



Energy research Centre of the Netherlands

# **Socio-economic indicators of renewable energy in 2008**

**Update of data of turnover and employment of  
renewable energy companies in the Netherlands**

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## Acknowledgement/Preface

This scoping study focuses on socio-economics of renewable energy in the Netherlands, in particular the turnover and workforce of renewable energy companies. The authors wish to express gratitude for co-reading by Ingo Bunzeck, although the study's contents remain their responsibility. The scoping study has been mainly conducted in the framework of EurObserv'ER (ECN project number 7.7903) and partially under project number 5.0185.

## Abstract

This study focuses on socio-economics of renewable energy, particularly on the turnover generated and the employment created by renewable energy companies in the Netherlands. As data of renewable energy companies is still scarce and incomplete, the figures presented in this study are generally estimates that are fraught with some uncertainty. Still, the turnover of companies in this sector is tentatively estimated at €2.26 billion and the employment at approximately 7,000 people in 2008.

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## Summary

This study presents an overview of Dutch companies engaged in wind energy, photovoltaic energy (PV), solar thermal energy, biofuels, solid biomass, biogas and municipal solid waste, small hydro and related technologies, geothermal energy and geothermal heat pumps. This scoping study - although based on data that were available at the time of writing, but inevitably incomplete - has been conducted in the framework of a European project called EurObserv'ER, which collects data on deployment of renewable energy (RE) in EU countries. The focus of the present study is *socio-economic data* such as turnover and employment of RE companies particularly in the Netherlands. As data of turnover and employment are scarce and incomplete, the figures presented are generally estimates that are fraught with some uncertainty.

The total installed capacity of *wind energy* (onshore plus offshore) in the Netherlands stood at 2,121 MW<sub>e</sub> by the end of 2008, according to Statistics Netherlands (CBS). The primary energy equivalent of electricity generation was 15.32 PJ<sub>e</sub>. With regard to the turnover of wind energy companies in the Netherlands, this study presents an estimate of €400 million in 2008. The total number of employees of wind energy (component) companies in the Netherlands is estimated at 700.

The total installed capacity of *photovoltaic power* (PV) in the Netherlands stood at 57 MW<sub>e</sub> by the end of 2008. The primary energy equivalent of electricity generation was 0.14 PJ<sub>e</sub>. With regard to the turnover of PV companies in the Netherlands, CBS presents a figure of €413 million in 2008. The number of employees of PV (component) companies in the Netherlands is 566.

The total installed capacity of *solar thermal energy* in the Netherlands stood at 503 MW<sub>th</sub> by the end of 2008. The primary energy equivalent of solar thermal energy was 0.88 PJ. With regard to the turnover of solar thermal energy companies in the Netherlands, this study presents a figure of €22 million in 2008. The number of employees in the Netherlands is estimated at 590.

Approximately thirteen companies are active on *biofuel* production in the Netherlands. In 2008, the primary energy equivalent of biofuel production amounted to 14.03 PJ in 2008. With regard to the turnover of biofuel companies in the Netherlands, this study presents a figure of €150 million in 2008. The number of employees in the Netherlands is estimated at 250.

A number of companies are active on (conversion of) *solid biomass* in the Netherlands. In 2008, the primary energy equivalent of solid biomass stood at 44.51 PJ in 2008. With regard to the turnover of companies in the Netherlands, this study presents a figure of €62 million in 2008. The number of employees in the Netherlands is estimated at 240.

At least six companies focus on production of equipment for *biogas* plants in the Netherlands. In 2008, the primary energy equivalent of biogas was 9.30 PJ. With regard to the turnover of companies in the Netherlands, this study presents a figure of €62 million in 2008. The number of employees in the Netherlands is estimated at 240.

There are nine companies active in energy (electricity and/or heat) generation from *municipal solid waste* (MWS) in the Netherlands. In 2008, the primary energy equivalent of the biogenic fraction of MSW was 29.27 PJ in 2008. With regard to the turnover of companies in the Netherlands, this study presents a figure of €1,100 million in 2008. The number of employees in the Netherlands is estimated at 4,250.

There are about eight companies active in hydro power or related technologies in the Netherlands. In 2008, the total hydro capacity stood at 37 MW<sub>e</sub>, and the electricity generated was equivalent to 0.36 PJ<sub>e</sub>. The turnover of these companies is estimated at €1.5 million and the number of employees is estimated at 30 in 2008.

Finally, there are tens of companies engaged in (deep) geothermal energy, which is a relatively small but strongly growing renewable energy source in the Netherlands. Until this date, there is no official data of geothermal energy production, as geothermal heating projects started only very recently. With regard to the turnover of companies in the Netherlands, this study presents a figure of €50 million in 2008. The number of employees is tentatively estimated at 95.

For shallow geothermal energy - storage of heat and cooling based on shallow aquifers - and for geothermal heat pumps, it turned out to be impossible to collect (reliable) data in the framework of the present study.

All in all, renewable energy sources considered in the present study represent a total primary equivalent of 114.3 PJ in 2008. The total turnover of RE companies in the Netherlands is estimated at €2.26 billion in 2008 (in 2007, €1.9 billion). The total workforce of these companies in the Netherlands is estimated at 6,960 employees in 2008 (in 2007, 6,230). See also the table below.

*Table S.1 Key data turnover and employees of companies engaged in RE in the Netherlands*

Renewable energy sector	Turnover 2006 [€mln]	Employees 2006	Turnover 2007 [€mln]	Employees 2007	Primary energy [PJ] <sup>a</sup>	Turnover 2008 [€mln]	Employees 2008
Wind energy	225	325	300	500	15.322	400	700
Photovoltaics (CBS)	161	232	252	403	0.138	413	566
Solar thermal energy	N/A	N/A	19	514	0.879	22	590
Biofuels	N/A	N/A	134	224	14.032	150	250
Solid biomass	N/A	N/A	60	240	44.511	62	240
Biogas	N/A	N/A	60	240	9.297	62	240
Municipal solid waste	N/A	N/A	1,035	4,000	29.266	1,100	4,250
Small hydro & tidal	N/A	N/A	1.2	25	0.840	1.5	30
Geothermal energy	N/A	N/A	45	85	N/A	50	95
Geothermal heat pump	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	N/A	N/A	1,900	6,230	114.285	2,260	6,960

<sup>a</sup> The attribution of primary energy is based on the national renewable energy monitoring protocol applied by Statistics Netherlands (CBS), which refers to a substitution of fossil energy equivalents.

## 1. Introduction

The present study presents an overview of Dutch companies engaged in wind energy, photovoltaic energy (PV), solar thermal energy, biofuels, solid biomass, biogas and municipal solid waste, small hydro and related technologies, geothermal energy and geothermal heat pumps. The scoping study has been conducted in the framework of 'EurObserv'ER', an EU-wide database of renewable energy data. ECN Policy Studies contributes to this EU project.

The data conveyed refer to the year 2008 and cover:

- Number of companies engaged in each of the renewable energy technologies.
- Direct employment figures for each of the renewable energy technologies.
- Turnover of companies that are involved in renewable energy technology.
- Renewable energy produced or energy conserved (data from Statistics Netherlands, CBS).

The methodology applied was to convey data on turnover and employment of companies engaged in renewable energy in the Netherlands as far as publicly available data was accessible. Also, a few organisations and companies have been contacted for accurate information. Sometimes, data was readily available but in most cases more generic information had to be converted to the format used. For instance, some companies are engaged in several technologies, some of which are renewable or focused on the Dutch market. Therefore, a lot of data has the character of a first appraisal for renewable energy companies in the Netherlands.

