree days according to (Visser, 2004). The reason is that almost every winter since 1990 was ‘too warm’ compared to average value in the last 30 years. This structural trend is used to correct emissions in policy evaluations, both for

[1] The avoided emission for non-CO_2 GHGs will be covered in a separate study.

historic years and in scenarios. Estimated emission for 2010, reported as part of international agreements, will be influenced by this so-called climate trend correction. Corrections for temperature are not accepted in international reporting for historic years. But corrected emission figures are presented yet. This is because analyses of reduction efforts focus on emission trends without effects of climate trends or temperature variations. Secondly, for the period 2008-2012 the average *estimated* value of actual emissions has to be reported. The emission figure for 2010, calculated with described corrections for temperature- and climate trends, is thought to be a good representation of this average value.

Emission trends

In Table 2.2 updated emission figures, corrected for climate and temperature trends, are given for some relevant years. The year 1998 is the last year before of the Climate Policy Action Plan (VROM, 1999) went into action, 2000 is base year for scenarios and 2003 the most recent year with figures available. Figures regard energy related emissions, calculated from energy use figures and emission factors per fuel following the new CBS/SenterNovem calculation method for CO_2 emissions. In the 2005 issue of (RIVM-NIR) the total CO_2 emissions, including that from non-energy sources, will be published.

Table 2.2 *Trends in energy related CO_2 emissions (temperature and climate corrected)*

	1990	1995	1998	2000	2003	2010[1]
Households	21.1	20.9	19.7	20.2	18.9	*18.4*
Industry	39.6	34.7	33.4	32.5	32.0	*34.1*
Agriculture	7.9	8.5	7.6	7.4	6.5	*7.7*
Services	9.5	9.8	10.3	9.6	11.8	*9.8*
Transport	30.4	33.4	35.3	36.7	38.3	*38.1*
Refineries	11.0	11.0	11.6	11.5	11.2	*13.1*
Electricity/Waste	40.1	47.2	50.0	48.1	53.9	*58.6*
Distribution	0.1	1.2	1.9	2.0	1.4	*0.6*
Other	1.7	1.7	2.2	2.2	2.0	*2.7*
Total	161.2	168.6	172.0	170.0	175.9	*183.2*
(Statistical)	(162.8)	(171.7)	(174.2)	(170.9)	(181.7)	x

[1]Reference Outlook, scenario Global Economy.

In Figure 2.1 the development of CO_2 emissions is related to that of total primary energy consumption (TPEC) and GDP.

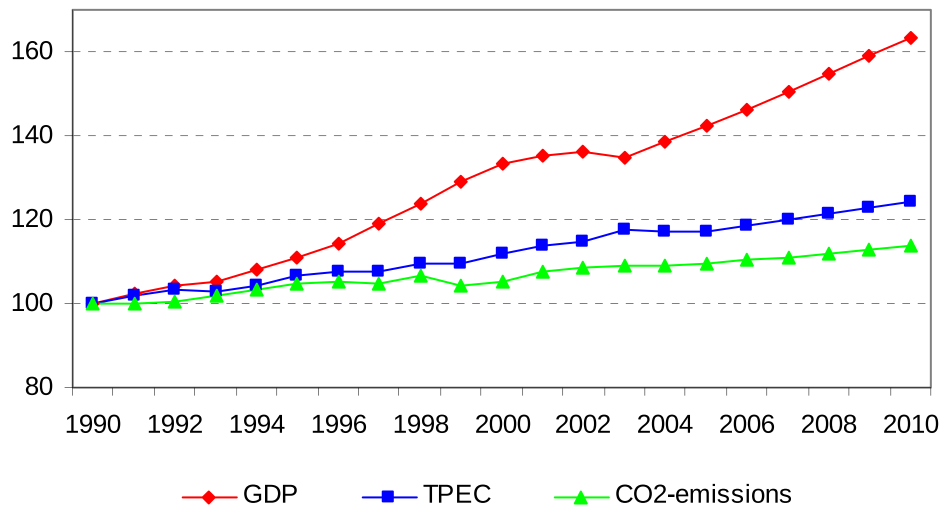

Figure 2.1 *Trends for GDP, energy consumption and CO_2 emissions 1990-2010 (1990 = 100)*

2.2 Total avoided emission 1990-2010

Historic avoided emission figures presented here have been calculated on basis of realised energy savings and renewable energy production. Realised energy savings were calculated using energy consumption figures up to 2002. Very recently these consumption figures have been updated, but the earlier saving results have been used in the analysis of emission reduction. It is estimated that historic emission reduction figures presented here should change only slightly in case of adjusted saving results. For future years the most recent and final results of the Reference Outlook (Dril, 2005) have been used.

Contributions to emission reduction

Emission reduction in the energy system can be realised by means of energy savings, renewable energy production and (policy induced) substitution between energy carriers. For each category the emission reduction is determined and summed up (see Figure 2.2). Emission factors are needed to determine emission reductions from energy mutations. For fuels a fixed emission factor can be used; for electricity factors depend also on the composition of the production system. Because of this difference a distinction has been made between mutations regarding fuel use and mutations regarding electricity use.

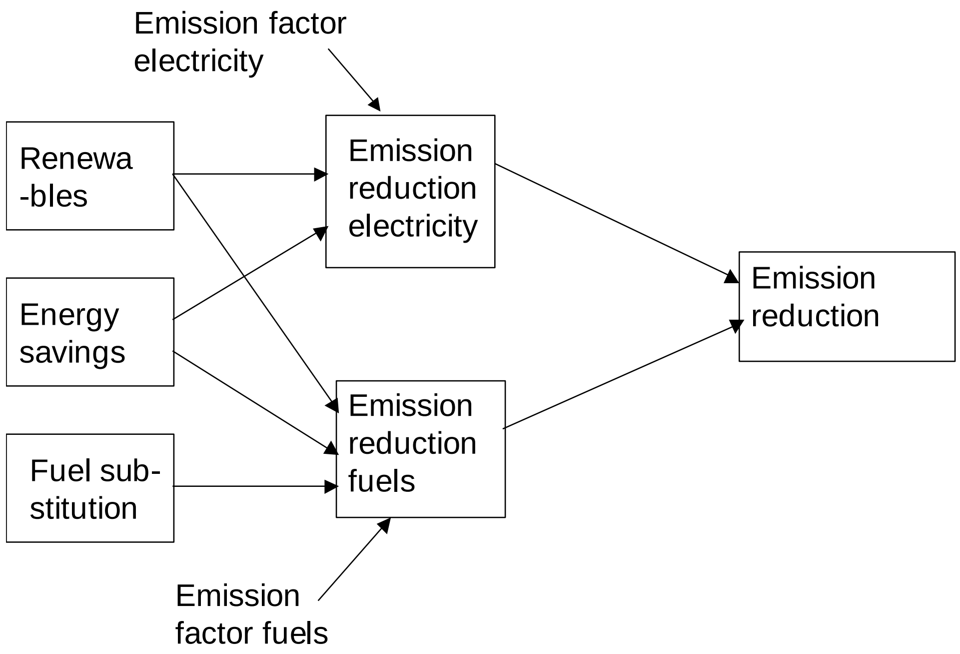

Figure 2.2 *Calculation scheme for reduction of CO_2 emissions*

Reduction due to energy savings
As to contribution of savings a further des-aggregation is made:
- savings on final consumption,
- savings with own cogeneration systems,
- savings resulting from heat deliveries.

The calculation of realised energy savings follows the method in Protocol Monitoring Energy savings (PME) described in (Boonekamp, 2001). Savings on final consumption are equal to the difference in energy use between reference trend and realised trend (for fuel and electricity apart). The reference trend is determined by means of scaling base year consumption with growth in so-called energy relevant variable. This variable is supposed to 'predict' final energy use trends without savings. Savings from cogeneration equal the difference in fuel input between cogeneration and split production of heat and electricity. Finally, savings from heat delivery are set equal to the difference between own heat production in gas fired boilers and (waste) heat from combined production, rated at 0.5 PJ gas per PJ heat.

Savings on fuel are converted into reductions using the emission factor of specific fuel saved. Savings on electricity are converted using an average emission factor for central electricity production system (see Table 2.3).

Reduction due to renewable energy
The contribution of renewable energy sources is determined according to the calculation method of protocol renewable energy (PDE) described in (SenterNovem, 2004). The contribution is expressed in amount of fossil fuel or electricity from the grid replaced. To calculate this amount a reference system is chosen for each renewable production option. The replaced energy carriers must be converted into avoided emissions. Due to different emission factors a distinction is made here regarding the replaced energy carrier:
- natural gas
- electricity from conventional production
- other energy carriers.

Reduction due to fuel substitution

The contribution of substitution between (fossil) energy carriers regards only direct policy induced shifts in fossil fuel mix, e.g. use of CO_2-free energy carriers (not from renewable sources) or use of gas in stead of coal in power stations (not market driven). This substitution is only relevant in the future, depending on the scenario chosen.

Emission factors used

Emission factors for fossil fuels and electricity from central production are given in Table 2.3. Fossil fuel emission factors are given but the emission factor of electricity depends on composition of production system. Here a distinction is made between the period 1990-2000 and the period 2000-2010. For the first period reduction regards extra savings and renewable production with respect to base year 1990, based on statistical information. For 2000-2010 the base year is 2000 and scenario results are used. The factor for 1990-2000 is based on average emission per kWh of central electricity production according to (MONIT, 2004). This production, excluding imports and decentralized cogeneration, is regarded as 'alternative' for electricity saved or renewable electricity produced. For year 2010 a factor based on build margin (STAG-CHP) as well as operational margin (26% coal and 74% gas) provides an emission factor of 0,11 Mton/PJ (Ybema, 2002). The average factor for 2000-2010 is based on a combination of emission factors for 2000 and 2010.

Table 2.3 *Emission factors used in calculation of reductions*

Kton/PJ	1990 - 2000	2000 - 2010
Natural gas	56	56
Oil (transport)	73	73
Coal (electricity)	95	95
Electricity (central production)	190	150

Realised national emission reduction

For historical years energy saving figures presented are based on results of protocol calculations for 1990-2001 (Boonekamp, 2001) and calculations for 1995-2002 (Boonekamp, 2004b). For future years saving figures are based on results (in PME-format) from recent reference scenario Global Economy (GE) described in (Dril, 2005). The renewable production figures for recent years have been based on yearly monitoring results of (Ecofys), for earlier years different sources have been used (ECN-Trends). For future years renewable production is based on results for the GE scenario.

In Table 2.4 realised or estimated avoided emissions are presented. The reduction for 1998 is also given, as the Climate Policy Action Plan (VROM, 1999) was then agreed on. The year 2000 is base year for scenario trends and 2003 is the most recent year with figures on emission developments. The reduction for 2010 is the sum of reduction for 1990-2000 and reduction for 2000-2010.

Table 2.4 *National avoided CO_2 emissions up to selected years and period*

[Mton]	1995	1998	2000	2003	2010[1]	1998-2010
Energy savings	13	22	28	30	*52*	*30*
Renewable energy	0.5	1.1	1.6	2.8	*7.6*	*6.5*
Substitution	0	0	0	0	*0*	*0*
Total	13	23	30	33	*60*	*37*
(Fraction of emission)	(8%)	(13%)	(18%)	(19%)	*(33%)*	

[1] Reference Outlook, scenario Global Economy.

It appears that in 2010 total energy related CO_2 emissions would have been 32-33% higher without the effects of energy savings and renewable production from 1990 on. Reduction due to (non-market oriented) fuel substitution is absent in the GE-scenario. Until 2003 avoided emission is mainly the result of savings; after 2003 renewable energy plays a more substantial role in ongoing reduction. The additional contribution of savings in the period 2000-2010 amounts to 24 Mton (52 - 28), less than was the case for 1990-2000.

The last column shows the additional avoided emissions after 1998, the year of publication of the Climate Implementation Plan. Compared to the period until 1998 the speed of reduction has slightly increased, mainly because of fast growing contribution of renewable energy. The contribution of policy to this speeding up will be described in the next section.

Over the total period 1990-2010 a cumulative amount of almost 600 Mton of CO_2 emissions is avoided. This is equal to on average 30 Mton per year or 17% of total emissions.

2.3 Avoided emission due to policy measures

Definition of policy induced reduction

As mentioned in Chapter 1 all policy measures that were part of policy evaluations have been taken account of as reduction measures. This includes measures that aim at other energy policy goals, e.g. less import dependence, or aim at other environmental goals, such as limiting acidification. Sometimes emission reduction is even secondarily, e.g. lower speed limits that increase traffic safety. For savings only part of total reduction can be attributed to policy measures, as also autonomous energy savings take place. This depends on type of energy use, years of observation and sector. For renewable energy it has been supposed that all extra production (excluding waste incineration) is the result of policy efforts. Substitution between energy carriers generally is not part of policy induced emission reduction. However, dedicated substitution (e.g. production of hydrogen or a ‘forced’ shift from coal to gas) is seen as 100% policy dependent.

Only policy measures that were active in the period 1990-2010 have been analysed as to their contribution to emission reduction in this period. So, the contribution of earlier measures that ended before 1990, but still reduce emissions after 1990, is not taken into account. Besides national policy there are also EU-policy measures that focus on savings or renewable energy. Generally speaking, these EU-measures have been translated into national measures (e.g. fraction of total electricity consumption from renewable sources) or are already covered by national policy (e.g. EU target for electricity from cogeneration). An exception forms the ACEA covenant for fuel efficiency of cars; this has been made part of total set of policy measures though.

Overview of policy measures

In the period 1990-2010 a few hundred policy measures or policy initiatives have been present or are still active. For each sector the important policy measures with respect to realised emission reductions have been selected (see Table 2.5).

Table 2.5 *Overview of important policy measures for emission reduction per sector*[1]

	Households	Industry	Agriculture	Services	Transport	Energy Sector
Buildings standards	×			×		
Transport fuel excise duty					×	
Voluntary agreements (MJA), 1989-2000		×	×			
Subsidy schemes for renewables, 1990 -	×			×		×
Subsidies buildings (SEBG), 1991-1994	×			×		
Environm. Action Plan (MAP),1991-2000	×	×	×	×		×
Variable tax deduction (VAMIL), 1991 -		×	×	×		×
Environmental Fuel tax (BSB), 1994 -		×	×	×		×
Subsidies cogeneration (BSET), 1994-1996		×		×		×
Energy Performance Norm (EPN), 1996	×	×		×		
Regulatory Energy Tax (REB), 1996 -	×			×		
Energy labeling appliances >1996	×					
Energy Investment Tax Cut (EIA), 1997-		×	×	×		×
Agreement GLAMI/AMvB, 1997-2010			×			
CO_2 Reduction Programme, 1997-		×	×	×		
Investment Facility Non-Profit, 1998-2003				×		
Car efficiency covenant (ACEA), 1999 -					×	
Sust. building covenant (DUBO), 1999 -	×					
Coal Covenant, 1999 -						×
Energy Premium Rebate (EPR), 2000-2003	×					
Energy Performance Advice (EPA), 2000 -	×					
Energy labeling cars, 2001 -					×	
Voluntary agreements (MJA-2), 2001 -		×	×			
Benchmark Covenant (BM), 2001 -		×				×
BANS climate covenant, 2002 -	×			×		
BLOW-wind energy covenant, 2002?						×
MEP-compensation cogeneration, 2002 -		×	×	×		
Emission Trading System (ETS), 2005 -		×				×
New driving style (HNR), 2001?					×	
Green investment facility			×	×		

[1]Abbreviations: see Appendix 3.

