Renewable energy in the Netherlands 2008

Statistics Netherlands

The Hague/Heerlen, 2009

Explanation of symbols

.	= data not available
*	= provisional figure
**	= second provisional figure
x	= confidential figure
–	= nil
–	= (if used between two numbers) up to and including
0 (0,0)	= the number is less than half of the chosen unit
field left blank	= a figure cannot be specifief on logical grounds
2007–2008	= from 2007 to 2008 inclusive
2007/2008	= the average over the years 2007 to 2008 inclusive
2007/'08	= production year, fiscal year, school year etc. beginning in 2007 and ending in 2008
1997/'98–2007/'08	= financial year etcetera from 1997/'98 to 2007/'08 inclusive

W	= watt (1 J/s)
kW	= kilowatt (1,000 J/s)
Wh	= watt-hour (3,600 J)
J	= joule
ton	= 1,000 kg
M	= mega (10^6)
G	= giga (10^9)
T	= tera (10^{12})
P	= peta (10^{15})
a.e.	= natural gas equivalent (1 a.e. is approximately 31.65 MJ)
mln	= million
MW_e	= megawatt electrical capacity
MW_{th}	= megawatt thermal capacity

Due to rounding-off, it may be that the statet totals do not always correspond exactly with the sum of the individual figures.

Publisher
Statistics Netherlands
Henry Faasdreef 312
2492 JP The Hague

Prepress
Statistics Netherlands - Grafimedia

Cover
TelDesign, Rotterdam

Cover photo
W. Bos

Translation
T. Skelton

Information
Telephone + 31 (88) 570 70 70
Telefax + 31 (70) 337 59 94
Via contact form: www.cbs.nl/information

Internet
www.cbs.nl

ISBN: 978-90-357-2068-8

6019801010 C-90

Contents

Foreword 5

Summary 6

1. Introduction 7
- 1.1 Renewable Energy Monitoring Protocol 7
- 1.2 Time of capacity measurement 7
- 1.3 Data sources used 7
- 1.4 History and role of Statistics Netherlands 8
- 1.5 Statistics Netherlands publications on renewable energy and release policy 9
- 1.6 Alerts service 10
- 1.7 Chapter guide 10

2. General overview 11
- 2.1 Total renewable energy 11
- 2.2 Renewable electricity 13
- 2.3 Renewable heat 16
- 2.4 International renewable energy statistics 16
- 2.5 Renewable energy in the Energy Balance 29

3. Hydropower 31

4. Wind energy 32

5. Solar energy 37
- 5.1 Solar electricity 37
- 5.2 Solar heat 39

6. Ambient heat 42
- 6.1 Heat pumps 43
- 6.2 Heat/cold storage 47

7. Biomass 51
- 7.1 Municipal waste incineration plants 52
- 7.2 Co-firing of biomass in power stations 54
- 7.3 Wood stoves for heating in industry 55
- 7.4 Household wood stoves 57
- 7.5 Other biomass combustion 58
- 7.6 Biogas from sewage purification plants 59
- 7.7 Landfill gas 60
- 7.8 Biogas on farms 61
- 7.9 Other biogas 63
- 7.10 Biofuels for road transport 64

8. References 68

Foreword

In this annual report, *Renewable energy in the Netherlands 2008,* Statistics Netherlands (CBS) presents a quantitative overview of the production and use of renewable energy, an explanation of the most important developments, and a description of the methods used to derive the figures.

The annual report describes different sources of renewable energy, such as wind energy, solar energy, biomass co-firing in power stations, and the use of biofuels in road transport. The report also considers the relationship between renewable energy statistics, Statistics Netherlands' Energy Balance Sheet for the Netherlands, CertiQ's green electricity certification system, the international energy assessments of the International Energy Agency (IEA) and Eurostat, and national and international policy objectives. The report is primarily intended for anyone who wants to know the details of developments in renewable energy, and how the relevant figures should be interpreted.

In 2008, the total contribution of renewable energy to the overall energy supply in the Netherlands was 3.4 percent. This is approximately half of a percent point more than in 2007. The increase was mainly caused by an increase in the generation of renewable electricity, from 6.0 to 7.5 percent of all electricity use. The increase in renewable heat and renewable transport fuels was considerably smaller.

This is the sixth year in a row that Statistics Netherlands has compiled this report. In previous years it has always appeared around 1 December, with figures for the preceding year. This year Statistics Netherlands has moved the publication date forward by three months, so that users have the information sooner. The downside of this is that the figures for last year are still provisional. Experience from previous years, however, teaches us that usually the differences between the provisional and definite figures are limited. The definite figures for 2008 are expected to be published on Statistics Netherlands' website in November.

Statistics Netherlands would like to thank everyone involved in gathering the figures and drafting the report. Firstly, all those who reported their figures by completing the survey questionnaires, and who, where necessary, provided additional explanations. Secondly, those organisations which helped us by making their information and expertise available: CertiQ, SenterNovem, TNO, the Heat Pumps Foundation (*Stichting Warmtepompen*), VERAC (the trade association for suppliers of air conditioning equipment), IF Technology, Holland Solar, the provincial governments, the Dutch Ministry of Housing, Spatial Planning and the Environment Inspectorate (VROM-inspectie), the University of Utrecht, and Wind Service Holland (WSH). Thirdly, we would like to thank SenterNovem for financial support for the translation into English.

Director General of Statistics
G. van der Veen

The Hague/Heerlen, September 2009

Summary

Consumption of renewable energy in the Netherlands rose from 2.9 to 3.4 percent of total energy use in 2008. This was mainly the result of an increase in the production of renewable electricity, from 6.0 to 7.5 percent of total electricity use. This increase was primarily electricity generated from biomass and wind energy.

Just as in previous years, many new large wind turbines became operational in 2008. Installed wind capacity rose particularly sharply as a result of a new offshore wind farm. Wind energy now accounts for approximately one third of all renewable energy used in the Netherlands.

The increase in electricity production from biomass was achieved through a rise in co-firing biomass in power stations, and also through the opening of two medium-sized installations for combustion of wood waste, and one medium-sized installation for burning chicken manure.

The proportion of biofuels used in road transport increased slightly, from 2.8 to 3.0 percent of all petrol and diesel consumed in 2008. Suppliers of petrol and diesel were required to ensure that 3.25 percent of the fuels they sold in 2008 were biofuels. Slightly less biofuel was used in 2008 than required, therefore. The main reason for this was that considerably more than the required quantity was used in 2007. Suppliers were able to carry this extra amount over to the following year.

The use of renewable heat also grew only slightly: from 2.0 to 2.1 percent of the required quantity of useful heat. This rise was mainly due to an increase in the use of heat and cold from ambient air and from the ground using heat pumps and heat/cold storage.

1. Introduction

Renewable energy has been spearheading Dutch energy policy for some years. Part of this drive includes an annual report on renewable energy in the Netherlands. This report describes the developments in 2008. The methods and sources used are also described.

1.1 Renewable Energy Monitoring Protocol

In calculating renewable energy a number of choices must be made, such as which energy sources count, and how the different forms of energy are counted. These choices have been made in consultations between trade associations, institutes, and the Ministry of Economic Affairs, and are set out in the Renewable Energy Monitoring Protocol (SenterNovem, 2006).

The method used for calculating renewable energy is the substitution method. This essentially consists of two steps. The first is to determine the production of useful forms of energy (electricity, heat and gas) from the different renewable energy sources. The second is to calculate the avoided use of primary fossil energy (such as natural gas and coal). This is the amount of energy that would be needed using conventional (reference) technologies to produce the same quantity of energy as with renewable technologies. The protocol describes the reference technology for each renewable energy source, and gives the key figures necessary for efficient calculation of the useful energy production from the renewable technology (such as electricity production per installed capacity of solar panel).

According to the protocol, net electricity and heat production is used to calculate renewable energy. Therefore, wherever electricity and heat production are discussed in this report, it can be assumed that this always means net production, even though it is not mentioned explicitly each time.

As a result of new developments and insights in the field of renewable energy, the protocol is adapted on a regular basis. The first version appeared in 1999, the second in 2002, the third in 2004, and the fourth at the end of 2006. A fifth version is currently in progress.

1.2 Time of capacity measurement

A capacity is given for several renewable energy technologies. This is frequently the electrical and/or thermal capacity, and sometimes also the surface area. The reference date for this capacity is December 31 of the reporting year. With large increases in capacity, such as with wind energy, the average capacity in a certain year can deviate substantially from the capacity at the end of the year. In assessing production per capacity in particular, this has to be taken into account.

1.3 Data sources used

The figures are based on a diverse range of data sources. One important source is the CertiQ administration, part of the national grid operator, TenneT. CertiQ receives monthly statements from the regional grid operators, detailing electricity production at the majority of installations that produce renewable power. For wind turbines and hydropower installations the renewable electricity production is known immediately. For renewable electricity production from the co-firing of biomass in power stations, in addition to electricity production we also need to know what percentage of this is renewable at each relevant power station. The owners of the power stations send these percentages separately to CertiQ. Then they must also submit an auditor's certificate confirming the correctness of the data. Corrections may follow. On the basis of the renewable electricity production determined by CertiQ, CertiQ issues renewable electricity certificates. These are used to obtain subsidies from EnerQ (up to and including 2008) or from SenterNovem (as from 2008). The certificates can also be used to sell renewable electricity to end-users, or to trade.

A second important source comes from regular Statistics Netherlands (CBS) energy surveys. For biofuels for road transport, waste incineration plants and for other biogas these surveys are the most important source. For biogas from sewage purification plants we use Statistics Netherlands' Wastewater Purification survey. For solar electricity, solar thermal, heat pumps and heat from wood-burning stoves for commercial properties, specific questionnaires are sent out to the suppliers of the relevant systems. For heat/cold storage, use is primarily made of data about licences issued by the provinces under the groundwater law.

The biomass share of the combusted waste in waste incineration plants comes from SenterNovem. The landfill gas data come from the landfill gas survey of the Waste Registration Working Group (WAR – *Werkgroep Afvalregistratie*), comprised of SenterNovem and the Dutch Waste Management Association (VA – *Vereniging Afvalbedrijven*). The Heat Pumps Foundation (*Stichting Warmtepompen*) and the Air Conditioning Equipment Suppliers Association (VERAC – *Vereniging van Leveranciers van Airconditioning Apparatuur*) provide the sales data from their members. The data regarding domestic wood-burning stoves come from TNO.

As a check and to verify accuracy, use is also made of data about waste incineration plants from the Waste Registration Working Group (WAR), the environmental annual reports of the electricity power stations and waste incineration plants, company reports under the terms of the Biofuels Decision (VROM Inspectorate), Energy Investment Allowance (EIA – *Energie-investeringsaftrek*) data from SenterNovem about biomass installations, and data from Wind Service Holland (WSH) on the installed capacity of wind energy. The use of these sources is outlined in more detail in chapters 3 to 7.

1.4 History and role of Statistics Netherlands

In the 1990s several parties published data about renewable energy. Mutually agreed harmonisation, which resulted in among other things the first Renewable Energy Monitoring Protocol, has reduced the differences. Up to and including the 2002 reporting year, the Ecofys consultancy published an annual report in cooperation with Novem. In this they cooperated with Statistics Netherlands, KEMA and a number of other parties. As from 2003, Statistics Netherlands, financed by the Ministry of Economic Affairs, has been responsible for the complete observance and reporting of renewable energy in the Netherlands. Two important reasons for the shift from Ecofys to Statistics Netherlands are:

1. Under the Statistics Netherlands (CBS) Act, Statistics Netherlands has, in principle, access to all governmental and semi-governmental administrative data collected for the implementation of legal tasks (including CertiQ's renewable electricity certificates files and SenterNovem subsidies).
2. The increasing prominence of renewable energy in the Netherlands means that it is also becoming more important to integrate this into the Statistics Netherlands Energy Balance in the most effective way possible.

In recent years Europe has become more and more important in renewable energy policy. As a result, European statistics are also becoming increasingly important. Statistics Netherlands is responsible for providing Dutch data for the majority of official European statistics. This also applies to energy statistics, which are compiled by Eurostat in close cooperation with the International Energy Agency (IEA). Until 1 January 2009, European energy statistics were compiled on the basis of a gentleman's agreement. To ensure quality and timeliness, these agreements were converted into formal legislation, which became effective on 1 January 2009 (European Parliament and the Council, 2008). This legislation also applies to renewable energy statistics. This legal obligation means that the structural resources of Statistics Netherlands have been extended to compiling renewable energy statistics. A specific contract from the Ministry of Economic Affairs regarding renewable energy statistics is therefore no longer necessary.

1.5 Statistics Netherlands publications on renewable energy and release policy

StatLine

StatLine is Statistics Netherlands' electronic database in which virtually all published figures are found, including a short explanation of the methodology. Currently there are nine StatLine tables about renewable energy:
1. Renewable energy; avoided primary energy
2. Renewable energy; production and capacity
3. Renewable electricity
4. Biofuels for transport
5. Wind energy per month (only Dutch)
6. Wind energy per province (only Dutch)
7. Wind energy by hub height (only Dutch)
8. Solar electricity; market (only Dutch)
9. Solar thermal: covered collector sales (only Dutch).

The annual renewable energy figures are in principle updated three times per year. In February the provisional figures for renewable electricity appear, and in April provisional total figures for all renewable energy. Both these cover the preceding year. The breakdown of renewable energy is limited because the information from many sources is still insufficiently reliable. A second publication of annual figures occurs in June, when more reliable provisional annual figures are published. For each energy source/ technology combination a provisional figure is available. In November the definite figures are published. The CO_2 figures are still not definite at the end of the year. This is because these are related to CO_2 figures from the Emission Register, which is only finalised later.

For renewable electricity and newly installed covered solar collectors, Statistics Netherlands publishes provisional quarterly figures within three months of the end of each quarter. Provisional figures for wind energy are published on a monthly basis.

Annual report

The report you are now reading is published once a year. The year in the title always refers to the most recent reporting year. Up to and including reporting year 2007, the report was always based on the definite figures, and thus it appeared around 1 December in the year following the most recent reporting year. This report, Renewable Energy in the Netherlands 2008, is based on the second provisional figures for 2008, and can therefore appear three months earlier. Experience shows that the differences between the second provisional figures and the definite figures are mostly quite small. This was the case up to and including the previous version. This report is the first one that is translated into English.

Articles on the website

In addition to the StatLine publications, Statistics Netherlands also publishes articles about renewable energy in its online magazine, and on the Manufacturing and energy theme page. Articles in the online magazine (also available in English) are aimed at the press and the general public. They may be linked to the publication of new figures, or to an analysis of already published figures. In 2009, web articles appeared regarding the provisional figures for renewable electricity in 2008 (Segers and Wilmer, 2009a) and for renewable energy in general (Segers and Wilmer, 2009b). On the theme page, articles can appear both for the press and the general public, and for a more specialised audience. Specialised articles go into more depth on certain aspects of the statistics. In April 2009 an article appeared about the methodological aspects of a Statistics Netherlands Windex (Segers, 2009a). This will be discussed in more detail in chapter 4. In the same month another article appeared on solar electricity (Wilmer and Segers, 2009). Statistics Netherlands also provides renewable energy indicators for the Environment and Nature Compendium (*Milieu- en Natuurcompendium*, PBL et al., 2009).

Customised tables

Customised tables are made at the request of users, and contain figures that cannot be found in StatLine. In April 2009 a customised table was published with a progression over time of the proportion of renewable energy (1990 to 2008), calculated using gross end use method from the EU directive on renewable energy (Statistics Netherlands, 2009).

Location on Statistics Netherlands' (CBS) website

Almost all information on renewable energy can most quickly be found as follows. Go to Statistics Netherlands' homepage (www.cbs.nl). Under the column *Themes* you will find the theme *Manufacturing and energy*. You then have access (via tables) to the *Figures*, and also to the *Publications* in the area of the topic. If you click on *Figures*, you will see a pre-selection of tables about manufacturing and energy. If you want other tables, then scroll down. There you can click on *All tables about Manufacturing and energy in the databank StatLine*. Open the folder *Energy* and then *Renewable energy*. Here you will find a complete overview of all StatLine tables relating to renewable energy. Below the *Figures* tab you will also have the chance to click on customised tables. Under *Publications* you will find all articles and other publications, such as this report.

On the homepage you can also select *Figures* instead of *Themes,* and thereafter *Figures by theme* (then you will arrive at the above-mentioned selection), or *StatLine database*. If you opt for the latter, you can choose between *searching by keyword* or *selecting by means of the topic tree*. If you choose to *select by means of the topic tree*, you must then click on *Manufacturing and energy*.

1.6 Alerts service

If you want to be kept actively informed about new Statistics Netherlands publications on renewable energy, send an email to DuurzameEnergie@cbs.nl and mention that you wish to be added to the renewable energy statistics mailing list. You can also indicate if you are only interested in specific components, for example wind energy.

1.7 Chapter guide

Chapter 2 gives an overview of all sources of renewable energy. In this chapter there are separate sections about the avoided use of primary fossil energy, renewable electricity, renewable energy, heat, and about international renewable energy statistics. Chapter 3 discusses hydropower; chapter 4 wind energy; chapter 5 solar energy; chapter 6 ambient heat; and chapter 7 biomass.

2. General overview

2.1 Total renewable energy

As part of its Third Energy Bill, the Netherlands has set a target that 10 percent of all energy consumption in 2020 must derive from renewable sources (Ministry of Economic Affairs, 1995). Under a coalition agreement between the CDA, PvdA and the Christenunie, this target has now been raised to 20 percent. In conjunction with the EU, a binding target was set of 14 percent renewable energy for the Netherlands in 2020 (European Parliament and the Council, 2009). However the calculation method applying to the EU target is different from that for the national target (see also 2.4).

Developments

The share of renewable energy in national energy consumption increased to 3.4 percent in 2008 (table 2.1.1). This is mainly due to an increase in the production of renewable electricity from wind energy and biomass.

Table 2.1.1
Use of renewable energy in avoided use of fossil primary energy and avoided emission of CO_2 according to the substitution method of the Protocol Monitoring Renewable Energy (SenterNovem, 2006)

	1990	1995	2000	2005	2006	2007	2008**	2008**
Avoided use of fossil primary energy (PJ)								*Share within renewable energy (%)*
Combination of source and technology								
Hydro power	0.8	0.8	1.2	0.7	0.9	0.9	0.8	0.7
Wind energy	0.5	2.8	6.9	17.2	22.5	28.2	35.1	30.7
Solar								
Solar electricity	0.0	0.0	0.1	0.3	0.3	0.3	0.3	0.3
Solar heat	0.1	0.2	0.4	0.8	0.8	0.8	0.9	0.8
Ambient energy								
Heat pumps	.	0.3	0.6	1.8	2.6	3.4	4.6	4.0
Heat/cold storage	0.0	0.0	0.2	0.5	0.6	0.7	0.8	0.7
Biomass								
Municipal waste, renewable fraction	6.1	6.1	11.4	11.9	12.4	13.0	12.7	11.1
Biomass co-firing in large scale power plants	–	0.0	1.8	30.5	29.4	15.7	19.7	17.3
Wood stoves for heating in industry	1.3	1.6	1.8	1.9	2.1	2.4	2.5	2.2
Household wood stoves	6.2	5.3	5.7	5.5	5.5	5.5	5.5	4.8
Other biomass combustion	0.4	0.6	2.3	4.4	5.3	5.6	9.1	8.0
Landfill gas	0.3	2.1	1.9	1.6	1.5	1.4	1.3	1.1
Biogas from sewage purification plants	1.9	2.2	2.3	2.1	2.1	2.1	2.3	2.0
Biogas on farms [3]				0.1	0.5	1.4	2.8	2.5
Other biogas	0.5	0.8	1.0	1.2	1.4	1.4	1.7	1.5
Biofuels for road transport	–	–	–	0.1	2.0	13.0	14.0	12.3
Type of energy								
Electricity from domestic sources	6.3	10.6	22.0	60.3	65.4	59.0	74.6	65.4
Heat and cold	10.4	10.3	13.7	18.5	20.9	22.6	24.3	21.3
Gas	1.4	1.9	1.9	1.6	1.5	1.3	1.2	1.1
Transport fuels	0.0	0.0	0.0	0.1	2.0	13.0	14.0	12.3
Total use of renewable energy	18.1	22.8	37.6	80.5	89.8	95.9	114.2	100.0
Calculation of the share of renewables in energy supply								
Total energy use in the Netherlands (PJ) [2]	2,702	2,964	3,065	3,311	3,233	3,353	3,330	
Contribution of renewable energy to the national energy balance sheet of Statistics Netherlands (PJ)	31	36	55	94	100	106	125	
Total use of energy in the Netherlands with renewable sources according to the substitution method (PJ)	2,689	2,951	3,048	3,298	3,222	3,343	3,319	
Share of renewables in energy supply (%)	0.7	0.8	1.2	2.4	2.8	2.9	3.4	
Calculation of avoided emissions of CO_2								
Avoided emission of CO_2 due to the use of renewable energy (kton)	1,124	1,454	2,480	5,659	6,138	6,765	7,939	
Total CO_2 emission in the Netherlands (Mton) [1]	159	171	170	176	172	173	.	
Avoided emission of CO_2 due to renewable energy (% of total CO_2 emissions) [1]	0.7	0.9	1.5	3.2	3.6	3.9	4.6	

Source: Statistics Netherlands.

[1] Calculated according to the definitions of the Kyoto Protocol.
[2] Consumption of all energy in the national energy balance sheet of Statistics Netherlands.
[3] Included in other biogas to 2004.

The most important sources of renewable energy are the co-firing of biomass in electricity power stations, wind energy, municipal waste incineration plants, and – since 2007 – also the use of biofuels for road transport. Together, these four sources account for 71 percent of the renewable energy consumed.

Besides breaking it down by source-technology combination, it is also possible to classify renewable energy by the form of energy. Table 2.1.1 identifies four forms of renewable energy: electricity production, heat and cold production, use as gas (landfill gas converted into natural gas, and the final consumption of biogas) and biofuels for road transport. In 1990, heat production was still the most dominant form. However, the rise in renewable electricity production has been much stronger than renewable heat production. As a result, renewable electricity production is now the most important energy form.

In 1990 the percentage of avoided CO_2 emissions (compared to total CO_2 emissions) was still the same as the percentage of avoided primary energy (compared to total energy consumption). However, in recent years the percentage of avoided CO_2 has clearly been higher than the percentage of avoided primary energy. The explanation for this is that the share of renewable electricity has increased within total renewable energy. Electricity generation in the reference situation produces relatively large amounts of CO_2 per consumed amount of primary energy, through the use of coal; this is because the combustion of coal produces a relatively large amount of CO_2 per unit of primary energy.

Method

The avoided use of fossil primary energy was calculated according to the Renewable Energy Monitoring Protocol (SenterNovem, 2006). For renewable electricity production the avoided use of fossil primary energy and the avoided emission of CO_2 was calculated by using a reference: all conventional Dutch electricity production plants. The reference efficiencies and emissions factors were calculated from the Dutch Energy Balance Sheet and the CO_2 emissions calculations related to it (table 2.1.2).

Table 2.1.2
Used reference efficiencies for production of electricity based on exergy [1] and CO_2 emission factors for all non-renewable electricity production

	Efficiency [2]		CO_2 emission factor fuel use for electricity production [3]			
	at production site	at end user	coal and coal products	oil products	natural gas	all non-renewable fuels [4]
	%		*kg/GJ primary energy*			
1990	40.7	39.1	103.4	67.1	56.8	72.9
1991	40.7	39.1	103.9	66.7	56.8	71.1
1992	40.4	38.8	104.3	66.2	56.8	70.1
1993	40.3	38.7	104.8	65.8	56.8	70.0
1994	40.5	38.9	105.2	65.3	56.8	71.5
1995	41.0	39.4	105.6	64.9	56.8	72.5
1996	41.9	40.2	105.9	65.2	56.8	71.1
1997	43.6	41.9	107.7	68.5	56.8	73.1
1998	43.5	41.8	107.5	68.0	56.8	72.0
1999	43.7	42.0	110.0	70.0	56.8	70.7
2000	43.5	41.8	107.4	68.3	56.8	70.7
2001	42.6	40.9	108.0	68.3	56.8	71.1
2002	42.7	41.1	107.9	75.7	56.8	71.2
2003	42.7	41.0	108.3	75.9	56.8	71.6
2004	43.1	41.4	109.1	70.8	56.8	70.6
2005	43.2	41.5	110.8	71.5	56.8	70.7
2006	43.8	42.1	105.9	68.1	56.8	69.5
2007	43.9	42.1	108.2	61.9	56.7	69.8
2008**	43.7	42.0	108.2	61.9	56.7	68.9

Source: Statistics Netherlands.

1) See Protocol Monitoring Renewable Energy (SenterNovem, 2006) for an explanation.
2) Calculated from the national energy balance sheet of Statistics Netherlands according to the Protocol Monitoring Renewable Energy.
3) Calculated from the database for CO_2 emissions of the Pollutant Release and Transfer Register.
4) Coal and coal products, oil products, natural gas and nuclear heat.

One exception to this is installations in which fossil fuels and biomass are fired at the same time (Protocol). For these installations it is assumed that 1 Joule of biomass replaces 1 Joule of fossil fuels. The avoided emission of CO_2 is then calculated by adopting the main fossil fuel at the installation concerned.

