Renewable energy in the Netherlands 2010

Statistics Netherlands

Renewable energy
in the Netherlands
2010

Explanation of symbols

.	data not available
*****	provisional figure
******	revised provisional figure (but not definite)
x	publication prohibited (confidential figure)
–	nil
–	(between two figures) inclusive
0 (0.0)	less than half of unit concerned
empty cell	not applicable
2011–2012	2011 to 2012 inclusive
2011/2012	average for 2011 to 2012 inclusive
2011/’12	crop year, financial year, school year, etc., beginning in 2011 and ending in 2012
2009/’10 –2011/’12	crop year, financial year, etc., 2009/’10 to 2011/’12 inclusive
W	watt (1 J/s)
kW	kilowatt (1,000 J/s)
Wh	watt-hour (3,600 J)
J	Joule
ton	1,000 kilo
M	mega (10^6)
G	giga (10^9)
T	tera (10^{12})
P	peta (10^{15})
nge	natural gas equivalents (1 nge is approximately 31.65 MJ)
mln	million
bln	billion
MWe	megawatt electrical capacity
MWth	megawatt thermal capacity
	Due to rounding, some totals may not correspond to the sum of the separate figures.

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Foreword

In recent years, renewable energy has become increasingly important in a society in which sustainability is often a top priority. Just as previous editions, this eighth annual report, *Renewable Energy in the Netherlands 2010,* describes developments in the area of renewable energy, and interprets the related figures.

The most important result emerging from this report is that the renewable energy share in total energy consumption rose from 1 percent in 1990 to 3.7 percent in 2010. This rise occurred mainly after 2003 due to a subsidy on the production of renewable electricity and an obligation to blend biofuels for road transport as from 2007. However, the share of renewable energy dropped from 4.1 percent to 3.7 percent between 2009 and 2010. On the one hand, this was because total consumption of energy rose considerably, and on the other because consumption of biofuels for road transport decreased. The significant rise in total energy consumption can be ascribed to the cold winter of 2010 and the economic recovery. The consumption of renewable energy is only affected by these two factors to a limited extent.

This annual report first gives a quantitative overview of production and consumption of renewable energy such as wind energy, solar energy, biomass for co-firing at power stations, and the use of biofuels in road transport. In addition, an explanation is provided for the most important developments. Attention is paid to the relationship between the 'renewable energy' statistics and the Dutch energy balance sheet of Statistics Netherlands, the CertiQ system of certificates of Guarantees of Origin for green power, and the energy balance sheets of the International Energy Agency (IEA) and Eurostat. Lastly, a description of the methods used to arrive at the numbers is included in the report.

The report indicates to what extent the policy targets for renewable energy are being realised. *Renewable Energy in the Netherlands 2010* provides structure to the large quantity of figures about renewable energy. The publication is intended for everyone who is, or wishes to be, active in the world of renewable energy, such as market parties, researchers, policymakers and students.

I would like to thank everyone who has been involved in compiling the figures and the report. Firstly, the people who completed the questionnaires and, where required, provided additional explanation. In addition, the organisations that helped us compile this annual report by making their data and knowledge about their field of work available: CertiQ, NL Agency, TNO, the Dutch Heat Pump Association (DHPA), the VERAC (the Dutch trade association for suppliers of air-conditioning equipment), Holland Solar, the provinces, the Ministry of Housing, Spatial Planning and the Environment (VROM) Inspectorate and the Utrecht University. Lastly, I would like to thank NL Agency again for their support in translating this publication into English.

G. van der Veen
Director General, Statistics Netherlands

Summary

The share of renewable energy in total energy consumption rose from 1 percent in 1990 to 3.7 percent in 2010. This rise occurred mainly after 2003 due to a subsidy on the production of renewable electricity and the obligation to blend biofuels for road transport as from 2007.

However, the renewable energy share dropped from 4.1 percent to 3.7 percent between 2009 and 2010. On the one hand, this was because total consumption of energy rose considerably, on the other because of a reduction in the consumption of biofuels for road transport.

The significant rise in total energy consumption can be ascribed to the cold winter of 2010 and the economic recovery. The consumption of renewable energy is only affected by these two factors to a limited extent. The consumption of biofuels for road transport fell despite a small rise in the obligation of fuel suppliers to blend biofuels. This seems contradictory, but can be explained by the fact that the law offers suppliers the option to blend more than required in one year, and less in another. Suppliers made use of this flexibility by blending less than required during 2010, thus exploiting the additional efforts made during 2009 and earlier.

The production of renewable electricity equalled 9 percent of total electricity consumption in 2010, just as in 2009. This means the European Renewable Electricity Directive target of 2001 was achieved. Electricity production from wind turbines was 13 percent less in 2010 than in 2009, because there was so little wind in 2010. This drop was compensated by an increase in the co-firing of biomass in power stations.

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Introduction

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Introduction

1.1 Renewable Energy Monitoring Protocol

A number of choices must be made when calculating the renewable energy share, such as which sources to include and how to add up the different types of energy. These choices were made in consultation with trade organisations, knowledge institutions and the Dutch Ministry of Economic Affairs, Agriculture and Innovation, and are defined in the Renewable Energy Monitoring Protocol (NL Agency, 2010).

The Renewable Energy Monitoring Protocol describes three methods to calculate the renewable energy share:

- Substitution method
- Gross final consumption method
- Primary energy method

The substitution method calculates how much consumption of fossil energy is avoided by the consumption of renewable energy. This method has been used for national policy targets since the 1990s. As the new government has abandoned the national policy target for renewable energy, the political significance of this method has decreased. However, it is still relevant because it provides insight into avoided consumption of fossil energy and avoided CO_2 emissions, the main reasons to promote renewable energy.

The gross final consumption method is used in the 2009 EU Renewable Energy Directive. In this Directive, European governments and the European Parliament have jointly agreed that renewable sources will account for 20 percent of the final energy consumption by 2020. Countries with plenty of cheap natural resources for renewable energy, such as Austria with ample hydropower, contribute more than average. Countries with few cheap natural resources for renewable energy, such as the Netherlands, may contribute less. A target of 14 percent renewable energy was set for the Netherlands. This target is binding.

The primary energy method is traditionally used in the international energy statistics of the International Energy Agency (IEA) and Eurostat.

The substitution method was the key element in the previous edition of this publication. But interest in the figures obtained via this method has decreased because the national policy target, which was calculated using the substitution method, has been abandoned. Statistics Netherlands has therefore started using gross final consumption as the key method. Figures obtained using the other methods are still available, however. Section 2.6 provides more information about the different methods.

1.2 Data sources used

The figures are based on a variety of data sources. One important source is data from the administration of CertiQ, which is part of the national transmission system operator TenneT. CertiQ receives notification on a monthly basis from regional distribution system operators about electricity production from a large portion of the systems that produce renewable power. In this way renewable electricity production from wind turbines and hydroelectric power stations is available immediately. For renewable electricity production from the co-firing of biomass in power stations, in addition to the amount of electricity produced, information is also needed about the biomass share in the total quantity of fuels used. Power station owners send this information to CertiQ. Later, they must also submit an audit report about the correctness of the data. Corrections follow if necessary. CertiQ issues certificates for Guarantees of Origin for green power based on renewable electricity production as determined by them. These Guarantees of Origin are a precondition for obtaining a subsidy. The Guarantees of Origin can also be used to sell green power to end users and to trade green power.

Regular energy surveys conducted by Statistics Netherlands are a second important source. These surveys are the most important source for transport biofuels and waste incinerators. Statistics Netherlands' Wastewater Treatment survey was used for information on biogas from sewage water purification plants. Specific surveys were sent out to suppliers of the relevant systems for solar power, solar heat, heat pumps and wood-burning boilers for heat in companies. For heat/cold storage Statistics Netherlands used mainly data from the provinces about permits in the context of the Dutch Groundwater Act.

The figure for the biomass share of waste in waste incinerators was provided by NL Agency. Landfill gas data originate from the landfill gas survey of NL Agency's Waste Registration Working Group and the Dutch Waste Management Association. The Dutch Heat Pump Association (DHPA) and VERAC supplied sales data from their members. Data on household wood-burning stoves came from TNO.

To check the data and assess their accuracy, information was used from the Waste Registration Working Group about waste incinerators, from the annual environmental reports about power stations and waste incinerators, from company reports in the context of the Biofuels Act (Ministry of Housing, Spatial Planning and the Environment (VROM) Inspectorate), and from the NL Agency Energy Investment Allowance (EIA) about biomass systems. The use of the sources is explained further in chapters 3 to 9.

1.3 History

Various parties published information about renewable energy in the 1990s. As a result of increasing harmonisation, the differences between them became smaller and smaller, resulting for example in the first Renewable Energy Monitoring Protocol. Up to and including reporting year 2002, Ecofys consultancy published an annual report on behalf of Novem. They cooperated with Statistics Netherlands, KEMA and a number of other parties in this respect. Statistics Netherlands has been responsible for the full measuring and reporting of renewable energy in the Netherlands since reporting year 2003.

1.4 Statistics Netherlands renewable energy publications and release policy

StatLine

StatLine is Statistics Netherlands' online database, in which nearly all published figures can be found, including a short methodological explanation. It currently contains nine StatLine tables about renewable energy:

1. Renewable energy; consumption (also available in English)
2. Renewable energy; capacity and production (also available in English)

3. Renewable electricity (also available in English)
4. Biofuels for road transport (also available in English)
5. Wind energy per month
6. Wind energy per province
7. Wind energy by hub height
8. Solar power; market
9. Solar heat: sales of covered collectors

In principle, annual figures for renewable energy are updated three times per year. Provisional figures about renewable electricity are published in February and provisional figures about total renewable energy are published in April. Both relate to the previous year. Breakdowns and analyses of renewable energy are then still limited because insufficiently reliable information is available from many sources. The second publication of annual figures occurs in June, when revised provisional annual figures are published. A provisional figure is then available for each source-technology combination. The definite figures are published in December.

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

Annual report

The present report is published once a year. The year specified in the title relates to the most recent reporting year in the report. The Dutch version of the annual report is based on the revised provisional figures. Experience has taught us that the differences between revised provisional figures and definite figures are only slight in most cases.

The annual report on 2008 was the first to be translated into English. The present report is the second one translated into English. The decision on whether to translate is made every year; there is no translation schedule yet.

The original Dutch report on 2010 was published in September 2011. Editing of the translated report was completed in December 2011, after the definite figures for 2010 became available. This translated report is based on the definite figures for 2010. Therefore, data in this report deviate slightly from the data in the original Dutch version, but are consistent with data available on StatLine at the moment of publication (January 2012).

Articles on the website

In addition to StatLine, Statistics Netherlands also publishes articles about renewable energy in its Web Magazine, and on its Manufacturing and Energy theme page. Articles in the Web Magazine are aimed at the media and a wider audience. They may be linked to the publication of new figures, or to an analysis of already published figures. Web Magazine articles were published about the 2010 provisional figures for renewable electricity (Segers and Wilmer, 2011) and about renewable energy in general (Segers, 2011a) in 2011. Web Magazine articles are translated into English. Articles may be published on the theme page for both the media and a wider audience, or for a more specialist audience. Articles for a more specialist audience provide greater depth into specific aspects of the statistics. Two articles were published about biofuels for road transport (Segers, 2011b and 2011c) in April 2011. A report was published about the contribution of the production of renewable energy to the economy (Van Rossum et al., 2011) in June 2011. Statistics Netherlands also supplies indicators about renewable energy for the *Compendium voor de Leefomgeving* (Compendium of the Living Environment; Netherlands Environmental Assessment Agency et al., 2011).

Customised tables

Customised tables are created at the request of users and contain figures that cannot be found on StatLine, but are otherwise published on Statistics Netherlands' website (see below). A few tables were published in December 2009 containing data about the breakdown of the figures by province for wood-burning stoves >100 kW, thermal storage, and biogas at agricultural sites.

Where to find information on Statistics Netherlands' website

The easiest way to find information about renewable energy is to go to www.cbs.nl and select English at the top. You will find *Manufacturing and Energy* in the Themes column. You will then have access (via tabs) to *Figures,* and *Publications* on this theme. If you click on a header under *Figures*, a preselection of tables about manufacturing and energy will be displayed. If you wish to view the figures for other tables, scroll down. You can also click *All tables in the databank StatLine*. Next open the *Energy* folder, followed by *Renewable energy*. Here you will find a complete overview of all StatLine tables about renewable energy. You will also find the option to click to the customised tables at the bottom of the *Figures* tab. All articles and other publications such as this report can be found under *Publications*.

You can also select *Figures* on the homepage instead of *Themes,* and then *Figures by theme* (you will then reach the abovementioned selection) or *StatLine database*. If you decide to use the last option, you can choose between *searching based on a keyword,* or *selecting by theme*. If you decide to *select by theme*, click *Manufacturing and Energy,* followed by *Energy* and finally *Renewable energy*.

1.5 Alert service

If you wish to be kept informed actively on new Statistics Netherlands publications about renewable energy, email HernieuwbareEnergie@cbs.nl, specifying that you wish to be included in the mailing list for renewable energy statistics. You can also specify that you are only interested in specific components such as, for example, wind energy.

1.6 International figures about 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 website provides access to the figures. Next, select the *Energy* theme at the bottom of the page. You can then select from different options at the top left. *Main tables* provides access to predefined summarising tables. *Publications* provides access to the PDF versions of different publications. Detailed figures can be found through the *Database* link, which is comparable to the Statistics Netherlands StatLine database. The renewable energy figures can be found under *quantities* and then *supply, transformation and consumption* within *Database*.

The address of the IEA website is www.iea.org. The standard IEA publication about renewable energy is *Renewables Information*. It is not freely available, but can be purchased as in print or as a PDF file. In addition to calculating statistics, the IEA also has an umbrella function for various technology-focused partnerships. They are referred to as 'Technology Agreements' or 'Implementing Agreements'. There are a number of these types of partnerships with regard to renewable energy, which often have websites, such as www.ieabioenergy.com (biomass), www.iea-pvps.org (solar power), and www.iea-shc.org (solar heat). Various publications can be found on these websites, and they also sometimes contain unique statistical information.

The official Eurostat renewable energy publications are published relatively late after the reporting year has ended. The European Commission has commissioned Observ'ER to compile fast publications for each renewable energy sector. These publications can be found through the www.eurobserv-er.org website, and are available relatively quickly after the end of the reporting. Sometimes only estimates are provided, which may reduce the quality of the figures. Conversely, the Observ'ER publications are usually suitable for a fast indication of developments in the most important countries.

Lastly, some European trade associations are also active in the field of statistical information. The European Wind Energy Association (www.ewea.org), for example, usually publishes figures around 1 February about the sales of wind turbines (in MW) per country in the previous year. The trade organisation for producers of bioethanol (www.epure.org), biodiesel (www.ebb-eu.org), thermal solar energy systems (www.estif.org) and heat pumps (www.ehpa.org) also present figures per country.

1.7 Reader's guide

Chapter 2 provides an overview of all renewable energy sources. This chapter contains separate sections about total renewable energy, renewable electricity, renewable heat, renewable transport energy and international renewable energy statistics. Chapter 3 discusses hydropower, chapter 4 wind energy, chapter 5 solar energy, chapter 6 geothermal energy, chapter 7 aerothermal heat, chapter 8 heat from just milked milk, and chapter 9 a range of technologies for the use of biomass.

General overviews

2

General overviews

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- Substitution method
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- Primary energy method
- Comparing the methods

2.1 Total renewable energy

The 2009 EU Renewable Energy Directive stipulates that in 2020, 14 percent of gross final energy consumption in the Netherlands must be derived from renewable energy sources. This Directive was a joint decision of the governments of the EU countries and the European Parliament. Achieving this target is an important element of Dutch renewable energy policy (Ministry of Economic Affairs, Agriculture and Innovation, 2011a).

Developments

The previous government, comprising the CDA (Christian Democratic Alliance), Labour and ChristianUnion parties, set a national target of 20 percent renewable energy as well as the EU target. This target was based on the calculation of the renewable energy share using the substitution method, used in the Netherlands since the 1990s. The new government, comprising the VVD (People's Party for Freedom and Democracy) and CDA parties has abandoned this national target.

This section (2.1) provides figures based on the gross final consumption method. Section 2.6 provides figures in accordance with the substitution method and a description of the differences between the methods for calculating the total renewable energy share.

The share of renewable energy in total final consumption of energy fell from 4.1 to 3.7 percent in 2010. This decrease was mainly the result of a decrease in the consumption of biofuels for road transport and a 7 percent increase in total final consumption of energy. This increase is the result of the cold weather of 2010 and the economic recovery.

The consumption of renewable energy depends only to a limited degree on outside temperatures and annual fluctuations in the economy. Wood-burning stoves, for example, are the most important source of renewable heat in households. These wood burners are mainly used because they are enjoyable, and not as a main source of heat. Electricity produced by wind turbines depends mainly on the wind. But investments in new wind turbines depend on the economic situation to a certain degree. However, the realisation time for a new project can quickly amount to a few years. Any possible effect of the economic recovery on the expansion of wind capacity will therefore only be noticeable in a year or two.

The consumption of biofuels for road transport has decreased despite a slight rise in the legal obligation of petrol and diesel suppliers to supply biofuels. This seems contradictory, but can be explained by the fact the law offers the option to do more than required one year, and less during another year. Suppliers have made use of this flexibility by doing more than was prescribed in 2009 and previous years, and by doing less than prescribed in 2010.

The most important renewable energy sources and technologies in the Netherlands are the co-firing of biomass in power stations, wind energy, waste incinerators, biofuels for road transport and the consumption of wood by households. Together, these five sources account for more than 70 percent of the final consumption of renewable energy.

Almost half of final consumption of energy from renewable sources occurs in the form of electricity. This mainly involves electricity produced by wind turbines and co-firing of biomass in power stations. However, heat from renewable energy sources also delivers an important contribution: 40 percent in 2010.

2.1.1 Gross final consumption of renewable energy

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Gross final consumption of renewable energy (PJ)									
Energy source/technique									
Hydro power[1]	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Wind energy[1]	0.2	1.1	2.7	7.3	9.1	11.4	14.1	16.1	16.2
on shore	0.2	1.1	2.7	7.3	8.9	10.3	12.2	13.5	13.5
off shore	–	–	–	–	0.2	1.1	2.0	2.6	2.8
Solar energy	0.1	0.2	0.5	0.9	0.9	1.0	1.0	1.1	1.2
solar electricity	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2
solar heat	0.1	0.2	0.4	0.8	0.8	0.8	0.9	0.9	1.0
Geothermal energy		0.0	0.2	0.6	0.8	1.1	1.6	1.9	2.4
Aerothermal heat	.	0.0	0.1	0.4	0.6	0.9	1.2	1.6	1.9
Biomass	20.3	22.3	25.6	42.0	45.4	53.8	58.1	66.9	64.2
municipal solid waste, renewable fraction	3.7	3.9	7.7	8.1	8.6	8.9	9.1	10.7	11.3
co-firing of biomass in central electricity plants	–	0.0	0.8	13.1	12.2	7.4	8.9	10.4	12.9
wood boilers for heat in companies	1.7	2.1	2.1	2.1	2.3	2.6	2.7	2.8	2.8
wood stoves in houses	12.2	11.9	9.5	11.1	11.6	12.1	12.2	12.2	12.3
charcoal	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
other biomass combustion	0.4	0.5	1.4	3.5	4.4	4.7	6.5	7.4	6.4
biogas from landfills	0.2	1.2	1.1	0.9	0.8	0.8	0.8	0.7	0.7
biogas from sewage water purification	1.4	1.7	1.8	1.7	1.7	1.7	1.8	1.8	1.8
biogas, co-digestion of manure[2]				0.1	0.3	1.1	2.3	3.4	4.0
biogas, other	0.5	0.8	1.0	1.1	1.3	1.3	1.5	1.7	2.1
biofuels for road transport	–	–	–	0.1	1.8	13.0	12.0	15.6	9.6
Energy application									
Electricity	2.9	5.2	10.3	26.8	28.3	26.4	33.2	38.7	42.2
Heat	18.0	18.9	19.0	24.7	27.2	29.1	31.2	33.7	34.6
Transport	–	–	–	0.1	1.8	13.0	12.0	15.6	9.6
Total final consumption of renewable energy	20.9	24.1	29.4	51.6	57.3	68.5	76.4	88.1	86.4
Calculation of share of renewable energy									
Total gross final energy consumption (PJ)[3]	1,819	2,035	2,140	2,230	2,164	2,227	2,278	2,146	2,306
Share of renewable energy in gross final energy consumption (%)	1.1	1.2	1.4	2.3	2.6	3.1	3.4	4.1	3.7

Source: Statistics Netherlands.

