Environmental accounts of the Netherlands 2009

Statistics Netherlands

The Hague/Heerlen 2010

Explanation of symbols

.	= data not available
*	= provisional figure
**	= revised provisional figure
X	= publication prohibited (confidential figure)
-	= nil or less than half of unit concerned
-	= (between two figures) inclusive
0 (0,0)	= less than half of unit concerned
blank	= not applicable
2009–2010	= 2009 to 2010 inclusive
2009/2010	= average of 2009 up and including 2010
2009/'10	= crop year, financial year, school year etc. beginning in 2009 and ending in 2010
1999/'00-2009/'10	= crop year, financial year, etc. 1999/'00 to 2009/'10 inclusive

Due to rounding, some totals may not correspond with the sum of the seperate figures.

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Foreword

The economic recession in 2009 had a direct impact on the environment. Energy use decreased in almost all industries, with the largest reductions in transport, manufacturing and construction. Greenhouse gas emissions by industries fell by nearly 3 percent. Also the environmental pressure with respect to eutrophication, acidification and local air pollution was reduced. As a consequence of the economic recession, less natural gas has been produced for both the domestic market and for exports. The rate of depletion of our energy resources thus slowed down. However, the effects of the financial crisis for the environment were not exclusively positive. Preliminary results indicate that investments in environmental equipment by manufacturing and energy supply decreased.

The first part of *The environmental accounts of the Netherlands 2009* provides an overview of the most recent developments in the relationship between the environment and the economy, with special attention for the effects of the economic recession. Part two presents three studies that provide more in-depth analyses for specific topics. The first study examines the methodology and preliminary results for quarterly CO_2 emission accounts. It demonstrates that these emissions show a clear seasonal pattern. The second study looks at the relationship between household characteristics such as (disposable) income and size and the burden these types of households place on the environment due to their consumption patterns. It finds that greenhouse gas emissions increase with rising income and thus consumption. The third study investigates trade-offs between economic development and environmental pressure by calculating and comparing multipliers for different industries using input-output analysis. The study shows that the output and employment multipliers for the Environmental Goods and Services Sector are above the average of the Dutch economy.

In this annual report, *Environmental Accounts of the Netherlands*, Statistics Netherlands (CBS) presents a broad quantitative overview of important economic-environmental developments. The Environmental Accounts provide a systematic description of the relationship between the environment and the economy and can be used for analyses of various types. Key indicators that can be derived from the environmental accounts provide an insight into the interrelationships between the environment and the economy, and into the issue of environmental sustainability of our economy.

The last few years the international interest in environmental accounting has been growing. In 2012 this will culminate in the acceptation of the System of integrated Environmental and Economic Accounting (SEEA) as an international statistical standard. This year, the Dutch Environmental Accounts are published for the first time in English to disseminate its results also to the international community.

The Director-General of Statistics Netherlands

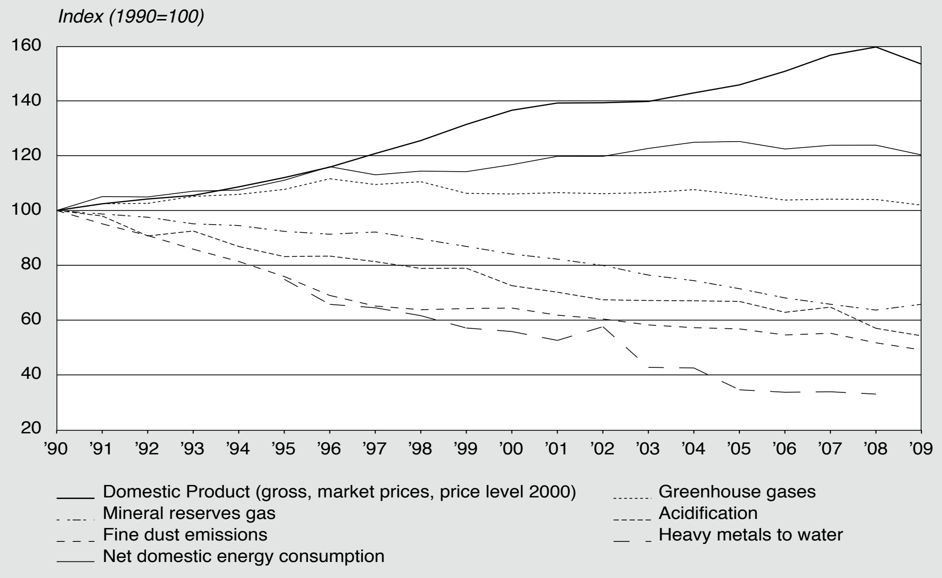
Drs. G. van der Veen

The Hague/Heerlen, November 2010

Summary

Economic developments have an impact on the environment. Environmental accounts describe the relationship between the economy and the environment. Because the environmental accounts are integrated with concepts from the national accounts, developments in the field of the environment and macro-economic developments in the Netherlands can be compared directly (see Statline for some key indicators). Key indicators can be derived from the environmental accounts that provide insight into sustainability with respect to the development of the environment and the economy. The integrated system makes it possible to quantify and analyse the underlying causes of changes in environmental indicators. The effects of changes in – among other things – economic growth, environmental efficiency and international trade can therefore be expressed in figures. This publication presents the results of the environmental accounts developed by Statistics Netherlands.

1 Development gross domestic product and environmetal indicators



Financial crisis tempers economy's energy use

Net energy consumption by economic activities decreased by 2.9 percent in 2009 as a direct result of the financial crisis. The largest reductions in energy use took place in transport, manufacturing and construction. The energy intensity of the economy as a whole increased by 1 percent on the previous year. This is the first time in six years that energy intensity deteriorated. A side effect of the financial crisis is that energy dependency on imports decreased. This is because domestic demand for gas saw a relative increase, while the domestic demand for oil products decreased.

Water use per capita reduced in 2009

Since 1990 annual tap water consumption by households has remained quite stable, despite population growth. Through efficiency measures, household water use per capita has been reduced by 9 percent since 1990. In 2009, water use per capita dropped again. Households use nearly two thirds of all tap water supplied in the

Netherlands. Total abstraction of water by the Dutch economy decreased by 2 percent in 2008 with respect to 2007.

The Netherlands has a monetary trade surplus but a physical trade deficit

The material flows related to domestic extraction of natural resources are for a large part determined by gravel and sand. Most of these materials are used for infrastructural projects to raise roads and houses or to strengthen dikes and coastal defences. The Netherlands has a physical trade deficit but a monetary trade surplus which indicates that cheap bulk materials are imported and turned into more expensive high-quality export products. Despite economic growth, material consumption in kilos decreased slightly between 1996 and 2007.

Construction industry generates 74 percent of all mineral waste

Between 2000 and 2008 the amount of domestically generated waste remained stable at around 64 billion kg. In the same period the amount of waste disposed of on landfill sites decreased significantly. In 2008, almost 14 percent of all waste generated in the Netherlands had a commercial value for the generator. Minerals constitute the largest part of total waste generation. The construction industry generates 74 percent of all mineral waste during demolition and construction activities

Greenhouse gas emissions of the economy increased since 1990 while IPCC emissions decrease

Since 1990 greenhouse gas emissions have decreased by 5.7 percent according to the IPCC guidelines. This puts the Netherlands on course to realise its Kyoto targets. However, the emission of greenhouse gases generated by the Dutch economy increased by 2.0 percent in the same period. These differences are primarily due to the treatment of emissions by international transport, which is only partly included in the Kyoto figures. Precisely in this period, international transport grew rapidly in the Netherlands, pushing up greenhouse gas emissions.

Greenhouse gas emissions by industries decreased by 2.7 percent in 2009

While the economy shrank 3.9 percent, the decrease in greenhouse gas emissions by industries was smaller at 2.7 percent. The emission intensity deteriorated for the first time in several years. There are three causes for this. First, the emissions of energy supply companies, which contribute 28 percent to the total emissions by industries, increased by 0.5 percent. Because of lower prices for natural gas and large scale maintenance works in energy plants in neighbouring countries, the competitive position of Dutch electricity companies improved. Second, some service industries contributed much to the decline in GDP, but much less to the total reduction in greenhouse gas emissions, as these are emission-extensive economic activities. Third, the winter of 2009 was colder than in 2008, which induced more combustion of gas for heating offices and greenhouses and thus more CO_2 emissions.

No change in carbon footprint over time

Despite a decrease in greenhouse gas emissions by the Dutch economy, worldwide emissions as a result of Dutch consumption needs, the carbon footprint, remained unchanged between 1996 and 2009. In this period, emissions embedded in import products increased while emissions embedded in export products decreased. This was due to more efficient production processes in the Netherlands and to more imports from ‘environmentally unfriendly’ countries. Especially non-OECD countries have emitted more for Dutch consumption needs than vice versa.

Emissions of air pollutants down further in 2009

The emissions of different air pollutants such as acidifying substances, particulate matter, smog forming and ozone layer depleting substances dropped by approximately 5 percent in 2009. This decline is larger than the economic shrinkage of 3.9 percent in 2009, indicating an improvement in emission intensities. Emissions to air and economic development showed significant absolute decoupling since 1990. The different environmental themes related to air pollutants, except for greenhouse gases, were down by at least 45 percent on 1990 levels.

Reduced emissions of heavy metals and nutrients to surface water and sewers in 2008

Net discharge of heavy metals and nutrients to water by the Dutch economy decreased in 2008 compared to 2007. Cadmium, copper and zinc had the highest share in the total decrease in emitted heavy metal equivalents by the Dutch economy. This was partly the result of reduced heavy metal emissions by sewage and refuse disposal services and partly of reduced emissions by manufacturing. The emissions decreased especially in manufacturing of electrical and optical equipment, paper and paper products, petroleum products and fabricated metal products. The economic recession has hit manufacture of basic metals particularly hard, resulting in production cuts. Despite the decline in production, their emissions increased. Hence their environmental performance decreased significantly.

Growing value of oil and gas reserves has come to a halt

On 1 January 2010, the value of the remaining natural gas reserves amounted to 164 billion euros, or 29 percent of Dutch GDP. The growing trend in value, largely due to rising prices of oil and gas since 2005, stopped due to a severe cut in oil and gas prices in 2009. For the first time since 1998 the remaining physical reserves at the end of the year, in this case 2009, were higher than at the beginning of a year. This was primarily the result of an upward re-evaluation of remaining expected reserves in 2009 that more than compensated for the extraction in 2009.

Less environmental tax revenues in 2009

Revenues from environmental tax fell by 2.4 percent in 2009, to 19.3 billion euro. This was mainly caused by lower tax revenues from passenger cars and motorcycles, since car imports and sales plummeted. The proportion of environmental tax in total tax revenues remained stable at 14 percent which means that the green tax reform is still stagnating. Households are charged most energy tax. In 2009 households were responsible for one quarter of total CO_2 emissions, while they accounted for 60 percent of the energy tax. This means that the ‘polluter pays’ principle does not apply for energy tax. One reason for this unequal financial burden is that households have to pay much higher energy tax rates than companies.

Electricity and gas supply faced a deficit of emission permits in 2009

Companies participating in the European Union Emissions Trading System for CO_2 permits as operators in 2009 received emission permits for an amount slightly more than their actual CO_2 emissions of 81.1 megatons in 2009. The Dutch ETS sector thus possessed enough CO_2 permits to be able to surrender sufficient number of permits to cover the 2009 CO_2 emissions. However, certain industries, such as electricity and gas supply, did face a deficit of permits in 2009 and had to secure (significant amounts of) additional permits via, for example, purchase from other industries, traders or from abroad. ETS companies (operators) caused 50 percent of total CO_2 emissions generated by the Dutch economy as a whole, while they contributed only 7.4 percent to GDP in 2009.

Environmental investments by manufacturing and energy supply decreased in 2009

In 2007 environmental investments had increased by 50 percent on 2005. Particularly municipalities, agriculture and transport invested more in the environment. Municipalities invested particularly in separated sewage networks for rain and waste water. Preliminary results indicate that manufacturing and energy supply companies invested 2.7 billion euro in the period 2006–2009. Environmental investments by the energy sector in windmills contributed in particular to this increase. In 2009 the environmental investments by manufacturing and energy supply had fallen 24 percent on 2008, probably as a direct result of the financial crisis.

Environmental Goods and Services Sector contributed 12.8 billion euro to GDP in 2008.

With a contribution of 12.8 billion euro to the gross domestic product (GDP) in 2008, the Dutch EGSS accounted for 2.1 percent of total GDP. This share remained stable in the period 1995–2008. Dutch GDP in current prices rose by 95 percent in the period 1995–2008, while the EGSS grew by 112 percent. So the Dutch EGSS grew slightly faster than the Dutch economy. With regard to employment, in terms of full-time equivalents, the EGSS has a 1.8 percent share in total employment in the Netherlands. Employment in the EGSS rose by 34 percent in the period 1995–2008. Activities related to energy saving and sustainable energy systems, industrial environmental equipment and environmental advice play a relatively modest role in the EGSS, but are growing fast. These innovative activities have grown faster than the average growth rate of employment in the EGSS.

CO_2 emissions show a clear seasonal pattern

Emissions of CO_2 per quarter show a clear seasonal pattern. Emissions in the first and fourth quarter are significantly higher than in the second and third quarters. This is mainly the result of the Dutch climate. Average temperatures are lower in quarter 1 (winter) and quarter 4 (fall) than in quarter 2 (spring) and quarter 3 (summer). As a result of lower average temperatures houses and offices need more heating. This means more natural gas combustion, which induces more CO_2 emissions. The financial crisis that started in 2008 clearly had a negative impact on CO_2 emissions (fewer emissions). Although it seems that CO_2 emissions anticipate the pattern of economic decline and growth, it is debatable if information on quarterly CO_2 emissions can serve as a structural early warning sign for negative or positive economic developments.

Air emissions increase with rising income

This study investigated the feasibility of compiling an environmental account for households, which describes the relationship between household characteristics such as income and size, and air emissions – both direct and indirect. This analysis was done using household budget survey data that provide a breakdown of the average expenditures on goods and services of various household types. Greenhouse gas emissions embedded in consumption in 2007 amounted to 22 ton CO_2 equivalents per household on average. The results show that emissions per household rise with increasing household income. This is driven by the larger volume of consumption by high income households, which is only partly offset by a decreasing emission intensity of expenditures with increasing income.

Output and employment multipliers for the Environmental Goods and Services Sector above average

This study investigates trade-offs between economic development and environmental pressure by calculating and comparing multipliers for different industries using input-output analysis. Various types of multipliers are ranked which allows for the presentation of trade-off profiles in the form of spider webs. The overall multiplier effect on GDP for the Dutch economy in 2008 was 0.74, which means that every euro increase in output on average adds 74 cents to GDP. The average greenhouse gas multiplier effect is 0.27 ton CO_2 equivalents. The study shows that the output and employment multipliers for the Environmental Goods and Services Sector are above the average of the Dutch economy.

Table 1
Environmental accounts, key figures

	Unit	1990	1995	2000	2005	2006	2007	2008*	2009*
Economy									
Domestic product (gross, market prices)	*mln euro*	243,652	305,261	417,960	513,407	540,216	571,773	596,226	571,979
Domestic product (gross, market prices, price level 2000)	*mln euro*	306,034	342,776	417,960	446,282	461,430	479,521	488,543	469,416
Value added (gross, basic prices)	*mln euro*	223,832	275,686	373,415	456,182	479,012	507,650	529,319	509,619
Value added (gross, basic prices, price level 2000)	*mln euro*	276,842	308,196	373,415	400,032	413,356	429,776	438,570	423,533
Final consumption expenditure households	*mln euro*	121,102	151,058	210,823	250,343	254,875	264,099	270,751	262,585
Final consumption expenditure households (price level 2000)	*mln euro*	155,860	170,120	210,823	220,581	219,823	223,684	226,193	220,633
Investments in fixed assets (gross)	*mln euro*	55,328	63,500	91,652	97,016	106,373	114,340	122,688	108,906
National income (net, market prices)	*mln euro*	205,249	264,570	365,672	440,176	476,147	499,203	499,045	468,661
Population	*x 1,000*	14,893	15,424	15,864	16,306	16,334	16,358	16,405	16,486
Labour input of employed persons	*x 1,000 fte*	5,536	5,774	6,534	6,478	6,583	6,728	6,811	6,730
Taxes (received by goverment)	*mln euro*	62,197	70,835	99,060	124,042	132,332	141,040	143,500	137,317
Stocks									
Mineral reserves gas [1]	*bln Sm^3*	2,113	1,952	1,777	1,510	1,439	1,390	1,345	1,390
Valuation mineral reserves gas [1]	*mln euro*	69,236	60,742	64,444	99,846	123,328	139,092	165,814	163,657
Mineral reserves oil [1]	*mln Sm^3*	64	53	30	27	38	37	34	50
Valuation mineral reserves oil [1]	*mln euro*	3,525	1,692	1,690	3,273	4,116	4,722	5,379	6,354
Extraction									
Natural gas	*bln Sm^3*	72	78	68	73	71	68	80	74
Materials	*mln kg*	.	.	246,360	213,294	213,295	214,943	.	.
Groundwater	*mln m^3*	.	.	.	994	1,058	988	972	.
Use									
Net domestic energy consumption	*petajoules*	2,912	3,233	3,398	3,644	3,565	3,604	3,605	3,502
Tapwater	*mln m^3*	1,166	1,171	1,127	1,087	1,099	1,088	1,093	1,093
Material consumption biomass	*mln kg*	.	.	49,574	47,209	45,169	46,872	.	.
Material consumpton metals	*mln kg*	.	.	7,766	5,426	3,711	7,407	.	.
Material consumption non-metallic minerals	*mln kg*	.	.	165,550	130,986	136,461	137,972	.	.
Material consumption fossil fuels	*mln kg*	.	.	75,716	78,158	74,946	76,476	.	.
Environmental goods and services sector									
Labour input	*x 1,000 fte*	.	93	110	118	119	122	125	.
Value added (basic prices)	*mln euro*	.	6,046	8,618	10,071	11,369	12,296	12,818	.
Environmentally related activities and transactions									
Environmental taxes	*mln euro*	5,824	9,249	13,973	17,270	18,677	18,503	19,757	19,278
Environmental fees	*mln euro*	1,619	2,367	2,906	3,722	3,954	4,116	4,201	4,176
Environmental costs	*mln euro*	3,864	6,601	9,116	10,105	.	11,337	.	.
Environmental costs by enterprises [2]	*mln euro*	861	1,209	1,531	1,548	1,557	1,533	1,494	.
Environmental investments by enterprises [2]	*mln euro*	557	418	417	334	542	436	764	580
Environmental pressure									
Greenhouse effect	*mln CO_2-eq.*	229,702	247,344	243,526	243,070	238,449	239,177	238,896	234,189
Ozone layer depletion	*1,000 CFK11-eq.*	5,878	641	216	174	170	161	155	148
Acidification	*mln ac-eq.*	38	31	27	25	24	25	22	21
Fine dust emissions	*mln kg*	81	62	52	46	44	45	42	40
Eutrophication [3]	*mln eutr-eq.*	232	214	174	155	150	138	128	128
Solid waste production	*mln kg*	52,450	53,983	64,013	61,213	62,029	63,232	64,474	.
Landfilled waste	*mln kg*	14,982	9,209	4,907	2,137	3,205	2,617	2,147	.
Heavy metals to water [3]	*1,000 eq.*	148	111	83	51	50	50	49	.
Nutrients to water [3]	*1,000 eq.*	26,811	14,805	10,988	8,143	8,046	7,362	7,147	.
Rest of the world									
Import of goods	*mln euro*	102,919	126,867	208,558	241,157	274,775	298,650	322,567	267,740
Export of goods	*mln euro*	111,679	144,366	232,334	281,867	316,270	342,311	366,252	306,119
Import of materials	*mln kg*	.	.	292,323	318,804	335,637	356,226	.	.
Export of materials	*mln kg*	.	.	241,393	272,589	290,914	302,711	.	.
Environmentally adjusted aggregates									
Adjusted national income for depletion of mineral resreves (net)	*mln euro*	203,157	262,580	362,588	434,739	468,351	493,068	487,745	463,286

[1] Balance as of 31st of december.
[2] Own activities, NACE 10-41, excl. NACE 36631 and 37 (1990 and 1995, >20 employees; 2000 and after, >10 employees).
[3] Net approach.

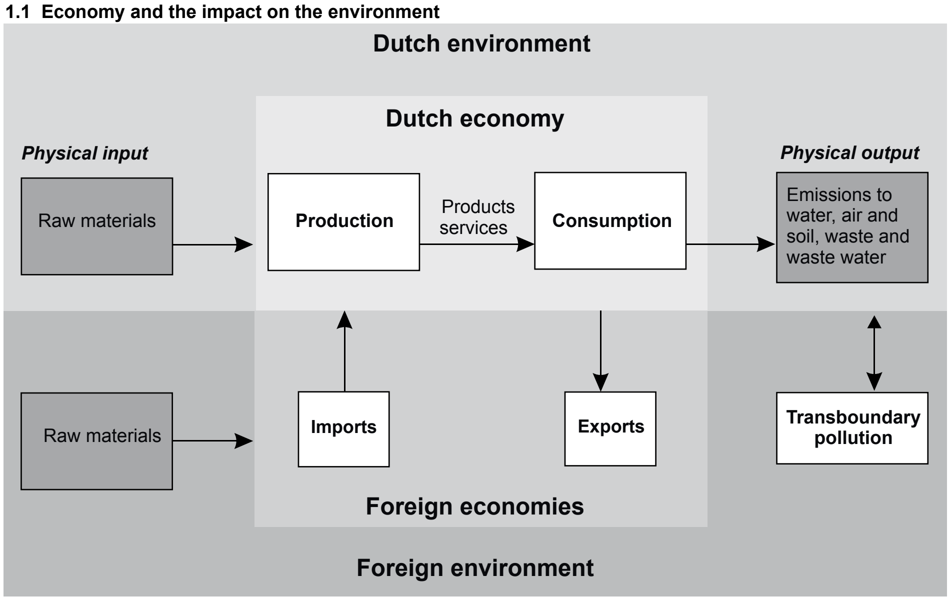
* Preliminary figures.

Recent environmental economic developments

1. Introduction

The economy and the environment are closely interconnected. First, the economy depends on the environment as a source of all kinds of raw materials, such as energy, biological and mineral resources that are essential inputs into economic production processes. Non-renewable resources, such as crude oil and natural gas, are becoming increasingly scarce, which may have significant economic consequences. Renewable resources, such as wood and fish, are often exploited in a non-sustainable way which may have detrimental effects on ecosystems and hamper future production possibilities. Secondly, economic activities also depend on the environment as a sink for their residuals in the form of waste, and emissions to air and water. Pollution contributes to several environmental problems, such as climate change, acidification, local air pollution, and water pollution which may give rise to public health concerns. A consistent statistical description of the interactions between the economy and the environment is therefore important to determine the sustainability of our society. For this purpose the System of Environmental and Economic Accounting (SEEA) has been developed.

1.1 Economy and the impact on the environment



The System of integrated Environmental and Economic Accounting (SEEA)

The System of integrated Environmental and Economic Accounting (SEEA) is an international statistical system that brings together economic and environmental information in a common framework to measure the contribution of the environment to the economy and the impact of the economy on the environment (UN et al., 2003; referred to as SEEA 2003). Environmental accounts are 'satellite accounts' to the System of National Accounts (SNA; UN et al, 2009; referred to as 2008 SNA). Satellite accounts are extensions to the National Accounts that allow for conceptual variations in order to facilitate the analysis of the wider impact of economic change. Environmental accounts use similar concepts (such as residence) and classifications (e.g. for economic activities and products) to those employed in the SNA but at the same time enlarge the asset boundary to include also non-SNA assets such as ecosystems in recognition of the services they provide that often lie outside the market mechanism. They also introduce additional classifications (e.g. for residuals) and definitions (e.g. environmental subsidies).

By using common concepts, definitions and classifications, the SEEA provides a transparent information system for strategic planning and policy analysis which can be used to identify more sustainable paths of development. Because the environmental accounts are integrated with concepts from the national accounts, developments in the field of the environment and macro-economic developments can be directly compared. Key indicators can be derived from the environmental accounts that provide insight into the sustainability with respect to the development of the environment and the economy. The integrated nature of the system makes it possible to quantify and analyse the underlying causes of changes in environmental indicators.

The SEEA is currently being revised and is scheduled to be released in 2012. The revised SEEA will be the statistical standard for environmental-economic accounting as the System of National Accounts is the statistical standard for economic accounts. It will provide an internationally agreed set of recommendations expressed in terms of concepts, definitions, classifications, accounting rules and standard tables in order to obtain international comparability of environmental-economic accounts and related statistics.

Environment statistics and environmental accounts

One of the main differences between environmental statistics and environmental accounts is that environmental accounts follow the residence concept that underlies the SNA. An institutional unit is said to be resident within the economic territory of a country if it maintains a centre of predominant economic interest in that territory (2008 SNA). GDP is an aggregate measure of production by all resident units. However, some of this production may occur abroad and as a result GDP differs from the sum of all production that takes place within the geographic boundaries of the national economy. Likewise, the environmental accounts record, for instance, air emissions as a result of activities of residents which differ from the emissions occurring on Dutch territory normally recorded in environment statistics. Differences therefore primarily arise as a result of international transport and tourism. One of the tasks of the environmental accounts is to integrate source statistics based on territory principles, such as energy statistics, into residence based accounts. At the same time bridging tables are compiled that link environment statistics to the environmental accounts.

SEEA building blocks

The SEEA comprises four categories of accounts:

1. *Physical flow accounts*

Physical flow accounts show the origin and destination of materials in the economy and/or the environment, in a similar way to the supply and use tables of the National Accounts. They take into account three types of material flows: natural resources, products and residuals. Natural resources, such as crude oil, iron ore or wood, are the required inputs for economic production processes and thus flow from the environment to the economy. Products are materials that are produced or purchased within the economy; for example, energy products, food products and chemical products. Residual flows are materials that flow from the economy to the environment. These include emissions to air (carbon dioxide, sulphur oxides, fine dust), emission to water (heavy metals, nutrients,) emission to soil (nutrients) and the production of waste and wastewater. Physical flow accounts make it possible to monitor the pressures the national economy exerts on the environment, in terms of both inputs of resources and outputs of residuals.

2. *Asset accounts*

Asset accounts describe the natural resources that are important for the economy. They show the opening and closing stocks and the changes that occur within the accounting period. These assets are accounted for both in physical and monetary terms. Examples are the asset accounts for natural gas and crude oil (subsoil accounts) or renewable resources, such as fish and timber stocks. Asset accounts make it possible to assess whether these natural assets are being depleted or degraded, or are being used in a sustainable way.

3. Economic accounts for environmental transactions

In these accounts, all sorts of monetary transactions with an environmental aspect are identified separately from within the National Accounts. Examples are environmental taxes, environmental subsidies and the emission trading system. They also include accounts for environmental protection and resource management that provide for the identification and measurement of society's response to environmental concerns. In addition, the environmental goods and services sector consists of a separate grouping of all economic activities with the intent of relieving pressure on the environment. With the aid of economic accounts we can monitor the effectiveness and costs of environmental and climate policies as well as determine how important the environmental sector has become in terms of employment and output.

4. Accounts for extended SNA aggregates

The fourth category covers the valuation techniques for measuring environmental depletion of natural resources, as well as degradation of natural assets. These accounts further address ways to adjust standard National Accounts aggregates (net income, net savings), for depletion and degradation.

Dutch environmental accounts

Statistics Netherlands has a long history in environmental accounting (de Haan, 2004; Schenau et al., 2010). The bureau first presented an illustrative NAMEA (National accounting matrix including environmental accounts) in 1991. The original design contained a complete system of national flow accounts, including a full set of income distribution and use accounts, accumulation accounts and changes in balance sheet accounts. Statistics Netherlands has gradually extended the Dutch system of environmental accounts. Initially, accounts were developed for air emissions, water emissions, waste, energy and water. Recently, new accounts have been added on material flows, the environmental goods and service sector, and emission permits.

The Dutch environmental accounts are compiled following the general concepts, definitions and classifications as described in SEEA 2003 and the 2008 SNA. More specific information on the methodology can be found on Statistics Netherlands' website (www.cbs.nl), which contains a general description of the methodology. For some subjects specific methodological reports are available. The data of the Dutch environmental accounts are published in StatLine, the electronic database of Statistics Netherlands.

This publication

The environmental accounts of the Netherlands 2009 consists of two parts. Part one provides a general overview of the most recent developments in the area of environment and economy by presenting all accounts for which Statistics Netherlands currently produces data. These are:

Physical flow accounts:
- Energy consumption
- Water abstraction and use
- Material flows
- Solid waste
- Greenhouse gas emissions according to different frameworks
- Greenhouse gas emissions from production
- Greenhouse gas emission trade balance for the Netherlands
- Local and transboundary air pollution
- Emissions to water
- Regional water accounts

Asset accounts:
- Oil and natural gas reserves

Economic accounts for environmental transactions:

- Environmental taxes and fees
- CO_2 emission permits
- Environmental protection expenditure
- The environmental goods and services sector

Part two presents three studies that provide more in-depth analyses for specific subjects. The first study examines the methodology and preliminary results of the compilation of quarterly CO_2 emission accounts. It discusses the seasonality of CO_2 emissions and particularly how to correct for the weather effect (heating of buildings) in order to make a better comparison with economic developments. It also comprises a detailed analysis of the development of CO_2 emissions during the recent financial crisis. The second study looks at air emission accounts (greenhouse gases) for households. These accounts establish a relationship between household characteristics such as (disposable) income and size and the burden these place on the environment. This is done on the basis of household budget survey (HBS) data, which provide a breakdown of expenditure by various household types. In addition, the study shows how households with different characteristics can best be compared to address the question of which households are (most) responsible for these emissions. The third study investigates trade-offs between economic development and environmental quality. It does this by calculating and comparing multipliers for different industries using input-output analysis. The study also estimates the importance of the environmental goods and services sector (EGSS) in the Netherlands by calculating the indirect effects of its further growth.

Future work

The Dutch environmental accounts are still being developed. New projects will be initiated in the coming years to expand and improve the system. Among other things, projects are under way to further improve and extend existing parts of the accounts, for instance by compiling a longer time series for greenhouse gases as well as asset accounts for renewable resources such as water. Other envisaged additions are accounts for environmental subsidies, adaptation expenditure, and resource use and management. Lastly, the data from the environmental accounts will be used to conduct detailed environmental-economic analyses. Future publications will report on the results of these projects.

2. Energy consumption

Energy is essential to all economies, both as input for production processes and as a consumer commodity. The impacts of economic developments on the environment are to a large degree determined by the consumption of energy. Energy use is often directly linked to the emission of the greenhouse gas CO_2 and many other environment pollutants. It is also directly related to the depletion of non-renewable energy resources like crude oil and natural gas. Improvement of energy efficiency and decoupling energy consumption from economic growth are important goals for sustainable development. The energy accounts provide an overview of energy production and consumption by different industries and by households. The data are fully consistent with the concepts of the National Accounts. The energy accounts can be used to determine how energy use by economic activities changes over time, which industries are most energy intensive, how efficient energy is used in production processes and how dependent the economy is on energy imports.[1)]

The methodology of the energy accounts is described in the report *The Dutch energy accounts* (Schenau, 2010). The data of the energy accounts are available on request at Statistics Netherlands.

Financial crisis tempers economy's energy use

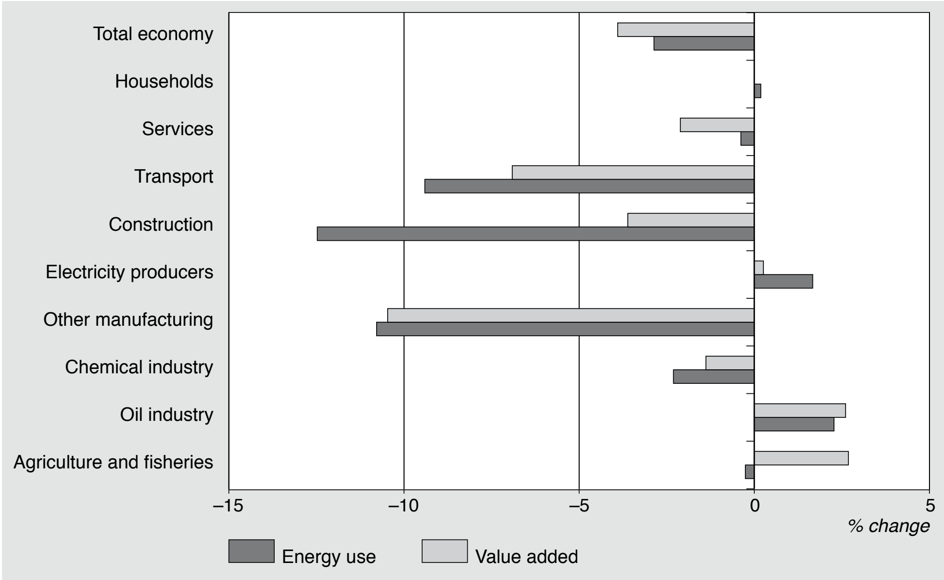
The financial crisis had a pronounced effect on energy consumption by economic activities. Overall, net energy consumption decreased by 2.9 percent. This means that economic growth (–3.9 percent) fell by more than energy consumption. Energy use decreased in almost all industries, with the largest reductions in transport, manufacturing and construction. The volume of construction output fell by more than 5 percent, resulting in a lower use of energy products for construction activities, such as bitumen, and fuel for mobile equipment. In agriculture output and value added still increased in 2009 as a result of favourable weather conditions. In horticulture, the use of gas remained more or less at the same level. Low electricity prices led horticulturalists to make less use of CHP (Combined Heat and Power) equipment to produce electricity. This was partly compensated by the colder winter which had an upward effect on natural gas consumption to warm the greenhouses. In manufacturing, the basic metal industry recorded the largest drop in energy use (–21 percent), a direct result of lower production. Companies manufacturing fabricated metal products, electrical and optical equipment, and publishers and printers also used significantly less energy. In the transport sector, the global recession and the resulting decline in international trade reduced demand for transport services. In 2009, value added in the transport sector was 7 percent down on 2008. Maritime transport, air transport and inland shipping suffered most. As a result, energy consumption by the transport sector decreased by more than 9 percent.

Two sectors of industry used more energy in 2009: electricity companies and oil refineries. Although the use of electricity in the Netherlands dropped by 6 percent, electricity companies did produce more electricity. This was because significantly less electricity was imported, while electricity exports increased. As a result, energy companies used 2 percent more energy. Oil refineries managed to maintain the same level of the output for oil products, particularly by increasing exports. Energy consumption in the services sector increased primarily because of a higher use of natural gas to heat offices.

Energy use by households remained more or less constant. Use of natural gas for heating homes was approximately the same as in 2008, although the winter was somewhat colder than in the previous year. Also the use of petrol and diesel for cars was the same as in the previous year.

1) In this chapter energy use is equal to all net energy use, which is defined as final energy use for energetic and non- energetic purposes by residents plus transformation losses by residents.

2.1 Change in value added and energy use, 2008–2009

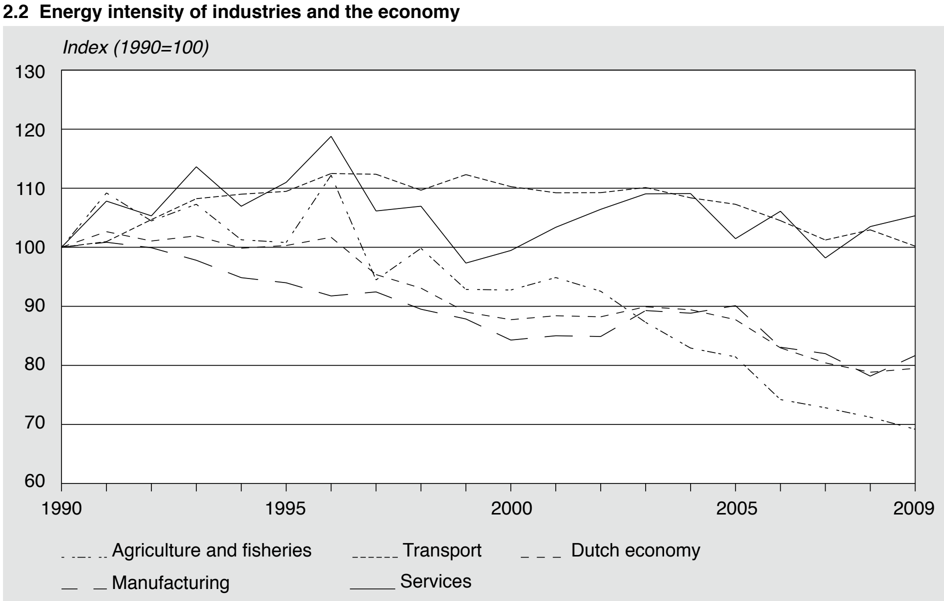


Energy intensity increases in 2009

Net energy consumption of the Dutch economy has increased by 20 percent since 1990. Energy use by the aviation sector, chemical sector, refineries and electricity producers in particular has increased. The largest increase was in air transport, where the use of jet fuel doubled. In fishery and textile manufacturing energy use has decreased as the economic significance of these sectors has declined. Energy use by households has increased by 13 percent in the last nineteen years. This was mainly caused by the increase in electricity use and the use of car fuels.

Energy intensity, defined as energy use per unit of value added (in constant prices), is an indicator for the energy efficiency of the economy or individual production processes. A decrease in energy intensity can be caused by more efficient energy use in production processes, for example by energy conservation, or by systematic changes in the economy. Since 1990 the energy intensity of the Dutch economy has decreased by 21 percent. Agriculture and manufacturing particularly contributed to this improvement. Remarkably, the energy intensity in the transport and services sectors decreased in this period. In 2009, the energy intensity of the economy as a whole increased by 1 percent from the previous year. This is the first time that energy intensity deteriorated in the space of six years. This increase was mainly caused by the manufacturing industry.

2.2 Energy intensity of industries and the economy

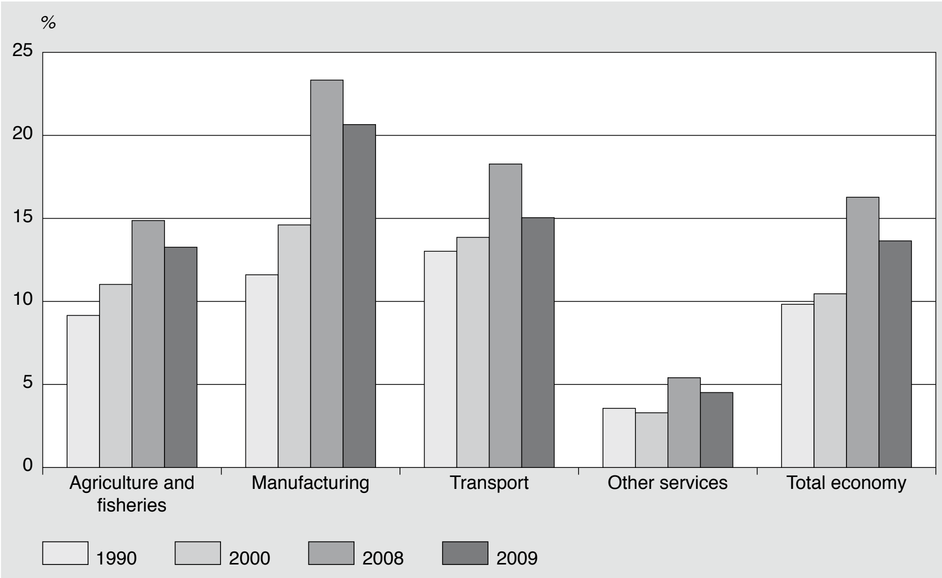


Energy costs

Energy costs for companies decreased from 101 billion euro in 2008 to 79 billion euro in 2009. In addition to lower energy consumption, this decrease is particularly the result of to the sharp fall in energy prices. Crude oil prices peaked in 2008 as the emerging economies of China and India increased their demand for oil products while refinery capacity was restricted and possibilities to respond to the short term demand for oil products were limited. As a result of the financial crisis, oil prices fell at the end of 2008 as the demand for energy decreased. Households also benefited from the lower energy prices. In 2009 households spent almost 9 percent of their budgets on energy (natural gas, electricity, motor fuels).[2)]

Energy costs have become increasingly important for companies in the past nineteen years. While these costs accounted for only 10 percent of the total intermediate consumption of companies in 1990, this percentage had risen to 14 percent in 2009. Energy costs are particularly important in manufacturing, horticulture and transport. In manufacturing of food, drink and tobacco, paper and paper products, and the basic metals, energy costs almost doubled in the period 1990–2009.

2.3 Share of energy costs in intermediate consumption



Energy dependency decreasing

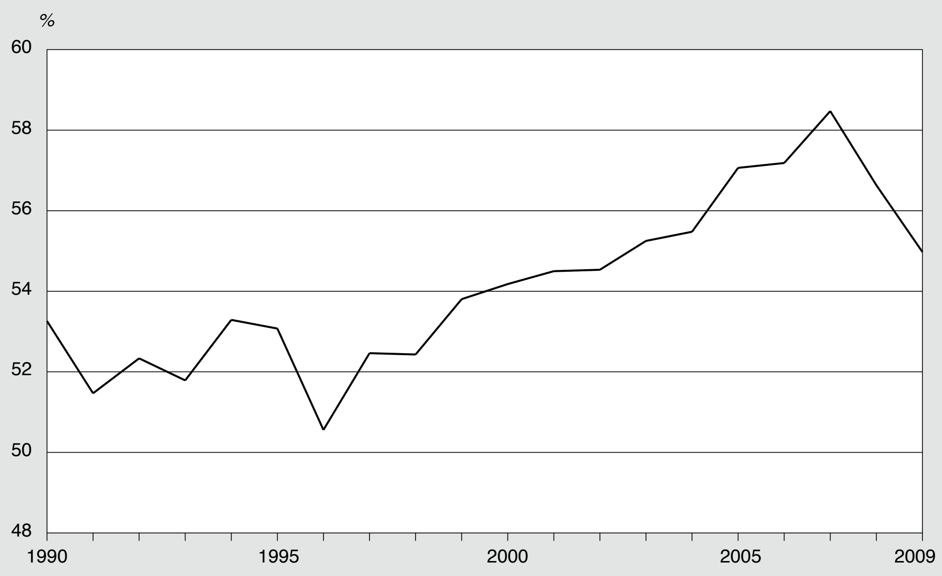
Energy sources such as oil, coal or natural gas can be either extracted from a country's own territory or imported from other countries. If a large amount of these resources have to be imported, a national economy will become very dependent on other countries. Energy dependency can be calculated as the share of net domestic energy consumption originating from imported energy products. In 2009 the energy dependency of the total Dutch economy was 55 percent.[3)] This means that more than half of net energy consumption originates from outside the Netherlands, while the remainder was extracted within its own borders. The Netherlands has substantial stocks of recoverable natural gas beneath the surface. Since its discovery in the 1950s and 1960s, natural gas has been extracted for the benefit of the Dutch economy. Accordingly, the Netherlands is self-supporting with respect

2) Excluding VAT on energy products.

3) In the calculation of the energy dependency it is assumed that the imported energy can not be substituted with energy extracted from the national territory. If complete substitution is assumed the energy dependency would be lower. For example, the Netherlands extract more natural gas than is needed for domestic use. If this surplus gas could be substituted for crude oil or oil products (which have to be imported), the energy dependency would be around 25 percent.

to natural gas. For oil and coal, however, the situation is completely the opposite. The few oilfields on Dutch territory do not supply nearly enough crude oil to meet the large domestic and foreign demand for Dutch oil products. Since the closure of the coal mines in the province of Limburg, all coal is imported.

2.4 Energy dependency of the Dutch economy



Between 1996 and 2007 the Dutch economy became increasingly dependent on imported sources of energy. The share of imported energy rose from 51 percent in 1996 to 58 percent in 2007. The increase in dependency was mainly caused by the increased demand for oil products. In the 1990s the growing demand for crude oil products was compensated by the increasing use of natural gas, supplied from domestic sources, for the production of electricity. Since 2000 the domestic demand for natural gas has remained stable. As a side effect of the financial crisis, energy dependency decreased between 2008 and 2009 as the domestic demand for gas increased in relative terms, while the domestic demand for oil products decreased. The production of oil products in the Netherlands in particular is very dependent on imports of crude oil. Demand for oil products decreased especially strongly in manufacturing and transport, sectors hit hard by the recession.

3. Water abstraction and use

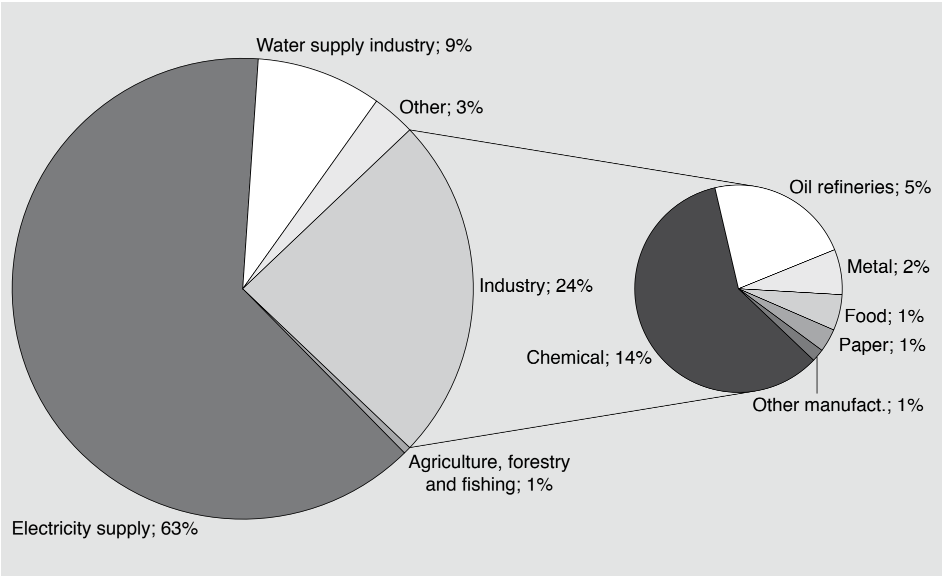
Water plays a key role in the Dutch economy. Water is abstracted from the environment and can be used as a direct input in production processes, for instance for cooling purposes. The water supply industry abstracts a great deal of groundwater to produce tap water of drinking water quality that is subsequently used by industries and households. Depending on its source, water can be distinguished into surface water, groundwater, supplied tap water and 'supplied other kinds of water'.[1] Given the importance of water for society, policies are in place to reduce water pollution and protect ground and surface water bodies. The water accounts provide information on water abstraction, water supply and use by different industries and households. Integrating water data with economic information makes it possible to monitor water conservation policies.