Avoided emissions due to policy measures

With respect to determination of policy reductions a distinction has to be made between historic and future years. For historic years the contribution of policy is determined per sector and for separate measures, based on (Jeeninga, 2002) and (Boonekamp, 2002). For Households and Services the recent evaluation (Joosen, 2004) has been used too. For future years the policy effect is also determined per sector, but now for the set of policy measures in total. The policy effect is set equal to the difference between emission results of the GE-scenario and that of a GE-variant without any policy measure from 2000 on (Dril, 2005). In Figure 2.3 and Table 2.6 results are given for the Netherlands in total.

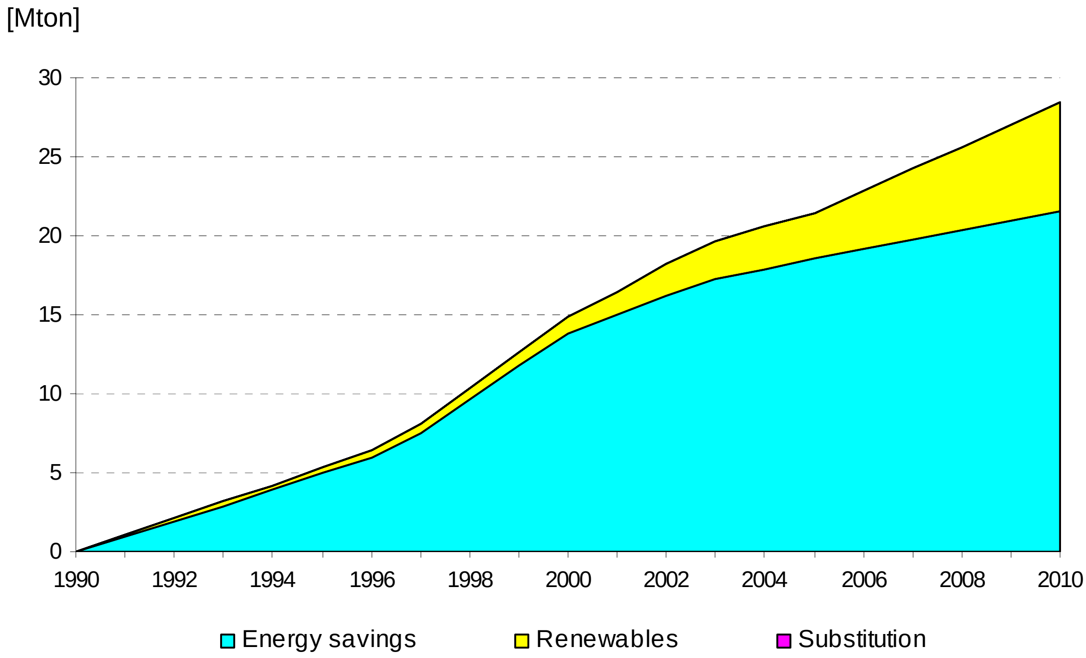

Figure 2.3 *Yearly avoided emissions due to policy 1990-2010*

It appears that policy measures have provided for about 50% of all avoided emission realised in the period 1990-2010. The policy contributions increase in the course of time. However, the high value in 2003 is also due to stagnating total avoided emissions. Despite a strong increase in renewable energy production after 2000, being fully counted as a policy effect, the relative policy contribution decreases after 2003. Policy induced substitution between coal and gas in electricity production does not occur in the GE-scenario.

Table 2.6 *Avoided CO_2 emissions due to policy in selected years and period*

[Mton]	1995	1998	2000	2003	2010[1]	1998-2010
Savings	5	9-10	14.0	17.0	*22.0*	*12.0*
Renewable energy	0.4	0.8	1.1	2.4	*6.9*	*6.1*
Substitution	0	0	0	0	*0*	*0*
Total	5	10-11	15.0	19-20	*28.0*	*18.0*
Fraction of total reduction	(40%)	(45%)	(50%)	(60%)	*(48%)*	

[1]Reference Outlook, scenario Global Economy.

The last column shows the effects after introduction of the Climate Implementation Plan (VROM, 1999). The total amount of policy induced emission reduction after 1998 is relatively higher than the amount until that year, taking into account difference in length of periods. However, this is not the case for the contribution of energy savings. The accelerated increase in policy-induced reduction is due to renewable energy only.

Cumulative policy induced emission reductions over the period 1990-2010 equal almost 300 Mton. The 15 Mton on average per year constitute 9% of total emissions.

2.4 Emission trading

The internationally agreed 'assigned amount' according to the Kyoto protocol regards domestic emissions minus the emissions due to JI, CDM and emission trading. For JI and CDM an amount of 20 Mton has been planned in (VROM, 1999). For industry and energy sectors a European emission trading system has been set up. Emission rights will be allocated to these sectors for the period until 2012, as part of the national allocation plan (NAP). The difference between actual emissions and allocated emission rights must be purchased abroad, or can be sold. In Table 2.7 the results for the GE-scenario are presented. It proves that both sectors have to buy emission right abroad. A margin has been introduced to take account of emissions due to reservations or opt-out cases. Total emission rights purchased constitute about 8% of total avoided emissions domestically in 2010. However, with respect to cumulative avoided emissions in the period 1990-2010 the fraction is in the order of 2%.

Table 2.7 *Emissions of trading sectors for 2010 in the Netherlands (GE-scenario)*

	Emitted	Allocated	Margin	Import
Industry + refineries	50	48	2	1
Power stations	49	44	1	4
Total	99	92	3	5

3. EMISSION REDUCTION COSTS

3.1 Introduction

The total costs of emission reduction are an important indicator of efforts to reduce CO_2 emissions in the Netherlands. In Figure 3.1 the determination of gross and net total reduction costs are shown. Reduction of CO_2 emissions is accomplished mainly by energy savings or by renewable energy production. Both savings and renewable production demand extra investments that can be converted to yearly capital costs. These extra costs are more or less compensated by benefits, the avoided costs of fossil fuel purchases or the proceeds of renewable energy carriers sold. Gross costs and benefits result in net costs that could be positive or negative depending on the values of inputs. For (forced) substitution between two fossil energy carriers the difference in price defines avoided fuel cost. If coal fired power stations are replaced by gas-fired systems the difference in investments costs determines gross reduction costs.

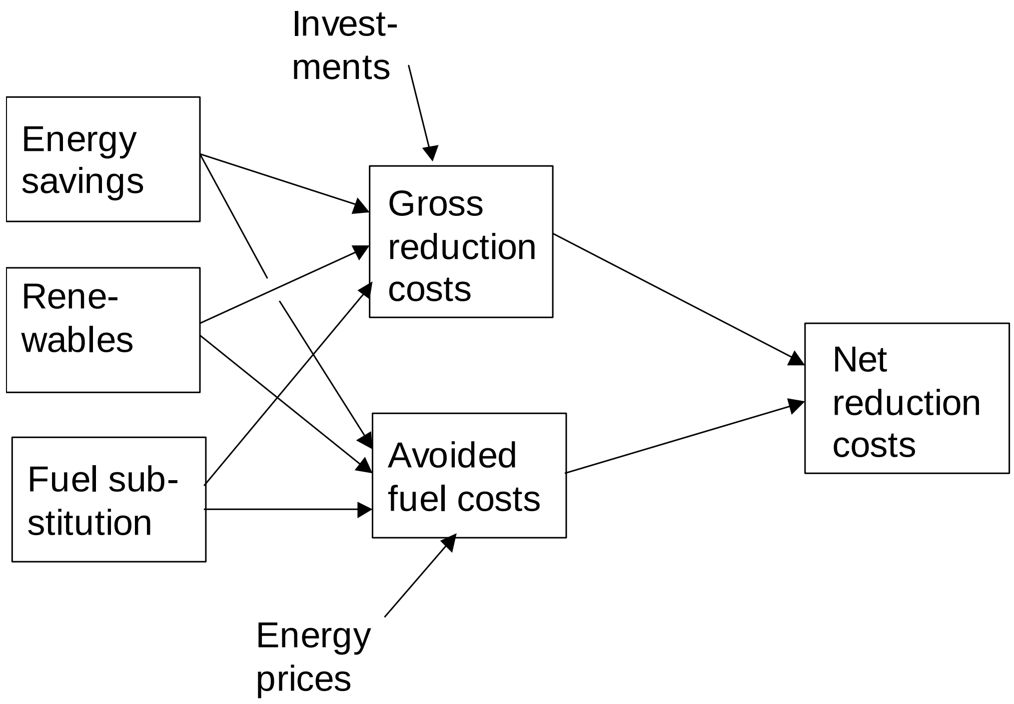

Figure 3.1 *Calculation of net reduction costs for CO_2 emissions*

Reduction costs are determined for historic years (1990-2003) and future years (2000-2010). The calculation method is the same; however, actual calculation differs due to availability of figures on reduction and costs.

3.2 Definition of reduction costs

National and end users costing approach
According to (VROM, 1998) CO_2 reduction costs can be calculated according to:
- National costing approach
- End users costing approach.

The national costing approach determines costs and benefits of emission reduction from a national point of view, with equal cost/benefit calculations for all actors that accomplish reduction. The end users costing approach on the other hand is meant to calculate reduction costs as each end user experiences them. In Table 3.1 differences between the two approaches are highlighted for an example case with figures for households.

Table 3.1 *Example of cost effectiveness calculation for national and end users approach*

		End user approach			National approach		
		gas	electr.	totaal	gas	electr.	totaal
Investment	[mln. €]			4305			4305
Subsidies				852			0
Net investment				3453			4305
Discount rate		0.08			0.05		
Life time	15 year						
Capital costs				403			415
Other costs				0			135
Total costs				403			550
Savings	[PJ]	26.5	6.2		26.5	6.2	
Price	[€/GJ]	13.9	94.5		3.2	8.3	
Cost savings		368	583	951	84	51	135
Net costs				-548			+415
Emission factor	[Mton/PJ]	0.06	0.11		0.06	0.11	
Reduction	[Mton]	1.49	0.68	2.16	1.49	0.68	2.16
Effectiveness	[€/ton]			-253			+192

In the national approach no subsidies, or any other financial transfers, are taken into account when calculating yearly capital costs. Also the discount rate is generally lower than used by energy users. However, in the national approach costs to carry out reduction policy measures are part of total costs (see 'Other costs' in Table 3.1). Energy prices differ also between national and end users approach. In the national approach the marginal price of an extra unit of energy consumption for the country as a whole is used. For the Netherlands this 'shadow price' is set equal to import prices of relevant primary energy carriers, thus without all margins, taxes, etcetera. Especially for households and transportation prices differ to a great extent for both approaches. As a result net costs could be a positive figure for the national approach and a negative figure for the end users approach (see Table 3.1). For other sectors, especially industrial users, price differences will be less extreme. Because the national discount rate is lower than the industrial rate, national cost effectiveness could be more favourable than end users effectiveness in this case. In this report the national costing approach is applied. However, to check calculation results, the end use costing approach has also been used (see Section 3.4.1).

All costs of reduction activities are covered (see next section) except:

- costs of policy formulation itself,
- cost of reduction measures abroad,
- organizational costs in firms related to activities to avoid emission (often called transaction costs if it concerns implementation of saving options).

Relationship between profitability, costs and efforts

In Chapter 1 it has been stated that efforts regard *extra* costs of emission reduction activities. Therefore profitable investments into energy savings should be omitted from cost calculations. However, 'profitable' is related to the end users costing approach while costs are calculated here for the national approach. In Table 3.2 different profitability cases for the end user approach are transferred into cost cases for the national approach that define the effort.

Table 3.2 *Profitability cases end users approach and costs in national approach*

End users approach	National approach	Effort
Autonomous (profitable without subsidies/taxes)	Net benefits (industry) to modest net costs (households)	No/Yes
Free riders (profitable without subsidies/taxes)	Net benefits (industry) to modest net costs (households)	No/Yes
Financially supported (profitable due to subsidies/taxes)	Modest net costs (industry) to high net costs (households)	Yes
Regulated (not profitable)	High net costs (services and households)	Yes

Regulated emission reductions, e.g. performance standard for new dwellings, are by nature not profitable[2]. This is the more true in the national approach without subsidies and taxes, and often lower benefits due to applied national shadow prices. Therefore regulated reduction activities will constitute an effort. The same holds for energy savings and renewable production that are marginally profitable because of subsidies and taxes. Without policy support and with lower benefits the net national costs will be positive. In the autonomous case investments in savings could be quite profitable for households. But without high taxes and with much lower shadow prices net costs will result in the national approach yet. For industry taxes are much lower and energy prices resemble shadow prices. Here profitable investments lead to negative net national costs. So, autonomous reduction activities will constitute efforts or no efforts, depending on the sector taken. The same reasoning is valid for free riders that receive subsidies while their investment should be made autonomously.

It has not been possible to make a distinction between free riders and stimulated investments into emission reduction. Moreover, data do not permit a reliable estimate of the part of autonomous reduction that does not constitute an effort. Therefore only total reduction costs are calculated and presented as an effort indicator. These costs should be seen as an upper bound from the point of view of efforts.

3.3 Government expenditures on emission reduction

Emission reduction is often realised with financial support of government. The total expenditures by government to reduce CO_2 emissions form one of the indicators of Dutch efforts. But these figures on support are also used to determine the amount of investments - in saving options and renewable energy production - that are needed to calculate the indicator 'reduction costs'. Therefore the government expenditures will be presented first.

[2] This regards effective standards, not old standards still in place but not active anymore.

Government expenditures in relation to emission reduction can be divided into:

- direct support to implementation of saving or renewable options,
- indirect support through R&D-activities,
- organizational costs of support schemes.

Direct support regards all kind of financial support schemes; normally this support should lead in a short time to visible emission reductions. However, this is not always the case. For instance, present support for cogeneration is needed mainly to preserve existing production capacity, and thus hardly generates *extra* reduction. Support for R&D activities will lead to future emission reductions but part of research will be terminated without actual follow up[3]. The last category regards management of support schemes. Not included in these expenditures are costs of policy making by ministries or advice councils and R&D activities of universities.

Almost all expenditures are part of the budget of national government; however in some cases financial flows do not show up in government budgets. For instance, financial support as part of the Environmental Action Plan (MAP) was paid by distribution companies. They were allowed to put a levy on the energy bill of their customers to raise the money needed. Finally it has to be mentioned that provinces and municipalities also provide some financial support from their own budgets. This very small part of all expenditures has not been taken into account.

