



Energy research Centre of the Netherlands

# **Socio-economic indicators of renewable energy in 2009**

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

**P. Lako  
L.W.M. Beurskens**

## Acknowledgement/Preface

This scoping study focuses on the turnover and workforce of renewable energy companies in the Netherlands. The authors wish to express gratitude for co-reading by H.M. Londo, although the study's contents remain their responsibility. The study has been conducted in the framework of the European project EurObserv'ER (ECN project number 7.7903).

## Abstract

This study focuses on the turnover and workforce of Dutch renewable energy companies, in particular for wind energy, photovoltaic electricity (PV), solar thermal energy, biofuels, solid biomass, biogas and municipal solid waste, small hydro and related technologies, geothermal energy and geothermal heat pumps. As data of renewable energy companies is still scarce and incomplete, the figures presented in this study are generally estimates with some uncertainty ( $\pm 20\%$ ). Still, the turnover of companies in this sector is tentatively estimated at €3.4 billion and the direct employment at approximately 10,200 people in 2009. The data presented is inevitably incomplete and reflects the view of the authors.

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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 the European IEE-funded project EurObserv'ER ([www.eurobserv-er.org](http://www.eurobserv-er.org)), which collects data on deployment of renewable energy (RE) in EU countries. The focus of the present study are *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 with some uncertainty ( $\pm 20\%$ ).

The total installed capacity of *wind energy* (onshore plus offshore) in the Netherlands stood at 2,221 MW<sub>e</sub> by the end of 2009. The primary energy equivalent of electricity generation was 16.5 PJ<sub>e</sub>. With regard to the turnover of wind energy companies in the Netherlands, the present study gives an estimate of €820 million in 2009. The total number of employees of wind energy (component) companies in the Netherlands is estimated at 1,350.

The installed capacity of *photovoltaic electricity* (PV) in the Netherlands stood at 68 MW<sub>e</sub> by the end of 2009. The primary energy equivalent of electricity generation was 0.166 PJ<sub>e</sub>. A detailed overview of PV related companies and activities indicates that the turnover of PV companies may be estimated at €1,025 million and the number of employees at 1,240 in 2009.

The installed capacity of *solar thermal energy* in the Netherlands stood at 539 MW<sub>th</sub> by the end of 2009. The primary energy equivalent of solar thermal energy was 0.90 PJ. With regard to the turnover of solar thermal energy companies in the Netherlands, this study presents a figure of €57 million in 2009. The number of employees in the Netherlands is estimated at 1,500.

Approximately thirteen companies are active on *biofuel* production in the Netherlands. In 2009, the primary energy equivalent of biofuel production amounted to 15.4 PJ. With regard to the turnover of biofuel companies in the Netherlands, this study presents a figure of €140 million in 2009. The number of employees in the Netherlands is estimated at 230.

A number of companies are active on (conversion of) *solid biomass* in the Netherlands. In 2009, the primary energy equivalent of solid biomass stood at 43.1 PJ in 2008. With regard to the turnover of companies in the Netherlands, this study presents a figure of €65 million in 2009. The number of employees in the Netherlands is tentatively estimated at 250.

At least six companies focus on production of equipment for *biogas* plants in the Netherlands. In 2009, the primary energy equivalent of biogas was 8.5 PJ. With regard to the turnover of companies in the Netherlands, this study presents a figure of €95 million in 2009. The number of employees in the Netherlands is tentatively estimated at 1000.

There are nine companies active in energy (electricity and/or heat) generation from *municipal solid waste* (MWS) in the Netherlands. In 2009, the primary energy equivalent of the biogenic fraction of MSW was 14.4 PJ. With regard to the turnover of companies in the Netherlands, this study presents a figure of €1,100 million. The number of employees is estimated at 4,250, including 'up-front' employment.

There are about eight companies active in hydro power or related technologies in the Netherlands. In 2009, the total hydro capacity stood at 37 MW<sub>e</sub>, and the electricity generated was equivalent to 0.353 PJ<sub>e</sub>. The turnover of these companies is estimated at €1.5 million and the number of employees is estimated at 30.

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 2009. 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 data in the framework of this study.

All in all, renewable energy sources considered in the present study represent a total primary equivalent of 121.8 PJ in 2009. The total turnover of RE companies in the Netherlands is estimated at €3.4 billion in 2009 (in 2008, €2.7 billion). The total workforce of these companies is estimated at 10,200 employees in 2009 (in 2008, 8000). See also Table S.1 below. Based on a ratio between indirect and direct employment of 0.88, the total direct and indirect employment of companies engaged in renewable energy in the Netherlands may be estimated at 19,200. The data presented is inevitably incomplete and reflects the view of the authors.

*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	Turnover 2008 [€mln]	Employees 2008	Turnover 2009 [€mln]	Employees 2009
Wind energy	430	625	550	850	700	1,150	820	1,350
Photovoltaic	200	300	328	525	580	800	1,025	1,243
Solar thermal energy	N/A	N/A	30	800	34	900	57	1,500
Biofuels	N/A	N/A	40	70	130	210	140	230
Solid biomass	N/A	N/A	60	240	62	240	65	250
Biogas	N/A	N/A	60	240	62	240	95	1,000
Municipal solid waste	N/A	N/A	1,035	4,000	1,100	4,250	1,100	4,250
Small hydro & tidal	N/A	N/A	1.2	25	1.5	30	1.5	30
Geothermal energy	N/A	N/A	45	85	55	170	98	360
Geothermal heat pump	N/A	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>2,165</b>	<b>6,875</b>	<b>2,725</b>	<b>8,000</b>	<b>3,400</b>	<b>10,200</b>

## 1. Introduction

This scoping study presents an overview of the turnover and employment 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. It has been conducted in the framework of 'EurObserv'ER', an EU-wide database of renewable energy data, to which ECN Policy Studies contributes.

The data conveyed refer to the year 2009 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 (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 crude appraisal for renewable energy companies in the Netherlands.

Chapter 2 starts with a short overview of the methodology used in retrieving and analyzing data of turnover and employment of renewable energy technologies. After that, nine renewable energy technologies are covered followed by a chapter with conclusions:

- Wind energy (Chapter 3).
- Photovoltaic electricity (Chapter 4).
- Solar thermal energy (Chapter 5).
- Biofuels (Chapter 6).
- Solid biomass (Chapter 7).
- Biogas (Chapter 8).
- Municipal Solid Waste (Chapter 9).
- Small hydro power, tidal power, and 'Blue Energy' (Chapter 10).
- Geothermal energy (Chapter 11).
- Overview and conclusions (Chapter 12).

## 2. Methodology

The methodology used to retrieve and analyse data of turnover and employment of renewable energy technologies consisted of the following methods:

- Use of data provided by Statistics Netherlands (CBS) or data from companies in Municipal Solid Waste. In a similar way, data were provided for geothermal energy based on annual accounts or sector-specific information. It is assumed that the coverage of the sectors is almost complete.
- Collection of data on a company-by-company base, for wind energy, photovoltaic energy, biofuels, and small hydro. The method is assumed to provide data of turnover and employment that are accurate with an uncertainty margin of 20%.
- Collection of scattered data on turnover and employment of a sector, i.e. for solar thermal energy, solid biomass, and biogas. The method is less accurate than the preceding methods, and the uncertainty margin may be 35%.

The uncertainty margins of the second (20%) and third (35%) categories are somewhat arbitrary. They are only used for illustration purposes. Also, several companies are not only active in the renewable energy sector but also in other businesses (e.g. industrial gearboxes). For such companies, corrections have been applied.



### 3. Wind energy

Wind turbine companies which manufacture turbines or components, and produce related services (R&D, engineering and design) including companies engaged in offshore wind, 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.

#### 3.1 Actiflow

Actiflow is an engineering company in Breda (a spin-off from Delft University of Technology) with a special focus on flow engineering. Services range from the building industry to medical services, from automotive to aerospace, and from oil and gas to wind energy (Internet Source 1). Its wind-related workforce is estimated at 5 people.

#### 3.2 Advanced Tower Systems (ATS)

Advanced Tower Systems (ATS) in Enschede developed a new tower concept for large wind turbines as an economically and logistically attractive alternative to steel towers. ATS is a joint venture of MECAL, Hurks Group BV and Juwi Holding AG, established in May 2005 (REW, 2009; Internet Source 2). Its workforce is estimated at 64 people (Internet Source 3).

#### 3.3 Ampelmann

The Ampelmann company in Delft (a spin-off from Delft University of Technology) focuses on the development, construction, lease and sale of offshore access solutions. The Ampelmann is a ship-based self stabilizing platform that actively compensates all vessel motions to make offshore access safe, easy and fast. The system has proven itself successfully in the offshore wind industry (Internet Source 4). Its wind-related workforce is estimated at 5 people.

#### 3.4 Arcadis

Arcadis is an international engineering company in Amersfoort with a workforce of 15,000 people and a turnover of €1.8 billion (Internet Source 5). One activity relates to searching for locations for onshore and offshore wind farms. Its wind-related workforce is estimated at 5 people.