[1] Including normalisation procedure in the EU directive on renewable energy.
[2] Up to and including 2004 part of other biogas.
[3] Calculated according the definitions in the EU directive on renewable energy.

Method

The calculation method for final consumption of renewable energy is described for each energy source in chapters 3 to 9. Eurostat's SHARES application was used to determine the denominator. This application calculates the gross final consumption of energy based on annual questionnaires about energy that every Member State completes and sends to Eurostat and the IEA. There is an ongoing discussion between Statistics Netherlands and the IEA and Eurostat about how energy consumption in the petrochemical sector should be registered. This means that total final consumption may increase or decrease by a few percentage points for all years compared with the current figures, depending on the outcome of the discussion.

2.2 Renewable electricity

The Dutch government set a target for renewable electricity for 2010, aiming for 9 percent of electricity consumption from renewable sources. This target arose from the 2001European renewable electricity Directive (European Parliament and Council, 2001). In practice, only renewable electricity from national sources counted. No separate subtarget was agreed for renewable electricity in the new EU Directive, but countries must report on the planned and realised renewable electricity share per year. In its action plan for renewable energy submitted to the EU, the Netherlands has indicated that it is now aiming for 37 percent renewable electricity in 2020 (Ministry of Economic Affairs, Agriculture and Innovation, 2010).

Calculation of the share of renewable electricity differs slightly for the new EU Directive from that for the old target for 2010. Firstly, a procedure has been included in the new EU Directive to normalise wind and hydropower production, which will largely remove random fluctuations as a result of the weather. A second difference is that gross production rather than net production is assumed in the new EU Directive. The realisation of the 'old' target for 2010 and the current state of affairs of the new Directive are both examined in this publication. Therefore, the renewable electricity share is presented in accordance with both definitions.

2.2.1 Net production of renewable electricity (mln kWh), without normalisation for wind and hydro

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Wind, of which	56	317	829	2,067	2,734	3,438	4,260	4,581	3,993
on shore	56	317	829	2,067	2,666	3,108	3,664	3,846	3,315
off shore	–	–	–	–	68	330	596	735	679
Hydro power	85	88	142	88	106	107	102	98	105
Solar electricity	0	1	8	34	35	36	38	46	60
Biomass, of which	579	808	1,671	4,808	4,691	3,538	4,531	5,422	6,284
municipal solid waste, renewable fraction	462	528	987	984	1,013	1,095	1,070	1,207	1,397
co-firing of biomass in central electricity plants	–	4	198	3,310	3,103	1,711	2,116	2,472	3,043
other biomass combustion	33	35	216	235	236	254	664	895	894
biogas from landfills	16	138	153	127	123	111	106	97	90
biogas from sewage water purification	66	100	105	117	125	136	142	143	154
biogas, co-digestion of manure[1]				8	54	171	339	484	527
biogas, other	2	3	12	26	37	59	93	124	178
Total renewable	720	1,214	2,650	6,996	7,566	7,118	8,931	10,147	10,442
Total net consumption of electricity[2]	78,582	88,947	104,943	114,471	116,085	118,463	119,705	113,837	116,929
Renewable share of net consumption of electricity (%)	0.9	1.4	2.5	6.1	6.5	6.0	7.5	8.9	8.9

Source: Statistics Netherlands.

1) Up to and including 2004 part of other biogas.
2) Inclusief de netverliezen, exclusief het verbruik voor elektriciteitsopwekking. Berekend als de som van het finaal verbruik van elektriciteit en de inzet voor overige omzettingen uit de CBS-Energiebalans.

2.2.2 Gross production of renewable electricity in the Netherlands (mln kWh), with normalisation for wind and hydro according to the EU directive on renewable energy

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Wind, of which	56	314	744	2,033	2,540	3,166	3,925	4,481	4,503
on shore	56	314	744	2,033	2,477	2,862	3,376	3,762	3,737
off shore	–	–	–	–	63	303	549	719	765
Hydro power	85	98	100	100	100	99	100	100	101
Solar electricity	0	1	8	34	35	36	38	46	60
Biomass, of which	670	1,017	2,021	5,280	5,191	4,019	5,149	6,129	7,058
municipal solid waste, renewable fraction	539	703	1,272	1,266	1,312	1,395	1,409	1,572	1,763
co-firing of biomass in central electricity plants	–	4	208	3,449	3,244	1,816	2,248	2,615	3,237
other biomass combustion	34	36	234	253	256	279	741	1,009	1,015
biogas from landfills[1]	21	161	180	148	144	132	126	118	109
biogas from sewage water purification	70	106	111	123	132	143	150	150	164
biogas, co-digestion of manure[2]				9	59	187	370	528	575
biogas, other	4	7	17	32	44	67	104	137	196
Total renewable	811	1,431	2,873	7,447	7,866	7,320	9,212	10,756	11,721
Total gross consumption of elektricity	81,098	92,319	108,545	118,713	120,293	122,772	124,052	118,392	120,917
Renewable share of gross consumption of electricity (%)	1.0	1.5	2.6	6.3	6.5	5.9	7.4	9.1	9.7

Source: Statistics Netherlands.

[1] Including indirect electricity production from biogas upgraded to natural gas quality and injected into the natural gas grid.
[2] Up to and including 2004 part of other biogas.

Developments

Dutch national production of renewable electricity was 9 percent of total electricity consumption in 2010. So the target was achieved. The former Minister of Economic Affairs predicted in 2006 that the Netherlands would reach the 2010 target. This prediction has therefore been proven correct.

The foreseen achievement of the target was the reason to terminate the subsidy scheme for the production of renewable electricity (Environmental Quality of Electricity Production, known under its abbreviation MEP in Dutch) for new projects in 2006. The government thus prevented a large budget overspend..

Supporters of and investors in renewable energy, however, still complain about the decision to discontinue the Environmental Quality of Electricity Production scheme. The new subsidy scheme (Renewable Energy Production Incentive Scheme, known under its abbreviation SDE in Dutch) only started in 2008, and during that time investors in renewable energy projects had little reassurance about the financial preconditions. Not many projects were realised based on the Renewable Energy Production Incentive Scheme in 2010 (NL Agency, 2011), among other things because of the long project realisation time. Time is needed to arrange permits and funding and to build systems. Many applications, however, have been submitted and approved (NL Agency, 2011), although it is not yet clear whether all these approved applications will actually lead to realised projects.

Electricity production by wind turbines dropped sharply in 2010 because there was very little wind. Moreover, very few new wind turbines were erected compared to previous years. New turbines are no longer being erected under the Environmental Quality of Electricity Production scheme, and those to be built under the Renewable Energy Production Incentive Scheme have yet to start.

The drop in the electricity production by wind turbines was compensated by an expansion of co-firing of biomass in power stations. The changes with regard to other renewable electricity sources and technologies were relatively limited.

On balance, the share of renewable electricity remained approximately the same when calculated using the previous method. With the new calculation method under the 2009 EU Renewable Energy Directive, the renewable electricity share rose, because the decrease in wind electricity production was largely offset by the normalisation procedure.

Guarantee of Origin certificates for green power

National and foreign renewable electricity producers can obtain a of Guarantee of Origin certificate for their renewable energy through CertiQ. On the one hand this Guarantee of Origin is required to be able to claim subsidies for green power, and on the other to provide end users with a guarantee that the power they buy is really green. It has been agreed in the Renewable Energy Monitoring Protocol that imports of green power are defined as imports of Guarantees of Origin.

Demand for green power rose to 27.5 billion kWh in 2010. This is the number of Guarantees of Origin redeemed for the delivery of green power. The figure is 2 billion kWh higher than the previous year, and is the equivalent of 24 percent of total electricity consumption.

2.2.3 Overview of Garantees of Origin for renewable electricity, excluding certificates for combined heat and power (mln kWh)

	2002	2003	2004	2005[2]	2006	2007	2008	2009	2010
Created from domestic production	2,357	2,648	4,077	6,733	8,198	6,704	9,000	10,187	10,701
Import	8,149	9,713	10,462	9,799	9,110	12,271	18,924	16,938	15,987
Redeemed	3,662	12,315	16,227	14,791	14,567	16,620	21,530	25,372	27,450
Expired	6	1,831	297	228	1,227	832	426	844	653
Withdrawn[1]	20	42	119						
Non-tradable certificates	–	–	65	339	305	251	328	522	573
Export	–	–	3	26	186	233	1,476	309	417
Stock at the start of the year	636	7,456	5,628	3,455	4,580	5,603	6,643	10,807	10,886
Stock change	6,819	–1,828	–2,173	1,125	1,023	1,039	4,165	78	–2,405
Stock at the end of the year	7,456	5,628	3,455	4,580	5,603	6,643	10,807	10,886	8,480

Source: CertiQ.

[1] From 2005 onwards withdrawn certificates are subtracted from created certificates.
[2] The data for 2005 are not fully balanced. Because of the limited difference (20 mln kWh) the cause has not been further investigated.

As national production of renewable electricity was considerably lower than the demand for green power, imports of Guarantees of Origin were considerable; they have been higher than the Guarantees of Origin issued for Dutch national renewable electricity production for many years now.

In an international perspective, there is probably still a surplus of Guarantees of Origin for green power. This can be seen from the (still not inconsiderable) quantity of expired certificates and the fact that green power is not or is only slightly more expensive than 'grey' power. The reason for the surplus is that in many countries only the supply side of renewable electricity is stimulated, while in the Netherlands the demand side is also considered by offering green power to end users. The increase in demand for green power in the Netherlands has probably not led to an increase in green power production in the Netherlands, or elsewhere in Europe, but only to an increase in the number of existing systems outside the Netherlands for which applications for certificates have been made.

Issuing Guarantee of Origin certificates for the national renewable electricity production is not exactly the same as actual physical production. The maximum difference during the past 5 years has been 10 percent. There are several reasons for the difference. Firstly, only net production counts for the physical production in table 2.2.1, whereas Guarantees of Origin can be issued for gross production. Secondly, there is usually one and sometimes a couple of months between the physical production and the issue of the Guarantees of Origin. Thirdly, some systems produce renewable electricity, but do not apply for a Guarantee of Origin.

2.3 Renewable energy for heating

In contrast to renewable electricity and renewable energy for transport, there were and are still no specific policy targets for renewable heat, at Dutch national or European level. Under the EU Renewable Energy Directive, countries must report each year on the planned and realised share of renewable sources in the total final consumption of energy for heating. In its action plan for renewable energy submitted to the EU, the Netherlands has indicated that it is now aiming for 9 percent renewable heat in 2020 (Ministry of Economic Affairs, 2010).

In the previous report on Renewable Energy in the Netherlands, the renewable heat share was still being calculated based on the production of useful heat, as far as possible in accordance with the substitution method from the Renewable Energy Monitoring Protocol. These figures were not broadly applied. Therefore, in this publication the renewable heat share is only calculated based on the gross final

2.3.1 Gross final consumption of energy from renewable sources for heating

	1990	1995	2000	2005	2006	2007	2008	2009	2010
	TJ								
Solar heat	87	193	446	764	793	823	858	932	1,001
Geothermal energy	0	33	157	622	835	1,123	1,555	1,946	2,442
Aerothermal heat	.	18	91	418	613	875	1,244	1,586	1,921
Biomass	17,880	18,670	18,338	22,888	24,936	26,297	27,517	29,276	29,243
municipal solid waste, renewable fraction	1,806	1,358	3,126	3,520	3,868	3,839	4,066	5,007	4,992
co-firing of biomass in central electricity plants	–	1	15	693	552	821	789	939	1,267
wood boilers for heat in companies	1,682	2,103	2,150	2,068	2,306	2,552	2,686	2,792	2,766
wood stoves in houses	12,167	11,891	9,508	11,103	11,561	12,056	12,174	12,232	12,347
charcoal	270	270	270	270	270	270	270	270	270
other biomass combustion	233	347	550	2,572	3,522	3,723	3,835	3,725	2,763
biogas from landfills[1]	134	628	462	360	330	333	356	305	269
biogas from sewage water purification	1,143	1,279	1,362	1,306	1,262	1,218	1,262	1,280	1,259
biogas, co-digestion of manure[2]				24	135	441	973	1,543	1,907
biogas, other	446	792	897	971	1,129	1,044	1,106	1,184	1,403
Total renewable	17,967	18,914	19,032	24,692	27,176	29,117	31,174	33,740	34,607
Total final use of energy for heating	1,083,632	1,236,853	1,212,131	1,209,563	1,123,369	1,171,128	1,210,207	1,130,601	1,270,463
Renewable share in final energy use for heating (%)	1.7	1.5	1.6	2.0	2.4	2.5	2.6	3.0	2.7

Source: Statistics Netherlands.

1) Including gross final consumption for heating from biogas upgraded to natural gas quality and injected into the natural gas grid.
2) Up to and including 2004 part of other biogas.

consumption, in accordance with the choice of gross final consumption as the central method for the total renewable energy share in this publication.

Developments

The share of renewable heat is growing gradually. In contrast to renewable electricity, the development of renewable heat is stimulated far less through subsidies. This is related to the lack of specific policy targets.

The share of renewable heat decreased in 2010. This was due to the significant rise in total final consumption of energy for heating, mainly because of the cold weather and the economic recovery.

Wood stoves in households are the most important source for renewable heat. Figures on these include a degree of uncertainly (see also 9.5). The growth is mainly in geothermal and aerotherrmal heat, which is often used through heat pumps.

2.4 Renewable transport energy

Renewable energy for transport was initially stimulated via the 2003 European Renewable Transport Fuel Directive. The aim of this Directive was to increase the biofuel share in the delivered petrol and diesel (for cars) from 2 percent in 2005 to 5.75 percent by 2010. This Directive was a reason for the Netherlands to enforce the delivery of biofuels as from 2007, with a slight delay, via a legal obligation for suppliers. Much discussion subsequently arose regarding the advisability of the use of biofuels, and the mandatory share for 2010 has been reduced from 5.75 to 4 percent in the Netherlands.

The European 2009 Renewable Energy Directive contains a binding target for renewable transport energy as well as a binding target for 'total' renewable energy: the consumption of renewable transport energy must be 10 percent of the total consumption of petrol, diesel, biofuels and electricity in transport by 2020. The scope is, therefore, slightly broader than the old 2003 Directive, because electricity and diesel used for forms of domestic transport other than road transport (i.e. shipping and trains) also count. The consumption of diesel for mobile machines (tractors in agriculture, and machines in the construction sector) do not count as transport with regard to international energy statistics, and therefore fall outside the target for transport in the EU 2009 Renewable Energy Directive. The use of biofuels in mobile machines does, however, count with regard to renewable heat and the overall target.

Table 2.4.1 provides the calculation of the renewable transport energy share in accordance with the new EU Directive. It therefore deviates slightly from 9.11.1, which is in accordance with the definitions from the old EU 2003 Renewable Transport Energy Directive.

Since 2006, the most important component of renewable transport energy has consisted of biofuels, which were stimulated by a discount on excise duties in 2006, and by a legal obligation as from 2007. An increasing share of petrol and diesel that oil companies deliver must contain biofuels, However, they do have the option to supply more in one year and less in another. This explains why the quantity of biofuels actually delivered does not increase at the same pace as the requirement.

Many biofuels are produced from food crops such as maize and soya. The use of food crops as biofuels can drive up their prices, which is often viewed as undesirable. In addition, the use of biofuels from food

2.4.1 Calculation of the renewable share in final consumption of energy for transport according to the EU-directive on renewable energy

	Calculation	2005	2006	2007	2008	2009	2010
Biofuels							
Sold on the market (TJ)	A	101	1,766	13,031	12,048	15,606	9,577
of which double counting (TJ)	B					3,216	3,574
Sold on the market, including double counting (TJ)	C=A+B	101	1,766	13,031	12,048	18,821	13,151
Renewable electricity for transport, excluding road transport							
Total use of electricity for transport (TJ)	D	5,770	5,770	5,670	5,790	5,970	6,200
Average share of renewable electricity in the EU (%)[1)]	E	12.9	13.9	14	15.1	15.8	16.6
Use of renewable electricity for transport (TJ)	F=D×E/100	744	802	794	874	943	1,029
Renewable electricity for road transport							
Total use of electricity for road transport (TJ)	G	20	20	20	20	20	20
Average share of renewable electricity in the EU (%)[1)]	H	12.9	13.9	14	15.1	15.8	16.6
Bonus factor for renewable electricity in road transport	I	2.5	2.5	2.5	2.5	2.5	2.5
Use of renewable electricity for road transport ((TJ)	J=G×H/100×I	6	7	7	8	8	8
Berekening aandeel hernieuwbaar vervoer uit Richtlijn Hernieuwbare Energie							
Total numerator (TJ)	K=C+F+J	852	2,575	13,831	12,930	19,773	14,189
Denominator (use of petrol, diesel and electricity for transport) (PJ)	L	463	479	485	484	470	473
Renewable share in use of energy for transport (%)	M=K/1000/L*100	0.2	0.5	2.8	2.7	4.2	3.0

Source: Statistics Netherlands.

1) According to the EU directive on renewable energy the share of renewable electricity is taken from the year two years before the reference year. The directive allows member states to chooce either the EU average or the national share of renewable electricity. In practice this implies the largest of both. For the Netherlands the largest is the EU-average.

crops often only delivers a limited saving with regard to greenhouse gas emissions compared with the use of fossil fuels. The use of biofuels from waste streams is less – or not at all – affected by these disadvantages. In order to stimulate the use of biofuels from waste, they count double towards the blending obligation in the Netherlands since 2009, as well as for the transport target from the EU 2009 Renewable Energy Directive. They are not, however, counted double for the general target from the EU Directive for the renewable share in the total final energy consumption.

Chapter 9.11 contains more information about policy, developments and the observation method for biofuels for road transport.

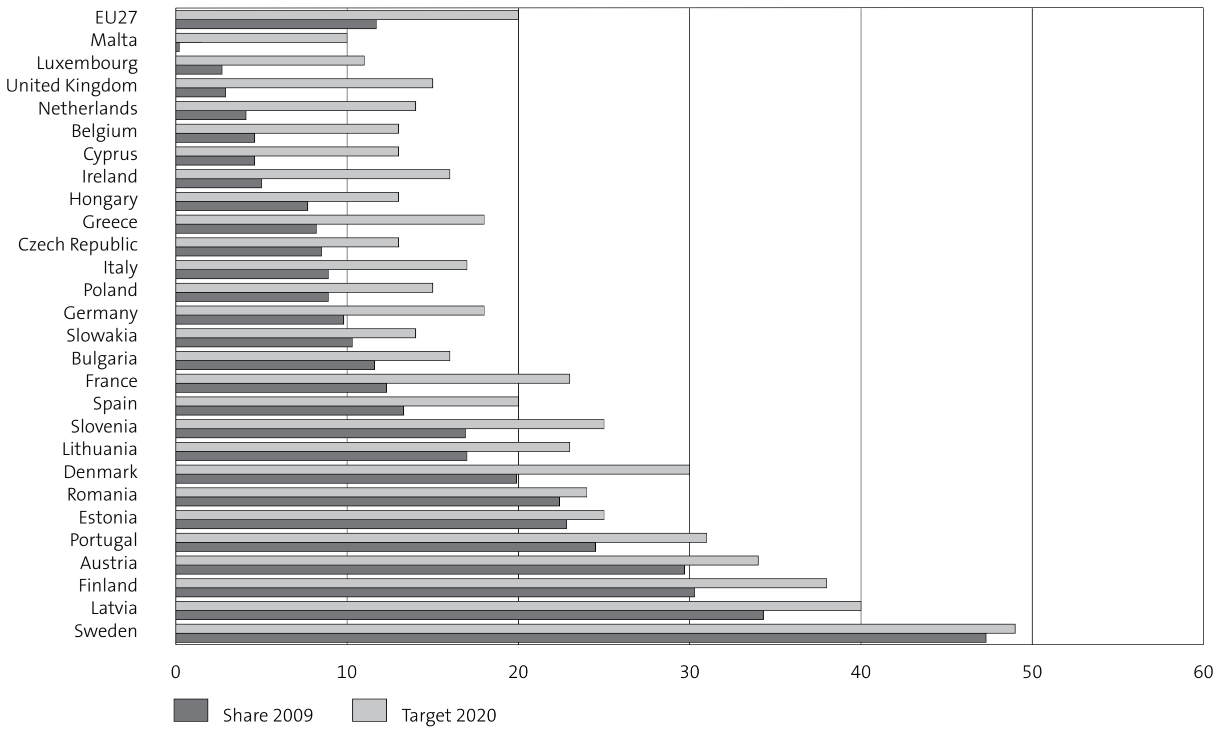
2.5 International comparisons

Compared with many other European countries, the Netherlands has only little renewable energy. It is sixth from the bottom in the renewable energy share table. While approximately 4 percent of all energy is from renewable resources in the Netherlands, this figure is a massive 50 percent in Sweden, the leading country.

