Environmental accounts of the Netherlands 2012

Statistics Netherlands

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Explanation of symbols

.	Data not available
*	Provisional figure
**	Revised provisional figure (but not definite)
x	Publication prohibited (confidential figure)
–	Nil
–	(Between two figures) inclusive
0 (0.0)	Less than half of unit concerned
empty cell	Not applicable
2012–2013	2012 to 2013 inclusive
2012/2013	Average for 2012 to 2013 inclusive
2012/'13	Crop year, financial year, school year, etc., beginning in 2012 and ending in 2013
2010/'11–2012/'13	Crop year, financial year, etc., 2010/'11 to 2012/'13 inclusive
W	Watt (1 J/s)
kW	Kilowatt (1,000 J/s)
Wh	Watt-hour (3,600 J)
J	Joule
tonne	1,000 kg
M	Mega (10^6)
G	Giga (10^9)
T	Tera (10^{12})
P	Peta (10^{15})
nge	Natural gas equivalents (1 nge is approximately 31.65 MJ)
mln	Million
bln	Billion
MWe	Megawatt electrical capacity
MWth	Megawatt thermal capacity

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

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Foreword

While the Dutch economy shrank 1.2 percent in 2012, energy use rose by 2 percent and the greenhouse gas emissions remained more or less at the 2011 level. Dutch natural gas reserves decreased in 2012 and with the current exploitation rate they may be depleted within 15 years. Environmental tax revenues diminished as well. These and other results can be found in this edition of the *Environmental Accounts of the Netherlands*.

The *Environmental Accounts of the Netherlands 2012* by Statistics Netherlands (CBS) presents a broad quantitative overview of the recent key developments in the relationship between the environment and the economy. It covers developments in energy, water, materials, greenhouse gas emissions and air pollution, as well as policy instruments and economic opportunities. Environmental accounts can be used to provide indicators for policy frameworks such as sustainable development and green growth.

Three articles provide more in-depth analyses of specific topics. The first article describes the main results from the first monitor on material flows. This monitoring system, based on macro-economic data, was set up to support Dutch resource policy. From it indicators can be derived on the efficient use and reuse of and dependency on resources.

The second article systematically explores the issues of energy use and the emissions of sulphur dioxide (SO_2) and carbon dioxide (CO_2) from a historical perspective. It describes how the Netherlands developed into an energy-intensive economy between 1950 and the early 1970s and how patterns of energy use and emissions have changed since.

The third article explores how carbon footprints can be calculated in such a way that they are consistent with official statistics. It lists the challenges that lie ahead in bringing the footprint calculations within the realm of official statistics. The preliminary results show among other things that over 19 percent of the Dutch carbon footprint abroad is due to emissions that occur in China during the production of goods that are eventually consumed in the Netherlands.

The *Environmental Accounts of the Netherlands 2012* is published simultaneously with the publication *Green growth in the Netherlands 2012*. In this publication the green state of the Dutch economy is analysed on the basis of 33 indicators, many of which are derived from the environmental accounts.

Director General of Statistics
G. van der Veen

Heerlen/The Hague, November 2013

Contents

Summary

Increase in net energy use

Net domestic energy use for the Dutch economy rose by almost 2 percent in 2012. This is a relatively small increase given the decline of 5 percent in 2011. The 2012 increase was mainly caused by the cold winter and a greater demand for energy by the chemical industry. The increase was offset by the economic crisis, which reduced the demand for energy by industrial companies. In addition, less energy was used for the production of electricity as more cheap electricity was imported, mainly from Germany. The energy intensity of the Dutch economy increased in 2012.

Greenhouse gas emissions remained stable in 2012

Greenhouse gas emissions by Dutch production and consumption activities in the Netherlands remained virtually the same in 2012 as in 2011 while the economy shrank by 1.2 percent. The emission intensity, greenhouse gas emissions divided by GDP, therefore increased. In 2011 there had still been a substantial decrease in the emission intensity. The main reason why the economic downturn was not accompanied by lower emissions was the relatively cold weather in 2012. The carbon dioxide (CO_2) emissions barely changed. The emission of methane (CH_4) fell by 1.4 percent and that of nitrous oxide (N_2O) by 0.2 percent.

Decrease of fine dust and acidifying emissions

The total emissions of acidifying substances, expressed as acid equivalents, decreased by 1 percent in 2012 compared to 2011. Emissions of these substances have been cut by 57 percent since 1990. Acidification of the environment is caused by the emission and deposition of nitrogen oxides (NO_x), sulfur dioxide (SO_2) and ammonia (NH_3). Acidification affects the biodiversity and can cause damage to sensitive areas, such as forests and heaths. The agricultural and transport sectors are mainly responsible for acidifying emissions. The total emission of fine dust fell by 4 percent in 2012 compared to 2011.

Further decrease of environmental tax revenues

Total revenues from environmental taxes and fees diminished further in 2012. The decrease in environmental tax revenue is mainly caused by falling revenues from the tax on cars and motorcycles, and from abolishing groundwater and waste tax. The share of environmental taxes in the total tax revenues received by the government is 13.7 percent, the lowest share since 2008.

Environmental Goods and Services Sector (EGSS) increased in 2011

The total production and value added of the EGSS increased in 2011. Employment was more or less stable in 2010 and 2011. More solar and wind energy led to more value added by renewable energy production in 2011. The traditional environmental activities such as waste, wastewater management, wholesale in waste and scrap and recycling also raised their value added. Value added in the EGSS came to 2.4 percent of the Dutch GDP in 2011 while the EGSS contributed 1.7 percent to total employment.

First monitor for material flows in the Netherlands

Worldwide population growth and increasing wealth have led to more demand of natural resources. As a result some resources are becoming economically scarce. Dutch policymakers are now developing a strategy to secure a supply of vital resources in the future. To support Dutch resource policy, a system to monitor physical material flows (in

kilos) is set up on the basis of macro-economic data for the year 2008. A whole set of indicators can be derived from this system. For example, the efficient use of resources can be determined by the amount of material that is needed to generate one euro of value added. The dependency on resources can be determined by looking at the country of origin for particular resources and at their use by industries. Another indicator that can be derived is the amount of secondary resources used relative to primary resources. For many of the indicators it is difficult to draw conclusions on the performance of a particular industrial branch because comparisons in time cannot yet be made. In 2014 a dataset will be compiled for 2010, making comparisons in time possible.

Energy use from a historical perspective

Statistics Netherlands (SN) has been publishing serial and incidental statistics on energy use and emissions to air since 1960. Environmental politics require long-term trends of these issues. In this study, we have constructed the very first long-term time series for 1960-2012 that are consistent with the national accounts approach. The data are aggregated into five energy carriers and seven industries plus households. From 1960 onwards, energy use increased as GDP rose, especially in the petrochemical industry. CO_2 emissions have grown likewise, but SO_2 emissions did not. The difference may be explained by the proportional use of energy carriers and by changes in emission factors. SO_2 emissions have been reduced by desulfurization of fuels and by filtering flue gas. In recent years, most CO_2 emissions came from electricity and gas supply and from households. The long-term time series show a strong connection between economic growth, energy use and emissions to air.

Calculating carbon footprint consistent with official statistics

Many carbon footprint estimates are currently available that, on closer inspection, provide very different insights into the level and annual changes of the Dutch carbon footprint. In this edition we report on our research on providing provisional estimates of the Dutch carbon footprint, using a publicly available multi-regional input/output table (WIOD) which we have made consistent with the Dutch national accounts and environmental accounts data. Our main findings are that the carbon footprint (CO_2 only) amounted to 202 Mton CO_2. This equals 12.2 ton on a per capita basis. Of all CO_2 emissions abroad because of final consumption in the Netherlands, China contributed the most with 19 percent.

Samenvatting

Toename netto energieverbruik

Het netto binnenlands energiegebruik voor de Nederlandse economie groeide in 2012 met bijna 2 procent. Dit is een relatief kleine toename, gezien de daling van 5 procent in 2011. De koudere winter en de toegenomen vraag naar energie door de chemische industrie zijn de belangrijkste oorzaken van de stijging. De stijging werd enigszins gecompenseerd door de economische crisis. Door deze crisis hadden industriële bedrijven een lagere vraag naar energie. Daarnaast werd er minder energie gebruikt voor de productie van elektriciteit in Nederland, omdat er meer goedkope elektriciteit werd geïmporteerd, voornamelijk uit Duitsland. De energie-intensiteit van de Nederlandse economie steeg in 2012.

Uitstoot broeikasgasemissies blijft stabiel in 2012

De uitstoot van broeikasgassen is in Nederland nagenoeg gelijk gebleven in 2012 in vergelijking met het voorgaande jaar. Dit terwijl de economie kromp met 1,2 procent in 2012. De emissie-intensiteit, de uitstoot van broeikasgassen gedeeld door het bbp nam toe. In 2011 was er nog een aanzienlijke afname van de emissie-intensiteit. Het relatief koude weer in 2012 is de belangrijkste reden waarom de economische neergang niet gepaard ging met een daling van de uitstoot. De uitstoot van koolstofdioxide (CO_2) is nauwelijks veranderd. De uitstoot van methaan (CH_4) daalde met 1,4 procent en die van stikstofoxide (N_2O) met 0,2 procent.

Afname van de verzurende emissies en fijnstof uitstoot

De totale uitstoot van verzurende stoffen, uitgedrukt als zuur equivalenten, daalde met 1 procent in 2012 ten opzichte van het voorgaande jaar. Sinds 1990 is de uitstoot van deze stoffen gedaald met 57 procent. Verzuring wordt veroorzaakt door de emissie en depositie van stikstofoxiden (NO_x), zwaveldioxide (SO_2) en ammoniak (NH_3). Verzuring is van invloed op de biodiversiteit en kan schade veroorzaken aan kwetsbare gebieden, zoals bossen en heidevelden. Vooral de landbouw- en transportsector zijn verantwoordelijk voor verzurende emissies. De totale emissie van fijnstof daalde in 2012 met 4 procent ten opzichte van 2011.

Verdere daling van de inkomsten uit milieubelastingen

Net als in 2011 daalden de totale inkomsten uit milieubelastingen en milieuheffingen in 2012. De daling van de inkomsten uit milieubelastingen is voornamelijk te wijten aan dalende inkomsten van de belasting op personenauto's en motorrijwielen. De opbrengsten van milieubelastingen zijn verder gedaald omdat twee belastingen werden afgeschaft. Het aandeel van milieubelastingen als onderdeel van de totale belastingopbrengsten van de overheid is met 13,7 procent op het laagste punt sinds 2008.

Groei milieusector in 2011

De totale productie en de toegevoegde waarde van de milieusector (in het Engels de EGSS) zijn toegenomen in 2011. De werkgelegenheid was min of meer stabiel tussen 2010 en 2011. Vooral door meer opwekking van zonne-en windenergie steeg de toegevoegde waarde van duurzame energieproductie in 2011. De toegevoegde waarde van de traditionele milieuactiviteiten (afval, afvalwaterbeheer, groothandel in afval en schroot en recycling) nam ook toe. De toegevoegde waarde in de milieusector was gelijk aan 2,4 procent van het Nederlandse bbp in 2011. In dat jaar droeg de milieusector 1,7 procent bij in de totale werkgelegenheid.

Eerste monitor voor materiaalstromen in Nederland

Wereldwijde bevolkingsgroei en toenemende welvaart hebben geleid tot een toenemende vraag naar natuurlijke hulpbronnen. Als gevolg hiervan wordt een aantal grondstoffen economisch schaars. Nederlandse beleidsmakers ontwikkelen nu een strategie om het aanbod van vitale natuurlijke hulpbronnen in de toekomst veilig te stellen. Ter ondersteuning van het Nederlandse grondstoffenbeleid is een statistisch systeem ontwikkeld om fysieke materiaalstromen (in kilo's) te monitoren op basis van macro-economische gegevens voor het jaar 2008. Uit dit systeem kan een hele reeks indicatoren worden ontleend. Bijvoorbeeld, het efficiënte gebruik van hulpbronnen, de afhankelijkheid van hulpbronnen en de hoeveelheid secundaire hulpbronnen die gebruikt worden. Voor veel van deze indicatoren is het moeilijk om conclusies te trekken over de prestaties van een bepaalde bedrijfstak, omdat vergelijkingen in de tijd nog niet kunnen worden gemaakt. In 2014 zal een dataset voor het jaar 2010 worden opgesteld waardoor vergelijkingen in de tijd mogelijk worden.

Energiegebruik in historisch perspectief

Sinds 1960 heeft het Centraal Bureau voor de Statistiek seriële en incidentele statistieken gepubliceerd over energieverbruik en emissies naar lucht. Milieupolitiek heeft lange termijn ontwikkelingen van deze onderwerpen nodig. In dit onderzoek zijn voor de eerste keer lange-termijn tijdreeksen samengesteld voor de jaren 1960–2012, die in overeenstemming zijn met de aanpak van de nationale rekeningen. De gegevens zijn geaggregeerd tot vijf energiedragers en zeven sectoren plus huishoudens. Vanaf 1960 steeg het energiegebruik met het toenemende bbp, met name in de petrochemische industrie. CO_2-emissies zijn vergelijkbaar gegroeid, maar SO_2-uitstoot niet. Het verschil kan worden verklaard door het proportionele gebruik van energiedragers en door veranderingen in de emissiefactoren. SO_2-uitstoot is verminderd door ontzwaveling van brandstoffen en door het filteren van rookgas. In de afgelopen jaren was de meeste CO_2-uitstoot afkomstig van het electriciteits- en gasaanbod en van huishoudens. De langlopende tijdreeksen laten een sterk verband zien tussen economische groei, energiegebruik en emissies naar lucht.

Berekenen van de carbon footprint consistent met officiële statistieken

Tegenwoordig zijn er vele carbon footprint schattingen beschikbaar die bij nader inzien heel andere inzichten laten zien, zowel op het niveau van de Nederlandse carbon footprint als hun jaarlijkse veranderingen. Hier wordt verslag gedaan van het onderzoek naar voorlopige schattingen van de Nederlandse carbon footprint op een openbare multiregionale input-output tabel (gekozen is voor WIOD) die in overeenstemming met de Nederlandse nationale rekeningen en gegevens uit de milieurekeningen is gemaakt. De belangrijkste bevindingen zijn dat de carbon footprint (CO_2) 202 Mton CO_2 bedroeg in 2009. Dit is gelijk aan 12,2 ton per hoofd. Van alle CO_2-uitstoot in het buitenland uitgestoten als gevolg van de consumptie in Nederland, droeg China met 19 procent het meeste bij.

Environmental accounts, key figures[1)]

	Unit	1990	1995	2000	2005	2010	2011*	2012*
Economy								
Domestic product (gross, market prices, price level of 2005)	**million euros**	352,065	394,332	480,825	513,407	549,265	554,453	547,538
Final consumption expenditure households (price level of 2005)	**million euros**	176,890	193,074	239,268	250,343	252,611	249,905	245,801
Investments in fixed assets (gross, price level of 2005)[2)]	**million euros**	67,050	73,446	100,979	97,016	93,620	99,290	95,312
Population (1 January)	**x 1,000**	14,893	15,424	15,864	16,306	16,575	16,656	16,730
Labour input of employed persons	**x 1,000 FTE**	5,536	5,774	6,534	6,478	6,719	6,753	6,735
Environmentally adjusted aggregates								
Adjusted national income for depletion of mineral resreves (net)	**%**	1.2	0.9	0.7	1.0	2.1	1.8	1.8
Energy								
Net domestic energy use	**petajoules**	2,940	3,229	3,387	3,656	3,782	3,539	3,602
Energy intensity	**MJ / euro**	8.4	8.2	7.0	7.1	6.9	6.4	6.6
Extraction natural gas	**billion Sm³**	72	78	68	73	86	79	78
Mineral reserves gas[3)]	**billion Sm³**	2,113	1,952	1,777	1,510	1,304	1,230	1,130
Valuation mineral reserves gas[3)]	**million euros**	69,236	60,742	64,444	99,846	155,106	140,105	147,060
Water								
Groundwater abstraction	**million m³**	1,215	1,255	1,019	1,013	1,006	992	-
Tapwater use	**million m³**	1,166	1,171	1,127	1,086	1,090	1,080	1,070
Tapwater use intensity	**litre / euro**	3.3	3.0	2.34	2.1	2.0	1.9	1.95
Heavy metals to water[4)]	**1,000 eq.**	146	110	82	51	41	-	-
Nutrients to water[4)]	**1,000 eq.**	26,811	14,800	10,756	7,977	6,292	-	-
Materials								
Material consumption biomass	**million kg**	-	-	50,358	48,552	47,709	50,441	-
Material consumption metals	**million kg**	-	-	7,681	6,299	6,034	6,031	-
Solid waste production	**million kg**	52,450	53,983	64,013	61,610	59,024	-	-
Landfilled waste	**million kg**	14,982	9,209	4,907	2,137	1,527	-	-
Greenhouse gas emissions and air pollution								
Greenhouse gas emissions and air pollution	**million CO_2-eq.**	230,477	247,114	243,218	242,036	244,144	230,614	230,302
Greenhouse gas emission intensity	**CO_2 eq. / 1,000 euro**	655	627	506	471	444	416	421
CFK emissions (ozone layer depletion)	**thousand CFK12-eq.**	6,198	765	260	173	137	131	124
Acidifying emissions	**billion ac-eq.**	46	35	30	28	21	20	20
Fine dust emissions	**million kg**	79	63	54	47	38	37	35
Policy instruments and economic opportunities								
Environmental taxes and fees	**million euros**	5,824	9,249	13,973	17,270	19,871	19,688	18,579
Share environmental taxes and fees in total taxes	**%**	9.4	13.1	14.1	13.9	13.9	14.1	13.7
Environmental costs	**million euros**	3,864	6,601	9,116	10,105	-	-	-
Labour input environmental goods and services sector	**x 1,000 FTE**	-	82	96	106	112	113	-
Value added environmental goods and services sector (basic prices)	**million euros**	-	6,081	8,223	9,949	13,876	14,328	-

1) Intensities in this table are based upon use/ emissions of both households and industries.
2) Excluding non-profit institutions.
3) Balance as of 31 December.
4) Net approach.

1. Introduction

Authors
Sjoerd Schenau
Marjan Verberk

The System of Environmental-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. This chapter introduces SEEA, its main building blocks and the relationship between environmental statistics and environmental accounts. In addition, a short outline is provided of this publication.

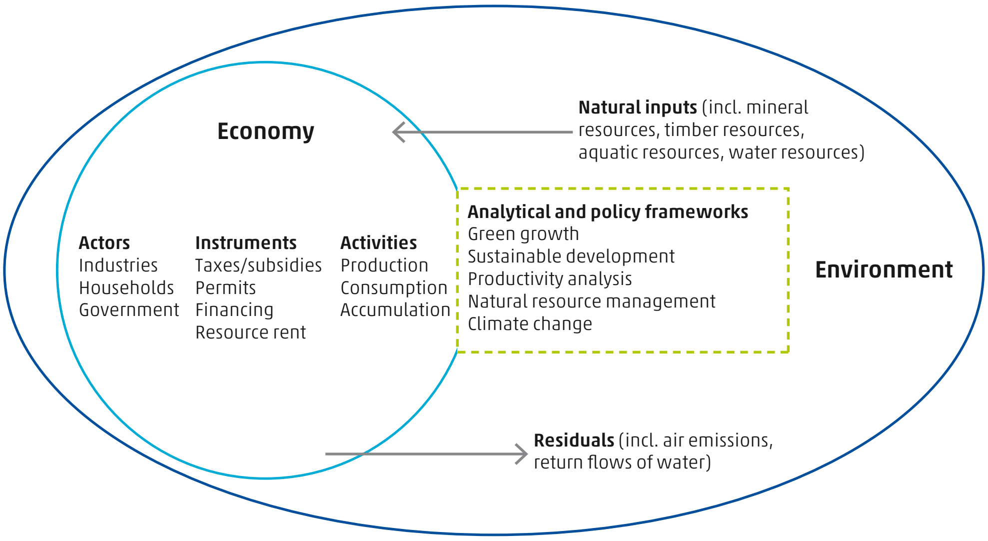
1.1 Environmental accounting

The economy and the environment are intertwined. The economy depends on the environment as a source 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.

The System of Environmental-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., 2012; referred to as SEEA 2012). 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).

1.2 The SEEA conceptual framework

1.2.1 The SEEA conceptual framework



Source UN et al. (2012).

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, environmental developments and macro-economic developments can be compared directly. Key indicators can be derived from the environmental accounts. These provide insight into sustainability with respect to environmental and economic developments. The integrated nature of the system makes it possible to quantify and analyse the underlying causes of changes in environmental indicators. The SEEA supports sustainable development and green economy policies and can be used to inform research and economic-environmental policies such as climate change mitigation, resource efficiency, natural resource management, evaluation of policy instruments and the development of the environmental goods and services sector.

The SEEA Central Framework was adopted as an international statistical standard by the United Nations Statistical Commission in February 2012. As an international standard, it has the same status as the System of National Accounts (SNA), from which such key economic indicators as GDP are derived. SEEA provides an internationally agreed set of recommendations expressed in terms of concepts, definitions, classifications, accounting rules and standard tables which will help to obtain international comparability of environmental-economic accounts and related statistics.

SEEA building blocks

The SEEA comprises three 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 inputs, 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), emissions to water (heavy metals, nutrients), emissions to soil (nutrients, etc.) 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 natural 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 in both 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. Environmental activity accounts

In these accounts, all sorts of economic 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 expenditure 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 these 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.

Environmental statistics and environmental accounts

There are several differences between environmental statistics and environmental accounts. Environmental statistics are usually directly based on the source statistics, i.e. surveys or registers. There is, often with good reason, no full consistency between one set of statistics and another. SEEA on the other hand provides an integrated set of a accounts in which there is full consistency between one account and another in terms of concepts, definitions and classifications. An important difference 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 geographical 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 environmental statistics. 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 environmental statistics to the environmental accounts.

1.3 The 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. In recent years accounts were developed for air emissions, water emissions, waste, energy and water, material flows, the environmental goods and services sector, and emission permits.
The Dutch environmental accounts are compiled following the general concepts, definitions and classifications as described in SEEA 2012 and the 2008 SNA. More specific information on the methodology can be found on Statistics Netherlands' website (www.cbs.nl). Specific methodological reports are available on some subjects. The data of the Dutch environmental accounts are published in StatLine, the electronic database of Statistics Netherlands.

This edition

The environmental accounts of the Netherlands 2012 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 clustered in the following chapters:

Energy
- Energy consumption
- Oil and natural gas reserves

Water
- Water abstraction and use

Materials
- Material flows

Greenhouse gas emissions and air pollution
- Greenhouse gas emissions according to different frameworks
- Greenhouse gas emissions from production
- Greenhouse gas emissions from household activities

- Quarterly CO_2 emissions
- Quantifying CO_2 emissions according to the control-criterion
- Air pollution

Policy instruments and economic opportunities
- Environmental taxes and fees
- Environmental subsidies and transfers
- Environmental protection expenditure
- Economic opportunities of the environmental goods and services sector

The topics ‘emissions to water’, ‘solid waste’ and emission permits are not included in this edition, because these accounts will be compiled biannually from 2013 onwards. The first update will take place in November 2014.

Part two presents three studies that provide a more in-depth analysis of their specific subjects. In chapter 7 the first monitor on material flows is discussed. From this system indicators can be derived on the efficient use and reuse of resources and resource dependency. Chapter 8 systematically explores the issues of energy use and the emissions of sulphur dioxide (SO_2) and carbon dioxide (CO_2) from a historical perspective. It shows how patterns of energy use and emissions have changed since the 1960s. Chapter 9 explores how carbon footprints can be calculated in such a way that they are consistent with official statistics. It also provides an overview of the challenges that lie ahead in bringing the footprint calculations within the realm of official statistics.

1.4 Green growth

This edition is published simultaneously with ‘*Green growth in the Netherlands 2012*'. The publication updates the twenty OECD indicators of the first edition in 2011, adds thirteen new indicators, and includes an international comparison. The main conclusion is that the Dutch economy is turning ‘greener’ but at a very slow pace. For example, greenhouse gas emissions have fallen, but only by 7 percent since 2000. The share of renewable energy in total energy consumption has risen, but only from 1.4 to 4.4 percent. The share of the environmental goods and services sector (EGSS) in employment and value added has been increasing, but slowly. In an international perspective, the Netherlands has the highest share of green taxes in Europe and a high implicit tax rate for energy.

2. Energy

Authors
Bram Edens
Eefje Lammers
Daan Zult

The net domestic energy use in the Dutch economy grew by almost 2 percent in 2012. In this chapter two important energy related subjects are presented. First, the energy use by production and consumption activities is discussed and compared with economic variables. Second, an overview is provided on the remaining natural gas and oil reserves, both in physical and monetary terms.

2.1 Energy use

Energy is essential to all economic activities as input for production processes and as a consumer commodity. As global demand for energy increases and non-renewable energy resources like crude oil and natural gas become scarce, energy prices increase to a point where they may hamper future economic developments. The impact of economic developments on the environment is largely determined by the use of energy. Energy use is often directly linked to the emission of the greenhouse gas CO_2 and many other environmental pollutants. Improving energy efficiency and decoupling energy use from economic growth are major goals for green growth. The energy accounts represent a consistent framework in which energy data, both in monetary and physical terms, have been integrated into the national accounting framework. Physical energy flow accounts (PEFA) show all energy flows that occur within the economy, with the environment and with the rest of the world. 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 energy use is related to the creation of value added and how dependent the economy is on energy imports.

The methodology of the energy accounts is described in the report Compilation of physical energy flow accounts in the Netherlands (Schenau, 2012). The data of the energy accounts can be found in StatLine, the online database of Statistics Netherlands.

Energy use in the Dutch economy has slightly increased

Net domestic energy use[1)] in the Dutch economy increased by almost 2 percent in 2012. This is a small increase after the 2011 decrease of 5 percent. The relatively colder winter and the greater demand for energy by the chemical industry are the main causes. The increase is tempered by the moderate economic climate, in which especially manufacturing companies

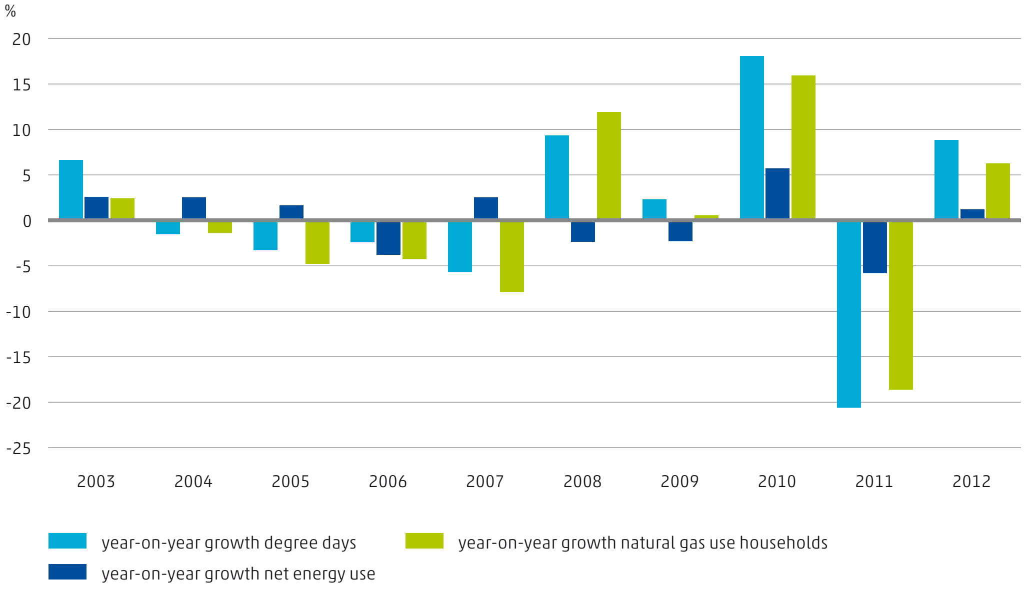
2% increase in net domestic energy use in 2012

[1)] Net energy use is eual to the total amount of domestic energy used in an economy through production and consumption activities. This includes all final energy use for energetic and non-energetic purposes plus conversion losses.

had a lower demand for energy. The Dutch electricity market was affected by low priced electricity available from Germany and Norway, which led to an increase in imports and a decrease in electricity production.

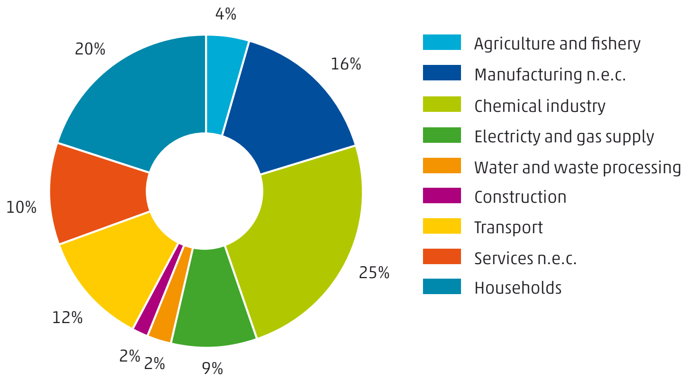
The weather always has a substantial impact on the total net use of energy. In particular households and the service sector use more natural gas when a winter is relatively cold. Figure 2.1.1 shows the net energy use development of the total economy, the natural gas use of households and the development of the number of 'degree days[2)]' (KNMI, 2013). The year 2012 was relatively cold compared to the previous year, which translates into an increase in both the total use of net energy and the use of natural gas by households.

2.1.1 Change in net energy use in the Dutch economy, the use of natural gas by households and the number of 'degree days'



The current distribution of net energy use among industries can be seen in Figure 2.1.2 below.

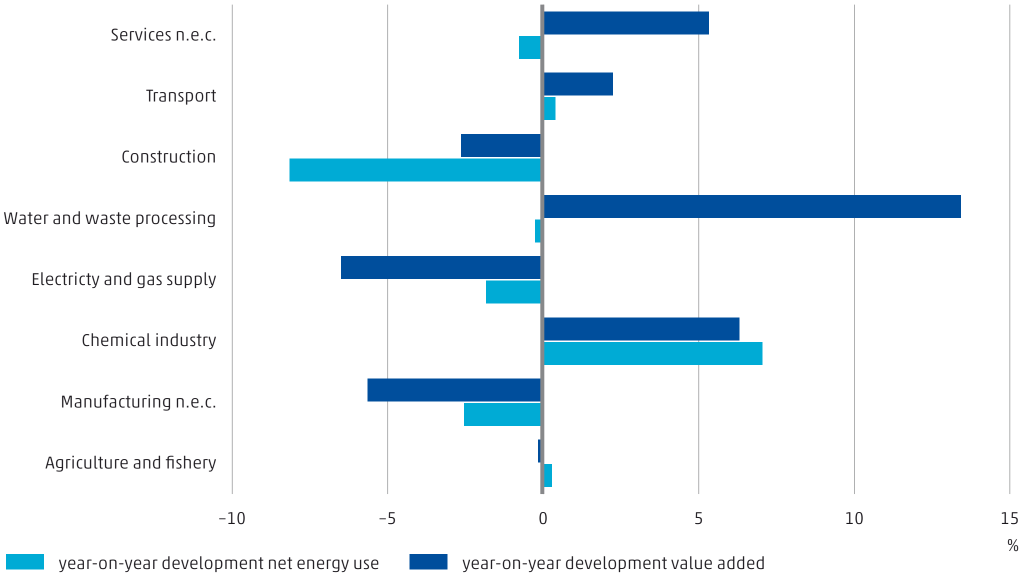
2.1.2 Net energy use in 2012 per sector



2) Measure for the average outside temperature. If the average temperature on a particular day is x degrees below 18 °C, that day counts as x degree day. If the average outside temperature exceeds 18 °C, that day counts as 0 degree day.

The chemical industry, manufacturing n.e.c. and electricity and gas supply together use around 50 percent. Also households, services n.e.c. and transport play an important role in Dutch energy use. Figure 2.1.3 below shows the 2011–2012 development of net domestic energy use and value added of the various sectors of the Dutch economy. There are substantial differences between the sectors of the economy in terms of net year-on-year development of energy use.

2.1.3 Change in net energy use and value added (in constant prices) per sector over the period 2011–2012



The electricity and gas supply, the chemical industry and other manufacturing used less net energy per euro of value added while the transport sector, construction, water and waste processing and services used more net energy per euro of value added. It is interesting to zoom in further on the Electricity and gas supply companies, because at first it seems they increased their unit of value added per unit of energy use substantially. However, besides producing energy, electricity companies can also trade and transport energy. It seems that especially this last category, the traders in energy, increased their value added, because while the total Dutch energy production decreased by 10 percent, the imports increased by 88 percent. Importing energy was favourable in 2012 because energy from Germany and Norway was available at low prices due to a large surplus in energy production. Because the import of energy requires no domestic use of energy, the net use of energy per euro of value added declined.

The transport sector shows a mixed picture for 2012. The volume of transport over water and by air increased (+3 percent and +3.2 percent) while the transport over land declined (–1.5 percent). When we compare these developments with the net energy use of the same transport sectors, we see that the net energy use of transport over land has decreased slightly (–0.2 percent) and transport over water and air has increased (+5.9 percent and +0.2 percent). The relative low growth in net energy use of air transport can be explained by increased passenger density in airplanes.

In most industry sectors, like manufacturing of basic metals, manufacturing of construction materials and manufacturers of electrical equipment the net energy use has decreased. This is the result of the unfavourable economic conditions in 2012, because as production levels dropped less energy was required. The oil industry shows a relatively large decline in net energy use while the production in constant prices only decreased slightly (–0.3 percent). An important exception is the chemical industry, where both the production and the net energy use increased. This increase is mainly driven by increased exports to countries outside Europe.

Increase in net energy use since 2000

Net domestic energy use of the Dutch economy has increased by 6 percent since 2000. Accordingly, there is relative decoupling between energy use and economic growth with respect to this period. Net energy use rose in aviation, the chemical sector, and waste management. Energy use increased in most service industries. Energy use fell in among others horticulture, fisheries, the manufacturing of food products, manufacture of textile and leather products, manufacture of paper and paper products, publishing and printing, manufacture of other non-metallic mineral products, and water transport. Households used 2 percent more energy than in 2000.

Energy intensity decreased in the last decade

Energy intensity, defined as energy use per unit of value added (fixed price level), is an indicator for the energy efficiency of the economy or different industries. A decrease in energy intensity can be caused by changes in production processes, for example by energy conservation, by systematic changes in the economy, or simply variation in temperature. The latter is the case for the total economy, the service industries and agriculture. The energy intensity of the Dutch economy, adjusted for this temperature effect, has decreased by 6 percent since 2000. All sectors contributed to this improvement. In 2012, the energy intensity of the economy as a whole increased by 2 percent on the previous year. This was mainly due to the service industries. In manufacturing the energy intensity improved slightly.

2.2 Oil and natural gas resources

The Netherlands has significant quantities of natural gas as well as some smaller oil deposits. Since the discovery of these natural resources in the 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. These resources are not inexhaustible however. Although new resources are discovered occasionally, almost 75 percent of the initial gas resources has been extracted already according to our current knowledge. This chapter addresses the physical and monetary aspects of oil and natural gas resources.
The methodology for the valuation and compilation of stock accounts for the oil and natural gas resources 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 resources can be found in the annual reports 'Natural resources and geothermal energy in the Netherlands' (TNO/Ministry of Economic Affairs, 1988–2013).

New classification system of resources introduced

In 2013 a new system was implemented in the Netherlands for classifying and reporting on oil and gas resources called the Petroleum Resource Management System (PMRS), see TNO / Ministry of Economic Affairs (2013). The PRMS distinguishes between Reserves, Contingent Resources and Prospective Resources classifying projects not only according to their geological uncertainty but also according to their chance of commerciality. The total reported remaining Dutch gas resources consist of the categories that are most likely to be actually produced; the reserves plus a subset of the contingent resources that are pending commercial development. The introduction of the PMRS has not caused a break in the time series of Dutch natural gas resources, but has changed their classification. The reported resources do not include unconventional resources such as shale gas, which would be classified according to the PRMS as prospective resources as they are considered undiscovered, not demonstrated through actual drilling activities.

Production of natural gas decreased

In 2012, the production (gross extraction) of natural gas[3)] from the Dutch gas fields amounted to 78 billion standard cubic metres (Sm^3)[4)] compared to 79 billion Sm^3 in 2011. Compared to 2011, total production was 0.5 percent less, notwithstanding the cold winter months of 2012. This can be explained by a reduction in domestic demand for instance in the electricity producing industry.

2.2.1 Physical balance sheet of natural gas

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
	billion Sm^3										
Opening stock	1,865	1,997	1,836	1,572	1,510	1,439	1,390	1,364	1,390	1,304	1,230
Reappraisal	248	–45	–59	–62	–71	–49	–26	26	–86	–74	–100
New discoveries of natural gas	33	15	25	15	9	5	3	3	5	6	4
Re-evaluation of discovered resources	287	18	–17	–46	–9	14	52	95	–5	–2	–25
Gross extraction	–72	–78	–68	–73	–71	–68	–80	–74	–86	–79	–78
Underground storage of natural gas[1)]	–	–	1	0	0	–1	1	0	2	2	1
Other adjustments	0	0	0	42	0	2	–2	1	–2	–2	–1
Net closing stock	2,113	1,952	1,777	1,510	1,439	1,390	1,364	1,390	1,304	1,230	1,130

Source: TNO / Ministry of Economic Affairs, 1988–2013

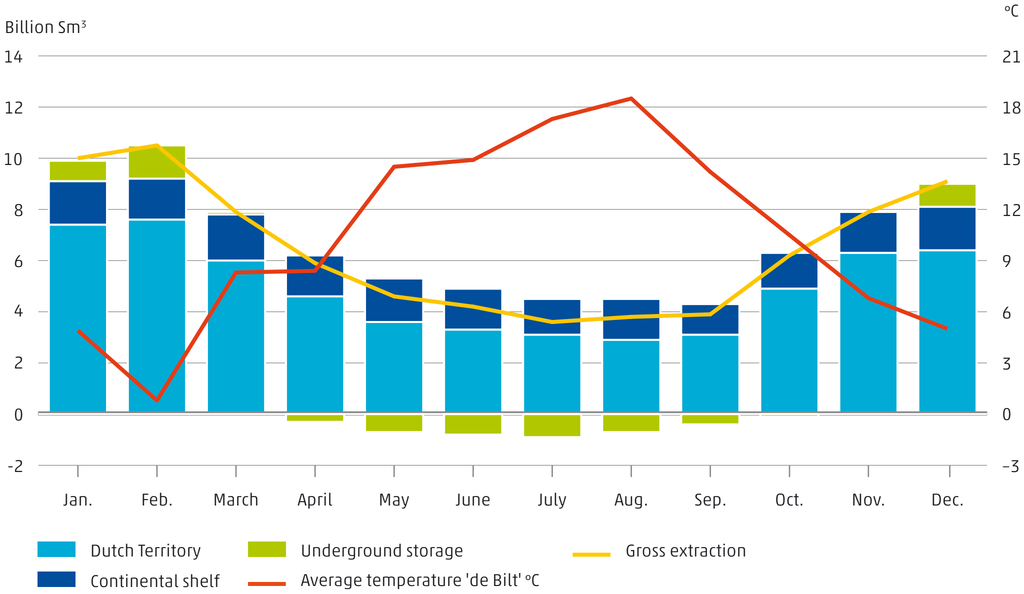
1) In 1997 natural gas has been injected in one of the underground storage facilities for the first time.

3) 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.

4) 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.

At the end of 2012, the remaining expected resources of natural gas in the Netherlands were estimated at 1,130 billion Sm³. This corresponds to 38,335 petajoules. The Dutch economy in 2012 used 3,602 petajoules of net energy, part of which was imported. Assuming that the net annual production remains constant at its 2012 level, the Dutch natural gas resources are sufficient to meet 15 years of production.
As Figure 2.2.2 shows, the extraction of natural gas follows a seasonal pattern that is primarily driven by the weather conditions, with peak extractions during winter months. This is because natural gas is the prime source for heating homes and buildings in the Netherlands. Since 1997, the Netherlands also uses underground storage facilities which are replenished during summer months. The largest withdrawal from storage in 2012 occurred in February.

2.2.2 Monthly pattern of abstraction of natural gas from reserves and underground storage



Source: TNO / Ministry of Economic Affairs, 2011–2013.
http://www.knmi.nl/klimatologie/maand_en_seizoensoverzichten.