In Chapter 2 an overview has been given of all important policy measures that have contributed to reduction of CO_2 emissions in the period 1990-2010. In Table 3.3 financial measures with the most substantial expenditures are presented. The item ECN regards R&D-costs on renewables, energy efficiency and clean fuels. The item SenterNovem constitutes organizational costs of subsidy schemes and costs of programmes to demonstrate new technologies or stimulate energy saving behaviour (for instance energy saving driving style). Total includes a number of measures with small budgets. An extended overview for all historic years is given in Appendix 1.

Table 3.3 *Government expenditures on policies to reduce CO_2 emissions*

[mln. €[1]]	1990-1998	1999-2003	2004-2010[2]	1990-2010
TIEB	70	12	*0*	*82*
SEBG	125	0	*0*	*125*
BSET	297	0	*0*	*297*
MAP	658	174	*0*	*832*
EIA	83	710	*618*	*1411*
VAMIL	290	261	*20*	*570*
EPR	0	485	*83*	*568*
MEP	0	508	*3661*	*4169*
REB (exemption)	31	1268	*433*	*1732*
ECN	216	143	*190*	*549*
Novem	365	512	*215*	*892*
Other	84	245	*114*	*443*
Total	2219	4117	*5335*	*11670*

[1]Sum of yearly expenditures, not discounted.
[2]Reference Outlook, scenario Global Economy.

[3] E.g. terminated programme on solid oxide fuel cells.

In Figure 3.2 trends in expenditures are given for all major financial support measures. Long lasting expenditure categories are Novem (research and demonstration), MAP (subsidies for saving and renewable options) and EIA (tax facility for investments by companies). Recent important schemes have been EPR, to stimulate efficient appliances, and exemptions to pay REB for renewable energy. In the past the BSET scheme has stimulated cogeneration with substantial subsidies. The MEP is expected to become by far the major support scheme in the future, both for renewable options and cogeneration.

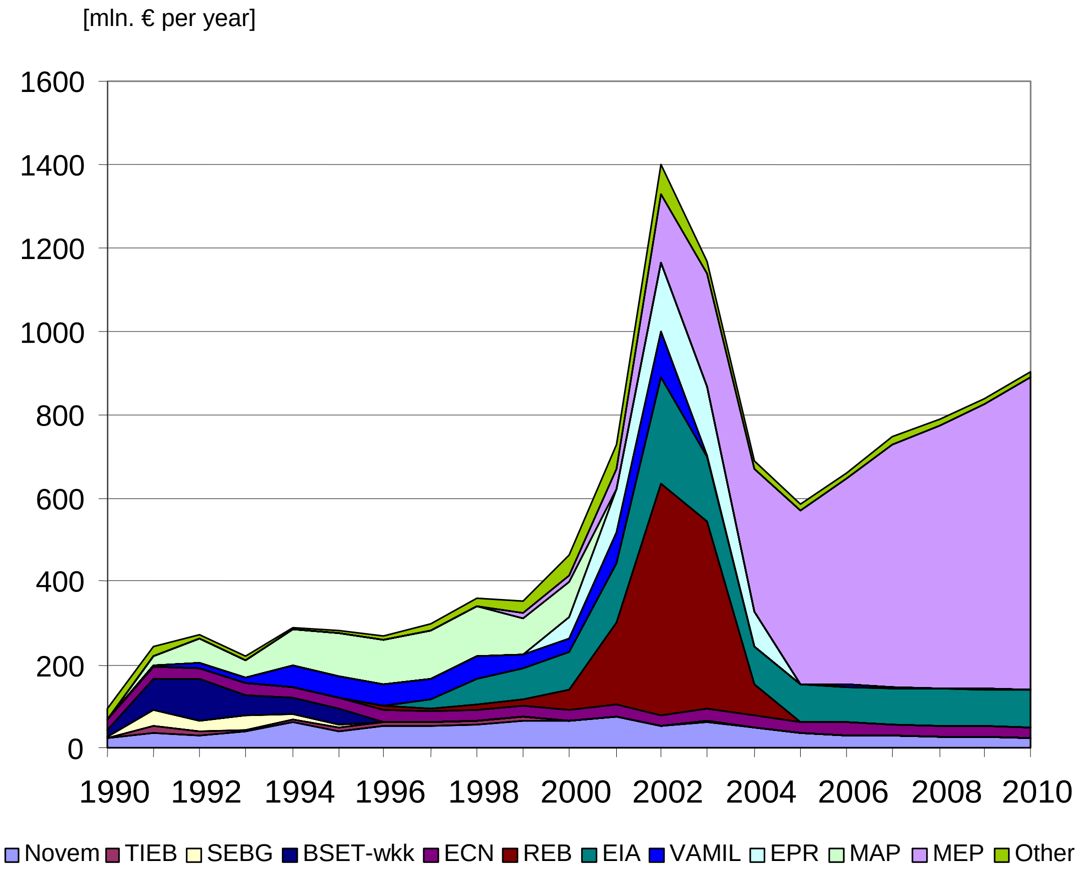

Figure 3.2 *Trends in financial support for emission reduction, per policy measure*

Specification of items in figure:

Novem:	research and demonstration programmes
TIEB:	Tender budget energy saving
SEBG:	Energy saving in existing buildings
BSET-WKK:	subsidy for combined heat & power production
ECN:	R&D on renewable energy options and energy savings
REB:	exemption to pay REB in favour of renewable production
EIA:	Energy investment credit on corporate income tax
VAMIL:	Variable depreciation of investment for corporate income tax
EPR:	energy premium rebate for saving investments
MAP:	Environmental Action Plan of distribution companies (subsidies, information, etc.)
MEP:	kWh-compensation programme for CHP and renewables

The category ‘other’ comprises:

SEEV:	subsidies on condensing gas boilers
EMA:	Stimulation of energy and environmental advices
EINP:	Energy investment credit for non-tax paying companies
FS&D:	Subsidy for feasibility studies & demonstration projects

NEWS:	subsidy for new technologies (i.e. WKK)
EINP:	Energy Investment subsidy for Non-Profit organizations
CRP:	CO_2 Reduction Programme
Senter:	cost for subsidizing organization
GB:	tax reduction on earned interest on green investments
Old ’87-’91:	insulation subsidy on rented houses
Local:	Subsidy for climate policy of local government
Low income:	Energy subsidy for low-income households
Waste:	Tax facility for improved waste to energy efficiency.

Total expenditures, split into energy savings and renewable energy production, are presented in Table 3.4 (see also Figure S.2). Until 1998 three quarters of support went into energy savings; in future years 60% will be devoted to renewable energy. Overall both applications receive almost the same amount of support. As the last column shows more than 80% of all expenditures is spent after the start of climate policy implementation plan. In the period 2004-2010 the MEP will play the most important role. Two-third of total expenditures for renewable energy is supplied by the MEP-scheme. The MEP also becomes the major support scheme for savings (cogeneration).

Table 3.4 *Total government support for energy savings or renewable energy*

	1990-1998	1999-2003	2004-2010	1990-2010	1999-2010
Renewable energy	579	2008	*3181*	*5768*	*5189*
Energy savings	1640	2109	*2154*	*5903*	*4263*
Total	2219	4117	*5335*	*11670*	*9452*

Remarks on government expenditures and emission reduction

Reductions due to policy measures have been presented in Section 2.3. It must be remarked that these policy induced emission reductions are partly due to non-financial policy measures, such as the energy performance standard. These measures do not lead to government expenditures. Therefore the total amount of policy induced emission reduction should not directly be related to total financial support.

The expenditures presented regard different periods, both short and long. However, expenditures in one period will provide for reductions in a number of consecutive years. So the total amount of subsidies in 1998-2003 will give rise to reductions after 2003. However, these reductions are taken account of in the analysis for 2004-2010. Expenditures in 2004-2010 reduce emissions after 2010 that are not taken into account here. On the other hand, registered policy reductions in 1990-1998 are partly the result of policy expenditures in the eighties that are not counted here. In principle expenditures in short periods cannot be related to emission reductions in the same period. For the long period 1990-2010 it is acceptable to trade reductions resulting from expenditures in the eighties against reductions after 2010 due to expenditures before 2010. Here total expenditures can be compared with total avoided emissions.

3.4 Calculated investments and reduction costs

3.4.1 Investments for emission reduction

Estimation method for investment

For the majority of saving and renewable options yearly operational costs are (very) low compared to yearly capital costs from investments. So, the main part of gross reduction costs arises from investments in saving options and renewable energy. For energy savings this regards the extra investments compared to the conventional system or no-saving situation.

For *future years* investment figures are available from model calculations. Especially investments for renewable energy options are well known from the modelling of profitability and penetration. However, in practice various problems occur with investments for savings. Total investment for a system has to be divided into the part attributable to energy savings and the remaining part. For high efficiency boilers, extra investment, compared to a conventional boiler, is taken as relevant investment. But when medium-efficiency boilers become standard, the extra investment figure changes. In industrial processes part of total investment could be attributed to savings and part to increased production speed and quality. In scenario models only the first part is reported.

For *historical years* statistical figures on investments by enterprises are available, but not disaggregated to energy applications. Therefore these figures have to be estimated as good as possible. To this end investments in each sector are divided into:

a. investments calculated from subsidies and other financial support,
b. investments calculated from non-financial policy measures,
c. other investments.

Other financial support could be tax deduction schemes or green financing schemes. Non-financial policy measures consist of regulation (standards, performance standards, etc.) or voluntary agreements. Other investments regard all other cases, for instance autonomous savings due to technological progress, or economically profitable investments.

For *renewable energy* options it is supposed that nearly all investments are related to a subsidy scheme (see Figure 3.3). Regulation does regard renewable options only indirectly, as with performance standards for new dwellings or some voluntary agreements. The corresponding increase in renewable production is supposed to be small. Profitability of renewable options has been, or will be, such that penetration without government support is hardly realised. Therefore the category ‘other investments’ does not exist here.

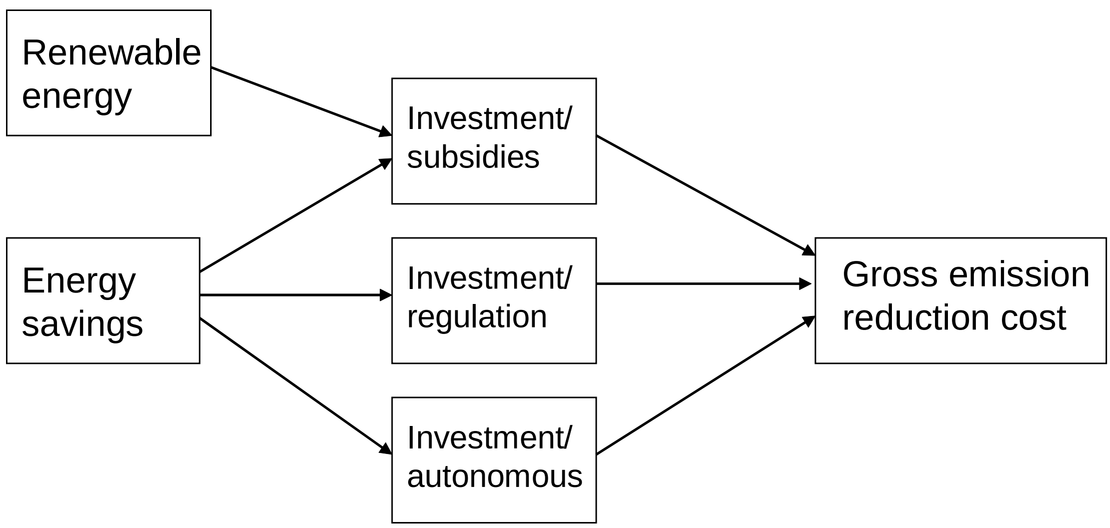

Figure 3.3 *Calculation of gross emission reduction costs*

For *energy savings* the investments can be attributed to all three categories mentioned (see Figure 3.3). The amount of investments connected to subsidies can be derived from the amount and type of subsidy given. Most subsidy schemes subsidize a fixed part of (extra) investment. As the amount of subsidies is known quite well, this offers an opportunity to determine related investments. However, in some cases more than one subsidy scheme is used for the same investment; in that case double counting of investments is taken care of. Investments due to non-financial policy regard mainly regulation, for instance energy performance standards for new dwellings. Often extra investment per regulated system is determined at the formulation of standards. Therefore total investments can be calculated from the amount of systems under regulation. Finally it must be remarked that financial policy measures are often accompanied by non-financial measures, such as agreements, labels, etc. In that case the effect of non-financial measures on investments is not determined, as investments already follow from the financial schemes. However, this does not mean that these measures do not contribute to emission reduction (see results).

The last category ‘other investments’ is often the most difficult to quantify. Generally, both number of saving options and extra investment figure per option are not known well. In cases where the amount of ‘other investments’ could not be determined directly it has been estimated in an indirect way using supplemental information. The first check on the amount of other investments uses the derived total cost effectiveness, according to the end users costing approach, for all savings realised. This figure resembles profitability of total investments in energy savings and emission reduction. If this cost effectiveness figure is below zero, benefits are higher than costs and the investment is (more or less) profitable. Generally one may expect that:

- Investments due to subsidies are marginally profitable, thus lead to an effectiveness figure around 0.
- Forced investments due to non-financial policy, such as regulation, are not profitable, resulting in a cost effectiveness figure >0.
- Other (autonomous) investments without support must have been substantially attractive, meaning a cost effectiveness figure <0.

In case of both subsidized and ‘other’ investments only, one may expect an effectiveness figure <0. Given the policy related investments, the amount of other investment should be in such a range that the resulting total cost effectiveness figure does not exceed the zero-level. In case of substantial forced investments, due to regulation, a positive total cost effectiveness figure should show up. Again other investments should be in line with this result.

The second check is based on the fraction of policy induced emission reduction, calculated earlier (see Chapter 2). In most sectors renewable energy hardly contributes to emission reduction. Therefore the calculated policy fraction of emission reduction (see Table 2.4) is representative for the part of total savings due to policy. This policy fraction for savings should, broadly speaking, be lower than the fraction of policy related investments. Investments connected to policy will produce relatively less savings than other investments, as these latter have to be very profitable to be taken anyhow. Both checks have been performed for all sectors; if necessary the amount of other investments has been adjusted between reasonable margins. However, the presented investment figures will show substantial uncertainty margins.

Investments from financial support

For each type of support scheme, the ratio of financial support to extra investment is known reasonably well. So, from the amount of subsidy the amount of investments could be calculated. With help of expenditures (see Table 3.3) and specific subsidy/investment ratios per scheme total investments have been calculated for each year, for each sector and for savings or renewables. Investments, presented in Figure 3.4, regard both saving options and renewable energy production.