2.2 Renewable electricity

The Dutch government has set a target for renewable electricity: 9 percent of electricity consumption in the Netherlands in 2010 must come from renewable sources. This objective stems from the European directive on renewable electricity (Directive 2001/77/EG). In this respect imports may only be counted if the exporting country agrees explicitly with this (Renewable Energy Monitoring Protocol, 2006 and European Commission, 2004). To date, no such agreements have been made by the Netherlands.

This section describes domestic production, subsidies, imports, and renewable electricity certificates.

Domestic production

In 2008, national net renewable electricity production was 7.5 percent of net electricity consumption (table 2.2.1). That is considerably more than the 6.0 percent achieved in 2007. This is the result of an increase in electricity production from wind energy and biomass. Electricity production from wind energy has been growing strongly for years, with the installation of new turbines on land and at sea, and the replacement of smaller turbines with larger models with a higher capacity (chapter 4).

The rise in electricity production from biomass was mainly the result of an increase in the co-firing of biomass in electricity power stations (section 7.2), and the introduction of new medium-sized plants for burning waste wood and chicken manure (section 7.5). Electricity production from biogas produced on farms also increased (section 7.8).

Table 2.2.1
Net renewable electricity production (GWh)

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008**
Wind, of which	56	317	829	825	946	1,318	1,867	2,067	2,733	3,438	4,256
onshore	56	317	829	825	946	1,318	1,867	2,067	2,666	3,108	3,660
offshore	–	–	–	–	–	–	–	–	68	330	596
Hydro	85	88	142	117	110	72	95	88	106	107	102
Solar	0	1	8	13	17	31	33	34	35	36	38
Biomass, of which	579	809	1,695	2,037	2,556	2,225	2,968	4,831	4,715	3,569	4,592
renewable fraction of municipal waste	462	530	1,003	962	942	959	931	1,001	1,029	1,116	1,058
co-fired in large scale power plants	–	4	198	563	1,082	757	1,539	3,310	3,103	1,711	2,181
other biomass combustion	33	35	216	221	216	205	217	235	235	254	667
landfill gas	16	138	153	160	176	166	134	127	123	111	104
biogas from sewage purification plants	64	97	108	115	119	111	126	119	128	139	145
biogas on farms [3]								9	55	173	340
other biogas	4	7	16	16	21	27	21	31	42	65	97
Total renewable [1]	720	1,215	2,674	2,992	3,629	3,645	4,963	7,020	7,589	7,149	8,988
Total net electricity consumption [2]	78,582	88,947	104,943	107,144	108,452	109,965	114,625	114,471	116,085	118,463	119,226
Renewable fraction in net electricity consumption (%)	0.9	1.4	2.5	2.8	3.3	3.3	4.3	6.1	6.5	6.0	7.5

Source: Statistics Netherlands.

[1] Saving of electricity by heat/cold storage is not included.
[2] Including distribution losses, excluding use for electricity production. Calculated as the sum of final use of electricity plus the input for other transformations from the national energy balance sheet of Statistics Netherlands.
[3] Included in other biogas to 2004.

Subsidies

Producing renewable electricity is in many cases a lot more expensive than producing conventional electricity. In order to get projects off the ground, the government subsidises production. The most important scheme is the Environmental Quality of Electricity Production Law (MEP – *Wet Milieukwaliteit Electriciteitsproductie*). Using the MEP, the government subsidises the additional costs of renewable electricity production compared with conventional electricity. This difference is called the 'financial gap'. In 2008, 550 million euro was paid in MEP subsidies for renewable electricity (excluding subsidies for cogeneration (CHP), EnerQ, 2009).

After the implementation of the MEP in mid-2003, its popularity grew strongly. To keep costs under control, in May 2005 the scheme was closed to new applications from the two largest-scale technologies: co-firing of biomass in power stations and offshore wind. In August 2006, the Minister for Economic Affairs closed the MEP completely to new applications. The reason given for this was a large influx of applications, which led to a considerable overshoot of the estimated costs. The minister's estimation now is that the targets for 2010 will be achieved with the current subsidised and unsubsidised projects (Ministry of Economic Affairs, 2006).

As a follow-up to the MEP in 2008, the Ministry of Economic Affairs set up a new subsidy for renewable energy: the renewable energy stimulation scheme (SDE – *stimuleringregeling duurzame energie*). This is broader in scope than the MEP; it also includes projects for green gas. Another important difference is that the number of new projects per year is limited by budget caps per category. Moreover, the subsidy varies annually, depending on the price of electricity.

In 2008 the SDE subsidy was requested for many new projects. But a considerable amount of time can pass between applying for the subsidy and the relevant installation becoming operational. As a result, the impact of the SDE on renewable electricity production in 2008 was very limited. The MEP is closed to new projects; for existing projects the subsidy continues until their time limit expires (usually ten years). For now therefore, the MEP remains an important support for renewable electricity production.

Besides the MEP and the SDE, the Energy Investment Allowance Scheme (EIA – *Energie-investeringsaftrekregeling*) is also available to investors in renewable electricity installations. Using the EIA, investors can get a tax allowance. Many investments in installations producing renewable electricity also fall under the 'green investment' tax regulation. This makes lending money to investors somewhat cheaper.

Renewable electricity certificates

Through CertiQ, national and foreign producers can obtain renewable electricity certificates for their renewable electricity (see also chapter 1). This certificate is necessary to be able to make use of the subsidies for renewable electricity, and it also serves as a guarantee to consumers that the renewable electricity they use is actually 'green'. Under the Renewable Energy Monitoring Protocol it is agreed that imports of renewable electricity are defined as imports of certificates.

Demand for renewable electricity certificates increased to 21.5 thousand GWh in 2008. This is 5 thousand GWh more than the year before, and the equivalent of 18 percent of total electricity consumption. The increased demand is possibly linked to media coverage of climate change and sustainability. Energy suppliers also use the certificates to attract new customers. In addition, there is increasing interest among governments and companies in making their electricity use cleaner (CertiQ, 2009).

The increase in national production of renewable electricity was considerably smaller than the rise in national demand for renewable electricity certificates. For this reason imports of renewable electricity certificates also rose strongly.

From an international perspective there is probably still a surplus of renewable electricity certificates. This is visible in the considerable quantity of expired certificates, and the fact

Table 2.2.2
Imports of renewable electricity via certificates

	Wind	Hydro	Solar	Biomass	Total	
	GWh					*% of net domestic consumption*
2002	36	3,731	–	4,382	8,149	7.5
2003	240	769	–	8,704	9,713	8.8
2004	376	2,570	–	7,516	10,462	9.1
2005	4	8,313	–	1,482	9,799	8.6
2006	–	7,680	–	1,430	9,110	7.8
2007	140	10,684	–	1,447	12,271	10.4
2008**	140	18,409	–	374	18,924	15.9

Source: CertiQ and Statistics Netherlands.

Table 2.2.3
Overview of renewable electricity certificates from CertiQ, excluding certificates for combined heat and power (GWh)

	2002	2003	2004	2005 [2)]	2006	2007	2008
Certificates issued							
Domestic production	2,357	2,648	4,077	6,733	8,198	6,704	9,000
Imports	8,149	9,713	10,462	9,799	9,110	12,271	18,924
Total	10,506	12,362	14,539	16,532	17,308	18,975	27,924
Certificates cancelled	3,662	12,315	16,227	14,791	14,567	16,620	21,530
Certificates expired	6	1,831	297	228	1,227	832	426
Certificates withdrawn [1)]	20	42	119				
Certificates for own consumption	–	–	65	339	305	251	328
Exports	–	–	3	26	186	233	1,476
Stock on 1 January	636	7,456	5,628	3,455	4,580	5,603	6,643
Stock change	6,819	–1,828	–2,173	1,125	1,023	1,039	4,165
Stock on 31 December	7,456	5,628	3,455	4,580	5,603	6,643	10,807

Source: CertiQ.

[1)] From 2005 onwards these are subtracted from certificates issued.
[2)] There is a statistical discrepancy in the net result for 2005. Because of the small amount (20 GWh), the cause was not investigated.

that renewable electricity is not, or is only slightly, more expensive than non-renewable electricity. The reason for the surplus is that in many other countries only the supply side of renewable electricity is stimulated, whereas in the Netherlands the demand side also gets attention by means of offering renewable electricity to end-users. The increase in demand for renewable electricity in the Netherlands has probably not led to an increase in renewable electricity production in the Netherlands or elsewhere in Europe, but only to an increase in the number of existing installations requesting certificates. The question of whether the consumption of renewable electricity also contributes effectively to an increase in production is called the question of 'additionality'.

In 2008 this additionality was discussed several times in the media, against the background of the political process surrounding the new European Directive on renewable energy, which once again set out the rules for renewable electricity certificates. In December 2008 the European Parliament and the European Council (for which read the governments of the EU countries) reached political agreement over this new directive (European Parliament and the Council, 2009). With regard to renewable electricity certificates it was agreed that these would continue to exist, in order to give end-users the chance to make their electricity consumption greener. However, the international trade in certificates will play no role in determining whether or not each country achieves its obligatory targets. Under certain conditions however, it is possible for countries to trade in renewable electricity (statistical transfers). This happens at national level, and is separate from the certificates.

The quantity of renewable electricity certificates issued for national production (table 2.2.3) has, up to and including 2005, always been lower than the total national production of renewable electricity (table 2.2.1). In 2005, the difference was still 1,000 GWh. This occurred largely because most waste incineration plants did not request renewable electricity certificates, whereas their renewable electricity production was counted in the renewable energy statistics. However, in recent years a large number of municipal waste incineration plants have requested certificates, and the difference between the certificates for national renewable electricity production (9,000 GWh in 2008), and actual total national renewable electricity production (8,988 GWh in 2008) has almost disappeared.

Besides this, differences between the renewable electricity certificates system and renewable electricity production also originate from the time difference between effective production and the issue of the certificate. This explains why the production according to the certificates is sometimes a little higher than effective production, and sometimes a little lower. Another cause of the differences is that certificates are mainly issued based on gross production, whereas the renewable energy statistics refer to net production (Renewable Energy Monitoring Protocol, SenterNovem, 2006). The difference between net and gross production can be several percent (see also section 2.4).

2.3 Renewable heat

In previous renewable energy annual reports, renewable heat was always expressed in avoided primary energy. This calculation method made mutual comparison of renewable sources possible. It was, however, not possible to calculate the share of renewable heat in the total heat supply. With the help of the Dutch National Heating Expertise Centre (*Nationaal Expertisecentrum Warmte*) and in consultation with the Energy Research Centre of the Netherlands (ECN) Statistics Netherlands has developed a method for calculating the share of renewable heat (Segers, 2009b). It was decided to calculate renewable heat as useful heat production, in accordance with the calculation method for the percentages of renewable electricity and renewable fuels for road transport. Useful heat is the heat available after conversion losses in boilers, transport losses outside the home or business property, and that is used for heating.

Table 2.3.1
Useful renewable heat and cold (TJ)

	1995	2006	2007	2008**
Solar heat	137	599	623	654
Heat pumps	182	2,240	3,030	4,091
Heat/cold storage	28	547	633	738
Municipal waste, renewable fraction	1,227	3,537	3,519	3,593
Biomass co-firing in large scale power plants	1	469	698	684
Houeshold wood stoves	5,068	5,191	5,191	5,191
Wood stoves for heating in industry	1,472	1,930	2,144	2,257
Other biomass combustion	337	3,078	3,262	3,307
Biogas	2,825	2,370	2,216	2,209
Total	11,277	19,961	21,316	22,724
Total production of useful heat	1,169,000	1,093,000	1,069,000	1,093,000
Share of renewable heat	1.0	1.8	2.0	2.1

Source: Statistics Netherlands.

The renewable share of useful heat production in recent years was approximately 2 percent. That is less than the proportion of renewable electricity, which grew from 6.5 percent of consumption in 2006 to 7.5 percent in 2008. An important difference with renewable electricity is that there are fewer subsidies available for renewable heat. That partly explains why the production of renewable electricity grew faster.

The biggest contributions to renewable heat come from wood-burning stoves in households (almost a quarter), heat pumps (almost a fifth) and municipal waste incineration plants (one sixth). Renewable heat production has grown in recent years largely as a result of an increase from heat pumps.

2.4 International renewable energy statistics

International energy statistics are compiled by Eurostat, the International Energy Agency (IEA) and the UN. They are based on data that member states send to these organisations. In European energy policy, renewable energy statistics play an important role in whether or not targets are achieved.

Targets

The European Union set its first target for renewable energy in 1997: 12 percent of primary energy consumption in 2010 must come from renewable sources (European Commission, 1997). This target was not set out in formal legislation.

Later, a specific target was set for renewable electricity (European Parliament and the Council, 2001). This is an indicative target for the proportion of electricity that should come from renewable sources. For the entire EU this was set at 21 percent of total gross electricity consumption, to be achieved in 2010. There are separate individual targets for each country, because geographical circumstances can vary enormously (see also table 2.4.1).

There is also a separate target for biofuels in road transport (European Parliament and the Council, 2003). This is expressed as the proportion of biofuels in the total energy content of all petrol and diesel on the market. The target percentages are 2 for 2005, and 5.75 in 2010.

In March 2007 the heads of government agreed that in 2020, 20 percent of the overall energy supply should come from renewable energy, and that this target would be defined with binding legislation. In early 2008 the European Commission published a proposal for this legislation (European Commission, 2008). In 2008, the Council (for which read the governments of the EU countries) and the European Parliament debated this proposal and formulated amendments. At the end of 2008 they reached a political compromise over the amendments. In June 2009 the renewable energy directive was officially published (European Parliament and the Council, 2009).

In the renewable energy directive, separate targets have been agreed for each country, just as in the directive for renewable electricity. This distinction was made because of differences in geographical circumstances, differences in wealth, and differences in efforts made towards renewable energy in the past. For the Netherlands, the European agreement is that in 2020, 14 percent of gross final energy consumption must come from renewable sources.

For renewable energy use for transport, the renewable energy directive has set a separate target: namely 10 percent of the total consumption in 2020. This is the same for every country. There was a great deal of discussion about this target (see also 7.10). As a result, the directive outlines sustainability criteria which liquid biomass must satisfy. These criteria apply both to the target for total renewable energy, and to the target for energy use in transport. At this time it is not yet clear exactly how the sustainability criteria will be measured. A balance must be made between administrative costs on the one hand and accuracy on the other.

For renewable electricity no separate targets have been set. However, the member states are obliged to draw up action plans in which renewable electricity must explicitly be taken into account. This also applies to renewable heat.

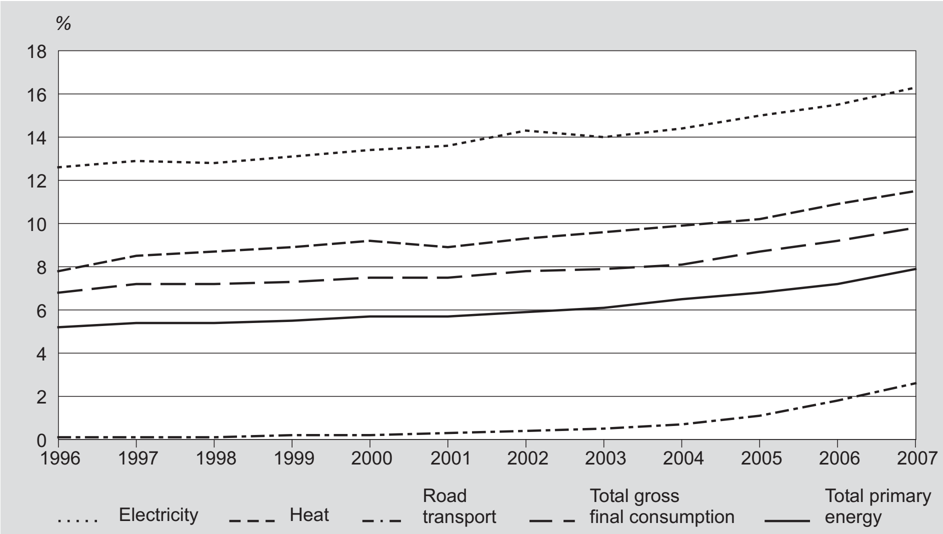
There are several ways to calculate the proportion of renewable energy. For the 2010 targets set in 1997, it was decided to use primary energy consumption as defined in the Eurostat and IEA energy statistics. The 2009 renewable energy directive has opted for gross final energy consumption. Calculations using this method lead to higher renewable energy percentages. There are two main reasons for this. Firstly, hydropower (an important source of renewable energy) and wind energy give a relatively low figure using the primary energy method. Secondly, in the gross final energy consumption method of the directive, non-energetic use of energy (for example in the production of plastics) is excluded from the calculation. As a result the denominator in the calculation becomes smaller, whereas the numerator does not, because non-energetic use of renewable energy does not exist within the definitions of the energy statistics. The different methods will be discussed in more detail in the 'methods' section.

There has been a great deal of political discussion about the target for transport fuels (10 percent in 2020). The result of those discussions is a complex calculation method for the proportion of renewable energy in transport energy consumption. Elements of this target are (i) an extension of the base to include the use of electricity for transport (now primarily trains), where in the numerator, part of the electricity used is counted as renewable, (ii) a bonus factor of 2.5 for the use of electricity in road transport, and (iii) the double counting of certain renewable biofuels.

Developments

The contribution of renewable energy to European energy supplies has been increasing slowly for years. Since 2003 this rate of growth has increased, but it is clear that at the current rate, the 2010 targets will not be achieved (figure 2.4.1).

2.4.1 Share of renewable energy in the EU-27. Hydropower and wind energy are normalised according the procedures in the new EU directive



Source: Eurostat and calculations by Statistics Netherlands.

The contribution to electricity from renewable sources is relatively the largest in the electricity, heat and transport sectors. The share of renewable sources in electricity was approximately 16 percent in 2007. This is mainly accounted for by hydropower, which has been a very important source of electricity production in some countries for many years (table 2.4.1). Hydropower is responsible for almost two-thirds of renewable electricity production in the EU. The increase in renewable electricity production has not, however, come from hydropower, but from wind energy and biomass. Many new wind turbines have been installed, especially in Germany, Spain and Denmark. Solar electricity is mainly generated in Germany and Spain. In Germany the contribution of solar electricity to the total electricity supply is 0.5 percent.

In the Netherlands renewable electricity production is approximately half the European average. This is mainly due to an almost complete lack of hydropower. If hydropower is not taken into consideration, the contribution of renewable sources to electricity supplies is above the European average. Renewable electricity production in table 2.2.1 is lower than that in table 2.4.1, mainly because Eurostat does not yet count the biomass content of municipal waste. See also the further explanation in the ‘methods’ section, below.

In terms of gross final energy consumption, heat is a lot more important than electricity. The contribution of renewable energy to total heat supplies is a lot lower than to electricity, and was 11.5 percent in 2007 in the EU. More than half of renewable heat comes from the combustion of wood in households, something that is relatively insignificant in the Netherlands (table 2.4.2). That is therefore the main reason why the proportion of renewable heat in the Netherlands is low compared to the rest of Europe.

Table 2.4.1
Gross production of renewable electricity, based on the database on the website of Eurostat

		Hydro, not norma-lised 1)	Hydro, norma-lised 1)2)	Wind, not norma-lised	Wind, norma-lised 2)	Solar	Geo-thermal	Municipal waste 3)	Solid biomass	Biogas	Liquid biomass	Total rene-wable 1)2)	Total gross consump-tion of electri-city 1)	Rene-wable share 1)2)
		GWh										TWh		%
Belgium	2006	359	356	363	343	2	–	1,090	1,406	279	227	3.7	94	3.9
	2007	389	365	491	457	6	–	805	1,818	289	195	3.9	94	4.2
Bulgaria	2006	4,238	2,507	20	20	–	–	–	–	–	–	2.5	38	6.7
	2007	2,874	2,663	47	41	–	–	–	–	–	–	2.7	38	7.0
Cyprus	2006	–	–	–	–	1	–	–	–	–	–	0.0	5	0.0
	2007	–	–	–	–	2	–	–	–	–	–	0.0	5	0.0
Denmark	2006	23	23	6,108	6,178	2	–	1,830	1,777	272	44	10.1	39	26.2
	2007	28	23	7,173	6,463	2	–	1,760	1,829	271	–	10.3	38	27.1
Germany	2006	19,931	20,339	30,710	30,216	2,220	–	7,278	6,518	6,155	1,314	74.0	612	12.1
	2007	20,904	16,957	39,713	34,825	3,075	–	8,260	10,381	8,520	2,917	84.9	613	13.9
Estonia	2006	13	14	76	83	–	–	–	25	13	2	0.1	9	1.5
	2007	21	15	91	106	–	–	–	24	12	–	0.2	10	1.6
Finland	2006	11,494	13,784	156	158	3	–	294	10,538	27	–	24.8	94	26.5
	2007	14,177	13,743	188	188	4	–	369	9,661	29	–	24.0	94	25.6
France	2006	56,659	65,916	2,189	2,150	12	–	3,228	1,250	551	.	73.0	506	14.4
	2007	58,706	65,154	4,052	3,817	17	–	3,506	1,390	638	.	74.5	508	14.7
Greece	2006	6,048	3,916	1,699	1,677	1	–	–	–	114	–	5.7	65	8.8
	2007	2,591	3,950	1,818	2,086	1	–	–	–	184	–	6.2	67	9.3
Hungary	2006	186	184	43	39	–	–	187	1,134	37	–	1.6	43	3.7
	2007	210	187	110	93	–	–	282	1,374	47	–	2.0	44	4.5
Ireland	2006	724	757	1,622	1,498	–	–	–	8	121	–	2.4	29	8.2
	2007	667	748	1,958	1,945	–	–	–	13	119	–	2.8	29	9.7
Italy	2006	36,994	41,592	2,971	3,111	35	5,527	2,917	2,312	1,336	–	56.8	353	16.1
	2007	32,816	40,916	4,034	4,002	39	5,569	3,025	2,298	1,447	–	57.3	355	16.2
Latvia	2006	2,698	2,902	46	45	–	–	–	7	35	–	3.0	7	40.4
	2007	2,733	2,910	53	49	–	–	–	5	38	–	3.0	8	38.6
Lithuania	2006	397	428	14	16	–	–	–	19	5	–	0.5	12	4.0
	2007	421	424	106	85	–	–	–	48	5	–	0.6	12	4.7
Luxemburg	2006	103	128	58	53	21	–	57	–	33	–	0.3	7	4.1
	2007	107	130	64	55	21	–	66	–	37	–	0.3	7	4.3
Netherlands	2006	106	100	2,733	2,540	35	–	2,777	1,840	361	1,660	9.3	120	7.8
	2007	107	99	3,438	3,176	36	–	2,960	1,970	511	124	8.9	121	7.3
Austria	2006	34,878	38,429	1,752	1,724	15	3	503	2,554	68	60	43.4	68	64.1
	2007	35,993	38,956	2,015	1,909	17	3	365	3,312	85	75	44.7	68	66.2
Poland	2006	2,042	2,333	256	325	–	–	–	1,851	160	–	4.7	150	3.1
	2007	2,352	2,346	522	525	–	–	–	2,360	195	–	5.4	153	3.5
Portugal	2006	11,002	10,613	2,925	2,937	5	85	586	1,380	33	–	15.6	54	28.9
	2007	10,092	10,906	4,037	4,096	24	201	551	1,530	65	–	17.4	54	31.9
Romania	2006	18,356	16,386	1	1	–	–	–	4	–	–	16.4	58	28.1
	2007	15,966	16,710	3	2	–	–	–	34	2	–	16.7	60	28.1
Slovenia	2006	3,591	4,177	–	–	–	–	–	76	35	–	4.3	15	28.3
	2007	3,266	4,125	–	–	–	–	–	63	48	–	4.2	15	27.7
Slovakia	2006	4,399	4,222	6	8	–	–	47	367	8	–	4.7	29	16.1
	2007	4,451	4,386	8	5	–	–	45	441	11	–	4.9	30	16.5
Spain	2006	25,890	31,153	23,297	23,828	125	–	814	1,570	666	–	58.2	292	19.9
	2007	27,763	31,713	27,509	28,983	509	–	1,474	1,553	608	–	64.8	294	22.0
Czech Republic	2006	2,550	1,975	49	37	1	–	19	731	176	–	2.9	71	4.1
	2007	2,089	2,011	125	103	2	–	20	968	215	–	3.3	72	4.6
United Kingdom	2006	4,593	4,857	4,225	4,114	10	–	1,734	3,324	4,881	7	18.9	402	4.7
	2007	5,089	4,765	5,274	5,167	11	–	1,885	2,920	5,195	–	19.9	397	5.0
Sweden	2006	61,722	67,905	987	972	–	–	1,419	7,503	46	243	78.1	149	52.3
	2007	66,160	68,681	1,430	1,250	–	–	1,851	8,496	64	167	80.5	150	53.6
EU-27	2006	308,996	334,996	82,306	82,073	2,488	5,615	24,780	46,194	15,412	3,456	515.0	3,322	15.5
	2007	309,972	332,880	104,259	99,429	3,766	5,773	27,224	52,488	18,635	3,461	543.7	3,338	16.3

Source: Eurostat, calculations Statistics Netherlands.

1) Excluding pumped storage.
2) Hydro and wind are normalised according to the procedures from the EU directive on renewable energy.
3) Including the non-renewable fraction.