The methodology for compiling the water accounts is described in the report *Dutch water flow accounts* (Graveland, 2006). The data of the water accounts can be found on StatLine, the electronic database of Statistics Netherlands.

Total abstraction of water by Dutch economy decreased by 2 percent in 2008

The total water abstraction by the Dutch economy in 2008 amounted to 14.3 billion m^3. As figure 3.1 shows, almost two thirds of the water requirements of the Dutch economy come from the electricity supply industry. This industry abstracts all its water from surface water bodies, primarily for cooling purposes. Most of the cooling water is, after use, returned to the surface water immediately. The water supply industry is responsible for 9 percent of total water abstraction, with 61 percent abstracted from groundwater.

3.1 Water abstraction by the Dutch economy in 2008



Agriculture abstracts only 1 percent, which is low compared to other countries. This is because the Netherlands has a temperate climate with rainfall distributed throughout the year. The biggest user of primarily surface water within manufacturing is the chemical

[1] 'Other water' is water of different, superior or inferior quality compared to tap water. One can think of unfiltered and filtered water, or distilled and demineralised water. This water is produced by water companies or other industries and delivered to other companies, particularly in the chemical industry. This category of 'other water' on average compares to 6–7% of the total use of tap water (VEWIN, 2010). The delivery of 'other water' by the water companies is excluded from tap water.

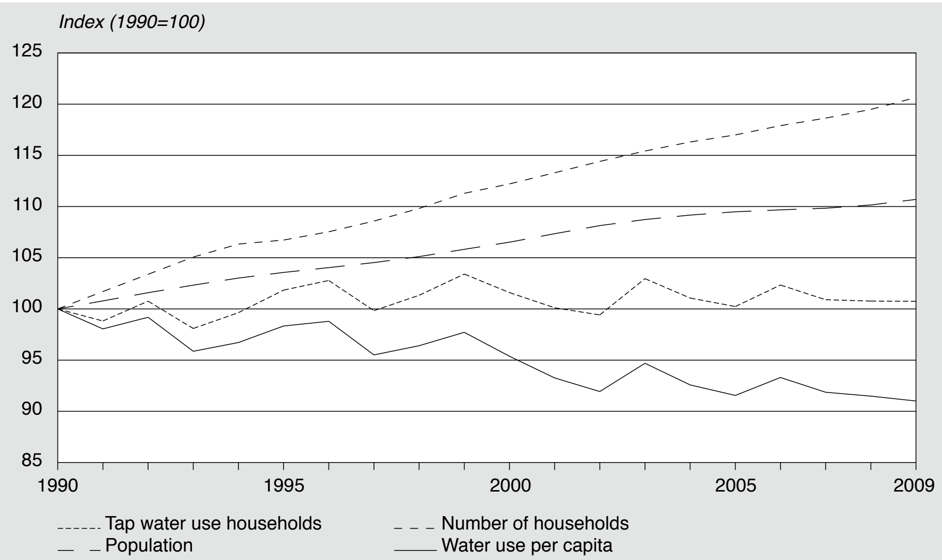
industry, followed by the oil industry and the manufacture of metal products, food products and paper products industries.

In 2008 total water abstraction by the Dutch economy decreased by 2 percent on 2007. This decrease was primarily due to a 4 percent reduction by electricity supply. By contrast, manufacturing industries showed a 4 percent increase in water abstraction.

Household use of tap water per capita and per household continues to decline

Around 7.7 percent of all abstracted water is turned into tap water as supplied by the water supply industry. Total tap water use in 2009 amounted to 1.1 billion m^3. Households account for nearly two thirds (66 percent) of overall tap water use in the Netherlands.[2)] Since 1990, the total annual amount of water used by households increased only by 1 percent, despite population growth. Through efficiency measures, household water use per capita has been reduced from 47.9 m^3 in 1990 to 43.6 m^3 in 2009. This is a decrease of 9 percent in nineteen years. The efficiency gain comes from water saving measures and appliances such as the installation of interrupters on toilet flush systems and the application of water saving toilets. An additional explanation is the use of new improved household appliances such as washing machines, dishwashers and taps and shower heads that save water. Daily tap water use per household has dropped by 16 percent from 322 litres in 1990 to 269 litres in 2009, which equals 98 m^3 per year. This drop is explained by the smaller size of the average household, partly due to the increased number of one person households. In years with hot and dry summers, as was the case in 2003 and 2006, water use is usually a few percent above the general downward trend as more water was used for showering and watering the gardens.

3.2 Development of tap water use by households, size of population and number of households



Source: VEWIN, 2010A, 2010B; CBS 2010.

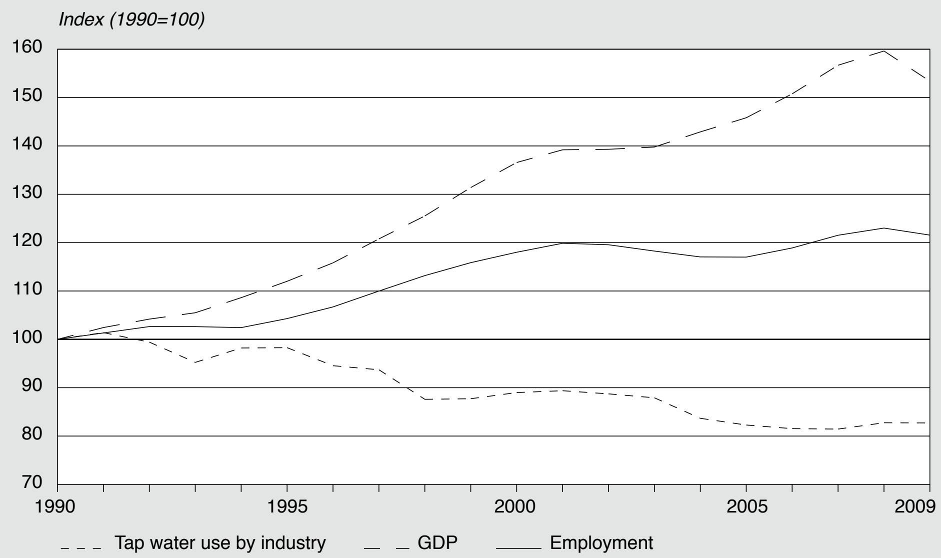
Tap water use by industry no longer decreases

In contrast to households, industries had used progressively less tap water since 1990, but in 2008 they started using an additional 2 percent again. In 2009 industrial tap water use remained constant. The chemical industry, food and beverage manufacturers and agriculture are extensive users of tap water. In addition, the manufacture of basic

2) Due to a break in the data in 2007, as a result of a shift from business use to residential use, the figures provided here for households and industries differ slightly from the VEWIN 2007 figures. (See VEWIN water statistics 2007, 2008 and 2009).

chemicals, oil-refineries, and the health and social welfare sectors use significant amounts as well.

3.3 Volume change GDP, employment and tap water used for production

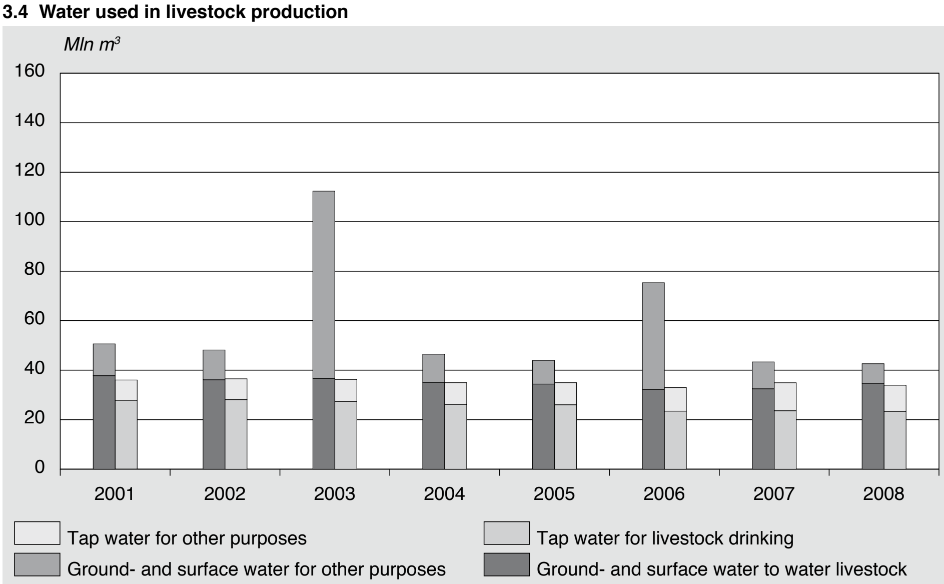


Source: VEWIN, 2010A, 2010B, CBS 2010.

Water in livestock production predominantly used for drinking purposes

Water abstraction and use figures are compiled at the aggregated industry level. We gathered more detailed information on some sectors to allow further analysis, of agriculture for example. Agriculture and horticulture have an average 4 percent share in the total amount of tap water used in the Netherlands, which shows a slight downward trend. However, there is an evidential influence of the weather in warm dry years, when use is generally higher. A major category of tap water use in agriculture is drinking by cattle and other livestock. As figure 3.4 shows, this covers on average over 70 percent of the tap water used in livestock production. One of the main causes of the reduction in tap water use is therefore the smaller herd. In 2008, 11 percent less tap water was required for drinking by cattle compared with 2001. Switching from tap water to ground water and/or surface water for drinking by livestock provides an opportunity to further reduce tap water use in livestock production. On the other hand the constant quality of tap water is valuable for livestock.

3.4 Water used in livestock production



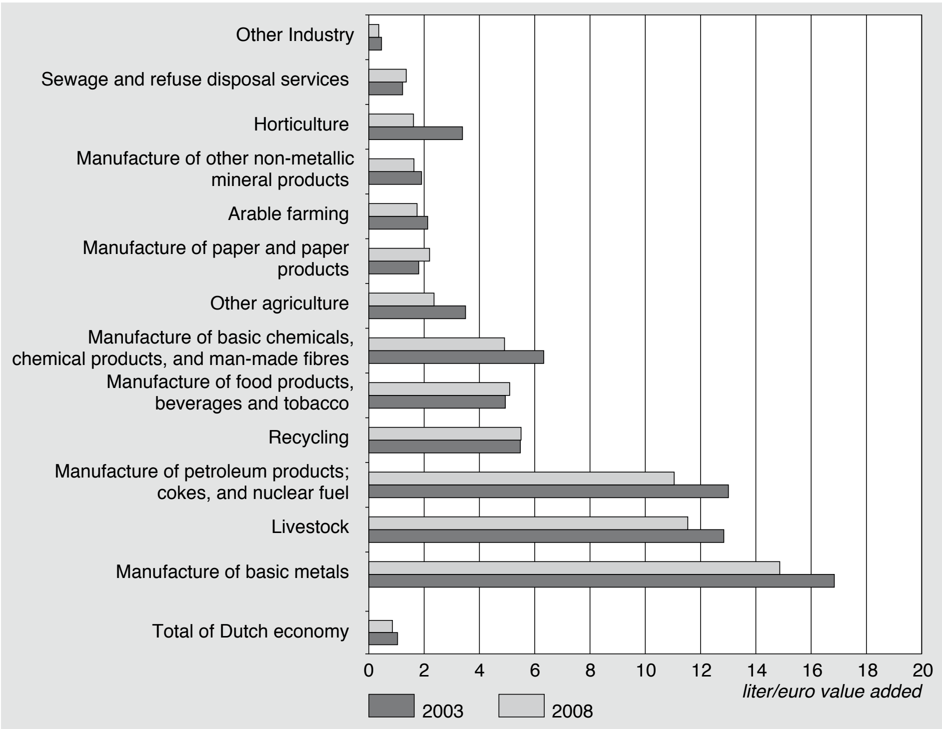
Source: Veen van der et al, 2010

Besides tap water the livestock also drink ground and surface water. In the livestock sector, in the period 2001 to 2008, about two-third was used for drinking (LEI, 2009; Veen, van der, 2009; Veen, van der, et al. 2010). The remaining use of ground and surface water is mainly for irrigation of crops such as (green) maize and pastures. In agriculture in general, groundwater is mainly used for irrigation and for watering livestock, which leads to a 5 percent share in total groundwater use. In the last couple of years only 6 percent (ranging from 4 to 9 percent) of the area of agricultural land in the country has been irrigated (once or several times throughout the growing season). Crops in the Netherlands are predominantly grown under rain-fed conditions.

Water use intensity continues downward trend

Water use intensity for an industry can be defined as the use of water (either surface, ground or tap water individually or the sum of the three) in litres divided by its value added.[3)] This may depend on the objective of the analysis. Figure 3.5 shows the water use intensities of tap water for selected industries for the years 2003 and 2008. On average, nearly one litre of tap water is used for every euro of added value generated by the Dutch economy. This water use decreased from 1.04 litres in 2003 to 0.85 litres in 2008, while in 1990 even 1.64 litres of tap water was used per euro of value added. The manufacturing of basic metals has the highest water use intensity rate for tap water, followed by livestock breeding, the manufacturing of petroleum products, cokes, and nuclear fuel, waste recycling, manufacture of food and beverages, and chemicals. The industries with the highest use intensity rates use 13 to 17 times more water to earn a euro than the average level for the Dutch economy. Water use intensity for tap water in 2008 was less than in 2003 in virtually all sectors.

3.5 Industries with the highest use intensities for tap water



Tap water-intensive industries, like the manufacture of basic metals (–12 percent), livestock (–10 percent), or manufacture of petroleum products (–15 percent) showed significant reduction in tap water use intensity rates. The recycling of waste (0 percent), manufacture of food products, beverages and tobacco (+3 percent), manufacture of paper and paper products (+22 percent) and sewage and refuse disposal services (+11 percent) did not manage to improve their tap water use intensity.

3) Value added is expressed in constant prices (prices of 2000).

4. Material flows

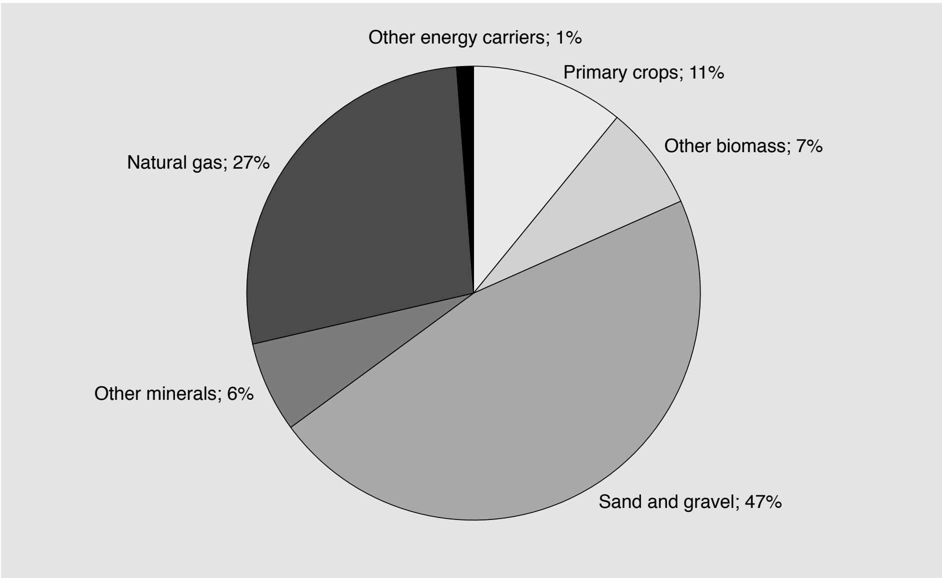
The consumption of goods affects the environment in many ways. First of all natural resources, needed as input for the production process, are being extracted which may cause their depletion. Secondly, environmentally harmful substances may be released into the environment during the production process. Finally, at some point in time goods are discarded and become waste that needs further treatment. Such goods may be partly recycled but part may be returned to the environment, either by incineration or landfilling.

Material flow accounts describe the inputs, throughputs and outputs of goods in the economy in material terms. They include all goods that enter or leave the economy[1)] ranging from raw materials, semi-finished products and products. All goods are assigned to one of five basic categories – biomass, metals, minerals, fossil fuels, other – based on their predominant make-up. Cars for instance are assigned to metals. Material flow accounts support policies that deal with material use, dematerialization and material substitution. For a description of the methodology and definitions used see Delahaye and Nootenboom (2008). The data on materials flows can be found on StatLine, the electronic database of Statistics Netherlands.

Extraction mainly consists of sand and gravel

Domestic extraction of natural resources in the Netherlands (215 billion kg in 2007) largely consists of gravel and sand. Around 84 percent of the sand and gravel is used for infrastructural projects to raise roads and land for house construction or to strengthen dikes and coastal defences. The remainder is used in the production of concrete and cement. The extraction of natural gas accounts for 27 percent of total extraction due to the exploitation of the substantial natural gas reserves of the Netherlands.

4.1 Domestic extraction (total of 215 billion kg) for the Netherlands, 2007



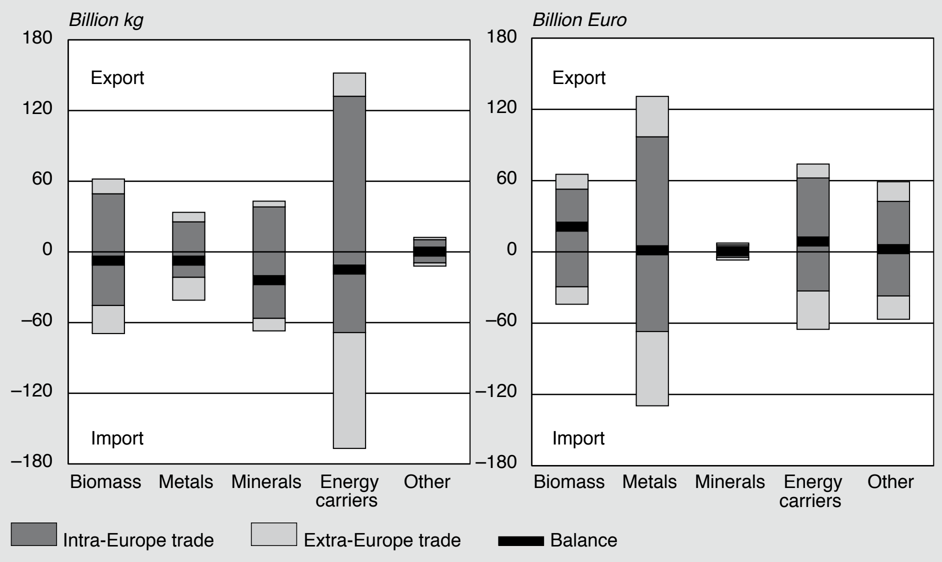
Physical trade deficit, monetary trade surplus

The extraction of natural resources is not sufficient to meet Dutch domestic demand. Therefore the Netherlands depend on imports of resources and goods from other countries. At the same time other countries depend on us for their material needs. The Dutch exports

1) Excluding bulk water.

of goods amounted to around 300 billion euros in 2007. Figure 4.2 shows the monetary (left hand side) and physical (right hand side) imports (–) and exports (+) for five groups of materials. A distinction is made between flows from and to European countries (intra European) and between flows from and to non-European countries (extra European).

4.2 Physical (left-hand side) and monetary (right-hand side) imports (-) and exports (+) for groups of materials by the Netherlands, 2007



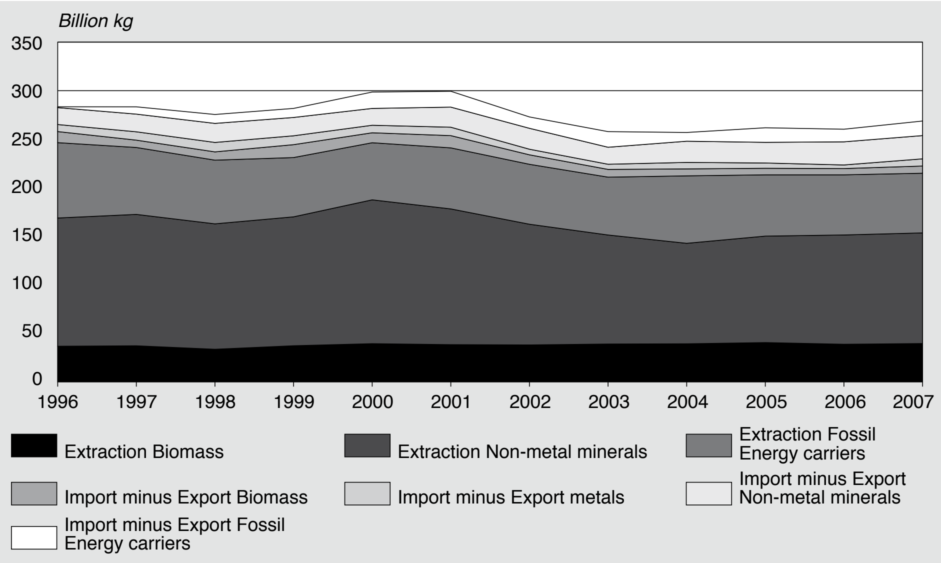
The Netherlands have a physical trade deficit which implies that imports of materials exceed exports. At the same time there is a monetary trade surplus indicating that the export value is higher than the import value. The Dutch economy can therefore be characterized as one that turns cheap bulky materials into more expensive high-quality products. The monetary trade surplus is particularly high for biomass due to large exports of, for example, vegetables, flowers and cigarettes. A monetary trade surplus exists also for energy carriers. Imports consist mainly of crude oil while exports consist of more expensive oil products, like petrol, and domestically extracted natural gas. In monetary terms the volume of imports and exports is relatively large for metals and metal products. The metals category includes metal products such as cars and electronics, so due to the high prices per kilo the physical imports and exports of these materials are relatively low.

The largest physical trade deficit can be observed for minerals. This deficit can be attributed to the large import of sand and gravel. Imports are required because the extraction of sand and gravel in Netherlands is somewhat limited by spatial and socioeconomic constraints. Besides re-exports, imported sand and gravel are mainly used in the construction industry and for the production of concrete and cement. Sand used for infrastructural work, for example as foundation for roads and houses, is not imported. The physical amounts of imports and exports are dominated by energy carriers. Energy carriers are mainly imported from outside Europe. Almost all coal and most of the crude oil come from outside Europe. Exports of energy carriers are destined for the European market and consist mainly of petroleum products and natural gas. Biomass flows are also relatively large in physical terms. A closer look at the biomass flows reveals that they consist mainly of primary crops (processed and non-processed crops that are not directly used as animal feed). Imported primary crops consist for 41 percent of cereals. The import of oil bearing crops, especially soybeans (18 percent), is also relatively large. Soybeans come from outside Europe and are mainly processed into animal feed. The physical export of primary biomass consists mainly of vegetables and products made from potatoes.

Change in domestic material consumption determined by sand and gravel

Domestic material consumption (DMC) is an indicator which expresses the total consumption of materials by the economy. It is estimated by adding the amount of extraction to the imports and subtracting the exports. From 1996 until 2007 the DMC decreases with around 5 percent. In the same period the economy grew 35 percent. These findings point to a dematerialization of the Dutch economy. The difference between exports and imports is a relative small part of the total DMC. Therefore, changes in DMC over time are mainly determined by the extraction of materials. In turn, extraction is dominated by minerals and especially sand and gravel. There is a peak around the year 2000, when there was a great demand for sand used for the construction of two high-speed railway links. The expansion of the Rotterdam harbour will raise the demand for extracted sand from 2008 onwards.

4.3 Domestic material consumption broken down for extraction and import-export balance for different material categories in time



More in-depth analysis of the individual material flows is required to answer questions about material substitution, material intensity or resource dependency issues (see Delahaye and Nootenboom, 2009).

5. Solid waste

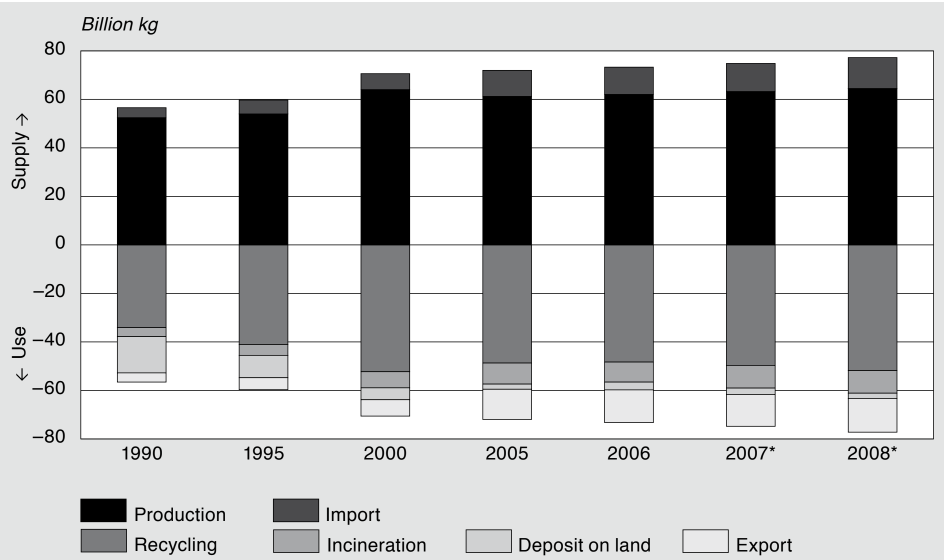
Treatment of solid waste involves recycling, incineration and disposal on landfill sites. Each treatment method causes different kinds of environmental problems. In general the most environmentally benign treatment is recycling, as recycling recovers natural resources. Waste incineration results in environmentally damaging gaseous emissions. A positive consequence of incineration is the recovery of energy. Disposal on land is the least favourable way to treat waste. Landfills take up space, are often permanent and require years of maintenance. Dutch waste policy focuses on reducing waste generation and increasing the share of recycled waste.

The waste accounts describe the supply and use of solid waste with regard to the Dutch economy. Waste supply consists of imports and production of waste by economic actors like households and industries. Waste use consists of exports and treatment of waste like recycling, incineration and disposal on landfill sites. Waste is recorded at the first time it is generated. Therefore, there is no double counting of waste in the waste accounts. For a detailed description of the used methodology and definitions see Delahaye (2006) and Delahaye *et al.* (2010). The data of the waste accounts can be found on StatLine, the electronic database of Statistics Netherlands.

Waste production remains stable

In 2008 Dutch residents (industry plus households) generated 64 billion kg of waste; this comes down to 4 ton per capita. If lined up, the garbage trucks needed to carry this amount of waste would circle the earth. Additionally 13 billion kg of waste was imported. Of the total waste supply (production plus import) 67 percent is recycled in the Netherlands and 18 percent is exported. Waste deposited on landfill sites only accounted for 3 percent of the total waste use in the Netherlands in 2008. Successful changes in waste management policies caused a significant decrease in the amount of waste deposited on land since 1990. Remarkably, a small increase in waste deposited on land can be observed in 2006. This was due to stricter regulations prohibiting the export of waste for disposal to Germany. Therefore, more waste had to be treated in the Netherlands. The capacity of the Dutch incineration and recycling facilities could not handle this increased supply of waste, so waste had to go to landfill sites. In 2008 the amount of waste disposal on land decreased as a result of newly opened incineration plants. Another positive development in waste treatment is the increase in recycled waste from 65 percent in 1990 to 82 percent in 2008. Between 1990 and 2000 waste generation saw a 22 percent increase. Since 2000, in spite

5.1 Supply and use of solid waste



* Preliminary data.

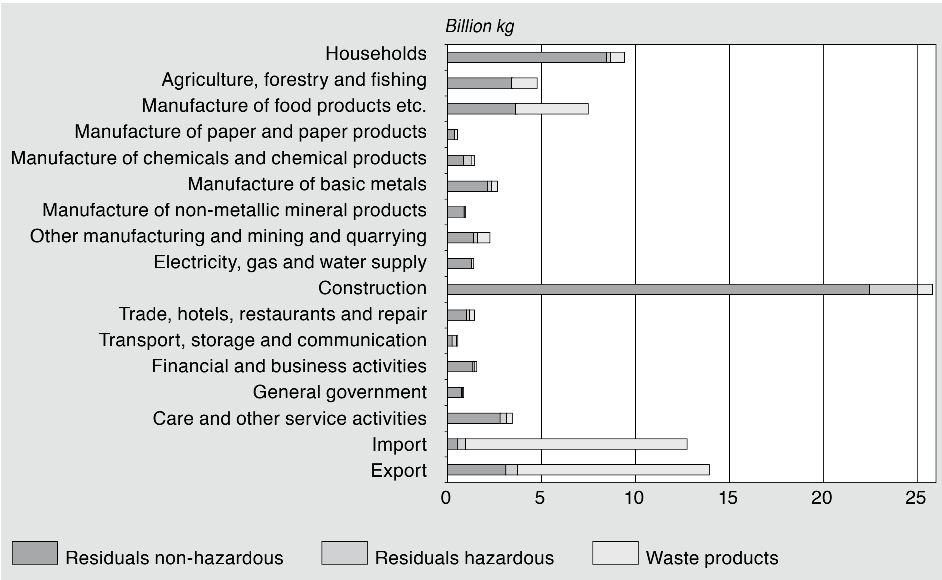
of economic growth and increased consumption, the total amount of generated waste has remained stable.

Food industry, main producer of waste products

Waste can be referred to as a waste product when it has commercial value for the generator. Without this commercial value is considered a waste residual. Waste products can often be used directly as a resource in the production process. Of the total waste generated in the Netherlands 14 percent are waste products. Imported and exported waste consists predominantly of waste products.

Also, the manufacturers of food products generate a lot of waste products, relatively speaking. These waste products consist of organic waste that is sold as feed for livestock. As mentioned before, most of the generated wastes are waste residuals. The construction industry generates the largest amount of waste residuals. Residuals can be broken down further into hazardous and non-hazardous waste according to European regulation (see European Communities, 2002). The chemical industry is the largest generator of hazardous waste in relative terms. In absolute terms, most hazardous waste is generated by the construction industry.

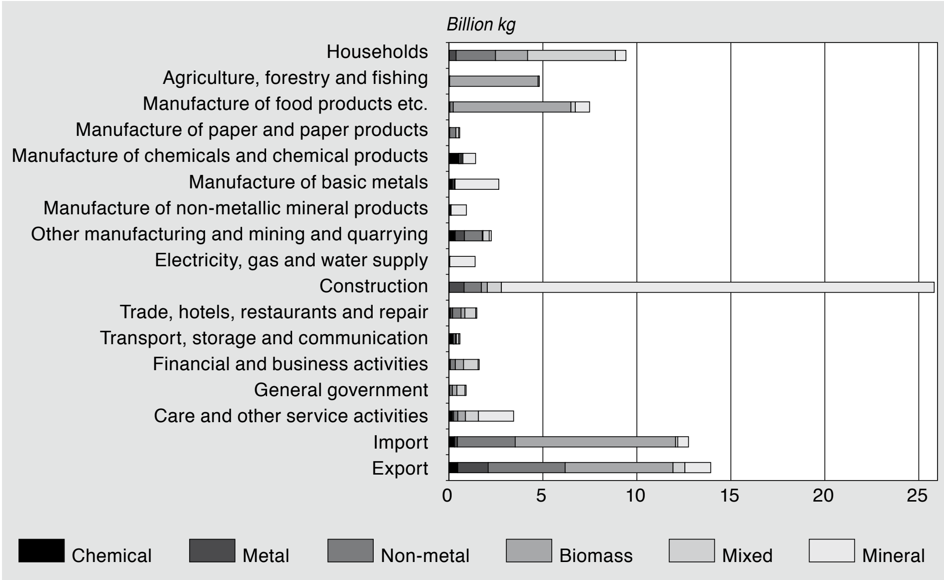
5.2 Generation of waste residuals (hazardous and non-hazardous) and waste products by activity, 2008



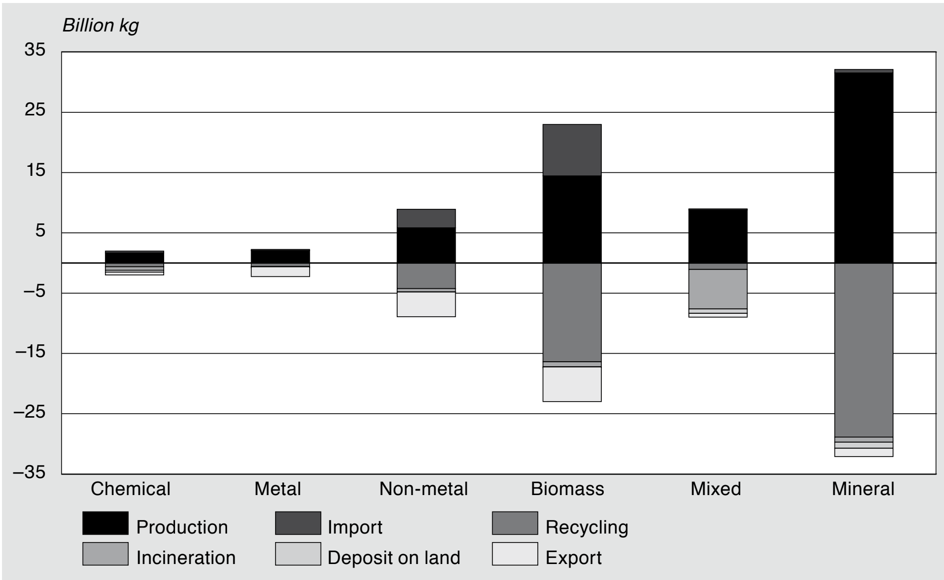
Mineral waste the largest waste category

Waste can also be classified into different types, based on their material composition. Minerals constitute the largest part of total waste generated in the Netherlands, followed by biomass. The construction industry generates 73 percent of all mineral waste during demolition and construction activities. Some 90 percent of the total supply of mineral waste is recycled in the Netherlands. Other major producers of waste are households. Households typically generate a lot of mixed waste, on average 650 kilo per household. Mixed household waste contributes much to the total amount of incinerated waste. Agriculture and the manufactures of food products generated 76 percent of biomass waste, consisting of animal and vegetable waste. Most of the imported and exported waste consists of biomass like offal. Some 71 percent of the total supply of biomass waste is recycled in the Netherlands.

5.3 Generation of different types of waste by activity, 2008



5.4 Waste supply and use for different waste types, 2008



6. Greenhouse gas emissions according to different frameworks

Climate change is one of the major global challenges of our time. There is abundant scientific evidence that the emission of greenhouse gases caused by economic activities contributes to climate change (e.g. IPCC, 2007; PBL, 2010). Accelerating emissions of carbon dioxide, methane, and other greenhouse gases since the beginning of the 20th century have increased the average global temperature by about 0.74°C and altered global precipitation patterns (IPCC, 2007). Combustion of fossil fuels, deforestation, but also specific agricultural activities and industrial processes are the main drivers of the increased emission of greenhouse gasses. Enhanced concentrations of greenhouse gasses in the atmosphere will increase global temperatures by radiative forcing. Likewise, climate change has a direct impact on all kinds of economic processes. These impacts may be positive or negative, but it is expected that the overall impact will be primarily negative. In order to design effective mitigation policies, one must have a good conception of the economic driving forces of climate change. The *air emission accounts* can be used to analyse the environmental implications, in terms of greenhouse gas emissions, of production and consumption patterns. Because of their compatibility with the national accounts greenhouse gas data can be directly linked to the economic drivers of global warming.

There are several frameworks for estimating the greenhouse gas emissions for a country yielding different results. Well-known are the emissions reported to the UNFCCC (United National Framework Convention on Climate Change) in particular under the Kyoto Protocol, but also environment statistics as well as the air emission accounts provide independent greenhouse gas estimates. The differences are not the result of disputes about the accuracy of the estimates themselves, but arise from different interpretations on what has to be counted. The inclusion or exclusion of certain elements depends on the concepts and definitions that underlie these frameworks. The estimates differ in their possible applications for analysis and policy making.

In this chapter the above mentioned frameworks and their resulting estimates are explained. A bridge table (see table 6.1) provides insight in the relations between these different conceptions.

Table 6.1
Bridge table for greenhouse gases

	1990	1995	2000	2005	2007	2008	2009*
	Mton CO_2-eq.						
1. Stationary sources [1)]	187	197	185	183	177	178	174
2. Mobile sources on Dutch territory	34	36	40	42	42	43	42
3. Mobile sources according to IPCC	31	34	37	39	39	40	38
4. Short cyclic CO_2	6	6	8	10	9	11	11
5. Total, IPCC (excl. LULUCF) = 1 + 3 - 4	212	225	215	212	207	207	201
6. Land Use, Land-Use Change and Forestry (LULUCF)	3	3	3	3	3	3	3
7. Total, IPCC (incl. LULUCF) = 5 + 6 (Kyoto-protocol)	215	228	218	215	210	210	204
8. Actual emissions in the Netherlands = 1 + 2	221	233	225	225	219	220	216
9. Residents abroad	14	20	25	25	26	25	24
10. Non-residents in the Netherlands	5	5	6	7	6	7	6
11. Total emissions by residents = 8 + 9 - 10	230	247	244	243	239	239	234

[1)] Stationairy sources are inclusive short-cyclic CO_2.

1. Greenhouse gas emissions according to the IPCC regulation

The IPCC (Intergovernmental Panel on Climate Change) has drawn up specific guidelines to estimate and report on national inventories of anthropogenic greenhouse gas emissions and removals (IPCC, 1996). ‘Anthropogenic’ refers to greenhouse gas emissions and removals that are a direct result of human activities or are the result of natural processes that have been affected by human activities. In general the IPCC records all emissions that occur on the Dutch territory, with a few specificities. Emissions originating from the so-called short cyclic carbon cycle, such as the combustion of biomass and emission from biochemical processes, are left aside in the IPCC calculations. It is assumed that these emissions do not structurally contribute to higher greenhouse gas concentrations in the atmosphere. The emissions by road traffic are calculated according to the total domestic deliveries of motor fuels, regardless of the nationality of the user of the motor fuel or the location where the use takes place. For air transport and shipping only emissions caused in domestic transport are considered. A complicating factor is that distinction between international and domestic travel is based on destination of the travel, with the result that emissions from a ship sailing around the world and therefore traversing international waters, count as domestic travel if the destination is a national port. Emissions related to bunkering of airplanes and ships are mentioned in the IPCC reports as a memorandum item, but are not included in the targets of the Kyoto Protocol.

The IPCC guidelines include not only sources but also sinks – that is emissions absorbed by nature for instance through carbon sequestration, whereas these are excluded from air emission accounts and environment statistics. However, not all emissions absorbed by nature are included, only those that occur on so-called managed lands including managed forests which are areas under human influence. Emissions and sinks due to land-use changes are also taken into account.[1)]

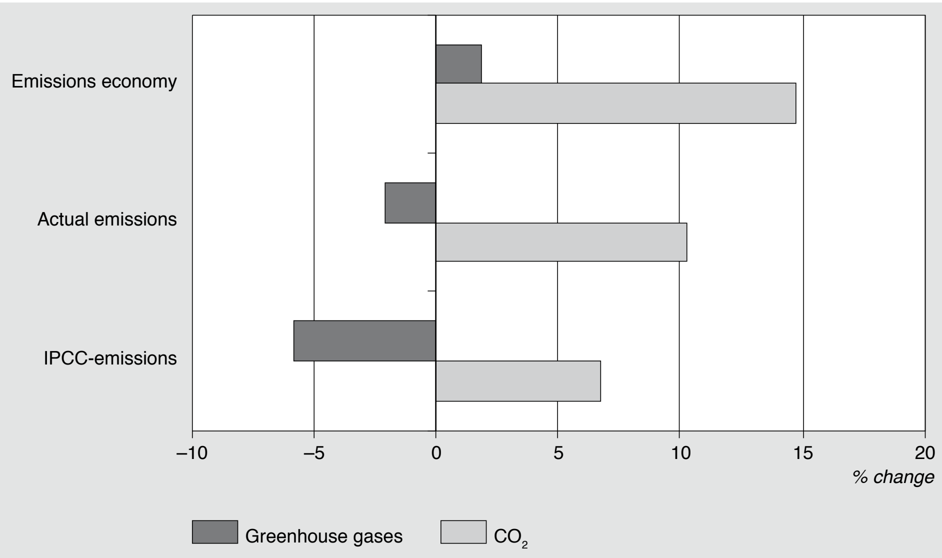
2. Greenhouse gas emissions in the Dutch territory

Statistics Netherlands annually publishes the actual greenhouse gas emission for the Netherlands. These are greenhouse gas emissions that actually take place on the Dutch territory. In contrast to the IPCC guidelines, all emissions by mobile sources that occur on the Dutch territory are accounted for, regardless of where the fuels are purchased. Also short cyclic carbon emissions are included in the actual emissions. With regard to international transport (inland shipping, seagoing vessels, air transport), only those emissions are included that occur within the national territory. The actual emissions are used as input for several modelling and scenario analyses, and are the basis for the calculation of the air emission accounts.

3. Greenhouse gas emissions by the Dutch economy

Besides the actual emissions, Statistics Netherlands also annually publishes the total greenhouse gas emissions by economic activities, which are calculated according to the national accounting principles. These include all emissions caused by the residents of a country, regardless where the emissions take place. For stationary emission sources the

6.2 Change in CO_2 and greenhouse gas emissions between 1990 and 2009 according to different frameworks



1) In the IPCC reports the category Land use, land use change and forestry (LULUCF) includes the total emissions and sinks for CO_2 from land use and forestry activities (IPCC, 1996). The category is either a net source if biomass harvest/destruction exceeds regrowth in the inventory year, or a net sink if regrowth exceeds harvest/destruction.

resident principle will generally converge with emission data as recorded in the emission inventories. For mobile sources, however, substantial differences may occur. Transport activities by residents, like road transport, shipping and air transport, and related emissions to air may also occur abroad. Likewise, non-residents may cause pollution within the Dutch territory. The greenhouse gas emissions caused by Dutch economic activities are thus equal to the actual emissions plus emissions caused by residents abroad minus emissions caused by non-residents on the Dutch national territory.

The total greenhouse gas emissions by the economy provide an important indicator for the environmental pressure caused by Dutch economic activities. The emissions can be compared directly with all sorts of macro-economic parameters from the national accounts, such as GDP, total employment etc. at the national level, but also for different industries. In addition, they can be used for all kind of environmental–economic analysis and modelling, such as decomposition analysis but also the calculation of the emission trade balance and the carbon footprint (see chapter 7 and 8).

IPCC emissions decrease, emissions by economic activities increase

The total greenhouse gas emissions for the Netherlands according to the guidelines of the IPCC were equal to 201.1 Mton CO_2 equivalents in 2009.[2)] This is 5.7 percent below the emission level in 1990, the base year for the Kyoto Protocol. The CO_2 emissions, however, increased by 6.8 percent during this period, which was less than the reductions in emissions of all other greenhouse gases (CH_4, N_2O, F-gases). This puts the Netherlands on course to realise its Kyoto targets (see below). The emissions of greenhouse gases generated by the Dutch economy were equal to 234 Mton in 2009 and increased by 2.0 percent between 1990 and 2009. These differences are primarily due to the omission of emissions by international transport which is only partly included in the Kyoto figures. Precisely in this period, international transport grew rapidly in the Netherlands, pushing up greenhouse gas emissions. Also, emissions from short-cyclic CO_2, for example the combustion of waste, have increased rapidly in this period. Finally, the actual greenhouse gas emissions in the Dutch territory have decreased slightly since 1990 (2.0 percent). Accordingly, the IPCC emission data presents the most optimistic viewpoint.

Emission data and the Dutch climate policy

The aim of the Dutch climate policy is to meet its obligation for emission reductions as stipulated in the Kyoto Protocol and to achieve further emission reductions for the medium-long period as has been agreed upon within the European Union. For the Netherlands, the Kyoto target was set at a 6 percent emission reduction for the period 2008–2012 with respect to 1990, the base year for the Kyoto Protocol. This means that on average the Netherlands may emit 200 Mton CO_2 eq. each year for the period 2008–2012. To meet its Kyoto target, the Netherlands makes use of the three flexible Kyoto mechanisms, namely emission trading, Joint Implementation (JI) and Clean Development Mechanism (CDM). As the Dutch government aims to acquire 13 Mton CO_2 eq. from emission permits abroad (JI and CDM projects) the domestic emission target is 213 Mton CO_2 eq. each year.

The Kyoto targets, however, will not be sufficient to prevent global climate change (VROM, 2010). Therefore, the Dutch government has formulated ambitious new climate and energy targets for 2020 in order to become one of the cleanest and most energy efficient countries in the world.[2)] These targets are:
- to cut emissions of greenhouse gases by 30 percent in 2020 compared to 1990 levels;
- to double the rate of yearly energy efficiency improvement from 1 to 2 percent in the coming years;
- to reach a share of renewable energy of 20 percent by 2020

1) Excluding LULUCF.
2) VROM (2010). www.vrom.nl accessed in June 2010.

With these ambitions the Dutch government follows the 2007 European spring Council which concluded that a reduction of greenhouse gas emissions of 30 percent by industrialized countries by 2020 is necessary to limit global climate change to 2 degrees Celsius above pre-industrial levels.

The Dutch climate policy and emission targets are primarily based on the emissions as calculated by the IPCC guidelines. These emissions, however, do not provide a complete picture of all emissions related to Dutch (economic) activities. Particularly, emissions caused by Dutch transportation activities are largely excluded, as only a small part is included in the IPCC emissions. Furthermore, an alternative to the frameworks presented here, which are all based on emissions inherent in production, is to calculate the emissions that are required to satisfy Dutch consumption. This issue is taken up in chapter 8.

7. Greenhouse gas emissions from production

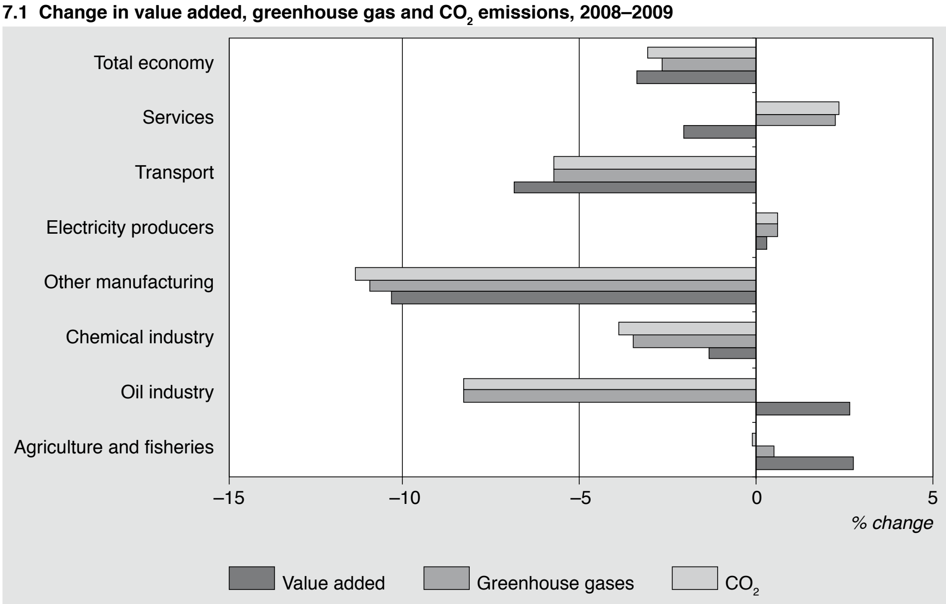
The air emission accounts provide information about the contribution of the economy to climate change and the activities in which these emissions occur, so that the ‘hotspots’ in the production patterns can be identified. In addition, due to the compatibility with the national accounts framework, the greenhouse gas emissions can be directly linked to the output of the economic activities, so that the environmental performance of different industries can be compared by looking at decoupling, or by calculating emission intensities (eco-efficiency).