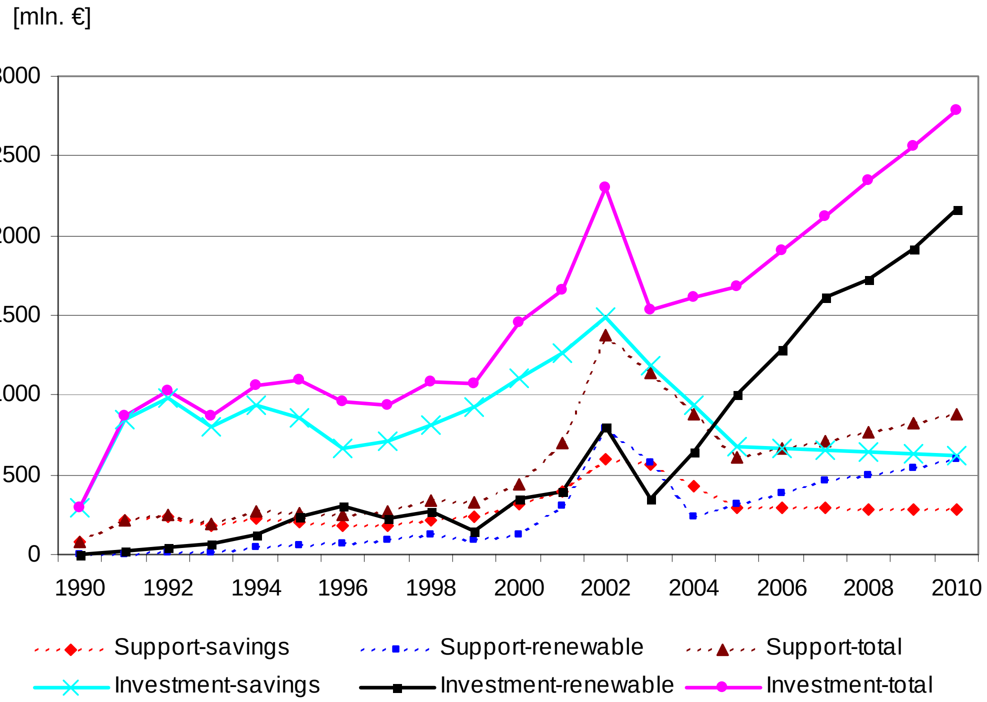

Figure 3.4 *Total yearly support for savings and renewables, and corresponding total yearly investments 1990-2010*

Investments from non-financial policy measures

Non-financial policy measures for emission reduction regard mainly (performance) standards, covenants and dedicated taxes (see Table 3.5). Other important policy instruments are the MAP-scheme of distribution companies and the new emission trading system.

Table 3.5 *Non-financial policy measures and extra investments involved*

	Sectors[1]	Reduction	Investment part of:
GLAMI-covenant/AMvB, 1990-2010	A	high	VAMIL, EIA, etc.
Energy labeling appliances >1996	H	low	EPR-effect
Sust. Building covenant (DUBO), 1999	H	low	Standards/EPN
Energy Performance Advice (EPA), 2000 -	H	low	EPR, etc.
Buildings standards new dwellings	H, S	low	x
Regulatory Energy Tax (REB), 1996 -	H, S	medium	EPR, EINP, etc. (partly)
BANS climate covenant, 2000 -	H, S	low	Financial measures
Environm. Action Plan (MAP), 1991-2000	all	low	Financial measures
Energy Performance Norm (EPN), 1996	H, S, I	high	x
Voluntary agreements/MJA-2, 2001 -	I, S	medium	EIA, etc.
Voluntary agreements/MJA, 1989-2000	I	high	VAMIL, EIA, etc.
Environmental Fuel tax (BSB), 1994 -	I, E	medium	EIA, etc.
Benchmark Covenant (BM), 2001 -	I, E	medium	EIA, etc.
Emission Trading System (ETS), 2005 -	I, E	low	EIA, etc.
BLOW wind covenant, 2002? -	E	medium	Financial measures
Coal Covenant, 1999 -	E	medium	MEP-biomass
New driving style (HNR), 2001?	T	low	No investments
Energy labels cars, 2001 -	T	low	ACEA-covenant
ACEA-covenant, 1999 -	T	high	x

[1]H = Households, S = Services, I = Industry, A = Agriculture, T = transport, E = Energy.

For most non-financial measures no extra investments are calculated here. However, this does not mean that these measures do not contribute to emission reduction. It means that resulting investments already have been accounted for in the preceding analysis on financial support. For instance covenants are generally combined with financial support schemes (support is often a prerequisite for signing the covenant). More investments thanks to the covenant lead to increased use of the support scheme; therefore extra investments are already covered by investments calculated from financial measures. The same holds for extra investments due to taxes, with exception of future REB-tax for households. After 2003 no subsidy schemes are available for electricity use and gas use in existing dwellings. So, extra investments due to the REB are not covered yet. Taxes could also influence behaviour with respect to energy consumption but this does not concern investments.

The remaining non-financial measures to be taken care of are:

- energy (performance) standards for new dwellings,
- energy performance standards (EPN) for buildings (partly),
- ACEA-covenant for efficient vehicles.

The investments as a result of the EPN for buildings are partly taken care of in the calculation of investments that make use of the EIA support scheme. The ACEA-covenant, although part of EU-policy, is used in this country analysis as this covenant contributes to extra Dutch investments into energy savings. In Table 3.6 estimated investment due to these non-financial measures are presented. Figures for dwellings and buildings have been calculated from newly build volume, saving options deployed and extra costs compared to reference systems. For future years this has been checked with scenario results. The difference in investment figures for new dwellings in GE-scenario and policy free variant (see description in Chapter 2) covers extra investments due to performance standards. The cost figures for ACEA-covenant are based on (EC, 2004). The figures presented also comprise some investments due to non-financial measures for freight transport.

Table 3.6 *Total investments due to non-financial policy measures*

[billion €]	1990-2000	2000-2010[1]	1990-2010
Building standards:			
- dwellings	4.8	*7.7*	*12.4*
- buildings	0.1	*1.0*	*1.1*
Transport			
ACEA - covenant, etc.	0.9	*4.5*	*5.4*

[1]Reference Outlook, scenario Global Economy.

Investments also have been calculated per sector. The results of financial or non-financial policy measures are shown in Figure 3.5 (for savings only). Electricity consists of power stations, waste incineration and distribution. Investments regard high efficiency STAG-units, cogeneration for process heat and small cogeneration at distribution companies. The greater part of household investments is attached to the non-financial policy measure ‘performance standards for new dwellings’. The same holds for the transport sector with respect to ACEA-covenant. In other sectors investments are totally or for the greater part calculated from the financial measures.

Policy related investments for renewable energy production are connected to financial policy measures only. These investments are concentrated in sectors distribution and power stations.

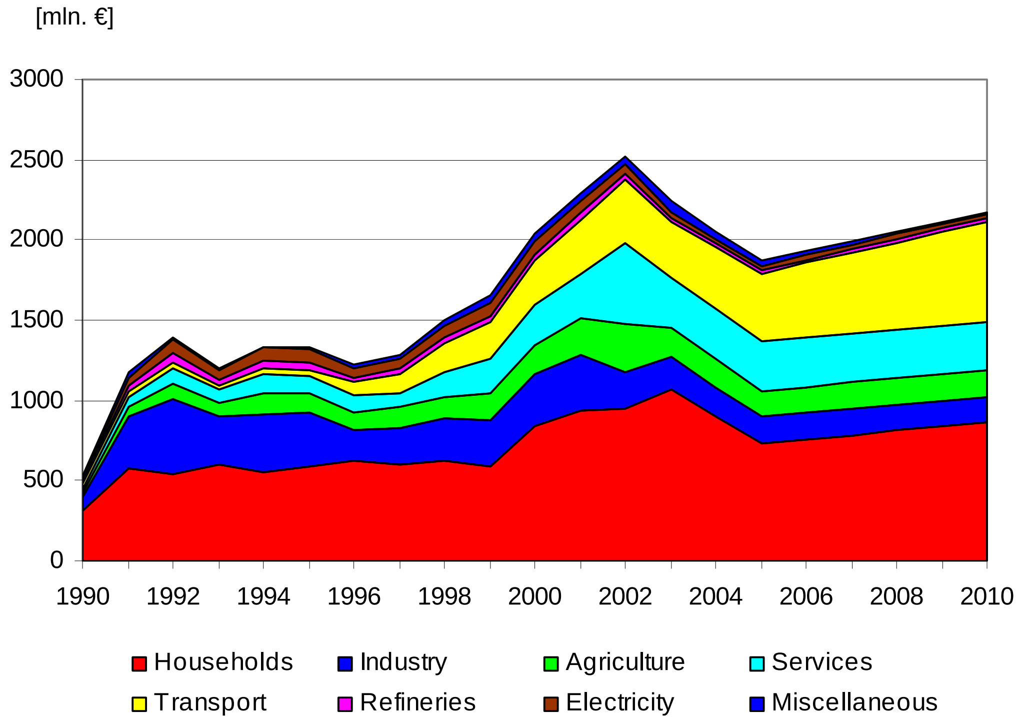

Figure 3.5 *Yearly investments per sector for savings, related to financial and non-financial policy measures*

Other investments

'Other investments' comprises all investments not related to policy measures. As mentioned earlier only saving options count, as virtually all investments in renewable energy options are financially supported. 'Other investments' for savings could also be depicted as autonomous investments that are taken because it is profitable, because energy users want to contribute to the solution of the green house problem, or any other reason. The amount of autonomous investments has been estimated and checked for each sector as described earlier. Also specific sector knowledge and information on energy users that do not apply for financial support for their investments has been used (see Appendix 2). Over the period 1990-2010 the fraction of other investments equals 15-20% of all investments for savings.

Total investments

In Table 3.7 total investment figures, including autonomous investments, are shown. Investments increase after 2000, especially for renewable energy production. In all sectors, except industry, volume of investments after 2000 is higher than before 2000.

Table 3.7 *Total investments for savings or renewable energy*

[billion €]	1990-2000	2000-2010[1]	1990-2010
Renewable energy	2	*12*	*14*
Energy savings	19	*24*	*43*
Total reduction	21	*36*	*57*
from which:			
- households	7	*10*	*17*
- industry	5	*3*	*8*
- agriculture	1	*2*	*3*
- services	2	*4*	*6*
- transport	1	*5*	*6*
- electricity	3	*12*	*16*

[1]Reference Outlook, scenario Global Economy

The average investment level is 2 billion € in the period 1990-2000 and almost 4 billion € in 2000-2010. This is equal to 3% of total investments in the Netherlands.

3.4.2 Net yearly costs of emission reduction

Gross costs of emission reduction comprise yearly capital costs due to investments plus yearly operating & maintenance (O&M) costs. Gross costs minus benefits of reduction activities result in net reduction costs for each year (see Figure 3.1).

Yearly capital costs are determined from total investments using an annuity factor. The value depends on the discount rate and the average lifetime of investments. In the national costing approach adopted here a discount rate of 4% and an average lifetime 15 years is used. The O&M-costs are estimated as a small percentage of total investments.

If energy users save energy they benefit from a decrease in purchased gas, electricity or motor fuels. In case of renewable energy benefits for the producer constitute the proceeds of sold output. Benefits at the national level arise because energy savings and renewable energy production result in a lower consumption of primary energy in the form of gas, oil and coal. To calculate national benefits prices of these primary energy carriers are needed. In the national costing approach these prices must resemble avoided costs for the country as a whole (for method see Section 3.2). Therefore import prices or comparable prices for high volumes have been taken. In Table 3.8 national fossil fuel price levels are shown for different years.

The benefits according to national costing approach are also calculated for each sector. As sectoral benefits also regard less electricity consumption, a ‘national’ electricity price is needed. This price is set equal to the price for base load electricity use for big industrial users (see Table 3.8, last column).

Table 3.8 *Energy prices used to calculate national benefits from savings or renewables*

[€/GJ]	Gas	Oil	Coal	Electricity
1990	2.9	3.9	2.0	5.6
1995	2.7	3.0	1.8	6.1
2000	3.7	4.3	2.0	8.1
2010	3.5	4.3	1.6	8.5

On basis of investments, O&M-costs, avoided energy consumption and energy prices the yearly costs of emission reduction have been calculated. However, energy prices used to calculate these benefits vary for each year in the past and future. So, net cost will vary too, even if gross cost should be constant over the years. Here it has been chosen to present cost figures for years 2000 and 2010 only (see Table 3.9). Total costs reach their highest level in 2010; this is partly due to decreasing prices in the scenario after 2000. End use sector Households faces the highest net costs due to investments in new dwellings that are not profitable at national energy prices. Transportation regards mainly cars, but also trucks and inland shipping. The high net costs for electricity supply regard the substantial build up in renewable energy, especially offshore wind and biomass. In the national costing approach these options are not profitable. In all sectors gross cost increase between 2000 and 2010; the same holds for net costs, except for industry. In industry benefits increase slightly faster than costs after 2000.

Table 3.9 *Gross costs, benefits and net costs of emission reduction activities, according to the national costing approach*

	2000			2010[1]		
Billion €[2]	Gross costs	Benefits	Net costs	Gross costs	Benefits	Net costs
Households	0.7	0.3	0.4	*1.7*	*0.6*	*1.1*
Industry/refineries	0.6	0.7	-0.1	*0.9*	*1.2*	*-0.3*
Agriculture	0.1	0.1	0	*0.3*	*0.2*	*0.1*
Services	0.2	0.1	0.1	*0.6*	*0.2*	*0.4*
Transportation	0.1	0.1	0	*0.6*	*0.3*	*0.3*
Electricity supply	0.4	0.2	0.2	*1.7*	*0.4*	*1.3*
National	2.1	1.4	0.6	*5.6*	*2.9*	*2.9*

[1]Reference Outlook, scenario Global Economy.

[2]$€_{2000}$ values.

3.5 Taxes for emission reduction

3.5.1 Overview of taxes

The amount of environmental taxes could also be seen as an indicator of efforts to reduce emissions. It increases the price of energy or the costs of energy using activities, such as road traffic. In turn this will lead to lower energy consumption and CO_2 emissions. For instance, according to (CPB, 1997) a tax based price increase, from 18% for households to 4% for industry, decreases total energy consumption with 2%.

An overview of taxes that have a direct effect on energy consumption is presented in Table 3.10. The total amount of taxes increased from 5.8 billion € in 1990 to 13.9 billion € in 2002, an increase of 140%. Compared to total income of Dutch national government the percentage has increased from 9% in 1990 to 13% in 2002.

Table 3.10 *Environmental tax revenues in the Netherlands and % of governmental income*

[mln. €]	Vehicle tax (BPM)	Road tax	Excise duty on motor fuels	Fuel tax (BSB)	Energy tax (REB)	Fraction of government income [%]	REB exemptions /remittance	MAP levy
1990	1206	1770	2554	277		9.1		0
1991	1284	1814	2640	413		8.7		53
1992	1556	1933	3020	644		10.1		88
1993	1457	2288	3829	658		10.7		88
1994	1661	2269	4174	594		11.7		112
1995	1813	2245	4316	607	0	12.4	0	125
1996	1892	2806	4386	656	424	13.9	11	122
1997	2061	2348	4749	650	814	14.0	12	95
1998	2425	2591	5056	658	824	14.5	17	87
1999	2840	2765	5168	633	1408	14.7	24	86
2000	2875	2941	5290	612	1775	14.5	120	88
2001	2939	2888	5224	607	2320	13.9	473	0
2002	2741	2924	5737	516	2003	13.3	710	0
2003							270	

Sources CBS; RIVM-MC, VROM 2005, IBO energy subsidies.