Production of oil increased

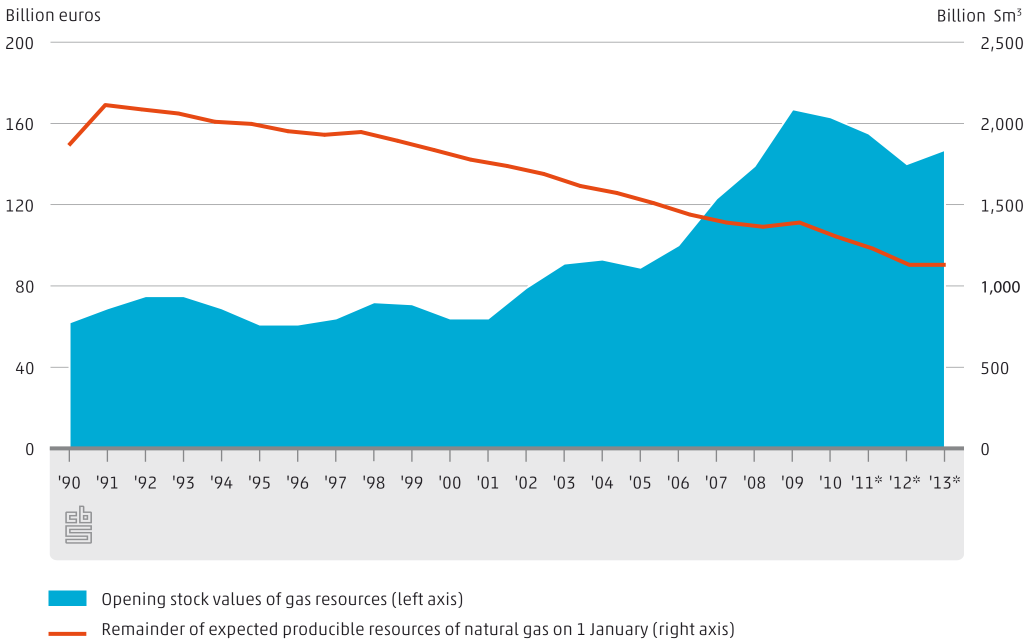
The production of oil increased in 2012 to 1.32 million Sm³ which is a 4 percent increase compared to 2011. This is primarily due to the Schoonebeek field which started producing again in 2011. The total expected oil reserves and contingent resources were estimated at 48.1 million Sm³ at the end of 2012. This is an increase of 19 percent compared to 2011. This increase is the result of a positive revaluation of the onshore oil fields of 9.2 million Sm³.

Value of gas resources increased by 5 percent

On 1 January 2013, the value of the producible resources of natural gas[5)] amounted to 147 billion euros. This is an increase of 5 percent compared to 2012 when the resources were estimated at 140 billion euros.

5) In the absence of market prices, the value of oil and gas reserves has been derived with the net present value methodology in which assets are valued as discounted streams of expected resource rent. More information on the various assumption used can be found in (Veldhuizen et al., 2009).

2.2.3 Natural gas reserves in physical and monetary units



Sources: TNO / Ministry of Economic Affairs, 1988–2013 and Statistics Netherlands (2013); http://statline.cbs.nl.

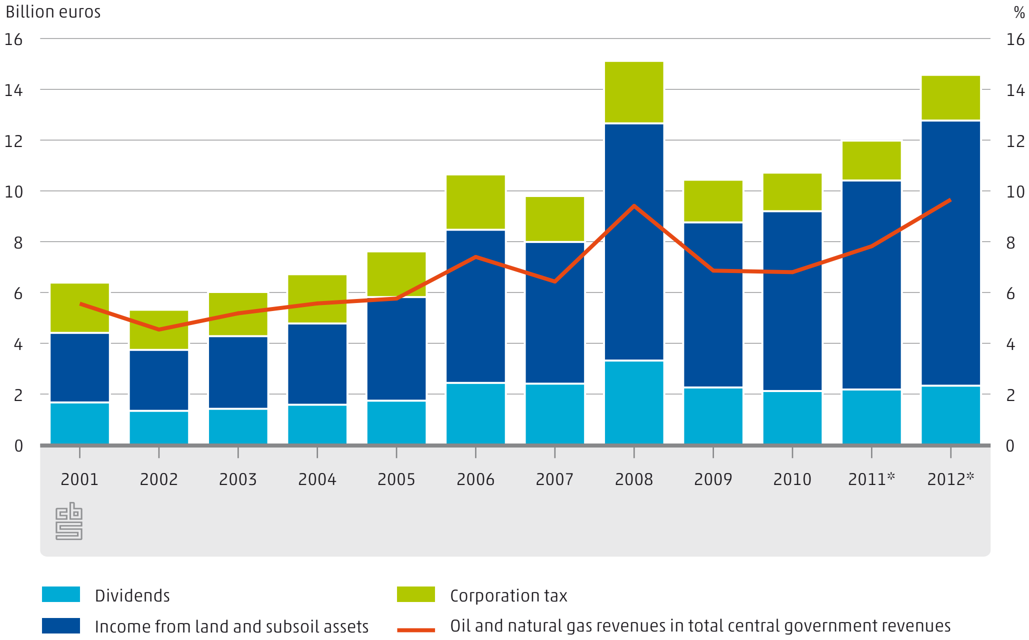
Oil and natural gas revenues contribute 9.7 percent to central government revenues

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. The government revenues consist of dividends, corporation tax and income from land and subsoil assets in the form of concession rights. In 2012 government revenues from oil and gas amounted 14.5 billion euros, a significant increase on 2011 when the revenues were 11.9 billion euros. This is equal to a 9.7 percent contribution to central government revenues. This is the highest relative contribution on record, which is caused by a combination of high natural gas revenues and a shrinking government budget. Over the last ten years, the benefits arising from oil and gas extraction, contributed on average 7.1 percent to the total revenues of the Dutch central government.

Depletion of oil and gas resources reduces net national income by 1.8 percent

The total value generated by the exploitation of the oil and natural gas resources 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 resources as income. The extraction hampers future opportunities for production and income. So the depletion costs should be properly offset against income, just as the depreciation of produced assets is treated via the 'consumption of fixed capital'. This would constitute equal treatment of natural and produced capital used in production.

2.2.4 Oil and natural gas revenues and their share in central government revenues



Source: Statistics Netherlands (2013); http://statline.cbs.nl Table D.13.2.

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 resources causes a downward adjustment to net national income in 2012 of 1.8 percent. This is the same as in 2011.

3.

Water

Author
Cor Graveland

In 2012 tap water use by businesses decreased by almost 4 percent on 2011, while GDP decreased less with 1.2 percent. In this chapter the water use of Dutch economic activities is presented. Long time series are now available for tap water use and groundwater abstraction. Also, water use on a regional, i.e. River Basin level, is discussed.

3.1 Water use

Water plays a key role in the Dutch economy and society as a whole. Water from natural resources finds its way as uptake and transpiration of soil water by natural vegetation and in agriculture. Water also is abstracted and used either as a direct input in production processes, for instance for cooling purposes, or more indirectly, for example in agriculture for watering crops and animals. The water supply industry abstracts large amounts of fresh water to produce tap water of drinking water quality that is subsequently used by industries and households. Depending on its source, a distinction can be made between flows of surface water and groundwater. While 'other kinds of water' also is produced, i.e. by water companies, and delivered to other companies[1)]. Given the importance of water, there are a variety of policies in place to reduce water pollution and protect ground and surface water bodies qualitatively and quantitatively. The water accounts provide information on water abstraction, water supply and use by different industries and households. Integrating water data with economic information and monetary information on water makes it possible to monitor water conservation policies and particular instruments.

The methodology and sources used for compiling the water flow accounts are described in the reports *Dutch water flow accounts (Graveland, 2006) and in Water abstraction and –use at River Basin Level* (Baas and Graveland, 2011). The data of the water accounts can be found on StatLine, the electronic database of Statistics Netherlands. The coverage of the figures in this chapter differ, depending on the availability of the (historic) data. Generally 2011 figures are covered, in some cases also 2012 figures are included.

Less groundwater and far more surface water abstracted by the Dutch economy in 2011

The total abstraction of groundwater by the Dutch economy in 2011 amounted to 992 million m^3, which is a reduction of over 1 percent compared to 2010. Abstraction by agriculture decreased significantly compared to 2010 with its dry spring and summer requiring extra water for irrigation, although 2011 and 2009 also were dry and required extra water for irrigation. Use and abstraction of groundwater in the manufacturing

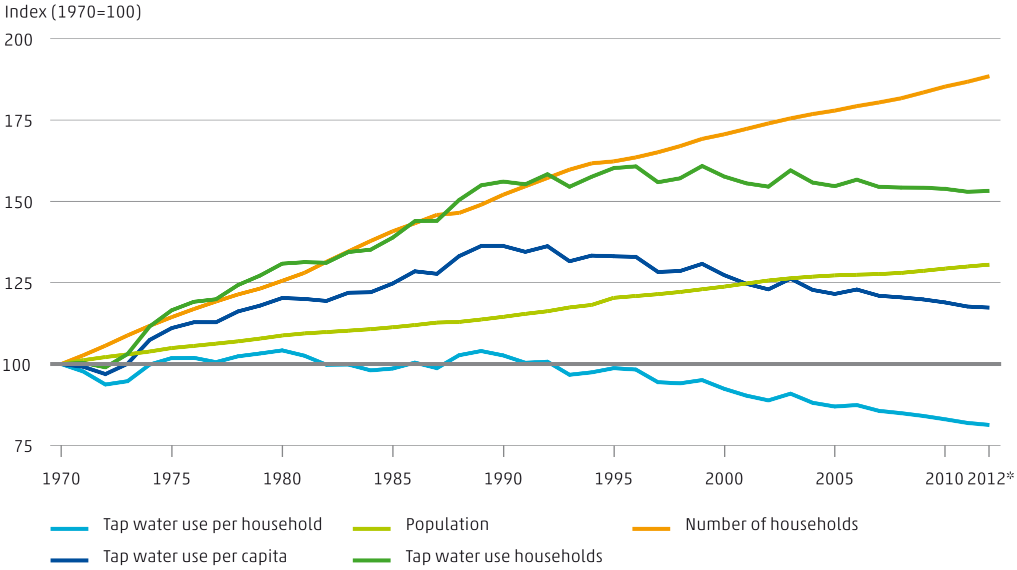
1) 'Other water', (incl. 'industrial water') is water of different quality compared to tap water. This may be partially treated water, for instance, pre-treated surface water, or water that has been optimised to the needs of the business market, for instance, distilled and demineralised water (VEWIN, 2012). This water is produced by water companies or other industries and delivered to other companies, particularly the chemical industry (VEWIN, 2012). The delivery of 'other water' by the water companies is excluded from the calculations of tap water presented in this chapter. If the delivery of 'other water' were included in the calculations this would add another 6–7 percent to total use of tap water.

industry remained more or less stable. Abstraction from surface water amounted to 15.3 billion m³ in 2011, which is 9 percent up compared to 2010. This is mainly explained by a sharp increase for the electricity supply companies and to lesser extent for the refineries and agriculture. The water supply companies also abstracted 4 percent more surface water.

Per capita household use of tap water declined after 1990 peak

In 2011 around 7.5 percent of the water abstracted from ground and surface water was turned into tap water supplied by the water supply industry, for groundwater alone this was 76 percent. Total tap water use in 2012 amounted to 1,070 million m³. Households account for 72 percent of overall tap water use in the Netherlands[2)]. Since 1990, the total annual amount of tap water used by households has decreased by 2 percent while the Dutch population increased by 12 percent.

3.1.1 Tap water use by households, size of population and number of households



Source: VEWIN, 1987; 1988; 1995; 1998; 2007; 2008; 2010; 2012a, 2012b, 2013; Lodder; StatLine 2013.

In 1970 tap water use was 109 litres a day (40 m³ per person per year). It peaked in 1990 when it came close to 150 litres a day, and reached 128 litres per capita in 2012. Roughly since 2000 water use has shown a systematic reduction each year, with the exception of 2003 and 2006 which had particularly hot and dry summers. At such times people use up to 3 percent more water for showers and watering plants. The initial rise between 1970 and 1990 was the result of growing service levels i.e. with changing bathing behaviour and the swift adoption of modern household appliances such as automatic washing machines that

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 are adjusted for the period before 2007 and as a result can differ from the VEWIN figures. For 2007 onwards figures are identical with VEWIN figure (See also VEWIN water statistics 2007, 2010, 2012, 2013).

used significant amounts of water. The drop in the water use after 1990 can be explained by the availability and purchase of more efficient household appliances and water saving toilettes and showerheads. The taxes that were implemented from 1995 onwards, namely the tax on groundwater abstraction and the tap water tax itself, added incentives for extra water saving measures.

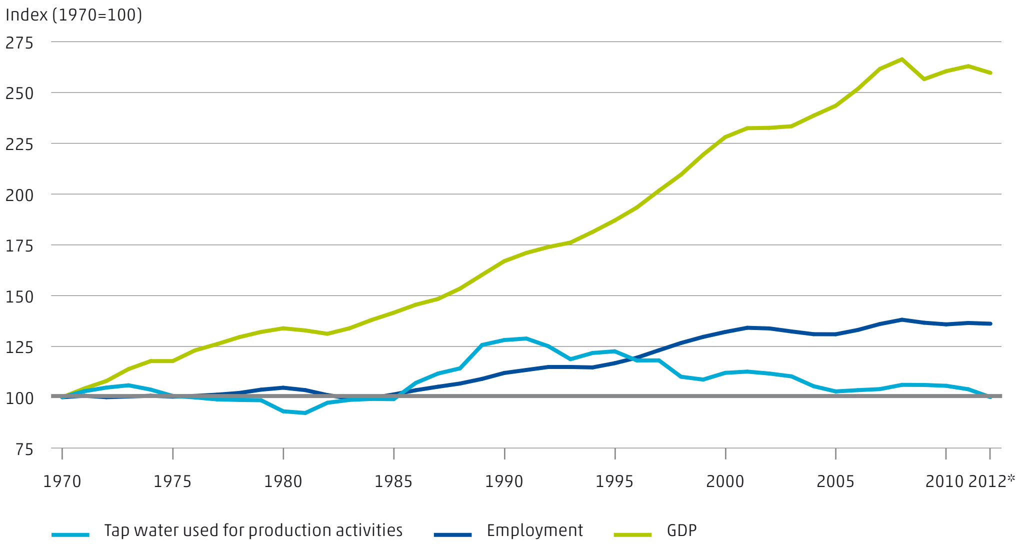
Daily tap water use per household amounted to 351 litres in 1970, experienced a peak at 361 litres in 1990, and was down to 286 litres in 2012. This is 19 percent reduction in 42 years or 104 m³ per year for an average household in 2012. The drop in use per household from 1990 onwards can be explained by the on-going trend towards smaller average household sizes together with the decreasing use of tap water use per person as mentioned above.

Tap water use by industries stable since 2005

Tap water use levels by businesses were lowest around 1980, peaked around 1990, and returned to exactly the 1970 level in 2012. The drop in tap water use between 1973 and 1980 was the result of the economic slump caused by the two oil crises in 1973 and 1979. In the 1980–1990 decade, tap water use by industry grew by 38 percent as a result of the economic recovery. Tap water use for production activities peaked around 1990. However industries have progressively succeeded in using less tap water since 1991. Although water use by industry has more or less stabilised from 2005 onwards, it has continued its previous downward trend in 2012.

128 litres of tap water used per person per day in 2012

3.1.2 Volume change GDP, employment and tap water used for production activity



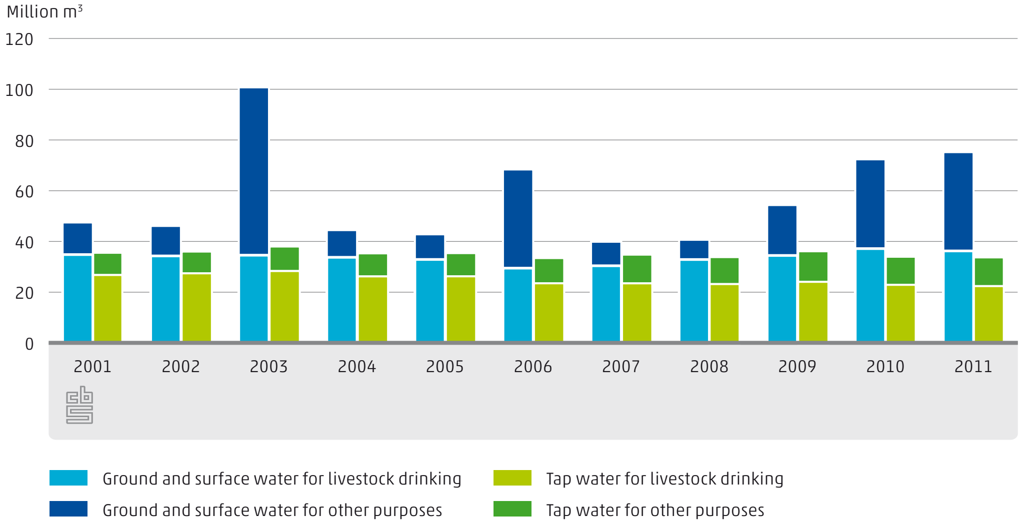
Source: VEWIN, 2010; 2011; 2012; 2013; StatLine 2013.

In 2012 tap water use by businesses decreased by 3.7 percent on 2011, while GDP decreased less with 1.2 percent. As a result tap water use intensity has gone down in 2012. The chemical industry, food and beverage manufacturers and agriculture are extensive users of tap water. In addition, oil refineries, and the health and social welfare sectors use significant amounts too.

Water use in livestock production determined by weather and livestock numbers

Tap water used by agriculture shows a slight downward trend and amounts to an average of over 4 percent of total tap water used in the Netherlands. Drinking water for cattle and other livestock is a major category of tap water use. Tap water for drinking purposes has shown a downward trend in recent years, from 26.9 million m^3 in 2001 to 22.5 million m^3 in 2011. Also the share in tap water uses for animal husbandry has fallen. While tap water used in livestock production, like cleaning activities, showed an upward trend with slight variations. The influence of the weather in warm and dry years is clear, with generally a few percent extra tap water used.

3.1.3 Water used in livestock production [1)]



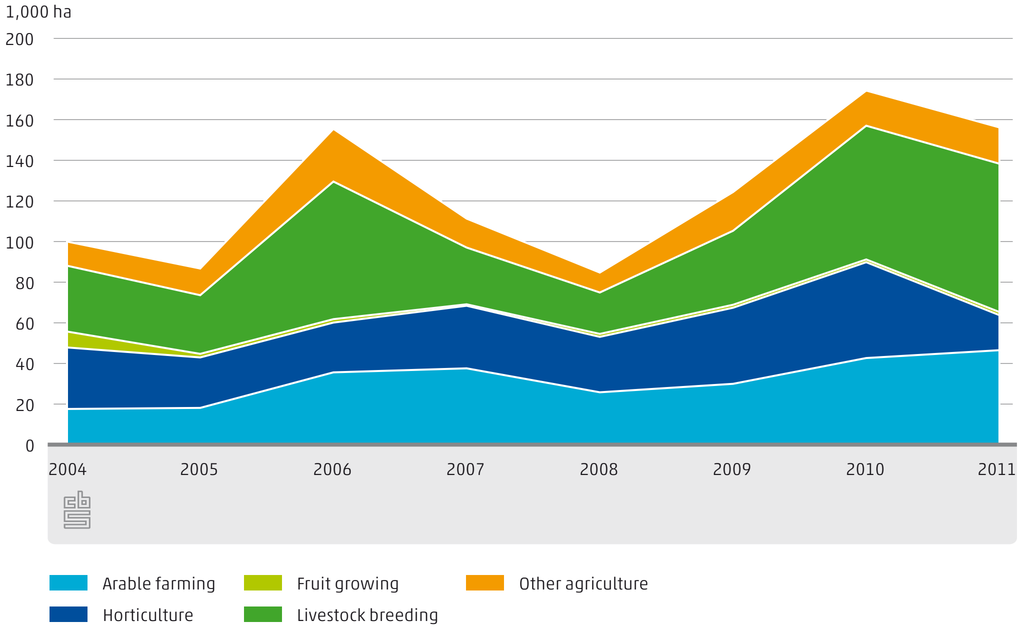
Source: Van der Meer and H. van der Veen, 2011; Van der Meer, 2013a; Van der Meer, a; 2013b; 2013c.

1) A new farm activity classification has been adopted for the whole timeseries, which resulted in a slight adjustment of the outcomes.

One major reason why less tap water is used is the dwindling number of livestock. In 2011, overall 5 percent less tap water was required in animal husbandry than in 2001. Switching from tap water to groundwater and/or surface water for watering livestock offers a further opportunity to reduce tap water use in livestock production. On the other hand, the constant quality of tap water is valuable for livestock and cannot always be met by ground- or surface water. Most of surface and groundwater abstracted by the sector, 63 percent, was used for drinking in the period 2001–2011. However, in dry years more ground- and surface water is used for irrigation for animal husbandry. (Van der Meer and Van der Veen, 2011; Van der Meer, 2013a, 2013b, 2013c).

Crops in the Netherlands are predominantly grown under rain-fed conditions, which means crops largely rely on existing fresh water resources as groundwater, soil water and indirectly also surface water. Normally the fresh water used up from these sources are replenished in the course of the year. In addition fresh surface and groundwater is abstracted, mainly for watering livestock, but also for irrigating crops such as green maize, and pastures. In 2011 agriculture had a 9 percent share in total groundwater abstraction. More farm land has been prepared for irrigation in recent years (De Rooij, 2011). The actual area that is irrigated at least once every growing season also increased in recent years, from 5 percent of cultivated land in 2004 to over 9 percent in 2010 and over 8 percent in 2011. In practice this irrigated area on average is irrigated close to 2.5 times a season. Figure 3.1.4 shows that a larger area is irrigated in warmer and particularly dryer years as 2006, 2010 and 2011, and as a result more groundwater and surface water are applied and required to abstract, see for example 3.1.3.

3.1.4 Irrigated areal by agricultural subsector, areal irrigated at least once a season

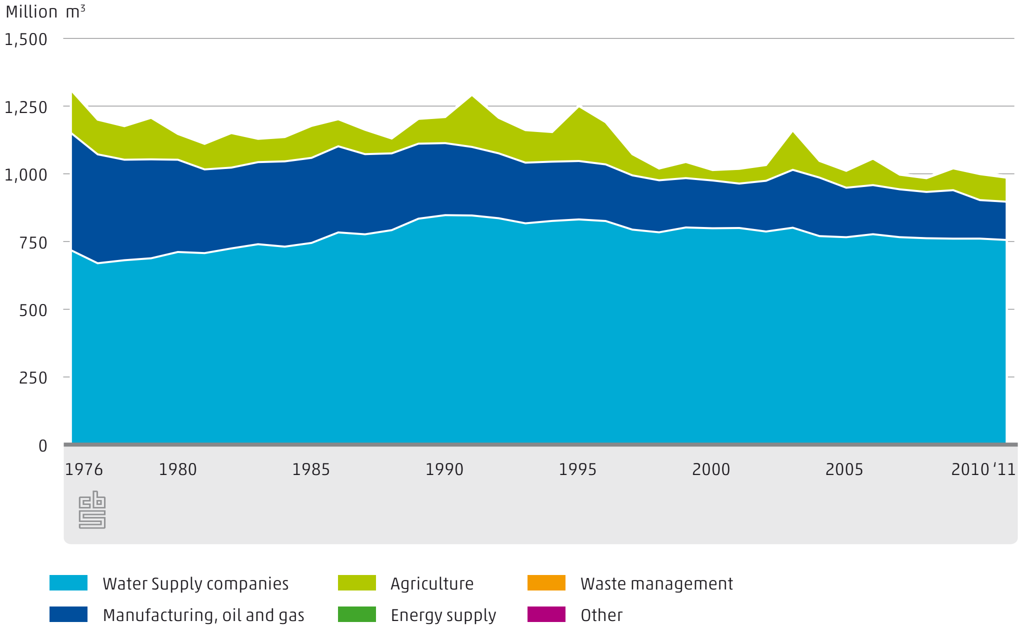


Source: Van der Meer, 2013a; 2013b; 2013c.

Less groundwater and more surface water abstracted by the Dutch economy since 1976

Fresh groundwater is a scarce resource in the country and should be managed with care. Efforts to deal with this scarcity started already in the sixties, first on a regional basis. As a result of (sub)national regulations and efficiency gained, the abstraction of groundwater by the Dutch economy over a longer period of time fell from 1,318 million m^3 in 1976 to 992 million m^3 in 2011. Comparison of a three year average of 2010 to 1977 yield a reduction of groundwater abstraction by businesses of 18 percent in 35 years. Manufacturing and companies in crude oil and gas production showed the strongest ability to reduce groundwater abstraction, with a steady reduction to over 60 percent. Agriculture saved water for irrigation in conjunction with saving fuel for pumping, largely as a result from reconsidered irrigations leading to a 35 percent reduction of groundwater abstraction. While having great annual fluctuations due to climate conditions. The water supply industry abstracted the most with 69 percent on average, supplying others in the economy, but it also grew strongest at around 10 percent since 1976. Not surprisingly, over time the pattern of abstractions follows the pattern of the water volumes supplied by the water supply industry to households and production activities (Figure 3.1.1 and 3.1.2).

3.1.5 Groundwater abstraction for production activities by industry[1)]



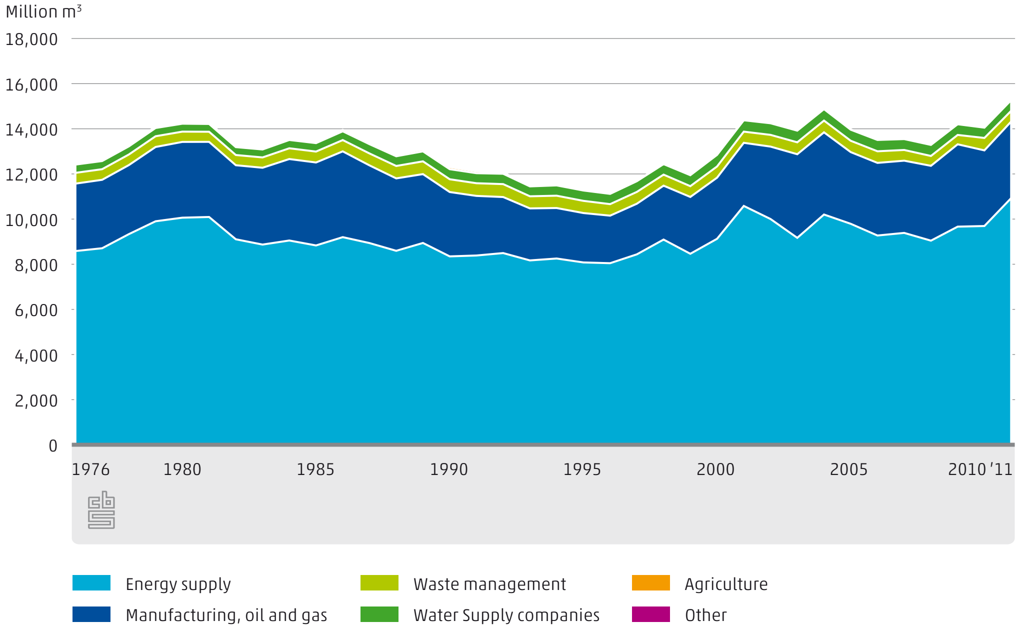
Source: Lodder et al., 2013; VEWIN, 2010; 2012a, 2012b, 2013; StatLine 2013.

1) Energy Supply, waste management and 'other' are not visible. These represent at average 0.16, 0.18 and less than 0.00 percent respectively.

Fresh surface water is less scarce. Large quantities of fresh and marine surface water are used for cooling. These are abundantly available in the delta areas from the rivers Rhine and Meuse and from the North Sea. Any scarcity of fresh surface water may originate from the quality aspect of the fresh water bodies and requirements for aquatic life that need to be safeguarded. Under certain circumstances, with long hot dry spells, problems may arise like fish mortality. Abstractions of surface water than may be restricted in order to limit the heating of the surface water bodies by the discharges of cooling water, this hardly occurred in recent years though. So usually, surface water is easily and abundantly abstractable as is illustrated by the data.

In contrast to groundwater, the abstraction of surface water has extended by 14 percent in total since 1976 and apart from agriculture all sectors have extended their abstractions. The energy supply industry (electricity), with close to 70 percent takes the largest part of the abstracted surface water, followed by manufacturing and crude oil and gas production. Most abstracted surface water, both marine and fresh water, is used for cooling purposes, mainly in power production. In case of fresh water, the water abstracted for cooling generally is returned to the inland fresh water system after use allowing subsequent use. This return can be regarded and classified as a return to the environment (regulated discharge) and as “in-stream” (non-consumptive) use.

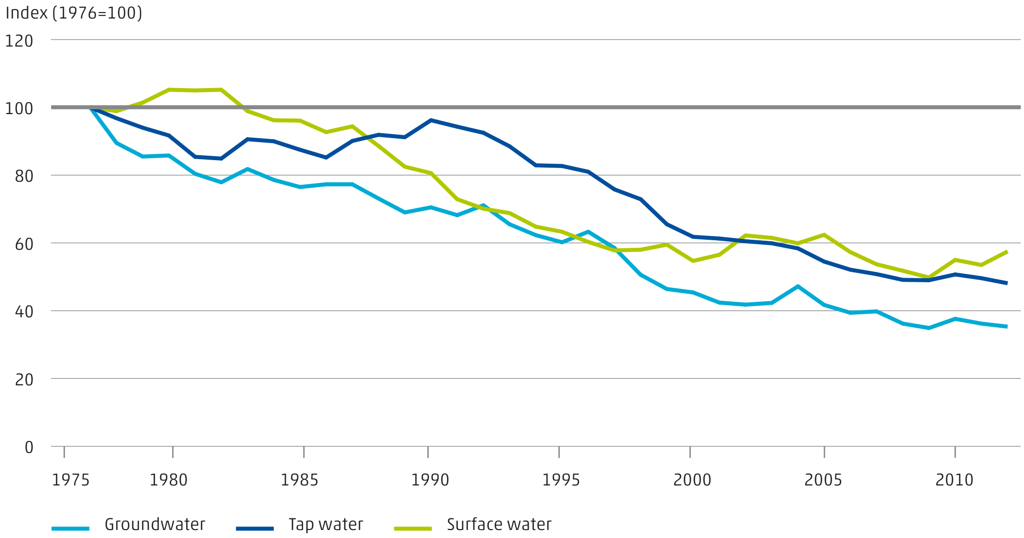
3.1.6 Surface water abstraction by industry[1)]



Source: Lodder et al., 2013; VEWIN, 2010; 2012a, 2012b, 2013; StatLine 2013.

1) Agriculture and 'other' are not visible. These represent at average 0.36 and less than 0.00 percent respectively.

3.1.7 Water use intensities production activity by value added



Source: Statistics Netherlands, 2013; Lodder et al., 2013; VEWIN, 2010; 2012; 2013.

Note: Preliminary results of analysis time series data. Ground- and surface water abstractions include abstraction by the water supply industry for tap water production.

Water use intensities on a consequent downward track

Water use intensity for an industry can be defined as the use or abstraction of water in litres divided by its value added[3], expressed in euros. Since 1976 the size of the economy in terms of value added has more than doubled, while tap water use and the water abstractions from the environment have hardly grown or even contracted. As a result the water intensity of the Dutch economy has halved for tap water use and groundwater abstraction and close to halved for surface water abstraction. Generally each subsequent year economic performance improved while the water use and abstraction from water resources diminished or just remained constant.

Lower groundwater use intensity

On average between 2003 and 2011, 2.49 litres of groundwater was abstracted for every euro of value added generated by the Dutch economy. In 2011 this was 2.27 litres per euro, a little less than the 2.42 litres in 2010 and significantly less than the 3.04 litres in 2003. Arable farming and livestock breeding again showed the highest water use intensity rates, followed by the manufacturing of paper and paper products, manufacturing of basic metals, other agriculture, and manufacture of food products, beverages and tobacco products. The industries with the highest use intensity rates used up to ten times more water to earn a euro than the average for the Dutch economy in 2003[4]. In 2011 this was at most 7.5 times.

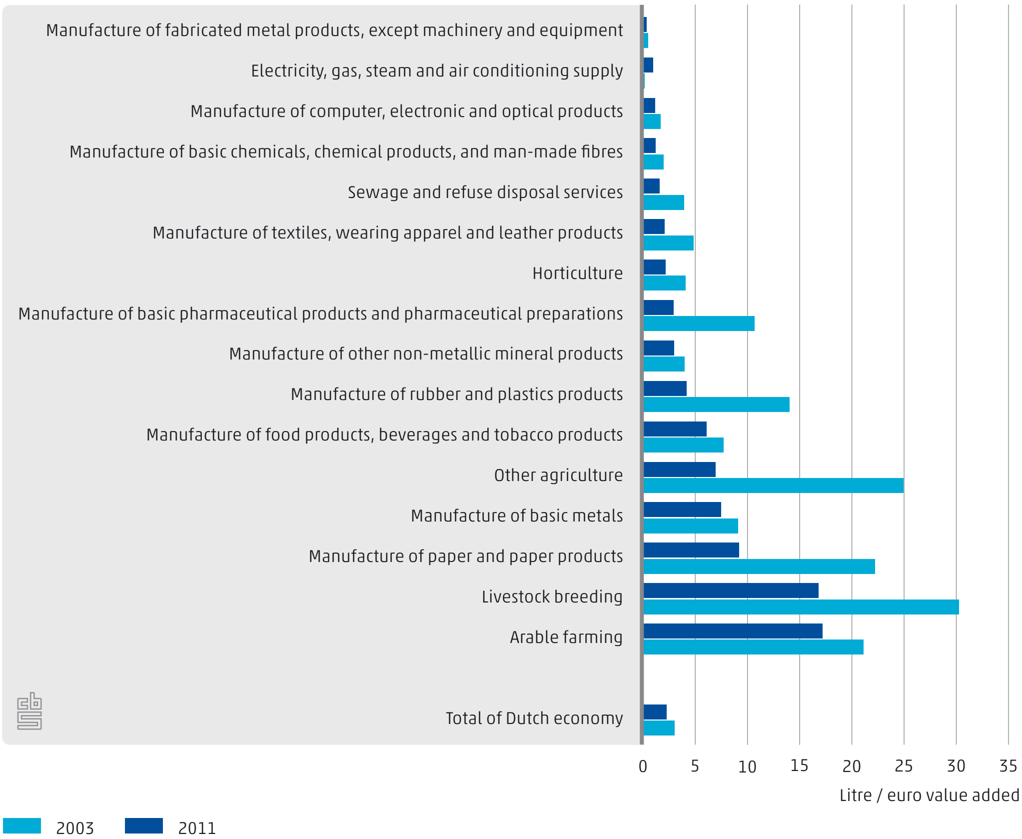
In 2011 most sectors showed lower groundwater intensities than in the warm and dry year 2003. The exception was the electricity industry where the groundwater abstraction intensity was seven times higher because of a newly established cogeneration plant. This plant generates both electricity and steam, and for the latter it makes use of groundwater. Compared to 2009, although not visible in Figure 3.1.8, the intensity slightly decreased in 2010. The first signals of a recovering economy were accompanied by a slight reduction in water use. However, one should be cautious in drawing firm conclusions, as groundwater abstraction and the resulting intensities are dependent on weather conditions. This is particularly true for agriculture, where water abstraction for irrigation is largely determined by water shortages resulting from warm and dry summer weather.

Regional water use

There is a growing interest in obtaining regional data on water use and abstraction, in particular for the river basins[5]. Such data are relevant for analysis and reporting to the Water Framework Directive (WFD). The methodology for compiling regional water abstraction and use is described in a special report for Eurostat Water abstraction and -use at River Basin Level (Baas and Graveland, 2011). These figures have been updated for 2009 and 2011.

[3] Value added is expressed in constant year 2005 prices.
[4] This figure may be slightly underestimated as for several industries that use small amounts of groundwater, the precise abstractions are not known.
[5] The Netherlands is divided into four river basins: Ems, Meuse, Scheldt and Rhine. The Rhine basin is divided into four sub-basins: Rhine West, Rhine North, Rhine Centre and Rhine-East. The 2009 update is described in Graveland and Baas, 2012.

3.1.8 Industries with the highest use intensities for groundwater



Note: Value added is expressed in constant year 2000 prices.

Fresh groundwater abstraction in all river basins dominated by water supply industry

Most groundwater is abstracted in the Meuse river basin, in 2011 this was 34 percent of total groundwater abstraction in the country. Groundwater is predominantly abstracted and used by the water supply industry, which dominates the groundwater abstraction in all river basins. The share in abstraction of the water supply industry in 2011 varies between 73 percent in Rhine East and Meuse and 86 percent for Rhine North and 87 percent in the Ems River Basin.

3.1.9 Abstraction of groundwater per (sub-)River Basin, 2011[1)]

		Total NL	Rhine-North	Rhine-East	Rhine-Center	Rhine West	Ems	Meuse	Scheldt
Fresh groundwater	**NACE Rev.2**	**million m³**							
Total		991.9	70.5	184.7	119.1	216.4	43.9	335.1	22.2
Agriculture, forestry, fishing	01-03	88.5	2.6	21.5	9.9	2.8	2.4	47.9	1.2
Public Water supply companies	36	755.7	60.5	134.1	94.5	166.4	38.1	244.6	17.6
Industry; power plants; etc.	06-35; 37-99	147.6	7.4	29.0	14.7	47.1	3.4	42.5	3.4
Private Households		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Baas and Graveland (2011); Graveland en Baas (2012); LEI, 2013b; 2013c; VEWIN 2012; 2013; Statistics Netherlands (2013).

1) This figure and the next are based on data compiled in 2011. In 2012 and 2013 different items were updated leading to slight adjustments. Previous figures for 2011 in this paragraph may therefore be slightly different.

Large differences exist in the abstraction of surface water between the river basins. With a share of 47 percent of total abstraction, most surface water is abstracted in the Rhine-West (sub-) river basin. In the Meuse river basin 34 percent of all surface water is abstracted in 2011. Most power plants and major industries are located in these (sub-) river basins. In the Rhine-West, electricity supply and manufacturing are responsible for 44 percent of the country's fresh surface water abstraction. Water supply companies were responsible for only 5 percent of total surface water abstraction in 2011. Besides the amounts of fresh water presented here, regions like Rhine-West, Scheldt and Ems also use significant amounts of (salt) marine water for cooling by power plants and for major industrial sites.

3.1.10 Abstraction of fresh surface water per (sub-)River Basin, 2011

		Total NL	Rhine-North	Rhine-East	Rhine-Center	Rhine West	Ems	Meuse	Scheldt
Fresh surface water	**NACE Rev.2**	**million m^3**							
Total		9,069.2	387.8	222.5	687.0	4,297.7	39.9	3,106.9	357.7
Agriculture, forestry, fishing	01–03	30.9	5.7	5.7	4.0	9.4	1.4	3.2	1.5
Public Water supply companies	36	473.2	0.0	0.0	0.0	271.5	6.3	195.4	0.0
Industry; power plants; etc.	06–35; 37–99	8,565.0	382.1	216.9	683.0	4,016.8	32.2	2,908.3	356.1
Private Households		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Baas and Graveland (2011); Graveland and Baas (2012); LEI 2013; VEWIN 2012; 2013; Statistics Netherlands (2013).

4. Materials

Authors
Roel Delahaye
Marjan Verberk

The Netherlands has a physical trade deficit, which implies that imports of materials exceed exports in terms of weight. In this chapter the inputs, throughputs and outputs of goods in the economy in material terms are described. These data support policies that deal with material use, dematerialization and material substitution.

4.1 Material flows

The consumption of goods affects the environment in many ways. First of all, natural resources are needed as input for the production process. Their extraction may cause their depletion. Secondly, environmentally harmful substances may be released into the environment during the production process. Eventually goods are discarded and become waste that requires further treatment. Waste will largely be recycled but some part will end up in the environment, either after incineration or in landfills. Besides these environmental issues, materials, and especially natural resources play a key role in the industrial production processes. In recent years some resources were greatly in demand, which has led to scarcity and high prices. This development puts pressure on the security of supply of some materials.

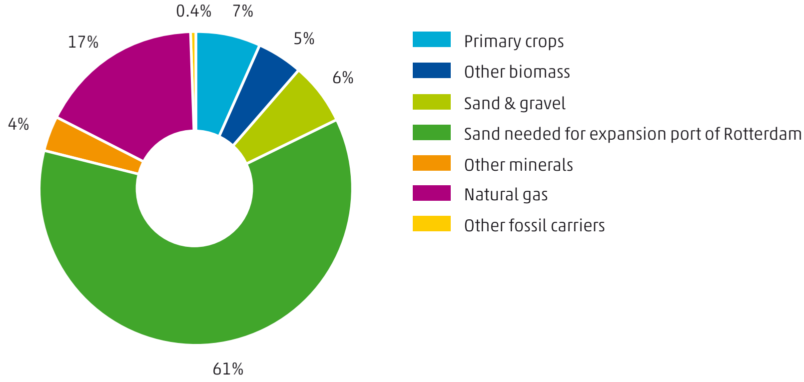
Material flow accounts describe the inputs, throughputs and outputs of goods in the economy in material terms. They include all goods that enter or leave the economy[1)] ranging from raw materials and semi-finished products to final products. All goods are assigned to one of five basic categories – biomass, metals, non-metallic minerals, fossil fuels and other products – 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 (366 billion kilograms in 2011) largely consists of gravel and sand. Around 90 percent of the sand and gravel is used in infrastructural projects to raise roads and land for the construction of buildings or to strengthen dikes and coastal defences. In the period 2009–2011 a large amount (61 percent) was needed for the expansion of the port of Rotterdam, the so-called 'Tweede Maasvlakte'. The remainder is used in the production of concrete and cement. The extraction of natural gas accounts for 17 percent of total extraction, as the substantial natural gas reserves of the Netherlands are exploited.[2)]

1) Excluding bulk water.
2) The extraction of oil is too little to take into account.

4.1.1 Domestic extraction (total of 366 billion kilos) for the Netherlands, 2011



Physical trade deficit, monetary trade surplus

The extraction of natural resources is not sufficient to meet domestic demand. Therefore, the Netherlands depends on imports of resources and goods from other countries. The Dutch imports of materials reached 382 billion kilograms in 2011. At the same time other countries depend on the Netherlands for their material needs. The Dutch exports of goods amounted to around 331 billion kilograms in 2011. Figure 4.1.2 shows the physical (upper graph) and monetary (lower graph) imports (–) and exports (+) for five groups of materials. A distinction is made between flows to and from EU27 and to and from non-European countries (non-EU27).

