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Geothermal Energy Use, Country Update for The Netherlands

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ABSTRACT

This article deals with the Dutch developments and policies in the domain of geothermal energy. This article is an update of the article from 2013 (Van Heekeren and Bakema, 2013) and gives the developments in the period 2013-2016. At present 14 DGE projects are established, with a combined capacity of 127 MWth. Heat production (GJ) from DGE has doubled in the last two years, with a 59% growth in 2015. In 2015 more than 2000 ATES and 50.000 GHPS system are in operation.

1. INTRODUCTION

This article deals with the Dutch developments, status quo and policies in the domain of geothermal energy. It includes deep geothermal energy (DGE) and shallow geothermal (SGE) (including underground storage (UTES) and ground source heat pumps (GHPS)). The 2nd section deals with the status 2015, i.e. the actual figures for geothermal installations. Section 3 briefly presents the history and policy backgrounds, while Section 4 attempts to forecast some developments. Each section has a subsection for direct use applications and a subsection for shallow geothermal..

2. STATUS 2015

2.1 Status Direct Use Geothermal

Projects. In 2015 one new deep geothermal project (doublet nr 14, Vierpolders) was completed (but the project was not yet operational at the end of the year). And drilling started on nr 15 (CLG – Californië Lipzig Gielen). Figure 1.

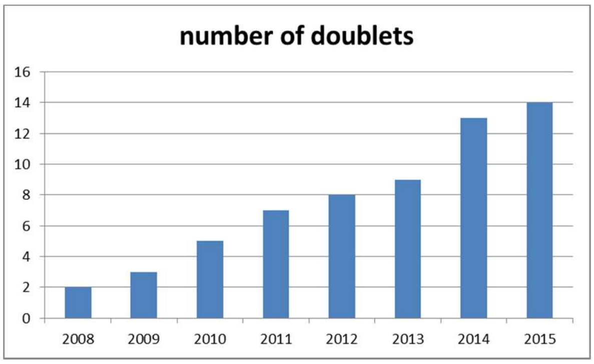

Figure 1: Number of deep geothermal doublets.

Capacity. In 2015 the combined capacity of Dutch installations increased from 103 MWth to an estimated 127 MWth, the last figure includes the estimate for the Vierpolders plant that will be on stream in 2016 (and may have to be adjusted once production tests have been finalised). The CLG plant is not included in this estimate as it is still under construction. Fig 2.

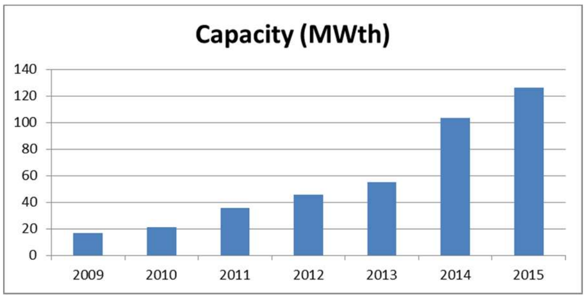

Figure 2: Combined capacity of Dutch deep geothermal doublets in MWth.

The average capacity of Dutch installations increased somewhat as some of the 2014 projects became fully operational in 2015 and recently drilled projects tend to have a larger capacity than the average of earlier projects. Figure 3.

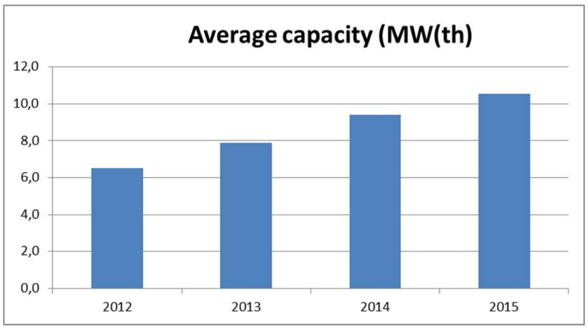

Figure 3: Average capacity of Dutch deep geothermal doublets in MWth.

