# Developments of Heat Distribution Networks in the Netherlands

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June 2015
ECN-E--15 069

In samenwerking met
RVO.nl

Rijksdienst voor Ondernemend Nederland

# Acknowledgement

The basis of this report sprang from the internship of Robin Niessink at ECN, in the context of a master Energy Science at Utrecht University. The results of this internship are used in this report. The authors like to thank the heat companies, Eneco Warmte & Koude B.V., Ennatuurlijk B.V., N.V Nuon Warmte and SVP Holding B.V. for their input. Final editing was provided by Hilke Rösler, partly on the basis of quality assurance co-reading by Marc Londo. Funding by the Netherlands Enterprise Agency RVO.nl made it possible to make this report publicly available. While many parties cooperatively shared their insights and provided data, final responsibility for this report lies with the authors.

# Abstract

Until recently, collective heat supply using heat distribution networks played a minor role in the energy system of the Netherlands. However, as part of the energy transition, renewed political attention arose to enhance (waste) heat utilization using heat distribution networks. Also plans rose to connect more buildings to heat distribution networks in the future. This study was conducted in order to gain more insight into the existing heat distribution networks and the projected developments from the present towards 2030. In order to analyse the current situation, data on existing networks and the amount of connected dwellings and service sector buildings in 2013 were collected. This work resulted in aa comprehensive overview for all heat distribution networks in 2013, including amongst others the heat suppliers, heat producers, heat sources, amount of connected dwellings and utility buildings as well as the heat demand and heat production for each network. Furthermore, projections on heat supply and heat production for the networks were developed, based on the expected amount of new dwellings with district heating in the future and the average heat demand per building. Developments regarding heat sources were taken into account to estimate the heat production per type of source. With this information, projections on collective heat supply were made for the National Energy Outlook scenarios.

# Contents

# List of Figures

# List of Tables

# Summary

Historically, collective heat supply using heat distribution networks has played a minor role in the energy system of the Netherlands. As part of the energy transition, there is renewed political attention for enhanced (waste) heat utilization using heat distribution networks. Also, there are plans to connect more buildings to heat distribution networks in the future. Therefore, the role of collective heat supply in the Dutch energy economy may become more important. This study had the objective to obtain a renewed overview of the existing heat distribution networks in the Netherlands and to describe the expected developments from the present towards 2030. Using this information, projections on collective heat supply were made for the National Energy Outlook scenarios.

The current situation was analysed using data from Statistics Netherlands (Energie Nederland) on the amount of dwellings with district heating in 2013, an overview report about existing heat distribution networks from CE Delft, direct information from energy suppliers as well as other information sources. Overview tables were made for the existing networks in 2013, indicating heat suppliers, heat producers, heat sources, connected dwellings, non-residential buildings and other relevant characteristics. The heat supply and heat production (i.e. including losses) for each network in 2013 were either calculated, or provided directly by the supplier. The projections on the amount of dwellings with district heating, heat supply and heat production are based on the projected amount of new dwellings with district heating in the future and the average heat demand per dwelling. Developments regarding heat sources were taken into account to estimate the production per type of heat source. A projection on heat supply and production for non-residential buildings was based on the same growth trend of heat supply to dwellings.

Based on the findings of this study, the following conclusions can be drawn for the current situation and the future developments regarding heat distribution networks in the Netherlands.

There are currently 13 large scale heat distribution networks in the Netherlands with each more than 5,000 connected consumers. The largest networks are located in Rotterdam, Almere, Utrecht - Nieuwegein, Amsterdam, and Purmerend. Furthermore,

the Amernet is a large heat distribution network in the province Noord Brabant supplying heat to Tilburg, Breda, Oosterhout and the horticultural area near Made and Waspik.

There are approximately 6,900 small-scale heat distribution networks. About 300 of these are owned by energy suppliers. The other networks are owned by small firms, associations of homeowners, housing corporations and other parties. The majority of small heat distribution networks is supplied with heat from a gas-fired heat source.

The number of dwellings connected to heat distribution networks is under current policy projected to grow from 363.000 dwellings in 2013 to 549.000 dwellings in 2030. In total, 17% of all new dwellings in the Netherlands built between 2013 and 2030 will be connected to a heat distribution network, whereby the largest shares of new dwellings are located in Rotterdam, Almere, Utrecht, Amsterdam, Den Haag, Tilburg, Arnhem and Nijmegen.

The total heat supply to dwellings with district heating is projected to increase from 11.5 PJ in 2013 to 12.9 PJ in 2030. The heat supply to existing dwellings will decrease, but will be counteracted by an additional heat demand for new dwellings adding 3.6 PJ in 2030. In order to estimate heat production, 15% distribution losses were assumed on average for all networks.

Today the main source for the existing heat distribution networks is waste heat from power plants. This share is, on basis of the forecasts, expected to decrease over the years, from 69% in 2013 to about 44% in 2030. The heat supply of small cogeneration units is expected to decrease from 16% in 2013 to 11% in 2030. Waste incinerators will replace an important part of the heat supply from power plants and CHP units. The role of waste incinerators in collective heat supply is projected to grow significantly towards 2030, reaching a share of 30% in 2030. The main reason for this is the commissioning of the Nieuwe Warmteweg and Leiding over Noord in Rotterdam. Furthermore, more waste heat from the AVI Duiven and the ARN waste incinerator in Arnhem and Nijmegen will be used. The share of biomass/biogas as a heat source doubles from 7% in 2013 to 14% in 2030, mainly because of the substitution of natural gas for biomass in Purmerend. Other (renewable) sources retain a relatively small contribution over the years.

A key uncertainty in the projections lies in the number of dwellings that will be connected to heat distribution networks in the future. Suppliers indicated a higher likelihood for new dwellings to be connected than for existing dwellings. Therefore, existing dwellings potentially changing to district heating are currently not taken into account in their projections. A reason for this is that the plans to connect existing dwellings are not sufficiently concrete. The projections in this study follow this argument. However, the amount of dwellings with district heating in 2030 would be substantially higher when ambitions of municipalities were taken into account. If ambitions of Rotterdam, Amsterdam, Zuid-Holland and Arnhem and Nijmegen would be fully realised, the result is a total heat demand of 15.8 PJ in 2030 instead of 12.9 PJ. The difference between the projections is mainly attributable to the number of existing dwellings that will change to district heating.

Under the assumption that the annual heat supply to non-residential buildings follows the same trend as the heat supply to dwellings, the heat demand for non-residential buildings increases from 5 PJ in 2013 to 5.6 PJ in 2030. The accuracy of these figures is limited as a consequence of the simplified approach. With more information on the expected number of connected non-residential buildings in the future and the average heat demand, an improved estimate can be made on how much heat will be supplied to non-residential buildings. The same holds for the sectors horticulture, waste water and industry for which currently no projection as a consequence of missing this information could be made.

The total heat supply to dwellings and non-residential buildings is projected to increase from 16.5 PJ in 2013 to 18,5 PJ in 2030. Assuming that 15% of the heat is lost in the networks, the total heat production for dwellings and non-residential buildings is 19.4 PJ in 2013 and 21,8 PJ in 2030 respectively.

Although there is potential in certain regions to utilize waste heat from the industry in the future, a large increase of this source in heat supply is not expected in the coming years. The main reason for this is that the capacity of current heat sources is large enough to deal with the projected growth in demand. Furthermore, high investments are required for new networks or to connect sources of waste heat to the existing networks. Increasing the use of other sources in the future also requires major investments in heat networks. However, the suppliers of renewable and waste heat cannot always give a guarantee for long-term supply security, because it is not certain whether they will be in business for a period of decades. This poses a risk to the infrastructure investor. With a decreasing heat demand for both new and existing dwellings, it is not certain whether these type of connections will result in a return on investment.

# 1 Introduction

The Energy Research Centre of the Netherlands (ECN) collaborates with the Netherlands Environmental Assessment Agency (PBL), Statistics Netherlands (CBS) and the Netherlands Enterprise Agency (RVO.nl) on the National Energy Outlook (Dutch: *Nationale Energieverkenning/NEV*). In this annual publication, an overview is presented of the Dutch energy system from 2000 to present and the expected developments towards 2030. The subjects within the NEV are the physical indicators, such as energy demand, energy supply and greenhouse gas emissions as well as economic indicators such as economic added value and employment related to energy. The aim of the NEV is to provide a factual foundation for the societal debate about energy in the Netherlands (Hekkenberg & Verdonk, 2014) among which factual foundation on the heat system.

As collective heat supply only played a minor role in the energy system of the Netherlands up till now, this type of heat supply was scarcely described in the NEV. Several current developments related to heat distribution networks deserve however attention. First, it is expected that a higher share of new dwellings will be connected to heat distribution networks compared to the share of already connected dwellings. The largest growth will be concentrated in urban areas, where there are possibilities to connect dwellings to existing heat distribution networks (Hekkenberg & Verdonk, 2014). Second, an important development occurs at the supply side. Heat distribution networks often have “older” power plants as heat source and some of these power plants are not competitive on the electricity market anymore (Hekkenberg & Verdonk, 2014). As a consequence, these power plants are expected to stop with their heat production in the coming years. Since the connected buildings will still demand heat in the future, alternative sources will be needed. Renewable heat supported by the SDE+ subsidy could be a feasible alternative (Hekkenberg & Verdonk, 2014). A change is already visible as the use of heat from renewable sources increased with about 10% in 2013 (Hekkenberg & Verdonk, 2014). In particular, waste incinerators were responsible for a higher heat supply to nearby industry via new heat distribution networks. A third noticeable development is the recent political attention for more utilization of industrial waste heat using heat distribution networks. In the letter *Warmtevisie* from the ministry of Economic Affairs to the Dutch Parliament, the ambition for enhanced utilization of industrial waste heat for heat distribution networks is mentioned (EZ, 2015). The ministry indicates that the utilization of waste heat contributes for an important part to the energy transition, the security of supply and the competitiveness of the national industry. For instance, there are possibilities to connect existing industrial firms in the industrial area of Rotterdam to the existing heat distribution network (De Buck et al., 2012).

As a consequence of the above-mentioned developments, the role of heat distribution networks is likely to become more important in the future. Better insight into the current situation and future developments of the heat system is therefore needed. The latest report containing a comprehensive overview of heat distribution networks in the Netherlands was published by CE Delft in 2009 (Schepers & van Valkengoed, 2009). In the meantime, the amount of connected buildings, heat suppliers, heat producers, heat sources etc have changed. These changes have to be taken into account in future forecasts.

The objectives of this study are:

- To create an overview of the heat distribution networks in the Netherlands with the most recent data (2013), indicating the heat sources, heat producers, heat suppliers, amount of connected dwellings, non-residential buildings, heat supply, heat production per source and other characteristics.
- To provide an overview of the expected developments of heat distribution networks in the Netherlands, while taking into account a decreasing heat demand per building, a growth of dwellings and non-residential buildings connected to existing heat distribution networks, potential new heat distribution networks, decommissioning of heat sources, new heat sources and other developments.
- To create projections towards 2030 for the total heat supply and production per heat network and provide a breakdown per type of heat source. The resulting figures are used to support the NEV on the subject of collective heat supply in the Netherlands.

The outline of the report is as follows. In chapter 2, the research context is given with background information on heat distribution networks and the role of collective heat supply in the Netherlands. In chapter 3, the methodology to analyze the current situation as well as the methodology behind the projections towards 2030 is given. In chapter 4, an overview is given of the current heat distribution networks in the Netherlands. In chapter 5, the developments and projections are described towards 2030. In chapter 6, the methodology and results are discussed. Chapter 7 concludes and provides an answer to the research question.

# 2

# The Dutch heat system

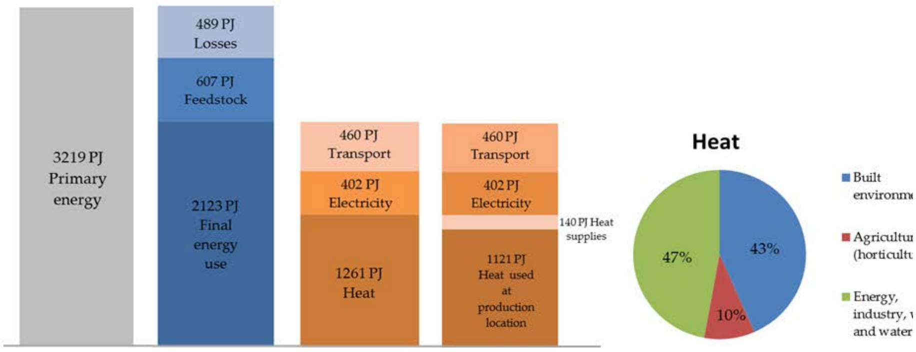
This chapter provides relevant background information for the study, on the Dutch energy system (section 2.1), the key elements of heat distribution networks (2.2) and a concise SWOT analysis of them (2.3)

## 2.1 Figures on heat supply and demand.

The context of heat distribution networks in the energy system of the Netherlands can be identified by looking at the energy breakdown of the Netherlands. The breakdown of primary energy use in 2013 is shown in **Figure 1**. The Netherlands used in total 3219 PJ primary energy in 2013. 2123 PJ was used as final energy, 607 PJ was used as feedstock (e.g. oil used to make plastics) and the remaining 489 PJ was lost (e.g. due to energy conversion). The final energy use can be subdivided into 460 PJ for transportation, 402 PJ for electricity and 1261 PJ for heat. Out of the primary energy used for heat production 43% was used in the built environment, 10% in agriculture (mainly horticulture) and the remaining 47% in the energy, industry, waste and water sectors.

The use of heat in the sectors built environment, industry and agriculture in total accounts for about 40% of the primary energy use in the Netherlands (Hekkenberg & Verdonk, 2014). Therefore, reducing the energy use of these sectors plays an important role in keeping on track with the Dutch policy targets and, ultimately, achieving a sustainable energy system of the Netherlands (Hekkenberg & Verdonk, 2014).

**Figure 1**: Primary energy breakdown of the Netherlands in 2013



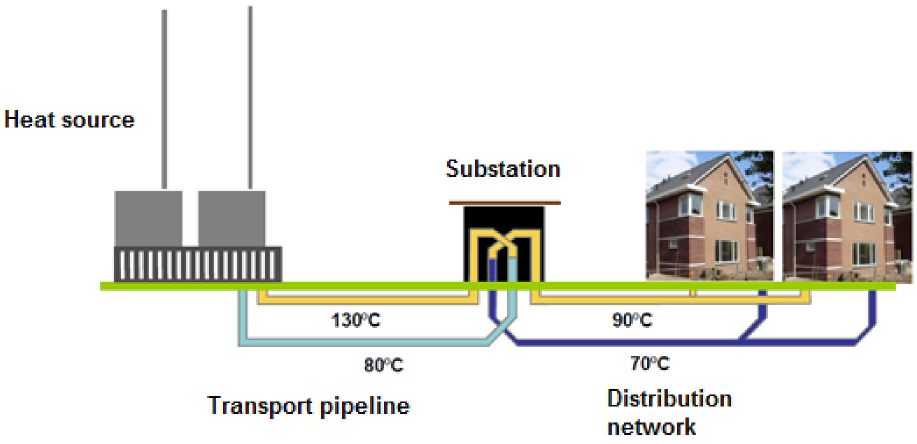

**Sources for Figure 1**: Based on figures from *De Nederlandse Energiehuishouding (NEH)* database (ECN b, 2015) and Statistics Netherlands (Segers, 2015).

Heat is used for space heating, hot tap water and for industrial process heat. The largest share of heat (1121 PJ) is consumed at the location where it is produced. The remaining share of heat (140 PJ) is delivered from the production location to another location. This includes both deliveries of steam and deliveries of hot water. Statistics Netherlands (CBS) estimated that total heat delivered in 2013 was 140 PJ, of which 112 PJ steam and 28 PJ hot water (Segers, 2015). Of the total hot water deliveries, a certain share is supplied to dwellings, non-residential buildings and other consumers using heat distribution networks. The hot water deliveries to dwellings were estimated by CBS at 11 PJ in 2013. The deliveries to non-residential buildings were around 5 PJ, around 4PJ went to horticulture and less than 1PJ was supplied to both the waste water and the industrial sector (Segers, 2015).