There are nine renewable (sustainable) energy technologies that are covered as well as a Chapter with conclusions:

- Wind energy (Chapter 2).
- Photovoltaic power (Chapter 3).
- Solar thermal energy (Chapter 4).
- Biofuels (Chapter 5).
- Solid biomass (Chapter 6).
- Biogas (Chapter 7).
- Municipal Solid Waste (Chapter 8).
- Small hydro power, tidal power, and 'Blue Energy' (Chapter 9).
- Geothermal energy (Chapter 10).
- Conclusions, summarised in Chapter 11.



## 2. Wind energy

Wind turbine companies which manufacture turbines and components, and produce related services (R&D, engineering and design) constitute a growing industry with many representatives in the Netherlands. This chapter focuses on data of turnover and employment of these companies, as far as available. The companies are Suzlon Blade Technology (SBT), Blue H Technologies, Composite Technology Centre (CTC), Darwind, Emergya Wind Technology (EWT), Harakosan Europe, Home Energy, Lagerwey Wind, LM Glasfiber Holland, Mecal, Polymarin Composites, Rheden Steel, Siemens Netherlands, Vestas Benelux, and Wind Energy Solutions (WES).

### 2.1 Suzlon Blade Technology (SBT)

Suzlon Blade Technology (SBT) in Hengelo - formerly AE-Rotor Techniek, founded in 2001 (Internet Source 1) - is experienced in composites technology. Since a few years, it is part of the globally operating SBT, a 100% subsidiary of Suzlon Energy Ltd of India. SBT Baroda (India), with 300 fte constituting a considerable part of SBT's total workforce of about 3,500 fte, is the main centre of Suzlon's wind turbine blade manufacturing. Suzlon Energy Ltd, which recently acquired Repower, is the world's number four in wind turbine manufacturing. Its policy is based on forward and backward integration of the main components of wind turbines, among which wind turbine blades. SBT Hengelo's main activities are aerodynamic and structural design of wind turbine blades, selection of materials and processes, project management, and design of tooling on outlines. Suzlon also has a small representative office in Amsterdam. The workforce of Suzlon in the Netherlands was approximately 70 fte in 2008 (Schuring, 2009).

### 2.2 Blue H Technologies

The main activities of Blue H Technologies bv in Oosterhout are: a subsidiary responsible for its intellectual property (IP) and know-how; an engineering division responsible for R&D, logistics and outsourcing of the manufacturing of the hardware; and various project operating companies responsible for development of offshore wind farms, for commissioning local environmental impact and geological studies, and for applying the necessary approvals and authorisations. The workforce of Blue H is tentatively estimated at 10 people in 2008 (Internet Source 2).

### 2.3 Composite Technology Centre (CTC)

Composite Technology Centre (CTC) in Almelo is an engineering company established in 2001, with experience in composites and wind energy. In-house know-how and experience covers areas ranging from aerodynamic design, via structural design and material knowledge to production processes, such as Resin Infusion Molding (RIM). It believes in a strong cooperation and co-maker ship with its customers, to enforce the capacities of each other (Internet Source 3; Ter Laak, 2007). Its workforce is tentatively estimated at 15 employees in 2008 (in 2007, 12).

### 2.4 Darwind

Darwind in Utrecht, which was established in 2005, was acquired from Econcern (after its bankruptcy) by XEMC Windpower Co., Ltd, in Xiangtan, China, in 2009. It focuses on the development of large offshore wind turbines of approximately 5 MW. Its workforce stood reportedly at approximately 45 employees in 2008 (Internet Source 4; De Ingenieur, 2008).

## 2.5 Emergya Wind Technologies (EWT)

Emergya Wind Technologies bv (EWT) in Schoondijke is specialised in manufacturing and supply of direct drive (gearless) wind turbines of 750 kW and 900 kW. It started operations in February 2004, based on key assets including IPR of the company currently known as Lagerwey Wind. From 2005 to 2006, turnover increased from €7.3 mln to €81 mln, a very fast increase which may be explained by the availability of proven (Lagerwey) technology. Considering that EWT sought investment capital of €30 mln in July 2009, and that it aims to launch a 2 MW prototype wind turbine in China by mid-2010 (Internet Sources 5-6), the workforce of EWT in the Netherlands is estimated at 90 employees in 2008 (in 2007, 100).

## 2.6 Harakosan Europe

Harakosan Europe bv (Lelystad) is a Dutch manufacturer of multi-megawatt gearless wind turbines for electric power generation (Internet Source 7). The company was founded in 2005 on the basis of the Zephyros estate which was acquired by Harakosan Co. Ltd (Japan) to create Harakosan Europe bv. It has been its philosophy to dedicate a small wind engineering intensive staff to the constant evolution of the concept of direct drive permanent magnet wind turbines. Its main product is a 2 MW permanent magnet direct drive wind turbine, designed for near-shore and offshore applications. Its workforce is estimated at 20 employees in 2008 (in 2007, 16).

## 2.7 Home Energy and other manufacturers of small urban wind turbines

Home Energy bv, Schoondijke, *inter alia* develops and manufactures small urban wind turbines (product name Energy Ball®) with rated capacities of 500 W and 2,250 W (Internet Source 8). The number of small urban wind turbines in the Netherlands is approximately 300. Also, the work force of Home Energy and similar companies in the Netherlands is approximately 30 fte, and the aggregate turnover approximately €2.8 mln in 2008, according to (NWEA, 2009).

## 2.8 Lagerwey Wind

Lagerwey Wind, established in Barneveld in 2006, focuses on development of innovative wind turbine concepts. It aims to provide designs that can be adapted to the special needs of customers. Lagerwey erected a new direct drive 2 MW wind turbine and initiated design of a 2.5 MW direct drive wind turbine in 2009 (Internet Source 9). Its workforce is estimated at 7 employees.

## 2.9 LM Glasfiber Holland

LM Glasfiber (Denmark) is the world's leading supplier of wind turbine blades. LM Glasfiber (Holland) bv in Heerhugowaard is one of its centres for design and manufacturing of wind turbine blades. It also has a Global Business Office in Amsterdam (Internet Source 10). In 2008, LM Glasfiber's global workforce was 7,217 employees and revenue was €885 mln (LM Glasfiber, 2009). The workforce in the Netherlands is tentatively estimated at 25 employees in 2008.

## 2.10 Mecal

Mecal bv, founded in 1989 and with offices in Enschede, Veldhoven, and Groningen, as well as the USA and Japan, is experienced in applied engineering (e.g. applied mechanics) and product development. Its focus is on wind energy and semiconductor equipment manufacturing (Internet Source 11). It manufactures hybrid wind turbine towers, so-called Advanced Tower Systems (ATS). Its relevant workforce in the Netherlands is estimated at 50 employees (worldwide 100).

## 2.11 Polymarin Composites

Polymarin Composites, founded in 2004, and with a production plant in the Eemshaven, has developed and produced fibre-reinforced composite structures. In 2008, the workforce stood at approximately 55 employees, but in July 2009 Polymarin became bankrupt (Internet Source 12).

## 2.12 Rheden Steel

Rheden Steel bv in Rheden is a subsidiary of Smulders Group bv in Helmond, with over 1,000 employees in Europe among which Belgium, manufacturing complicated steel constructions (Internet Source 13). The relevant workforce in the Netherlands is estimated at 50 employees.

