Geothermal Energy Use, 2013 Country Update for the Netherlands

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ABSTRACT

This article deals mainly with the Dutch developments and policies in the domain of deep geothermal energy: history, policy background and status quo. A separate section (5) describes the developments in the domain of Shallow geothermal Energy (SGE).

1. BACKGROUND AND HISTORY

In the Netherlands, the use of geothermal energy started in the early 80ties. In first instance, the objective was to store solar energy for space heating in winter. Later on, the scope of application broadened to the storage of thermal energy (both heat and cold) from other sources than solar and to geothermal heat pumps. Because of the facts that in the 80ties the R&D efforts were focused on larger scale applications (building applications instead of individual houses), and that in the Netherlands shallow aquifers can be found almost everywhere, many projects started using groundwater wells to store and extract thermal energy.

Research efforts in the 80ties were also directed at deeper geothermal wells and direct use applications, but these efforts remained unrewarding at that time as production costs per energy unit were inevitably higher than fossil fuel costs. It should be mentioned that the Netherlands produces significant amounts of natural gas and in these days CO_2 emissions were not perceived to be as important as they are today.

At the beginning of this century the setting started to change. Gas prices were rising sharply and public interest in Carbon Light energy options increased. Renewed interest in deep geothermal energy in the beginning of this century led to the implementation of the first deep projects, mostly for the heat demand of greenhouses. Policies followed later and are still struggling to keep pace with practical developments.

To understand current geothermal policies one should incorporate the context of the wider renewable energy settings. Early attempts to develop deep geothermal energy in the period 1975 – 2000 were basically both unsuccessful and costly, an unfortunate combination. An exploration drilling in the 80ties to 3.000 meter in Asten, province of Noord-Brabant produced only a few cubic meter per hr of water and the second drilling in Asten was cancelled.

It was (correctly) assumed that a second attempt really had to be failure proof, as the funding organisations were not amused. Consequently the total setup of the second attempt near Naaldwijk in the province of Zuid-Holland in the 90ties was exceptionally thorough – with corresponding huge costs estimates. So this second project was abandoned by the ministry for financial reasons in the predevelopment stage. All in all some 20 mln euro was spent in 1975 – 2000 with remarkably little results. Gas and oil prices at the end of the century were low and showed no trend of increases that could make geothermal (or any other form of renewable energy) profitable.

The government attitude in respect to the renewed geothermal interest in the early years of this century was therefore justifiably chilly. It proved to be nearly impossible to insert geothermal energy in the existing policy frameworks. The governmental mind-set towards the geothermal community was described as Mushroom Management (Keep them in the dark and feed them shit). It was thanks to the tenacity (or simply Dutch stubbornness) of just a few persons both in and outside government circles, that nevertheless the first projects emerged in this frosty policy environment.

The first ‘deep’ geothermal project (Minewater project in Heerlen, Limburg, 2007) targeted the lukewarm water in mineshafts of a former coal mine.

This Minewater project resembled in many aspects the ‘normal’ ATES (Aquifer Thermal Energy Storage) system. The legal difference was the depth. Some of these old mineshafts were at depths of 700 meter. In legal terms (i.e. the Mining Act) deep geothermal starts at a depth of > 500 meter. This was therefore the first deep geothermal project in legal terms.

Picture 1: Minewater project Heerlen (2008); the first Mining Act licence for geothermal energy.

After this stepping stone project the first Direct Use application was drilled in Bleiswijk in 2007/2008 by a tomato grower for heating 7 hectare of greenhouses – later extended to 14 hectare. This horticultural project created wide interest. But the announcement of a second doublet at the end of 2008 – by the same investor – really drove the message home in horticultural circles, that this option should perhaps not be ignored. Applications for exploration increased rapidly to 103 per January 1st 2013 (Ref 2).

Picture 2: Horticultural project at Grubbenvorst/-Venlo (2012); triplet for geothermal energy at depths of 1.600 – 2.600 meter.

2. POLICY DEVELOPMENT

The Netherlands had the advantage of a sophisticated Mining Act. Though mainly developed for oil and gas the Mining Act also covers geothermal energy at depths of > 500 meter. An important factor is that all data collected during drilling and production becomes public information after a five year period. As several thousand deep boreholes have been drilled for oil and gas over the years the geothermal community has access to an incredible wealth of free and accessible data on which to base project development.

