TECHNOLOGY FACTSHEET

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LOW TEMPERATURE HEAT NETWORKS (DISTRICT HEATING)

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Sector	Households
	Other sectors
ETS / Non-ETS	Non-ETS
Type of Technology	Network
Description	This factsheet presents generalized information and figures on heat networks, for households and other sectors, supplying low temperature (LT) heat. LT heat networks belong to the newer generations of district heating that make use of renewable heat sources such as undeep geothermal, low temperature waste heat from industry, solar thermal plants and (aquifer/mine/ground) heat storage/heat buffers (Lund et al., 2014). Waste heat can also come from cooling processes in commercial buildings such as data centers and supermarkets (CE, 2018). Heat is supplied at lower temperatures than in regular high temperature heat networks. The main benefit of using lower temperatures is that distribution losses are reduced since the temperature difference with the surroundings is lower (CE, 2018). In this factsheet, LT-heat means heat supplied to end-consumers that has a temperature level below 55ºC, which means it is below the supply temperature of regular high temperature heat networks (70-90ºC). A temperature classification for heat networks could be as follows: indicate heat supplied to end-consumers between 55ºC and 70ºC as medium temperature heat, 40-55ºC as low temperature heat, and below 40º as very low temperature heat (Ecofys and Greenvis, 2016). In a LT network the heat supplied to the end consumer has a temperature of below 55ºC and the return temperature is about 20-30ºC (Ecofys and Greenvis, 2016). There are also very low temperature networks that deliver heat below 40ºC to end consumers. Whether LT or even very low T heat is suitable for space heating depends on the heating system and insulation level of the considered building. For hot tapwater a (booster) heat pump or similar installation (including hot water storage/buffer) is needed in order to upgrade the temperature to above 55-60ºC (CE, 2018). Water temperatures below 55-60ºC are not suitable for hot tap water due to the current legislation around Legionella prevention (Ecofys and Greenvis, 2016). The temperature lift can also be achieved by using a collective (centralized) heat pump. LT-heating systems are required in dwellings, which requires sufficient insulation, at least corresponding to a dwelling with energy label B (Ecofys and Greenvis, 2016). A LT-heating system consists of low temperature radiators (wall heating) and/or under floor heating. Costs for these measures are included in this factsheet (see 'Other'). Due to higher insulation standards for new buildings and refurbishment of existing buildings more and more buildings will be suitable for low temperature heating in future years. A distinction can be made between large and small scale heat distribution networks, the first supplying more than 150 TJ of heat per year (ECN, 2017). Currently, low temperature networks in the Netherlands are small scale. A typical small scale heat network consists of heat source(s), back up heat source(s) and a distribution network including connections to the dwellings. Inside a dwelling a heat delivery kit (with heat exchanger) is installed in order to transfer hot water to the central heating system inside the dwelling. Depending on sort of network (size, type of heat source) one or more substations could be a component of a small scale network as well. This factsheet includes all network components from source to end user including heat delivery kits. The energy in- and output section does only include heat losses in the distributin network itself. It does not include heat losses of the heat source and in the heating system inside the building. Other possible designs for low temperature networks are: 1) heat cascading , 2) dwellings connected to the return flow of the primary heat transport pipeline of a HT network and 3) forming a separate cluster of dwellings supplied with a low temperature heat source inside a HT heat network. (Ecofys and Greenvis, 2016).
TRL level 2020	TRL 9
	Commercial technology. There are three LT-heat networks supplying heat to dwellings in the Netherlands in 2016 (Ecofys and Greenvis, 2016). Connecting buildings to LT heat networks is in practice more feasible for new buildings with a high insulation level than it is for existing buildings. Supplying LT-heat to existing buildings poses a challenge due to insulation requirements, modifications to the heat delivery systems inside buildings, and booster heat pumps. Hence the TRL is lower.