The combined effect of these three factors led to a 59% increase of heat production in 2015 compared to 2014. By far the most important production increase was however caused by the projects that were completed in 2014 and therefore started to contribute significantly in 2015. A similar overall production increase had occurred in 2014 and deep geothermal production more than doubled in the last two years (and counting). Figure 4.

For 2016 the expectations are that CLG and possibly one or even two new projects will be drilled, leading to a double digit growth in 2016.

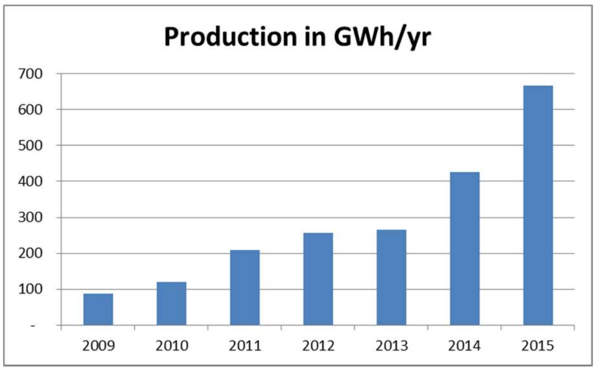

Figure 4: Combined production levels of Dutch deep geothermal doublets in GWh.

2.2 Status Shallow Geothermal Energy

Shallow geothermal energy consists of GSHP (Ground Source Heat Pumps) and UTES (Underground Thermal Energy Systems). Prevalent in underground thermal energy storage are open systems (groundwater wells, called Aquifer Thermal Energy Storage, (ATES)), while closed-loop systems (Borehole Thermal energy Storage (BTES)) are rare. Typical temperature ranges for storing energy are between 7 – 17 ° C. Heating is done in combination with heat pumps.

Figure 5 shows the number of registrated ATES systems in the last eight years (2008-2015). It is expected that in 2020 there will be 3000 ATES systems which together pump more than 300 million m3 each year and save up to 3000 TJ (Figure 6). BTES systems were not registrated up to 2014; it's expected that 5 % of the UTES systems are BTES. Main applications for UTES are utility buildings (offices, hospitals). In general ATES systems are used for the projects with more than 5.000 $m^{2.}$ floor space.

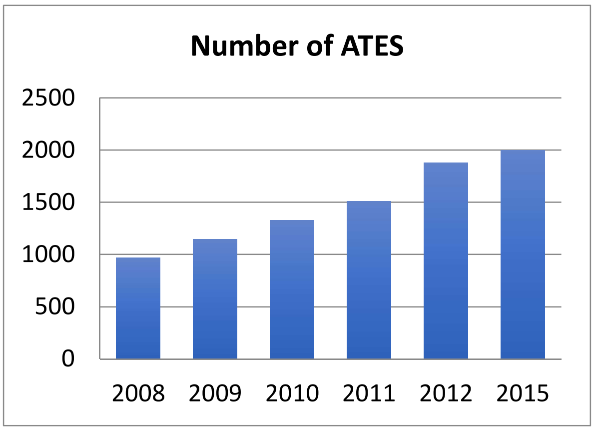

Figure 5: Development of Aquifer Thermal Energy Storage projects.

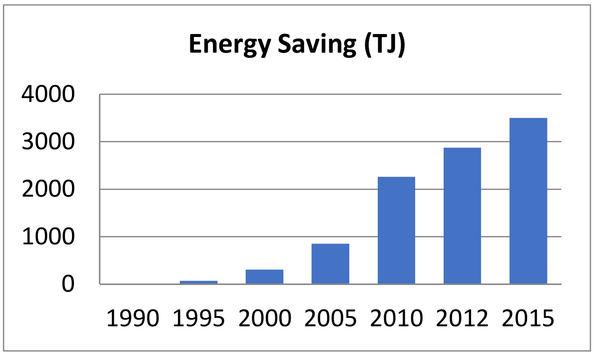

Figure 6: Development of energy savings (in TJ) by shallow geothermal energy applications; source: CBS, 2014, Renewable energy in the Netherlands.