## 2.13 Siemens Netherlands

Siemens (Germany) is a global manufacturer of power plants, and also of wind turbines. It has core competence centres for wind turbine R&D in Copenhagen (Denmark), Aachen (Germany), Delft (Netherlands), Keele (United Kingdom), and Boulder, Colorado (USA). Siemens continues to invest in wind energy R&D to reduce investment risks and improve project economics (Internet Source 14). Its relevant workforce in the Netherlands is estimated at 75 employees.

## 2.14 Vestas Benelux

Vestas Wind Systems A/S, Randers (Denmark), the world market leader in wind energy, has a subsidiary in Rheden (Vestas Benelux). Activities in the Benelux focus *inter alia* on servicing of wind turbines. Vestas Benelux has approximately 200 employees (Internet Source 15). The workforce of Vestas Benelux's that is active in the Netherlands is estimated at 150 employees.

## 2.15 Wind Energy Solutions (WES)

Wind Energy Solutions bv (WES), established in 2003, is manufacturer of two-bladed, passive pitch, wind turbines of 80 kW and 250 kW, and also of a three-bladed 2.5 kW Tulipo (WES5) wind turbine (Internet Source 16). Its workforce is estimated at 8 people in 2008 (in 2006, 6).

## 2.16 Summary

Tables 2.1 summarises the cumulative wind capacity (2,121 MW<sub>e</sub>), and the estimated turnover (approximately €400 mln) and employment (~700 people) of wind turbine companies in 2008. According to the European Wind Energy Association (EWEA), the number of employees that are involved in wind energy in Europe is 108,600, of which 2,000 in the Netherlands (EWEA, 2009). The number of 2,000 employees in the Netherlands is, however, not substantiated by EWEA. Therefore, the number of approximately 700 (Table 2.1) is retained in the present study.

Table 2.1 *Key data turnover and employees of wind companies in the Netherlands*

Company	Turnover	Employees	Cumulative wind	Turnover	Employees
	2006 [€mln]	2006	capacity 2008 [MW <sub>e</sub> ] <sup>a</sup>	2008 [€mln]	2008
Suzlon Blade Technology (SBT)	N/A	~30		N/A	70
Blue H Technologies	- <sup>b</sup>	- <sup>b</sup>		N/A	~10
Composite Technology Centre (CTC)	N/A	12		N/A	~15
DarwinD	N/A	N/A		N/A	~45
Emergya Wind Technologies (EWT)	81	100		~70	~90
Harakosan Europe BV	N/A	16		N/A	~20
HomeEnergy & other urban WT Co's	N/A	N/A		2.8	~30
Lagerwey Wind	N/A	4		N/A	~7
LM Glasfiber (Holland)	N/A	~20		N/A	~25
Mecal	N/A	~25		N/A	~50
Polymarin Composites	1.5	15		N/A	~55
Rheden Steel	N/A	N/A		N/A	~50
Siemens Netherlands	- <sup>b</sup>	- <sup>b</sup>		N/A	~75
Vestas Benelux	- <sup>b</sup>	- <sup>b</sup>		N/A	~150
Wind Energy Solutions (WES)	1.1	6		~ 1.5	~8
Total wind turbine (component) Co's	~225 <sup>c</sup>	~325 <sup>c</sup>	2,121 <sup>a</sup>	~400 <sup>c</sup>	~700 <sup>c</sup>

a The cumulative wind energy capacity in the Netherlands amounts to 2,121 MW<sub>e</sub> at the end of 2008 (CBS, 2009).

b Data for Blue H Technologies, Siemens Netherlands, and Vestas Benelux were not analysed prior to 2008.

c Some wind turbine companies also produce other components or services, which have been excluded.

Sources: Schuring, 2009; Ter Laak, 2007; De Ingenieur, 2008; NWEA, 2009; LM Glasfiber, 2009; CBS, 2009; Internet Sources 1-16.

### 3. Photovoltaic power

The photovoltaic (PV) industry, producing solar modules (based on solar cells), solar panels and components is a nascent industry with several companies in the Netherlands. This Chapter focuses on data of turnover and employment, as far as available. Data is presented of the PV companies Advanced Surface Technology (AST), Mastervolt, Helianthos (NUON), OTB Solar, Scheuten Solar, Siemens Solar Projects, Solland Solar Energy, and Ubbink Solar Modules.

#### 3.1 Advanced Surface Technology (AST)

Advanced Surface Technology (AST) bv in Bleiswijk is a start-up of the Technical University Delft - see, e.g., (Schoonman, 2005). AST aims to develop and commercialise innovative solar cells and modules (Internet Source 17). Data of its turnover and/or workforce is not available.

#### 3.2 Mastervolt

Mastervolt was founded in 1991, and offers AC and DC solutions for customers in the global marine, mobile and renewable energy markets, among which inverters for PV. In 2005, Mastervolt had 115 employees in the Netherlands and abroad, and its turnover was €35 mln. (Internet Source 18) makes mention of 30 employees in the Netherlands out of 100 worldwide in 2008.

#### 3.3 NUON Helianthos

NUON Helianthos' mission is: 'Helianthos wants to provide customers with the means to generate clean electricity through innovative PV products at a price competitive with that of conventional electricity'. In 2000, Akzo Nobel entered into cooperation with Shell Solar to bring Helianthos products to the market. In 2004, this cooperation was terminated. In 2006, Akzo Nobel agreed to sell Helianthos to NUON. Various cooperative projects co-financed by SenterNovem to bring the technology from lab to pilot plant level have been carried out over the past years (Schlatmann, 2005). In 2007, Helianthos (Arnhem) had a staff of about 35 employees (Jongerden, 2007). Helanthos' current workforce is tentatively estimated at 35 employees.

#### 3.4 OTB Solar

OTB Solar in Eindhoven is a 100% subsidiary of OTB Group, a leading company in the design, engineering, development, and manufacturing of tailor-made inline production equipment. OBT Solar, with regional offices in the USA, Singapore, and India, defines its core activity as the development and marketing of state-of-the-art production machinery for solar cell manufacturing (Internet Source 19). From 2005 to 2006, its turnover increased from €16 mln to €30 mln (ED, 2006). Its workforce is estimated at 20 employees in 2008 (in 2006, 55).

#### 3.5 Scheuten Solar

Scheuten Solar bv is an innovative and leading solar company that develops, produces, designs and sells PV solar modules and total PV solar solutions. The PV production facility for Multi-sol® is located in Gelsenkirchen (Germany), and the production facility for Optisol® in Venlo. Scheuten employs a staff of nearly 1,600 and achieved a turnover of €467 mln in 2008 (Internet Source 20). In the present study, 11% of its total number of employees and 27% of its turnover in 2008, i.e. 175 staff and €128 mln turnover respectively, is attributed to the Netherlands.

### 3.6 Siemens Solar Projects

The subsidiary of Siemens in the Hague includes a Center of Competence named Siemens Solar Projects. It supplies grid-connected and autonomous energy supply with photovoltaic power. Siemens has its own inverter techniques (Internet Source 21). Its workforce is estimated at 15 employees in 2008.