To complete the picture the Table also presents the REB exemption and the MAP levy. The REB exemption is the part of energy tax that doesn't show up in government budget because it is transferred directly to renewable energy suppliers. Without this transfer the figure for the REB tax would be higher. The MAP levy regarded a 1-2% raising of energy tariffs by distribution companies to finance their activities on stimulating energy savings and renewables. This levy, as part of their environmental action plan, could be seen as a pseudo tax.

3.5.2 Regulatory Energy Tax (REB)

In 1996 the new tax on energy, called 'regulerende energiebelasting' or REB, has been introduced and has continuously risen since. The tax was highest for the first quantities of energy consumed and levelled off quickly with higher volumes. In 2001 the tax made more than 30% of the price of natural gas for households. For electricity this amount was nearly 35%. For large energy consumers, as can be found in industry and energy sector the average tax level was very small. Their marginal tax rate was zero but in 2004 also a small tax was applied to the largest volumes.

The main target of this green tax was governmental income. It was part of a plan to lower the tax on labour and to increase the tax on environmental pollution. The bases of governmental income should become broader whit this tax. A second target was increased energy prices that should result in energy efficiency improvement. The last target was direct stimulation of energy saving and sustainable energy. Part of the tax received by energy distribution companies was not passed on to government. With it they financed energy saving programmes or used the money to buy or produce green electricity. Until recently households that bought green electricity didn't have to pay an REB tax. The decline in governmental income in 2002 was a result of unexpected high imports of renewable electricity. To overcome this import problem the REB regulation has changed. Furthermore part of the saving programme, called Energy Premium Rebate (EPR), has stopped by 2003. Due to these changes the figure of 710 mln. € has declined to about 270 mln. € in 2003 (see Table 3.10). This last amount is not all support as in 2003 a new financial instrument was introduced, the 'Environmental quality electricity production' (MEP) scheme. The kWh-compensation from the MEP took over the supporting role of REB. Budget for the MEP came from an extra charge on the bill of each electricity customer (€ 34 in 2003). This charge should be adapted in relation to future need for kWh-compensation for renewable production and co-generation (see Figure 3.2).

3.5.3 Transport taxes

Increasing the cost of road traffic is a vital element of the Dutch government's policy to restrain traffic growth. The increase should aim at a general rise in the costs associated with car use rather than ownership. Raising fuel prices is one such measure. It was decided to increase petrol excise duty by eight cents a litre in 1990. Since this date further increases have been introduced, not only on petrol (unleaded and leaded) but also on diesel. In 1991 for instance a quarter guilder price jump ‘Quarter of Kok’ was introduced (€ 0,114 per litre). The increase in fuel price was restricted as ‘tourism’ to foreign petrol stations in Belgium of Germany had to be avoided.

Since 2004 the road tax (MRB) is yearly adjusted for inflation. The road tax depends on the weight of the car and the type of fuel. Mean road tax in 2004 for a passenger car on gasoline of 1000 kg is € 292 and for a diesel car of 1280 kg it amounts to € 976 (BD, 2004).

If one buys a new car in the Netherlands, a tax called BPM has to be paid. In 1992 BPM followed up BVB that was no longer allowed due to European rules. BPM for a passenger car on gasoline is 45.2% of the list price minus € 1540. For a passenger car on diesel it is also 45.2% but raised with € 328.

These changes have more then doubled government income from taxes in transportation between 1990 and 2002. This has contributed to the rising share of taxes in total government income, although the contribution of other taxes has risen faster.

CO_2 effect of transport taxes

The effect of the Dutch car purchase tax is estimated to be avoided emissions of 0.6 to 1 million ton of CO_2 annually according to (Harmsen, 2003) and (Kampman, 2001). This corresponds to approximately 2 to 3% of total CO_2 emissions in the transport sector in the Netherlands. The calculation of this effect is based on a comparison of the average car size in the Netherlands compared to the average size in countries without purchase tax. However, the comparison might overestimate the effect on the car size, since there might be other factors that also contribute to the lower average car size in the Netherlands. On the other hand, it is mentioned that present purchase tax level has not yet influenced total car fleet. Therefore it should be expected that the effect would increase in the years to come.

3.5.4 Environmental Fuel Tax (BSB)

For environmental reasons a fuel tax was introduced in the Netherlands. In 1994 the fuel tax did get its present name BSB and was made part of the law on environmental taxes. The tax level for some fuels is shown in Table 3.11. In 2004 the BSB has been stopped for most fuels. Instead of a small separate BSB the excise duty on motor fuels and the REB for other fuels has been raised. The BSB on coal has been maintained in 2004 at a level of € 12.28 per 1000 kg. As an alternative a combined tariff of € 0.21 per GJ or € 2.6 per kg CO_2 can be used.

Table 3.11 *Fuel tax (BSB) levels for 2003*

Type of fuel	Unit	Fuel tax [€]
Gas oil (not for transport)	1000 l.	14,19
Heavy fuel oil	1000 kg	16,57
Coal	1000 kg	11,99
Natural gas 0 - 10 mln. m^3	1000 m^3	11,00
Natural gas > 10 mln. m^3	1000 m^3	7,30

4. NON-MONETARY EFFORT INDICATORS

4.1 Scope, objective and approach

The most important indicators for CO_2 emission reduction are the avoided emissions and the costs associated with this reduction as discussed in Chapter 3. However, these will not show the complete picture of the activities related to reduction that is carried out by different actors. Examples of other, non-financial, effort indicators are:

- time spent by households to gather information on saving options,
- time spent by households on activities that lead to emission reduction, such as recycling of glass and paper,
- voluntary activities of companies to reduce emissions beyond economic criteria,
- time companies spend on indirect activities: implementing emission rules, reporting, etc. (to the extent that this is not covered already in the environmental cost figures).

This chapter presents the results of an investigation into indicators for other efforts on CO_2 emission reduction. Definition of ‘effort’ has already been given in Chapter 1. In Figure 1.2 total efforts are related to emission trends. Autonomous reduction activities are excluded from ‘effort’; on the other hand not all efforts will result in avoided CO_2 emissions. This reasoning is also true for ‘other efforts’ analysed here. The other efforts regard (pursued) emission reductions outside the world of financial considerations and quantities. A first inquiry showed that great number of different examples on non-financial reduction activities could be found. However, it proved to be impossible to provide for a systematic overview of all relevant reduction efforts, let alone to quantify effort indicators or the reduction effects. Most of these activities have never been monitored because they were not part of the economic system with its well-documented financial quantities.

To overcome this problem, it has been decided to concentrate on a set of indicators that:

- may be useful to broaden the picture of Dutch efforts on CO_2 emission reduction,
- can be quantified to a satisfactory extent for the Netherlands,
- are also available in the same format for other (European) countries.

Due to time and resource constraints, a pragmatic approach has been chosen. Several types of indicators have been defined: diffusion, policy effort, R&D activities and environmental consciousness. In an iterative process a preliminary set of indicators, based on data availability, was developed. This resulted in approximately 40 indicators covering all sectors. This was short listed to a set of about 10 indicators that had minor overlap with cost indicators. As well, indicator data for the Netherlands and other (European) countries were relatively easy accessible. Because the focus has been on easy to handle indicators, this approach will not result in a comprehensive overview of non-financial effort indicators.

In the following sections the indicators, roughly divided into diffusion of saving options, policy efforts and R&D activities are presented. Three remarks need to be made.

- Most indicators give only a comparison between the Netherlands and other countries at a past point in time; the picture could be different in 2010 because other countries catch up. However, as it is often more difficult to start up an environmental-friendly practice (early mover), and other countries can profit from this, the effort should be rated larger when it is implemented earlier.
- Secondly, some indicator differences between countries could be explained by country-specific circumstances. When these differences play a large role, this will be indicated. In other cases, the differences will be seen as indicator of relative efforts of countries.

- Finally, the meaning of each indicator for national CO_2 emission reduction varies. For example, the total effect of more organic food consumption may be much less compared to increased use of public transport. It is however difficult - perhaps impossible - to quantify the importance of each indicator.

It is important to keep this chapter's objective in mind: investigate the possibility to present other indicators of efforts being undertaken to reduce emission of CO_2 for specific activities that can be taken (mainly) to reduce these emissions, for different sectors in the economy. It is a first attempt, not aiming to give a complete and comprehensive assessment. Conclusions should be drawn with great care, particularly in the case of individual indicators. Given all uncertainties it is advisable to judge the indicators as set.

4.2 Diffusion indicators

Diffusion indicators mostly deal with energy efficient energy practices or technologies (so-called saving options) and indicate the extent to which the saving options have penetrated the market. The penetration of saving options often encompasses investments, subsidies, energy savings and lower energy bills. Therefore there will be an overlap with the reporting on emission reduction, reduction costs and government spending. However, diffusion indicators also indicate the amount of other activities outside economics. Emphasis has been laid on indicators that are available for EU-countries from the Odyssee database (Odyssee, 2003). Normally a higher penetration means more emission reduction. Here, also some 'negative' indicators are explored where a lower value indicates a positive effect on CO_2 reduction.

4.2.1 Households

Label A for cold appliances
Refrigerators and freezers take a large share of household electricity consumption. The refrigerators on the market have been classified as to their energy-efficiency: Label A represents the most efficient appliances and Label F the least efficient. Label A appliances have the best energy efficiency and thus reduce emissions at power stations. The label system is mandatory but not the purchase of A-label appliances. A-label appliances sometimes are more expensive than other appliances and take more space for the same useful volume (because of the thicker insulation). Its market penetration can thus be seen as an indicator for household effort for CO_2 reduction. The figures in Figure 4.1 are taken from (Odyssee, 2003). The Netherlands clearly takes the lead in penetration of Label A cold appliances, followed by Belgium, while Portugal and Spain are lagging behind.

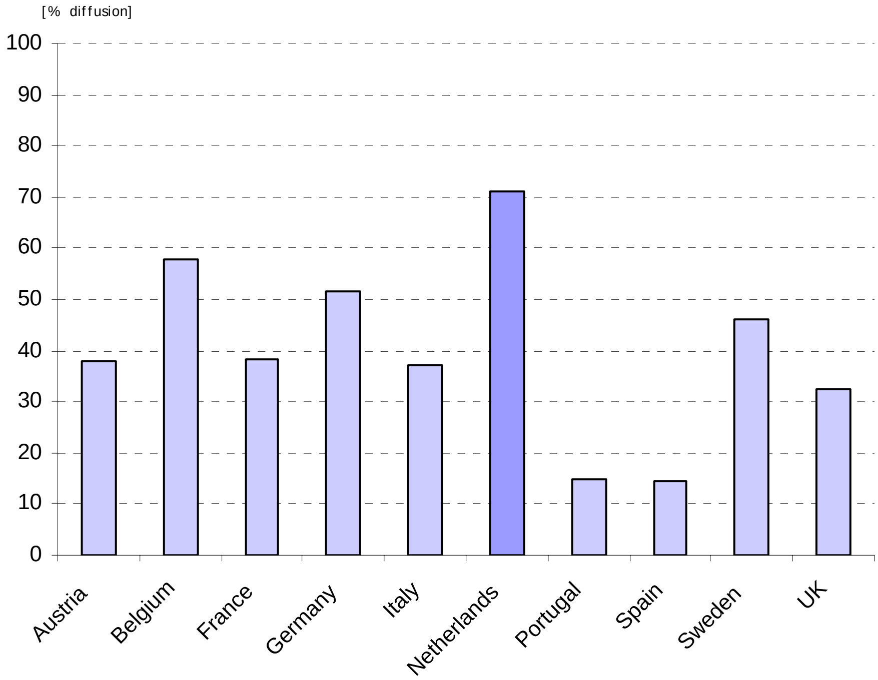

Figure 4.1 *Diffusion of Label A cold appliances in Europe in 2002*

Organic products

WUR (2004) concludes that, in the Dutch situation, organically produced vegetables (non-greenhouse) and milk products have a lower energy content, while for other products such as meat and fruit the differences are small or unclear. However, as milk and vegetables constitute a large part of food consumption, we provisionally conclude that there is a positive effect on CO_2 emission reduction. In addition, a large part of organic products will be consumed for other reasons than environmental concerns. The annual per capita spending on organic products in 2002 in Figure 4.2 are available from (GAIN, 2004). To correct for income differences across countries, these figures have been divided by per capita income.

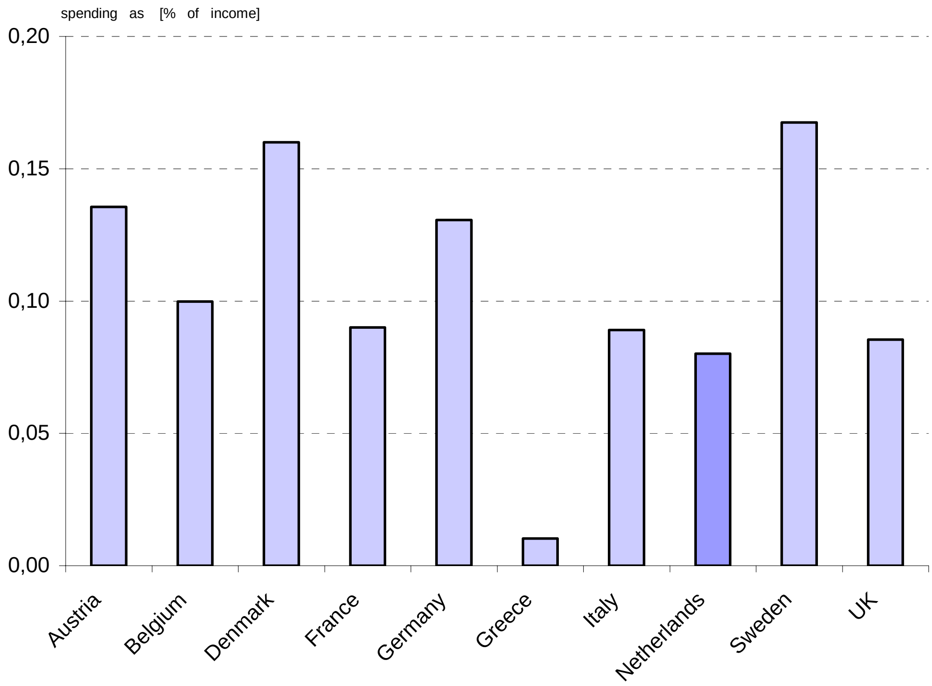

Figure 4.2 *Consumer spending on organic food: expenditures in 2002 as % of income*

In this case, in the Scandinavian households are spending the most on organic food, followed by Austria and Germany. The Netherlands is among the lower in Europe.

Glass and paper recycling

Secondary input from recycling instead of primary input saves considerably on energy needed in paper- or glass production (SKG, 2004). The share of paper or glass that is collected from households for recycling indicates the commitment of citizens to contributing to these ways of emission reduction. Data for Figure 4.3 are taken from (EC, 2003).