In the period 2013-2015 the number of new UTES systems has dropped with more than 50 %. The main reasons are the economic crises and the overcapacity of office buildings (vacancy 8.000.000 m^2 floor space) . Due to more strict energy saving regulations for new and existing buildings, it's to be expected that the number of UTES will reached higher growth rates in the coming years. The number of new high (50 – 80 °C) temperature storage systems was very low the last five years. New markets for HTES are the combination with geothermal energy and district heating (40 °C) systems. Due to low temperature heating systems the new HTES systems can have lower storage temperatures (50 °C) than the systems build in the nineties (90 °C).

In 2015 the Dutch heat pump industry claimed 50.000 installed GSHP-systems. Each year the market is growing 10 %. The main market for GHPS is the housing sector (heating only). Growth rates will increase due to the large growth of new build homes and the transition towards gas-free areas. On the other hand due to strict regulations on underground systems, the market moves to air sourced heat pumps.

3. POLICY DEVELOPMENT 2013-2015

3.1 Policy Development Direct Use Geothermal 2013-2015

The main trends in energy policy in recent years were a) the growing concern for subsidence caused by natural gas production in the northern parts of the country and b) the perception that the Dutch renewable energy targets for 2020 (REAP = Renewable Energy Action Plan) were highly likely to be unachievable. The seismic events caused by subsidence caused the government to cut nearly 50% of natural gas production from the northern provinces. At the same time a national discussion was started on how to achieve the renewable energy targets.

One obvious outcome was that renewable heat was still a relatively unexplored domain. For deep geothermal a new policy document was published 'Geothermal Acceleration Plan for Horticulture' (ministry of Economic Affairs, July 2014).

This Acceleration Plan identified a new (lower) target of 5 PJ (roughly 1.400 GWh) deep geothermal energy production in 2020 (in horticulture, at present effectively the only significant market for direct use geothermal energy in The Netherlands). The document also indicated some policy options to achieve this target.

A much welcomed initiative was the establishment of a public-private partnership for knowledge development, called 'Knowledge Agenda'. Both governance and funding is public-private. The partnership assigns (small scale) contracts for consulting and research actions. Results are always in the public domain.

However, the main policy instrument for deep geothermal in The Netherlands remains the SDE+ (Stimulering Duurzame Energie, basically a Feed in Premium instrument). The SDE+ conditions gradually improved in recent years, both in terms of the contribution per kWh and in terms of scope of the regulation (to include triplets and 'dual play' wells - gas and geothermal).

With respect to the policy instrument of government guarantee on drilling risks the budget was extended and some technical improvements were introduced.

The policy instruments certainly encouraged increases in capacity and production levels of new plants as can be seen in section 2. However, the main goal of the policy improvements was to increase the number of new drillings from roughly two doublets per year to five. And in this respect the efforts were frustrated by financing difficulties.

In recent years the financing issues proved to be the main bottleneck – even in situations that the business case for new plants was in other aspects satisfactory. This bottleneck is fairly difficult to address as the horticultural sector – the main market for deep geothermal - is generally already heavily financed. Also natural gas prices are currently (early 2016) low, undermining the sense of urgency of investors in renewable energy.

3.2 Policy Developments Shallow Geothermal energy 2013-2015

SGE is economical very feasible for the utility sector and has besides some tax advantage no subsidiaries. To promote SGE in the housing sector, a new subsidy for heat pump will be introduced in 2016. The support will start at € 2.500 up to 10 kW and an extra € for each kW added.

Due to the new degree on SGE systems (Wijzingsbesluit bodemenergiesystemen, July 2013) some major changes have occur. From October 2014 all the professionals and companies involved in SGE will be obligate to certification. This is effected in different BRL's (Beoordelingsrichtlijnen). These guidelines describe the quality of design, construction, management and maintenance of the underground-part of the SGE system. More than 200 companies have already been certified (www.rwsleefomgeving.nl). Although companies see the big advantage of the certification, it also leads to larger administrative costs. Therefore some part of the SGE business will move to other (less sustainable) technologies like air sourced heat pumps. To achieve a level playing fields, the SGE branch organisation (www.bodemenergienl.nl) is promoting certification for all sustainable heating and cooling technologies.