#### 3.5 Ballast Nedam

Ballast Nedam NV in Nieuwegein is a company group offering a wide range of products and services related to construction of houses, buildings, and infrastructure. With various activities in building, infrastructure, and engineering, it has a workforce of 4,000 people and a turnover of €1.4 billion in the Netherlands. It is *inter alia* engaged in design and construction of offshore wind farms (Internet Source 6). Its wind-related workforce is estimated at 25 people.

#### 3.6 2-B Energy

2-B Energy was founded in 2007 and is active in the field of offshore wind energy. The company is currently developing a new concept for offshore wind power plants together with a network of partners in the industry. The 2-B concept includes differentiating designs for the rotor, nacelle, support structure and electrical system. This holistic approach, covering the full life cy-

cle of all components, is claimed to result in significant cost savings compared to current technologies (Internet Source 7). The number of employees in 2009 is estimated at 10.

### **3.7 Bettink Service en Onderhoud**

Bettink Service en Onderhoud in Barneveld is specialised in maintenance of (onshore) wind turbines. Its number of employees is reportedly 25 (Internet Source 8).

### **3.8 Blue H Technologies**

Blue H Technologies bv in Oosterhout focused on the development of a floating structure for offshore wind turbines (Internet Source 9). Blue H USA is furthering the so-called Submerged Deepwater Platform (SDP), developed by Blue H Technologies, primarily for the US market (Internet Source 10). Since 2009, no wind-related workforce is assumed for the Netherlands.

### **3.9 BMT ARGOSS**

BMT ARGOSS (subsidiary of BMT Group Ltd) in Marknesse is leading in the field of marine environmental information. BMT Group is an international multi-disciplinary engineering, science and technology consultancy, with a staff of 1,300, offering a broad range of services, particularly in the defence, energy, environment, shipping and ports and logistics sectors. (Internet Sources 11-12). The wind-related workforce of BMT ARGOSS is estimated at 10 people.

### **3.10 Bureau Waardenburg**

Bureau Waardenburg is an independent research and consultancy agency in the field of ecology, environment and landscaping, with approximately 70 employees (Internet Source 13). The workforce involved in studies on the impacts of wind farms is estimated at 5 people.

### **3.11 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 14; Ter Laak, 2007). Its workforce is tentatively estimated at 15 employees in 2008 (in 2007, 15) and a similar number in 2009.

### **3.12 Croon Electrotechniek**

Croon Electrotechniek bv is part of TBI Holdings bv, a Dutch real estate, construction, and technology group. It is specialised in the design, installation, and maintenance of electrical installations for the wind industry (Internet Source 16). By the end of 2009, its workforce stood at 1,967 (Internet Source 17). Its wind-related workforce is estimated at 85 people.

### **3.13 DELTA**

The wind-related workforce of DELTA is tentatively estimated at 20 people.

### 3.14 Dynamar

Dynamar bv in Alkmaar is specialised in credit and marketing reports in the maritime sector (Internet Source 18). Its wind-related workforce is estimated at 2 people.

### 3.15 E-Connection Project

E-Connection Project bv in Bunnik develops innovative projects, mainly on- and offshore wind projects in the Netherlands (Internet Source 19). It has an estimated workforce of 5 people.

### 3.16 Ecofys and Evelop (Eneco)

Ecofys and Evelop are subsidiaries of Eneco (Rotterdam) focused on energy conservation and renewable energy (Ecofys), and the development, construction and operation of on- and offshore wind farms (Evelop), respectively (Internet Source 20). Eneco and its subsidiaries is involved in the development and operation of about seven onshore wind farms and has been awarded three offshore wind projects. Its wind-related workforce is estimated at 100 people.

### 3.17 Emergya Wind Technologies (EWT)

Emergya Wind Technologies bv (EWT) is specialised in manufacturing and supply of direct drive (gearless) wind turbines of 750 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, based on the proven Lagerwey technology. EWT's global workforce of is over 100, and that of the Netherlands (head office Amersfoort) approximately 90 (Internet Source 21).

### 3.18 Essent (RWE)

The wind-related workforce of Essent (subsidiary of RWE) is tentatively estimated at 25 people.

### 3.19 Fugro

Fugro is an international engineering company, with activities in three divisions, geotechnical, survey, and geoscience. By the end of 2009, Fugro employed some 13,500 staff in more than 50 countries. Fugro offers *inter alia* services related to sustainable energy, among which on- and offshore wind. The latter activities are localised in the UK (Internet Source 22). It is estimated that about 15 employees in the Netherlands are engaged in services for on- and offshore wind.

### 3.20 GL Garrad Hassan Netherlands

GL Garrad Hassan (UK) is a renewable energy consultancy, focused on on- and offshore wind, wave energy, tidal energy, and solar energy (Internet Source 23). Its subsidiary in the Netherlands, with offices in Delft and Heerenveen, has a workforce of an estimated 8 people.

### 3.21 Global Wind Power

Global Wind Power bv (formerly Lagerwey Wind bv) in Amstelveen, focuses *inter alia* on the development and marketing of the Direct Drive PMG Class II 2000kW wind turbine (GWP82-2000kW) and the Class I 750kW Norwin wind turbine (GWP47-750kW). The company had a number of vacancies lately (Internet Sources 24-25). Its workforce is estimated at 8 employees.

### 3.22 GustoMSC

GustoMSC is an alliance of experienced specialists offering a wide range of design, engineering, construction and installation services to offshore markets (Internet Source 26). The offshore activities of GustoMSC are not confined to oil and gas, but include offshore wind. GustoMSC was *inter alia* involved in the construction of the offshore wind farm Kentish Flats in the UK. Its workforce in the Netherlands engaged in offshore wind is estimated at 30 people.

### 3.23 Heerema Group

The Heerema Group (with offices in the Netherlands, Luxembourg and Switzerland) designs, fabricates, transports, installs and removes facilities for the exploitation of oil and gas at sea, comprising Heerema Marine Contractors (HMC) and Heerema Fabrication Group (HFG). The latter has experience in offshore wind substructures, substations (topsides and substructures), etc (Internet Source 27). Its wind-related workforce in the Netherlands is estimated at 30 people.

### 3.24 Home Energy and other small urban wind turbine manufacturers

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 28). 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).

### 3.25 LM Wind Power (R&D) Holland

LM Wind Power (Denmark) is the world's leading supplier of wind turbine blades, besides supplying wind turbine brakes. LM Wind Power (R&D) 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. By end of the year 2009, LM Wind Power employed 4,676 people, and its revenue stood at €777 mln (Internet Source 29). The workforce in the Netherlands is tentatively estimated at 25 employees.

### 3.26 MECAL

MECAL, founded in 1989 and with offices in the Netherlands (Enschede), the USA and Japan, focuses on wind energy, semiconductor equipment, and vision and optronics (Internet Source 30). In wind energy, MECAL provides services in turbine design, due diligence, inspections, and consultancy. It is a partner in the joint venture Advanced Tower Systems (ATS). Its wind-related workforce in the Netherlands is estimated at 25 employees (worldwide 100).

### 3.27 Meewind

The investment company 'Seawind Capital Partners' of Meewind in Heemstede (Internet Source 31) participates in the offshore wind farms Belwind (Belgium). It has 2 employees.

### 3.28 NGup

NGup in Almelo and Nijverdal is active in repair, inspection, maintenance, and manufacturing of wind turbine rotor blades (Internet Source 32). Its workforce in the Netherlands is tentatively estimated at 30 people.

### 3.29 Nuon (Vattenfall) / Noordzeewind

The wind-related workforce of Nuon (subsidiary of Vattenfall) including Noordzeewind and WEOM, a consultancy recently acquired by Nuon, is tentatively estimated at 40 people.

### 3.30 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 33).

### 3.31 Raedthuys Groep

Raedthuys Groep in Enschede is involved in the development of onshore wind and bio-energy projects. The expertise of Raedthuys is in planning, acquisition of permits and project development (Internet Source 34). Its workforce related to wind projects is estimated at 20 people.

### 3.32 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 35). The relevant workforce in the Netherlands is estimated at 50 employees.

### 3.33 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 is market leader with respect to offshore wind (Internet Source 36). Siemens continues to invest in wind energy R&D to reduce investment risks and improve project economics. Its relevant workforce in the Netherlands is estimated at 75 employees.

### 3.34 Sif Group

Sif Group bv in Roermond is specialised in the manufacture of tubular structures, such as offshore wind farms (Internet Source 37). An estimated 30 out of its 150 employees are assumed to be engaged in manufacturing of monopoles (diameter up to 4 m) for offshore wind farms. Suzlon Blade Technology (SBT) Suzlon Blade Technology (SBT) in Hengelo — formerly AE-Rotor Techniek, founded in 2001 (Internet Source 38) — 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), constituting a considerable part of SBT's total workforce of about 2,500 FTE, is the main centre of Suzlon's wind turbine blade manufacturing. Suzlon Energy Ltd, which 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 manage-

ment, and design of tooling on outlines. Suzlon also has a small representative office in Amsterdam. Suzlon's workforce in the Netherlands was approximately 70 FTE in 2008 (Schuring, 2009) and presumably also in 2009.

### 3.35 Ulstein Sea of Solutions

Ulstein Sea of Solutions in Vlaardingen (subsidiary of Ulstein Group) is specialized in the design of complex offshore construction vessels (Internet Source 39). Recently, Ulstein developed a wind turbine installation vessel called the Windlifter, The total workforce of the Ulstein Group is estimated at 700-800 people, of which an estimated 10 is engaged in wind-related activities.