There are two important reasons why the Netherlands ranks so low on the European list. Firstly, it has almost no hydropower, because of the slight height differences in our rivers. Secondly, only small quantities of wood are used by households. Nearly all households in the Netherlands are connected to the natural gas grid, or a district heating system. In many other countries these connections are not available in rural locations. They need to use oil, coal, electricity or wood to heat their homes. In these cases wood more quickly becomes attractive than in the case of competition with natural gas, which is attractive in terms of price and ease of use. In addition in many other countries, the forest area per resident is much larger, and therefore a lot more wood is available.

But these are not the only two reasons for the lower share of renewable energy in the Netherlands than, for example, Denmark, Germany or Spain. The governments in those countries have supported 'new' types of renewable energy such as wind energy or biogas more than in the Netherlands. This is a political choice. Stimulating these types of renewable energy costs money, either directly or indirectly, and politicians do not always deem it essential to spend money on this in the Netherlands.

2.5.1 Share of renewable energy in gross final energy consumption



Source: Eurostat (2011a).

2.6 Comparing methods for the calculation of the total renewable energy share

The Renewable Energy Monitoring Protocol describes three methods to calculate the renewable energy share:

- Substitution method
- Gross final consumption method
- Primary energy method

Substitution method

The substitution method calculates how much consumption of fossil energy is avoided by the consumption of renewable energy. This method has been used since the 1990s for national policy targets. As the new government has abandoned the national policy target for renewable energy, the political importance of this method has decreased. However, the method is still important because it provides insight into avoided consumption of fossil energy and avoided CO_2 emissions, the most important motives for promoting the consumption of renewable energy.

Starting points for the substitution method are the production of renewable electricity, the production of useful renewable heat and the consumption of biofuels. Subsequently, the quantity of fossil energy required to produce the same quantity of electricity, heat or transport fuels is calculated. Reference technologies are used for this, which are defined in the Renewable Energy Monitoring Protocol. For electricity the reference is the central power station production, excluding power stations that produce a great deal of heat, for which it is assumed that electricity production is largely determined by heat demand. The selection of this reference is in agreement with the Energy Saving Monitoring Protocol (Energy Saving Monitoring Platform, 2011).

2.6.1 Used reference efficiencies and CO_2 emission factor for electricity production

	Efficiency		CO_2 emission factor for fuel use for electricity production
	at production site	at end user	
	%		kg/GJ primary energy
1990	39.5	37.6	71.5
1995	39.5	37.6	71.1
2000	41.8	39.8	71.3
2005	42.1	40.2	68.9
2006	43.0	41.0	69.9
2007	43.4	41.4	68.9
2008	42.6	40.7	68.9
2009	43.4	41.4	68.7
2010	44.4	42.5	67.3

Source: Statistics Netherlands/ECN.

Gross final consumption method

The gross final consumption method is used in the EU 2009 Renewable Energy Directive, in which European governments and the European Parliament jointly agreed that 20 percent of final energy consumption should come from renewable sources by 2020.

Final consumption is made up of three components in the Directive: electricity, heating and transport. For electricity it equals gross domestic production. For heating, it equals renewable energy final consumption (for example, using wood in stoves), plus sales of heat from renewable sources for heating. For transport it refers to biofuels delivered to the domestic market, which may or may not have been blended with standard petrol and diesel.

The EU Directive concerns only final energy consumption in the end-use sectors as defined in the international energy statistics for: manufacturing (excluding refineries), services, agriculture, households and transport. A small contribution from transport losses from electricity and heat, and the internal consumption of electricity and heat for electricity production should be added to this. It is also important to note that this only concerns energetic consumption of energy. Non-energy consumption, for example oil or biomass for producing plastics, is not included in the calculations.

Lastly, a negative correction also takes place for countries with a large energy consumption share for air transport. For the Netherlands this correction resulted in a reduction in total final energy consumption of about 1 percent.

One specific issue regarding the gross end use method in the Renewable Energy Directive is that electricity production from wind energy and hydropower is normalised to correct for years with excessive or little wind or precipitation.

Primary energy method

The primary energy method is traditionally used in the international energy statistics of the International Energy Agency (IEA) and Eurostat. Statistics Netherlands uses this method in its Energy Balance sheet, just as the IEA and Eurostat. The primary energy method is based on the first form of energy that can be measured and used. For wind energy this is electricity, for biomass, it is energy content, not electricity or heat produced from it. Biomass is only added to the energy statistics system (as primary production) when it is suitable and intended for use as an energy carrier. Rapeseed is therefore not yet included as 'biomass', while biodiesel is.

The difference between the Energy Balance sheets of Statistics Netherlands and those of IEA/Eurostat is that blended biofuels are included as biomass in the international energy balance sheets, while they are included as petroleum products in Statistics Netherlands' Energy Balance sheet. After blending, biofuels are no longer 'present' in the Dutch Energy Balance sheet. Blending therefore counts as primary consumption. In the IEA/Eurostat balance sheets, however, primary biofuel consumption equals delivery to the domestic market of blended and, possibly, pure biofuels. Blended biofuels are imported and exported. Thus blending does not equal deliveries to the domestic market.

A second difference between the balance sheets of the IEA/Eurostat and Statistics Netherlands is that Statistics Netherlands includes flared biomass, while the IEA and Eurostat exclude flared biogas (see also 9.8). A third difference is that Statistics Netherlands does not include charcoal.

Fourthly, there is a difference with regard to household wood consumption. This arises from the review of these figures in 2010 (Segers, 2010a) for the renewable energy statistics. This review has been adopted in Statistics Netherlands' reports to IEA and Eurostat, but not yet in the national Energy Balance sheet.

Comparing the methods

The three methods differ significantly. All three have their strengths and so all three are used. Therefore, the renewable energy share has been calculated using all three methods.

What is notable is that the resulting percentages for the renewable energy share are basically the same according to all three methods, but that the contribution of the separate components varies greatly.

2.6.2 Comparison between different methods for the calculation of the share of renewable energy in the Netherlands, 2010

	Gross final consumption (according to the EU directive on renewable energy)	Avoided use of fossil primary energy (substitution method)	Primary energy consumption (IEA, Eurostat)	Primary energy consumption (Energy Balance Statistics Netherlands)
Use of renewable energy (TJ)				
Naar Bron/techniek				
Hydro power	364	820	378	378
Wind energy	16,210	36,508	14,375	14,375
Solar electricity	216	508	216	216
Solar heat	1,001	972	1,001	1,001
Geothermal energy, deep	318	315	318	318
Geothermal heat, shallow	2,124	1,375		
Geothermal cooling, shallow		851		
Aerothermal heat	1,921	879		
Heat form just milked milk		351		
Biomass				
municipal solid waste, renewable fraction	11,339	16,874	34,208	34,208
co-firing of biomass in central electricity plants	12,920	28,545	28,545	28,545
wood boilers for heat in companies	2,766	2,613	2,766	2,766
wood stoves in houses	12,347	7,395	12,347	12,347
charcoal	270		270	
other biomass combustion	6,415	9,892	14,703	14,703
biogas from landfills	660	1,138	1,538	1,941
biogas from sewage water purification	1,848	1,500	2,101	2,297
biogas, co-digestion of manure[2)]	3,976	4,775	5,747	5,747
biogas, other	2,109	2,364	2,900	2,900
biofuels for road transport	9,577	9,577	9,577	8,637
Energy application				
Electricity	42,197	91,294		
Heat	34,607	26,382		
Transport	9,577	9,577		
Total renewable	86,381	127,253	130,991	130,381
Calculation of the share of renewable energy consumption				
Total primary energy consumption (PJ)		3,478	3,492	3,492
Totaal final energetic consumption of energy (PJ)	2,306			
Renewable share (%)	3.7	3.7	3.8	3.7

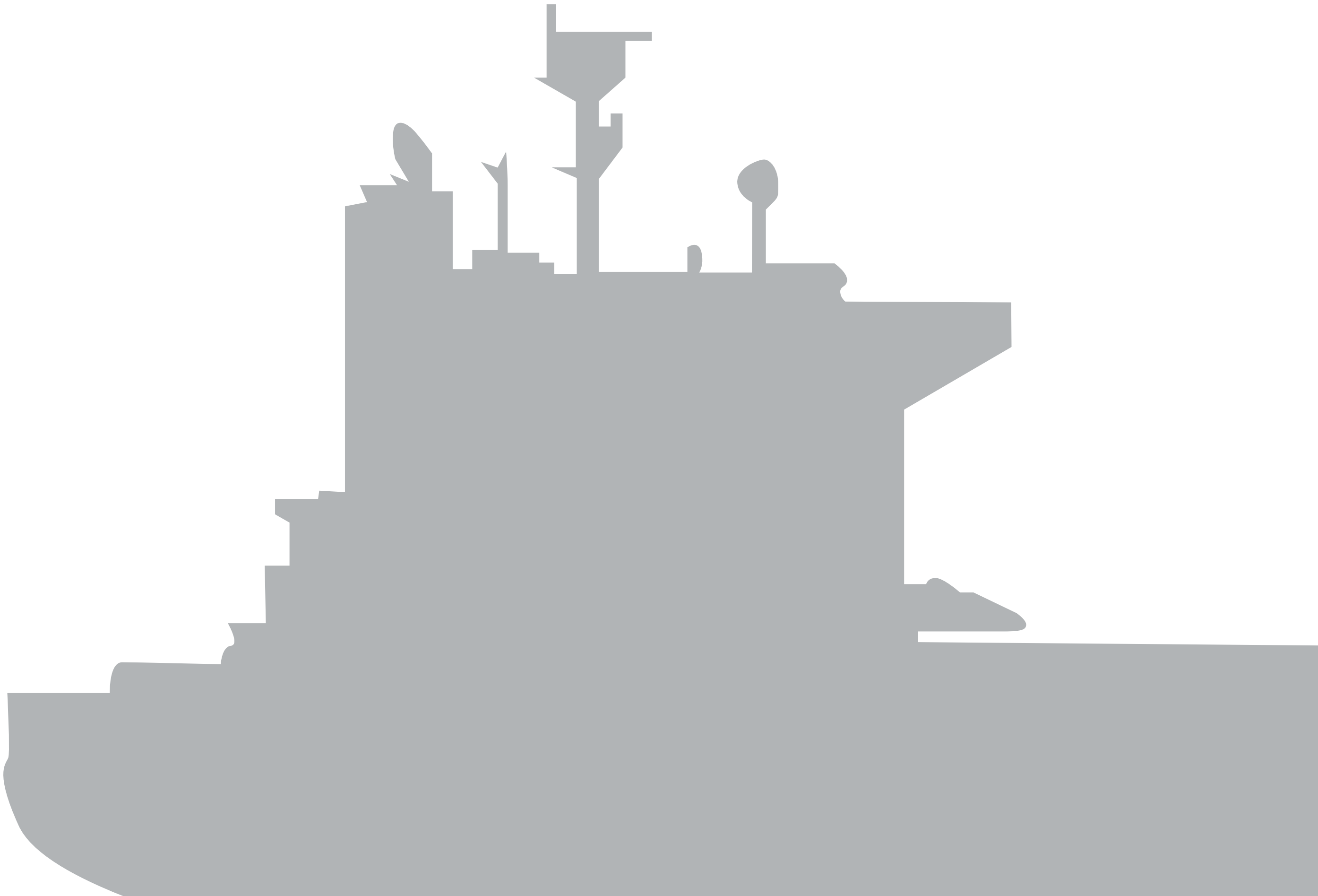
Source: Statistics Netherlands.

Renewable electricity, for example, contributes more in the substitution method. This is because only electricity produced counts in the other two methods, while the substitution method considers the fossil energy an average power station would require to produce the same amount of electricity. This is two to two and a half times as much. On the other hand, household wood consumption counts for a lot less in the substitution method, because the average low efficiency of wood stoves is taken into account. Waste incineration is the most important source in the primary energy method. This is because the energy content of the incinerated waste counts here instead of the electricity and heat produced. Another important factor is that the denominator for the gross final consumption method is considerably smaller. This is mainly because it does not include conversion losses related to electricity production and non-energy consumption.

The disadvantage of the substitution method is that it is slightly more complicated. The advantage is that it is the best approach for determining the avoided consumption of fossil energy and avoided CO_2 emissions: both important reasons for stimulating renewable energy (Statistics Netherlands, 2010, Segers, 2008).

Hydropower

3



Hydropower

- Developments
- Method

Developments

Electricity production in 2010 was on a par with 2009 (table 3.1). Total production is dominated by three hydropower stations in the larger rivers (producing more than 90 percent of the power). No significant hydroelectric power stations have been added since 1990. The annual variation in production will therefore be strongly determined by variations in water supply in the rivers. Normalised figures are therefore used for the calculations in the European Renewable Energy Directive and the new Renewable Energy Monitoring Protocol. The normalised electricity production from hydropower is practically constant: it accounts for 0.4 percent of the total final consumption of renewable energy.

3.1 Hydro power

	Number of systems ≥0,1 MW	Installed power	Electricity production	Normalised electricity production[1]	Gross final consumption	Avoided use of fossil primary energy	Avoided CO_2 emission
		MW	*mln kWh*		*TJ*		*kton*
1990	5	37	85	85	306	775	55
1995	5	37	88	98	353	895	64
2000	6	37	142	100	362	865	62
2005	6	37	88	100	361	857	59
2,006	6	37	106	100	361	840	59
2007	6	37	107	99	358	825	57
2008	6	37	102	100	360	846	58
2009	6	37	98	100	360	829	57
2010	7	37	105	101	364	820	55

Source: Statistics Netherlands.

[1] According to the method in the EU directive on renewable energy.

Method

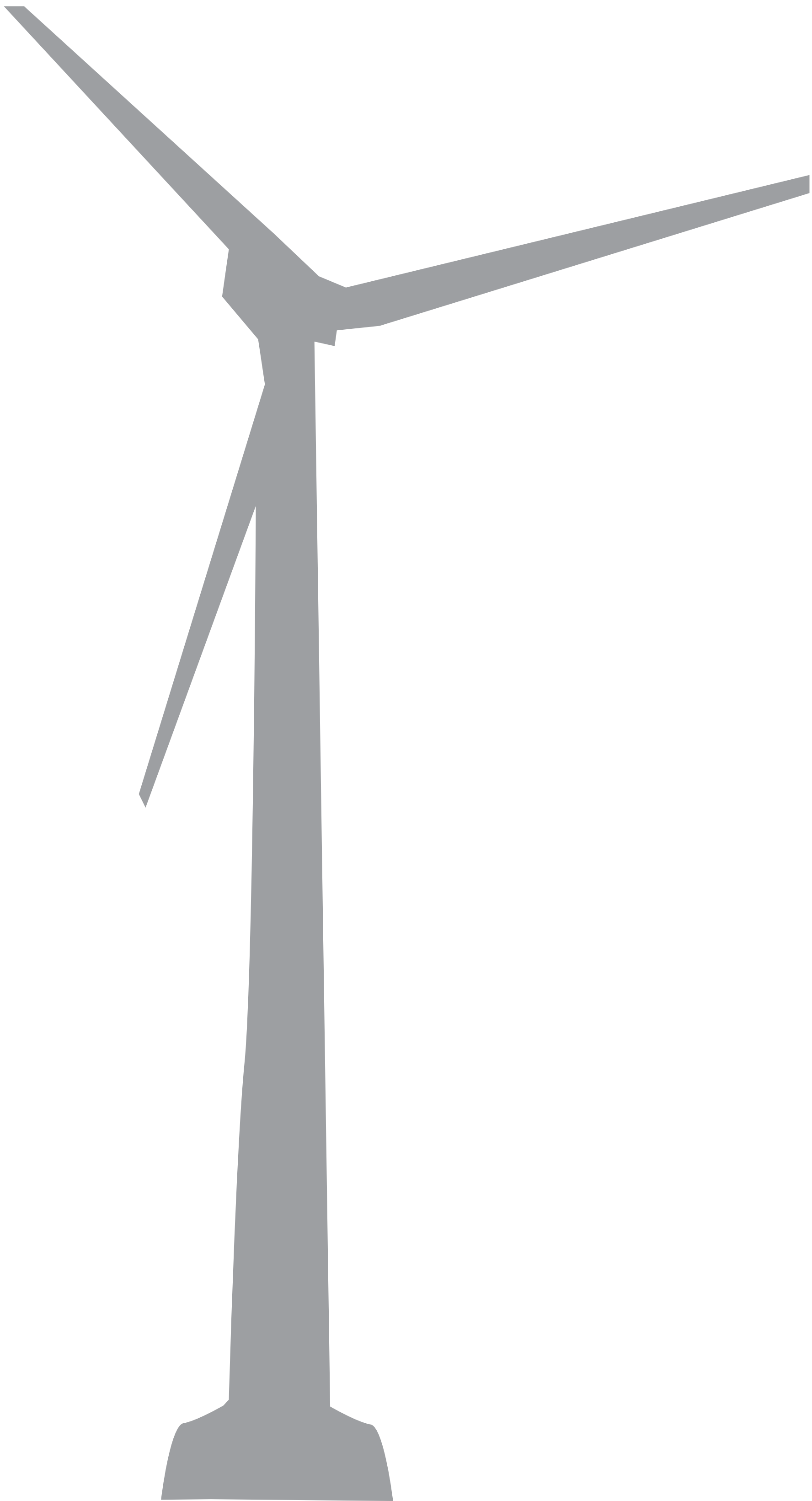
Data for the period 1990 to 1997 came from Statistics Netherlands surveys. Data from EnergieNed were used for the period 1998 to June 2001, and data from CertiQ have been used from July 2001. Specifications from the companies included in Statistics Netherlands' energy surveys have also been used as a check in 2002. The difference between annual electricity production according to Statistics Netherlands' surveys and electricity production according to the CertiQ data was approximately 1 percent in 2002. Statistics Netherlands stopped asking about electricity production from hydropower in its own surveys in 2004, to prevent unnecessary administrative burden. Only if implausible results emerge from the registration are owners of hydroelectric power stations contacted. This occurs once a year at the most.

The normalisation procedure calculates the electricity production from hydropower by multiplying the capacity by the average production per unit of capacity over the past 15 years. Data are not available for the years before 1990. Therefore, the number of years for the normalisation procedure is lower for 2004 and previous years, and has been adjusted based on the availability of data for the calculation of the normalised electricity production. The gross final consumption is the same as the normalised electricity production.

A lower limit of 0.1 MW of installed capacity per installation is used for both the capacity and electricity production. There are a few smaller installations below this limit with a total estimated capacity of approximately 0.3 MW, which is less than 1 percent of the total. The margin of error in renewable energy from hydropower is estimated to be approximately 2 percent.

Wind energy

4



Wind energy

- Developments
- Method

Developments

The installed capacity for wind energy barely grew in 2010 (table 4.1). Electricity production even fell considerably, due to the reduced quantity of wind. However wind energy does continue to be an important form of renewable energy. The contribution of wind energy to the total final consumption of renewable energy in the Netherlands was about 20 percent in 2010.

Financial support from the government is indispensable for the cost-effective operation of a wind turbine. In August 2006, the Minister of Economic Affairs terminated the main subsidy scheme of the time, the Environmental Quality of Electricity Production scheme (know in Dutch under its abbreviation MEP), because of its extensive popularity and the financial obligations for the government that arose from it. Existing projects and projects that had already been submitted still received the subsidy. As wind turbine projects have a long realisation time, only the 2009 figures show the effect of the ending of the subsidies.