A second major change in the new legal framework is the licensing for BTES systems. To get a licence all new BTES systems have to make an environmental risk assessment in which the influence on other SGE has to be calculated. This new regulation has led to better underground spatial planning. Due to the success of SGE and the expected growth, municipalities are making "SGE master plans". Up to 2015 more than 25 master plans are made for areas like business areas, inner cities and hubs for data centres.

3.3 Future Policy development Direct Use Geothermal

At the end of 2015 a study into this financing problem was started. One of the possible solutions may be the extension of the existing government guarantee scheme to the production phase. As it now covers only drilling risks (i.e. geological risks of less production than forecasted & audited).

Another policy question is how to extend the current market for deep geothermal to include industrial (higher temperature) applications and district heating for residential areas.

On a more general level the sector needs to reassess the overall perspectives and targets. The last (and only) general deep geothermal National Action Plan dates from 2011 and is up for renewal –in terms of targets, policies and communication efforts.

3.4 Future policy development for SGE

In 2016 the Dutch Government will launch the new policy on underground planning (STRONG, Structuurvisie ondergrond). STRONG deals with all the activities in the underground. For SGE this results in more focus on spatial planning, integration with other underground use (remediation) and protection of drinking water bearing layers.

4. CONCLUSIONS

For deep geothermal energy is it safe to say that both the number of projects and the amount of energy produced is increasing steadily. Policy instruments greatly help this development, but financing is still the biggest hurdle. The envisaged increase in the number of projects has therefore not been achieved yet. Due to the economic crises the growth of SGE has slowed down. Still SGE is a fully accepted and economical interesting technology. It will play a major role in the energy transition the next decade.

REFERENCES

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Acknowledgements

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Tables A-G

Table A: Present and planned geothermal power plants, total numbers

Not applicable

Table B: Existing geothermal power plants, individual sites

Not applicable

Table C: Present and planned geothermal district heating (DH) plants and other direct uses, total numbers

	Geothermal DH plants		Geothermal heat in agriculture and industry		Geothermal heat for individual buildings		Geothermal heat in balneology and other **	
	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)	Capacity (MW_{th})	Production (GWh_{th}/yr)
In operation end of 2015 *			115	667				
Under constru-ction end 2015			25					
Total projected by 2018	20	116	185	1074				
Total expected by 2020	55	320	225	1305				

Table D1: Existing geothermal district heating (DH) plants, individual sites

Not applicable

Table D2: Existing geothermal direct use other than DH, individual sites

Locality	Plant Name	Year commis-sioned	Cooling **	Geoth. capacity installed (MW_{th})	Total capacity installed (MW_{th})	2015 produc-tion * (GWh_{th}/y)	Geoth. share in total prod. (%)
Heerlen	Heerlen	2007		0,5		2	
Bleiswijk	VDB 1&2	2008		9,0		54	
Lansingerland	VDB 3&4	2009		7,3		32	
Pijnacker	Ammerlaan	2012		6,9		41	
Pijnacker	Duijvestijn	2012		8,0		24	
The Hague	Aardwarmte Den Haag	2012		0,0		0	
Koekoekspolder	Koekoekspolder	2012		7,4		49	
Honselersdijk	Green Well Westland	2012		11,4		34	
Venlo/ Grubbenvorst	Wijnen	2013		11,2		88	
Heemskerk	Floricultura	2014		5,5		32	
Middenmeer	Agriport warmte VoF	2014		14,1		106	
Middenmeer	Agriport Wieringermeer Geothermie VoF	2014		13,8		78	
De Lier	VoF Geothermie De Lier	2014		16,0		138	
Vierpolders	Vierpolders	2015		15,7		0	
total				126,7		678	

** If cold for space cooling in buildings or process cooling is provided from geothermal heat (e.g. by absorption chillers), please mark with Y (for yes) or N (for no) in this column. In case the plant applies re-injection, please indicate with (RI) in this column after Y or N.