### 3.36 Van Oord

Van Oord Groep in Rotterdam is a marine contractor, active in dredging, offshore and marine engineering projects, with a workforce of more than 4,000 people (Internet Source 40). Initially, Van Oord focused on construction activities such as export and inter-array cable installation, etc. The participation in the legacy company Mammoet Van Oord enabled Van Oord to expand activities with foundation and topside installation and transport. In 2009, Van Oord signed a contract for the engineering, procurement and construction of the first part of the Belwind offshore wind park project. Its wind-related workforce in the Netherlands is estimated at 30 people.

### 3.37 Vestas Benelux

Vestas Wind Systems A/S, Randers (Denmark), the world market leader in wind energy, has a subsidiary in Arnhem, the Netherlands, with approximately 200 employees (Internet Source 41).

### 3.38 WEOM

WEOM, a consultant for wind energy projects, has been acquired by Nuon. As its turnover is consolidated in that of Nuon, its workforce is included in the wind-related employees of Nuon.

### 3.39 Wind Energy Solutions (WES)

Wind Energy Solutions bv (WES) in Opmeer 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 42). Its workforce is estimated at 8 people in 2008 and 2009 (in 2006, 6).

### 3.40 Windunie

Windunie is a joint venture of owners of wind turbines in North Holland. The electricity generated by wind farms owned by Windunie is traded in the Netherlands (Internet Source 43). The employment related to Windunie is deemed to be very small.

### 3.41 WMC / EWTW

The Knowledge Centre WMC in Wieringerwerf is a research institute for materials, components and structures. The major activities are fundamental and applied research on Fibre Reinforced Plastics (FRP) and wind turbine structures (Internet Source 44). In close proximity to WMC, the ECN Wind Turbine test site EWTW (ECN Wind Energy Facilities bv, a 100% subsidiary of ECN, just like WMC) is meant to facilitate the measurement and development programs of

ECN by testing large wind turbines. EWTW generates income from operating a small wind farm at the same site to offset the costs of operation of the test site. EWTW is in negotiation with the municipality to increase the test facility and simultaneously increase the number of wind turbines in the commercial wind farm at the site. The total number of employees of WMC and EWTW in 2009 is estimated at 24.

### 3.42 XEMC Darwind

XEMC Darwind in Hilversum, established in 2005, was acquired by XEMC Windpower Co., Ltd, in Xiangtan, China, in 2009. It focuses on the development of large offshore wind turbines of 5 MW. Its workforce stood at 45 employees in 2008 and 72 in 2009 (Internet Sources 45-46; De Ingenieur, 2008).

### 3.43 XEMC VWEC

XEMC VWEC (formerly STX Windpower bv and Harakosan Europe) is a subsidiary of XEMC Windpower Co. (China). This company produces a 2 MW permanent magnet direct drive wind turbine (originally denoted as Zephyros), designed for near-shore and offshore applications (Internet Source 47). Its workforce is estimated at 20 employees.

### 3.44 Summary

At the end of 2009, the total wind capacity in the Netherlands stood at 2221 MW (2149 MW in 2008), of which 1993 MW onshore wind and 228 MW offshore wind, supplying 16.48 PJ<sub>e</sub> or 4.578 TWh to the grid (CBS, 2010). Table 3.1 summarises the turnover and employment of wind turbine companies in 2009. According to the European Wind Energy Association (EWEA), the number of employees that are involved in wind energy in Europe was 108,600 in 2009, of which 2,000 in the Netherlands (EWEA, 2009). The number of 2,000 employees in the Netherlands, however, is not substantiated by EWEA. Therefore, the number of approximately 1,350 (Table 3.1) and a turnover of approximately €820 mln is retained in the present study.

Table 3.1 Key data turnover and employees of wind companies in the Netherlands

Company	Turnover 2006 [€mln]	Employees 2006	Turnover 2008 [€mln]	Employees 2008	Turnover 2009 [€mln]	Employees 2009
Actiflow	-	-	-	-	N/A	5
Advanced Tower Systems (ATS)	-	-	-	-	N/A	64
Ampelmann	-	-	-	-	N/A	5
Arcadis	N/A	N/A	N/A	N/A	N/A	5
Ballast Nedam	N/A	N/A	N/A	N/A	N/A	25
2-B Energy	-	-	-	-	N/A	10
Bettink Service en Onderhoud	N/A	N/A	N/A	N/A	N/A	25
Blue H Technologies	- <sup>a</sup>	- <sup>a</sup>	N/A	~10	-	-
BMT ARGOSS	N/A	N/A	N/A	N/A	N/A	10
Bureau Waardenburg	N/A	N/A	N/A	N/A	N/A	5
Composite Technology Centre (CTC)	N/A	12	N/A	~15	N/A	15
Croon Electrotechniek	N/A	N/A	N/A	N/A	N/A	85
DELTA	N/A	N/A	N/A	N/A	N/A	20
Dynamar	N/A	N/A	N/A	N/A	N/A	2
E-Connection Project	-	-	-	-	N/A	5
Ecofys and Evelop (Eneco)	N/A	N/A	N/A	N/A	N/A	100
Emergya Wind Technologies (EWT)	81	100	~70	~90	N/A	90
Essent (RWE)	N/A	N/A	N/A	N/A	N/A	25
Fugro	N/A	N/A	N/A	N/A	N/A	15
GL Garrad Hassan Netherlands	N/A	N/A	N/A	N/A	N/A	8
Global Wind Power (Lagerwey)	N/A	4	N/A	~7	N/A	8
GustoMSC	N/A	N/A	N/A	N/A	N/A	30
Heerema Group	N/A	N/A	N/A	N/A	N/A	30
HomeEnergy & other urban WT Co's	N/A	N/A	2.8	~30	N/A	30
LM Wind Power (R&D) Holland	N/A	~20	N/A	~25	N/A	25
Mecal	N/A	~25	N/A	~25	N/A	25
Meewind	N/A	N/A	N/A	N/A	N/A	2
NGup	N/A	N/A	N/A	N/A	N/A	30
Nuon (Vattenfall) / Noordzeewind	N/A	N/A	N/A	N/A	N/A	40
Polymer Composites	1.5	15	N/A	~55	-	- <sup>c</sup>
Raedthuys Groep	N/A	N/A	N/A	N/A	N/A	20
Rheden Steel	N/A	N/A	N/A	~50	N/A	50
Siemens Netherlands	-	-	N/A	~75	N/A	75
Sif Group	N/A	N/A	N/A	N/A	N/A	30
Suzlon Blade Technology (SBT)	N/A	~30	N/A	70	N/A	70
Ulstein Sea of Solutions	N/A	N/A	N/A	N/A	N/A	10
Van Oord	N/A	N/A	N/A	N/A	N/A	30
Vestas Benelux	-	-	N/A	~150	N/A	200 <sup>c</sup>
Windunie	-	-	-	-	-	-
Wind Energy Solutions (WES)	1.1	6	~1.5	~8	N/A	8
WMC / EWTW	N/A	18	N/A	22	N/A	24
XEMC DarwinD	N/A	N/A	N/A	~45	N/A	72
XEMC VWEC	N/A	16	N/A	~20	N/A	20
Total wind turbine (component) Co's	~430 <sup>a</sup>	~625 <sup>a</sup>	~700 <sup>a</sup>	~1,150 <sup>a</sup>	~820 <sup>a</sup>	~1,350 <sup>a</sup>

a 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; Internet Sources 1-47.



## 4. Photovoltaic electricity

Photovoltaic (PV) electricity companies, producing solar cells or modules, panels and components represent a nascent industry with several representatives in the Netherlands. This chapter focuses on data of turnover and employment, as far as available. The companies are subdivided in four categories, which are reviewed in the order presented below:

- Companies producing equipment and materials for PV cells/modules.
- Companies producing (components for) PV cells and/or modules.
- Companies developing technology or providing services.
- PV system suppliers.

### 4.1 Equipment and materials companies for PV cells/modules

#### 4.1.1 Cedova

Cedova bv, based at the High Tech Campus in Eindhoven, is a leading edge supplier of serviced foundry facilities to the opto-electronics industry (Internet Source 48). Its specialty is the growth and processing of III-V compounds. Its workforce is tentatively estimated at 5 people.

#### 4.1.2 DHV

DHV bv in Amersfoort is a consultancy and engineering company. It is also active in the design of photovoltaic cells plants, e.g. for Arise Technologies of Canada in Bischofswerda, Germany (Internet Source 49). Its workforce related to design of PV cells plants is estimated at 15 people.

#### 4.1.3 Enthone

Enthone Inc. is a Cookson Electronics company, a division of Cookson Group plc, London. It is a leading supplier of high performance specialty chemicals and coatings used in the electronics and surface finishing industries. One of its subsidiaries is Enthone Benelux bv in 's Hertogenbosch. Enthone PV chemistries for solar cell manufacturing increase cell efficiency while lowering production costs and increasing throughput and yield (Internet Source 50). The workforce related to such materials for the PV industry in 's Hertogenbosch is estimated at 30 people.