## 2.2 Heat sources and heat distribution networks

The heat supply chain involves heat production, transport, distribution and end use by the consumer. In a heat distribution network, hot water or steam is produced at a heat source and transported in a network of insulated pipes to end-users. End-users can be non-residential buildings (i.e. school buildings, offices, stores, swimming pools etc.), industrial firms, agriculture (i.e. mostly horticulture) and dwellings. If the heat distribution network is used to supply hot water to households and non-residential buildings it is also called district heating.

**Figure 2**: Schematic picture of a heat distribution network.




A heat distribution network generally consist of a primary transport network and a secondary distribution network, separated by a heat transfer (sub)station (Dutch: *warmteoverdrachtsstation*), see **Figure 2** (Stultjens, 2012). A heat exchanger is located at the (sub)station. Similar to a household heating system, a heat distribution network consists of inlet and outlet flows through pipes (Schepers & van Valkengoed, 2009). There is one inlet flow of high temperature and one outlet flow of low temperature. In a conventional system, there is a flow of high temperature water, at around 130 °C, from the inlet of the network and the heat is delivered to dwellings at a temperature of around 90 °C. Newer networks can work at lower temperatures, but in order to supply hot tap water, a delivery temperature of at least 70 °C is required (RVO, 2015).

Since heat demand of consumers fluctuates over time, it is not always possible to match demand and supply for one single primary centralized heat source. In order to achieve a more flexible supply side, secondary heat sources or backup boilers are utilized. This is mainly the case for large heat distribution networks. The backup boiler also provides replacement during hours of failure or maintenance of the primary heat source. Backup boilers can either be located in the primary transport network or in the secondary distribution network (Schepers & van Valkengoed, 2009).

More than one heat source can feed its heat into one heat distribution network. The possible heat sources for heat distribution network are as follows (Schepers & van Valkengoed, 2009):

- Coal-fired (or coal co-fired with biomass) and gas-fired power plants ("power plant").
- Natural gas-fired cogeneration plants ("combined heat and power/CHP").
- Small natural gas-fired cogeneration units ("small CHP")
- Waste incinerators
- Biomass heator CHP plants
- Biogas plants
- Centralized (steam) boilers
- Heat pumps combined with aquifer thermal energy storage (ATES)

- Collective solar thermal systems
- Geothermal systems
- Industrial waste heat

Waste heat originates from sources that do not have heat production as their main activity; examples are power plants, waste incinerators, refineries and other industrial processes (Daniëls et al., 2011). The utilization of waste heat for heat distribution networks is an option to lower the primary energy use and to reduce $CO_2$ emissions compared to individual heat supply (Schepers & van Valkengoed, 2009).

A definition of a large scale heat distribution network is a network that consist of more than 5,000 connected consumers (Schepers & van Valkengoed, 2009). For large networks, the main heat sources are power plants, waste incinerators, industry and refineries. For small scale heat distribution networks, the main heat sources are CHP-plants, small cogeneration units, bio-CHP plants and collective boilers (Daniëls et al., 2011).

In the Netherlands the share of collective heat supply using heat distribution networks has been relatively modest in the past. Only 3.2% of households were supplied by a heat distribution network in 2012. For new buildings the share is higher, 16% (Hekkenberg & Verdonk, 2014). However, the amount of new buildings is relatively low, and new buildings have lower heat demand than existing buildings. Therefore, these two effects combined will not lead to a large increase in collective heat supply (Hekkenberg & Verdonk, 2014).

## 2.3 SWOT analysis of heat distribution networks

**Benefits of heat distribution networks**

- The option to reuse waste heat and application of combined heat and power (CHP). The utilization of waste heat and CHP leads to primary energy savings and reduced $CO_2$ emissions (RVO.nl, 2015).
- The flexibility to connect different heat sources to the networks. Using a variety of heat sources and related fuels lowers the dependency on natural gas. It also increases the security of supply and anticipates on developments in the market portfolios of suppliers. This particularly holds for newer (renewable) options (Knuvers, 2005).
- Comfort for end users since the heat is instantly available from the source. There is no maintenance needed for an individual boiler by the consumer. Also, space is saved in the building since no boiler is needed.
- Heat distribution networks contribute to sustainable and economical regional area development (RVO.nl, 2015) (van Kann, 2010).

**Downsides of heat distribution networks**

- The source and consumer of heat have to be operational for a sufficiently long lifetime to make the investments in heat infrastructure feasible (Daniëls et al., 2011).

- Heat losses in the distribution network. Because of this, heat distribution only leads to lower $CO_2$ when waste heat or CHP is applied, not when a central heat-only boiler replaces multiple household boilers.
- Very high initial capital costs for the network infrastructure resulting in a long payback period (Wetzels, 2010) (Tata Steel, 2015).
- The consumer has no flexibility to choose his own heat supplier and pays a price per GJ according to the *Niet Meer Dan Anders (NMDA)* principle (Schepers & van Valkengoed, 2009). This principle ensures that the consumer does not pay more for district heating than the person would otherwise pay for heating using an individual gas-fired boiler. This principle can potentially lead to financial losses for projects. However, consumers still claim that the NMDA principles leads to higher prices than gas heating.
- Certain technical issues (in the past) such as difficulties in proper room temperature regulation. Also, not properly functioning heat measurement devices resulting in costs that are not according to consumption (Knuvers, 2005).
- Cooking on gas is not an option in dwellings with district heating. Electricity has to be used for cooking, at some additional cost.

**Opportunities related to heat distribution networks**

- There are densely clustered built environments available in the Netherlands where a new heat network can be potentially constructed or buildings can be connected to existing networks (RVO.nl, 2015).
- There is a significant additional potential (tens of petajoules) of waste heat available that could be reused in a feasible way (Daniëls et al., 2011; Van den Wijngaart et al., 2012).
- Small scale application is possible in the first stage of a project. At a later stage, the heat distribution network can be expanded in a modular way.
- Technological developments leading to lower costs in future years.
- A heat distribution network can be used for cooling purposes as well.

**Threats to further expansion of heat distribution networks**

- There are constraints on the possible locations in urban areas (Wetzels, 2010) (Eneco, 2015). In some cases, there is low space availability for new heat distribution networks in urban areas due to the existing gas network.
- Energy saving measures on the individual level, lowering the energy demand of buildings make a connection to a district heating network less profitable from the point of view of the supplier.
- Conflicting options for household heating systems, for example with micro-CHP or electric heat pumps.

# 3

# Methodology

This chapter describes the data and analysis methods to come to the overview of the current situation (section 3.1) and the projections towards 2030 (section 3.2).

## 3.1 Current situation in 2013

The aim is to provide an overview of heat distribution networks in the Netherlands and to obtain the heat delivered and heat production per source. The current situation is defined as the situation in year 2013 as this was the most recent year for which a complete dataset was available on the number of dwellings with district heating per municipality.

A bottom-up approach was followed by collecting data for each separate network. By summing up all the networks, the total picture for the Netherlands was obtained. For each separate network, data were collected on amongst others the heat source(s), heat producer(s), heat supplier(s), amount of connected dwellings, amount of non-residential buildings and heat supply to non-residential buildings. The estimations on heat supply and production for dwellings with district heating are explained in 3.1.3.

### 3.1.1 Data on existing heat distribution networks

This section describes the data used to obtain the overview of the current heat distribution networks.

**CE Delft**
In 2009, CE Delft published a report containing a comprehensive overview of existing heat distribution networks in the Netherlands (Schepers & van Valkengoed, 2009). The following information from this report for the year 2009 was used:

- Heat distribution network names for each municipality (in 2009, there were 79 municipalities with district heating out of 418 municipalities in total)
- The amount of connected dwellings per heat distribution network
- The amount of connected non-residential buildings per heat distribution network
- The heat source(s) per heat distribution network. Non-renewable heat sources include coal-fired or natural gas-fired power plants, natural gas-fired CHP-plants, small scale natural gas-fired cogeneration units or a collective natural gas-fired boiler. Renewable heat sources include heat pumps (combined with aquifer thermal energy storage/ATES), waste incinerators, geothermal sources, biomass/biogas and industrial waste heat.
- The heat producer(s) for each heat distribution network
- The heat supplier for each heat distribution network
- The starting year of supply for each heat distribution network

**Energie-Nederland and CBS**

Energie-Nederland collected data on the total number of dwellings with district heating per municipality in the Netherlands in 2013 which ECN received via CBS (Energie-Nederland, 2015).

In these data, the term “dwelling” refers to either one of the following types of buildings:

- Apartments/flats
- Row houses/town houses
- Corner houses
- Semi-detached houses
- Detached houses

For 6.889 out of the 362.787 dwellings with district heating, the type of building was not defined.

There are 96 municipalities with district heating in total in 2013. In most municipalities, an increase in the amount of dwellings with district heating is visible compared to 2009, indicating that most of the networks have expanded in past years.

**Other data**

Other information sources used to describe the current situation are as follows:

- Personal communication with heat suppliers Nuon, Eneco, Ennatuurlijk, and StadsVerwarming Purmerend in order to obtain information about their heat networks and to verify the figures for the current situation (Eneco, 2015) (Ennatuurlijk, 2015) (Nuon, 2015) (SV Purmerend, 2015).
- *Nuon $CO_2$ reductierapporten* (Nuon, 2014). The report contains figures on the amount of dwellings and non-residential buildings (also in dwelling-equivalents) connected to the heat networks of Nuon, describes recent developments and ambitions and provides future projections on connected buildings per network. All municipalities in which Nuon is the heat supplier for a large network are included in the report, these are: Amsterdam, Almere, Arnhem, Duiven-Westervoort, Nijmegen, Lelystad, Leiden and Rotterdam (south).
- Information from heat suppliers, municipalities, waste treatment companies and other reports. For large scale networks other than Nuon, figures on other connected consumers and heat deliveries were collected from these sources.

### 3.1.2 Analysis of existing heat distribution networks

**Dwellings**

The report from CE Delft (Schepers & van Valkengoed, 2009) was taken as a starting point in order to analyze the current situation. Most of the heat distribution networks that existed in 2009 are still existing today and the figures on the amount of connected buildings could be updated using the newer figures from Energie-Nederland. Information from several sources was combined in order to create a new overview of the current situation. The following approach was used:

- In case of one (still existing) heat distribution network per municipality, the Energie-Nederland figure is taken for the amount of connected dwellings in 2013 instead of the figure from CE Delft.
- Other data (see 3.1.1) were used to update all other relevant information for each network.
- In case of more than one heat distribution network per municipality, the dwellings in that municipality are divided over the networks based on best available information. The municipalities for which this is the case are Amsterdam, Rotterdam and Den Haag. For Amsterdam, data on the amount of connected dwellings per network were available directly from other information sources such as *Nuon* $CO_2$ *reductierapporten* (Nuon, 2014). For Den Haag, an estimate was made based on the shares of dwellings per network as reported in another information source (TNO, 2013). For Rotterdam, the distribution is based on data provided by Eneco and Nuon (Eneco, 2015) (Nuon, 2014).

**Non-residential buildings and others**

The information on the number of non-residential buildings with district heating is limited. Therefore, the number of non-residential buildings per network reported in (Schepers & van Valkengoed, 2009) is used. Except for cases when other, more recent information, was available from suppliers.

No data were found on the number of connected consumers in the horticultural, waste water and industrial sector.

### 3.1.3 Heat demand and production

**Heat demand and production for dwellings**

The heat demand for dwellings with district heating is calculated by multiplying the number of dwellings with district heating with the average heat demand per dwelling.

The average heat demand for a dwelling with district heating is one of the outputs of SAWEC (Jeeninga & Volkers, 2003), the household energy model used for the NEV (ECN a, 2015). The value is a weighted average over the different dwelling types and is corrected for climate conditions in the Netherlands using the concept of degree-days.

Since the heat sources and the number of connected dwellings per network are known, the heat supply and heat production share per source (e.g. power plant, CHP-plant, biomass) can be calculated as well. Heat production were calculated with an average heat loss of 15% during transport. Losses are very different for different networks and depending on material, diameter and structure of the network. Losses in transport pipelines are generally lower than in the distribution network.

**Heat demand and production for non-residential buildings and others**
In order to determine the heat demand of non-residential buildings with district heating, a bottom-up approach per heat network could not be used. No complete dataset was available on the number of non-residential buildings for all networks in all municipalities. Moreover, non-residential buildings are known for their wide variation in heat demand therefore it is not feasible to use the average heat demand of a few utility buildings to come to an overall demand for all utility buildings. Therefore, the total heat demand for non-residential buildings in the Netherlands calculated by CBS was used. The accuracy of this figure has its limitations since it non-residential buildings is calculated as total heat supply minus the heat deliveries to other sectors (mainly the residential sector).

For large scale networks, suppliers provided data on heat supply to utility or business to business (including horticulture and industry) (Ennatuurlijk, 2015) (Eneco, 2015) (Nuon, 2014) (SV Purmerend, 2015). Figures on this are reported in Appendix A. In order to calculate heat production, heat losses were estimated at 15% on average (similar as for dwellings).

## 3.2 Projections towards 2030

The aim is to make projections on the number of dwellings with district heating and the total heat supply and production per source. It has been chosen to only include dwellings that have a high certainty to be connected to heat networks in the future. Suppliers indicated a higher likelihood for new dwellings to be connected than for existing dwellings. Therefore, existing dwellings potentially changing to district heating are currently not taken into account in the projections. A reason for this is that the plans to connect existing dwellings are not sufficiently concrete. The projections in this study follow this argument. The resulting projections are mostly in accordance with what energy suppliers have indicated as feasible. In Chapter 6, a projection is shown in case of higher ambitions for district heating in future.

### 3.2.1 Data on developments of heat distribution networks

This section gives a description of the data.

In order to create projections towards 2030, the following information was used:

- A projection on the total number of new dwellings per municipality per year from 2013 to 2030 from *ABF Research - Primos prognose* (ABF Research , 2014).
- The projected heat demand per dwelling from 2013 to 2030 is taken from the SAWEC (ECN a, 2015) household energy model, this is explained further in 3.2.3.
- Developments described in the letter *Warmtevisie* by the ministry of Economic Affairs (EZ, 2015).

- Energy suppliers provided information on recent and planned developments (Eneco, 2015) (Ennatuurlijk, 2015) (Nuon, 2015) (SV Purmerend, 2015).
- *Nuon* $CO_2$ *reductierapporten* (Nuon, 2014). The report describes developments and ambitions and provides future projections on connected buildings per network or per municipality. All relatively large municipalities where Nuon is the heat supplier are included in the report, these are: Amsterdam, Almere, Arnhem, Duiven-Westervoort, Nijmegen, Lelystad, Leiden and Rotterdam.

### 3.2.2 Analysis of developments of heat distribution networks

In order to create projections for the number of connected buildings towards 2030, the following assumptions were made and analysis was done.

**Dwellings**
General assumption: Per municipality, the share of new dwellings that was expected to be connected to a heat distribution networks was considered to be equal to the share of existing dwellings with district heating in 2013.

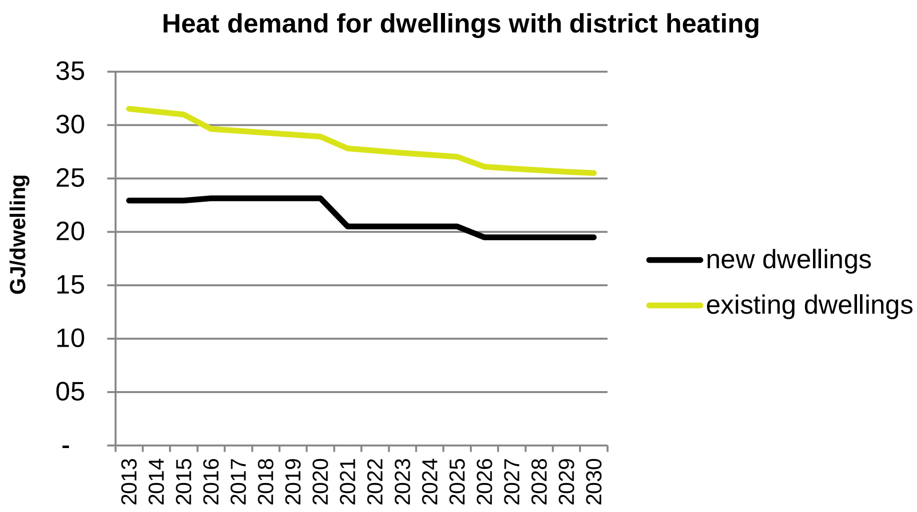
In case more specific knowledge or data on the growth per network and/or per municipality was available, this information was used instead. This information could come from heat companies and/or from municipalities. For example:
- The projections from Nuon Warmte were used for the municipalities in which this company is active (Nuon, 2015). In Amsterdam for example the share of new built dwellings connected to district heating will to be 52% to meet the Nuon projections, while the current share of existing buildings connected to a district heating system is only around 7%.
- The cities of Rotterdam and Utrecht have high and relatively concrete ambitions for district heating. For these cities, growth estimates have been made that lie between the (higher) ambitions of the cities themselves the (lower) estimates of Eneco, the heat company involved.