For a description of the methodology of the air emission accounts see CBS (2010). The data of the air emission accounts can be found on StatLine, the electronic database of Statistics Netherlands.

Greenhouse gas emissions by industries down 2.7 percent

The total greenhouse gas emissions by industries equalled 188.0 Mton CO_2 eq. in 2009, which was 2.7 percent lower than the previous year.[1] As a result of the economic recession, greenhouse gas emissions fell in almost all economic activities during 2009. There are large differences across industries. In manufacturing emissions decreased by almost 8 percent. Particularly, in the basic metals, rubber and plastic products, building materials and publishing and printing industries, emissions dropped by more than 10 percent due to sharp decreases in output which consequently required less energy. Oil and gas production are the exceptions. They noted an increase in value added driven by a surge in exports. Emissions were reduced at the same time by changing the mix of energy resources used in the refineries. The emissions in the transport sector fell sharply, as international trade was hit hard by the global recession. Value added in the service sector declined, but emissions increased as offices needed more heating due to the colder winter. Agriculture created more value added as a result of more favourable weather conditions, but total greenhouse gas emissions remained more or less the same as in the previous year.

7.1 Change in value added, greenhouse gas and CO_2 emissions, 2008–2009



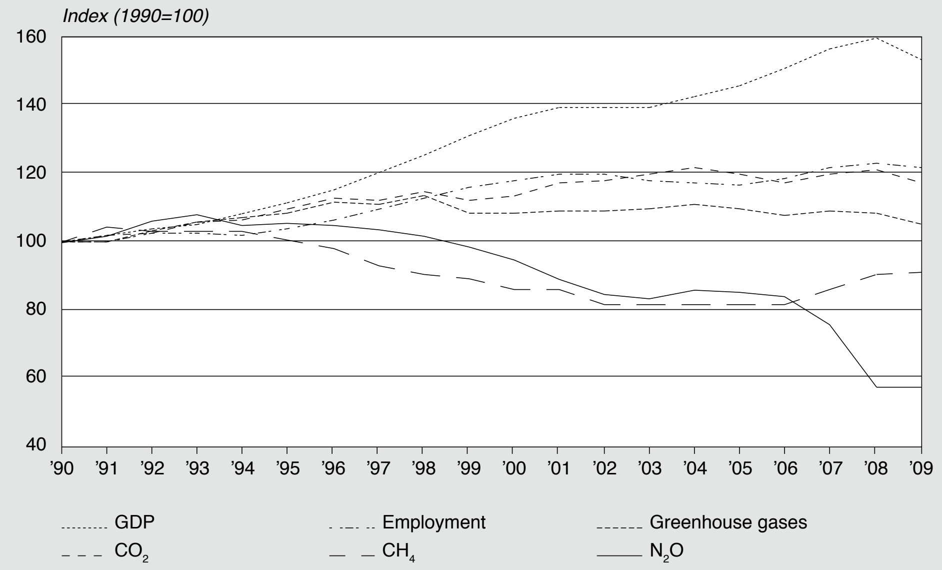
[1] The total emissions by the economy, which includes emissions by households and emissions from waste sites, equalled 234.2 Mton (see also chapter 6), which is 2.0 percent lower than in 2008.

Emissions of nitrous oxide stabilised in 2009, after a dramatic reduction realised by the chemical industry in the previous year. Methane emissions have increased for the second successive year. This was caused by more emissions from cattle breeding, as the number of livestock (cows) increased.

Emission intensity deteriorated in 2009

In 1990–2008 economic growth was considerably higher than the increase in greenhouse gas emissions. While the economy grew at a rate of 60 percent and employment by 23 percent, the emissions of greenhouse gases by industries increased only by 8 percent. Accordingly, relative decoupling took place in the Netherlands: i.e., the growth rate of greenhouse gases from production processes was lower than the GDP growth rate. Absolute decoupling only took place for methane and N_2O emissions.
In 2009 the economy shrank 3.9 percent whereas the decrease in greenhouse gas emissions was only 2.7 percent. The emissions of CO_2 decreased most, with 3.2 percent. The emissions of N_2O stayed the same (–0.1 percent), whereas the emission of methane increased (+0.7 percent). The emission intensity for greenhouse gases, which is an important measure of the environmental pressure caused by economic activities, deteriorated for the first time in several years.

7.2 Volume change GDP, employment and greenhouse gas emissions by industries

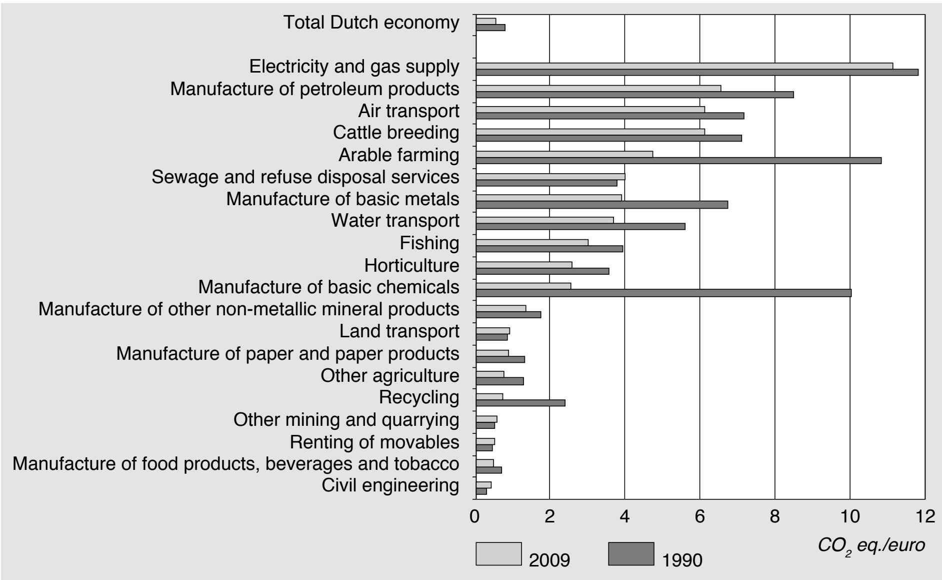


There are several reasons why greenhouse gas emissions decreased less than GDP. First, the emissions of energy supply companies, which contribute 28 percent to the total emissions by industries, increased 0.5 percent. In spite of a lower domestic demand for electricity, the energy suppliers managed to increase their production by 6 percent. Because of lower prices for natural gas and large scale maintenance works in energy plants in neighbouring countries, the competitive position of Dutch electricity companies improved. As a result, more electricity was exported. Second, some service industries like wholesale trade, retail trade, employment agencies and banking contributed much to the decline in GDP, but contributed much less to the total reduction in greenhouse gas emissions, as these are emission-extensive economic activities. Third, the winter of 2009 was colder than in 2008, which led to more combustion of gas to heat offices and greenhouses and thus more CO_2 emissions.

Emission intensity decreases for almost all industries

Eco efficiency is a prominent concept in environmental policies. Air emission accounts in combination with economic parameters (production output or value added) can be used to calculate greenhouse gas intensities. Emission intensities can be used to compare industries within one economy to identify the most eco-efficient ones, and to compare across countries to identify the best performers or to monitor development over time to assess improvements in eco efficiency. Figure 7.3 shows the twenty industries with the highest greenhouse gas emission intensities for the Netherlands (here defined as greenhouse gas emissions per unit value added). In 2009, electricity and gas supply had the highest greenhouse gas intensity followed by the manufacturing of oil products, air transport, and cattle breeding. Services generally generate the least greenhouse gas emissions per unit value added. The emission intensity of land transport is much lower than air or water transport. Notable are also the high emission intensities in agriculture. This is caused by the high methane and N_2O emissions from cattle and the application of manure and fertilizers on farm land. Between 1990 and 2008 the emission intensities decreased in almost all industries. Particularly arable farming and the manufacture of basic chemicals have significantly improved their eco efficiency. The chemical industry accomplished this by reducing N_2O emissions in the production of nitric acid and more efficient energy use. In arable farming emission reductions were achieved by more efficient use of manure and fertilizer. For the economy as a whole, the greenhouse gas intensity decreased 33 percent between 1990 and 2009.

7.3 Industries with the highest greenhouse gas intensity

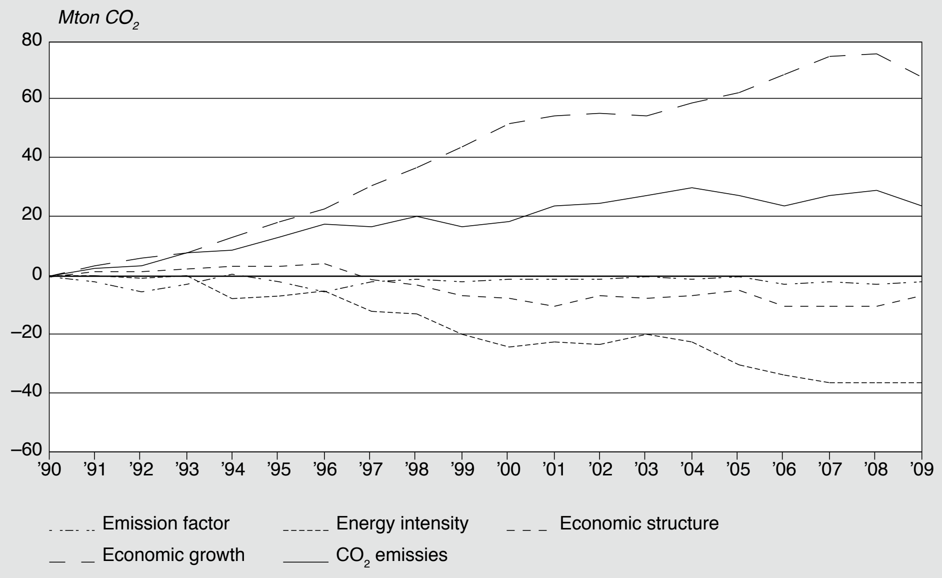


More efficient energy use cannot stop the increase in CO_2 emissions

The change in the level of CO_2 emissions by economic activities in the period 1990–2009 can be explained by different factors. First of all, an overall increase in economic growth may have led to more CO_2 emissions. A change in the energy mix (the energy products used in the production process) may also have influenced emission levels. The economic structure may have changed, for example due to a change in the input output relations of the intermediate use, or a change in composition of the final demand for products and services. Finally, eco-efficiency improvements of the production process may have decreased CO_2 emissions. Structural decomposition analysis allows us to account in detail for the factors underlying the changes in emissions.

During the last nineteen years economic growth clearly has been the driving force behind the increase in CO_2 emissions, which were only partially negated by an increase in efficiency (emission factor and energy intensity effect). Emissions would have been about 49 percent higher, if there had been no changes in efficiency and structure. The improvement of the energy intensity (energy saving) has reduced the increase in CO_2 emissions in particular. Structural changes in the economy or a change in the mix of energy products clearly had less effect on the total change in emissions. The decrease in emissions between 2008 and 2009 is solely the result of the recession. In fact, results show that the energy intensity worsened in 2009.

7.4 **Structural decomposition analysis of CO_2 emissions**



8. Greenhouse gas emission trade balance for the Netherlands

There are different ways in which countries can be held accountable for their contribution to the greenhouse gas effect[1]. The *production approach* considers greenhouse gas (GHG) emissions caused during the economic activities of a country's residents. However, the production approach does not take into account GHG emissions that occur abroad, during the production of products that are consumed in the home country,[2] the so called embodied or indirect emissions. The approach in which GHG emissions are related to the consumption requirements of countries is referred to as the *consumption approach* or carbon footprint. Indirect emissions can be calculated with a technique called environmentally extended input-output analysis (a.o. de Haan, 2004). The Dutch emissions according to the consumption approach consist of the emissions embodied in imports for domestic use plus a part of the domestic GHG emissions, namely those inherent in the production of products destined for domestic final consumption. The remaining domestic GHG emissions that occur during the production of products destined for export are attributed to consumption abroad.

The difference between the production and consumption approach becomes apparent if one looks at a process referred to as 'carbon leakage' or the 'pollution haven hypothesis'. The hypothesis is basically that developed countries specialize in clean production and start to import 'dirty' products from developing countries. If GHG-intensive products are no longer produced in the country but imported, this leads to a reduction in emissions according to the production approach, while this may result in an increase of emissions according to the consumption approach if, for instance, foreign production turns out to be more emission intensive.

The difference between emissions according to the production and the consumption approach can be determined by the greenhouse gas trade balance of the Netherlands with the rest of the world (for technical details on the used methodology see Edens et al., 2010). It equals the GHG emissions embodied in export products minus emissions embodied in import products. From the greenhouse gas balance, the carbon footprint for the Netherlands can be calculated, i.e. all greenhouse gas emissions that result from Dutch consumption needs.

Greenhouse gas emission balance slightly positive in 2009

The preliminary GHG balance of trade for the Netherlands with the rest of the world was slightly positive in 2009. A positive balance indicates that greenhouse gases emitted domestically during the production of export products are higher than the greenhouse gases emitted abroad during the production of goods and services imported by the Netherlands. As a result of this positive balance, the carbon footprint, i.e. the global emissions as a result of Dutch consumption needs, was equal to 228 Mton GHG emissions, which is slightly less than the emission by Dutch residents.

The emission trade balance can also be compiled separately for the three most important greenhouse gases: CO_2, CH_4 (methane) en N_2O (nitrous oxide). The CO_2 balance is positive. In 2009, the exports of CO_2-intensive products from glasshouse horticulture, the chemical industry and refineries exceeded the imports of CO_2-intensive products like electronics. The balances for nitrous oxide and, especially, methane are negative. The negative trade balance for methane is due to large imports of crude oil and natural gas whose production is frequently accompanied by venting and flaring in which large amounts of methane are released.

1) F-gases such as CFCs also contribute to global warming but they are not included in the results presented here due to lack of reliable emission data for foreign countries on an industry level.

2) A wide definition of consumption is used here that consists of all final demand categories minus exports: final consumption by households, final consumption by government, investments and changes in inventories.

Table 8.1
Greenhouse gas emissions as a result of Dutch consumption needs, 2009

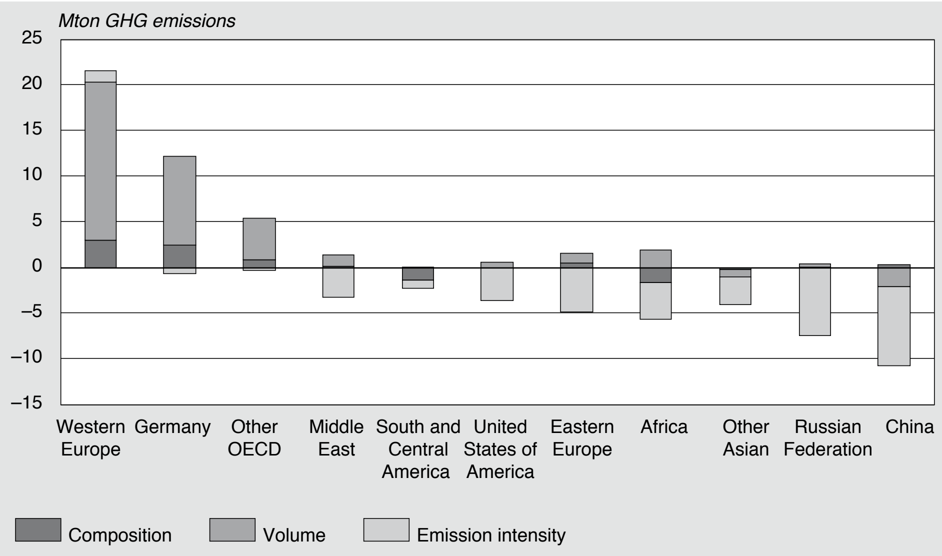
	Total GHG	CO_2	CH_4	N_2O
	Mton CO_2-equivalents			
1. Emissions attributed to imports	99	70	20	10
2. Emissions attributed to exports	103	86	9	8
3. Emission balance of trade = 2–1	3	16	–11	–2
4. Emissions by residents	232	203	17	12
5. Global emissions from Dutch consumption needs = 4–3	228	187	28	14

Non-OECD countries emit for Dutch consumption needs

The Dutch GHG balance of trade can be specified for different regions. Especially non-OECD[3] regions such as China, Russia, other Asia, and Africa show a negative trade balance. The individual balances can be broken down into three effects: an intensity effect that measures differences in emission intensity, a volume effect that measures the difference in value between imports and exports, and a composition effect that measures differences in the composition of imports and exports[4].

The negative trade balance with China is primarily caused by the intensity effect: the balance would have been significantly reduced if China had used Dutch production technology with the corresponding lower emissions coefficients. The trade balance is also driven to a large extent by the volume effect which shows that the Netherlands is a net importer from China. The positive balance with Germany is primarily the result of the volume effect which expresses that the Netherlands is a large exporter to Germany. The composition effect also plays a major role, which reflects that Dutch exports consist of emission-intensive products such as chemicals and horticulture products, whereas imports from Germany consist on average of less emission intensive products.

8.2 Greenhouse gas trade balance for Netherlands for different regions broken down into a volume, composition and emission-intensity effect, 2009



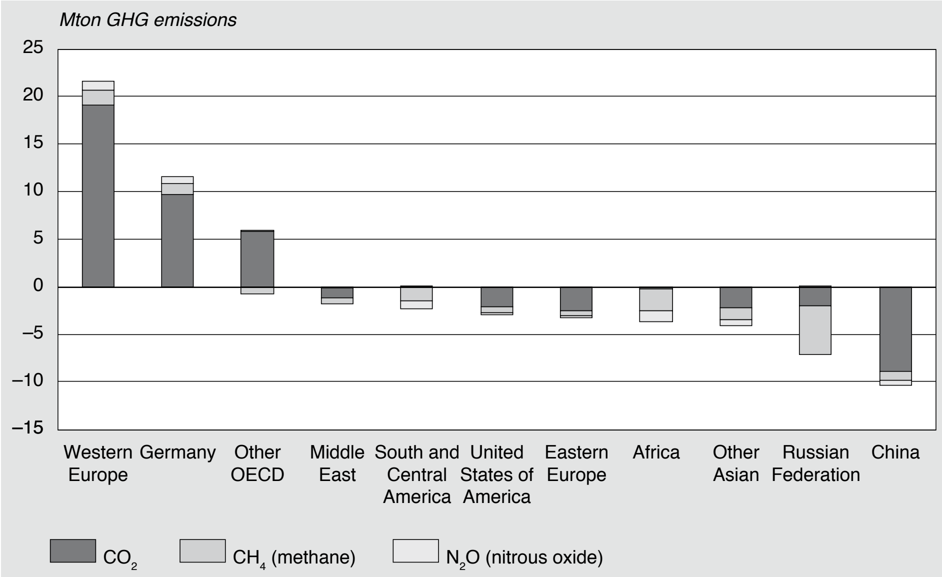
[3] OECD stands for Organisation for Economic Cooperation and Development.

[4] The cross-section into a composition and volume effect is slightly distorted due to the model used (Edens et al. 2010).

CO_2 the most important greenhouse gas

The GHG trade balance can also be broken down into the different greenhouse gases. This shows that for most countries CO_2 is the most important gas. An exception is Russia, where relative large amounts of CH_4 are released in the air from leaks during the extraction and transportation of natural gas. The emission intensity of oil and gas production is lower in the Middle-East, which results in a relatively lower importance of methane in the trade balance despite the major imports of crude oil from these countries. The negative trade balances with Africa and South- and Middle-America are driven by CH_4, and N_2O as the Netherlands are large importers of agricultural products from these regions.

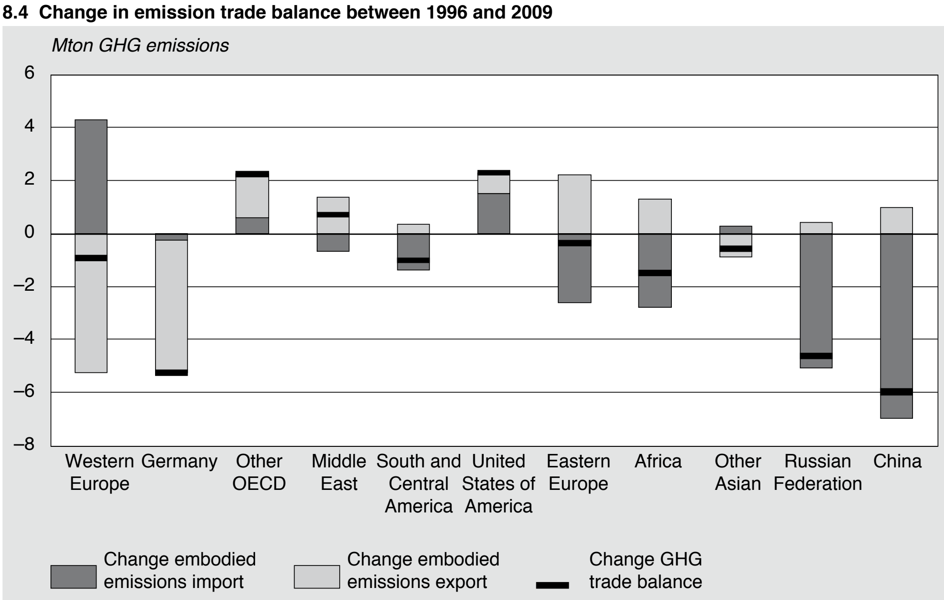
8.3 Emission trade balance broken down into individual GHG, 2009



GHG trade balance decreases over time, carbon footprint remains stable

Between 1996 and 2009 the GHG trade balance has decreased from an 18 Mton GHG emission (in CO_2 equivalents) surplus to a 3 Mton GHG emission surplus. Reasons for this development are twofold. First, the Dutch production process has become more efficient, i.e. the same output could be produced with the release of fewer emissions. Therefore, the emissions embodied in Dutch export products have decreased over time despite the

8.4 Change in emission trade balance between 1996 and 2009



increase in export volumes. This development is especially apparent in the trade balance with Germany. A large part of the decrease in the trade balance with Germany is due to the increased export of ‘cleaner’ products. Secondly, imports of products from ‘environmental unfriendly’ countries have increased. Therefore, emissions embodied in Dutch import products have increased. This development is apparent in the trade balance with China and Russia.

The emission trade balances with the United States of America and ‘other OECD’ countries show the largest increase. For the USA the increase is mainly due to decreased emissions embedded in products imported by the Netherlands. On the other hand, the increase for ‘other western’ countries is mainly due to an increase in emissions embodied in exports from the Netherlands.

The carbon footprint (emission by residents minus the emission trade balance) is more or less the same as in 1996. The decrease in the GHG trade balance went together with a decrease in emissions by Dutch production activities (see chapter 6). From a production approach perspective it seems that the Netherlands is making progress in the reduction of GHG emissions, while from a consumption approach perspective no apparent reduction in global emissions can be observed.

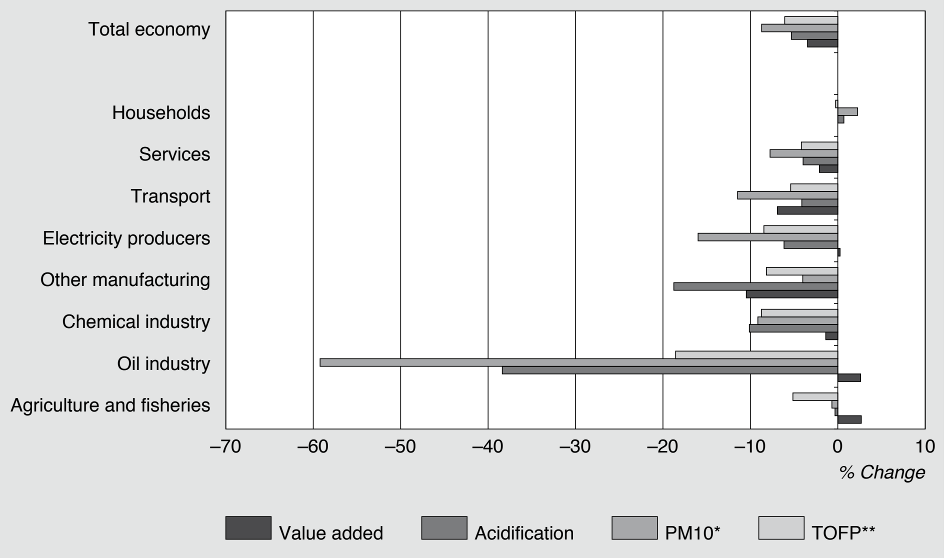
9. Air pollution

Production and consumption activities cause emissions of a variety of substances to the air. Due to their physical and chemical characteristics some substances have global effects such as greenhouse gases (see chapters 7, 8 and 14). The air emissions we discuss in this chapter, such as particulate matter or nitrogen oxides, have a local impact on human health or the quality of the environment or have an impact at the regional scale. Air emissions of several substances can be combined by weighting them by their respective impacts to form indicators for a number of environmental themes that are important from a policy perspective. The themes discussed here are acidification, PM10 emissions, smog formation, and ozone layer depletion.[1)]
For a description of the methodology used see CBS (2010). The data of the air emission accounts can be found on StatLine, the electronic database of Statistics Netherlands.

Emissions of acidifying pollutants decreased by 5 percent in 2009

Acidification is caused by the emissions and deposition of nitrogen oxides (NO_x), sulphur dioxide (SO_2) and ammonia (NH_3). The combined emissions of these acidifying substances, expressed as acid equivalents, decreased by 5 percent in 2009. Since 1990 acidification has decreased by 46 percent. As a result of the economic downturn the emissions dropped in practically all economic activities, although large differences exist between industries and types of acidifying substance.

9.1 Change in value added, emissions of acidifying substances, particulate matter (PM10) and smog, 2008–2009[1]



* PM10, Particulate matter (less than or equal to a nominal 10 microns).
** TOFP, Tropospheric Ozone Formation Potential, is an indicator for the formation of tropospheric ozone.
*** Strong growth in chemical industry for PM10 is explained by changed methodology for a single company and therefore excluded from this figure for reason of comparison.
[1] Figures for 2009 are provisional, as some sources are not complete and/or definitive.

The emissions of nitrogen oxides (NO_x) in 2009 were reduced by 5 percent. Transport, in particular transport over water, was the main contributor to this decline due to much less transport activity. In road transport the transition to cleaner engines also helped to cut emissions. Electricity companies reduced NO_x emissions as well. Strict environmental

[1)] Smog formation and emission of particulate matter are not officially 'environmental themes' under the Dutch National Environmental Policy plan number II, but belong to the theme 'transboundary air pollution'. Emissions of substances that contribute to ozone layer depletion, here is the sole exception having an effect globally as is the case for the greenhouse gasses.

measures taken at power plants have more than halved emissions since 2003. Households too have steadily decreased their NO_x emissions in recent years. This is predominantly because car engines are becoming less and less polluting due to tightening the European exhaust gas standards. Energy efficiency improvement in space heating and the application of less polluting boilers have contributed as well.

Sulphur dioxide emissions even fell by 15 percent in 2009. Sulphur dioxide emissions are mainly caused by water transport (56 percent), followed by the oil industry (16 percent), and electricity production (7 percent), and the basic metal industry (4 percent). Several sectors with large emissions were severely hit by the recession and the decline in international trade. However, technological improvements and policies are also important. Looking after the influence of policies, the International Maritime Organisation (IMO) for example has issued regulation by the so-called MARPOL Convention for the Maritime POLution. This regulation puts restrictions on vessels with regard to the sulphur content of marine fuel oil. The aim is to prevent pollution from vessels. Gradually, the allowable sulphur content in fuel oil is reduced to begin with in the emission control areas. The oil industry realized a remarkable reduction of 43 percent. This was largely achieved by using more natural gas in stead of crude oil in the refining process, which has much lower sulphur concentrations, and through the application of desulphurisation of flue gas. The basic metal industry also showed a severe reduction of 43 percent as well also as a result of economic downturn. Ammonia emissions, primarily due to livestock, remained at the same level as in 2008. The NO_x emissions are responsible for almost half of the emissions of acidifying pollutants, Ammonia for about one third and Sulphur dioxide emissions only for 14 percent in 2009. The share of SO_2 has decreased since 1990.

PM10 and emissions of ozone precursors decreased in 2009

The total emissions of particulate matter in 2009 fell by approximately 5 percent compared to 2008. Especially the oil industry and the electricity producers showed significant reductions, which were able to offset the significant increase in emissions of the chemical industry. Emissions of ozone precursors (CH_4, CO, NMVOC, NO_X) are weighted by their tropospheric ozone formation potentials, or smog formation in short. These emissions were reduced across all activities.

9.2 Contributions to value added and environmental themes in 2009

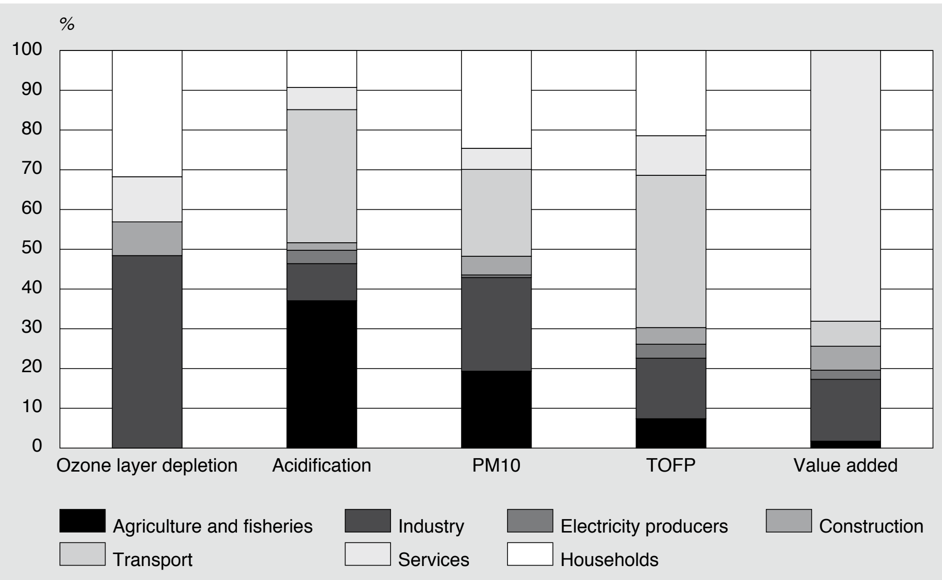


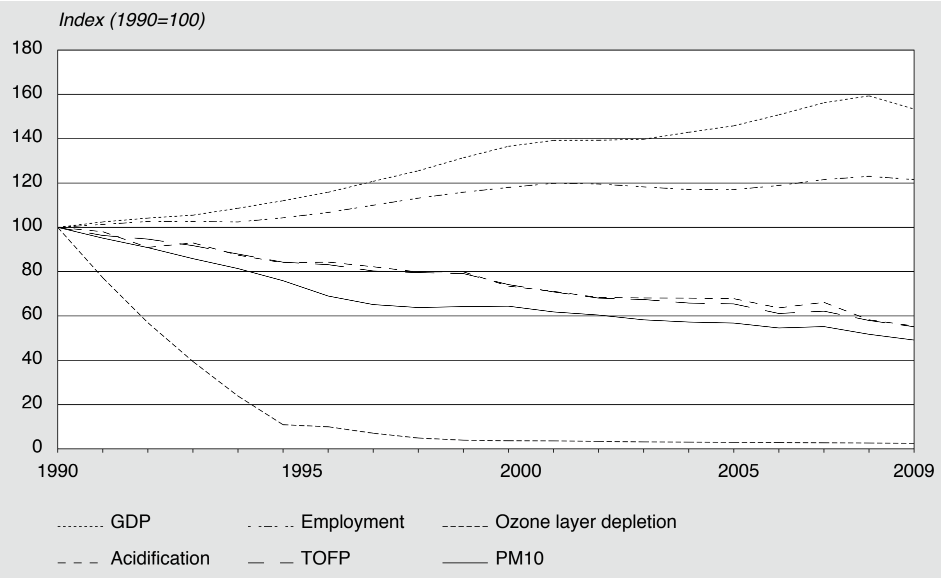
Figure 9.2 provides a breakdown of the environmental themes in 2009 by economic sectors and households. It demonstrates that whereas services are responsible for almost 70 percent of value added, their contribution to environmental themes is small. Acidification is dominated by agriculture and transport, while ozone layer depletion is primarily driven

by industries. Contribution to smog formation is dominated by emissions from transport, while PM10 emissions show a mixed picture: households, transport, manufacturing and agriculture are all significant contributors.

Decoupling of non-greenhouse gas emissions to air and economic growth continues in 2009

Between 1990 and 2008 the Dutch economy grew at a rate varying between 0 to 5 percent annually. Employment increased continuously with a short interruption in 2003 and 2004. At the same time the emission of all substances to air were cut by half or more, with the exception of CO_2 emissions (for details see chapter 7). The drop in all local air pollutants described in this chapter implies that both absolute and relative decoupling have taken place in the Netherlands since 1990.[2)] 2009 was no exception. Although for the first time in nineteen years the economy shrank with 3.9 percent, the emissions to air excluding the non-greenhouse gasses generally came down by around 5 percent compared to 2008. The emission intensities that measure the environmental pressures caused by economic activities for the different substances, thus continued to improve notwithstanding the economic slump.

9.3 Volume changes in GDP, employment and several environmental themes



When we focus on the emissions of particulate matter we observe that the 5 percent reduction in 2009 is quite substantial. At the start of the century yearly reductions averaged around 2 percent after a series of steep reductions in the nineties. The easiest reductions seem to be used already. To find new reductions appears to be harder.

Reduced particulate matter emissions driven primarily by improved efficiency

In order to better understand the pattern of PM10 emissions over time, a structural decomposition analysis (SDA) was performed for the period 1990–2009. A SDA is an

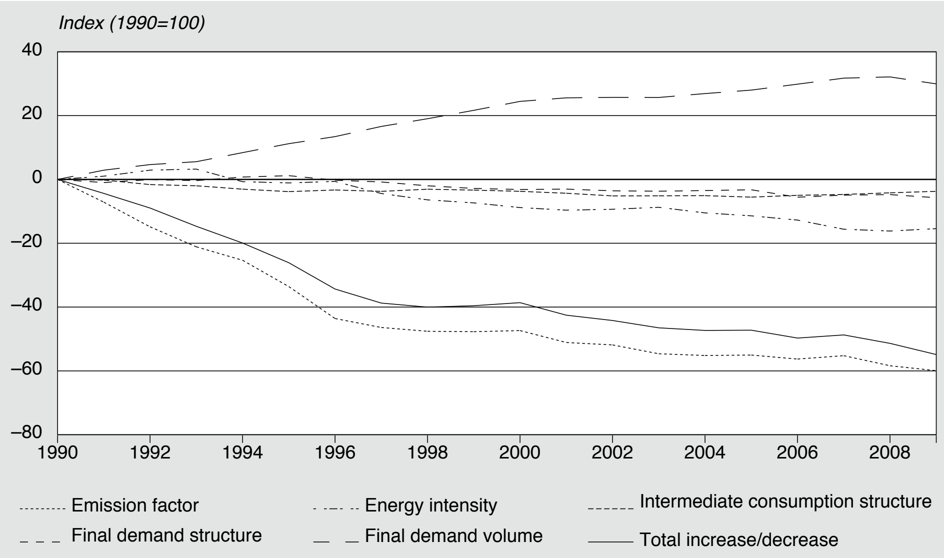
2) Decoupling occurs when the growth rate of an environmental pressure is less than that of its economic driving force (e.g. GDP) over a given period. Decoupling can be either absolute or relative. Absolute decoupling occurs when the emission of a pollutant is stable or decreases while the economic driving force shows growth. Decoupling is supposed to be relative when the growth rate of a pollutant or environmental theme is positive, but less than the growth rate of the economic variable.

3) The methodology of the SDA can be found on the website of Statistics Netherlands (www.cbs.nl).

instrument that provides information about the driving forces behind emissions (CBS 2010).[3] Figure 9.4 demonstrates that growth of economic activities in the last nineteen years would have caused particulate matter emissions to be 30 percent higher. Fortunately, the impact of economic growth was offset by several other driving forces.
The main driver is emission intensity improvement which we decomposed into two aspects: the effect of improved emission factors (i.e. less emissions per unit of energy use) and lower energy intensities (i.e. less use of energy per unit value of output) that contributed 60 and 15 percent respectively to the reduction of the original 1990 emissions. Changes in the composition of final demand and the structure of the economy contributed another 6 and 4 percent respectively towards emissions reduction.

Based on the decomposition analysis, the picture that emerges is that in the early nineties reductions were primarily achieved by various technological measures such as improvements in combustion processes as well as end-of-pipe technologies such as air scrubbers and filters which yielded improved emission factors. After these low hanging fruits have been picked, further reductions are driven by innovation that is partly stimulated by stricter regulations. An example is the reduction of the sulphur content of marine fuel oil. Reductions therefore continue, but at a slower pace. Finally, the decrease in emissions between 2008 and 2009 is largely explained by the shrinking economy as is shown by the dip of the final demand factors.

9.4 Structural decomposition of particulate matter emissions expressed as cumulative percentage changes compared to 1990



Manufacturing, construction and energy companies yielded the best performance in terms of reducing particulate emission intensities. Livestock production lagged behind with a reduction of around 30 percent. Emissions of particulates are inherent in keeping livestock, as they originate from feed, manure, skin flakes and litter. These emissions are primarily a function of the number of livestock and therefore hard to reduce.

10. Water emissions

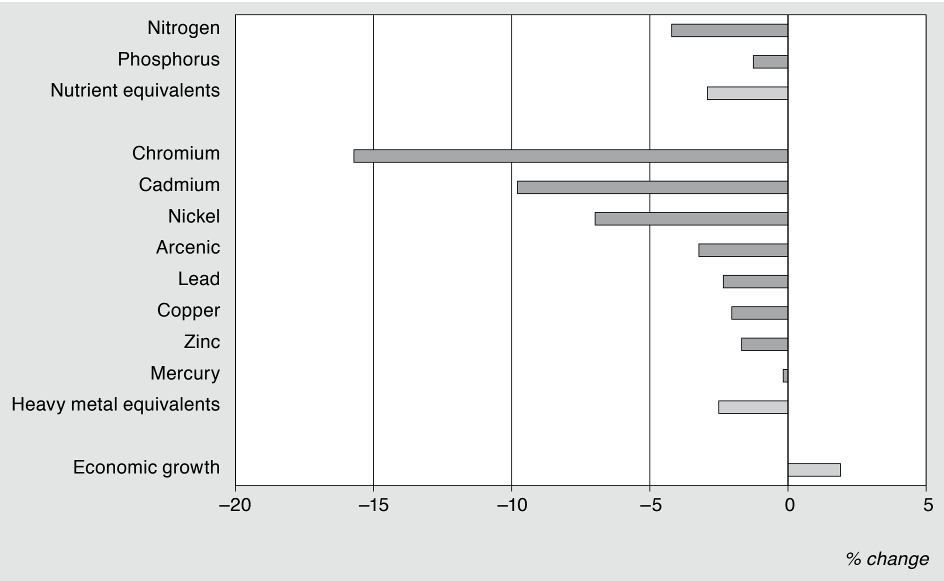
The availability of clean water is essential for both humans and nature. However, everyday surface waters are exposed to discharges of harmful substances by industries and households that could cause severe damage to ecosystems in ditches, rivers and lakes. The European Water Framework Directive (WFD) was introduced to meet European environmental quality standards in the future. The Water Framework Directive states that all domestic surface waters should meet certain specific targets by 2015, in qualitative and quantitative terms. Two important groups of substances causing water pollution are heavy metals and nutrients. Heavy metals naturally occur in the environment, but are toxic in high concentrations. An excess amount of nutrients in the surface water causes algae and duckweed to grow disproportionally, which can cause certain species of fish, aquatic plants and other organisms to disappear. Economic activities are often directly linked to the emission of pollutants into the environment. Improvements in the emission intensity of production processes and decoupling between water emissions and economic growth are essential to guarantee a good water quality for the future.

The water accounts provide information about the emissions to water by industries and households and are fully consistent with the concepts of the national accounts. Indicators for the pollution of surface water by heavy metals and the eutrophication of the surface water are derived from the water accounts. Because it is consistent with the national accounting framework, this physical information on the emissions to water could be directly compared with economic information like value added. This consistency also suits environmental-economic modelling. For a description of the methodology used to compile the water accounts see CBS (2010). The data of the water accounts can be found on StatLine, the electronic database of Statistics Netherlands.

Reduced emissions of heavy metals and nutrients in 2008

The net discharge of heavy metals and nutrients to water by the Dutch economy decreased in 2008 compared to 2007. Expressed in heavy metal equivalents, emission of heavy metals to water decreased by 2.5 percent. Emission of nutrients to water, expressed in nutrient equivalents, declined by 2.9 percent. The damaging nature of different heavy metals varies which is expressed in different weights for each heavy metal in the equivalent. For example, mercury and cadmium have a more damaging effect on water bodies than chromium and lead. The same applies for the nutrients phosphorus and nitrogen. The weight of phosphorus in the equivalent is ten times that of nitrogen (see Adriaanse, 1993).

10.1 Emissions to water 2007–2008, net approach



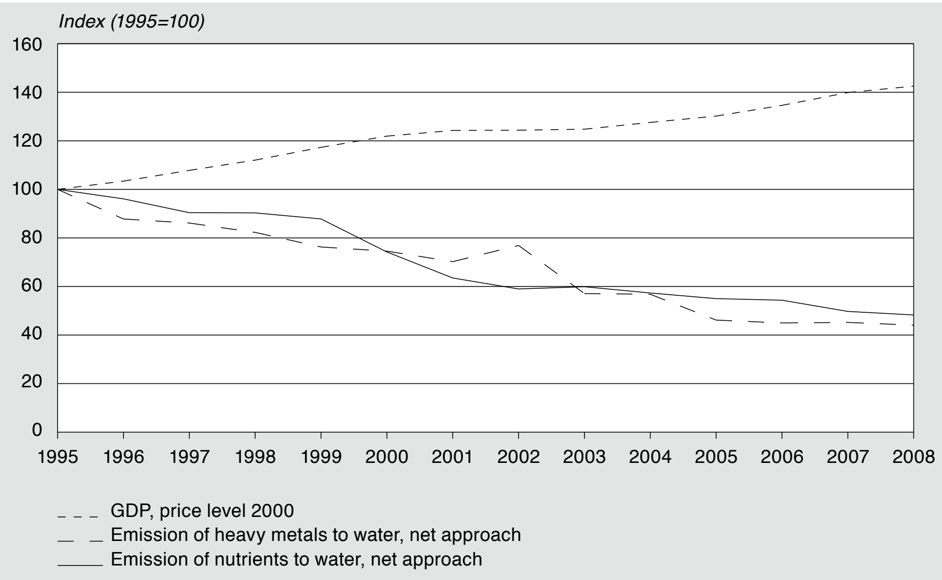
The individual heavy metals and nutrients show different emission levels and trends. Although chromium showed the strongest decline with a decrease of 15.7 percent, cadmium, copper and zinc had the highest share in the total decrease in emitted heavy metal equivalents by the Dutch economy. This was partly the result of reduced heavy metals emissions by sewage and refuse disposal services and partly the result of reduced emissions by manufacturing. The emissions decreased especially in manufacture of electrical and optical equipment, paper and paper products, petroleum products and fabricated metal products. The financial crisis has hit the manufacture of basic metals particularly hard, resulting in production cuts. Despite the decline in production, their emissions increased by 29 percent. Hence their environmental performance decreased significantly.

The decline in nitrogen emissions was responsible for much of the decrease in emitted nutrient equivalents. This is the result of reduced emissions by sewage and refuse disposal services and manufacture of food products, beverages and tobacco. These industries improved their environmental performance. The treatment efficiency of sewage treatment plants improved for both nutrients. In addition, less precipitation in 2008 compared to 2007 partly contributed to a decrease in atmospheric deposition. In contrast, the manufacture of chemical products increased their discharge of nitrogen and phosphorus to water.

Better environmental performance results in decoupling economic growth and emissions to water

In 2008 the economy of the Netherlands grew by 1.9 percent whereas emissions to surface water and sewer systems decreased. Accordingly, there is absolute decoupling between the emissions to water and the economic growth for 2008. This is a continuation of the same trend that has been observed since 1995. In the period 1995–2008 economic growth equalled 43 percent (figure 10.2). Emissions were substantially reduced in this period: heavy metals by 56 percent and nutrients by 52 percent.[1)] This reduction is mainly caused by a reduction in the emission intensity by producers and reduced emissions by other domestic sources. In 1995 the emission of heavy metals and nutrients (measured in heavy metal equivalents and nutrient equivalents) was almost equal for producers and households. However, in 2008 households emitted almost two and a half times more nutrients to water than producers did. Households emitted twice as much heavy metals than producers. Environmental performance of companies and institutions has improved substantially in the period 1995–2008. In contrast, the discharge of nutrients to water by

10.2 Economic growth and contribution of the Dutch economy to water emissions, net approach



1) Run-off and seepage by agriculture are excluded in this analysis.