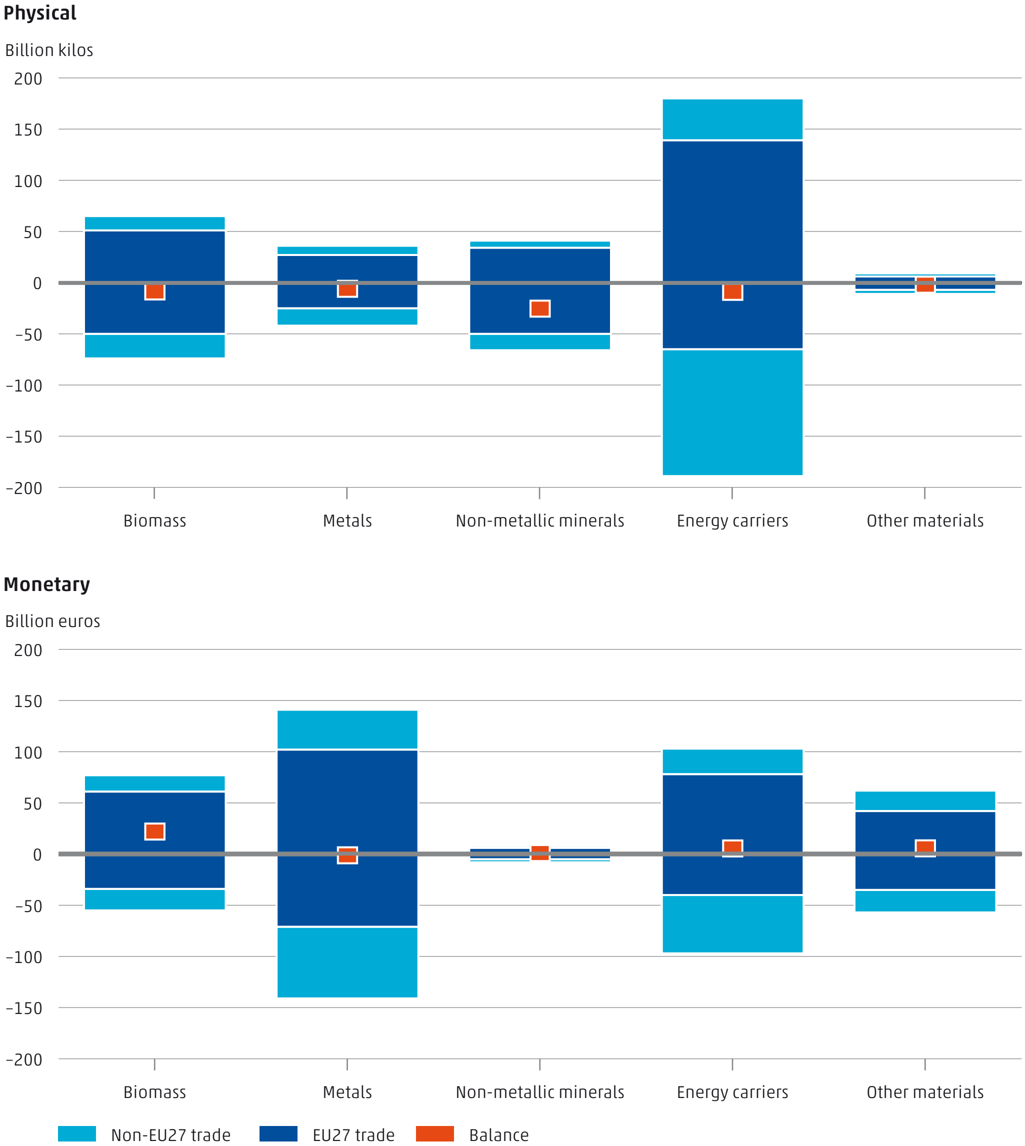
382 billion kg
of materials imported in 2011

Overall, the Netherlands has a physical trade deficit, which implies that imports of materials exceed exports in terms of weight. 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 bulk materials into more expensive high-quality products. The monetary trade surplus is particularly high for biomass, given the exports of, for example, vegetables, flowers and cigarettes. The Netherlands also has a monetary trade surplus for energy carriers. Imports consist mainly of crude oil while exports consist of more expensive oil products, such as petrol, and domestically extracted natural gas. In monetary terms the volume of imports and exports is relatively large for metals and metal products, such as cars and electronics.

At the import side, the trade with EU27 and non-EU27 countries in physical terms is nearly fifty-fifty. The Netherlands is very dependent on non-EU countries for energy carriers, almost 66 percent. For all other groups of materials the dependency on EU countries is about two thirds. Energy carriers are the largest material group, so the development in this category is most important for the total division of imports between EU27 and non-EU27. On the other hand, the Netherlands exports many energy carriers to countries in the EU. As a consequence, the share of EU27 trade in physical terms on the export side is 78 percent, and 22 percent in non-EU27 trade. The EU is very important for the export-orientated Dutch market. In monetary terms, the percentages of EU27 and non-EU27 are more or less the same.

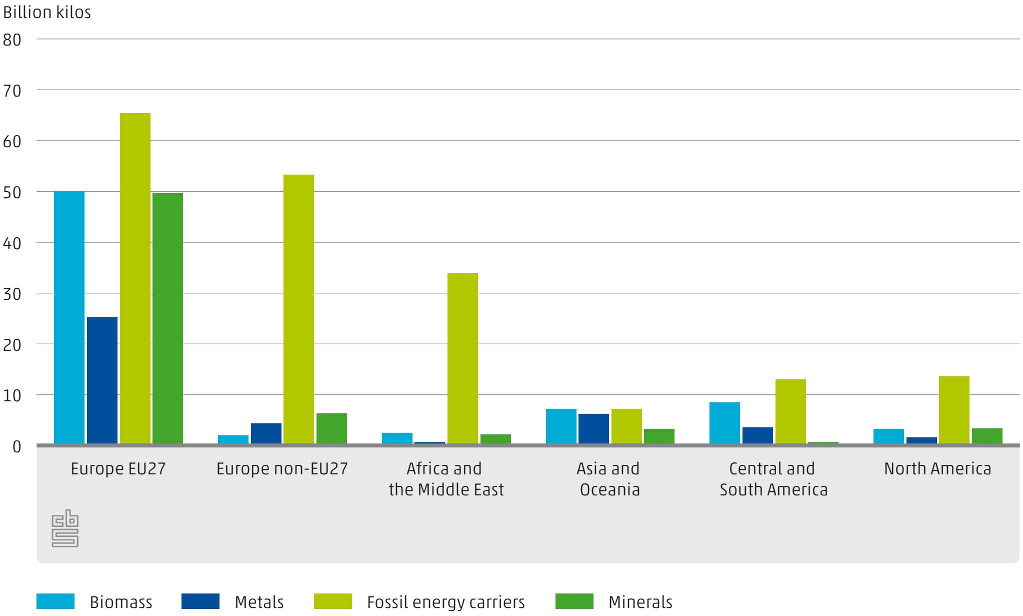
The largest physical trade deficit is in minerals, which can be attributed to the massive imports of sand and gravel. The extraction of sand and gravel in the Netherlands itself is limited. Besides re-exports, imported sand and gravel are mainly used in the construction industry and for the production of concrete and cement. Sand used in infrastructural works, for example in the foundations of roads and houses, is not imported.

4.1.2 Physical (upper graph) and monetary (lower graph) imports (–) and exports (+) for groups of materials by the Netherlands, 2011



In Figure 4.1.2 the import and export figures for European countries are published and discussed. A distinction is made between EU27 and non-EU27. Figure 4.1.3 shows the import figures for different parts of the world and not only for European countries.
The physical import and export volumes are dominated by energy carriers. Energy carriers and their derived products are largely imported from other European countries: Norway natural gas and Russia for crude oil. Almost all coal comes from non-European regions: South America and Africa. Exports of energy carriers are destined for the European market and consist mainly of oil 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). Cereals make up 40 percent of the primary crops imported. They are mainly imported from France. The imports of oil bearing crops, especially soybeans, are also relatively large. Soybeans mostly come from Brazil and are mainly processed into animal feed. The physical exports of primary biomass consists mainly of vegetables and products made from potatoes.

4.1.3 Imports from the rest of the world

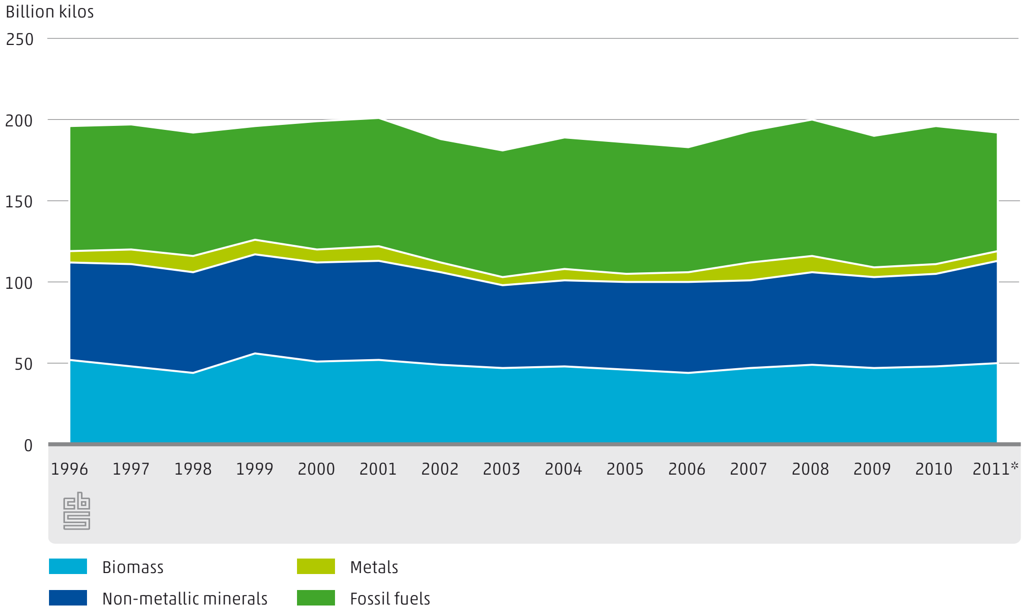


Dematerialization of the Dutch economy

Domestic material consumption (DMC) is an indicator that 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. In 2011 the DMC was much higher than in 1996, but not as high as in 2009 and 2010. In the period 1996–2011 the economy grew by 36 percent. Until 2008, there was a clear dematerialization of the Dutch economy. The expansion of the port of Rotterdam greatly raised the domestic demand for sand from 2008 onwards. If we do not take this part of the total extraction of sand and gravel into account, the Dutch economy continued to dematerialize, so there has been dematerialization from 1996 onwards.

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. As mentioned above the enormous increase of extraction of sand and gravel in 2009 and 2010 was caused by the amount of sand needed for the expansion of the port of Rotterdam. For this reason this kind of sand is not taken into account in Figure 4.1.4.

4.1.4 Domestic material consumption for different material categories in time (excluding sand needed for the expansion of the port of Rotterdam)



5.

Greenhouse gas emissions and air pollution

Authors
Cor Graveland
Eefje Lammers
Maarten van Rossum et. al.

Greenhouse gas emissions in the Netherlands remained virtually the same in 2012 as in the previous year, while the economy shrank by 1.2 percent. This chapter discusses the emissions of greenhouse gases and other pollutants to air by the Dutch economy. First, in section 5.1 greenhouse gas emissions according to different frameworks are discussed. In section 5.2 and 5.3 the emissions by respectively Dutch production and consumption activities are presented. Also, CO_2 emissions are presented for the first and second quarter of 2013 in section 5.4. In section 5.5 a new approach to account for responsibility by attributing emissions by the criterion 'span of control' or ultimate controlling institute (UCI) is explored. Finally, in section 5.6 the emissions for other pollutants to air are presented.

5.1 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 concentration of greenhouse gases in the atmosphere substantially. As a result the average global temperature rose by about 0.8°C and global precipitation patterns changed (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 gases. In 2013 the concentration of CO_2 in the atmosphere reached the level of 400 parts per million for the first time in human history. Such enhanced concentrations of greenhouse gases in the atmosphere, CO_2 in particular, will increase global temperatures by radiative forcing. Likewise, climate change has a direct impact on all kinds of economic processes. This may be positive or negative, but the expectation is that the overall impact will be primarily negative. A good conception of the economic driving forces of climate change is key to the design of effective mitigation policies. The air emission accounts can be used to analyse the environmental pressures and responsibilities 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. The best-known are the emissions reported to the UNFCCC (United National Framework Convention on Climate Change) in particular under the Kyoto Protocol, but also environmental statistics as well as the air emission accounts provide independent greenhouse gas emissions estimates. The differences are not the result of disputes about the accuracy of the estimates themselves, but arise from different interpretations of 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 section we explain the above mentioned frameworks and their estimates. A bridge table (see Figure 5.1.1) provides insight in how their different conceptions are related.

5.1.1 Bridge table for greenhouse gases

	1990	1995	2000	2005	2009	2010	2011	2012*
	Mton CO_2-equivalents							
1. Stationary sources[1]	187	195	183	181	172	184	169	168
2. Mobile sources on Dutch territory	33	36	40	42	42	42	43	43
3. Mobile sources according to IPCC	31	34	37	39	38	38	39	37
4. Short cyclic CO_2	6	6	8	10	12	13	13	13
5. Total, IPCC (excl. LULUCF) = 1 + 3 - 4	213	223	213	209	198	209	194	193
6. Land Use, Land Use Change and Forestry (LULUCF)	3	3	3	3	3	3	3	3
7. Total, IPCC (incl. LULUCF) = 5 + 6 (Kyoto-protocol)	216	226	216	213	201	212	197	196
8. Actual emissions in the Netherlands = 1 + 2	220	231	223	222	215	226	212	211
9. Residents abroad	15	21	26	27	25	25	26	26
10. Non-residents in the Netherlands	5	5	6	7	7	7	7	7
11. Total emissions by residents = 8 + 9 - 10	230	247	243	242	233	244	231	230

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

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 from 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 the only emissions considered are those caused in domestic transport. A complicating factor is that the distinction between international and domestic travel is based on the travel destination, 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. Sinks represent the greenhouse gases stored in the atmosphere, either stemming from anthropogenic or natural sources, absorbed by nature for instance through carbon sequestration in organic matter, i.e. in living forests. 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)].

Greenhouse gas emissions within the Dutch territory (actual emissions)

Statistics Netherlands annually publishes the actual greenhouse gas emission for the Netherlands. These are greenhouse gas emissions that actually take place within the Dutch territory. In contrast to the IPCC guidelines, all emissions by mobile sources that occur within 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 functions as the basis for the calculation of the air emission accounts.

203,549 million kg CO_2
emitted by Dutch economic activity in 2012

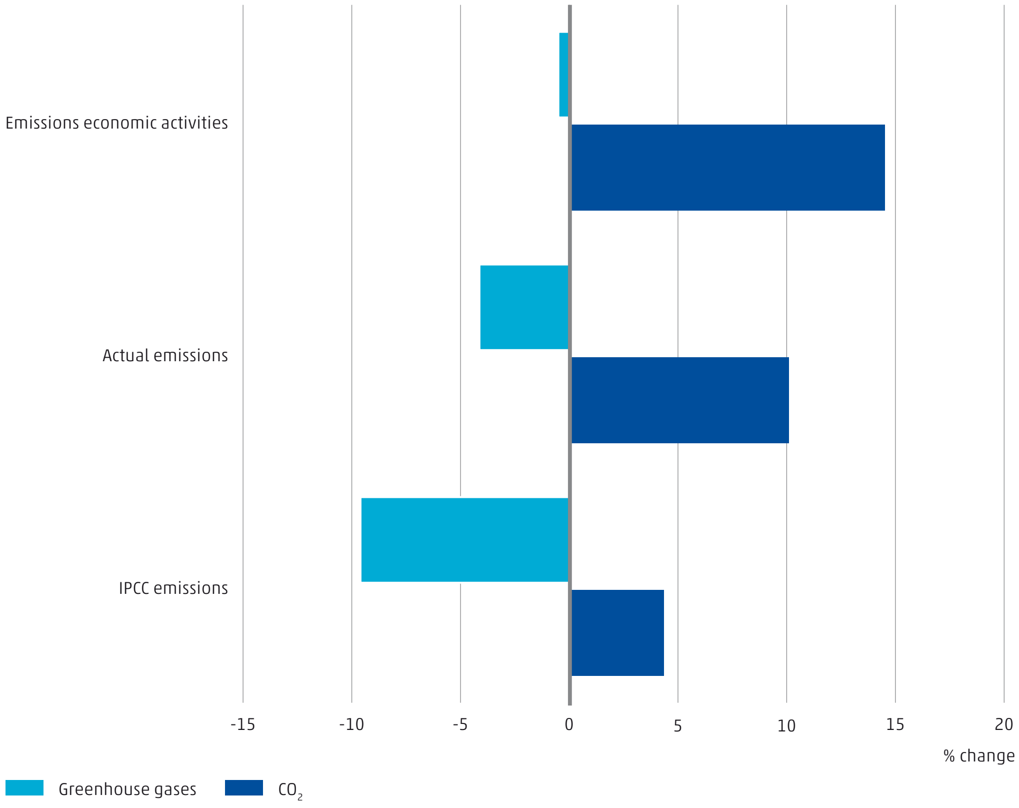
Greenhouse gas emissions by the Dutch economy

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

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 of emissions if biomass harvest/destruction exceeds regrowth in the inventory year, or a net sink if regrowth exceeds harvest/destruction.

5.1.2 Change in CO_2 and greenhouse gas emissions between 1990 and 2012 according to different frameworks



IPCC emissions further down, emissions by economic activities equalled

The total greenhouse gas emissions for the Netherlands according to the IPCC guidelines equalled 193 Mton CO_2 equivalents in 2012[2)]. This is 10 percent below the emission level in 1990, the base year for the Kyoto Protocol. The CO_2 emissions, however, extended with 7 Mton, a 4 percent increase during this period. This CO_2 emission growth was more than outweighed. Strong emission reduction efforts have led to a halving of the emissions of all other greenhouse gases (CH_4, N_2O, F-gases). These developments for the Netherlands together with additional carbon credits for the non-ETS sectors enabled the country to meet its Kyoto targets (see below).

The emissions of greenhouse gases generated by the Dutch economy equalled 230 Mton in 2012 which is almost the same level of emissions as in 1990. The differences between these conceptualisations are primarily due to the different treatment of the emissions caused by international transport which is only partly included in the Kyoto figures. Precisely in this period, strong extension of international transportation activity by Dutch residents pushed up greenhouse gas emissions by 75 percent. Also, emissions from short-cyclic CO_2, for example the combustion of waste, have increased rapidly particularly in the middle of this period.

2) Excluded LULUCF emissions and uptake.

Emission data and climate policy

The aim of the Dutch climate policy was to meet its obligation for emission reductions stipulated in the Kyoto Protocol and to achieve further emission reductions for the medium-long period beyond Kyoto as has been agreed upon within the EU. 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 was allowed to emit 200 Mton CO_2 equivalents each year, which is 1001 Mton CO_2 equivalents for the entire Kyoto period. The Kyoto 5-year period has come to an end in 2012, and 997 Mton CO_2 equivalents have been emitted. This suggests that the Netherlands remained just below its target. Although, it is somewhat more complicated, as both the industry sectors that participate in the emissions trading system (ETS) and non-ETS sectors, have to comply with the target set. The ETS sector is responsible for compliance themselves and had to handover sufficient number of permits to cover emissions. They did. The Dutch government has taken responsibility over the emissions caused by the Non-ETS sector. In 2012 Non-ETS emissions for the Kyoto period proved to be higher than originally allowances were allocated to, therefore the Dutch government anticipated and has obtained credits (CERs / ERUs) abroad, in order to cover the Non-ETS emissions in the country and to comply for these sectors as well. To meet the Kyoto target, the Netherlands made use of the three flexible Kyoto mechanisms: emission trading, Joint Implementation (JI) and Clean Development Mechanism (CDM), (Statistics Netherlands, 2012b; NEa, 2013).

In 2007 the European Council adopted a long-term climate objective, in which the EU strives to limit the average global temperature increase to 2°C compared to pre-industrial levels (EC, 2007). To implement this objective, the European Council decided to realize an emission reduction of at least 20 percent by 2020 compared to 1990. This again is to be achieved via a combined approach with the EU emissions trading system (EU-ETS) and non-ETS sectors. The large emitters are obliged to participate in the newly developed EU-ETS for the second commitment period 2013–2020. The Netherlands has a binding national target set to reduce emissions by 16 percent in 2020 in sectors not covered by the EU-ETS, such as transport, housing, agriculture and waste. The ETS sectors no longer have national binding targets, but an overall European target is set for 2020. The competitiveness of industries covered by the EU-ETS is particularly addressed as the production from certain sectors and sub-sectors may potentially be exposed to a significant risk of 'carbon leakage' as they face competition from industries in countries that are not subject to comparable greenhouse gas emissions restrictions. As a result these companies will receive higher shares of free allowances in the 2013–2020 period.

The contribution to a global and broad post-Kyoto climate agreement by the EU will be 30 percent reduction, provided that other developed countries contribute comparable emission reductions, and economically more advanced developing countries contribute adequately according to their responsibilities and capabilities. In addition, the European Council formulated goals for energy saving (20 percent of the estimated use in 2020), renewable energy (20 percent of the final use of the EU in 2020) and for biofuels (minimum of 10 percent of the total fuel consumption in 2020).
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. For instance, a large part of the emissions caused by Dutch transport activities are excluded from the IPCC emissions. Furthermore, alternatives to the frameworks presented here, which are all based on

emissions inherent in production, calculate the emissions that are required to satisfy Dutch consumption or to account for it by attributing emissions according to the criterion 'span of control' by Dutch companies in or outside Dutch territory[3)].

5.2 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. This enables the analysis of 'potential' for targeted reduction actions. In addition, due to the compatibility with the national accounts framework, the greenhouse gas emissions can be directly linked to the economic performance by activity, so that the environmental burden of the different industries can be analysed. Either via assessing the extent to which decoupling takes place, or via emission intensity calculations (eco-efficiency).

For a description of the methodology used see Statistics Netherlands (CBS) (2010). The data of the air emission accounts, as well as the 'actual emissions' and IPCC emissions, can be found on StatLine, the electronic database of Statistics Netherlands.

Slight decrease in greenhouse gas emissions by industries

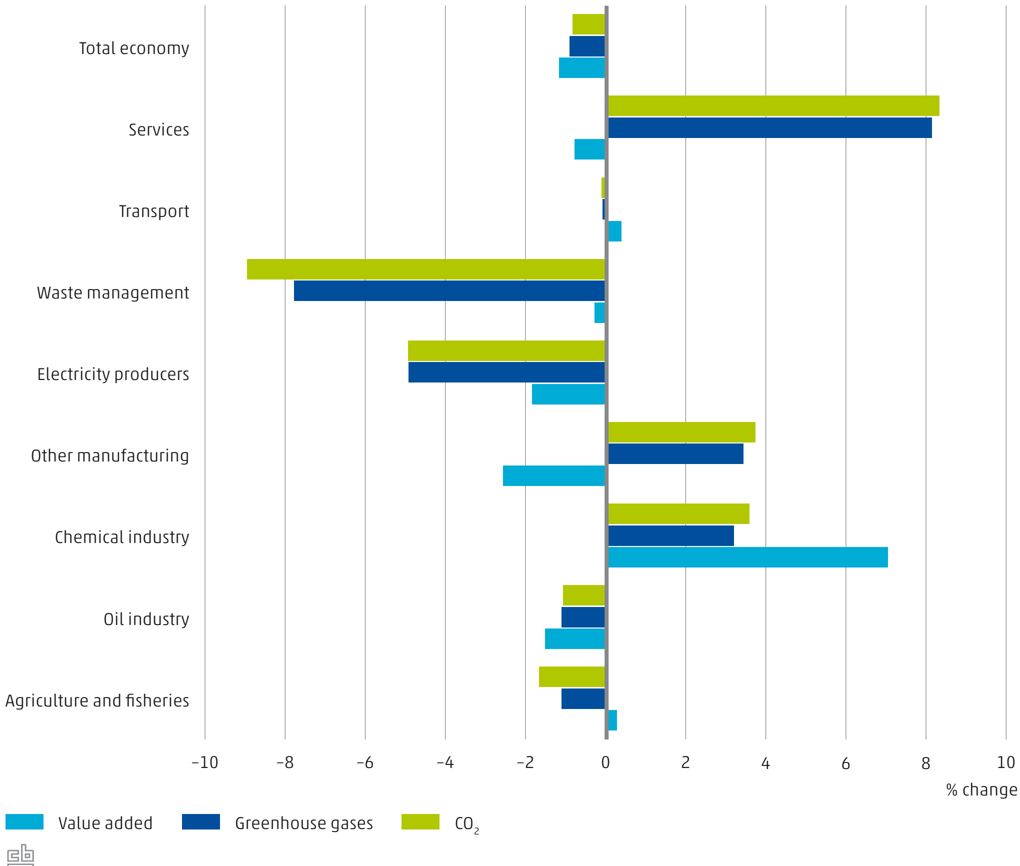
The total greenhouse gas emissions by industries equalled 189.2 Mton CO_2 equivalents in 2012, which was 0.9 percent less than in the previous year. The total emissions by the economy, which includes emissions by households, equalled 230.3 Mton CO_2 equivalents (see also section 5.1), which is almost the same as in 2011 (minus 0.1 percent). CO_2 emission from production activities decreased by 0.8 percent. A variety of developments underlie these limited overall changes. The relatively cold winter has led to extra energy required for heating, particularly in the services sectors. The continued economic stagnation and other changes in the production sphere have led to reductions in several larger emission-intensive industries including the electricity producers, except for the chemical industry. Emissions of methane decreased by 2 percent and emissions of nitrous oxide by 1 percent.

Greenhouse gas emissions in agriculture fell by 1 percent, mainly because less natural gas was combusted in horticulture. In the period with relative cold weather in 2012, growers regularly decided to limit the heating of their glasshouses taking into consideration the higher energy costs. Methane emissions from cattle remained stable. In manufacturing, the continued economic crisis had its effect on emission levels. Emissions in manufacturing showed a scattered picture. Emissions decreased in several manufacturing industries, but increased in others. Particularly the chemical industry increased its emissions due to higher production levels. On the other hand, emissions fell in the basic metal industry

3) Section 5.5 provides more details on CO_2-emissions according to the 'span of control' criterion.

and less in refineries, both industries with very emission-intensive production processes. For the second year in a row the electricity companies produced less electricity. In 2012 almost 10 percent less electricity was produced domestically. Although the electricity exports increased, so did the imports of electricity which reached their highest level ever, resulting in large net imports. The fuel mixture used for electricity production also changed significantly. Less natural gas and more coal, lead to more carbon-intensive production of electricity, partly compensating the effect of the production loss, as a result CO_2 emissions fell by 5 percent in 2012. Burning coal without capturing the carbon emissions causes more CO_2 emissions than gas. In monetary terms though, the electricity companies maintained their production and value added levels, as the energy distribution companies were able to grow and network companies only lost little of their production in 2012. Waste management produced less greenhouse gas emissions, with less CO_2 emissions partly as a result from less waste incineration. Methane emissions from landfill sites continue to fall, by another 8 percent in 2012. These emissions have been falling for several years because less waste is deposited in landfill sites today and emissions from existing sites are lessening. The level of transport activity and the emissions of the transport sector both barely changed. Only emissions for land transport decreased by 1 percent. Water transport and air transport remained constant. Emissions in the services sectors grew, due to a longer period with cold winter weather, so that extra natural gas was combusted to heat the offices.

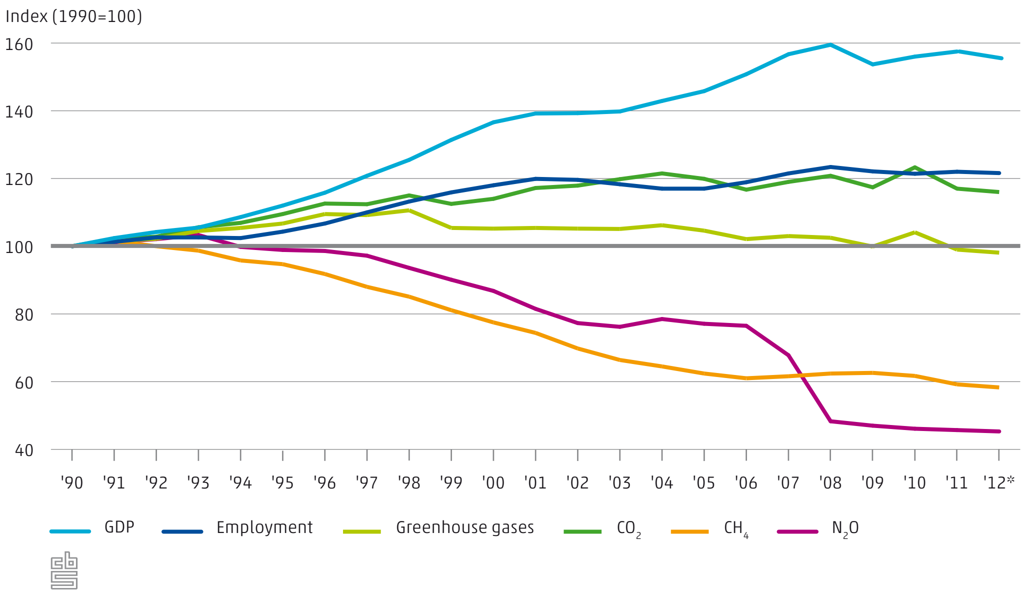
5.2.1 Change in value added, greenhouse gas and CO_2 emissions, 2011-2012



Emission intensity increased in 2012

In 2012 the Dutch economy contracted by 1 percent, whereas greenhouse gas emissions hardly changed (minus 0.1 percent). As a result the emission intensity for greenhouse gases, which is an important measure of the environmental pressure caused by economic activities, deteriorated. The main reason is the colder weather in 2012, with more energy used for heating offices than in the mild winter of 2011. This explains the slight increase of CO_2 emissions per unit value added. In manufacturing, the emission intensity for many industries deteriorated. However, for several of the large emitters such as the manufacturers of chemicals, the basic metal industry and also electricity producers, emission intensity improved.

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

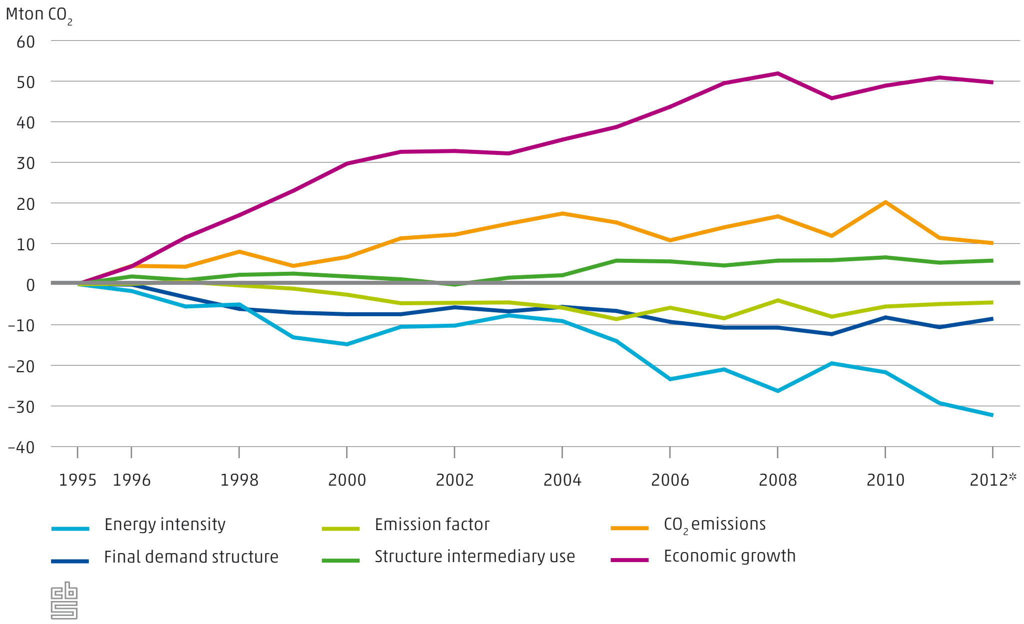


In the period 1990–2012, economic growth far exceeded greenhouse gas emissions. While the economy grew by 56 percent and employment by 22 percent, the emissions of greenhouse gases by industries fell by 2 percent. This is the third time in 22 years and after 2011 for a subsequent year that we observe absolute decoupling in the Netherlands with respect to the 1990 emission levels. Absolute decoupling here means lower emissions than in 1990 despite economic growth. For CO_2 emissions, there is still only relative decoupling, i.e. the emission rate increased by 16 percent, although this is substantially less than the GDP growth rate.

Crisis and enhanced energy efficiency stabilised CO_2 emissions in the last decade

The change in the level of CO_2 emissions by economic activities in the period 1995–2012 can be explained by different factors. Structural decomposition analysis allows us to account in detail for the factors underlying the changes in emissions (Dietzenbacher and Los, 1998; De Haan, 2001)[4]. First of all, economic growth may have contributed to extended CO_2 emissions. A change in the energy mix (the energy products used in the production process) may also have had an influence on the 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 the composition of the final demand structure for products and services. Finally, eco-efficiency improvements of the production processes, either via integrated technologies, add-on technologies or else, may have lowered CO_2 emissions. Figure 5.2.3 shows the results of a structural decomposition analysis of CO_2 emissions for the period 1995–2012.

5.2.3 Structural decomposition analysis of CO_2 emissions



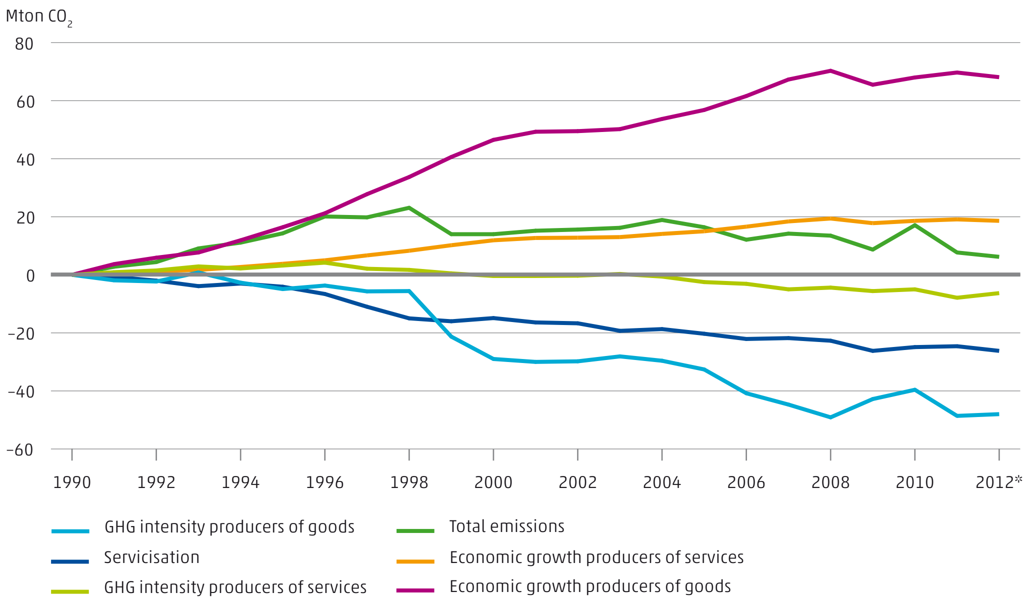
Economic growth has been the prime driving force behind the increase of CO_2 emissions since 1995, which were partly counteracted by improved energy efficiency as demonstrated by the energy intensity reduction as well as by the changes in final demand structure and emission factor. CO_2 emissions in 2012 would have been about 36 percent higher than 1995 levels if no such improvements in energy efficiency or energy saving had been achieved or if there had been no change in environmental efficiency and economic structure. Structural changes in the economy or changes in the mix of energy products both had limited effect on the total change in the reduction of emissions. Also the carbon capture and storage technologies, providing opportunities for lowering the emission factor to further reduce CO_2 emission, are hardly applied. Such technologies so far mainly hold a promise for significantly reduction of the emission factor in future. For the last decade the limited economic growth and energy efficiency gain led to stabilising CO_2 emissions. The decrease in emissions between 2011 and 2012, was the result not only of economic decline but, mainly, of lowered energy intensity.

[4] See also Annex III in: Milieurekeningen methoden (Environmental Accounting Methodologies) www.cbs.nl.

Higher shares of service industries enable decoupling of emissions from economic growth

Servicisation, which is the increase in the share of service industries in the total economy, has been a key structural economic development of the past decades in many developing economies. In the Netherlands, the service industries too grew faster than manufacturing, construction and agriculture. The share of the services sector in total value added rose from 67 percent in 1990 to 74 percent in 2012 at the expense of the producers of goods.

5.2.4 Decomposition analysis greenhouse gas emissions, effect of servicisation



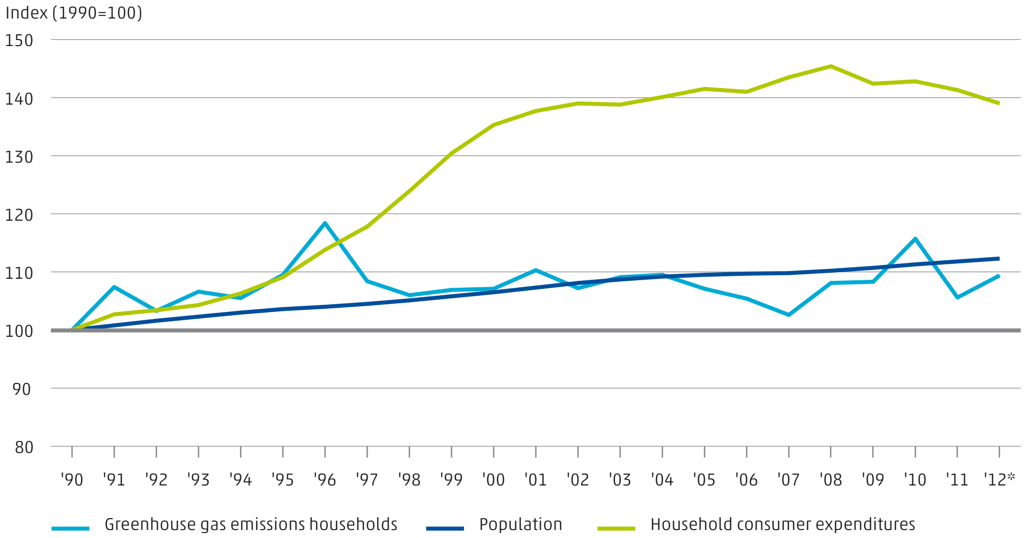
The shift to a more service-based economy affects the emission of greenhouse gases. Since the production of services tends to be much less emission-intensive than the production of goods, the rise in the production of services has caused the economy as a whole to become less emission-intensive. The effect of servicisation is determined by calculating what the greenhouse gas emissions would have been if the share of services in the economy had remained the same. If the share of services in the economy had not increased since 1990, the greenhouse gas emissions in 2012 would have been 14 percent higher.

One third of the decoupling between greenhouse gas emissions and economic growth can be explained by the phenomenon of servicisation. The remaining two thirds of decoupling can be attributed to the more eco-efficient production of goods, primarily in agriculture and some heavy industries like the chemical industry. Efficiency gains in the services sectors have hardly contributed to the decoupling. This is mainly because the transport sector largely determines the total greenhouse gas emissions of the services sector, being responsible for about half of its greenhouse gas emissions. Its large share and strong growth over the last two decades, plus the limited gain in eco-efficiency means the transport sector has increased emission intensity within the overall services. The other service sectors have significantly lower emission intensities, which also improved on 1990.

5.3 Greenhouse gas emissions from household activities

Households directly contribute to the emission of greenhouse gases by consuming energy products for heating, cooking and generating warm water, and by using motor fuels for driving. The air emission accounts provide information on the level of these emissions and provide the opportunity to compare these with monetary information from the national accounts. In this section we present the developments in the direct emissions by households and the underlying causes.

5.3.1 Change in direct greenhouse gas emissions by households, population and household consumer expenditure



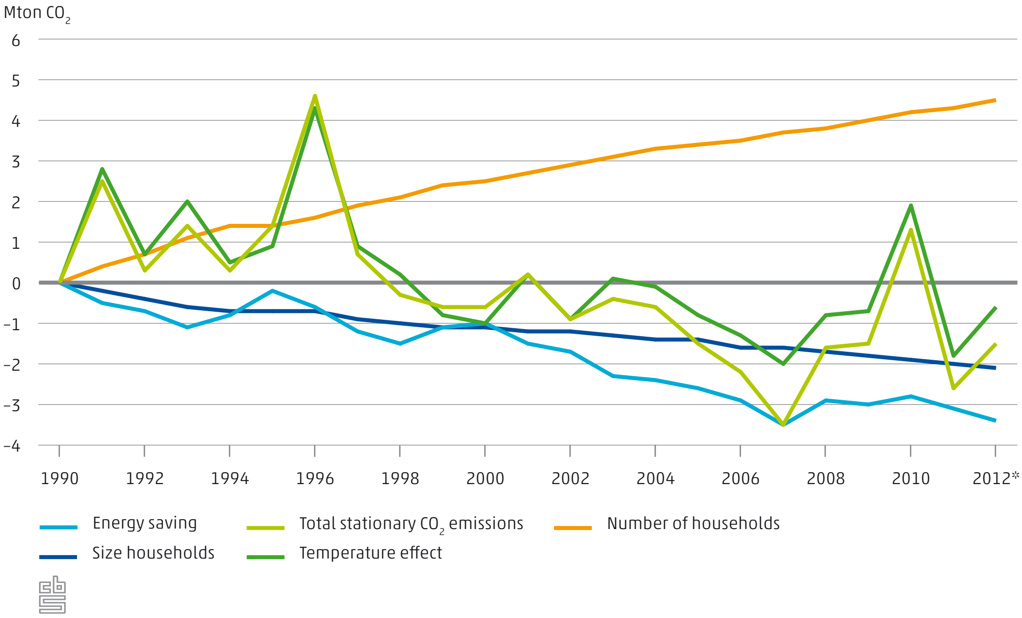
In 2012 direct greenhouse gas emissions from households rose by 3.5 percent with respect to 2011. The main reason for increased emissions was the extended use of natural gas for space heating (6 percent) due to long periods of cold winter weather. The CO_2 emitted by cars rose by 1 percent in 2012. Compared to industries, households cause minor direct emissions of the other greenhouse gases alongside CO_2, such as CH_4 (methane) and N_2O (nitrous oxide). CH_4 emissions rose by 6 percent, partly explained by the extra energy used for space heating, while N_2O emissions rose by 29 percent.