There is now another subsidy scheme for new wind turbines: the Renewable Energy Production Incentive Scheme (known in Dutch under its abbreviation SDE). This was opened to applications from April 2008. This scheme has not yet led to the realisation of much new wind power generation capacity: 70 MW of wind turbines had been installed under the scheme at the beginning of 2011 (NL Agency, 2011). Many applications with regard to new wind turbines have been submitted under the new scheme, however, and have

4.1 Renewable energy form wind

	Number of wind turbines			Capacity			Electricity production		Effect	
	newly installed	decommis-sioned	operational[1]	newly installed	decommis-sioned	operational[1]	not normalised	normalised[2]	avoided use of fossil primary energy	avoided CO_2 emission
				MW			*mln kWh*		*TJ*	*kton*
Total										
1990	70	.	323	15	.	50	56	56	510	36
1995	336	52	1,008	109	12	250	317	314	2,865	204
2000	47	9	1,291	38	1	447	829	744	6,411	457
2005	125	69	1,710	166	17	1,224	2,067	2,033	17,387	1,198
2006	157	37	1,830	348	11	1,561	2,734	2,540	21,268	1,487
2007	123	62	1,891	211	23	1,749	3,438	3,166	26,259	1,809
2008	191	44	2,038	416	16	2,149	4,260	3,925	33,170	2,285
2009	52	118	1,972	110	36	2,222	4,581	4,481	37,168	2,539
2010	28	27	1,973	30	15	2,237	3,993	4,503	36,508	2,457
On shore										
2006	121	37	1,794	240	11	1,453	2,666	2,477	20,737	1,450
2007	123	62	1,855	211	23	1,641	3,108	2,862	23,742	1,636
2008	131	44	1,942	296	16	1,921	3,664	3,376	28,530	1,966
2009	52	118	1,876	110	36	1,994	3,846	3,762	31,206	2,131
2010	28	27	1,877	30	15	2,009	3,315	3,737	30,303	2,039
Off shore										
2006	36	–	36	108	–	108	68	63	530	37
2007	–	–	36	–	–	108	330	303	2,517	173
2008	60	–	96	120	–	228	596	549	4,641	320
2009	–	–	96	–	–	228	735	719	5,962	407
2010	–	–	96	–	–	228	679	765	6,205	418

Source: Statistics Netherlands.

[1] At the end of the reporting year.
[2] According to the method in the EU directive on renewable energy.

been approved. Another 1,500 MW in wind turbines may be installed based on the allocated subsidies (NL Agency, 2011). It is still unclear whether all these new turbines will actually be realised.

The first Dutch offshore wind farm became operational in 2006, followed by a second one in 2008. Together, these two farms now produce approximately one tenth of the wind power and one sixth of the electricity production from wind energy. Offshore wind turbines therefore produce more electricity per unit of capacity than onshore wind turbines. On the other hand, offshore wind turbines are considerably more expensive. Subsidies have been allocated to 600 MW of new offshore wind farms (NL Agency, 2011).

Electricity production by wind turbines depends significantly on the available wind supply, which fluctuates considerably. There is less wind on average in summer than in winter. There may also be considerable differences on an annual basis. Windex is a wind supply indicator: a Windex of 100 indicates an average wind year. The Windex for 2010 was 77 (table 4.2). Thus 2010 was an extremely poor wind year; on average, turbines produced 23 percent less electricity than expected. The Windex has been compiled in the Netherlands since 1988, and never before was it so low.

The development of electricity production from wind energy per capacity unit shows a strong relationship with the Windex (table 4.2 and figure 4.3). This is the case for capacity in terms of power and also in terms of rotor area. Over the past five years, the development of electricity production from wind turbines per unit of capacity has been slightly higher than developments in the availability of wind. This means the

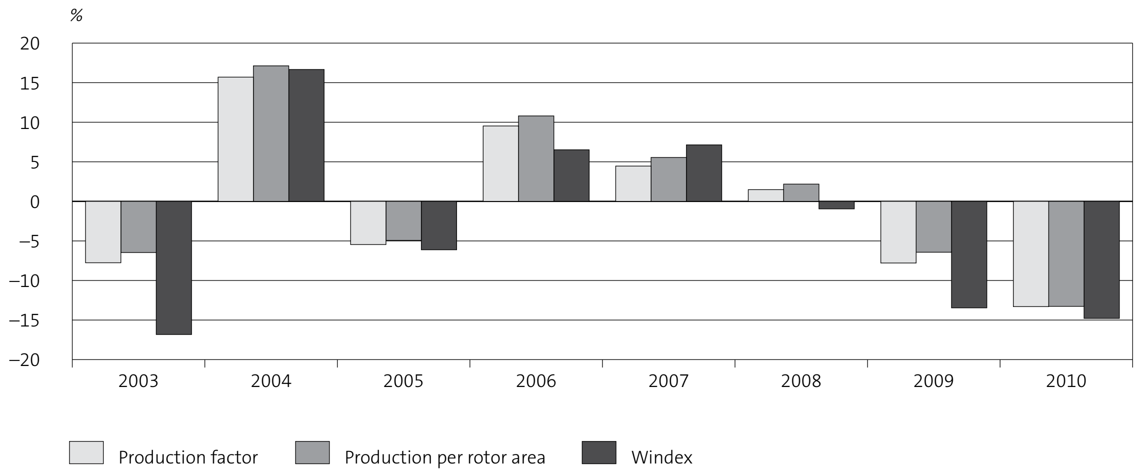
4.2 Renewable energy from wind, electricity production per capacity and Windex

	Electricity production	Windex (WSH/CBS)	Production factor[1]	Full load hours[2]	Electricity production per rotor area[3]
	mln kWh		*%*	*uren*	*kWh per m²*
Total					
2002	947	.	20	1,773	733
2003	1,320	.	19	1,635	685
2004	1,871	.	22	1,897	802
2005	2,067	.	20	1,789	763
2006	2,734	.	22	1,970	851
2007	3,438	.	24	2,113	926
2008	4,260	.	24	2,144	936
2009	4,581	.	23	2,049	909
2010	3,993	.	20	1,796	797
On shore					
2006	2,666	98	22	1,959	845
2007	3,108	105	23	2,047	892
2008	3,664	104	24	2,083	912
2009	3,846	90	22	1,916	853
2010	3,315	77	19	1,661	740
Off shore					
2006	68	.	29	2,505	1,182
2007	330	.	35	3,051	1,440
2008	596	.	30	2,614	1,124
2009	735	.	37	3,223	1,386
2010	679	.	34	2,976	1,280

Bron: 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.

4.3 Wind energy on shore, annual change of the production factor, production per rotor area and Windex (WSH/CBS)



Source: Statistics Netherlands and WSH.

4.4 Onshore wind energy by hub height

	Number of turbines[1]	Capacity[1]	Rotor area[1]	Electricity production	Production factor[2]	Production per rotor area[2]
		MW	*1000 m²*	*mln kWh*	*%*	*kWh per m²*
2009						
30 m and less	193	43	92	65	17	702
31–50 m	706	348	861	665	20	714
51–70 m	633	787	1,821	1,434	21	791
71 and more	344	816	1,701	1,682	24	1,006
Total	1,876	1,994	4,475	3,846	22	853
2010						
30 m and less	195	43	91	51	14	559
31–50 m	687	337	839	546	19	651
51–70 m	644	797	1,845	1,224	18	664
71 and more	351	832	1,727	1,494	21	874
Total	1,877	2,009	4,502	3,315	19	740

Source: Statistics Netherlands.

1) At the end of the reporting year.
2) Calculated as the average of the monthly electricity production per unit of capacity or per unit of rotor area at the end of each month. Weights have been applied that are proportional to the number of days in a month and the capacity or rotor area at the end of each month.

technical performance of the wind turbines is slowly increasing. There are at least two reasons for this. Firstly, turbines are continuously becoming taller, and therefore they catch more wind (table 4.4). Secondly, poor performance wind farms are being replaced fairly quickly. In addition, a relatively high average wind supply at new locations may also play a role.

Interestingly, the effect of the hub height above ground level on electricity production per rotor surface area unit is greater than the same effect on electricity production per capacity unit (production factor; table 4.4). The reason for this is that more capacity is installed on taller turbines for each rotor surface area unit.

4.5 Wind energy per region

	2009				2010			
	number of turbines[1]	capacity[1]	electricity production	production factor	number of turbines[1]	capacity[1]	electricity production	production factor
		MW	*mln kWh*	*%*		*MW*	*mln kWh*	*%*
Groningen	202	362	828	24	205	362	707	22
Friesland	322	154	331	25	325	158	290	21
Flevoland	597	616	1,001	19	580	604	835	16
North Holland	315	287	563	23	322	306	496	19
South Holland	150	246	503	24	148	244	427	20
Zeeland	206	208	416	23	206	208	364	20
North Brabant	52	64	104	20	59	70	110	18
Other provinces	32	58	99	20	32	58	86	17
Total on shore	1,876	1,994	3,846	22	1,877	2,009	3,315	19

Source: Statistics Netherlands.

[1] At the end of reporting year.

Most turbines are erected in coastal areas, which is not surprising as there is more wind there. Wind supply, however, is not the only factor taken into account for the location of wind turbines. The perception of integration into the landscape also plays an important role. This explains why most wind turbines are found in Flevoland, despite the fact that this province does not have the most favourable wind conditions (SenterNovem, 2005a, table 4.5).

Method

The capacity was determined from the wind monitor, as maintained by KEMA until the end of 2003, and the administration of CertiQ Guarantees of Origin for renewable electricity. The KEMA database was linked to the CertiQ administration at an individual level for this purpose. The capacity levels for each connection point were checked for plausibility by making comparisons with the CertiQ electricity production data. The moment a turbine is put into and taken out of operation is determined based on the CertiQ electricity production data in combination with Windservice Holland (WSH) data and information on the Internet.

Numbers of turbines, hub heights and rotor surface areas were determined based on WSH, and on individual data registered by NL Agency in the context of assessing energy investment allowance applications.

Electricity production is calculated based on the administration of the CertiQ certificates for the Guarantees of Origin. In addition, an additional estimate was made for wind farms for which the production is unknown by CertiQ. This additional estimate was based on installed capacity and on an average production factor, and amounts to approximately 5 GWh from 2005 (less than 0.5 percent of total production). To determine electricity production, data from the EnergieNed green label system were used for the period 1998–2001, data from the KEMA wind monitor for 1996 and 1997, and data from Statistics Netherlands for the years up to 1995.

Windenergienieuws (WindEnergyNews), the successor to WSH, also publishes figures for electricity production from wind energy on its own website. These are higher than Statistics Netherlands' figures, because Windenergienieuws bases its figures on annual production of total wind turbines under average wind conditions based on pre-estimated data. This is based on the total production capacity at the moment the website is visited. As capacity is increasing, it is always higher than the average capacity in the most recent year published by Statistics Netherlands.

The margin of error in Statistics Netherlands' figures regarding electricity production was estimated to be 2 percent at the end of 2010.

The Windex is calculated based on the production data of the wind turbines. This basically means that the wind turbines themselves are regarded as wind meters. Wind turbines with a clearly deviating production compared to a regional average are not included. The implicit assumption in calculating the Windex in this way is that wear, and the number of breakdowns not filtered out do not have any significant effect. The method for obtaining the Windex is described extensively in Segers (2009). Windexes up to and including 2007 come from WSH and are also based on wind turbine production data.

An alternative method for calculating the Windex is by using wind measurements. The issue with this method is that wind is not measured as standard at the height of the wind turbines, but often close to ground level. It is possible to convert these ground wind measurements to the hub height of the wind turbines above ground level using model calculations, but these model calculations contain a certain degree of inaccuracy. The advantage of calculating a Windex based on wind measurements instead of wind turbine production data is that the probability of a slow shift of the Windex over time is smaller. It would be wise to compare the time series of both methods.

Solar energy

5

Solar energy

5.1 Introduction

5.2 Solar power
- Developments
- Method

5.3 Solar heat
- Developments
- Method

5.1 Introduction

Solar energy is split into two parts: the conversion of solar radiation into electricity (solar power or photovoltaic solar energy), and the conversion of solar radiation into heat (solar heat or thermal solar energy). The contribution of solar energy to total final consumption of renewable energy in the Netherlands is small: approximately 1.4 percent.

5.1.1 Solar energy

	Gross final consumption	Avoided use of fossil primary energy	Avoided CO_2 emission
	TJ		*kton*
1990	88	76	4
1995	197	177	10
2000	474	489	28
2005	887	1,053	63
2,006	918	1,089	65
2007	951	1,122	67
2008	996	1,172	70
2009	1,096	1,302	78
2010	1,217	1,479	89

Source: Statistics Netherlands.

5.2 Solar power

Developments

Both electricity production and the installed capacity of solar power have increased significantly in the last few years. The capacity added in the Netherlands rose in 2010, partly because of the Renewable Energy Production Incentive Scheme started in 2008. More than 20 MW was added in 2010. This is nearly twice as much as in the previous year.

The total contribution of solar power to renewable energy in the Netherlands is approximately 0.3 percent. Solar power accounts for almost 0.5 percent of renewable electricity produced in the Netherlands.

Solar electricity systems are realised with and without national subsidies. A total budget for 69 MW was available from the Renewable Energy Production Incentive Scheme for solar power from its beginning in 2008 through to 2010. 18 MW had been realised up to 1 March 2011 (NL Agency website). As the scheme for solar power was quickly oversubscribed every year, lots were drawn and only some applications were honoured.

Approval of the application does not entail an obligation on the part of the applicant to actually install a system, but it does entitle him to a subsidy if he installs the system within a specific time frame. Prices for solar electricity systems are decreasing, making it attractive to postpone the actual purchase. In addition, due to the limited probability of a subsidy application being honoured, project plans are only worked out when a subsidy is allocated. This takes time and may also hit problems, further reasons why installation of new systems lags behind subsidy allocations.

The prices of solar panels have fallen considerably in the last couple of years as producers have succeeded in lowering their costs. Many relatively cheap solar panels from China have also come onto the market – four of the six largest solar panel factories in the world are located there (Observ'ER, 2011b).

The lower prices for solar panels enable funding of panels without subsidies under the Renewable Energy Production Incentive Scheme. In this case, however, for small consumers another financial incentive is crucial: the option to balance produced power with consumed power. This balancing is allowed up to a maximum of 3,000 or 5,000 kWh, and has the advantage that no VAT and energy tax need be paid for the own produced power. Moreover, the energy company that delivers and buys power does not receive a payment for absorbing fluctuations in the supply and demand of electricity from the solar power producer. In addition to the national Renewable Energy Production Incentive Scheme subsidy, there are also some regional subsidies for solar panels.. Statistics Netherlands does not have an overview of these.

According to estimates by a number of large solar panel suppliers, between 50 to 80 percent of panels delivered to the national market were linked to a Renewable Energy Production Incentive Scheme subsidy in 2010. In general, this corresponds with the fact that realised installed solar panel capacity registered

5.2.1 Solar electricity

	Newly installed capacity	Operational capacity	Electricity production	Gross final consumption	Avoided use of fossil primary energy	Avoided CO_2 emission
	MW		*mln kWh*	*TJ*		*kton*
1990	.	1	0	1	3	0
1995	0.4	2	1	4	10	1
2000	3.6	13	8	28	70	5
2005	1.7	51	34	122	304	21
2,006	1.5	52	35	125	306	21
2007	1.4	53	36	128	309	21
2008	4.4	57	38	138	340	23
2009	10.7	68	46	165	398	27
2010	20.7	88	60	216	508	34

Source: Statistics Netherlands.

5.2.2 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
2005	4.9	3.2	42.6
2,006	5.0	3.3	43.6
2007	5.3	3.4	44.4
2008	5.2	3.5	48.5
2009	5.0	4.3	58.2
2010	5.0	5.1	77.6

Source: Statistics Netherlands.

5.2.3 Companies trading and manufacturing solar panels and components of solar panels

	2005	2006	2007	2008	2009	2010
	kW					
Solar panels						
Imports	23,677	25,052	x	x	x	x
Production	x	x	x	x	x	x
Exports	20,942	22,148	34,005	64,089	72,493	117,665
Afzet binnenland aan eindgebruikers	1,663	1,521	1,399	4,444	10,669	20,682
Domestic sales by end users						
Not-grid connected	323	278	558	239	91	291
Grid connected, energy companies	–	160	66	151	802	768
Grid connected, others	1,340	1,083	775	4,054	9,776	19,623
Domestic sales by customer						
To installers	.	.	.	.	6,916	11,308
Directly to end users	.	.	.	.	3,753	9,374
Employment	*fte*					
Total	141	232	403	552	545	622
research & development	17	28	32	41	56	59
production of complete panels and components	21	92	198	263	x	x
sales	.	.	.	.	96	132
installation	.	.	.	.	19	50
engineering en project management for installation	.	.	.	.	71	79
other	.	.	.	.	x	x
	mln euro					
Turnover	113	161	252	408	332	491

Source: Statistics Netherlands.

through the Renewable Energy Production Incentive Scheme equals approximately 60 percent of the capacity added as observed by Statistics Netherlands in 2009 and 2010.

Solar electricity systems are divided into three categories: (autonomous) systems not connected to the grid, systems connected to the grid that are owned by an energy company, and other systems not connected to the grid. The systems not connected to the grid are used for small-scale applications at locations where there is no connection to the electricity grid, such as summer houses, yachts, water troughs for cattle and buoys in water.

At the request of Holland Solar and NL Agency, Statistics Netherlands collected not only data about the installed systems, but also about imports and exports of solar panels, and the jobs, turnover and expenditure for Research and Development at companies active in trade and manufacturing of solar electricity systems and parts thereof (table 5.2.3). The recent growth of these companies is caused by the increased demand for solar energy systems domestically, but mainly abroad. Approximately 85 percent of 2010 sales were exported. The market for solar energy systems is much larger in our neighbouring countries because of more generous subsidy schemes. 200 MW was added in Belgium in 2010, and no fewer than 7,000 MW was added in Germany (Observ'ER, 2011b).

Turnover did not keep pace with sales at a national and international level in 2009. This was partly the result of lower prices for solar panels.

Method

Ecofys, BECO and Holland Solar monitored how much new capacity was installed for the years up to and including 2003, through a survey among suppliers of solar panels. The Holland Solar trade organisation, SenterNovem (now NL Agency) and Statistics Netherlands developed a questionnaire together covering the information needs of all three organisations for reporting year 2004. Holland Solar submitted a list of suppliers to Statistics Netherlands and Statistics Netherlands sent out and processed the survey.

Based on information from Holland Solar and the response, the 2010 suppliers can be divided into three strata: 16 large, 23 medium and 25 small companies. After intensive reminder actions, the response rate of large companies was 90 percent, for medium-sized companies it was 95 percent, and for smaller companies it was 90 percent. Estimates were made for non-responding companies based on data from the previous year, VAT data from the Tax and Customs Administration, or the average within the stratum. This estimation amounts to a few percentage points with regard to the added capacity in 2010.

Total solar energy system capacity registered at CertiQ rose from 20 MW at the start of 2010 to 30 MW by the end of 2010. The absolute level is much lower at CertiQ than the Statistics Netherlands data in table 5.2.1. This is logical, because many old installations are not entitled to a subsidy on their production, and therefore have no interest in CertiQ to registration. Registering energy production with CertiQ is mandatory in order to receive the Renewable Energy Production Incentive Scheme subsidy. It can, therefore, be expected that most new systems will register. However, there is a difference between the increase at CertiQ (10 MW) and the 20 MW new installed capacity in Statistics Netherlands' figures. There are several explanations for this. Firstly, some panels are installed without a Renewable Energy Production Incentive Scheme subsidy (see the *Developments* section for more information). Secondly, it is also possible that some time will elapse between the commissioning of the panel and it being registered with CertiQ. Thirdly, Statistics Netherlands measures the deliveries from suppliers to installers and directly to end users. The moment of delivery and installation may be delayed, for example, if an installer is increasing his stock. Fourthly, installers may in turn serve customers abroad, and therefore the related deliveries to installers will be included in the count incorrectly as panels added in the Netherlands.

The lifetime of a solar energy system is set at 15 years. So it is assumed that the systems installed in 1995, for example, were taken out of service in 2010.

Electricity production is calculated using fixed indices for the annual production per unit of installed capacity (Renewable Energy Monitoring Protocol, NL Agency 2010). For systems not connected to the grid, a production of 400 kWh per kW capacity applies, for systems connected to the grid, a production of 700 kWh per kW capacity. The new Protocol specifies that, if possible, the CertiQ data for the new systems must be used for the calculation of electricity production. This has not yet taken place for the 2010, because data for the whole of 2010 are only known for few new projects.

There is uncertainty with regard to both the estimate of the installed panels and the average number of full-load hours. Statistics Netherlands estimates the total margin of error in electricity production from solar panels at 15 percent.

5.3 Solar heat

Active solar thermal energy systems can be split into covered and uncovered systems. Covered systems are closed systems. This means the difference between the system temperature and the ambient temperature is larger than in an uncovered system. The heat production per m^2 is also greater in covered systems because of the larger temperature difference. A distinction is also made within covered systems between systems with a collector area smaller than 6 m^2 and systems with a larger collector area. Small covered systems are better known as solar boilers. These are most often used in homes. Systems with a collector area greater than 6 m^2 are mainly used in non-residential buildings. Uncovered systems are mainly used for swimming pools.