TECHNICAL DIMENSIONS

	Functional Unit		Value and Range								
Capacity	TJ		5.40								
			0.54	-	13.50						
			Current			**2030**			**2050**		
Potential	TJ	NL	-			-			-		
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Market share	%	Number of households	0.01			-			-		
			0.01	-	0.01	*Min*	-	*Max*	*Min*	-	*Max*

Capacity utlization factor	-
Full-load running hours per year	-
Unit of Activity	-
Technical lifetime (years)	40.00
Progress ratio	-
Hourly profile	Yes
Explanation	There were three small low-T networks supplying heat to dwellings in the Netherlands in 2016 (Ecofys and Greenvis, 2016). In total, around 1.000 dwellings are connected to these networks. One of these is the Mijnwater project in Heerlen, which is also an example of an open network where multiple sources are connected. The heat source is waste heat from an abandoned coal mine pit in combination with heat storage. It is a very low temperature network since the supply temperature is only 28ºC and return temperature 16ºC (Ecofys and Greenvis, 2016). Some 200,000 m2 of floor space (buildings and houses) are connected. This comprises, until now, 270 homes, various office buildings, (primary) schools, day nurseries, sports hall and two supermarkets (Mijnwater project, 2018). Another project is the Smart Climate Grid in Roosendaal. The heat source is a waste incinerator. Heat supply temperature is 40ºC and return temperature 25ºC (Ecofys and Greenvis, 2016). This network has a connection to the school building ROC Kellebeek and to 30 new dwellings (Lenteakkoord, 2018). Finally, there is a low temperature network in Duindorp (Scheveningen) that uses seawater of 11ºC. A central heat pump is used in case the temperature is lower. There are 750 dwellings connected to this network. Each dwelling has a separate heat pump that further increases the temperature to 45ºC for floor heating and 55ºC to 65ºC for domestic hot water (Ecofys and Greenvis, 2016). The capacities given in the 'capacity' section above indicates heat supply to dwellings only. The annual heat delivery of the existing networks is based on the assumption of 18 GJ heat demand per dwelling. This 18 GJ is the average heat demand for an A label dwelling based on VESTA model of PBL (PBL/VESTA, 2017). There are also collective heat and cold storage networks (collective aquifer thermal energy storage or ATES networks) in the Netherlands. These supplied about 0,7 PJ in 2015 (ECN, 2017). The heat demand of consumers varies in time and the heat supply of the heat sources is load following. In low-T heat networks, renewable heat sources are used which are not always available. To reach 100% security of supply, there are different alternatives. For example, (gas-fired) back-up boilers, heat storage/buffers or a connection to a large scale heat network (Ecofys and Greenvis, 2016). Technical potential is limited by the amount of buildings in the stock that can be upgraded to a sufficient level of insulation combined with a low temperature heating system. The technical lifetime (of the pipelines) of a low-T heat network is about 40 years (CE, 2018).

COSTS

Year of Euro	2015

	Euro per Functional Unit	Current			2030			2050		
Investment costs	mln. € / TJ	469.15			431.61			375.32		
		469.15	-	469.15	431.61	-	431.61	375.32	-	375.32
Other costs per year	mln. € / TJ	-			-			-		
		Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Fixed operational costs per year (excl. fuel costs)	mln. € / TJ	16.56			15.24			13.25		
		16.56	-	16.56	15.24	-	15.24	13.25	-	13.25
Variable costs per year	mln. € / TJ	-			-			-		
		Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*

Costs explanation	There is limited costs information available about LT heat network in the Netherlands. Costs presented above are for a collective aquifer thermal energy storage (ATES) network. The heat source is collective ATES system combined with a central collective heat pump. All heat is produced by the heat pump and auxiliary electric heating. This system is only possible for homes that have an A label or better and have the possibility for a LT-heating system based on VESTA model (PBL/VESTA, 2017). Assumption is an average heat demand per dwelling of about 18 GJ per year which is the heat demand of an A label dwelling (based on VESTA model). In total 200 dwellings are connected to the network and there is a heat supply of 3,5 TJ per year. The investment consists of the distribution network including connections to the dwellings. The costs in the table above are expressed per TJ. The fixed operational costs per year consists of maintenance costs for the different components of the heat network (PBL/VESTA, 2017). Costs can be further reduced by innovation and design optimization. In the calculation for the Dutch climate agreement proposal (INEK/Energieakkoord, 2018) cost reductions for heat networks in 2030 are assumed between 0% and 15% (avg. 8%). In the VESTA model (VESTA/PBL, 2017) a cost reduction between 17%-24% (avg. 20%) is assumed in the long run. Cost reduction factors used above are estimates within these ranges.