Table 2.4.2
Renewable heat in the EU, based on the database on the website of Eurostat

		Final use (excl. transport and excl. electricity)							Sold heat from renewable sources	Total gross final consump-tion of renewable heat	Total gross final consump-tion of heat	Share of renewable heat
		Solar	Geo-thermal	Solid biomass in house-holds	Solid biomass not in house-holds	Biogas	Municipal waste [1]	Liquid biomass				
		TJ								*PJ*		%
Belgium	2006	138	74	8,777	19,519	477	–	481	211	30	904	3.3
	2007	193	61	8,363	18,621	156	–	407	229	28	767	3.7
Bulgaria	2006	–	1,368	26,587	4,199	–	–	–	27	32	219	14.7
	2007	–	1,368	25,415	2,864	–	–	–	1	30	212	14.0
Cyprus	2006	1,812	–	209	66	1	–	–	–	2	23	9.0
	2007	2,240	–	369	113	6	–	–	–	3	24	11.4
Denmark	2006	381	–	32,329	6,671	1,054	2,877	–	39,657	83	336	24.7
	2007	411	–	39,009	6,917	1,149	2,427	–	40,256	90	330	27.3
Germany	2006	11,783	6,400	192,554	57,896	–	–	–	43,827	312	4,826	6.5
	2007	13,199	7,700	208,000	60,373	–	–	–	48,356	338	4,382	7.7
Estonia	2006	–	–	12,107	4,798	28	–	–	3,750	21	64	32.4
	2007	–	–	15,862	4,568	49	–	–	3,324	24	70	34.2
Finland	2006	26	–	41,240	142,532	533	951	–	58,761	244	618	39.5
	2007	26	–	40,800	145,515	708	1,160	–	52,279	240	601	40.0
France	2006	1,153	5,442	317,482	71,112	3,778	21,632	–	9,433	430	2,980	14.4
	2007	1,485	5,442	303,620	72,571	3,848	24,632	–	9,474	421	2,805	15.0
Greece	2006	4,568	474	29,393	9,597	251	–	–	–	44	354	12.5
	2007	6,687	602	31,696	10,379	105	–	–	–	49	353	14.0
Hungary	2006	82	3,405	21,689	10,050	115	–	–	1,164	37	443	8.2
	2007	104	3,379	22,423	8,018	198	–	–	1,424	36	397	9.0
Ireland	2006	23	42	703	6,859	188	–	–	–	8	229	3.4
	2007	52	87	943	6,537	158	–	–	–	8	220	3.5
Italy	2006	1,457	8,916	68,400	16,500	–	–	1,608	12,543	109	2,545	4.3
	2007	2,186	8,916	58,001	14,000	–	–	1,646	9,639	94	2,587	3.6
Latvia	2006	–	–	31,647	11,038	88	–	–	4,453	47	110	42.8
	2007	–	–	30,931	11,006	85	–	–	4,301	46	109	42.7
Lithuania	2006	–	–	18,096	5,348	41	–	–	5,651	29	115	25.3
	2007	–	–	16,809	5,326	55	–	–	5,726	28	112	25.0
Luxemburg	2006	7	–	650	–	–	–	–	186	1	51	1.7
	2007	8	–	650	–	–	–	–	209	1	50	1.7
Netherlands	2006	812	–	9,586	5,252	2,750	–	–	5,099	23	1,120	2.1
	2007	843	–	9,586	5,649	2,656	–	–	5,453	24	1,130	2.1
Austria	2006	4,157	240	74,197	47,907	373	–	439	19,459	147	591	24.8
	2007	4,457	240	66,522	50,365	398	–	439	24,029	146	550	26.6
Poland	2006	11	535	104,500	66,333	577	1,650	–	3,848	177	1,605	11.1
	2007	15	439	95,000	69,095	375	1,812	–	4,717	171	1,551	11.1
Portugal	2006	988	430	48,600	56,974	–	–	–	–	107	307	34.8
	2007	1,071	430	48,600	58,680	–	–	110	–	109	311	35.0
Romania	2006	–	563	107,639	19,738	–	–	–	2,616	131	747	17.5
	2007	1	1,088	112,254	22,356	29	–	–	751	136	700	19.5
Slovenia	2006	–	–	13,573	3,972	81	–	–	349	18	97	18.6
	2007	–	–	13,573	3,404	72	–	–	348	17	85	20.4
Slovakia	2006	–	67	1,290	10,205	201	–	–	1,698	13	297	4.5
	2007	–	68	1,643	13,613	95	–	–	2,113	18	278	6.3
Spain	2006	3,064	322	85,036	69,394	2,633	–	–	–	160	1,410	11.4
	2007	3,876	322	85,256	69,450	2,677	–	–	–	162	1,448	11.2
Czech Republic	2006	128	–	40,138	17,854	1,021	842	–	3,253	63	659	9.6
	2007	152	–	46,606	18,361	1,081	911	–	3,364	70	621	11.3
United Kingdom	2006	1,519	33	11,339	5,918	2,250	4,261	–	–	25	2,745	0.9
	2007	1,879	33	12,600	6,266	2,472	5,014	–	–	28	2,639	1.1
Sweden	2006	241	–	24,952	178,983	–	–	–	106,435	311	578	53.8
	2007	360	–	25,260	185,708	–	–	–	110,103	321	571	56.3
EU-27	2006	32,350	28,311	1,322,713	848,715	16,440	32,213	2,528	322,420	2,606	23,975	10.9
	2007	39,245	30,175	1,319,791	869,755	16,372	35,956	2,602	326,095	2,640	22,901	11.5

Source: Eurostat, calculations Statistics Netherlands.

[1] Including the non-renewable fraction.

Table 2.4.3
Consumption of biopetrol and biodiesel for road transport, based on the database on website of Eurostat

		Biopetrol	Biodiesel [1)]	Total biopetrol and biodiesel	Total use of petrol and diesel for road transport	Share of renewable energy in use of petrol and diesel for road transport
		TJ			*PJ*	%
Belgium	2006	–	–	–	333	–
	2007	–	3,643	3,643	340	1.1
Bulgaria	2006	–	216	216	87	0.2
	2007	–	96	96	83	0.1
Cyprus	2006	–	–	–	26	–
	2007	–	37	37	28	0.1
Denmark	2006	160	–	160	175	0.1
	2007	240	–	240	183	0.1
Germany	2006	13,722	131,441	145,163	2,192	6.6
	2007	12,402	154,811	167,213	2,140	7.8
Estonia	2006	–	–	–	30	–
	2007	–	–	–	31	–
Finland	2006	28	–	28	168	0.0
	2007	55	–	55	173	0.0
France	2006	6,219	23,894	30,113	1,761	1.7
	2007	11,688	49,984	61,672	1,778	3.5
Greece	2006	–	1,914	1,914	269	0.7
	2007	–	3,562	3,562	283	1.3
Hungary	2006	456	–	456	179	0.3
	2007	1,126	74	1,200	177	0.7
Ireland	2006	24	73	97	185	0.1
	2007	145	744	889	194	0.5
Italy	2006	–	6,732	6,732	1,571	0.4
	2007	–	5,909	5,909	1,575	0.4
Latvia	2006	54	74	128	42	0.3
	2007	–	74	74	48	0.2
Lithuania	2006	214	589	803	48	1.7
	2007	459	1,739	2,198	59	3.7
Luxemburg	2006	–	37	37	93	0.0
	2007	27	1,472	1,499	91	1.6
Netherlands	2006	784	950	1,734	464	0.4
	2007	3,696	9,324	13,020	472	2.8
Austria	2006	–	5,417	5,417	320	1.7
	2007	721	8,418	9,139	324	2.8
Poland	2006	2,305	1,472	3,777	449	0.8
	2007	3,002	1,030	4,032	502	0.8
Portugal	2006	–	2,923	2,923	256	1.1
	2007	–	5,550	5,550	255	2.2
Romania	2006	–	–	–	166	–
	2007	–	1,692	1,692	169	1.0
Slovenia	2006	–	74	74	63	0.1
	2007	–	552	552	71	0.8
Slovakia	2006	54	1,815	1,869	72	2.6
	2007	516	3,205	3,721	80	4.7
Spain	2006	4,814	2,374	7,188	1,358	0.5
	2007	4,760	11,417	16,177	1,406	1.2
Czech Republic	2006	54	742	796	234	0.3
	2007	–	1,261	1,261	245	0.5
United Kingdom	2006	2,010	5,483	7,493	1,664	0.5
	2007	3,243	11,224	14,467	1,685	0.9
Sweden	2006	6,049	1,981	8,030	306	2.6
	2007	7,636	4,276	11,912	313	3.8
EU-27	2006	36,945	188,201	225,146	12,515	1.8
	2007	49,714	280,096	329,810	12,709	2.6

Source: Eurostat, calculations Statistics Netherlands.

1) Including the use of other liquid biomass for road transport.

Table 2.4.4
Gross final consumption [1] of renewable energy, based on the database on the website of Eurostat in May/June 2009

		Renewable electricity [2]	Renewable heat	Renewable transport fuels	Total gross final energy [3] consumption	Renewable share in gross final energy consumption [3]	
						Without transport fuels	With transport fuels
		PJ				*%*	
Belgium	2006	13	30	–	1,627	2.6	2.6
	2007	14	28	4	1,489	2.8	3.1
Bulgaria	2006	9	32	0	463	8.9	9.0
	2007	10	30	0	453	8.7	8.7
Cyprus	2006	0	2	–	69	3.0	3.0
	2007	0	3	0	72	3.8	3.8
Denmark	2006	36	83	0	695	17.2	17.2
	2007	37	90	0	696	18.3	18.3
Germany	2006	267	312	145	9,566	6.1	7.6
	2007	306	338	167	9,090	7.1	8.9
Estonia	2006	0	21	–	128	16.6	16.6
	2007	1	24	–	139	17.5	17.5
Finland	2006	89	244	0	1,156	28.8	28.8
	2007	86	240	0	1,147	28.5	28.5
France	2006	263	430	30	6,810	10.2	10.6
	2007	268	421	62	6,654	10.4	11.3
Greece	2006	21	44	2	932	7.0	7.2
	2007	22	49	4	953	7.5	7.9
Hungary	2006	6	37	0	778	5.4	5.5
	2007	7	36	1	734	5.8	6.0
Ireland	2006	9	8	0	556	2.9	3.0
	2007	10	8	1	555	3.2	3.4
Italy	2006	205	109	7	5,588	5.6	5.7
	2007	206	94	6	5,650	5.3	5.4
Latvia	2006	11	47	0	185	31.3	31.4
	2007	11	46	0	191	29.9	29.9
Lithuania	2006	2	29	1	216	14.3	14.6
	2007	2	28	2	226	13.2	14.2
Luxemburg	2006	1	1	0	179	1.1	1.1
	2007	1	1	1	177	1.1	2.0
Netherlands	2006	34	23	2	2,160	2.6	2.7
	2007	32	24	13	2,181	2.6	3.2
Austria	2006	156	147	5	1,178	25.7	26.2
	2007	161	146	9	1,143	26.9	27.7
Poland	2006	17	177	4	2,656	7.3	7.5
	2007	20	171	4	2,672	7.1	7.3
Portugal	2006	56	107	3	795	20.5	20.9
	2007	63	109	6	804	21.3	22.0
Romania	2006	59	131	–	1,111	17.1	17.1
	2007	60	136	2	1,080	18.2	18.4
Slovenia	2006	15	18	0	215	15.5	15.5
	2007	15	17	1	213	15.4	15.6
Slovakia	2006	17	13	2	471	6.4	6.8
	2007	18	18	4	462	7.6	8.4
Spain	2006	209	160	7	4,119	9.0	9.2
	2007	233	162	16	4,229	9.3	9.7
Czech Republic	2006	11	63	1	1,162	6.4	6.4
	2007	12	70	1	1,139	7.2	7.3
United Kingdom	2006	68	25	7	6,324	1.5	1.6
	2007	72	28	14	6,208	1.6	1.8
Sweden	2006	281	311	8	1,447	40.9	41.4
	2007	290	321	12	1,459	41.9	42.7
EU-27	2006	1,854	2,606	225	50,786	8.8	9.2
	2007	1,957	2,640	330	50,029	9.2	9.8

Source: Eurostat, calculations Statistics Netherlands.

[1] Including the non-renewable fraction of municipal waste.
[2] It is assumed that gross final consumption of renewable electricity equals gross production, as in the EU directive for renewable energy. Also, hydro and wind are normalised according to the methods in this regulation.
[3] Total gross final energy consumption is capped for a high share of aviation, according to the procedure in the EU directive for renewable energy.

Petrol and diesel are the most important fuels in the transport sector. In the EU the contribution of renewable sources to these transport fuels is small compared to electricity and heat supplies. Only in recent years has the use of biofuels for road transport had some significance. This is mainly due to biodiesel in Germany and France (table 2.4.3).

Total gross final consumption of renewable energy is the sum of gross final consumption for electricity, heat and transport (table 2.4.4). Heat is the main factor in this, and biofuels for road transport still play a limited role. As outlined above, sustainability criteria are also important in the renewable energy directive. At this time it is not yet clear what the consequences of these criteria will be. It could be that a portion of the biofuels used does not count. For this reason two gross consumption percentages have been calculated: a percentage with biofuels for transport and a percentage without. In addition, the sustainability criteria also apply to liquid biofuels that are used outside the transport sector. For the time being, for simplicity, these have been counted in the calculation of the total proportion of renewable energy in gross energy consumption in table 2.4.4.

Sweden leads the EU in terms of the proportion of renewable energy in its gross consumption. It is a country with large areas of woodland and large amounts of hydropower for relatively few people. The same applies to Finland, Latvia and Austria. In Germany the consumption of renewable energy has grown strongly in recent years. Even so, the proportion of renewable energy in this country is still below the EU average. In the Netherlands the contribution of renewable energy to the total energy supply is relatively small. In the largest sector in particular, heat, there is little use of renewable energy.

Methods

Internationally, the choices made with respect to definition and presentation style differ from those made nationally in the Renewable Energy Monitoring Protocol (SenterNovem, 2006). As a consequence the international figures for the Netherlands deviate from the national figures.

International renewable energy statistics are part of a unified system of international energy statistics (IEA/Eurostat, 2004). These are based on common surveys by the International Energy Agency (IEA), Eurostat and the United Nations. Statistics Netherlands participates in these surveys for the Netherlands according to the IEA and Eurostat definitions. IEA and Eurostat traditionally use the so-called primary energy method, also called the input method. Because this has some disadvantages, the European Commission, in its proposal for a renewable energy directive (European Commission, 2008), looked for an alternative, and as a result has developed the final energy method. The substitution method is used in the Netherlands, and a so-called life cycle analysis (LCA) is frequently carried out for biofuels. All methods are explained in detail below. First of all, we discuss the question of which forms of renewable energy count.

– Heat pumps, heat and cold storage, and household waste

Cold is not viewed internationally as an energy carrier. For this reason cold storage is a form of energy saving, and therefore only appears indirectly in international energy statistics as reduced electricity consumption, such as in the Dutch Energy Balance Sheet. Storage of ambient heat possibly falls under geothermal energy. Official documentation (IEA/Eurostat, 2004 and explanations in the surveys) gives no definite answer to this. For the time being, following consultations with Eurostat, it has been decided not to include it because the heat comes not from the ground, but from the atmosphere. In the new European renewable energy directive, geothermal energy is defined as all energy that comes from under the surface of the earth. Using this definition, heat storage clearly does count.

Heat from heat pumps only appears in IEA and Eurostat statistics if it involves heat that is sold. According to the IEA and Eurostat, this heat currently does not fall under renewable energy. In the Netherlands the bulk of heat pumps are owned by the users of the heat they produce. Statistics Netherlands has no data about heat from heat pumps that is sold. For this reason Statistics Netherlands does not declare this to the IEA and Eurostat. In the new European renewable energy directive however, heat pumps are taken into account, irrespective of whether the heat is sold or not (European Parliament and the Council, 2009). However, it has been agreed that heat pumps only count if they meet a requirement for energy efficiency. Eurostat is currently investigating how heat pumps can be incorporated into energy statistics. It is discussing this with statisticians from the member states, the energy department at the European Commission (DG TREN), and European trade associations.

A big difference between Eurostat and the IEA is that Eurostat also includes the non-biomass share of municipal waste that is combusted in municipal waste incineration plants, whereas the IEA does not include this. The reason Eurostat includes the non-biomass part, is that many countries do not split their declaration about the quantity of waste combusted in waste incineration plants into biomass and non-biomass. In such cases the IEA itself makes an assumption about the split, whereas Eurostat does not. Eurostat is urging member states to make this distinction (Eurostat, 2008).

– Substitution method and primary energy method

The Dutch method for calculating renewable energy is called the substitution method. This looks at what the primary energy consumption would be in a reference situation if no renewable energy was used. The IEA and Eurostat do not use this method.

Instead, the IEA and Eurostat count the first useful form of energy for end users, which they treat as primary production (IEA/Eurostat, 2004). This is called the primary energy method, or the input method. For wind energy, hydropower and solar electricity therefore, this means electricity production. For biomass combustion it means the energy content of the biomass, and for biogas it means the energy content of the usefully consumed biogas (thus excluding flaring). For solar thermal energy it means the heat available to the heat distribution medium, minus optical and collector losses. The Renewable Energy Monitoring Protocol (SenterNovem, 2006) provides key figures for calculating solar thermal energy according to this definition.

– Final energy consumption method from the EU directive for renewable energy

In the draft of the renewable energy directive (European Commission, 2008), the Commission chose a third method: the so-called final energy method. This is also used in the final version of the directive (European Parliament and the Council, 2009). In this method the *gross* final *energetic* energy consumption is taken as a starting point (the denominator), and it looks at what part of this comes from renewable sources. It is important to know here that at Eurostat and the IEA, the term final consumption is limited to meaning final consumption outside the energy sector. The difference between ordinary final consumption and gross final consumption is that the gross figure also counts the consumption of heat and electricity for electricity generation, and transport losses.

For heat this primarily concerns the final energetic use of biomass, and for transport it concerns the use of biofuels. The gross end use of renewable electricity and of sold renewable heat is not explicitly available in the energy statistics. For this reason this is defined as the production of renewable electricity and of sold renewable heat, possibly then corrected for trade between member states.

An important point in the EU directive is that liquid biomass can only count if it meets the sustainability criteria formulated in the directive. These criteria are connected to the production method and origin of the liquid biomass, and do not depend on the liquid biomass itself. An administrative system is therefore needed to review whether the liquid biomass used meets the conditions in the directive. This system is still in development. At this moment therefore it is not yet clear whether or not the liquid biomass used meets the criteria.

There is also still a great deal of uncertainty regarding heat pumps. The directive says heat pumps do count, and that the input of heat from the ground, surface water or air counts as renewable energy. Therefore the conversion losses during the production of the electricity consumed by the heat pumps are not taken into account. On the other hand, heat pumps only count if the so-called Seasonal Performance Factor (SPF, a measure of energy performance) meets a certain condition. There are several ways to define and measure this SPF. This also applies to the energy production of the heat pumps. The directive stipulates that the European Commission will establish a method for determining the SPF and the heat production of heat pumps by 2013 at the latest.

During the last stage of the political decision-making regarding the EU renewable energy directive, the definition of gross final consumption was again slightly modified. Countries with a relatively high energy consumption for air transport need not count the portion of this that lies above a certain limit in their gross final energy consumption. In the directive this limit has been set at 4.12 percent for Cyprus and Malta, and 6.18 for the other countries. The Netherlands has a relatively large amount of air transport, and thus in 2007 it qualified for this 'aircraft discount'. This was approximately 1 percent of gross consumption. The gross consumption of countries with relatively little air transport is not adjusted upwards. As a result the air transport discount makes it easier to achieve the targets.

– LCA method

In addition to primary energy, substitution and final energy, there is a fourth method to calculate renewable energy: life cycle analysis (LCA). This goes a step further than the substitution method, in the sense that it compares not just the end use of renewable energy carriers to conventional energy carriers, but the complete production processes of renewable and conventional energy carriers. For biofuels for road transport in particular it is usual to make this type of analysis ('well to wheel'), because at least half the CO_2 emissions saved can be lost during the production process of the current generation of transport biofuels. LCA studies are certainly useful. However, for statistical purposes the method is still cumbersome to apply, because LCA efficiency depends strongly on the individual production process. Therefore using the LCA situation can be more difficult than the substitution method when defining an objective, acceptable reference (for example, how to deal with agricultural waste streams that can also be used as animal fodder).

– Outcomes by method

Table 2.4.5 shows the avoided primary energy (national) and the demand (= consumption) of primary energy (international) by energy source. What is notable is that for wind energy, hydropower and solar electricity, renewable energy is much higher using the substitution method widely applied in the Netherlands. For municipal waste incineration plants and household stoves, renewable energy is much higher according to the primary energy method. These differences are explained by differences in definition.

Wind energy, for example, is calculated in the substitution method using a fictitious input, based on an electricity power station that requires two to three units of primary energy to make one unit of electrical energy. However, in the primary energy method, wind energy is measured directly as the electricity production. For municipal waste incineration plants and household stoves, the substitution method takes the difference in efficiency between these installations and a standard installation into account, whereas the primary energy method does not. Because of the relatively low efficiency of waste incineration plants and household stoves, there are large differences between the figures derived with the substitution method and the primary energy method. The differences in definition had little overall impact in 2008. The calculation of the renewable share in both methods is divided by the total primary energy consumption. The consequences of definition differences in this case are small.

Table 2.4.5 also shows the final energy method figures for the Netherlands in 2008. What is immediately noticeable is that the denominator is considerably smaller than with the other methods. This occurs because conversion losses are omitted, both in the numerator and the denominator. Another fundamental difference is that non-energetic

Table 2.4.5
Comparison between different methods to calculate renewable energy in the Netherlands, 2008**

	Substitution	Primary energy	Gross final energy consumption according to the EU directive on renewable energy	
			With heat pumps and biofuels	Without heat pumps and biofuels
	TJ			
Hydro power	840	367	360	360
Wind energy	35,061	15,322	14,053	14,053
Solar electricity	330	138	138	138
Solar heat	861	879	879	879
Heat pumps	4,622		9,884	
Heat/cold storage	820		113	113
Municipal waste, renewable fraction	12,716	29,266	9,004	9,004
Biomass co-firing in large scale power plants	19,692	19,692	9,143	9,143
Wood stoves for heating in industry	2,508	2,678	2,678	2,678
Household wood stoves	5,464	9,316	9,316	9,316
Other biomass combustion	9,111	12,825	6,486	6,486
Landfill gas	1,307	1,778	828	828
Biogas from sewage purification plants	2,262	2,046	1,815	1,815
Biogas on farms	2,845	3,691	1,435	1,435
Other biogas	1,679	1,782	1,336	1,336
Biofuels for road transport	14,032	14,032	14,032	
Total renewable energy	114,151	113,811	81,501	57,584
Total use of energy (PJ)	3,319	3,330	2,227	2,227
Share of renewable energy (%)	3.4	3.4	3.7	2.6

Source: Statistics Netherlands.

energy consumption is also omitted, such as in the manufacture of plastics. By contrast, renewable electricity counted in the numerator is much lower than in the substitution method.

Because of the uncertainties in the EU directive regarding heat pumps and biofuels, two alternative final energy methods have been developed, a (high) variant with heat a pumps and biofuels, and a (low) variant without. In the low alternative, the proportion of renewable energy comes to 2.6 percent; in the high alternative to 3.7 percent. Precisely how the directive develops in the coming years is therefore very important. Moreover, in the high alternative it is important to realise that the energy production of heat pumps could be far too high (see also section 6.1), because of the margin of error in estimating the full-load hours.

– Advantages and disadvantages of the different methods

The advantage of the substitution method is that it is a reasonable approximation of the avoided use of fossil fuels, and the associated avoided CO_2 emissions. These are two important reasons why renewable energy is stimulated. There are, however, also disadvantages to this method (IEA/Eurostat, 2004). Firstly, according to this report the substitution method has limited significance if renewable electricity production is the dominant form of electricity production (in countries with a lot of hydropower). Secondly, the reference efficiencies are difficult to determine objectively. Thirdly, the substitution method leads to artificial conversion losses if the attributed consumption of primary energy is also incorporated into the energy balance sheet. The first and third disadvantages do not apply to the Dutch situation since the renewable energy calculation is separate from Statistics Netherlands' Energy Balance Sheet. The second objection is overcome by letting the involved parties choose using the Renewable Energy Monitoring Protocol.

Although the desire for international comparability is increasing, the advantages of the substitution method for the Dutch situation clearly outweigh the disadvantages. The situation is different internationally: on the one hand because there are countries in which hydropower is an important source of electricity production, and on the other because it is difficult for a group of countries to agree on a reference. This explains why the IEA and Eurostat do not use the substitution method.

The advantage of the final energy method is that all forms of electricity generation are compared in the same way. A disadvantage, however, is that 1 joule of electricity counts as the equivalent of 1 joule consumed for heat or transport. An example will make this clear. Take 1 joule of biomass. If this was used for electricity production, it would lead to approximately 0.4 of a joule of renewable energy. This same joule of biomass used directly for heating however leads to 1 joule of renewable energy. This is a difference of a factor of 2.5, whereas in both cases the quantity of fossil fuel replaced is approximately the same. In the final energy method therefore, renewable electricity is undervalued and renewable heat and transport are overvalued. One consequence of this could be that countries will invest more in heat and transport, whereas in terms of the avoided use of fossil fuels it could be much more efficient to invest in renewable electricity.