#### 4.1.4 Eurotron

Eurotron in Bleskensgraaf offers a complete solution for the PV module manufacturing process for backside contact cells (Internet Source 51). As it is a rather new company (in 2009, it was selected as supplier by Canadian Solar), its workforce is estimated at 15 people in 2009.

#### 4.1.5 Lamers High Tech Systems

Lamers High Tech Systems bv in Nijmegen - a subsidiary of Air Liquide (present in over 75 countries with 42,300 employees) - is a leading supplier in the semi-conductor market. It offers *inter alia* clean rooms for manufacturing of PV cells (Internet Source 52). The workforce in the Netherlands related to equipment (clean rooms) for the PV industry is estimated at 30 people.

#### 4.1.6 Levitech

Levitech is a global player in semiconductor production solutions for the IC and solar industry. A spin-off of ASM International, it was established (in 2009) around its core product, the Levitor™ system, used in the semiconductor industry for Rapid Thermal Processing (RTP). As Levitech originated as a divestiture from ASM International in the course of 2009, its 'PV related' workforce by the end of 2009 is tentatively estimated at 20 people (Internet Source 53).

#### 4.1.7 Mallinckrodt Baker

Mallinckrodt Baker (USA), with a subsidiary in Deventer, which manufactures *inter alia* chemicals for PV cell manufacturing (Internet Source 54). About 15% of its workforce of 200 people in the Netherlands is assumed to be related to the PV industry, i.e. 30 people.

#### 4.1.8 Mecco

Mecco in Drunen - division of BE Semiconductor Industries NV in Duiven - manufactures and supplies plating systems to suit a wide variety of products, *inter alia* for the PV cell industry. After introduction of its the Cell Plating Line (CPL) in 2009, Mecco launched its Direct Plating Line (DPL) for metallization directly onto silicon, which can be used together with the CPL platform, fitting into advanced metallization routes developed by the PV industry. The PV related turnover is estimated at €10 million and the workforce at 45 people (Internet Source 55).

#### 4.1.9 NTS-Group

NTS-Group with several manufacturing plants in Bergeijk, Deurne, Eindhoven, and Nijmegen, has extensive knowledge in the field of optical and mechatronic systems. Its turnover in the Netherlands is reportedly €95 million and its workforce in the Netherlands is about 500 people (Internet Source 56). An estimated 10% of its turnover and workforce in the Netherlands is assumed to be 'PV related, i.e. a turnover of €10 million and a workforce of 50 people.

#### 4.1.10 Rimas

Rimas Group bv in Beringe is specialized in PV module manufacturing equipment. Since 2005, the company has grown from 12 to 30 employees (2009) and has been able to more than double its turnover (Internet Source 57). Its number of employees is estimated at 30 by the end of 2009.

#### 4.1.11 Smit Ovens

Smit Ovens in Eindhoven (Son) is specialized in thermal processes (ovens) for the display, glass and electronics industries with a workforce of 50 people (Internet Source 58). One of its products is a thermal process for thin-film solar panels. In 2010, it completed a project to specify, design, test and build a selenium deposition and crystallization oven for production of CIGS (Copper Indium Gallium Selenide) PV panels. Its PV related workforce is put at 25 people.

#### 4.1.12 SolayTec

SolayTec is a spin-off company from TNO focuses on Atomic Layer Deposition (ALD) on solar cells. ALD machines from SoLayTec are intended for industrial production in the solar market. The start-up dates from 2010, which is why no turnover or workforce could be attributed to the company in 2009 (Internet Sources 59-60).

#### 4.1.13 Stork Prints Group

Stork Prints Group (SPG) bv in Boxmeer - a subsidiary of Bencis Capital Partners (60%) and Stork (40%) - is a leading company in the textile and graphics printing market. Most of the processes applying conductor paste to silicon solar cells require screen printing. An alternative to the standard wire mesh screen is the metal stencil (Internet Source 61). Its workforce in the Netherlands related to the PV cell industry is tentatively estimated at 35 people.

#### 4.1.14 Sunlab

Sunlab bv in Petten is a subsidiary of ECN offering three instruments, (Internet Source 62). The turnover and workforce are relatively small and are consolidated in ECN's unit Solar Energy.

#### 4.1.15 Tempress

Tempress in Vaassen since 2007 (subsidiary of Amtech Systems, Inc.) develops and manufactures diffusion and LPCVD furnaces for the semiconductor, MEMS, Nano and solar industries (Internet Source 63). Its workforce related to the PV industry is estimated at 100 people in 2009 (Jong, 2011).

#### 4.1.16 VDL ETG

VDL Enabling Technologies Group (ETG) in Eindhoven supplies to the Original Equipment Manufacturing industry related to the automotive sector, but is also specialized in vacuum deposition systems for PV cells, based on crystalline silicon and thin-film technology (Internet Source 64). Its workforce related to the PV industry is tentatively estimated at 15 people.

### 4.2 Companies producing (components for) PV cells and/or modules

#### 4.2.1 Alrack

Alrack in Eindhoven, a mechatronics specialist at Veldhoven, develops a new electric connection between the solar panel and the grid in cooperation with six other innovative companies in the provinces North Brabant and Limburg (Internet Source 65). As a start-up with 9 employees received a subsidy of nearly €1 mln from the government and the province North Brabant. The number of employees in 2009 is put at 5.

#### 4.2.2 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 global turnover was €35 mln. (Internet Source 66) makes mention of 30 employees in the Netherlands out of 100 worldwide in 2008. Currently, the global workforce is 150 employees (Internet Source 67). It is assumed that Mastervolt has a turnover of €25 million and 75 employees in the Netherlands.

#### 4.2.3 Nuon Helianthos

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). Helianthos' current workforce is tentatively estimated at 35 employees.

#### 4.2.4 OM&T

OM&T (Optical Media & Technology) bv in Eindhoven, a Dutch subsidiary of Moser Baer India Ltd, is an optical media technology company offering an extensive range of specialized test discs, for use by optical disc drive and player and associated component producers (Internet Source 68). The number of employees related to the PV industry is tentatively estimated at 10.

#### 4.2.5 Scheuten Solar

Scheuten Solar bv in Venlo is an innovative and leading solar company that develops, produces, designs and sells PV solar modules and total PV solar solutions. It is categorised as a company producing PV cells or modules, although it also supplies complete PV systems. PV production facilities are in Gelsenkirchen (Germany), and Venlo. The parent company Scheuten employs a staff of about 1,800. In 2008, Scheuten achieved a turnover of €467 mln (Internet Source 69). In the present study, its turnover in the Netherlands is estimated at €135 mln and the number of employees 190.

#### 4.2.6 Solar Modules Nederland

Solar Modules Nederland bv in Kerkrade manufactures solar modules with 25 employees. It originated in 2009, and production started in the first half of 2010. In May 2010, the production capacity of PV modules reached the level of 25 MW<sub>p</sub>/year. (Internet Source 70). In 2009, when Solar Modules Nederland was initiated, the workforce was probably approximately 5 people.

#### 4.2.7 Solland Solar

Solland Solar bv is a polysilicon solar cell producer (currently a subsidiary of Delta, and in the near future of Delta and Schott of Germany). It is headquartered in Heerlen/Aachen on the border between Germany and the Netherlands. After initially high growth rates – in 2007, Solland Solar had 200 employees, and in 2008 approximately 400 (Internet Source 71) – it was forced to lay off 86 people (temporary contracts) in 2009 (Delta, 2010). In 2009, its turnover in the Netherlands is estimated at €70 mln, and the Dutch workforce is estimated at 135 people.

#### 4.2.8 SunCycle

SunCycle in Eindhoven, which originates from 2005, is specialized in concentrating panels for PV systems (CPV). In 2009, a reproducible CPV systems was developed and tested (Internet Sources 72-73). The workforce in 2009 is estimated at approximately 5 people.

#### 4.2.9 Ubbink Solar

Ubbink Solar bv in Doesburg – subsidiary of Ubbink Groep (originally Centrosolar and Econcern) – supplies PV systems consisting of PV modules, mounting systems, cabling and converters (Internet Source 74). Its turnover is estimated at €4 mln and its workforce at 20 people.

## 4.3 Companies developing technology or providing services

### 4.3.1 Advanced Surface Technology (AST)

Advanced Surface Technology (AST bv, a subsidiary of A Group) develops and produces solar cells in Leeuwarden. Data with regard to turnover is not available. The workforce of AST and another subsidiary of A Group, Thin Film Factory bv, is reportedly 23 people (Kruithof, 2010; Internet Source 75).

### 4.3.2 MiPlaza

MiPlaza (Microsystems Plaza) in Eindhoven (an activity of Philips research) offers expertise, service and infrastructure, enabling companies to carry out high-tech research in the most efficient way. One of its activities is analysis of the composition and structure of materials and processes (Internet Source 76). Its 'PV related' workforce is estimated at 10 people.

### 4.3.3 OTB Solar

In February 2010, due to the takeover of OTB Group OTB Solar bv in Eindhoven became a subsidiary of Roth & Rau AG of Germany. OTB's product portfolio consists of systems and technologies for the solar industry, especially antireflective coating systems and turnkey production lines for use in the manufacture of crystalline silicon solar cells. From 2005 to 2006, its turnover increased from €16 mln to €30 mln (ED, 2006). Its turnover in 2009 is estimated at €95 mln and the workforce is reportedly 200 employees (in 2006, 55) (Internet Source 77).