**Non-residential buildings and others**
Due to limited data availability, no analysis was done on the number of connected non-residential buildings and other connected consumers in the sectors horticulture, waste water industry. Only a projection on heat supply for non-residential buildings was made as explained in 3.2.4.

### 3.2.3 Projected heat demand for dwellings

The heat demand per municipality and for the Netherlands in total was calculated using the average heat demand per dwelling with district heating in the Netherlands. New dwellings have a lower average heat demand compared to existing dwellings as a result of improved design. Furthermore, dwellings with district heating have a lower average heat demand compared to other dwellings, because most of these dwellings were built in later years. For both existing and new dwellings, the heat demand per dwelling is projected to decrease in future years due to continued improvements in design or refurbishment. The heat demand per dwelling as calculated by ECN (SAWEC model, (ECN a, 2015)) is shown in **Figure 3**.

**Figure 3**: Heat demand for dwellings with district heating from the SAWEC model.




## 3.2.4 Projected heat demand and production

**Heat demand and production for dwellings**

To calculate the heat demand in each year, $Q_{total}$ (in GJ), the following formula is used:

$$Q_{total} = D_{existing} \times HD_{existing} + D_{new} \times HD_{new}$$

In which, $D_{existing}$ is the number of existing dwellings in 2013, $D_{new}$ is the number of new dwellings after 2013, $HD_{existing}$ is the heat demand of existing dwellings in 2013 (in GJ/dwelling) and $HD_{new}$ is the heat demand of new dwellings after 2013 (in GJ/dwelling).

Since the number of dwellings and the sources per heat distribution network and municipality are known, the heat demand per type of source (e.g. power plant, CHP-plant, waste incinerator) can be calculated.

In order to calculate heat production, losses in the heat distribution network were taken into account. Similar to 2013, these losses were assumed to be 15% on average.

**Heat demand and production for non-residential buildings and others**

In order to make projections for heat demand and production for non-residential buildings a simplified approach was used. It was assumed that the annual growth rate of the heat demand of non-residential buildings was equal to the annual growth rate for the heat demand of dwellings. To calculate production, the assumption of 15% losses on average was again used.

Projections for horticulture and industry weren't made due to limited data availability on the developments in these sectors.

# 4

# Current situation

In this chapter, an overview of existing heat distribution networks is given. A distinction between large and small heat distribution networks was made. A large heat distribution networks consist of more than 5,000 connected consumers (Schepers & van Valkengoed, 2009). The large district heating networks are described in more detail as these networks supply to the largest share of total  consumers, that is >84% of dwellings with district heating.

An overview of information regarding the scale, locations, suppliers, starting year of supply, producers, heat sources, the amount of connected dwellings and non-residential buildings and the heat supply and production per network is given in the tables of **Appendix A and B**.

## 4.1 Large heat networks in the Netherlands

In 2013, there were 13[1] large heat distribution networks in the Netherlands. This includes the network of Lelystad that has passed over 5,000 connected dwellings in 2013. There were about 363,000 dwellings connected. This is approximately 5% of the total of 7.5 million dwellings in 2013 (Energie-Nederland, 2015).

**Large heat distribution networks**

Large scale heat distribution networks are currently located in the following municipalities:

- Rotterdam
- Almere
- Utrecht
- Amsterdam
- Purmerend

[1] The network in Utrecht and Nieuwegein counts as one network. Capelle aan den IJssel is part of the network of Rotterdam. Tilburg and Breda are both connected to the Amernet. The network in Duiven and Westervoort is one network.

- Tilburg
- Den Haag
- Nieuwegein
- Breda
- Duiven – Westervoort
- Capelle aan den IJssel
- Leiden
- Enschede
- Helmond
- Lelystad

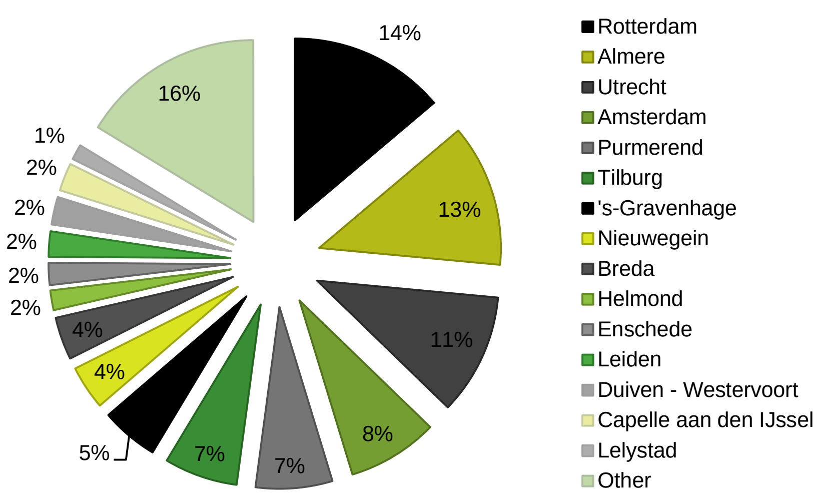
In order to extend the overview, the following small scale heat distribution networks (between 3,000 and 5,000 connected consumers) are described as well:

- Eindhoven
- Arnhem
- Houten
- Amersfoort
- Nijmegen

**Dwellings with district heating**

The distribution of dwellings with district heating over different municipalities is shown in **Figure 4** (Energie-Nederland, 2015). The largest number of dwellings with district heating are in Rotterdam (50,000) followed by respectively Almere, Utrecht, Amsterdam, Purmerend, and the other municipalities. Another large network is the Amernet in Tilburg and Breda.

**Figure 4**: Distribution of dwellings with district heating over different municipalities in 2013.




The total heat supply for district heating to dwellings was 11.5 PJ in 2013 (see Methodology for explanation).

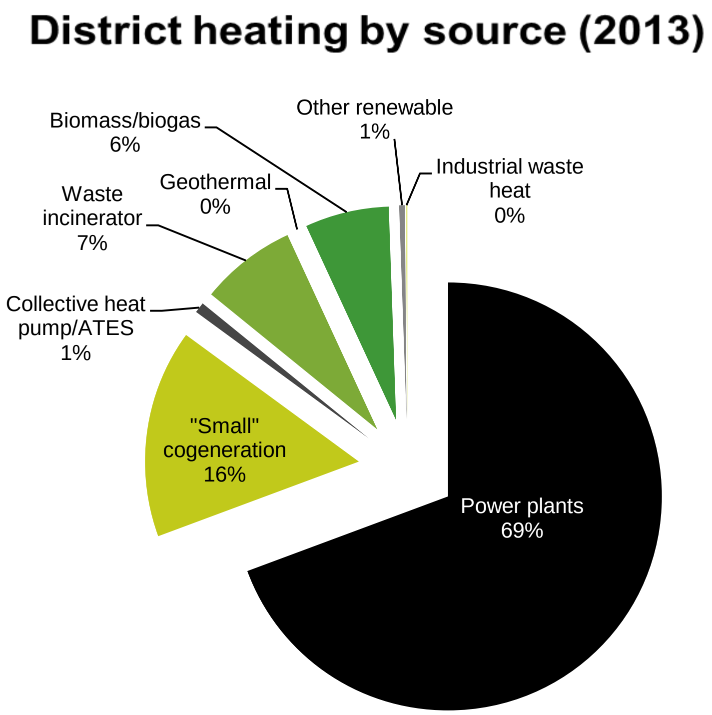
**Non-residential buildings**

The amount of non-residential buildings connected to each network is given in Appendix A. According to CBS, the total heat supply to non-residential buildings was 5 PJ in 2013 (see Methodology for explanation).

## 4.2 Heat sources for district heating

The shares of different heat sources for district heating in 2013 can be viewed in **Figure 5**. The main primary energy source used for district heating is natural gas. It is the main fuel for power plants and cogeneration units supplying to the networks. Also the peak boilers used for peak demand and back-up capacity generally use gas, but these installations are not taken into account in this figure. One exception to the networks supplied by gas powered plants, is the network in Tilburg and Breda, which is supplied by the Amercentrale, a coal-fired power plant (co-fired with biomass). Another 7% of the heat comes from waste incinerators, for example in the heat distribution network of Duiven – Westervoort, Amsterdam, Alkmaar and Dordrecht. Biomass and biogas have a 6% share of the total heat supply to district heat networks. Heat from collective heat pump/ATES (Aquifer Thermal Energy Storage), other renewable sources such as collective solar thermal and industrial waste heat all make a small contribution to the total. There was no share of geothermal energy in collective heat supply to dwellings in 2013.

**Figure 5**: Shares of different heat sources used for district heating in 2013.



## 4.3 Heat networks per municipality

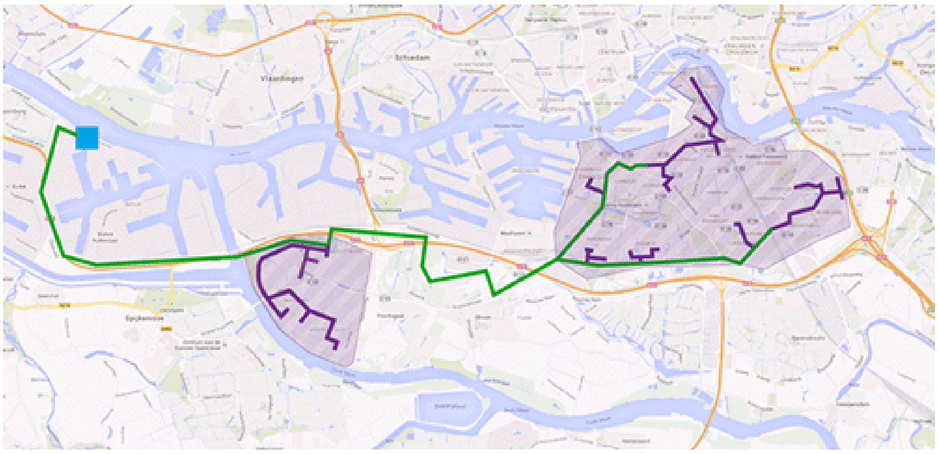
**Rotterdam**

There are multiple coupled heat distribution networks in Rotterdam. An overview of the networks is given in Appendix A **Table 3**. In 2013, the networks in Rotterdam supplied heat to about 50,000 dwellings (Energie-Nederland, 2015) and 1,500 utility building (Schepers & van Valkengoed, 2009).

The large scale heat distribution network is owned by Eneco. The heat sources during the first part of 2013 were the ROCA plant and CHP plant Galilei-1 both gas-fired and owned by E.On. The unit Galilei-1 has been decommissioned during 2013 and in the following years the AVR Rozenburg took over the heat production (Eneco, 2015). Backup boilers were located in the network of Eneco, but are owned by E.On (Schepers & van Valkengoed, 2009).

In the autumn of 2013, a new heat transport pipeline called *De nieuwe warmteweg (*The new heatway*)* was commissioned (AVR.nl, 2015). This involves a 26-kilometre long pipeline from the waste incinerator AVR Rozenburg to the centre of Rotterdam. The trajectory of the pipeline and the supply area of the network of Nuon are shown in **Figure 6** (Nuon, 2014). Waste heat is supplied to the heat distribution networks in Rotterdam-Zuid and Hoogvliet. In 2013, Nuon supplied heat to about 3,800 dwellings in Rotterdam-Zuid and Hoogvliet using temporary boilers, though in 2014 all heat was supplied by *AVR* (Nuon, 2014). Eneco supplies to the other dwellings in Rotterdam Zuid and Rotterdam North (Northside of the Maas).

**Figure 6**: Map of the heat supply area of Nuon of *De nieuwe warmteweg* in Rotterdam.



Purple lines = Transport pipelines Nuon

Green line = Transport pipeline *Warmtebedrijf Rotterdam*

Blue square = AVR Rozenburg

Purple area = Supply area Nuon

The network in Capelle aan den IJssel is part of the network of Rotterdam North. It is supplied with heat from the ROCA power plant and had about 8,950 connected dwellings in 2013. Since the commissioning of *De Nieuwe Warmteweg*, this network is also partly supplied with waste heat from AVR Rozenburg (Eneco, 2015).

**Almere**

There is one large scale heat distribution network in Almere owned by Nuon. Currently, the heat is supplied by the CHP-plant of Nuon in Diemen, the *Diemencentrale*, which also supplies to the network of Amsterdam. Through a 8.5 km long pipeline, heat is transported from the Diemencentrale under lake IJmeer to the heat transfer station of Almere Poort (Nuon, 2014). From there, heat is further distributed to Almere Poort, Almere stad and Almere Noorderplassen as shown in **Figure 7**. Before commissioning of the pipeline from the Diemencentrale, the heat was produced by two gas-fired CHP-units in Almere, Almere-1 and Almere-2, owned by Nuon. During 2013, these plants were decommissioned.

In 2013, there were about 46,000 connected dwellings in Almere (Energie-Nederland, 2015). About 700 non-residential buildings are connected to the network in total (Nuon, 2014). An overview of the heat distribution network in Almere is given in **Table 4**. On two locations in Almere backup capacity has been installed (Nuon, 2015). Next to the Diemencentrale, about 12% of the heat in Almere Poort in 2014 was supplied by the Nuon "Solar-collector-Island" located in Almere Noorderplassen (Nuon, 2014).

**Figure 7**: Map of the supply area for the heat distribution network in Almere.


Purple lines = Transport pipeline Nuon

Blue square = Diemencentrale

Purple area = Supply area Nuon

**Utrecht – Nieuwegein**

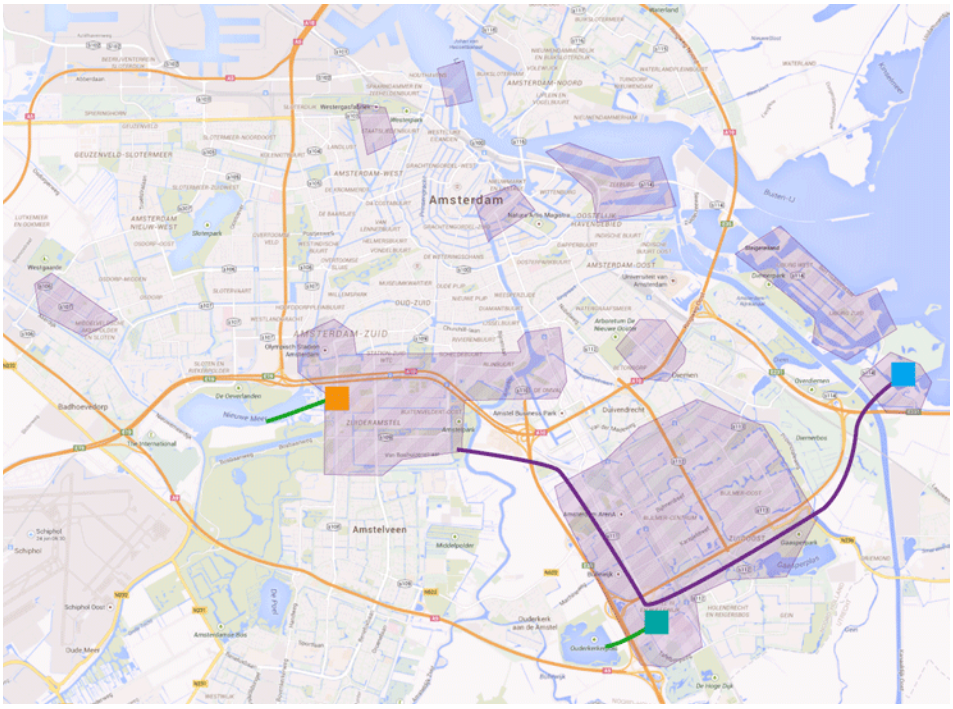
The heat distribution network in Utrecht and Nieuwegein, owned by supplier Eneco, consists of networks located in Utrecht city, the new Leidsche Rijn district and the town of Nieuwegein that are connected to the same main transport pipeline. Therefore the network can be considered as one network, instead of three separate ones (Schepers & van Valkengoed, 2009). About 39,000 dwellings in Utrecht and about 14,200 dwellings in Nieuwegein were connected to this network in 2013 (Energie-Nederland, 2015). Furthermore, about 1,800 non-residential buildings were connected in 2013 (Eneco, 2015). An overview of the network is given in **Table 5**. The main heat sources are the power plants in Lage Weide and Merwedekanaal both owned by Nuon. Peak demands in winter are delivered by peak boilers.