But otherwise the legal framework had to be build up from scratch. Three major policy improvements were achieved in the period 2008 to 2012. First a governmental risk guarantee scheme was developed to insure the geological risk of insufficient production volumes. Although the scheme was – and still is - unsatisfactory in some respects, it was nevertheless crucial for the financing of the projects.

A second major step was the publication of the ‘National Action Plan for Geothermal Energy’ (2011, Ref 4). Though far from visionary, the document was a solid analysis of the strengths and weaknesses and included an analysis of the potential (11 – 14 PJ per year) that could be achieved in 2020.

The third step was the inclusion in 2012 of sustainable heat in the Feed In scheme (SDE+) that existed for other forms of renewable energy. The incentive for geothermal heat (in 2012) amounted to 5,4 euro per GJ (1,5 eurocent per kWh of heat). Over 30 applications were submitted in the first year (2012). Some 830 mln euro – approximately half of the Dutch budget for renewable energy – was allocated to deep geothermal projects.

The impact of this budget claim was such that the Dutch wind energy lobby persuaded the ministry to install – in 2013 - a ceiling or cap on the eligible energy produced by geothermal projects. This cap discourages the development of larger projects (> 18 MW_{th}). The absurdity and senselessness of this ‘Capping’ policy was pointed out in strong terms and the debate will continue. But as long as the cap is in force the 2020 potential will have to be adjusted to more modest levels – roughly estimated to be 30 to 40% lower than the 11 to 14 PJ target of the 2011 National Action Plan Geothermal Energy.

3. STATUS QUO 2013

The period 2009 up to mid-2013 witnessed the emergence of several new projects bringing the total number of deep geothermal installations to nine (of which two were in the process of start-up). Two new projects started drilling in March and April 2013 and it is expected that construction of some more wells will start in 2013. An overview of the sites on the map of the Netherlands can be found on the Platform Geothermie website (Ref 1). A description of each project – in Dutch – with the core information (temperatures, depth, production volumes) is presented there as well.

Total capacity at the end of 2012 was 40 MW_{th} and the yearly production is roughly 200 GWh (heat).

All wells except the first Minewater project are Direct Use applications. The temperatures of the nine current deep wells vary between 60 ^{0}C (1.600 meter) and 87 ^{0}C (2.900 meter). The well temperatures confirm the expected average temperature gradient of 3,1 ^{0}C per 100 meter as stated e.g. by Lokhorst & Wong (2007, Ref 3). Production volumes vary roughly between 100 and 200 m^3 per hour. All wells - except the Minewater project - are aquifer based systems and the only product is heat (no cooling or electricity).

So far the Dutch scene more or less resembles the conditions found in France and Germany. However, there are also some striking differences.

a) The major application is horticulture. Nine out of the eleven current and on-going projects (will) provide heat to greenhouses. Six projects are owned and operated by individual horticultural companies and the other three wells are operated by a joint venture between several adjacent horticultural firms. Some operators supply heat to buildings as well (or are planning to do so in the future).
b) In most wells some dissolved natural gas was found in volumes of usually < 1 kg per m^3. Therefore every new well is nowadays equipped from the start with gas separation and cleaning units. During testing of the wells the gas is flared. As soon as stable conditions have been reached and more or less accurate estimates can be made of (future) gas volumes, the gas is cleaned and used in heaters or cogeneration equipment.
c) As a consequence of these dissolved gas conditions the Health & Safety precautions have been sharply increased in recent years and the drilling conditions are now identical to the oil & gas standards.

Picture 3: Temporary gas separation & cleaning equipment (The Hague, 2012).

4. OUTLOOK FOR THE FUTURE

The current development course shows strongly conflicting influences. The impact of new projects in 2013 and 2014 will probably be significant. However these projects sourced from the period that exploration licences were granted in large numbers and the detrimental effects of the capping of the Feed-in scheme were not yet visible. The number of exploration licences has gone down strongly and is expected to stabilise on a level of five to ten per year.

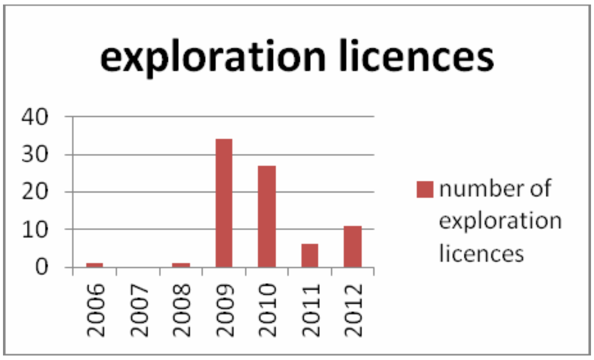

Table 1: Graph of exploration licences 2006 – 2012.