Omitting non-energetic use (just 10 percent of the total final energy consumption in the EU (Eurostat, 2007)) from the denominator of calculation, has the effect of increasing the percentage of renewable energy, because the renewable non-energetic consumption in the denominator of the calculation, according to the definition of the energy statistics, is zero. An alternative to omitting this is to define certain forms of non-energetic consumption as biomass. The advantage of this would be that the replacement of fossil resources with sustainable resources is stimulated in the same way as the replacement of fossil energy with renewable energy. A similar argument goes for the use of fuels for international sea transport. In international energy statistics this counts as a form of export and not as consumption. The article: ‘Three options to calculate the percentage of renewable energy: an example for a EU policy debate” (Segers, 2008) discusses the different methods in more detail.

– Differences in release policy

Besides methodological aspects, the differences between national and international figures also have another cause: the time lag between the moment Statistics Netherlands supplies the figures to the international organisations, and the moment they are published by those organisations. Thus the figures for 2007 in the IEA (2008) were based on the so-called mini-survey that Statistics Netherlands sent to the IEA in May 2007. The data in this survey correspond roughly to the second provisional figures that Statistics Netherlands published in June 2007. The second provisional figures deviate slightly from the definite figures for 2007, published in November 2008. The data which now appear on the Eurostat website run up to and including reporting year 2007, and were based on the declarations of member states in autumn 2008.

Method, renewable electricity

For renewable electricity, domestic production is always used as the basis, both nationally and internationally. Imports of renewable electricity do not appear at all in international statistics. Under the terms of the new renewable energy directive, it will be possible in the future for member states to trade mutually in renewably produced electricity. This is separate from both the effective physical flow of electricity and the international trade in renewable energy certificates.

The first difference is that internationally, gross electricity production is always the basis, whereas nationally it is net electricity production. The main consequence of this is that, internationally, municipal waste incineration plants appear to contribute more to renewable electricity (table 2.4.6), because the relatively large internal electricity consumption of these installations is not discounted.

In addition, there are three different definitions in use internationally. The IEA uses renewable electricity production as a percentage of total electricity production as its leading indicator (IEA, 2008). Eurostat on the other hand uses renewable electricity production as a percentage of total electricity *consumption* (Eurostat, 2009). This conforms largely with what is usual at a national level, with the definition of renewable electricity in the EU directive (2001/77/EG), and with the new renewable energy directive (European Parliament and the Council, 2009). The difference between the definition in the directives and the Eurostat definition is that Eurostat also counts electricity production from the non-biomass portion of incinerated municipal waste in municipal waste incineration plants as renewable electricity. The reason for this is that data are only available for a few member states regarding the split between these biomass and non-biomass portions. The IEA has solved this by estimating the split for the countries where these data are lacking. Eurostat is more reserved about this.

A new element in the EU renewable energy directive as from 2009 is the standardisation procedure for electricity from hydropower (15 years) and wind energy (5 years). This is designed to filter out the influence on the figures of annual fluctuations in the quantities of wind and precipitation. For wind energy, this procedure has the effect of making Dutch electricity production much lower in 2008. There are several reasons for this. Firstly, it was 5 percent windier in 2008 than the average over the past 5 years. Secondly, the rise in the average number of full-load hours (3 percent in the past 5 years) by offshore wind farms and higher masts was slowed down. Thirdly, the standardisation procedure uses the installed capacity of wind turbines at the end of the year. That causes some noise.

Table 2.4.6
Renewable electricity in the Netherlands according to national and international methods, 2008**

	National	Eurostat	IEA	EU directive renewable electricity	EU directive renewable energy
	Net GWh	*Gross GWh*			
Production of renewable electricity					
Hydropower	102	102	102	102	100
Wind energy	4,256	4,256	4,256	4,256	3,904
Solar	38	38	38	38	38
Biomass co-firing in large scale power plants	2,181	2,316	2,316	2,316	2,316
Other biomass combustion	667	747	747	747	747
Municipal waste, renewable fraction	1,058	1,392	1,392	1,392	1,392
Municipal waste, non-renewable fraction		1,508			
Biogas	686	725	725	725	725
Total	8,988	11,085	9,577	9,577	9,223
Total use of electricity	119,226	123,495		123,495	123,495
Total production of electricity			107,645		
Renewable electricity production as percentage of total use of electricity	7.5	9.0		7.8	7.5
Renewable electricity production as percentage of total production of electricity			8.9		

Source: Statistics Netherlands.

International figures for renewable energy on the internet

The address of the Eurostat website is http://epp.eurostat.ec.europa.eu. The *Statistics* tab at the top of the page gives access to the figures. Then select the topic *Energy* at the bottom of the page. On the left-hand side at the top you have a choice of more options. Under *Main tables* you will find pre-defined summary tables. *Publications* gives access to pdf versions of several publications. The detailed figures are found via *Databases*, as in Statistics Netherlands' StatLine database. The figures for renewable energy are found via *Databases* under *Energy statistics – quantities,* and then under *Energy statistics – supply, transformation and consumption*.

The address of the IEA website is www.iea.org. The IEA's standard publication about renewable energy is called *Renewables Information.* It is not freely available, but is available for purchase as a hardcopy or as a pdf. Besides compiling statistics the IEA also has an umbrella function for diverse technology-oriented collaborations. These are called *technology agreements* or *implementing agreements*. A number of these collaborations exist for renewable energy, and frequently have their own publications. Information about these collaborations can be found via the IEA homepage: click on the *Energy Technology Agreements* tab (top left) and then on *Renewable Energy*. SenterNovem coordinates the Dutch participation in these collaborations, and provides information about this via www.senternovem.nl/kei.

Official publications from Eurostat about renewable energy appear relatively long after the end of the reporting year. Nevertheless, to get a quick overview of developments, the European Commission has contracted out the task of swiftly creating publications by renewable energy sector (Observ'ER). The publications can be found on the website www.eurobserv-er.org, and are available relatively rapidly after the end of the reporting year. Sometimes they are compiled using estimations, which can have a negative impact on the quality of the figures. On the other hand Observ'ER publications are generally useful to get a quick indication of developments in the most important countries.

Lastly, some European trade associations also produce statistical information. The European Wind Energy Association (www.ewea.org) generally publishes figures around 1 February on the sale of wind turbines (in MW) by country during the previous year. Likewise, the trade associations for bioethanol producers (www.ebio.org), biodiesel (www.ebb-eu.org), solar thermal energy systems (www.estif.org) and heat pumps (ehpa.fiz karlsruhe.de) all publish figures by country.

2.5 Renewable energy in the Energy Balance Sheet

Statistics Netherlands' Energy Balance Sheet is the integration framework for all its physical energy statistics. In the Energy Balance Sheet, energy balance sheets are established by sector for each energy carrier. Renewable energy is also a component of the Energy Balance Sheet, not in terms of avoided primary energy, but in terms of underlying energy production. In the sections below we describe how each renewable energy source, or group of renewable energy sources, has been incorporated into the Energy Balance Sheet.

Hydropower, wind energy and solar electricity

Hydropower, wind energy and solar electricity are included under primary production of electricity, where the amount produced is equivalent to electricity production from renewable energy. The breakdown of wind energy by sector was, until 2007, based on the direct observations for the distribution companies. Of the remaining wind energy, 25 percent was allocated to 'other consumers' and 75 percent to local electricity and heat production companies. This allocation ratio was determined several years ago and remained unchanged until 2007. As from 2008 wind energy has been split between the sectors on the basis of the owners of renewable energy certificates.

Solar thermal energy

Solar thermal energy is included under the production by the 'heat, solid and liquid biomass and waste' group of energy carriers. Here the value is equivalent to the heat production as calculated using the definition of the IEA (section 2.4). In breaking this down between sectors, it is assumed that all solar thermal systems and swimming pool systems <30 m^2 are located in households, and that all other solar thermal systems are located with 'other consumers'.

Heat pumps

Renewable energy from heat pumps appears as the production from 'heat, solid and liquid biomass and waste'. Its value is equivalent to the gross heat production of the heat pumps. The electricity and gas consumption of the heat pumps is part of final consumption. Heat pumps in residential buildings fall under the housing sector, and heat pumps in non-residential buildings fall under 'other consumers'. The time range for heat pumps was heavily revised in 2007 (Statistics Netherlands, 2007). The Energy Balance Sheet itself was not revised. For this reason, in order to avoid a break in the Energy Balance Sheet, the older, previous figure for heat pumps was retained. The total production of heat from heat pumps in Statistics Netherlands' Energy Balance is thus 10.5 PJ for the second provisional figures for 2008.

Heat/cold storage

The electricity saving from heat/cold storage does not appear (directly) in the Energy Balance Sheet, because it is a saving. It does appear indirectly, however, as reduced electricity consumption. The consumption of heat from heat/cold storage appears because it refers to the use of ground-source heat. With an efficiency of 90 percent, the gas saving can be back-calculated as production from ‘heat, solid and liquid biomass and waste’. All heat/cold storage is allocated to ‘other consumers’, because this technology is applied mainly in the non-residential sector.

As a result of a revision of the time range for heat/cold storage, the level of this activity in the Energy Balance Sheet is higher than it would have been on the basis of the above description. To keep the range in the Energy Balance Sheet similar for heat/cold storage, the previous year’s figures have been retained. The generation of heat from heat/cold storage in the Energy Balance Sheet is thus 1.1 PJ in the second provisional figures for 2008.

Municipal waste incineration plants

In the Energy Balance Sheet this sector includes all companies whose main activity is waste incineration. In the renewable energy statistics it covers only the waste incineration plant itself, including flue gas cleaning, pre-separation and post-separation (Renewable Energy Monitoring Protocol, SenterNovem, 2006). Other activities at the same site are excluded. This difference explains why electricity and heat production in the renewable energy statistics (section 7.1) deviate somewhat from the electricity and heat production in the Energy Balance Sheet. The incinerated waste appears as primary production of ‘heat, solid and liquid biomass and waste’, which is used for conversions.

Solid and liquid biomass

In the Energy Balance Sheet, biomass is incorporated under ‘heat, solid and liquid biomass and waste’. There is currently no imports or exports of biomass. All biomass consumed therefore appears as primary production. In the next revision of the Energy Balance Sheet an attempt will be made to record imports and exports.

Biogas

The renewable energy statistics distinguish between four types of biogas: landfill gas, biogas from sewage purification plants, biogas from farms, and other biogas. The Energy Balance Sheet takes these together. Flaring (sections 7.6 and 7.7) appears as primary production and final consumption. Landfill gas that is converted into natural gas appears in the Energy Balance Sheet as biogas supplied, and not via an ‘other conversion’. The reason for this is that after conversion to natural gas it is no longer recognisable as biomass, which is important for CO_2 emission calculations. With landfill gas it is also important to note that a large part of production is attributed to ‘other consumers’ (frequently the owners of landfill sites), and the electricity production from landfill gas is attributed to the distribution companies (frequently the owners of the gas generators). The supply of landfill gas occurs between these two sectors. Sewage purification plants fall under ‘other consumers’. Other biogas is broken down by company among the relevant sectors.

3. Hydropower

Developments

Table 3.1 shows the installed capacities of hydropower and associated electricity production. The total production is dominated by three power stations on the larger rivers (more than 90 percent of capacity). Since 1990, there no additional large hydropower plants have been constructed. For this reason the annual variation in production is determined mainly by variations in river water levels. Electricity production in 2008 was the same as in 2007. Hydropower contributes 0.7 percent of the total primary fossil energy avoided through renewable energy.

Table 3.1
Hydropower

	Number of systems ≥0.1 MW	Operational capacity	Electricity production	Avoided use of fossil primary energy	Avoided emission of CO_2
		MW	*GWh*	*TJ*	*kton*
1990	5	37	85	752	55
1995	5	37	88	773	56
2000	6	37	142	1,179	83
2001	6	37	117	991	70
2002	6	37	110	927	66
2003	6	37	72	607	43
2004	6	37	95	794	56
2005	6	37	88	733	52
2006	6	37	106	871	61
2007	6	37	107	877	61
2008**	6	37	102	840	58

Source: Statistics Netherlands.

Method

The information for 1990 to 1997 was derived from Statistics Netherlands surveys. From 1998 to June 2001 it came from EnergieNed, and since July 2001 the data are based on the CertiQ renewable energy certificates. In 2002, the declarations of the companies in the Statistics Netherlands energy surveys were used as a control. The difference between annual electricity production according to Statistics Netherlands surveys and electricity production according to CertiQ's files was approximately 1 percent in 2002. To avoid unnecessary additional surveys, the Statistics Netherlands stopped asking about electricity production from hydropower in 2004. It only contacts the owners of hydropower plants in the event of implausible results appearing in the records. This happens once a year at most.

For both installed capacity and electricity production a lower limit of 0.1 MW installed capacity per plant is used. Below this limit there are a few small installations with a combined estimated capacity of approximately 0.2 MW. This is 0.5 percent of the total. The margin of error in renewable energy from hydropower is estimated to be approximately 2 percent.

4. Wind energy

Developments

The installed capacity of onshore wind energy has increased in recent years by approximately 200 MW per year. This explains the increase in electricity production from this source (table 4.1). The first offshore wind farm came on line in 2006, with a capacity of 108 MW, and in early 2008 it was joined by a second farm with a capacity of 120 MW. As a result, the total growth in capacity in 2006 and 2008 was much higher. In terms of avoided consumption of fossil primary energy, wind energy now accounts for almost a third of all renewable energy in the Netherlands.

Financial support from the government is indispensable to operate a wind turbine profitably. In August 2006 the Minister of Economic Affairs ended the most important subsidy regulation, as it was so popular that the government could not afford the subsidies. Existing projects and projects that were already eligible were not affected by this decision. As wind turbine projects have a long lead time, the abolition of the subsidies had hardly any impact on the 2008 figures.

Table 4.1
Renewable energy from wind

	New installed wind turbines	New installed capacity	New installed rotor area	Number of wind turbines [1]	Capacity [1]	Rotor area [1]	Electricity production	Avoided use of fossil primary energy	Avoided emission of CO_2
		MW	*1,000 m²*		*MW*	*1 ,00 m²*	*GWh*	*TJ*	*kton*
1990	70	15	31	323	50	103	56	495	36
1995	336	109	268	1,008	250	568	317	2,783	202
2000	47	38	89	1,291	447	1,062	829	6,861	485
2001	60	40	121	1,342	485	1,179	825	6,975	496
2002	152	200	459	1,450	670	1,608	946	7,976	568
2003	200	243	567	1,595	906	2,155	1,318	11,112	796
2004	168	204	461	1,651	1,073	2,533	1,867	15,594	1,101
2005	127	168	378	1,709	1,224	2,871	2,067	17,222	1,218
2006	155	346	716	1,826	1,558	3,559	2,733	22,463	1,561
2007	123	211	494	1,889	1,748	4,002	3,438	28,193	1,968
2008**	181	389	854	2,029	2,121	4,817	4,256	35,061	2,416

Source: Statistics Netherlands.

[1] 31 December.

Table 4.2
Renewable energy from wind, electricity production per capacity and Windex

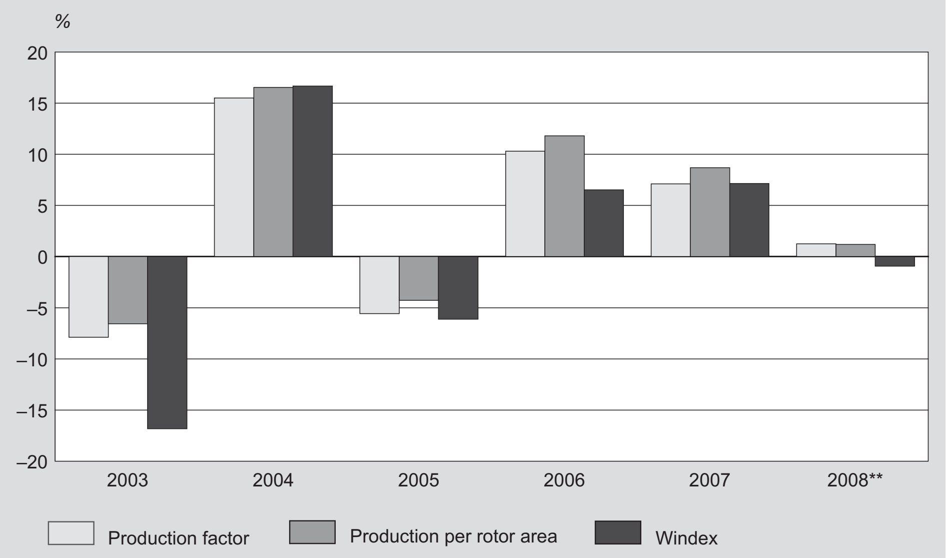
	Electricity production	Windex (WSH/CBS)	Production factor [1]	Full load hours [2]	Electricity production per rotor area [3]
	GWh		*%*	*hours*	*kWh per m²*
2002	946	101	20	1,775	731
2003	1,318	84	19	1,635	683
2004	1,867	98	22	1,892	796
2005	2,067	92	20	1,789	762
2006	2,733	98	23	1,973	852
2007	3,438	105	24	2,114	926
2008**	4,256	104	24	2,145	937

Source: Statistics Netherlands and WSH.

[1] The production factor is defined as actual production divided by maximum production calculated from the capacities at the end of each month. This is also known as the capacity factor.
[2] The number of full load hours is the number of hours during which the wind turbines would need to operate on full load to achieve the realised production. The full load hours are proportional to the production factor.
[3] Calculated as the average of the monthly electricity production per rotor area at the end of each month. This is weighted according to the number of days in each month and the rotor area at the end of each month.

Electricity production by wind turbines largely depends on the supply of wind, which fluctuates enormously. On average there is less wind in summer than in winter. There can also be considerable differences from one year to the next. One measure of the amount of wind is the so-called Windex. Unsurprisingly, therefore, the development of electricity production from wind energy per unit of capacity is very consistent with this Windex (table 4.2, figure 4.1). It does not matter whether this capacity is expressed in terms of installed capacity or rotor area. Over the last five years the increase in electricity production from wind turbines per unit of capacity has been slightly above the increase in wind supply. That means that the technical performance of wind turbines has gradually increased. There are three reasons for this. Firstly, there are more turbines in relatively favourable sites, such as at sea. Secondly, more taller turbines are becoming operational, and as a result they can harness more wind (table 4.3). Thirdly, under-performing wind farms have closed down.

4.1 Wind energy, annual change in production factor, production per rotor area and Windex (WSH/CBS)



Source: Statistics Netherlands and WSH.

Table 4.3
Onshore wind energy by hub height

	Number of wind turbines 1)	Capacity 1)	Rotor area 1)	Electricity production	Production factor	Electricity production per rotor area
		MW	*1,000 m²*	*GWh*	%	*kWh per m²*
2007						
30 m or less	223	49	104	101	20	825
31–50 m	812	377	933	775	24	848
51–70 m	602	758	1,748	1,473	23	872
71 m or more	216	457	988	759	24	1,014
Total	1,853	1,640	3,773	3,108	23	892
*2008***						
30 m or less	204	44	95	82	21	844
31–50 m	808	380	936	779	24	838
51–70 m	620	775	1,790	1,560	23	880
71 m or more	301	694	1,466	1,239	25	1,021
Total	1,933	1,893	4,287	3,660	24	912

Source: Statistics Netherlands.

1) 31 December.

It is notable that the influence of the hub height on electricity production per unit of rotor area is greater than on electricity production by unit of capacity (production factor) (table 4.3). The reason for this is that on taller turbines, more capacity is installed per unit of rotor area.

Table 4.4
Wind energy per region

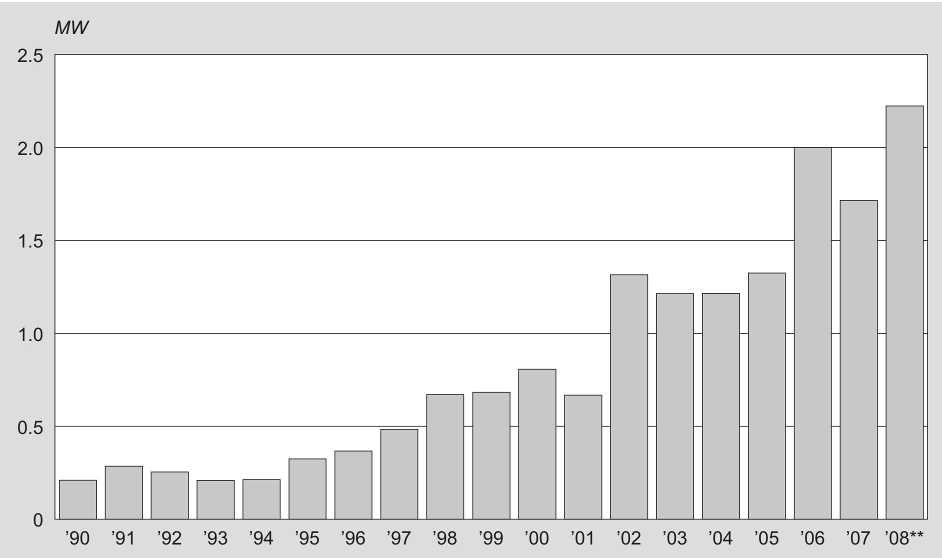
	2007				2008**			
	Number of wind turbines 1)	Capacity 1)	Electricity production	Production factor	Number of wind turbines 1)	Capacity 1)	Electricity production	Production factor
		MW	*GWh*	%		*MW*	*GWh*	%
Onshore								
Groningen	207	126	289	25	263	302	465	25
Friesland	329	139	310	27	335	145	338	27
Flevoland	597	616	1,102	21	596	615	1,140	21
North Holland	303	249	507	24	306	278	578	26
South Holland	154	243	532	27	149	243	568	27
Zeeland	201	198	241	23	205	207	414	23
North Brabant	41	39	76	22	46	49	80	23
Other provinces	21	31	51	20	33	55	78	20
Total on shore	1,853	1,640	3,108	23	1,933	1,893	3,660	24
Offshore	36	108	330	35	96	228	596	30
Total	1,889	1,748	3,438	24	2,029	2,121	4,256	24

Source: Statistics Netherlands.

1) 31 December.

The dsitribution of onshore wind turbines shows that most turbines are located in coastal regions. This is not surprising, as there is more wind there. But wind supply is not the only factor affecting the positioning of turbines. The perception of how they fit into the landscape also plays an important role. That explains why the largest concentration of turbines is in Flevoland, even though this province does not have the most favourable wind conditions (SenterNovem, 2005a, Table 4.3).

4.2 Average power capacity of new installed onshore wind turbines



Source: Statistics Netherlands.

Wind turbines have become larger and larger in recent years. This is not a constant process, but occurs in fits and starts with the introduction of new models of wind turbines (figure 4.2). Until recently, 0.9 or 1 MW wind turbines were the standard. Since 2006 the average has risen rapidly to 2 or 3 MW.

Method

The installed capacity is determined by a wind monitor, such as that maintained by KEMA until the end of 2003, or the administration behind the CertiQ renewable energy certificates. The KEMA database is linked on an individual basis to the CertiQ administration. The capacity per grid connection is checked for plausibility by comparing it with the electricity production data from CertiQ. The moment a turbine becomes or ceases to be operational is determined using the same data. If there is inconsistency between the different sources, Wind Service Holland (WSH) data are used as a supplement.

Table 4.5
Capacity of wind energy (MW) per province, 31 December

	2007			2008**	
	CBS	WSH	LSOW	CBS	WSH
Onshore					
Groningen	126	126	162	302	383
Friesland	139	133	134	145	146
Flevoland	616	615	616	615	617
North Holland	249	250	277	278	276
South Holland	243	248	245	243	245
Zeeland	198	195	206	207	204
North Brabant	39	40	38	49	57
Other provinces	31	32	31	55	55
Total onshore	1,640	1,639	1,709	1,893	1,983
Offshore	108	108		228	228
Total	1,748	1,747		2,121	2,211

Source: Statistics Netherlands (CBS) , Wind Service Holland (WSH, 2009) and Landelijke Stuurgroep Ontwikkeling Windenergie (LSOW, 2008).

The capacity per province was compared with two other, largely independent sources (table 4.5). It appears that the differences are as a rule no larger than 10 MW, and generally at most a few MW. One exception is the high figure for Groningen in 2008 according to WSH (2009) and for Groningen, North Holland and Zeeland in 2007 according to the National Steering Committee for the Development of Wind Energy (LSOW – *Landelijke Stuurgroep Ontwikkeling Windenergie*, 2008). The most important cause of these differences is the moment a turbine becomes or ceases to be operational. In Groningen, North Holland and Zeeland in both 2007–2008 and 2008–2009, large wind farms came on line around the new year (WSH, 2009). It seems LSOW (2008) and WSH (2009) counted these somewhat earlier. Statistics Netherlands counts a wind turbine from the moment it produces electricity according to CertiQ records.

The number of turbines, hub heights and rotor areas are taken from WSH and the individual details registered by SenterNovem in connection with the assessment of applications for the Energy Investment Allowance (EIA).