**Amsterdam**

In Amsterdam, there is one large scale heat distribution network owned by Nuon, another large scale heat distribution network named *Westpoort Warmte* and multiple small networks. An overview of the networks in Amsterdam is given in **Table 4**.

One of the large networks is located in Amsterdam-Southeast and is supplied with waste heat from the Diemencentrale. The Diemencentrale supplies heat to the network in Zuideramstel, Buitenveldert, Stadionbuurt, Zuidoost, Amstelkwartier, De Omval, IJburg, Diemen and Amstelveen as well as the network in Almere. The supply area of this network is shown in **Figure 8**. The supplier of the network in Amstelveen is Eneco. In 2013, about 13,400 dwellings in Amsterdam were connected to the network of Nuon (Nuon, 2014). There were 207 non-residential buildings connected to the network in 2013 (Nuon, 2014).

**Figure 8**: Map of the supply area for the Nuon Diemencentrale.



Purple lines = Transport pipeline Nuon

Blue square = Diemencentrale

Purple area = Supply area Nuon

A second large scale heat distribution network is the network of Westpoort Warmte. Westpoort Warmte is a joint venture of the municipality Amsterdam and Nuon and supplies to the west and northern parts of Amsterdam, see supply area in **Figure 9**. The heat source is the waste incinerator of *Afval-energiebedrijf (AEB).* The remaining heat is from biogas plants, one on the *AEB* site, one owned by *Waternet* and one by *Orgaworld* (AEB, 2015). All these biogas plants supply heat to *AEB*. The heat network of *AEB* Amsterdam has expanded substantially, from 680 dwellings in 2009 (Schepers & van Valkengoed, 2009) to 7,500 connected dwellings in (Nuon, 2014). There were 170 non-residential buildings connected in 2013 (Nuon, 2014).

**Figure 9**: Map of the supply area for Westpoort Warmte (Nuon/AEB Amsterdam).


Green square = AEB Amsterdam

Purple area = Supply area Nuon district heating

In 2013, around 8,000 dwellings in Amsterdam were supplied with the heat from “small” CHP units distributed over several locations (Schepers & van Valkengoed, 2009). The amount of dwellings supplied by these sources stayed almost constant between 2009 and 2013. (Nuon, 2015).

In Amsterdam, the total number of connected dwellings has grown from 16,500 dwellings in 2009 (Schepers & van Valkengoed, 2009) to 29,000 dwellings in 2013 (Energie-Nederland, 2015).

**Purmerend**

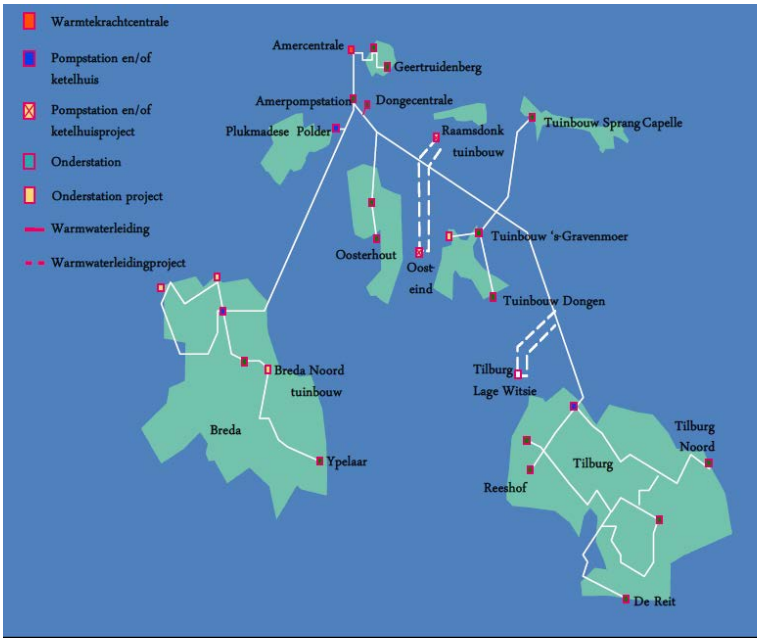
There is one large scale heat distribution network in Purmerend owned by *Stadsverwarming Purmerend (SVP)*, a standalone supplier for this town. In 2013, the heat source was a CHP-plant owned by Nuon and there was one gas-fired back-up boiler for this network also owned by Nuon. There were about 24,700 dwellings connected to this network in 2013 (Energie-Nederland, 2015). About 1,000 non-residential buildings were connected in 2013 (SV Purmerend, 2015). An overview of the current situation is given in **Table 6**.

**Amernet (Tilburg, Breda, Oosterhout, Geertruidenberg, Made, Waspik)**

Amernet is the largest heat distribution network in the province Noord-Brabant. Ennatuurlijk is the supplier for the consumers in Tilburg, Breda, Oosterhout, Geertruidenberg and the horticultural areas located in Made and Waspik. The heat supply area of the Amernet is shown in **Figure 10** (Stultjens, 2012). The heat source is the Amercentrale, a coal-fired power plant owned by Essent. In 2013, about 38,900 dwellings were connected to the Amernet (Energie-Nederland, 2015). In Tilburg and Breda, respectively 23,600 and 13,700 dwellings were connected in 2013 (Energie-Nederland, 2015). The amount of connected non-residential buildings to Amernet was about 800 in 2013 (Ener2, 2010). An overview of the Amernet can be found in **Table 7**.

The Amercentrale co-fired biomass in 2013[2]. On a weight basis, 35% of the fuel share wasbiomass (Essent, 2015). An estimation is that about 30% of the energy produced by this unit was generated from burning biomass (Ennatuurlijk, 2015).

**Figure 10**: Map of the heat supply area of the Amernet.




**Den Haag**

There are multiple heat distribution networks located in Den Haag. An overview is given in **Table 8**.

A large scale network is located in the district Ypenburg and Pijnacker-Nootdorp. Eneco is the supplier for this network and the heat source is the CHP plant Ypenburg owned by Eneco. There were about 13,700 dwellings connected to this network in 2013 (Energie-Nederland, 2015).

Furthermore, there are two separate networks in Den Haag for which Eneco is the supplier. One network is supplied by power plant Den Haag owned by E.On and the other by CHP-plant Wateringseveld owned by Eneco.

Including Ypenburg, about 18,400 dwellings were connected to the networks in 2013 (Energie-Nederland, 2015). The amount of connected non-residential buildings in 2013 is equal to 447 (Eneco, 2015).

**Duiven – Westervoort**

There is a large scale heat distribution network in Duiven and Westervoort. The heat source of this network is the waste incinerator in Duiven owned by AVR. Nuon is the supplier and owner of the network and the backup boiler. There were 8,950 dwellings (Energie-Nederland, 2015) and 200 non-residential buildings (Nuon, 2014) connected in

[2]: Due to damage caused by a fire accident in 2014, biomass co-firing was stopped in that year. It is not yet clear when co-firing will be resumed.

2013. One backup boiler is located in Westervoort and is fuelled with natural gas and oil. An overview of the heat network in Duiven - Westervoort is given in **Table 9**.

**Leiden region**

There is one large scale network in the region Leiden, located in Leiden, Leiderdorp and Oegstgeest. The supplier and owner of the network is Nuon. The primary transport line for this network is also owned by Nuon. The heat source is a CHP-plant in Leiden owned by E.On and there is one back up boiler owned by E.On. There were about 8,200 dwellings in Leiden, 500 dwellings in Leiderdorp and 1,000 dwellings in Oegstgeest connected to this network in 2013 (Energie-Nederland, 2015). The amount of non-residential buildings connected in 2013 is about 200 (Nuon, 2014). An overview of the heat network is given in **Table 10**.

**Enschede**

There is one large scale heat distribution network in Enschede owned by Ennatuurlijk. An overview for this network is given in **Table 11**. The gas-fired CHP-plant Marssteden in Enschede was decommissioned in 2009 (Ennatuurlijk, 2015b). Currently, the majority of heat is produced by the waste incinerator of Twence located in Enschede and the remaining share is produced by CHP units. Ennatuurlijk is the supplier and owns the substations and the network. There were about 6,000 dwellings (Energie-Nederland, 2015) and 200 non-residential buildings (Regio Twente, 2015) connected to the network in 2013.

**Helmond**

There is one large scale heat distribution network in Helmond. Ennatuurlijk is the supplier. The majority of heat is produced by a CHP-plant in Helmond owned by Essent and the other part by boilers. There were 6,400 dwellings connected to the network in 2013 (Energie-Nederland, 2015). An overview for this network is given in **Table 12**.

**Lelystad**

In Lelystad, there is one heat distribution network owned by Nuon. The heat sources are a biomass plant and a small CHP-unit on another location (Nuon, 2014). Backup boilers are installed on both locations. Nuon is the heat producer and supplier and owns the transport and distribution network. There were about 5,000 dwellings (Energie-Nederland, 2015) and 51 non-residential buildings (Nuon, 2014) connected in 2013. An overview for this network is given in **Table 13**.

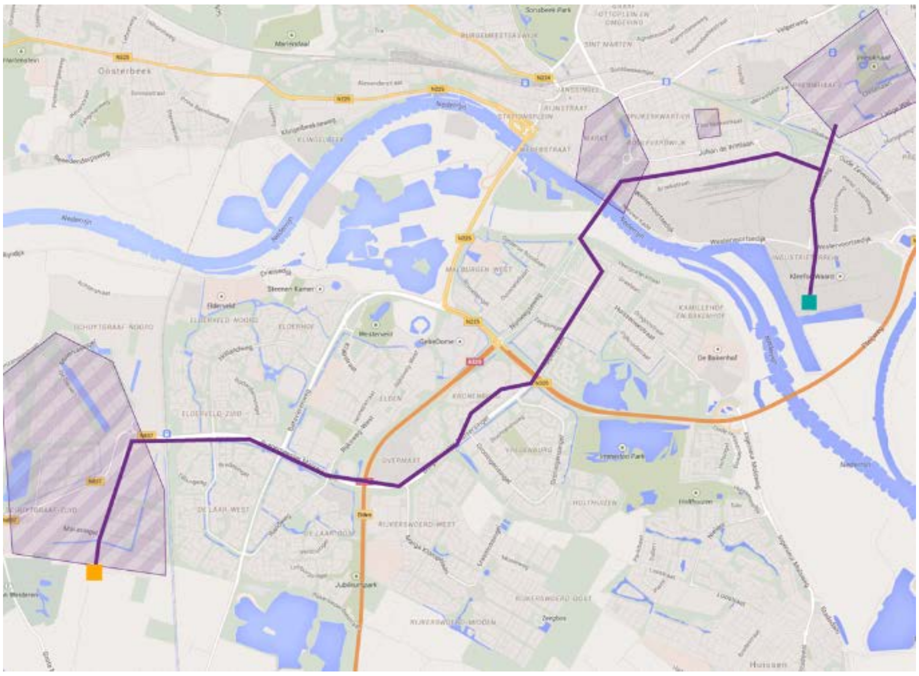
**Eindhoven**

There are two heat distribution networks in Eindhoven. Ennatuurlijk is the supplier. The heat is produced by a CHP-plant in Eindhoven and by a biomass plant both owned by Essent. There were 4,300 dwellings connected to these heat distribution networks in 2013 (Energie-Nederland, 2015). An overview for this network is given in **Table 14**.

**Arnhem**

There is one small scale heat distribution network in Arnhem. The heat source of this network is the CHP-plant Kleefse Waard owned by Nuon. Nuon is the supplier and owns the network and the backup boiler. A map of the heat network is given in **Figure 11** (Nuon, 2014). There are 4,000 dwellings (Energie-Nederland, 2015) connected and 77 non-residential buildings (Nuon, 2014) connected in 2013. One backup boiler is located in Schuytgraaf and is fuelled with natural gas and bio-diesel. An overview for this network is given in **Table 9**.

**Figure 11**: Supply area of the heat network in Arnhem



Purple lines = Transport pipeline Nuon

Green square = CHP-plant Kleefse Waard

Orange square = back up boiler Schuytgraaf

Purple area = Supply area Nuon

**Houten**

There is one small scale heat distribution network in Houten. The heat source is the CHP-plant Vijfwal owned by Eneco. Eneco is supplier and owns the transport and distribution network and the backup boilers. There are about 3,800 dwellings (Energie-Nederland, 2015) and 18 non-residential buildings (Eneco, 2015) connected in 2013. An overview for this network is given in **Table 15**.

**Amersfoort**

There is one small scale heat distribution network in Amersfoort. The heat source is the CHP-plant in Vathorst owned by Eneco. Eneco is supplier and owns the transport and distribution network and the backup boilers. There were about 3,200 dwellings connected in 2013 (Energie-Nederland, 2015). An overview for this network is given in **Table 16**.

**Nijmegen**

There is a small scale heat distribution network in Nijmegen. Nuon is supplier and owns the network and the backup boiler. The heat sources of this network are temporary gas-fired boilers in the area Waalsprong owned by Nuon. There is also a CHP-unit in Marienburg owned by Nuon which is a separate network. There were about 3,200 dwellings (Energie-Nederland, 2015) and 4 non-residential buildings connected in Nijmegen in 2013 (Nuon, 2014). An overview of the network in Nijmegen is given in **Table 9**.

## 4.4 Small heat networks

There are thousands of small scale heat distribution networks (<5,000 consumers) spread out over the Netherlands. An overview of these small heat distribution networks per municipality is given in **Table 17**. (Appendix B). Due to the large number of different suppliers and owners, precise information on the networks is difficult to obtain (Koop et al., 2011).

In 2009, there were about 6,900 small networks in the Netherlands (Schepers & van Valkengoed, 2009). Out of this total, 6,600 networks are owned by small firms, associations of homeowners and other parties. In most cases these are small networks of less than 50 consumers. A precise distinction with collective heat supply for apartment buildings (*blokverwarming*) can sometimes be difficult to make (Schepers & van Valkengoed, 2009). The other 300 small scale networks are owned by energy suppliers Nuon, Eneco and Ennatuurlijk. The majority of these networks have a cogeneration unit as their heat source. Waste heat, heat pumps or biomass are also used in a number of occasions.

The small scale heat distribution networks of **Nuon** are located in the following municipalities: Amstelveen, Diemen, Leiderdorp, Leidschendam-Voorburg, Oegstgeest, Coevorden, Culemborg, Ede, Hilversum, Wageningen and Zandvoort.

The small scale heat distribution networks of **Eneco** are located in the following municipalities: Amstelveen, Barendrecht, Delft, Haarlem, Lansingerland, Papendrecht, Pijnacker-Nootdorp and Zoetermeer.

The small scale heat distribution networks of **Ennatuurlijk,** are located in the following municipalities: Maastricht, Heerlen, Apeldoorn, Leeuwarden, Sittard-Geleen, Zeewolde, Deventer, Bergen op Zoom en Goes.

