TECHNOLOGY FACTSHEET

Geothermal heat production, shallow depth (>500 , < 1500 meter)

Date of factsheet	25-7-2021
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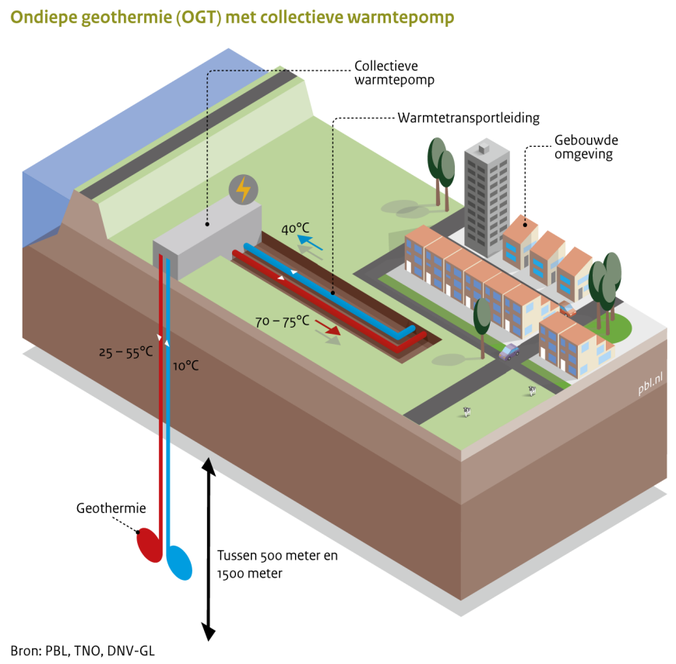
Sector	Agriculture: Horticulture Built environment
ETS / Non-ETS	Non-ETS
Type of Technology	Renewable
Description	This technology represents the application of heat production from shallow geothermal formations in The Netherlands and delivery of heat to the built environment. A typical project exists of two wells, a production and an injection well, also called doublet. The wells are either fully vertically drilled or with a curvature. The bottom of the wells is situated in a water holding layer, and it lies between 500 and 1500 meters below ground level. In the Netherlands, water holding layers of sand, clay or sandstone are found in this range (geological formation "Noordzee groep"). The temperature of the extracted warm water varies typically between 25 and 55^{o}C depending on the depth and the type of layer. Salty warm water (brine) is pumped up through the production well, but needs thermal uplifting to a useful temperature level of 65-75^{o}C through means of a heat pump. After heat exchange in the collective heat pump, the cooled brine water is injected back underground through the injection well. In principle there is no loss of water. The injection temperature lies around 10^{o}C . The installation consists of two bore holes, usually in steel with liners, a production pump (Electric Submersible Pump, ESP), an above ground collective heat pump and an injection pump. In some cases, anti-scaling prohibitors may be required and need to be added in the brine flow. Although systems with low temperature heat delivery to buildings, each equipped with an individual heat pump, are considered for the SDE++, we choose as a reference a system with a collective heatpump. A heat network or a heat distribution network may be required, but it is not part of this factsheet. The connection to a network as well as a heat transfer station between the heat pump and the distribution network are included in the reference system and thus in the cost figures.



Bron: PBL, TNO, DNV-GL

TRL level 2020	TRL 8
	Most of the techniques applied (drilling, ESP, heat pump) are mature and commercially available. So far (2020) no commercial application of shallow geothermal heat extraction has been developed in the Netherlands, hence a TRL level 8 is chosen. As this technology is supported by the renewable subsidy scheme in the Netherlands (SDE++), it is expected that from 2021 onwards, projects could be implemented.