### 3.7 Solland Solar Energy

Solland Solar Energy Holding bv is a solar cell producer, with the majority of its shares owned by the Dutch company Delta. Solland Solar, headquartered in Heerlen/Aachen on the border between Germany and the Netherlands, has a production capacity of 170 MWp/a, and supplies to the Business to Business market only, i.e. to solar module producers and OEMs (Original Equipment Manufacturers) integrating its cells into OEM products. It aims to play a significant role in the economic use of solar energy by substantially increasing the production of solar cells and by establishing strategic partnerships with other companies in order to reduce the overall cost of solar energy (Internet Source 22). Its workforce is estimated 70 employees in 2008.

### 3.8 Ubbink Solar Modules

The manufacturing plant for PV modules of Ubbink Solar Modules bv in Doesburg was a joint venture of Centrosolar AG (70%, Munich, Germany) and Econcern bv (30%, Utrecht). The plant which opened in 2006 had an output of 6 MWp/a in 2007. It sourced its cells from Solland Solar Energy. Ubbink Solar was reported to have 36 employees in 2007, and its turnover may have been €5 mln in 2008. Ubbink Solar - subsidiary of Econcern - became bankrupt in 2009.

### 3.9 Summary

Tables 3.1 summarises data of PV capacity (57 MW<sub>e</sub>) in the Netherlands, and data of the aggregate turnover (€413 mln) and workforce (566 employees) of companies in 2008 (CBS, 2009).

Table 3.1 *Key data turnover and employees of PV component companies in the Netherlands*

Company	Turnover 2006 [€mln]	Employees 2006	Cumulative PV capacity 2008 [MW <sub>e</sub> ] <sup>a</sup>	Turnover 2008 [€mln]	Employees 2008
Advanced Surface Technology					
Mastervolt	~35	~30		~35	~30
NUON Helianthos	~15	~20		~35	~35
OTB Solar	~30	~55		~40	~60
Scheuten Solar <sup>b</sup>	~45	~70		~128	~175
Siemens Solar Projects the Hague	~12	~15		~15	~15
Solland Solar Energy	~24	~42		~50	~70
Ubbink Solar Modules				~5	~36
Balance				~105	~145
<b>Total (PV component companies)</b>	<b>161</b>	<b>232</b>	<b>57<sup>a</sup></b>	<b>413<sup>c</sup></b>	<b>566</b>

a The cumulative capacity of PV in the Netherlands amounts to 57 MW<sub>e</sub> by the end of 2008 (CBS, 2009).

b Data refer to the estimated turnover and employees of Scheuten Solar in the Netherlands.

c The total turnover of PV companies was €413 million in 2008 (€161 million in 2006), according to CBS.

Sources: Schoonman, 2005; Schlatman, 2005; Jongerden, 2007; ED, 2006; CBS, 2009; Internet Sources 17-22.

## 4. Solar thermal energy

### 4.1 Installed capacity 2008

The solar thermal energy industry, producing, distributing, and installing solar collectors for hot water and heating (if applicable) is a nascent business in the Netherlands, which is why data is relatively scarce. According to (CBS, 2009), the cumulative collector area in the Netherlands amounted to 704,000 m<sup>2</sup> in 2008 (in 2007, 673,000 m<sup>2</sup>), which is equivalent to 503 MW<sub>th</sub> (in 2007, 481 MW<sub>th</sub>), based on the ‘rule-of-thumb’ of 1.4 m<sup>2</sup>/kW<sub>th</sub> from (Holland Solar, 2007).

### 4.2 Turnover 2008

Data of turnover and employment of solar thermal energy companies is really scarce. Therefore, a rule-of-thumb was derived from (Holland Solar, 2009), giving a ratio of a turnover of €1 million per year for each MW<sub>th</sub> of solar thermal installed per year. Based on the capacity calculated from the collector area in m<sup>2</sup>, the capacity added in 2008, 22 MW<sub>th</sub>, is equivalent to a turnover of €22 mln, whereas the capacity added in 2007, 19 MW<sub>th</sub>, is equivalent to €19 mln turnover.

### 4.3 Employment 2008

Holland Solar (2009) also provides a yardstick for the employment as a function of the annual installed solar thermal capacity. In one scenario, 8,000 employees are equivalent to a capacity of 300 MW<sub>th</sub> per year. Based on this ratio, the capacity added in 2008, 22 MW<sub>th</sub>, is equivalent to 590 employees, and the capacity added in 2007 (19 MW<sub>th</sub>) is equivalent to 514 employees.

### 4.4 Summary

Table 4.1 summarises the cumulative capacity (503 MW<sub>th</sub>), and estimated turnover (approximately €22 mln) and workforce (~590 employees) of solar thermal energy companies in 2008.

Table 4.1 *Key data turnover and employees of solar thermal companies in the Netherlands*

Company	Turnover 2007	Employees 2007	Cumulative solar thermal capacity 2008	Turnover 2008	Employees 2008
	[€mln]		[MW <sub>th</sub> ] <sup>a</sup>	[€mln]	
Total solar thermal energy sector	~19	~514	~503	~22	~590

a Calculated from the cumulative collector area in m<sup>2</sup> from (CBS, 2009), and a rule-of-thumb of 1.4 m<sup>2</sup>/kW<sub>th</sub>.  
Sources: Holland Solar, 2007; Holland Solar, 2009; CBS, 2009.

## 5. Biofuels

In the Netherlands, several biofuel plants have been commissioned in the last few years, some of which producing bioethanol and most of them producing biodiesel. Also, production of biomethanol has been initiated. Furthermore, a number of biofuel production plants are being commissioned, under construction or planned. These biofuel plants are addressed below in alphabetical order.

### 5.1 Abengoa

Abengoa (Spain) is commissioning a large bioethanol plant in Rotterdam. The bioethanol plant has a capacity of 480 million litres of bioethanol per year, based on 1.2 Mt of cereal per year as feedstock. The plant will have 75 employees in 2009 (Internet Source 23).

### 5.2 Biodiesel Amsterdam

In 2009, BioDiesel Amsterdam has commissioned the Austrian company BDI - BioDiesel International AG - to construct of a multi-feedstock biodiesel plant in Amsterdam, with a contract value of €31 million. The plant will become part of the future-oriented energy park in the port of Amsterdam in which the company BioDiesel Amsterdam, a part of Greenmills, will recycle vegetable and organic waste materials. The plant will have a capacity of 100,000 t (113 million litres) of biodiesel, produced from cooking oil and animal fats. In addition to the production of biodiesel, electricity and heat will also be extracted from a biogas plant (Internet Source 24).

### 5.3 Biodiesel Kampen

Biodiesel Kampen, established in 2006, produces biodiesel (FAME, Fatty Acid Methyl Ester) from used vegetable oils. The capacity of the plant is 50 million litres of biodiesel per year (Internet Source 25).

### 5.4 BioDsl

Since September 2008, BioDsl in Breda produces 11.5 million litres of biodiesel per year from used vegetable oils. The investment is estimated at €2 million (Internet Sources 26-27).

### 5.5 BioMCN

In July 2009, BioMCN started production of biomethanol in its plant in Delfzijl. It consists of a conversion unit in which glycerol - by-product of biodiesel (FAME) plants - is converted into syngas. Then, the syngas is used in a large, two-train, methanol plant at Delfzijl to produce biomethanol. The production capacity is 200,000 t biomethanol per year (Internet Source 28).

### 5.6 Biopetrol Industries

By the end of 2009, Biopetrol Industries will commission a biodiesel plant in Rotterdam, with a capacity of 400,000 t of biodiesel and 60,000 t of glycerine per year. The plant will primarily use rapeseed oil as a feedstock (Internet Source 29).