# 5

# Developments towards 2030

In this chapter, an overview of the developments for the heat distribution networks is given. The information about the number of new dwellings per municipality and changes in heat sources per network have been used in the projections for dwellings and non-residential buildings towards 2030. This chapter also provides projections on heat supply and heat production for heat networks from present towards 2030 therein including a breakdown per type of heat source. This projection is based on the current policy. The heat vision of the Ministry of Economic Affairs aims at a higher penetration of district heating, but the instrumentation for this policy is still under development.

## 5.1 General developments

There are multiple ongoing developments regarding heat distribution networks:

- Some municipalities have indicated that they have plans to further develop existing and/or new heat distribution networks. For instance, the existing networks in Amsterdam and Rotterdam will expand and in Nijmegen a new network will be constructed.
- Some of the heat sources for the networks will be decommissioned in coming years. These sources need to be replaced assuming that households and industry still demand heat in the future.
- Other (renewable) heat sources will be used for networks towards 2030. For example, there are plans of using more waste heat for the network in Rotterdam (EZ, 2015). Furthermore, biomass will be used in Purmerend instead of natural gas (see Chapter 5.2).

In most municipalities, new dwellings will be connected to the heat distribution networks towards 2030. The projected increase in dwellings with district heating per municipality is shown in **Figure 12**. The municipalities in which the most expansion takes place are respectively Amsterdam, Rotterdam, Utrecht and Almere. Municipalities where no expansion is expected currently are Helmond, Enschede and Lelystad (Ennatuurlijk, 2015) (Nuon, 2015). As indicated in the Methodology no existing dwellings are projected to change to district heating. The heat demand for district heating will increase towards 2030 as shown in **Figure 13**.

As described in the methodology section (3.2.3) the projections in **Figure 12** and **Figure 13** do not always reflect completely the vision of the heat supply company. In the methodology section is also described why has been decided to diverge from their numbers.

**Figure 12**: Projection of amount of dwellings with district heating.

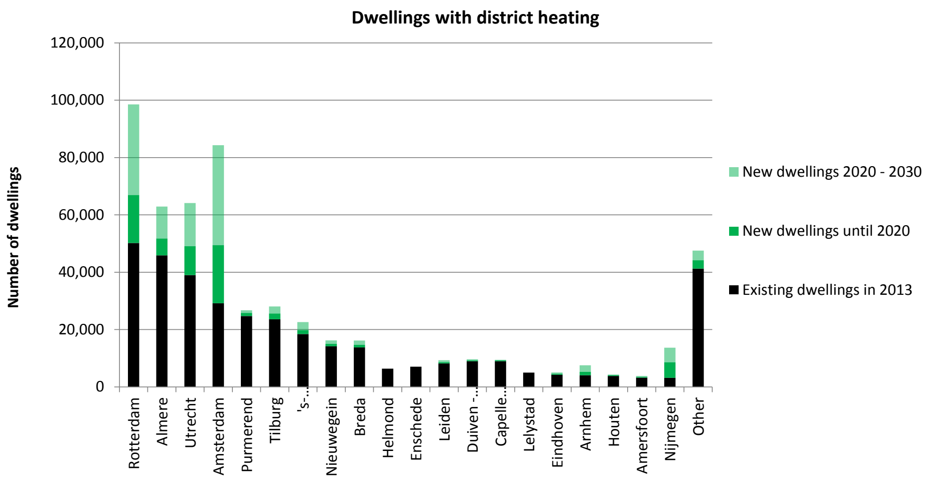
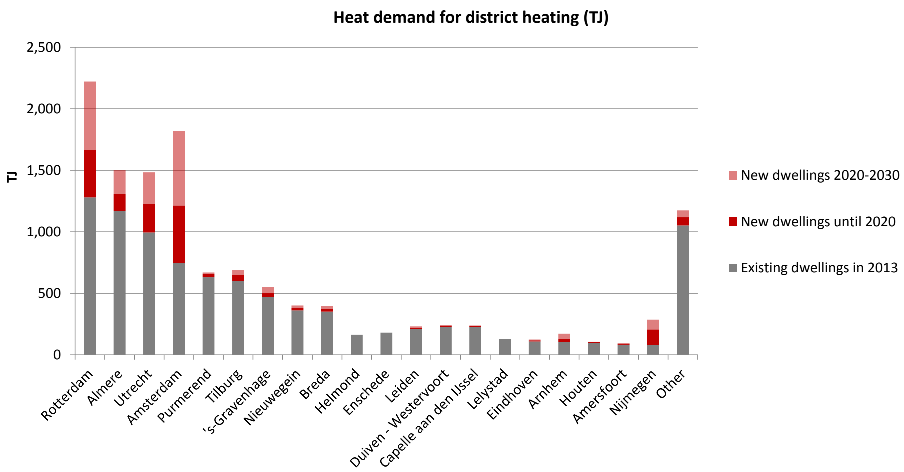



**Figure 13**: Projected heat demand for district heating.

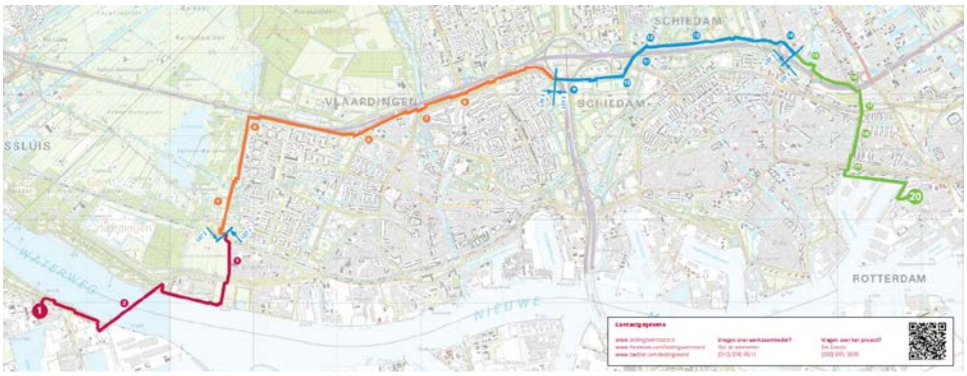


## 5.2 Developments per region

**Rotterdam**

- A recent large scale project in Rotterdam is the construction of the *Leiding over Noord* (*Pipeline over North*). The trajectory of this pipeline is shown in **Figure 14**. This pipeline has been connected to waste incinerator AVR Rozenburg similar to *De Nieuwe Warmteweg* (see 4.3). The first heat for this network was delivered at the end of 2014 (AVR.nl, 2015). As a result, the energy source for the networks in Rotterdam changed from natural gas to waste heat. Both *De Nieuwe Warmteweg* and the *Leiding over Noord* are coupled with the AVR Rozenburg and form one heat distribution network.
- The ROCA plant is expected to be operational until 2030, but its operation will depend on developments of gas and electricity prices. The ROCA plant is connected to the heat network of Eneco in Rotterdam and also supplies to the horticultural area in Zuid-Holland. About 15%-20% of total heat supply to dwellings in Rotterdam is by the ROCA (Eneco, 2015).
- The capacity of AVR Rozenburg is expected to be large enough to deal with the increase in amount of consumers in coming years (Eneco, 2015). Therefore, no additional sources are required towards 2030. For peak demand additional peak capacity might be needed.
- In the future, new dwellings will be connected to the networks in Rotterdam. It has been assumed that 75% of all new dwellings in Rotterdam will be connected to the district heating network. This means 48,000 new dwellings towards 2030. This number is higher than the amount projected by Eneco, which foresees an increase between 25,000 and 50,000 dwelling equivalents, so including also non-residential buildings. However, the higher number is used for the projections in this report as explained in the methodology section. The district heating network in Rotterdam will expand to about 100,000 connected dwellings in total in 2030. The Nuon projections indicate a growth from 36 to 165 non-residential buildings in period 2013 to 2030 (Nuon, 2014).

**Figure 14**: The pipeline trajectory for *De leiding over Noord* in Rotterdam.



*Warmte Rotonde in Zuid-Holland*

The province Zuid-Holland, the municipalities of Rotterdam, Den Haag, Delft and Westland are collaborating with amongst others Havenbedrijf Rotterdam, Warmtebedrijf Rotterdam, E.ON, ENECO, Westland Infra (25 stakeholders in total) to develop a regional heat distribution network for existing dwellings and the horticultural area of Zuid-Holland(EZ, 2015). The network named the *Warmte rotonde* will be supplied with heat from geothermal sources, waste heat from the port of Rotterdam and other (renewable) sources. The Warmte rotonde will lead to a reduction in primary energy use of 20 PJ and 1 million tonnes of $CO_2$ per year (EZ, 2015).A map of the network layout is shown in **Figure 15** (EZ, 2015). The project will be executed in steps, whereby the area in the west will be the first step in the development. However, at the moment, the Warmte rotonde is not included in the projections of this study due to the uncertainties about the realization and the amount buildings that would be connected.

**Figure 15**: The regional heat network called De Warmte rotonde planned for the province Zuid-Holland.


**Almere**

- In the future, new dwellings will be added to the networks in Almere. The network is projected to expand to 63,000 dwellings in 2030. This means that 17,000 new dwelling will be connected over the years which is equal to 59% of the new dwellings in Almere. Most of the expansion will be realized in Almere Poort (Nuon, 2015).
- The number of connected non-residential buildings will increase from 700 to 738 in 2024 (Nuon, 2014).

**Utrecht – Nieuwegein**

- In the future, new dwellings will be added to the network in Utrecht and Nieuwegein and the total is projected to increase to about 80,000 dwellings in 2030. This means that 27,000 new dwellings will be connected over the years. For Utrecht, there will be an increase of 25,000 dwellings in 2030, which is equal to 75% of all new dwellings built in Utrecht. Eneco believes these projections are too high under current policy. For Nieuwegein an increase of 2,000 dwellings in 2030 is expected, which is equal to 75% of all new dwellings in Nieuwegein.

- Since January 2015, Eneco is the producer for the network of Utrecht and Nieuwegein instead of Nuon (Eneco, 2015).
- Eneco plans to develop a biomass plant for the heat distribution network of Utrecht and Nieuwegein. It is likely that a biomass plant will be constructed in 2020 (Eneco, 2015). This plant is expected to provide about 25% of the heat supply in total (Eneco, 2015).

**Amsterdam**

- In the future, new dwellings will be added to the networks in Amsterdam. Based on projections from Nuon, the total will increase to 85,000 dwellings in 2030 (Nuon, 2014). This is an increase of 55,000 new dwellings compared to 2013 and is equal to 52% of all new dwellings in Amsterdam built towards 2030.
- In the beginning of 2015, Nuon and AEB Amsterdam initiated the project Noorderwarmte. This involved construction of a heat transport pipeline of 16 km underneath the IJ-lake, in order to transport heat from AEB to Amsterdam -Noord. The pipeline will be commissioned at the end of 2016. In 2030, approximately 20,000 customers will be supplied with waste heat from this source (Nuon, 2014). These dwellings are included in the projections of this study.
- The heat networks in Amsterdam will be extended, improved in flexibility of supply and sustainability of supply. Also, a “small ring” will be constructed to distribute heat. The government has paid to do a feasibility study (EZ, 2015). In the future, one (small) ring shaped network is possible together with one heat buffer at Diemen and one heat buffer at Westpoort (Nuon, 2015).
- To improve the flexibility of supply a heat buffer at the location of the Diemencentrale has been constructed. The purpose of this is to store heat for dwellings and non-residential buildings in Almere, Amsterdam, Diemen and Amstelveen. Using a heat buffer enables the Diemencentrale to operate more efficiently, because it can store surplus heat when electricity demand is low and can supply heat when electricity demand is high. The buffer will be commissioned in 2015 (Nuon, 2014).

*Network of Diemercentrale*

- There is a projected growth from 13,400 connected dwellings in 2013 to 37,000 connected dwellings in 2030 (Nuon, 2014).
- Nuon projections indicate an increase from 207 to 341 non-residential buildings in the period 2013 to 2030 (Nuon, 2014).

*Network Westpoort Warmte*

- There is a projected growth from 7,500 connected dwellings in 2013 to 39,000 connected dwellings in 2035 (Nuon, 2014).
- Nuon projections indicate an increase from 36 to 165 non-residential buildings in the period 2013 to 2035 (Nuon, 2014).

*Small CHP units in Amsterdam*

- Consumers who are currently supplied by small CHP units will be connected to one of the large heat networks in Amsterdam during the period 2015 - 2020. This will be done exclusively on locations where it is technically and economically feasible to do so (Nuon, 2015).

**Purmerend**

- In the beginning of 2013, Stadsverwarming Purmerend (SVP) started the construction of a biomass-heat-plant named the *BioWarmteCentrale* (BWC). SVP will use the BWC and two back-up boilers to supply its own heat starting from March 2015. Previously, Nuon produced the heat for this network using a gas-fired CHP plant and one back-up boiler. The BWC will burn woodchips collected from the natural areas of Staatsbosbeheer (SVP, 2015).
- In the future, new dwellings will be added to the network in Purmerend and the total is projected to increase to 26,700 dwellings in 2030. This means that 1990 new dwellings will be connected over the years.
- There is a study conducted aimed at investigating whether the peak demand can be covered using renewable sources (*Vergroening van de piek*), but there are no concrete plans for this at the moment (SV Purmerend, 2015).

**Amernet (Tilburg, Breda, Oosterhout, Geertruidenberg, Made, Waspik)**

- In the future, new dwellings will be connected to the Amernet and the total is projected to increase from 38,900 dwellings in 2013 to 45,900 connected dwellings in 2030. This means that 7,000 new dwellings will be connected over the years. It is projected that in Tilburg and Breda, respectively 4,500 and 2,400 new dwellings will be connected toward 2030.
- It is expected that Unit 8 of the Amercentrale will be decommissioned in 2016. The unit 9 of the Amercentrale fueled with coal and biomass is expected to remain operational and take over the supply (Ennatuurlijk, 2015).
- The shares of primary energy sources in unit 9 (35% biomass and 65% coal) are assumed to remain constant towards 2030 as it is currently not expected that the share of biomass increases (Ennatuurlijk, 2015).

**Den Haag**

- In the future, new dwellings will be added to the networks in Den Haag and Ypenburg and the total is projected to increase to about 22,600 dwellings in 2030. This means that 4,000 new dwellings will be connected over the years, which equal 8% of new dwellings in Den Haag toward 2030.
- About 890 new dwellings Pijnacker-Nootdorp will be connected to the network of Ypenburg in 2030.
- A geothermal project in 2013 had gone bankrupt. Whether there will be a new Geothermal project is dependent on the developments of the *Warmte* rotonde. If the *Warmte rotonde* will be commissioned, it is likely that waste heat from Rotterdam can be used. Otherwise, geothermal energy might prove to be a feasible option in Den Haag (Eneco, 2015).

**Duiven – Westervoort**

- There is a projected expansion of this network from 9,200 connected dwellings in 2013 to 9,500 connected dwellings in 2030 (Nuon, 2014).
- Nuon projections indicate an increase from 201 to 210 connected non-residential buildings in the period 2013 to 2021 (Nuon, 2014).
- A heat buffer has been constructed on the AVR location. This will provide more flexibility for use of waste heat. (Nuon, 2014)
- In the region Nijmegen, Arnhem, Duiven and Westervoort, Nuon plans to expand the heat distribution networks in the future. A project called Green Alliances Duiven is

developed together with Nuon to improve the sustainability of the industrial area Nieuwgraaf, where a large number of large consumers is located (Nuon, 2014).

**Leiden region**

- There is limited expansion possible due to the capacity of the existing E.On power plant (Nuon, 2014). The E.On power plant is not competitive on the market anymore and will most likely stop production by 2020 (Nuon, 2015).
- New sources are possible from 2020 onwards. A feasibility study is done by Nuon on connecting buidlings to the network in Rotterdam. With this connection, waste heat from port of Rotterdam can be supplied to the network (Nuon, 2014).
- The network in the Leiden region will grow with about 1,300 new dwellings in 2030, which is equal to 15% of all new dwellings in the region. The projection is that about 9,500 dwellings will be connected to the network in 2030.

**Enschede**

- No new dwellings and non-residential buildings will be connected to the heat distribution network in Eindhoven towards 2030 (Ennatuurlijk, 2015).

**Helmond**

- No new dwellings and non-residential buildings will be connected to the heat distribution network in Helmond towards 2030 (Ennatuurlijk, 2015).