TECHNICAL DIMENSIONS

	Functional Unit		Value and Range								
Capacity	MWth		8.00								
			8.00			-			8.00		
Potential	NL	MWth	Current			2030			2050		
			-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
Market share	NL	%	-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*

Capacity utlization factor	1.00
Full-load running hours per year	3500-6000
Unit of Activity	MWh th/year
Technical lifetime (years)	15.00
Progress ratio	
Hourly profile	yes
Explanation	Typical size of a shallow geothermal project for the built environment is considered to be 8 MWth in the SDE++2021 advice. Full load hours depend on the application: an application in the horticultural sector or feeding into a large heat network may be 6000 hours or more, for an application in a small scale or new heat distribution network, 3500 hours is the default. The potential for the Netherlands is expected to be large given the fact that most subsurface consists of sand and clay layers up to 1500 meter depth.

COSTS

Year of Euro	2015

	Euro per Functional Unit	Current			2030			2050		
Investment costs	mln. € / MWth	1.96			-			-		
		1.96	–	2.03	*Min*	–	*Max*	*Min*	–	*Max*
Other costs per year	mln. € / MWth	-			-			-		
		Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
Fixed operational costs per year (excl. fuel costs)	mln. € / MWth	0.16			-			-		
		0.11	–	0.16	*Min*	–	*Max*	*Min*	–	*Max*
Variable costs per year	mln. € /	-			-			-		
		Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*

Costs explanation	Investment cost include the underground installation, heat excahnger, heat pump, connection to a heat distribution network and a heat transfer station. Operational costs include the electricity costs of the heat pump based on a 6000 hours system. Operational costs for a 3500 hours per year system would amount to 111 euro 2020/kWth. The costs are based on the SDE++2021 advice, prices are converted from euro2020 to euro2015 using a factor of 1.02. Shallow geothermal installations are not yet implemented in the Netherlands which makes it difficult to provide cost projections. Economy of scale could lead to cost reductions, but advanced materials, location-specific requirements and higher safety requirements could lead to cost increases.

ENERGY IN- AND OUTPUTS

	Energy carrier	Unit	Current			2030			2050		
Energy carriers (per unit of main output)	*Main output:* Heat	PJ	-1.00			-			-		
			-1.00	–	-1.00	*Min*	–	*Max*	*Min*	–	*Max*
	Electricity	PJ	0.27			-			-		
			0.27	–	0.27	*Min*	–	*Max*	*Min*	–	*Max*
	Geothermal heat	PJ	1.00			-			-		
			1.00	–	1.00	*Min*	–	*Max*	*Min*	–	*Max*
		PJ	-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*

Energy in- and Outputs explanation	For a 8 MWth system with 6000 hours per year, SDE++ assumes 12980 MWh electricity consumption. For a 3500 hour system, 7570 MWh is assumed.

MATERIAL FLOWS (OPTIONAL)

	Material	Unit	Current			2030			2050		
Material flows			-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*
			-			-			-		
			Min	–	*Max*	*Min*	–	*Max*	*Min*	–	*Max*

Material flows explanation	

EMISSIONS (Non-fuel/energy-related emissions or emissions reductions (e.g. CCS)												
	Substance	Unit	Current			2030			2050			
Emissions			-			-			-			
			Min	–	Max	Min	–	Max	Min	–	Max	
			-			-			-			
			Min	–	Max	Min	–	Max	Min	–	Max	
			-			-			-			
			Min	–	Max	Min	–	Max	Min	–	Max	
			-			-			-			
			Min	–	Max	Min	–	Max	Min	–	Max	
Emissions explanation	There may be disolved gas produced together with the warm brine water, in case of a pressurised system, this gas will stay disolved. If not pressurised, a gas separation unit may be required. The recoverd gas is often combusted on site in a boiler or gas engine. How much gas, and thus CO2, is co-produced through geothermal energy is currently under research by TNO.											
OTHER												
Parameter	**Unit**		**Current**			**2030**			**2050**			
			-			-			-			
			Min	–	Max	Min	–	Max	Min	–	Max	
			-			-			-			
			Min	–	Max	Min	–	Max	Min	–	Max	
			-			-			-			
			Min	–	Max	Min	–	Max	Min	–	Max	
			-			-			-			
			Min	–	Max	Min	–	Max	Min	–	Max	
Explanation												
REFERENCES AND SOURCES												
1	SDE+2021: EINDADVIES BASISBEDRAGEN SDE+ 2021 , PBL 2021											