Electricity production is calculated from the administration behind the CertiQ renewable energy certificates. The monthly production data by grid connection code is also assessed for plausibility. Moreover estimations are made for wind farms whose production data are not covered by CertiQ. These estimations are made on the basis of capacity and average production factor, and have amounted to approximately 5 GWh since 2005 (less than 0.5 percent of total production). For electricity production for the years 1998–2001, data from the EnergieNed green labelling system were used; for 1996 and 1997 the KEMA wind monitor was used; and for the years up to and including 1995, Statistics Netherlands statistics were used.

WSH also publishes figures for electricity production from wind energy on its own website. These are higher than Statistics Netherlands' figures, as WSH assumes annual production for the entire wind farm under average wind conditions on the basis of design data. It therefore assumes the production capacity of the wind farm at the moment of the website is visited. Because of the strong growth in capacity, this is always considerably higher than the average capacity in the last year as published by Statistics Netherlands. Moreover, Statistics Netherlands publishes actual production and WSH the production under average wind conditions. The wind supply in recent years has frequently been lower than average, which increased the difference between the WSH and Statistics Netherlands figures. Lastly, Statistics Netherlands assumes effective production and

WSH production from design data without breakdowns, which may during the start-up phase.

The margin of error in Statistics Netherlands' electricity production figures at the end of 2008 is estimated to be 2 percent. For the capacity at the end of 2008, the margin of error is higher, approximately 3 percent.

The Windex has for many years been determined by WSH on the basis of the effective production of dozens of wind turbines spread across all regions with many turbines. Wind turbines on wind farms are not included, because they can interfere with one another. WSH takes downtime as a result of breakdowns and/or maintenance into account. In January 2008, WSH indicated that it wants to stop compiling the Windex, as it is becoming increasingly difficult to collect production data on a voluntary basis.

From analysis of a number of years (Statistics Netherlands, 2008), it is clear that the Windex correlates well with the aggregate production from a large fixed group of wind farms from the Statistics Netherlands database, which contains the production data of almost all wind farms in the Netherlands. As a result, Statistics Netherlands has been investigating the possibility of making a Windex based on production data from its database. The disadvantage of this database with respect to the WSH data is that no explicit information is incorporated about breakdowns. The advantage of Statistics Netherlands' database is that these data cover a much larger number of wind farms. The conclusion of the investigation was that it is possible make a Windex of similar quality to the WSH Windex based on Statistics Netherlands data (Segers, 2009a). However, it is still very difficult to be certain that no small deviations in the Windex will arise in the long term.

As a result of the conclusion of this investigation, Statistics Netherlands has begun producing a monthly Windex in StatLine, as from reporting month January 2008. The Windex will be published within two months after each reporting month. The plan is to break the Windex down over a number of regions in autumn 2009.

5. Solar energy

Solar energy is split into two forms: the conversion of solar radiation into electricity (solar electricity, or photovoltaic solar energy) on the one hand, and the conversion of solar radiation into heat (solar thermal energy) on the other. The contribution of solar energy to total renewable energy in the Netherlands is small – approximately 1 percent.

Table 5.0.1
Solar energy

	Avoided use of fossil primary energy	Avoided emission of CO_2
	TJ	*Kton*
1990	76	4
1995	177	10
2000	487	28
2001	601	35
2002	701	42
2003	886	54
2004	985	59
2005	1,047	63
2006	1,085	65
2007	1,123	67
2008**	1,191	71

Source: Statistics Netherlands.

5.1 Solar electricity

Developments

Both electricity production from, and the installed capacity of solar electricity have increased in the last year. After a decline in 2004 as a result of the ending of the EPR (Energy Premium Regulation) subsidy, installed capacity in the Netherlands increased in 2008 as a result of the SDE (Renewable Energy Stimulation) regulation, which came into effect on 1 April 2008. In 2008, 4.5 MW was installed, three times as much as in the previous year.

The total contribution of solar electricity to renewable energy in the Netherlands is approximately 0.3 percent. Solar electricity contributes 0.4 percent of all renewable electricity produced in the Netherlands.

In 2008, the SDE regulation had a budget to cover 18 MW of requests for solar electricity. As of early 2009 subsidies had been granted for almost the entire amount

Table 5.1.1
Solar electricity

	New installed capacity	Operational capacity	Electricity production	Avoided use of fossil primary energy	Avoided emission of CO_2
	MW		*GWh*	*TJ*	*Kton*
1990	.	1	0	3	0
1995	0.4	2	1	10	1
2000	3.6	13	8	66	5
2001	7.8	21	13	115	8
2002	5.8	26	17	149	11
2003	19.9	46	31	270	19
2004	3.6	49	33	287	20
2005	1.7	51	34	295	21
2006	1.5	52	35	298	21
2007	1.4	53	36	304	21
2008**	4.5	57	38	330	23

Source: Statistics Netherlands.

(Ministry of Economic Affairs, 2009). This means that applicants have the certainty of knowing that they will receive the subsidy if they install a solar electricity system within four years after approval of their application. Applicants have no obligation to actually buy a system. In any case it is clear that in 2008, only a portion of the subsidy applications approved have actually led to installations.

In the new subsidy round (SDE 2009) a number of things have changed. Firstly subsidy is now not only available for small systems (up to and including 3.5 kW), but also for somewhat larger systems (up to and including 100 kW). Secondly, the maximum period between the approval of the subsidy application and actual installation has been shortened to one and a half years. The total budget is similar, and is will cover 20 MW (SenterNovem website).

Solar electricity systems are classified in three categories: non-grid-connected (stand-alone) systems, grid-connected systems owned by an energy company, and other grid-connected systems. Non-grid-connected systems are used for small-scale recreational applications in places where there is no connection to the electricity grid, such as garden sheds, boats, caravans and outhouses. These systems are also used professionally, for example in cattle water troughs, solar lighting towers and buoys.

Table 5.1.2
Operational capacity of solar electricity systems, by system type

	Stand-alone	Grid connected	
		energy companies	others
	MW		
1990	0.8	0.0	0.0
1995	2.1	0.0	0.3
2000	4.1	0.2	8.5
2001	4.3	2.5	13.7
2002	4.6	2.5	19.2
2003	4.7	2.5	38.8
2004	4.9	3.2	41.3
2005	4.9	3.2	42.6
2006	5.0	3.3	43.6
2007	5.3	3.4	44.4
2008**	5.2	3.5	48.5

Source: Ecofys (1989 to 1999), BECO (2000 to 2002), Holland Solar (2003) and Statistics Netherlands (2004 onwards).

Table 5.1.3
Companies trading and manufacturing solar panels and components of solar panels

	2004	2005	2006	2007	2008 **
	kW				
Solar panels					
Imports	13,160	23,677	25,052	x	x
Production	–	x	x	x	x
Domestic sales to end users	3,604	1,663	1,521	1,399	4,444
not grid connected	434	323	278	558	239
grid connected, energy companies	679	–	160	66	151
grid connected, others	2,491	1,340	1,083	775	4,054
Exports	9,770	20,942	22,148	34,005	64,898
	fte				
Employment	147	141	232	403	566
research & development	23	17	28	32	41
production of complete panels and components	10	21	92	198	263
other	115	103	112	173	262
	mln euro				
Turnover	90	113	161	252	413

Source: Statistics Netherlands.

At the request of Holland Solar and SenterNovem, Statistics Netherlands not only collects data about installed systems, but also about imports and exports of solar panels, and employment levels, turnover and expenditure on research and development at companies active in the trade in and production of solar electricity systems and their components (table 5.1.3). The growth of these companies has been caused by increased demand for solar energy systems both in the Netherlands and (especially) abroad (Observ'ER, 2009).

Method

For the years up to and including 2003, the inventory of installed capacity was carried out by Ecofys, BECO and Holland Solar. Installed capacity was always determined using a survey of solar panel suppliers. Since 2004 Holland Solar, SenterNovem and Statistics Netherlands have together developed a survey covering the information needs of all three organisations. Holland Solar provides Statistics Netherlands with a list of suppliers, and Statistics Netherlands sends out and processes the survey.

On the basis of information from Holland Solar and the response in 2008, the companies in 2008 were divided into three groups (strata): 14 large, 14 medium-sized and 21 small. After regular reminders the response rate was 85 percent from both the large and medium-sized companies, and 90 percent from smaller companies. For companies not responding, figures were estimated on the basis of data from the previous year, VAT data from the Dutch Tax Administration, and the average in the relevant stratum. These estimations amounted to a few percent of the installed capacity in 2008. The largest margin of error probably arises from the data supplied by the companies. At a national level the margin of error in the installed capacity in 2008 is approximately 5 percent, according to Statistics Netherlands estimations.

The lifespan of a solar electricity system is set at 15 years. This means it is assumed that systems installed in 1993 were taken out of service in 2008.

Electricity production was calculated using fixed key figures for annual production per installed capacity (Renewable Energy Monitoring Protocol, SenterNovem 2006). For non-grid-connected systems a production of 400 kWh per kW capacity applies, and for grid-connected systems a production of 700 kWh per kW capacity.

5.2 Solar heat

Developments

Table 5.2.1 shows the contribution of solar heat to renewable energy, by both covered and uncovered systems. In 2008, more solar thermal systems were installed than the

Table 5.2.1
Solar heat

	Operational collector area	Avoided use of fossil primary energy	Avoided emission of CO_2
	1,000 m²	*TJ*	*kton*
1990	76	73	4
1995	162	167	9
2000	360	421	24
2001	416	486	27
2002	475	552	31
2003	524	617	35
2004	582	698	39
2005	620	752	42
2006	646	787	44
2007	673	819	46
2008**	704	861	48

Source: Statistics Netherlands.

year before. The installed surface area increased by approximately 4 percent compared to 2007. The total contribution of solar heat to renewable energy in the Netherlands (in terms of avoided usage of primary energy) is around 0.8 percent.

In active solar thermal energy systems a distinction is made between covered and uncovered systems. Covered systems are closed systems, and therefore the difference in temperature between the system and its surroundings is larger than in uncovered systems. With a larger temperature difference the heat production per m^2 is also greater in covered systems. Covered systems are further subdivided into systems with a collector area smaller than 6 m^2, and systems with a collector area larger than 6 m^2. Small covered systems are better known as solar boilers. These are used in residential buildings. There are also systems with a collector area larger than 6 m^2; these are mainly used in non-residential buildings. Uncovered systems are used in swimming pools. Table 5.2.2 gives an overview of this breakdown; it includes a column with the number of installations for systems with a collector area below 6 m^2 (solar boilers).

Just as for solar electricity, a subsidy regulation for solar heat was also introduced in 2008: the renewable heat for existing homes subsidy regulation. The subsidy depends on the expected energy production, and according to SenterNovem estimates amounts to approximately 700 euro per boiler (Minister for Economic Affairs, 2008). The subsidy is intended to last for four years and has a budget to cover approximately 50 to 60 thousand solar boilers (SenterNovem website). This is approximately half the current number of installed solar boilers.

Table 5.2.2
New installed solar thermal systems, by system type

	Number	Area		
	Covered, collector area ≤6 m^2 (solar boilers)	Covered, collector area ≤6 m^2 (solar boilers)	Covered, collector area >6 m^2	Uncovered
		1,000 m^2		
1990	544	2	1	9
1995	3,375	11	2	13
2000	7,971	25	3	28
2001	8,736	27	3	28
2002	10,035	28	6	29
2003	8,385	23	4	25
2004	7,844	21	5	36
2005	7,294	18	3	29
2006	5,626	13	2	24
2007	6,365	17	2	28
2008**	7,981	21	2	28

Source: Statistics Netherlands.

Method

The basis for the statistics is a database established by Ecofys for the years up to and including 2002 (Warmerdam, 2003). Statistics Netherlands has updated the database in the years since then. The figures for installed covered systems are obtained from a quarterly survey of the system suppliers. The response rate was 90 percent for reporting year 2008. The list of suppliers was established with the help of SenterNovem and the Holland Solar trade association.

Installed uncovered systems are inventoried using an annual survey of the six suppliers of such systems. The list of suppliers was established using data from the Renewable Energy Project Office (Projectbureau Duurzame Energie, 2004). The response rate was 85 percent for reporting year 2008.

It is assumed that solar boilers have an average lifespan of 15 years. That means those installed in 1993 are no longer taken into account in calculating the contribution of solar heat to renewable energy. As systems may well have been replaced or taken out of circulation earlier or later than this, there is a margin of error.

For many somewhat larger projects, Ecofys established a database of owners (Warmerdam, 2003). In 2005 Statistics Netherlands approached the owners of 130 systems, asking them whether they were still in use. The information from this call-around was processed in 2005, for reporting year 2004 in the solar thermal systems database. The owners have not been approached again since then. The importance of the information does not justify the effort required or the survey burden that would be imposed. Instead, the information from 2005 has been extrapolated so that the 'survival chance' per age group remains the same. For other smaller systems, Statistics Netherlands assumes the lifespan is 15 years.

Renewable energy from solar heat is calculated using key figures for energy production per solar thermal system, and energy production per m^2 of collector area (for non-solar boilers). In addition, the extra electricity consumption of the solar thermal systems compared to standard (reference) systems is taken into account. The key figures are in the Renewable Energy Monitoring Protocol (SenterNovem, 2006).

The biggest uncertainty in the figures comes from uncovered systems. The margin of error in renewable energy from these is estimated to be 25 percent; for solar thermal systems as a whole it is estimated to be 15 percent.

6. Ambient heat

Ambient heat is energy that comes from the surroundings and is used for heating or cooling by means of a heat pump and/or seasonal storage in the ground.

Developments

Table 6.0.1
Ambient heat

	Avoided use of fossil primary energy	Avoided emission of CO_2
	TJ	*Kton*
1995	285	13
2000	809	35
2001	925	39
2002	1,119	47
2003	1,380	54
2004	1,826	69
2005	2,328	82
2006	3,192	116
2007	4,149	139
2008**	5,441	183

Source: Statistics Netherlands.

Renewable energy from ambient heat and cold is growing relatively quickly. Nevertheless the contribution to total renewable energy is still limited to approximately 5 percent.

It is notable that the growth in this energy source is not linked to a strong subsidy regulation, such as the MEP (Environment Quality of Electricity Production) for renewable electricity. The main financial support from the government is the Energy Investment Allowance (EIA), in which 44 percent of the investment amount is tax-deductible. If the venture makes a sufficient profit, this means a grant of 11 percent of the total investment amount. The energy standards for buildings also promote the use of ambient heat.

The growth mainly derives from two technologies that can be used for both heating and cooling: heat/cold storage and reversible heat pumps. These two technologies obviously fit well with a growing demand for cooling. A second explanatory factor is probably the rise in natural gas and electricity prices, as the use of ambient heat reduces the use of

Table 6.0.2
Building permits for new non-residential construction, value of buildings to be constructed

	2000	2001	2002	2003	2004	2005	2006	2007	2008
	mln euro								
Total	5,995	6,313	4,831	4,459	5,249	4,857	6,100	6,696	8,208
Groningen	168	144	113	128	265	115	319	199	609
Friesland	216	180	164	171	162	174	185	251	330
Drenthe	131	144	157	108	155	99	170	135	218
Overijssel	361	349	250	271	381	404	401	311	419
Flevoland	200	284	233	89	321	201	173	207	226
Gelderland	544	640	658	467	489	500	773	923	986
Utrecht	482	605	309	324	384	370	484	305	494
North Holland	1,354	1,239	888	724	779	664	1,016	938	1,078
South Holland	1,046	1,157	903	914	1,097	1,061	1,031	1,731	1,736
Zeeland	115	111	170	211	112	113	181	120	162
North Brabant	1,019	1,028	736	743	778	845	1,024	1,109	1,481
Limburg	357	434	251	309	326	311	343	464	470

Source: Statistics Netherlands.

natural gas for heating and electricity for cooling. A third factor is the increase in non-residential construction (table 6.0.2); ambient heat can often be applied relatively cheaply in new construction projects. A fourth factor is the maturing of the technology. There is now a sufficient number of efficiently running hot/cold storage projects, which gives investors the confidence to purchase these (Techniplan et al., 2006). A fifth factor is the low additional cost of buying an air conditioning unit with a heat pump option (reversible heat pump) compared to a unit without a heat pump option.

It should be stated in this respect that the figures for the main category of heat pumps (reversible) in particular are very uncertain. The absolute level of the figures must therefore be treated with caution. What is certain is that there has been a recent rapid increase.

Method

According to the Renewable Energy Monitoring Protocol (SenterNovem, 2006) seasonal storage of heat/cold is counted as a renewable energy technology, on the condition that no use is made of heat produced from fossil energy carriers. In many heat/cold storage projects a heat pump is used to use the stored heat. The heat produced in these projects counts in the renewable energy statistics for heat pumps, and not as heat/cold storage. The methods used for heat pumps and heat/cold storage are explained in more detail in the following two sections.

6.1 Heat pumps

A heat pump takes in low temperature heat and supplies heat at a higher temperature. To do this it requires energy, but much less than the quantity of heat it delivers. Thus a heat pump can use outdoor air (e.g. at 10°C) to heat an indoor space (e.g. to 20°C). The energy for the space heating therefore comes from the outdoor air (which as a result is cooled slightly) and the energy consumed by the heat pump. According to the Renewable Energy Monitoring Protocol (SenterNovem, 2006) heat pumps count as renewable energy if the heat they use does not come from fossil sources. In practice renewable heat pumps are primarily used in residential and non- residential buildings, and in agriculture.

Developments

Table 6.1.1 gives a complete overview of heat pumps used for renewable energy. The number of heat pumps increased by 20 thousand in 2007, to 85 thousand. The total installed capacity for heat production is almost 400 MW. The total contribution of heat pumps to renewably generated energy is approximately 4.6 PJ of avoided primary energy. This is 4 percent of the renewable energy total.

Table 6.1.1
Heat pumps

	New installed number	New installed thermal capacity	Operational number	Operational thermal capacity	Avoided use of fossil primary energy	Avoided emission of CO_2
		MW		*MW*	*TJ*	*kton*
1995	553	10	8,470	128	254	11
2000	2,412	38	16,054	224	589	20
2001	2,321	33	17,923	250	650	20
2002	4,897	42	22,366	284	772	24
2003	5,430	74	27,338	352	970	26
2004	8,182	127	35,060	471	1,365	38
2005	8,112	154	42,330	613	1,830	48
2006	12,300	230	53,784	831	2,566	74
2007	14,465	291	67,403	1,111	3,446	91
2008**	18,525	392	85,082	1,491	4,622	127

Source: Statistics Netherlands.

Most heat pumps are located in non-residential buildings (table 6.1.2), and also in greenhouses. The sharp increase in recent years is also mainly concentrated in non-residential buildings. These are mainly reversible heat pumps, most of them air-to-air heat pumps, which are purchased primarily to cool a building. Modern air conditioners that can both cool and heat nowadays cost only slightly more than those that can only cool. This is one explanation for the sharp rise in the number of reversible heat pumps. The question is whether all reversible heat pumps are also actually used for heating. The assumption of an average of 3,000 full-load hours for heating in the Protocol (SenterNovem, 2006) seems to be on the high side.

Table 6.1.2
Heat pumps by sector, type and heat source, 2008**

	New installed number	New installed thermal capacity	Operational number	Operational thermal capacity	Avoided use of fossil primary energy	Avoided emission of CO_2
By sector and type		*MW*		*MW*	*TJ*	*kton*
Non-residential [1]						
Standard and combi [2]	756	36	4,846	191	840	32
Heat pump boilers for tap water	–	–	124	0	1	0
Reversible	9,605	284	36,439	991	2,915	61
Total	10,361	320	41,409	1,182	3,756	94
Heat recovery from milk cooling	467	7	7,000	112	257	13
Residential						
Standard and combi [2]	5,635	48	16,220	141	437	16
Heat pump boilers for tap water	949	1	18,946	28	93	3
Reversible	1,113	15	1,506	28	80	2
Total	7,697	65	36,673	197	610	21
By heat source (estimate)						
Water	2,612	103	12,531	445	1,626	53
Soil	1,486	16	6,779	62	199	7
Air	13,960	266	58,772	871	2,540	54
Milk	467	7	7,000	112	257	13
Total	18,525	392	85,082	1,491	4,622	127

Source: Statistics Netherlands.

[1] Including agriculture, excluding heat recovery from milk cooling.
[2] Including all gas-driven heat pumps.

Table 6.1.3
New installed heat pumps

	New installed number					New installed thermal capacity				
	2004	2005	2006	2007	2008**	2004	2005	2006	2007	2008**
By sector and type						*MW*				
Non-residential [1]										
Standard and combi [2]	644	590	753	662	756	26	35	20	28	36
Heat pump boilers for tap water	10	–	–	–	–	0	–	–	–	–
Reversible	3,801	3,684	6,422	8,994	9,605	77	98	177	231	284
Total	4,455	4,274	7,175	9,656	10,361	103	133	197	259	320
Heat recovery from milk cooling	506	509	512	467	467	8	8	8	7	7
Residential										
Standard and combi [2]	707	1,481	2,565	2,687	5,635	8	9	23	23	48
Heat pump boilers for tap water	2,412	1,848	2,048	1,655	949	4	3	3	2	1
Reversible	102	–	–	–	1,113	4	–	–	–	15
Total	3,221	3,329	4,613	4,342	7,697	15	12	26	25	65
By heat source (estimates to 2007)										
Water	.	.	2,164	2,185	2,612	.	.	66	85	103
Soil	.	.	1,283	1,344	1,486	.	.	11	11	16
Air	.	.	8,342	10,469	13,960	.	.	145	187	266
Milk	.	.	512	467	467	.	.	8	7	7
Total	8,182	8,112	12,300	14,465	18,525	127	154	230	291	392

Source: Statistics Netherlands.

[1] Including agriculture, excluding heat recovery from milk cooling.
[2] Including all gas-driven heat pumps.

Some heat pumps are applied in combination with heat/cold storage. These are standard heat pumps and reversible water-to-water heat pumps. The renewable energy from heat/cold storage has also grown strongly in recent years (see also section 6.2), which also explains the increase in the sale of heat pumps.

Remarkably, the new installed capacity of heat pumps in households doubled in 2008. In terms of capacity, households now account for one sixth of all installed capacity. A subsidy regulation for heat pumps in existing homes came into effect in September 2008. This only applies to heat pumps that deliver their heat to central heating systems in which the energy is then transported by water (for example radiators or underfloor heating). As of April 2009 the number of applications was just 100 (SenterNovem, 2009). For 2008 therefore, this regulation still had very little or no impact on the installation of heat pumps.

The use of heat pumps in the dairy industry entails the use of heat from the cooling of milk for the heating of tap water. This type of system has existed for a long time, and there is talk of a replacement market.

Method

According to the Renewable Energy Monitoring Protocol (SenterNovem, 2006) only heat generated by pumps that make use of ambient heat is regarded as renewable energy. Heat pumps which make use of waste heat from industry or from power stations are not included, as in current practice this waste heat comes from fossil energy carriers. Energy saved by using these heat pumps does count towards total energy savings (Boonekamp, et al., 2001). Many heat pumps are used to make use of the heat from heat/cold storage projects. The heat from these projects counts in the renewable energy statistics for heat pumps, and not in those for heat/cold storage.

In practice, it is mainly heat pumps in buildings and agriculture that use ambient heat. For heat pumps that have cooling and not heating as their primary function (reversible heat pumps), only the energy savings during heat production are counted.

– Classification

The Renewable Energy Monitoring Protocol (SenterNovem, 2006) distinguishes six types of heat pumps:
1. standard electric heat pumps
2. combi electric heat pumps
3. electric heat pump boilers
4. electric reversible heat pumps
5. gas absorption heat pumps
6. heat recovery from milk cooling.

Standard heat pumps are primarily designed for space heating. Combi heat pumps are designed for space and tap water heating. Heat pump boilers are designed for heating tap water, and reversible heat pumps are designed for heating and cooling. Electric heat pumps use electricity as a power source; gas absorption heat pumps use natural gas. In heat recovery from milk cooling, heat from milk is used to warm tap water. The number of suppliers of combi electric heat pumps and gas absorption heat pumps is very small. Because of the limited reliability as a result of incomplete response and confidentiality regulations, Statistics Netherlands does not publish separate annual data on these two categories, and they are considered together with standard heat pumps.

From an international perspective, a different classification of heat pumps is frequently used (European Commission, 2007 and 2008; CSTB, 2006; Forsen, 2008). This is based on the source of the heat:
1. Ground source heat pumps
2. Water source heat pumps
3. Air source heat pumps

Ground source heat pumps use heat from the ground without removing groundwater from it. The heat is extracted from the ground using a fluid in an enclosed hose or tube. This fluid is frequently water with an antifreeze agent, such as salt. Ground source systems are also called ‘brackish’, ‘brine’ or ‘closed loop’ systems. Water source heat pumps use groundwater or surface water. Air source heat pumps use outdoor air or ventilation air.

The new renewable energy directive (European Parliament and the Council, 2009) is based primarily on another classification: aerothermal (outdoor air), hydrothermal (surface water) and geothermal (everything that comes from beneath the surface of the earth). There are still very few hydrothermal systems. The subsidy regulation for renewable heat in existing houses (commencement date September 2008) also distinguishes heat pumps that use air as a heat source and those that use the ground or groundwater (SenterNovem).

The energy performance of heat pumps is better if the temperature difference is smaller. In water source systems this difference is generally the smallest, as the temperature of groundwater drops only slowly because of its buffer effect. In ground source systems the water in the ground is not removed, and the buffer effect is smaller. In air source systems this effect is entirely absent, as a result of which the temperature difference in these systems is the largest. Because of the strong relationship between the energy performance of the heat pump and the heat source, a classification by heat source is in principle a good way to classify the energy statistics for heat pumps.