Dutch households were responsible for 41.0 Mton of greenhouse gas emissions in 2012, which represent 18 percent of the total emissions by economic activities. The development of these emissions can be compared directly with population growth or consumer expenditures. It turns out that final consumption by households grew significantly faster than the emissions. Development of the emissions seem to align with population growth if assessed over a longer period of time, implying the direct emissions from households seem to remain reasonably stable per capita over time.

Effect of energy saving by households on emissions stabilising

The CO_2 emissions by households produced in and around the home have fallen by 7 percent since 1990. These so-called emissions from stationary sources originate for the most part from the combustion of natural gas for space heating, production of warm water and from cooking (93 percent). Emissions from wood stoves and fireplaces are responsible for 6 percent. The causes for the decrease in emission levels for stationary sources can be further analysed by decomposition analysis. The changes in emissions can be decomposed into several factors, including the number of households, the average household size, the effect of the average temperature and an energy saving effect.

5.3.2 Decomposition analysis for CO_2 emissions by households (stationary sources)

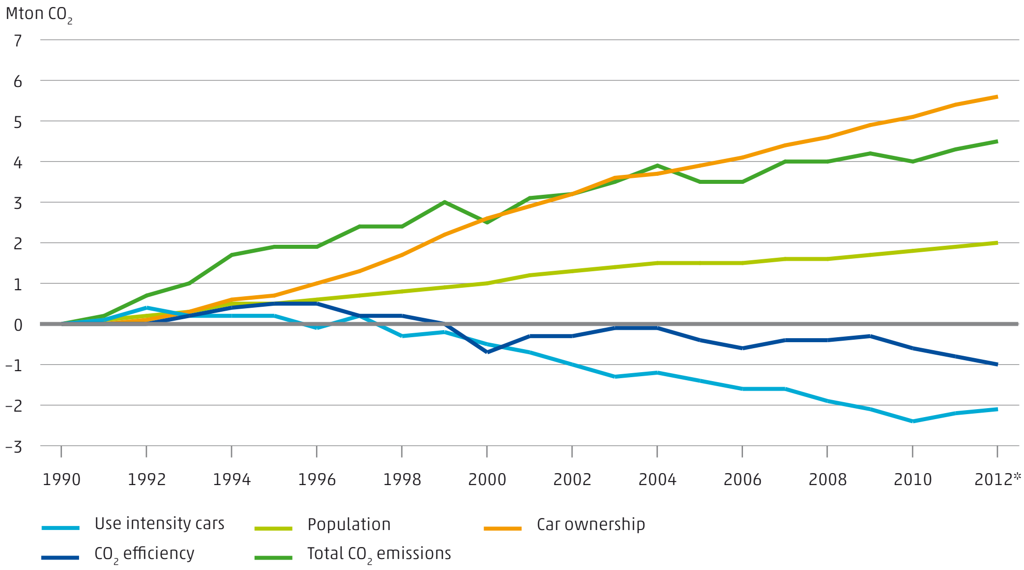


The gradual increase in the number of households caused a 4.5 Mton increase in the level of CO_2 emissions. All other factors had a lowering effect on the emissions. The weather conditions (average winter temperature) have a dominant effect particularly in years when winters are relatively cold, such as in 1996 and 2010 and 2012, when emissions peaked as more natural gas was combusted for heating. Overall, the average temperature caused emissions to rise in the 1990s and to fall in the 2000–2010 period. More interesting is probably the effect of the energy saving that can be deduced form this analysis. Energy saving led to an emission cut of 3.4 Mton between 1990 en 2012. Better home insulation and high efficiency boilers resulted in a 15 percent CO_2 reduction, which is on average 0.8 percent a year. The energy saving has primarily been realised after 2000. However, not much progress has been made over the last five years.

Increased car ownership raises CO_2 emissions

CO_2 emissions due to the use of road vehicles by households increased by 29 percent on 1990. The causes for the increase in emission levels for mobile sources can be further analysed by decomposition analysis. The changes in emissions can be decomposed into several factors, including population growth, car ownership, traffic intensity (number of kilometres driven per car) and a CO_2 efficiency effect (emissions per kilometre). The impact of the population increase has been a 13 percent rise in emissions on 1990. However, the main contributor to higher CO_2 emissions is the increase in car ownership, with an upward effect of 37 percent. In 1990 there were three cars per ten Dutch inhabitants, in 2012 four per ten. The effect is partially offset by the fact people drive less (lower mileage). More households now own a second car used mainly for short trips. Strikingly, CO_2 emissions per kilometre travelled has not changed much in 21 years. An improvement in the CO_2 efficiency can be observed as of 2009. The average CO_2 emissions per vehicle kilometre from new cars in the Netherlands have fallen sharply in the past three years. This is partly due to European standards, which have led to more fuel efficient cars on the market. While the demand for fuel-efficient cars also has risen under the influence of Dutch tax measures.

5.3.3 Decomposition analysis for CO_2 emission by households (mobile sources)



5.4 CO_2 emissions on quarterly basis

Accurate and timely measurements of the amount and the origin of the emitted greenhouse gases 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. In 2011 Statistics Netherlands started publishing quarterly CO_2 emissions 45 days after the end of a quarter, at the same moment as the first quarterly GDP estimate is published (flash). The quarterly CO_2 emissions are compatible with the national accounts and can be linked directly to economic output, allowing the comparison of the environmental performance of different industries. The CO_2 emissions are calculated according to the definitions of the environmental accounts.

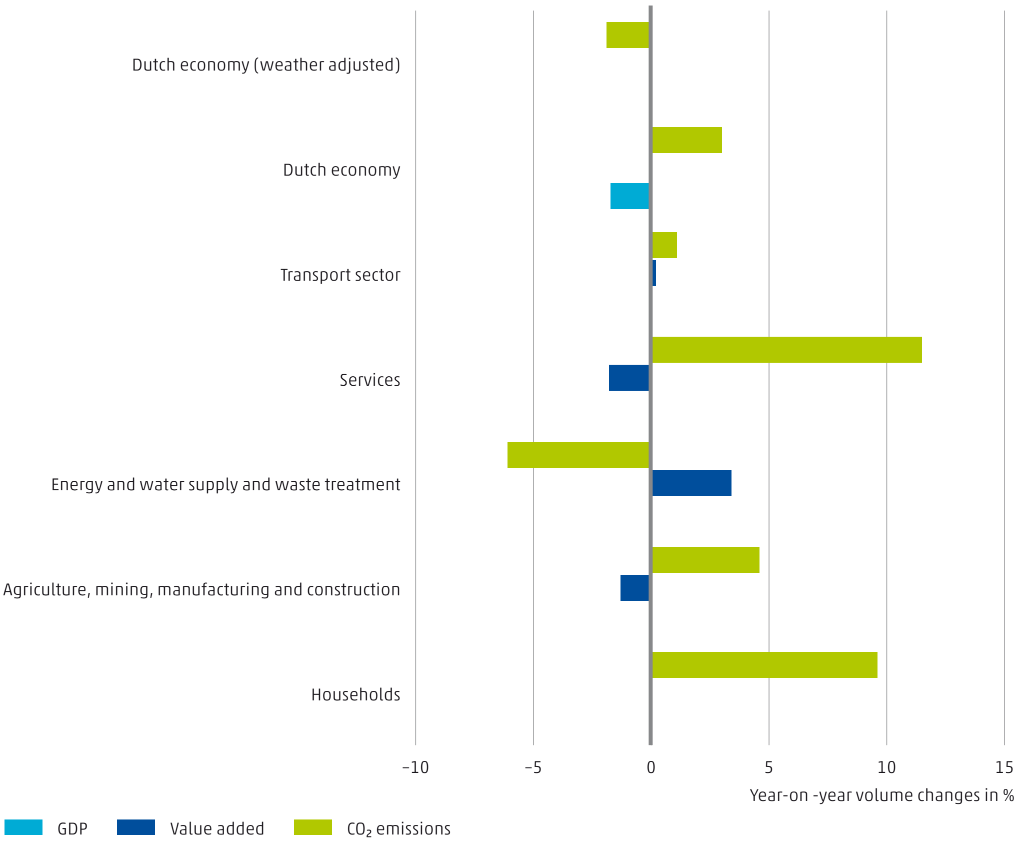
Besides these year-on-year changes there are also weather adjusted changes. For households, agriculture and some other services the assumption is that the natural gas consumption has not changed compared to the same quarter of the previous year.

Quarter 1 2013

Economic contraction dampens growth of CO_2 emissions in the first quarter of 2013

In the first quarter of 2013 3.0 percent more CO_2 was emitted by the Dutch economy than in the same quarter a year earlier, while the economy shrank by 1.7 percent. Emissions have increased due to more natural gas consumption for space heating. The energy-intensive companies faced an economically tough quarter, which has dampened the emissions.

5.4.1 Change in CO_2 emissions and economic development, first quarter of 2013 (flash)



Weather plays an important role

The first quarter of 2013 was colder than the first quarter of 2012. This is why more natural gas was consumed by households and service industries for space heating. To correct for the weather effect the weather adjusted CO_2 emissions are calculated as well. Without this weather effect CO_2 emissions would not be 3.0 percent more, but 1.9 percent less. Compared to last year, March was especially cold. Natural gas production and energy trading companies have benefited economically from the cold weather. The impact of the weather in the Netherlands on economic growth through the consumption of natural gas was about plus 0.3 percentage points. The treasury also benefits from a cold winter because the natural gas revenues are higher.

Lower CO_2 emissions by energy companies

CO_2 emissions from energy and water supply and waste management were 6 percent lower. The energy companies once again produced less electricity than in the same quarter a year earlier. Dutch electricity plants have used less coal and blast furnace gas to produce electricity. Burning coal and blast furnace gas goes along with relatively more emissions than other fuels.

Shrinking production by heavy industry leads to lower CO_2 emissions

The production of the chemical industry shrank in the first quarter of 2013 compared to the same quarter in 2012 and CO_2 emissions also fell, especially in the petrochemical industry. Fewer chemicals were exported to foreign economies. Also the oil industry has emitted less CO_2. The production of oil products dropped in the first quarter of 2013 compared to the previous year. The exports of oil products used as inputs in the production process decreased in particular.

Quarter 2 2013

CO_2 emissions higher despite economic contraction in the second quarter of 2013

In the second quarter 1.6 percent more CO_2 has been emitted by the Dutch economy than in the same quarter of 2012. The economy shrank in the second quarter by 1.8 percent year on year. Emissions increased due to more consumption of natural gas for space heating and the use of more coal and blast furnace gas in power plants.

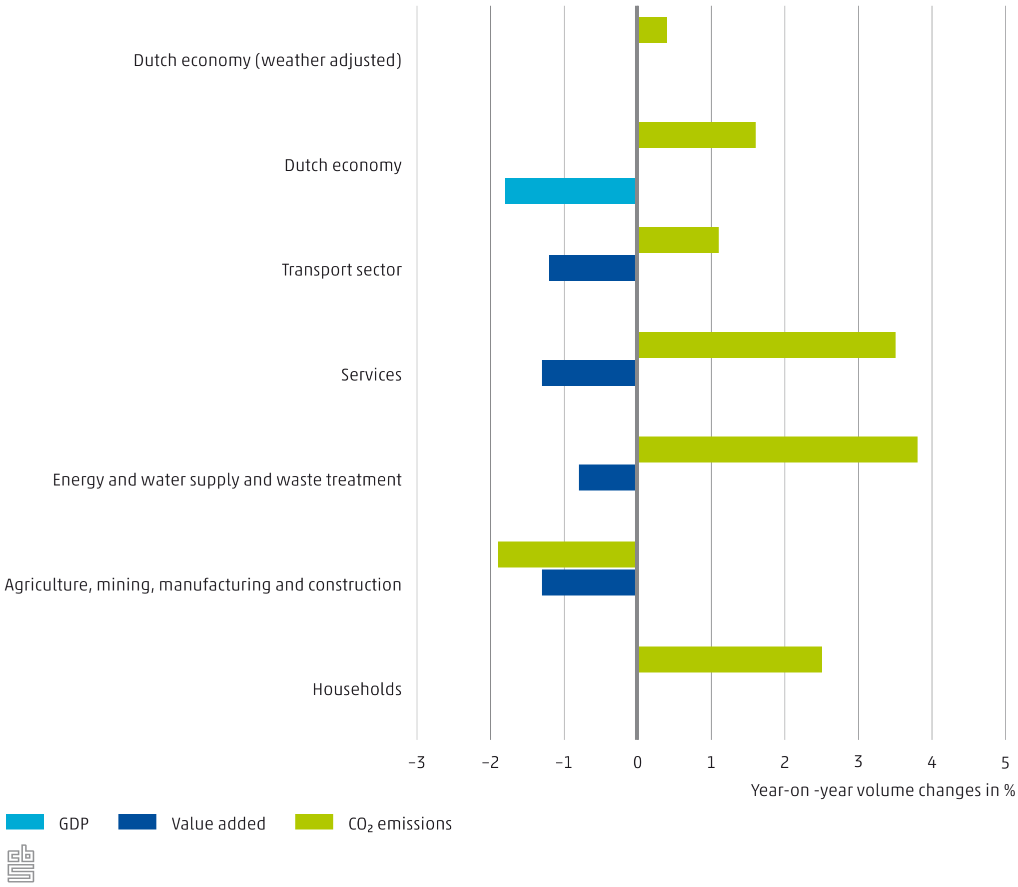
Weather plays an important role again

Just like the first quarter of 2013 the second quarter was colder than a year ago. May was especially cold. The consumption of natural gas for space heating was therefore higher. Without this weather effect only 0.4 percent more CO_2 would have been emitted.

Change in fuel mix results in more CO2 emissions by energy companies

In the second quarter of 2013, CO_2 emissions from energy companies, water and waste management were 3.8 percent higher than a year earlier. The energy companies produced less electricity than in the same quarter a year earlier. But because more coal and blast furnace gas and less natural gas were used for production, emissions were ultimately higher. Burning coal and blast furnace gas results in higher CO_2 emissions than burning natural gas. This change in the fuel mix has contributed to the extra emissions.

5.4.2 Change in CO_2 emissions and economic development, second quarter of 2013 (flash)



Increase CO_2 emissions from transport sector

The transport sector was responsible for higher CO_2 emissions while the value added decreased. This is mainly the result of more production of aviation. Air transport had a better quarter than in 2012 and this has been accompanied by more air movements. Per unit value added, air transport emits more CO_2 than other branches in the transport sector.

Lower chemical production causes decrease of CO_2 emissions

The cluster agriculture, mining, manufacturing and construction has emitted less CO_2 than in the same quarter of 2012. Both the production of chemicals and the associated CO_2 emissions in the second quarter of 2013 shrank compared to the same quarter in 2012. The oil industry emitted less CO_2. The production of oil products in the second quarter of 2013 decreased compared to a year earlier.

5.5 Quantifying CO_2 emissions according to the control criterion

Introduction

Statistics Netherlands published a study on "quantifying CO_2 emissions according to the control criterion". This experimental study was financed by Eurostat and has been published on the website of Statistics Netherlands.

Different ways exist of attributing greenhouse gas emissions like carbon dioxide (CO_2) to individual countries. Well-known are the territory-based approach which underlies Kyoto Reporting and the production based approach which is followed in the System of Environmental Accounts (SEEA). Also well-known is the consumption based approach using environmentally-extended input-output analysis (EE-IO).

Due to the advancement of globalisation, these different perspectives yield different estimates. There is by now extensive literature (around carbon leakage) which investigates whether developed economies, regularly with adopted carbon mitigation policies and national emission ceilings settled, shift economic activities and as a consequence environmental burden towards developing economies.

Moreover globalisation affects air emissions and the allocation of it. Globalisation has become an extensively discussed topic over the last two decades. Particularly for a small and open economy like the Netherlands, international developments have major consequences (Internationalisation Monitor 2011, CBS, 2011).

In this study we have explored a new approach to account for responsibility by attributing emissions by the criterion span of control or ultimate controlling institute (UCI). The main intuition here is that in a globalising world, the controlling units are not only most likely to receive most of the profits, but they also decide on the location of polluting activities. In that sense, this approach would be closer to an income perspective[5)]. Aim of the study was to compile and supply additional and relevant environmental-economic information on the issue of 'span of control' in the context of a globalising world. The span of control analysis consists of two parts: dividing the domestic emissions between Dutch and foreign span of control and estimating the Dutch control emissions abroad. The methodology used is discussed in more length in Van Rossum et al. (2012).

The research question of the study was how much CO_2 emissions does the Netherlands emit according to the criterion span of control and to what extent do these span of control emissions deviate from other emission aggregates like the production and the consumption approach?

5) In the SNA national income is an aggregate which takes also income transfers with the rest of the world into account.

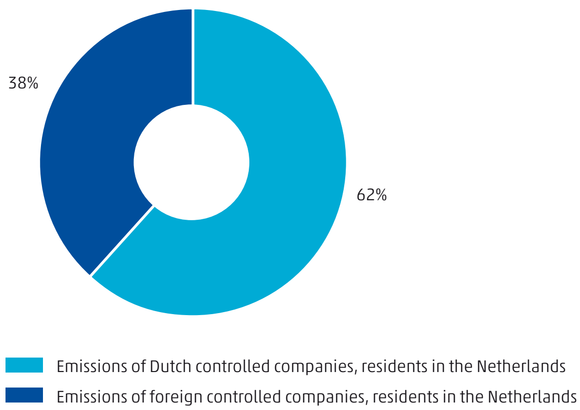
Results and conclusions

5.5.1 Total emissions of Dutch controlled companies in the Netherlands and abroad, 2008

	Mton CO_2 emissions
I Emissions of Dutch controlled companies, residents in the Netherlands	104
II Emissions of Dutch controlled companies, foreign residents	138
III Total emissions of Dutch controlled companies	242
IV Emissions of foreign controlled companies, residents in the Netherlands	64
V Emissions according to the residents principle (SEEA type emissions)	168

Table 5.5.1 shows that emissions of Dutch controlled companies equal 242 Mton CO_2. Approximately 44 percent of these are emitted by Dutch residents and 56 percent by foreign residents in foreign economies. Approximately 38 percent of all SEEA type emissions (production approach) are emitted by foreign controlled companies in the Netherlands. Approximately 62 percent of all SEEA type emissions (production approach) are emitted by Dutch controlled companies in the Netherlands (see Figure 5.5.2).

5.5.2 Allocation of emissions by Dutch residents, 2008

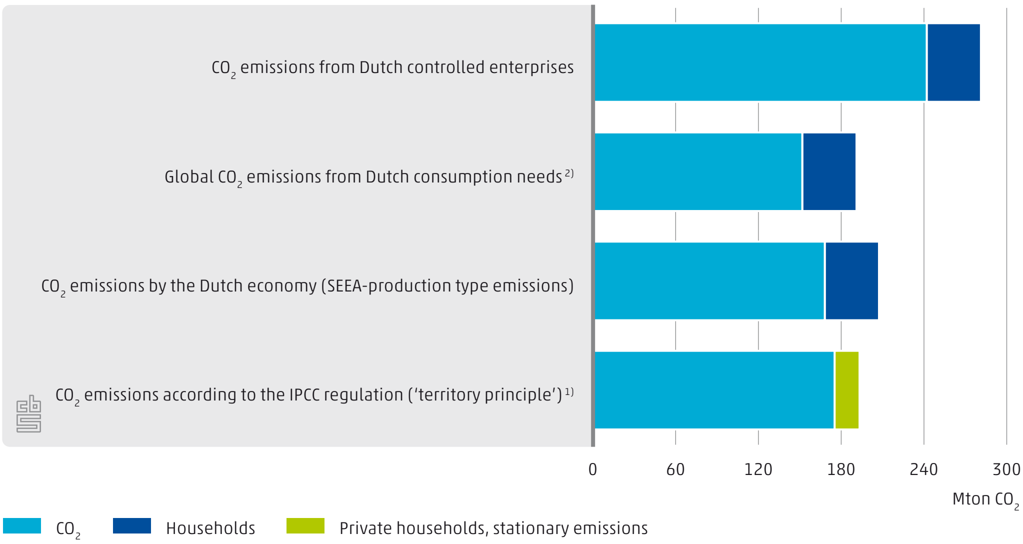


Comparison of different approaches for emissions

The different approaches for assessment of CO_2 emissions yield considerable different and interesting results. Emissions of Dutch controlled companies in the Netherlands and abroad equal 242 Mton CO_2. This figure is 44 percent larger than the CO_2 emissions from the Dutch economy according to the production approach (SEEA type) and 27 percent larger than the consumption approach (including direct emissions of households). For this 242 Mton of Dutch controlled CO_2 emissions, 43 percent is indeed emitted by Dutch residents, while 57 percent is emitted by foreign residents in foreign economies.

An approximated 38 percent of all emissions from production in the Dutch economy (production approach (SEEA type) are emitted by foreign controlled companies active in the Netherlands. As a consequence, 62 percent of emissions stemming from Dutch production (SEEA type) are still controlled by Dutch companies in the Netherlands.

5.5.3 'Dutch' CO_2 emissions following different frameworks and concepts, 2008



[1] Private households: A private household is a collection of one or more people sharing the same living space, who provide their own everyday needs in a private, non-commercial way. Here only stationary emissions are presented separately, as emissions from transport are excluded because they are not separately distinguished.

[2] Figure based upon actual figure for emissions by residents in 2008 and the surplus of the 'Emission balance of trade' in 2009.

Foreign controlled industries in the Netherlands

For production activities in the Dutch economy, emissions stem from industries that are for a substantial part foreign controlled. More than half of the emissions of some industries stem from foreign controlled activities. Particularly the emissions of air transport, and the manufacturing of basic metals, paper and paper products, basic chemicals and man-made fibres, chemical products, oil products, electrical and optical equipment, other non-metallic mineral products, rubber and of transport equipment. Air transport has the highest share, while other transport means, like land and water transport, show only limited foreign controlled shares.

Dutch controlled industries abroad

Dutch controlled emissions in foreign economies in Europe are concentrated in a few industries, particularly in the manufacture of chemicals and chemical products and in the manufacture of basic metals. Outside Europe, Dutch controlled activities are pretty much dominated by the manufacture of chemicals and chemical products and to a lesser extent by mining and quarrying.

Uncertainty of the results and policy relevance

It is a challenge to find and select proper emission factors for emissions from Dutch controlled activities in foreign economies. Activities in a certain industry may be similar but can also be quite different (is not homogeneous). The selection for the one, Dutch based, or other, foreign based coefficients had large impact on results of Dutch controlled activities abroad. The impact was strongest for Dutch controlled activities outside Europe. The certainty of the results for Dutch controlled emissions in foreign economies lags behind. This is due the fact that the assessment cannot directly be based on observed data (which exists, but is not available at the required firm-level). Data modelling is required that makes use of different and not at all straightforward emission coefficients.

The data presented in this study can be very useful for analysing the carbon leakage phenomenon. To have information on the economic activities as well as the environmental burden can help policy makers in fact based decision-making dealing with environmental issues in a globalising world.

Recommendations and status of the figures

Time series
The study presents a span of control analysis for emissions in a single year. It is very interesting to monitor the dynamics in activities relevant for span of control abroad and domestically over time. Changes over time cannot be analysed appropriately with data for 2008 only. In order to gain insight in the dynamics of span of control (changes in UCI), in quality of the data and the methods applied we recommend repeating the analysis for another year. To enhance relevance for policy we recommend compiling time series data for emissions based on the criterion span of control. Such time series data can eventually help answer questions regarding carbon leakage.

Globalisation and development in privatisation can presumably be monitored over time with time series data. This may well be an interesting application for industries operating globally and for policy makers.

Emission coefficients
In the study we used WIOD data to calculate emissions abroad of Dutch controlled companies. We recommend exploring more alternative data sources for emission coefficients. Such emission coefficients can be more detailed and/or accurate for certain activities in certain regions/countries.

Link UCI and income transfers
Emission intensity of an economy is nowadays quite regularly monitored over time in many countries. For example the Green Growth framework of the OECD recommends monitoring this ratio indicator over time. As an extension to emission intensities calculated from production type emissions and GDP, we recommend monitoring emission-intensity based on a quite different concept for both the physical and the economy part.

In this study we made an attempt to calculate emissions related to span of control. These span of control emissions will be the new numerator. These foreign controlled emissions can best be confronted from a conceptual point of view, with national income of a country. National income will in this case be the new denominator. So from an analytical point of view it would be very useful to have information on income transfers with destination the Netherlands by Dutch controlled industries in foreign economies (inflow of income). Vice versa, we also need information on income transfers from foreign controlled companies in the Netherlands having destination abroad (outflow of income).

Status of the figures
The figures presented in this study have the status of additional experimental analytical information which can potentially be used as a basis for further in-depth research in the field of globalisation and air emissions. The figures may complement existing information

on emissions to air like aggregates as the Kyoto figures and SEEA type of emissions. The figures may be used as supplementary analytical background information that can be input for economic-environmental decision making and policy.

5.6 Air pollution

Production and consumption activities cause the emission of a variety of substances to the air. Due to their physical and chemical characteristics some substances, such as greenhouse gases, have effects on a global scale. The air emissions discussed in this section, such as particulate matter or nitrogen oxides, have a more local or regional impact. Their impact may be on human health or on the quality of the environment. Air emissions of several substances can be aggregated by weighting them by their respective impacts to form indicators to measure their contribution to a variety of key environmental themes. The themes discussed here are acidification, smog formation, particulate matter emissions, and ozone layer depletion.[6)] Some polluting substances contribute to several themes, like NO_x for example to both acidification and smog formation (TOFP), while CH_4 contributes to both the greenhouse effect and smog.[7)]

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

Emissions of acidifying pollutants continue their downtrend

Acidification is caused by the emissions and resulting deposition of nitrogen oxides (NO_x), sulphur dioxide (SO_2) and ammonia (NH_3), effecting the living environment. The combined emissions of these acidifying substances, expressed as acid equivalents decreased again in 2012, now by 1 percent. Since 2000 acidifying emissions have been cut by 35 percent. Acidifying soils and ground and surface water has a negative impact on the biodiversity of natural areas such as forests and heaths, but also in agricultural areas. Because acidification also affects ground and surface water, it forms a threat to drinking water. Agriculture and transport in particular are responsible for the acidifying emissions. This is mainly due to the ammonia emissions from livestock farming, and to the emissions of nitrogen oxides and sulphur dioxide by transport over water, but also from air travel and transportation by households. The quantities of emissions from these sectors and activities are much higher than those from refineries and the chemical industry.

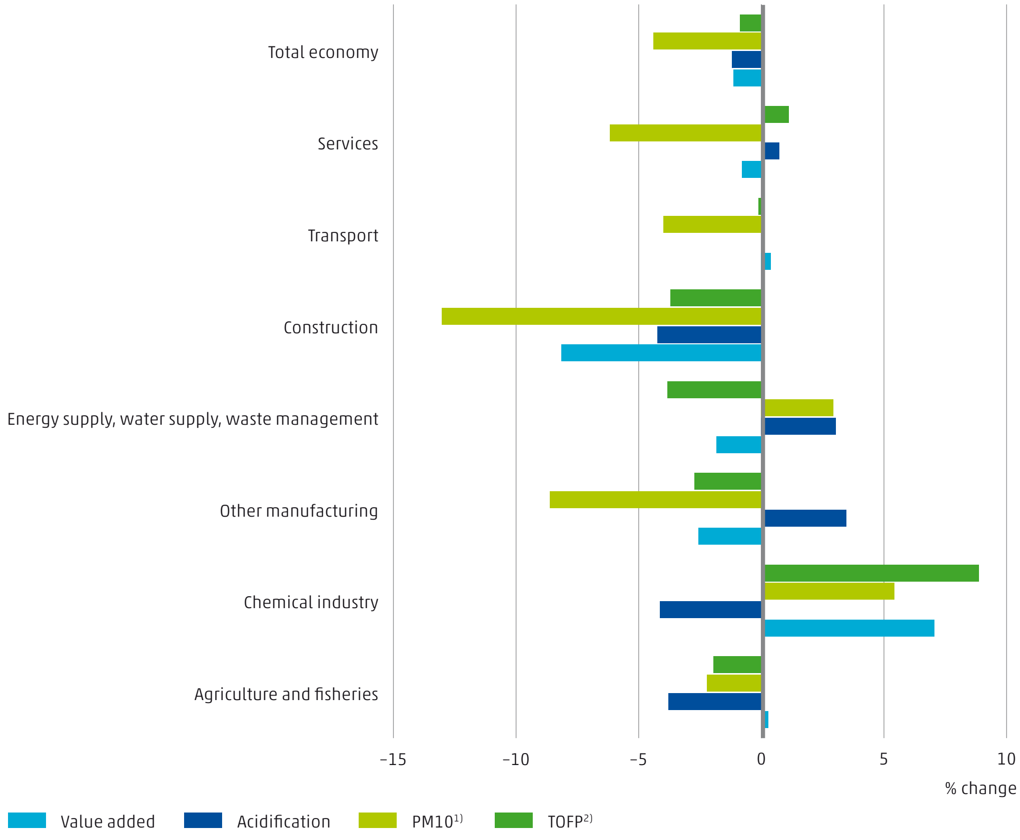
6) Smog formation and emission of particulate matter are not officially 'environmental themes' under the Dutch National Environmental Policy plan number II, but belong to the theme 'transboundary air pollution'. Emissions of substances that contribute to ozone layer depletion, form the sole exception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

7) TOFP, Tropospheric Ozone Formation Potential is an indicator for the formation of tropospheric ozone.

The emissions of nitrogen oxides (NO_x) fell by 1 percent in 2012. Road transport contributed particularly to this decrease (minus 5 percent) while production was down 1.5 percent. In road transport the growing number of vehicles with cleaner engines help to cut emissions. This is a direct effect of robust European legislation with gradually tightened emission standards for all kinds of road vehicles in particular those with diesel engines. The emissions resulting from water transport remained stable, while air transport extended its emissions by 4 percent. Electricity companies reduced their NO_x emissions by 5 percent, mainly as a direct effect of the strongly reduced domestic electricity production for the second year in a row. Strict environmental measures taken at power plants have resulted in a structural reduction of over 60 percent of NO_x emission of in the last decade.

Households too have steadily decreased their NO_x emissions to less than half of their 2000 emission level. This is predominantly the result of the continuously improved performance of car engines, due to tightening exhaust gas standards being set by the European Union. Other contributing factors are improved energy efficiency in space heating, more better insulated houses, better performance of homes in energy terms and related emissions, and the application of improved boilers.

5.6.1 Change in value added, emissions of acidifying substances, particulate matter (PM10) and smog, 2011-2012



1) PM10, Particulate matter (with aerodynamic diameter less than or equal to a nominal 10 microns).
2) TOFP, Tropospheric Ozone Formation Potential, is an indicator for the formation of troposheric ozone.

Sulphur dioxide emissions (SO_2) rose by 5 percent in 2012. Sulphur dioxide emissions are mainly caused by water transport (44 percent), the oil industry (19 percent), electricity production (10 percent), and the basic metal industry (9 percent). Advancing technology and the implementation of environmental policies resulted in a reduction of emissions for the different sectors. For example, the MARPOL Convention regulation, issued by the International Maritime Organisation (IMO), places restrictions on the sulphur content of marine fuel oil used by vessels to prevent pollution from vessels. Gradually, the allowable sulphur content in fuel oil is reduced to begin with in defined protected areas called (Sulphur) 'emission control areas'. This also affects air emissions by seagoing vessels that are part of the Dutch economy, accountable for the emissions caused everywhere they go. The oil industry and the electricity plants have, notwithstanding strong growth, been able to structurally reduce SO_2 emissions since 1990. The annual reductions are mainly achieved through technical measures, such as the application of desulphurisation of flue gases, and in certain cases also by using more natural gas and changing to a different fuel mix at the expense of fuels with higher sulphur content. For both industries this downtrend has stopped in 2012.

Ammonia emissions NH_3, primarily stemming from livestock and from the application of manure on arable land, were cut by 4 percent in 2012. In animal husbandry, by far the main contributor to the national NH_3 emissions, cattle breeding and pig farming reduced their emissions. The (NO_x) emissions are responsible for 55 percent of the emissions of acidifying pollutants, ammonia for one third and sulphur dioxide emissions only for 12 percent in 2012. The share of SO_2 has decreased since 2000.

5.6.2 Contributions to value added and environmental themes in 2012

PM10 and emissions of ozone precursors continue to decrease in 2012

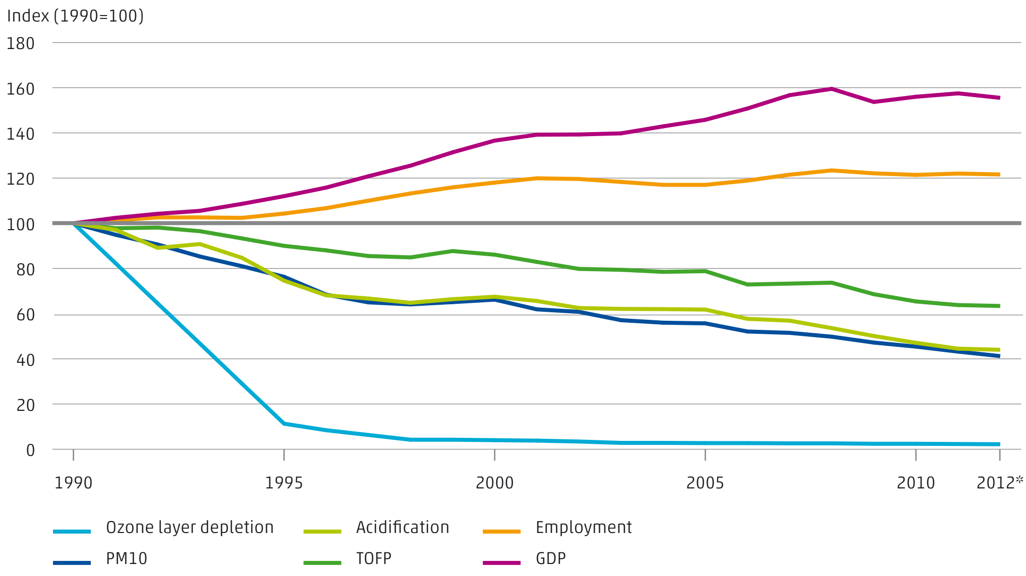
The total emissions of particulate matter in 2012 decreased by 4 percent compared to 2011. Several industries achieved substantial reductions in two decades. Reductions in agriculture and transport appeared to be much harder to achieve, resulting in the highest shares in total emissions for those industries. 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 showed a decline of 1 percent across all activities.

Figure 5.6.2 provides a breakdown of the environmental themes and value added in 2012 by economic sectors and households. It demonstrates that whereas services (excluding transport) are responsible for 70 percent of value added, their contribution to environmental themes is 8 percent at most. Ozone layer depletion is primarily driven by waste management and construction, while acidification is dominated by agriculture and transport, PM10 emissions originate from a mixture of sectors where transport, households, mining and manufacturing and agriculture all contribute substantially. Contribution to smog formation is dominated by transport emissions stemming primarily from the transport sectors, but also from transportation activity across all industries and households.

Non-greenhouse gas emissions to air continue to decouple from economic growth in 2012

Between 1990 and 2012 the Dutch economy grew at a rate varying between 0 to 5 percent annually with the exception of 2009 and 2012. Employment showed a growing trend, although limited and with several interruptions around 2003 and in recent years. At the same time the emission of all substances to air were cut by 35 percent or more, with the sole exception of CO_2 emissions and the F gases (for greenhouse gases see section 5.1, 5.2 and 5.3). The drop in all local air pollutants described in this section implies that absolute decoupling has taken place in the Netherlands since 1990. Gases contributing to ozone layer depletion were no exception. These emissions are still decreasing, although the major reductions were achieved prior to 2000. Emission levels for particulate matter and the substances contributing to acidification and to smog formation to some extent also, generally show the same pattern of decline since the nineties. Net energy use, as one of the main denominators of emissions of several of these substances, has gone up. It shows that, with a variety of explanations, emission factors have structurally improved.

5.6.3 Volume changes in GDP, employment and several environmental themes



6. Policy instruments and economic opportunities

Authors
Cor Graveland
Marianne Schuerhoff
Joram Vuik et. al.

Governments can choose between several policy instruments such as taxes, subsidies and regulations to steer development in a preferred direction. In section 6.1 and section 6.2 environmental taxes and environmental subsidies are discussed. Monitoring the extent and effects of these 'green' instruments is of great interest to policy makers. In section 6.3 environmental protection expenditures of water boards are presented. Environmental measures may also create new opportunities for economic activities that may generate new jobs and stimulate economic growth. In section 6.4 a quantitative overview of the environmental goods and services sector (EGSS) for value added, production and employment in the period 1995–2011 is presented.

6.1 Environmental taxes and fees

Introduction

Production and consumption activities result in pressure on the environment. The pressure can be due to the use of natural resources, the generation of waste, and the emission of pollutants. The government has several options to discourage environmentally damaging consumptive or productive activities. Imposing environmental taxes and fees is one of them.

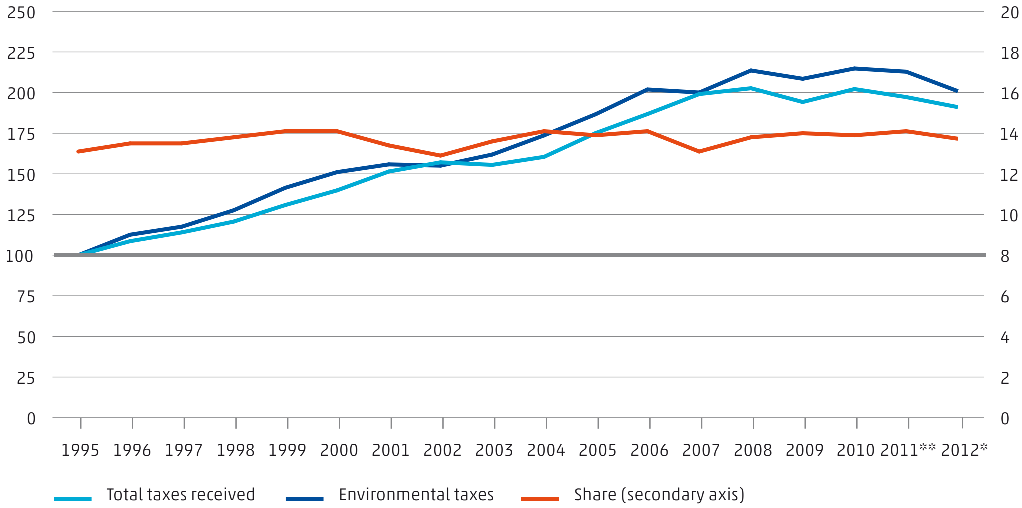
The main difference between a tax and a fee is the use of revenues. Tax revenues flow into the general budget, while the revenues of fees is mostly used to provide environmental services (earmarked). Environmental taxes and fees relate to activities or products that have a negative effect on the environment. According to SEEA (UN et al., 2012) and the Eurostat 2001 and 2013 statistical guidelines, an environmental tax is "A tax of which the tax base is a physical unit (or a proxy of a physical unit) of something that has a proven, specific negative impact on the environment". Examples of environmental taxes are the tax on gas and electricity use, excise duties on petrol and other motor fuels or motor vehicle tax. Examples of environmental fees are sewerage charges and fees on the after-care of refuse dumps.

Environmental tax revenues can increase when new taxes are introduced or a tax is redesigned (tariffs, exemptions, reductions, tax bases etc.). Revenues can also rise when the production or consumption of taxed goods increase. Similarly, a drop in revenues may reflect less production or consumption of taxed goods. This may be beneficial to the environment, but also there may be substitution with similar (un-taxed) products.
This section reports on the revenues from the various environmental taxes and fees and shows who are actually paying them. The first two parts deal with the development of environmental taxes. This is followed by an elaboration of the results for environmental fees. The last two parts concern the implicit tax rate on energy and different tax payers. The data can be found in StatLine, Statistics Netherlands' online database. For a description of the methodology the reader is referred to Statistics Netherlands (2010).

Development of environmental tax revenues and total tax revenues

In 2012 total environmental tax revenues came to 18.6 billion euros, down 5.6 percent on 2011. The share of environmental tax revenues in the total tax revenues received by central government amounted to 13.7 percent[1)] in 2012. The share of environmental taxes has varied over time and peaked in 2004 (Figure 6.1.1).

