TECHNOLOGY FACTSHEET

SMALL-SCALE HEAT NETWORKS HIGH TEMPERATURE - HOUSEHOLDS - DISTRICT HEATING

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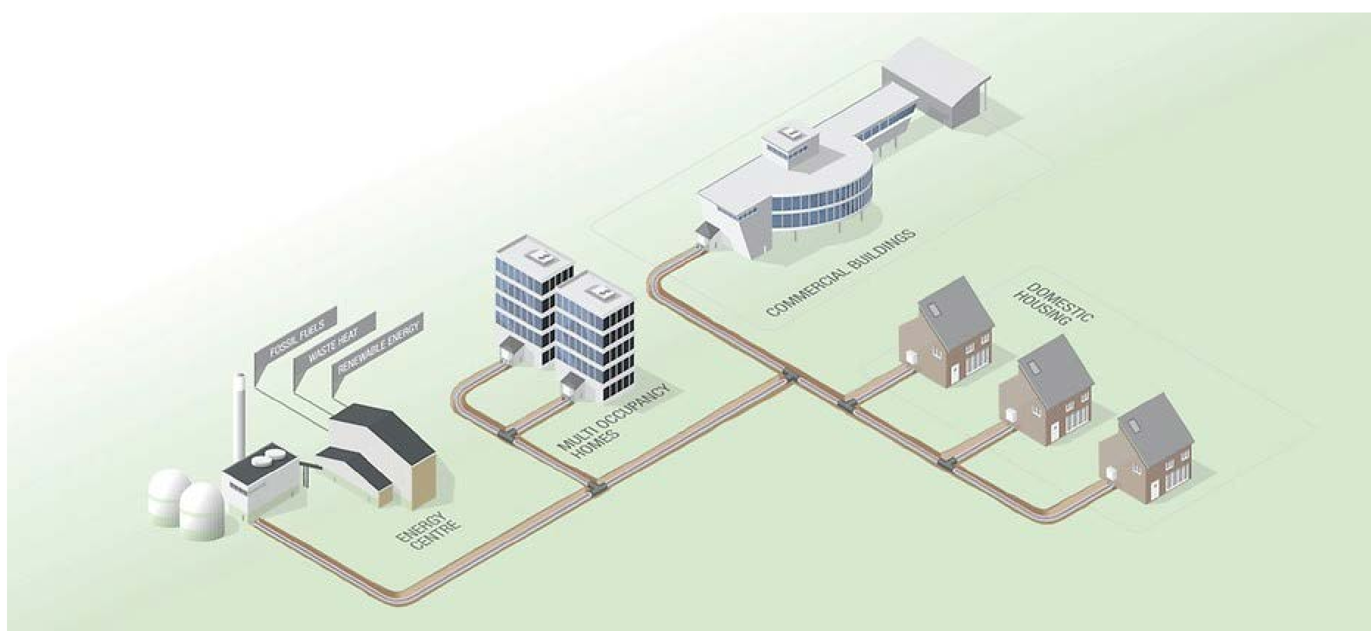
Sector	Households
	Other sectors
ETS / Non-ETS	Non-ETS
Type of Technology	Network

Description

This factsheet presents generalized information and figures on small scale heat networks for households also known as district heating. In district heating homes and other end consumers receive heat from a central heat source via an underground network of hot water pipes. A distinction can be made between large and small scale heat distribution networks, the latter supplying ≤ 150 TJ per year (ECN, 2017). This factsheet focuses on small scale heat networks. Small scale district heating typically consist of main heat source(s), back-up boiler(s), distribution substations 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. This factsheet considers all components of the heat network. It does not include heat losses of the main heat source(s) and heat losses of the heating systems inside the dwellings. Costs in the costs section are excluding costs of the main heat source and main substation.

In contrast to a large scale network there typically is no primary transport pipeline in a small scale network. Whether there are substations or not depends on the sort of network (e.g. depending on size of the distribution network). In case of a heat network with a biomass heat source with about 1.000 connected dwellings, there can be a main substation with heat exchanger and multiple distribution substations. In other cases, there can be only distribution substations (so no main substation with heat exchanger) or no substations at all.

Heat for small scale heat networks can originate from amongst others gas-fired CHP-units, heat only boilers (gas-fired), biomass heat plants, waste incinerators, collective heat and cold storage (a.k.a. collective aquifer thermal energy storage/ATES), geothermal sources and industrial waste heat sources. In 2015, heat for small scale district heating mainly originated from gas-fired CHP-units (ECN, 2017). Hot water delivered to consumers typically has a temperature of 90°C and the return flow to heat source has a temperature of 70°C (ECN, 2015).



Source: https://www.rehau.com/gb-en/micropages/discover-the-rehau-hub/discover-knowledge/district-heating--heat-networks-cpd

TRL level 2020	Substance
	Commercial technology. In the Netherlands there were over 50.000 connections to a small scale district heating network in 2015 (ECN, 2017).