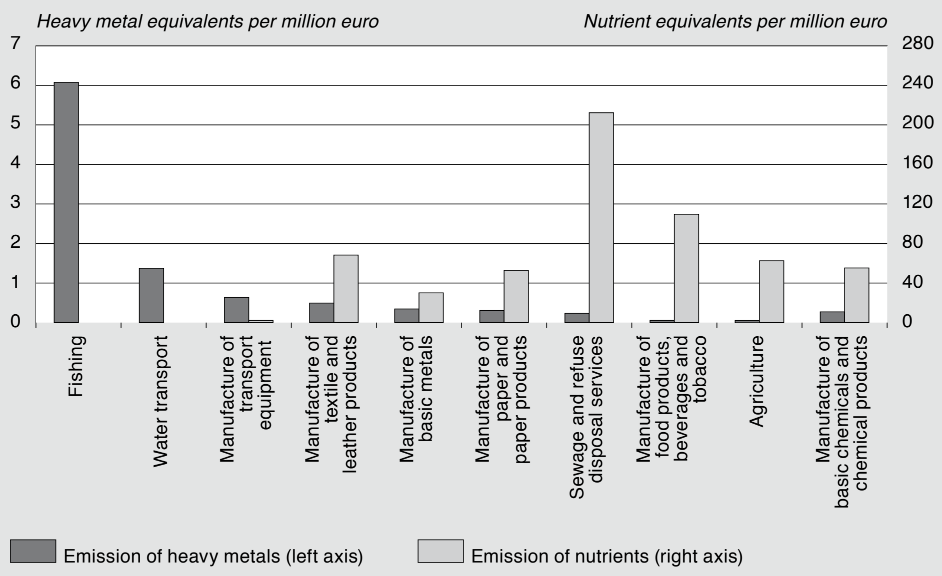
households has increased, partly due to the population increase. Another explanation is the increased use of dishwasher tablets by households which contain relatively much phosphorus.

High heavy metal-intensity for fisheries and water transport

The emissions intensity (water emissions per euro value added) differs very much between industries.[2)] In 2008, the industries fisheries and water transport were responsible for relatively great emissions of heavy metals to water per euro value added (figure 10.3). The source of these emissions is the antifouling topcoat applied on the outside of sea-going vessels and fishing vessels. This antifouling topcoat prevents vessels from becoming fouled with algae and other organisms. However most of the coatings cause a lot of emissions of copper to the surface water.

The highest nutrient-intensity in 2008 was noted by the sewage and refuse disposal services.[3)] This can be explained by the nature of the activities of this industry. The main activities of the sewage and refuse disposal services is soil sanitation and collecting and processing waste produced by other industries and households. Both activities cause quite a lot of emissions being released into sewer and surface water. Manufacture of food products, beverages and tobacco discharges relatively many nutrients to water per euro value added, because a lot of food leftovers reach the sewer system when the production facilities are cleaned. These food leftovers contain a lot of nitrogen and phosphorus.

10.3 Water pollution by industry per million euro value added in 2008



2) Run-off and seepage by agriculture are excluded in this analysis and for sewage and refuse disposal services effluents are not included.

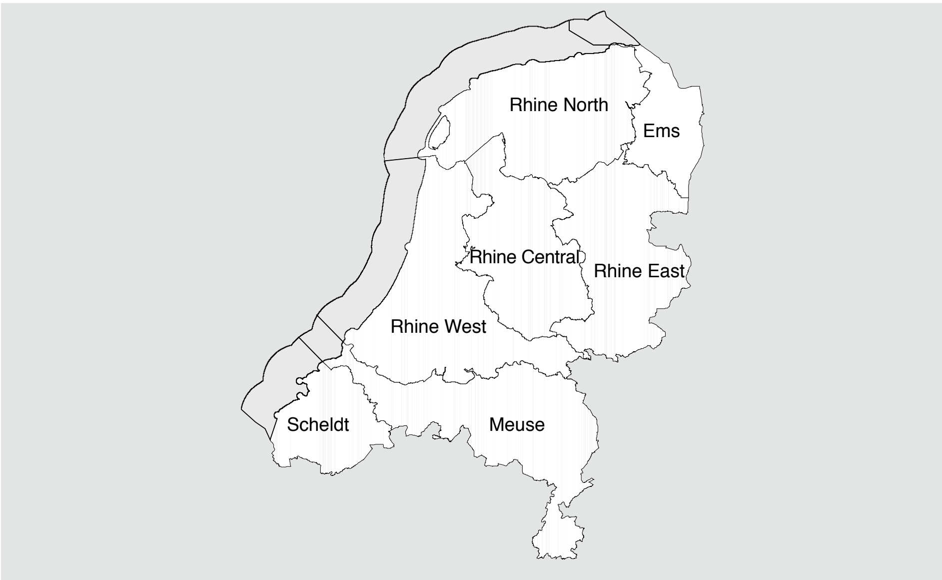
3) Effluents of sewage treatment plants are excluded in this analysis.

11. Regional water accounts

Water pollution is primarily a local environmental problem. For this reason the water quality targets that have been defined within the European Water Framework Directive were determined at river basin level (PBL, 2008). There are large differences between river basins in emissions to water and economic activity. Usually, a river basin with many economic activities will have more emissions to water than a river basin with less economic activities. In addition, a river basin that is characterised by many manufacturing activities will generally cause more emissions than a river basin that only houses service industries. These relationships can be determined by making use of the regional water accounts.

The water accounts, also known as NAMWA (National Accounting Matrix including Water Accounts), describe the relationship between the physical water system and the economy at national and river basin scale (see also chapter 10). NAMWARIB is developed in order to provide information at river basin level and provides economic and environment related information at the level of the four main river basin districts in the Netherlands: Rhine, Meuse, Scheldt and Ems. As the Rhine basin covers approximately 70 percent of the entire Dutch territory, this basin is split into four sub regions: North, East, West, and Centre (see figure 11.1).

11.1 The Dutch main river basins



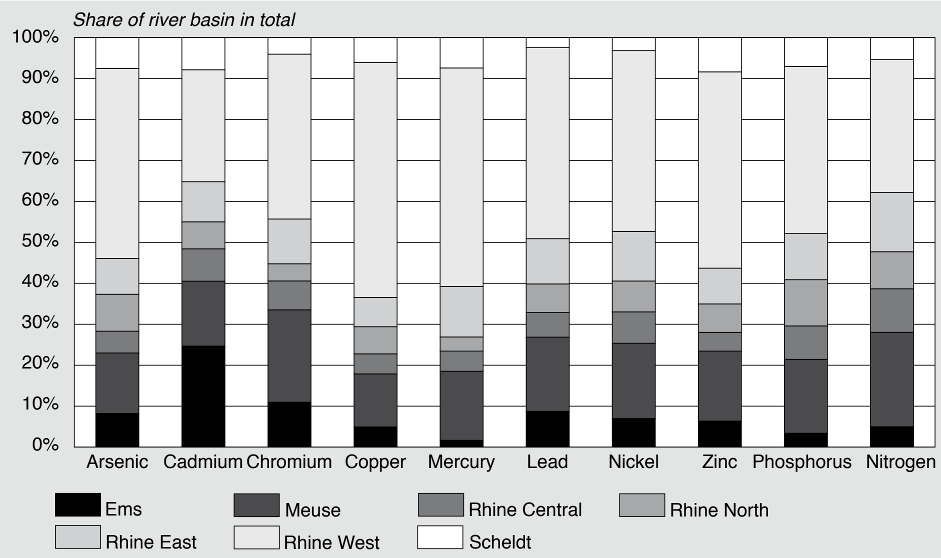
The regional water accounts are, like the national water accounts, fully consistent with the concepts of the national accounts. In NAMWARIB (National Accounting Matrix including Water Accounts for River Basins), the emission of nutrients and heavy metals to the water are allocated to the economic activities causing these emissions. Key economic indicators (value added, production, employment, and others) for the different economic activities (58 industries) are compiled for the seven different river basins. The methodology of the regional water accounts is described in the report *'Integrated river basin accounting in the Netherlands and the Water Framework Directive'* (Brouwer *et al.* 2005). In the Netherlands, data on water emissions are compiled by a number of government institutions working together in the framework of the Pollutant Release and Transfer Register (PRTR). Statistics Netherlands is one of the partners in this project. Regional data on water emissions are also accessible via the website of the PRTR (http://www.emissieregistratie.nl).

Emissions to water and value added highest in Rhine West

The river basin Rhine West is the largest river basin and encompasses the urban agglomeration of Western Holland, which is the economic centre of the Netherlands.

Accordingly, the Rhine West river basin contributed 49 percent to the Dutch gross domestic product in 2006. Rhine West is also the river basin with the largest amount of emissions for both heavy metal equivalents as well as for nutrient equivalents. The Meuse river basin, which is characterised by a lot of manufacturing activities, has a relatively high share in total value added (21 percent) and has an equal share of 21 percent in total emissions of nutrients.

11.2 Emissions to water by producers for the various river basins, 2006[1]



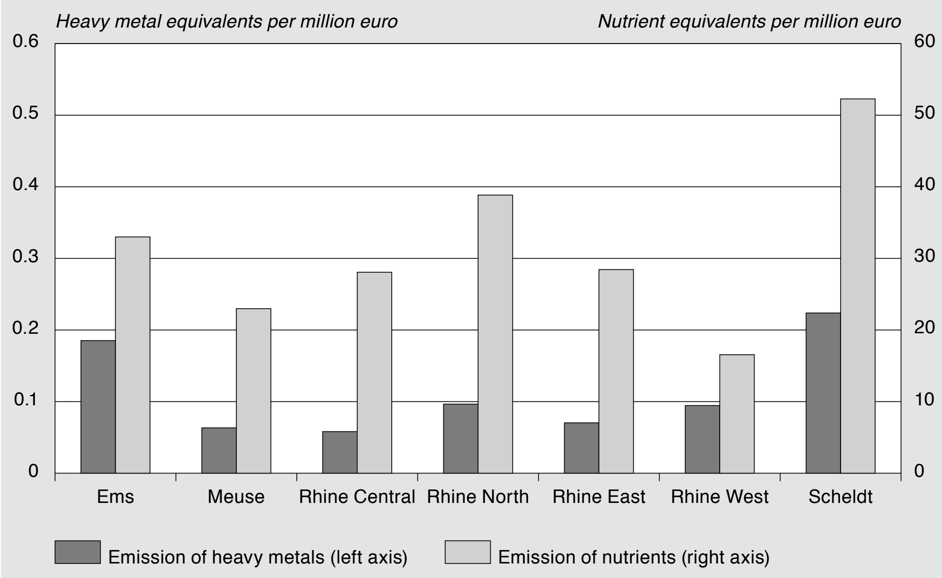
[1] Run-off and seepage are included in this analysis. Effluents by sewage and refuse disposal services are excluded.

Looking at the different pollutants, we find a great deal variation for the different river basins. This can partly be explained by the different kinds of economic activity in the different areas and partly by a difference in environmental efficiency. For instance, copper is predominantly emitted in the river basin Rhine West. It is mainly caused by the activities transport over water, agriculture and land transport. In addition, the heavy metal cadmium is predominantly emitted in the river basins Ems and Rhine West. In the Ems area, the manufacture of basic chemicals and man-made fibres is largely responsible for the cadmium emissions. The chemical sector is relatively large in this river basin and also relatively emission intensive. The presence of this industry is partly explained by the favourable locations of industrial zones nearby important shipping routes in these river basins. In the Rhine West area emissions of cadmium are also quite substantial. These emissions are caused by a few different economic activities like the industries live stock, water transport, manufacture of basic metals, manufacture of electrical and optical equipment, and arable farming.

High emission intensity in the Scheldt and Ems river basins

In 2006, Rhine West generated 49 percent of all value added created within the Dutch river basins. At the same time, Rhine West was only responsible for 36 percent of all emitted nutrient equivalents. This difference can partly be explained by the type of economic activities carried out in Rhine West. Rhine West accommodates a relatively great part of the services industries, which are on average less emission intensive. In contrast, water pollution per euro value added (measured in equivalents) is relatively high in the river basins Scheldt and Ems. This high emission intensity can partly be explained by the presence of some particular industries in these river basins performing below average with respect to environmental efficiency. The low environmental efficiency in Scheldt and Ems is explained by the more flexible environmental regulations of the local authorities. The discharge permits issued by the Directorate-General for Public Works and Water Management are more flexible in the Ems and Scheldt regions. The water authority fine tunes the permits in accordance with the impact on the aquatic system. For instance, the aquatic system in marine waterways is less vulnerable than small river aquatic systems. This means that although environmental efficiency may have been low in these regions, the actual impact on water quality could be moderate (van Rossum and van de Grift, 2009). The economic activities in the Meuse basin are relatively emission extensive, especially regarding heavy metal equivalents. Livestock is an important activity generating value added in this region. As manure contains a lot of cadmium, zinc and copper, the Meuse region is responsible for the emission of relatively many heavy metal equivalents. One might therefore expect that the emission intensity for agriculture in Meuse river basin is pretty high. However, the realized emission intensity of agriculture is relatively low. Much of the manure produced is transported to areas other than Meuse. This is triggered by the relatively strict environmental regulation related to manure treatment in the Meuse area (LEI, 2006). It means that the manure intensive livestock industry transports its environmental problems related to manure production to other regions.

11.3 Emission intensity per river basin in 2006



12. *Oil and natural gas reserves*

The Netherlands has significant subsoil quantities of natural gas as well as some smaller oil deposits. Since the discovery of these stocks in the nineteen fifties and sixties they have been exploited for the Dutch economy. The extraction of natural gas makes a significant contribution to the Dutch treasury and to economic growth. The revenues from oil and gas extraction in recent years contributed on average about 3 percent to total government revenue. These subsoil resources are not inexhaustible however. Although new reserves are discovered occasionally, the cumulated production of natural gas in physical terms have exceeded remaining reserves as known today, already in 1999. More than two third of the initial gas reserves, to current knowledge, has been depleted already due to the yearly extractions. This chapter addresses the physical and monetary aspects of oil and natural gas reserves.

The methodology for the valuation and compilation of stock accounts for the oil and natural gas reserves is described in the report 'valuation of oil and gas reserves in the Netherlands 1990–2005' (Veldhuizen et al., 2009). The physical data of the oil and natural gas reserves can be found in the annual reports 'Oil and gas in the Netherlands' / 'Natural resources and geothermal energy in the Netherlands' (1987–2009), (TNO / Ministry of Economic Affairs, 1988–2010).

Production of natural gas down due to economic decline

In 2009, the production of natural gas[1)] from the Dutch gas fields amounted to 74 billion Sm^3 compared to 80 billion Sm^3 in 2008. This is close to the average production of the last ten years. Less natural gas was produced for the domestic market and exports because of the economic downturn.

Table 12.1
Physical balance sheet of natural gas

	1990	1995	2000	2005	2006	2007	2008	2009
	billion standard m³							
Opening stock	1,865	1,997	1,836	1,572	1,510	1,439	1,390	1,345
Reappraisal	248	–45	–59	–62	–71	–49	–45	45
New discoveries	33	15	25	15	9	5	3	3
Re-evaluation	287	18	–17	–46	–9	14	33	95
Gross extraction	–72	–78	–68	–73	–71	–68	–80	–74
Underground storage[1)]			1	0	0	–1	1	0
Other adjustments	0	0	0	42	0	2	–2	20
Closing stock	2,113	1,952	1,777	1,510	1,439	1,390	1,345	1,390

Source: TNO / Ministry of Economic Affairs (1987-2010), 'Oil and gas in the Netherlands' / 'Natural resources and geothermal energy in the Netherlands'. Ministry of Economic Affairs, Directorate General for Energy and Telecom. The Hague, The Netherlands.

1) In 1997 natural gas has been injected in one of the underground storage facilities for the first time.

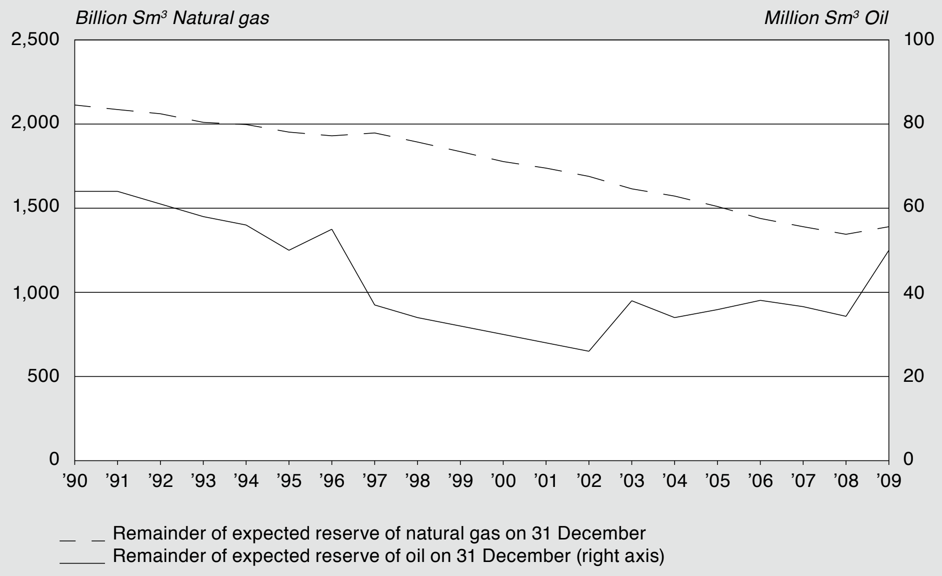
1) The production equals the gross extraction at the expense of the reserve which excludes the use of natural gas from underground storage facilities as these are considered inventories that have been produced already.

At the end of 2009, the remaining expected reserves of natural gas[2)] in the Netherlands were estimated at 1390 billion standard cubic metres (Sm^3).[3)] This corresponds to 47,200 petajoules. The Dutch economy in 2009 used 3,500 petajoules of net energy, part of which was imported like crude oil. Assuming that the net annual production remains constant at its 2009 level, Dutch natural gas will last for about 19 more years.

Reserves of natural gas increase due to revaluation

In 2009, 3 billion Sm^3 of new natural gas has been discovered by exploratory wells. This is comparable to the discoveries in 2008. The new discoveries have decreased every year. Despite significant production combined with a small volume of new discoveries, the remaining natural gas reserves increased by 45 billion Sm^3. This is explained by the re-evaluation of the reserves in which the reserves were upwardly adjusted with 95 billion Sm^3 in 2009.[4)]
Improved understanding through drilling of appraisal and production wells, increased knowledge of the fields in production, and technological advancement (like deliquification technology) have had a significantly larger impact on the expected stocks than the new discoveries. The expected oil reserves were estimated at 50 million Sm^3 at the end of 2009, which is 16 million Sm^3 above the level of the previous year. This adjustment can be explained by the redevelopment of the Schoonebeek oil field.

12.2 Dutch Reserves of oil and natural gas



2) The *expected reserve* is the remaining amount of gas or oil based on geological surveys which is supposed to be extractable with existing technology. The expected reserve includes the probable reserves, and is therefore larger than the mere proven reserves. Inventories are also included. The classification categories referred to are based upon the McKelvey Box system as explained in SEEA 2003.

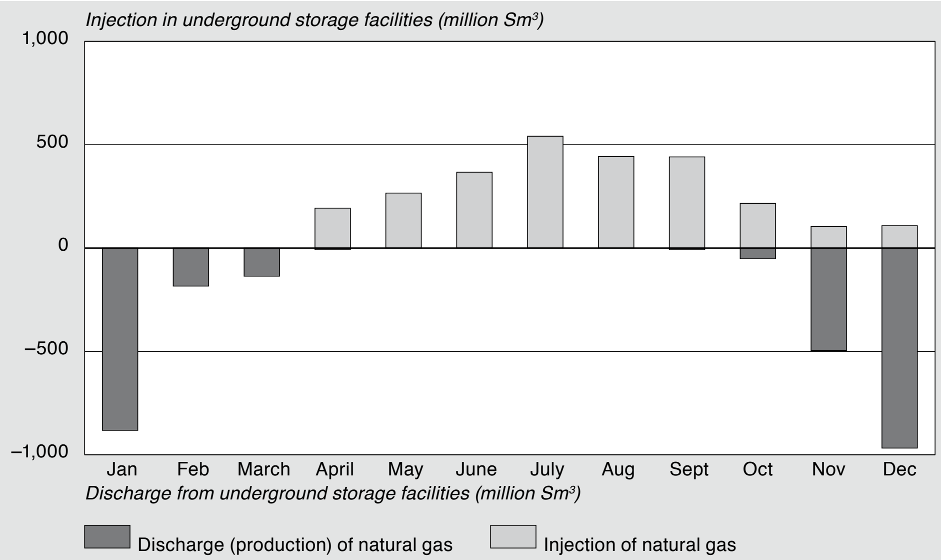
3) The 'standard' cubic meter (Sm^3) indicates a cubic metre of natural gas or oil under standard conditions corresponding with a temperature of 15 °C and a pressure of 101.325 kPa.

4) An amount of 19 billion Sm^3 was added to the reserve base due to an adjustment of the reserves of the Underground Gas Storage Fields. In former years only the amount of the cushion gas was in corporated in the figures. In the figures of 2009 also the amount of working gas and remaining gas was incorporated.

Underground storage facilities used extensively for second subsequent year

In 1997, natural gas has been stored in one of the underground storage facilities for the first time. At the end of 2009, the Netherlands had four underground storage facilities for natural gas in place. The first phase, between 1997 and 2000, was used to build up these inventories of natural gas. In 2008 and 2009 the gas storage facilities showed their usefulness as they were used extensively. In total an amount of 2,679 million Sm^3 gas was injected and 2,725 million Sm^3 was withdrawn over the course of 2009. As a result of two successive cold winters, withdrawals took place mostly in January and December and to a lesser extent in November. In the course of the year (April – September and October) the stocks have been replenished again by means of gas injections. The latest facility at Bergermeer has been filled from May till December. By comparison, in 2008 almost the double amount of 5,476 million Sm^3 was injected and 4,417 million Sm^3 withdrawn.

12.3 Use of underground storage facilities in 2009



Source: TNO/Ministry of Economic Affairs, Natural resources and geothermal energy in the Netherlands, 2010.

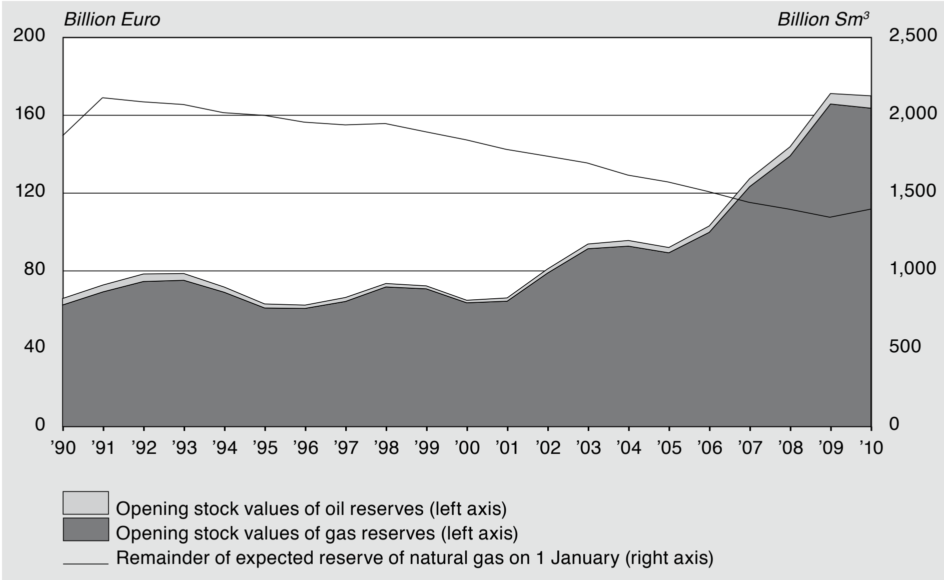
Growing value of oil and gas reserves has come to a halt

On January 1st 2010, the value of the reserves of natural gas[5)] had run up to 164 billion euro. This corresponds to more than a quarter of GDP generated in the Netherlands in 2009. Although the physical quantity of expected natural gas in the Dutch subsoil has declined since 1990, the monetary value of the remaining natural gas reserve in the same period has risen sharply. After years with strong growth, however, the value decreased by 1 percent mainly because of lower prices for natural gas and oil, which had risen sharply in the previous four years.

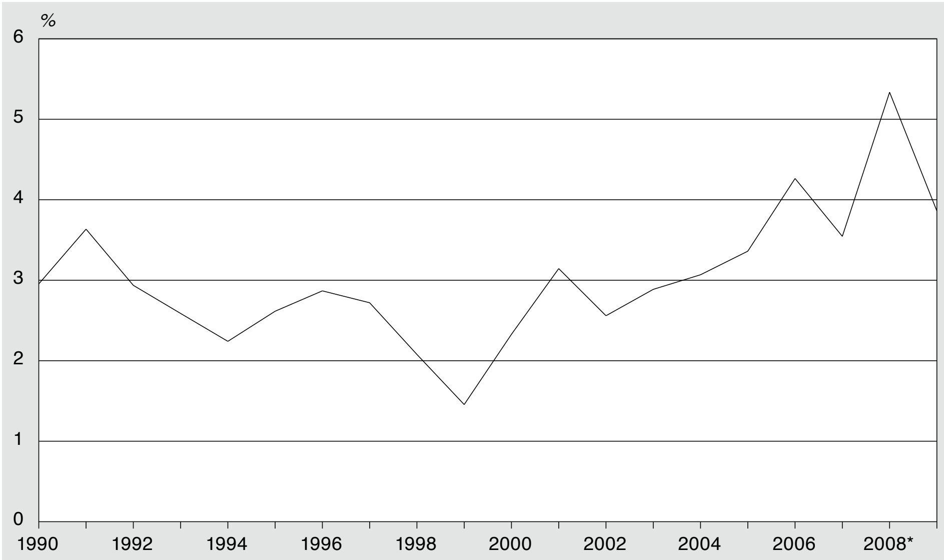
Around 80 percent of the rents earned with the extraction of oil and gas reserves are appropriated by the government through fees and royalties. The remainder flows to the oil and gas industry. In 2009 government revenues from oil and gas amounted 10 billion euro. This implies a 4 percent contribution to general government revenues. Over the last twenty years, the benefits arising from oil and gas extraction, contributed on average 3 percent to total revenue of the Dutch Government. The share in revenues increased from 1.5 percent in 1999 to 3.9 percent in 2009 with a peak of 5.3 percent in 2008.

5) In the absence of market prices, the value of oil and gas reserves has been derived with the net present value methodology (Veldhuizen et al., 2009; CBS, 2007 & 2009) in which assets are valued as discounted streams of expected resource rent which is calculated using the operating surplus of the oil and gas industry. Main assumptions used in the calculation are that the unit resource rent is calculated as the average of the past three years, and for the future is supposed to increase according to the existing inflation rate. Furthermore, a constant decline in the extraction rate has been applied until the point of exhaustion.

12.4 Reserves in physical and monetary units



12.5 Share of oil and gas revenues in government revenues



* Provisional figure

Depletion of oil and gas reserves reduces net national income with 1.1 percent

The total value generated by the exploitation of the oil and natural gas reserves is regarded as income in the national accounts. The System of National Accounts (SNA) does in fact record the depletion of natural resources in the balance sheets but not in the production or income generation accounts. From a perspective of sustainability, it is not correct to regard the complete receipts from exploitation of oil and natural gas reserves as income. The extraction hampers future opportunities for production. So the depletion costs should be properly offset against income, just as the depreciation of produced assets is treated in the consumption of fixed capital.[6)] This would constitute equal treatment of natural and produced capital used in production.

6) The depletion is calculated as the value of the extraction less the return to natural capital.

In SEEA balancing items of the current accounts, such as net income and savings, are adjusted for depletion in addition to consumption of fixed capital. The depletion of the Dutch oil and natural gas reserves causes a downward adjustment to net national income in 2009 of close to 1.1 percent. This is a decrease compared to 2008 when the correction was close to 2.3 percent. The decrease can be explained by lower prices for natural gas and crude oil together with a lower extraction level than in 2008. The smaller benefits generated from oil and natural gas extraction in 2009 are accompanied by lower cost of depletion.

13. Environmental taxes and fees

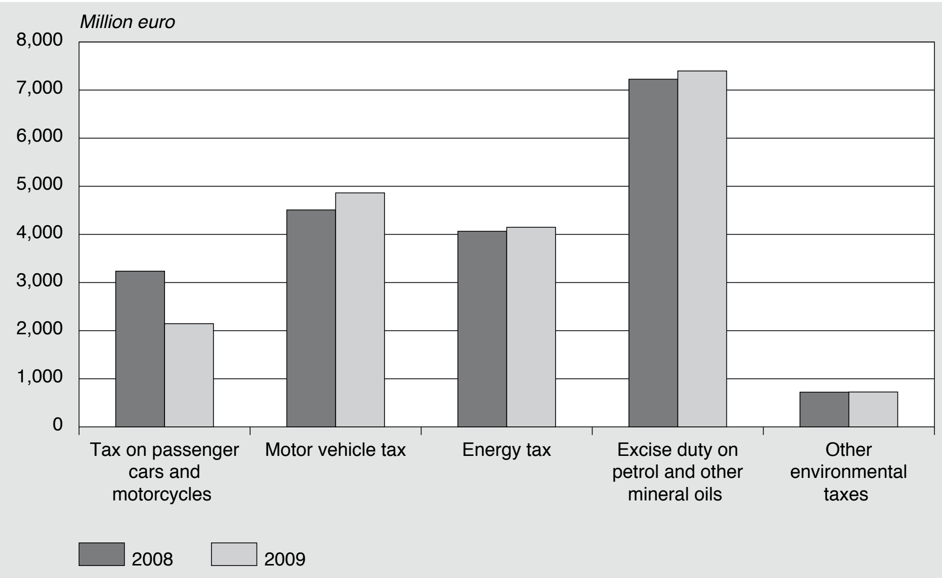
Everybody in society contributes to environmental pressures by producing waste and by buying and using products and undertaking activities that harm the environment. One of the duties of the government is to take care of public goods like the environment. To fulfil this task, central government can use various policy instruments, among which environmental taxes and fees. Tax revenues are a government's main source of income. An environment-related tax is a tax whose tax base is a physical unit (or a proxy of it) of something that has a proven, specific negative impact on the environment (European commission – Eurostat, 2001). Environmental taxes are levied to discourage people from undertaking activities that pollute the environment. These taxes include excise duties on petrol and other motor fuels, import or sales tax on motor vehicles, motor vehicle tax and tax on the abstraction of water. The government can use revenues from these environmental taxes for all kind of purposes and does not have to use them exclusively to finance environment protection measures. Besides levying taxes, central and local government, for instance water boards, have the possibility to charge fees. Companies and households are charged directly for some polluting activities, such as the discharge of waste water to the sewers and the production of waste. Revenues from these environmental fees are used directly to finance environmental measures, like the sanitation of waste water or the collection and processing of waste. This means environmental fees are seen as payments for services, while no service is supplied in return for environmental taxes.

Statistics Netherlands compiles annual data on environment-related taxes and fees by economic activity. The data can be found on StatLine, Statistics Netherlands' online database. For a description of the methodology see CBS (2010).

Less environmental tax revenues in 2009

Revenues from environmental taxes in the Netherlands fell by 2.4 percent in 2009, to 19.3 billion euro. This was mainly caused by lower revenues from the tax on passenger cars and motorcycles as a result of a considerable decrease in car imports and sales. Tax on passenger cars and motorcycles is paid once only, when the vehicle is registered or first used in the Netherlands. In addition, the Dutch government lowered the tax rate on the purchase of motor vehicles by 2.3 percent in 2009. Compared to 2008, tax revenues from the purchase of cars and motorcycles decreased by 1,092 million euro (34 percent). As part of the transition plan for mobility, the government raised the rate of the motor vehicle tax for 2009 which resulted in an increase of 354 million euro with respect to the previous year. Motor vehicle tax is a recurrent tax paid by people in whose name a car, van,

13.1 Environmental tax revenues in 2008 and 2009



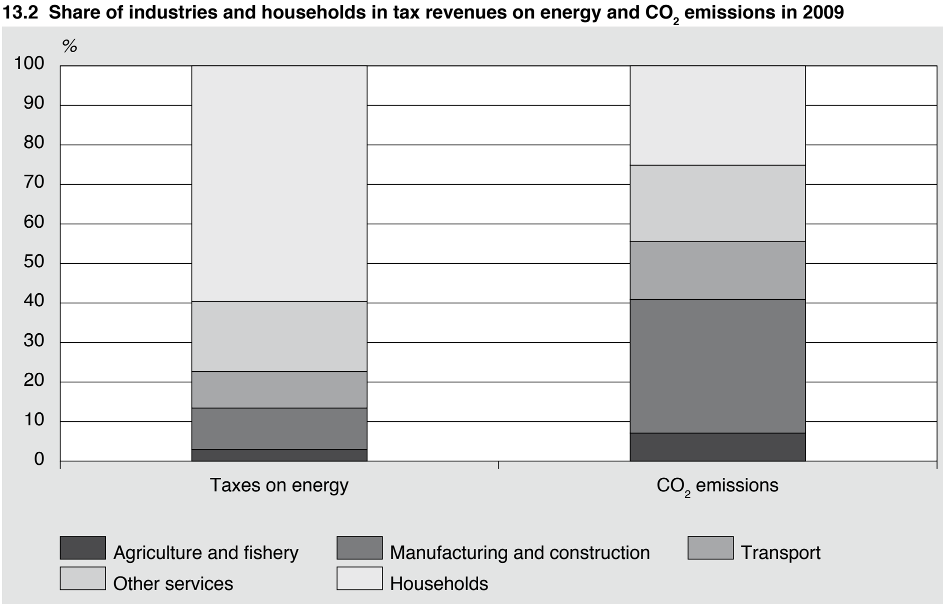
motorcycle or lorry is registered. Other minor increases were recorded for the energy tax and excise duty on petrol and other mineral oils, which were the result of increased tax rates.

In 2009, green taxes accounted for 14 percent of total tax revenues. Environmental tax reform aims to shift the tax burden away from taxes on income and capital and towards taxes on consumption, pollution, and inefficient use of energy and resources. This shift can be monitored by looking at environmental taxes as a percentage of total taxes and social contributions. Between 1990 and 1996, the share of environmental taxes increased from 9.4 to 13.5 percent. Since then it has stabilised.

Most taxes on energy paid by households

Taxes on energy include all taxes on the use of certain energy products for both transport and stationary purposes. For transport purposes the most important energy products are petrol and diesel, for which consumers are charged an excise duty. The energy tax is a tax levied on the consumption of energy products for stationary use (natural gas, other gases, electricity and certain mineral oils).[1)] Together, excise duties on petrol and mineral oils and the energy tax are classified as the group of taxes on energy. These taxes are paid by the various sectors of industry and by households. The amount of taxes actually paid are determined by the amount of energy products used, the tax rates and possible exemptions. In the Netherlands, the emission of the greenhouse gas carbon dioxide (CO_2) is directly linked to energy use, which makes it possible to compare the amount of CO_2 emitted and taxes on energy. Accordingly, the 'polluter pays' principle can be tested. In 2009 households were responsible for one quarter of total CO_2 emissions, while they accounted for 60 percent of taxes on energy. By contrast the manufacturing and construction industry contributed 34 percent to the emission of CO_2, whereas their contribution to tax revenues on energy products was only 10 percent. At 7 percent and 3 percent, the ratio of CO_2 emissions and taxes on energy respectively was also out of proportion for the agriculture and fishery sector. This means that the 'polluter pays' principle does not apply for taxes on energy.

13.2 Share of industries and households in tax revenues on energy and CO_2 emissions in 2009



One of the reasons for this unequal financial burden is the fact that households have to pay much higher rates of energy tax than companies. In the Netherlands, the rates are linked to the amount of energy consumed, and there are reduced rates for bulk consumers. In 2009 companies paid 1.7 euro per gigajoule, while households paid 9.6 euro per

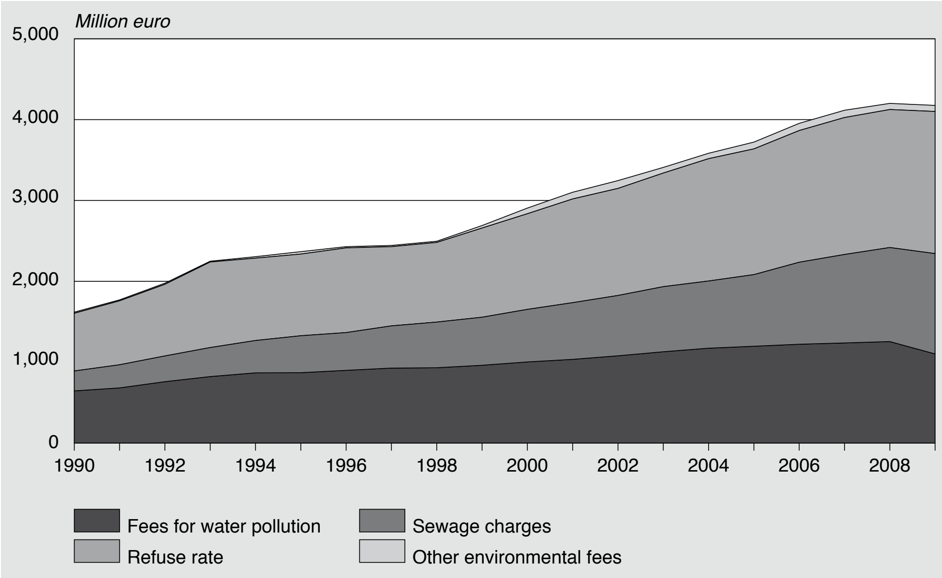
1) Natural gas, other gases and electricity used to generate electricity are exempt from energy tax.

gigajoule. Also, some transport activities, such as water transport and air transport, are exempt from fuel tax, or have to pay only a reduced rate.

Environmental fees unchanged

Revenues from environmental fees remained virtually unchanged in 2009 compared to 2008, at 4.2 billion euro. Sewage charges did increase in 2009, to 1,241 million euro. However, fees paid for water pollution fell from 1,255 to 1,102 million euro. On average, households paid 436 euro in environmental fees.

13.3 Environmental fee revenues



14. CO_2 Emission permits

The Kyoto Protocol is an international agreement that sets binding targets for the reduction of greenhouse gas emissions. For the Netherlands, the Kyoto target was set at a 6 percent emission reduction for the period 2008–2012 – the first Kyoto commitment period – with respect to 1990, the base year for the Kyoto Protocol. This means that the Netherlands may emit 1001.3 Mton CO_2 equivalents during this 5 year period, which is the national emission cap. The Dutch government has received from the United Nations in total 1,001.3 million Assigned Amounts Units (AAUs) or 'Kyoto units', each equivalent to one ton of CO_2 equivalent emission. At the end of the Kyoto commitment period, the Netherlands must surrender a sufficient amount of permits in order to cover the actual emissions that occurred during the period.

The Protocol stipulates that countries meet their targets primarily through national measures. However, the Protocol also offers the possibility to use three flexible mechanisms, namely emission trading, Joint Implementation (JI) and Clean Development Mechanism (CDM). Emission trading is the trading of emission permits, which allow the owner to emit one tonne of CO_2 equivalents. JI and CDM are mechanisms that allow parties to obtain credits (CERs and ERUs) through investments in for example energy conservation projects in developing countries that reduce greenhouse gas emissions. These credits can also be traded on the (secondary) market.[1)] The objectives of these mechanisms are to enhance cost-effectiveness in emission reduction as well as stimulate green investments.

In 2005, the European Union Emissions Trading System (EU ETS) was launched. Although the EU ETS covers also limited amounts of other greenhouse gases, we will focus in this chapter on CO_2. Presently, the EU ETS is the world's largest emissions trading system. Large energy-intensive enterprises are obliged to participate in the EU ETS.[2)] These companies will be referred to here as ETS companies. Based on a national allocation plan, the Dutch government has reserved from its total of 1,001.3 million AAUs around 437 million allowances to, in particular the CO_2 emissions of, the ETS sector (these are called AAU-EUAs). With the exception of 16 million allowances aimed for auctioning, these allowances are allocated to the existing ETS companies and a limited deposit is for allocation to new entrants to the ETS sector and for legal proceedings.[3)]

If a company emits less CO_2 in a particular year than the amount their allocated allowances allow for, it can sell the surplus on the market or save it for use (surrender) or sale in another year. Companies that emit more than the number of allowances they have received will have to secure additional permits or risk a fine. In the Netherlands, companies that still have a shortage of permits at the moment of surrender face a 100 euro fine per ton of CO_2 (Dutch Emissions Authority, 2009). Apart from companies obliged to participate – the operators – other parties such as financial institutions or individuals are also allowed to participate in permit trading – the traders.[4)] Each country that participates in the EU ETS is required to have a national emissions authority which is the entity responsible for registration and facilitation of the emission trading within the country.

1) CERs: Certified Emission Reductions obtained from CDM projects in developing countries. ERUs: Emission Reduction Units obtained from emission reduction JI projects in developed countries.

2) EU ETS covers around 10,500 installations across the 27 Member States of the European Union plus Iceland, Liechtenstein and Norway. Some sectors such as aviation, shipping, road transport and other services are not required to participate in the CO_2-trading system.

3) In this chapter 'permit' is used as a generic term that covers both allowances and credits. Although allowances and credits both represent the right to emit one ton of CO_2, they have different prices due to different risks and conditionalities.

4) In the Dutch CO_2 Emissions Trading Registry these parties have a 'person holding account' and are referred to as 'persons'.

Finally, the government itself is allowed to purchase permits on the market, or either obtain credits via investments in CDM and JI projects abroad, for the non ETS sector in case the actual emissions would be higher than the national emission cap (non ETS share).

A distinction can be made between the first trading period, which lasted from 2005 to 2007 and the second trading period from 2008 to 2012. Whereas the first period aimed to test the registration system and trading operations, the current second trading period concurs with the official first commitment period under the Kyoto protocol. A distinction is also made between the emission year which is the calendar year and the trade year. Within the compliance cycle, operators obtain allowances for emissions in the current year (T) at the end of February, have to file their emissions report on emission of the previous year (T-1) to the NEa at the end of March, and have to surrender permits connected to emission of the previous year (T-1) no later than 30 April. This implies however that trade in permits continues for several months after the close of emission year.

In this chapter we present for the first time detailed balances for CO_2 emission permits in the Netherlands. Part of the (aggregated) data of emission permits and emission trading can be found on the website of the Dutch Emissions Authority (http://www.emissieautoriteit.nl/english)[5]. For detailed descriptions of the carbon dioxide emission within the Dutch economy and within the context of the Kyoto protocol, we refer to chapters 6, 7, and 8, and the article on the Quarterly CO_2 emissions.

Half of the CO_2 emissions caused by the Dutch economy are covered by the emissions trading system

The total CO_2 emissions from Dutch companies that are obliged to participate in the EU ETS in 2009 amounted to 81.1 Mton.[6] This is 2.9 percent less than the 83.5 Mton CO_2 emitted in 2008. In 2009, ETS companies together accounted for about 50 percent of total CO_2 emissions by industries (i.e. excluding direct emissions by consumers) in the Dutch economy. This share is comparable to 2008 and slightly higher than in 2005–2007.

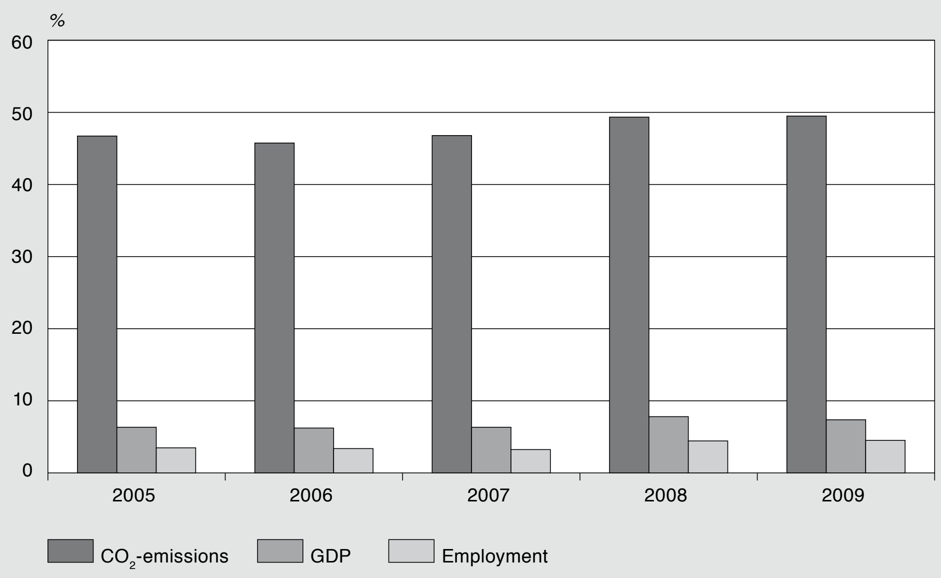
In 2008 some 180 new companies in the Netherlands joined the CO_2 emissions trading. Until 2008 many of the smaller companies, such as brickworks, horticulture holdings and food producers could get exempted from ETS if they were able to prove that their annual emissions were less than 25 kilotons of CO_2. The Dutch Registry contains close to 800 parties of which 600 were active in 2009. Operators form the majority with 382 active account users. In 2009 an additional 24 companies joined the EU ETS. Around 330 traders have set-up an account in the Registry of the Dutch Emissions Authority since its inception in 2005. In 2009 218 remained active.

As figure 14.1 shows, the joint contribution to GDP of the companies participating in the EU ETS amounted to only 7.4 percent in 2009. The share in total employment of the ETS companies is even less. This illustrates that only the most emission-intensive firms are obliged to participate in emissions trading. Although more companies started to participate in the second trading period, which started in 2008, this has led to only a small increase in the share of GDP.

[5] The Dutch Emissions Authority (NEa) is a government organization whose mission is to monitor compliance with laws and regulations governing the trade in CO_2 as well as NO_x emissions. The NEa supports the implementation of emissions trading, and acts as an independent regulator to monitor and review compliance.

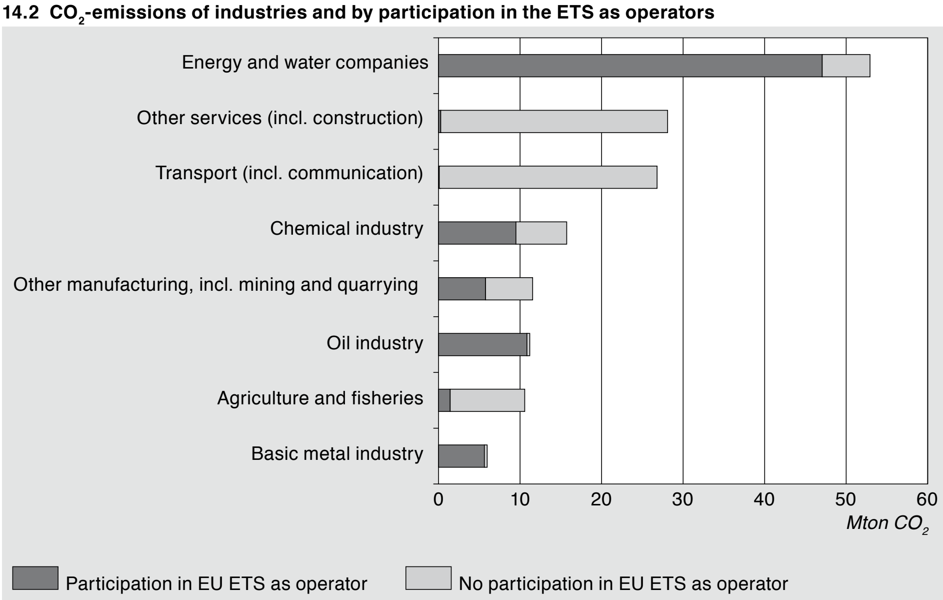
[6] The Netherlands has opted to include also N_2O emissions from nitric acid production in the emission trading system. Therefore this figure as well as other figures in this chapter include the N_2O emissions. These N_2O emissions are however small compared to the total CO_2 emissions under the Dutch ETS system (about 0.6-0.7 percent).