6.1.1 Environmental taxes and total taxes received



18,6 billion euros

in environmental tax revenues in 2012

The decrease of environmental tax revenues in 2012 has several reasons. One is the abolition of the groundwater and the waste tax. The motivation was that they yielded relatively small revenues, the environmental effects of abolishment were expected to be minor and their collection was labour intensive (Ministry of Finance, 2010). Environmental tax revenues further decreased due to a new regulation introduced for the tax on passenger cars and motorcycles. This is a one-off tax paid upon the registration of a new passenger car or motorcycle. The growing popularity of the tax-exempted cars cut into the revenues of this tax. The decrease in revenues for environmental taxes could not be offset by the registration of a new tax. In 2011 and 2012 CO_2 emission permits, which the national

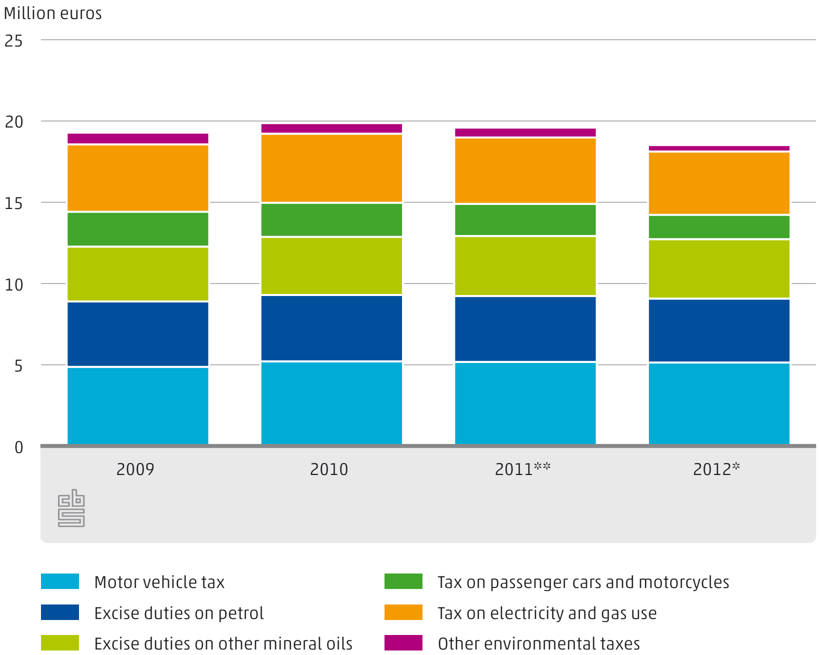
1) This share is calculated as "environmental taxes" divided by "total taxes received by the government". In the Green Growth publication (Statistics Netherlands, 2013) a similar indicator is used where the share is calculated as "environmental taxes and environmental fees" divided by "total taxes and social contributions received by the government". According to this calculation the share of environmental taxes and fees has been about 9–10 percent in recent years.

accounts registers as taxes, were accounted for for the first time. The auctioned emission permits are registered at the moment the permits are returned. They generated revenues of 56 million euros in 2012.

Environmental tax revenues by type of tax

The Netherlands usually breaks down environmental taxes into two types. The first category consists of taxes under the 1995 environmentally based tax act. These include a wide range of taxes such as the tax on electricity and gas use, tap water tax and fuel tax and the now abolished flight tax, groundwater and waste tax. The tax on electricity and gas use provides the largest share of revenues under the environmentally based tax act. Most of the other environmental taxes come under taxes on mobility. These include the excise duties on petrol and other mineral fuels, the tax on passenger cars and motorcycles, and the motor vehicle tax. The revenues of the taxes on mobility account for almost three quarters of the environmental tax revenues (Figure 6.1.2).

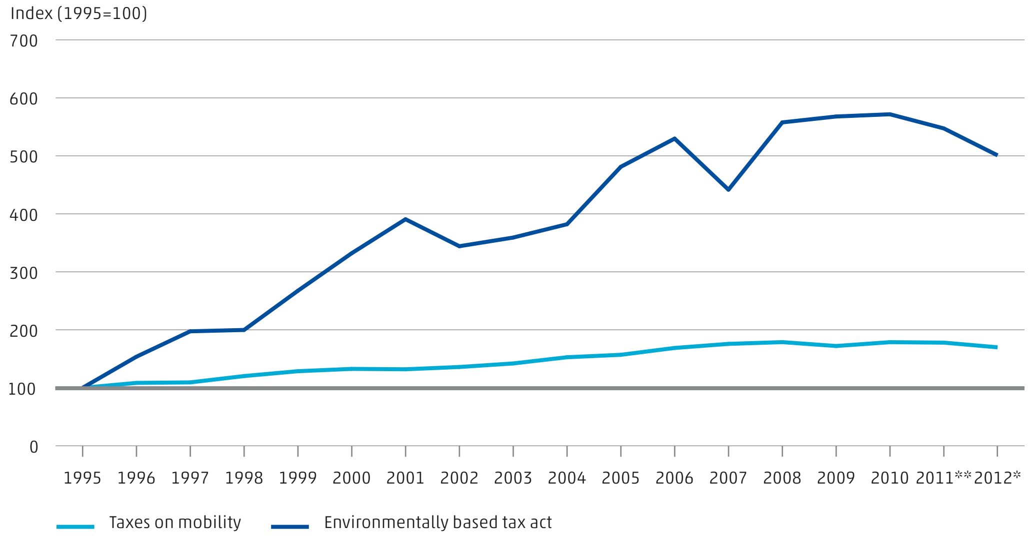
6.1.2 Revenue of environmental taxes



Note: The manure surplus tax and emission permits are excluded from this figure.

Figure 6.1.3 shows how these two tax groups have developed since 1995. Both showed an upward trend. But while the mobility taxes developed relatively smoothly, taxes under the environmentally based tax act behaved more volatile, partly because of the numerous changes in the act. The tax rates and the extent of the tax on electricity and gas use increased in particular over the years. The gradual increase of mobility taxes reflects the gradual increase in the number of vehicles and traffic during this time. In 2011 and 2012 the revenues of both groups declined. It was the first time since 1995 that revenues fell two years in a row.

6.1.3 Two groups of environmental taxes



Note: The manure surplus tax and emission permits are excluded from this figure.

Development environmental fee revenues

Compared to environmental taxes, environmental fees yield much smaller total revenues. In 2012, environmental fees yielded a quarter of the environmental tax revenues. The revenues from environmental fees saw a 6.7 percent increase, to 4.6 billion euros in 2012. Revenues increased for all except three environmental fees: the provincial groundwater fee and the fees on water pollution, and the after-care of refuse dumps. As these taxes together only account for 0.7 percent of all environmental fees, the effect was small.

Tax rate for energy

The implicit tax rate for energy is calculated by dividing the energy taxes (excise duties on petrol and other motor fuels, fuel tax and tax on electricity and gas use) by net domestic energy use. In 2012 the average implicit tax rate for energy per GJ (gigajoule) was 3.2 euros. The amount of tax paid per unit of energy varies per sector and per user category. For example, in 2012 households paid an average of 8.6 euros per GJ energy used, whereas producers only paid 1.7 euros. This is because small users pay a higher tax rate on electricity and gas use than bulk users. In 2012, households paid more than half of the energy taxes.

Tax payments

The revenues of environmental fees and taxes are attributed to three types of tax payers: private households, industries and non-residents. Private households pay most of the revenues of the environmental fees and taxes. While their contribution to the environmental fees has increased since 1995, their share in environmental taxes has remained rather stable. On average households pay 74 percent of the environmental fees and 57 percent of the environmental taxes. Non-residents contribute on average less than 1 percent of the environmental fees and almost 3 percent of the environmental taxes. Industries pay the remainder: on average 25 percent of the environmental fees and 40 percent of the environmental taxes.

6.2 Environmental subsidies and transfers

Environmental subsidies are important economic instruments for achieving national environmental policy objectives and for compliance with international agreements. Subsidies, including tax exemptions, receive a great deal of attention in the political arena. Environmental subsidies are used to promote a wide variety of activities that aim to protect the environment, use resources more efficiently and safeguard natural resources through enhanced management. It is therefore important to gain a better understanding about their size, beneficiaries, distribution and development over time.

The Netherlands has a large variety in subsidy schemes, (see textbox). Some focus on mitigating current expenditures for environmental protection or resource management activities by economic agents, such as the subsidy scheme sustainable energy production (SDE, Stimuleringsregeling duurzame energieproductie), which is a production-based subsidy for producers of renewable energy. There are schemes of a capital nature that focus on reducing the (private) costs resulting from investments in equipment, installations and accessories directly used for environmental protection. Some schemes result in actual payments, while others allow tax exemptions. Moreover, environmental subsidy schemes differ in terms of their origin (central government, municipalities, EU) and the domain to which they apply (air, water, etc.).

In 2010 Statistics Netherlands executed a pilot project for Eurostat testing the statistical framework for environmental subsidies/transfers that is being developed within Eurostat, the UN and the OECD, and contributed to on-going discussions in this field (Graveland, Edens and Tebbens, 2011). The framework with definitions, concepts and classifications and compilation aspects is further developed by the Task Force on environmental transfers under Eurostat's umbrella, in place since 2010. Also involved in the development was the London Group on Environmental Accounting, as part of the SEEA revision that has led to the SEEA2012.

This section presents the results for environmental subsidies and other transfers for the period 2006–2012. The methodology, definitions and scope of the presented figures are discussed in the Environmental Accounts of the Netherlands 2010 (Statistics Netherlands, 2011a).

Environmental protection transfers less than 0.5 percent of total government transfers

Table 6.2.1 provides a general overview of total expenditures and transfers by the Dutch government sector in 2012, according to purpose based upon COFOG (Classification of the Functions of Government, UN). Transfers make up more than half of the total expenditures, with social transfers being the largest category. Subsidies, as defined in the national accounts, constitute a mere 2.6 percent of total government expenditures. Subsidies here include only the so called explicit subsidies on environmental protection, which are direct monetary transfers from the government to the beneficiaries.
The transfers dedicated to environmental protection according to COFOG, amount to 606 million euros in 2012. This is only 0.2 percent of total expenditures by the government sector and about 0.4 percent of total transfers by the government sector.

6.2.1 Total government expenditure and transfers by purpose (COFOG), 2012

COFOG	Total expenses	Total transfers	Social transfers	Subsidies	Income transfers	Capital transfers
	million euros					
General public services	32,594	8,251		178	7,238	835
Defence	7,531	228		58	164	6
Public order and safety	12,337	207		107	95	5
Economic affairs	31,867	6,869		5,427	364	1,078
Environmental protection	10,045	606		53	80	473
Housing and community amenities	3,561	376		31	55	290
Health	53,411	46,798	45,719	1,010	67	2
Recreation, culture and religion	10,372	2,397	-	327	1,690	380
Education	34,841	3,786	1,672	375	70	1,669
Social protection	105,530	93,456	92,597	357	459	43
Total	302,089	162,974	139,988	7,923	10,282	4,781
Of which central government [1]		116	0	47	30	39

[1] For Central government 'D.6 Social contributions and benefits' is allocated to 'Social Transfers' and 'D.7 Other current transfers' to 'income transfers'.

Figure 6.2.2 shows a time series of transfers for environmental protection, broken down by type of transfer, for the central government sector to non-government sectors. So its scope is narrower than Table 6.2.1 as it considers only the central government, while it excludes other government sectors as recipients.
Capital transfers are transactions, either in cash or in kind, in which the ownership of an asset (other than cash and inventories) is transferred from one institutional unit to another, or in which cash is transferred to enable the recipient to acquire another asset, or in which the funds realised by the disposal of another asset are transferred. The capital transfers in 2012 started to recover a bit from their 2011 low. Current transfers consist of all transfers that are not transfer of capital. Current transfers are classified into two main categories: general government and other sectors. (OECD).
Subsidies account for more than 40 percent of environmental transfers in 2012. Other current transfers accounted for about 25 percent, substantially less compared to the 46 percent in 2011. This is followed by capital transfers with a 34 percent share. The amount of transfers expressed in current prices varies between 116 (in 2012) and 266 million euros (in 2010). In 2011 transfers from the central government sector dedicated

to environmental protection faced a severe drop of 37 percent compared to 2010. In 2012 it dropped by another 30 percent. These subsidies halved compared to the 2006–2010 average. The drop since 2010 seems a slightly delayed side-effect of the economic downturn of 2008. The drop in confidence and tax revenues meant that the government bodies at different levels had to reconsider and tried to reduce all expense categories, including the environmental ones. Although investments for environmental protection by industry peaked in 2008, they diminished significantly in 2009, but are showing a slight upward trend recently[2)]. Contrary to diminishing subsidies recently, industry appear to maintain investments or even extend those, showing an upward trend since 2003.

6.2.2 Transfers for environmental protection by central government by type of transfer (current prices)

Textbox Overview of main subsidy / transfer schemes

MEP/SDE: (in Dutch: Milieukwaliteit Elektriciteitsproductie). Scheme for subsidising electricity producers that produce renewable energy (wind, solar, biomass, hydro). The MEP is succeeded by the SDE (in Dutch: Stimulering Duurzame Energieproductie). The SDE is a grant that pays (a part of) projects in the field of renewable gas and renewable electricity that are not yet economically profitable, and is therefore wider than the MEP.

- **MIA (In Dutch: Milieu Investerings Aftrek): MIA is a tax relief scheme for entrepreneurs willing to invest in environmentally-friendly or improved equipment. This environmental investment deduction scheme provides a tax deduction of up to a 40 percent of taxable profit.**
- **VAMIL (In Dutch: Vrije of willekeurige Afschrijving MILieu-investeringen): Scheme which allows freedom of choice for the rate and timing of depreciation of environmental investments. During a period of accelerated depreciation this will result in benefits in the**

2) See: Environmental expenditures by industry ('In Dutch: 'Milieukosten van bedrijven').

form of lower profit tax. The VAMIL is not supposed to provide net tax reduction over the entire life of an investment, as profit tax will be higher in later years when depreciation is lower. VAMIL is just advantageous for entrepreneurs in terms of liquidity gained. As long as environmental investment is increasing, total benefits are likely to be positive. When there is less environmental investment, there are fewer possibilities for accelerated benefits and as a result, benefits in such periods may be lower than higher profit taxes, with a negative total implicit subsidy as a result.

- EIA (In Dutch: Energie Investerings Aftrek): Energy Investment Deduction, with a tax deduction of up to 40 percent of taxable profit. It is a tax relief scheme for entrepreneurs who invest in energy-efficient equipment or renewable energy technology. In contrast to VAMIL, EIA and MIA actually provide net tax reduction over the lifetime of the related investment.
- Green investment (In Dutch: groen beleggen): a tax incentive scheme for investments in green projects that benefit nature and the environment. Investors are exempted from the usual 1.2 percent wealth tax and in addition they obtain a 1.3 percent tax break. So in total they obtain a 2.5 percent reduction. These investments go to green funds, with which environmental projects such as wind turbines and organic farms are funded. That can be done at below market rates, benefiting investors in green projects.
- WBSO (In Dutch: Wet Bevordering Speur- en Ontwikkelingswerk): Dutch tax incentive scheme for innovation and the promotion of research and development (R&D). Resident companies investing in R&D can receive a grant that partly compensates the labour costs for R&D. Part of these grants can be assigned to environmental R&D.
- BPM (In Dutch: Belasting op Personenauto's en Motorrijwielen) is a tax paid when purchasing a car or motorcycle. This tax is levied in addition to VAT (percentage over current value), and duty (cars / motorcycle from outside EU-territory). As of 2010, a new environmentally motivated adjustment of the tax measure meant that the amount of BPM for cars is partly determined by its CO_2 emissions (gram per kilometre according to test data of the type of car). The implicit subsidy is a (partial) relief of the BPM dependent on environmental performance. Exempted from BPM are cars with emissions below the limit set by the responsible authority. However, this measure has to meet the principle of budget neutrality so one could question whether this in fact constitutes an off budget subsidy. For now, the lost tax revenues by government from the exempted cars are included as an implicit subsidy.

Lower implicit environmental subsidies in 2012

Implicit subsidies consist of foregone tax revenues due to various fiscal measures, such as tax exemptions or reductions in tariffs. The various measures have subsequently been classified as environmentally motivated, based on a review of their objectives. Like the environmentally motivated explicit subsidies, the implicit subsidies at average have decreased after 2010, although limited to 3 percent less in 2011 and in 2012. The EIA tax exemptions grew in 2011 and fell again in 2012. For one part this can be attributed to the changes in investment in renewable energy technologies and for another part to the changes in requirements for investment to be eligible for the EIA scheme. Also the implicit subsidies of the MIA scheme, returned more or less to their pre-2010 levels. This also may partially be due to variation among the investment types eligible for this scheme. Compensation for green investments showed a drop of 18 percent in 2011 and lost another 30 percent in 2012 which reflects both lost confidence, and changed eligibility of the scheme.

The drop of environmentally motivated implicit subsidies (excl. fiscal measures) of 12 percent in 2011 and 21 percent in 2012 was largely compensated by the increased use of fiscal measures to stimulate the purchase of more efficient cars. This resulted in 3 percent decrease of environmentally motivated implicit subsidies overall for both years.

6.2.3 Environmentally motivated implicit subsidies

	2005	2006	2007	2008	2009	2010	2011	2012
	million euros							
Wage taxes (reductions in)								
WBSO	36	38	38	43	66	65	69	55
Environmental investments (exemptions)								
VAMIL	–130	34	50	23	35	52	36	33
EIA	117	286	160	116	88	115	144	96
MIA	60	94	94	50	65	123	71	76
Forestry related	6	6	11	9	9	9	9	9
Wealth taxes (reductions in)								
Forest and nature landscapes	4	4	4	5	5	6	6	6
Green investments	91	115	131	157	150	162	133	95
BPM/MRB (reductions in)[1]								
Energy efficient vehicles (e.g. electric / hybrid)	25	14	14	5	16	65	108	190
Diesel cars with PM filter	15	29	39	0	0	0	0	0
Excise duties (reductions in)								
Biofuels	0	50	0	0	0	0	0	0
Inheritance tax (exemption)								
Nature landscapes	0	0	0	3	4	3	4	3
Total	224	670	541	411	438	600	580	563

Source: Ministry of Finance (2005-2012); Ministry of Finance (2013).
[1] Reduction of income tax liability of (very) efficient company cars (leased), is excluded in this overview. Exclusion has to deal with its feature of (at least partly) budget neutrality. While for 2011 the implicit subsidy provided is supposed to be 196 million euros (estimate Ministry of Finance).

Both the explicit and implicit subsidies declined although at different rates and with some clear exemptions, for example the strong growth of support for more efficient vehicles between 2010 and 2012. Compared to total expenditures by the central government the environmentally motivated subsidies, explicit and implicit together, remains small with a 0.4 percent share in 2012. This is dominated by the implicit subsidies.

6.3 Environmental protection expenditures of water boards

The Dutch government, in cooperation with private enterprise, takes all kinds of measures to protect the environment. Such measures result in costs for industries, households and for the government itself. Environmental protection includes all measures aimed to prevent the damaging consequences of human acts or activities on the environment. It includes expenditures for measures to improve the environmental quality of air, water (including waste water), soil and groundwater, waste and noise. Data on environmental protection expenditures and its financing are available for the economic sectors government, enterprises and households.

In the Netherlands the responsibility for water management is shared amongst 24 water boards, belonging to the government sector. Water management has traditionally been important in the Netherlands in order to prevent the country from flooding. However, water quantity management is not included in the environmental protection expenditure. The expenditures reported here pertain to protecting water systems from pollution by purifying industrial and household waste water before discharge into rivers and lakes. This section reports on the environmental protection expenditures and investments by water boards.

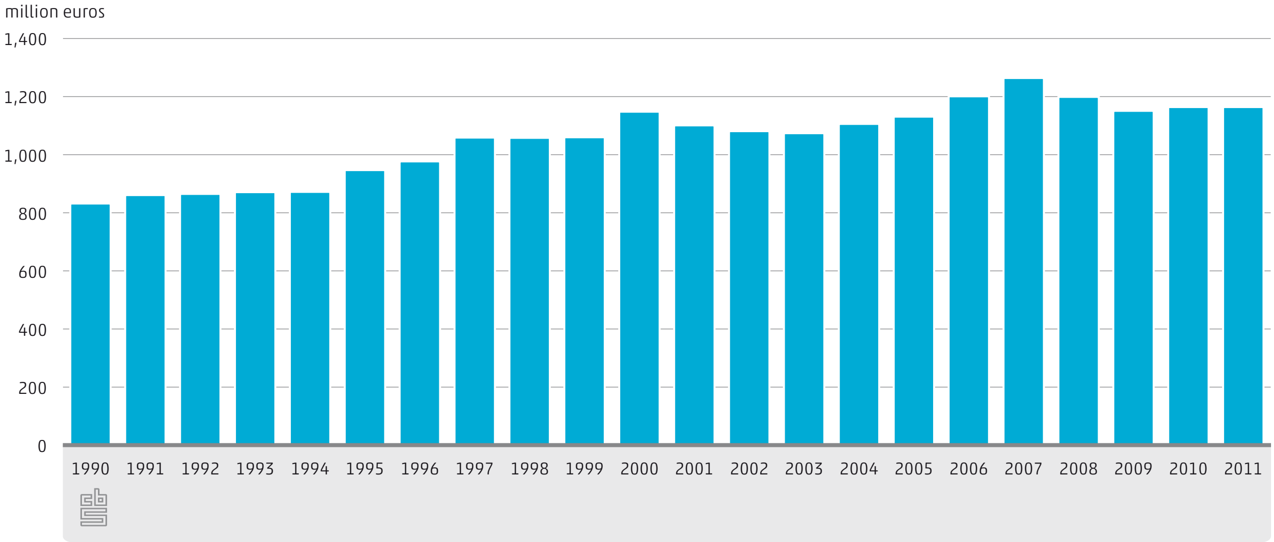
The methodology for the compilation of environmental protection expenditure statistics can be found on the website of Statistics Netherlands. The data on environmental protection expenditure can be found on StatLine, the electronic database of Statistics Netherlands.

Environmental protection expenditures of water boards in 2011 at 2009 level

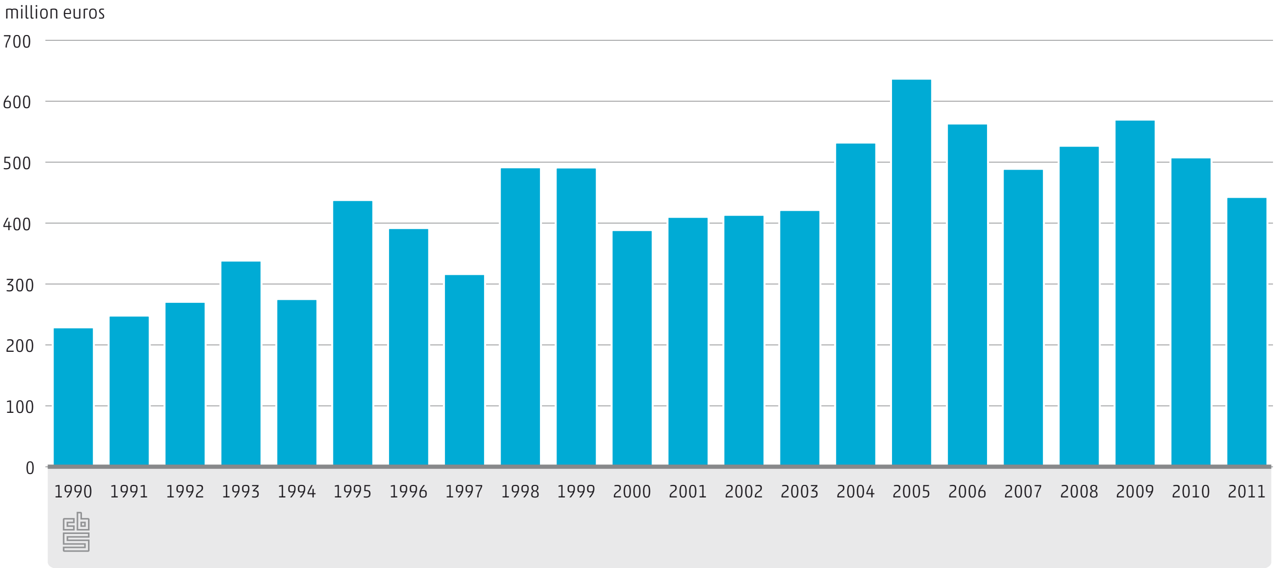
The environmental protection expenditures are equal to the annual costs of environment-related activities and include capital costs, current operation costs, personnel costs etc. From 1990 to 2000 environmental costs of water boards (in constant prices of 2011) have increased from about 800 million in 1990 to about 1.1 billion in the year 2000. This is mainly due to more stringent legislation, in particular for industries. Part of the purification of industrial waste water, required by the more stringent legislation, is implemented by water boards resulting in increased environmental protection expenditures assigned to water boards. All environmental protection expenditures are either paid through household levies (fees on water pollution) or through transfers of payments from industries to water boards.

Most legislation has been in place since 2000, resulting in an almost constant environmental protection expenditure of about 1.1 billion euros annually in the Netherlands for water boards. The peak level in 2007 of more than 1.2 billion followed after substantial investments in 2005, which increased the capital costs. After 2007 the expenditures levelled off to about 1.1 billion euros. In general, the environmental protection expenditures of water boards are around 50 to 60 percent of the total expenditures by water boards.

6.3.1 Environmental expenditures of water boards in million euros in prices of 2011



6.3.2 Environmental investments of water boards in million euros in prices of 2011



Less environmental investments by water boards after 2005

Environmental investments by water boards are mainly aimed at improving, renovating or maintaining water purification and sludge processing facilities. In general, time series of investments are more volatile than time series of expenditures. The same pattern is observed for investments in environmental protection systems compared to expenditures on environmental protection by water boards. At its peak in 2005, the environmental investments by water boards were three times as high as in 1990. Generally the environmental investments of water boards are around 60 percent of the total investments made by water boards.

After the investment peak in 2005, followed by the expenditure peak in 2007, investments have decreased to about twice the investment level of 1990, returning to an average level of around 450 million euros. As a general rule of thumb, investments levels of water boards are slightly less than half the expenditure levels.
Due to the increasing scarcity of raw earth materials, water boards are encouraged to invest in systems that can extract these materials from waste water and use the remaining sludge deposit to generate energy. These modern developments of investments by water boards in sustainable purification and processing systems (recycling) are expected to increase in the coming years and are encouraged by the Dutch government.

6.4 Economic developments in the environmental goods and services sector

In order to reduce the pressures on the environment that lead to resource depletion and deterioration, environmental measures are becoming more and more stringent. Dutch policymakers are interested in economic impact of these measures. In general, environmental policy has (economic) pros and cons. First, there is the impact of the additional financial burden for companies, because they may have to invest extra to comply with environmental regulations. Second, there are the new (job) opportunities that result from these regulations. A good starting point in evaluating the opportunities is by monitoring the companies and institutions that "produce goods and services that measure, prevent, limit, minimise or correct environmental damage, resource depletion and resource deterioration" (Eurostat, 2009). All these companies and institutions belong to the environmental goods and services sector (EGSS). EGSS statistics measure the size of the 'green economy' in the Netherlands. The green economy contributes to total employment, total production, exports and to the Dutch gross domestic product. According to the definition used in the Eurostat handbook on the EGSS (Eurostat, 2009) the sector consists of a heterogeneous set of producers of environmental goods and services. definition was also adopted by SEEA (UN et al., 2012). Various activities come under the definition of the EGSS.

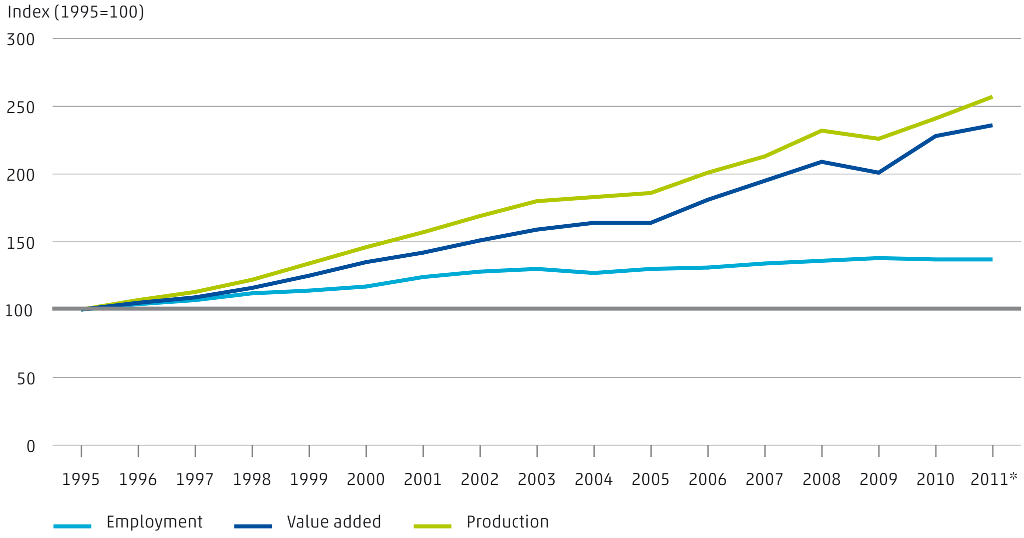
This section presents a quantitative overview of the EGSS for value added, production and employment in the period 1995–2011. Figures for the time series (1995–2011) have been revised for various reasons. Activities, such as water and waste management, wholesale of waste and scrap, and recycling are updated for 2010 and based on the national accounts. The 2010 figures published in 2012 were based on preliminary national accounts figures; these have been updated in 2013. Figures for 'Environmental advice, engineering and other services' or 'Energy saving and sustainable energy systems' are revised for the complete time series 1995–2011, because the set of businesses that are included has been updated.

The data are compiled according to the guidelines of the handbook on the EGSS (Eurostat, 2009). Data collection is based on three methodological studies carried out at Statistics Netherlands (commissioned by Eurostat). An overview of these studies is presented in a methodological paper on the EGSS available at the website of Statistics Netherlands.

(Statistics Netherlands, 2012a). The next section presents some time-series of three economic indicators of the EGSS, i.e. employment (in FTE), production and value added (both in million euros).

Stable employment, growth in production and value added in 2011

6.4.1 Employment, production and value added in the EGSS



Production and value added, both measured in current prices, show continuous growth from 2005 onwards, except for 2009. Value added of the EGSS has increased by 136 percent between 1995 and 2011 while employment in the EGSS has increased by 37.4 percent. Figure 6.4.1 shows that this variable has been more or less stable since 2009.

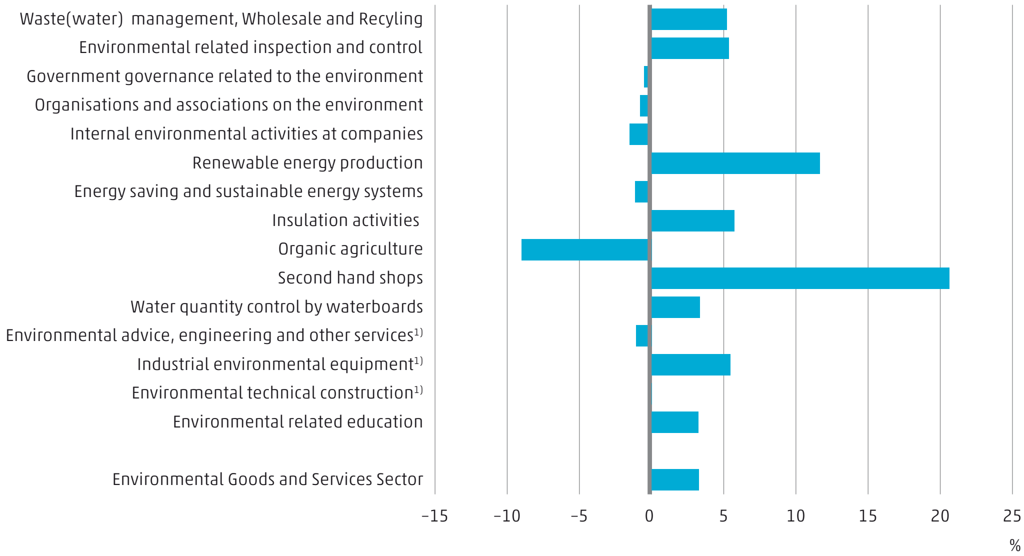
Many activities contribute to value added and employment in the EGSS

In order to analyse the current status of the EGSS, it is interesting to decompose the sector's growth into the different activities that take place in it. The next two figures show the growth in value added and employment per activity over 2010–2011.

Figure 6.4.2 shows that the value added of second hand shops grew strongly in 2011, but this activity still has a small share in the EGSS (0.6 percent of value added). Value added also increased in renewable energy production[3]. This increase can be explained by more production of solar and wind energy. The first because of an increase in the installed capacity, the latter because of an increase in wind supply. In 2010 the Windex[4] (a measure

3) This activity also includes solar energy produced by households.
4) A windex of 100 means that wind supply was equal to the mean supply of all months in the 1996–2005 period.

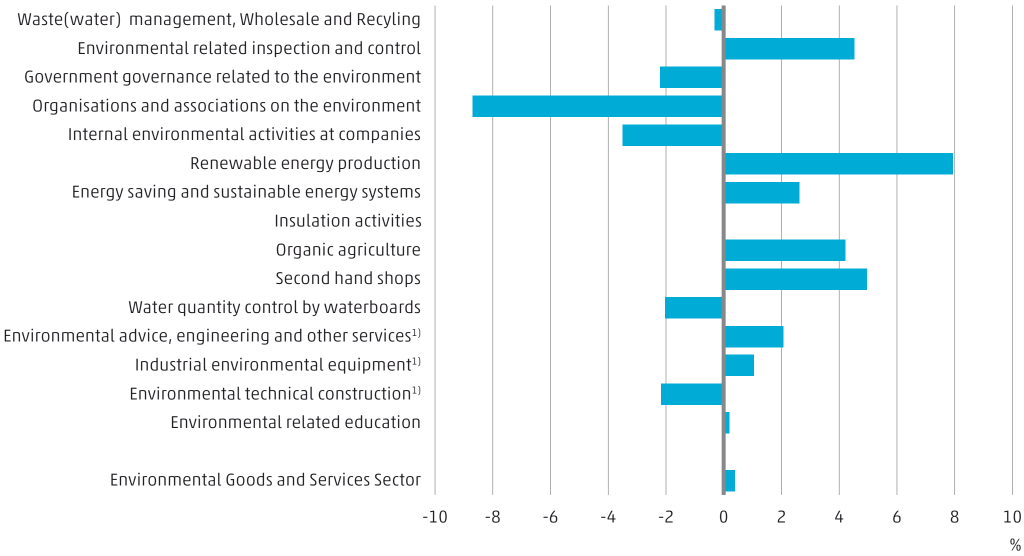
6.4.2 Change in value added for different activities in EGSS, 2010-2011* (current prices)



1) Not related to energy saving and sustainable energy systems.

of wind supply, Statline CBS) had an index of 77 and was at its lowest point ever estimated. The year 2011 was a more average year in terms of wind supply (Windex: 96). Value added decreased for organic agriculture. This is partly explained by less favourable price developments for agricultural products in 2011.

6.4.3 Change in employment (FTE) for different activities in EGSS, 2010-2011*



1) Not related to energy savings and sustainable energy systems.

Employment related to sustainable energy systems and energy saving also grew in 2011. The value chains of both solar and offshore wind related products contributed most to this growth. Wholesale in waste and scrap showed an increase both in value added and in employment in 2011. Great international demand for used metals led high metal prices and trade volumes. This also reflects in the fact that both imports and exports of waste and scrap materials increased due to re-exports. After 2009, employment in organisations and associations related to the environment started to decrease. Many of these organisations work with large numbers of volunteers, who are not part of the employment figures.

The Dutch EGSS consists of companies and institutions that participate in various activities. Despite the overall growth of employment in the EGSS between 1995 and 2011, employment in some activities (e.g. Internal environmental activities at companies and Government governance related to the environment) actually declined in this period (Figure 6.4.4).

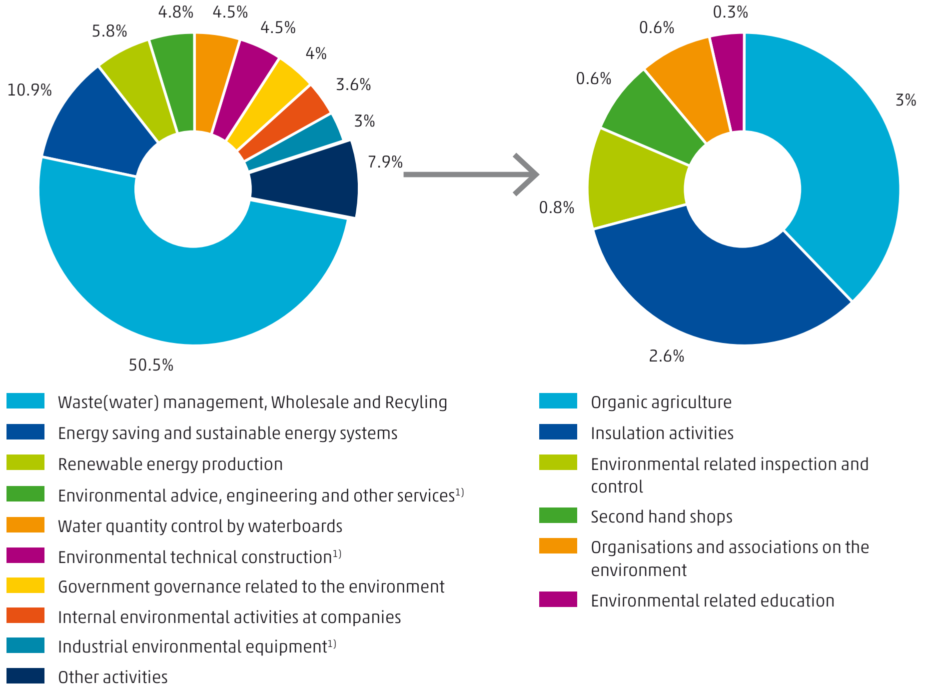
Traditional environmental activities like sewage and refuse disposal services, wholesale in waste/scrap and recycling play a significant role. About 51 percent of all value added in the EGSS is generated by these activities (Figure 6.4.5). The remainder of total value added is generated by a variety of different activities, such as environmental activities carried out by government bodies, activities related to water quantity management and other management tasks of the government account for approximately 9 percent of total value added.

6.4.4 Production, value added and employment in the Environmental Goods and Services Sector in the Netherlands

	Production		Value added		Employment	
	1995	2011*	1995	2011*	1995	2011*
Group/Activities	**billion euros**				**FTE (x1,000)**	
Waste(water) management, Wholesale and Recyling	5.8	15.2	3.0	7.2	27.4	36.4
Environmental related inspection and control	0.0	0.2	0.0	0.1	0.1	2.5
Government governance related to the environment	0.7	1.4	0.4	0.6	6.9	6.2
Organisations and associations on the environment	0.0	0.1	0.0	0.1	0.9	1.6
Internal environmental activities at companies	1.3	1.4	0.6	0.5	10.5	4.9
Renewable energy production	0.1	1.8	0.1	0.8	0.4	2.8
Insulation activities	0.3	0.8	0.1	0.4	4.1	6.2
Organic agriculture	0.1	1.3	0.1	0.4	1.0	3.2
Second hand shops	0.1	0.3	0.0	0.1	2.1	5.2
Water quantity control by waterboards	0.5	1.3	0.3	0.7	3.6	3.9
Energy saving and sustainable energy systems	1.9	5.0	0.6	1.6	8.7	16.3
Environmental advice, engineering and other services[1)]	0.5	1.3	0.3	0.7	4.7	8.2
Industrial environmental equipment[1)]	0.8	1.5	0.2	0.4	3.7	5.4
Environmental technical construction[1)]	1.1	2.3	0.3	0.6	7.3	9.3
Environmental related education	0.0	0.1	0.0	0.0	0.6	0.5
Total Environmental Goods and Services Sector	13.2	34.0	6.1	14.3	82.0	112.7

[1)] Not related to energy saving and sustainable energy systems.

6.4.5 Distribution of value added EGSS over different activities, 2011*



1) Not related to energy saving and sustainable energy systems.

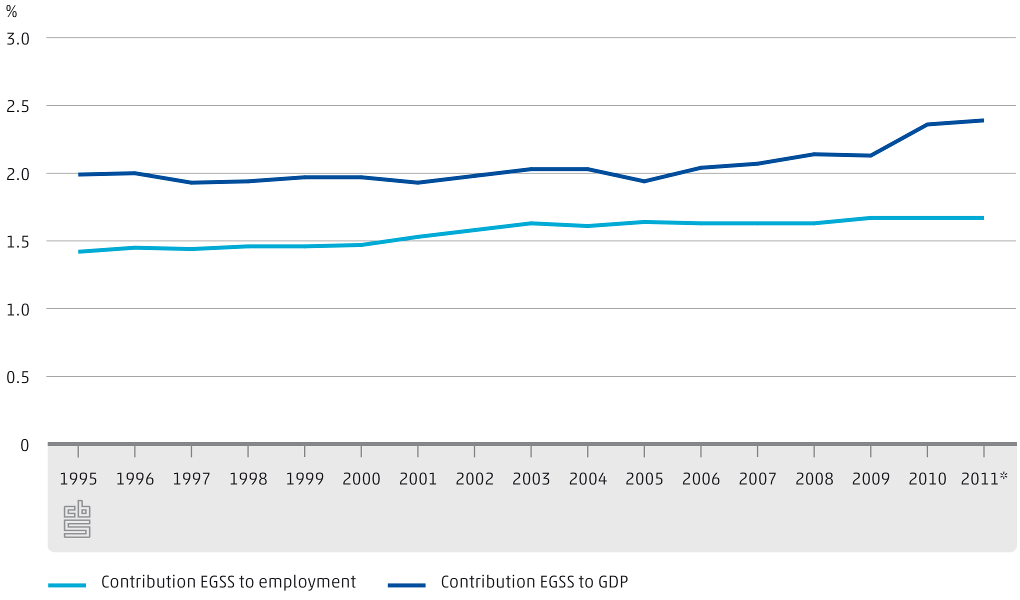
A component of the EGSS is the sustainable energy sector. The sustainable energy sector – which cuts across all industries of the Standard Industrial Classification (NACE) – consists of companies and institutions that physically produce renewable energy, as well as companies earlier in the value chain[5)]. Apart from renewable energy, the sustainable energy sector also includes companies and institutions that focus on energy saving activities.
The sustainable energy sector in 2011 was responsible for 17 percent of the total value added in the EGSS. Producers active in energy saving and sustainable energy systems (pre-exploitation phase) were responsible for 11 percent of total value added and producers of renewable energy (exploitation phase) for 6 percent.