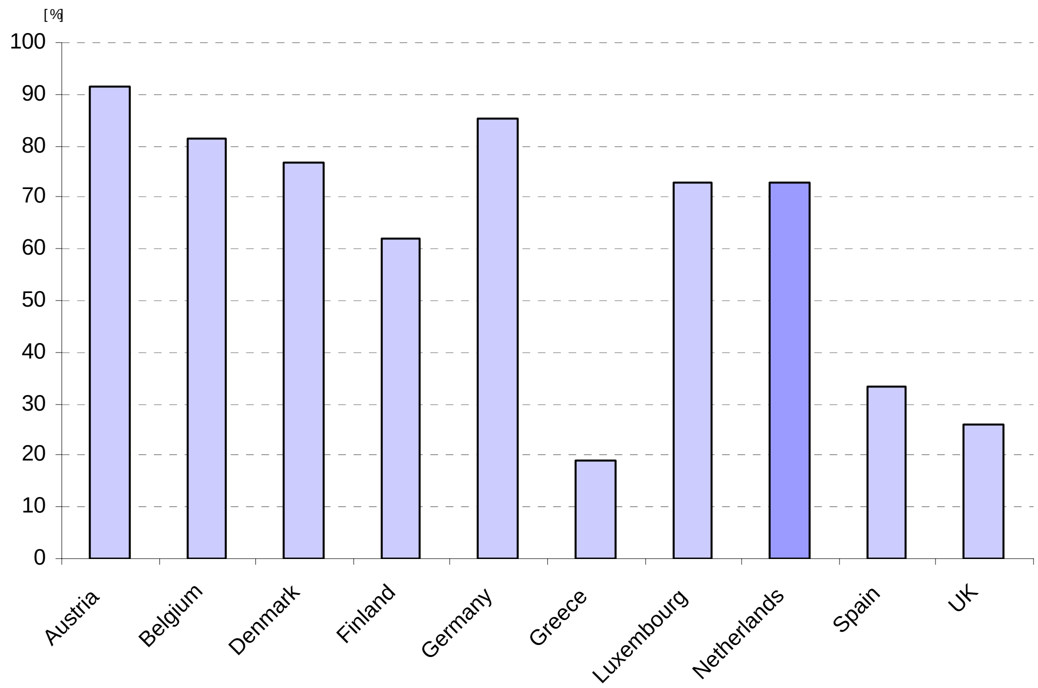

Figure 4.3 *Waste glass recycling: collection as share of generation for 2003*

Waste glass collection rates are above 70% for several countries, including the Netherlands. However, Austria achieves over 90%. The UK, Spain and Greece are way behind. For paper collection the data are less well documented in Eurostat, but for four EU countries the figures can be compared. It appear Figure 4.4 that the Netherlands exhibits a lower collection of waste paper rate compared to Austria and Germany.

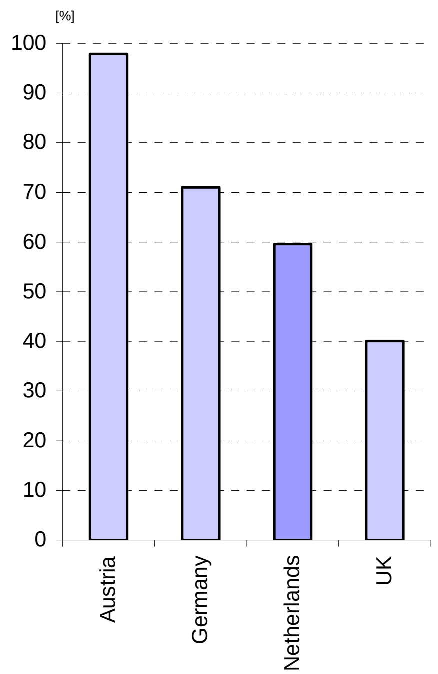

Figure 4.4 *Waste paper recycling: collection as share of generation (2002)*

Municipal waste generation
The amount of waste from households has a twofold relation with emissions. First, it is an overall measure of the effort to recycle all kinds of items. Secondly it is a measure for the amount of physical consumption and the speed of replacement of durables. This physical 'throughput' of households must be produced and thus determines the energy consumption by companies. A higher figure for waste generation means more emissions, so this is a 'negative' indicator.

Considerable differences across countries appear from Figure 4.5. Denmark and Spain produce 50% more municipal waste compared to Greece and Sweden, but also The Netherlands is well above average. The source of the data, (EC, 2003), also stated that the definitions of municipal waste were not uniformly applied and that cross-country analysis would be problematic. Reinders et al (2003) have shown that the indirect energy requirement of a household correlates strongly with expenditures. Therefore, the figures between countries may be corrected for expenditure differences, but this explains only a small part of the differences. For example, the two extremes of Sweden and Denmark have comparable household expenditures.

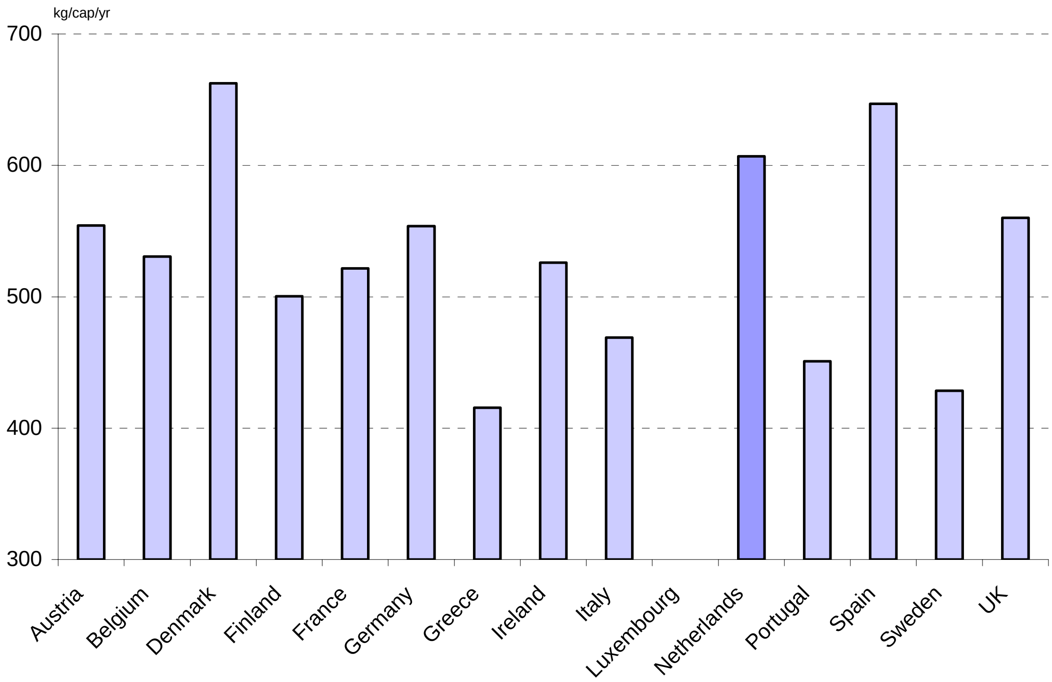

Figure 4.5 *Annual per capita waste generation in the EU in 2000*

4.2.2 Transport

Public transport
Public transport is (in general) less energy intensive compared to private transport. However, it often takes more time for travel and it demands substantial subsidies. Therefore, a higher fraction of public transportation relates to efforts of both the population and the government. The share of public transport in total person-kilometres is therefore a useful indicator. Figure 4.6 shows this indicator for several European countries in 2001 (Odyssee, 2003).

In public transport, The Netherlands appears to be among the low-scoring countries with approximately 12% in person-kilometres, while several others in Europe achieve around 20%.

This conclusion holds even more if the high population-density is taken into account. However, this could be partly accounted for by more cycling (see next indicator).

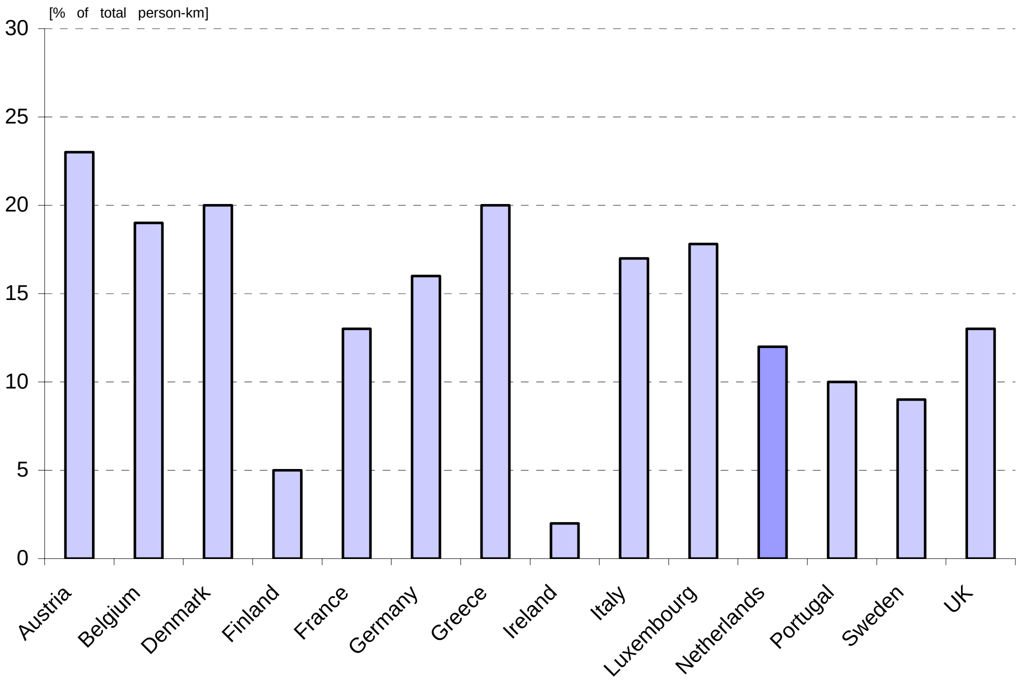

Figure 4.6 *Share of public transport in total person-kilometres travelled*

Bicycle travel

Insofar bicycle trips replace trips by car or public transport they reduce emissions. Although bicycle use offers also personal advantages (costs, physical condition, etc.) more use of bicycles can be seen as a voluntary contribution to emission reduction. The indicator can be expressed in % of total person-kilometres or in km per capita per year.) Data for a limited number of countries in 2001 are provided by (Odyssee, 2003).

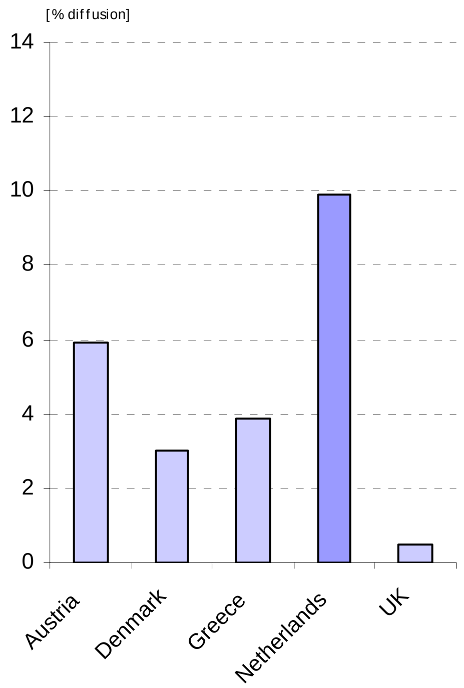

Figure 4.7 *Share of non-motorised transport in total person-kilometres travelled in 2001*

Non-motorised transport mainly comprises cycling for most countries. From data of five European countries, the Netherlands clearly shows the highest share (approaching its figure for public transport). Other countries follow at considerable distance, of which the figure for mountainous Austria, can be regarded as strikingly high.

4.2.3 Industry

In several industry sectors recycled materials can be used as input in the production process. This substantially reduces energy consumption associated with material input procurement. For instance, in the cement industry, using blast furnace slag or fly ash is the main structural improvement to reduce CO_2 emission (process as well as fuel related). Relevant sectors are:

- Pulp and paper
- Aluminium
- Steel
- Cement (no reliable data found, therefore not further discussed here).

The following three indicators should be interpreted with care and the value and meaning of the outcomes is subject to discussion. Import and export of materials play a major role in the ‘choice’ for a certain production process and the share of recycled input may depend thereon. In this regard, the collection indicators present clearer picture of efforts but are not always available for different countries.

Use of recycled materials in pulp and paper industry

As every country produces and consumes paper, its pulp and paper industry can in principle use waste paper as input. Therefore, the figures for this indicator in Figure 4.8 can be compared. However, some country-specific conditions need to be considered, e.g. paper-exporting countries such as Finland will achieve a lower recycled input percentage compared to non-exporting countries at the same collection rate. Fresh paper importing countries on the other hand, can more easily achieve high waste paper rates. It appears that Denmark has the highest waste paper share, followed by the Netherlands, Spain and the UK.

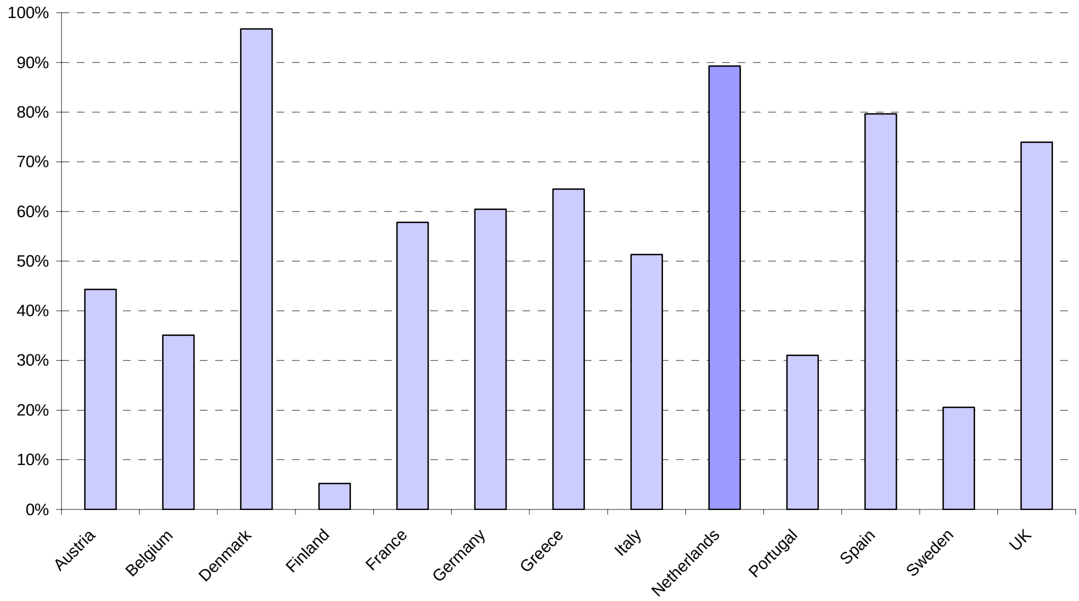

Figure 4.8 *Waste paper input in pulp and paper industry (EC, 2003)*

Use of recycled materials in aluminium industry

In aluminium industry, primary and secondary aluminium can be produced, the former of which uses a very power-intensive process, while the latter is basically melting recycled aluminium. There is no significant difference in product quality. Some countries do not have primary aluminium at all as is shown by the 100% cases in Figure 4.9. Others use a mix of primary and secondary. The use of primary aluminium as an effort indicator is a matter of debate. It can be seen as supporting an energy-intensive economy as it is possible, in principle and in the longer term, to recycle all aluminium and not producing any new primary. Therefore, the share of recycled materials in aluminium industry is an indicator for CO_2 reduction. Four countries in the EU-15 achieve a 100% score, while the Netherlands then appears to be far below average.