Developments

The number of newly installed covered solar heating systems was the same in 2010 as in 2009, but clearly larger than in previous years. This is because of the Existing Housing Renewable Heating subsidy scheme, which came into effect in 2008. It was intended to last for four years, and the budget represents approximately 50 to 60 thousand solar boilers (NL Agency website), approximately half the current number of installed solar boilers. The subsidy scheme was discontinued at the beginning of 2011, because the Minister of Economic Affairs, Agriculture and Innovation believed renewable energy could be stimulated more efficiently through the Renewable Energy Production Incentive Scheme (Economic Affairs, Agriculture and Innovation, 2011b).

The total contribution of solar heat to the consumption of renewable energy in the Netherlands was approximately 1.1 percent in 2010.

Method

The basis for the statistics is the database that Ecofys set up for the years up to and including 2002 (Warmerdam, 2003). Statistics Netherlands updated the database in the subsequent years. The data for the added covered systems were obtained through a quarterly survey of suppliers of these systems. The response rate was 90 percent for 2010. The list of suppliers was drawn up with the assistance of NL Agency and the Holland Solar trade organisation.

New uncovered systems were counted using an annual survey among suppliers of these systems. The list of suppliers was drawn up based on data from the Renewable Energy Project Office (2004). The response was 100 percent for 2010.

It is assumed that solar boilers have a lifetime of 15 years on average. This means that those installed in 1995 are no longer included in the calculation of the contribution to renewable energy. As systems may be removed from operation or replaced earlier or later, there is a margin of error.

For many larger projects, Ecofys has set up a database of owners (Warmerdam, 2003). Statistics Netherlands approached 130 system owners, asking them whether they were using their system in 2005. For solar thermal systems this information was processed in the database in 2005 for reporting year 2004. The owners of these systems were not called again in the years that followed. The required effort and survey burden cannot be justified by the importance of the information. Instead, the information from 2005 was extrapolated, by assuming that the 'survival chance' remains the same per age class. Statistics Netherlands assumes a lifetime of 15 years for smaller systems.

5.3.1 Solar heat

	Number			Collector area			Production[2)]	Use	Effect	
	newly installed	decommis-sioned	operatio-nal[1)]	newly installed	decommis-sioned	operatio-nal[1)]	according to IEA/Eurostat	gross final consump-tion	avoided use of fossil primary energy	avoided CO_2 emission
				1,000 m²			*TJ*			*kton*
Total										
1990	.	.	.	12	1	76	87	87	73	4
1995	.	.	.	26	3	162	193	193	167	9
2000	.	.	.	55	6	360	446	446	419	24
2005	.	.	.	49	10	620	764	764	748	42
		.								
2,006	.	.	.	39	13	646	793	793	783	44
2007	.	.	.	48	21	673	823	823	812	46
2008	.	.	.	52	21	704	858	858	832	47
2009	.	.	.	80	22	761	932	932	904	51
2010	.	.	.	76	26	811	1,001	1,001	972	55
Solar boilers (covered ≤ 6 m²)										
1990	544	–	2,129	2	–	6	10	10	11	1
1995	3,375	52	13,804	11	0	43	70	70	66	4
2000	7,971	184	49,269	25	0	147	239	239	247	14
2005	7,294	544	90,279	18	2	261	425	425	465	26
2006	5,626	1,815	94,090	13	5	269	438	438	485	27
2007	6,365	2,135	98,320	17	7	280	455	455	505	28
2008	7,284	1,914	103,690	20	6	294	478	478	513	29
2009	11,522	2,501	112,711	34	8	320	521	521	559	31
2010	10,397	3,300	119,808	32	11	341	555	555	595	33
Covered > 6 m²										
1990	.	.	.	1	0	11	17	17	16	1
1995	.	.	.	2	0	16	26	26	28	2
2000	.	.	.	3	2	28	45	45	50	3
2005	.	.	.	3	0	46	75	75	83	5
2,006	.	.	.	2	0	48	78	78	86	5
2007	.	.	.	2	1	50	81	81	89	5
2008	.	.	.	3	4	49	79	79	90	5
2009	.	.	.	11	2	58	94	94	106	6
2010	.	.	.	18	2	74	120	120	126	7
Uncovered										
1990	.	.	.	9	1	60	60	60	45	3
1995	.	.	.	13	2	103	97	97	73	4
2000	.	.	.	28	3	186	162	162	122	7
2005	.	.	.	29	8	313	264	264	201	11
2006	.	.	.	24	8	330	278	278	211	12
2007	.	.	.	28	14	344	287	287	219	12
2008	.	.	.	28	11	361	300	300	229	13
2009	.	.	.	34	12	383	317	317	239	14
2010	.	.	.	27	13	396	327	327	250	14

Source: Statistics Netherlands.

1) At the end of reporting year.
2) Definition IEA/Eurostat: Available heat for the medium that is responsible for the heat transfer minus optical and collector losses.

Renewable energy from solar heat is calculated in accordance with indices for energy production per solar boiler, and energy production per m^2 of collector area (for non-solar boilers). The additional electricity consumption of solar boilers compared to the standard (reference) systems is also taken into account. The indices can be found in the Renewable Energy Monitoring Protocol (NL Agency, 2010).

The greatest uncertainty is in the figures for uncovered systems. The margin of error in renewable energy from uncovered systems is estimated to be 25 percent, the margin for total solar thermal energy is estimated to be 15 percent.

Geothermal energy

6

Geothermal energy

6.1 Introduction

Geothermal energy is all energy derived from below the Earth's surface. Deep geothermal energy is heat that comes from inside the Earth's core. Shallow geothermal energy is heat or cold from the ambient air that has been stored for six months in the top layer of ground. Winter cold is used in summer and summer heat is used in winter. Shallow geothermal energy is also referred to as heat/cold storage. The boundary between deep and shallow geothermal energy will, in principle, depend on the specific project. In the Renewable Energy Monitoring Protocol the boundary is set at 500 metres below ground level. This boundary seems to work well in practice. For projects deeper than 500 metres, a permit is required based on the Mining Act; for projects at a depth of less than 500 m, a permit is required based on the Dutch Groundwater Act.

Developments

Geothermal energy has been expanding considerably in the last few years. This mainly concerns shallow geothermal energy, using heat through heat pumps.

6.1.1 Geothermal energy

	Extracted heat	Extracted cold	Gross final consumption	Avoided use of fossil primary energy	Avoided CO_2 emission
	TJ				*kton*
1990	2	10	.	7	0
1995	40	46	33	68	4
2000	206	311	157	309	18
2005	731	795	622	853	46
2,006	971	962	835	1,088	58
2007	1,265	1,031	1,123	1,280	65
2008	1,722	1,215	1,555	1,645	82
2009	2,126	1,375	1,946	1,998	100
2010	2,640	1,611	2,442	2,542	130

Source: Statistics Netherlands.

6.2 Deep geothermal energy

One company in the Netherlands has been using deep geothermal energy since the end of 2008. It produces heat to heat greenhouses. The success of this project has stirred up interest in deep geothermal energy and drilling took place for many new projects in 2010.

The costs of deep geothermal energy stem mainly from having to drill down to a depth of 1 km or more. There is no guarantee that drilling will be successful. As this is a serious risk, the government has created a scheme to cover part of the risk of unsuccessful drilling in order to stimulate the development of deep geothermal energy while limiting the risk for project initiators.

6.2.1 Deep geothermal energy

	Number of installations	Heat production	Avoided use of fossil primary energy	Avoided CO_2 emission
		TJ		*kton*
2007	–	–	–	–
2008	1	96	95	5
2009	1	142	141	8
2010	2	318	315	17

Source: Statistics Netherlands.

6.3 Shallow geothermal energy

With regard to shallow geothermal energy, a distinction can be made between the extraction of heat in winter and the extraction of cold in summer. This often takes place by pumping groundwater from, for example, a depth of 150 metres. This groundwater of between 5 and 10 degrees C is used to cool buildings in summer. After cooling, it is heated to between 10 and 15 degrees and returned to another place in the ground at a comparable depth. This heated water is pumped up again in winter and used to heat buildings, after which the cooled water is again returned to the ground and the cycle is complete. Shallow geothermal energy is also referred to as heat/cold storage.

Water of between 10 and 15 degrees is not directly suitable to heat buildings to a comfortable temperature in winter. Therefore, heat pumps are often used to bring the energy to a higher temperature level. The working of a heat pump can be compared to the inverse working of a fridge. A fridge makes the inside colder by pumping the heat from inside to outside. As a result, it becomes (slightly) hotter outside the fridge. A heat pump makes the outside (slightly) colder and the inside hotter. A heat pump also uses electricity in the same way a fridge does. For heat pumps that use shallow geothermal energy, one unit of electricity delivers approximately 4 units of heat on average. The generation of 1 unit of electricity usually costs 2 to 2.5 fossil energy units. On balance, therefore, a heat pump is energetically more efficient than a standard natural gas boiler.

A limited quantity of shallow geothermal heat is used without heat pumps. This mainly concerns preheating ventilation air.

Shallow geothermal energy can also be broken down into open systems and closed systems. Groundwater is extracted in open systems, after which heat exchange takes place above ground for cooling and heating. The groundwater is then pumped back. In closed systems a closed tube or hose is inserted into the ground to a depth of 50 or 100 m. A liquid flows through this tube to transport heat, and this is heated or cooled through the tube walls. No groundwater is extracted from the soil in closed systems. A larger section of soil is involved in the storage of heat and cold in open systems due to the flow of groundwater. The average capacity of these systems is therefore greater. Open systems are often applied in large non-residential buildings, greenhouses or residential districts. Closed systems are often used for small non-residential buildings and (small groups of) homes. Open systems are also referred to as ‘water systems’ and closed systems as ‘ground systems’.

6.3.1 Shallow geothermal energy

	Extracted heat		Extracted cold		Gross final consumption		Avoided use of fossil primary energy		Avoided CO_2 emission	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
	TJ								*kton*	
Heat, total	1,985	2,322			1,804	2,124	1,130	1,375	42	55
used with heat pumps	1,804	2,124			1,804	2,124	956	1,185	33	44
used without heat pumps	181	198					174	190	10	11
Cold			1,375	1,611			727	851	50	57
Total	1,985	2,322	1,375	1,611	1,804	2,124	1,857	2,227	92	112

Source: Statistics Netherlands.

6.3.2 Heat pumps with the use of shallow geothermal energy

	Number of newly installed installations			Newly installed thermal capacity		
	2008	2009	2010	2008	2009	2010
				MW		
Open systems (with extraction of ground water)						
Non residential buildings	602	383	380	75	50	54
Residential, total	2,010	2,337	2,647	28	34	25
residential, only space heating	816	949	1,251	16	20	19
residential, space heating and hot tap water	1,194	1,388	1,396	11	14	6
Total	2,612	2,720	3,027	103	84	79
Closed systems (without extraction of ground water)						
Non residential buildings	175	366	257	4	15	18
Residential, total	1,313	2,223	1,410	12	21	16
residential, only space heating	332	790	606	4	10	10
residential, space heating and hot tap water	981	1,433	804	8	11	6
Total	1,488	2,589	1,667	16	36	34
Total	4,100	5,309	4,694	119	121	113

Source: Statistics Netherlands.

Developments

The use of shallow geothermal energy has increased considerably in recent years. The technology has been applied widely, especially in new large non-residential buildings such as offices. It is relatively profitable because these buildings often require cooling, and the heating and cooling system of new buildings can be adapted to use geothermal energy during installation. A few large-scale shallow geothermal energy systems have also been installed in horticultural greenhouses. A total of 200 million m^3 of water was pumped by open systems in 2010.

Fewer homes and offices were built in 2010 than in 2009. Heat pumps are often installed in new buildings, and therefore it was to be expected that the sale of heat pumps would also decrease. This was not the case in 2010. Sales of heat pumps (in terms of capacity) remained approximately the same. This could mean the market share of heat pumps for the supply of energy in new buildings has increased. It could also be caused by an increase in the use of heat pumps in the renovation of buildings.

Method

Two information sources were used for the calculation of geothermal energy: heat pump supplier sales data and heat/cold storage data collected by the provinces with respect to heat/cold storage project permits.

Heat pump sales data were collected in partnership with trade organisations. The Dutch Heat Pump Association (DHPA, formerly Stichting Warmtepompen) and VERAC supplied sales data from their members. Statistics Netherlands contacted suppliers who were not members of either organisation. The production of geothermal energy and the avoided consumption of primary fossil energy of heat pumps for geothermal energy were calculated based on Renewable Energy Monitoring Protocol indicators.

Heat pump data collected by Statistics Netherlands and Stichting Warmtepompen were set up differently in the past, when the heat source was not specified. Statistics Netherlands has converted the old data into the new format using data collected in 2007 and 2008, which were available in both the old and the new formats.

Renewable energy from cold and from used heat without a heat pump is derived from data on groundwater flows provided by the provinces, and from Renewable Energy Monitoring Protocol indicators. Statistics Netherlands estimates the margin of error in the renewable energy figures from shallow geothermal energy to be approximately 25 percent.

Aerothermal heat

7

Aerothermal heat

- Developments
- Method

Aerothermal heat can be used to heat buildings using a heat pump. The principle is the same as for geothermal energy heat pumps, but an important difference is that geothermal heat has a higher average temperature than outside air. The difference in temperature between the heat source and the heat exchange system is therefore higher, and an aerothermal heat pump requires more electricity than a geothermal heat pump. On the other hand, the installation of a geothermal system is much more expensive than an aerothermal heat pump.

The EU Renewable Energy Directive uses the term aerothermal heat for heat from external air.

External air is mainly used for heating in non-residential buildings. Reversible heat pumps are often used. The heat pumps can be used in summer to cool the building and in winter to heat it. The additional costs of using the heat pumps not only for cooling but also for heating are limited. The heat pumps are therefore often applied with very little subsidy. A tax allowance can be applied for through the Energy Investment Allowance Scheme for efficient heat pumps.

Developments

The use of aerothermal heat is growing steadily. The installation of heat pumps is relatively inexpensive for new buildings. Fewer residences and offices were built in the last two years than in previous years. Seen from this perspective, the sales of heat pumps are still quite high, at three to four thousand aerothermal heat pumps for homes and nearly ten thousand for other buildings.

Aerothermal heat represents more than 2 percent of the final consumption of renewable energy.

Method

The method for measuring aerothermal heat is the same as that for heat pumps using shallow geothermal heat. Sales data for heat pumps were collected in partnership with trade organisations. The Dutch Heat Pump Association (formerly the Stichting Warmtepompen) and VERAC (Vereniging van Leveranciers van Airconditioning Apparatuur; the Association of air-conditioning equipment suppliers) provided sales data of their members. Statistics Netherlands contacted suppliers who were not members of either organisation. The heat production and avoided consumption of primary fossil energy of aerothermal heat pumps were calculated based on Renewable Energy Monitoring Protocol indicators.

Heat pump data collected by Statistics Netherlands and Stichting Warmtepompen were set up differently in the past, when the heat source was not specified. Statistics Netherlands has converted the old data into the new format using data collected in 2007 and 2008, which were available in both the old and the new formats.

Reversible heat pumps can also be used as standard air-conditioning systems for cooling only, in combination with, for example, a standard heating boiler that provides all or some of the heat. Heat pump suppliers are not able to provide accurate estimates of the percentage of reversible heat pumps that are actually and substantially deployed to provide heating. The indicator for the full-load hours of the aerothermal heat pumps is therefore uncertain. Statistics Netherlands estimates the margin of error of renewable energy from aerothermal heat data to be 50 percent.

7.1 Aerothermal heat

	Extraction of heat from outside air	Gross final consumption	Avoided use of fossil primary energy	Avoided CO_2 emission
	TJ			*kton*
Total				
1995	18	18	9	0
2000	91	91	43	1
2005	418	418	187	4
2,006	613	613	277	5
2007	875	875	386	8
2008	1,244	1,244	513	10
2009	1,586	1,586	679	16
2010	1,921	1,921	879	26
Non residential buildings				
1995	9	9	2	–0
2000	67	67	23	0
2005	321	321	112	2
2,006	506	506	191	3
2007	747	747	287	5
2008	1,068	1,068	392	6
2009	1,376	1,376	534	11
2010	1,666	1,666	698	19
Residential				
1995	9	9	6	0
2000	24	24	20	1
2005	97	97	75	2
2,006	106	106	86	3
2007	128	128	99	3
2008	176	176	121	4
2009	210	210	145	5
2010	254	254	181	7

Source: Statistics Netherlands.

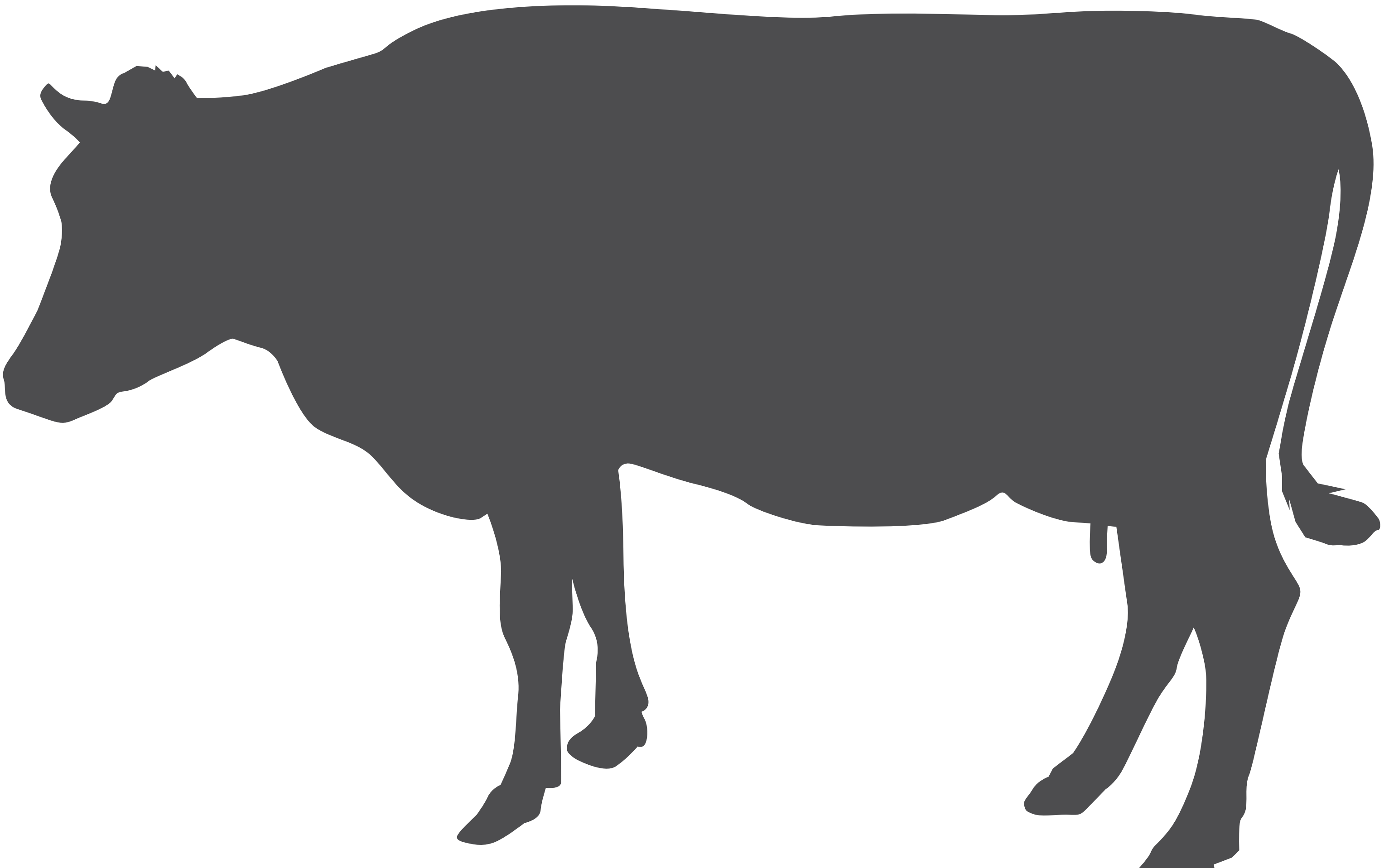
7.2 Heat pumps that use aerothermal heat

	Number of newly installed installations			Newly installed thermal capacity		
	2008	2009	2010	2008	2009	2010
				MW		
Delivery to heating systems based on air						
Non residential buildings	9,659	9,745	8,741	223	201	208
Residential	1,237	424	931	14	4	10
Total	10,896	10,169	9,672	236	204	218
Delivery to heating systems based on water						
Non residential buildings	184	166	175	17	12	11
Residential, total	3,071	3,274	2,429	10	9	10
residential, space heating with and without hot tap water	2,122	2,592	1,862	9	8	9
residential, only hot tap water	949	682	567	1	1	1
Total	3,255	3,440	2,604	27	21	21
Total	14,151	13,609	12,276	263	226	239

Source: Statistics Netherlands.