The share of the EGSS in the Dutch economy stable in 2011

In 2011 the EGSS, as share of the economy in terms of value added, constituted 2.4 percent of the Dutch gross domestic product (GDP). This share hardly changed over 2010–2011. The contribution to employment was 1.7 percent in 2010 and 2011. However, as Figure 6.4.6 shows, over the period 1995–2011 the employment share shows a pattern of sustained growth, from 1.4 percent in 1995 to 1.7 percent in 2011. A similar increase holds for the share of the EGSS in GDP, which has shown an upward trend from 2005 onwards. This comes down to a contribution of 6 billion euros to Dutch GDP in 1995 and 82,000 full-time equivalents to total employment. In sixteen years this has risen to a contribution of 14.3 billion euros to GDP and 113,000 FTE to total employment in 2011.

5) For more detail see Economic Radar of the Sustainable Energy Sector in the Netherlands, 2008–2011 (CBS, 2013).

6.4.6 Contribution of EGSS to GDP and employment



7. Monitoring material flows

Authors
Roel Delahaye
Daan Zult

To support Dutch resource policy, a statistical system to monitor physical material flows (in kilos) is set up on the basis of macro-economic data for the year 2008. From this system, a whole set of indicators can be derived. This chapter presents the first results from a feasibility study, commissioned by the Ministry of Economic Affairs, Agriculture and Innovation, to support the Dutch resource policy on the basis of macro-economic data available at Statistics Netherlands.

7.1 Introduction

Worldwide population growth and increasing wealth have led to a growing demand of natural resources. As a result some resources are becoming scarce, leading in turn to higher prices. Scarcity refers to economic scarcity, i.e. a deficit of supply on the world market. More information on this issue can be found in one of the many recent research reports (e.g. Chatham House, 2012; European Commission, 2010; MacKinsey Global Institute, 2011; PBL, 2011).

The Netherlands and other European countries have relatively few natural resources. Therefore, individual countries (e.g. DEFRA, 2012; Federal Ministry of Economics and Technology, 2010) and the European Commission are developing strategies to secure the supply of vital resources in the future. In 2008 the European Commission launched the 'Raw Materials Initiative' which advocates secure, undisturbed access to natural resources on the world market (European Commission, 2008). Raw materials have been high on the European agenda ever since (see European Commission, 2010; 2011b). Issues addressed include: more efficient use of resources, sustainable production of European extracted resources, increasing the recycling rate, and containing resource prices and their fluctuations. A flagship initiative for a resource efficient Europe was launched within the Europe 2020 strategy, as a more efficient use of resources is the key to securing economic growth and employment in Europe (European Commission, 2011a).

In addition to the European initiatives, the Dutch government has drawn up its own resource initiative memorandum in order to stimulate national policymaking (Ministry of Foreign Affairs, 2011). Its primary target is to secure the sustainable supply of biotic and a-biotic natural resources in the future. There are three ways to accomplish this. First, by substituting resources for alternative resources (e.g. fossil fuels for biomass). Second, by increasing the recycling rate. And third, by limiting the demand for resources by increasing resource efficiency. Several studies have been conducted in recent years to support the Dutch resource policy. These were studies on future scarcity and potential policy measures (M2i, 2009; PBL, 2011; HCSS, 2009; HCSS et al., 2011), the impact of material use on the environment (CE, 2010), the impact of critical materials on the economy (Statistics Netherlands and TNO, 2010) and the biobased economy (SER, 2010).

This chapter presents a feasibility study, commissioned by the Ministry of Economic Affairs, Agriculture and Innovation, to support the Dutch resource policy on the basis of macro-economic data available at Statistics Netherlands. The purpose of this study is to gain insight in the physical material flows (in kilos) to, from and within the Dutch economy. A database is set up from which policy relevant indicators are derived, that deal with issues like efficient resource use, economic dependency of resources and the use of secondary resources. The year under consideration is 2008.

This chapter is set up as follows. The introduction is followed by a methodology section explaining the framework for recording data on material flows. Here, the quality and the usability of the data are discussed. The section on results first presents an aggregated picture of material flows for the Netherlands. Next, indicators are derived and discussed with three themes in mind: efficient use of resources, dependency on resources, and recycling of resources. The final section is on conclusions and future work.

7.2 Methodology

Supply and use tables

Material flows are recorded in the framework of supply and use tables. Supply and use tables are set up according to internationally agreed principles and definitions that are consistent with a framework also used to set up the system of national accounts. (UN et al., 2009, 2012). Table 7.2.1 is a schematic representation of physical supply and use tables. These tables show e.g. flows of products, residuals and natural resources to and from industrial branches within the economy, households (consumption), the environment and other economies (imports and exports). The physical use and supply tables are mainly derived from the monetary use and supply tables.

However, in the national accounts, products are expressed in terms of their monetary value and therefore residuals (e.g. solid waste or CO_2 emissions) and natural resources (at the time of extraction) are not part of them. Of course, although residuals and resources have no monetary value, they do have mass, and therefore they are part of a physical system of use and supply tables. Therefore the use and supply tables from the national accounts are complemented with additional data sources on residuals and natural resources. However, there are also material flows for which no data source is available (like the water loss during the production process).

Fortunately, an important property of supply and use tables is that supply and use for each good and each industry are balanced (i.e. what goes in also comes out). To get a mass balance for each industry a balancing item is added. The balancing item represents the sum of different items such as the exchange of gases (besides CO_2) between the environment and the economy during the combustion of fossil fuels (like the O_2 uptake), the addition or removal of water during the production process (for example in the production of beverages) and commodity flows that cannot be derived from monetary data (for example, a restaurant has a physical input of products but produces only (non-physical) services. The balancing item also represents all mass accumulated or extracted in the economy, like for example the construction industry that produces buildings and infrastructure.

7.2.1 Schematic representation with exemplary data of physical supply and use tables

Supply table	Industrial branches Agric.	Mining	Indus.	Serv.	Import	Cons.	Accum.	Envir.	Total
Products									
Agricultural pr.	39	0	0	0	24				63
Mining pr.	0	113	4	4	156				277
Industry pr.	0	0	218	6	144				368
Services	0	0	0	0	0				0
Residuals									
Solid waste	4	0	48	7	1	8	1		69
Air emissions	10	3	141	57	0	37			248
Resources								148	148
Balance item	14		6			9			29
Total	67	116	417	74	325	54	1	148	

Use table	Industrial branches Agric.	Mining	Indus.	Serv.	Final demand Cons.	Export	Inves.	Accum.	Total
Products									
Agricultural pr.	2	0	35	1	6	19	0		63
Mining pr.	2	8	185	11	1	70	0		277
Industry pr.	12	0	117	28	47	160	4		368
Services	0	0	0	0	0	0	0		0
Residuals									
Solid waste	1	0	43	12	0	13	0		69
Resources	40	108	0	0					148
Balance item	10	0	37	22				208	277
Total	67	116	417	74	54	262	4	208	

The physical supply and use tables that are used to derive indicators have a much higher level of detail than Table 7.2.1. About four hundred commodities, 130 industrial branches, sixteen types of solid waste and ten types of natural resources are distinguished at the most detailed level.

Compilation of the tables

First, the monetary supply and use tables of the national accounts are converted into physical tables. This conversion is established by using price information from different sources like the international trade statistics. Price information for a single product group could differ between industrial branches because of the heterogeneity or quality of certain product groups (for example meat from the slaughterhouse is generally cheaper than meat from the meat processing industry). For some commodities, for example energy carriers, physical information was directly available and no conversion of monetary data was required. The procedure provides the physical supply and use of all commodities.
The next step involves the addition of material flows that have no monetary value. These are mainly flows between the environment and the economy (e.g. emission to air and extraction of natural resources) but also flows within the economy like the supply and use of solid waste. Data to estimate these flows are derived from several modules of the environmental accounts.

Finally, balancing items are added that reconcile the supply and use for each industrial branch. Some of the balancing items were derived from other variables, like the O_2 uptake is estimated on the basis of fossil fuels used for combustion. The loss/gain of water during a production process was only roughly estimated on the basis of available data on the water content of products. In some cases the balancing item was a result of the difference between supply and use. This was, for example, the case in the construction industry. Here the balancing item represents the amount (i.e. weight) of buildings and infrastructural works constructed. With all data in place, the supply and use tables were balanced. Large differences between supply and use were removed after a critical investigation of the data. One of the things investigated was the relationship between the inputs and the output for an industrial branch. For example, for a certain amount of meat produced, the input of a certain number of animals is expected. In the end the remaining small differences were automatically removed through computer software.

Extensions of the supply and use tables

The physical supply and use tables can be combined with other data that serve to estimate indicators on resource use. The first data added is on the country of origin and destination of all imported and exported commodities. Second, the traded commodities are allocated to their stage of production. Three levels of production are distinguished: raw materials, semi-finished products and finished products. Third, the imports and exports of commodities can be linked to coefficients of raw material equivalents (RME). The RME of a product indicates the amount of raw materials required during the whole production chain. For example the raw materials needed to produce tomatoes include seeds, energy and fertilizer. The RME coefficients were estimated by a research institute (commissioned by Eurostat). They performed a mixed Leontief-LCA calculation, using hybrid Input-Output Tables (HIOTs), to determine the coefficients (IFEU, 2012).

Data quality

The supply and use tables are compiled in order to derive indicators on the meso and macro level. This level of detail is lower than the level of detail found in the supply and use tables. Indicators cannot be derived at a higher level of detail because the quality of the data in the tables is not always considered sufficient for publication. Unfortunately, it is difficult to estimate error margins because the data are assembled from different sources of unknown quality and often cannot be verified with alternative data sources. Therefore, in order to publish reliable data and avoid any breach of confidentiality, the level of aggregation is higher than might be strictly necessary. In 2014, the compilation of a new set of supply and use tables and the integration of related studies and other potential data sources, will hopefully give more insight into the quality of the data.

7.3 Results

In annex 1a and 1b we present the physical supply and use tables for the Netherlands. In this chapter we discuss a selection of the indicators that can be derived from these tables. These indicators deal with three key themes in the Dutch resource strategy, namely resource efficiency, resource dependency and the recycling of materials.

Resource efficiency

The efficient use of resources is important, because natural resources are limited and the extraction can be harmful to the environment. Companies also benefit from efficient resource use because it reduces costs and dependency on resources. The European Commission proposed resource productivity (GDP/DMC[1)]) as a provisional leading indicator to represent the best available proxy for resource efficiency of a country. However, for the Netherlands this indicator seems to substantially overstate the resource intensity in the production process, because the DMC is highly affected by the large extraction of sand while a large part of economic activity takes place in the services sector which uses only few resources. It is therefore more meaningful to measure resource efficiency per industrial branch. The physical supply and use tables presented here aim to provide such information.

One way to indicate the resource efficiency of a branch of industry is by calculating its material intensity, i.e. divide its materials used in kilos by its value added in euros (see Table 7.3.1). The material used consists of commodities, secondary resources and extraction of resources. Some industrial branches like Other mining and quarrying have a relative high material intensity while others, like the production of equipment, have a relative low material intensity. The higher the material intensity, the more kilos are required to generate one euro of value added. The differences in resource intensity between industrial branches are caused by the different types of materials used in their production processes. For instance, Other mining and quarrying mainly uses abundant resources like sand and gravel while the Electronic equipment industry uses more scarce and semi-finished products.

Another way of indicating resource efficiency is by calculating the material productivity index, which is defined as the amount of goods produced, in kilos, divided by the amount of materials used in kilos (see Table 7.3.1). A material productivity index close to one indicates that only a small share of the materials used is lost during the production process (e.g. as solid waste or emissions to air).

In itself, the value of the two resource efficiency indicators discussed above have little meaning. However, they become more meaningful when time series or cross-country figures are available. Comparisons in time and of similar industrial branches in different countries provide insight in the status and development of resource efficiency of industrial branches. Unfortunately, for the moment Dutch data are only available for 2008.

1) GDP = Gross Domestic Product, DMC = Domestic Material Consumption.

7.3.1 Resource efficiency for a selection of industrial branches: material intensity and productivity

	Material intensity	Material productivity
	kilos used material per euro value added	kilos produced product per kilo used material
Crude petroleum and natural gas production	3.2	0.99
Other mining and quarrying	73.6	1.00
Manufacture of food products, beverages and tobacco	6.2	0.75
Manufacture of textile and leather products	0.6	0.74
Manufacture of wood and wood products	2.1	0.89
Manufacture of paper and paper products	4.0	0.85
Publishing and printing	0.9	0.86
Manufacture of petroleum products	20.9	0.93
Manufacture of chemicals	4.5	0.89
Manufacture of rubber and plastic products	1.6	0.92
Manufacture of other non-metal products	17.0	0.96
Manufacture of basic metals	8.6	0.66
Manufacture of fabricated metal products	0.8	0.88
Manufacture of electronic equipment	0.3	0.86
Manufacture of electrical equipment	0.9	0.90
Manufacture of machinery and equipment n.e.c.	0.3	0.86
Manufacture of transport equipment	0.6	0.88
Other manufacturing	0.2	0.77

Resource dependency

Resource dependency on other countries is a key political issue. Therefore, this section discusses a couple of indicators related to resource dependency. These indicators are: self-sufficiency, production stage of imported goods, imports of raw materials per country and the resource footprint of imported materials.

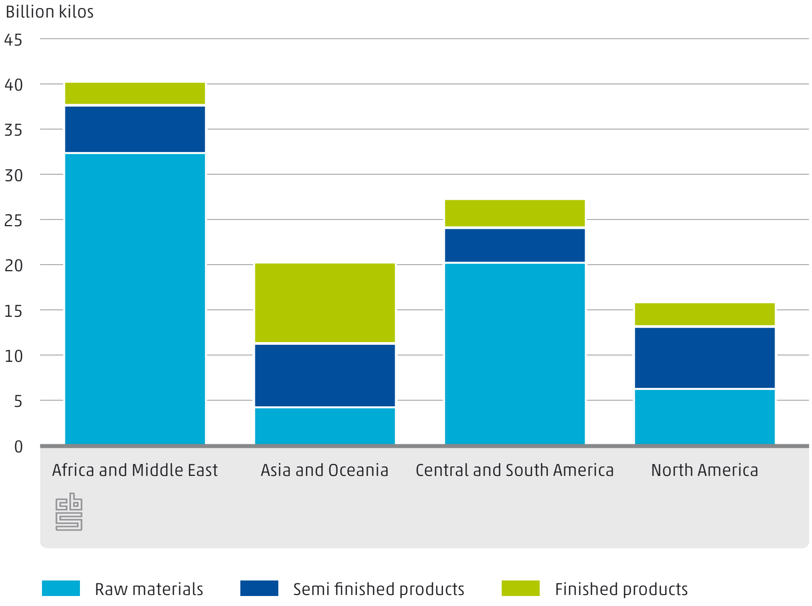
A country is self-sufficient when it is independent from other countries. The dependency on other countries for materials can be indicated by estimating the share of domestic material consumption covered by domestic extraction of natural resources. Independence from other countries implies that the domestic material consumption equals domestic material extraction. The Netherlands is completely dependent on other countries for metal ores as no metal ore is extracted domestically. Dutch dependency for biomass on other countries (24 percent) may seem strange because of the large agricultural sector . However, it imports specific crops like animal feed (e.g. soybeans). Also, within a product classification there can be extraction and consumption of different goods. For example, the Dutch extraction of fossil energy carriers consists mainly of natural gas. However, Dutch consumption of fossil energy carriers consists mainly of crude oil and crude oil products. These different types of fossil energy carriers are no substitutes for each other. The same applies for biomass: the consumption of biomass includes soybeans while a major part of Dutch extraction consists of potatoes (and not soybeans).

7.3.2 Percentage of resource consumption that can be covered by domestic extraction

	Consumption resources (million kilos)	Percentage covered by extraction
Commodity		
Biomass	50,428	76
Fossil energy carriers	111,341	60
Metals	5,402	0
Minerals	70,219	71

Imported products can be allocated to different processing stages such as raw materials, semi-finished products and final products. Final products (like cars) are used for consumption or capital formation while semi-finished and raw materials (respectively metal sheets and iron ore) are used as input in the production processes. Raw materials form half of the total imports (including re-exports). Most raw materials are energy carriers used to produce motor fuels. Most of the raw materials are imported from other European countries[2]. The largest amounts of raw materials from imports outside of Europe come from Africa, the Middle East and Central and South America. Raw materials imported from South and Central America are mainly coal and iron ore. Crude oil is imported from the Middle East and Africa. Disregarding Europe, half of the finished products are imported from Asia. Animal feed and palm oil are imported from Malaysia and Indonesia while electronics are imported from China.

7.3.3 Imports (including re-exports) from outside the EU by level of processing, 2008

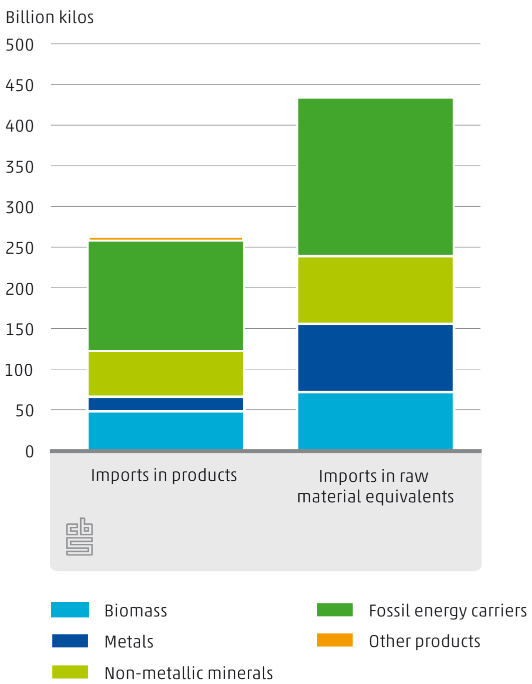


[2] European countries are defined according to the classification used by the United Nations. According to this classification Russia is allocated to Europe.

Instead of assigning imported products to different stages of processing (like raw materials), imported products can be expressed in raw material equivalents (RME). The RME of a product indicates the amount of raw materials required during the whole chain of its production. The imports of products expressed in RME are 1.6 times higher than the actual amount of imports. For metals, the imports in RME are 4.5 times higher, because the production of metal products requires a large amount of metal ores. The RME of imports are a measure of the natural resource footprint of Dutch imports. Unfortunately, the footprint of Dutch material consumption could not be estimated as RME for exports are not yet available.

Amount of imported metal 4.5 times higher when converted to raw material equivalents

7.3.4 Imports (excluding re-exports) in actual products and products converted to RME



Recycling materials

Recycling materials reduces the depletion of natural resource reserves. Recycling also reduces the dependency on countries with natural resource reserves. Figure 7.3.5 shows the use of primary and secondary resources for a few economic sectors. Secondary resources cover solid waste and products from the recycling industry. For each sector, the type of material that is considered an important resource input is taken into account. In agriculture, especially animal husbandry, a lot of animal feed is used. In the Manufacturing of other non-metallic mineral products industry the input in the production process consists mainly of minerals like sand and gravel. The same goes for the construction sector. Metals are used in the Manufacture of basic metal industry. Electricity producers use mostly fossil energy carriers to produce electricity, but their input of secondary resources consists of biomass. As table 7.3.5 shows, for each economic sector the share of secondary resources in the total use is determined. Manufacturing of wood and paper uses relatively much secondary resources while Manufacturing of other non-metallic mineral products industry uses relatively few.

7.3.5 Use of primary and secondary resources

Sector	Commodity	Use primary resource	Use secondary resource	Share secondary in total
		billion kilos	billion kilos	
Agriculture	Biomass	5	5	48
Manufacture of food, beverages and tobacco products	Biomass	31	8	20
Manufacture of wood, paper and of products thereof	Biomass	1	3	79
Manufacture of other non-metallic mineral products	Non-metal minerals	19	1	6
Basic metals industry	Metals	5	1	19
Electricity, gas and steam supply	Fossil/biomass	18	1	6
Construction work	Non-metal minerals	37	29	44

Instead of looking at the use of secondary resources one can look the amount of waste that is produced per kilo produced product. In Manufacturing of other non-metallic mineral products the amount of waste per kilo product is relatively low. This in contrast to the Manufacturing of basic metal industry, where the amount is relatively high. However, this comparison between economic sectors is hardly meaningful, because different kinds of materials and different kinds of processes are involved. A comparison in time or cross-country would give an indication of the performance of an economic sector.

7.3.6 Percentage waste per unit product

Sector	Product supply	Waste supply	Waste per kilo product
	billion kilos	billion kilos	%
Agriculture	41	2.6	6
Manufacture of food products, beverages and tobacco products	60	7.5	11
Manufacture of wood, paper and of products thereof	8	0.8	9
Manufacture of other non-metallic mineral products	41	0.9	2
Basic metals industry	16	3.4	17
Manufacture of chemicals and chemical products	47	1.4	3

In considering consumption instead of production, a similar analysis can be conducted for households. Here it turns out that half a kilo waste is produced for each kilo of consumption. The use of fossil energy carriers is not considered because they are converted into air emission instead of solid waste.

7.3.7 Percentage of waste per kilo household consumption

	Consumption	Waste supply	Waste per kilo consumption
	billion kilos	billion kilos	%
Households	20	10.1	33

7.4 Conclusions and future work

This chapter presents the results of the first attempt to monitor physical material flows for the Netherlands in 2008. Material flows are recorded in physical supply and use tables (in kilos) that are set up according to the national accounts framework. From these tables meso and macro indicators were derived to support resource policy. Indicators at a more detailed level are not derived because the data quality cannot be guaranteed. Indicators concern issues like efficient material use, recycling of materials and dependency on resources.

Efficient resource use can be indicated by calculating material intensity and material productivity. Material intensity is defined as the amount of material required to generate one euro of value added. Material productivity shows the amount of goods that can be produced with one kilo of input. The differences in efficient resource use between industrial branches are due to the different types of materials used in the different kinds of production processes. Material intensity deals with the amount of waste produced per kilo produced product and with the recycling of materials. The ratio between the use of primary and secondary materials can be derived from the supply and use tables. The dependency of the Netherlands on resources is determined by linking imports with information on the country of origin and the raw material equivalents of products. The Netherlands is completely dependent on other countries for metals as no metal ore is extracted domestically. The amount of imported metallic products is 4.5 times lower than the amount of metal ore needed to produce the imported products, because the production of metallic products requires a large amount of metal ores.

For many of the derived indicators it is difficult to draw conclusions on the performance of particular industrial branches, because so far comparisons in time or comparisons with similar industrial branches in other countries cannot be made. In 2014 a dataset for the year 2010 will be compiled making comparisons in time possible.

Annex 1A Supply table in million kilos, 2008

		Agricul-ture, forestry and fishing	Mining and quarying	Manu-facture of food pro-ducts, bevera-ges and tobacco	Manu-facture of textile and leather products	Manu-facture wood, paper and publi-shing	Manu-facture petro-leum products	Manu-facture of chemi-cals	Manu-facture of rubber and plastic products	Manu-facture of other non-metal products	Manu-facture of basic metals
1	Products of arable farming, horticulture, forestry and fishery	25,495	0	0	0	0	0	0	0	0	0
2	Live animals and animal products	15,699	0	0	0	0	0	0	0	0	0
3	Crude petroleum and natural gas	0	67,150	0	0	0	13	0	0	0	991
4	Other mining and quarrying products	0	33,816	604	0	0	155	2,770	19	628	0
5	Meat and fish products	202	0	3,657	1	0	0	0	0	0	0
6	Potato, vegetable and fruit products	0	0	4,358	0	0	0	2	0	0	0
7	Food products n.e.c.	0	0	30,012	0	0	0	59	0	0	0
8	Dairy products	13	0	5,855	0	0	0	3	0	0	0
9	Grain and starch products	0	0	8,511	0	0	0	0	0	0	0
10	Tobacco products	0	0	7,003	0	0	0	0	0	0	0
11	Textiles and leather products	0	0	0	455	6	1	18	0	0	0
12	Wood and wood products (excl. furniture)	0	0	0	0	2,285	0	0	186	0	0
13	Paper products, printed matter and recorded media	0	0	0	7	7,010	0	0	20	0	0
14	Petroleum products	0	0	0	0	0	58,152	2,241	0	0	2,317
15	Chemical products	18	30	253	1	0	1,090	41,964	62	34	7
16	Rubber and plastic products	0	0	5	1	27	0	38	2,569	1	0
17	Glass and construction materials	0	18	0	0	73	0	3	45	40,806	45
18	Basic metals	0	0	0	0	0	0	0	0	0	8,605
19	Metal products	0	0	2	6	22	0	0	4	2	50
20	Machinery and equipment	0	0	0	1	4	0	2	6	0	4
21	Transport equipment	0	0	0	1	0	0	0	5	2	0
22	Furniture and other manufactured goods	0	0	0	1	4	0	2	0	1	1
23	**Total of row 1–22**	**41,427**	**101,014**	**60,260**	**474**	**9,431**	**59,411**	**47,102**	**2,916**	**41,474**	**12,020**
24	Waste and recycled products	73,961	109	7,539	91	975	142	1,408	173	915	2,957
25	Extraction										
26	CO_2 emissions	10,660	2,279	4,094	214	1,438	13,280	16,186	249	2,343	6,031
27	Balancing item	61,763	1,660	14,411	180	1,170	5,658	9,308	202	1,319	2,751
28	Total	187,811	105,062	86,304	959	13,014	78,491	74,004	3,540	46,051	23,759

Manufacture of fabricated metal products	Manufacture of electronic equipment	Manufacture of electrical equipment	Manufacture of machinery and equipment n.e.c.	Manufacture of transport equipment	Other manufacturing	Electricity and gas supply	Water supply and waste treatment	Construction	Services	Total Column 1–20	Households	Accumulation	Import	Flows from the environment	Total
0	0	0	0	0	40	0	0	0	3	25,538			26,991		52,529
0	0	0	0	0	0	0	0	0	0	15,699			731		16,430
0	0	0	0	0	0	113	0	0	127	68,394			100,150		168,544
0	0	0	0	0	10	0	0	286	6,339	44,627			51,877		96,504
0	0	0	0	0	0	0	0	0	2	3,862			2,409		6,271
0	0	0	0	0	0	0	0	0	128	4,488			3,369		7,857
0	0	0	0	0	0	0	0	0	0	30,071			7,515		37,586
0	0	0	0	0	0	0	0	0	0	5,871			2,458		8,329
0	0	0	0	0	0	0	0	0	5	8,516			3,053		11,569
0	0	0	0	0	0	0	0	0	0	7,003			2,971		9,974
2	0	2	1	0	6	0	0	0	50	541			1,400		1,941
7	0	0	2	1	116	0	0	0	124	2,721			4,923		7,644
6	0	0	0	0	16	0	0	0	562	7,621			7,629		15,250
0	0	0	0	0	0	0	0	0	4,812	67,522			61,438		128,960
0	43	17	4	0	3	0	165	0	24	43,715			31,149		74,864
33	3	2	9	2	17	0	0	0	8	2,715			2,641		5,356
34	20	1	0	0	5	0	0	0	20	41,070			17,232		58,302
15	3	0	5	0	0	0	0	0	0	8,628			13,028		21,656
4,062	0	7	122	17	28	0	0	0	65	4,387			2,223		6,610
37	305	1,064	1,443	46	84	0	0	0	12	3,008			4,369		7,377
29	1	0	12	1,704	46	0	0	0	14	1,814			3,751		5,565
32	0	0	2	15	820	1	0	1	236	1,116			1,409		2,525
4,257	**375**	**1,093**	**1,600**	**1,785**	**1,191**	**114**	**165**	**287**	**12,531**	**398,927**			**352,716**		**751,643**
435	25	58	144	192	284	1,295	17,322	23,122	5,614	136,761	10,054	4,569	14,576	0	165,960
														154,846	154,846
391	96	178	350	174	403	52,623	8,089	2,344	48,436	169,858	38,206	764		0	208,828
270	96	108	262	152	800	27,388	6,382	84,253	39,595	257,728	44,654	0		275,169	577,551
5,353	592	1,437	2,356	2,303	2,678	81,420	31,958	110,006	106,176	963,274	92,914	5,333	367,292	430,015	1,858,828

Annex 1B Use table in million kilos 2008

		Agricul-ture, forestry and fishing	Mining and quar-rying	Manu-facture of food pro-ducts, bevera-ges and tobacco	Manu-facture of textile and leather products	Manu-facture wood, paper and publi-shing	Manu-facture petro-leum products	Manu-facture of chemi-cals	Manu-facture of rubber and plastic products	Manu-facture of other non-metal products	Manu-facture of basic metals
1	Products of arable farming, horticulture, forestry and fishery	4,759	0	28,064	2	789	0	149	14	0	0
2	Live animals and animal products	411	0	14,065	0	0	0	0	0	0	0
3	Crude petroleum and natural gas	3,251	850	1,632	70	595	55,927	10,131	91	630	5,933
4	Other mining and quarrying products	1,177	1,634	574	17	79	8	1,950	0	19,110	5,298
5	Meat and fish products	0	0	1,340	31	0	0	2	0	0	0
6	Potato, vegetable and fruit products	7	0	1,042	0	0	0	17	0	0	0
7	Food products n.e.c.	13,286	0	8,203	0	5	0	454	1	0	0
8	Dairy products	4	0	2,953	0	0	0	140	0	0	0
9	Grain and starch products	60	0	3,534	0	106	0	35	0	11	0
10	Tobacco products	0	0	317	0	0	0	170	2	0	0
11	Textiles and leather products	10	1	11	161	32	0	7	9	8	0
12	Wood and wood products (excl. furniture)	106	12	171	11	1,170	9	154	85	82	26
13	Paper products, printed matter and recorded media	17	5	956	18	4,403	6	157	148	101	29
14	Petroleum products	638	80	61	6	19	6,675	9,436	7	101	2,428
15	Chemical products	1,412	18	394	166	316	1,158	25,439	1,813	222	160
16	Rubber and plastic products	55	4	248	13	160	2	122	224	58	9
17	Glass and construction materials	225	9	459	0	119	0	206	13	6,137	554
18	Basic metals	0	8	1	1	19	0	76	58	307	2,194
19	Metal products	3	23	129	2	33	2	35	5	9	10
20	Machinery and equipment	0	9	12	1	7	7	22	5	6	13
21	Transport equipment	1	1	0	0	0	0	0	1	1	0
22	Furniture and other manufactured goods	0	1	0	2	0	1	1	0	1	0
23	**Total of row 1–22**	**25,422**	**2,655**	**64,166**	**501**	**7,852**	**63,795**	**48,703**	**2,476**	**26,784**	**16,654**
24	Waste and recycled products	74,912	0	7,610	142	3,072	0	531	703	2,324	1,625
25	Extraction	38,112	99,270	1,113	0	0	0	3,763	0	7,143	0
26	CO_2 emissions	0	0	0	0	0	0	0	0	0	0
27	Balancing item	49,365	3,137	13,415	316	2,090	14,696	21,007	361	9,800	5,480
28	Total	187,811	105,062	86,304	959	13,014	78,491	74,004	3,540	46,051	23,759

Manufacture of fabricated metal products	Manufacture of electronic equipment	Manufacture of electrical equipment	Manufacture of machinery and equipment n.e.c.	Manufacture of transport equipment	Other manufacturing	Electricity and gas supply	Water supply and waste treatment	Construction	Services	Total Column 1–20	Households	Accumulation	Export	Flows to the enviroment	Total
0	0	1	0	1	15	6	0	10	1,142	34,952	2,454	325	14,798		52,529
0	0	0	0	0	0	0	0	0	25	14,501	94	108	1,727		16,430
106	27	49	118	68	53	18,513	81	291	4,979	103,395	7,641	1,699	55,809		168,544
37	0	0	0	51	39	0	8	37,192	1,303	68,477	253	495	27,279		96,504
0	0	0	0	0	0	0	0	0	377	1,750	873	60	3,588		6,271
0	0	0	0	0	0	0	0	0	794	1,860	1,537	38	4,422		7,857
0	0	0	0	0	4	84	1	0	687	22,725	1,846	772	12,243		37,586
0	0	0	0	0	5	0	0	0	658	3,760	1,967	121	2,481		8,329
0	0	0	0	0	0	0	10	38	361	4,155	2,377	165	4,872		11,569
0	0	0	0	0	0	0	0	0	2,518	3,007	2,488	220	4,259		9,974
4	2	0	1	6	50	0	3	1	95	401	539	101	900		1,941
123	20	24	38	56	382	0	25	1,402	1,303	5,199	790	254	1,401		7,644
87	47	11	28	44	110	7	23	38	2,940	9,175	773	19	5,283		15,250
55	7	513	23	40	156	569	125	1,295	16,938	39,172	5,953	2,064	81,771		128,960
146	81	87	73	96	280	93	146	498	1,429	34,027	684	337	39,816		74,864
84	45	45	82	175	155	13	18	626	525	2,663	251	204	2,238		5,356
143	41	33	20	120	135	6	168	34,570	4,997	47,955	1,720	1,072	7,555		58,302
2,838	79	171	588	402	438	34	20	556	59	7,849	0	90	13,717		21,656
1,181	30	32	341	307	244	10	48	1,056	396	3,896	95	495	2,124		6,610
24	57	78	257	71	90	34	17	254	246	1,210	295	892	4,980		7,377
0	0	0	2	591	4	0	1	6	273	881	390	2,557	1,737		5,565
0	0	1	0	12	67	1	2	90	148	327	806	896	496		2,525
4,828	**436**	**1,045**	**1,571**	**2,040**	**2,227**	**19,370**	**696**	**77,923**	**42,193**	**411,337**	**33,826**	**12,984**	**293,496**		**751,643**
0	0	167	297	0	0	1,237	24,826	29,093	0	146,539		2,133	17,288	0	165,960
0	0	0	0	0	0	0	0	0	5,445	154,846					154,846
0	0	0	0	0	0	0	0	0	0	0		0		208,828	208,828
525	156	225	488	263	451	60,813	6,436	2,990	58,538	250,552	59,088	105,298		162,613	577,551
5,353	592	1,437	2,356	2,303	2,678	81,420	31,958	110,006	106,176	963,274	92,914	120,415	310,784	371,441	1,858,828

8.

Emissions of carbon dioxide and sulphur dioxide between 1960 and 2012

Authors
Wiet Koren
Bob Lodder
Jan Pieter Smits

Since 1972 Statistics Netherlands has been publishing on air emissions of specific compounds that may threaten the environment. This chapter describes the compilation of time series of carbon dioxide and sulphur dioxide, representatives of acid rain and the greenhouse effect respectively. Furthermore, the chapter explores the trends of these indicators in the 52 years between 1960 and 2012 and the influences of economic growth and energy use on these trends.

8.1 Economic growth and energy use

Compared to other Western European countries, the long-run changes in energy use in the Netherlands shows an interesting and somewhat different pattern. Of course, economic development and energy use are closely linked as increases in output tend to go hand-in-hand with increases in the use of energy. However, not all segments of the economy use equal amounts of energy. Trade and services tend to use much less energy than for example the petrochemical industry. In this chapter the time series of energy use are basically broken down at the level of industries and households, in order to see which parts of the economy were responsible for the increases in energy use. The emissions of carbon dioxide (CO_2) and sulphur dioxide (SO_2) are closely linked to the energy use, even though the emission of pollutants differs across energy-carrier (notably coal, oil and natural gas) and industry (and households) where it is used. Therefore, also the growth of these emissions can rather easily be attributed to the industries and the household sector responsible.

On the eve of World War I the Dutch economy could still be considered energy extensive. From the early 1920s onwards the energy intensity of the Dutch economy increased, albeit at a rate comparable with that of the rest of Western Europe. It was after World War II that the energy intensity increased clearly much faster in the Netherlands than in other countries. The relative levels of energy intensity have been quite high since the early seventies.

International comparative statistics clearly indicate that, from an environmental economic perspective, the Netherlands went through a remarkable rise of energy use per unit of GDP in the first decades after World War II, whereas these levels were actually declining in most other countries (Maddison, 1991). As the use of (fossil) energy is directly related to the emissions of all kinds of pollutants to air, these long term developments directly reflect historical changes in environmental pressures.

In this chapter we present the first long time series for energy use, CO_2 and SO_2 emissions calculated according to the concepts and definitions of the environmental accounts. This makes a direct comparison possible with macro-economic indicators such as GDP, both at the national level and at the industry level. Using this new time series, this article systematically explores the issues of energy use and the emissions of CO_2 and SO_2 from a historical perspective. It describes the sudden development of the Netherlands into an energy-intensive economy between the fifties and the early seventies of the 20th century. This is the period in which huge supplies of natural gas were found in the Northern part of the Netherlands, which boosted the growth of energy-intensive activities such as the petro-chemical and basic metal industries as well as intensive horticulture. Next we describe how patterns of energy use and emissions changed from the 1970s onwards. We pay special attention to the remarkable contrast in the changes of the emission of CO_2 and SO_2 over time. Whereas the SO_2 emissions saw an initial phase of rapid increase followed by a rapid decline, the levels of CO_2 emissions stabilised at relatively high levels from the 1970s onwards.

Section 8.2 focuses on the methodology with which the new time-series on energy use and the emission of CO_2 and SO_2 were constructed. In section 8.3 the main results are presented and analysed. We pay special attention to the identification of the key drivers of the long-run changes in energy use and emissions, such as the economic growth at the industry level, changes in the energy mix in production and consumption as well as changes in energy intensity and emission efficiency. Section 8.4 provides a discussion and some conclusions.

8.2 Compiling consistent time series

Data sources and classifications

Statistics Netherlands has been publishing data on energy use since 1946 (Statistics Netherlands, 1946–1960) and data on air emissions since 1960 (Statistics Netherlands, 1975; CBS-Statline, 2013a). These data and other sources have been used in compiling energy accounts for 23 different energy carriers and 17 sectors plus households (van der Helm et al, 2010). For publishing purposes these data are aggregated into 5 energy carriers (energy series only) and 7 sectors plus households (Table 8.2.1). Emission series of carbon dioxide are compiled from existing data and estimates. Sector details on CO_2 emissions before 1995 are estimated from emission-relevant energy use and process emission factors, and brought in line with published data when available. Sulphur dioxide emission data are constructed from similar published sources. In the next subsections these methods are described more specifically.

8.2.1 Sectors

Sectors	ISIC 2008 categories
Total Dutch economy	A-U plus households
Agriculture, forestry and fishing	A
Industry (except refineries, chemical industry, and basic metal manufacture) and mining	B,C,E,F minus 19-21 and 24
Refineries and chemical industry	19-21
Basic metals industry	24
Electricity and gas supply	D
Transport	H
Other sectors	G, I-U
Total private households	-

Construction of the energy time series: Net domestic energy use and emission-relevant energy use

In this study, two sets of energy series are prepared, net domestic energy use and emission-relevant energy use. The net domestic energy use is equal to final energy use for energetic and non-energetic purposes plus conversion losses. For each industry it can be calculated as the amount of energy used (bought from third parties or extracted from the environment) minus the amount that is produced (and sold to third parties).

In order to calculate emissions to air, the calculation of the emission-relevant energy use is highly relevant. This is the use of energy carriers resulting in physical flows of gaseous or particulate materials to the atmosphere, such as CO_2, CH_4, NO_x, SO_2, PM10 etc. Most emission-relevant energy use relates to the combustion (i.e. oxidation) of energy carriers resulting in emissions. It may also relate to venting, e.g. of methane in the mining industry and to certain industrial production processes for instance in the refinery and chemical industry. Emission-relevant energy use excludes the energy that remains in the product in production processes, e.g. use of oil for the production of plastics or natural gas for fertilisers.

Time series for net domestic energy use have been compiled in accordance with the definitions of national accounts and as such give an overview of the use of energy by Dutch economic activities (Statistics Netherlands, 2010). This means that the figures from the energy accounts can be directly related to macroeconomic data from the national accounts. All data are calculated in Joules or multiples thereof.

The energy accounts are based on data from the physical energy balances. In order to obtain consistency with the definitions of the national accounts some adjustments are made to the energy balance figures. Corrections must be implemented to comply with the residence principle and to account for goods in transit. Furthermore consumption is disaggregated and classified according to the International Standard Industrial Classification (ISIC 1993 / ISIC 2008) which directly concurs with the national accounts. Complete energy accounts are available from 1995 onwards, from which net domestic energy use can be derived (i.e. ‘final consumption plus conversion losses’), but also emission-relevant energy use (CBS-Statline, 2013b).

Sector data on energy consumption are available for most energy carriers. Any difference between the sum of all sectors and the aggregate of the energy balance is settled in government and other services. The figures between 1990 and 1995 are based on data from the printed publications of ‘De Nederlandse Energiehuishouding’ (industry sector), agriculture data on StatLine (CBS-Statline 2013c) and final consumption data on StatLine (other sectors).