### 4.3.4 Philips Applied Technologies

Philips Applied Technologies in Eindhoven is experienced in applying and integrating a wide range of technologies including software, electronics, robotics, precision motion and sensors (Internet Source 78). However, a reorganisation could affect Philips Applied Technologies.

### 4.3.5 RGS Development

RGS Development, based in Broek op Langedijk, worked on the completion of a pilot machine for PV cell manufacturing based on an innovative technology called Ribbon Growth on Substrate (RGS). This is an activity of Sunergy/Solwafer, which is covered in the following.

### 4.3.6 Solwafer/Sunergy

Solwafer/Sunergy in Broek op Langedijk is a start-up based on the RGS technology for manufacturing of PV cells. It is planning an industrial-scale production facility (Internet Source 79). Data on workforce is not available. The workforce in 2009 is estimated at 5 people.

## 4.4 PV system suppliers

### 4.4.1 IBC Solar

IBC Solar bv in Amstenrade – a subsidiary of IBC Groep in Germany – focuses on engineering and installation of (turnkey) PV systems (Internet Source 80). Data on turnover or workforce is not available. Its workforce in the Netherlands is tentatively estimated at 20 people.

#### 4.4.2 Oskomera Solar Power Solutions

Oskomera Solar Power Solutions bv in Deurne is a subsidiary of Oskomera Group, a group of companies that develop, engineer, manufacture and install windows, walls and load-bearing constructions. The solar division offers PV systems based on multi-crystalline silicon cells (Internet Source 81). The turnover is estimated at €10 mln and the workforce at 25 people.

#### 4.4.3 Siemens Netherlands

The subsidiary of Siemens in the Hague is *inter alia* engaged in inverter technology (Internet Source 82). Its 'PV related' workforce is estimated at 15 employees in 2008 and 2009.

#### 4.4.4 SolarTotal

SolarTotal Holding bv in Bommel is active in distribution and installation of PV systems in Belgium, France, Spain, the Netherlands, Italy, and Germany. Since the start of its operations in 2006, revenues have increased to an expected €40 million in 2008. Currently it has over 100 employees and franchisees (Internet Source 83). The turnover in the Netherlands is estimated at €4 million, and the number of employees at 20.

### 4.5 Summary

At the end of 2009, the total installed PV capacity in the Netherlands stood at 68 MW (in 2008, 57 MW), supplying 0.166 PJ<sub>e</sub> or 0.046 TWh to the grid (CBS, 2010). Table 4.1 summarises data of the turnover and workforce of PV related companies in 2009. The turnover is estimated at €1025 mln, and the workforce at 1,240 employees. The data may be compared to the turnover of €488 mln, and a workforce of 588 people in (CBS, 2010). The datasets differ with respect to the coverage of the PV industry. Table 4.1 provides an encompassing view of PV companies and activities. The workforce in Table 4.1 may be slightly overestimated (persons vis-à-vis FTEs).

Table 4.1 *Key data turnover and employees of PV related companies, Netherlands*

Company	Turnover 2006 [€mln]	Employees 2006	Turnover 2008 [€mln]	Employees 2008	Turnover 2009 [€mln]	Employees 2009
<i>Equipment and materials companies</i>						
Cedova	N/A	N/A	N/A	N/A	N/A	5
DHV	N/A	N/A	N/A	N/A	N/A	15
Enthone	N/A	N/A	N/A	N/A	N/A	30
Eurotron	N/A	N/A	N/A	N/A	N/A	15
Lamers High Tech Systems	N/A	N/A	N/A	N/A	N/A	30
Levitech	N/A	N/A	N/A	N/A	N/A	20
Mallinckrodt Baker	N/A	N/A	N/A	N/A	N/A	30
Meco	N/A	N/A	N/A	N/A	10	45
NTS-Group	N/A	N/A	N/A	N/A	10	50
Rimas Group	N/A	N/A	N/A	N/A	N/A	30
Smit Ovens	N/A	N/A	N/A	N/A	N/A	25
SolayTec	-	-	-	-	-	-
Stork Prints Group	N/A	N/A	N/A	N/A	N/A	35
Sunlab	-	-	-	-	-	-
Tempress	N/A	N/A	N/A	N/A	N/A	100
VDL ETG	N/A	N/A	N/A	N/A	N/A	15
Subtotal	N/A	N/A	N/A	N/A	N/A	445
<i>Companies producing (components for) PV cells and/or modules</i>						
Alrack	N/A	N/A	N/A	N/A	N/A	5
Mastervolt	10	30	10	30	25	75
Nuon Helianthos	N/A	20	N/A	35	N/A	35
OM&T	N/A	N/A	N/A	N/A	N/A	10
Scheuten Solar	45	70	128	175	135	190
Solar Modules Nederland	-	-	-	-	-	5
Solland Solar	24	42	50	70	70	135
SunCycle	-	-	-	-	-	5
Ubbink Solar	-	-	5	36	4	20
Subtotal	130	200	340	470	400	480
<i>Companies developing technology or providing services</i>						
Advanced Surface Technology	-	10	-	20	-	23
MiPlaza	N/A	N/A	N/A	N/A	N/A	10
OTB Solar	30	55	60	125	95	200
Philips Applied Technologies	N/A	N/A	N/A	N/A	N/A	N/A
RGS Development	-	-	-	-	-	-
Solwafer/Sunergy	-	-	-	-	N/A	5
<i>PV system suppliers</i>						
IBC Solar	N/A	N/A	N/A	N/A	N/A	20
Oskomera Solar Power Solutions	N/A	N/A	N/A	N/A	10	25
Siemens Netherlands	N/A	15	N/A	15	N/A	15
SolarTotal	N/A	N/A	N/A	N/A	4	20
Subtotal	50	100	135	300	150	318
Total PV related industries	200 <sup>a</sup>	300 <sup>a</sup>	580 <sup>a</sup>	800 <sup>a</sup>	1025 <sup>a</sup>	1243 <sup>a</sup>

<sup>a</sup> Some companies also produce other components or services, which have been excluded.

Sources : Schlatmann, 2005 ; Jongerden, 2007 ; Delta, 2010 ; ED, 2006 ; CBS, 2010 ; Kruithof, 2010 ; Internet Sources 48-83.

## 5. Solar thermal energy

### 5.1 Installed capacity 2009

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, 2010), the cumulative collector area in the Netherlands amounted to 755,000 m<sup>2</sup> in 2009 (in 2008, 704,000 m<sup>2</sup>), which is equivalent to 539 MW<sub>th</sub> (in 2008, 503 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).

### 5.2 Turnover 2009

Data of turnover of solar thermal energy companies is scarce. Holland Solar uses €1,000 per m<sup>2</sup> collector area as a rule-of-thumb for current solar thermal systems with glazed collectors (van Amerongen, 2010). Based on this figure, estimate for systems with unglazed collectors is €400 per m<sup>2</sup> collector area. The 45000 m<sup>2</sup> of glazed collector area and 29,000 m<sup>2</sup> of unglazed collectors installed in 2009 is equivalent to a turnover of €57 mln, whereas the collector area added in 2008, resp. 23,000 m<sup>2</sup> and 28,000 m<sup>2</sup> is equivalent to €37 mln turnover.

### 5.3 Employment 2009

Holland Solar (2009) also provides a yardstick for the employment as a function of the annual turnover in solar thermal energy. In one scenario, 8,000 employees are equivalent to €300 mln turnover. Based on this ratio, turnover of 2009 (€57 mln) is equivalent to 1500 employees, and the turnover of 2008 (€34 mln) is equivalent to 900 employees.

### 5.4 Summary

According to (CBS, 2010), the cumulative collector area amounted to 755,000 m<sup>2</sup> in 2009, which is equivalent to 539 MW<sub>th</sub>, supplying the energy equivalent of 0.90 PJ. Table 5.1 summarises the estimated turnover (approximately €57 mln) and the number of employees (~1,500) of companies engaged in solar thermal energy in 2009.

Table 5.1 *Key data turnover and employees solar thermal energy companies the Netherlands*

Solar thermal energy sector	Turnover 2007 [€mln]	Employees 2007	Turnover 2008 [€mln]	Employees 2008	Turnover 2009 [€mln]	Employees 2009
Total	~30	~800	~34	~900	~57	~1500

Sources: Holland Solar, 2007; Holland Solar, 2009; Amerongen, 2010; CBS, 2010.



## 6. 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. For an overview of biofuel plants see the website of Agentschap NL (Internet Source 84).

### 6.1 Abengoa

Abengoa (Spain) is commissioning a large bioethanol plant in Rotterdam. The plant has a capacity of 480 mln l (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 85).

### 6.2 Biodiesel Amsterdam

In 2009, BioDiesel Amsterdam bv has commissioned the BDI – BioDiesel International AG – of Austria to construct a multi-feedstock biodiesel plant in Amsterdam, with a contract value of €31 million. The plant – 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 – will have a capacity of 100,000 t (113 mln l) of biodiesel from cooking oil and animal fats. In addition to biodiesel, electricity and heat will also be extracted from a biogas plant. The number of employees is estimated at 10-24 (Internet Source 86-87).