Heat from
just milked milk

8



Heat from just milked milk

- Developments
- Method

The use of energy released through cooling milk on dairy farms to heat tap water is a special type of renewable energy. The cooling system can be considered to be a heat pump that takes heat from the milk (i.e. cools it) and delivers it at a higher level (hot tap water). The heat from the milk comes from the cows. This source of renewable energy cannot be grouped with any of other categories of renewable energy, and therefore constitutes a special group within the classification of renewable energy, even though amount of energy involved is limited. The dairy sector calls this type of renewable energy heat recovery.

Developments

The recovery of heat during the cooling of milk has been applied for many years and is increasing, stimulated by increases in scale, higher energy prices, and support provided by the Energy Investment Allowance Scheme. The contribution of this type of renewable energy in 2009 to the avoided consumption of fossil energy was approximately 350 TJ (substitution method). This represents 0.3 percent of all renewable energy. The heat from cooling of milk is not included in the gross final consumption method, because this type of energy is not included in the international energy statistics, nor is it mentioned in the EU Renewable Energy Directive.

8.1 Heat from cooling of just milked milk

	Total number of dairy cows in the Netherlands	Number of dairy cows on farms with regeneration of heat	Extraction of heat from milk	Avoided use of fossil primary energy	Avoided CO_2 emission
	1,000		*TJ*		*kton*
1995	1,708	400	150	175	8
2000	1,504	445	167	203	9
2005	1,433	491	184	225	11
2,006	1,420	500	188	232	11
2007	1,413	548	205	256	12
2008	1,466	623	234	288	14
2009	1,489	689	258	322	16
2010	1,479	740	277	351	18

Source: Statistics Netherlands.

Method

The percentage of dairy cows on a dairy farm with a heat recovery system compared to the total number of dairy cows is estimated based on an inventory of the main suppliers of milk cooling systems in the Netherlands in 2006 and 2010, and research performed by de Koning and Knies (1995) for 1995. The data for the missing years have been interpolated. The total number of dairy cows is taken from the Agricultural Survey of Statistics Netherlands. Multiplication of this number with the percentage of dairy cows on a farm with heat recovery gives the total number of dairy cows on a dairy farm with a heat recovery system. The Renewable Energy Monitoring Protocol includes indices for the heat production per cow and the electricity consumption of the cooling system. These indices were used to calculate the avoided consumption of primary fossil energy.

Biomass

9

Biomass

9.1 Introduction
- Developments
- Green gas
- Biomass and sustainability
- Imports and exports
- Definition of biomass as a source of energy

9.2 Municipal solid waste incinerators
- Developments
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9.3 Co-firing of biomass in central electricity plants
- Developments
- Method

9.4 Wood boilers for heat in companies
- Developments
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9.5 Household wood stoves
- Developments
- Method

9.6 Other biomass combustion
- Developments
- Method

9.7 Biogas from sewage water purification plants
- Developments
- Method

9.8 Landfill gas
- Developments
- Method

9.9 Biogas, co-digestion of manure
- Developments
- Method

9.10 Other biogas
- Developments
- Method

9.11 Biofuels for road transport
- Developments
- Method

9.1 Introduction

Biomass is the major source of renewable energy in the Netherlands and is used in many ways. The three most important large-scale applications are: waste incineration (Section 9.2), co-firing of biomass in central electricity plants (Section (9.3) and the use of biofuels in road transport (Section 9.11). Moreover, there are wood boilers for heat in companies (Section 9.4) and wood stoves in houses (Section 9.5). In addition to being burned directly, the biomass can first be converted into biogas by micro-organisms. This occurs without human intervention at landfill sites (Section 9.8). Wet organic waste flows are often suitable for conversion into biogas through digestion. This takes place at many sewage water purification plants (Section 9.7) and wastewater treatment plants in industry (Section 9.10). A lot of biogas is made from the digestion of manure in combination with other organic material (co-digestion of manure) (Section 9.9). Lastly, there is the 'other biomass combustion' category. This includes a range of very different projects (Section 9.6).

Developments

In 2010, the total consumption of biomass remained approximately the same as in 2009. The consumption of biofuels for road transport dropped sharply. This drop was offset by an expansion of the co-firing of biomass in central electricity plants. In the final consumption of renewable energy from biomass, the drop in the use of biofuels was only partly offset by an increase in co-firing. This is due to conversion losses in power stations, resulting in less than half the energy from co-fired biomass ending up in produced renewable energy and heat.

Co-firing biomass and the use of biofuels for road transport can vary greatly from one year to the next. One important reason for this is the relatively low investment costs. As a result, owners of power stations and oil companies can respond fairly quickly to changing conditions such as subsidy changes, changes in the legal utilisation obligation and price differences between fossil and biomass fuels.

The picture is more stable for municipal solid waste incinerators. This is because investment costs are the major factor. Once the installation is in place, it is in the owner's interest to use it as much as possible. Furthermore, government policy aims to keep waste disposal at a minimum. In combination with the limited incineration capacity for household waste, this means that the installations and systems were almost fully utilised. The increase between 1995 and 2000 was caused by the installation of new systems. In the last two years, a number of installations have been expanded, and completely new installations have been built. As a result, the market has become less restricted, more waste has been incinerated, and the production of renewable energy from waste has increased.

There was a marked growth in other biomass combustion in 2008 and 2009. This was primarily the result of the start of three medium-sized installations that convert used wood into electricity, and one medium-sized installation that generates electricity by incinerating poultry manure.

The avoided consumption of primary fossil energy is usually lower than the biomass consumption (Section 9.1.1): 1 joule of biomass saves less than 1 joule of fossil energy, because of the relatively low efficiency of biomass installations. This is particularly true for municipal solid waste incinerators and household wood stoves. When calculating the avoided consumption of primary fossil energy, the increased or decreased use of primary fossil energy in the production of biomass when compared to the production of reference fuels (Renewable Energy Monitoring Protocol) is not taken into account. This means no lifecycle analysis (LCA) has been carried out. This can make quite a difference, particularly for transport

9.1.1 Biomass

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Biomass consumption (TJ)									
Municipal solid waste, renewable fraction	13,205	15,450	25,512	26,659	26,616	27,845	30,549	32,441	34,208
Co-firing of biomass in central electricity plants	–	33	1,755	30,522	29,445	15,702	19,692	22,788	28,545
Wood boilers for heat in companies	1,682	2,103	2,150	2,068	2,306	2,552	2,686	2,792	2,766
Wood stoves in houses	12,167	11,891	9,508	11,103	11,561	12,056	12,174	12,232	12,347
Charcoal									
Other biomass combustion	440	577	3,695	5,628	6,623	7,077	13,069	16,177	14,703
Biogas from landfills	392	2,238	2,313	1,909	1,926	1,909	1,858	1,641	1,538
Biogas from sewage water purification	1,516	1,834	1,925	1,946	2,010	1,998	2,045	2,046	2,101
Biogas, co-digestion of manure[2]				82	591	1,872	3,697	5,279	5,747
Biogas, other	468	826	974	1,158	1,382	1,475	1,850	2,249	2,900
Biofuels for road transport	–	–	–	101	1,766	13,031	12,048	15,606	9,577
Total	29,869	34,952	47,831	81,176	84,225	85,517	99,669	113,250	114,433
Gross final consumption (TJ)									
Municipal solid waste, renewable fraction	3,748	3,888	7,704	8,078	8,590	8,862	9,138	10,666	11,339
Co-firing of biomass in central electricity plants		16	763	13,109	12,230	7,359	8,883	10,353	12,920
Wood boilers for heat in companies	1,682	2,103	2,150	2,068	2,306	2,552	2,686	2,792	2,766
Wood stoves in houses	12,167	11,891	9,508	11,103	11,561	12,056	12,174	12,232	12,347
Charcoal	270	270	270	270	270	270	270	270	270
Other biomass combustion	357	478	1,393	3,482	4,444	4,727	6,504	7,357	6,415
Biogas from landfills	211	1,208	1,109	894	849	810	812	729	660
Biogas from sewage water purification	1,396	1,660	1,760	1,750	1,737	1,733	1,802	1,821	1,848
Biogas, co-digestion of manure[2]				56	348	1,114	2,305	3,444	3,976
Biogas, other	461	816	957	1,086	1,287	1,284	1,481	1,678	2,109
Biofuels for road transport				101	1,766	13,031	12,048	15,606	9,577
Total	20,291	22,332	25,613	41,996	45,388	53,796	58,101	66,947	64,228
Avoided use of fossil primary energy (TJ)									
Municipal solid waste, renewable fraction	6,217	6,323	11,971	12,329	12,779	13,352	13,560	15,578	16,874
Co-firing of biomass in central electricity plants	–	33	1,755	30,522	29,445	15,702	19,692	22,788	28,545
Wood boilers for heat in companies	1,308	1,636	1,806	1,914	2,145	2,382	2,516	2,627	2,613
Wood stoves in houses	4,643	4,751	4,429	6,025	6,452	6,905	7,096	7,211	7,395
Charcoal									
Other biomass combustion	557	693	2,430	4,509	5,398	5,734	9,325	11,026	9,892
Biogas from landfills	340	2,096	1,986	1,608	1,519	1,416	1,410	1,264	1,138
Biogas from sewage water purification	1,022	1,209	1,464	1,452	1,324	1,442	1,497	1,477	1,500
Biogas, co-digestion of manure[2]				76	459	1,444	2,984	4,300	4,775
Biogas, other	406	711	870	998	1,185	1,227	1,465	1,878	2,364
Biofuels for road transport	–	–	–	101	1,766	13,031	12,048	15,606	9,577
Total	14,493	17,451	26,710	59,535	62,471	62,634	71,593	83,756	84,674

Source: Statistics Netherlands.

[1] Up to and including 2004 part of other biogas.

fuels: the conversion of raw plant materials into biofuels costs more energy than the conversion of crude oil into petrol and diesel (Edwards et al., 2007).

Green gas

There has been a great deal of recent interest in green gas, i.e. biogas that is refined to natural gas quality and then injected into the regular natural gas grid. Direct injection of biogas into the gas grid is not possible because its caloric value is much lower. There are plans to realise a significant share of the gas supply through green gas.

Green gas has been generated at four landfill sites for some years now: approximately 0.4 PJ (0.025 percent of total natural gas use in the Netherlands). A number of new projects outside the landfill sites are being prepared, piloted, or have just started up. In 2010, the total green gas production of these new projects was less than 0.05 PJ.

Biomass and sustainability

In the last few years there has been wide social debate on the sustainability of biomass use. This debate often refers to the protection of tropical forests, CO_2 effectiveness across the entire chain, and the impact on food prices. Within renewable energy statistics, no distinction is yet made between sustainable and non-sustainable forms of biomass. All forms of biomass are included (Renewable Energy Monitoring Protocol). The reason for this is that no generally accepted and applied criteria were yet in place to assess the sustainability of biomass in 2010.

Imports and exports

A great deal of biomass is produced domestically, almost always residual flows. For biomass to be co-fired, a significant amount comes from abroad. These are primarily wood pellets (small compressed blocks of wood). In 2009, approximately 20 PJ of energy from co-fired biomass and other biomass combustion originated from abroad (over half).

The domestic production of biodiesel increased further in 2010, while its use dropped dramatically. As a result, the Netherlands was a net exporter of biodiesel in 2010, while in 2007 and 2008 it was a net importer.

Until 2009 the Netherlands was a net importer of biopetrol. For 2010 the situation is unclear, because a number of factories started up whose production data are confidential. Data from the Netherlands Emissions Authority (2011), however, show that the raw materials for biopetrol delivered on the Dutch market (mainly maize, cereals and sugar cane) originated from abroad.

Solid biomass is also exported. According to NL Agency's European Waste Shipment Regulation (EWSR) records, approximately 11 PJ of biomass waste as a source of energy was exported in 2008, mainly construction wood and used wood.

Definition of biomass as a source of energy

Theoretically, biomass can take many forms, for example, food or newspapers. However, energy statistics only include biomass when it is used as a source of energy. For example, imports of palm oil for the food industry are not included.

9.2 Municipal solid waste incinerators

Developments

The production of renewable energy from municipal solid waste incinerators was fairly constant for many years, but rose clearly in 2009 and 2010 (9.2.1 and 9.2.2). This increase is mainly because of the start up of new installations. The capacity expansion in the Netherlands and Germany has had a negative effect on the payments for incinerating waste. As a result, the owner of the Rotterdam municipal solid waste incinerator decided to cancel a planned overhaul and instead to close the installation at the end of 2009. In 2010 a new waste incinerator started up in Delfzijl. This installation is special because it supplies steam to nearby industries.

In 2010, waste incinerators accounted for approximately 13 percent of final renewable energy consumption.

The biomass share of the incinerated waste decreased gradually between 1990 and 2002, with the emergence of separate collection for organic waste. In 2003, this decrease came to an end. In the last few years the biomass share seems to have been increasing again, although as uncertainty in the biomass figures is relatively high it is too soon to speak of an upward trend.

9.2.1 Installations for combustion of municipal solid waste: capacity, combusted waste, energy balance

	Combusted waste		Electricity				Heat			Fossil fuels
	Mass	Energy	Capacity	Gross production	Consumption	Net production	Supply	Deliveries	Net production	Consumption
	kton	*TJ*	*MW*	*mln kWh*			*TJ*			
1990	2,780	22,840	196	933	134	799	.	.	3,124	–
1995	2,913	28,654	276	1,308	325	983	1,442	3,969	2,528	93
2000	4,896	49,767	394	2,520	565	1,956	2,831	9,026	6,195	796
2005	5,454	56,722	429	2,738	609	2,129	1,908	9,521	7,614	938
2006	5,545	55,450	429	2,777	632	2,144	1,903	10,090	8,187	886
2007	5,801	58,010	506	2,960	636	2,324	1,728	9,874	8,146	1,068
2008	6,053	62,346	506	2,922	703	2,219	2,030	10,464	8,434	1,016
2009	6,333	63,609	546	3,130	726	2,404	1,752	11,722	9,970	986
2010	6,586	64,543	586	3,376	701	2,675	1,694	11,251	9,557	950

Source: Statistics Netherlands.

9.2.2 Installations for combustion of municipal solid waste: renewable fraction and renewable energy

	Waste		Electricity		Heat	Gross final consumption			Effect	
	renewable fraction	combusted renewable waste	gross renewable production	net renewable production	renewable production	electricity	heat	total	avoided use of fossil primary energy	avoided CO_2 emission
	%	*TJ*	*mln kWh*		*TJ*					*kton*
1990	58	13,205	539	462	1,806	1,942	1,806	3,748	6,217	415
1995	54	15,450	703	528	1,358	2,530	1,358	3,888	6,323	428
2000	51	25,512	1,272	987	3,126	4,578	3,126	7,704	11,971	803
2005	47	26,659	1,266	984	3,520	4,557	3,520	8,078	12,329	802
2006	48	26,616	1,312	1,013	3,868	4,723	3,868	8,590	12,779	837
2007	48	27,845	1,395	1,095	3,839	5,022	3,839	8,862	13,352	868
2008	49	30,549	1,409	1,070	4,066	5,071	4,066	9,138	13,560	879
2009	51	32,441	1,572	1,207	5,007	5,659	5,007	10,666	15,578	999
2010	53	34,208	1,763	1,397	4,992	6,348	4,992	11,339	16,874	1,076

Source: Statistics Netherlands.

The difference between gross and net electricity production is much greater for waste incinerators than for other conversion technologies. This is mainly because waste incinerators consume a lot of electricity for flue gas scrubbing. Some waste incinerators also use a fair amount of fossil fuels for this purpose. The use of fossil fuels is factored into the calculation of the production of renewable energy and heat (Renewable Energy Monitoring Protocol (NL Agency, 2010)).

Method

Waste incinerators are defined as installations suitable for mixed waste flows. Installations developed for specific waste flows such as the new thermal conversion installation in Duiven for paper sludge, and the used wood incinerators of the Twence plant in Hengelo, Afvalverwerking Rijnmond (Rijnmond Industrial Waste Processing Company) and the domestic waste processing plant in Alkmaar, are not considered waste incinerators. They are treated under 'other biomass combustion'.

Figures on electricity capacity originate from Statistics Netherlands' statistics on means of electricity production. The time series of the amount of incinerated waste comes from NL Agency and is provided in the framework of the Waste Registration Working Group (WAR, an alliance between NL Agency and the Dutch Waste Management Association) through a survey conducted among waste incineration plants.

NL Agency data on caloric value and biomass fraction were used, which are based on waste flow observations and a calculation method originating from the Renewable Energy Monitoring Protocol (NL Agency, 2010).

The electricity and heat production of waste incinerators is determined on the basis of Statistics Netherlands' energy surveys. The response to these surveys was over 80 percent. Missing data were estimated based on environmental annual reports and the Waste Registration Working Group. These energy data were compared with Waste Registration Working Group data (up to 2008) and environmental annual reports. Based on the comparison of the environmental annual reports and the energy surveys, Statistics Netherlands estimates that the margin of error in the energy production figures of municipal solid waste incinerators in 2010 was approximately 5 percent.

All in all, the largest uncertainty in renewable energy from waste incinerators is in determining the biomass share. This margin of error is estimated to be 10 percent.

9.3 Co-firing of biomass in central electricity plants

The main fuel of power stations in which biomass is co-fired is coal. Some of this fuel can be substituted with various types of biomass. Wood pellets are often used. These are small compressed blocks of wood. Compressing costs money and requires energy, but makes transport easier and enables clean combustion with limited loss of electrical efficiency.

Developments

After a strong growth between 2003–2005, the co-firing of biomass in power stations decreased slightly in 2006 and even halved in 2007 (Table 9.3.1). It increased again subsequently, and in 2010 about the same amount of biomass was co-fired as in 2005 and 2006. In 2010, the co-firing of biomass accounted for approximately 15 percent of renewable energy final consumption.

The increase in co-firing between 2003 and 2005 was the result of the incorporation of a number of technical modifications, which made it possible to co-fire larger amounts of biomass. In addition, the 2005 subsidy rates were probably more than sufficient to cover the additional costs of co-firing (De Vries et al., 2005). Because of the rapid growth, the Dutch Ministry of Economic Affairs closed the subsidy scheme for new projects in May 2005. In addition, the subsidy rates for existing co-firing projects for liquid biomass were drastically adjusted downwards as from 1 July 2006. Combined with the social debate about the sustainability of palm oil, this probably resulted in the rapid decrease of co-firing in 2007.

The growth after 2007 was caused by the expansion of co-firing capacity in power stations that already co-fired biomass in 2007. Biomass costs more than coal. The additional revenue from the subsidy and from CO_2 rights apparently outweighed these additional costs.

9.3.1 Co-firing of biomass in central electricity plants

	Biomass	Electricitity		Heat	Gross final consumption			Effect	
	consumption	gross production	net production	production	electricity	heat	total	avoided use of fossil primary energy	avoided CO_2 emission
	TJ	*mln kWh*		*TJ*					*kton*
1990	-	-	-	-	-	-	-	-	-
1995	33	4	4	1	15	1	16	33	3
2000	1,755	208	198	15	748	15	763	1,755	166
2005	30,522	3,449	3,310	693	12,416	693	13,109	30,522	2,394
2006	29,445	3,244	3,103	552	11,678	552	12,230	29,445	2,228
2007	15,702	1,816	1,711	821	6,538	821	7,359	15,702	1,462
2008	19,692	2,248	2,116	789	8,094	789	8,883	19,692	1,743
2009	22,788	2,615	2,472	939	9,414	939	10,353	22,788	2,158
2010	28,545	3,237	3,043	1,267	11,653	1,267	12,920	28,545	2,703

Source: Statistics Netherlands.

Method

In principle the production of renewable electricity is calculated based on data from the CertiQ administration of Guarantees of Origin certificates for green power. Production of renewable energy is calculated by multiplying total electricity production of an installation by the ‘renewable’ share of the fuels used (based on energy content). The implicit assumption is that 1 joule of biomass substitutes 1 joule of fossil fuels, an assumption that is also applied in the EU Renewable Energy Directive. The fuel substitution is probably not 100 percent, but slightly less. For the calculation of the subsidy rates for co-firing (Environmental Quality of Electricity Production subsidy scheme), fuel substitution is assumed to be 90 percent for gas-fired stations and 93 percent for coal-fired stations (de Vries et al., 2005 and Tilburg, et al., 2007).