## 5.7 Biovalue

In 2007, Biovalue started production of biodiesel in the Eemshaven. The plant with a capacity of 80,000 t of biodiesel per year makes use of rapeseed oil as a feedstock. The number of employees is 28 (Internet Source 30).

## 5.8 'B2G'

In 2009, Neste Oil started construction on a biodiesel plant, based on its proprietary NExBTL technology, in Rotterdam, with a capacity of 800,000 t per year. The investment cost of the plant (called 'B2G') is estimated at €670 million. It will be commissioned in 2011, and create over 100 jobs. The feedstock is rapeseed oil, waste animal fat and palm oil (Internet Source 31).

## 5.9 CleanerG

In April 2008, a biodiesel plant of CleanerG bv started production in Zwijndrecht. Its production capacity is 200,000 t of biodiesel per year. The plant uses rapeseed oil, soybean oil, and palm oil as feedstock (Internet Source 32).

## 5.10 Ecoson, VION Food

In December 2007, Ecoson started production of refined fats (43,750 t per year) and biodiesel (4,500 t per year) in its plant at Son, the Netherlands. The investment cost was €10 million. The plant is based on processed animal fats and other 'waste' fats (Rietveld, 2007).

## 5.11 J&S Bio Energy

J&S Bio Energy, Utrecht, is due to construct a plant with a capacity of 200,000 t biodiesel per year in Amsterdam. The investment cost would be €42.5 million, and its workforce would be 30 employees (Internet Source 33).

## 5.12 Nedalco

Royal Nedalco (Bergen op Zoom), has been planning to build a bioethanol plant with a capacity of 200 million litre bioethanol per year in Sas van Gent. The investment cost was estimated at €150 million. The plant, however, has not been realised (Nedalco, 2007).

## 5.13 N2 Energie

In 2010, N2 Energie is due to commission a so-called 2<sup>nd</sup> generation bioethanol production plant in Hardenberg. The plant has a production capacity of 33.5 million litre of bioethanol per year. The investment cost is put at €50 million (Internet Sources 34-35).

## 5.14 Rosendaal Energy

In 2008, Rosendaal Energy started producing biodiesel from rapeseed oil, soy oil, and palm oil in a production plant at Sluiskil, with a capacity of 250,000 t biodiesel per year. The investment cost of the plant was €40 million. In 2009, the plant became bankrupt (Internet Sources 36-37).

## 5.15 Unica Ecopower

Unica Ecopower bv is a company that builds and operates bio-energy plants, e.g. producing bio-fuels, biogas and electricity (Internet Source 38).

## 5.16 Summary

Tables 5.1 summarises the primary energy from biofuels in the Netherlands, as well as the estimated turnover (~€150 mln) and employment (~250 people) of biofuel companies in 2008.

Table 5.1 *Key data turnover and employees of biofuel (component) companies in the Netherlands*

Company	City	Biofuel/ product	Turnover 2007 [€mln] <sup>a</sup>	Employees 2007 <sup>a</sup>	Primary energy produced 2008 [PJ] <sup>b</sup>	Turnover 2008 [€mln] <sup>a</sup>	Employees 2008
Abengoa	Rotterdam	Bioethanol					~5
N2 Energie	Hardenberg	Bioethanol					~10
Nedalco	Sas van Gent	Bioethanol					~10
BioMCN	Delfzijl	Biomethanol					~30
Sunoil Biodiesel bv	Emmen	Biodiesel					~12
Biodiesel Kampen bv	Kampen	Biodiesel					~12
Biovalue bv	Eemshaven	Biodiesel					~12
Ecoson, VION Food	Son	Biodiesel					~10
J&S Bio Energy	Amsterdam	Biodiesel					~20
Rosendaal Energy bv	Sluiskil	Biodiesel					~25
BioDsl bv	Breda	Biodiesel					~4
CleanerG bv	Zwijndrecht	Biodiesel					~20
Biopetrol Industries	Rotterdam	Biodiesel					~40
Greenmills	Amsterdam	Biodiesel					~5
'B2G'	Rotterdam	Biodiesel					~10
Unica Ecopower	Hoevelaken	Design & engineering					~25
<b>Total</b>			~134	~224	14.0	~150	~250

a Data on turnover in 2008, and employment and turnover in 2007 is mostly not available on company level.

b The equivalent primary energy production of biofuels for transport amounts to 14 PJ in 2008 (CBS, 2009).

Sources: CBS, 2009; Nedalco, 2007; Rietveld, 2007; Internet Sources 23-38.

## 6. Solid biomass

The industry producing biomass-based technologies is an industry with several representatives in the Netherlands. Data of turnover and employees is presented of Agrotechnology and Food Innovations, A&F, BTG, W.K. Crone, Dordtech Engineering, HoSt, KARA Energy Systems, and Polow Energy Systems (SenterNovem, 2006).

### 6.1 Agrotechnology and Food innovations (A&F)

Agrotechnology and Food innovations (A&F) constitute a department of WUR, Wageningen:

- Sustainable biomass production.
- Biomass logistics and pre-treatment.
- Bioconversion and biofuels.
- Biomass-to-energy and products chain aspects.

### 6.2 Biomass Technology Group (BTG)

Biomass Technology Group bv in Enschede is an independent, private firm which for the past 25 years has specialised in the process of conversion of biomass into biofuels and bio-energy. Production and use of bio-energy shall take place in an environmentally, socially, and economically sustainable manner. Fields of expertise include (Internet Source 39):

- Bioenergy conversion processes.
- Biomass based decentralised rural electrification.
- Production of solid and liquid biofuels.
- Biomass and biofuels logistics and pre-treatment.

### 6.3 W.K. Crone

W.K. Crone, in Nieuwerkerk a/d IJssel (Zuid Holland), supplies boilers and equipment for industrial, utility, and agricultural applications, in particular wood/coal combustors - Bubbling Fluidized Bed Boilers - and wood pellets stoves.

### 6.4 Dordtech Engineering

Dordtech Engineering, Dordrecht, is a developer and producer of CHP and generator sets for alternative fuels, such as biogas, bio oil, and hydrocarbon vapours.

### 6.5 HoSt

HoSt in Hengelo is an engineering and contracting company, specialised in energy technology and processes. It builds wood-fired combined heat and power installations, based on the HoSt gasification and gas cleaning technology.

### 6.6 KARA Energy Systems

KARA Energy Systems bv is a developer, manufacturer and supplier of wood fired boiler systems for converting solid biomass fuels into energy up to 15 MW thermal input.

## 6.7 Polow Energy Systems

Polow Energy Systems, in the Hague, is specialised in process technology, and particularly in energy recovery (Torbed® technology) and heat processes in industry and agriculture.

## 6.8 Summary

The number of employees of the above mentioned seven companies engaged in solid biomass (R&D, engineering and design, manufacturing) is estimated at 240 people in 2008, based on an average of about 35 employees per company. The turnover is tentatively estimated at €62 mln per year. Table 6.1 summarises the primary energy equivalent of solid biomass, and estimates of the turnover (~€62 mln) and workforce (~240 employees) of a number of companies in 2008.