### 6.3 Biodiesel Kampen

Biodiesel Kampen bv, established in 2006, produces biodiesel (FAME, Fatty Acid Methyl Ester) from used vegetable oils in a plant with a capacity of 125 mln l/yr (Internet Source 88).

### 6.4 BioDsl

Since September 2008, BioDsl bv in Breda produces 11.5 mln l/yr of biodiesel from used vegetable oils. The investment is estimated at €2 million (Internet Sources 89-90).

### 6.5 BioMCN

In July 2009, BioMCN started biomethanol production in Delfzijl. It consists of a conversion unit in which glycerol – by-product of biodiesel (FAME) plants – is converted into syngas, which is used in a two-train, 200,000 t/y methanol plant to produce biomethanol. The current number of employees is estimated at 30 (Internet Source 91-92).

### 6.6 Biopetrol Industries

By the end of 2008, Biopetrol Industries AG started up a biodiesel plant in Rotterdam, with a capacity of 400,000 t of biodiesel and 60,000 t/yr of glycerine. The plant will primarily use rapeseed oil as a feedstock (Internet Source 93). However, the plant was not in operation during 2009 (Te Buck, 2010).

## 6.7 Biovalue

In 2007, Biovalue bv started production of biodiesel in the Eemshaven. The 80,000 t/yr plant makes use of rapeseed oil as a feedstock. The number of employees was 28 (Internet Source 94). In 2010, Delta – parent company of Biovalue – decided to close the biodiesel plant (Internet Source 95).

## 6.8 'B2G' (biodiesel plant Neste Oil)

In May 2009, Neste Oil started construction on a biodiesel plant ('B2G'), based on its proprietary NExBTL technology, in Rotterdam, with a capacity of 800,000 t per year. The investment cost is estimated at €670 million. It will be commissioned in 2011, and will create over 100 jobs. The feedstock is palm oil, rapeseed oil, waste animal fat and palm oil (Internet Source 96).

## 6.9 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. Its number of employees is put at 12 (Internet Source 97).

## 6.10 Ecoson

In December 2007, Ecoson – a business unit of VION Food Group – 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).

## 6.11 Vesta Biofuels

Vesta Biofuels bv, 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 98). The plant will be in operation in 2011.

## 6.12 Nedalco

Royal Nedalco (Bergen op Zoom) currently supplies 10 mln l/yr of bioethanol to the transport sector. A plan to build a dedicated bioethanol plant in Sas van Gent has not been realised (Nedalco, 2007).

## 6.13 Bio Rights

Bio Rights bv is due to build a so-called 2<sup>nd</sup> generation bioethanol production plant in Hardenberg. The plant would have a production capacity of 6.5 mln l/yr of bioethanol (Internet Sources 99-100). Alternatively, the bioenergy plant will be used to supply biogas and/or electricity.

## 6.14 Rosendaal Energy

In 2008, Rosendaal Energy bv started producing biodiesel from rapeseed oil, soy oil, and palm oil in a 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 101-102).

### 6.15 Sunoil Biodiesel Emmen

In 2006, Sunoil Biodiesel started production of biodiesel in a plant at Emmen with a capacity of 80,000 l/yr (Internet Source 103). Its employment is estimated at 12 people.

### 6.16 Dutch BioDiesel

Since 2009, Argos produces biodiesel in a plant of its subsidiary Dutch BioDiesel bv at Rotterdam with a capacity of 250,000 t/yr. The investment cost of the plant has not been disclosed (Internet Source 104).

### 6.17 Sunoil ETBE

In 2006, Sabic Europe in Geleen started production of bio-ETBE (Ethyl Tertiary Butyl Ether) as an additive to gasoline. No data of production or investment is available (Internet Source 105).

### 6.18 Summary

According to (CBS, 2010), in 2009 biofuels sold in the Netherlands amounted to 15.4 PJ. Table 6.1 summarises the estimated turnover (~€140 mln) and indicative employment (~230 people) of biofuel companies in 2009.

Table 6.1 *Key data turnover and employees of biofuel companies in the Netherlands*

Company / City	Biofuel/ product	Turnover 2007 [€mln] <sup>a</sup>	Employees 2007	Turnover 2008 [€mln] <sup>a</sup>	Employees 2008	Turnover 2009 [€mln] <sup>a</sup>	Employees 2009
Abengoa / Rotterdam	Bioethanol				~5		~5
Bio Rights / Hardenberg	Bioethanol						
Nedalco / Bergen op Zoom	Bioethanol				~4		~4
BioMCN / Delfzijl	Biomethanol				~30		~30
Sunoil Biodiesel / Emmen	Biodiesel		~12		~12		~12
Biodiesel Kampen / Kampen	Biodiesel		~12		~12		~12
Biovalue / Eemshaven	Biodiesel		~28		~28		26 <sup>b</sup>
CleanerG / Zwijndrecht	Biodiesel				~12		~12
Ecoson, VION Food / Son	Biodiesel		~10		~10		~10
Vesta Biofuels/ Amsterdam	Biodiesel						
Rosendaal Energy / Sluiskil	Biodiesel				~25		~25
BioDsl / Breda	Biodiesel				~4		~4
Biopetrol Industries / Rotterdam	Biodiesel				~40		~40
BioDiesel Amsterdam / Amsterdam	Biodiesel				~5		10-24
'B2G' (Neste Oil) / Rotterdam	Biodiesel				~10		~10
Dutch BioDiesel / Rotterdam	Biodiesel						~25
Sunoil ETBE / Geleen	Bio-ETBE		~10		~10		~10
<b>Total</b>		~40	~70	~130	~210	~140	~230

a Data on turnover in 2008 and 2009, and employment and turnover in 2007 is hardly available by company.

B Delta, owner of Biovalue bv, decided to close the biodiesel plant in July 2009.

Sources : Nedalco, 2007 ; Rietveld, 2007 ; te Buck, 2010 ; Internet Sources 84-105.

## 7. 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, AFSG, BTG, W.K. Crone, Dordtech Engineering, HoSt, KARA Energy Systems, and Polow Energy Systems (SenterNovem, 2006). A separate paragraph refers to a new technology that is developed to enhance the conversion of (solid) biomass in heat and power, i.e. torrefaction.

### 7.1 Agrotechnology & Food Sciences Group (AFSG)

Agrotechnology and Food innovations Group (AFSG) of Wageningen University has the following activities:

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

### 7.2 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 106):

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

### 7.3 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.

### 7.4 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.

### 7.5 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. HoSt is also engaged in biogas projects.

## 7.6 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.

## 7.7 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.

## 7.8 Torrefaction initiatives

Recently, KEMA published on behalf of Agentschap NL (formerly SenterNovem) (Kleinschmidt, 2010). Table 7.1 provides some key data of initiatives/start-ups related to torrefaction.

Table 7.1 *Key data initiatives/startups with respect to torrefaction in NL*

Initiative	Development stage	Capacity [t/year]	Expected date of start-up	Number of employees
Biolake bv	N/A			
BO2GO	Permit			
E-clair Energy nv	Planning			
FoxCoal bv	Planning			
Qlyte bv (DSM)	Permit			
Stamproy (SGI)	Start-up	45,000	2010	< 4-6
Topell bv	Engineering	50,000-60,000	2011	6-8
Torr-Coal bv	Construction	35,000	2010	6-8

## 7.9 Summary

The primary energy equivalent of solid biomass in the Netherlands was 43.1 PJ in 2009 (CBS, 2010). The number of employees of the six companies in solid biomass (R&D, engineering and design, manufacturing) as well as the initiatives/start-ups engaged in torrefaction considered is estimated at 250 people in 2009, based on a conservative estimate of an average of about 35 employees per company, and the turnover is put at €65 mln per year (Table 7.2).

Table 7.2 *Key data turnover and employees 'solid biomass companies' in the Netherlands*

Company	TurnoverEmployees		TurnoverEmployees		TurnoverEmployees	
	2007 [€mln] <sup>a</sup>	2007 <sup>a</sup>	2008 [€mln] <sup>a</sup>	2008 <sup>a</sup>	2009 [€mln] <sup>a</sup>	2009 <sup>a</sup>
Agrotechnology and Food Sciences						
Biomass Technology Group (BTG)						
W.K. Crone						
Dordtech Engineering						
HoSt						
KARA Energy Systems						
Polow Energy Systems						
Torrefaction initiatives						
<b>Total</b>	<b>~60</b>	<b>~240</b>	<b>~62</b>	<b>~240</b>	<b>~65</b>	<b>~250</b>

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

Sources : SenterNovem, 2006 ; Internet Source 106 ; Kleinschmidt, 2010.

## 8. 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 Biogastechniek (SenterNovem, 2006). Also, an approximation of FTEs and turnover of operating and maintaining biogas plants in the Netherlands is presented.

### 8.1 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.

### 8.2 Brouwers BioEnergy

Brouwers BioEnergy bv, Leeuwarden (Friesland), supplies turnkey biogas plants at farm-scale. It 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.

### 8.3 Certified Energy

Certified Energy bv, 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.

### 8.4 OGIN Biogas

OGIN Biogas, 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.