Specifications provided by companies surveyed by Statistics Netherlands were used for calculation of consumption of biomass, and also the efficiency of the stations. Consequently, data from the CertiQ administration and from the Statistics Netherlands' surveys can be compared on an individual basis. Annual environmental reports were also used for verification purposes. Underlying causes of differences larger than 200 TJ for 'biomass consumption' were always clear, or were ascertained through inquiries at the power stations before the definite figures were determined. Apart from the uncertainties in fuel substitution, the margin of error in renewable energy from co-firing biomass in stations is estimated to be 3 percent.

9.4 Wood boilers for heat in companies

Developments

A few years ago large numbers of new wood boilers and stoves for heat production were installed, mainly smaller boilers (approximately 100 kW) for agriculture. This trend peaked in 2006 and 2007, after which the total capacity of added boilers and stoves decreased again. In 2010, many boilers and stoves were taken out of operation, mostly larger boilers from the wood industry.

Wood consumption in wood-fired boilers for heat in companies represented approximately 3 percent of the renewable energy final consumption in 2010.

9.4.1 Wood boilers for heat in companies

	Number			Capacity			Consumption of wood		Heat production	Gross final consumption	Effect	
	newly installed	decommissioned	operational[1]	newly installed	decommissioned	operational[1]	mass	energy			avoided use of fossil primary energy	avoided CO_2 emission
				MW			kton	TJ				kton
1990	.			.		218	102	1,682	1,177	1,682	1,308	74
1995	.			.		273	127	2,103	1,472	2,103	1,636	93
2000	.			.		301	130	2,150	1,625	2,150	1,806	103
2005	209	21	740	21	4	319	125	2,068	1,723	2,068	1,914	109
2006	516	31	1,225	57	18	357	140	2,306	1,930	2,306	2,145	122
2007	417	7	1,635	46	7	397	155	2,552	2,144	2,552	2,382	135
2008	274	39	1,870	31	9	419	163	2,686	2,264	2,686	2,516	143
2009	125	16	1,979	21	3	438	169	2,792	2,365	2,792	2,627	149
2010	177	21	2,135	17	19	435	168	2,766	2,351	2,766	2,613	148

Source: Statistics Netherlands.

[1] At the end of reporting year.

9.4.2 Operational thermal capacity (MW) of wood boilers for heat in companies by sector

	Wood industry	Furniture industry	Construction	Trade	Agriculture	Other	Total
2006	158	65	8	49	76	1	357
2007	159	63	9	48	110	8	397
2008	159	62	10	45	129	14	419
2009	158	61	10	45	142	22	438
2010	144	59	11	44	150	28	435

Source: Statistics Netherlands.

9.4.3 Operational number and capacity of wood boilers for heat in companies by capacity

	Number					Capacity				
	≤ 0,1 MW	> 0,1 t/m 0,5 MW	> 0,5 t/m 1,0 MW	> 1 MW	Total	≤ 0,1 MW	> 0,1 t/m 0,5 MW	> 0,5 t/m 1,0 MW	> 1 MW	Total
						MW				
2006	841	221	65	98	1,225	49	65	48	196	357
2007	1,186	271	81	97	1,635	69	74	58	196	397
2008	1,388	305	81	96	1,870	79	87	59	194	419
2009	1,457	343	83	96	1,979	84	94	60	199	438
2010	1,595	368	82	90	2,135	91	98	60	187	435

Source: Statistics Netherlands.

Method

Data on the number of wood boilers for heat in companies and their capacity are based on inventories of suppliers of wood-burning boilers and stoves >18 kW for 1991 (Sulilatu, 1992), 1997 (Sulilatu, 1998) and 2004 – 2010 (Statistics Netherlands).. Data for missing years were interpolated.

Heat production was calculated from the capacity based on 1,500 full-load hours (Renewable Energy Monitoring Protocol). Consumption of biomass was based on heat production and efficiencies described in the Renewable Energy Monitoring Protocol (NL Agency, 2010).

The breakdown by sector was based on data from boiler and stove suppliers. The sector in which stoves and boilers were used (in terms of capacity) was unknown for just over 10 percent of the stoves and boilers; For these stoves and boilers it is assumed that the distribution across the sectors was the same as for the other stoves and boilers.

9.5 Household wood stoves

Developments

The use of wood in household wood stoves has remained approximately constant over the last two decades (9.5.1). The avoided fossil primary energy consumption has risen, however, because the average efficiency

9.5.1 Wood stoves in households

	Operational number	Biomass consumption		Heat production	Gross final consumption	Avoided use of fossil primary energy	Avoided CO_2 emission
	1 000	*kton*	*TJ*				*kton*
Total							
1990	928	785	12,167	4,410	12,167	4,643	264
1995	950	767	11,891	4,513	11,891	4,751	270
2000	962	613	9,508	4,208	9,508	4,429	252
2005	956	716	11,103	5,724	11,103	6,025	342
2006	952	746	11,561	6,129	11,561	6,452	366
2007	947	778	12,056	6,560	12,056	6,905	392
2008	943	785	12,174	6,741	12,174	7,096	402
2009	940	789	12,232	6,851	12,232	7,211	408
2010	936	797	12,347	7,025	12,347	7,395	419
Open fire places							
1990	605	281	4,361	436	4,361	459	26
1995	541	244	3,776	378	3,776	397	23
2000	477	186	2,881	288	2,881	303	17
2005	419	170	2,633	263	2,633	277	16
2006	411	166	2,579	258	2,579	271	15
2007	402	163	2,526	253	2,526	266	15
2008	394	160	2,475	248	2,475	261	15
2009	391	158	2,457	246	2,457	259	15
2010	384	155	2,410	241	2,410	254	14
Built-in hearths							
1990	145	150	2,330	1,097	2,330	1,155	66
1995	253	243	3,763	1,791	3,763	1,885	107
2000	244	156	2,422	1,211	2,422	1,274	72
2005	223	157	2,438	1,287	2,438	1,354	77
2006	215	156	2,424	1,286	2,424	1,354	77
2007	206	156	2,426	1,295	2,426	1,363	77
2008	197	150	2,321	1,246	2,321	1,311	74
2009	188	143	2,211	1,192	2,211	1,255	71
2010	179	136	2,106	1,143	2,106	1,203	68
Free-standing stoves							
1990	178	353	5,476	2,877	5,476	3,028	172
1995	156	281	4,352	2,345	4,352	2,468	140
2000	241	271	4,205	2,709	4,205	2,851	162
2005	313	389	6,032	4,174	6,032	4,394	250
2006	326	423	6,558	4,585	6,558	4,827	274
2007	339	458	7,105	5,013	7,105	5,276	299
2008	352	476	7,378	5,248	7,378	5,524	313
2009	361	488	7,565	5,413	7,565	5,698	323
2010	374	505	7,831	5,641	7,831	5,938	336

Source: Statistics Netherlands and TNO.

of the stoves has increased. Domestic wood stoves represent one seventh of gross final consumption of renewable energy in the Netherlands.

Three types of wood burners can be distinguished within this group: open fireplaces, built-in hearths and free-standing wood stoves. The last two groups are used more often and have a higher efficiency. The number of open fireplaces and built-in hearths is decreasing, but that of free-standing stoves is increasing.

Method

Data on numbers of domestic wood stoves in use, the use of wood and efficiency are from TNO (Netherlands Organisation for Applied Scientific Research). TNO collects these data for its annual report on emissions, based on sample surveys on the use of wood in Dutch households. The missing data are supplemented with a stock model for wood stoves, sales figures and expert estimates of the efficiencies and lifespan of stoves.

The most recent sample surveys on the use of wood in households was carried out in the winter of 2006/'07. Statistics Netherlands analysed the results and compared the data to previous studies on the use of wood in households (Segers, 2010b). The studies demonstrated that the uncertainty of the estimates is high, and that wood consumption estimates on the supply side (estimates of the available wood) were always much lower than the estimated results through the demand side (sample surveys of households). It is not known which estimate is more accurate. Statistics Netherlands and TNO currently prefer the wood consumption estimate provided through the demand side, as the empirical basis seems stronger. Finding an explanation for the discrepancy between the supply and demand sides of the chain through a further study would be advisable. Statistics Netherlands estimates a 50 percent margin of error for wood consumption data.

9.6 Other biomass combustion

Other biomass combustion is all biomass combustion not included in the above categories. This includes the combustion of paper sludge, various biomass fuel stocks in cement kilns, animal fat outside power stations, and the production of electricity through biomass combustion outside power stations.

Developments

Combustion of other biomass decreased in 2010 after considerable increases in the previous years. The decrease was mainly due to biomass consumption at a few companies that use relatively high quantities of biomass. Other biomass combustion was responsible for 7 percent of renewable energy final consumption in 2010.

The growth in the years prior to 2010 was mainly caused by new electricity production projects supported by Environmental Quality of Electricity Production subsidies (MEP). In 2010, the new Renewable Energy Production Incentive Scheme (SDE), had not yet resulted in many electricity production projects using solid or liquid biomass.

Method

CertiQ is the main source of information on electricity production, supplemented by information from Statistics Netherlands' production and conversion surveys. These surveys are the main source of information about the use of biomass and heat production in cogeneration (CHP). Environment reports and NL Agency information from the Energy Investment Allowance Scheme were used as supplementary and control information.

9.6.1 Other biomass combustion

	Biomass consumption			Electricity		Heat production			Gross final consumption			Effect	
	total	in electricity producing installations	final	gross production	net production	total	in combined heat and power plants	from final consumption	electricity	heat	total	avoided use of fossil primary energy	avoided CO_2 emission
	TJ			*mln kWh*		*TJ*							*kton*
1990	440	440	–	34	33	233	233	–	124	233	357	557	36
1995	577	477	100	36	35	337	247	90	131	347	478	693	44
2000	3,695	3,333	362	234	216	513	188	326	843	550	1,393	2,430	165
2005	5,628	3,524	2,104	253	235	2,249	468	1,781	910	2,572	3,482	4,509	280
2006	6,623	3,677	2,946	256	236	3,078	576	2,502	922	3,522	4,444	5,398	333
2007	7,077	3,981	3,097	279	254	3,262	626	2,636	1,004	3,723	4,727	5,734	351
2008	13,069	9,929	3,140	741	664	3,340	695	2,645	2,669	3,835	6,504	9,325	597
2009	16,177	13,152	3,024	1,009	895	3,238	700	2,538	3,632	3,725	7,357	11,026	711
2010	14,703	12,725	1,979	1,015	894	2,378	784	1,594	3,653	2,763	6,415	9,892	637

Source: Statistics Netherlands.

The efficiency of biomass burned only to produce heat, is assumed to be 90 percent, the reference efficiency for large-scale heat production, unless information is available which provides a different value.

At least one reliable source is available for the figures for 2010. The margin of error in renewable energy from other biomass combustion is therefore estimated as approximately 10 percent.

9.7 Biogas from sewage water purification plants

Developments

The production of renewable energy using biogas from sewage water purification plants has been quite stable in recent years (9.7.1), and accounted for approximately 2 percent of renewable energy final consumption in 2010. Eighty sewage water purification plants extract biogas which is subsequently utilised. The trend in the last few years has been to convert more biogas into electricity, and to use less biogas through direct combustion for other processes. Approximately 10 percent of the extracted biogas at sewage water purification plants is flared (see also section 9.8).

Method

The data are taken from Statistics Netherlands' wastewater treatment survey (Zuivering van Afvalwater). The response to this survey was 100 percent. The main uncertainty concerns heat, which is usually not measured but estimated.

9.7.1 Biogas from sewage water purification plants

	Biogas				Electricity[1]		Heat from combined heat and power[1]		Gross final consumption			Effect	
	production	flared	used in electricity producing installations	final use outside the digester	gross production	net production	gross production	net production	electricity	heat	total	avoided use of fossil primary energy	avoided CO_2 emission
	TJ				*mln kWh*		*TJ*					*TJ*	*kton*
1990	1,724	209	891	312	70	66	352	69	254	1,143	1,396	1,022	67
1995	1,984	151	1,326	134	106	100	530	103	381	1,279	1,660	1,209	82
2000	2,068	143	1,345	397	111	105	553	108	398	1,362	1,760	1,464	97
2005	2,124	178	1,575	256	123	117	649	135	443	1,306	1,750	1,452	95
2006	2,216	206	1,725	179	132	125	620	42	474	1,262	1,737	1,324	90
2007	2,218	220	1,813	81	143	136	682	157	515	1,218	1,733	1,442	96
2008	2,212	166	1,818	84	150	142	713	140	540	1,262	1,802	1,497	100
2009	2,273	226	1,828	100	150	143	749	120	542	1,280	1,821	1,477	98
2010	2,297	196	1,926	84	164	154	758	99	589	1,259	1,848	1,500	99

Source: Statistics Netherlands.

[1] The difference between net and gross consists of own use for biogas production and for conversion of biogas into electricity.

From survey year 2004, respondents were requested to split the heat based by designated use. A large part of the heat is used to maintain the temperature of the biogas production process. This heat is included in the calculation of gross final consumption, but not included in the calculation of the avoided consumption of fossil primary energy.

Information on which percentage of the produced heat in the cogeneration systems was used for the fermentation process is not available for before 2004. It is assumed that the distribution for fermentation and other processes before 2004 is the same as that after 2004.

Gross final consumption for heating from sewage water purification plant biogas consists of final consumption of the biogas (heat boilers) plus a contribution from this biogas used in cogeneration systems. The heat from cogeneration systems is not sold, but used by the purification plant itself, and therefore not included in international (renewable) energy statistics. Instead of the heat produced by cogeneration systems, the statistics include the consumption of biogas by cogeneration allocated to heat production. In accordance with the suggestion in the guidelines for energy statistics (IEA/Eurostat 2010), Statistics Netherlands splits the fuel consumption of the cogeneration systems with unsold heat between electricity and heat, based on the production of electricity and heat in joules. This procedure results in a higher value for the gross final consumption for unsold heat from cogeneration systems than that of the heat production itself.

The margin of error for sewage water purification plant biogas is estimated to be 10 percent.

9.8 Landfill gas

Landfill gas is biogas from landfill sites. Most of the captured landfill gas is converted into electricity, but at four sites it is converted into a gas with properties similar to those of natural gas, that is subsequently injected into the natural gas grid. This is also called green gas. Some landfill gas is also used directly for heating applications. Landfill gas is flared if local conditions and the methane concentration of the gas are insufficient to use it cost-effectively. Flaring is preferred to the direct escape of landfill gas into the atmosphere because this converts the methane in the gas into CO_2, which per molecule contributes less towards global warming.

Developments

The production of renewable energy from landfill gas has passed its peak (9.8.1). The decrease is caused by the reduction of the amount of waste dumped since the start of the 1990s (Waste Registration Working Group, 2009). In 2010, landfill gas provided approximately 1 percent of renewable energy final consumption.

9.8.1 Biogas from landfills

	Biogas		Electricity		Heat	Natural gas	Gross final consumption			Effect	
	production	flared	gross production	net production	production	production[1]	electricity	heat	total	avoided use of fossil primary energy	avoided CO_2 emission
	TJ		mln kWh		TJ						kton
1990	724	332	17	16	20	171	77	134	211	340	21
1995	2,786	548	142	138	151	675	580	628	1,208	2,096	137
2000	3,098	786	158	153	44	616	647	462	1,109	1,986	132
2005	2,503	594	131	127	68	446	534	360	894	1,608	104
2006	2,486	560	127	123	41	445	519	330	849	1,519	100
2007	2,475	566	114	111	72	417	477	333	810	1,416	92
2008	2,452	595	109	106	106	396	455	356	812	1,410	91
2009	2,120	479	100	97	66	387	424	305	729	1,264	81
2010	1,941	403	93	90	55	345	391	269	660	1,138	72

Source: Statistics Netherlands.

[1] Including a limited amount of delivered crude biogas.

Method

The data up to 1996 were taken from Statistics Netherlands' energy survey. From 1997 the data were taken from the landfill gas survey of the Waste Registration Working Group (2009). Up to reporting year 2004, this survey was carried out by the Dutch Waste Management Association. NL Agency took it over in 2005. This survey covers all energy data of all Dutch waste disposal sites.

The response to the Waste Registration Working Group survey was 100 percent, or nearly 100 percent, in the last few years. However, some respondents do not answer all the questions on energy. The missing data are estimated based on known data.

Gross final consumption of landfill gas converted into natural gas is calculated by first calculating the renewable share of natural gas consumption (as the production of natural gas from biogas divided by total natural gas consumption), and then multiplying this share by the sum of (i) final consumption of natural gas, (ii) production of electricity from natural gas and (iii) sold heat from natural gas. This method has been agreed in the renewable energy working group of Eurostat (2011b).

The result of this method for 2009 is that 62 percent of natural gas production from biogas is considered to be final consumption of heat, and 17 percent is considered to be final consumption of electricity. The rest of natural gas from biogas ends up as non-energy consumption, or is lost through conversion into electricity, whether or not in combination with heat production.

Statistics Netherlands estimates the margin of error in gross final consumption of energy from landfill gas to be 10 percent.

9.9 Biogas, co-digestion of manure

Co-digestion of manure consists of the production of biogas through the anaerobic digestion of manure together with other plant products. Co-digestion of manure, also called anaerobic manure digestion, can take place without other materials, but this is not common because it is technically more difficult and less cost efficient.

In previous editions of Renewable Energy in the Netherlands, co-digestion of manure was called 'Biogas at agricultural businesses'. Co-digestion of manure usually takes place at or by agricultural businesses. However, partly as a result of increases in scale, the installations are increasingly often operated by a cooperation of agricultural businesses, joint ventures of energy companies and agricultural businesses, or by energy companies specialised in the operation of digestion systems (Segers, 2011d). Some of these systems are not located at the agricultural site itself, but, for example, on an industrial estate. The term biogas at agricultural businesses was therefore no longer accurate, and was changed into co-digestion of manure.

Developments

The growth of renewable energy produced by co-digestion of manure has levelled off since 2009. Each year some 20 new sites started operating a manure digester between 2005 and 2008. In 2010 only 4 new locations started this process. The slowdown in growth was the result of the ending of subsidies for new installations under the Environmental Quality of Electricity Production subsidy scheme (MEP) in August 2006. A new subsidy scheme, the Promotion of Sustainable Energy Production Scheme (SDE), is now available, but was introduced only recently, and therefore has not yet had time to influence the realisation of new installations.

At the end of 2010, 91 companies had an electricity-producing manure digester. Their joint net electricity production was 530 million kWh, accounting for approximately 5 percent of all renewable electricity. The

9.9.1 Biogas from co-digestion of manure

	Number of companies	Biogas	Electricity[1]				Heat from combined heat and power[1]		Gross final consumption			Effect	
		production and use in electricity producing installations	capacity	gross production	net production	full load hours[2]	gross production	net production	electricity	heat	total	avoided use of fossil primary energy	avoided CO_2 emission
		TJ	*MW*	*mln kWh*			*TJ*						*kton*
2005	17	82	5	9	8	.	13	5	32	24	56	76	5
2006	37	591	18	59	54	5,600	63	4	213	135	348	459	32
2007	53	1,872	43	187	171	5,700	207	20	673	441	1,114	1,444	99
2008	78	3,697	76	370	339	5,900	476	106	1,332	973	2,305	2,984	204
2009	87	5,279	94	528	484	6,300	785	257	1,901	1,543	3,444	4,300	290
2010	91	5,747	98	575	527	6,000	1,028	453	2,069	1,907	3,976	4,775	316

Source: CBS.

1) The difference between net and gross consists of own use for biogas production and for conversion of biogas into electricity.
2) The number of full load hours is the number of hours that the biogas motors would need to run at maximum capacity to achieve the realised electricity production. The calculation takes into account the number of operational months of a project. The first three operational months are excluded to eliminate the effect of possible start up problems.

current manure digesters are not all operating at full capacity. The average number of full-load hours was 6,000, 70 percent of the theoretical maximum. The scale of manure digestion is increasing: while the electrical power generated per company was 0.3 MW at the end of 2005, this had increased to 1.1 MW by the end of 2010. Manure digesters provided approximately 4.5 percent of renewable energy final consumption in 2010.

2.5 billion kg of wet biomass was digested in 2010. More than half of this was manure. Total manure production in the Netherlands was 70 billion kg. About 2 percent of this is used in the digesters. The caloric value of the different types of input for the manure digesters varies greatly. For manure it is relatively low. The manure share is much smaller (approximately 15 percent) in terms of energy than in terms of mass (more than 50 percent).

Maize is an important co-product that is also digested, but a range of other products are also digested with the manure: residues from the food industry, food retail, animal food and fodder industry, or even primary agricultural products. The quantity of glycerine consumed by the manure digesters in 2009 was remarkably high. Glycerine is a by-product of the production of biodiesel. This product represented 20 percent of the co-substrate mass on average; it contributed twice as much energy as maize in 2009. In 2010 much less glycerine was used: it accounted for only 5 percent (by mass) of the co-substrates.