**Lelystad**

- There will almost be no increase in connected dwellings in Lelystad. It is projected that 7 new dwellings will be connected until 2024 (Nuon, 2014). In the projections, there will be no expansion of the network in Lelystad towards 2030.
- There is potential for another biomass unit or other small CHP-unit(s) in the future. The feasibility for this is currently studied (Nuon, 2015).

**Eindhoven**

- About 800 new dwellings will be connected to the heat distribution network in Eindhoven towards 2030 (Ennatuurlijk, 2015).

**Arnhem**

- In the future, new dwellings will be added to the network in Arnhem. The number of connected dwellings will increase from 4,000 in 2013 to about 7,550 dwellings in 2030. This equals 21% of all new dwellings toward 2030. In Schuytgraaf 6,250 new dwellings will be connected. In Presikhaaf 1,300 dwellings will be connected (Nuon, 2014).
- In 2014 the network was coupled with the network Duiven-Westervoort. At the end of 2014 the coupled network was commissioned and is now supplied with waste heat from AVR (Nuon, 2014).
- The CHP-plant Kleefse Waard is expected to stop heat supply to the network in 2015 (Nuon, 2014). Thereafter, all heat will then be supplied by the waste incinerator of AVR.

**Houten**

- There is a projected increase of about 500 dwellings in 2030. This amounts to 20% of the new dwelllings in Houten built toward 2030 (Eneco, 2015).

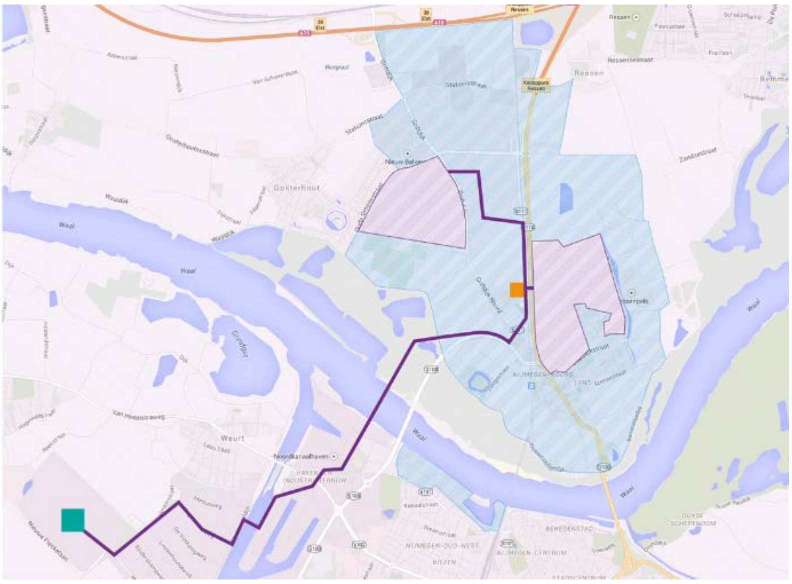
**Amersfoort**

- An expansion of about 600 dwellings towards 2030. This is equal to 5% of the new dwellings in Amersfoort toward 2030 (Eneco, 2015).

**Nijmegen**

- There is a projected increase from 3,400 dwellings in 2013 to 13,700 dwellings in 2030.
- In 2014, the network of Nijmegen was coupled to the ARN waste incinerator. The transport pipeline is owned by Alliander, the other parts of the heat distribution network are owned by Nuon. The commissioning of the network was end 2014 (Nuon, 2014). A map of the heat network is shown in **Figure 16**.
- Nijmegen can be potentially coupled to the network in Arnhem and Duiven-Westervoort. The feasibility for this connection is currently investigated (Nuon, 2015).

**Figure 16**: Map of the heat network in Nijmegen.



Purple lines = Transport pipeline Nuon

Green square = ARN Weurt

Orange square = back up boiler Pieter Wiersma

Light blue area = Current supply area Nuon

Pink area = Future supply area Nuon

**Developments of small heat distribution networks**

For small networks of Eneco, Nuon, Ennatuurlijk, little developments are currently expected (Eneco, 2015) (Nuon, 2015) (Ennatuurlijk, 2015). This is because the current networks are often dimensioned to the heat source(s) and no changes are currently expected for this.

The developments in Delft are dependent on the development of the Warmte rotonde in Zuid-Holland. If this project would be completed, there is potential to connect consumers to the network because the pipeline already passes through Delft (Nuon, 2015).

## 5.3 Developments of heat supply and production

**Heat supply for dwellings with district heating**

For existing dwellings in 2013, the heat supply will decrease towards 2030 as a result of energy efficiency measures, see **Figure 17**. New dwellings will contribute to the heat demand over the years, adding about 3.5 PJ to the total by 2030 see **Figure 18**. The projection on the total heat supply (per source) for district heating is shown in **Figure 19**. Overall, the heat supply will increase from 11.5 PJ in 2013 to 12.9 PJ in 2030.

**Figure 17**: Projected heat supply for existing dwellings with district heating per source

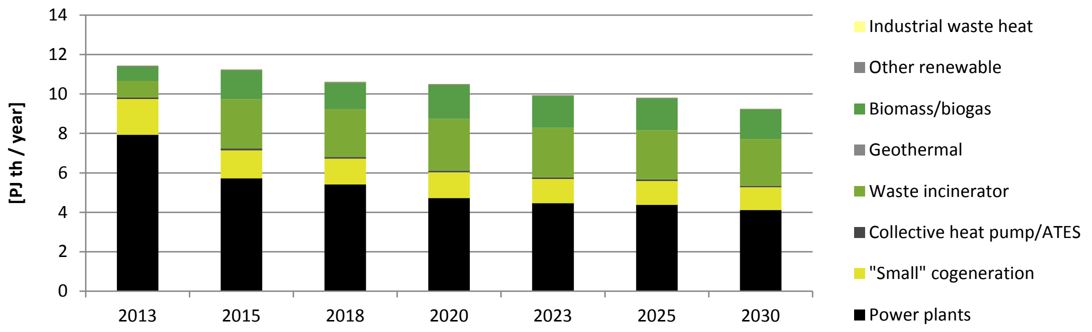



**Figure 18**: Projected heat supply for new dwellings with district heating per source

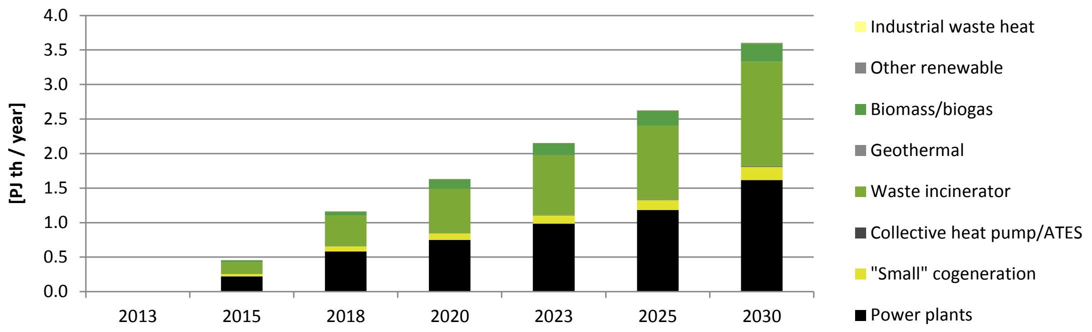
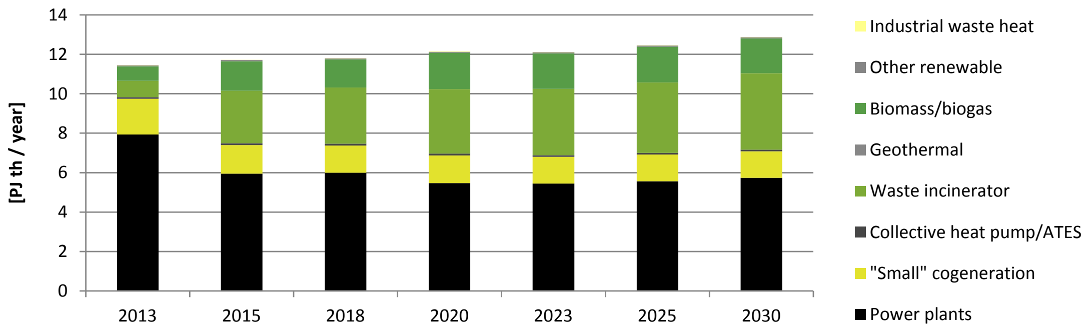


**Figure 19**: Projected heat supply for total amount of dwellings with district heating per source




Power plants will remain the largest source of heat supply for district heating, although their share in the total production will be decreasing over the years, from 69% to 44% in 2030. For small cogeneration units a small decrease in the production share is projected for 2030, from 16% to 11%. The role of waste incineration in collective heat supply is projected to grow significantly towards 2030 and will reach a share of about 30% in 2030. The share of biomass/biogas doubles from 7% in 2013 to 14% in 2030. Other sources make a relatively small or no contribution to the total. These are heat pumps (combined with ATES), geothermal energy (0%), other renewable sources such as collective solar systems and industrial waste heat. Heat pumps and other renewable sources (such as solar thermal) are mostly used in small scale networks. Geothermal energy is also often used for horticulture instead of dwellings because of the lower temperature heat. A growth in utilization of industrial waste heat is not expected, therefore this share will remain negligible over the years.

The projected heat supply per source for dwellings with district heating in 2013 (in PJ) is given in **Table 1**.

**Table 1**: Projected heat supply to dwellings with district heating [PJ]

| | 2013 | 2015 | 2018 | 2020 | 2023 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| **Power plants** | 7.88 | 5.89 | 5.93 | 5.41 | 5.39 | 5.50 | 5.68 |
| **"Small" cogeneration** | 1.80 | 1.44 | 1.38 | 1.40 | 1.35 | 1.36 | 1.34 |
| **Collective heat pump/ATES** | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.08 |
| **Waste incinerator** | 0.83 | 2.67 | 2.86 | 3.27 | 3.37 | 3.57 | 3.88 |
| **Geothermal** | - | - | - | - | - | - | - |
| **Biomass/biogas** | 0.79 | 1.55 | 1.47 | 1.91 | 1.86 | 1.87 | 1.82 |
| **Other renewable** | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| **Industrial waste heat** | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| **Total** | 11.45 | 11.71 | 11.80 | 12.14 | 12.11 | 12.45 | 12.87 |

**Total heat supply and production for heat distribution networks**

The projected total heat supply to dwellings and non-residential buildings connected to heat networks (in PJ) in shown in **Table 2**. Assuming that 15% of the heat is lost in the networks, the heat production is 19.4 .1 PJ in 2013 and 21.8 PJ in 2030.

**Table 2**: Projected heat supply to dwellings and non-residential buildings [PJ]

| | 2013 | 2015 | 2018 | 2020 | 2023 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| **Dwellings** | 11.45 | 11.71 | 11.80 | 12.14 | 12.11 | 12.45 | 12.87 |
| **Non-residential buildings** | 5.00 | 5.12 | 5.15 | 5.30 | 5.29 | 5.44 | 5.62 |
| **Total heat demand** | 16.45 | 16.83 | 16.95 | 17.45 | 17.40 | 17.89 | 18.49 |
| **Total heat production** | 19.35 | 19.80 | 19.94 | 20.53 | 20.47 | 21.04 | 21.75 |

# 6

# Discussion

The following discussion points are addressed in this chapter:

- Limitations of the followed approach
- Difference between ambitions and realizations for district heating
- Uncertainties about the heat supply from renewable sources

**Limitations of the followed approach**

- There are uncertainties in the number of dwellings that will be connected to heat distribution networks in the future. Suppliers indicated that they project newly built dwellings to provide the largest share of new connections to district heating networks (Ennatuurlijk, 2015) (Eneco, 2015) (Nuon, 2015) (SV Purmerend, 2015). Existing dwellings changing to district heating are currently not taken into account in these projections, mainly because the plans for this are not sufficiently concrete yet. However, when these existing dwellings would be taken into account, a larger growth of district heating in the Netherlands would be projected.
- In the W*armtevisie* (EZ, 2015) new policy initiatives have been announced for district heating. If the heat policy of the Ministry of Economic Affairs leads to a better business case for district heating, the number of dwellings connected to the district heating could be considerably higher.
- The average heat demand per dwelling was used in order to calculate the total heat demand. The figure is a weighted average over the different dwelling types for the Netherlands. However, there are differences between municipalities in the number of dwellings per type as well as differences in the age distribution of the dwellings. On a municipal level this leads to some uncertainty in the demand for district heating. To obtain more accurate figures per municipality in a further research, information on the distribution of different dwelling types and ages of dwellings would have to be taken into consideration.
- In this study less attention has been paid to the developments of the small scale heat distribution networks as these networks have a relatively small contribution to the total heat supply. The growth projections for small networks are mostly based on the amount of new dwellings in the considered municipality. It is possible that some of other relevant developments, for instance a changes of some heat sources, have been overlooked.
- It was assumed that the heat supply to non-residential buildings grows at the same annual rate as the heat supply to dwellings with district heating. This is however a simplified approach and with more information about the growth of connected non-residential buildings in the future, an improved estimation can be made about how much heat is supplied to this sector. Moreover the fact that the heat demand

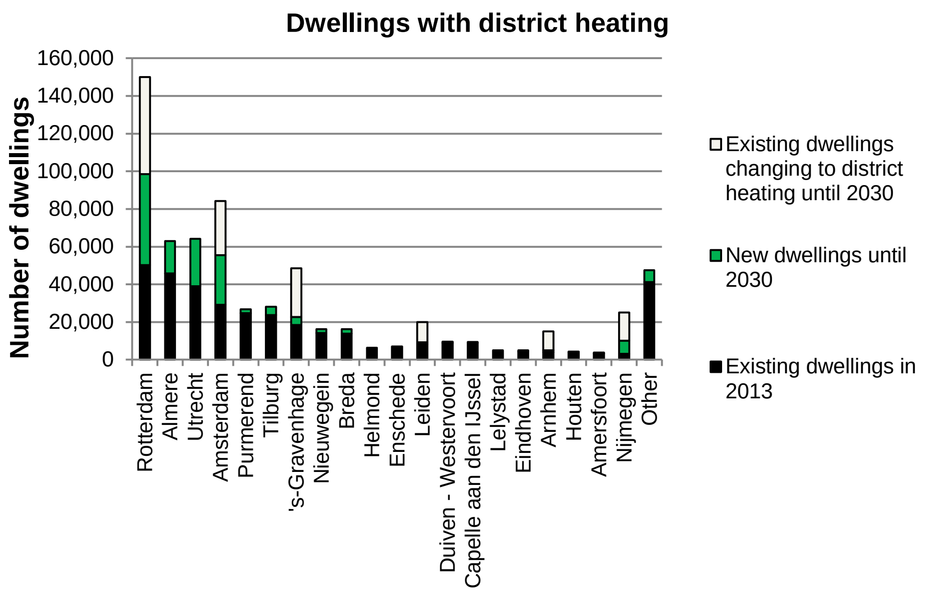
in 2013 for non-residential buildings is the residual heat demand, calculated as the difference between total supply and supply to all other sector (Segers, 2015), is also not very accurate starting value.

**Differences between ambitions and realizations for district heating**

There are municipalities that have expressed higher ambitions for heat supply using heat networks in the future than this study projects. An alternative projection on the amount of dwellings with district heating, in case ambitions would be fully realized, is shown in **Figure 20**. In this scenario, the following ambitions were included. Rotterdam and Amsterdam would respectively achieve 150,000 and 130,000 connected dwellings in 2030. Den Haag would achieve 50,000 connected dwellings and Leiden 20,000 as a result of their connection to *De warmte rotonde*. Arnhem and Nijmegen would respectively achieve 15,000 and 25,000 connected dwellings.

The total heat supply to dwellings with district heating would be equal to 15.8 PJ in 2030, which is  substantially higher than in the current projections. An expansion of district heating of this order cannot be realized without connected existing dwellings to the networks (Nuon, 2014).