14.1 Share of ETS companies in total CO_2 emissions of industries, GDP and employment



Among the industries, the share of companies participating in the EU ETS as measured by their share in the CO_2 emissions can be very different, as only companies with production plants with large thermal power installations are obliged to participate.[7] As figure 14.2 shows, almost all companies in energy supply, the oil industry, the paper manufacturers, and the manufacturers of materials for construction and basic metals, participate in EU ETS as operators. The share of CO_2 emissions by ETS companies in total CO_2 emissions from the chemical industry has increased from 40 percent in 2005 to 60 percent in 2009. The shares by manufacturers of food products and beverages, textile, rubber and plastic products and, electrical and optical equipment are 59, 17, 7 and 8 percent respectively. Other sectors of industry such as manufacturing machinery, metal products, printing, the timber industry and the construction sector do not participate at all. In the agricultural sector, only 14 percent is represented, as only some major horticultural holdings are obliged to participate in the trading system. Notably, the transport sector, which accounts for more than 16 percent of the Dutch CO_2 emissions, is hardly represented in the trading system. This will change in 2012 when airlines will be required to participate in the EU ETS

14.2 CO_2-emissions of industries and by participation in the ETS as operators



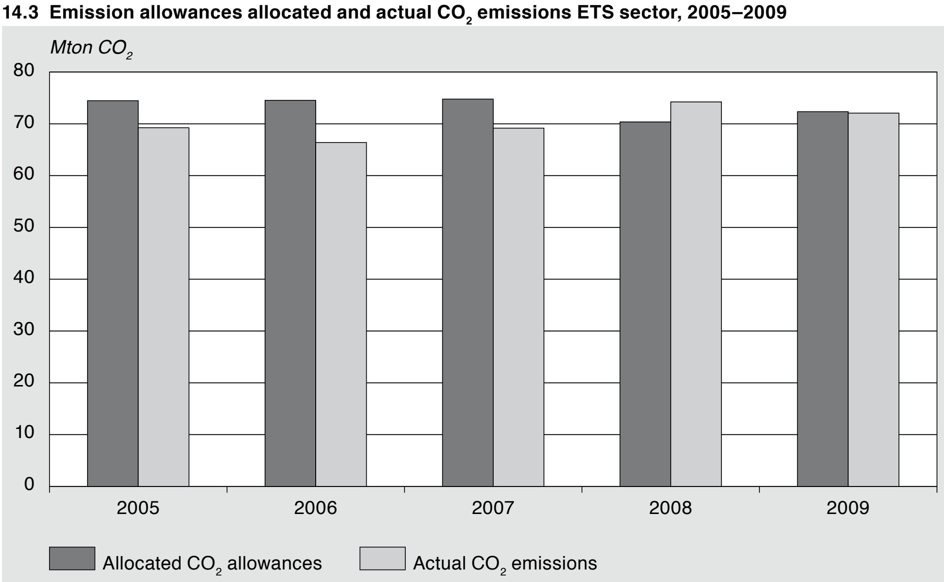
[7] Some additional companies are included within the system in areas specifically designated by the authorities.

as well. Only 1 percent of the CO_2 emissions of the services sector are accountable under the trading system. Only several large university hospitals participate right now.

Large excess of CO_2 permits in the first trading period 2005 – 2007

During the first trading period large annual surpluses of permits existed. On average, the participating companies emitted 76.8 Mton CO_2 annually which was 8 percent less than the amount of allowances received. Only emissions by energy companies were higher than their allocated allowances. Almost all other industries had significantly more allowances than they actually needed. For instance, the basic metal industry emitted only 62 percent of the total allowances they got. Because the excess CO_2 allowances could not be transferred to the second trading period, most companies offered their surplus on the market.

14.3 Emission allowances allocated and actual CO_2 emissions ETS sector, 2005–2009



Source: Dutch Emission Authority, 2010B; Statistics Netherlands 2010.

Excess of CO_2 emission permits again in 2009

Although fewer allowances were allocated for the second trading period, in an attempt to downsize the market and as a result the national emissions, so far there has only been an overall shortage in allowances for 2008. This shortage amounted to 4.4 million CO_2 permits.

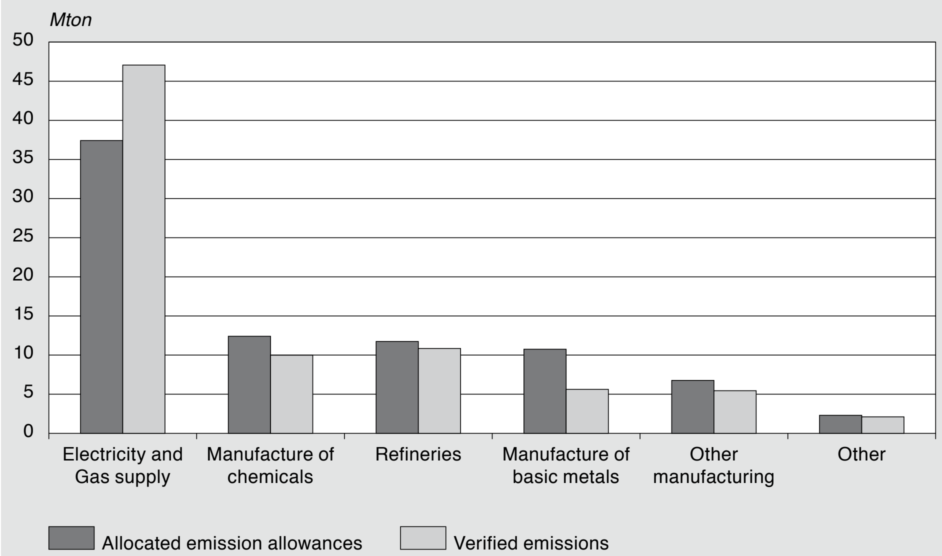
In 2009, the ETS companies together emitted 81.1 Mton of CO_2. That is close to the amount of emission allowances the companies received at the beginning of the year. The small surplus is largely explained by the economic recession which caused emissions to drop (see chapter 7). Therefore there was no shortage for the country as a whole and as a result incentives for emission reductions remained below expectations.

The electricity and gas supply industry was the only industry in 2009 with a clear shortage of emission allowances (Figure 14.4). Their CO_2 emissions proved to be 26 percent higher than the allowances they received for 2009 based on the allocation procedure. Therefore they had to secure additional permits for at least 9.4 Mton of CO_2 emissions.[8)] Among the industries with excess allowances, basic metal possessed almost half. This large surplus

[8)] In the first trading period electricity companies had obtained allowances for free but nevertheless raised the price of electricity for their customers. For this reason, the electricity companies faced a cut in the second period on their quantity of allowances. These withheld allowances were partly distributed to other industries, through the new allocation plan and as a premium, to compensate them for higher electricity prices.

in the metal industry is connected to the shortage in the electricity and gas supply industry. The basic metal industry obtains allowances connected to the combustion of cokes oven gas and gas from blast-furnaces. In practice, however, these gases are not emitted but delivered to and used by the electricity company. Subsequently, these emissions are not assigned to the basic metal industry when the amounts required to surrender are assessed. Due to an agreement, the electricity producer receives part of the allowances originally allocated to the basic metal industry.

14.4 Allocated emission allowances and actual CO_2 emissions ETS sector, 2009

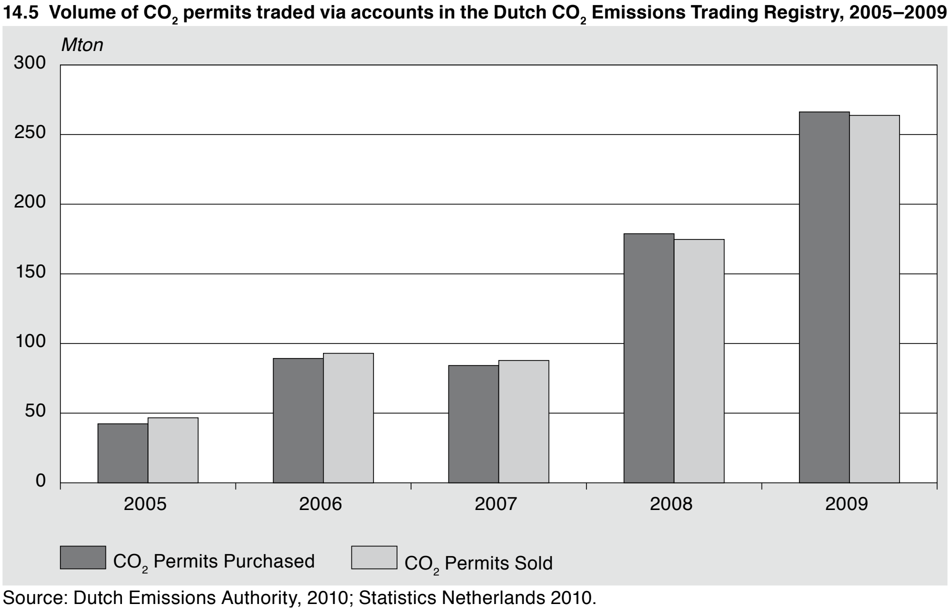


Source: Dutch Emissions Authority, 2010C; Statistics Netherlands 2010.

Volume of emission permits traded since 2005 growing rapidly

The volume of the trade in emission permits has grown rapidly since 2005. In 2009 the volume in terms of permits sold on the market accounted for 264 Mton CO_2. This is 6 times more than in 2005. The amount of permits sold was 3.5 times the number of allowances originally grandfathered by the government at the beginning of 2009. This means that permits, on average, have been traded and exchanged between account holders over three times in the course of the emission year till the moment of surrender. Part of this trade was with parties abroad.

14.5 Volume of CO_2 permits traded via accounts in the Dutch CO_2 Emissions Trading Registry, 2005–2009



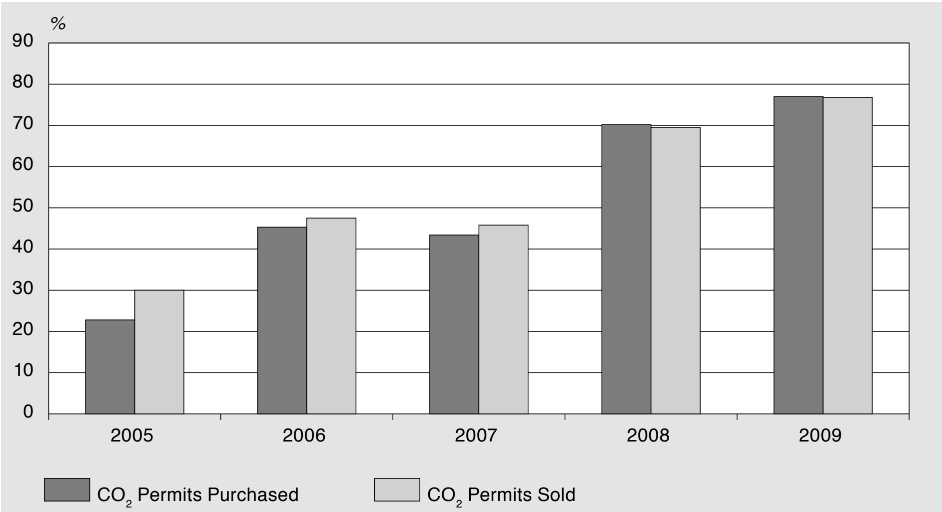
Source: Dutch Emissions Authority, 2010; Statistics Netherlands 2010.

The amount traded by operators has proved to be more or less constant over the years with an amount of permits corresponding to 20 – 30 million ton of CO_2. The growth in trade is thus predominantly caused by the person account holders. In 2009 more than 90 percent of both purchase and sale of the permits was done by the traders. Their objectives and risks are different from those of operators. Operators with large emissions have to operate with care as they have to safeguard sufficient numbers of permits in order to be able to surrender the required number of permits at the end of the year to avoid fines.[9] Within the operators, energy companies are responsible for 44 percent of trade followed by the manufacture of basic metals.

Emissions trading in the Netherlands dominated by non-residents

It is important to stress that non-residents are also able to hold an account with the Dutch Emission Authority. The number of non-residents has grown steadily since the start of emission trading. Not surprisingly perhaps, the share of non-residents in the trade volume has also steadily increased as is shown in figure 14.6. In 2009 over three quarter of the trade was performed by non-residents.

14.6 Share of non-residents in total trade of permits, 2005–2009*



Source: Dutch Emissions Authority, 2010C. Statistics Netherlands 2010.

* This figure represents only the AAU-EUAs, thus excludes the CERs or eventually ERUs.

Credits increasingly important

For policy purposes it is relevant to monitor the total amount of permits being held by residents of the Dutch economy (both operators and traders) as well as changes therein during the accounting period. This can be expressed by a balance sheet such as depicted in figure 14.7 which shows stocks and flows of permits (allowances and credits) at the aggregated macro level. The opening stock represents all permits owned by Dutch residents on the first of January of the respective year. For instance the opening stock on the 1st of January 2005 was zero as allowances where grandfathered only in the course of the year. The closing stock represents permits owned on the 31st of December for each year which equals the opening stocks of the subsequent year. The permits in the opening stock that are awaiting surrender principally represent a liability to the government caused by emissions in the previous year. During the year changes in stocks are due to surrender and grandfathering as well as market transactions. Surrender takes place in the year following the year in which the emissions actually took place.

[9] The trade of permits does not necessarily reflect the economic activities taking place in a particular year as trading can continue after 31 December until the surrender takes place before the 1st of May of the following year. Moreover permits can be saved for a subsequent year.

The balance sheet can also be broken down into institutional sectors or industries. However, the precise recording of permits in the national accounts is still under discussion with a final decision expected in the coming months.[10]

Table 14.7
Balance sheet of CO_2 permits, 2005–2009 [1]

Total	2005	2006	2007	2008	2009
	CO_2 permits (= tonnes of CO_2)				
1 Opening stock 1 st-January	–	70,784,933	68,325,649	74,142,032	63,011,421
2 Allocated free of charge (grandfathered)	86,093,888	86,949,294	87,233,598	76,801,532	83,681,383
3 Purchased - permits (allowances)	27,472,011	58,954,037	63,310,723	145,018,178	162,503,245
of which free and non-free permits [2]	22,852,534	44,926,549	45,200,538	98,269,610	95,748,673
of which from ROW [3]	4,619,477	14,027,488	18,110,185	46,748,568	66,754,572
4 Purchased - credits				16,408,706	15,190,342
of which purchased				8,967,516	8,120,228
of which from domestic projects	–	–	–	–	–
of which from ROW				7,441,190	7,070,114
5 Sold - permits (allowances)	44,790,536	71,963,498	66,238,364	149,318,028	163,540,181
of which free and non-free permits [2]	38,161,489	53,980,789	49,729,949	104,215,459	96,059,261
of which to ROW [3]	6,629,047	17,982,709	16,508,415	45,102,569	67,480,920
6 Sold - credits				10,152,343	12,848,908
of which to other residents				5,302,843	6,820,006
of which to ROW				4,849,500	6,028,902
7 Losses (cancelled permits) [4]	–	–	–	5,952,286	20
8 Surrendered, permits, credits, etc.	–	80,354,338	76,887,804	79,698,681	83,512,670
9 Closing stock 31 December	70,784,933	68,325,649	74,142,032	63,011,421	64,169,748

Source: Dutch Emissions Authority, 2010C; Statistics Netherlands 2010.

[1] Excluding non-residents in the Dutch CO_2 Emissions Trading Registry.
[2] Distinction between free and non-free permits cannot be made yet. Free permits are allowances originally obtained for free via grandfathering.
[3] ROW is Rest of the World.
[4] Replaced, and handed over (fines, etc.).

It should be emphasized that the system boundaries of the national permit registry do not exactly comply with the system boundary of the national accounts which is restricted to residents of the Dutch economy. Differences may arise because Dutch residents (traders or operators) may have an emission account in a registry abroad.[11] The current opening and closing stocks in the balance sheet as well as the volumes of trade should therefore be considered as an underestimate. Permits held by Dutch residents abroad are, due to data limitations so far not included and would add to these stocks for the Netherlands. The allocation and surrender figures (by the operators) are exact though.

The ratio of credits over allowances increases from 2008 to 2009 which shows that the flexible mechanisms of the Kyoto Protocol are becoming increasingly important instruments. With regard to the trade, both the trade with residents within the country as with trading partners abroad has grown rapidly since 2005. Regarding the trade in allowances, the number of allowances sold is larger than the number of allowances purchased. For credits it is the other way around, in 2008 and 2009 more credits were purchased than sold. This is the result of differences in conditions and opportunities for use between credits and allowances which also leads to price differences.

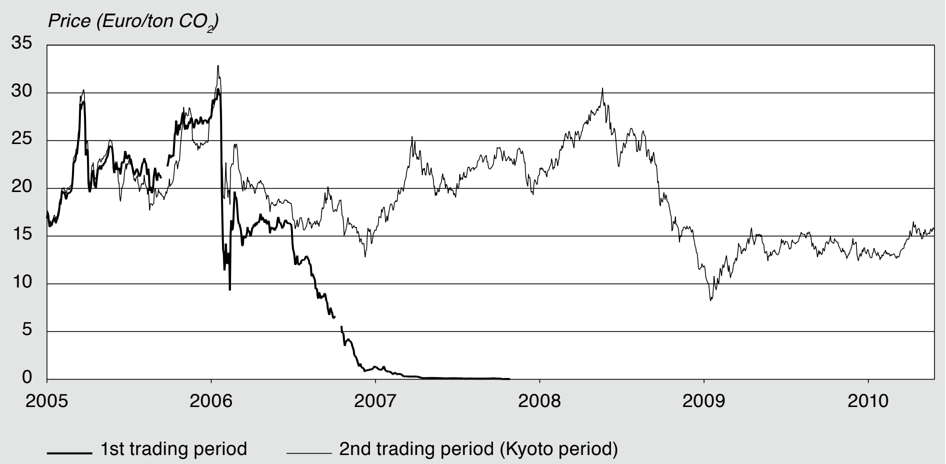
Large price fluctuations in CO_2 permits

The first trading period (2005–2007) showed an erratic course in the price for CO_2 allowances.[12] In 2005 and the beginning of 2006 prices went up to 30 euros per ton of CO_2. A cold winter and rising oil prices caused power producers to switch to cheaper coal with higher CO_2 emissions than natural gas, which led to rising prices in 2005. In April 2006

[10] Options that have been considered are recording of permits as financial assets, or as a combination of a non-produced non-financial assets and a financial asset.
[11] The analogy would be with having a bank account abroad.
[12] Different types of markets exist. The price discussed here is the price of futures of EU allowances.

the permit price dropped by more than half, after some large companies in the Netherlands, Belgium, Czech Republic and France announced they needed less permits in 2005 than the allocated number. In 2007 permit prices to the end of the first trading period dropped to nearly zero. The permits were virtually worthless because in the European market had a large surplus of permits and these rights could not be transferred to the next trading period.

14.8 Price of CO_2 allowances (EUA Futures Contracts)[1]



Source: ECX, Historic Data 2010.

[1] AAU is an Assigned Amount Unit or Kyoto unit, permits that so-called Kyoto Parties get 'assigned'. EUA or better AAU-EUA is a European Union Allowance. These are permits that 'operators' that participate within the European ETS system for CO_2 get assigned and that can be traded. Of course the type of market, either spot or futures market, has an influence on the price.

At the beginning of the second trading period (2008–2012) the price of the allowances was over 20 euro per ton of CO_2. Early 2008 the price went up because fewer allowances were allocated, which in turn created more scarcity on the market for permits. By mid 2008, however, prices began to fall again. In February 2009 the allowance prices fell below 10 euro per ton of CO_2 for a short period. Due to the financial and economic crisis, production in several industries fell sharply and hence so did greenhouse gas emissions. Companies started to offer many permits on the market, which made the price fall. The low CO_2 price reduces incentives to invest in innovative technologies such as wind and solar power, which was one of the main reasons for the implementation of a cap and trade system. Since the beginning of 2009 prices have recovered and roughly lie between 13 and 15 euro per ton CO_2.

15. Environmental protection expenditure

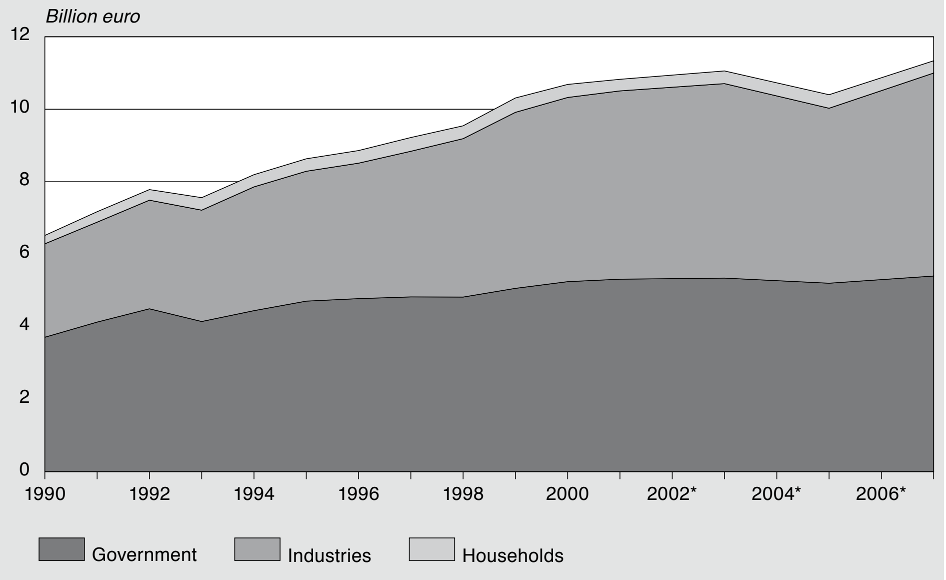
The Dutch government, in cooperation with private enterprise, takes all kinds of measures to protect the environment. Such measures result in costs for industries and households. One example is the ‘Green Label Greenhouse (GLG)’. This new greenhouse for professionally growing horticultural crops reduces the environmental impact, mainly because it requires less energy and fertilizer. Investing in GLG is stimulated by several environmental subsidies. In 2007 agriculture received almost 300 millions euro in ‘GLG subsidy’ from these environmental regulations. For 2009 and 2010 the government provided extra funds to combat the economic crisis and to stimulate private investments, including 30 millions euro in environmental subsidies (in total).

Environmental protection includes all measures aimed to prevent the damaging consequences of human activities or acts on the environment (VROM, 1998). It includes expenditures for measures to improve the environmental quality of air, water (incl. waste water), soil and groundwater, waste and noise. Data on environmental costs and its financing are available for the economic sectors government, enterprises and households. The methodology for the compilation of environmental protection expenditure statistics can be found on the website of Statistics Netherlands.[1] The data on environmental expenditure can be found on StatLine, the electronic database of Statistics Netherlands.

Environmental costs increase in 2007

From 1990 to 2007 total Dutch environmental costs increased by almost 75 percent to over 11 billion euro.[2] Between 2003 and 2005 environmental costs decreased for the first time in a decade. This decline was caused by lower environmental costs in manufacturing,

15.1 Environmental costs to sector (price level 2007)



[1] http://www.cbs.nl/en-GB/menu/themas/natuur-milieu/methoden/dataverzameling/korte-onderzoeksbeschrijvingen/2010-environmental-protection-expenditure-pub.htm.

[2] In this chapter environmental costs (after transfers) and investments are expressed in constant prices (price level of 2007). Since 1993 the specialised producers are analysed and integrally incorporated in the figures; in 1990–1992 the specialised producers were estimated in the business sector. For 2002, 2004 and 2006 averages were calculated for total environmental costs because direct information was missing.

[3] Specialized producers are enterprises specializing in the collection and treatment of waste and wastewater.

specialised producers and central government.[3] A part of past environmental investments in manufacturing is depreciated, which decreased capital costs. In 2005 to 2007 environmental costs increased again to a higher level than in 2003. The rise is caused by manufacturing, specialised producers and also by District Water Boards and municipalities. The treatment of waste and waste water accounts for approximately 60 percent of all environmental costs.

The total environmental costs for government bodies are approximately the same as for industries. The contribution of households in total environmental costs is small (4 percent). Between 1990 and 1995 government bodies contributed more than 55 percent and enterprises about 40 percent to the environmental costs. The environmental costs of industries increased most in relative terms. Government bodies are engaged in administrative activities, such as drafting policies, making laws and regulations and monitoring compliance. In addition, they are involved in waste water treatment and in the collection and treatment of waste and sewage.

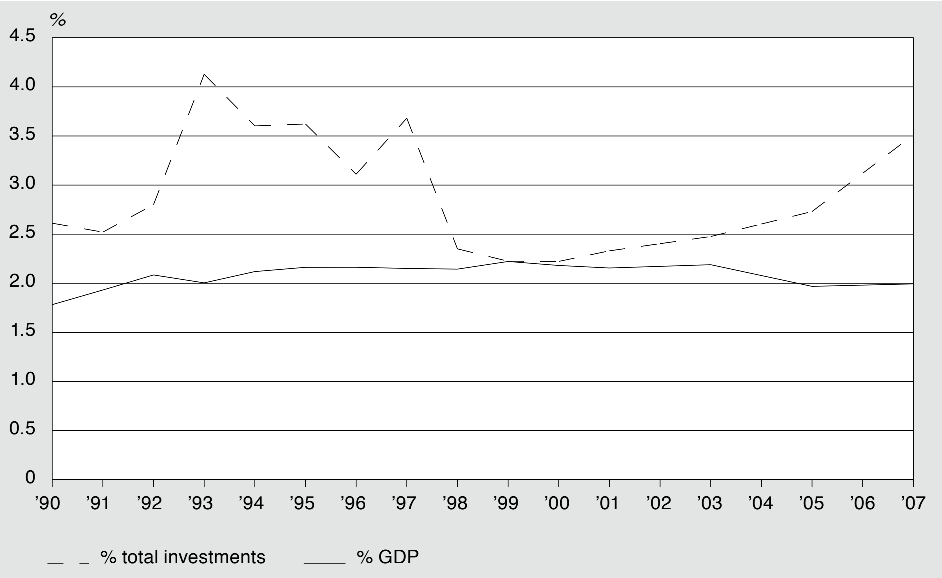
Agriculture has relative more environmental costs than manufacturers

Since 1997 the share of environmental costs in total costs for agriculture has doubled to 4.4 percent in 2007.[4] This was primarily due to higher costs of manure processing and investments in green label greenhouses. In the same period, the share of environmental costs in the total costs for manufacturing decreased from 1.2 percent in 1997 to 0.9 percent in 2007. Investments of the early nineties have depreciated, reducing the capital costs. Within manufacturing the share of environmental costs is highest for emission intensive industries like manufacturing oil products and basic chemicals.

Environmental investments increased in 2007

In 2007 total Dutch environmental investments had increased by 50 percent on 2005. Municipalities, agriculture and transport invested more in the environment. Municipalities invested in separated sewage networks for waste water and rain water. The new environmental investments in the industrial sector are in generating renewable energy, such as wind power. Environmental measures in traffic contributed to higher investments,

15.2 Share of environmental costs in GDP and environmental investments in total investments



[4] Calculated as the share in total intermediate consumption.
[5] Traffic costs are financed by enterprises and households.

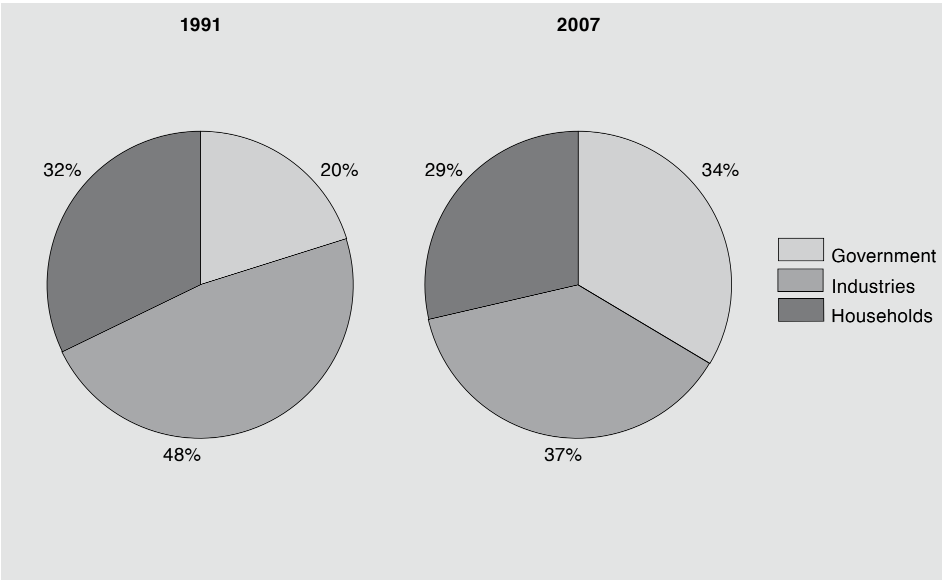
such as the installation of soot filters in passenger cars and the commitment to the Euro-4 standard.[5)] In agriculture, sustainable innovations from environment-friendly greenhouses and livestock stalls contributed to higher investments. Environment-friendly livestock buildings reduce ammonia emissions through an improved manure discharge. Preliminary results indicate that manufacturing and energy supply have invested 2.7 billion euro in the period 2006–2009. This is 60 percent more than in the previous period**.** The environmental investments in windmills by the energy sector have contributed greatly to this increase. However, in 2009 the environmental investments by manufacturing and energy supply fell by 24 percent, probably as a direct result of the financial crisis.

The share of environmental investments in total investments was high during 1993–1998. Strict environmental requirements led to substantial investments such as new wastewater treatment plants by district water boards and incineration plants by waste contractors. Huge contracts in the industrial sector also led to investments impulses. In 1998, the rate of environmental investments decreased to 2.4 percent. Since 1998 the share of environmental investments in total investments has been increasing slightly every year and more rapidly in 2006 and 2007.

Share of environmental costs in GDP stabilized

The comparison of environmental costs with Gross Domestic Product (GDP) provides insight into the relative importance of environmental policy for the economy. The total environmental costs as a percentage of GDP stabilized during the years 1990–2007. After a slight increase in the nineties the share in GDP remained constant (only a small decrease between 2003 and 2005). The relative environmental burden with respect to expenditure for the whole economy has not increased. In the nineties environmental costs increased, among others as the result of higher costs for waste and waste water treatment**.**

15.3 Net environmental costs after transfers by sector



Increased percentage government in net environmental costs after transfers

The net environmental costs after transfers, which are equal to environmental costs plus levies minus subsidies, show the contribution of a sector to the financing of environmental measures. For example, households have relatively little direct environmental costs, but their net environmental costs after transfers are high because they pay a lot in environmental levies. The share of government in net environmental costs after transfers increased at the expense of enterprises.[6)] In 1991 the government paid 20 percent of all net environmental costs after transfers. This increased to almost 34 percent in 2007. In this period the share

6) Dutch net environmental costs after transfers are calculated every odd year.

of enterprises in net environmental costs after transfers decreased. Compared to the low environmental costs (figure 15.1), households finance a major part of net environmental costs after transfers, namely on average 30 percent. Households pay many levies including water and sewerage charges and the waste product levy.

16. The environmental goods and services sector

In order to reduce pressures on the environment that lead to resource depletion and deterioration, environmental measures are becoming more and more stringent. The economic consequences of environmental measures and environmental concerns are of great interest to policymakers. They approach these topics from two perspectives. On the one hand, their interest focuses on the financial burden that is placed on the polluting industries, as they have to invest in pollution abatement control in order to comply with environmental regulation. On the other hand, environmental measures will bring about new economic activities that may create new jobs and stimulate economic growth. Policymakers therefore need information on companies and institutions that produce goods and services that measure, prevent, limit, minimise or correct environmental damage, resource depletion and resource deterioration. All these companies and institutions belong to the environmental goods and services sector (EGSS). EGSS statistics are intended to measure the size of the 'green economy' in the Netherlands. This green economy contributes to total employment, total production and the Dutch gross domestic product.

According to the definition for the EGSS used in the handbook on the EGSS (Eurostat, 2009) the sector consists of a heterogeneous set of producers of technologies, goods and services. Various activities fall under the definition of the EGSS. Table 1 presents quantitative data for economic variables for two years, 1995 and 2008, for these various activities. The data are compiled according to the guidelines of the handbook for EGSS (Eurostat, 2009). Data collection is based on three methodological studies carried out at Statistics Netherlands (van Rossum and Schenau, 2006; van Rossum and Kulig, 2008; van Rossum and van Geloof, 2009).

Table 16.1
The Environmental Goods and Services Sector in the Netherlands, 2008

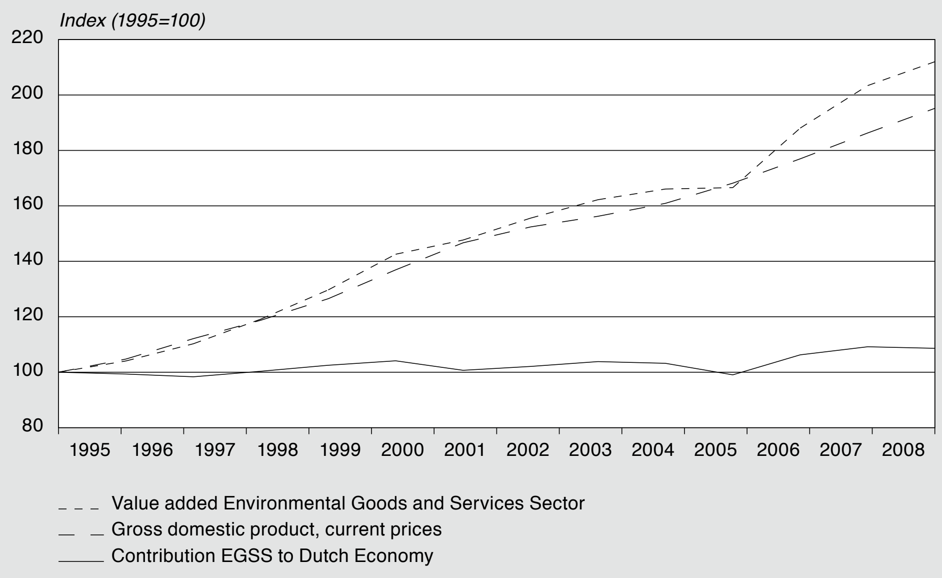
	Production		Value added		Employment	
	1995	2008	1995	2008	1995	2008
Group Activities	*million euro*				*man-years (x 1,000)*	
Sewage and refuse disposal services	3,831	8,762	1,513	3,271	20.7	27.0
Wholesale in waste and scrap	1,474	2,694	1,232	2,191	4.8	5.0
Environmental related inspection and control	15	156	7	90	0.1	1.5
Government governance related to the environment	667	1,571	369	693	6.9	8.1
Organisations and associations on the environment	46	154	28	84	0.9	1.9
Internal environmental activities at companies	1,254	1,495	561	597	10.5	5.4
Renewable energy production	96	872	62	545	–	–
Insulation activities [2]	3,230	4,770	1,250	2,009	27.6	32.8
Organic agriculture	136	921	65	294	0.9	2.3
Recycling	325	1,228	72	282	1.4	2.8
Second hand shops	84	257	28	90	2.1	4.1
Water quantity control by waterboards	513	1,105	294	559	3.6	3.7
Energy saving and sustainable energy systems	485	2,837	162	829	3.4	11.4
Environmental advice, engineering and other services [1]	293	1,474	158	742	3.5	10.7
Industrial environmental equipment [1]	425	1,245	120	292	3.4	5.0
Environmental technical construction [1]	393	873	94	218	2.6	2.6
Environmental related education	42	42	31	31	0.6	0.4
Total Environmental Goods and Services Sector	13,308	30,457	6,046	12,818	92.9	124.6

[1] Not related to energy saving and sustainable energy systems.
[2] Including installation of heating, ventilation, and air conditioning systems.

EGSS accounts for 12.8 billion euro in value added

The EGSS contributed 12.8 billion euro to the Dutch gross domestic product and 124,600 full-time equivalents (FTE's) to employment in 2008. Total production value equalled 30.5 billion euro. The Dutch EGSS consists of companies and institutions participating in various activities. Traditional environmental activities like sewage and refuse disposal play a significant role. About 26 percent of all value added of the EGSS is generated in this industry. Construction companies engaged in insulation activities and wholesale traders of waste and scrap are also important players in the sector. The remainder of total value added is generated by a variety of different activities. For example, recycling companies contribute 2 percent while shops selling used goods account for 1 percent of total value added of the EGSS. Environmental activities carried out by government bodies still play an important role. Activities related to water quantity management and other management tasks of the government account for approximately 10 percent of total value added.

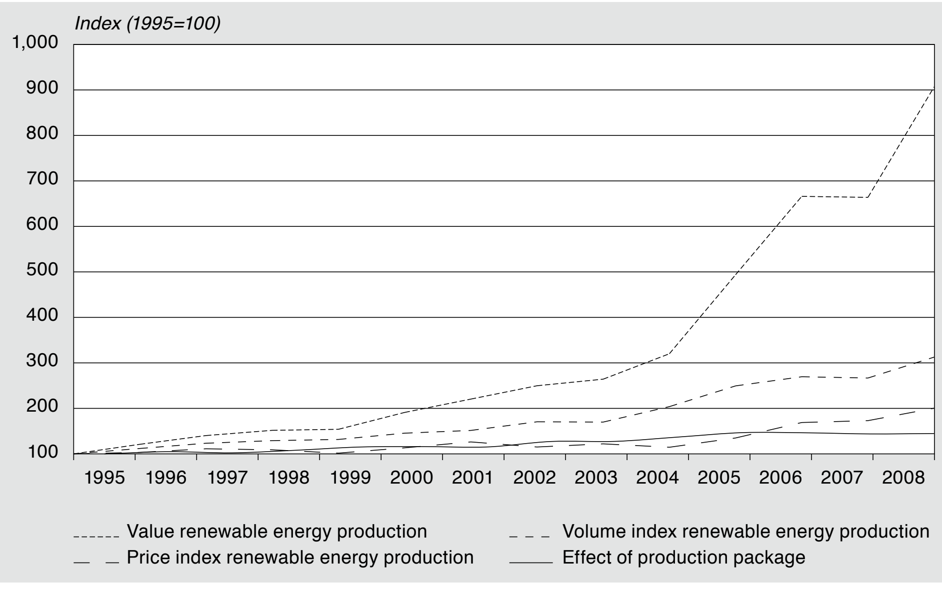
16.2 Contribution of the value added of the EGSS to the Dutch economy, indices



Contribution of EGSS to GDP is stable over time

With a contribution of 12.8 billion euro to the gross domestic product (GDP) in 2008, the Dutch EGSS accounted for 2.1 percent of total GDP. This share remained stable in the period 1995-2008. Dutch GDP in current prices rose by 95 percent in the period 1995-2008, while the EGSS grew by 112 percent. Therefore, the Dutch EGSS grew slightly faster than the Dutch economy. With regard to employment, in terms of full-time equivalents, the EGSS has a share of 1.8 percent in total employment in the Netherlands. Employment in the EGSS rose by 34 percent in the period 1995-2008. On average, employment in the EGSS grew faster than employment in the Dutch economy. Activities related to energy saving and sustainable energy systems, industrial environmental equipment and environmental advice play a relatively modest role in the EGSS, but are growing fast. These more innovative activities have grown faster than the average growth rate of employment in the EGSS. Sewage and refuse disposal services and wholesale trade in waste and scrap have grown more slowly than the average growth rate of employment in the EGSS.

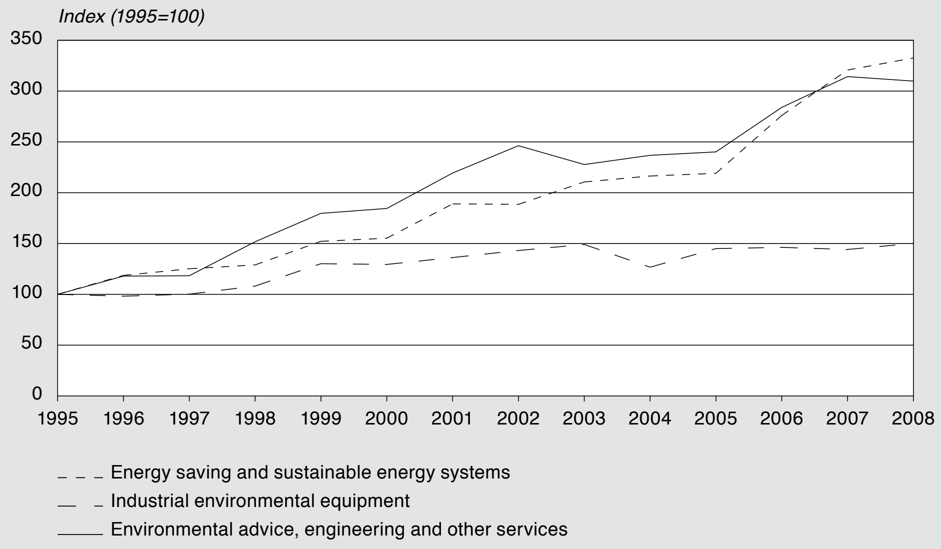
16.3 Production value of renewable energy, index



Renewable energy suppliers increased production in 2008

The production value of renewable energy was 36 percent higher in 2008 than in 2007. This increase is partly the result of more physical production (particularly more production by wind turbines and more production through biomass intake in energy plants), and partly the result of higher energy prices. Energy producers generated nine times more production value in 2008 than in 1995. Again the increase is partly the result of more physical production of renewable energy (by a factor 3) and partly the result of higher energy prices (by a factor 2). Another cause is that the composition of renewable energy being produced has changed. In the course of time, relatively more electricity has been produced at the expense of heat. In 1995, only 30 percent of the production package of renewable energy producers consisted of electricity, while this was nearly 65 percent in 2008. So, from a qualitative point of view, the composition has improved (1 joule of electricity is worth more than 1 joule of heat). This change in the production package has led to a higher production value for renewable energy producers (by a factor 1.5). These three factors combined (3*2*1.5=9) explain the increase in production value.

16.4 Energy saving and sustainable energy systems, industrial environmental equipment, environmental advice, engineering and other services), employment



Growing market for energy saving and sustainable energy systems [1)]

Within the EGSS a distinction can be made between more traditional environmental activities, such as sewage and refuse disposal services and wholesale in waste and scrap, and more novel activities. The latter activities are characterised by their innovative character. For example, activities related to energy saving and sustainable energy systems also generate employment. These activities alone accounted for approximately 11,400 full-time equivalents in 2008, the result of a growth rate of approximately 230 percent in the period 1995-2008. Value added in 2008 equalled nearly 830 million euro. Examples of these activities are the production of energy-saving technology, wind technology and solar panels. In the services industry, a lot of energy advice and energy-engineering is produced

1) There is no typical classification system for activities like environmental advice, engineering, industrial equipment, energy saving and sustainable energy systems. These activities are scattered over many different NACE classes, e.g. manufacturing, services and construction. Statistics Netherlands has set up a database with companies carrying out EGGS activities. This database of environment-related companies was re-assessed and consequently considerably adjusted in 2010 (in terms of numbers and composition). The population in the new database has been linked with the Dutch business register in order to compile statistics on value added, production and employment. As a result of the change in the population, figures for these activities differ from those published previously.

for third parties. In manufacturing, a great deal of sophisticated industrial environmental equipment[1] is produced, for example foil applications for waterproofing, underground pipe systems for purification activities, water treatment systems, water quality-control systems and purifying systems for gases. The employment related to these activities has grown in the course of the years, to reach approximately 5,000 full-time equivalents in 2008. In recent years, a large number of small and medium-sized companies providing environmental advice and environmental engineering[1] have been started up. These services alone account for 742 million euro of value added in 2008, a growth rate of approximately 370 percent in the period 1995-2008.

In-depth articles

Quarterly CO_2 emissions for the Netherlands – preliminary results

1. Introduction

There is mounting scientific evidence indicating that the emission of greenhouse gasses by human activities contributes to climate change (IPCC, 2007). Over the past centuries atmospheric greenhouse gas concentrations have increased, leading to a disrupted balance of the climate system. Climate change could affect ecosystems and economies all over the world. Many national and international agreements and regulations to reduce climate change have been formulated. Accurate and timely measurements of the amount and origin of the emitted greenhouse gasses are essential to help governments achieve their objectives. Data on national greenhouse gas emissions (national emission inventory and environmental accounts) usually become available nine months after the end of the year under review. Quarterly based CO_2 emission data could serve as a short term indicator for policymakers and researchers to assess how the greenhouse gas emissions change in response to economic growth or decline, as carbon dioxide is the most important anthropogenic greenhouse gas.

The main purpose of air emission accounts for carbon dioxide on a quarterly basis is to have data for the most important greenhouse gas available much earlier. Quarterly based CO_2 emission data will help to detect timely breaking points in currently estimated trends for emitted greenhouse gasses. In addition, quarterly emission data allow an in-depth analysis of the drivers of climate change. As the data are compatible with national accounts, CO_2 emissions can be linked directly to economic output allowing the comparison of the environmental performance of different industries. This new information could support national policy. Also, reporting the data to Eurostat could be advanced in time. More importantly, the general public can be informed on a timely and more regular basis whether emissions have grown or declined in a particular period in time. The interrelationship between the economy and the environment, in other words the mechanisms at work, can be made explicit and communicated on a regular basis. Presenting the tension between economic growth and environmental pressure on a timelier basis can raise awareness among the general public. Communicating the mechanisms at work on a timelier and more frequent basis may lead to understanding them and entice consumers and producers into making more sustainable choices in the future.