Explanation to table E: 'Shallow geothermal' installations are considered as not exceeding a depth of 400 m and (natural) geothermal source temperatures of 25 °C. Installations with geothermal source temperatures >25 °C and depth >400 m should be reported in table D1 or D2, respectively. Distribution networks from shallow geothermal sources supplying low-temperature water to heat pumps in individual buildings are not considered geothermal DH *sensu strictu*, and should be reported in table E also.

Table E: Shallow geothermal energy, ground source heat pumps (GSHP)

	Geothermal Heat Pumps (GSHP)[1], total			New (additional) GSHP in 2014		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2014	45986	1160	4595[2]	2510	96	5
Projected total by 2018[3]	60000	1500	6000			

Table E2: Shallow geothermal energy, Underground Thermal Energy Storage (UTES)

	Aquifer Thermal Energy Storage (ATES)			Borehole Thermal Energy Storage (BTES)[4]		
	Number[5]	Capacity[6] (MW_{th}) Heat / Cold	Production (GWh_{th}/yr) Heat / Cold	Number	Capacity (MW_{th}) Heat / Cold	Production (GWh_{th}/yr) Heat / Cold
In operation end of 2015[7]	1976	H: 988 C: 988	H: 997[8] C: 537	100	H: C:	H:50 C:27
New (additional) in 2014 *	125	H: 62 C: 62	H: 66 C: 7	10	H: C:	H:3 C:0.3
Projected total by 2018[9]	2600	H: 1300 C: 1300	H: 1297 C: 698	150	H: C:	H:65 C:35

[1] GSHP, ATES and BTES

[2] Total heat production from the HP

[3] Annual growth 10 % (estimation)

[4] No data available. Estimation, 5 % of the ATES systems

[5] Number of actual licenses for ATES (LGR- database), October 2015

[6] No data available, Estimation, average size of ATES 500 kW cooling/heating

[7] October 2014

[8] CBS, hernieuwbare energie annual report 2014, September 2014

[9] 10 % annual growth (estimation)

Table F: Investment and Employment in geothermal energy

	in 2015 *		Expected in 2018	
	Expenditures ** (million €)	Personnel *** (number)	Expenditures ** (million €)	Personnel *** (number)
Geothermal electric power	0			
Geothermal direct uses	63	530	85	710
Shallow geothermal	35	400	50	600
total				

* If 2014 numbers need to be used, please identify such numbers using an asterisk

** Expenditures in installation, operation and maintenance, decommissioning

*** Personnel, only direct jobs: Direct jobs – associated with core activities of the geothermal industry – include "jobs created in the manufacturing, delivery, construction, installation, project management and operation and maintenance of the different components of the technology, or power plant, under consideration". For instance, in the geothermal sector, employment created to manufacture or operate turbines is measured as direct jobs.

Table G: Incentives, Information, Education

	Geothermal el. power	Geothermal direct uses	Shallow geothermal
Financial Incentives – R&D	None	DIS	limited
Financial Incentives – Investment	none	RC	Only for small HP
Financial Incentives – Operation/Production	none	FIT	None
Information activities – promotion for the public	limited	Limited, via geothermie.nl	www.bodemenergienl.nl www.sikb.nl
Information activities – geological information	no	www.nlog.nl	www.wkotool.nl www.dinoloket.nl
Education/Training – Academic	universities	universities	www.bodemenergienl.nl
Education/Training – Vocational	none	none	none

Key for financial incentives:

DIS	Direct investment support	FIT	Feed-in tariff	-A	Add to FIT or FIP on case the amount is determined by auctioning
LIL	Low-interest loans	FIP	Feed-in premium		
RC	Risk coverage	REQ	Renewable Energy Quota	O	Other (please explain)