**Figure 20**: Projection of dwellings with district heating including ambitions.




**Uncertainties about the utilization of waste heat**

Five factors influence the feasibility for waste heat utilization, the potential energy savings and emissions reductions, and the costs to utilize waste heat (Daniëls et al., 2011):

- *Type of source:* Which source(s) can be combined with which consumer(s). What are the characteristics of the source and consumer?
- Temperature*:* How much heat can be supplied at a certain temperature? And how much heat is demanded at a certain temperature?
- *Time period:* Do supply and demand patterns match with each other? And will both the source and consumer exist for long enough?

- *Proximity, density and scale*: Mow many of the sources and consumers are large enough and are close enough to each other?
- *Alternatives:* Are there alternatives to avoid using waste heat, for instance, by reducing heat demand, or supplying heat in another way? Are those alternatives cheaper, and do those alternatives achieve more energy savings and emission reductions?

Although there is a potential in certain regions to utilize waste heat from industry, a substantial increase is not expected in the coming years. This because the capacity of current sources is large enough to deal with the projected growth in heat demand. Furthermore, considerable investment costs are required for new networks and/or for connecting sources of waste heat to the existing networks. An increased use of other (renewable) sources also requires major investments in heat networks. Moreover, the suppliers of renewable and waste heat cannot always give a guarantee for long-term supply security, because it is not certain whether they will be in business for a period of decades. With a decreasing heat demand for both new and existing dwellings, it is then questionable whether investments in district heating infrastructure can be recouped.

# 7

# Conclusions

Based on the results the following conclusions are drawn for the current situation and the developments of heat distribution networks in the Netherlands. Finally, we provide some key limitations and considerations.

**On the current situation of heat distribution networks in the Netherlands**

- There are currently 13 large scale heat distribution networks. The largest networks are located in Rotterdam, Almere, Utrecht - Nieuwegein, Amsterdam, and Purmerend. The Amernet is a large heat distribution network that supplies to multiple municipalities including Tilburg and Breda.
- There are approximately 6,900 small scale heat distribution networks. About 300 of these are owned by energy suppliers. The other networks are owned by small firms, *associations* of homeowners and other parties. The majority of small heat distribution networks is supplied with heat from a gas-fired heat source.
- The heat supply to dwellings is equal to 11.5 PJ in 2013. Supply to non-residential buildings was 5.0 PJ in 2013, 4PJ went to horticulture and < 1PJ to both the waste water and industry sector.

The largest share of heat supply to dwellings will be by power plants, altough the share will decrease over the years, from 69% in 2013 to about 44% in 2030. For small cogeneration units, a decrease from 16% to 11% of the production share is projected for 2030. The role of waste incinerators in the collective heat supply is projected to grow significantly towards 2030 and will reach a share of 30% in 2030. The main reason for this increase is the commissioning of the *Nieuwe Warmteweg* and *Leiding over Noord* in Rotterdam. Also, in Arnhem and Nijmegen waste heat is used instead of natural gas. The share of biomass/biogas doubles from 7% in 2013 to 14% in 2030. The change from natural gas to biomass in Purmerend is mainly responsible for this. The other heat sources make a relatively small contribution to the total over the years.

**On the future of heat distribution networks in the Netherlands**

- The number of dwellings connected to a heat distribution network is projected to increase from 363,000 dwellings in 2013 to 549,000 dwellings in 2030. In total, 17% of the new dwellings in *the* Netherlands built since 2013 will be connected to a heat distribution network in 2030, of which the largest shares of new dwellings are located in Rotterdam, Almere, Utrecht, Amsterdam, Den Haag, Tilburg, Arnhem and Nijmegen.

- The total heat demand for dwellings with district heating will increase from 11.5 PJ in 2013 to 12.9 PJ in 2030. *The* heat demand for existing dwellings will decrease but this will be counteracted by an additional heat demand for new dwellings adding 3.6 PJ in 2030. For non-residential buildings, the assumption is that heat demand follows the same growth as for dwellings. For horticulture, industry and waste water sectors, no projection has been made due to limited available data on this.
- The **total heat supply** by heat distribution networks (to dwellings and non-residential *buildings*) is projected to increase from 16.5 PJ in 2013 to 18.5 PJ in 2030 under the current policy.
- Assuming that 15% of the heat is lost in the distribution networks the **total heat production** (for *dwellings* and non-residential buildings) is projected to be 19.4 PJ in 2013 and 21.8 PJ in 2030.

**Some key limitations and considerations**

- There are uncertainties in the amount of dwellings that will be connected to heat distribution networks in the future. Suppliers indicated that the largest shares of new dwellings with district heating will be new dwellings. Existing dwellings changing to district heating are currently not taken into account in their projections, because the plans for this are not sufficiently concrete yet.
- The amount of dwellings with district heating in 2030 would be substantially higher when ambitions of municipalities are taken into account. If ambitions of Rotterdam, Amsterdam, Zuid-Holland and Arnhem and Nijmegen would be realised, the result would be a total heat supply of 15.8 PJ in 2030 instead of 12.9 PJ. The major difference with the current projection is in the amount of existing dwellings that are required to change to district heating in order to realize the ambitions.
- Another assumption is that the heat supply to non-residential buildings has the same annual change as the heat supply to dwellings. Under this assumption, heat supply increases from 5 PJ in 2013 to 5.6 PJ in 2030. This is however a simplified approach and the accuracy of these figures is thus limited. With more information about the projected amount of connected non-residential buildings in the future and the average heat demand, an improved estimate could be made about how much heat will be supplied to non-residential buildings.
- Although there is a potential in certain regions to utilize waste heat from industry in the future, a considerable increase is not expected in the coming years. The reason for this is that the capacity of current sources is sufficient to deal with the projected growth in heat demand.
- Moreover, high investment costs are required for new networks or to connect sources of waste heat and other renewable sources to the existing networks. In combination with the fact that the suppliers of renewable and waste heat cannot always give a guarantee for long-term supply security, and with a decreasing heat demand for both new and existing dwellings, it is then questionable whether investments in district heating infrastructure can be recouped.

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# Appendix A. Overview tables heat distribution networks in 2013

**Table 3**: Heat distribution networks in Rotterdam in 2013

| Heat distribution network in Rotterdam (2013) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat network** | Scale (Large/small) | Location(s) | Supplier | Producer | Heat source | Primary energy source | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Number of connected non-residential buildings in 2013 [c] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ]** | Heat produced for network in 2013 [TJ]*** |
| **Rotterdam (total)** | | **Rotterdam** | | | | | | **43564** | **50210** | **1500 [a]** | **1580** | | |
| **Eneco - Rotterdam** | Large | Rotterdam | Eneco | E.On | | | | 42500 | 46297 | 1500 [a] | 1460 | 2490[d] | 4070 |
| | | Rotterdam | | | CHP plant Galileï | Natural Gas | 1946 | 42500 | Source decommissioned | Source decommissioned | Source decommissioned | Source decommissioned | Source decommissioned |
| | | Rotterdam | | | ROCA power plant | Natural Gas | 1983 | | | | | | |
| | Large | Capelle aan den IJssel | | | | | | | 8950 | N/A | 280 | | |
| **Nuon - Rotterdam** | Small | Rotterdam - Zuid | Nuon | AVR | Waste incinerator | Waste | 2013 | - | 1811 [c] | 18 [c] | 60 | | |
| | Small | Rotterdam - Hoogvliet | Nuon | Nuon | Boilers (temporary) | Natural gas | 2003 | 910 [a] | 1948 [c] | 18 [c] | 60 | | |

a) (Schepers & van Valkengoed, 2009)
b) (Energie-Nederland, 2015)
c) (Nuon, 2014)
d) (Eneco, 2015)
*) Calculated based on average heat demand per dwelling (as described in the methodology)
**) Calculated using dwelling equivalents (Nuon, 2014)
***) Including 15% distribution losses

**Table 4**: Heat distribution networks in Amsterdam and Almere in 2013

| Heat distribution networks in Amsterdam and Almere (2013) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat distribution network** | Scale (large/small) | Location(s) | Supplier | Producer | Heat source | Primary energy source | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Number of connected non-residential buildings in 2013 [c] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ]** | Heat produced for network in 2013 [TJ]*** |
| **Amsterdam (total)** | | Amsterdam | | | | | | 16542 | 29185 | | | | |
| **Amsterdam – Nuon** | Large | | | Nuon | Diemen centrale | Natural gas | | | 75630 | 952 | 1880 | 1550 | 3900 |
| | | Zuideramstel, Buitenveldert, Stadionbuurt, Zuidoost, Amstelkwartier, De Omval and IJburg, Diemen | Nuon | | | | 2002 | 7400 | 13374[c] | 207 | 420 | 1080 | 1700 |
| **Amstelveen** | | Amstelveen | Eneco | | | | 1997 | 545 | 573 | 45 [d] | 18 | 90 [d] | 100 |
| **Almere** | | Almere Poort, Almere stad, Almere Noorderplassen | Nuon | | | | 1979 | 42300 | 45872 | 700 | 1450 | 370 | 2100 |
| **Westpoort Warmte** | Large | Westpoort and Nieuw-West | Nuon and AEB Amsterdam | | | | **1993** | **682** | **7500**[c] | **170** | **240** | **550** | 900 |
| | | | | Nuon and AEB Amsterdam | Waste incinerator | Waste | 1993 | 682 | | | | | 560 |
| | | | | Nuon and AEB Amsterdam | Biogas plant | Biogas | N/A | | Connected to AEB | | | | N/A |
| | | | | Orgaworld | Biogas plant | Biogas | 2011 | | Connected to AEB | | | | N/A |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Waternet | Biogas plant | Biogas | 2011 | | Connected to AEB | | | | N/A |
| **“Small” CHP-units** | Small | Amsterdam, several locations | Nuon | Nuon | “Small” CHP-units | Natural Gas | 1994 - 2003 | 8460 | 8311 | | N/A | | N/A |

a) (Schepers & van Valkengoed, 2009)
b) (Energie-Nederland, 2015)
c) (Nuon, 2015)
d) (Eneco, 2015)
*) Calculated based on average heat demand per dwelling (as described in the methodology)
**) Calculated using dwelling equivalents (Nuon, 2014)
***) Including 15% distribution losses

**Table 5**: Heat distribution network in Utrecht and Nieuwegein in 2013

**Heat distribution network in Utrecht and Nieuwegein (2013)**

| Heat network | Scale (Large/small / renewable) | Location(s) | Supplier | Producer | Heat source | Primary energy source | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Number of connected non-residential buildings in 2013 [c] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ] [c] | Heat produced for network in 2013 [TJ]** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Utrecht - Nieuwegein** | **Large** | **Utrecht, Leidsche Rijn and Nieuwegein** | **Eneco** | **Nuon** | **Power plant Lage weide and power plant Merwedekanaal** | **Natural gas** | **1992** | **40400** | **53200** | **1800** | **1650** | **2050** | **4260** |
| | | Utrecht (city)<br>Leidsche Rijn | Eneco | Nuon | Power plant Lage weide, power plant Merwedekanaal | Natural gas | 1992 | 40400 | 39000 | 1650 | 1200 | 1900 | 3600 |
| | | Nieuwegein | Eneco | Nuon | Power plant Lage weide, power plant Merwedekanaal | Natural gas | 1992 | | 14200 | 150 | 450 | 150 | 660 |

a) (Schepers & van Valkengoed, 2009)
b) (Energie-Nederland, 2015)
c) (Eneco, 2015)
*) Calculated based on average heat demand per dwelling (as described in the methodology)
**) Including 15% distribution losses

**Table 6**: Heat distribution network in Purmerend in 2013

| Heat distribution network in Purmerend (2013) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat network** | Scale (Large/small/ renewable) | Location(s) | Supplier | Producer | Heat source | Primary energy source | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Number of connected non-residential buildings in 2013 [c] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ] | Heat produced for network in 2013 [TJ] [c] |
| **Purmerend** | **Large** | **Purmerend** | **Stadsverwarming Purmerend (SVP)** | **Nuon** | **CHP-plant Purmerend** | **Natural gas** | **1981** | **24300** | **24700** | **1000** | **780** | **N/A** | **1370** |

a) (Schepers & van Valkengoed, 2009)
b) (Energie-Nederland, 2015)
c) (SV Purmerend, 2015)
*) Calculated based on average heat demand per dwelling (as described in the methodology)

**Table 7**: Amernet in 2013

| Amernet (Tilburg, Breda) (2013) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat network** | Scale (Large/small) | Location(s) | Supplier | Producer | Heat source | Primary energy source | Starting Year supply | Number of connected dwellings in 2010 [a] | Number of connected dwellings in 2013 [b] | Number of connected non-residential buildings in 2010 [a] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ] [c] | Heat produced for network in 2013 [TJ]** |
| **Amernet (total)** | **Large** | | **Ennatuurlijk** | **Essent** | **Amercentrale** | **Coal (co-fired with biomass)** | **1981** | 33579 | **38865** | 795 | **1220** | **1700** | **3380** |
| | | Tilburg | | | | | | 16732 | 23614 | 432 | 740 | 110 | 3380 |
| | | Breda | | | | | | 15397 | 13769 | 276 | 430 | 350 | |
| | | Oosterhout | | | | | | 855 | 868 | 11 | 30 | 1240 | |
| | | Geertruidenberg | | | | | | 595 | 614 | 13 | 20 | | |
| | | Made | | | | | | 0 | 0 | 44 | 0 | | |
| | | Waspik | | | | | | 0 | 0 | 19 | 0 | | |

a) (Ener2, 2010)
b) (Energie-Nederland, 2015)
c) (Ennatuurlijk, 2015)
*) Calculated based on average heat demand per dwelling (as described in the methodology)
**) Including 15% distribution losses

**Table 8**: Heat distribution networks in Den Haag in 2013

| Heat distribution networks in Den Haag (2013) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat network** | Scale (Large/small/ renewable) | Location(s) | Supplier | Producer | Heat source | Primary energy source | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Number of connected non-residential buildings in 2013 [c] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ] [c] | Heat produced for network in 2013 [TJ]** |
| **Den Haag (total)** | | **Den Haag** | | | | | | **14005** | **18438** | **447** | **580** | **1190** | **2040** |
| **Den Haag – Ypenburg** | Large | Ypenburg, Pijnacker-Nootdorp | Eneco | Eneco | CHP plant Ypenburg | Natural Gas | 2005 | 8900 | 13712 | 80 | 360 | 20 | 440 |
| | | Ypenburg | | | | | | | 11387 | | 290 | | |
| | | Pijnacker-Nootdorp | | | | | | | 2325 | | 70 | | |
| **Den Haag** | Small | Den Haag | Eneco | E.On | Power plant Den Haag | Natural Gas | 1977 | 3517 | 4163 | 353 | 130 | 1160 | 1480 |
| **Den Haag** | Small | Den Haag | Eneco | Eneco | CHP plant Wateringseveld | Natural Gas | 2005 | 1588 | 2889 | 14 | 90 | 10 | 120 |

a) (Schepers & van Valkengoed, 2009)
b) (Energie-Nederland, 2015)
c) (Eneco, 2015)
*) Calculated based on average heat demand per dwelling (as described in the methodology)
**) Including 15% distribution losses

**Table 9**: Heat distribution networks in Duiven – Westervoort, Arnhem and Nijmegen in 2013

| Heat distribution network in Duiven – Westervoort, Arnhem and Nijmegen (2013) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat network** | Scale (large/small) | Location(s) | Supplier | Producer | Heat source | Primary energy source | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Number of connected non-residential buildings in 2013 [c] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ]** | Heat produced for network in 2013 [TJ]*** |
| **Duiven - Westervoort** | **Large** | **Duiven, Westervoort** | **Nuon** | **AVR** | **AVR Duiven** | **Waste** | **1982** | **8500** | **8954** | **200** | **280** | **100** | **440** |
| | | Duiven | | | | | 1982 | 5811 | 6221 | 200 | 200 | 70 | |
| | | Westervoort | | | | | | 2689 | 2733 | | 90 | 30 | |
| **Arnhem (total)** | **Small** | **Arnhem** | **Nuon** | **Nuon** | **CHP-plant Kleefse Waard** | **Natural gas** | **2001** | **1550** | **4049** | **77** | **130** | **230** | **370** |
| **Nijmegen (total)** | **Small** | **Nijmegen** | **Nuon** | **Nuon** | **Boilers Waalsprong (temporary) + CHP-plant Marienburg** | **Natural gas** | **1998/1992** | **2330 + 120** | **3192** | **4** | **100** | **5** | **150** |

a) (Schepers & van Valkengoed, 2009)

b) (Energie-Nederland, 2015)

c) (Nuon, 2014)