ENERGY IN- AND OUTPUTS

	Energy carrier	Unit	Current			2030			2050		
Energy carriers (per unit of main output)	*Main output:*	PJ			-1.00			-1.00			-1.00
	Heat		-1.00	-	-1.00	-1.00	-	-1.00	-1.00	-	-1.00
	Heat	PJ			1.11			1.09			1.06
			1.11	-	1.11	1.09	-	1.09	1.06	-	1.06
		PJ			-			-			-
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
		PJ			-			-			-
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*

Energy in- and Outputs explanation	Energy in- and outputs associated with the network losses are given here. Losses associated with the heat production are not included as they belong to the heat source. Heat losses in networks depend on temperature of the heat in comparison to the temperature of the surroundings. Heat losses occur in primary transport pipelines and in secondary distribution networks (e.g. convection, conduction and radiation losses). In case of high temperature networks it is well known that heat losses in the secondary distribution network can be substantial. One of the reasons to use low temperature networks is that losses in the networks are reduced. Network losses in a high-T network generally amount to 10-30% (on average about 25%) (ECN, 2017) This is depending on length of network/how densely the network is clustered. Ecofys and Greenvis (2016) indicate that at a temperature reduction from 90°C to 50°C heat losses in the pipes decrease by 4/7 because of the smaller temperature difference with the ground through which the pipe goes. Based on this, heat losses in low temperature networks are assumed at 11% on average. In the future losses may decrease further due to innovation and design optimization.

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											

OTHER

Parameter	Unit	Current			2030			2050		
Low temperature radiators	Euro2015/dwelling			1,498			1,124			749
		828	-	2,441	621	-	1,831	414	-	1,221
Floor heating	Euro2015/dwelling			7,192			5,394			3,596
		4,952	-	12,375	3,714	-	9,282	2,476	-	6,188
Insulation costs to label B	Euro2015/dwelling			7,991			5,993			3,996
		4,995	-	17,980	3,746	-	13,485	2,497	-	8,990
	Euro2015/dwelling			-			-			-
		Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*

Explanation	A difference with high-T heat networks is that there are additional measures needed for dwellings to make them suitable for low temperature heating. These measures consist of insulation measures, low temperature radiators (wall heating) and/or under floor heating. Low temperature heating is only suitable for a dwelling with a minimum insulation level of B (Ecofys and Greenvis, 2016). Costs of the three measures vary depending on the type of dwelling: highest costs per dwelling are for free standing houses and lowest costs for apartments. The costs of these measures for terraced houses fit somewhere in between. Costs for low-T radiators for a terraced house are 1.500 euro (excl. VAT) (Ecofys and Greenvis, 2016). Typical costs for under floor heating for a terraced house are around 7.200 euro (excl. VAT) (Ecofys and Greenvis, 2016). In the table above, the costs for 2020 are converted to euro2015 using an inflation factor (100/100,11). In the table above costs are excluding VAT. Insulation costs for a terraced house with a year of construction before 2000 are around 8.000 euro (excl. VAT) for an insulation level corresponding to energy label B. For an apartment dwelling (unit) with year of construction before 2000 insulation costs to label B amount to 5.000 euro (excl. VAT). Insulation costs to label B for a free standing house can be up to 18.000 euros (excl. VAT) (adapted from Ecofys and Greenvis, 2016). In the calculations for the Dutch climate agreement proposal, a cost reduction range for insulation measures and low-T heating is assumed of 15%-50% by 2030 (INEK/Energieakkoord, 2018). Assumed here is a 25% cost reduction in 2030 and a 50% cost reduction in 2050.

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