In the past, however, Statistics Netherlands has been reluctant to use classification by heat source, because it is difficult for suppliers to know how their heat pumps are installed. On the basis of contacts with suppliers and their trade associations however, this has been overcome. For 2008 the survey was extended with a classification based on heat source, and experiences indicate that this has not proved a problem for suppliers. At present there are ongoing discussions about an update of the Renewable Energy Monitoring Protocol. The classification of heat pumps is one of the subjects being discussed between the parties concerned.

– Collection and processing of data

The basis for the statistics is the heat pump database set up by Ecofys in 1994 (de Graaf et al., 1996), and for the years up to and including 2002 (Graus and Joosen, 2003). This database gives the number and capacity of delivered heat pumps by supplier, year and type. Statistics Netherlands has updated this database for the years since, and also established a conversion between the old and the new heat pump classifications (SenterNovem, 2004). In this conversion it is assumed that dehumidifiers and double function heat pumps fall under reversible heat pumps, and that 20 percent of ordinary heat pumps (old classification) are combi heat pumps.

Since 2005 a correction has been applied for heat pumps taken out of use. The assumption is that 20 percent of the heat pumps from the base year of the statistics (1994) have been taken out of use since 2005. The idea behind this assumption is that the heat pumps that were present in the Netherlands in 1994 were installed in the years from 1990 to 1994, and that the average lifespan is 15 years.

The data for installed heat pumps originated from the heat pump suppliers. The Heat Pumps Foundation (Stichting Warmtepompen) surveys its thirteen members and sends the results to Statistics Netherlands. The air conditioning equipment suppliers association (VERAC, 16 members) does the same. The remaining (approximately) 35 suppliers were approached directly by Statistics Netherlands. The response rate was over 90 percent.

For heat recovery from milk cooling, use was made of an estimation of the most important suppliers of milk cooling systems in 2006. In 2006, an estimated 30 percent of dairy farms had a heat recovery system. For cows this figure is somewhat higher (35 percent), because heat recovery systems occur relatively frequently on larger farms (de Koning and Knies, 1995). There were a total 1.4 million dairy cows in 2006, of which

500 thousand were on farms with a heat recovery system. The renewable energy was calculated according to the Renewable Energy Monitoring Protocol (SenterNovem, 2006). For 1995 the number of cows on a farm with a heat recovery system was 400 thousand (de Koning and Knies, 1995). Figures for the intervening years were interpolated. The average capacity of an installation is estimated to be 16 kW, based on field data. In estimating the number and capacity of new installations, a lifespan of 15 years was assumed. In 2007 an agricultural census also asked about the presence of heat recovery systems. The initial results indicated that 6 percent of dairy farms had one. This clearly contradicts the suppliers' estimation. For the renewable energy statistics the suppliers' estimation has been deemed to be the more reliable. Many dairy farmers probably overlooked the question about heat recovery systems. For 2007 it was assumed that the proportion of dairy farms with heat recovery systems increased from 35 to 36 percent. The number of dairy cows (agricultural census) remained approximately the same, at 1.4 million.

The questionnaire was expanded for reporting year 2008. As a result, Statistics Netherlands now collects information on reversible heat pumps >10 kW in households and other sectors. It was previously assumed that all reversible heat pumps >10 kW were situated in non-residential settings. Because of this change there is a perceptible break in the time series on reversible heat pumps in households (table 6.1.3).

As mentioned above it is potentially desirable in the long term to change to a heat pump classification based on heat source. In anticipation of this possible adjustment, Statistics Netherlands has estimated the data on heat pumps by heat source. To do this, data from the survey about the heat source of reversible heat pumps was used from 2005, and of all heat pumps from 2008. Statistics Netherlands also looked at the statistics for heat/cold storage. Because of the estimations, the data broken down by heat source are less accurate than the data according to the standard breakdown.

– Margin of error

The largest margin of error in the figures on renewable energy from heat pumps is in figures on reversible heat pumps for heating. These reversible heat pumps are mainly purchased for cooling (air conditioning). Reversible heat pumps with a capacity of <10 kW are not included, because in practice these are almost always used for cooling (Renewable Energy Monitoring Protocol, 2006). In the protocol, 3,000 full-load hours is assumed for reversible heat pumps, based on an estimate by Traversi (2004). Several actors in the field have identified this estimate as improbably high. Also, the COP (Coefficient or Performance) used for reversible heat pumps (3) is only an estimate and has a lot of influence on the results.

To summarise: half of the reversible heat pumps in the statistics may not be used for heating. This would mean an overestimate. When everything is taken into account, the margin of error in the renewable energy from heat pumps is estimated to be 40 percent.

6.2 Heat/cold storage

In heat/cold storage systems, heat and cold are stored in the ground to be used two seasons later. Cold groundwater is used for cooling in summer. This heats up the groundwater, and this heat is used in winter for heating, which cools the groundwater again. Heat/cold storage systems therefore avoid the use of fossil fuels in two ways, one for heating and the other for cooling. At present, heat/cold storage is mainly applied in new large-scale non-residential buildings.

Heat/cold storage systems are divided into two categories: open systems and closed systems. In open systems groundwater is pumped up, the heat exchange takes place above ground, and the water is then returned underground. In closed systems a heat-bearing fluid is introduced into the ground via a closed system (for example a tube), whereupon the heat exchange takes place underground. The capacity of open systems is larger, because by withdrawing the water and the resulting groundwater flows, a larger volume of the ground can be used. In closed systems only the part directly surrounding the tube is used. For this reason closed systems are mainly used in residential buildings, and open systems in non-residential buildings. No licence is necessary for closed systems, but one is required for open systems.

Developments

Table 6.2.1 shows the development of heat/cold storage since 1990. After a slow increase from 1990, the growth in heat/cold projects developed rapidly from 1995 onwards. From 2003 the growth rate slackened off, only to increase sharply again in 2006. Part of these fluctuations correlate to the construction of residential and non-residential buildings, which in turn correlates with the economic situation. But the strong rise from 2006 is certainly not fully explained by this. The main reason may be that suppliers of heat/cold storage systems are increasingly able to persuade purchasers that heat/cold storage is an efficient and sufficiently reliable way to provide heating and cooling. The rising price of natural gas has helped in this.

What also played a role in 2006 was that heat/cold storage began to take off in the glasshouse industry, accounting for 20 percent of new capacity in 2006 and 2007.

Not too much meaning should be read into the decline in installed capacity in 2007. Uncertainty over the exact start-up moment of new projects has distorted the figures.

Table 6.2.1
Heat/cold storage

	New installed thermal capacity	Operational thermal capacity	Avoided use of fossil primary energy	Avoided emission of CO_2
	MW		*TJ*	*kton*
1990	0	1	3	0
1995	18	31	31	2
2000	53	219	220	15
2001	64	282	275	19
2002	114	396	347	24
2003	81	476	409	28
2004	68	541	461	31
2005	52	593	498	34
2006	151	743	625	43
2007	97	804	703	48
2008**	166	968	820	56

Source: Statistics Netherlands.

Table 6.2.2
Heat/cold storage per province in 2007

	Number of projects	Licensed flow [1)]	Actual flow	Operational thermal capacity	Avoided use of fossil primary energy	Avoided emission of CO_2
		mln m^3		*MW*	*TJ*	*kton*
Projects with licence						
Groningen	13	3	2	10	11	1
Friesland	17	3	2	7	6	0
Drenthe	12	1	1	3	3	0
Overijssel	26	12	7	21	27	2
Gelderland	88	26	14	89	76	5
Flevoland	13	4	2	13	8	1
Utrecht	35	14	8	41	33	2
North Holland	106	46	25	142	121	8
South Holland	129	51	28	165	151	10
Zeeland	7	4	2	13	8	1
North Brabant	101	40	23	134	106	7
Limburg	28	5	3	10	15	1
Total	575	210	118	648	564	38
Projects without licence	.			156	139	10
All projects	.			804	703	48

Source: Statistics Netherlands.

1) Of all projects operational on 31 December 2007.

Table 6.2.3
Heat/cold storage per sector in avoided use of primary fossil energy 2007

	Share
	%
Non-residential construction	69
Glasshouse horticulture	9
Other agriculture	11
Residential construction	9
Manufacturing	2

Source: Statistics Netherlands.

Most heat/cold storage systems are found in the provinces of North Holland, South Holland and North Brabant (table 6.2.2). This distribution of heat/cold storage systems across the provinces roughly reflects the distribution of non-residential construction in these provinces (table 6.0.2).

The bulk of renewable energy from heat/cold storage systems still comes from non-residential construction (table 6.2.3), accounting for 70 percent of the total. Other sectors are agriculture (glasshouses, manure cooling, and heating and cooling in mushroom cultivation), and residential construction.

Method

According to the Renewable Energy Protocol Monitoring (SenterNovem, 2006), the seasonal storage of heat/cold is counted as a renewable energy technology, provided no use is made of waste heat produced from fossil energy carriers. Many heat/cold storage projects use heat pumps to make use of the heat. The heat produced in these projects is counted in the renewable energy statistics for heat pumps, and not as heat/cold storage.

The first step in collecting statistics for heat/cold storage is to make an inventory of the projects and to determine a measure for the energy supply. The most important sources for this information are the provincial governments, because most heat/cold storage projects are obliged to apply to them for a licence. Just as last year, all provincial governments were asked to provide a complete list of heat/cold storage projects; all the provinces provided such a list. In each project the maximum annual flow is known, because this is a standard part of the licence – a standard condition in the licence is to provide the annual flow volume realised. These figures were also requested from the provinces for 2005 to 2007, and were available for 372 projects. On average approximately half the authorised flow volume is used. In smaller projects a bigger portion is utilised than in larger projects. Missing annual flows were estimated on the basis of the maximum authorised flow and the proportion of this used in the above-mentioned 372 projects. The size of the project is also taken into account.

For many projects the moment of them coming into use is uncertain. Often, missing data about annual flows is an indication that a project has not yet started. But it is also possible that the project operator has not yet supplied the data to the provincial government. For reporting year 2007, Statistics Netherlands asked the provincial governments for a declaration of missing annual flow data. As a consequence it became clear that for a number of new projects, it had been erroneously assumed that they had started in 2006. As a result, the figures for 2006 are probably somewhat too high, and the figures for newly installed capacity in 2007 too low. In a subsequent revision of the renewable energy statistics, these improved insights will also be processed for the previous years.

Data on annually realised flows often only become available to the provinces somewhat late in the year. For this reason Statistics Netherlands asks for them during the summer. As a consequence, in the more detailed provisional figures for 2008, all flows are estimated on the basis of the authorised flow and the proportion utilised (depending on the size of the project). Because the information on the realised flows in 2008 is not yet available, the estimation of the moment of coming into use of newly authorised projects is also subject to a margin of error. The large number of newly authorised projects means this has a significant impact on the reliability of the more detailed provisional figures for 2008 for heat/cold storage. As a result of this reduced reliability, no breakdowns are available for the more detailed provisional figures for 2008 (tables 6.2.2 and 6.2.3). This breakdown will be available in the definite 2008 figures (November 2009) as a customised table on Statistics Netherlands' website.

For one particular type of project (single-source systems with a heat exchanger in the ground) discussion is ongoing about whether or not they require a licence. In practice this affects relatively small projects for which no licence was requested. These projects are included in the observations on the basis of information from the system suppliers.

Small open projects and closed projects are not required to have a licence. Provincial governments generally have no information on these projects. For this reason in 2007, the drilling companies involved in these projects were approached to obtain an estimate (CBS, 2007). This inventory was repeated in 2008 for reporting year 2007, for the 8 most important drilling companies. The contribution of the remaining drilling companies was estimated.

The second step in drawing up the statistics for heat/cold storage projects is to determine whether heat pumps are present. For the four provinces with the most projects (North Holland, South Holland, North Brabant and Gelderland), use is made of the project descriptions that were known to the provinces up to and including 2006. We know whether or not there is a heat pump for almost half these projects. For the remaining projects the presence of a heat pump was estimated on the basis of information from the projects where one is known to be present. In doing this, the factors with the most influence on the presence of a heat pump (sector and project size) are taken into account. In non-residential construction a heat pump is present in approximately 50 percent of cases; in residential construction the figure is 75 percent. For the closed systems it is assumed that a heat pump is always present.

The third step is the calculation of the avoided use of fossil primary energy and avoided CO_2 emissions according to the Renewable Energy Monitoring Protocol (SenterNovem, 2006). For heat/cold storage the calculations are based on Koenders and Zwart (2006).

For some projects only the capacity is known and not (an estimate of) the flow. This affects projects with single-source systems with a heat exchanger in the ground. For this group of somewhat smaller projects, use was made of key figures based on capacity. These key figures for projects with a heat pump are: 0.5 GJ avoided use of fossil primary energy per kW and 34 kg of avoided CO_2 emissions per kW. For projects without a heat pump, the figures are: 1.2 GJ avoided use of fossil primary energy per kW, and 80 kg avoided CO_2 emissions per kW. These figures were derived from the key figures in the Protocol and an assumption of 170 m^3 displaced water per kW capacity. That assumption is based on 10 projects with a heat exchanger in the ground, for which both the capacity and the maximum flow are known. Furthermore it is assumed that this maximum flow is used in its entirety. Meanwhile, both the authorised flow and the capacity are known for 25 projects with single-source systems with a heat exchanger in the ground, and the authorised flow comes to 300 m^3 per kW capacity. In the current figures the contribution of single-source systems is therefore probably too low. These new insights will be taken into consideration in the next revision of these statistics.

To get an idea of the capacity of the installed systems for all projects, an estimation was made. This is based on a key figure of 1/325 kW per m^3 authorised flow, which in turn is based on data collected by Ecofys about projects with a starting date up to and including 2002.

The most important contribution to renewable energy by heat/cold storage is made by licensed systems. For these systems a fairly reliable method (Koenders and Zwart, 2006) is available to calculate the avoided use of fossil primary energy and avoided CO_2 emissions, based on actual energy flows in around 60 projects. The most uncertain factor in this is possibly the energy performance of the reference for cooling. There is a wide margin of error in the estimations for the remaining projects. Their contribution to the total, however, is relatively small. The margin of error in the renewable energy from heat/cold storage is estimated to be approximately 25 percent. Uncertainty about the start-up moment of a project also causes extra distortion in the year-on-year changes.

7. Biomass

Biomass is the most important source of renewable energy and is used in many ways. The three main large-scale applications are: municipal waste incineration plants (section 7.1), the co-firing of biomass in electricity power stations (7.2) and the use of biofuels in road transport (7.10). These are followed by wood stoves for heat in companies (7.3) and in households (7.4). Besides direct combustion, biomass can also be converted into biogas by micro-organisms. On landfill sites (7.7) this happens without any additional human intervention. Wet organic waste streams are frequently suitable to be converted into biogas by means of digestion. This happens in many sewage purification plants (7.6) and also in industrial effluent purification installations (7.9). A relatively new development is the rise of biogas installations on farms (7.8), where, among other things, manure is digested. Lastly, there is also the category of other biomass combustion. This includes a range of very different projects (7.5).

Developments

Renewable energy from biomass grew strongly in 2004 and 2005. In 2006 and 2007 the growth rate decreased, and in 2008 it showed another strong rise. The fluctuations are largely due to the co-firing of biomass in electricity power stations. The investment costs for this technology are relatively low. The additional costs with respect to conventional power generating technologies mainly relate to the extra cost of the fuel used. Depending on, among other things, subsidy tariffs and the relative prices of biomass and fossil fuels, the owners of power stations can decide in a relatively short period of time to use more or less biomass as a replacement for coal or natural gas. That is an important reason for the variations over time in the co-firing of biomass.

The enormous fall in the co-firing of biomass in power stations in 2007 was compensated for by an almost as large increase of the use of biomass for road transport in that year. This was caused by the coming into effect of the Biofuels Decision in 2007 (Bulletin of Acts and Decrees, 2006), which obliges petrol and diesel suppliers to ensure that biofuels make up a certain percentage of the vehicle fuels available at the pump.

In the other large application of biomass, waste incineration plants, the picture much is more stable. This is because investment accounts for most of the costs. Once the

Table 7.0.1
Biomass

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008**
Use (TJ)											
Municipal waste, renewable fraction	13,205	15,450	25,512	24,637	25,510	25,059	26,066	26,659	26,616	27,845	29,266
Biomass co-firing in large scale power plants	–	33	1,755	5,408	9,866	7,127	14,123	30,522	29,445	15,702	19,692
Wood stoves for heating in industry	1,682	2,103	2,150	2,102	2,054	2,010	1,966	2,068	2,306	2,552	2,678
Household wood stoves	11,476	9,742	9,766	9,593	9,466	9,316	9,316	9,316	9,316	9,316	9,316
Other biomass combustion	440	577	3,695	3,944	3,825	4,059	4,992	5,628	6,623	7,070	12,825
Landfill biogas	392	2,238	2,313	2,303	2,494	2,257	2,041	1,909	1,926	1,909	1,778
Biogas from sewage purification plants	1,779	1,834	1,925	2,068	2,073	2,006	2,033	1,946	2,010	1,998	2,046
Biogas on farms [1)]								82	591	1,872	3,691
Other biogas	468	826	974	989	994	1,129	1,211	1,158	1,382	1,475	1,782
Biofuels for road transport	–	–	–	–	–	134	134	101	1,979	13,031	14,032
Total	29,442	32,802	48,089	51,044	56,283	53,097	61,882	79,389	82,193	82,769	97,105
Avoided use of fossil primary energy (TJ)											
Municipal waste, renewable fraction	6,093	6,117	11,417	10,864	11,340	11,484	11,209	11,874	12,400	12,979	12,716
Biomass co-firing in large scale power plants	–	33	1,755	5,408	9,866	7,127	14,123	30,522	29,445	15,702	19,692
Wood stoves for heating in industry	1,308	1,636	1,806	1,808	1,809	1,811	1,813	1,914	2,145	2,382	2,508
Household wood stoves	6,231	5,334	5,701	5,603	5,541	5,464	5,464	5,464	5,464	5,464	5,464
Other biomass combustion	440	577	2,317	2,598	2,859	3,098	3,899	4,397	5,319	5,632	9,111
Landfill biogas	336	2,050	1,934	1,925	2,038	1,803	1,628	1,580	1,500	1,406	1,307
Biogas from sewage purification plants	1,866	2,197	2,299	2,438	2,435	2,345	2,348	2,127	2,068	2,132	2,262
Biogas on farms [1)]								78	456	1,441	2,845
Other biogas	497	834	1,013	1,027	1,041	1,144	1,207	1,151	1,364	1,412	1,679
Biofuels for road transport	–	–	–	–	–	134	134	101	1,979	13,031	14,032
Total	16,770	18,778	28,242	31,670	36,929	34,411	41,827	59,208	62,140	61,581	71,617

Source: Statistics Netherlands.

[1)] Included as other biogas to 2004.

installation is operational, it is important for the owner to use it as much as possible. Moreover, government policy is aimed at sending as little waste as possible to landfill. In combination with the limited total capacity for incinerating household waste, this means that the installations operate at almost full capacity. The increase between 1995 and 2000 was caused by new installations coming into use.

The avoided use of fossil primary energy is as a rule lower than the use of biomass (table 7.0.1). This is because the efficiency of biomass applications is relatively low. This is particularly true in municipal waste incineration plants and wood stoves in households. In calculating the avoided use of fossil primary energy, the higher or lower use of fossil primary energy in the production of the biomass compared with the production of the reference fuel is not taken into account (Renewable Energy Monitoring Protocol). No life-cycle analysis (LCA) has therefore been carried out. This can certainly be important in transport fuels, because making biofuels for transport from crude vegetable materials requires more energy than making petrol and diesel from crude oil (Edwards et al., 2007).

Sustainability of biomass

In recent years there has been increasing social discussion about the sustainability of the use of biomass, frequently citing the protection of tropical forests, CO_2 effectiveness over the entire chain and the impact on food prices. All forms of biomass are still included in the renewable energy statistics (Renewable Energy Monitoring Protocol), as commonly accepted operational criteria to assess the sustainability of biomass are still lacking.

Imports

Most biomass comes from national sources, almost always waste streams. For biofuels for road transport, co-firing of biomass, and for other biomass combustion, however, the majority of the raw materials come from overseas. These include palm oil, pellets (compacted woodchips) and agricultural waste (Junginger et al., 2006; Sikkema et al., 2007). The total import of biomass for co-firing and other biomass combustion is estimated to be 13 PJ in 2007, (Sikkema, personal communication). As in 2006, that is almost 60 percent of total biomass used for these applications.

The national production of biodiesel covered less than one third of the total consumption in 2007 and 2008. The remainder therefore comes from net imports. Stocks of biodiesel increased strongly in 2007 and 2008. The total net imports of biodiesel were approximately 9 PJ in 2007, and 12 PJ in 2008. For biopetrol it is not possible to state what portion of consumption comes from overseas, because national production is confidential.

Biomass is also exported: an estimated 13 PJ in 2004 (Junginger et al., 2006). Waste wood is an example of exported biomass. No recent figures are available, however.

Definition of biomass as an energy carrier

In theory biomass can take on many forms: for example food or newspapers. In energy statistics, however, biomass is only counted if it is used as an energy carrier. Therefore, for example, imports of palm oil for the food industry are not included.

7.1 Municipal waste incineration plants

Developments

The production of renewable energy from municipal waste incineration plants (MWIPs) fell slightly in 2008 compared with the previous year (tables 7.1.1 and 7.2.2). This was mainly due to start-up problems at a new waste incinerator in Amsterdam, which does burn waste, but still generates little electricity.

In general the annual fluctuations in the energy production of MWIPs are for the most part determined by whether or not large-scale maintenance is undertaken and whether or not there are any breakdowns. Renewable energy from MWIPs accounts for 11 percent of all renewable energy in the Netherlands.

Between 1990 and 2002, the biomass fraction of incinerated waste gradually fell. This was due to the separate collection of kitchen and garden waste. Since 2003 this fall has ceased.

The difference between the gross and net electricity production in MWIPs is relatively large. This is mainly because the MWIPs use a lot of electricity for flue gas cleaning. Many newer MWIPs use relatively little electricity, but instead a substantial quantity of natural gas for flue gas cleaning. The use of these fossil fuels is discounted from the calculation of avoided primary energy (Renewable Energy Monitoring Protocol, SenterNovem, 2006).

Method

In the determination of renewable energy, municipal waste incineration plants are defined as installations which are appropriate for mixed waste streams. Installations developed

Table 7.1.1
Municipal waste incineration plants: capacity, incinerated waste, net energy production

	Electrical capacity	Incinerated waste		Used electricity	Gross electricity production	Net electricity production	Heat supply	Heat deliveries	Net heat production	Use of fossil fuels
	MW	*kton*	*TJ*	*GWh*			*TJ*			
1990	196	2,780	22,840	134	933	799	.	.	3,124	–
1995	277	2,913	28,654	325	1,308	983	1,442	3,969	2,528	93
2000	394	4,896	49,767	565	2,520	1,956	2,831	9,026	6,195	796
2001	394	4,776	49,096	545	2,461	1,916	2,834	8,510	5,677	854
2002	394	5,010	51,573	561	2,467	1,905	2,492	9,154	6,662	540
2003	400	5,030	53,318	566	2,606	2,040	2,949	10,140	7,191	758
2004	400	5,232	55,459	570	2,550	1,980	2,503	9,930	7,427	941
2005	429	5,454	56,722	609	2,738	2,129	1,908	9,521	7,614	938
2006	429	5,545	55,450	632	2,777	2,144	1,903	10,090	8,187	886
2007	506	5,801	58,010	636	2,960	2,324	1,728	9,874	8,146	1,068
2008**	506	6,097	60,970	696	2,900	2,204	2,035	10,352	8,318	906

Source: Statistics Netherlands.

Table 7.1.2
Municipal waste incineration plants: renewable fraction and renewable energy

	Renewable fraction	Biogenic waste input	Gross renewable electricity production	Net renewable electricity production	Renewable heat production	Avoided use of fossil primary energy	Avoided emission of CO_2
	%	*TJ*	*GWh*		*TJ*		*kton*
1990	58	13,205	539	462	1,806	6,093	412
1995	54	15,450	705	530	1,363	6,117	420
2000	51	25,512	1,292	1,003	3,176	11,417	764
2001	50	24,637	1,235	962	2,849	10,864	733
2002	49	25,510	1,220	942	3,295	11,340	759
2003	47	25,059	1,225	959	3,380	11,484	772
2004	47	26,066	1,199	931	3,491	11,209	744
2005	47	26,659	1,287	1,001	3,579	11,874	790
2006	48	26,616	1,333	1,029	3,930	12,400	812
2007	48	27,845	1,421	1,116	3,910	12,979	856
2008**	48	29,266	1,392	1,058	3,992	12,716	827

Source: Statistics Netherlands.

for specific waste streams, such as the new thermal conversion installation for paper sludge in Duiven, the waste wood incinerators at Twence in Hengelo, and at the ‘Huisvuilcentrale’ in Alkmaar, are not included with MWIPs. They do count towards renewable energy, but as other biomass combustion.