### 8.5 Orgaworld Netherlands

Orgaworld Netherlands, Uden (Noord Brabant), is an innovative and fast growing company which is active in Canada and the Netherlands. It 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.

### 8.6 Thecogas Biogastechniek

Thecogas Biogastechniek bv (detached from PlanET, Germany, in 2009) in Lochem, specialised in the construction of biogas plants, has an estimated 40 employees (Internet Source 107).

## 8.7 Operation and maintenance of biogas plants

The employees and the turnover related to operation and maintenance of biogas plants in the Netherlands is estimated based on data of electricity generation based on biogas in (CBS, 2010) and the operation and maintenance costs of biogas based electricity in (Lensink et al, 2009), as exemplified in Table 8.1.

Table 8.1 *Employment and turnover related to biogas in the Netherlands based on statistics of biogas based electricity and operation and maintenance costs*

	Electricity generated [GWh]	Capacity [kW]	O&M costs [€kW]	O&M employment [FTE]	O&M turnover [million €]
Tip gas	98	14,916	240	89	3.6
Biogas sewage plants	143	21,766	220	120	4.8
Biogas agricultural companies	470	71,537	240	429	17.2
Other biogas	111	16,895	210	89	3.5
Total biogas	822	125,114		727	29

Sources : CBS, 2010 ; Lensink et al, 2009.

## 8.8 Summary

The primary energy equivalent of biogas in the Netherlands was 8.5 PJ in 2009 (CBS, 2010). The workforce of companies engaged in biogas plants and equipment (R&D, engineering and design, manufacturing) as well operation and maintenance of the biogas plants is estimated at approximately 1,000 people, and the turnover at €95 million (Table 8.2).

Table 8.2 *Key data turnover and employees of biogas (component) companies in the Netherlands*

	Turnover 2007 [€mln]	Employees 2007	Turnover 2008 [€mln]	Employees 2008	Turnover 2009 [€mln]	Employees 2009
BiogaS International Project						
Brouwers BioEnergy						
Certified Energy						
OGIN Biogas						
Orgaworld Netherlands		~40		~40		~40
Thecogas Biogastechniek						~40
Operation and maintenance	N/A	N/A	N/A	N/A		~ 730
Total	~60	~240	~62	~240	~95	~1,000

Sources: SenterNovem, 2006; Internet Source 107.



## 9. 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 Energy from Waste (Delfzijl), Attero (Moerdijk and Wijster), HVC Groep, OMRIN (Harlingen), SITA ReEnergy, Twence, and Van Gansewinkel Groep. Data of these companies is presented below.

### 9.1 ARN (Nijmegen)

ARN bv (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 108). Its turnover (related to MSW to power) is estimated at €26 million, and its (relevant) workforce at 105 employees.

### 9.2 Afval Energie Bedrijf Amsterdam

Afval Energie Bedrijf, owned by the municipality of Amsterdam, operates the largest complex of combustion of MSW for power (and heat) in the Netherlands (Internet Source 109). 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.

### 9.3 E.ON Energy from Waste

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

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

Attero – 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 111). Its turnover (related to MSW to power and heat) is estimated at €300 million, and its (relevant) workforce at 1,200 employees.

### 9.5 HVC Groep

HVC Groep, which is owned by 56 municipalities, operates MSW plants at Alkmaar and Dordrecht, of which that in Dordrecht does not produce electricity (Internet Source 112). 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 a, Table 8.1).

## 9.6 OMRIN (Harlingen)

OMRIN, owned by 31 municipalities in Friesland, operates a 22 MW<sub>e</sub> (net) MSW plant at Harlingen (Internet Source 113), 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.

## 9.7 SITA ReEnergy

SITA ReEnergy in the Netherlands – a subsidiary of SITA Corporation which is active in seven European countries – operates an MWS plant in Roosendaal which does not (yet) produce electricity or heat (Internet Source 114). 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.

## 9.8 Twence

Twence by 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 115). 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).

## 9.9 Van Gansewinkel Groep

Van Gansewinkel Groep (active in 7 countries) operates MSW plants in Duiven, Rijnmond and Rotterdam (Internet Source 116). The total capacity stood at 146 MW<sub>e</sub> (net), based on 650 kt/a of MSW until the end of 2009. After closure of the MSW plant at Rotterdam by the end of 2009, approximately 130 jobs were lost (VGWG, 2010). Turnover related to MSW to power and heat is estimated at €420 million, and the workforce at 1,680 employees (see footnote Table 9.1).

## 9.10 Summary

The primary energy equivalent of the biogenic part of MSW amounted to 14.4 PJ in 2009 (CBS, 2010). Table 9.1 presents estimates of the turnover in energy generation (electricity, CHP) based on MSW in 2008 and 2009 (assumed constant), i.e. €1,100 million (in 2007, €1,035 million), and the relevant workforce, i.e. approximately 4,250 people, including 'up-front' employment (in 2007, 4,000).

Table 9.1 *Key data turnover and employees of companies in MSW power in the Netherlands*

Company	Turnover	Employees	Turnover	Employees	Turnover	Employees
	2007 [€mln]	2007	2008 [€mln]	2008	2009 [€mln]	2009
Afval Energie Bedrijf (Amsterdam)			~92	~370		
ARN (Nijmegen)			~26	~105		
E.ON Energy from Waste (Delfzijl)			~28	~110		
Attero (RWE)			~300	~1,200		
HVC Groep (Alkmaar)			~134 <sup>a</sup>	~535 <sup>s</sup>		
OMRIN (Harlingen)			~26	~105		
Twence (Twente)			~64 <sup>a</sup>	~145 <sup>a</sup>		
Van Gansewinkel Groep (Duiven, Rijnmond and Rotterdam)			~420 <sup>c</sup>	~1,680 <sup>b</sup>		
<b>Total</b>	~1,035	4,000	~1,100	4,250	~1,100	4,250

a 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.

B Approximately 80% of turnover and employment allocated to Netherlands, 35% of which for MSW power.

Sources: Internet Sources 108-116.

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

Eight 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, Eneco, and the Membrane Technology Group of the University of Twente for ‘Blue Energy’.

### *Bluewater*

Bluewater, an international company in offshore production systems (Internet Source 117), provides engineering and consultancy services to Tocordo for tidal energy devices (see below).

### *Tocordo*

Tocordo 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 118).

### *Ecofys/Eneco*

Ecofys, currently a subsidiary of Eneco (Rotterdam), developed a pilot tidal stream power unit called C-Energy in the Westerschelde (Internet Source 119).

### *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 120).

### *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 121).

### *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 122). Also the Membrane Technology group of the University of Twente is engaged in R&D on membranes for Blue Energy (Internet Source 123).

### *Summary*

The electricity generated by hydropower was 0.35 PJ<sub>e</sub> (98 GWh), based on 37 MW<sub>e</sub> capacity (CBS, 2010). Table 10.1 provides estimates of turnover and employment of the companies in 2008 and 2009 (assumed constant).

Table 10.1 Key data turnover and employees hydropower related companies in the Netherlands

	Turnover 2007 [€mln]	Employees 2007	Turnover 2008 [€mln]	Employees 2008	Turnover 2009 [€mln]	Employees 2009
Aggregate	1.2	25	1.5	30	1.5	30

Sources: Internet Sources 117-123.

## 11. Geothermal energy

### 11.1 Deep geothermal energy

The so-called 'Platform Geothermie' (Internet Source 124) counts 53 members, among which companies engaged in deep geothermal energy, utilities and municipalities. The Ministry of Economic Affairs published an overview of geothermal energy licenses in 2009 (Table 11.1).

Table 11.1 *Licenses for geothermal energy production granted in 2009*

License holder	License	Date of entry	[km <sup>2</sup> ]
Gemeente Den Haag	Den Haag	03-04-09	36
P.N.A. van Dijk Beheer B.V.	Brielle	10-04-09	7
Van Schie Vastgoed B.V.	Ens	15-04-09	7
J.W.M. Scheffers cs	Honselersdijk	20-06-09	5
Gedeputeerde Staten van Overijssel	Koekoekspolder	20-06-09	33
Plantenkwekerij L. Ammerlaan B.V.	Bleiswijk 2	23-06-09	5
A+G van den Bosch B.V.	Bleiswijk 3	23-06-09	2
A.P.M. Ammerlaan cs	Bleiswijk 4	23-06-09	7
De Bleiswijkse Zoom 1 B.V.	Bleiswijk 5	23-06-09	5
R.H.M. Scheffers	Monster	24-06-09	4
Jamuflo B.V.	De Kwakel	26-06-09	18
D.T.M. Grootcholten	Naaldwijk	26-06-09	4
Houdstermaatschappij Oosterom B.V.	Waddinxveen	16-07-09	14
S.S. Beheer B.V.	Middenmeer	16-07-09	24
AC Hartman Beheer B.V. cs	Sexbierum	17-07-09	11
G. Kahlman	Delft	28-08-09	61
Gemeente Brielle cs	Brielle 2	13-10-09	29
Tuinbouwbedrijf Wijnen B.V.	Californië 1	13-10-09	7
Tuinbouwontwikkelingsmij B.V.	Dinteloord	13-10-09	21
De Ruiter Seeds Production NL B.V.	Lansingerland 2	13-10-09	6
Wayland Nova B.V.	Maasbree	13-10-09	22
W.P.K. Beheer B.V.	Made	13-10-09	33
Van Kester-Grootcholten Beheer B.V.	Middenmeer 2	13-10-09	15
A.P.M. Zuidgeest cs	Honselersdijk 2	14-10-09	4
N.W. Duijvestijn cs	Honselersdijk 3	14-10-09	7
Coop. Bloemenveiling FloraHolland U.A.	Naaldwijk 2	14-10-09	4
A.P.M. Zuidgeest cs	Maasdijk	21-10-09	6
Themato Productie B.V.	Berkel en Rodenrijs 1	19-11-09	6
Ce-Ren Beheer B.V.	Heemskerk	09-12-09	11
Harting-Vollebregt Beheer B.V.	De Lier	09-12-09	23
Harting-Vollebregt Beheer B.V.	De Lier 3	09-12-09	11
Kwekerij de Westhoek B.V. cs	Maasland	18-12-09	9
Total			457

Source: EZ, 2010.