The horticultural sector - that used to be the major source of applications for exploration licences – has to meet with increasing demands and obligations to comply with more stringent safety precautions. This bites into the category of the fairly straightforward owner-user wells that supply greenhouses. Especially smaller projects suffer as the costs of stricter safety measures have to be carried by a lower heat production.

On the other end of the spectrum the large projects, e.g. groups of greenhouses, district heating systems and cogeneration projects will suffer from current ill-conceived government policies that discourage the larger projects.

So there is a fairly bright short term outlook caused by pre 2012 policies and a rather bleak prospect for mid and longer term development in the Netherlands. This outlook reflects the impact of government policies on the development of geothermal energy.

5. SITUATION SHALLOW GEOTHERMAL

The Shallow Geothermal Energy (SGE) market in the Netherlands is a national market. Designers, installers and consultants are, besides a few exceptions, all Dutch. It is expected that more than 200 companies are involved in the SGE market. There are no numbers present of the exact amount. The total turnover is estimated to be about € 45 to 55 million per year.

Prevalent in underground thermal energy storage are open systems (groundwater wells, called aquifer thermal energy storage, ATES), while closed-loop systems can mainly be found in ground source heat pump plants.

Table 2 shows the number of systems in the last five years (2007-2011). The number of boreholes for BTES is estimated, because these systems are not registered. This number also does not say anything about the number of systems, because one system can have more than one borehole.

year	ATES (open systems)	amount of water (mln m^3/yr)	BTES closed-loop (boreholes)
2007	819	117	23,000
2008	969		28,000
2009	1,149		33,000
2010	1,329		38,000
2011	1,509	229	43,000
2012	1,650*		48,000*

* expected

Table 2: Development of shallow geothermal systems

The size of the ATES systems in the Netherlands varies a lot. The smallest systems are in the order of a few cubic meters per hour. The biggest running system is the one of the Technical University of Eindhoven (TUE) and has a capacity of 3.000 m^3 per hour and 12 million m^3 per year.

The size of the closed-loop systems varies from one single loop for one house up to more than 1.000 loops for a complete residential area (Schoenmakers-hoek in Etten-Leur has 1.200 houses with 1 loop per house and some utility).

In the past 25 years, there was only one year (around 1998) that there was a subsidy for SGE systems. The success of SGE in the Netherlands is more the result of having the right people in the right place at the right time:

In the first phase (1980-1990) the new technique started up:

- there were some people with ambition and courage;
- the government proposed a prohibition on the discharge of cooling water;
- the first demonstration projects were made.

In the second phase (1990-2003) the first commercial projects were realised:

- The insecurity in the market of using a new kind of technique was taken away:
  - there was a risk fund for the first couple of projects;
  - the government supported research to the long term effects of SGE so that the market and government had a better idea of what they were actually doing.
- Some well running pilot projects were set up that gave a good example.
- Education of clients and consultants, courses and handbooks about SGE were set up.
- The Groundwater law was changed, so that ATES had a legal framework.
- There was a lot of marketing and promotion by means of information meetings and folders and websites for SGE.
- In this period the Kyoto Protocol was signed by the Netherlands so the urgency for energy saving and sustainable energy was even more clear. This resulted in the Building Act, which included regulations about energy saving for buildings.

In the third phase (2003 to present) there has been a real breakthrough for the technique:

- The government took more action to take away insecurities by doing more research on the effects in the subsurface and implementing a certification program for drillers.
- Also, other users of the subsurface (industry, drinking water) have been taken into account more and more and combinations between SGE and these other users are found.
- Clients, contractors and system operators are being educated as well.
- A process has been started for changing the law, so that BTES systems will be included in the legal framework as well (paragraph 6.1). Also all parties (consultant, installers, contractors) have to be certified.
- The provinces include SGE in the provincial policies and more and more municipalities are incorporating SGE in the subsurface planning.
- Good working systems are guaranteed by a good control on permits and energy saving of a system.

On 1 July 2013, a new decree will be effectuated, the Decree on SGE systems (Wijzigingsbesluit bodemenergiesystemen). The goal of this decree is to stimulate the use of SGE systems. Also, it provides some legal ‘tools’ to establish regulations for closed-loop systems. Furthermore, the decree has the following goals:

- creating a more equal position for ATES and BTES (closed loop);
- organizing the subsurface so that it can be optimally used;
- securing the quality of construction of SGE systems by means of certification;
- better implementation of SGE system in construction projects.