The figures on electrical capacity come from Statistics Netherlands figures for Electricity Production Sources. The time series on the incinerated waste originates from SenterNovem, which establishes this as part of the Waste Registration Working Group (WAR, a cooperation between SenterNovem and the Dutch Waste Management Association), using a survey of MWIPs. No WAR data were yet available for the second provisional estimate for 2008. For this reason, annual government environment reports were used to calculate changes between 2007 and 2008.

SenterNovem data were used for the calorific value and biomass fraction, based on observations from waste streams and a calculation method from the Renewable Energy Monitoring Protocol (SenterNovem, 2006). There were no new figures for 2008, so the figures from 2007 were retained.

The electricity and heat production of the MWIPs was determined on the basis of Statisitcs Netherlands’ energy surveys. The response to these was around 90 percent. Missing data were estimated on the basis of annual environment reports. The energy data were compared to data from the WAR (up to and including 2007) and with the annual environment reports. On the basis of the comparison between these annual reports and the energy surveys, Statistics Netherlands estimates the margin of error in the electricity production of the MWIPs in 2008 to be approximately 3 percent. For the definite figures for 2008, data from the WAR will also be used in the analysis.

When everything is taken into consideration, the largest margin of error in the renewable energy from MWIPs lies in determining the biomass fraction. This margin of error is estimated to be 10 percent.

7.2 Co-firing of biomass in power stations

Biomass co-firing in power stations covers existing large scale power stations that use coal or natural gas as their main fuel. Part of this main fuel can be replaced by various types of biomass. Coal-fired power stations mainly use agricultural waste streams or wood pellets, while gas-fired power stations frequently use vegetable oil.

Developments

After growing strongly in the years 2003–2005 co-firing biomass in power stations decreased slightly in 2006, and even halved in 2007 (table 7.2.1). In 2008 co-firing started to show an increase again. Co-firing now accounts for around one sixth of all renewable energy and a quarter of renewable electricity production.

The increase in co-firing from 2003 to 2005 was caused by the availability of new technological adaptations, as a result of which it became possible to co-fire larger amounts of biomass. Moreover, the subsidy tariffs in 2005 were probably sufficiently large to cover the incremental costs of co-firing (de Vries et al., 2005). A consequence of the rapid increase was that the Minister for Economic Affairs ended the subsidy regulation for new co-firing projects in May 2005. Moreover, on July 1 2006 the subsidy tariffs for existing co-firing projects for liquid biomass were also sharply reduced. Along with social concerns about the sustainability of palm oil, this probably contributed to the slump in co-firing in 2007.

In contrast to, for example, wind turbines or municipal waste incineration plants, the variable costs of co-firing are relatively large compared to the fixed costs. The variable costs (price of biomass) and yield (subsidy, saved fossil fuels, CO_2 emissions rights) can fluctuate a great deal. As a consequence, the amount of co-firing also fluctuates. Moreover, co-firing is still only applied in a limited number of power stations. Unusual

Table 7.2.1
Co-firing biomass in large-scale power plants

	Use of biomass	Gross electricity production	Net electricity production	Heat production	Avoided use of fossil primary energy	Avoided emission of CO_2
	TJ	*GWh*		*TJ*		*kton*
1990	–	–	–	–	–	–
1995	33	4	4	1	33	3
2000	1,755	208	198	15	1,755	166
2001	5,408	591	563	58	5,408	512
2002	9,866	1,134	1,082	222	9,866	906
2003	7,127	795	757	81	7,127	675
2004	14,123	1,609	1,539	325	14,123	1,202
2005	30,522	3,449	3,310	693	30,522	2,394
2006	29,445	3,244	3,103	552	29,445	2,228
2007	15,702	1,816	1,711	821	15,702	1,462
2008**	19,692	2,316	2,181	805	19,692	1,743

Source: Statistics Netherlands.

circumstances at one of these, such as major maintenance, can have a big effect on the figures.

Method

In principle data about renewable electricity production come from the administration behind the CertiQ renewable energy certificates. Renewable electricity production is calculated by multiplying the total electricity production of an installation by the renewable fraction of the fuels used (on an energy basis). The implicit assumption here is that 1 joule of biomass replaces 1 joule of fossil fuel. This fuel substitution is probably not 100 percent, but a few percent lower. In calculating the subsidy tariffs for co-firing (MEP report, Environmental Quality of Electricity Production) it is assumed to be 90 percent for gas-fired power stations and 93 percent for coal-fired power stations (de Vries et al., 2005 and Tilburg, et al., 2007).

For the input of biomass, use was made of data submitted by companies in response to Statistics Netherlands' surveys. The efficiency of the power stations is also inferred from survey data. The data from the CertiQ administration and Statistics Netherlands' surveys can thus be compared on an individual basis. Moreover, the annual environmental reports are used as a control. Where there was a difference in the use of biomass between the sources greater than 200 TJ, it was either always clear what the cause was, or it was determined afterwards by requesting definite figures from the power stations concerned. Apart from uncertainties in the fuel substitution rate, the margin of error in renewable energy from the co-firing of biomass in power stations is estimated to be 3 percent. Analysis of the second provisional 2008 estimates is not yet complete. For this reason the margin of error is somewhat larger this year, approximately 5 percent.

7.3 Wood stoves for heating in industry

Developments

The contribution to the production of renewable energy from wood stoves which provide heating for company buildings and processes increased again in 2008 compared with the previous year, but the increase was not as large as in 2007 and 2006 (table 7.3.1). As in previous years, most new capacity was installed in the agriculture sector. Many wood stoves are located in the wood and furniture industries, where they mainly burn their own waste wood; there is a replacement market within these sectors. The growth in recent years has occurred mainly in medium-sized stoves with a capacity between 18 and 500 kW.

Table 7.3.1
Wood stoves for heating in industry

	New installed number	New installed thermal capacity	Operational number 1)	Operational thermal capacity 1)	Use of wood	Heat production	Avoided use of fossil primary energy	Avoided emission of CO_2
		MW		MW	TJ			kton
1990	.	.	.	218	1,682	1,177	1,308	73
1991	.	.	.	218	1,682	1,177	1,308	73
1995	.	.	.	273	2,103	1,472	1,636	93
1997	.	.	.	300	2,314	1,620	1,800	102
2000	.	.	.	301	2,150	1,625	1,806	103
2001	.	.	.	301	2,102	1,627	1,808	103
2002	.	.	.	302	2,054	1,628	1,809	103
2003	.	.	.	302	2,010	1,630	1,811	103
2004	31	11	552	302	1,966	1,632	1,813	103
2005	209	21	740	319	2,068	1,723	1,914	109
2006	516	57	1,225	357	2,306	1,930	2,145	122
2007	417	46	1,635	397	2,552	2,144	2,382	135
2008**	279	31	1,893	418	2,678	2,257	2,508	142

Source: Statistics Netherlands.

1) On 31 December.

Table 7.3.2
Operational thermal capacity (MW) of wood stoves for heating in industry by sector

	Wood industry	Furniture industry	Construction	Trade	Agriculture	Other	Total
2004	153	73	10	56	8	1	302
2005	159	70	11	55	24	1	319
2006	158	65	8	49	76	1	357
2007	159	63	9	48	110	8	397
2008**	158	62	9	45	132	12	418

Source: Statistics Netherlands.

Table 7.3.3
Operational number and thermal capacity of wood stoves for heating in companies, by capacity

	Number				Capacity			
	2005	2006	2007	2008**	2005	2006	2007	2008**
					MW			
≤0,1 MW	431	841	1,186	1,366	25	49	69	77
>0,1 t/m 0,5 MW	146	221	271	350	50	65	74	89
>0,5 t/m 1,0 MW	63	65	81	81	45	48	58	57
>1 MW	100	98	97	96	199	196	196	194
Total	740	1,225	1,635	1,893	319	357	397	418

Source: Statistics Netherlands.

Method

The data about the number and capacity of wood stoves for heating in industry are based on inventories of the suppliers of wood stoves >18 kW, with base years of 1991 (Sulilatu, 1992), 1997 (Sulilatu, 1998) and 2004 to 2008 inclusive (Statistics Netherlands). Missing years are interpolated.

Heat production was calculated from capacity on the basis of 1,500 full-load hours (Renewable Energy Monitoring Protocol). For the input of biomass, heat production and efficiency are assumed to be as described in the Renewable Energy Monitoring Protocol (SenterNovem, 2006).

The suppliers of stoves >18 kW also supply stoves to households. The installed capacity of these was estimated to be approximately 50 MW in 2008. Assuming 1,500 full-load hours, this results in approximately 300 TJ of avoided fossil primary energy use in 2008. These large stoves in households are not yet included in the statistics. They will be included when the results of the government housing study (WoON, see section 7.4) have been processed.

The breakdown by sector was based on the declarations of the stove suppliers. For 20 percent of the stoves (in terms of capacity) in 2008, it was not known under which sector they fell. It was assumed that the breakdown between the sectors for these was the same as for the other 80 percent of stoves.

7.4 Household wood stoves

Developments

The contribution of household wood stoves to renewable energy has been kept constant in recent years, because no recent data have become available (table 7.4.1). Household wood stoves provide around 5 percent of the total renewable energy in the Netherlands.

Three types of household wood stoves can be identified: open fireplaces, built-in hearths and free-standing stoves. The last two types are used far more often and have higher

Table 7.4.1
Wood stoves in households

	Operational number	Operational thermal capacity	Use of biomass	Heat production	Avoided use of fossil primary energy	Avoided emission of CO_2
	1,000	*MW*	*TJ*			*kton*
1990	988	4,403	11,476	5,919	6,231	354
1995	846	3,915	9,742	5,068	5,334	303
2000	838	4,203	9,766	5,416	5,701	324
2001	822	4,124	9,593	5,323	5,603	318
2002	807	4,047	9,466	5,264	5,541	315
2003	791	3,972	9,316	5,191	5,464	310
2004	791	3,972	9,316	5,191	5,464	310
2005	791	3,972	9,316	5,191	5,464	310
2006	791	3,972	9,316	5,191	5,464	310
2007	791	3,972	9,316	5,191	5,464	310
2008**	791	3,972	9,316	5,191	5,464	310

Source: Statistics Netherlands and TNO.

Table 7.4.2
Breakdown of household wood stoves

	Operational number	Operational thermal capacity	Use of wood	Heat production
	1,000	*MW*	*TJ*	
Open fireplaces				
1990	456	685	2,854	285
1995	365	547	2,260	226
2000	302	453	1,743	174
2008**	285	428	1,645	164
Built-in hearths				
1990	320	2,243	4,009	2,405
1995	318	2,226	3,942	2,365
2000	324	2,268	3,740	2,244
2008**	297	2,077	3,428	2,057
Free-standing stoves				
1990	211	1,475	4,613	3,229
1995	163	1,142	3,539	2,477
2000	212	1,482	4,283	2,998
2008**	210	1,467	4,242	2,970

Source: Statistics Netherlands and TNO.

efficiencies (table 7.4.2). The number of open fireplaces has fallen, while the number of the other two types of household wood stoves has remained more or less stable.

Method

The data for the number of household wood stoves originate from TNO, which mainly collects these for its annual emissions report (TNO, 2004, and Hulskotte et al., 1999). TNO bases its data on a survey of the stove suppliers trade association (VHR) about households. As this survey has not been carried out since 2002, for 2002 and 2003, sales data from the stove suppliers trade association and an assumption about lifespan were used. The trade association has not provided any figures for the past five years, and for this reason the figures for wood stoves have been kept at the same level.

Using the same numbers per type of stove, SenterNovem (2005b) calculates a figure of 5.0 PJ avoided primary energy. That is 10 percent less than shown in table 7.4.1. The difference is to a large extent caused by a difference in the assumed wood use per stove.

In the winter of 2006/2007 a number of questions about wood stoves were incorporated into the housing study (WoON) carried out by the Ministry of Housing, Spatial Planning and the Environment (VROM). Analysis of the results is not yet complete, but the first outcomes show that the margins of error in wood use are considerably higher than the 25 percent previously estimated (CBS, 2007b). The Renewable Energy Monitoring Protocol will be updated in 2009, and this will probably lead to a revision of the renewable energy statistics. The revision will also take advantage of the results for wood stoves from the WoON study in order to recalculate the time series for household wood stoves in consultation with TNO.

7.5 Other biomass combustion

Other biomass combustion includes all biomass combustion that does not fall under the previously mentioned categories. This includes the combustion of paper sludge, the combustion of various biomass fuels in cement kilns, the burning of animal fats in manufacturing, and electricity production from biomass combustion not at large scale power stations.

Developments

Other biomass combustion shows a clear upward trend (table 7.5.1). The reasons for this are that this activity is being carried out at more and more sites, and that some existing projects have been expanded. Over the last two years the increase has occurred in projects with electricity generation, which probably all qualify for the MEP subsidy.

Table 7.5.1
Other biomass combustion

	Total use biomass	Gross electricity production	Net electricity production	Heat production	Avoided use of fossil primary energy	Avoided emission of CO_2
	TJ	*GWh*		*TJ*		*kton*
1990	440	34	33	233	440	25
1995	577	37	35	337	577	33
2000	3,695	227	216	513	2,317	163
2001	3,944	232	221	674	2,598	183
2002	3,825	227	216	943	2,859	208
2003	4,059	215	205	1,184	3,098	233
2004	4,992	228	217	1,984	3,899	289
2005	5,628	247	235	2,248	4,397	320
2006	6,623	256	235	3,078	5,319	376
2007	7,070	279	254	3,262	5,632	391
2008**	12,825	747	667	3,307	9,111	630

Source: Statistics Netherlands.

Table 7.5.2
Other biomass combustion, with and without electricity production

	Number of installations	Use of biomass	Gross electricity production	Net electricity production	Heat production	Avoided use of fossil primary energy	Avoided emission of CO_2
		TJ	GWh		TJ		kton
With production of electricity							
2004	5	3,094	228	217	336	2,069	138
2005	5	3,524	247	235	468	2,418	159
2006	6	3,677	256	235	576	2,540	163
2007	13	3,973	279	254	626	2,703	176
2008**	16	9,747	747	667	718	6,235	416
Without production of electricity							
2004	7	1,899			1,648	1,831	151
2005	7	2,104			1,781	1,979	161
2006	8	2,946			2,502	2,780	212
2007	7	3,097			2,636	2,929	216
2008**	7	3,078			2,589	2,877	214

Source: Statistics Netherlands.

In 2007 this mainly involved smaller projects with a typical electrical capacity of a few MW.

In 2008, three new medium-sized projects began substantial production. These three each have an electrical capacity of a few dozen MW. They are waste wood incinerators in Alkmaar and Hengelo, and a chicken manure incinerator in Moerdijk.

It is notable that heat production in 2008 grew far less rapidly than electricity production, as cogeneration (CHP) was rarely available in new installations. This may be connected with the subsidy regulation, which is only aimed at renewable electricity production. This will change as from 2009. From then on the most important subsidy regulation (SDE) will include a bonus for the production of renewable heat from CHP.

Other biomass combustion contributes approximately 8 percent of national renewable energy production.

Method

For electricity production, the most important source is the CertiQ administration behind the renewable energy certificates, with information from Statistics Netherlands' production and conversion surveys as a supplementary source. These surveys are the most important source for the use of biomass and heat production from cogeneration (CHP). As a supplementary source and control, use is also made of annual environment reports, and SenterNovem information from the Energy Investment Allowance (EIA) regulation.

If the biomass is combusted only for heat production, it is assumed that the efficiency is equal to 90 percent, the reference efficiency for large-scale heat production, unless available information indicates a different efficiency rate.

For larger installations a minimum of one reliable source is present for the second provisional estimates for 2008. For this reason the margin of error in renewable energy generated by other biomass combustion is estimated to be approximately 10 percent.

7.6 Biogas from sewage purification plants

Developments

The production of renewable energy using biogas from sewage purification plants (SPPs) has been more or less stable in recent years (table 7.6.1). One development over the last few years is that more biogas is converted into electricity, and less is used for other

Table 7.6.1
Biogas from sewage water purification plants: primary and secondary production and renewable energy

	Production of biogas	Flared biogas	Net electricity production	Heat production	Useful final biogas consumption	Avoided use of fossil primary energy	Avoided emission of CO_2
	TJ		*GWh*	*TJ*	*mln m^3 a.e.*	*TJ*	*kton*
1990	1,779	.	64	437	25	1,866	115
1995	1,984	151	97	725	16	2,197	138
2000	2,068	143	108	708	18	2,299	143
2001	2,212	144	115	808	17	2,438	152
2002	2,272	199	119	895	13	2,435	152
2003	2,188	182	111	832	14	2,345	147
2004	2,253	220	126	760	13	2,348	148
2005	2,124	178	119	649	12	2,127	134
2006	2,216	206	128	620	9	2,068	131
2007	2,218	220	139	683	6	2,132	136
2008**	2,212	166	145	713	7	2,262	143

Source: Statistics Netherlands.

processes by means of direct combustion. The total contribution of biogas from SPPs to renewable energy in the Netherlands is approximately 2 percent. Approximately 10 percent of the biogas produced at SPPs is flared (see also section 7.7).

Method

The data above come from Statistics Netherlands' survey on waste water purification. The response to this was 100 percent.

The biggest margin of error arises from the heat produced. This is often not measured, but estimated. It is therefore not certain whether the fall in heat production visible in the last couple of years is an actual fall.

As from reporting year 2004, the survey has asked for heat production to be split up by intended use. It appears that approximately 50 percent of the heat is used the keep digestion at the right temperature. Until now this heat was counted as renewable heat, although it should not be according to the Renewable Energy Monitoring Protocol. The reason for this is that for other biogas (see 7.9) part of the heat is also used to maintain the temperature of the digester. Here however, it is not known what portion of the heat is used for this. A method to estimate this will be developed in the next revision of the renewable energy statistics, along with a method for estimating other forms of energy consumption for the production of all types of biogas. From then on, energy consumption during the production of the biogas will be fully deducted from the renewable energy production from biogas.

The margin of error in renewable energy generated by biogas from SPPs is estimated to be 10 percent, excluding the discounting of the heat used for digestion.

7.7 Landfill gas

Landfill gas is biogas from landfill sites. Most captured landfill gas is converted into electricity. At a few sites natural gas is made, and in addition to this a small amount of landfill gas is used directly for heating applications. Landfill gas is flared if local circumstances and the methane concentration of the gas are insufficient to render its use profitable. Flaring is preferred above letting the biogas escape to the atmosphere, because as a result of flaring most of the methane is converted into CO_2, which has a much smaller contribution per molecule to the greenhouse effect.

Developments

The production of renewable energy from landfill gas has passed its peak (table 7.7.1), as less waste has been sent to landfill since the beginning of the nineties (Waste

Registration Working Group – Werkgroep Afvalregistratie, 2007), and also the organic fraction in the waste has decreased (section 7.1). The contribution of landfill gas to renewable energy in the Netherlands is approximately 1 percent.

Table 7.7.1
Landfill gas: energy production and renewable energy

	Production of biogas	Flared biogas	Net electricity p roduction	Heat production	Useful final biogas consumption	Avoided use of fossil primary energy	Avoided emission of CO_2
	TJ		*GWh*	*TJ*	*mln m^3 a.e.*	*TJ*	*kton*
1990	724	332	16	20	5	336	21
1995	2,786	549	138	151	21	2,050	135
2000	3,098	786	153	44	19	1,934	127
2001	3,138	835	160	41	17	1,925	128
2002	3,252	758	176	86	14	2,038	137
2003	3,291	1,034	166	55	11	1,803	123
2004	2,811	770	134	66	14	1,628	108
2005	2,503	594	127	68	14	1,580	104
2006	2,486	560	123	41	14	1,500	98
2007	2,475	566	111	72	13	1,406	92
2008**	2,300	522	104	68	12	1,307	85

Source: Statistics Netherlands.

Method

Up to and including 1996, the data came from Statistics Netherlands' energy survey. Since 1997 the data originate from the landfill gas survey that is part of the Waste Registration Working Group (WAR, 2007). Up to and including reporting year 2004, this was carried out by the Dutch Waste Management Association (VA). Since 2005 it has been carried out by SenterNovem. This survey requests energy data from all landfill sites.

The data from the WAR were not yet available for the second provisional estimates for 2008,.For this reason data from CertiQ were used for electricity production. For natural gas production annual government environment reports were used where possible. For a significant number of the landfill sites with natural gas production however, no data were available for 2008. For these sites it was assumed that natural gas production in 2008 was equal to 2007. These figures are expected to be available for the definite 2008 figures

The response to the WAR survey for 2007 was 100 percent. However, not all questions were answered. Electricity production data were missing for 5 percent of landfill sites. The missing data were estimated on the basis of the known data.

Statistics Netherlands estimates the margin of error in avoided use of fossil primary energy to be 15 percent.

7.8 Biogas on farms

Developments

Renewable energy from biogas installations on farms is starting to take off. Electricity production has doubled from 173 to 340 GWh, equivalent to around 3 PJ of avoided use of fossil primary energy. Biogas installations on farms thus now produce twice as much renewable energy as solar energy installations.

Biogas installations on farms, also called manure or farm digesters, use mainly manure in combination with other vegetable matter. The digestion of manure alone is less

Table 7.8.1
Biogas on farms

	Number of farms	Electrical power	Biogas production	Gross electricity production	Net electricity production	Full load hours 1)	Heat production	Final biogas consump-tion	Avoided use of fossil primary energy	Avoided emission of CO_2
		MW	*TJ*	*GWh*			*TJ*	*mln m³ a.e.*	*TJ*	*kton*
2005	17	5	82	9	9	.	5	–	78	5
2006	37	18	591	59	55	5,600	4	–	456	32
2007	53	43	1,872	187	173	5,700	20	–	1,441	100
2008**	78	76	3,691	369	340	5,900	39	–	2,845	195

Source: Statistics Netherlands.

1) The number of full load hours is the number of hours during which the biogas installations would need to operate on full load to achieve the realised production. The calculation takes into account the number of operational months for each project. The first three months of operation are excluded to filter the effects of start up problems.

attractive from a technical-economic perspective. Until a few years ago environment laws made it very difficult to co-digest other materials (co-substrates). This has now changed, and the government has introduced a so-called 'positive list' of a large number of substances that can be co-digested along with manure. The introduction of the list removed the last obstacle preventing operators from buying manure digesters.

Another important precondition for manure digesters is the subsidy on the electricity produced. Due to the great popularity of this subsidy regulation, also among farmers with plans for a manure digester, the entire regulation for new installations was scrapped by the Minister of Economic Affairs in August 2006. Many farmers with advanced plans missed the boat. To help them, a special subsidy regulation was devised: the so-called digesters regulation. This has the same subsidy level as the MEP, but a ceiling of 270 million euro. A further 56 million euro was added to this in May 2007, as a result of which all applications can be remunerated (Ministry of Economic Affairs, 2007).

Table 7.8.2
Composition of feed stocks for biogas installations on farms

	Share			Mass		
	2006	2007	2008**	2006	2007	2008**
	%			*bln kilo*		
Manure						
Cattle manure	51	32	30			
Pig manure	48	52	65			
Other or unknown manure	1	16	5			
Total	100	100	100	0.2	0.4	0.9
Co-substrates						
Maize	67	39	44			
Other	33	61	56			
Total	100	100	100	0.1	0.3	0.5

Source: Statistics Netherlands.

At the end of 2008, 78 farms in the Netherlands had an electricity-producing manure digester. In total 1.4 billion kilos of wet biomass were digested. Around half of this was manure, and the rest co-substrate. As total manure production in the Netherlands was 70 billion kilos, around 1 percent of this was digested. The proportion of maize within the co-substrate decreased noticeably in 2007, as it was replaced by other materials. In 2008 the proportion of maize remained approximately the same, and even perhaps rose slightly. Besides maize a wide range of other products are digested, including waste from the food production industry, food retailers, the animal feed industry, or farming itself. What was notable was that 80 percent of the manure digesters co-digested glycerine in 2008. On average this product accounted for 10 percent of the co-substrate.

The scale of manure digestion operations is increasing. The electrical capacity per company at the end of 2005 was still 0.3 MW; by the end of 2008 it had risen to 1.0 MW.

Heat is released during the production of electricity from biogas, which could be used (cogeneration). Part of this is used to keep the digester warm, but in principle a lot of heat is left over. The possibility to use this on farms is however limited. Total heat use excluding for the digester was approximately 1 percent of all captured biogas. In 2007 this 1 percent was realised by approximately one third of the farm digesters. Generally it was used to heat barns and sheds and/or the farmhouse.

Method

The gross electricity production of manure digesters is determined by means of data from the administration of the CertiQ renewable energy certificates. From these data we also know what the companies with a digester supplied to the grid, but not whether the difference between grid delivery and gross production is used only for the digester, or also for the rest of the farm. For this reason the internal consumption of the digesters is estimated to be 5 percent for digesters smaller than 0.6 MW, and 9 percent for those larger (Zwart et al., 2006, Berglund and Börjesson, 2006). The data about capacity and the number of farms with biogas installations come from the CertiQ administration. The production from biogas was estimated on the basis of the electricity production and a standard gross electrical efficiency of 36 percent.

The data about the heat and substrate use come from an additional Statistics Netherlands' survey of farms with larger manure digesters as part of the manure statistics. Farms with the smallest digesters were not surveyed. The response to this survey was around 70 percent in 2007, and 50 percent for the 2008 second provisional figures. Missing data were estimated on the basis of the electricity production as inferred from the CertiQ files. The response rate is expected to be slightly higher for the definite figures. For the 2008 second provisional figures, the figure for heat production was not based on the Statistics Netherlands' survey, but was estimated on the basis of heat production in the previous year, and a fixed relationship between heat and electricity production. For the definite figures the results from the survey will be taken into account, however.