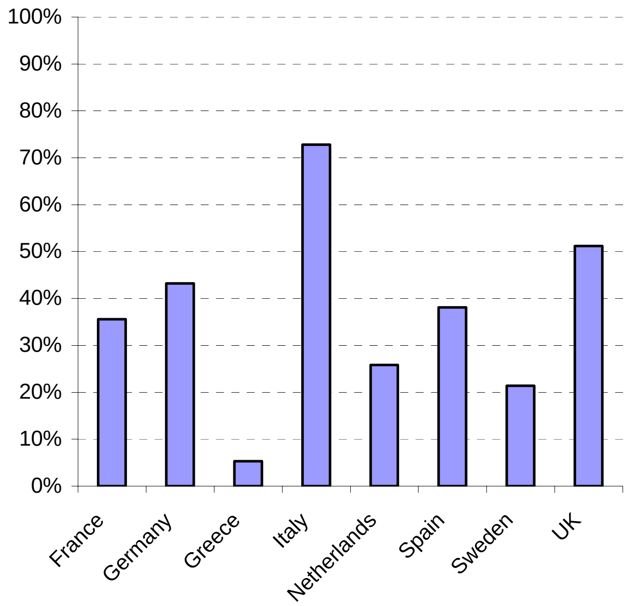

Figure 4.9 *Recycled material input share for aluminium industry (EC, 2003)*

Steel industry recycled materials input
Dutch steel industry uses the oxygen process, which allows only a low share of 'scrap' steel (Odyssee, 2003) to realise a high steel quality. The electric process, on the other hand, allows for unlimited use of recycled steel. Denmark, Greece, Ireland and Luxembourg produce all steel is this fashion, being much more energy-efficient. However, these efficiencies need to be regarded in the light of the type of process. The 'distance' to the best efficiency line, shown in Figure 4.10, gives the relative efficiency, which can be seen as the efficiency taking the type of process for granted. Then it is clear that the Dutch steel industry has one of the lowest secondary inputs. This means there is limited efficiency improvement possible in its steel industry, as it is close to the most efficient (conventional) oxygen process. Most other countries, however, have more room for improvement.

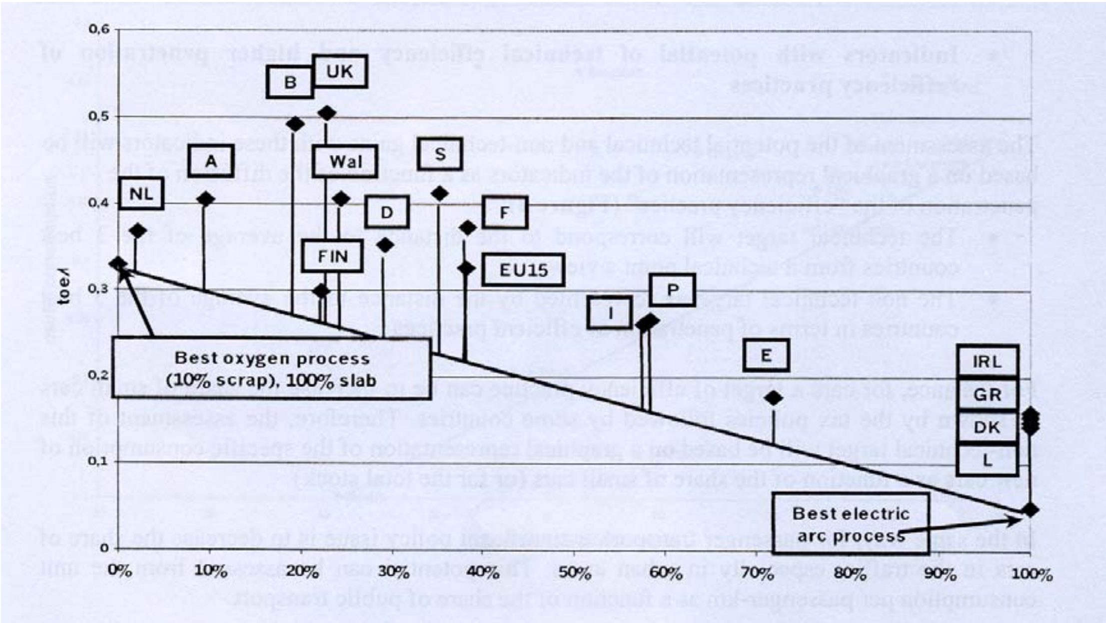

Figure 4.10 *BAT and countries' efficiency performance as a function of share electric process (Odyssee, 2003)*

Increase in renewable share in total electricity production since 1990
The historical share of renewable energy of countries highly depends on country specific conditions, such as presence of mountains with run-of-river hydropower. It is supposed that most of the 'easy potential' has been harnessed before 1990. The increase since 1990, however, will be mainly a result of policy and other efforts in a country. Chapter 3 has already quantified this effort in monetary terms, but implementation of renewable energy requires also considerable municipal organisational activities as well as other aspects such as loss of view due to wind turbines.

Therefore the increase in the renewable fraction since 1990 forms a general indicator of all emission reduction efforts in the field of renewables. The increase in share is calculated relative to total power production 1990, to account for differences in increases in production across countries. Data are taken from (IEA, 2004) and include power production from wind, solar, hydropower, biomass and waste. Figure 4.11 shows the substantial differences across a set of OECD countries, with Denmark taking the lead in developing renewable energy sources. For a several countries, there is hardly any increase in renewables since 1990. The Netherlands is among the average countries in this indicator.

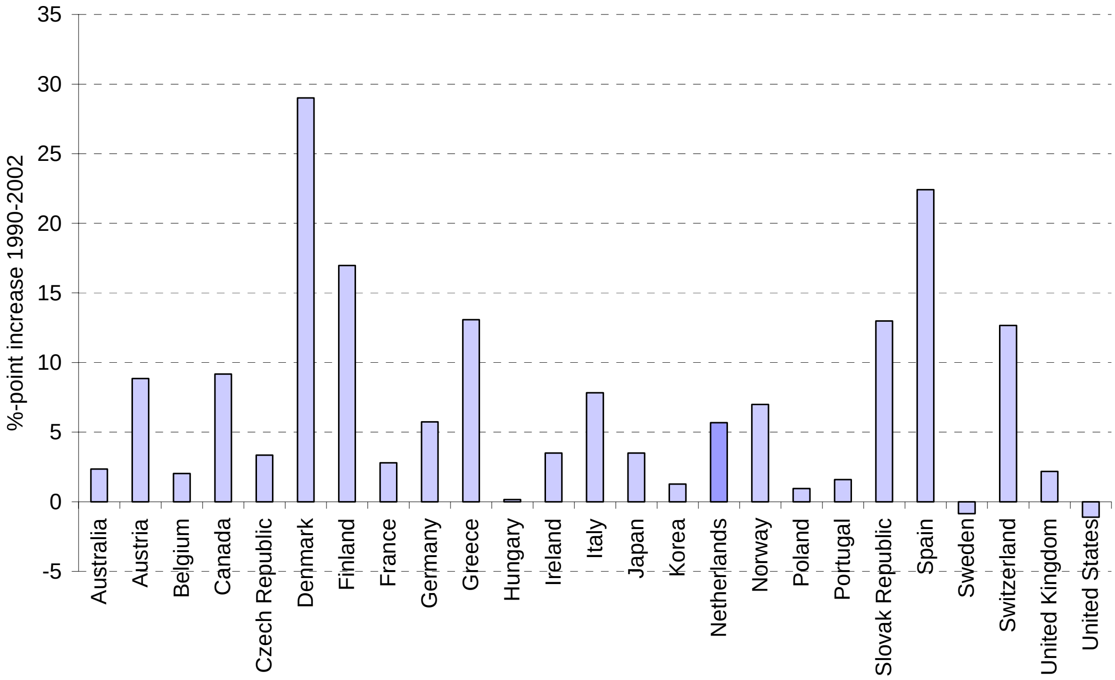

Figure 4.11 *Increase in share of renewables in total electricity production from 1990 to 2002, relative to 1990 total production*

4.3 Policy efforts and R&D

The diffusion indicators deal with changes that have a rather direct relation with CO_2 emission reductions. Some of these changes are a result of policy, others are less so. On the other hand, there will be quite some policy efforts that do not result in quantifiable changes in diffusion or behaviour that cause emission reduction. Here, we explore one as policy indicators, of which the ultimate effect in terms of emission is unclear.

Highway speed limit

Lower maximum speed is a powerful tool to lower fuel use per km driven and to increase emission reduction. Although this measure has other advantages (less traffic victims) and appears to have only minor effect on time travelled it is not quite acceptable to many groups in society. Therefore, a lower maximum speed indicates a strong policy effort. Figure 4.12 shows figures for most EU-15 countries. Striking is the absence in Germany of an actual highway speed limit: only an advice speed is given. With Italy as exception, all limits range from 110 to 130 km/hr, with The Netherlands being among the middle countries.

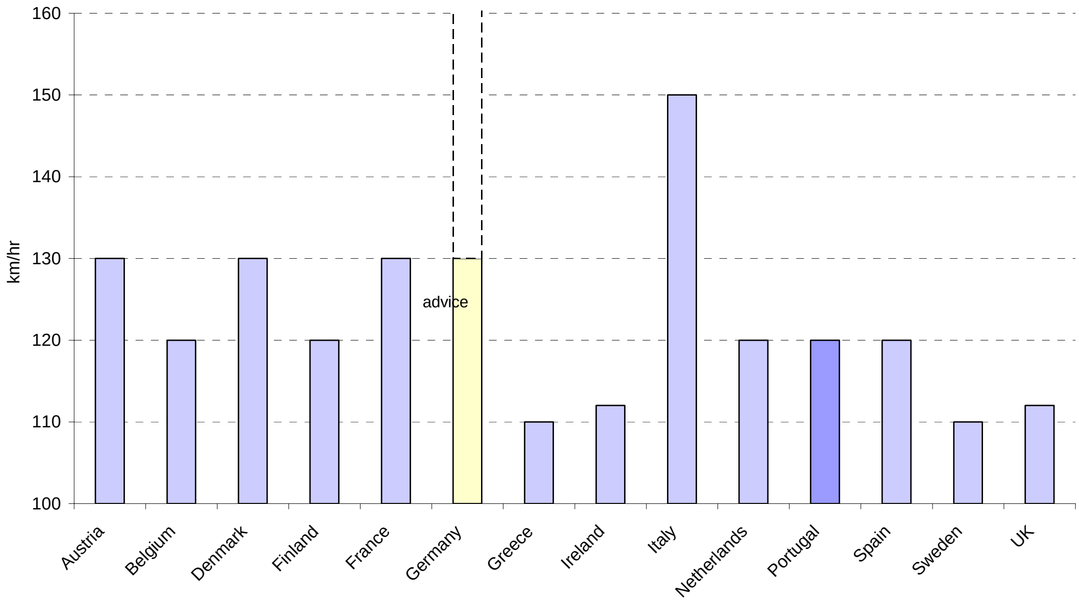

Figure 4.12 *Highway speed limits per country (Free Dictionary, 2004)*

Research and Development

A major part of government spending on energy-R&D will already be covered in the investigation of reductions and costs (see Chapter 3). The privately financed R&D will normally be part of normal business operation. But next to this there are also other efforts. E.g. the amount of manpower that is active to create the institutional structure for R&D, with its policy makers, advisory boards, conferences, etc.

However, within the limits of this indicator exercise, it has proven impossible to design a quantifiable indicator for which data are easily accessible. Therefore, R&D is not included in the set of indicators. It is also unclear whether or not it would be possible at all, i.e. with more effort, to include this important issue in the indicators.

4.4 Overview of indicators and conclusions

Table 4.1 gives an overview of the indicators discussed in the previous sections.
For each indicator, the relation to CO_2 reduction is mentioned. This relation may be quantifiable, difficult or impossible to quantify, or not present at all (in which case the *effort* is still there). The final column qualitatively indicates the relative outcome for the Netherlands. Here, ‘neg’ means the result should be seen in the light of a negative’ indicator. We again remark that the outcomes for each indicator are subject to interpretation and that country circumstances play a significant role.

Conclusions

Indicators for CO_2 reduction other than the reduction itself and the associated costs may provide valuable additional insights, as they show sector-specific contributions that have determined the success of emission reduction too. In this fashion, a more complete picture of the effort emerges, as not all efforts will be visible in actual reduction or costs. It also may provide insight in the mechanisms behind implementation of measures and the differences in success between countries.

This restricted exercise has shown that different countries achieve very different scores across the indicators investigated. The Netherlands for example, takes the lead in Label A appliances and cycling, but much less on waste generation and recycling and organic food market shares.

On the whole, it appears this country is among the average in Europe. However, no firm conclusions on the general level of effort can be drawn, as the indicators together constitute only a partial picture, which is a result of the pragmatic approach chosen.

There may exist a lot of other possible indicators that can be developed to assess the non-monetary efforts for CO_2 reduction in a more complete way. However, the relation between each chosen effort indicator and actual CO_2 reduction has to be specified. Also the overlap between reduction effects of different effort indicators has to be taken account of. For these reasons, the indicators are most useful when taken together to highlight the general level of reduction effort.

In short, the added value of this new approach lies in providing insights that cannot be shown by the more traditional approaches of cost calculation and policy evaluation. This preliminary exercise also shows that, in order to provide a comprehensive picture of non-monetary efforts, the indicators have to be chosen in a more systematic way to cover all sectors and a more elaborate analysis of the relevance and implications of each indicator is required.

Table 4.1 *Indicator overview*

Sector	Name	Unit	Relation to CO_2 quant.	qual.	Data source	Result NL
H	Label A for cold appliances	[%]	×		Odyssee	highest in Europe
H	Organic products market share	[%]		×	GAIN	below average Europe
H	Paper recycling	[%]		×	EC	3rd out of 4 EU countries
H	Glass recycling	[%]		×	EC	above average EU-15
H	Waste generation	[kg/cap*yr]		×	EC	above average EU-15 (neg)
T	Public transport	[% pkm]	×		Odyssee	above average EU-15
T	Bicycle travel	[% pkm]	×		Odyssee	highest across 5 countries
I	Recycled materials use					
	* Pulp and paper	[%]	×		EC	2nd EU-15
	* Steel	[%]	×		EC	lowest EU-15
	* Aluminium	[%]	×		EC	below average EU-15
R	Increase of renewables in national power production since 1990	[%-point]	×		IEA	average OECD
T	Maximum highway speed	km/hr	?	×	Free diction.	average

5. REDUCTION EFFORTS IN PERSPECTIVE

5.1 Economic meaning of efforts for CO_2 reduction

The financial consequences of emission reduction that were determined in Chapter 3 were expressed in absolute figures (billion € per year or period). In Table 5.1 these figures are related to the relevant figure at national level. Extra costs of energy savings and renewable energy production have been attributed to emission reduction, although they also serve other goals (see also Section 5.2). Therefore the figures in the Table should be seen as upper limits.