One of the main changes is that due to this Decree, certification for professionals and companies will be obligatory. This is effectuated in the BRL 11.000 and related protocol 11.001. This guideline describes the requirements on the quality of design, construction, management and maintenance of the underground part of SGE systems. It contains the requirements on training and work experience of the personnel that will work with SGE systems.

Currently, SGE is not legally anchored in the (subsurface) spatial planning. But more and more this becomes necessary, because the subsurface is becoming crowded, mainly in city centers. Therefore, in busy areas so-called SGE master plans are made. By means of a master plan it is possible to arrange small or large scale areas for the implementation of SGE systems (figure 4). Through organizing the utilization of the subsurface, interference between systems can be prevented and an optimal use of the subsurface can be guaranteed.

Figure 4: Example of a master plan in Amsterdam (Minervahaven/Houthavens)

The target to achieve by 2050 nearly thermal energy neutrality for the built environment is feasible if on a regional scale a balance of energy demand and supply can be realized. At the building level, the demand is minimized through insulation and heat / cold recovery and, where possible, through use of local thermal storage systems and heat pumps. The remaining part could be supplied at district level. This requires a long term vision of the use of geothermal energy, both individually and collectively, and investment in district heating and cooling networks and storage systems. This has implications for the integrated design at district level, the use and anticipation of individual systems, the variable supply from various other sources such as waste heat and cold and (temporary) overflow of other renewable energy sources. New management and operation models and the associated timely adjustment of laws and regulations are therefore necessary.

The effects on the primary energy supply in the Netherlands are really large. Up to 300 PJ of efficient generation based on shallow geothermal energy is a realistic expectation. The industry sector forecasts a turnover of 1.0-1.5 bln € in 2020, providing work for 4000-7000 persons.

REFERENCES

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4 Actie Plan Aardwarmte (April 2011, Dutch language). http://geothermie.nl/fileadmin/user_upload/documents/bestanden/wetgeving_en_beleid_oud/actieplan_aardwarmte_EL_I.pdf

Tables A-G

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

*Geothermal power plants are not available in the country.

Table B: Existing geothermal power plants, individual sites*

*Geothermal power plants are not available in the country.

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 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)
In operation end of 2012	39	202				
Under construction end of 2012	15	75				
Total projected by 2015	86	452				

* Includes uses for greenhouses

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

No data disclosed

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

	Geothermal Heat Pumps (GSHP), total			New GSHP in 2012		
	Number	Capacity (MW_{th})	Production (GWh_{th}/yr)	Number	Capacity (MW_{th})	Share in new constr. (%)
In operation end of 2012 [1]	29 300 [2]	745	880	5000		
Projected by 2015						

[1] Data for 2010, from Eur´ObserER, Heat Pump Barometer 2011

[2] Estimated for 2012: 1650 ATES systems and 48 000 borehole heat exchangers (closed loops); this is the number of boreholes, not of systems, as those might comprise more than one borehole

Table F: Investment and Employment in geothermal energy

	in 2012		Expected in 2015	
	Investment (million €)	Personnel (number)	Investment (million €)	Personnel (number)
Geothermal electric power	0	0	0	0
Geothermal direct uses	20	450	30	600
Shallow geothermal	50			
total	**70**			

Table G: Incentives, Information, Education

	Geothermal el. power	Geothermal direct uses	Shallow geothermal
Financial Incentives – R&D	None	0 to1 mln/yr	
Financial Incentives – Investment	None	Fiscal investment incentives and RC	Fiscal investment incentives
Financial Incentives – Operation/Production	Irrelevant (FIP only in theory)	FIP (important, order of magnitude is several hundred mln euro/year)	
Information activities – promotion for the public	None	Information activities are for > 90 % private initiatives, mostly by Platform Geothermie www.geothermie.nl	Bodemenergie NL webpage www.bodemenergienl.nl
Information activities – geological information	None	All mining data are public after 5 years	Available from Geologische Dienst Nederland – TNO at webpage: www.dinoloket.nl/
Education/Training – Academic	None	Starting at TU Delft	Courses given by Bodemenergie NL, courses by Stichting PAO, TU Delft
Education/Training – Vocational	None	none	Courses given by Bodemenergie NL

Key for financial incentives:					
DIS	Direct investment support	RC	Risc coverage	FIP	Feed-in premium
LIL	Low-interest loans	FIT	Feed-in tariff	REQ	Renewable Energy Quota