The production of electricity from biogas releases heat, most of which can be used (cogeneration, or CHP). Some of this heat is used to heat the digester: approximately 10 percent of the extracted biogas (Renewable Energy Monitoring Protocol, NL Agency, 2010). In principle, plenty of heat is left, but the options for using it in agricultural businesses are limited. Total heat utilisation outside the digester was approximately 5 percent of all extracted biogas.

9.9.2 Origin and composition of input for co-digestion of manure

	thousand million kg (wet)				TJ gross caloric value			
	2007	2008	2009	2010	2007	2008	2009	2010
Primary agriculture								
manure	0.44	0.91	0.80	1.38	569	1,235	1,037	1,896
maize	0.11	0.21	0.26	0.36	670	1,262	1,570	2,259
other products	0.03	0.03	0.03	0.04	153	151	151	208
total	0.58	1.14	1.08	1.78	1,392	2,647	2,758	4,363
Agro-industry	0.05	0.10	0.14	0.54	494	1,251	1,479	4,353
Other	0.09	0.17	0.29	0.23	816	2,276	3,925	2,557
Total	0.72	1.42	1.52	2.55	2,702	6,174	8,162	11,273

Source: Statistics Netherlands and OWS.

Method

Gross production of electricity by manure digesters is determined from the CertiQ administration of Guarantees of Origin for green power certificates. The production of biogas is estimated based on the production of electricity and a standard gross electricity efficiency of 36 percent. The internal consumption of electricity and heat is determined based on biogas production and indices from the Renewable Energy Monitoring Protocol (NL Agency, 2010). The consumption of heat for the digestion is not included in the calculation of the avoided consumption of fossil primary energy, but is included in the gross final consumption data.

Just as biogas from sewage water purification plants, the useful heat from cogeneration systems running on biogas from the co-digestion of manure is not sold, but used internally. Unsold cogeneration heat is not included in international energy statistics, which complicates the calculation of the gross final consumption for heating. Section 9.7 on sewage water purification plants provides more extensive information.

The data on heat and the substrate consumption in wet mass come from a supplementary survey conducted by Statistics Netherlands among agricultural businesses for manure statistics. Businesses with the smallest manure digesters were not included in the survey. The response to this survey was approximately 50 percent for 2009. Missing data were estimated based on the production of electricity derived from the CertiQ data. The substrate consumption in terms of mass was converted to energy using the caloric values and humidity values per type of substrate provided in the literature (Koppejan et al., 2009 and AID, 2003). For 2010 the data on heat and the composition of the input were calculated from OWS (2011). Response rate in this study was about 75 percent, but the data still contain some uncertainty, because not all co-products were specified by the respondents.

The CertiQ certificates of Guarantee of Origin of green power are a required precondition for subsidy, which in turn is a required precondition for the cost-efficient operation of manure digesters. The CertiQ administration therefore probably provides complete or nearly complete data on production by electricity installations using biogas from co-digestion of manure. The margin of error in gross production of electricity is therefore estimated to be no more than 5 percent. The margin in net production of electricity is higher, but no more than 10 percent. This is due to the aforementioned estimate method for the internal electricity use of the digesters. The uncertainty of the data related to the used prime material and the heat production is higher because of the small total number of businesses and the non-response rate.

9.10 Other biogas

For a long time, other biogas consisted mainly of biogas used in the food industry, where it is extracted through anaerobic water treatment processes to generate electricity and/or process heat. The digestion of organic waste from households and services in combination with the production of electricity is rising. Overall, projects at approximately 45 locations use other biogas, representing approximately 2 percent of gross renewable energy final consumption.

Developments

Production of renewable energy from other biogas has increased in the last few years (9.10.1). The increase consists mainly of new projects where electricity is generated. These projects are relatively attractive under the Environmental Quality of Electricity Production subsidy scheme (MEP). They are often non-food industry projects. in which mainly organic waste (vegetable, fruit and garden waste) or other wet organic waste flows from, for example, the food industry are digested.

9.10.1 Other biogas

	Biogas				Electricity[1]		Heat from combined heat and power[1]		Gross final consumption			Effect	
	production	used in electricity producing installations	used to heat the digestor	final use outside the digester	gross production	net production	gross production	net production	electricity	heat	total	avoided use of fossil primary energy	avoided CO_2 emission
	TJ				*mln kWh*		*TJ*						*kton*
1990	468	45	49	374	4	2	15	12	15	446	461	406	23
1995	826	129	79	618	7	3	69	57	25	792	816	711	41
2000	974	274	83	617	17	12	155	133	61	897	957	870	51
2005	1,158	405	97	656	32	26	135	106	115	971	1,086	998	59
2006	1,382	573	102	707	44	37	200	154	157	1,129	1,287	1,185	71
2007	1,475	795	87	594	67	59	202	133	240	1,044	1,284	1,227	75
2008	1,850	1,253	71	526	104	93	256	135	375	1,106	1,481	1,465	93
2009	2,249	1,569	86	594	137	124	379	231	494	1,184	1,678	1,878	118
2010	2,900	2,243	96	561	196	178	525	322	706	1,403	2,109	2,364	149

Source: Statistics Netherlands.

[1] The difference between net and gross consists of own use for biogas production and for conversion of biogas into electricity.

Method

Observations for biogas in the manufacturing industry are based on regular Statistics Netherlands surveys for the production, conversion and use of energy. Non-response rates were estimated based on historical data. For the industrial production of biogas, the additional estimated data were approximately 15 percent of the total in 2004.

The electricity production of many new projects is known at CertiQ. Statistics Netherlands receives the CertiQ production data and uses these as a basis. The production of biogas is calculated via the estimated efficiency of electricity production. The heat production of these newer projects is often limited to the heat required to maintain the digestion process, and can be estimated as a fixed fraction of the biogas production (Renewable Energy Monitoring Protocol, NL Agency, 2010). Other sources of information on heat are data from the NL Agency Energy Investment Allowance Scheme, government environmental annual reports, the internet and telephone checks.

The heat for digestion is not included in the calculation of the avoided consumption of primary fossil energy, but is included in the calculation of gross final consumption.

Just as biogas from sewage water purification plants, the useful heat from cogeneration systems running on biogas from the co-digestion of manure is not sold, but used internally. Unsold cogeneration heat is not included in international energy statistics, which complicates the calculation of the gross final consumption for heating. Section 9.7 on sewage water purification plants provides more extensive information.

The participation of companies that have signed the 'MJA-2' long-term agreement in the digital reporting of environmental annual reports has increased the coverage of the reports. The use of biogas is part of the reports. Statistics Netherlands has compared 2006 micro-level datasets from the environmental annual reports with their own observations. The data show that only companies with small quantities of biogas are missing. These companies are also covered by a supplementary estimate by Statistics Netherlands (75 TJ production and final consumption of biogas). The uncertainty due to the potentially missing companies with biogas is therefore estimated at approximately 50 TJ.

The weakest element of the observations is probably the estimate of heat production, because this is often not sold, and therefore not measured. Statistics Netherlands estimates the margin of error in the renewable energy from other biogas data at 10 percent.

9.11 Biofuels for road transport

Biofuels for road transport are more expensive than traditional petroleum-based fuels. In 2007 the Dutch government introduced a legal obligation for petrol and diesel suppliers to supply biofuels as a fraction of total supplied fuels, in order to stimulate the consumption of biofuels.

Pure biofuels cannot be used for common engines or road vehicles, but engines of existing road vehicles can run on petrol and diesel blended with biofuels. Most biofuels are therefore marketed in petrol and diesel blends. The obligation to supply biofuels is therefore also referred to as the 'blending obligation'.

The Dutch government's biofuel policy is strongly influenced by European Directives. The first was the 2003 European Directive on transport biofuels and other renewable fuels (European Parliament and Commission, 2003). In this non-binding Directive member states agreed to increase the contribution of biofuels from 2 percent in 2005 to 5.75 percent by 2010. The Directive resulted in the Dutch Biofuels Act (Dutch Bulletin of Acts and Decrees (Staatsblad), 2006), making it mandatory for suppliers to provide biofuels. The mandatory share originally increased from 2 percent in 2007 to 5.75 percent by 2010.

Later discussions arose about the advisability of biofuels. The following advantages of biofuels were often mentioned: the reduction of greenhouse gas emissions and the decrease in the dependence on ever-scarcer fossil sources, often from countries with which political relationships are unstable. An often mentioned disadvantage of biofuels is the limited reduction of the greenhouse gas emissions, which even may be negative if all effects, including indirect ones, are taken into consideration. Biofuels can also compete with food, which may become more expensive as a result. Lastly, nature conservation areas may be threatened by the increase in the cultivation of crops for biofuels. As a result of these discussions, the Dutch government decreased the mandatory percentage of biofuels for fuel suppliers in 2010 from 5.75 to 4.0 percent (Ministry or Housing, Spatial Development and the Environment 2008).

The new EU Renewable Energy Directive (European Parliament and Commission, 2009) contains a binding agreement that 10 percent of all transport energy will be from renewable energy sources in 2020. The discussion on the advisability of biofuels has resulted in the inclusion of sustainability criteria for liquid biomass in the Directive. These criteria should guarantee that humans, nature and the environment are sufficiently protected during the production of liquid biomass. Liquid biomass that does not meet the sustainability criteria may no longer be stimulated through subsidy schemes or consumption obligations from 2011 onwards.

Biofuels from waste and wood-like materials are considered to be very sustainable. As an additional stimulation of the use of this type of biofuel, the quantity of this type of fuel counts double towards the transport target indicated in the Renewable Energy Directive. The quantity cannot be doubled for the overall target. The Directive must be transposed into national legislation as from 2011. The Dutch government implemented the double counting of sustainable biofuels very quickly. The double value has been applicable in the national blending obligation since the 2009 reporting year (Dutch Government Gazette (Staatscourant), 2009).

The obligation to supply biofuels will slowly increase over the next few years from 4 percent in 2010 to 5.5 percent by 2014 (Dutch Bulletin of Acts and Decrees (Staatsblad), 2011). A new feature is that this obligation is not only applicable to road transport fuels, but also to mobile machines for agriculture and construction.

Developments

The physical consumption of biofuels in relation to all petrol and diesel for road transport decreased from 3.5 percent in 2009 to 2 percent in 2010. The blending obligation in 2010 was 4 percent. This does not necessarily mean that suppliers did not meet their obligations. Suppliers are allowed to meet their obligations with additional biofuel supply from previous years. Many suppliers did this in 2010. Also, in 2009 and 2010, many suppliers used biodiesel from waste that counts double for the obligation. In 2009, the double counting applied to 3.2 PJ of the physically marketed biodiesel. In 2010 this was 3.6 PJ. This double value is not applied to the figures for physical consumption. Moreover, there are a few other differences between physical consumption and the administrative obligation. This is further explained in the method section below.

The consumption of biodiesel has decreased considerably, from more than 3.5 percent in 2009 to 1.5 percent of all road diesel in 2010. The main reason is that the option for counting biofuels from waste twice has mainly been used for biodiesel use. The consumption of biopetrol remained approximately constant. Biofuels represented approximately 11 percent of the renewable energy final consumption in 2010.

A new element in 2010 is that oil companies voluntarily reported on the type or origin of the marketed biofuels (Dutch Emissions Authority, 2011). A notable element in these reports was that the biopetrol mainly consists of bioethanol. This bioethanol is mainly produced using maize from the United States.

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

	Deliviries of biofuels			Deleveries of all petrol and diesel	Realised share of biofuels (physically)	Obligatory minimum share of biofuels (administratively)	Gross final consumption	Avoided use of fossil primary energy
	mln litre	*mln kg*	*TJ*	*PJ*	*% on energy basis*		*TJ*	
Biopetrol								
2003	–	–	–	184	–	–	–	–
2004	–	–	–	183	–	–	–	–
2005	–	–	–	180	–	–	–	–
2006	38	28	798	184	0	–	798	798
2007	176	132	3,687	184	2	2	3,687	3,687
2008	218	163	4,524	183	2	2	4,524	4,524
2009	284	213	5,771	184	3	3	5,771	5,771
2010	278	208	5,614	184	3	4	5,614	5,614
Biodiesel								
2003	4	4	134	254	0	–	134	134
2004	4	4	134	263	0	–	134	134
2005	3	3	101	267	0	–	101	101
2006	29	25	968	279	0	–	968	968
2007	286	253	9,344	285	3	2	9,344	9,344
2008	231	203	7,524	288	3	2	7,524	7,524
2009	301	266	9,835	273	4	3	9,835	9,835
2010	121	107	3,963	275	1	4	3,963	3,963
Total								
2003	4	4	134	438	0	–	134	134
2004	4	4	134	446	0	–	134	134
2005	3	3	101	447	0	–	101	101
2006	67	54	1,766	463	0	–	1,766	1,766
2007	463	384	13,031	469	3	2	13,031	13,031
2008	449	367	12,048	471	3	3	12,048	12,048
2009	586	478	15,606	456	3	4	15,606	15,606
2010	399	315	9,577	459	2	4	9,577	9,577

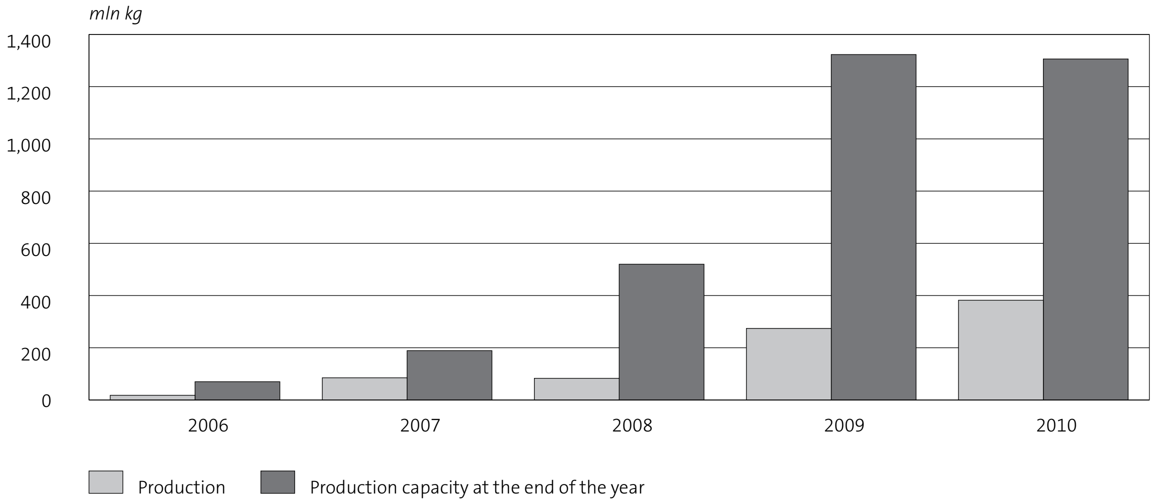
Source: Statistics Netherlands.

9.11.2 Biofules for road transport, balance

	Biopetrol			Biodiesel			Total		
	2008	2009	2010	2008	2009	2010	2008	2009	2010
	mln kg								
Pure biofuels									
Production	7	0	x	83	274	382	90	274	x
Imports minus exports	180	214	x	319	57	–337	499	271	x
Withdrawal from stocks	4	–13	7	–115	–3	64	–111	–16	72
Blending into petrol and diesel	190	201	171	287	328	109	478	529	280
Deliveries to the national end-user market	–	–	–	0	0	.	0	0	.
Blended biofuels									
Production from blending	190	201	171	287	328	109	478	529	280
Imports minus exports	–27	12	37	–84	–62	–2	–111	–50	36
Withdrawal from stocks	–	–	–	–	–	–	–	–	–
Deliveries to the national end-user market	163	213	208	203	266	107	367	478	315
Total									
Deliveries to the national end-user market	163	213	208	203	266	107	367	478	315

Source: Statistics Netherlands.

9.11.3 Production biodiesel



Source: Statistics Netherlands.

Other important raw materials for bioethanol are cereals from France and sugar beet from Brazil. The supplied biodiesel is mainly produced from used cooking oils from the Netherlands and Germany.

Dutch production of biodiesel in 2010 amounted to nearly 400 million kg, 100 million kg more than in 2009, and much more than national consumption. A large part of produced biodiesel is exported. In just a few years the Netherlands has changed from a net importer of biodiesel to a net exporter.

The capacity of biodiesel factories remained constant at 1,300 million kg, which is thus still significantly higher than total production of biodiesel. Other European countries, too, use only part of their biodiesel production capacity (European Biodiesel Board, 2009).

There are two reasons for this overcapacity. First, various national governments in Europe have cut back their subsidy schemes for biofuel production. For example, in the Netherlands, the blending obligation was adjusted from 5.75 to 4 percent in 2010, and in Germany the excise duty discount for biodiesel was reduced. Secondly, there is the competition from biodiesel factories outside Europe. Biodiesel production in the United States is subsidised, which led to the European biodiesel industry to lobby successfully for an import duty on biodiesel from the United States. As a result, imports from the US have collapsed since April 2009.

Method

The standard values from the European Renewable Energy Directive were used for the energy content.

Data collection for biofuel statistics is integrated in that for the petroleum statistics of Statistics Netherlands. All important players on the oil market (refineries, petrochemical industry, traders and storage companies) complete a form each month with a complete balance sheet for each oil product. Bio-ETBE, bio-MTBE, biopetrol and biodiesel are dealt with separately. The response to this survey was 100 percent in 2009 for companies relevant for biofuel data. Many companies, however, have trouble answering the question on the supply and delivery of blended biofuels.

In order to reduce the administrative burden, Statistics Netherlands lifted the obligation for respondents to answer this question monthly. Instead, they receive an additional questionnaire to be completed annually. For companies that have problems providing annual data on the destination of biodiesel and biopetrol after blending, Statistics Netherlands and/or the companies assume that on average the biofuels have the same destination as conventional petrol and diesel.

Companies are obliged to report annually on the quantity of biofuels they supply to the market for the national blending obligation according to their administration. Statistics Netherlands uses physical delivery to the market. Administrative deliveries may differ from physical deliveries for a number of reasons. First of all, companies may supply more in one year and compensate for this in another year. Secondly, some sustainable biofuels are counted twice towards the blending obligation from reporting year 2009. Statistics Netherlands' figures do not include the double value data. Thirdly, the blending obligation up to and including 2010 assumes a biomass percentage of 47 percent for bio-ETBE on an energy basis, while Statistics Netherlands assumes a percentage of 37 percent based on the EU Renewable Energy Directive. As of 2011 the blending obligation is also in accordance with the EU Directive. Fourthly, the blending obligation data do not exclude all exports of biofuels blended into petrol or diesel, because this is difficult to check. Companies are also allowed to trade their national blending obligation among each other. The national data, however, are not affected by these trades.

Statistics Netherlands' oil statistics cover only physical flows. The stock of blended biofuels is reported by only a few companies because it is very difficult to derive data on blended biofuel from business records. Statistics Netherlands therefore assumes that the changes in the physical stock of blended biofuels is zero (9.10.2) and that the blended biofuels are either delivered immediately to the national consumer market or exported.

Oil companies provide an annual report to the government in the context of the blending obligation. Up to and including reporting year 2010, this report was submitted to the Ministry of Housing, Spatial Planning and the Environment (VROM) Inspectorate. These reports also contain information on some physical biofuel flows. This information was compared to Statistics Netherlands' oil statistics data and follow-up questions were sent to some of the companies. All available data were used to determine the figures used in this report. Based on the comparison of various sources, Statistics Netherlands estimates that the margin of error in the biofuel consumption figures is approximately 15 percent. This is mainly caused by the uncertain data on the destination of the biofuels after blending.

The observations of Statistics Netherlands do not include information on the double value of certain biofuels to meet the blending obligation. The combination of information taken from the blending obligation reports and Statistics Netherlands' data has allowed Statistics Netherlands to determine the quantity of double-value biofuels physically marketed per reporting year. These figures also include some uncertainty. This margin of error percentage is not higher than that for the total quantity of biofuel delivered to the market.

The figures on the production of biofuels have been derived from a survey by Statistics Netherlands. The response to this survey was 100 percent.

Unlike other sustainable energy technology, there are no available data on the avoided emissions of CO_2 for biofuels for road transport. The avoided emission of CO_2 has always been under discussion. The current consensus is that the calculation of avoided CO_2 emissions for biofuels should include the complete production process chain and not be limited to the effect of direct substitution. However, information on this complete chain is not currently available. The new Renewable Energy Monitoring Protocol (NL Agency, 2010) has therefore decided not to publish new figures on the avoided emission of CO_2 based on road transport biofuel consumption in new renewable energy statistics.

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