Fully revised energy balances are available for the period 1975–1990 (Statistics Netherlands, 2005; Zakee and Segers, 2008). Source data from the energy balance are adjusted following the revision of the energy balances, and data of energy balance, energy and non-energy consumption are fitted. Adjustments are made to comply with the definitions of the national accounts and across the sectors according to the ISIC. This applies especially to shipping and fisheries outside Dutch territorial waters. Data for these industries were assembled using auxiliary variables such as transport volumes, number of ships, and tonnage.

The energy accounts for 1960–1975 are compiled in a similar way. However, because no energy balances existed for this period these were constructed using data from StatLine, energy statistics from the International Energy Agency (IEA; OECD, 1981, OECD, 1987) and NEH data. While published data from different sources appeared to differ, the same source is used for as many years as possible to avoid extra breaks in the time series. Detailed descriptions of the method of compiling the energy balances before 1975 and the energy accounts by industry are given in Van der Helm (2010a, 2010b).

We further aggregated these data into seven sectors plus households and five energy carrier groups of Table 8.2.1 and thereafter adapted these to the latest revisions of the current Statline time-series on net domestic energy use (CBS-StatLine, 2013b).

Construction of carbon dioxide emission time series

Statistics Netherlands has published statistics on CO_2 emissions over the period 1980–2012. These data concern the emissions on Dutch territory, whereas this chapter aims at emissions from Dutch economic activities. Emissions of carbon dioxide are primarily related to final energetic use of specific energy products or to energy used as transformation input for the production of electricity and heat. SenterNovem compiled a list of CO_2 emission factors of fossil fuel combustion in the Netherlands. The coefficients published in 2006 (SenterNovem, 2006) were used as a first input to estimate CO_2 emissions for 1960–1990. No coefficients have been published for the period before 1980. Emission coefficients for CO_2 per type of energy carrier are rather constant, although changes on year-on-year basis exist. Data from older publications of Statistics Netherlands are used as landmarks and also to fill in details per sector.

For the statistics on mobile sources, we used published data over the period 1980–1990 compiled by Statistics Netherlands (Statistics Netherlands, 1992). Data on earlier years were not available and are calculated by summing emissions from specific energy carriers for mobile purposes (petrol, LPG, diesel, jet fuel) for all sectors and adding emissions from fuel oil use for the sectors transport, fishery and 'other sectors'.

Beside the CO_2 emissions that are directly related to energy use, there are also emissions that arise from certain production processes, for instance, the production of concrete, and emissions that are released from landfills. Estimates of the emission from these processes were made using methods of Statistics Netherlands (Statistics Netherlands, 1993). Furthermore, information is used from process and product use emission protocols, established for the Netherlands in 2008 (VROM, 2008).

Construction of sulphur dioxide emission time series

Data on SO_2 emissions from road traffic and other mobile emissions have been published on specific years from 1960 onwards (Statistics Netherlands, 1984, 1990; CBS-Statline 2013b). For stationary sources, data from 1975 onwards were available (Statistics Netherlands, 1984b). Data for the period 1960–1990 are not fully consistent within and with the period 1990-now, due to differences in emission definitions and in enquiry and registration methods. Additional emission data from the literature were used (Thomas et al., 1988), as well as relevant auxiliary variables, such as total mileage of road traffic and average fuel consumption.

We have estimated emissions of seven industries plus households from available emission data and published and recalculated emission factors. Missing data for certain years are interpolated. Industry details are obtained by multiplying emission-relevant energy consumption and emission factors of 4 types of energy carriers: coal, fuel oil, other oil products and natural gas.

Similarly, SO_2 emission of shipping is calculated from energy use and averaged emission factors per year. In the total emission data, shipping outside the Netherlands is registered only as far as it concerns the Dutch territorial waters. By calculating emissions as energy use times emission factor the extraterritorial shipping belonging to the Dutch economy is incorporated. This results, of course, in differences with other emission publications that are based on territorial borders.

8.3 Energy use and emissions of industries and households

Overview

The level of net domestic energy use in the Netherlands has increased greatly between 1960 and 2012 (Figure 8.3.1). In the sixties and early seventies, net energy use increased yearly at a high rate. From 1973 to 1979, growth in net energy use slackened. From 1980 to 1983 a short dip in energy use is observed. From 1983 on, energy use increases again but at a somewhat slower pace than before. Since 2000 energy use seems to have stabilised. In total, net energy use increased by 281 percent on 1960, which is an average of 2.6 percent a year.

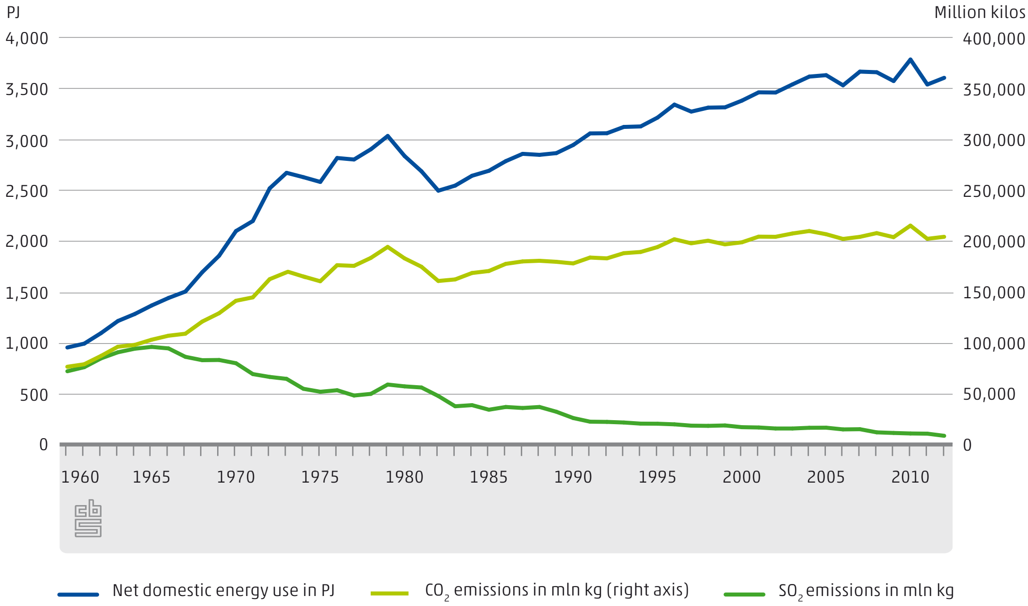
3,602,000

trillion joules Dutch energy use in 2012

The amounts of CO_2 emissions into air are huge: in 1960 already more than 75 billion kilos CO_2 were emitted by the Dutch economy. SO_2 emissions are much lower in absolute figures, however, the biological effects of SO_2 and its successors (e.g. lung irritation, damage to lichens and plants) are apparent at lower concentrations.

The emission patterns of CO_2 and SO_2 differ. CO_2 emissions closely follow the pattern of net energy use, whereas SO_2 emissions rise to a high of 935 million kilos in 1965 and start a steady decline afterwards to 75 million kilos in 2012, 8 percent of 1965 level. In contrast, CO_2 emissions were up 170 percent in 2012 on 1960.

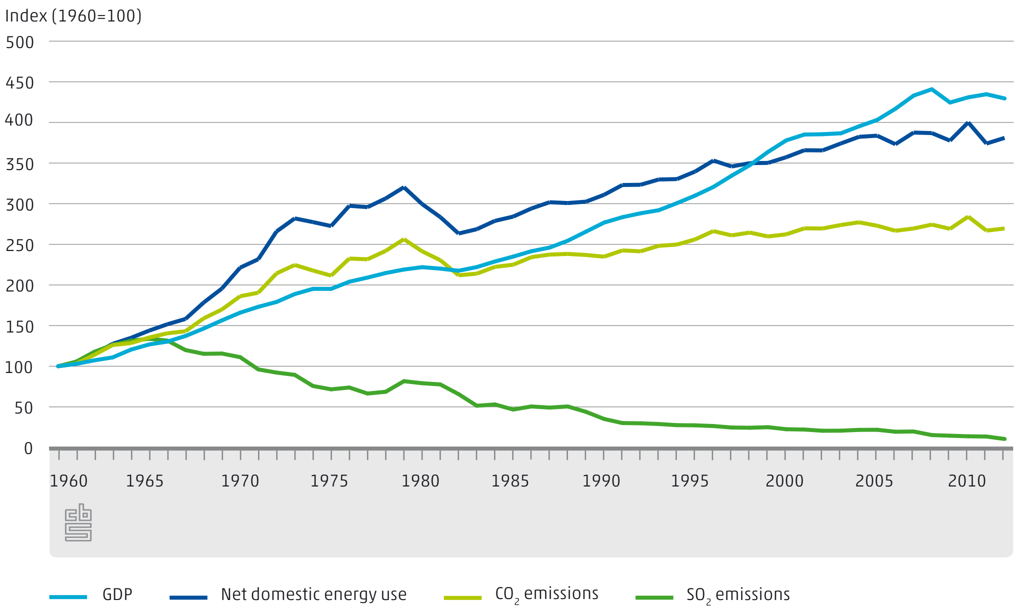
8.3.1 Net domestic energy use and CO_2 and SO_2 emissions



8.3.2 Net domestic energy use and CO_2 and SO_2 emissions, calculated as averages per person per day

	1960	1965	1970	1980	1990	2000	2010	2012
Net domestic energy use (kWh)	63	84.7	123	153	150	162	174	162
CO_2 emission (kilos)	18.1	22.9	29.7	35.4	32.6	34.2	35.5	33.2
SO_2 emission (kilos)	0.17	0.21	0.17	0.11	0.05	0.03	0.02	0.01

8.3.3 GDP at constant prices, net domestic energy use and CO_2 and SO_2 emissions



The Dutch population grew 47 percent between 1960 and 2012. When we take into account this growth and calculate energy use and emissions on a per capita basis, a similar pattern as in Figure 8.3.1 is obtained. For a better understanding of the extent of energy use and emissions, Table 8.3.2 gives the amounts per person per day for some years in the time series. The increase of energy use is steep at first, increasing from 63 kWh per person per day in 1960 to a peak of 165 kWh in 1979. From then on, the level remains more or less the same, with the level in 2012 being virtually identical to that of 1979.

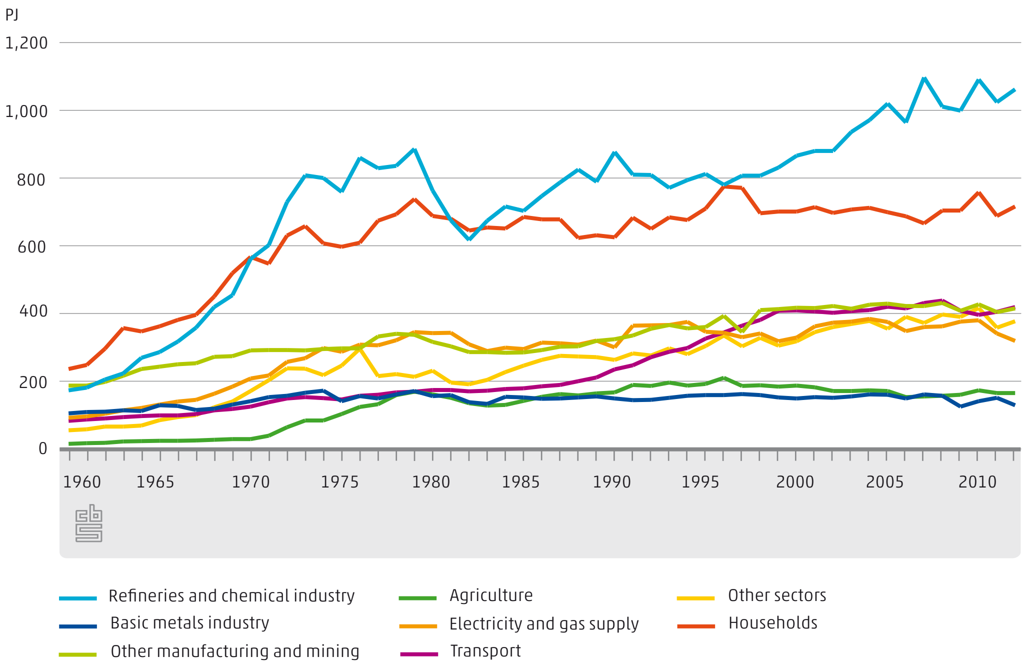
CO_2 emission follows energy use from 18.1 kilos per person per day in 1960 to a top of 37.9 kilos in 1979, but has actually been falling since then to an average of 34. This is still almost twice as high as in 1960. SO_2 lowers from 210 grams per person per day in 1965 to a mere 12 grams in 2012.

Much of the increase in energy use is due to growing economic activity. In Figure 8.3.3 net energy use and emissions have been compared with GDP, using 1960 as base year. Accordingly the degree of environmental economic decoupling can be determined. Energy use increased faster than GDP between 1960 and 1970, indicating that energy use is less efficient in this period. Energy crises in 1973 and 1979 brought a temporary relapse. From the mid eighties, net energy use grew at a slower pace than GDP indicating relative decoupling. The crossing paths of GDP and energy use indicate that overall the Dutch economy is becoming less energy intensive. Equally, the CO_2 emission increase exceeds GDP growth until 1982 and increases at a much slower pace. Finally, the decreasing SO_2 emissions from 1965 onwards indicate absolute decoupling for this indicator. These developments will be examined in more detail in the following sections.

Changes in energy use and emissions by industries

The industries that currently consume most energy are the oil and chemical industries. These two industries show a large increase of more than 400 percent between 1960 and 1975 (Figure 8.3.4). Other sectors have more moderate increases, all with the largest

8.3.4 Net domestic energy use by industries and households

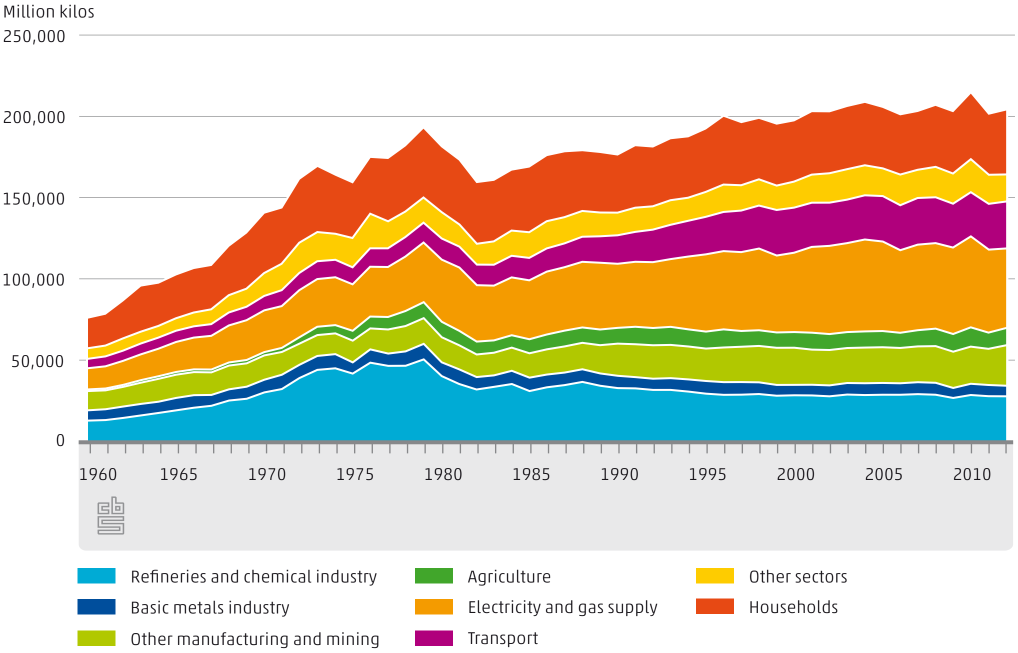


increase between 1960 and 1980. The transport sector diverges from this pattern, doubling its energy use between 1990 and 2000. Energy use of electricity and gas supply more than doubled between 1960 and 1980, but afterwards increased only slightly. The basic metals industry has the lowest increase of just 30 percent in 52 years.

Households are responsible for 20 to 25 percent of all energy use. The energy use by households was 173 PJ in 1960 and almost tripled until 1980. From then on, energy consumption by households has been more or less stable.

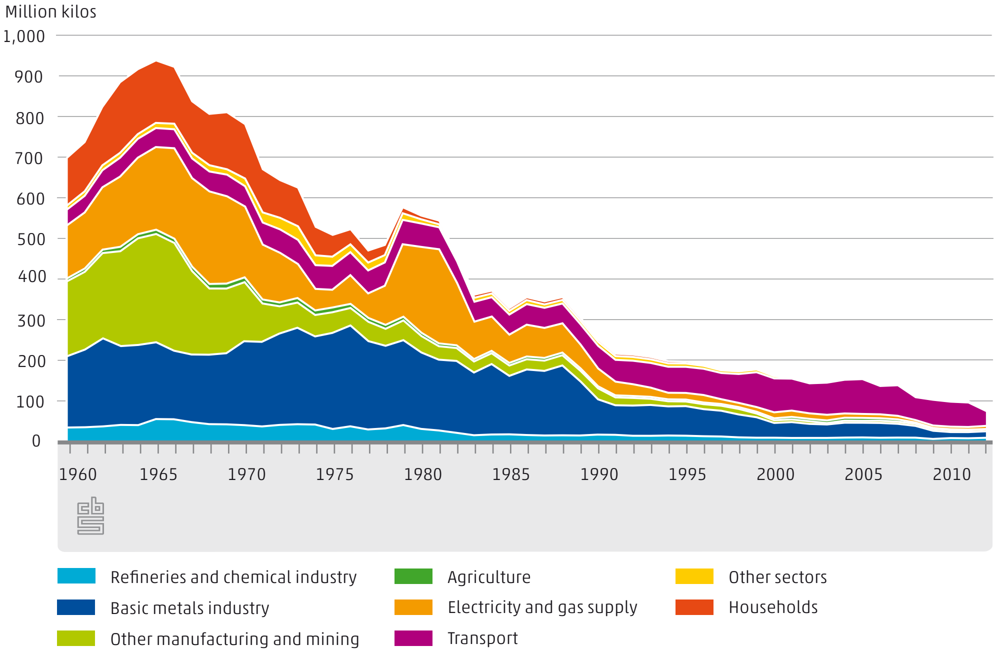
Most CO_2 emissions arise from energy-related processes and the overall pattern of CO_2 emissions therefore mimics the energy use pattern. However, in the refineries and chemical industry, energy carriers like oil are also incorporated in plastics and other materials and not used for combustion or electricity production. Accordingly, these industries have relatively lower CO_2 emissions compared to their energy use. Most CO_2 is produced by households and by electricity and gas supply (Figure 8.3.5). The emission of power plants has increased from 13 Mton to 49 Mton in 52 years, due to increased demand for electricity.

8.3.5 CO_2 emissions by industries and households



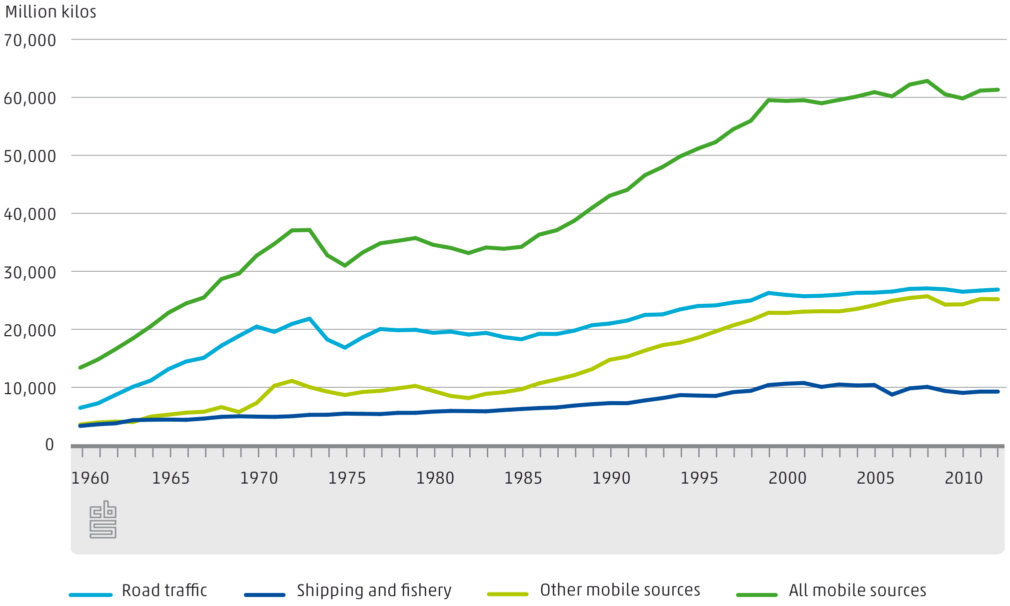
In contrast with CO_2, SO_2 emissions were cut dramatically in almost all sectors except the transport sector (Figure 8.3.6). In the sixties, SO_2 levels reached their top. The main emitting industry was the manufacturing sector. In homes, the replacement of hard coal by home heating oil and especially natural gas resulted in a quick reduction in domestic emissions in the seventies. Emissions from the electricity and gas supply sector decreased too, however with an interruption in the period 1979–1983, where a sudden increase occurs. The varying use of energy carriers in this sector will be examined in more detail in the section Changes in the energy mix.

8.3.6 SO_2 emissions by industries and households

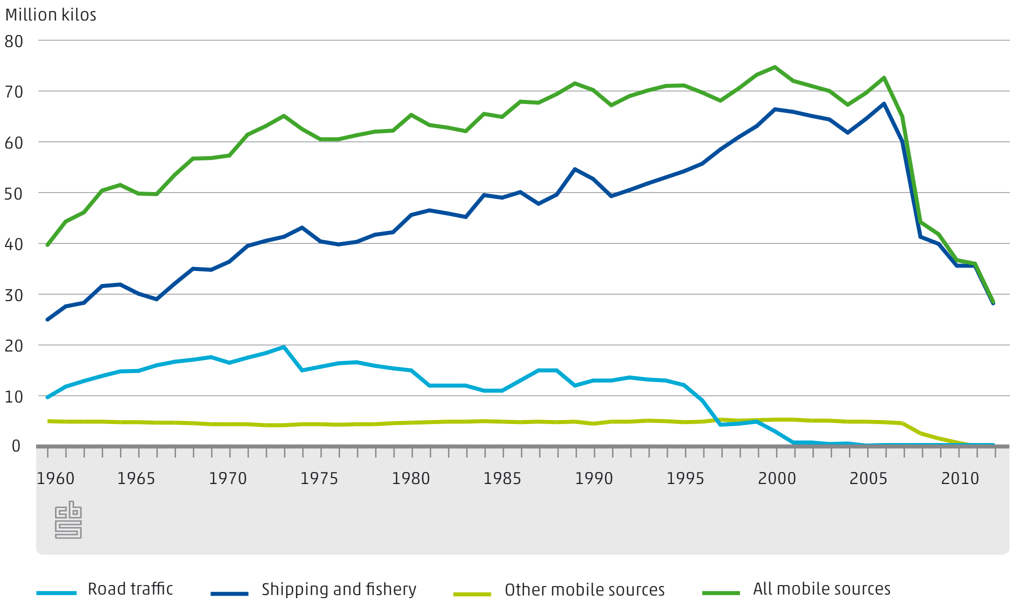


While other sectors decrease, the relative share of the transport sector in SO_2 emission increases from 10 percent in 1960 to 49 percent in 2012. Emissions of this sector are mostly from mobile sources. Cars, airplanes, ships and other mobile sources are important sources of CO_2 and SO_2 emissions. Almost one third of all CO_2 emissions are currently from mobile sources, and half of all SO_2 emissions.
The general use of cars came in the sixties, and with it CO_2 emissions from road traffic increased quickly (Figure 8.3.7). A second increase took place between 1985 and 2000, when a second car in the household became more general and road transport further increased. In these decades, holidays by airplane became more common, causing the large rise in the category 'other sources'. CO_2 emissions from shipping and fishery increased less conspicuously and even decrease after the year 2000.

8.3.7 CO_2 emissions of mobile sources



8.3.8 SO_2 emissions of mobile sources



SO_2 emissions from stationary sources like power plants and other industries have decreased since 1965. In contrast, emissions from mobile sources increased up to 2006 (Figure 8.3.8). The share of mobile sources in total SO_2 emissions rose from just 5 percent in 1965 to over 50 percent in 2006. Emissions from road traffic have decreased gradually to a negligible amount. Current emissions from mobile use occur mostly in the shipping industry. Policy regulations for decreasing emissions of sulphur dioxide are directed to the shipping branch for that reason.

What are the drivers behind changes in emissions?

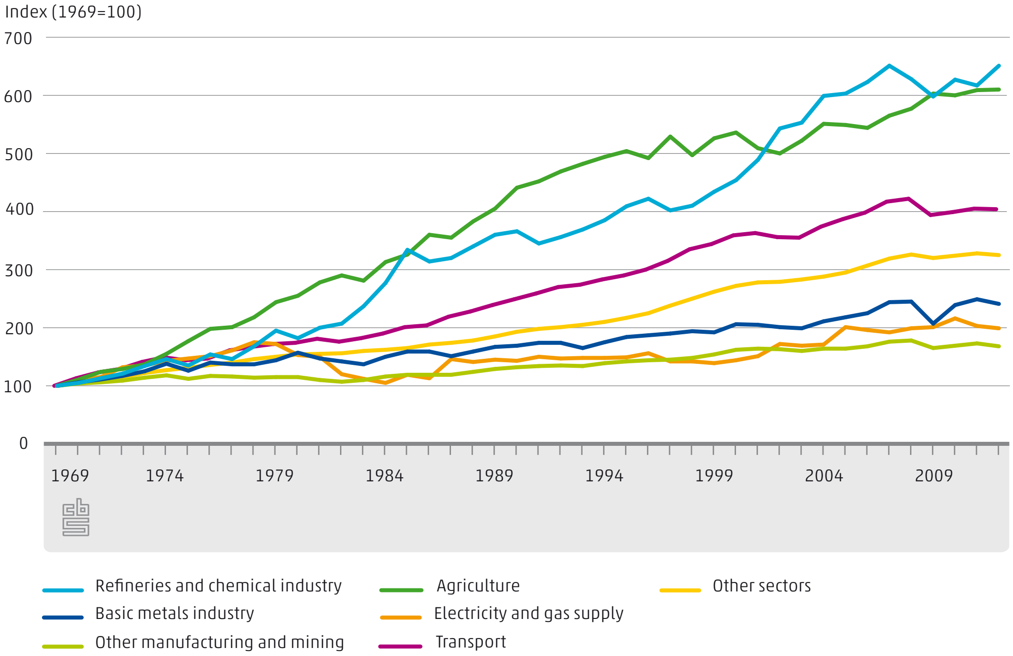
In this section three key factors will be investigated that have influenced the change in CO_2 and SO_2 emissions over time, namely the economic growth of the different sectors within the Dutch economy, the change of the energy mix that was used for production and consumption, and finally all kinds of improvements in the emission efficiency, which were taken deliberately but sometimes also occurred accidentily, to reduce emissions.

Economic developments

A key driver of energy use and related emissions to air is economic growth. As economic activities increased more energy was needed to produce all kinds of goods and services. By 2012, the economy had grown to 430 percent of its size in 1960.

The development of net energy use (and CO_2 emissions) clearly reflect some important economic – political developments of the Netherlands during this time period. The period following World War II was one of 'rebuilding' the country, characterised by strong economic growth, accompanied by a strong increase in energy demand. This increase ground to a sudden halt in 1973 due to the first global oil crisis. A sharp increase in energy prices and an economic slowdown resulted in lower energy use. For the first time energy saving became an important issue and research and development of alternative (renewable) energy sources took off. The second oil crisis in 1979 and the economic crisis in the early to mid eighties led to lower energy use. The economic recovery and high growth

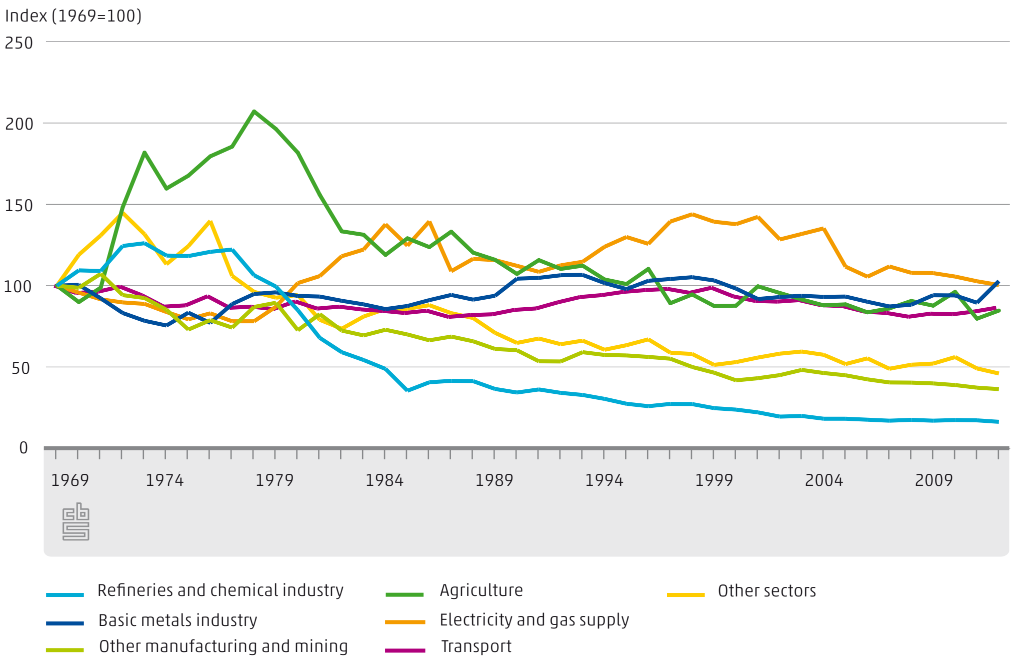
8.3.9 Volume growth of value added of industries



rates in the nineties resulted in higher energy use, although the increase was not as large as before.

Figure 8.3.9 shows how the value added of the different economic sectors of this study increased between 1969 and 2012. Fast growers are agriculture and the petrochemical industry. Other sectors grew more slowly. Among these are labour-intensive industries such as the textile industry and shipbuilding. Electricity and gas supply appears to alternate between ups and downs.

8.3.10 CO_2 emission intensity by industries[1)]



[1)] Emission intensity calculated as amount of CO_2 emission of the sector divided by value added of the sector (cp 2005).

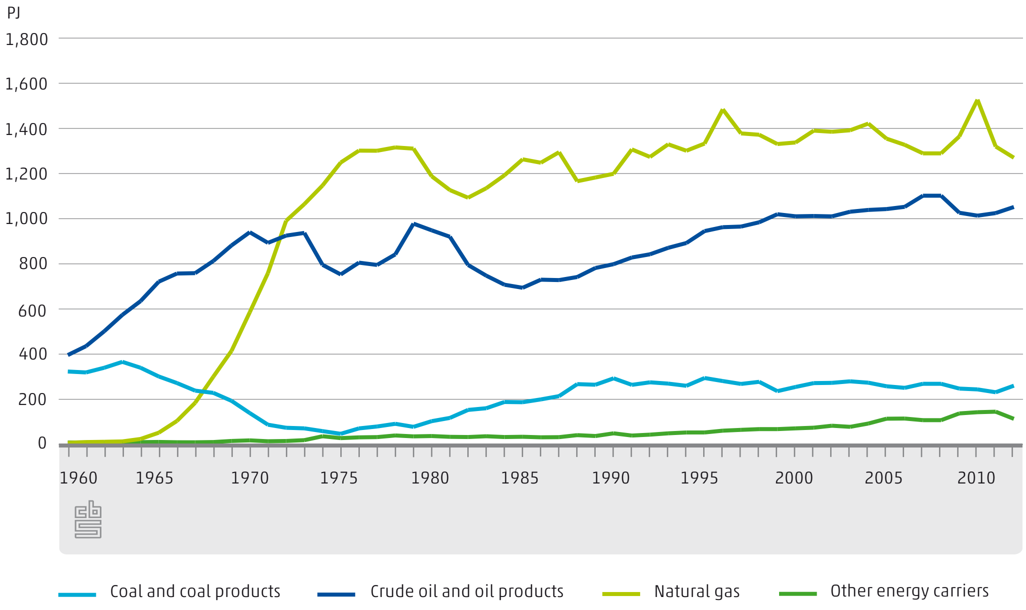
While growing, sectors may increase or decrease their use of energy and subsequent air emissions. If we look at the amount of emitted CO_2 per unit of economic growth, sectors appear to grow with a different volume of emission (Figure 8.3.10). Sectors with a rising emission per value added may be considered to increase their emission without completely offsetting this with economic benefit. All industries have become less emission intensive with the exception of the electricity and gas supply. Agriculture has a special development, becoming more and more emission-rich until 1978 and reducing its emission intensity thereafter. The increase in these years is caused by the growing greenhouse sector (horticulture), where, as in other sectors, energy efficiency becomes an issue with the rising oil and gas prices of the oil crises in the seventies.

Changes in the energy mix

The change in energy sources used for economic purposes had a great impact on Dutch society and on the emissions to air, since coal or oil emit more CO_2 and SO_2 than natural gas.

Coal as prime source was already replaced with crude oil and oil products before 1960 (Figure 8.3.11). Natural gas was introduced in 1960 but took a flight from 1965 onwards. Oil products remain the prime source for mobile transport, whereas gas and coal are mostly used for stationary purposes. The use of oil and natural gas increased over the time period in all sectors.

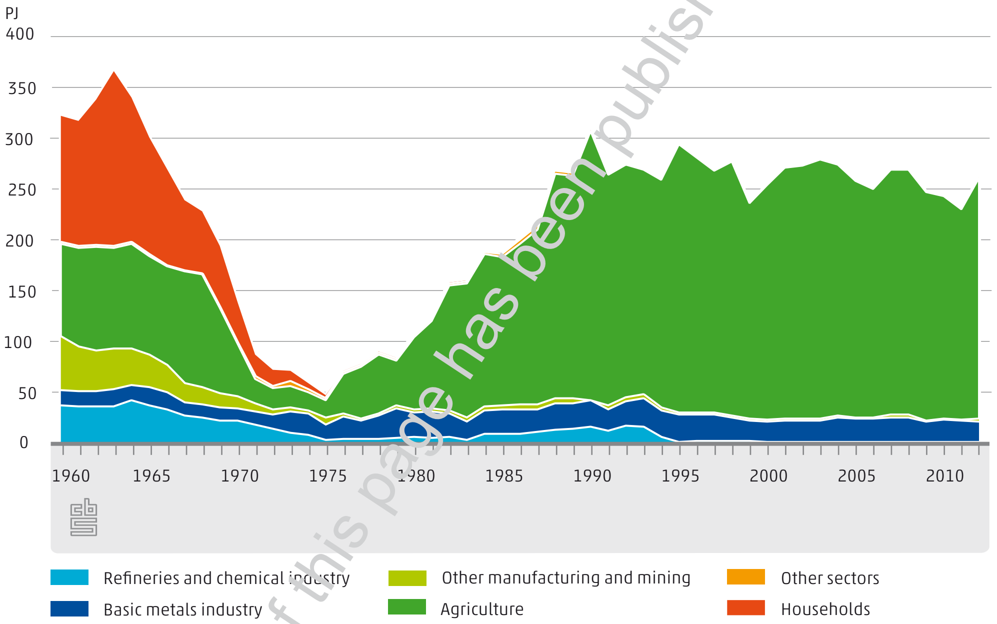
8.3.11 Emission-relevant energy use by energy carrier



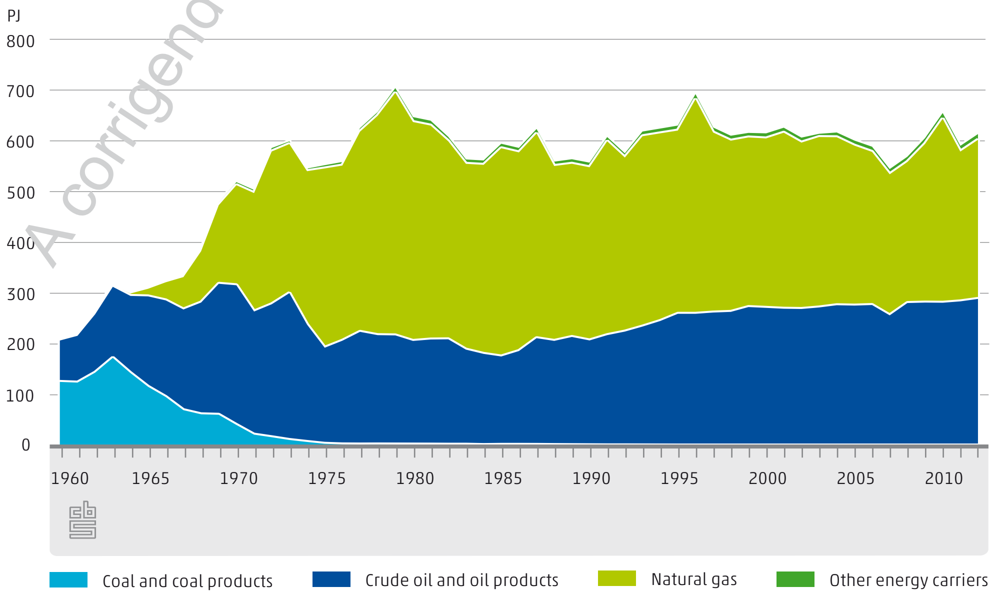
Coal has an interesting pattern of use in Dutch society. In 1960, it was used in all sectors of the economy, and especially for producing electricity and heating in households. However, this changed quite dramatically in approximately one decade. Coal mining in the Netherlands stopped in 1974, which coincides with the end of use of coal in households and most industries. In the basic metals industry, the use of coal could not be replaced and continued as before. Power plants initially used Dutch coal, but revived after 1975 on imported coal (Figure 8.3.12). Cheap coal imports could successfully compete with other energy sources like natural gas, and despite environmental apprehensions a number of new coal-fired power plants have been established. Very recently, in the summer of 2013, Dutch politics have reached a concept agreement to close down old coal-fired power plants, built before 1980 (SER, 2013).

Energy consumption in households grew until 1980, but has levelled off since then due to energy measures like better home insulation and high efficiency boilers. Counter effects are the adaptation to higher indoor temperature for thermal comfort and increased ventilation to avoid mites and moulds indoors. Energy carrier transitions in households have taken place surprisingly quick (Figure 8.3.13). In the sixties, newly built houses were provided with oil-fired heating systems, including an oil tank in the basement or under the yard. In older homes usually one or two coal stoves were present, which were replaced within

8.3.12 Emission-relevant energy use of coal by industries and households



8.3.13 Households: emission-relevant energy use



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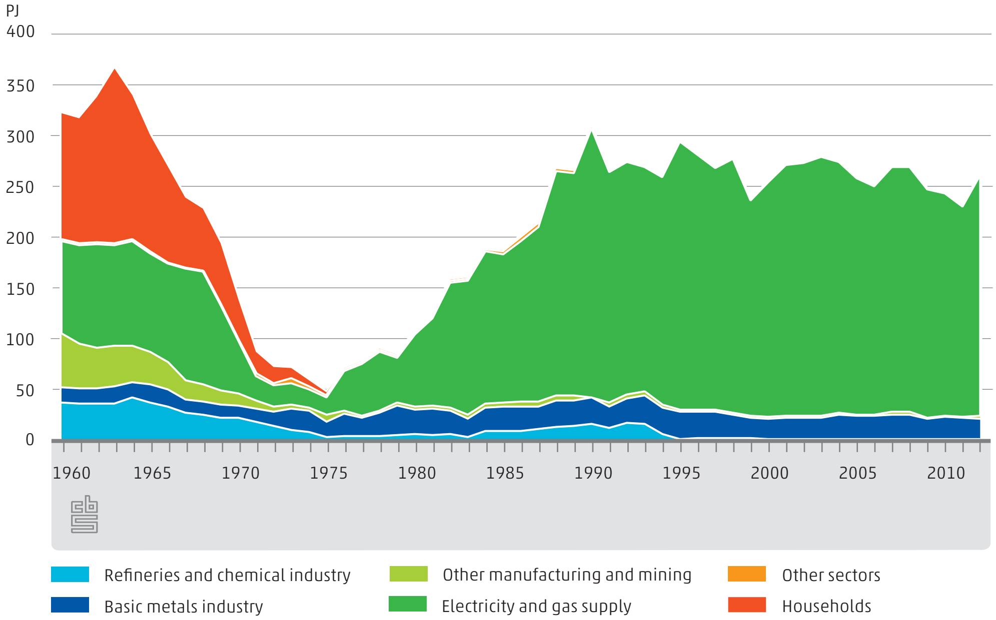
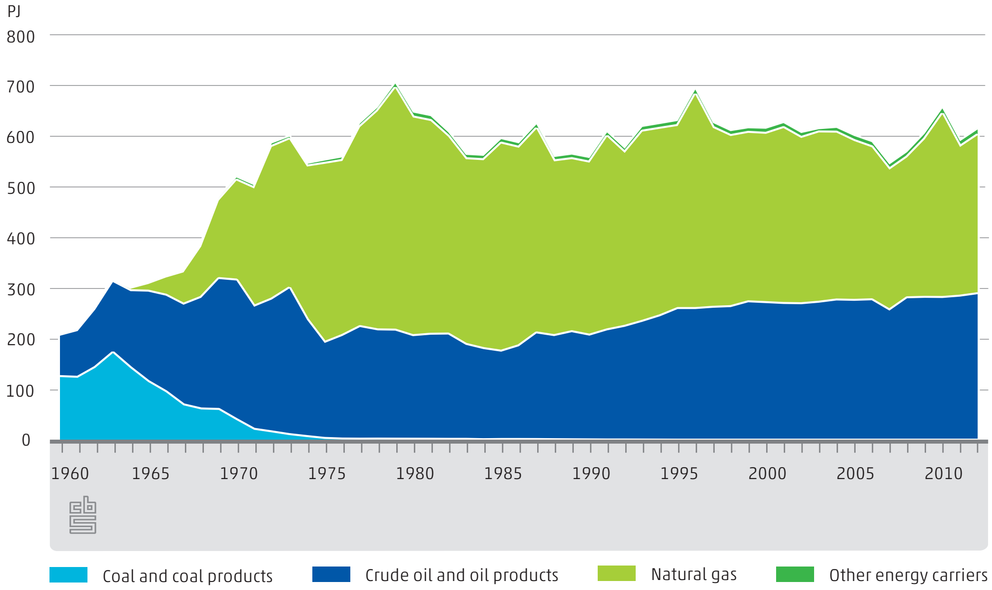


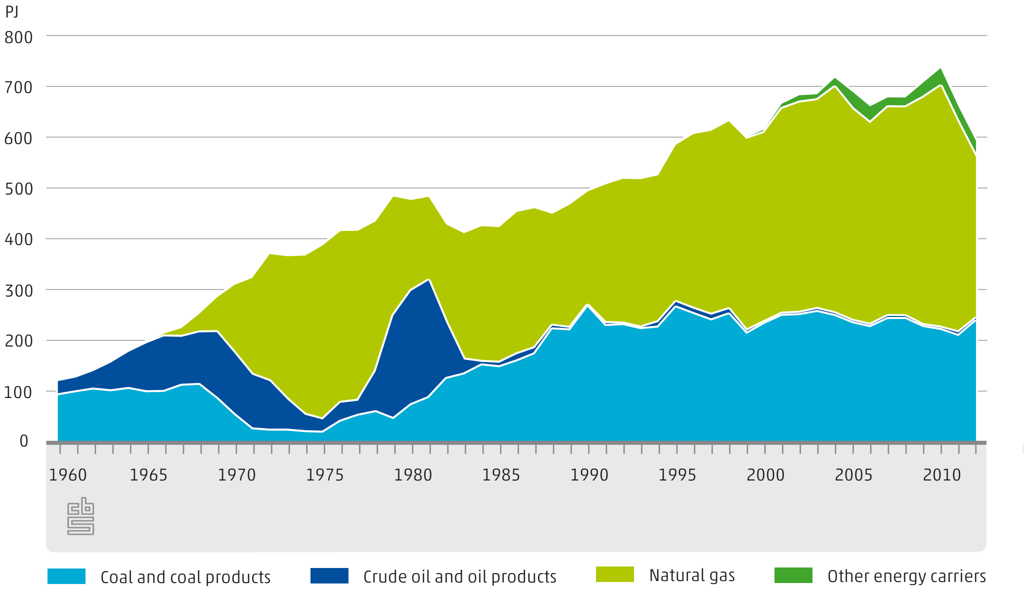
8.3.13 Households: emission-relevant energy use



a decade by gas heaters or gas-fired central heating. The use of natural gas was boosted by the construction of a network of pipelines which enabled almost all households to use natural gas as a primary energy source. Households mostly use oil in car engines. Despite more energy efficient engines, fuel use continued to grow as more bigger cars were purchased. Only in the last decade has the increase levelled off.