At present, Statistics Netherlands compiles annual air emission data for several air pollutants, among which greenhouse gasses (see also chapters 6 and 7). In the air emission accounts the same concepts and definitions are used as in the national accounts (see UN et al., 2003; Eurostat, 2009). Also, air emissions are attributed to different industries, households and other sources according to the same classification systems. By using the same framework as the system of national accounts the impact of the economy on the environment can be derived directly. Generally, the first data of the air emission accounts are published nine months after the year under review.[1)] By contrast, economic data from the national accounts are published 45 and 90 days after the end of each quarter.

The aim of this study is to investigate whether it is possible to compile CO_2 air emission accounts for the Netherlands on a quarterly basis.[2)] First we describe the methodology developed, using quarterly data from the energy statistics and national accounts to estimate quarterly CO_2 emissions. We compared the results and checked them with the annual air emission accounting data in order to evaluate the robustness of the methodology applied. Next, we present the first preliminary results for the period 2001 till the last quarter of 2009. The seasonality of CO_2 emissions is discussed and, particularly, how to correct for differences in weather conditions, which affect the heating of buildings, in order to make a better comparison with economic developments. Also, we made a detailed analysis of the

1) The first publication of air emissions according to the IPCC definitions (Kyoto protocol) also occurs at this moment in time.

2) This study was cofinanced by Eurostat.

developments of CO_2 emissions during the financial crisis. This study will end with some conclusions.

2. Methodology

The main goal of compiling CO_2 emissions on a quarterly basis is not so much estimating the level of emissions, but to determine the correct change in emissions with respect to the same quarter in the previous year. The focus is on developing the best methodology to estimate the changes in CO_2 emissions for both stationary and mobile sources.

The estimation methods presented here calculate the quarterly CO_2 emissions according to the resident principle i.e. according to the concepts and definitions of the System of National Accounts (SNA) and the System of Environmental and Economic Accounting (SEEA). This means adding emissions caused by residents abroad and subtracting emissions caused by non-residents from the total of emissions emitted within the national territory. Whereas for stationary sources it can be assumed that all energy products sold within a country will be consumed by resident units, this is not the case for mobile sources. This is why we have used other data sources besides the energy statistics to find the best way to estimate quarterly CO_2 emissions.

The quarterly air emission accounts have been compiled on a much more aggregated level than the annual accounts. Although data has been compiled on a more detailed industry level, including refineries, manufacture of basic chemicals, manufacture of basic metals, environmental services and agriculture, data will be published only for the following sectors:

- Agriculture, mining, manufacturing and construction (NACE 1-37 and NACE 45)
- Energy and water companies (NACE 40-41)
- Transport sector (NACE 60-62)
- Other services (NACE 45-55; NACE 63-95)
- Waste disposal sites (part of NACE 90)
- Households

In this section we describe the data sources, the general methodology to calculate the changes in quarterly CO_2 emissions for stationary and mobile sources, and the overall quality assessment.

2.1 Data sources

We used several data sources to compile quarterly CO_2 emissions. The most important data sources are the energy statistics that are published on a monthly basis. These statistics provide energy balances (supply and use) for oil products, natural gas and coal. The use of energy sources is further disaggregated into final use and use for transformation purposes. These monthly statistics do not provide much detail regarding the energy user. We only know about oil products how much is delivered to the oil refineries, the petrochemical industry and wholesale trade. In addition, separate data are available for the oil products delivered for transport purposes (final use and bunkering). For natural gas and coal we know how much is used by the energy companies to produce electricity and heat. For coal we also know how much is used by the manufacturing of basic metals. These energy statistics become available two months after the month under review.

Another major data source is the quarterly data from the National Accounts. The Quarterly National Accounts (QNA) provide a quantitative description of Gross Domestic Product, value added by kind of economic activity and the different final expenditures of GDP (consumption, investment, export and stock changes). The QNA production data are available in current and constant prices for different industries. From these production data we can calculate the quarterly changes in production with respect to the previous year. Quarterly National Accounts release their first estimate of the quarter under consideration after 45 days. The second estimate is published after 90 days. Each year the QNA data is adjusted (rebased) to the new annual National Accounts.
Finally, we used some additional data sources.

- The biomass input by energy companies and data on waste incineration are obtained from the statistics on renewable energy. Data become usually available 2 months after the end of the quarter under review.
- Heating degree days (HDD) is a quantitative index designed to reflect the demand for energy needed to heat a home or business. The HHD for one day equals the number degrees below 18 C˚. The HHD of a period is calculated by summing the HDD's for a number of days.
- For air transport we used the indicator 'Available Seat Kilometres' (ASK). Available Seat Kilometres (ASK) measures an airline's passenger carrying capacity. It is calculated as *seats available × distance flown*. This number can be calculated per plane, but is usually quoted per airline (at least in an investment context). A seat-kilometre is available when a seat that is available for carrying a passenger is flown one kilometre.

We used emission factors to calculate combustion and process emissions. The CO_2 emission factors used in this study are taken from the national fuels list (Vreuls et al., 2009).

2.2 Stationary sources

Stationary sources are all point sources for emissions, including installations for fuel combustion (generation of heat, power or energy), installations for industrial processes, and other non-mobile activities (such as storage and transfer). Emission due to combustion in stationary sources account for the largest part of total CO_2 emissions in the Dutch economy.

In order to estimate emissions on a quarterly basis, we first had to determine the annual emissions for each energy input in a particular industry. In most cases the emission levels obtained from the Dutch Emission Inventory are used here as a benchmark. Secondly, we needed to determine the emissions for the different energy inputs in a particular industry for every quarter. This was done by multiplying the quarterly consumption of a typical energy input with the relevant emission factors. Next, we had to select an indicator which is capable of estimating the emissions for the same quarter the next year for a particular energy input in a particular industry. Subsequently, we had to sum up the estimated emissions of the four quarters. The level and the development of the computed year emissions, which are based upon the four quarters, must be close to the yearly figures of the existing yearly statistics. Finally, after carrying out the estimates for the four quarters, we had to rebase the sum of the four quarters with the 'real' emissions at year-level before we could make estimates for the new quarters.

For certain industries, such as refineries, basic chemical industry, basic metal producers, environmental services and electricity producers, much of the information on energy inputs is directly available from the energy statistics. For other industries and households this information is lacking and some assumptions have to be made to attribute the remaining energy inputs to these industries. This especially holds for natural gas combustion by households and services. It is done by using several indicators such as heating degree days, gas use by regional supply systems and monetary production data from the quarterly national accounts.

Besides the direct combustion of fuels, CO_2 emissions can also be produced during certain industrial processes, such as the production of cokes, refining crude oil or the production of iron and steel. Process emissions are rather small with respect to total CO_2 emissions. We used information on production from the National Accounts to set emission levels at the quarterly level per industry. Production growth is the indicator for estimating emissions for the same quarter the year after.

2.3 Mobile sources

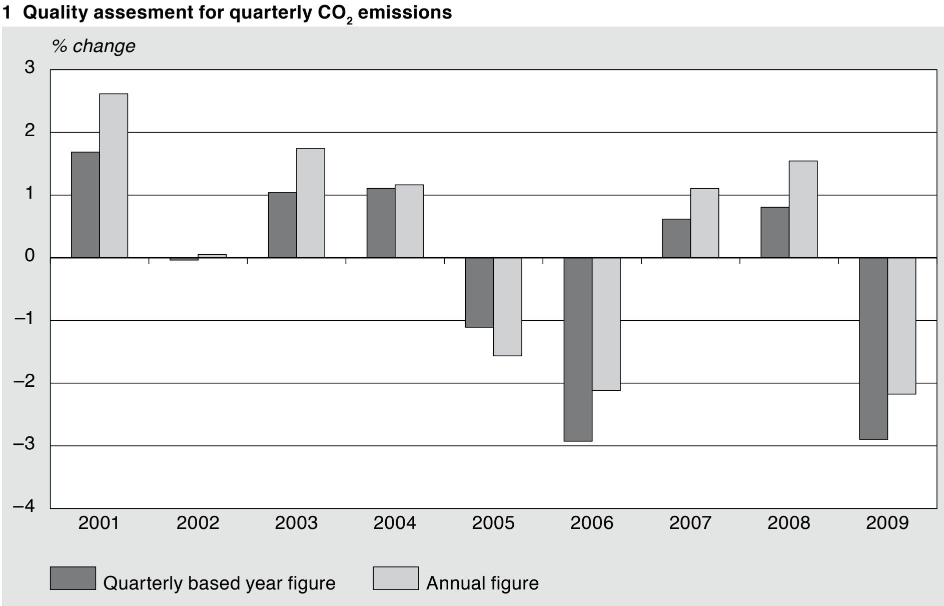
Mobile sources include a variety of means of transport such as passenger cars, trucks, inland waterway vessels, seagoing vessels and aircraft, as well as mobile machinery with combustion engines, such as farm tractors and forklifts. We applied a general methodology for each mode of transport (road, water and air transport), although the data sources used to calculate quarterly emissions for the mobile sources are different. Firstly, we selected a data source which is available on a monthly or quarterly basis to act as an estimator for the quarterly changes in CO_2 emissions. Secondly, we calculated the quarterly emissions for a base year. This was done by a) calculating the share of the emission for each quarter in the year total, which are based on the quarterly shares of the selected data source, and b) multiplying these shares with the annual CO_2 emissions which is already known from the annual air emission accounts. Thirdly, we calculated the quarterly changes for the selected data source. These estimated changes are used to calculate quarterly emissions by multiplying the quarterly changes with the quarterly emissions from the base year. Fourth, when the annual figure for CO_2 emissions becomes available from the annual air emission accounts, the quarterly emission from this year are rebased.

For road transport, we used the quarterly changes for delivery of oil products (petrol, diesel, LPG) as an estimator to calculate changes in CO_2 emissions. Then we assigned the emissions from road transport to economic sectors and households which are the result of transport activities in the course of their production or consumption. For this attribution we used a distribution key obtained from the annual emissions accounts of the previous year. For water transport (inland and seagoing vessels) quarterly changes in economic production provide the best indicator to estimate the changes in emissions. For air transport the indicator Available Seat Kilometres (ASK) provides the best results as this indicator corrects for the seat occupancy in the planes.

2.4 Quality assessment

The overall quality of the applied methodology can be tested by comparing the development of the sum of the estimated emissions for the four quarters with the development of the already existing annual statistic for CO_2 emissions from the air emission accounts. We made this quality assessment for the period 2001–2009. The results of the applied methodology for quarterly CO_2 emissions must be close to the annual data from the air emission accounts, because we need to avoid major adjustments in figures afterwards and difficulties in communicating about the CO_2 emissions data to the public. For the economy as a whole, the average error for quarterly CO_2 emissions (in absolute terms) is 0.6 percent over the period 2001–2009.

1 Quality assesment for quarterly CO_2 emissions



The average error is very different for the NACE classes under consideration. The average error is small for the energy companies (0.6 percent), which is good because this industry is responsible for nearly 25 percent of total emissions. The error for the industries manufacturing of petroleum products, chemicals and man-made fibres and basic metals is quite substantial (2–4 percent). This is mainly because there is no quarterly information on natural gas use for these sectors. This shortcoming leads to large deviations between the annual and quarterly figures. The problem is big at the meso-level, but quite small at macro level. This is because at the macro level there is information available on total natural gas use on a quarterly basis. The average error for household's combustion of natural gas is small (1.7 percent). Apparently, the indicator 'energy use via regional supply systems' is a pretty good estimator for household emissions. In contrast, the average error for services' emissions due to combustion of natural gas is quite large. This is mainly because energy use by services is a balance item in the energy statistics.

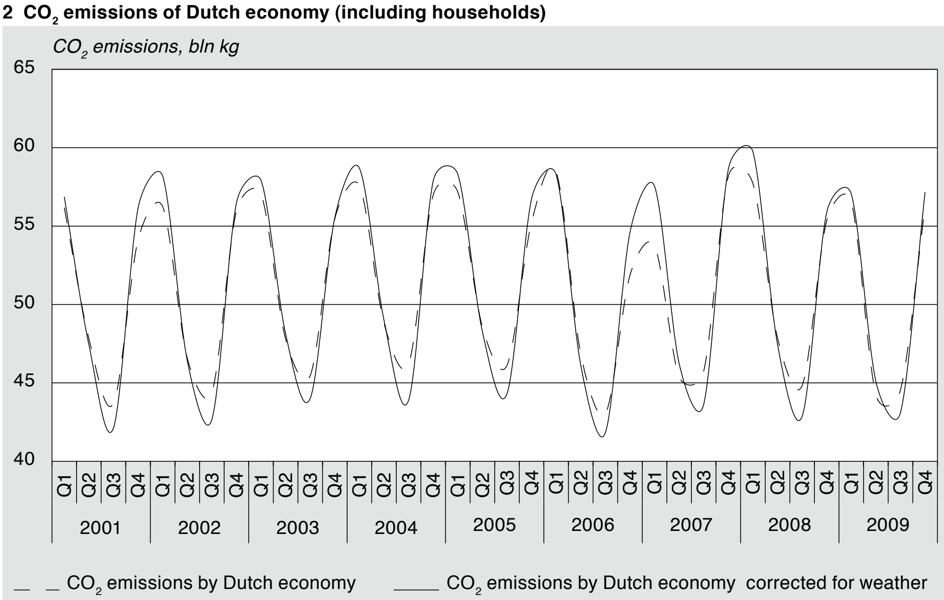
The average error for quarterly CO_2 emissions for all mobile sources is approximately 0.8 percent over the period 2001–2008. Overall, quarterly emissions for mobile sources seem to be more difficult to estimate than emissions from stationary sources. Quarterly emissions for water transport are particularly hard to estimate. This is mainly because the annual emissions from mobile sources are not directly calculated by using energy use data of the energy statistics, as is the case with stationary sources, but by using other statistical data sources. For example, emissions from road transport on annual basis are primarily based on the number of kilometres travelled by vehicles and not directly based on fuel consumption. This data source is not available on a quarterly basis and, therefore, other proxies have to be used to estimate the quarterly emissions. As described above, the best proxy for road transport is domestic fuel delivery. So using different data sources is the main cause for discrepancies between the annual and estimated quarterly emission data for mobile sources.

3. Results and discussion

3.1 The seasonality of CO_2 emissions

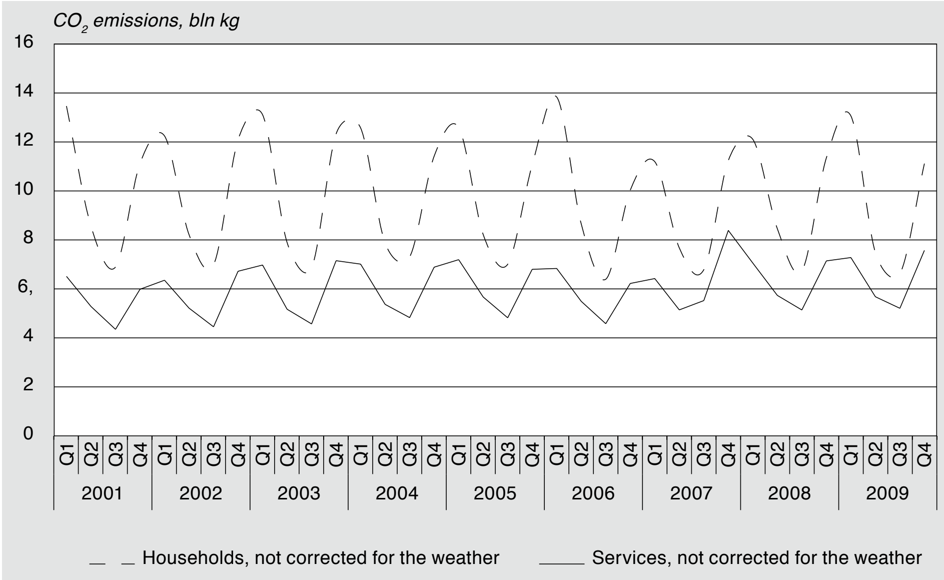
Emissions per quarter show a clear seasonal pattern (Figure 2). Emissions in the first and fourth quarter (Q1 and Q4) are significantly higher than in the second and third quarters (Q2 and Q3). On average, emissions vary between 42 and 60 Mton in the period 2001–2009. Emissions in Q1 and Q4 are higher for two reasons. Firstly, average temperatures are lower in quarter 1 (winter) and quarter 4 (fall) than in quarter 2 (spring) and quarter 3 (summer). As a result of lower average temperatures houses and offices need more heating. This heating goes along with increased natural gas combustion, which induces more CO_2 emissions.

2 CO_2 emissions of Dutch economy (including households)



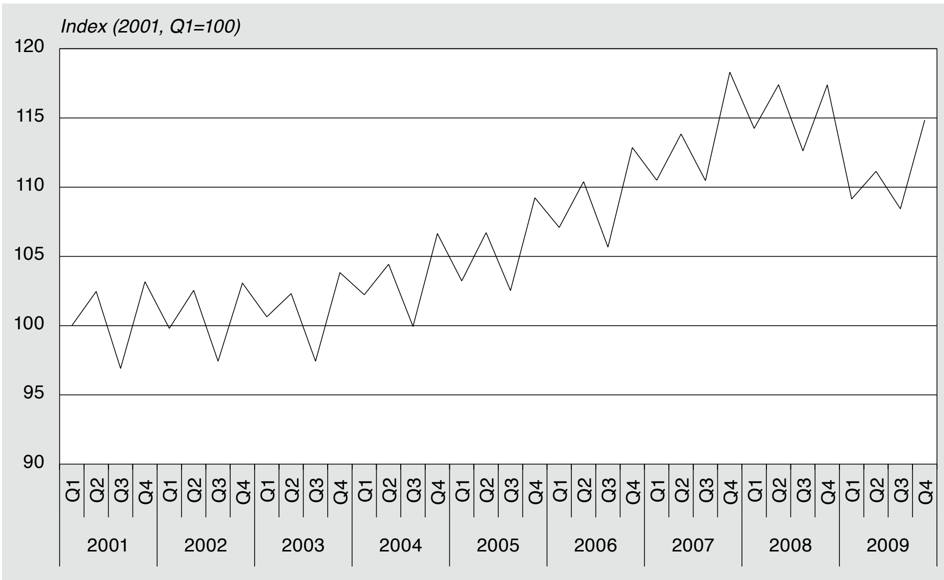
The temperatures in two corresponding quarters of different years may differ significantly. For example, the first quarter of 2008 was significantly colder than the first quarter of 2007.

3 CO_2 emissions by households and services



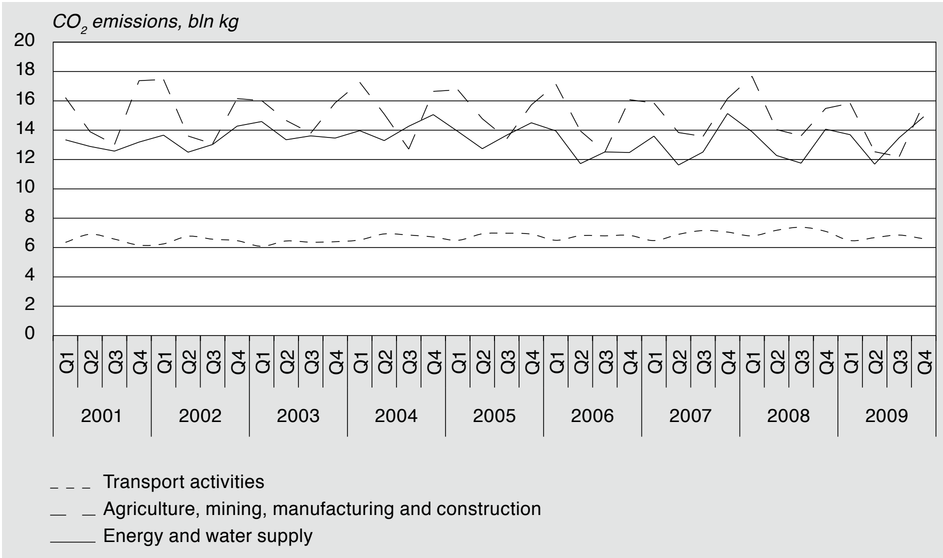
These differences in weather conditions greatly influence the emissions for households and services (Figure 3). This effect of different temperatures between two identical quarters in different years for households and services can be corrected by dividing the quarterly emissions by the number of heat degrees days and multiplying it with the average heat degrees days of that quarter as measured over a long time period (figure 2). By correcting for these differences in weather conditions, one can analyse the structural developments in CO_2 emissions of the Dutch economy over time.

4 Gross Domestic Product, price level 2000, index (2001, Q1=100)



The second reason for the strong seasonal pattern in quarterly CO_2 emissions is that economic activity also has a very strong seasonal pattern (Figure 4). Economic activity is usually greatest in quarters 2 and 4 and smallest in quarters 1 and 3. Economic activity has a significant impact on the combustion of fossil fuels and thereby on the CO_2 emissions to air. Figure 5 shows the emissions for the industrial sectors ‘transport’, ‘agriculture, mining, manufacturing and construction’ and ‘energy and water supply’. The emissions of transport are the lowest and not so volatile as those of the activities of ‘agriculture, mining, manufacturing and construction’ and ‘Energy and water supply’. The emissions of ‘agriculture, mining, manufacturing and construction’ are very volatile due to the seasonal pattern of emissions of agriculture. The emissions in horticulture are especially high in Q1 and Q4 and relatively low in Q2 and Q3. Horticulture, which is quite large in the Netherlands, combusts more natural gas in wintertime to heat its greenhouses. Also, animal farmers use more gas in winter to warm the stables. A relatively large part of total activity in air transport takes place in quarters 2 and 3 when tourists take their summer holidays. In these quarters the emissions are also relatively large. Energy companies only show a weak seasonal effect, with slightly higher emissions during winter due to the higher electricity production for lighting houses and offices.

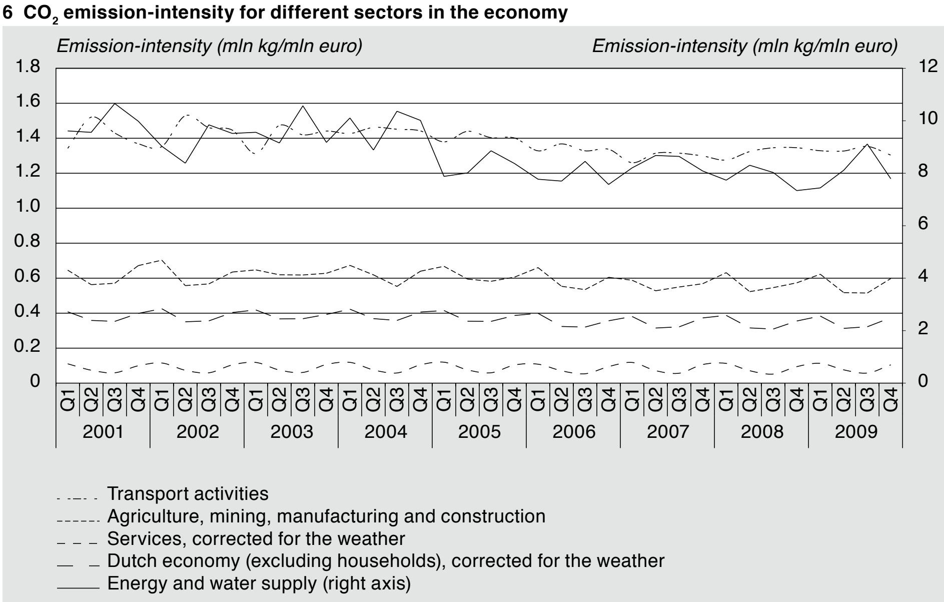
5 CO_2 emissions by transport activities, 'agriculture, mining, manufacturing and construction' and energy and water supply



3.2 Large differences in emission intensity per sector.

Emission intensity, defined as the number of emissions per unit value added, differs greatly from one economic sector to another. The emission intensity for energy and water supply is approximately 20 times higher than the emission intensity of the Dutch economy as a whole. The sector ‘services’ has the lowest emission intensity over time, whereas the

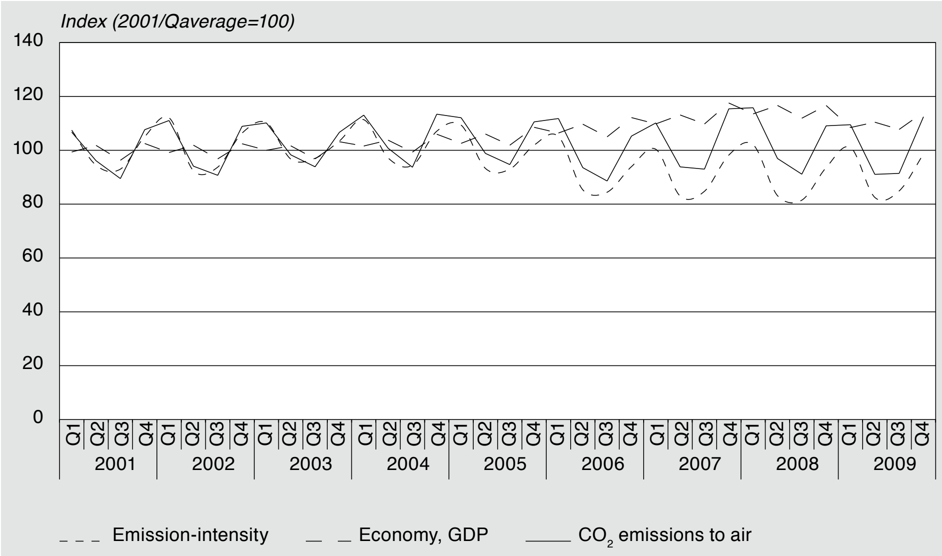
6 CO_2 emission-intensity for different sectors in the economy



emission intensity of the 'transport' sector is approximately 3.5 times higher than that of the Dutch economy as a whole. It holds that the emission intensities of all sectors have decreased over time. CO_2 emissions have a stronger seasonally pattern than GDP. Apparently, the effect of differences in the weather (heating) is quite large for CO_2 emissions.

Quarterly emissions also allow studying decoupling of CO_2 emissions with economic growth in more detail. In the period 2001–2009 GDP has grown faster than CO_2 emissions, leading to a decrease in emission intensity. As a result, the long term emission intensity has decreased over time.

7 Development of emission-intensity, excluding households, corrected for the weather, index (2001/Qaverage=100)



3.2 The effects of the financial crisis on CO_2 emissions

Many economists considered the financial crisis that started in 2008 to be the worst since the Great Depression of the 1930s. It contributed to the failure of key businesses, an estimated loss of trillions of U.S. dollars in consumer wealth, substantial financial commitments incurred by governments, and a significant decline in economic activity. The Dutch economy was hit hard. In 2009 economic growth was nearly -4 percent. Quarterly CO_2 emission accounts make an in-depth analysis possible of the development of CO_2 emissions in this period and the economic activities causing the observed changes. For the first 3 quarters of 2008, the quarterly national accounts still showed positive economic growth for the Netherlands. In the last quarter of 2008, the economy shrank by 0.8 percent, while it declined by 3.9 percent in 2009. The quartely decline was –4.5, –5.3, –3.7 and –2.2 percent respectively. Table 8

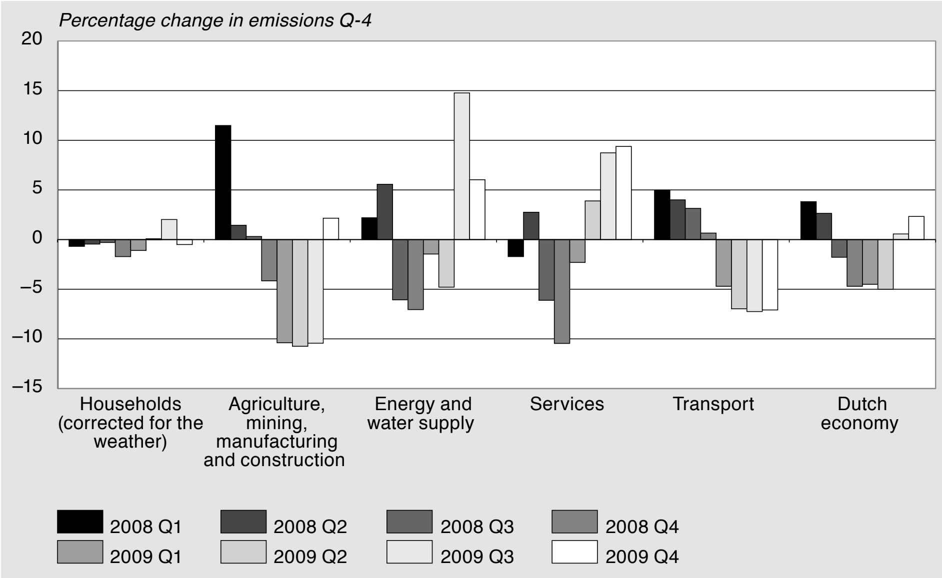
Table 8
Macro economic growth and growth per sector

		Agriculture, mining, manufacturing and construction	Energy and water supply	Services	Transport	Dutch economy
		%				
2008	Q1	3.8	8.4	3.1	3.7	3.4
2008	Q2	2.4	10.3	3.1	3.3	3.1
2008	Q3	1.0	1.1	2.5	0.8	1.9
2008	Q4	–5.0	2.4	0.9	–2.9	–0.8
2009	Q1	–9.1	2.4	–2.7	–8.5	–4.5
2009	Q2	–9.8	–2.6	–2.8	–7.2	–5.3
2009	Q3	–5.1	1.1	–2.4	–7.8	–3.7
2009	Q4	–2.1	–0.1	–1.4	–4.1	–2.2

shows economic growth for different sectors in the economy during 2008 and 2009. Comparing the economic growth data with the changes in CO_2 emissions reveals that the decrease in emissions started earlier (third quarter of 2008) than economic growth (Q4 of 2009). In addition, emissions of the total economy started to increase already in the second half of 2009, where economic growth was still negative. This result may suggest that quarterly CO_2 emissions could serve as some kind of early warning. Below, we present a more in depth analysis of quarterly emissions by sector (table 8 and figure 9) that will help to support or dismiss this observation.

The emissions of households (adjusted for weather conditions) are not very much influenced by the financial crisis. Both the emissions for heating and transport remained fairly constant in this period. This is in line with household consumption which decreased only slightly in 2009.

9 Change in CO_2 emissions per sector



The production sectors in the Dutch economy show a very different picture, however. In the first quarter of 2008 emissions of ‘agriculture, mining, manufacturing and construction’ increased substantially. This was mainly caused by more emissions from agriculture (more natural gas combustion for cogeneration in horticulture) and oil refineries (more refinery gas combustion). Since the fourth quarter of 2008 the emissions of ‘Agriculture, mining, manufacturing and construction’ have declined every quarter (compared to the same quarter of the previous year). This corresponds with the extreme negative economic growth in this sector. Manufacturing (oil refineries, chemical industry, and basic metal industry) is most responsible for this decline in emissions. The economic shrinkage of this sector levels off in the course of 2009. In the last quarter of 2009, it shows a slight recovery. The reduction in emissions levels off as well.

The CO_2 emissions of the energy companies already started to decrease in the third quarter of 2008. There were several causes for this decline. The main reason was a lower input of coal for the production of electricity. As the input of natural gas and biomass increased, the decline in CO_2 emissions is due to a change in the energy input mix. Also total electricity production by energy companies decreased while the electricity produced by other sectors (e.g. manufacturing, agriculture) increased. Finally, relatively more electricity from nuclear power was produced in the third quarter of 2008, lowering the CO_2 emissions from the energy companies. In the second half of 2009, energy companies showed a remarkable increase in emissions. In the third quarter these emissions increased with 15 percent. Growing exports were the main reason for the increase in emissions in this quarter, as the domestic demand for electricity did not change that much during 2009. The Netherlands imports less electricity than before and has become a net-exporter of electricity. The reason behind this change is probably the dip in natural gas prices. This improved the competitive position of Dutch energy companies, that greatly rely on the input of natural gas for their production process, resulting in an increase of the export of electricity. This change has induced a higher emission level for energy supply companies.

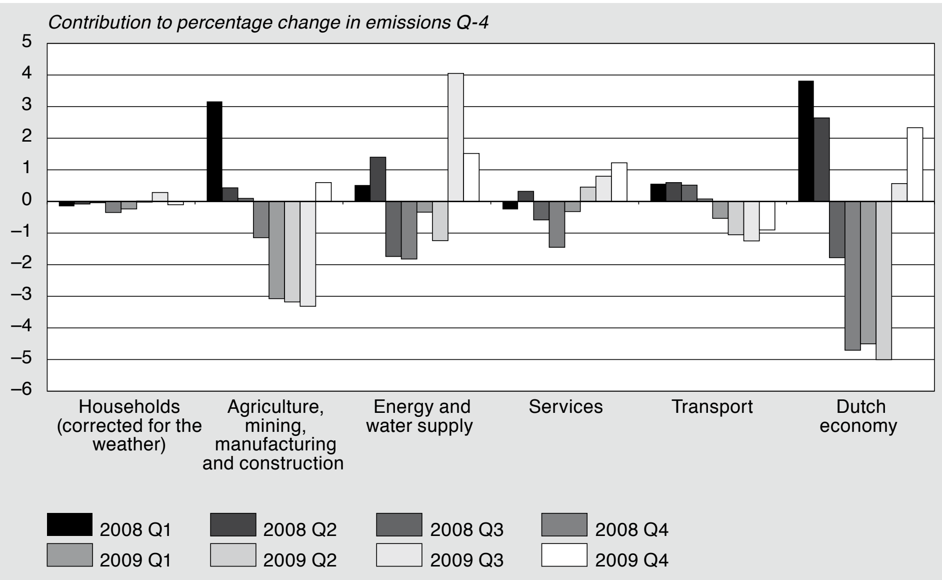
Emissions of services already declined in the third quarter of 2008. This was partly due to fewer emissions by waste incinerators. The increase in emissions in quarters 3 and 4 for services in 2009 is quite remarkable. This increase is mainly the result of more emissions of environmental services, more specifically waste incineration. Waste incinerators have incinerated more waste in these periods than in the previous periods. Maybe increased capacity has led to increased incineration activity.

Transport activities still grew in the first 3 quarters of 2008, but showed negative economic growth in the last quarter of 2008 and in all four quarters of 2009. This decline in activity resulted in lower CO_2 emissions by transport in these five quarters. Emissions by water transport were significantly lower, whereas emissions from air transport only dropped a few percent. Economic decline in the transport sector was sharper than the decrease in emissions. This can be explained by the fact that the transport of passengers and cargo by ships and planes was probably less energy efficient (lower load factor).

The developments in the emissions of all different sectors together determine the reduction or increase of emissions at national level on a quarterly basis. The share of emissions of each sector in total emissions is not equal for every sector. This is corrected by calculating the contribution of a typical sector to the increase (or decrease) in emissions at the national level. These contributions to percentage changes in emissions are presented in figure 10. It can be deduced from this figure that developments in energy supply and 'agriculture, mining, manufacturing and construction' sector mainly determined the overall developments for the whole economy.

Figure 11 provides a summary of the developments in a diagram displaying the developments in emissions and economic growth for all sectors and all quarters in 2008 and 2009. The impact of the financial crisis on CO_2 emissions is summarized in this diagram.

10 Contribution to percentage change in emissions



This brings us back to the question whether quarterly CO_2 emissions served as an early warning indicator for the financial crisis. Detailed analysis showed that the early decline in emissions in the third quarter of 2008 was mainly due to a decrease in emissions in energy companies and for a small part in the service and transport sectors. The reduction in emissions by energy companies was more the result of a different energy mix and not really of diminishing demand for electricity. In addition, the increase in CO_2 emissions by energy companies in the second half of 2009 was induced by growing electricity exports and more domestic supply for domestic demand. This was primarily the result of the improved competitive position of Dutch energy companies relative to energy companies abroad and not due to signs of an early economic recovery within the Dutch borders (total domestic demand for electricity declined in the last two quarters of 2009). Also more emissions by environmental services contributed to the increase in emissions in the second half of 2009. More productive capacity may have led to more incineration activity. We therefore conclude that, although it seems that CO_2 emissions anticipated the pattern of economic decline and growth, we cannot say that quarterly CO_2 emissions serve as a structural early warning sign for negative or positive economic developments.

4. Conclusions

This study shows that it is possible to compile CO_2 air emission accounts for the Netherlands on a quarterly basis. After comparing and checking the results with the annual air emission accounting data in order to evaluate the robustness of the methodology applied the results are satisfying. For the economy as a whole, the average error in development for quarterly CO_2 emissions (in absolute terms) is 0.6 percent over the period 2001–2009. There is no particular bias in the estimates one year the adjustment is positive while in other years the adjustments are negative.

Emissions per quarter show a clear seasonal pattern. Emissions in the first and fourth quarter (Q1 and Q4) are significantly higher than in the second and third quarters (Q2 and Q3). Emissions in Q1 and Q4 are much higher because average temperatures are lower in quarter 1 (winter) and quarter 4 (fall) than in quarter 2 (spring) and quarter 3 (summer). As a result of lower average temperatures houses and offices need more heating. This heating goes along with increased natural gas combustion, which induces more CO_2 emissions.

In 2008, there is no clear evidence that quarterly CO_2 emissions served as an early warning indicator for the financial crisis. Although it seems that CO_2 emissions anticipated the pattern of economic decline and growth, we cannot say that quarterly CO_2 emissions serve as a structural early warning sign for negative or positive economic developments in The Netherlands. Other factors, not really structural economic developments, were the reason that CO_2 emissions anticipated the pattern of economic decline and growth.

By making use of CO_2 air emission accounts on quarterly basis, the general public can be informed on a timely and more regular basis whether emissions have grown or declined in a particular period in time. The interrelationship between the economy and the environment can be made explicit and communicated on a regular basis. Presenting the tension between economic growth and environmental pressure on a timelier basis can raise awareness among the general public. Communicating the mechanisms at work on a timelier and more frequent basis may lead to understanding them and entice consumers and producers into making more sustainable choices in the future.

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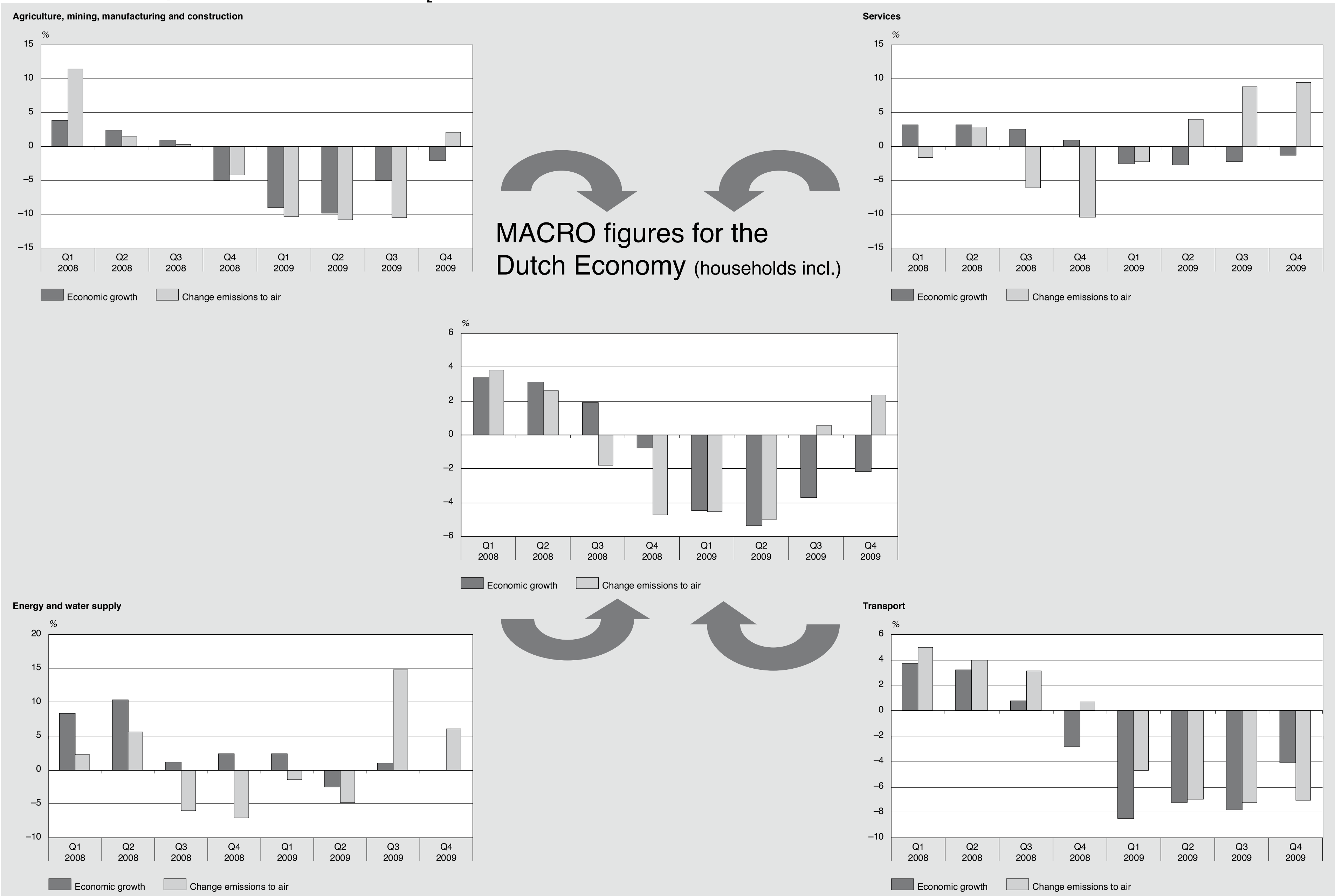
11 Overview of impact of financial crisis on CO_2 emissions



Environmental accounts for households

1. Introduction

We are currently witnessing a shift from attributing environmental pressures on the basis of production towards consumption as evidenced by the growing popularity of footprint type indicators. The basic idea is that eventually consumption needs drive production processes. The consumption approach which compares pressures required to satisfy consumption needs of countries complements the production approach (chapter 8). Consumption can be understood in a broad sense as all consumption needs of a country (government, households, investments etc.) excluding exports. As there is an increasing interest in developing policies that target consumer lifestyles (e.g. a tax on meat), we focus exclusively on final consumption of households in this study.

As an example of environmental pressures we will look at greenhouse gas emissions (GHGs) for the year 2007. The emissions due to household consumption can be distinguished into direct and indirect emissions. Direct emissions occur for instance when households drive their car or heat their homes. Indirect emissions are the emissions that accrue over the whole production chain in order to produce the products that households consume. Indirect emissions can be calculated using a technique called environmentally extended input output (IO) analysis. The sum of direct and indirect emissions will be referred to as total emissions.

The objective of this study is twofold. First of all, we investigate the feasibility of compiling an account for households in which a relationship is established between household characteristics such as (disposable) income and size, and environmental pressures. This is done on the basis of household budget survey (HBS) data that provide a breakdown of the expenditures by various household types. Second, we will address the question what the best metric is to compare emissions by households of different characteristics.
Within the System of National Accounts (SNA) there is the so-called social accounting matrix (SAM) that provides a breakdown of economic statistics by socio-economic strata, but there exists no further juxtaposition with environmental data. In the System of Environmental-Economic Accounts (SEEA), a satellite system of the SNA, the social dimension has not been fully developed yet. Our research hopes to contribute to further development of this issue.

The outline of this chapter is as follows. In section 2 we will discuss our methodology to calculate the direct and indirect emissions by household types and contrast it with methods that have been used by others. In section 3 we will present the results for total emissions by various household types. In section 4 we will analyse the results when emissions are attributed based upon equivalized expenditures instead of actual expenditures as a metric to compare households. Equivalence factors are estimated weights that are used to compare welfare of households with different size and income (CBS, 2004). A decomposition analysis is presented in which household expenditures for different incomes are decomposed into a volume and a composition effect with respect to an average household. In section 5 we will discuss our results and draw some conclusions.

2. Material and methods

2.1 Choice of method

Over the past couple of years several studies have investigated the relationship between household characteristics and environmental pressures (Wier et al., 2001; Statistics Sweden, 2003; Druckman and Jackson, 2009; Kerkhof et al., 2009). These studies have in common that they use household budget survey data on the expenditures of goods and services to attribute environmental pressures to household characteristics. They differ however with respect to the method used. Some use IO analysis, while others use Life Cycle Analysis (LCA) or a hybrid form; some use a domestic technology assumption, others a full-blown Multi-Region Input Output model (MRIO).

It is important to realize that source statistics such as HBS differ from national accounts data in their underlying classifications, concepts and definitions. For example, budget surveys do not impute the rent of housing for owner occupied dwellings, and therefore expenditures from budget surveys do not match national accounts totals. The consequence of these differences is that budget survey data cannot be used for their absolute expenditure levels, but only for estimating relative expenses on items of different households. When these relative proportions are subsequently multiplied with the household consumption figures of the SNA we obtain a disaggregation of consumption across household characteristics that is ocnsistent with the SNA. Likewise, the sum of emissions disaggregated by household type should add up to total emissions for the Netherlands as reported in the air emission accounts. This condition rules out approaches in which emission intensities for products are calculated and subsequently multiplied with HBS data. An additional advantage of using HBS data not for its level but only for estimating fractions is that well-known underreporting of expenditures on specific products (alcohol, tobacco etc.) is avoided.

The methodology applied in this study to calculate the indirect emissions resembles the methods described by Statistics Sweden 2003 and Wier et al. 2003, but differs in one important respect. These methods can be characterised as 'top-down' in the sense that emissions embedded in production of goods and services – calculated via IO analysis – are passed on to households where they are subsequently divided across household types proportionally with HBS data. The method we have used could be characterised as 'bottom-up' in the sense that HBS data is used to split the final demand category households into various socio-economic characteristics. It is only after we have split the consumption vector that we apply our IO model. The main advantage of this sequencing is that it enables subsequent usage of this socio-economic disaggregation of the consumption vector for multiple analyses.

Point of departure is the partial multi-region input-output model that is also used to compile the Dutch emission trade balance (CBS 2009; see chapter 8 in this publication). The model uses country specific emission intensities, but assumes the same (Dutch) production structure for all regions. It is partial in the sense that interregional trade is not taken into account properly. It is assumed that imports from country *x* were in fact produced in country *x* where the imports required by country *x* are estimated based upon the domestic technology assumption. As is common practice, re-exports (imports that are directly exported after minor modifications) are excluded from this analysis.