Table 6.1 *Key data turnover and employees 'solid biomass companies' in the Netherlands*

Company	Turnover 2007 [€mln] <sup>a</sup>	Employees 2007 <sup>a</sup>	Primary energy produced 2008 [PJ] <sup>b</sup>	Turnover 2008 [€mln] <sup>a</sup>	Employees 2008 <sup>a</sup>
Agrotechnology and Food Innovations					
Biomass Technology Group (BTG)					
W.K. Crone					
Dordtech Engineering					
HoSt					
KARA Energy Systems					
Polow Energy Systems					
<b>Total</b>	<b>~60</b>	<b>~240</b>	<b>44.5</b>	<b>~62</b>	<b>~240</b>

a Data on turnover and employment in 2007 and 2008 is generally not available on company level.

b The primary energy equivalent of solid biomass in the Netherlands was 44.5 PJ in 2008 (CBS, 2009).

Sources: CBS, 2009; SenterNovem, 2006; Internet Source 39.

## 7. Biogas

The industry producing biogas plants and related technology is an industry with several representatives in the Netherlands. Data of turnover and employees is presented of BiogaS International Project, Brouwers BioEnergy, Certified-Energy, OGIN Biogasinstallaties Nederland, Orgaworld, and Thecogas PlanET Biogastechniek (SenterNovem, 2006).

### 7.1 BiogaS International Project

BiogaS International Project bv, in Klazienaveen (Drenthe), is an installation group with 16 companies in the Netherlands, a turnover of around €200 mln, and some 1,600 employees. BiogaS International is a company that supplies tailor-made biogas plants, including maintenance contracts, project financing or leasing, guarantees, etc.

### 7.2 Brouwers BioEnergy

Brouwers BioEnergy, in Leeuwarden (Friesland), is supplier of turnkey biogas plants at farm-scale. Brouwers cooperates with a number of partners with experience in the agricultural sector. The biogas installations are modular, which enables contracting from different suppliers of components.

### 7.3 Certified-Energy

Certified-Energy, in Wanroij (Limburg), is an engineering and construction company specialised in renewable energy technology (in particular biogas installations), including preparation of building permits, consultancy, maintenance, and R&D. Certified-Energy is a licence partner of Schmack Biogas AG, Germany.

### 7.4 OGIN Biogasinstallaties Nederland

OGIN Biogasinstallaties Nederland, in Dronten (Flevoland), supplies biogas plants for the agricultural sector, as a representative of Linde-KCA Dresden (Germany) for the Benelux countries. This company supplies farm-scale biogas reactors for the digestion of manure and co-substrate.

### 7.5 Orgaworld

Orgaworld, in Uden (Noord Brabant), is an innovative and fast growing company which focuses on organic waste treatment, and particularly on the processing of organic waste to produce final products such as energy, fuels, and agricultural products. The technologies used are anaerobic digestion (the Biocel concept) combined with CHP producing electricity and compost as residual product.

### 7.6 Thecogas PlanET Biogastechniek

Thecogas PlanET Biogastechniek, in Lochem (Gelderland), is a Dutch/German company with about 40 employees, specialised in the construction of biogas plants. The German headquarter is in Vreden.

## 7.7 Summary

The workforce of the above mentioned companies engaged in biogas plants and equipment (R&D, engineering and design, manufacturing) is tentatively estimated at 240 people in 2008. Table 7.1 summarises the primary energy of biogas in the Netherlands, and the estimated turnover (~€62 million) and workforce (240 employees) of companies engaged in biogas in 2008.

Table 7.1 *Key data turnover and employees of biogas (component) companies in the Netherlands*

	Turnover 2007 [€mln]	Employees 2007	Primary energy produced 2008 [PJ] <sup>a</sup>	Turnover 2008 [€mln]	Employees 2008
BiogaS International Project					
Brouwers BioEnergy					
Certified-Energy					
OGIN Biogasinstallaties Nederland					
Orgaworld		~40			~40
Thecogas PlanET Biogastechniek					
<b>Total</b>	<b>~60</b>	<b>~240</b>	<b>9.3</b>	<b>~62</b>	<b>~240</b>

a Primary energy production of biogas in the Netherlands amounted to 9.3 PJ in 2008 (CBS, 2009).

Sources: CBS, 2009; SenterNovem, 2006.

## 8. Municipal solid waste

There are nine companies active in power generation or combined heat and power (CHP) based on municipal solid waste (MSW) in the Netherlands, viz. ARN (Nijmegen), Afval Energie Bedrijf (Amsterdam), E.On Benelux (Delfzijl), Essent Milieu (Moerdijk and Wijster), HVC Groep, OMRIN (Harlingen), SITA ReEnergy, Twence, and Van Gansewinkel Groep. Data of these companies is presented below.

### 8.1 ARN (Nijmegen)

ARN (Nijmegen) operates a combustion plant for MSW in Nijmegen with a capacity 23 MW<sub>e</sub>, based on 270 kt/a of MWS (Internet Source 40). Its turnover (related to MSW to power) is estimated at €26 million, and its (relevant) workforce at 105 employees.

### 8.2 Afval Energie Bedrijf Amsterdam

Afval Energie Bedrijf Amsterdam operates the largest complex of combustion of MSW for power (and heat) in the Netherlands (Internet Source 41). The total capacity of its MSW plants is some 80 MW<sub>e</sub> (net), based on 1,360 kt/a of MSW. Its turnover (related to MSW to power and heat) is estimated at €92 million, and its (relevant) workforce at 380 employees.

### 8.3 E.On Benelux

E.On Benelux operates a new MSW plant called BKB at Delfzijl (Internet Source 42), with a capacity is 28 MW<sub>e</sub> (net), based on 275 kt/a of MSW. Its turnover (related to MSW to power) is estimated at €28 million, and its (relevant) workforce at 110 employees.

### 8.4 Essent Milieu (*inter alia* AZN Moerdijk, Essent Milieu GAVI Wijster)

Essent Milieu (subsidiary of RWE), operates several MSW plants, among which in Wijster (GAVI) and Moerdijk (AZN Moerdijk). The combined generating capacity of these MSW to power plants - AZN Moerdijk also supplies heat - is estimated at 153 MW<sub>e</sub> (net), based on 1,630 kt/a of MSW (Internet Source 43). Its turnover (related to MSW to power and heat) is estimated at €300 million, and its (relevant) workforce at 1,200 employees.

### 8.5 HVC Groep

HVC Groep operates MSW plants at Alkmaar and Dordrecht, of which that in Dordrecht does not produce electricity - solely incineration (Internet Source 44). The capacity of the MSW plants (in particular that in Alkmaar) is 56 MW<sub>e</sub> (net), and the total capacity is 915 kt/a of MSW. Its turnover (related to MSW to power) is estimated at €134 million, and its (relevant) workforce at 535 employees (see footnote b, Table 8.1).

### 8.6 OMRIN (Harlingen)

OMRIN operates an MSW plant at Harlingen (Internet Source 45), with a capacity is 22 MW<sub>e</sub> (net), based on 220 kt/a of MSW. Its turnover (related to MSW to power) is estimated at €26 million, and its (relevant) workforce at 105 employees.

## 8.7 SITA ReEnergy

SITA ReEnergy (Internet Source 46) operates an MWS plant in Rosendaal which does not (yet) produce electricity or heat. Therefore, it is not considered in this overview of companies active in power generation or combined heat and power (CHP) based on municipal solid waste.

## 8.8 Twence

Twence operates two MSW plants in Twente with a combined capacity of 52 MW<sub>e</sub> (net), based on 520 kt/a of MSA (Internet Source 47). Its turnover (related to MSW to power) is estimated at €64 million, and its (relevant) workforce at 145 employees (see footnote b, Table 8.1).