Expenditures to enhance savings and renewable energy peaked in 2002 when they were equal to 1,3% of total government expenditures. However, until 2000 they constituted about 0,4% of total budget. Average total investments for 1990-2003 (including that of households) constituted 3% of total domestic investments in 2000. Total net (national) costs were less than 0,2% of GDP in 2000 but varied due to fluctuations in energy prices. The fraction of environmental taxes in total government income has grown considerably; in 2000 the fraction was 14-15%. (see also Table 3.10).

Table 5.1 *Financial aspects of emission reduction in relation to national quantities*

[billion €]	Emission reduction	Total Netherlands	Ratio [%]
Historic realisations:			
Government expenditures 2002	1,4	109	1,3
Investments (average 1990-2003)	2,4	79 (2000)	3
Total net costs for society 2000	0,6	363 (GDP)	0,2
Taxes (value for 2000)	14	100	14
Scenario Global Economy:			
Investments (average 1990-2010)	*3,7*	*100 (2010)*	*4*
Total net costs for society 2010	*3*	*460 (GDP)*	*0,6*

According to the scenario Global Economy average total investments for 2004-2010 could reach almost 4% of estimated total investments for 2010. Total reduction costs reach their highest point in 2010 when they constitute 0,6% of GDP.

5.2 Other effects of activities aimed at CO_2 emission reduction

All costs of extra energy savings and renewable energy production have been attributed here to the reduction of CO_2 emissions. However, these activities also contribute at the same time to other desired goals in policy and society, such as:

- Security of supply/mitigating import dependence
- Competitiveness of industry with abroad
- Limited sensitivity of economy to high energy prices
- Reduction of other emissions: NO_x, SO_2, HCs, etc.
- Creation of jobs/lowering unemployment
- New economic activities.

Import dependence and competitiveness of industry have been major reasons in Dutch energy policy (EZ, 1995) to stimulate energy savings in the era before the greenhouse gas problem was recognized. The first item is now part of EU-policy and in recent policy documents energy savings are also motivated from the perspective of security of supply (EU, 2002) on buildings and

(EU, 2004b) on savings to be realised). In the buildings directive and that on co-generation (EU, 2004a) also economic reasons are mentioned. The targets for renewable energy in 2010 {EU, 1998] have also been based on depletion of fossil fuel reserve and environmental protection in general.

If efforts serve more goals it is conceptually difficult to split costs to different goals. Often subjective choices have to be made. Therefore no attempt has been made to correct the CO_2 reduction costs calculated. However, given the other advantages of most reduction activities, the cost figures should be regarded as upper bounds.

5.3 Effects of climate policy intensification

In 1998 the Netherlands Climate Policy Implementation Plan was approved. This was the start of an intensification of national policy on emission reduction until 2010. In this section the earlier presented results on effort indicators in Chapter 2 and 3 are analysed as to the effect of intensification of policy. In Table 5.2 for each quantity the realised value is given for 2003 and the estimated value for the scenario year 2010. In both cases the value is split into the contribution of activities before 1998 (Pre) and the contribution of activities after 1998 (Post).

Table 5.2 Effort indicator trends before and after the Climate implementation plan

	1990 - 2003			1990 - 2010		
Total avoided	Pre	Post	Total	Pre	Post	Total
Yearly	23	19	33	<23	36	<60
Cumulative	216	33	249	379	214	592
Policy avoided						
Yearly	10	9	20	<10	18	<28
Cumulative	93	30	123	166	127	293
Cumulative:						
- government	2.3	4.1	6.4	2.3	9.5	11.8
- investments	15	16	31	15	41	57
- net national costs	7	1.8	8.9	12.1	12.8	24.9

The increase in yearly total emission reduction, between 2003 and 2010, is fully accounted for by the Post-1998 reduction activities. The effect of Pre-1998 activities is maintained because it is supposed that realised emission reductions up to 1998 last into the future. However, in some cases the reduction effect could disappear in the course of time. In that case the Pre-1998 effect will be slightly lower in 2010 compared to 2003. For yearly policy induced emission reductions the same reasoning is valid.

In 1998 avoided yearly emission is equal to the figure in the 'Pre' column for 2003 (see also Table 2.4). Without intensification there will be a constant increase in avoided yearly emissions. Given the length of periods the figure for 2010 should be 2.5 times the 1998-value. However, total reduction in 2010 is slightly higher than 2.5 times 23 Mton. This points at a small acceleration of emission reduction after 1998. The same analysis for policy induced emission reduction shows a somewhat stronger acceleration.

The cumulative avoided emissions show a different picture. The contribution of Pre-1998 reduction activities to total cumulative reduction is very high in 2003. This contribution continues to increase after 1998 and the contribution in 2010 is still larger than that of Post-1998 activities. It must be remarked that Post-1998 activities will give rise to avoided emissions after 2010, while the effect of Pre-1998 activities could disappear in the longer run. However, it must be concluded that earlier actions are just as important as intensified actions with respect to attaining emission reduction in 2010.

With respect to cumulative financial quantities the following holds. Government spending and investments have increased much faster after 1998 than would be the case at a constant pace (that leads in 2010 to 2.5 times the value in 1998). This finding highlights the intensified reduction policy very well. The same finding seems the case for net national costs. However, these costs rely heavily on the actual level of national energy prices in a chosen year. Therefore no strong conclusions can de drawn as to this item.

5.4 Reduction efforts in other countries

Dutch efforts to reduce CO_2 emissions are part of the commitment of the EU to the Kyoto targets. Therefore a comparison with other countries should focus on EU countries first. For most non-monetary indicators such a comparison, where possible, has already been presented in Chapter 4. However, little information could be found on historical emission reductions, policy contributions and the financial indicators: government expenditures, investments for reduction, environmental taxes and net reduction costs. The following could be said on the comparison.

With regard to realised emission reduction the same approach, as described for the Netherlands in Chapter 2, could be done for Europe. Realised energy savings per sector are available from (Odyssee, 2004). The increase of renewable production is given in Eurostat statistics. However, the scope of the study does not comprise this work.

The effect of policy measures in the period 1990-2001 on the total European emission of greenhouse gasses has been estimated at 5% by (Harmelink, 2004). CO_2 emissions would have been 3-4% higher in the absence of policies. From the results in Chapter 2 it follows that emission in the Netherlands would have been 9% higher in 2000, or three times as much as European average. However, the results in (Harmelink, 2004) do not regard the contribution of savings in industry, transport and energy sector due to higher taxes, subsidies, long term agreements, efficiency standards, etcetera.

For taxes only historic data are available. However, the percentage for the Netherlands (9.4%) is lower than that in Table 3.10 (13.9%). This is probably due to definition differences. For government expenditures on energy related R&D figures are available from the IEA. However, this report focuses on expenditures for stimulating implementation.

For future trends in emission reduction and costs some information is available from international scenario studies that present reduction/cost curves or discuss burden sharing (see EC, 2000). However, it is very difficult to compare these results with that for the Netherlands in this report. Scenarios may differ in many aspects and also definition of costs could diverge.

All in all it must be concluded that, given the scope and restrictions of this study, it has not been possible to relate the Dutch results on reduction efforts in a meaningful way to that of other European countries.

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APPENDIX 1 GOVERNMENT EXPENDITURES

Table A.1 *Yearly government expenditures to stimulate energy savings and renewable energy production, per policy measure*

[mln. €[1]]	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*
Novem	20	36	30	37	60	39	54	50	58	66	63	71	50	62
TIEB	0	14	11	6	10	8	5	11	5	8	1	1	1	1
SEBG	5	41	24	36	13	8	2	1	0	0	0	0	0	0
SEEV	0	2	5	6	0	1	0	0	0	0	0	0	0	0
EMA	0	0	0	0	1	0	1	2	3	1	0	1	0	0
NPR	5	0	0	0	0	0	0	0	0	0	0	0	0	0
FS&D	2	2	0	0	0	0	0	0	0	0	0	0	0	0
NEWS	0	0	0	0	0	0	0	0	0	2	2	0	0	0
BSET-wkk	20	73	100	47	36	39	2	0	0	0	0	0	0	0
EINP	0	0	0	0	0	0	0	0	1	5	9	13	32	1
CRP	0	0	0	0	0	0	0	0	0	2	4	3	4	7
Senter	0	0	0	0	4	1	2	3	5	8	8	7	8	5
ECN	26	29	27	28	28	27	26	25	25	27	27	30	29	30
REB	0	0	0	0	0	0	9	10	13	17	46	198	556	450
EIA	0	0	0	0	0	0	0	20	63	70	90	144	253	153
VAMIL	0	6	11	15	52	50	54	48	55	34	37	74	111	5
GB	0	0	0	0	0	0	5	10	6	6	5	9	14	7
EPR	0	0	0	0	0	0	0	0	0	0	50	103	167	167
MAP	0	22	61	45	84	107	106	114	120	90	84	0	0	0
Old '87-91	18	14	1	1	1	1	1	1	1	1	1	1	1	1
Innov.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MEP	0	0	0	0	0	0	0	0	0	11	16	49	164	268
Local	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Low income	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Waste	0	0	0	0	0	0	0	0	0	8	21	24	13	0
Total	96	241	270	219	289	281	267	296	356	355	463	728	1403	1168

[1]See explanation of abbreviations in Appendix 3.

APPENDIX 2 OTHER INVESTMENTS

Other investments regard the investments for energy saving that are not related to financial support schemes or non-financial policy measures. This amount has been estimated using different sources of information:

- Total penetration of saving options and specific investment figures (if available).
- Evaluations of support schemes specifying the amount of users that do not apply for financial support they could claim.
- Specific reduction costs for end users resulting from he estimates for total investment for savings.

Estimates per sector

Per sector the factors that have led to the estimate on 'other investments' will be presented.

For *households* the historic trends have been simulated with an adapted version of the model used earlier for scenario studies (Boonekamp, 1997). The model specifies all saving options in detail, including the (extra) investment and saving performance. For each saving options the historic penetration rates have been simulated. One of the results of the simulation is total investment in all saving options in a chosen period. It proves that almost all investments are due to government actions, either because the major part regards new dwellings with performance standard, or because autonomous saving options demand few investments.

For *industry* most investments are coupled to support as these energy users are well informed about subsidy schemes. Moreover transaction costs are relatively low because of the scale of energy use and saving measures. Insofar investments are not coupled to support, it is difficult to proof that they are the result of non-financial policy: the voluntary agreements in the past or emission trading caps in the future. These investments could also be characterized as autonomous (see also check of cost-effectiveness).

The greater part of *agriculture* energy use regards horticulture where a GLAMI-covenant, AMvB-standards (on energy use per crop) and subsidy schemes influence virtually all investments for savings. In this sector no autonomous investments have been supposed.

In the sector *services* all savings in new buildings are coupled to (non-)financial policy measures. In existing buildings a great number of non-financial measures have been active, such as covenants, information campaigns and demonstration projects in different branches. However, it has been difficult to decide how much investments are due to this policies and how much are autonomous (see also check of cost-effectiveness).

In *transport* the main reduction option is the increased motor efficiency for cars that follows from the ECEA-covenant between manufacturers and the EU. Substantial investments to reach the goals are foreseen. In freight transport investments in vehicles due to financial support has lowered energy use. For the remaining reduction it is difficult to make a distinction between the causes, autonomous or other policy measures (such as 'new driving style', lowering of speed limits, etc.).

For *refineries* the same division for investments has been applied as for industry, because both experienced the same government support and the same exogeneous influences.

Electricity production consists of central power production, waste incineration and distribution (including small scale cogeneration). This sector forms a special case as it has moved from a highly government controlled sector to a 'normal' business sector. In the first phase efficiency gains resulted from non-financial policy; demands on new capacity were part of the capacity extension plan that was approved by government. More recently a covenant on burning of biomass in coal plants was accompanied by financial support. In the future caps in the EU emission trading system could force investments in reduction. However, it is supposed that part of the modest investments in reduction has been, or will be, autonomous.

Check on investments via end users costs
Given the substantial uncertainties in the total investments for emission reduction in most sectors there is a need to check the estimates with information from other sources. To this end the costs according to the end users approach (see Chapter 3) has been calculated for each sector. These costs are compared with results found in the study 'Environmental costs of energy measures 1990-2010' (Boonekamp, 2004) and other studies. The sources mentioned do not regard total reduction costs for sectors or the Netherlands, but the costs of specific reduction activities or projects. Therefore the comparison has to be made in a relative sense, using specific costs per ton of CO_2 reduced. The specific costs are calculated from the total net yearly reduction costs for end users and the total realised emission reduction per year (see Section 2.2 and Table 2.4).

APPENDIX 3 ABBREVIATIONS

ACEA = Association Construction European Car? (covenant efficient cars)
AMvB = Greenhouse Horticulture Orders in Council (standards on energy use per crop)
BANS = Climate covenant with provinces and municipalities
BLOW = Intergovernmental Wind Energy Agreement
BM = Benchmarking covenant (industry and energy)
BSB = Environmental Fuel tax
BSET = Subsidy Scheme for Energy Conservation Techniques
BSET = Subsidy Scheme for Energy conservation Techniques
CRP = CO_2 Reduction Programme (general)
DUBO = Sustainable Building covenant
ECN = Energy research Centre of the Netherlands
EIA = Energy Investment Cut in corporate income tax
EINP = Energy investment subsidy for Non-Profit organizations
EMA = Energy and environmental advice (subsidy on advice to companies)
EPA = Energy Performance Advice
EPN = Energy Performance Norm
EPR = Energy Premium Rebate
ETS = Emission Trading Scheme
GB = Green Investment scheme (tax deduction on interest receipts)
GLAMI= Greenhouse Horticulture covenant
HNR = New Driving Style
IENP = Energy Investment subsidy for Non-Profit organizations
MAP = Environmental Action Plan (of distribution companies)
MEP = Environmental quality of electricity production' (kWh-compensation)
MJA = Long term Agreement (on energy efficiency)
MJA-2 = Long term Agreement on (indirect) energy savings
Novem = Netherlands Organization for Energy and Environment (now SenterNovem)
REB = Regulatory Energy Tax
SEBG = Subsidy scheme Energy Savings Buildings
SEEV = subsidies on efficient and clean gas boilers
TIEB = Tender Industrial Energy Savings
VAMIL= Variable depreciation of investments for corporate income tax
VROM = Ministry of Housing, Spatial Planning and Environment