2.2 Indirect emissions

In a first step, household budget survey data at its most detailed level (approximately 2500 different articles) is being collected for the following household characteristics: (disposable) income deciles and household size. Due to the small sampling size of the HBS and the uncertainties this causes especially when disaggregating data into household characteristics, we combined HBS data for three subsequent years 2006–2008. Accordingly, the year 2007 is 'smoothed' by weighting the 2006 and 2008 expenses with their appropriate CPI (consumer price index) factors at the most detailed level available and taking the average over these three years. This results in matrix H_{ah} which expresses expenditures for an average household of certain type.
In a second step, the classification of expenditure categories *a* of the HBS are allocated to the product classification *g* (around 150 relevant categories for final consumption by households) that is used in the IO tables of the Dutch National Accounts with the allocation matrix X_{ah}. This results in average expenditures on these product groups that are subsequently multiplied with the total number of households p_h of each characteristic to obtain absolute expenditures. Given differences in definitions and concepts between the National accounts and the HBS, these absolute HBS expenditures are solely used to calculate expenditure fractions F_{gh} by household type for each National Accounts product category by dividing by total expenditures on each product A_g.

$$F_{gh} = \frac{p_h X_{ga} H_{ah}}{A_g}$$

When National Accounts product groups are not covered by HBS data they are split either based upon fractions of a similar product group or using the fractions of total expenditures by household characteristic.

$$Y_{kh} = C_{kg} F_{gh}$$

Subsequently when the matrix C_{kg} which juxtaposes final household consumption in the industry breakdown *k* with the product breakdown *g* is multiplied with these fractions, we obtain a split of the final consumption in our IO table by household characteristics *h*. We have now obtained a disaggregation of our household consumption vector into different characteristics that is consistent with national accounts totals.

2.3 Direct emissions

The direct emissions of households are attributed to household characteristics based on HBS expenditure fractions. Direct emissions can be due to stationary sources (e.g. heating) or mobile sources (transport). The expenditures on natural gas are used as an estimator for stationary emissions. Emissions for mobile sources are attributed to household type by their respective fuel expenditures on the products diesel, LPG, and petrol. The total emissions for each of these three products have been calculated first by separately identifying these in the transport module that is also used for the compilation of the air emission accounts. This module calculates emissions based on fuel type and technology.

2.4 Conceptual issues

Household budget surveys do not cover institutional households (e.g. the elderly, prisoners etc.). In the SNA, expenditures of institutional households are booked as intermediate consumption of the responsible economic activity (e.g. medical services). In the air emission accounts, emissions by institutional households are also attributed to these same activities. There are therefore no inconsistencies as the institutional households are in all instances included under these activities.[1] However, this treatment does imply that emissions due to institutional households are attributed to the indirect emissions of households through their consumption of for instance medical services. Fortunately this bias is likely to be small as the number of people in institutional households constitutes less than 0.5 percent of the total population.

The exact definition of household consumption has a larger impact on results. Final demand categories are normally divided into final consumption of government, final consumption of households, investments, changes in inventories, and exports. It is sometimes argued that as all government consumption and part of investments benefit households, they should be subsumed under household consumption. For reasons of consistency, the definition of household consumption that we use is equal to the definition used in our MRIO model which is actual final consumption. It therefore includes individual services provided by government to households free of charge such as hospital services.[2] It also includes services provided by non-profit institutions serving households. It excludes however collective services provided by government such as defence as well as investments that could be attributed to households (e.g. construction of houses). Unfortunately, the HBS does not record such transfers free of charge as they are not actually spent by households. In fact, the broader the definition of consumption we choose, the more difficult it becomes to use HBS data. The assumption that we therefore implicitly make is that goods/services provided free of charge to households are consumed in the same ratio as purchased goods/services in the same product category.[3]

1) The SAM however does separately identify the institutional households.

2) Education provided by the government however has not been included in household final consumption. The indirect emissions due to household consumption are therefore slightly underestimated.

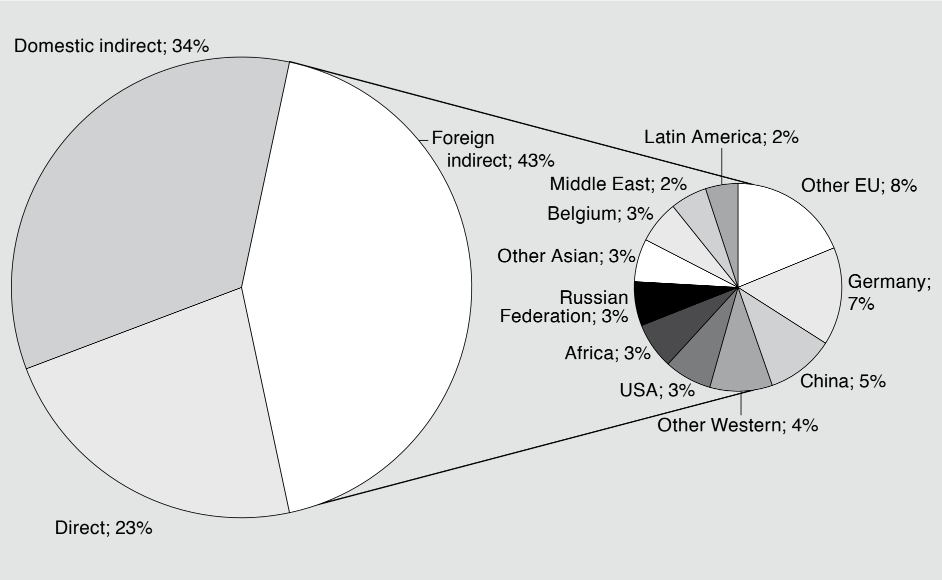
3) In case of health care, expenditures that are actually made by households i.e. not covered by insurance, increase with rising income. Therefore also the expenditures related to basic health care provided free of charge are distributed similarly. As a fair assumption is that health is distributed homogeneously across households of different characteristics, this would introduce a bias against higher income households.

3. Results

3.1 Households in general

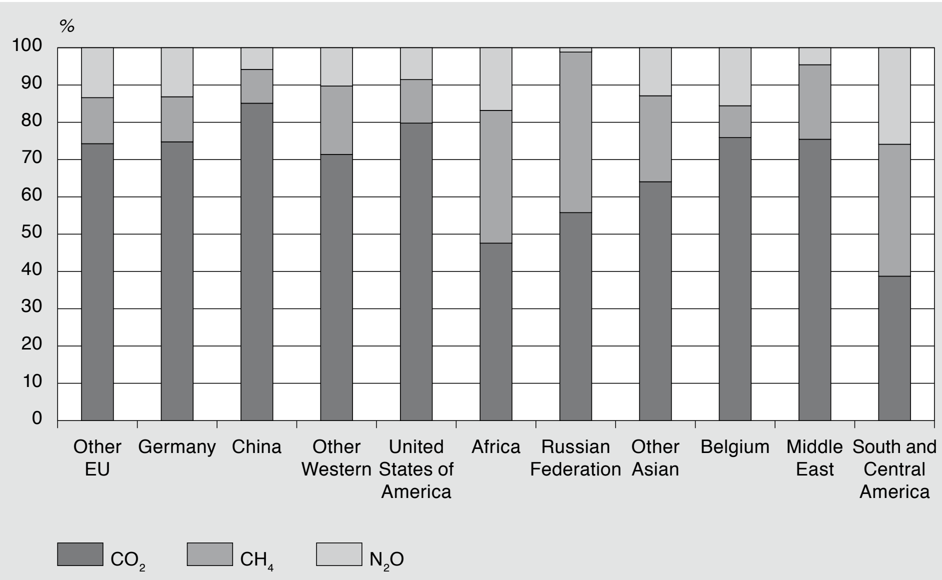
Figure 1 shows the direct and indirect GHG emissions as a result of total household consumption in the Netherlands in 2007. The GHG emissions amount to 22.3 ton CO_2 equivalents per household, of which 18.4 ton CO_2. This equals 9.9 ton CO_2 equivalents per capita, or 8.2 ton CO_2 per capita. The indirect emissions amount to 77 percent of total emissions. More than 43 percent of these indirect emissions occur abroad with other EU countries, Germany (largest trade partner), China, other Western countries, and USA constituting the top five.

1 Direct and indirect emissions behind Dutch household consumption



We have also calculated the effect of using the so-called domestic technology assumption, which assumes that the same emission intensities for production apply abroad. This has both a strong composition and level effect. It has a large overall effect on the GHG emissions per household: it would lower the amount to 18.7 ton CO_2 equivalents per

2 Distribution of emissions across regions and by type of greenhouse gas



household. This demonstrates that production abroad is on average more polluting than production in the Netherlands.
Due to the numerous assumptions made in these kinds of studies, it is difficult to compare our results to other studies. Kerkhof et al. (2009) found for the Netherlands a value of 19 ton CO_2 per household for the year 2000. Although this would not contradict our finding, it is hard to compare the results precisely due to the large time gap. Since 2000 the number of households in the Netherlands has increased by approximately 6 percent. Developments in emissions intensities and the average rise in household expenditures over these years are probably more important, though.

Figure 2 shows that there is large variance across regions in the type of GHGs that arise due to Dutch consumption. Large amounts of methane emissions are attributed to Russia because the Netherlands is a large importer of oil and gas. Oil and gas production is often accompanied by flaring and venting of gas which results in methane emissions. Emissions in China are predominantly CO_2 emissions. Attributed emissions in Latin America as well as in Africa are dominated by methane and nitrogen oxide emissions that are inherent in agriculture and livestock. The Netherlands is a large importer of agricultural products and meat from this region.

3 Final household consumption expenditures and total GHG emissions by COICOP categories

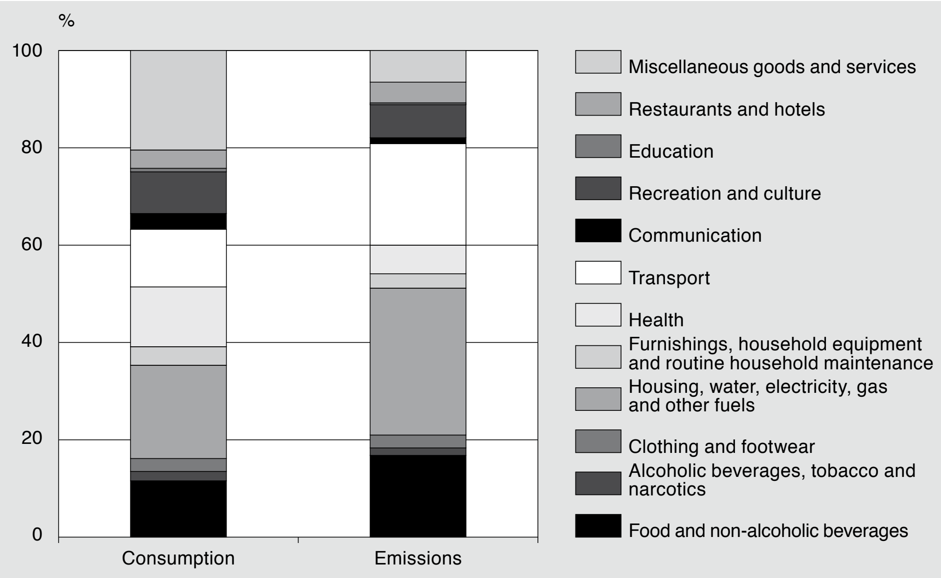


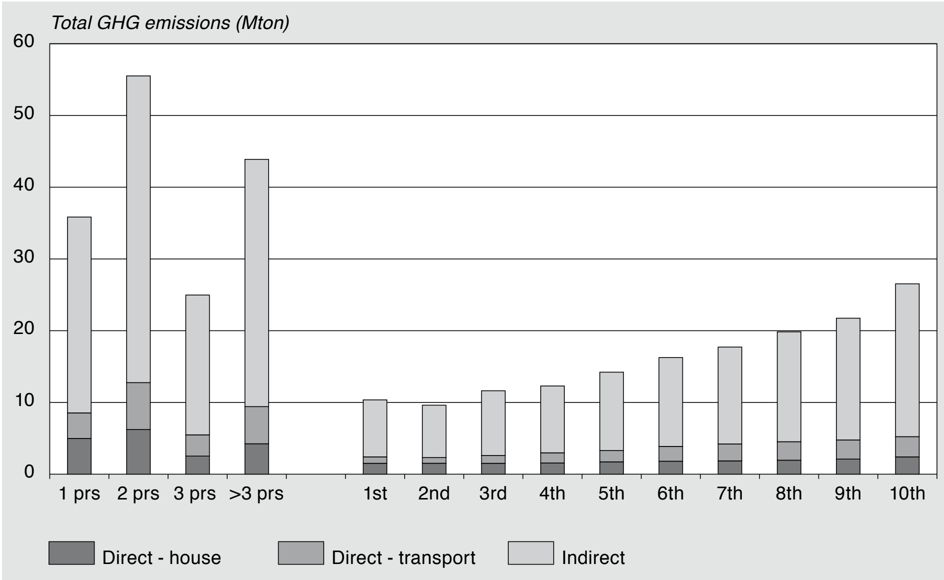
Figure 3 attributes expenditures by households as well as total emissions to COICOP[4] categories. COICOP is an international standard functional classification that classifies expenditures by purpose categories and is part of the standard tables of the Dutch National Accounts.[5] At its highest level COICOP distinguishes between twelve purpose categories. The allocation of emissions to COICOP categories is achieved by cross classifying the product classification used in the IO table (around 150 classes that are relevant for final consumption of households). When necessary, product categories were split between several COICOP categories.[6]

4) Classification of Individual Consumption by Purpose.
5) Due to definitional differences our breakdown is slightly different from the one presented in the National Accounts.
6) This is an example of what we have called a top-down analysis in section 2. To be precise, we made use of an existing more detailed scheme that attributes products at a lower level (around 450) to COICOP categories (12). When a high level product consisted of underlying products that were allocated to different COICOP categories, the higher level product emissions were split and attributed to these different COICOP categories based on HBS expenditures of an average household.

Most greenhouse gas emissions are attributed to housing, transport and food and beverages. By comparing the expenditures and emissions per COICOP category we can see that some categories are more emission intensive than others such as food, housing and transport. Less emission intensive categories are health and miscellaneous goods and services which exist primarily of services such as lawyers, brokers etc.

3.2 Households characteristics

4 Emissions attributed to household characteristics size (persons) and household income (deciles)



In this study we have disaggregated the total direct and indirect GHGs that can be attributed to the final consumption of households into two types of characteristics: household size expressed as the number of individuals per household and income expressed in deciles. The sum of emissions for each type of characteristic separately adds up to 160 Mton which is the total amount of direct and indirect GHG emissions that can be attributed to household consumption. Obviously, these absolute results are hard to compare as there are for instance more two- than three-person households.

5 GHG emissions per household for the characteristics household size and income

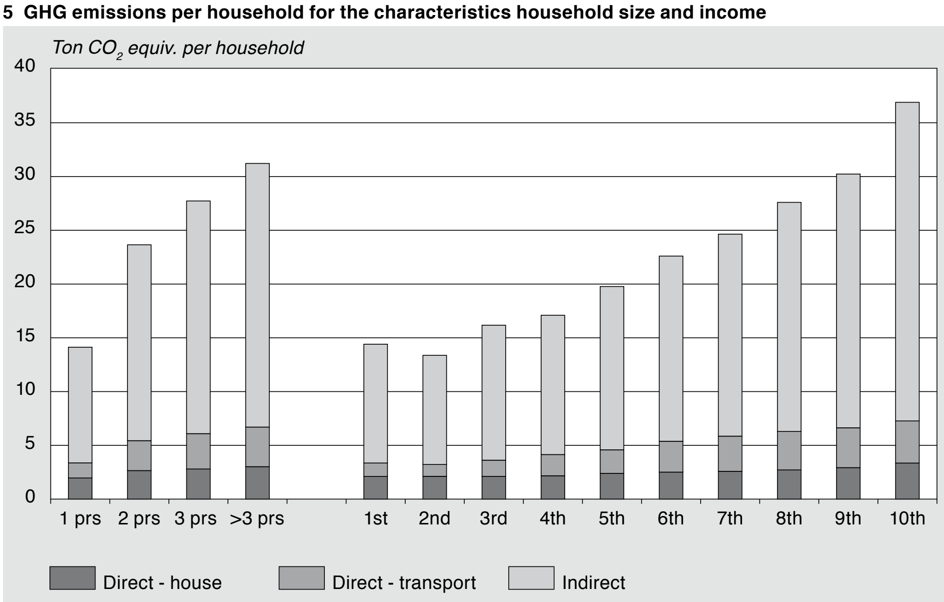


Figure 5 shows the total direct and indirect GHG emissions per household. It is obtained by dividing the amounts in figure 4 by the number of households of each characteristic (e.g. the total number of two-person households in the Netherlands). The pattern that emerges is that total emissions increase with household size as well as with rising household income except for the small dip that occurs for the second income decile. In relative terms, the direct emissions for housing as part of the total emissions decrease with increasing household size and income. This reflects the fact that direct emissions are associated with basic necessities such as heating and cooking.

6 Per capita GHG emissions for household size (persons) and household income (deciles)

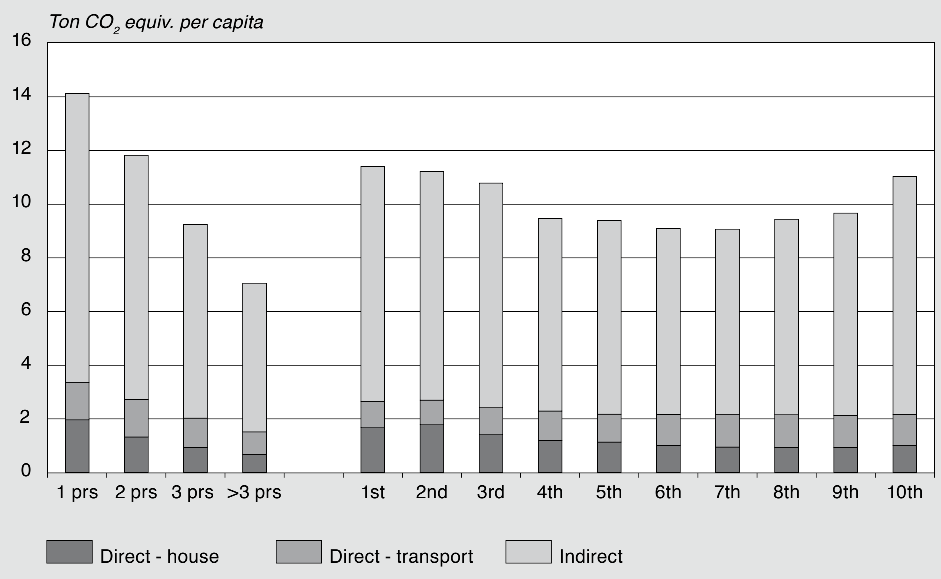
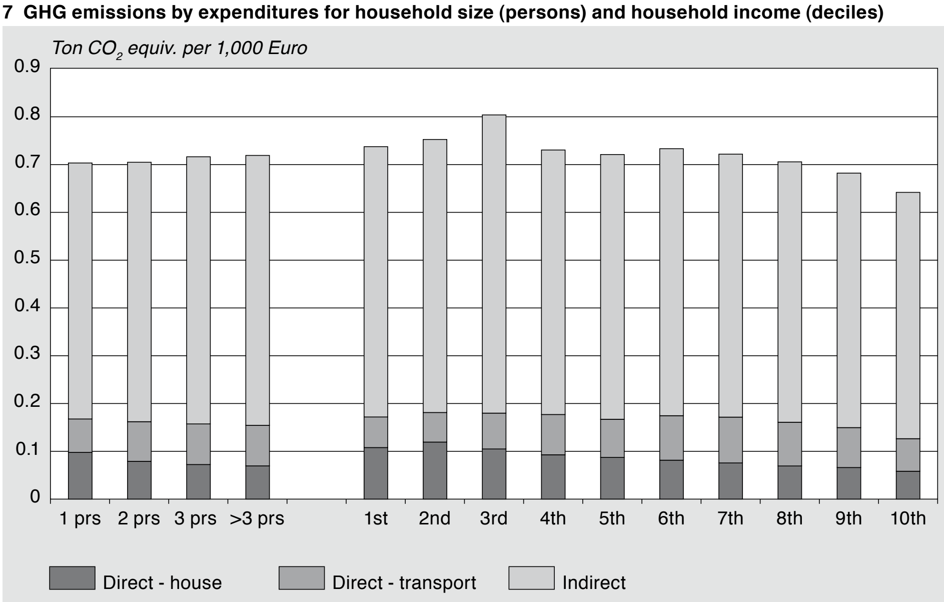


Figure 6 expresses total emissions of households of different size and income on a per capita basis. It is obtained by dividing the absolute amounts of figure 4 by the total number of individuals who make up each household characteristic (e.g. the total number individuals in all two-person households in the Netherlands). The pattern that emerges is that emissions decrease with household size. This is to be expected as there are economies of scale when several people share a house and food. Emissions per capita show a more mixed picture with respect to increasing income deciles. The total number of individuals in each income decile increases with rising income as high income households on average consist of larger families. However, as the increase in number of individuals slopes slightly

7 GHG emissions by expenditures for household size (persons) and household income (deciles)



downwards with rising income while the emissions per household slope slightly upwards (figure 5), the joint effect is that per capita emissions decrease with income, bottom out around the 7th decile, after which they increase again. On a per capita basis, the 7th income decile has the lowest emissions of 9.1 ton CO_2 equivalents per capita.

Figure 7 depicts the total emissions of households of different size and income now expressed as total emissions per 1000 euros spent. It is obtained by dividing the total emissions of figure 4 by the total expenditures of all households that make up each characteristic. We see that emissions remain fairly stable across household sizes. However, emissions peak for the third income decile after which they decrease with rising income.

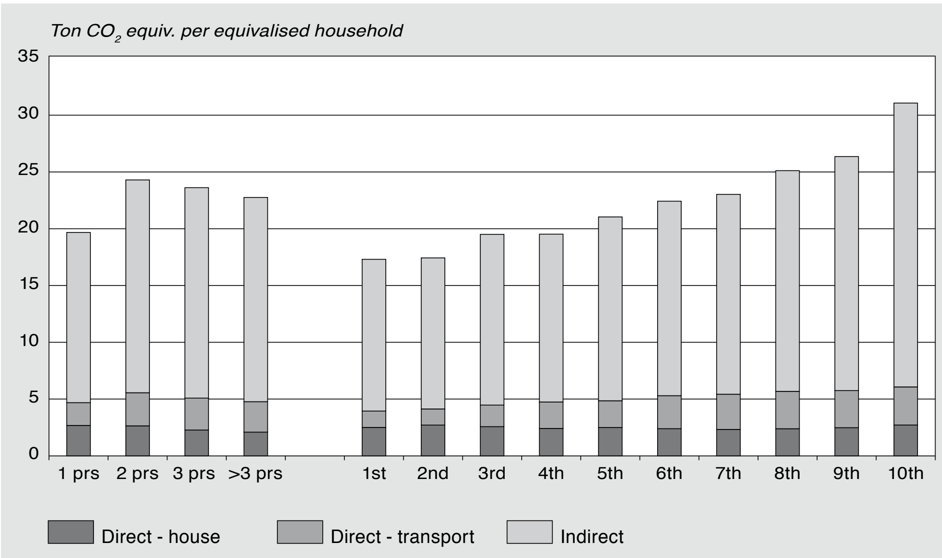
4. Analyses

In this section we will discuss our second research question: what is the best metric to compare emisisons by households? As we have seen in the results section there are various metrics with which we can compare households (per capita, per household, by expenditure). When we compare emissions on a per household basis one could argue that we discriminate against large households as they automatically generate more emissions by virtue of their larger size. Alternatively, when we compare pressures on a per capita basis one could argue that we discriminate against smaller households as there are clearly economies of scale involved in being part of a large(r) household. We clearly need a neutral metric to compare the environmental pressures of households of different characteristics with one another. The metric that is often advocated in the literature is to use so-called equivalised incomes (Statistics Sweden 2003).

4.1 Equivalised income

Equivalence factors are estimated weights that are used to compare the welfare of households of different sizes and income levels (CBS 2004). The weight of a single person household is by definition equal to one. These weights can be used to standardise income levels and likewise expenditures.[7] These correct for the fact that larger families need more income to enjoy the same amount of welfare as smaller families, due to the cost of having (additional) children that need food, clothing etc. A larger family size results in a higher

8 GHG emissions per household for the characteristic household size and income on the basis of equivalised income



[7] Savings are treated as delayed expenses.

weight. Households with a higher income that are otherwise comparable get a lower weight. The effect of higher income, however, is small compared to the opposite effect of larger family size. Other factors such as the ages of children are also taken into account as young children (0-3) tend to be more expensive than children in the age (4-11) for instance due to the need for childcare. It also matters whether the income is earned by one or two adults. When both parents need to work to earn a certain income, compared to a household where the same income is earned by one person, this results in additional costs for childcare and therefore a higher weight. As a rule of thumb children count for 0.5 and adults for one.

The same procedure to split the consumption vector (see section 2) is followed but now on the basis of equivalised expenditures. The real expenditures by household type are first made equivalent by using a set of weights which results in a different matrix H now based on equivalised expenditures. With all other matrices and vectors (C, X, A, p) the same as above, this results in a different split of the consumption vector Y.

Figure 8 shows the results of emissions by household size and income using equivalised expenditures. On the basis of equivalised expenditures one would conclude that two-person households are responsible for most emissions. We also clearly see a pattern emerging in which emissions rise with increasing income.

When we compare these results with figure 5 where standard incomes were used, we clearly see that using equivalised expenditures ameliorates differences across income deciles because equivalence weights increase with rising income (due to a combination of factors such as larger family sizes).[8)] Regarding household size, we see that the results lie somewhat in between the per capita and the (standard) household metrics. Also striking is that the small dip in emissions for the 2nd income decile that we observed in figure 5 disappears due to its relatively low weight. This could be because many 2nd income decile households consist of a single individual, for instance a student or young worker who has not yet started a family.

In the remainder we would like to present results based upon equivalised HBS data as this is the metric advocated in the literature (Statistics Sweden 2003, Wier et al 2001).

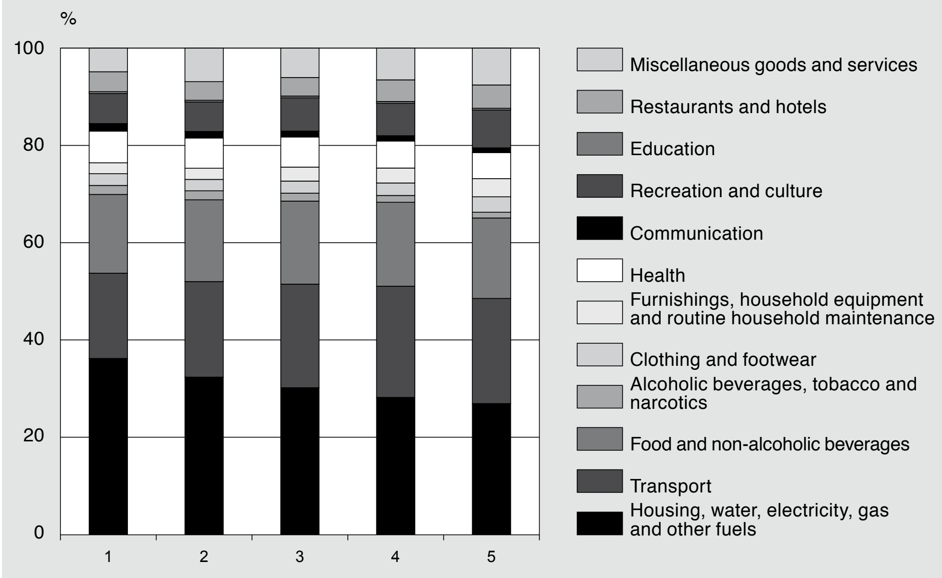
4.2 Emission patters due to rising income

We can attribute emissions to COICOP categories as before, but now for households of different income levels.

Figure 9 shows that around 50 percent of direct and indirect emissions are due to only two categories: transport and housing. In decreasing order of importance these categories are followed by food and recreation respectively. In relative terms, with increasing income, we see a declining proportion of emissions (direct plus indirect) related to the housing category. This supports our previous conclusion that households with a higher income require a relative smaller part for relatively emission intensive expenses such as heating homes. We see that the relative proportion of emissions related to health, communication and alcohol / tobacco decrease with higher income. Albeit less unambiguous, the categories transport, clothing and footwear, furnishings and household equipment all show an upward trend with rising income; the categories education and food provide more of a mixed picture. The functional allocation presented here could be relevant for policy makers as it demonstrates what types of behaviour should be targeted for each household characteristic when aiming to reduce carbon footprints.

8) The equivalence factors for 2007 are respectively for income deciles 1,12; 1,06; 1,14; 1,23; 1,31; 1,43; 1,51; 1,53; 1,65; 1,66. The 2nd income decile has the lowest weight.

9 GHG emissions allocated to COICOP categories for equivalised expenditures by income quintiles



4.3 Decomposition analysis

In order to better understand what drives the indirect emissions of households we performed a decomposition analysis. Decomposition analysis is a technique that allows to decompose a change in a certain variable into its driving forces. Although structural decomposition analyses are usually done when time series data are available, we have decomposed the domestic indirect emissions within a single year – 2007. The idea is to decompose household footprints of different income categories (in our case deciles) with respect to the average footprint of households into a composition and volume effect. The composition effect captures changes in footprints that are due to differences in the type of products that are consumed, for instance when compared to the average household purchases more emission intensive products are bought. The volume effect captures changes in footprints due to the fact that more products are being purchased than average. This is described by the following equation:

$$H_h = e_k \cdot L \cdot (\frac{Y_{kh}}{y_h}) \cdot y_h$$

where

H_h the domestic indirect emissions associated with final consumption of household *h*;

e_k the domestic emission coefficients per industry *k*;

L the Leontief inverse $(I - A_D)^{-1}$;

Y_{kh} / y_h the expenditure of household category *h* on industry *k* divided by total final consumption of household *h* by households; this is our composition term;

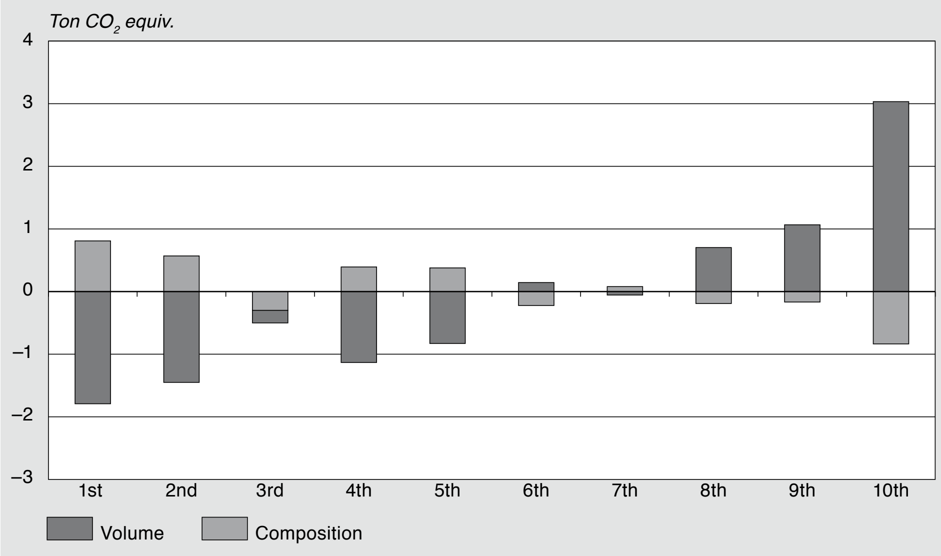
y_h the total final consumption of household *h* by households; this is our volume term.

Given that we decompose within a single year e_k and L are constant and only two decomposition equations remain that we have averaged.[9)]

Figure 10 shows that the volume effect clearly dominates the composition effect, with the composition effect off-setting the volume effect (except for the 3rd decile). This means that the increasing emissions with increasing household income are primarily the result of higher expenditures that would have lead to even higher emissions were it not for the fact that the composition of expenditures becomes relatively cleaner. This underlines our previous result where we saw that emissions per 1000 euro spent decrease with rising income (Figure 7).

9) For a discussion of the need to average see also Miller and Blair, 2009.

10 Decomposition analysis of indirect domestic emissions of households (by income deciles) with respect to the household average



Put differently, the decomposition analysis shows that consumption patterns for low incomes are more emission intensive than for average households, but this is more than offset by the lower volume of consumption resulting in less than average emissions. For high-end incomes the situation is exactly reversed.
The composition effect is dependent on the level of disaggregation that is used in the IO table, however. The more detail we distinguish in the IO table (we distinguished 60 industries), the more the household expenditures can differ from one another.

The deviation from the average trend for especially the 3rd income deciles can be explained by the fact that its composition profile by COICOP categories differs from that of the 2nd and 4th decile: a relatively smaller portion goes to housing and transport while a relatively larger part is due to miscellaneous goods and services. Admittedly, here we are reaching the limits of the discerning power of our analysis, which is the main reason why we did not show differentiation by COICOP for income deciles but for quintiles.

5. Discussison

We have compiled an environmental account for households consistent with national accounts concepts and environmental accounts data. Furthermore, we have been able to do so using source statistics that are all available from the same year, hereby avoiding some of the difficulties previous studies faced when combining data sources from different years. Although this type of analysis has been done before, we have developed a method that results in a split of the consumption vector of households which can be used for other analyses. However, there are still a number of caveats that apply.

Due to the small sample size of the HBS the level of disaggregation that we are reliably able to show in the accounts is somewhat disappointing, even after we have averaged several years of HBS data. One of the conclusions we draw from the consideration of uncertainty is that one should be cautious to use HBS data at high levels of disaggregation.[10)]
Moreover, several expenditures that are highly relevant from an environmental perspective (coverage of air travel) are not distinguished clearly in the current set-up of the HBS.

[10)] The uncertainty in HBS data has perhaps not always received sufficient attention. In the literature one can find for instance disaggregation by income deciles based on HBS data for a single year (e.g. Kerkhof et al. 2009).

Although the most detailed level for which the Dutch IO table can be constructed is 120 industries, in this study we have aggregated these to the level of detail of the Dutch air emission accounts which distinguishes emissions by 60 industries. Compared to previous studies, the number of industries that we distinguish in our IO table and our emission accounts is relatively small. However, there is a trade-off between increasing the level of detail of the IO table which would enhance its resolution and therefore the homogeneity of product groups, versus the larger errors this would introduce in our estimate of emission intensities for foreign regions at such a detailed level. It is difficult to estimate emissions intensities at the industry level as energy statistics as well as emission inventories are typically based on different classifications (e.g. process oriented in case of energy statistics instead of economic in case of economic statistics). As a result, having fewer industries will increase the reliability with which we can estimate emission intensities as there are fewer instances in which we have to split emissions between industries on the basis of secondary sources or assumptions. It is our experience that the emission intensities (especially when using country-specific ones) are to a large extent driving the result and therefore we have decided to use a low level of disaggregation.

Different metrics can be used to attribute responsibility for environmental pressures to household characteristics. The literature seems to have converged in advocating the use of equivalised expenditures. We believe it is still an open question whether using equivalence factors is the best approach to compare the environmental impact of households. The appeal of equivalence factors is that they can be used to compare the welfare of households with different sizes and income levels, by standardising their income levels. However, what is needed in our case is not a metric that is welfare neutral, but one that is environmentally neutral. Using equivalence factors can answer the question how much a family of a specific size should earn more in order to enjoy the same welfare as a single household. Now we want to know how much a certain family would be allowed to pollute more to be as polluting as a single household. As some consumption goods (e.g. heating) have a higher environmental impact than others, this requires that we go beyond a simple money numeraire.

More importantly, the use of equivalised expenditures results in attributing emissions to households on a non-factual basis. The emissions that result are no longer the emissions actually produced by those households, but more like virtual emissions that would result when incomes are equivalised. We therewith go beyond simple statistics which is the main reason why we have presented the results in a separate analysis section.
Concluding, what are the implications for policy makers? Our study shows that household emissions rise with increasing income. This result holds both for standard and equivalised expenditures per household. As income levels are expected to rise with rising economic growth this could be seen as a worrying sign. On the other hand, our results also show that the emission intensity of expenditures decrease with increasing income. This is because in relative terms, the emissions associated with basic necessities such as heating and cooking which have a high intensity, decrease with rising equivalised household income. Together with the fact that the environment is generally seen as a luxury good this may provide solace to others.

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Economic and environmental multipliers: analysis of trade-off relationships for different industries in the Netherlands

1. Introduction

When developing new policies, policymakers have to face trade-offs. Trade-offs are often most explicit in the choice between economic development and the quality of the environment. Economic growth and higher consumption levels may lead to increasing demands for energy and land and so contribute to climate change and loss of biodiversity. Trade-offs between economy and environment, however, do not always have to be negative. For instance, economic growth does not always have to be accompanied by increasing pollution or energy demand as analyses of decoupling illustrate. In addition, synergy is also conceivable in which economic development has positive environmental effects, for instance in case of renewable energy production.

The economic and environmental impact of policies to stimulate a particular industry often goes well beyond their direct effect on output, employment, or emissions. The growing interconnectedness of economic activities also leads to significant indirect or spill-over effects in the rest of the economy. These indirect effects can be determined by calculating multipliers derived from input-output (IO) analysis (e.g. Miller and Blair, 2009). Multipliers and multiplier effects can be useful instruments in economic analysis despite their limitations. While multipliers were traditionally compiled for economic variables such as output, value added, income, and employment (e.g. Eurostat, 2008; Miller and Blair, 2009), they can easily be extended to environmental parameters (Östblom, 1998; Lenzen 2001, Lenzen et al., 2004; Rueda-Cantuche and Amores, 2010). The most commonly used environmental variables are energy and CO_2. In this study we also quantify multipliers for other environmental variables such as greenhouse gas emissions, acidification and emissions of heavy metals to water. Knowledge of the magnitude of a wide range of multiplier effects of individual industries provides relevant information for the evaluation of trade offs (Foran et al., 2005).

In this chapter we will describe and analyse a variety of economic and environmental multipliers for different industries in the Netherlands. We will show that these multipliers can easily be derived by integrating information from national en environmental accounting into the IO tables. By comparing and ranking these multipliers for industries, the trade-off relationships between economy and environment can be determined and analysed. In addition, we estimate the importance of the Environmental Goods and Services Sector (EGSS) in the Netherlands by calculating the indirect effects of its further development. To obtain the appropriate multipliers for this sector, we present a method to link data from the EGSS to the data compiled in the National Accounts framework. The main challenge here is to adapt the original IO table in order to determine the associated input coefficients and multipliers for the EGSS.

This chapter is structured as follows: in the next section we present the general methodology for the computation of the different multipliers and multiplier effects. Also, we describe how the IO table was adapted to calculate the multipliers for the EGSS. The results are presented in section 3. First, several types of multipliers and multiplier effects for different industries are discussed and explained. Second, spider web figures are presented in order to visualize trade-off relationships between the economy and the environment for selected industries. Finally, the multipliers and multiplier effects for the EGSS are presented and compared. The chapter ends with a general discussion and conclusion.

2. Methodology

Input-output models are feasible instruments to trace the effects of changes in final demand through the economy over short periods of time, since they track the interconnections of production by industry at a high level of detail. In this function, they are called impact models or multiplier models. There are a number of different types of multipliers that can be generated by IO models (e.g. Eurostat, 2008; Miller and Blair, 2009).

The first general categorisation consists of a distinction between type I and type II multipliers. Type I multipliers capture the direct and indirect effects of a change in output for a particular industry. Type II multipliers capture not only indirect effects but also induced effects on other industries from the extra consumption spending of people working in these industries. In this study we will restrict ourselves to type I multipliers.

Type I multipliers can be broken down into a direct and an indirect effect. If there is an increase in final demand for a particular product or service, there will also be an increase in the output of that product. This is the direct effect. In addition, as producers increase their output, there will also be an increase in demand on products from their suppliers and so on, all the way down the supply chain. This is called the indirect effect. Although various definitions can be found in the literature, according to the terminology that we use in this chapter the indirect effect can be separated into backward and forward linkages. Backward linkages consist of the effect an increase in output of a particular industry has on its suppliers. This is also sometimes called the first order effect. The increased output of the suppliers themselves also has effects on other industries. These are sometimes called higher order effects or forward linkages.

There is a major distinction between multiplier effects and multipliers. Multiplier effects show the direct and indirect effects of changes in final demand (i.e. output) on a range of variables. The employment multiplier effect shows for instance how many jobs would be created in the economy if the manufacturing industry were to increase its output by 1 million. Suppose the direct effect of this is the creation of 5 jobs in manufacturing, and 10 additional jobs in the rest of the economy. Then the employment multiplier effect is 15.

Multipliers are normalized multiplier effects. The employment multiplier shows how many jobs would be generated in the economy as a whole for each job that is generated in a specific industry. In the example of manufacturing, the employment multiplier would be 3 (15/5): for each job within manufacturing two additional jobs in the rest of the economy are created. Multipliers and multiplier effects serve different purposes. Both are calculated and discussed in this study.

The methodology for the computation of multipliers and multiplier effects is discussed in detail below. For this study we used a 60 by 60 industry IO table, which is an aggregated IO table derived from the Dutch National Accounts. The 60 by 60 industry IO table corresponds with the classification that underlies the Dutch environmental accounts. Accordingly, all environmental variables, such as emissions to air and water, and also resource inputs such as energy and water can easily be linked to the IO table in order to derive the associated environmental multipliers and multiplier effects.

Output multipliers
Output multipliers[1] are commonly used to determine the impact of changes in final demand on output (e.g. Eurostat, 2008; Miller and Blair, 2009). An output multiplier for industry *j* is defined as the total value of production in all sectors of the economy that is necessary at all stages of production in order to produce one unit of product *j* for final demand. In other words, output multipliers relate the changes in sales to final demand by one industry to total changes in output (gross sales) by all industries. For example, an industry output multiplier of 1.75 would indicate that a change in sales to final demand of 1 euro by the industry in question would result in a total change in domestic output of 1.75 euro. The output multipliers correspond to the column sums of the Leontief inverse. This can be expressed formally as:

$$m_j = \sum_i [I - A_D]_{ij}^{-1} \qquad [1]$$

where m_j denotes the outcome multiplier for each industry *j*; A_D is the technical coefficients matrix and *I* the identity matrix.

[1] Sometimes called revenue multipliers.

Multiplier effects
The multiplier effects on other economic variables such as value added, income, employment as well as environmental multipliers in terms of GHGs, energy or water use can easily be calculated. These resource inputs are always net uses in order to avoid double counting. Mathematically this is done by premultiplying the Leontief inverse with a vector of coefficients of the variable of interest. These coefficients could be energy intensities or employment intensities per industry *j*. Mathematically, this can be expressed as:

$$f^z{}_j = \sum_i e^z{}_i [I - A_D]_{ij}^{-1} \quad [2]$$

where f_j denotes the multiplier effect for industry *j*; e_i represents the vector of intensities for the effect of study; the superscript *z* denotes the subject of our effect (energy, employment etc.). For example, the energy multiplier effect for industry *j* provides an estimate of the direct and indirect increase in energy use that would result from an additional unit of output of industry *j*.

Multipliers
Multipliers can be derived by normalizing the multiplier effects by dividing them by intensities. In formula this is represented as:

$$m^z{}_j = f^z{}_j / e^z{}_j \quad [3]$$

where $m^z{}_j$ denotes the z-multiplier for each industry *j*; the superscript *z* again denotes the subject of our multiplier (energy, employment etc.). For example, the employment multiplier for industry *j* expresses the number of jobs that would be created in the whole domestic economy due to the creation of one additional job at industry *j*. As a result of the normalisation, the direct effect is by definition equal to 1. The use of multipliers therefore facilitates the analysis of direct and indirect effects. It should be noted as well that due to the nature of the IO model, the output multiplier effect and the output multiplier are by definition equal.

Average multipliers and effects
In order to compare multipliers across industries, average multipliers are calculated by weighting the industry specific multipliers with their respective output.

$$\hat{m}^z = \sum_j m^z{}_j * x_j / \sum_i x_i \quad [4]$$

where $\hat{m}^z$ denotes the average z-multiplier effect; x_j the output of industry *j*. Likewise, average multiplier effects can be calculated by weighting the industry specific multiplier effects with their respective output and dividing by the total output, using the formula:

$$\hat{f}^z = \sum_j f^z{}_j * x_j / \sum_i x_i \quad [5]$$

where $\hat{f}^z$ the average z-multiplier effect for the domestic economy.

Multipliers for the Environmental Goods and Services Sector
The activities of the Environmental Goods and Services Sector are scattered across different industries. For example, companies producing environmental equipment are part of manufacturers of machinery and the producers of renewable energy are part of the energy supply sector. In the statistics for the EGSS these activities have been allocated to the corresponding NACE classification, which is the same classification system that is used for the IO tables.

In order to calculate multipliers and multiplier effects for the EGSS, one has to identify where these activities take place within the IO framework:

– Some activities of the EGSS, such as sewage and refuse disposal services or recycling, are in the standard 60 industries in the IO table. Their multipliers can be directly derived from the IO table used for this study.
– Other activities, such as organic farming and renewable energy production, have been separately identified in the IO table by creating additional columns and rows, using a

variety of data sources. First, the output, intermediate use and value added for these activities was obtained from the EGSS statistics. Second, specific information on the inputs for these industries was used to distribute the total intermediate consumption over the columns. For example, it is known that 75 percent of the intermediate consumption of biomass combustion is imported. Third, the rows were filled by distributing the output over the industries and final demand categories, assuming that in most cases the distribution was the same as the distribution of the non-EGSS activity.

– The remaining activities of the EGSS were not separately identified in the IO table. Effectively, it was assumed that these EGSS activities have identical multipliers as the ISIC category into which they are classified.

The multipliers and multiplier effects for the total EGSS sector were calculated by multiplying the output of the different activities by their multipliers and dividing this total by the total output of the EGSS.

3. Results

3.1 Multipliers and effects for the Dutch economy in 2008

Table 2 shows the results for seven calculated type I multipliers and effects in current prices for the year 2008. Output multipliers primarily measure the interdependencies among industries, and should not be mistaken for indicators for the importance of an industry for the overall economy (Cross and Ghanem, 2006). Industries with more linkages to other industries will have high output multipliers.

The average output multiplier is 1.71. This indicates that on average for every increase in final demand of 1 euro, the rest of the Dutch economy creates 0.71 eurocents of additional output. The industry with the highest output multiplier is livestock breeding. This is because raising livestock requires a large number of inputs from other industries such as fodder crops and soybeans. Other industries with high output multipliers are the manufacture of food products and beverages, civil engineering, construction of buildings and advertising. By contrast, petroleum and gas production has a very low output multiplier. This industry extracts and sells natural gas and crude oil so it has a low intermediate consumption and a high operating surplus relative to the total output. Manufacture of petroleum products, employment agencies, and subsidized education also have low output multipliers. There are only four industries –those with a multiplier larger than two- where the indirect effect is larger than the direct effect.