## 8.9 Van Gansewinkel Groep

Van Gansewinkel Groep operates MSW plants in Duiven, Rijnmond and Rotterdam (Internet Source 46). The total capacity of its MSW plants is 146 MW<sub>e</sub> (net), based on 650 kt/a of MSW. Its turnover (related to MSW to power and heat) is estimated at €420 million, and its (relevant) workforce at 1,680 employees (see footnote c, Table 8.1).

## 8.10 Summary

Table 8.1 presents a summary of estimates as well as of the primary energy in the form of MSW in the Netherlands (CBS, 2009). The turnover in energy generation (electricity, CHP) based on municipal solid waste of companies is estimated at approximately €1,100 million in 2008 (in 2007, €1,035 million), and the workforce at approximately 4,250 people (in 2007, 4,000).

Table 8.1 *Key data turnover and employees of companies engaged in MSW power in the Netherlands*

Company	Turnover 2007 [€mln]	Employees 2007	Primary energy produced 2008 [PJ] <sup>a</sup>	Turnover 2008 [€mln]	Employees 2008
Afval Energie Bedrijf Amsterdam				~92	~370
ARN (Nijmegen)				~26	~105
E.On Benelux (Delfzijl)				~28	~110
Essent Milieu				~300	~1,200
HVC Groep (active in MSW in Alkmaar etc)				~134 <sup>b</sup>	~535 <sup>b</sup>
OMRIN (Harlingen)				~26	~105
Twence ( <i>inter alia</i> MSW power)				~64 <sup>b</sup>	~145 <sup>b</sup>
Van Gansewinkel Groep (active in 7 countries)				~420 <sup>c</sup>	~1,680 <sup>c</sup>
<b>Total</b>	<b>~1,035</b>	<b>4,000</b>	<b>29.3</b>	<b>~1,100</b>	<b>4,250</b>

a Primary energy production of the biogenic part of municipal solid waste in the Netherlands amounted to 29.3 PJ in 2008 (CBS, 2009).

b It is assumed that 75% of the turnover and employment of HVC Groep and Twence afvalverwerking is related to electricity generation or CHP (Combined Heat and Power) based on MSW.

c Van Gansewinkel Groep operates MSW plants in Duiven, Rijnmond and Rotterdam. Approximately 80% of its turnover and employees is assumed refer to the Netherlands, of which 35% related to MSW power etc.

Sources: CBS, 2009; Internet Sources 40-48.



## 9. Small hydro power, tidal power, and ‘Blue Energy’

Seven companies and institutes are active in hydro power, tidal power, and ‘Blue Energy’. First, the term ‘Blue Energy’ denotes saline gradient energy, making use of, e.g. osmotic power due to difference in salt gradient between the North Sea and an estuary or lake. The companies and institutes that are active are Bluewater, Tocordo, Ecofys/Eneco, and Entry Technology Support for the more classical forms of hydro including tidal stream power, and REDstack, Wetsus and the Membrane Technology Group of the University of Twente for ‘Blue Energy’.

### *Bluewater*

Bluewater, an international company in offshore production systems (Internet Source 49), provides engineering and consultancy services to Tocardo for tidal energy devices (see below).

### *Tocardo*

Tocardo bv designs and develops tidal stream generators, ranging from 50 kW<sub>e</sub> (currently in operation at the Afsluitdijk) to 150 kW<sub>e</sub> (under development) and more (Internet source 50).

### *Ecofys/Eneco*

Ecofys, currently a subsidiary of Eneco (Rotterdam), developed a pilot tidal stream power unit called C-Energy in the Westerschelde (Internet Source 51).

### *Entry Technology Support*

Entry Technology Support bv is a small company that *inter alia* supports ‘classical’ hydro power and tidal stream energy with engineering and consultancy services (Internet Source 52).

### *REDstack*

REDstack bv (Sneek) is a company involved in ‘Blue Energy’, a technology that generates power from the saline gradient, e.g. between North Sea and IJsselmeer (Internet Source 53).

### *Wetsus*

Wetsus is an R&D establishment in Leeuwarden that is *inter alia* supportive of the Blue Energy technology with development activities and pilot plants (Internet Source 54).

### *Membrane Technology Group*

The Membrane Technology Group of the University of Twente is engaged in R&D on membranes for Blue Energy (Internet Source 55).

Based on this qualitative information, Table 9.1 provides key data of hydro power (generation, capacity) and companies engaged in hydro (-related) power generation in the Netherlands.

Table 9.1 *Key data turnover and employees of biogas (component) companies in the Netherlands*

	Turnover 2007 [€mln]	Employees 2007	Primary energy produced 2008 [PJ] <sup>a</sup>	Turnover 2008 [€mln]	Employees 2008
Aggregate	1.2	25	0.840	1.5	30

<sup>a</sup> The figure of 0.84 PJ<sub>e</sub> is equivalent to 102 GWh, and is based on a total hydro capacity of 37 MW<sub>e</sub>.

Sources: CBS, 2009; Internet Sources 49-55.

## 10. Geothermal energy

### 10.1 Deep geothermal energy

Several companies are engaged in deep geothermal energy in the Netherlands, among which:

- Deerns Raadgevende Ingenieurs.
- DWA Installatie- en Energieadvies.
- IF Technology (Internet Source 56).
- Eneco (Ecofys).
- E.On Benelux.
- RWE (Essent).
- TNO/NITG.

'Platform Geothermie' (Internet Source 57) provides the following list of its members (Table 10.1). It is noted that these actors are at least active in what is called 'deep geothermal energy'.

Table 10.1 *List of members of 'Platform Geothermie'*

Members A-I	Members J-Z
Aardwarmte Den Haag	Kamstrup
ARCADIS	KEMA
Baker Hughes INTEQ	NUON
BECi	PanTerra Geoconsultants
Brabant Water	Productschap Tuinbouw
Cumae	Provincie Drenthe
Delft Aardwarmte Project (DAP)	Provincie Overijssel
Deerns Raadgevende Ingenieurs	Provincie Zuid Holland
Deep Drill Group	RABO Bank
DLV Glas en Energie	Raedthuys Groep
Dick Swart Consultancy/PGMi	De Ruiter Boringen en Bemalingen
Dura Vermeer Ondergrondse Infra	Scientific Drilling
DWA	Schylger Energie Maatschappij
Ecofys	SchreuderGroep Ingenieurs/Adviseurs
E.ON Benelux	Shell
ENECO	Siemens Nederland
Essent (RWE)	Stadsgewest Haaglanden
European Drilling Systems	Tauw
Fugro Ingenieursbureau	T&A Survey
Gemeente Den Haag	Tebodin
Gemeente Gorinchem	Techniplan
Gemeente Heerlen	TNO-Bouw en Ondergrond (TNO/NITG)
GeoDelft/Deltares	Verhoeven Drunen
Grondboorbedrijf Haitjema	Visser & Smit Hanab
Grontmij	Volantis-Hollman Adviseurs
GTI	Westland Energie Services
IF Technology	

Source: 'Platform Geothermie' (Internet Source 57).

The investment cost of one doublet in a geothermal project is estimated at €6.5 mln or more. A doublet consists of production well and an injection well, which is required to manage environ-

mental effects. The injection well returns fluids from the production well at approximately the same depth, but - based on directional drilling - with a few kilometres distance from the production well, in order to delay cooling of the geothermal source. Table 10.1 provides a *preliminary* estimate of turnover and employment in geothermal energy<sup>1</sup>.