The CertiQ renewable energy certificates are a necessary condition for subsidies, which in turn are a necessary condition for the profitable development of a biogas installation on a farm. It is therefore very probable that the CertiQ administration provides a virtually complete picture of electricity production from biogas installations on farms. For this reason the margin of error in gross electricity production is estimated to be a maximum 5 percent. The margin of error in net electricity production is larger, a maximum 10 percent. This is due to the above-mentioned estimation method for the internal electricity consumption of the digesters. The margin of error in the data about the feedstock used is larger, due to the small number of farms and the lack of responses.

7.9 Other biogas

Other biogas consists mainly of biogas produced by and used in the food industry. Biogas is produced by means of anaerobic wastewater purification and is used for generating electricity and/or for process heat. Biogas from the digestion of compostable waste is also used for the production of electricity.

Developments

The production of renewable energy from other biogas has increased in recent years (table 7.9.1), mainly as a result of new projects where electricity is generated from biogas. These are relatively attractive because of support from the MEP regulation (Environmental Quality of Electricity Production). Many of these new projects are not in the food industry; they concern the digestion of compostable household waste or other wet organic waste streams that originate from, for example, the food industry. The contribution of other biogas to renewable energy in the Netherlands is approximately 1.5 percent.

Table 7.9.1
Renewable energy from other biogas

	Biogas production	Electricity production	Heat production	Useful final biogas consumption	Avoided use of fossil primary energy	Avoided emission of CO_2
	TJ	*GWh*	*TJ*	*mln m^3 a.e.*	*TJ*	*kton*
1990	468	4	15	14	497	29
1995	826	7	69	22	834	48
2000	974	16	155	22	1,013	59
2001	989	16	152	23	1,027	60
2002	994	21	180	21	1,041	62
2003	1,129	27	155	23	1,144	68
2004	1,211	21	123	28	1,207	71
2005	1,158	31	119	24	1,151	69
2006	1,382	42	197	25	1,364	82
2007	1,475	65	171	21	1,412	87
2008**	1,782	97	189	20	1,679	105

Source: Statistics Netherlands.

Method

For biogas in the manufacturing our knowledge relies on regular Statistics Netherlands surveys of the primary production, transformation and use of energy. Non-response is estimated on the basis of historical data. For the production of biogas in manufacturing, these estimates accounted for approximately 15 percent of the total in 2004.

The electricity production at many newer projects is known by CertiQ. Statistics Netherlands receives these production data from CertiQ and uses them as a basis. The production of biogas is then estimated using an assumed efficiency for electricity production, as well as the production of heat, which is frequently limited. In this way, Statistics Netherlands can produce the figures without asking the companies for them.

With the participation of LTA2 (Long-term Agreements-2) companies in electronic reporting as part of the annual environment reports, the coverage of the annual environment reports has increased. Biogas use is part of these reports. For 2006, Statistics Netherlands compared the data from the reports at a micro-level with its own observations. It appears that only companies with small amounts of biogas are missing from Statistics Netherlands' figures. These companies are partly covered by an estimation. The possible error from missing companies with biogas is therefore estimated to be approximately 50 TJ.

The weakest point in the observations is probably the estimation of heat production, because this is often not sold, and for this reason also often not measured. Statistics Netherlands estimates the margin of error in the renewable energy from other biogas to be 10 percent.

7.10 Biofuels for road transport

In recent years there has been a great deal of social and political discussion about the desirability of biofuels for transport. The advantages of biofuels are listed as: a reduction of greenhouse gas emissions and a reduced dependence on increasingly scarce fossil oil, which frequently also comes from countries with which the political relationship is regarded as unstable. The frequently mentioned disadvantage of biofuels is that the reduction of greenhouse gas emissions is only very limited, or sometimes even negative if all the (often indirect) effects are taken into account. The cultivation of biofuel crops may also compete with the cultivation of food crops, which as a result may become more expensive. Lastly, natural areas may become endangered by an increase in the cultivation of biofuel crops. As a result of these discussions, the Dutch government has reduced the obligatory percentage of biofuels from 4.5 to 3.75 percent for 2009, and from 5.75 to 4.0 percent for 2010 (Ministry of Housing, Spatial Planning and the Environment, 2008b).

In the current situation this mainly concerns biodiesel and biopetrol, which are blended in small quantities with ordinary petrol and diesel. At the pump, therefore, biofuels are not recognisable as such. A small portion of the biofuels is sold as pure vegetable oil (PVO) and used in adapted engines.

Developments

Last year the use of biofuels in transport grew slightly. In total around 500 million litres were sold, the equivalent of 14 PJ. That is 3.0 percent of all diesel and petrol sold at Dutch pumps. In 2008 biofuels for transport accounted for approximately 12 percent of all renewable energy in the Netherlands.
With the Biofuels Decision (Bulletin of Acts and Decrees, 2006) the government obliged the suppliers of petrol and diesel to make 3.25 percent of their sales biofuels in 2008. Actual sales were 3.0 percent, slightly lower than was stipulated. The main reason for

Table 7.10.1
Biofuels for road transport, deliveries to the national end-user market

	Deliviries of biofuels			Deliviries of all fuels	Realised share of biofuels	Mandatory minimum share of biofuels (VROM)	Avoided use of fossil primary energy	Avoided emission of CO_2
	mln litre	*kton*	*TJ*	*PJ*	*% on energy basis*		*TJ*	*kton*
Biopetrol								
2003	–	–	–	184	–	–	–	–
2004	–	–	–	183	–	–	–	–
2005	–	–	–	180	–	–	–	–
2006	38	28	1,010	184	0.55	–	1,010	73
2007	176	132	3,687	184	2.00	2.00	3,687	265
2008**	264	197	5,461	183	2.98	2.50	5,461	393
2009						3.00		
2010						3.50		
Biodiesel								
2003	4	4	134	254	0.05	–	134	10
2004	4	4	134	263	0.05	–	134	10
2005	3	3	101	267	0.04	–	101	7
2006	29	25	968	279	0.35	–	968	72
2007	286	253	9,344	285	3.28	2.00	9,344	694
2008**	263	232	8,571	288	2.98	2.50	8,571	637
2009						3.00		
2010						3.50		
Total								
2003	4	4	134	438	0.03	–	134	10
2004	4	4	134	446	0.03	–	134	10
2005	3	3	101	447	0.02	–	101	7
2006	67	54	1,979	463	0.43	–	1,979	145
2007	463	384	13,031	469	2.78	2.00	13,031	960
2008**	526	429	14,032	471	2.98	3.25	14,032	1,030
2009						3.75		
2010						4.00		

Source: Statistics Netherlands.

Table 7.10.2
Biofuels for road transport, balance sheet (kton)

	2007			2008**		
	Biodiesel	Biopetrol	Total	Biodiesel	Biopetrol	Total
Pure biofuels						
Production	85	x	x	83	x	x
Net imports	249	x	x	322	x	x
Withdrawal from stocks	–60	–25	–84	–115	4	–111
Blending into petrol and diesel	271	132	403	287	193	480
Deliveries to the national end-user market	3	–	3	3	–	3
Blended biofuels						
Production from blending	271	132	403	287	193	480
Net imports	–22	–	–22	–59	4	–55
Withdrawal from stocks	–	–	–	–	–	–
Deliveries to the national end-user market	250	132	382	229	197	426
Total						
Deliveries to the national end-user market	253	132	384	232	197	429

Source: Statistics Netherlands.

this was that the suppliers blended in much more than they were obliged to in 2007, and were permitted to carry this extra effort over to the following years.

Dutch production of biodiesel was 83 kton in 2008. This is approximately the same as in 2007, when 85 kton was produced. On the other hand, the capacity of biodiesel manufacturing facilities rose sharply: from 189 kton per year at the end of 2007 to 520 kton at the end of 2008. The capacity of the factories was therefore only partially exploited. There are two reasons for this. Firstly, some large new factories only became operational at the end of 2008, and secondly a lot of biodiesel was imported from the United States last year.

Statistics Netherlands' international trade records show that in 2008 approximately three-quarters of all imported biodiesel came from the United States. In contrast to Europe, where governments mainly stimulate the use of biofuels by means of obligations and tax discounts, the United States also stimulates the production of biofuels using subsidies. This means American biodiesel is relatively cheap. Last year European biodiesel manufacturers lobbied intensively against this – in their eyes – unfair competition. They succeeded, and in March 2009 the EU imposed an import duty on biodiesel from the United States.

For biopetrol the situation is more complicated, because the mixed biopetrol comes as bio-ETBE (Ethyl tert-butyl ether) and bioethanol. Bio-ETBE is a combination of bioethanol (47 percent by mass) and a fossil component. Bio-ETBE is often not made in the same factory (or even the same country) as the bioethanol. According to the European producers' trade association, bioethanol production in the Netherlands was 9 million litres (EBio, 2009). The total consumption of biopetrol (blended with ordinary petrol) was 264 million litres. The national production of bioethanol covered therefore only a very small part of direct and indirect consumption. In 2008 some Dutch companies produced bio-ETBE; their capacity runs into hundreds of thousands of tons (SenterNovem website, 2008). Data about exact production are confidential.

The Port of Rotterdam also provides figures for the international trade in biofuels (Port of Rotterdam, 2009). These figures cover incoming and outgoing flows via seagoing shipping. The data are derived from the safety records. These figures show that the international trade in biofuels is growing strongly. In 2008, 2.7 million tons of biodiesel were shipped (1.5 million tons more than in 2007), and 2.4 million tons of ethanol (0.8 million more than in 2007). The bulk of the ethanol is probably bioethanol.

When interpreting the Port of Rotterdam figures, it is important to realise that the incoming and outgoing flows each count separately. For ethanol the port also gives figures for arrivals (1.7 million tons in 2008) and departures (0.7 millions tons in 2008). The difference has therefore either been consumed in the Netherlands, for example by blending into petrol or in the production of ETBE, has been stored, or has been exported by means of inland shipping, road or rail.

Method

The data for 2003 to 2005 come from reports compiled by the Dutch government under the terms of the European directive on biofuels for road transport (European Parliament and the Council, 2003). In 2006, there was a discount on excise duty for the blending of biofuels. For this reason data from the Dutch Tax and Customs Administration could be used for that year, supplemented by information from direct observations by Statistics Netherlands as part of its oil statistics.

Since 2007 the data have come from Statistics Netherlands' oil statistics. For these, all important oil market players (refineries, petrochemical industry, traders and storage companies) fill out a monthly form, with a complete balance sheet by oil product. Bio-ETBE, bioethanol and biodiesel are each treated separately. The response rate to this survey was 100 percent in 2008 for those companies relevant to biofuels.
In its monthly oil survey, Statistics Netherlands also asks for the bio-component of imported and exported petrol and diesel. For some of the main companies on the market, this question is difficult to answer. For this reason, with a view to minimising the

administrative burden, Statistics Netherlands permitted these companies to supply this information annually instead of monthly. The response to this was 100 percent in 2008. For some companies it is also difficult to give information about the bio-component of imported and exported petrol and diesel on an annual basis. For this reason the net imports and exports of mixed biofuels in table 7.10.2 are relatively uncertain.

According to the Biofuels Decision, companies are obliged to report annually on how much biofuel in administrative terms they have supplied to the market. Statistics Netherlands determines the physical market supply. There are several reasons why administrative supplies may differ from physical supplies. Firstly, companies can trade their blending obligations. At a national level this makes no difference. Secondly, companies might trade more in one year and less the next. Thirdly, the Biofuels Decision assumes that the percentage of biomass in bio-ETBE is 47 percent on an energy basis, whereas Statistics Netherlands assumes this figure to be 37 percent (see also below). Fourthly, for the Biofuels Decision the biofuels that are blended in exported petrol or diesel are not by definition excluded, because it is difficult to check this.

The Ministry of Housing, Spatial Planning and the Environment (VROM) also reported figures for the use of biofuels in 2007: 2.0 percent for both petrol and diesel (VROM, 2008a). The reason for the difference with Statistics Netherlands' figure (2.8 percent) is that VROM uses figures about administrative supplies, as reported by the oil companies to the ministry under the terms of the Biofuels Decision.

For the energy content, since 2007 Statistics Netherlands has used the standard values as presented by the European Commission (European Commission, 2008). For biopetrol this means a drop from 36 to 28 MJ/kg. The difference can be explained by the assumption for 2006 that the energy content of the biomass fraction of bio-ETBE was equal to the energy content of bio-ETBE as a whole, whereas the European Commission uses the relatively low energy content of the biomass fraction alone. As a result, according to the Commission, the biomass fraction of bio-ETBE on an energy basis (37 percent) is considerably lower than the figure on a mass basis (47 percent). In the next revision of the renewable energy statistics, the figures for 2006 will also be calculated using 28 MJ/kg for biopetrol.

Statistics Netherlands' oil statistics cover physical flows. However, stocks of blended biofuels are only reported by one company, because it is difficult to gather data about blended biofuels from company records. For this reason Statistics Netherlands assumes that the changes in the physical stocks of blended biofuels are virtually nil (table 7.10.2), and that the blended biofuels are either supplied directly to the domestic end-user market or exported.

Statistics Netherlands has examined the biofuels reports that oil companies submit to VROM. Some companies have also proactively supplied information on physical flows to VROM, even though they were not obliged to do this. Wherever possible, this physical information was compared to information from Statistics Netherlands' oil statistics. This resulted in follow-up questions being asked to some companies. All available information was used for the eventual calculation of the figures,. On the basis of the comparisons between the various sources, Statistics Netherlands estimates that the margin of error in the figures for biofuels is approximately 10 percent.

Table 7.10.1 also shows CO_2 emissions avoided as a result of the use of biofuels. These avoided emissions were calculated by assuming that 1 joule of biofuel prevents the CO_2 emission of the combustion of 1 joule of petrol or diesel (Renewable Energy Monitoring Protocol, SenterNovem, 2006). Any additional greenhouse gas emissions during the production of the biofuels are not taken into account; if they are taken into account, the avoided emission of greenhouse gases is significantly lower (European Parliament and the Council, 2009). It could certainly even be halved.

8. References

Berglund, M. and Börjesson, P. (2006) Assessment of energy performance in the life cycle of biogas production. Biomass and Energy, volume 30. p. 254–266.

Boonekamp, P.G.M., Mannaerts, H., Vreuls, H.H.J., Wesselink, B. (2005) Protocol Monitoring Energiebesparing (Energy Saving Monitoring Protocol). ECN, CPB, Novem and RIVM, ECN report no. ECN-C-01-129, Petten.

Statistics Netherlands (2007) Duurzame energie in Nederland 2006 (Renewable energy in the Netherlands 2006). Statistics Netherlands.

Statistics Netherlands (2009) Tijdreeks aandeel duurzame energie volgens de finale energiemethode 1990–2008 (Share of renewable energy over time, according to the final energy method), Statistics Netherlands website, April 2009.

CDA, PvdA, Christenunie (2007) Coalition agreement between the Dutch parliamentary parties CDA, PvdA and ChristenUnie, 7 February 2007.

CertiQ (2009) Annual report 2008, CertiQ BV, Arnhem.

CSTB (2006) Proposal for a definition and calculation methods for renewable heat. ThERRA project. Intelligent Energy Europe grant EIE/05/129/SI2.420023.

Edwards, R., Larivé, J.-F., Mahieu, V., Rouveirolles, P. (2007) Well-to-wheel analysis of future automotive fuels and powertrains in the European context, CONCAWE, EUCAR and Joint Research Centre, March 2007.

EnerQ (2009) Annual report 2008, EnerQ BV, Arnhem.

EBIO, European Bioethanol Fuel Association (2009) Strong production growth despite legal uncertainties, Press release, April 2009.

European Parliament and the Council (2001) Directive 2001/77/EG concerning the promotion of electricity produced from renewable energy sources on the domestic market. Publication of the European Union, L 283/33, 27 October 2001.

European Parliament and the Council (2003) Directive 2003/30/EG on the promotion of biofuels or other renewable fuels in transport.

European Parliament and the Council (2008) European Parliament and Council regulation concerning energy statistics.

European Parliament and the Council (2009) Directive of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

European Commission(1997) Announcement by the Commission. Energy for the future: renewable energy sources. White paper for a communal strategy and an action plan. COM 1997 599 final.

European Commission(2004) Announcement by the Commission to the Council and the European Parliament. The share of renewable energy in the EU. COM 2004 366 final.

European Commission(2007) Decision by the Commission on the determination of environmental criteria for the granting of the European eco-label to electric, gas or gas absorption heat pumps (2007/742/EG).

European Commission (2008) Proposal for a directive of the European Parliament and of the council on the promotion of the use of energy from renewable sources. COM (2008) 19 final.

Eurostat (2008) Minutes of the meeting of the Working Group 'Renewable Energy Statistics', November 2007.

Eurostat (2009) Share of electricity from renewable energy to gross electricity consumption. Long term indicator environment and energy. (internet: epp.eurostat.ec.eu.int).

Forsen, M. et al. (2008) European Heat Pump Statistics, Outlook 2008, European Heat Pump Association 2008. http://ehpa.fiz-karlsruhe.de.

IEA/Eurostat (2004) Energy Statistics Manual, IEA, Paris.

IEA (2008) Renewables Information 2008 with 2007 data, IEA Paris.

De Graaf, L.E., de Jager, D., Stap, C.A.M., van Brummelen, M. and Blok, K. (1996) Nulpunts-vaststelling warmtepompen per 1-1-1995 (Fixing the zero point of heat pumps as 1-1-1995). Ecofys for Novem, Novem 2DEN-03.18, Utrecht.

Graus , W. and Joosen S. (2003) Inventory of heat pumps 1994–2002. Ecofys for Novem, Utrecht.

Hulskotte, J.H.J., Sulilatu, W.F. and Willemsen, A.J. (1999) Monitoringssystematiek openhaarden en houtkachels (Systematic monitoring of open fireplaces and wood stoves), TNO-MEP-R 99/170, Apeldoorn.

Junginger, M., de Wit, M. and Faaij, A. (2006) IEA Bioenergy task 40 – Country report for the Netherlands, Update 2006 Utrecht University, Utrecht.

Koenders, M.J.B. and Zwart, B.J. (2006) Besparingskentallen koude/warmteopslag Herziening factsheet koude-/warmteopslag 2006 (Key savings figures for heat/cold storage. Revision of heat/cold storage fact sheet 2006), IF Technology for SenterNovem.

De Koning, CJAM and P Knies (1995). Status van de warmtepomp in de melkveehouderij (Status of heat pumps in diaries). IKC Landbouw, Ede.

Landelijke Stuurgroep Ontwikkeling Windenergie (National Steering Group for the Development of Wind Energy – LSOW) (2007). BLOW annual report (2006) Combined annual reports from the state, the provinces and the Association of Netherlands Municipalities (VNG), The Hague.

Ministry of Economic Affairs (1995) Third Energy Bill. House of Representatives, session year 1995–1996, 24525, nos. 1–2, SDU, The Hague.

Ministry of Economic Affairs (2006). Doelstelling 9 procent duurzame elektriciteit in 2010 gehaald (Nine percent target for renewable electricity in 2010 reached). Press release, 18 August 2006.

Ministry of Economic Affairs (2008) Ruling of September 2 2008, no. WJZ / 8123674, concerning rules for the supply of subsidies for the greening of the energy household (Temporary energy regulation for market and innovation).

Ministry of Economic Affairs (2009) Letter of implementation of the Renewable Energy Subsidy (SDE) 2008, ET/ED / 9005705, 15 January 2009.

Ministry of VROM (Ministry of Housing, Spatial Planning and the Environment) (2008a) Report over 2007 in accordance with Article 4, first paragraph, of directive 2003/30/EG on the promotion of the use of biofuels or other renewable fuels in transport.

Ministry of VROM (Ministry of Housing, Spatial Planning and the Environment) (2008b) Biofuels targets. Letter from the minister to the House of Representatives, 13 October 2008, DGM2008099192.

Observ'ER (2009) Photovoltaic Energy Barometer, EurObserv'ER 178, www.eurobserv-er.org, Paris.

PBL (the Netherlands Environmental Assessment Agency), Statistics Netherlands and Wageningen University Research Centre (2009). Environmental and Nature Compendium, www.milieuennatuurcompendium.nl.

Port of Rotterdam (2008) Verdubbeling Rotterdamse overslag biobrandstoffen (Doubling of Rotterdam's biofuels turnover), press release, 29 February 2008.

Port of Rotterdam (2009) Sterke groei Rotterdam in biobrandstoffen (Strong growth in biofuels in Rotterdam), Press release, 17 March 2009.

Renewable Energy Projects Office (2004) www.pde.nl. Website no longer exists.

Segers, R. (2009a) Windex op basis van productiedata van het CBS afgeleid uit registratie van CertiQ (Windex based on production data from Statistics Netherlands derived from CertiQ registrations), Statistics Netherlands website, April 2009.

Segers, R. (2009b) Het energieverbruik voor warmte afgeleid uit de Energiebalans (Energy use for heat derived from the Energy Balance), article on Statistics Netherlands website, February 2009.

Segers, R. and Wilmer, M. (2009a) Forse groei duurzame elektriciteit (Strong growth in renewable electricity), Statistics Netherlands web magazine, February 2009.

Segers, R. and Wilmer, M. (2009b) Verbruik duurzame energie groeit (Use of renewable energy grows). Statistics Netherlands web magazine, April 2009.

Segers (2008) Three options to calculate the percentage renewable energy: an example for a EU policy debate. Energy Policy 36, p. 3243–3248.

SenterNovem (2004) Protocol Monitoring Duurzame Energie (Renewable Energy Monitoring Protocol), 2004 update. 2DEN-04.35. SenterNovem, Utrecht.

SenterNovem (2005a) Windkaart van Nederland op 100 m hoogte (Wind map of the Netherlands at a height of 100 m). Produced by KEMA. Publication number 2 DEN-05.04, SenterNovem, Utrecht.

SenterNovem (2005b) Status warmteproductie middels biomassaverbrandingsinstallaties 2005 (Status of heat production at biomass incineration plants). Produced by TNO. SenterNovem, Utrecht.

SenterNovem (2006) Protocol Monitoring Duurzame Energie, (Renewable Energy Monitoring Protocol) 2006 update. 2DEN-06.11. SenterNovem, Utrecht.

SenterNovem (2009) Website for the subsidy regulation for renewable heat in existing homes.

Sikkema, R and Junginger, M. (in preparation) Country report for the Netherlands, update 2007, IEA Bioenergy Task 40. Copernicus Institute, University of Utrecht.

Bulletin of Acts and Decrees (2006) Decision of October 20 2006, concerning regulations for the use of biofuels for transport (Biofuels for transport decision 2007), number 542.

Sulilatu, WF. (1992) Kleinschalige verbranding van schoon afvalhout in Nederland (Small-scale burning of clean waste wood in the Netherlands), TNO-MEP, for NOVEM, Apeldoorn.

Sulilatu, WF. (1998) Kleinschalige verbranding van schoon resthout in Nederland Small-scale burning of clean residual wood in the Netherlands), TNO-MEP, for NOVEM, EWAB no. 9831) Apeldoorn.

Techniplan Adviseurs, IF-Technology, New-Energy-Works (2006). Study of the maturity of the heat pumps market on behalf of SenterNovem (project number 20221-04-60-59-001).

Van Tilburg, X. Pfeiffer, E.A., Cleijne, J.W., Stienstra, G.J., Lensink, S.M. (2007) Technisch-economische parameters van duurzame elektriciteitsopties in 2008. Conceptadvies onrendabele topberekeningen, (Technical-economic parameters for renewable electricity options in 2008. Concept advice for calculating the financial gap.) ECN-E-06-025.

TNO (2004) Monitoring of wood stoves and open fireplaces as part of the annual emissions report.

Traversi, A. (2004). Beoordeling systematiek Protocol Monitoring Duurzame Energie (warmtepompen) (Systematic assessment of the Renewable Energy Monitoring Protocol (for heat pumps)). Advice from TNO to SenterNovem.

De Vries, H. J., Pfeiffer, A. E., Cleijne, J. W., van Tilburg, X. (2005) Inzet van biomassa in centrales voor de opwekking van elektriciteit. Berekening van de onrendabele top. (Use of biomass in power stations for the generation of electricity. Calculation of the financial gap.) Final report, ECN-C-05-088.

Warmerdam, J.M.(2003) Bijdrage Thermische zonne-energie 2002 (Contribution of solar thermal energy in 2002). Ecofys for Novem, Utrecht.

Werkgroep Afvalregistratie (Waste Registration Working Group) (2007). Afvalverwerking in Nederland: gegevens 2006 (Use of waste in the Netherlands: 2006 data). Vereniging Afvalbedrijven (Association of Waster Companies) and SenterNovem, SenterNovem, Utrecht.

Wilmer, M. and Segers, R. (2009) Zonnestroom in Nederland groeit langzaam (Solar electricity in the Netherlands is growing slowly), Statistics Netherlands website, April 2008.

WSH (2009) Wind Service Holland http://home.planet.nl/~windsh.

Zwart, K., Oudendag, D., Ehlert, P. and Kuikman, P.(2006) Duurzaamheid co-vergisting van dierlijke mest (The sustainability of co-digestion of animal manure). Alterra for SenterNovem.