In the electricity and gas supply sector the energy carrier of choice depends mostly on the availability of cheap energy. Before 1970, Dutch coal from the closing mines was gradually replaced with mostly oil (Figure 8.3.14). The increasing demand of energy is first stilled with more imported oil, and thereafter with Dutch natural gas. This gas was initially sold cheap but became more expensive after 1974. In the period 1979–1983, gas was partly replaced by oil and partly by imported coal. Then new coal-fired power plants are fuelled and gradually Dutch and imported (Russian) gas become the main energy sources for electricity and heating. In some power plants biomass is fired as secondary fuel.

8.3.14 Electricity and gas supply: emission-relevant energy use



Changes in emission factors

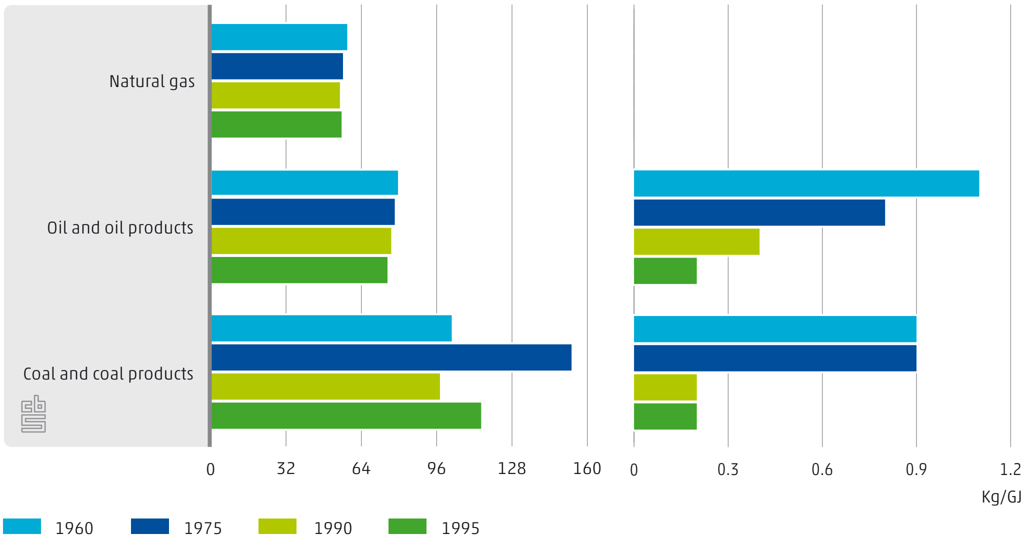
The amount of CO_2 or SO_2 that is emitted from a kilogram of energy carrier (coal, oil or gas) depends on intrinsic characteristics of the material and on the efficiency of the energy combustion process. While CO_2 is usually a product of the energy-delivering combustion of carbohydrates, SO_2 is a non-essential by-product.

The sulphur content of natural gas is usually quite low, but in crude oil and coal sulphur may present up to 4 percent (w/w)(Figure 8.3.15, right). Sulphur is emitted on combustion primarily as sulphur dioxide. The sulphur content of oil and coal differs from place to place: e.g. oil from Iran often has a sulphur content of more than 1 percent, whereas Nigerian oil is low in sulphur, generally below 0.2 percent. In fuel oil, sulphur content may be higher than in crude oil due to the extraction of low sulphur components during the refinery process.
The actual emission of SO_2 may be limited during or after the combustion process by desulfurization techniques. Desulfurization techniques were already applied before 1960. Desulfurization of oil takes place in refineries by hydro-desulfurization or hydro-treating,

in energy plants flue gas desulfurization is performed. Desulfurization techniques have improved in time, removing less than 80 percent in production plants as early as 1927, to the current potential 99 percent. Starting in 1987 and 1988, sulphur dioxide emission norms were issued for power plants, refineries and other industry (Buijsman et al, 2010). Power plants in the Netherlands do satisfy the norms for SO_2 but could emit less when using the best available techniques (EEA, 2013).

Combustion of sulphur-rich fuel oil by medium-speed sea ships may result in SO_2 emissions of 2000 g/GJ or higher (Marin, 2010). SO_2 emissions per litre of fuel are higher at higher cruising velocities. Until 2012, a maximum of 4.5 percent sulphur content (S) in fuel oil was enforced, and 1.5 percent on the North Sea and other SOx Emission Control Areas (SECA). In 2010, limits are lowered to 1 percent for SECA areas and these will be further reduced in 2015 to 0.1 percent; for ocean cruising, sulphur limits are lowered to 3.5 percent in 2012 and will be further lowered to 0.5 percent in 2020 (IMO, 2005).

8.3.15 Emission factors of CO_2 (left) and SO_2 (right) for three types of energy carriers [1)]



1) Emission factors in kg/GJ calculated from total emission-related energy use and emissions per year.

CO_2 emissions (Figure 8.3.15, left) differ from one energy carrier to another, but the differences are less spectacular than with SO_2 (Figure 8.3.15, right). Combustion of natural gas results in less CO_2 per energy unit than oil or coal. Carbon content, energetic value and combustion efficiency of the sources determine the result. These are average emission factors, individual batches and uses may be higher or lower. CO_2 emission factors changed only marginally over time. The changes reflect changes in quality of combustible material and improved efficiency of combustion.

Techniques to capture and store carbon dioxide during or after combustion are being developed. A small CO_2 storage system is operative in the North Sea, capturing CO_2 from a gas field and restoring it locally. After 2015, the demonstration project ROAD will capture CO_2 from a coal-fired power plant at the Maasvlakte and store it 20 kilometres offshore at a depth of 2 kilometres. Another capture technique, which first generates hydrogen and CO_2 from oil before combustion and next captures and stores this CO_2 is yet in its development stage. The political chances of (land-based) CO_2 storage are uncertain.

8.4 Environmental effects of economic growth

This chapter explored the dynamics of economic growth and environmental change for the period 1960–2012. New time-series were used to analyse the ways in which economic developments resulted in changes in the use of energy and the resulting emission of pollutants such as CO_2 and SO_2. These emissions largely result from the use of fossil fuels in the economy. It is therefore not surprising that initially increases in the emission of CO_2 and SO_2 closely followed the growth pattern of the economy. However, later the emission series of these pollutants showed a strong divergence. In 2012 the CO_2 emissions were 270 percent of their 1960 level, whereas for SO_2 this figure amounted to only 11 percent.

A more detailed analysis of the data reveals that the energy intensity of the Dutch economy showed quite a rapid increase until the 1970s. This rise is primarily caused by the rapid structural changes that the Dutch economy went through in the period 1950–1975. Labour intensive industries showed relatively slow growth, whereas energy-intensive activities such as the petrochemical industry were booming. This rapid growth of energy-intensive activities was the result of a deliberate decision of the Dutch government to promote the growth of these industries (Van Zanden, 1997).

When huge supplies of natural gas were discovered in the 1950s, the Ministry of Economic Affairs formulated an industrialisation policy aimed at extracting the newly found gas supplies quickly by boosting the growth of especially the petrochemical industries. The gas was even supplied at these industries at prices below the market level. A network of pipelines was constructed that provided households with natural gas. The rationale behind this policy was that in the 1950s and early 1960s it was expected that nuclear energy would become the most important source of energy, as a result of which the natural gas reserves would soon lose much of their economic value.

Therefore, the strong growth of energy intensity in the Dutch economy should not be seen in terms of a lack of energy efficiency, but rather as a structural change of the economy to energy-intensive activities . For instance, in the period 1960–2012 net energy increased just fourfold, whereas in the petrochemical industry it multiplied with a factor 6.

However, as soon as this transition into an energy-intensive economy was completed in the 1970s, society's views on energy use had changed completely. First of all, due to the strong resistance in parts of society to nuclear energy, oil and gas remained the most important energy sources for the economy. Secondly, due to the two oil crises of the 1970s, energy prices had reached very high levels. Therefore, the Dutch economy, now transformed into a rather energy-intensive economy, had become quite vulnerable to these price shocks. And finally, the environmental impacts were considerable in terms of energy use and the emissions of both CO_2 and SO_2.

In the changes of the emissions of CO_2 and SO_2 over time, the differences are quite striking. After an initial period where both pollutants rose fast, the series on SO_2 showed a rapid decline while the CO_2 emissions stabilised at quite high levels. The rapid decline of sulphur dioxide emission can be explained by the replacement of hard coal for home heating and manufacturing by oil and natural gas. Besides, desulphurisation techniques which were already available before 1960, were applied in the late sixties and seventies. Lastly, there are the recent regulations aimed at decreasing emissions in the shipping industry. SO_2 emissions will be relatively unimportant when these are fully worked out. The technical scope for such decreases in the CO_2 emission intensity is still limited. Capturing techniques are not yet fully developed and the potential risks of CO_2 storage on land are much debated.

9. Towards a MRIO based national accounts consistent carbon footprint

Authors
Bram Edens
Rutger Hoekstra

In this chapter we report on our research to provide provisional estimates of the Dutch carbon footprint using a publicly available multi-regional input output table which we have made consistent with Dutch national accounts and environmental accounts data. The main findings are that the carbon footprint (CO_2 only) in 2009 amounted to 202 Mton CO_2 which equals 12.2 ton on a per capita basis. Of all CO_2 emissions emitted abroad due to final consumption in the Netherlands, China contributed most with 19 percent.

9.1 Introduction

The expression "footprint" became popular in the context of environmental issues in the early 1990s with the introduction of the "ecological footprint" (Rees, 1992, Wackernagel and Rees, 1996). The ecological footprint has also paved the way for other footprints or indicators that use a similar philosophy. Examples include the carbon footprint (Peters, 2008; Peters and Hertwich, 2008), water footprint (Hoekstra, 2003; Hoekstra and Chapagain, 2008), land footprint (Weinzettel et al., 2013), biodiversity threats (Lenzen et al., 2012) and raw material equivalents (Schoer et al., 2012). All these indicators have in common that they relate consumption[1)] to environmental pressures. It is therefore often referred to as the "consumption perspective" or the "consumption-based approach". This is usually set against the "production perspective" where the direct environmental pressures generated by economic activities (both production, consumption and accumulation) are measured.

There are various methods to calculate footprints such as using coefficients from life-cycle inventories. However, input-output techniques that use the economic structure of economies in combination with environmental accounting data on for instance air emissions or energy use to calculate footprints have increased significantly recently. The advantage of these calculations is that they quantify the direct and indirect pressures of the full supply chains.[2)] For instance, if China produces intermediates for German exports to the Netherlands, the corresponding emissions in China and Germany are both taken into account.

In the past, Statistics Netherlands has published estimates for the Dutch carbon footprint based on input-output techniques using various model specifications but always based upon a domestic technology assumption in combination with country specific emission intensities (De Haan, 2004; Statistics Netherlands 2008; 2009; 2010). This approach has as its main drawback that it does not include to analyse intercountry trade, which requires a so-called multi-regional input-output table (MRIO) describing the structure of the world economy including all trade flows between countries. The advantage of using a MRIO for the calculations is that it allows for quantifying indirect pressures along the complete supply chains in order to obtain a country specific allocation of pressures.

1) Consumption includes all final demand categories excluding exports: final consumption by households and government, investments and changes in inventories.

2) Note that the use of input-output techniques to attribute energy use and environmental pressure to consumption started in the late 60s and early 70s (Hoekstra, 2010). However, the term "footprint" was not yet used for these calculations. The results of these calculations were usually referred to as energy/emissions "embodied" in consumption.

However, the construction of a MRIO is highly data intensive requiring numerous data sources (e.g. input-output tables of all countries; international trade statistics in goods and services; environmental accounts data, etc.) and therefore goes beyond the mandate of a national statistical office. At the same time, there is increasing political interest in using footprint indicators as evidenced by their inclusion in indicator sets of policy frameworks such as green growth or sustainable development (e.g. OECD, 2011).

In this chapter we report on our research to provide provisional estimates of the Dutch carbon footprint using a publicly available MRIO, namely the World Input Output Database (WIOD, Timmer et al., 2012) which we have made consistent with Dutch national accounts, microdata of trade statistics and environmental accounts data. We restrict ourselves in this study to an analysis of carbon dioxide (CO_2) emissions. In Section 2 we discuss the need for an "official" carbon footprint given the wide range of estimates that are available from various sources. In Section 3 the methodology is explained. In Section 4, the preliminary results for the Netherlands for the year 2009 are provided. Section 5 concludes.

9.2 The need for an "official" carbon footprint

Nowadays many carbon footprint estimates are available that are either based on MRIO calculations or other methods. Therefore, policy makers and the general public have an abundant choice of options to obtain footprint data. However, upon closer inspection the various sources provide very different insights. Figure 9.2.1 shows the carbon footprint estimates for the Netherlands of six sources that use four different MRIO databases (see textbox).

Characteristics of several MRIO databases

WIOD (World Input Output Database). Distinguishes 40 countries and 35 industries and contains a time series from 1995-2009 in current and constant prices. More information: www.wiod.org.

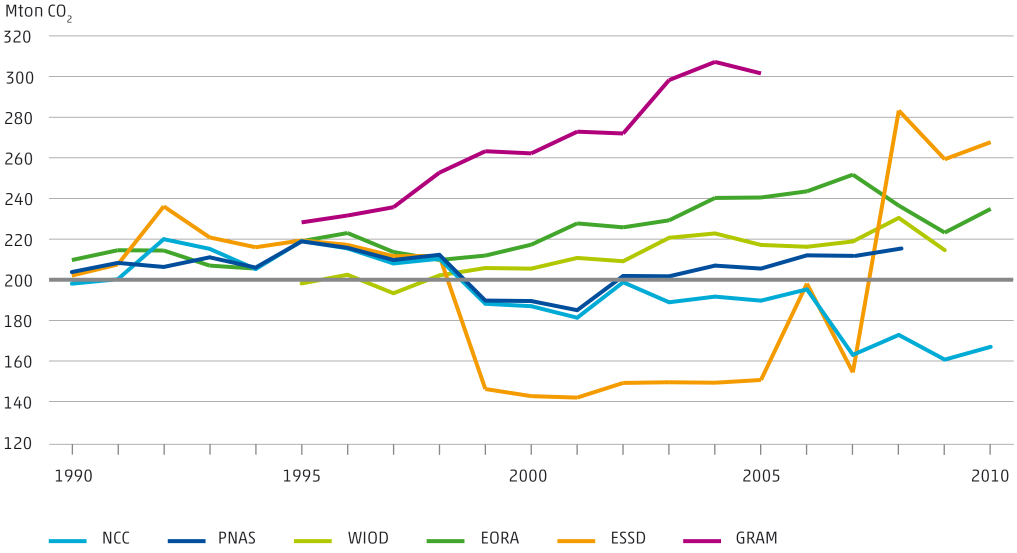
GTAP (Global Trade Analysis Project). Distinguishes 129 countries and 57 industries. Updated every 3 to 4 years, but no comparable time series exists. More information: www.gtap.agecon.purdue.edu.

EORA (no acronym). Distinguishes around 150 countries, with variable industry detail (20-500). A time series exists from 1990-2009. More information: www.worldmrio.org.

GRAM (Global Resource Accounting Model). Distinguishes 40 countries and 48 industries. Several years are available. More information: www.gws-os.com/de/content/view/627/302.

Source: Tukker and Dietzenbacher (2013); Hoekstra et al. (2013).

9.2.1. Dutch carbon (CO_2 only) footprint from six MRIO studies[1)]

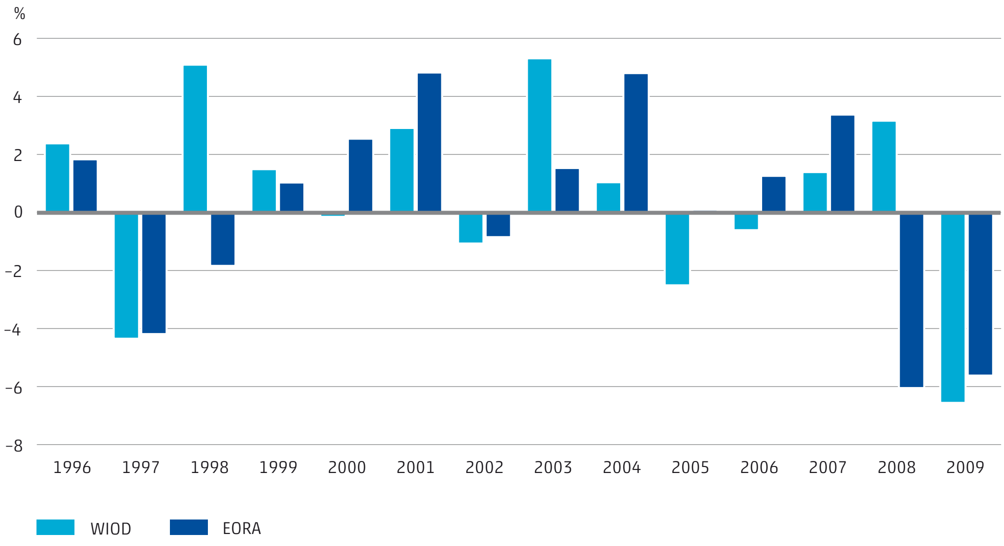


Sources: PNAS (Proceedings of National Academy of Sciences), Peters et al. (2011); NCC (Nature Climate Change), Peters et al. (2012) ; ESSD (Earth System Science Data), Le Quéré et al. (2013) ; EORA, Lenzen et al., (2012); GRAM, Wiebe et al. (2012); WIOD, Timmer et al. (2012).

1) The data for Figure 9.2.1 were supplied by Glen Peters (personal communication, June 2013). Peters et al. 2011, ibid., 2012, and Le Quéré all base their estimates on GTAP.

Figure 9.2.1 shows an enormous spread of the estimates in the size of footprint as well as the trend. Some show a rapid increase in the footprint (GRAM) while others show a fairly rapid decrease (NCC).

9.2.2 Year-on-year change in Dutch carbon footprint for WIOD and EORA



In Figure 9.2.1 the estimates of WIOD and EORA show a fairly similar development, although the level of the EORA footprint is generally higher. However, when we zoom in into the year-on-year development for WIOD and EORA estimates for the Dutch carbon footprint, as depicted in Figure 9.2.2, the annual changes can sometimes be quite different in magnitude. Even the sign is different in four of the fourteen years.

Given the range of estimates for the footprint, what can a Dutch policy maker conclude? What is the true level and trend of the carbon footprint for the Netherlands? Did the carbon footprint increase or decrease after 1995? What is the absolute level of the carbon footprint? What impact did the crisis have on the footprint? It is clear that these questions cannot be answered conclusively using Figure 9.2.1 or 9.2.2.

The underlying issue is that MRIO-based footprints do not aim (or claim) to provide conclusive results for individual countries. MRIO databases are produced to provide insight about global developments, but there are many reasons why the representation of an individual country in an MRIO table will differ from official statistics.

One of the greatest difficulties in the production of MRIO databases is the existence of asymmetries in trade statistics between countries: i.e. statistics of country A about the imports from country B are inconsistent with the statistics of country B which show the exports to country A. Such asymmetries are often resolved in the MRIO compilation process by using only the import data of all countries. This will affect estimates for the Netherlands severely, because it is known that countries underreport imports from the Netherlands due to the "Rotterdam effect". For example, when a Dutch trader re-exports Chinese computers to Germany, these computers will sometimes appear in German import statistics as coming from China. A second reason may be due to the fact that differences exist between the country data and the data available from international databases often used for the compilation of MRIO due to adjustments that have been made or different vintages of data. A third reason could be due to conceptual differences. For example, there are conceptual differences in the treatment of margins between the input-output table compiled by Statistics Netherlands and the format of the input-output required by Eurostat (see Hoekstra et al., 2012). A fourth issue pertains to aggregation levels. Statistical offices often have far more detailed data available e.g. regarding industry and product detail than is publicly disseminated, so they are able to better correct for heterogeneity. Finally, there are differences in the data source used for the carbon dioxide emissions. For further details about the empirical differences between the WIOD database and the official figures from Statistics Netherlands (see Hoekstra et al, 2013).

For those reasons we will explore a more direct approach here to calculate what we will call a "Single-country National Accounts Consistent" or "SNAC-carbon footprint". The method uses the MRIO-methodology but rather than "getting it right from a global perspective", the steps are geared towards making the results consistent to Dutch official statistics (see also Wilting and Vringer, 2007). We have decided to use the WIOD database as a point of departure due to its open source character and the existence of a time series.

9.3 Methodology

The method that we have used comprises the following steps that are discussed in detail elsewhere (Hoekstra et al., 2013). The WIOD website provides not only the definitive world input-output tables (WIOT) but also the intermediate steps in the production of the database (Timmer et al., 2012). Our method intervenes in the WIOD methodology at the stage of the "International Supply Use Tables" (IntSUT). In this stage, there is still an industry by commodity structure to the database which also means that the commodities can be linked to trade data. For forty countries and regions the IntSUT data are used, but for the Netherlands we used data from Statistics Netherlands (SUT, microdata on international trade and environmental accounts).

A WIOD balancing procedure is then followed to construct the WIOT from the IntSUT tables, with one important difference: the data for the Netherlands are kept unaltered at every stage of the calculations. The end results is therefore an adjusted "WIOD database" that is entirely consistent with Dutch official national accounts statistics.

There are three aspects of the production process that we will now explain in some more detail. First, the construction of the trade statistics which were tailor-made for this project. Second, the production of the supply and use tables and finally the conversion of the intSUT to WIOT tables.

Preparation of the Dutch trade in goods data

Compared to most other countries, the Netherlands has a high level of re-exports. They constitute about half of Dutch exports of commodities, and that is excluding transit trade (which is not part of the national accounts definition of imports and exports). This high level can be explained by several factors, for example a favourable position as the port to Europe, good infrastructure and skills in complex logistics (Kuypers et al. 2013). To accurately attribute the CO_2 emissions to consumption, the imports destined for consumption have been separated from the imports destined for re-exports. This is standard practice in national accounts, the novelty is that this separation is on country level and not on total imports. An estimate is made how much re-exports from country A pass through the Netherlands to country B. These re-exports are subsequently deducted from Dutch imports from country A and from Dutch exports to country B. This is accomplished by analysing micro data at the enterprise level, available from international trade in goods statistics, using the fact that 1) the larger traders are profiled; 2) some commodities are not produced in the Netherlands (for example bananas) and hence must be re-exports; 3) an analysis of differences in value of imports and exports at enterprise level in order to estimate the fraction of re-exports.

Production of the Dutch SUT data

The production of the IntSUT for the Netherlands requires the following steps. First of all, we exploit that the Dutch national accounts contain detailed information that is not made publicly available. For about 200 products (the SUTs are made at a more detailed level of 650 products) an IO table exists which summed over all products yields the Dutch IO table. Essentially, for each product we have a matrix which describes its origin (the supplier) and destination (the user), disaggregated by all valuation layers. Based on the information in the IO database we first of all exclude the value of re-exports.

The imports and exports of goods are subsequently split across countries using trade shares from trade in good statistics (see above). The imports and exports of services are split across countries using trade shares from international trade in services statistics. A novel aspect is that imports and exports due to processing and merchanting obtain a specific treatment.

These import and export values are divided by using the SUT at the more detailed level, where we make the assumption that the allocation of processing services over countries follows the distribution of trade in products that are being processed. We treat the supply and use of trade and transport margins as a service.

The free on board (fob) export value of products is split into the exports of product in basic prices and the exports of a service that rests on the exported product. The distribution of exported services follows the distribution of the goods they rest upon. With this information we are able to compile a Dutch international SUT, as well as the Dutch part of the IntSUTs of the other WIOD countries.

Balancing procedure

In order to incorporate official Dutch statistics in the IntSUT, the Dutch industry columns, Dutch final demand columns, Dutch goods and services rows and value added and margins rows in the IntSUT from WIOD are replaced with corresponding, more detailed official statistics as they are denoted in the Dutch national accounts. So this table becomes consistent with Dutch national accounts, and it is referred to as the Consistent IntSUT (C-IntSUT). However, as the IntSUT from WIOD constitutes a balanced system, where both global demand for each good in each country is equal to global supply of each good in each country and global value added plus margins is equal to global final demand, the C-IntSUT is unlikely to be balanced still. One example of such a source of imbalance is that a share of the exports that was part of final demand in the national account setting is suddenly part of the intermediate use of an industry in another country. This causes an imbalance, because the total final demand is no longer equal to the total value added. The imbalanced C-IntSUT is balanced by first setting the consistent global final demand equal to consistent global value added plus margins. And then, by means of Stone's reconciliation method (Stone et al., 1942), the rows and columns from the use table are reconciled (i.e. made equal) with the rows and columns from the supply table, without altering the official Dutch statistics and the value added of the countries.

This reconciliation procedure provides a balanced C-IntSUT, which can be used to create a C-WIOT. To achieve this, there are numerous computation methods that all require different assumptions which all have pros and cons. For a more detailed discussion on these methods we refer to the Eurostat manual on Input-Output methods (Eurostat, 2008). One of the main computation methods discussed in this manual is the 'fixed product sales structure assumption' (Model D in the Eurostat manual), which has the advantage that is has no negatives in the resulting input-output table. This method is applied to compute the C-WIOT.

9.4 Results

The carbon footprint in 2009 amounted to 202 Mton CO_2, which is about 4 percent lower than the result from the unadjusted WIOT shown in Figure 9.2.1. As shown in Figure 9.4.1 the footprint consists of 83 Mton embedded in imports, 80 Mton domestic indirect and 40 Mton due to direct emissions from final consumption and accumulation.

The total emissions according to the Dutch economy amounted to 205 Mton CO_2 which suggests that the emission trade balance for the Netherlands as a whole would be positive. A positive emission trade balance indicates that greenhouse gases emitted domestically during the production of exported goods is larger than the greenhouse gases emitted abroad during the production of goods and services imported by the Netherlands. This reflects both the emission intensive as the export oriented nature of the Dutch economy. We should be cautious, however, as the outcome is subject to uncertainty due to various assumptions inherent in using a MRIO.

9.4.1 Consumption and production CO_2 emissions in 2009

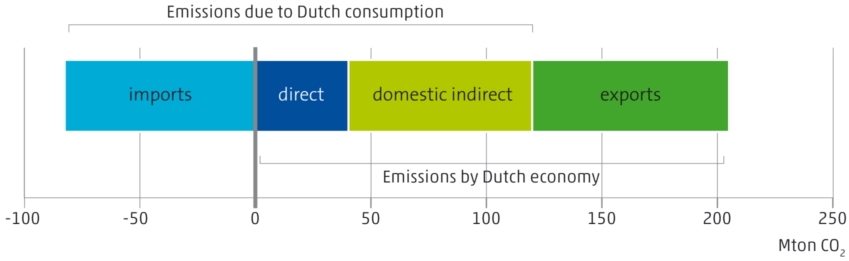
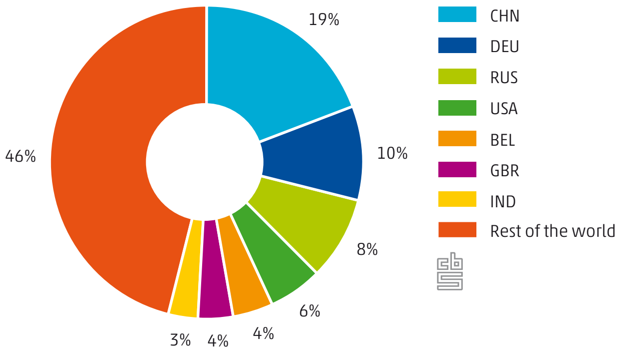


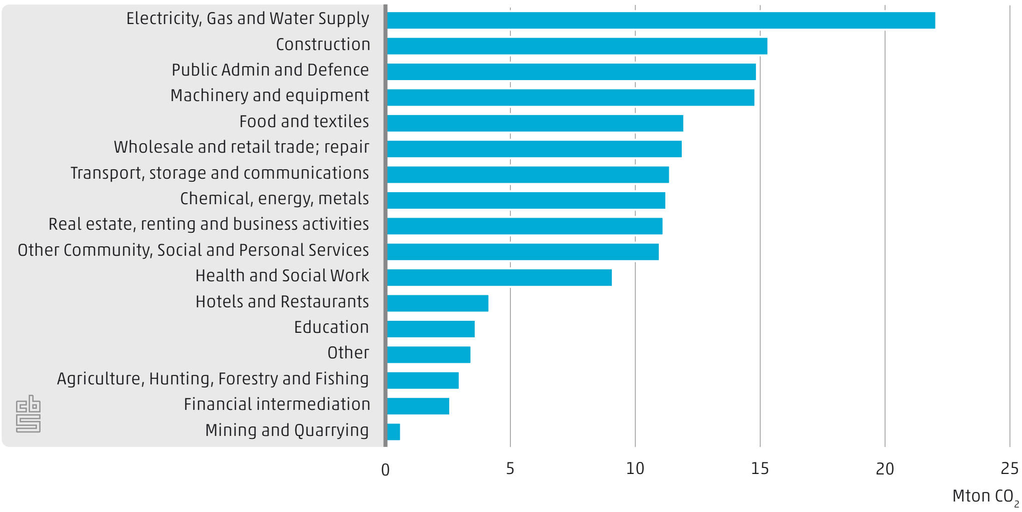
Figure 9.4.2 provides a breakdown of the import emissions into country of origin. Of all CO_2 emissions abroad due to final consumption in the Netherlands, China contributed most with 19 percent, followed by Germany at 10 percent and Russia at 8 percent.

9.4.2 Import emissions allocated to country of origin, 2009



The carbon footprint can also be broken down into consumption categories.The footprint emissions allocated to consumption categories are the result of both the expenditure levels and the indirect emissions generated per unit of expense in a particular category. Figure 9.4.3 shows that almost 22 Mton of the indirect carbon footprint is due to Dutch consumption of products from the electricity, gas and water supply sector, followed by construction services and machinery and equipment.

9.4.3 Indirect carbon footprint (2009) allocated to consumption categories (NACE rev. 2.1)

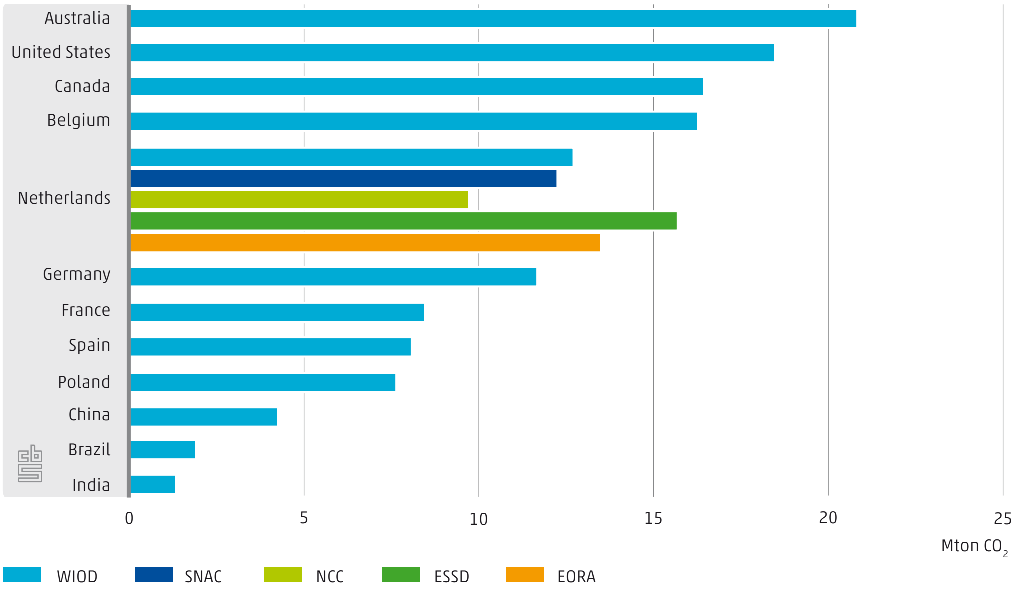


In 2009, on a per capita basis, the Dutch CO_2 emissions according to the SNAC approach equal 12.2 ton. As a comparison, Figure 9.4.4 depicts the per capita footprints of selected countries distinguished in WIOD obtained when using the original WIOT. It also includes the per capita estimates for the Netherlands from alternative studies mentioned earlier as well as the SNAC footprint. The highest per capita footprint is found in Australia at almost 20.8 ton CO_2 followed by the United States at 18.5, while the lowest is in India with 1.3 ton. The Chinese per capita footprint is 4.2 ton.

12,200 kg Dutch CO_2 emissions in 2009 per capita

The SNAC footprint lies within the range found by other studies. According to the alternative estimates, the Netherlands would rank at most 6 and at least 18 out of the 40 countries distinguished in WIOD, and according to SNAC method the Netherlands would rank 9th. The analysis is of course limited to the countries that are distinguished within WIOD.

9.4.4 Per capita carbon footprint of countries including various estimates for the Netherlands using different data sources (2009)



Source: population data, http://databank.worldbank.org.

9.5 Discussion and conclusions

In this chapter we have shown that the carbon footprint calculations which currently exist in the MRIO literature show an enormous range of estimates for the CO_2 footprint of the Netherlands. The trend and level differ greatly between studies, resulting in a very different rank of Dutch per capita footprint emissions among countries. There is therefore a need to know what the best or most acceptable estimate of the "real" footprint is.

We have developed a new method in which a MRIO (we have chosen WIOD) is adjusted to the Dutch national and environmental accounts in order to create a SNAC ("Single-country National Accounts Consistent") footprint. Of course, the results are still dependent on the WIOD estimates for foreign countries (economic structure and CO_2 emissions) but the domestic part and the trade shares have been adapted to the data from Statistics Netherlands.

The preliminary results show that the Dutch SNAC footprint lies within the range provided by other MRIO estimates for the Netherlands. The SNAC footprint is about 4 percent lower than the result obtained with the unadjusted WIOT because of significantly lower emissions embedded in imports. This is partly explained by the fact that we have used more detailed information to separate re-exports from imports and exports and valuation layers pertaining to trade and transport margins.
These preliminary findings suggest that the emission trade balance for the Netherlands would be positive, although the outcome is subject to uncertainty due to various assumptions inherent in using a MRIO.
This would be in general agreement with earlier analysis (Statistics Netherlands, 2010) where using a unidirectional model we also found a positive emissions trade balance.[3]

[3] Although the carbon footprint was estimated at the time at a mere 187 Mton CO_2

As expected, the allocation of the import emissions to countries is very different due to the use of a MRIO rather than a unidirectional model (Wilting, 2012), as an MRIO model allows us to follow the complete supply chain with the result that the emissions by China increase at the expense of emissions by Germany as the products we import from Germany require German imports from China as well.

There remain, however, several issues that warrant more research. First of all, in the short term the methodology and scripts used will undergo a detailed review before the results can be considered definitive. Second, as Figure 9.2.1 showed, it is very important to investigate the trend in the footprint. Third, a method will have to be created to update the WIOD database since there are no immediate plans to update the database beyond 2009.

There are a number of longer term challenges that may have a significant impact on MRIOs as well as this work at statistical offices. The Industry (ISIC/NACE) and Commodity (CPC/CPA) classifications have undergone revisions recently. The new classifications are now being processed by national accounting departments. The main problem for MRIO work will be the availability of time series of SUTs in the new classification structure. Furthermore, the 2008 SNA has introduced a number of changes in the treatment of 'goods for processing' and merchanting (Van Rossum et al., 2010). These changes have altered the way in which imports and exports are calculated in the national accounts which will therefore also affect footprint calculations.

The SNAC methodology that we have applied here is a potentially promising approach to reconciling the use of a MRIO model (the state of the art) with the official statistics of individual countries. Especially for countries such as the Netherlands that has a large trade sector, including re-exports, the use of official statistics is important, as it greatly affects the magnitude and allocation of the footprint. This procedure could be used to create other globalisation indicators such as "trade in value added" (see the work of the OECD) in a way that is consistent with national accounts.

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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^+.

Asset
A store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of carrying forward value from one accounting period to another.

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.

Capital transfers
Capital transfers are unrequited transfers where either the party making the transfer realizes the funds involved by disposing of an asset (other than cash or inventories), relinquishing a financial claim (other than accounts receivable) or the party receiving the transfer is obliged to acquire an asset (other than cash) or both conditions.

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.

Current transfers
Transactions in which one institutional unit provides a good, service or asset to another unit without receiving from the latter any good, service or asset directly in return as counterpart and does not oblige one or both parties to acquire, or dispose of an asset.

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.

Depletion
In physical terms, is the decrease in the quantity of the stock of a natural resource over an accounting period that is due to the extraction of the natural resource by economic units occurring at a level greater than that of regeneration.

Distributive transactions (D codes)
The D codes appear in all the sequence of accounts from the generation of income account up to and including the capital account. As their name implies, they show the impact of distribution and redistribution of income (and saving in the case of capital transfers). For all

distributive transactions, the receivable entries for all sectors including the rest of the world must balance the payable entries.

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 37, 38 and 39). 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 subsidies and similar transfers
Transfers intended to support activities which protect the environment or reduce the use and extraction of natural resources.

Environmental taxes
Taxes whose tax base is a physical unit (or a proxy of it) of something that has a proven, specific negative impact on 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.

Green growth
Green growth is about fostering economic growth and development while ensuring that the quality and quantity of natural assets can continue to provide the environmental services on which our well-being relies. It is also about fostering investment, competition and innovation which will underpin sustained growth and give rise to new economic opportunities (OECD definition).

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 copper 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 of 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 domestic energy use
Net domestic energy use is equal to the total amount of domestic energy used in an economy through production and consumption activities. This includes all final energy use for energetic and non-energetic purposes plus conversion losses.

Non-residents
All persons and businesses not belonging 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.

Residents
All persons and businesses belonging to the (Dutch) economy. These are people who stay in the Netherlands for more 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 it 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 2012
System of Integrated Economic Environmental Accounting 2012.

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.

Subsidies
Subsidies are current unrequited payments that government units, including non-resident government units, make to enterprises on the basis of the levels of their production activities or the quantities or values of the goods and services that they produce, sell or import.

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.

Authors

Roel Delahaye
Bram Edens
Cor Graveland
Rutger Hoekstra
Wiet Koren
Eefje Lammers
Bob Lodder
Albert Pieters
Maarten van Rossum
Sjoerd Schenau
Marianne Schuerhoff
Jan Pieter Smits
Marcel van Velzen
Marjan Verberk
Joram Vuik
Daan Zult

With contributions from

Kees Baas
Anne Boelens
Ellen Brinksma
Arthur Denneman
Rita Gircour
Otto Swertz