Table 10.1 *Key data turnover and employees of companies engaged in geothermal energy in the Netherlands*

	Turnover 2007 [€mln]	Employees 2007	Turnover 2008 [€mln]	Employees 2008
Companies engaged in drilling (equipment)			~13	~15
Companies engaged in design, engineering, consultancy, etc.			~20	
Deerns Raadgevende Ingenieurs				~3
DWA Installatie- en Energieadvies				~3
IF Technology				~9
Other design, engineering, consultancy, etc.				~30
Utilities (ENECO, E.On Benelux, Essent, etc.)			~14	~30
Other, e.g., TU Delft, TNO/NITG, authorities			~3	~5
<b>Total</b>	~45	~85	~50	~95

Source: Heekeren, 2009.

## 10.2 Shallow geothermal energy: storage of heat and cooling based on aquifers

Menkveld and Beurskens (2009) pay attention to the widespread use of storage of heat and cooling based on shallow aquifers in the Netherlands. In the framework of this scoping study, it turned out to be impossible to collect data on employment and turnover of companies active in this field. According to (CBS, 2009), the capacity of underground heat and cold storage stood at 968 MW<sub>th</sub> in 2008, and the amount of primary energy conserved amounted to 0.82 PJ.

<sup>1</sup> CBS does not provide data of geothermal energy production until this date.

## 11. Conclusions

This study presents an overview of Dutch companies engaged in wind energy, photovoltaic energy (PV), solar thermal energy, biofuels, solid biomass, biogas and municipal solid waste, small hydro and related technologies, geothermal energy, and geothermal heat pumps. This scoping study focuses on socio-economic data such as turnover and employment of renewable energy companies in the Netherlands. As data of turnover and employment are scarce and incomplete, the figures presented are generally estimates that are fraught with some uncertainty.

The results and conclusions are presented by renewable energy source:

### *Wind energy*

By the end of 2008, the combined on- and offshore wind capacity in the Netherlands stood at 2,121 MW<sub>e</sub>, supplying the primary energy equivalent of 15.32 PJ<sub>e</sub>. The turnover of wind energy companies in the Netherlands is estimated at €400 million and the number of employees at 700.

### *Photovoltaic power (PV)*

The total installed capacity of PV in the Netherlands stood at 57 MW<sub>e</sub> by the end of 2008, supplying 0.14 PJ<sub>e</sub>. Statistics Netherlands (CBS) presents figures for the turnover of PV companies of €413 million, and for the number of employees of 566 in 2008.

### *Solar thermal energy*

The total installed capacity of solar thermal energy in the Netherlands stood at 503 MW<sub>th</sub> by the end of 2008, supplying 0.88 PJ. The turnover of companies engaged in solar thermal energy is estimated at €22 million, and the number of employees at 590 in 2008. Both numbers are fraught with considerable uncertainty.

### *Biofuel production*

Approximately thirteen biofuel companies produced 14.03 PJ in 2008. The turnover in 2008 is tentatively estimated at €150 million, and the number of employees is estimated at 250.

### *Solid biomass*

The energy production based on solid biomass stood at 44.51 PJ in 2008. Based on fragmented data, the turnover of solid biomass companies is estimated at €62 million, and the number of employees is put at 240.

### *Biogas*

At least six companies are active in equipment for biogas plants. In 2008, the primary energy equivalent of biogas was 9.30 PJ in 2008. The turnover of the companies is tentatively estimated at €62 million in 2008, and the number of employees is estimated at 240.

### *Municipal Solid Waste (MSW)*

Nine companies in the Netherlands are engaged in energy generation from MSW, resulting in a primary energy equivalent of 29.27 PJ in 2008. The turnover of these companies is estimated at €1,100 million in 2008, and the number of employees is estimated at 4,250.

### *Hydro power and related technologies*

There are about seven companies active in hydro power or related technologies. In 2008, the total hydro capacity stood at 37 MW<sub>e</sub>, and the electricity generated was equivalent to 0.36 PJ<sub>e</sub>. The turnover is estimated at €1.5 million and the number of employees is put at 30 in 2008.

### *Geothermal energy*

There are tens of companies engaged in (deep) geothermal energy in the Netherlands. Based on information from the sector, the turnover of these companies is tentatively estimated at €50 million in 2008. The number of employees is tentatively estimated at 95. For shallow geothermal energy - storage of heat and cooling based on shallow aquifers - and for geothermal heat pumps, it turned out to be impossible to collect (reliable) data in the framework of the present study.

All in all, renewable energy sources considered in the present study represent a total primary equivalent of 114.3 PJ in 2008. Table 11.1 shows that the total turnover of RE companies in the Netherlands is estimated at €2.26 billion in 2008 (in 2007, €1.9 billion). The total workforce of RE companies in the Netherlands is estimated at 6,960 employees in 2008 (in 2007, 6,230).

*Table 11.1 Key data turnover and employees of companies engaged in RE in the Netherlands*

Renewable energy sector	Turnover 2006 [€mln]	Employees 2006	Turnover 2007 [€mln]	Employees 2007	Primary energy [PJ] <sup>a</sup>	Turnover 2008 [€mln]	Employees 2008
Wind energy	225	325	300	500	15.322	400	700
Photovoltaics (CBS)	161	232	252	403	0.138	413	566
Solar thermal energy	N/A	N/A	19	514	0.879	22	590
Biofuels	N/A	N/A	134	224	14.032	150	250
Solid biomass	N/A	N/A	60	240	44.511	62	240
Biogas	N/A	N/A	60	240	9.297	62	240
Municipal solid waste	N/A	N/A	1,035	4,000	29.266	1,100	4,250
Small hydro & tidal	N/A	N/A	1.2	25	0.840	1.5	30
Geothermal energy	N/A	N/A	45	85	N/A	50	95
Geothermal heat pump	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>Total</b>	<b>N/A</b>	<b>N/A</b>	<b>1,900</b>	<b>6,230</b>	<b>114.285</b>	<b>2,260</b>	<b>6,960</b>

a The attribution of primary energy is based on the national renewable energy monitoring protocol applied by Statistics Netherlands (CBS), which refers to a substitution of fossil energy equivalents.

Current energy and climate policies warrant a strong growth of renewable energy in Europe and in the Netherlands. For instance, the Netherlands is obliged to increase the share of renewable energy in useful energy to 14% in 2020 (compared to approximately 3.4% of the primary energy consumption in 2008). With regard to the turnover and the number of employees until 2020, it is to be expected that most renewable energy categories will show a healthy growth, except municipal solid waste. The latter energy source is already exploited to a very large extent. The development of the turnover and workforce of RE companies in the Netherlands depends on the extent to which the Netherlands will succeed in reaping the benefits of technological development. However, it should be noticed that some renewable energy technologies are labour-intensive and others much less.

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## Abbreviations and acronyms

A&F	Agrotechnology and Food innovations (Wageningen University and Research Centre)
AST	Advanced Surface Technology
BDI	BioDiesel International AG
BTG	Biomass Technology Group
CBS	Statistics Netherlands
CTC	Composite Technology Centre
EWEA	European Wind Energy Association
EWT	Emergya Wind Technologies
FAME	Fatty Acid Methyl Ester
FTE	Full Time Equivalent
MSW	Municipal Solid Waste
OEM	Original Equipment Manufacturer
PV	Photovoltaic power
SBT	Suzlon Blade Technology
WES	Wind Energy Solutions