TECHNICAL DIMENSIONS

	Functional Unit		Value and Range									
Capacity	TJ											9.13
					3.40		-					150.00
Potential	TJ	NL	Current			2030			2050			
					-			-			-	
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*	
Market share	%	Share of households			0.64			1.64			3.64	
			0.64	-	0.64	1.64	-	1.64	3.64	-	3.64	
Capacity utlization factor	-											
Full-load running hours per year	-											
Unit of Activity	TJ/year	-										
Technical lifetime (years)	40.00											
Progress ratio	-											
Hourly profile	Yes											

Explanation

Currently, there are 219 small scale heat networks in the Netherlands (Nationaal Warmtenet Trendrapport, 2018). Using figures from the ACM rendementsmonitor it is estimated there were around 50.000 end user connections in 2015 and approximately 2PJ of heat supply (ECN, 2017). Small heat networks supply heat to households but also to non-residential buildings and horticulture. For large scale networks 1,7% of connections is larger than 100kW (ECN, 2017). These connections consist of mostly non-residential buildings, but sometimes it is a group of dwellings. The connections smaller than 100kW mostly consist of dwellings. For small scale networks, the same share of large connections is assumed here in order to calculate the current market share (i.e. 0,6% of households in total based on 7,8 million households in 2017 from CBS). An average small scale network has about 50.000/219=230 connections and the average heat supply per network is about 2.000TJ/219=9TJ. A network with 100 dwellings connected would supply 3,4 TJ of heat per year assuming an average heat demand of 34 GJ/dwelling (34 GJ/dwelling is an average heat demand for dwellings based on the VESTA model of PBL).

In 2015, heat for small scale district heating mainly originated from natural gas-fired CHP-units. Other heat sources used are biomass plants (ECN, 2017). In 2015, around 1,2 PJ of heat was from natural gas fired heat sources including back up boilers, around 0,7 PJ from (collective) ATES, and around 0,1 PJ of heat for the small networks came from biomass (ECN, 2017).

The heat demand of consumers varies over time and the heat supply of the heat sources is thus load following. Heat is always available thanks to (gas-fired) back-up boilers. They supply heat at peak demand (in winter) or when the main heat source is shut down for maintenance. Back-up boilers are also used in the event of calamities and also in the transition when switching to a new main heat source (ECN, 2017).

The future market share of small scale heat networks is based on the annual growth of district heating over last years, which is an increase of around 0,1% per year (+1% between 2010 and 2017) (CBS, 2017). Assuming an increase of 0,1% per year, an estimate for the market share is 1,6% in 2030 and 3,6% in 2050. In the future the share of district heating could increase substantially, both for small and large scale networks, although this highly depends on scenario assumptions. According to modelling studies done by CE using the VESTA model of PBL, district heating has a potential of 220 PJ heat in 2050 (CE, 2016; PBL, 2017). Based on a scenario in which tax for natural gas increases to 1,5 euro/m3 in 2050, the market share could become 100PJ or about 50% final heat demand for the built environment in 2050. It is not specified which part of the increase can be attributed to small scale networks.

Main components of a heat network (pipeline infrastructure) have a lifetime of 40-60 years (CE, 2009b).

COSTS

Year of Euro	2015									
	Euro per Functional Unit	**Current**			**2030**			**2050**		
Investment costs	mln. € / TJ			302.94			278.70			242.35
		180.29	-	425.59	165.86	-	391.54	144.23	-	340.47
Other costs per year	mln. € / TJ			-			-			-
		Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Fixed operational costs per year (excl. fuel costs)	mln. € / TJ			7.57			6.97			6.06
		4.51	-	10.64	4.15	-	9.79	3.61	-	8.51
Variable costs per year	mln. € / TJ			-			-			-
		Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*

Costs explanation

In this example of a cost calculation a heat network with 1.000 dwellings is considered. A mix of 26% apartment dwellings and 74% terraced houses in considered which is based on the ratio in the Netherlands between these two types of dwellings obtained from CBS (CBS, 2016). All components of the heat network (see description) are included in the investment costs presented here except for the main heat source and main substation (it is a network without main substation). Depending on type of heat source this leads to an additional investment of 200-2000 euros per dwelling based on the VESTA model (PBL/VESTA, 2017). Components included in the investment costs are heat distribution substations, a distribution network and connections to the dwellings including heat delivery kits, as well as back-up boilers (with sufficient capacity to take over heat supply from main source). The cost range is based on the cost range for the different components as given by INEK/Energieakkoord and the Vesta model of PBL (INEK/Energieakkoord, 2018; PBL/VESTA, 2017). In this case example, present average investment costs for the entire network amount to 8k euros per apartment dwelling and 12 k euros per terraced house. A higher share of apartments compared to ground based dwellings leads to lower average investments costs per dwelling and vice versa.

The fixed operational costs per year consists of maintenance costs for the different components of the network (PBL/VESTA, 2017). In the supporting calculations for the Dutch climate agreement proposal (INEK/Energieakkoord, 2018) the fixed operational costs are assumed 2,5% of the initial investment.

Costs can be further reduced by innovation and design optimization. Design optimization means for instance to adjust the pipe diameters to the peak demand over the year. In the calculation for the Dutch climate agreement proposal (INEK/Energieakkoord, 2018) costs reductions for heat networks in 2030 are assumed between 0% and 15% (avg. 8%). In the VESTA model (VESTA/PBL, 2017) a costs reduction between 17%-24% (avg. 20%) is assumed in the long run. Costs reduction factors used above are 8% in 2030 and 20% in 2050.

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			1.25			1.20			1.15
			1.10	-	1.30	1.20	-	1.20	1.15	-	1.15
		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 total network losses (from source to end consumer) 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 mainly occur in the distribution networks (e.g. convection, conduction and radiation losses). Total network losses generally account for 10-30% (average about 25%) (ECN, 2017) This is depending on length of network/how densely the network is clustered. Losses for future heat networks can possibly be reduced due to innovation and/or improved energy control systems/ flow management systems. Here it is assumed, losses are 20% in 2030, and 15% in 2050, on average.

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**		
Pump energy	GJe/GJth			0.02			0.02			0.02
		0.02	-	0.02	0.02	-	0.02	0.02	-	0.02
				-			-			-
		Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
				-			-			-
		Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
				-			-			-
		Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*

Explanation

An electric pump is required in order to transport heat from the source through the heat distribution network (ECN, 2011). The required amount of pump energy in GJe per GJth is given above.

REFERENCES AND SOURCES

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