1 Value added multiplier effects for some selected industries

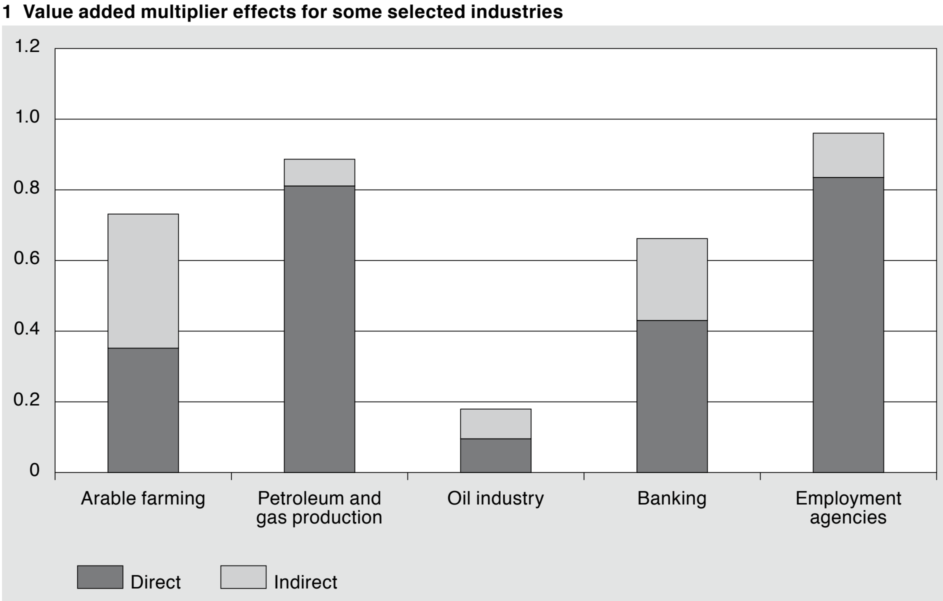


Table 2
Type I multipliers and effects in 2008

	Economy					Environment	
	Production	Value added	Employment		Import	Greenhouse gases	
	Multiplier=Effect	Effect	Effect	Multiplier	Effect	Effect	Multiplier
Average	**1.71**	**0.74**	**0.96**	**1.94**	**0.25**	**0.27**	**3.75**
Arable farming	1.98	0.73	1.30	1.73	0.25	1.83	1.20
Horticulture	1.68	0.77	1.14	1.41	0.20	1.52	1.33
Live stock	2.52	0.68	1.34	2.13	0.30	2.06	1.35
Other agriculture	1.81	0.78	1.29	1.52	0.20	0.42	1.56
Fishing	1.71	0.53	0.78	1.41	0.42	1.54	1.10
Crude petroleum and natural gas production	1.16	0.89	0.08	4.15	0.11	0.23	1.99
Other mining and quarrying	1.79	0.73	0.54	2.90	0.24	0.52	1.76
Manufacture of food products, beverages and tobacco	2.02	0.57	0.71	3.67	0.42	0.48	6.31
Manufacture of textile and leather products	1.69	0.54	0.83	1.73	0.44	0.16	2.98
Manufacture of paper and paper products	1.71	0.55	0.68	2.00	0.44	0.35	1.73
Publishing and printing	1.70	0.74	0.97	1.75	0.25	0.09	4.88
Manufacture of petroleum products; cokes, etc.	1.24	0.18	0.07	4.52	0.81	0.37	1.20
Manufacture of basic chemicals and man-made fibres	1.69	0.44	0.28	3.91	0.55	0.63	1.51
Manufacture of chemical products	1.83	0.53	0.65	2.71	0.46	0.17	3.75
Manufacture of rubber and plastic products	1.73	0.55	0.76	1.72	0.44	0.21	6.21
Manufacture of basic metals	1.51	0.49	0.47	2.05	0.50	0.95	1.19
Manufacture of fabricated metal products	1.70	0.60	0.84	1.85	0.39	0.14	4.19
Manufacture of machinery and equipment n.e.c.	1.69	0.59	0.80	1.93	0.40	0.09	5.38
Manufacture of electrical and optical equipment	1.76	0.50	0.83	2.14	0.51	0.10	5.14
Manufacture of transport equipment	1.82	0.52	0.68	2.57	0.48	0.09	7.34
Manufacture of wood and wood products	1.64	0.66	0.93	1.66	0.33	0.13	2.52
Manufacture of other non-metallic mineral products	1.84	0.70	0.80	2.09	0.29	0.50	1.56
Other manufacturing	1.52	0.77	1.81	1.20	0.23	0.13	2.81
Recycling	1.90	0.59	0.67	2.98	0.39	0.34	4.38
Electricity and gas supply	1.60	0.69	0.29	3.32	0.30	1.94	1.07
Water supply	1.66	0.81	0.69	1.98	0.17	0.20	5.47
Construction of buildings	2.19	0.76	1.04	2.52	0.24	0.13	8.35
Civil engineering	2.12	0.64	1.12	2.19	0.22	0.19	2.91
Building installation and completion	1.66	0.79	1.18	1.50	0.27	0.10	2.59
Trade and repair of motor vehicles/cycles	1.65	0.77	1.18	1.44	0.22	0.14	2.66
Wholesale trade (excl. motor vehicles/cycles)	1.48	0.79	0.89	1.45	0.20	0.10	4.30
Retail trade and repair (excl. motor vehicles/cycles)	1.61	0.87	1.98	1.20	0.12	0.13	3.75
Hotels and restaurants	1.69	0.77	1.40	1.33	0.20	0.27	2.67
Land transport	1.54	0.77	1.16	1.34	0.18	0.44	1.27
Water transport	1.58	0.51	0.57	1.94	0.47	1.34	1.23
Air transport	1.62	0.40	0.64	2.01	0.59	1.64	1.07
Supporting transport activities	1.66	0.77	0.93	1.80	0.21	0.21	9.76
Post and telecommunications	1.59	0.76	0.72	2.14	0.22	0.06	6.02
Banking	1.44	0.66	0.67	1.79	0.30	0.05	3.44
Insurance and pension funding	1.69	0.84	0.72	2.52	0.12	0.05	4.89
Activities auxiliary to financial intermediation	1.34	0.90	0.94	1.32	0.06	0.05	3.10
Real estate activities	1.45	0.92	0.33	2.79	0.06	0.03	8.61
Renting of movables	1.61	0.81	0.62	2.48	0.15	0.27	1.32
Computer and related activities	1.61	0.90	1.17	1.61	0.09	0.06	3.77
Research and development	1.32	0.66	0.90	1.24	0.36	0.13	2.56
Legal and economic activities	1.67	0.87	1.23	1.62	0.12	0.10	5.09
Architectural and engineering activities	1.78	0.88	1.33	1.68	0.12	0.07	4.62
Advertising	1.98	0.74	1.39	1.82	0.26	0.10	6.03
Activities of employment agencies	1.23	0.96	1.91	1.11	0.04	0.04	2.34
Other business activities	1.58	0.80	1.49	1.38	0.19	0.08	3.74
Public administration and social security	1.65	0.83	1.03	1.57	0.10	0.18	6.64
Defence activities	1.33	0.73	1.03	1.20	0.21	0.16	1.56
Subsidized education	1.31	0.92	1.38	1.17	0.05	0.08	2.43
Health and social work activities	1.33	0.88	1.56	1.16	0.08	0.09	2.79
Sewage and refuse disposal services	1.94	0.77	0.78	2.56	0.16	1.39	1.44
Recreational, cultural and sporting activities	1.95	0.77	1.26	1.79	0.19	0.23	3.37
Private households with employed persons	1.00	1.00	3.48	1.00	0.00	0.00	0.00
Other service activities n.e.c.	1.60	0.84	1.87	1.24	0.11	0.18	2.27

On average, services tend to have lower output multipliers than industries producing goods. Whereas goods producing industries are often highly interlinked with other goods producing industries as well as services (finance, legal, transportation), services producing industries such as banking, real estate, public administration require less inputs and therefore have lower output multipliers (Cross and Ghanem, 2006). Overall, there is a high linear correlation between the output multipliers and the share of the intermediate consumption (less imports) in the output ($R^2 = 0.91$). The total share of inputs required from domestic industries in the total output thus seems the main factor determining output multipliers.[2)]

2) Phrased in IO terminology, the first order effect (I+A) clearly dominates while higher order linkages ($A^2 + A^3 + ..$) are less important.

The value added multiplier effect can be used to study the effect of changes in final demand on GDP. The overall effect on GDP for the Dutch economy is 0.74, which indicates that for every euro increase in output an average of 74 cents are added to GDP. The remainder largely leaks away through imports as is shown by the import multiplier effect. The value added effect and the import multiplier effect add up to 1.[3)] Industries with the highest value added multiplier effect are employment agencies, real estate, education, and petroleum and natural gas production. The value added effect can be broken down into a direct and an indirect effect (see figure 1). The value added multiplier effect for employment agencies and petroleum and gas production largely consists of a direct effect due to the large value added per unit output that these industries create. Their indirect effects i.e. the value added created by other industries are not so high. Arable farming and banking have a much lower value added per unit output, but create much more additional value added in other industries. This is because these industries require inputs from industries that create a high value added. On the other hand, refineries have low value added multiplier effects, which is caused by low direct and indirect effects.

Above average output multipliers often go together with below average value added multipliers and vice versa. This is because high output multipliers tend to be correlated with high intermediate consumption which reduces value added. Exceptions are the construction of buildings, and recreation, that are both above average. The manufacture of oil products followed by air transport have the highest import multiplier effects which results in high leakages of output abroad.

The importance of an industry with respect to labour is expressed by the employment multiplier effect. The average employment multiplier effect is 0.96. This means that on average for every million euro of additional output 9.6 new jobs (measured in FTE) are created. The largest employment multiplier effect occurs in private households with employed persons, followed by retail trade and repair, which is primarily driven by the direct effect of these industries being very labour intensive and less so by the indirect spill-over effects.

The employment multiplier is the normalized multiplier effect which measures the number of jobs that are added in the domestic economy for each additional job created at the specific industry in question. The manufacture of petroleum products has the highest employment multiplier of all the industries under consideration. This may seem surprising at first, considering the low output multiplier of only 1.24 and the low employment effect, but it can be explained by the capital-intensive and labour-extensive nature of this industry. Due to its low labour intensity when normalized – in fact the lowest of all industries –and so divided by this small number, a large employment multiplier is obtained.

The largest GHG multiplier effects occur in agriculture, due to the large direct effects (i.e. high emission intensities). Also other energy intensive industries, such as energy and gas supply and air transport have high GHG multiplier effects. When we isolate the indirect effects, agriculture is still in the top five, however now accompanied by sewage and refuse disposal services and the manufacture of food products. Supporting transport activities and real estate activities have large GHG multipliers. The high GHG multiplier of real estate is primarily due to its low emission intensity.

3.2 Trade-off profiles

Changes in final demand have an economic and environmental impact that can be described by multiplier effects. However, multiplier effects have different dimensions (e.g. number of jobs, emissions), which makes it difficult to compare them for different industries. In order to facilitate an analysis of trade-offs it is therefore important to find a metric to assess these various effects.

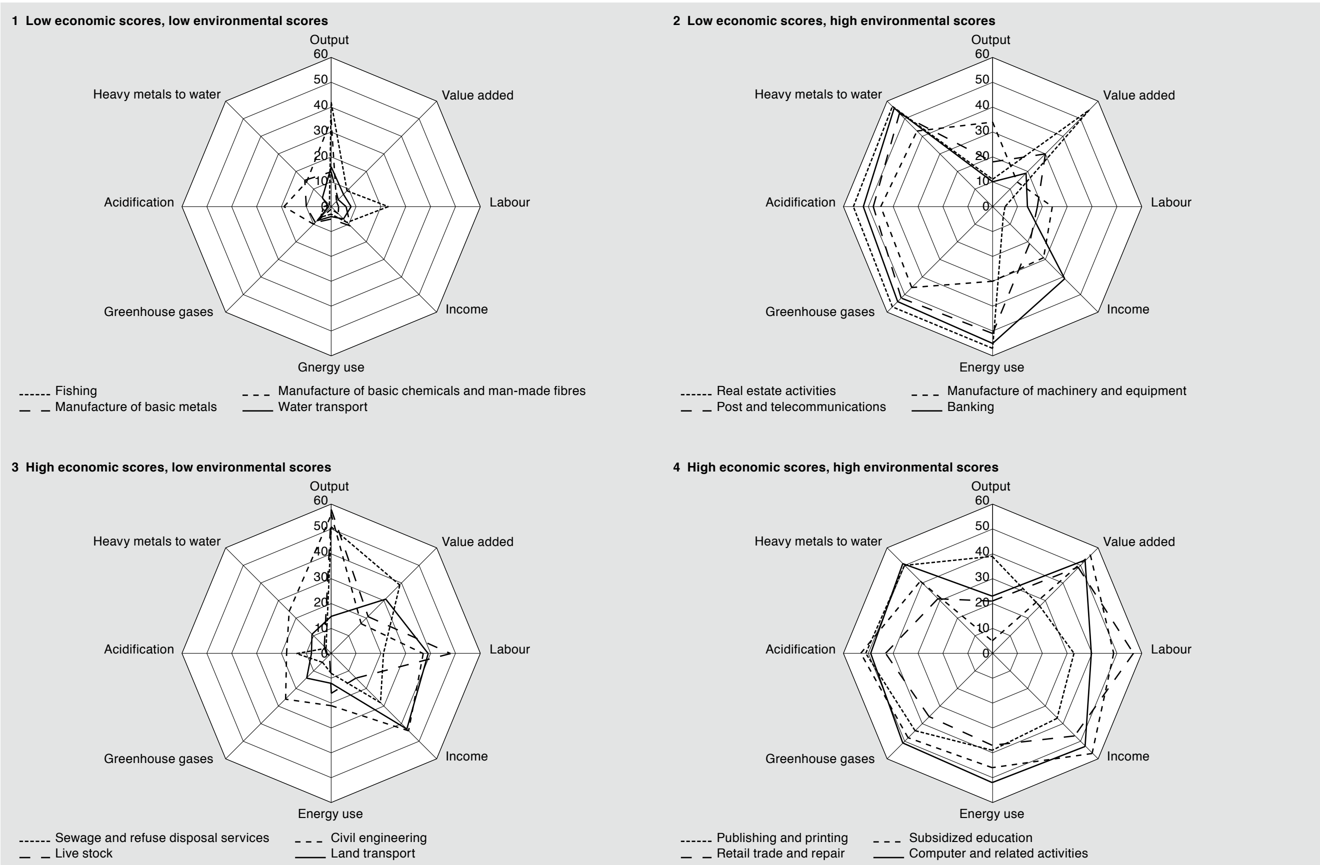
The method we have chosen is to rank the industries for each separate multiplier effect. Subsequently, in order to visualize these rankings and to facilitate their interpretation we

[3)] Except for minor differences related to taxes and subsidies devised trade-off profiles. These are spider webs that show the economic and environmental performances of an industry. By plotting different industries in these spider webs, the trade off between economy and environment can easily be visualised. In principle, a high ranking for the economic multiplier effects is ‘good’ in a sense that relative high amounts of value added, employment or income per unit output is created. Conversely, a high ranking for the environmental multiplier effects is ‘bad’ as this means that the direct and indirect amounts of pollution or energy consumption per unit output is high. To facilitate the interpretation of these trade off profiles, the environmental multiplier effects have been ranked in a reverse order (i.e. high multiplier effects have a low rank). So, for both economic and environmental variables high scores are ‘good’ and low scores are ‘bad’.

This is illustrated in figure 3 where four spider webs are shown with alternately high and/or low environmental and economic multiplier effects.

The first category (low economic scores, low environmental scores) includes industries like fishing, water transport, manufacture of basic metals and the manufacture of basic chemicals, oil refineries and energy companies. These are all energy intensive industries with relative high emissions to air and water. In addition, these industries create a relatively low value added per unit production. In addition, they are labour extensive. Accordingly, they score below average for both economic as well as environmental performances.

3 Trade-off profiles for different industries



The second category (low economic scores, high environmental scores) includes industries like real estate activities, manufacture of machinery, post and communication and banking. They all score well for the environmental variables, as these are emission extensive activities. Their economic performance, however, is below average.

The third category (high economic scores, low environmental scores) includes industries like sewage and refuse disposal services, live stock breeding, civil engineering and land transport. Here the economic performances are above average, whereas the environmental performances are below average as these are overall polluting activities.

The fourth category (high economic scores, high environmental scores) includes industries like publishing and printing, retail trade and repair, subsidized education and computer and related services. These are all capital extensive, energy extensive and labour intensive industries.

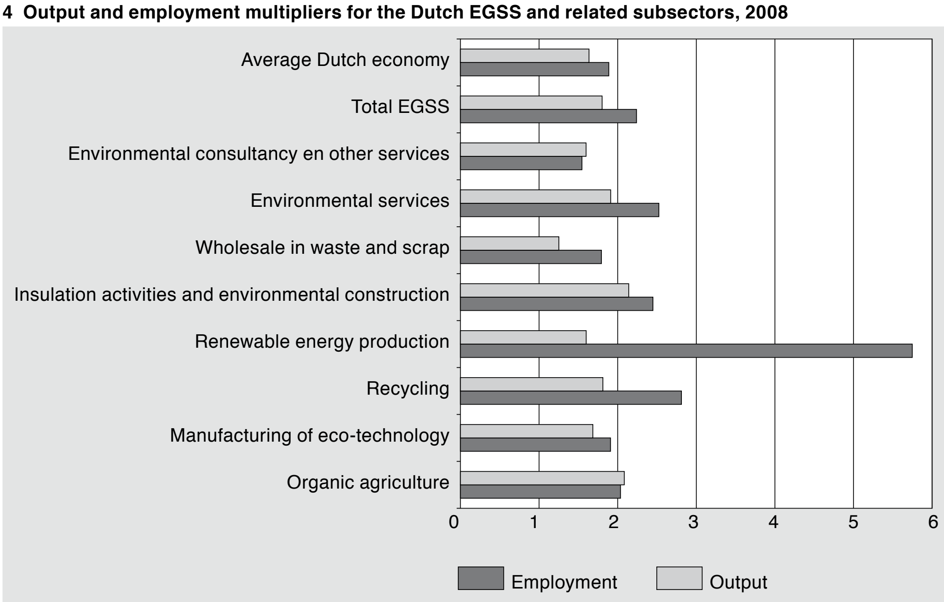
It is important to realise that high ranks do not imply that some activities are better than others. Each economic activity has its own function to fulfil in the economy and some products generate more pollution or require fewer workers than others. What it does purport to show is that economic activities impact on a wide range of phenomena that policymakers may want to consider.

3.3 Multipliers for the Environmental Goods and Services Sector

Environmental regulations and policies as well as the increased awareness about combating environmental pollution and preserving natural resources have led to the rapid increase in demand and supply of goods and services to prevent, measure, control, limit, minimise or correct environmental damage and resources depletion, i.e. environmental goods and services (Eurostat, 2009). The Environmental Goods and Services Sector (EGSS) consists of a heterogeneous set of companies that produces these environmental goods and services. Historically, environmental goods and services production mostly began with traditional markets driven by the demand for basic services, such as wastewater treatment or waste collection. With the drive towards cleaner and more resource efficient processes, products and materials, the activities of the sector have shifted to 'resources management'. Therefore, the EGSS is both a traditional and an emerging sector which includes companies created specifically to serve this emerging market (such as renewable and sustainable energy systems) and companies in more traditionally defined sectors (such as sewage and refuse disposal services).

In a transition towards a more sustainable economy and society the development of the Environmental Goods and Services Sector (EGSS) can play a key role. Growth of the EGSS induces more production of environmental goods and services for the benefit of the environment and contributes to economic growth. The environmental goods and services sector is nowadays seen as a promising business opportunity (e.g. Eurostat, 2009). An innovative environmental technology sector can help to stimulate growth if it is capable of tapping into rapidly growing export markets. In addition, the creation of 'green jobs' may help to reduce unemployment.

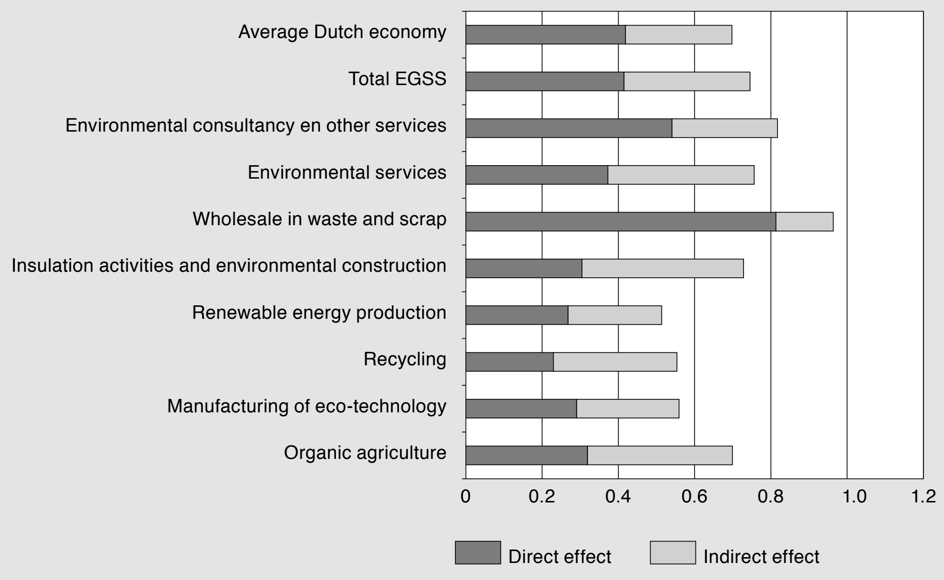
4 Output and employment multipliers for the Dutch EGSS and related subsectors, 2008



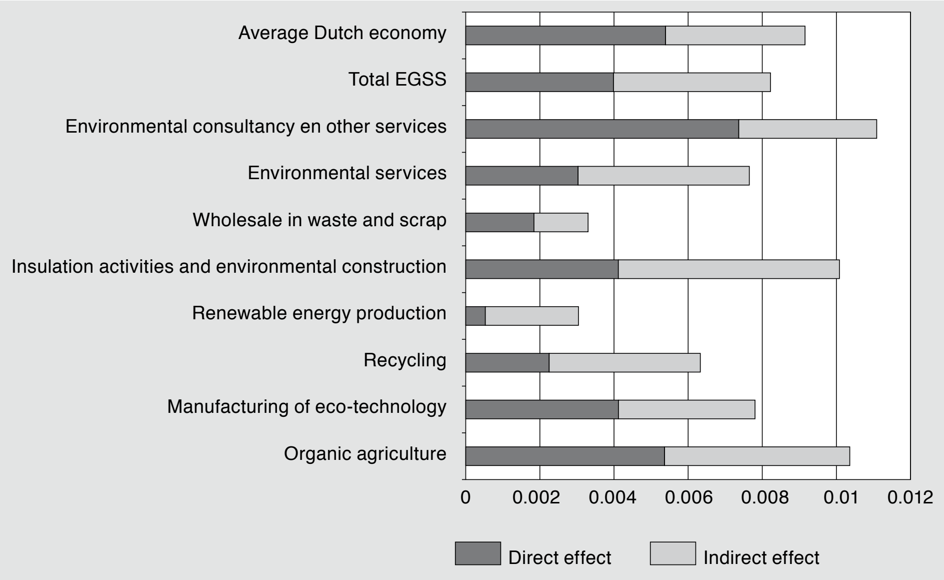
In chapter 16 we discuss the importance and development of the Dutch EGSS, where the impact of the EGSS is quantified in terms of the direct contribution to total output, value added and employment. Here, we specifically focus on the indirect effects of the EGSS in

comparison to other industries in order to determine the spill-over effects for both the economy and the environment.
The output multiplier of the total EGSS in 2008 was equal to 1.8. The output multiplier of the total EGSS is higher than the average output multiplier of the Dutch economy. This is primarily because environmental sewage and refuse disposal services and insulation activities, which represent a share of 41 percent (measured in value added) in the EGSS, have high multipliers, since a large part of their intermediate consumption is produced domestically. Manufacturing of environmental goods (industrial equipment, energy saving and sustainable energy systems, etc.) has a multiplier that is more or less equal to the Dutch average. Wholesale in waste and scrap has a relatively low multiplier. This industry recuperates paper, textiles, metals, etc. and subsequently sells them to other industries for recycling. The intermediate use is low as the inputs are often acquired for free from industries that want to get rid of their waste products. The spill-over effects of this industry are very low because this industry has little or no backward linkages with other industries.

5 Value added multiplier effects for the EGSS and relevant subsectors, 2008



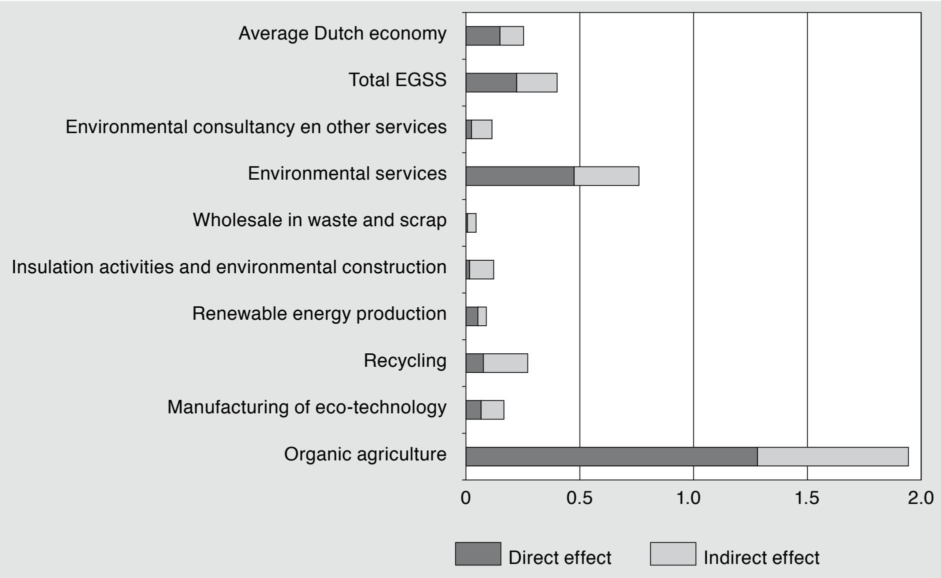
6 Employment multiplier effects for the EGSS and relevant subsectors, 2008



The employment multiplier for the Dutch EGSS was equal to 2.3 in 2008, which is significantly higher than the Dutch average of 1.9. Employment multipliers are particularly high for renewable energy production and the recycling industry. These industries are themselves rather labour extensive and have relative strong backward linkages with more labour-intensive industries. Wholesale in waste and scrap and environmental consultancy, on the other hand, have relatively small employment multipliers because these industries have little or no backward linkages with other industries.

In figure 5 and 6 the economic multiplier effects for value added and employment are shown by presenting both direct and indirect effects. The value added multiplier effect for the total EGSS are somewhat above average. This is primarily because the indirect effects are higher. When looking at different industries, some differences can be observed. Recycling, production of renewable energy and the manufacturing of environmental goods have low value added multiplier effects. The value added per unit output of these industries is rather low, but the indirect effects contribute considerably to their total effects. Wholesale in waste and scrap has a very high value added multiplier effect. This industry has a high value added to output ratio as the intermediate consumption is low. As a result, the indirect effects are low. Insulation activities and environmental construction has relatively the largest indirect effect. This is because of the strong backward linkages with other industries producing value added.

7 Greenhouse gas multiplier effects for the EGSS and related subsectors, 2008

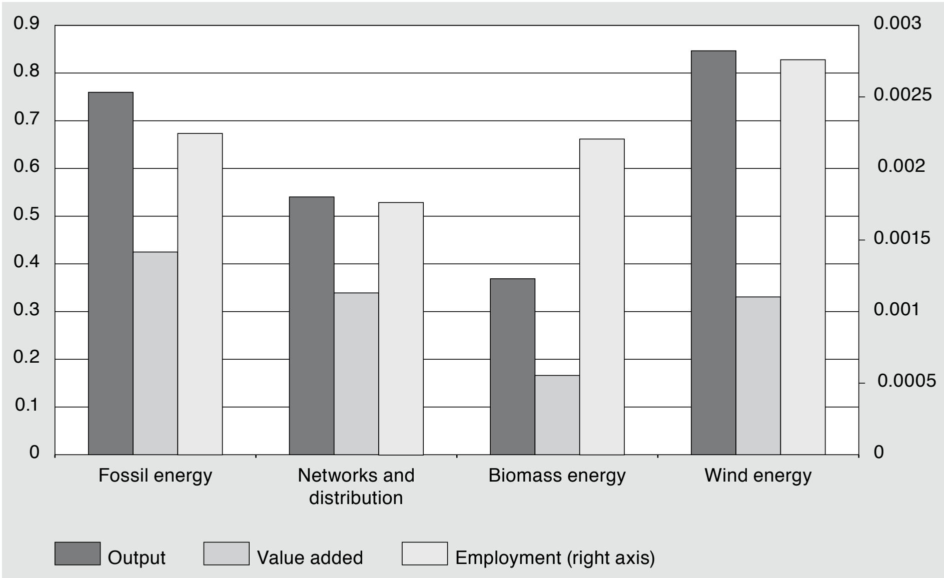


The employment multiplier effect for the EGSS is lower than the average for the Dutch economy. This is primarily because the direct effect is much lower. The EGSS is a relative labour extensive industry. The indirect effects for labour for the EGSS are above average. Wholesale in scrap and waste has a very low employment multiplier effect. This industry is quite labour extensive and also the indirect effects are quite low. Environmental consultancy has the highest employment multiplier effect. This is primarily because this industry is quite labour intensive by itself. Also organic farming and insulation activities have high employment multiplier effects, but here the indirect effects clearly dominate the direct effect.

We calculated the environmental multiplier effects for the EGSS for greenhouse gas emissions. This multiplier effect is above average for the total EGSS, indicating that an overall increase in output of this sector will produce more greenhouse gasses, than a similar increase of output of the Dutch economy on average. At first hand this may seem a strange result for the 'green part of the economy'. When we look in more detail, this is particularly the result of the presence of sewage and refuse disposal services in the EGSS. the production of large amounts of CO_2 and methane are inherent in waste incineration and waste water treatment. The direct emission effect clearly dominates, although the contribution of the indirect effects is also quite substantial. The same is true for organic farming. Like traditional farming, GHG emissions are high due to methane emissions from livestock and CO_2 emissions from the combustion of gas, needed for heating stalls and greenhouses. The GHG multipliers for organic farming, however, are somewhat lower than for traditional farming, indicating that the indirect effects are smaller for organic farming than traditional farming. One of the reasons is that organic farmers use less fertilizers and pesticides produced by the emission-intensive chemical industry. All other economic activities of the EGSS have GHG multipliers below average. As expected, renewable energy production has a very low GHG multiplier effect (0.09) when compared to electricity production using fossil energy (6.3). Also the manufacturing of environmental goods, insulation activities and environmental consultancy have relatively low GHG multiplier effects. For these activities, the indirect effects clearly dominate the direct effects.

One important and growing economic activity of the EGSS is the production of renewable energy. In the Netherlands, biomass combustion and wind energy production are the two main techniques for producing renewable energy. In 2008 they supplied 3.8 and 3.6 percent respectively of the total demand for electricity. These techniques are primarily employed by the energy companies (NACE 40).[4)] By splitting up the energy sector (NACE 40) in the IO table the different multiplier effects of renewable versus fossil we can compare energy production.

8 Indirect economic multiplier effects for the energy sector, 2008



Biomass combustion has a relatively low domestic output multiplier compared to the combustion of fossil fuels. This is because at present around 75 percent of the biomass used by electricity companies is imported. Biomass combustion therefore only has a small effect on the rest of the Dutch economy. When more domestically produced biomass is used, more domestic industries could ‘profit’ and the multipliers would improve. The value added of biomass combustion is low because the intermediate costs for biomass are quite high. In addition, the indirect effect for creating value added at other industries for this activity is also quite small. The indirect effect for value added for generating wind power is higher than for biomass combustion, but lower than for fossil energy combustion. This is because electricity producers using fossil fuels obtain much of their energy from the production of crude petroleum and natural gas. This industry creates a high value added as they extract energy resources directly from the environment with relatively little intermediate costs. The indirect effect for employment for generating wind energy, however, is higher that fossil fuel combustion. This is because wind production has stronger backward linkages with more labour intensive industries.

[4)] See also chapter 16.

4. Discussion

Multiplier analysis provides useful tools for analysing the trade-off relationships between the economy and the environment. The overall impact of an economic activity can be determined by accounting for the direct and indirect effects. Multipliers and multiplier effect, however, should be interpreted with care. Input-output multipliers are based on several assumptions that may limit their applicability, as is well known from the literature (Grady and Muller, 1988; Miller and Blair, 2009).

First, input-output models are static. There is no behaviour in the model, which is a major drawback compared to general equilibrium models. Second, the models are linear. This entails an assumption of proportionality between inputs and outputs, between total income and its components, and between employment and output. Such an assumption can be inappropriate in making estimates of short-run employment multipliers. As a rule employment responds much less than one-for-one with output increases, due to the overhead character of some labour and to the occasional prevalence of a certain degree of labour hoarding. Third, input-output models do not incorporate macroeconomic feedback such as increasing interest rates, which tends to reduce the impact of multipliers.

Fourth, multiplier analysis, as any model, depends on assumptions that are made whether certain variables are exogenous or endogenous. For instance, in an IO analysis, investments are usually regarded as outputs of the economic system rather than inputs into production. Hence the multipliers derived from the IO table do not include requirements for capital investments. Particularly for the production of renewable energy, which is a capital intensive and an emerging activity, this aspect may play an important role. For instance, a lot of new windmills were built in the Netherlands over the last few years. Much of the technology and machinery for windmills has to be imported, as the Netherlands lacks companies that produce these items. The consequence of this situation is apparently that the spill-over effects for the rest of the Dutch economy are quite small. Yet the construction of such windmills may stimulate domestic production when this is done by companies that are part of the Dutch economy. The quantification of the exact effect of investments may be the subject of future research, as methods exist to separate capital investments from the final demand and internalise it into the intermediate demand (see Lenzen, 2001).

Finally, one finding of our research is that multipliers (and effects) depend on the level of detail that is used in the IO table. The effects are significant and could be used to indicate a level of uncertainty or accuracy of multipliers. Higher levels of detail increase the reliability of the estimated output multipliers. However, they come at the costs of reduced reliability of all other multipliers and effects that require intensities (labour, GHGs etc.) as these intensities are often not known at such a high level of disaggregation. It is therefore important to compare multipliers for specific industries with average multipliers.

5. Conclusion

The average output multiplier for the Dutch economy in 2008 was 1.71. The overall multiplier effect on GDP for the Dutch economy was 0.74, which means that every euro increase in output on average adds 74 cents to GDP. The average greenhouse gas multiplier effect is 0.27 ton CO_2 equivalents.

Multipliers and multiplier effects differ significantly from one industry to another. In times of crisis when governments are asked to stimulate the economy, it is therefore important to assess the various effects that such policies on one industry may have on the total economy. In this study we visualise these effects of output stimulus by incorporating not only economic but also environmental dimensions. This allows us to depict where trade-offs and synergies are likely to occur. Industries such as publishing and printing, retail trade and repair, subsidized education and computer and related activities score well across both economic and environmental dimensions.

Whereas multiplier effects focus on the impact of changes in output, multipliers such as labour or GHG multipliers are indicators that can be used to analyze the effect of employment creation strategies or GHG reduction strategies on the whole economy. The manufacture of oil products has the highest employment multiplier, which may well indicate that a job created here has the largest employment enhancing effect. Real estate has one of the highest GHG multipliers, which may be interpreted as a signal for the government to attempt to reduce emissions here as one unit reduction (e.g. ton CO_2 equiv. per year) in this industry would result in almost nine units less in the domestic economy. However, it is important to realize that multipliers are always effectuated through input-output relationships due to the nature of the IO model. Therefore realizing one unit GHGs less would require a significant drop in output of the real estate industry (direct effect) itself and likewise changes in outputs of other industries (indirect effect – the output multiplier is 1.66 only slightly below average) as compared to a reduction in GHGs in a more emission intensive industry such as farming. In order to analyze the effects of policies it is therefore important to compare various multipliers. Another aspect to consider is the amount of leakages of output or employment that may occur through imports.

During the financial and economic crisis there were frequent calls for not merely resetting the traditional ‘grey’ economy, but for a transition towards a green economy. The argument being that this would not only be right from a climate perspective, but also makes economic sense (UNEP 2009). In this study we therefore investigated in more detail the indirect effects of the EGSS. Indeed, output and employment multipliers for the Environmental Goods and Services Sector are above the average of the Dutch economy. Accordingly, growth of this sector induces significant economic spill-over effects for the rest of the economy in terms of new jobs, value added and output. An increase in output of 1 million euro will induce an increase in value added of 745 thousand euro and will create 8 new jobs, of which respectively 330 thousand euro value added en 4 jobs are created outside the EGSS. Here, it is important to differentiate between the more traditional part of the EGSS and the more innovative part, because particularly for the latter there are opportunities for further growth. The results of this study show that that output and employment multipliers are also relatively high for the non traditional industries of the EGSS.

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Glossary

Acidification – Process by which soil or water becomes more acid (i.e. decreases in pH) as the result of the deposition of polluting substances (NO_X, SO_2, NH_3 and VOS (volatile organic substances)).

Acid equivalents – Measure used to determine to what degree a substance contributes to the acidification of the environment. One acidification equivalent is equal to one mole H^+.

Basic prices – The basic price is the amount receivable by the producer from the purchaser for a unit of a good or service produced as output minus any tax payable, and plus any subsidy receivable, on that unit as a consequence of its production or sale; it excludes any transport charges invoiced separately by the producer. Value added can be expressed in basic prices.

Bunkering – Deliveries of oil products to ships and aircraft engaged in international traffic.

CO_2-equivalents – measure that describes how much global warming a given type and amount of greenhouse gas may cause, using the functionally equivalent amount or concentration of carbon dioxide (CO_2) as the reference. The emissions of 1 kg methane is equal to 21 CO_2-equivalents and the emission of 1 kg nitrous oxides is equal to 310 CO_2-equivalents.

Climate change – The United Nations Framework Convention on Climate Change (UNFCCC) defines 'climate change' as 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'.

Consumption of fixed capital – Consumption of fixed capital represents the depreciation of the stock of produced fixed assets, as a result of normal technical and economical ageing and insurable accidental damage. Losses due to catastrophes and unforeseen ageing are seen as a capital loss.

Decoupling – Decoupling occurs when the growth rate of an environmental pressure is less than that of its economic driving force (e.g. GDP) over a given period. Decoupling can be either absolute or relative. Absolute decoupling is said to occur when the environmentally relevant variable is stable or decreasing while the economic driving force is growing. Decoupling is said to be relative when the growth rate of the environmentally relevant variable is positive, but less than the growth rate of the economic variable.

Domestic Material Consumption, DMC – Domestic material consumption in kg, defined as extraction plus imports minus exports.

Economic growth – The change in volume of gross domestic product (GDP) with respect to the previous year in market prices.

Effluent – Treated waste water flowing from the waste water treatment plant to the surface water.

End use (of energy) – The final energy use for energetic and non-energetic purposes (for example the use of lubricants) plus conversion losses (for example energy losses that occur at the transformation of coal into electricity by electricity companies).

Emissions – Polluting substances that are released from a source. Emissions can be divided into direct and indirect emissions. Direct emissions are directly discharged into the environment. Indirect emissions reach the environment by a roundabout way. For example, discharges into the sewer system that partially reach the surface water after purification by the sewage plants. In the context of IO analysis, indirect emissions refer to all emissions embedded in the production of goods and services. i.e. all emissions that have accrued over the supply chain.

Emission factor – A measure of the emissions per unit of energy use.

Emission-intensity – The emission intensity is measure for the efficiency by which polluting substances are emitted in production processes. The emission intensity is equal to the total emission (in kg or equivalents) divided by a monetary unit either value added (in euro) or output (in euro). It can be calculated for both individual economic processes as for the economy as a whole.

Energy-intensity – The energy intensity is measure for the efficiency by which energy is used in production processes. The energy intensity is equal to the net energy use (in PJ) divided by a monetary unit either value added (in euro) or output. It can be calculated for both individual economic processes as for the economy as a whole.

Environmental costs – The annual costs of environment-related activities which companies carry out themselves (interest and depreciation of environment-related investment and current costs such as operation, maintenance and supervision of environmental provisions).

Environmental fees – Fees that are levied to finance specific environmental measures, like the sanitation of waste water or the collection and processing of waste.

Environmental services – Industry that is occupied with collection and treatment of wastewater and waste and the clean-up of soil (NACE 90). Environmental services are part of the Environmental goods and service sector.

Environmental investments – Extra investment in capital goods intended to protect, restore or improve the environment.

Environmental goods and services sector **–** a heterogeneous set of producers of technologies, goods and services that measure, control, restore, prevent, treat, minimise, research and sensitise environmental damages to air, water and soil as well as resource depletion. This includes 'cleaner' technologies, goods and services that prevent or minimise pollution.

Environmental taxes – a tax whose tax base is a physical unit (or a proxy of it) of something that has a proven, specific negative impact on the environment (European commission – Eurostat, 2001). Environmental taxes are levied to discourage people from undertaking activities that pollute the environment.

Eutrophication – Excessive enrichment of waters with nutrients and the associated adverse biological effects.

Expected reserve – The amount of crude oil or natural gas that can be extracted according to a predefined expectation.

Fine dust (PM10) – Air-borne solid particles, originating from human activity and natural sources, such as wind-blown soil and fires, that eventually settle through the force of gravity, and can cause injury to human and other animal respiratory systems through excessive inhalation.

Final use of energy – Use after which no useful energy carriers remain.

Fixed capital formation – Expenditure for produced tangible or intangible assets that are used in the production process for more than one year.

Greenhouse gases – gases in the atmosphere that absorb and emit radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The most important greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), HFK's, PFK's en SF_6.

Gross domestic product (GDP) – value of all the goods and services produced in an economy, plus the value of the goods and services imported, less the goods and services exported.

Heavy metal equivalents – Emissions of copper, chromium, zinc, lead, cadmium, mercury and arsenic can be converted into heavy metal equivalents and can subsequently be added up. The conversion into equivalents takes into account the harmfulness of the metal for the environment. Mercury and cadmium, for example, are more harmful than cupper and zinc and therefore get a higher weight in the conversion calculation.

Industry – used synonymously with economic activity. Industries are distinguished in general at the 2-digit ISIC/NACE level (divisions). NB: manufacturing (in Dutch: industrie) is considered an economic sector.

Influent – Waste water transported to a waste water treatment plant (for treatment).

Intermediate consumption (purchasers' prices) – includes all goods and services used up in the production process in the accounting period, regardless the date of purchase. This includes for example fuel, raw materials, semi manufactured goods, communication services, cleansing services and audits by accountants. Intermediate consumption is valued at purchasers' prices, excluding deductible VAT.

Mobile sources –sources for emissions such as vehicles that are not stationary.

NACE code – Code identifying economic activities following the Nomenclature of Activities in the European Union (NACE).

Net environmental costs – Environmental costs plus environmental related taxes minus environmental subsidies.

Net energy use – End use of energy plus export of energy.

Non-residents – All persons and businesses that do not belong to the Dutch economy.

Nutrient-equivalents – Emissions of phosphorus and nitrogen can be can be converted into nutrient-equivalents and can subsequently be added up. The conversion into equivalents takes into account the harmfulness of the nutrients for the environment.

Operating surplus / mixed income – Gross operating surplus by industry is the balance that remains after deducting from the value added (basic prices) the compensation of employees and the balance of other taxes and subsidies on production. The operating surplus of family enterprises is called mixed income, because it also contains compensation for work by the owners and their family members.

Output (basic prices) – Output covers the value of all goods produced for sale, including unsold goods, and all receipts for services rendered. Output furthermore covers the market equivalent of goods and services produced for own use, such as own account capital formation, services of owner-occupied dwellings and agricultural products produced by farmers for own consumption. The output of such goods is estimated by valuing the quantities produced against the price that the producer would have received if these goods had been sold.

Products – Materials with an economic value.

Re-exports – Imported goods that are destined for use abroad. These goods must leave the country in (almost) unaltered condition and must change ownership to a Dutch resident.

Renewable energy – Energy from the following sources: hydropower, geothermal energy, solar energy, wind energy, tide/wave/ocean energy, solid biomass, wood, wood waste, other solid waste, charcoal, biogas, liquid biofuels and biodegradable material combusted from municipal waste.

Reserves – The expected reserve is the remaining amount of gas or oil based on geological surveys which is supposed to be extractable with existing technology. The expected reserve includes the probable reserves, and is therefore larger than the mere proven reserves. Inventories are also included. The classification categories referred to are based upon the McKelvey Box system as explained in SEEA 2003.

Residents – All persons and businesses that belong to the (Dutch) economy. These are persons that stay in the Netherlands for longer than one year and businesses that are established in the Netherlands, including companies from foreign enterprises that are located in the Netherlands.

Resident principle – According to the resident principle all emissions caused by residents or all energy or raw materials that are used by residents are accounted for.

Resource rent –income that accrues to the owner of a natural resource through its use in production. It is derived residually by deducting from output all the costs of production.

River basin – The land area drained by a river and its tributaries.

SEEA 2003 – System of Integrated Economic Environmental Accounting 2003.

Sector – a distinction is made between institutional sectors and economic sectors. Institutional sectors group together residents into five mutually exclusive sectors composed of the following types of units: a. Non-financial corporations; b. Financial corporations; c. Government units, including social security funds; d. NPIs serving households (NPISHs); e. Households. Economic sector is defined as a grouping of industries e.g. the agricultural sector.

Short-cyclic CO_2 – CO_2-emissions that are released during the combustion of biological degradation of biomass (i.e. combustion of wood in furnaces and burning of biomass in electricity plants). These CO_2-emissions are not part of the emissions as calculated by the IPCC guidelines.

Stationary sources – Sources for emissions from fixed point sources such as installations, power plants or other point sources. Includes all emissions not related to mobile sources.

TOFP – Tropospheric ozone forming potential. Indicator for the formation of tropospheric ozone (local air pollution). The formation of tropospheric ozone causes smog pollution.

Value added – The income created during the production process. Value added at basic prices by industry is equal to the difference between output (basic prices) and intermediate consumption (purchasers' prices).

Waste – Materials for which the generator has no further use for own purpose of production, transformation or consumption, and which he discards, or intends or is required to discard. Not included are materials that are directly re-used at their place of origin.

Waste product – Waste with an economic value to the generator.

Waste residual – Waste with no economic value to the generator.

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