*) Calculated based on average heat demand per dwelling (as described in the methodology)

**) Calculated using dwelling equivalents (Nuon, 2014)

***) Including 15% distribution losses

**Table 10**: Heat distribution network in Leiden in 2013

| Heat distribution network in Leiden (2013) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat network** | Scale (Large/small) | Location(s) | Supplier | Producer | Heat source | Primary energy source | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Number of connected non-residential buildings in 2013 [c] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ]** | Heat produced for network in 2013 [TJ]*** |
| **Leiden** | **Large** | | **Nuon** | **E.On** | **CHP-plant Leiden** | **Natural gas** | **1983** | **6100** | **9681** | **200** | **310** | **470** | **890** |
| | | Leiden | | | | | | | 8200 | 200 | 260 | 470 | 890 |
| | | Leiderdorp | | | | | | | 493 | N/A | 20 | | |
| | | Oegstgeest | | | | | | | 986 | N/A | 30 | | |

a) (Schepers & van Valkengoed, 2009)
b) (Energie-Nederland, 2015)
c) (Nuon, 2014)
*) Calculated based on average heat demand per dwelling (as described in the methodology)
**) Calculated using dwelling equivalents (Nuon, 2014)
***) Including 15% distribution losses

**Table 11**: Heat distribution networks in Enschede in 2013

| Heat distribution network in Enschede (2013) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat network** | Scale (Large/small) | Location(s) | Supplier | Producer | Heat source | Primary energy source | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Number of connected Non-residential buildings [2013] [c] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ] [c] | Heat produced for network in 2013 [TJ]** |
| **Enschede (total)** | | **Enschede** | | | | | | **6120** | **7100** | **200** | **210** | | |
| **Enschede** | Large | Enschede | Ennatuurlijk | Twence | Waste incinerator | Waste | 1984 | 5000 | 5963 [d] | 200 [d] | 180 | 340 | 590 |
| **Enschede** | Small | Enschede | | Essent | CHP units Tattersall & Roombeek | Natural gas | N/A | 570 + 550 | 1120 | 0 + 15 | 30 | N/A | N/A |

a) (Schepers & van Valkengoed, 2009)
b) (Energie-Nederland, 2015)
c) (Ennatuurlijk, 2015)
d) (Regio Twente, 2015)
*) Calculated based on average heat demand per dwelling (as described in the methodology)
**) Including 15% distribution losses

**Table 12**: Heat distribution network in Helmond in 2013

| Heat distribution network in Helmond (2013) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat network** | Scale (Large/small / renewable) | Location(s) | Heat source | Producer | Supplier | Primary energy source | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Number of connected non-residential buildings in 2013 [c] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ] [c] | Heat produced for network in 2013 [TJ] ** |
| **Helmond (total)** | **Large** | **Helmond** | **CHP-plant Helmond + boilers** | **Essent** | **Ennatuurlijk** | **Natural gas** | **1985** | **6400** | **6386** | **N/A** | **200** | **30** | **260** |

a) (Schepers & van Valkengoed, 2009)
b) (Energie-Nederland, 2015)
c) (Ennatuurlijk, 2015)
*) Calculated based on average heat demand per dwelling (as described in the methodology)
**) Including 15% distribution losses

**Table 13**: Heat distribution network in Lelystad in 2013

| Heat distribution network in Lelystad (2013) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat network** | Scale (Large/small/ renewable) | Location(s) | Heat source | Producer | Supplier | Primary energy source(s) | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Number of connected non-residential buildings in 2013 [c] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ]** | Heat produced for network in 2013 [TJ]*** |
| **Lelystad** | **Small** | **Lelystad** | **Biomass-plant (BMC) Lelystad + CHP-unit** | **Nuon** | **Nuon** | **Biomass and natural gas** | **1982** | **4800** | **5018** | **51** | **160** | **50** | **240** |

a) (Schepers & van Valkengoed, 2009)
b) (Energie-Nederland, 2015)
c) (Nuon, 2014)
*) Calculated based on average heat demand per dwelling (as described in the methodology)
**) Calculated using dwelling equivalents (Nuon, 2014)
***) Including 15% distribution losses

**Table 14**: Heat distribution network in Eindhoven in 2013

| Heat distribution network in Eindhoven (2013) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat network** | Scale (Large/small/ renewable) | Location(s) | Heat source | Producer | Supplier | Primary energy source | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Number of connected non-residential buildings in 2013 [c] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ] [c] | Heat produced for network in 2013 [TJ]** |
| **Eindhoven (total)** | **Small** | **Eindhoven** | **CHP-plant Meerhoven** | **Essent** | **Ennatuurlijk** | **Natural gas + biomass** | **1999** | **2750** | **4255** | **N/A** | **130** | **N/A** | **190** |
| | **Small** | **Eindhoven** | **CHP plant Eindhoven/ boilers** | **Essent** | **Ennatuurlijk** | **Natural gas + biomass** | | | | | | | |

a) (Schepers & van Valkengoed, 2009)
b) (Energie-Nederland, 2015)
c) (Ennatuurlijk, 2015)
*) Calculated based on average heat demand per dwelling (as described in the methodology)
**) Including 15% distribution losses

**Table 15**: Heat distribution network in Houten in 2013

| Heat distribution network in Houten (2013) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat network** | Scale (Large/small) | Location(s) | Heat source | Producer | Supplier | Primary energy source | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Number of connected non-residential buildings in 2013 [c] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ] [c] | Heat produced for network in 2013 [TJ]** |
| **Houten (total)** | **Small** | **Houten** | **CHP-plant Vijfwal** | **Eneco** | **Eneco** | **Natural gas** | **2001** | **2480** | **3800** | **18** | **120** | **10** | **150** |

a) (Schepers & van Valkengoed, 2009)
b) (Energie-Nederland, 2015)
c) (Eneco, 2015)
*) Calculated based on average heat demand per dwelling (as described in the methodology)
**) Including 15% distribution losses

**Table 16**: Heat distribution network in Amersfoort in 2013

| Heat distribution network in Amersfoort (2013) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat network** | Scale (Large/small) | Location(s) | Heat source | Producer | Supplier | Primary energy source | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Number of connected non-residential buildings in 2013 [c] | Heat delivery to dwellings in 2013 [TJ] * | Heat delivery to others in 2013 [TJ] [c] | Heat produced for network in 2013 [TJ] ** |
| **Amersfoort (total)** | **Small** | **Amersfoort** | **CHP-plant Vathorst** | **Eneco** | **Eneco** | **Natural gas** | **2006** | **1700** | **3230** | **0** | **95** | **0** | **110** |

a) (Schepers & van Valkengoed, 2009)
b) (Energie-Nederland, 2015)
c) (Eneco, 2015)
*) Calculated based on average heat demand per dwelling (as described in the methodology)
**) Including 15% distribution losses

# Appendix B. Overview table small heat distribution networks in 2013

**Table 17**: Municipalities with small scale heat distribution network(s) in 2013

| Heat distribution network | Municipality | Heat source(s) | Producer(s) | Supplier(s) | Primary energy source(s) | Starting Year supply | Number of connected dwellings in 2009 [a] | Number of connected dwellings in 2013 [b] | Heat delivery to dwellings in 2013 [TJ] * |
|---|---|---|---|---|---|---|---|---|---|
| Oosterheem | Zoetermeer | CHP-plant Oosterheem | Eneco | Eneco | Natural gas | 2004 | 2,471 | 2,773 | 87 |
| Heerhugowaard | Heerhugowaard | CHP-plant | HVC | Nuon | Natural gas | 1998 | 2,211 | 2,197 | 69 |
| Maastricht | Maastricht | Paperfactory Maastricht / CHP plant | Sappi | Ennatuurlijk | Waste heat | 2010 | N/A | 1,802 | 57 |
| | | Waste heat | | Ennatuurlijk | Waste heat | | | 107 [c] | |
| | | CHP plant | | Ennatuurlijk | Natural gas | | | 1,776 [c] | |
| Heerlen | Heerlen | | | Ennatuurlijk | | | 624 | 1,537 | 48 |
| | Het Loon | CHP plant | | Ennatuurlijk | Natural gas | | | 715 [c] | |
| | Parc Imstenrade | Gas boilers | | Ennatuurlijk | Natural gas | | | 309 [c] | |
| | Peter Schunckstraat | CHP plant | | Ennatuurlijk | Natural gas | | | 120 [c] | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | Welten | CHP plant | | Ennatuurlijk | Natural gas | | | 308 [c] | |
| Apeldoorn | Apeldoorn | Bio CHP - plant | Sewage treatment plant | Ennatuurlijk | Biogas | 2007 | 110 | 1,363 | 43 |
| | Zuidbroek | Waste heat / bio boiler | | Ennatuurlijk | Biogas | | | 1,439 [c] | |
| | Beekpark | CHP plant | | Ennatuurlijk | Natural gas | | | 155 [c] | |
| 's-Hertogenbosch | 's-Hertogenbosch | Collective ATES/heat pump | | Ennatuurlijk | | 2010 | | 1,280 | 40 |
| | Hinthammerpoort | Collective ATES/gas boiler | | Ennatuurlijk | | | | 470 [c] | |
| | Paleiskwartier | Collective ATES/gas boiler | | Ennatuurlijk | | | | 1,087 [c] | |
| Leeuwarden | Leeuwarden | CHP-plant | | | Natural gas | N/A | 978 | 1,276 | 40 |
| | Camminghaburen | Gas boilers | | Ennatuurlijk | Natural gas | | | 968 | |
| | Zuidlanden | Bio boiler | | Ennatuurlijk | Biomass | | | 396 | |
| Assendelft | Zaanstad | CHP-plant Assendelft | Nuon | Nuon | Natural gas | 2000 | 1,185 | 1,190 | 37 |
| Hoogveld | Sittard-Geleen | Biomass plant Sittard | BES | Ennatuurlijk | Biomass | 1998 | 796 | 1,165 | 37 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Oostpolder** | Papendrecht | CHP-plant Oostpolder | Eneco | Eneco | Natural gas | 2000 | 572 | 1,163 | 37 |
| **Kernhem** | Ede | Boilers (temporary) | Nuon | Nuon | Natural gas | 1999 | 1,117 | 1,138 | 36 |
| **Delft** | Delft | Collective boilers | Eneco | Eneco | Natural gas | 2009 | | 1,110 | 35 |
| **Boterdorp** | Lansingerland | CHP-plant Boterdorp | Eneco | Eneco | Natural gas | 2009 | 1,028 | 1,029 | 32 |
| **Broek op Langedijk** | Langedijk | CHP-plant | HVC | HVC | Natural gas | 2001 | 937 | 938 | 30 |
| **Polderwijk** | Zeewolde | CHP-plant | | Ennatuurlijk | Biogas | 2003 | 416 | 891 / 1,048 [c] | 28 |
| **SV Huttenweg + Reuver** | Almelo | CHP-unit + boilers, collective heat pumps | Cogas | Cogas | Natural gas/ electricity | 1984/2008 | 881 + 196 (1,077) | 865 | 27 |
| **Parijsch** | Culemborg | CHP-plant | Nuon | Nuon | Natural gas | 2000 | 529 | 855 | 27 |
| **Wezenland + Botlekstraat** | Deventer (different networks) | CHP-plant(s) | | Ennatuurlijk | Natural gas | N/A | 523 + 519 (1,042) | 801 | 25 |
| | Deventer Pothoofd | Collective ATES/heat pump | | Ennatuurlijk | | | | 348 [c] | |
| **Rijtuigweg** | Bergen op Zoom | Boilers + CHP unit | | | Natural gas | 1981 | 315 | 797 | 25 |
| **Vaanpark** | Barendrecht | CHP-plant | Eneco | Eneco | Natural gas | 2007 | 849 | 792 | 25 |
| **Wageningen** | Wageningen | CHP-plant | Nuon | Nuon | Natural gas | 1994 | 740 | 783 | 25 |

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|---|---|---|---|---|---|---|---|---|---|
| **Haarlem** | Haarlem | CHP plant + collective solar thermal | Eneco | Eneco | Natural gas + solar thermal | | | 763 | 24 |
| **Groningen** | Groningen | CHP-plant | | Ennatuurlijk | Natural gas | | | 738 | 23 |
| **Zandvoort** | Zandvoort | CHP-plant | Nuon | Nuon | Natural gas | 1998 | 541 | 688 | 22 |
| **Overdie + HVC Alkmaar** | Alkmaar | Heat pumps Overdie, HVC | HVC | HVC | Electricity, waste | 2007/2004 | 56 + 507 (563) | 563 | 18 |
| **Zwolle** | Zwolle | Boilers + CHP-unit | | Ennatuurlijk | Natural gas | | 0 | 525 | 17 |
| **Vlissingen** | Vlissingen | | | | | | 0 | 389 | 12 |
| **Goirle** | Goirle | | | | | | 0 | 376 | 12 |
| **Dordrecht** | Dordrecht | HVC Dordrecht | HVC | HVC | Waste | | 0 | 363 | 11 |
| **Ouverture** | Goes | Heat pumps | | | Electricity | 2002 | 261 | 320 | 10.1 |
| **Veldhoven** | Veldhoven | | | | | | 0 | 297 | 9.4 |
| **Zevenaar** | Zevenaar | Waste incinerator Zevenaar | | | Waste | | 0 | 291 | 9.2 |
| | Zevenaar | Bio boiler | | Ennatuurlijk | | | | 337 [c] | |
| **Hilversum** | Hilversum | Boilers (temporary) | Nuon | Nuon | Natural gas | 1998 | 279 | 265 | 8.3 |

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|---|---|---|---|---|---|---|---|---|---|
| **Leidschendam-Voorburg** | Leidschendam-Voorburg | | | | | | | 251 | 7.9 |
| **Hengelo** | Hengelo | Boilers + CHP-unit | | Ennatuurlijk | Natural gas | | | 239 | 7.5 |
| **Stadskanaal** | Stadskanaal | | | | | | | 228 | 7.2 |
| **Alblasserdam** | Alblasserdam / De Hellingen | Collective ATES/heat pump | | Ennatuurlijk | | | | 218 | 6.9 |
| **Beesel** | Beesel | | | | | | | 190 | 6.0 |
| **Binnenmaas** | Binnenmaas | | | | | | | 165 | 5.2 |
| **Hulst** | Hulst | | | | | | | 165 | 5.2 |
| **Woerden** | Woerden | | | | | | | 155 | 4.9 |
| **Gorinchem** | Gorinchem | | | | | | | 151 | 4.8 |
| **Dongen** | Dongen | | | | | | | 150 | 4.7 |
| **Hoogezand-Sappemeer** | Hoogezand-Sappemeer | | | | | | | 144 | 4.5 |
| **Uithoorn** | Uithoorn | | | | | | | 125 | 3.9 |
| **Midden-Delfland** | Midden-Delfland | | | | | | | 120 | 3.8 |

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|---|---|---|---|---|---|---|---|---|---|
| **Bodegraven-Reeuwijk** | Bodegraven-Reeuwijk | | | | | | | 118 | 3.7 |
| **Alphen aan den Rijn** | Alphen aan den Rijn | | | | | | | 104 | 3.3 |
| **Albrandswaard** | Albrandswaard | | | | | | | 95 | 3.0 |
| **Schagen** | Schagen | | | | | | | 90 | 2.8 |
| **Heiloo** | Heiloo | | | | | | | 86 | 2.7 |
| **Emmen** | Emmen | Gas boiler | | Ennatuurlijk | Natural gas | | | 82 | 2.6 |
| **Zuidplas** | Zuidplas | | | | | | | 79 | 2.5 |
| **Soest** | Soest | | | | | | | 70 | 2.2 |
| **Other small networks** | Other municipalities | | | | | | | 973 | 31 |

a) (Schepers & van Valkengoed, 2009)
b) (Energie-Nederland, 2015)
c) (Ennatuurlijk, 2015b)
*) Calculated based on average heat demand per dwelling (as described in the methodology)

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