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 environmental 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 produc-

tion well, in order to delay cooling of the geothermal source. According to (CBS, 2010), the amount of primary energy conserved by deep geothermal energy stood at 0.158 PJ in 2009 (0.106 PJ in 2008). Table 11.2 provides data of turnover and employment in geothermal energy.

*Table 11.2 Key data turnover and employees geothermal energy companies in the Netherlands*

	Turnover 2007 [€mln]	Employees 2007	Turnover 2008 [€mln]	Employees 2008	Turnover 2009 [€mln]	Employees 2009
Companies engaged in drilling (equipment)			~13	~15	~25	~40
Companies engaged in design, engineering, consultancy, etc.			~20	~ 45	~40	~ 110
Utilities (ENECO, E.ON Benelux, Essent)			~3	~30	~5	~40
Suppliers			~4	~30	~8	~90
Other, e.g., TU Delft, TNO/NITG, etc			~15	~50	~20	~80
<b>Total</b>	~45	~85	~55	~170	~98	~360

Source: Van Heekeren, 2009 and 2010.

## 11.2 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. The primary equivalent of shallow geothermal energy was 1.838 PJ (CBS, 2010).

## 12. Overview and conclusions

This study presents an overview of turnover and employment of Dutch companies engaged in wind energy, photovoltaic electricity (PV), solar thermal energy, biofuels, solid biomass, biogas, and municipal solid waste (MSW), small hydro and related technologies, geothermal energy, and geothermal heat pumps. As data on 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 2009, the combined on- and offshore wind capacity in the Netherlands stood at 2,221 MW<sub>e</sub>, supplying 16.48 PJ<sub>e</sub> or 4.578 TWh to the grid. The turnover of wind energy companies in the Netherlands is estimated at €820 million and the number of employees at 1,350.

### *Photovoltaic power (PV)*

The total installed capacity of PV in the Netherlands stood at 68 MW<sub>e</sub> by the end of 2009, supplying 0.166 PJ<sub>e</sub> or 0.046 TWh to the grid. Based on a detailed overview of PV related companies and activities, the turnover of PV companies is estimated at €1,025 million, and the number of employees at 1,240.

### *Solar thermal energy*

The total installed capacity of solar thermal energy in the Netherlands stood at 539 MW<sub>th</sub> by the end of 2009, supplying the energy equivalent of 0.90 PJ. The turnover of companies engaged in solar thermal energy is estimated at €57 million, and the number of employees at 1,500 in 2009.

### *Biofuel production*

Companies producing biodiesel, bioethanol, and biomethanol produced the energy equivalent of 15.4 PJ in 2009. The turnover in 2009 is tentatively estimated at €350 million, and the number of employees is estimated at 400.

### *Solid biomass*

The primary energy equivalent of solid biomass was 43.1 PJ in 2009. Based on fragmented data, the turnover is estimated at €65 million, and the number of employees is put at 250.

### *Biogas*

At least six companies produce equipment for biogas plants. In 2009, the primary energy equivalent of biogas was 8.5 PJ. The turnover is tentatively estimated at €95 million, and the number of employees including operation and maintenance of biogas plants is put at 1,000.

### *Municipal Solid Waste (MSW)*

Nine companies are engaged in energy generation from MSW, resulting in a primary energy equivalent of the biogenic fraction of 14.4 PJ in 2008. The turnover of these companies is estimated at €1,100 million, and the number of employees at 4,250.

### *Hydro power and related technologies*

There are about eight companies active in hydro power or related technologies. In 2009, the total hydro capacity stood at 37 MW<sub>e</sub>, supplying 0.35 PJ<sub>e</sub> or 0.098 TWh to the grid. The turnover is estimated at €1.5 million and the number of employees is put at 30.

### *Geothermal energy*

According to (CBS, 2010), the amount of primary energy conserved by deep geothermal energy stood at 0.158 PJ in 2009. There are tens of companies engaged in (deep) geothermal energy in the Netherlands. The turnover of these companies is tentatively estimated at €50 million, and the number of employees at 95. For shallow geothermal energy – storage of heat and cooling based on shallow aquifers – and for geothermal heat pumps, no (reliable) data were retrieved.

All in all, renewable energy sources considered in the present study represent a total primary equivalent of 121.8 PJ in 2009. Table 12.1 shows that the total turnover of RE companies in the Netherlands is estimated at €3.4 billion in 2009 (in 2008, €2.7 billion). The total workforce of RE companies in the Netherlands is estimated at 10,200 employees in 2009 (in 2008, 8,000). Based on (ADEME, 2009) the ratio between indirect and direct employment may be 0.88. Therefore, as elucidated in Appendix B, the total direct and indirect employment of companies engaged in renewable energy in the Netherlands may be estimated at 19,200 people.

*Table 12.1 Key data turnover and employees of companies engaged in RE in the Netherlands*

Renewable energy sector	Turnover 2006		Turnover 2007		Turnover 2008		Turnover 2009		
	Employees	Turnover	Employees	Turnover	Employees	Turnover	Employees	Turnover	
		[€mln]		[€mln]		[€mln]		[€mln]	
Wind energy		430	625	550	890	700	1,150	820	1,350
Photovoltaic energy		200	300	328	525	580	800	1,025	1,243
Solar thermal energy		N/A	N/A	30	800	34	900	57	1,500
Biofuels		N/A	N/A	40	70	130	210	140	230
Solid biomass		N/A	N/A	60	240	62	240	65	250
Biogas		N/A	N/A	60	240	62	240	95	1,000
Municipal solid waste		N/A	N/A	1,035	4,000	1,100	4,250	1,100	4,250
Small hydro & tidal		N/A	N/A	1.2	25	1.5	30	1.5	30
Geothermal energy		N/A	N/A	45	85	55	170	98	360
Geothermal heat pump		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
<b>Total</b>		N/A	N/A	2,165	6,875	2,725	8,000	3,400	10,200

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 3.8% of the primary energy use in 2009). 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. To which extent 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

ALD	Atomic Layer Deposition
CBS	Statistics Netherlands (Centraal Bureau voor de Statistiek)
CIGS	Copper Indium Gallium Selenide
CPL	Cell Plating Line
CPV	Concentrating photovoltaic power
CTC	Composite Technology Centre
DPL	Direct Plating Line
EWEA	European Wind Energy Association
FAME	Fatty Acid Methyl Ester
FTE	Full Time Equivalent
MSW	Municipal Solid Waste
OEM	Original Equipment ManufacturerPV Photovoltaic electricity
R&D	Research and Development
RE	Renewable Energy
RGS	Ribbon Growth on Substrate
RTP	Rapid Thermal Processing
SDP	Submerged Deepwater Platform

## Appendix A Direct and indirect employment RE companies

In (ADEME, 2009) a relationship is introduced between direct and indirect employment of companies active in renewable energy (RE). The ratio between indirect and direct employment in France is put at 0.88. If we transfer this ratio to the aggregate table (Table 11.1) we get the following total employment by renewable category (Table A.1).

*Tabel A.1 Key data direct plus indirect employment of RE companies in the Netherlands*

Renewable energy sector	Turnover 2006 [€mln]	Employees 2006 (direct and indirect)	Turnover 2007 [€mln]	Employees 2007 (direct and indirect)	Turnover 2008 [€mln]	Employees 2008 (direct and indirect)	Turnover 2009 [€mln]	Employees 2009 (direct and indirect)
Wind energy	225	1,177	550	1,674	680	2,172	800	2,534
Photovoltaic energy	200	564	328	987	580	1,504	1,025	2,337
Solar thermal energy	N/A	N/A	19	1,504	22	1,692	36	2,820
Biofuels	N/A	N/A	40	132	130	395	140	432
Solid biomass	N/A	N/A	60	451	62	451	65	470
Biogas	N/A	N/A	60	451	62	451	65	1,880
Municipal solid waste	N/A	N/A	1,035	7,520	1,100	7,990	1,100	7,990
Small hydro & tidal	N/A	N/A	1.2	47	1.5	56	1.5	56
Geothermal energy	N/A	N/A	45	160	50	320	50	677
Geothermal heat pump	N/A	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>2,165</b>	<b>12,926</b>	<b>2,725</b>	<b>15,031</b>	<b>3,398</b>	<b>19,197</b>