Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP)

Annex 42

Heat Pumps in Smart Grids

Market overview: Country report for the Netherlands

Appendix to the Final report

Operating Agent: The Netherlands

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Report no. HPT-AN42-2g

Market overview

Country report for THE NETHERLANDS

Report compiled by

ABSTRACT
This appendix provides the detailed summary report discussing the market overview for The Netherlands.

Table of contents

List of figures

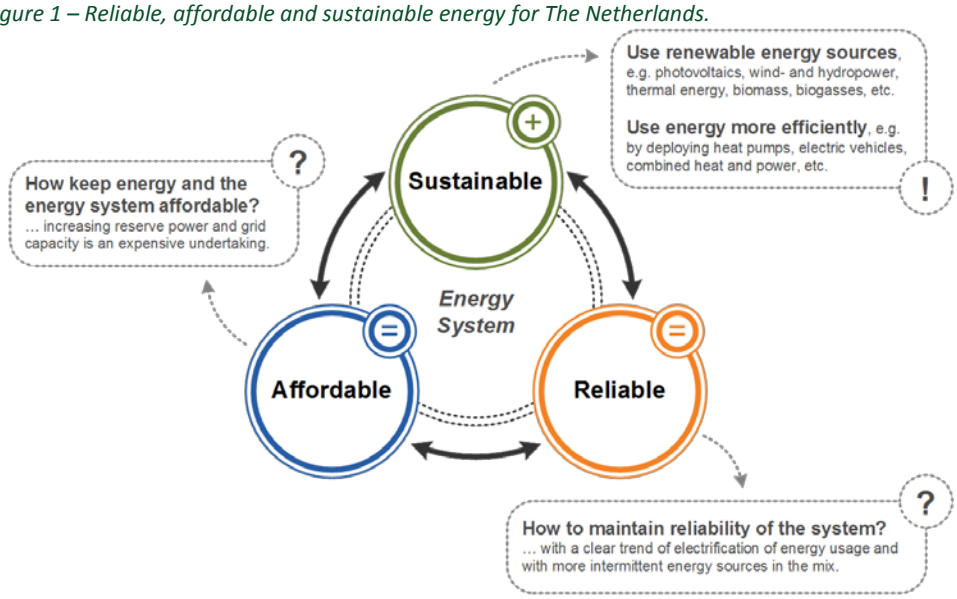
1 Overview of the Dutch Energy Sector

1.1 Overview of main challenges in the NL

The Transition

The biggest challenge in the transition in the Netherlands is to keep usage of energy affordable and reliable while at the same time make the entire system more sustainable. The target goals for the amount of sustainable energy are 14% in 2020, 16% in 2023 which are set in the new 2013 coalition energy agreement [**http://www.rijksoverheid.nl/onderwerpen/duurzame-energie/meer-duurzame-energie-in-de-toekomst**].

Figure 1 – Reliable, affordable and sustainable energy for The Netherlands.



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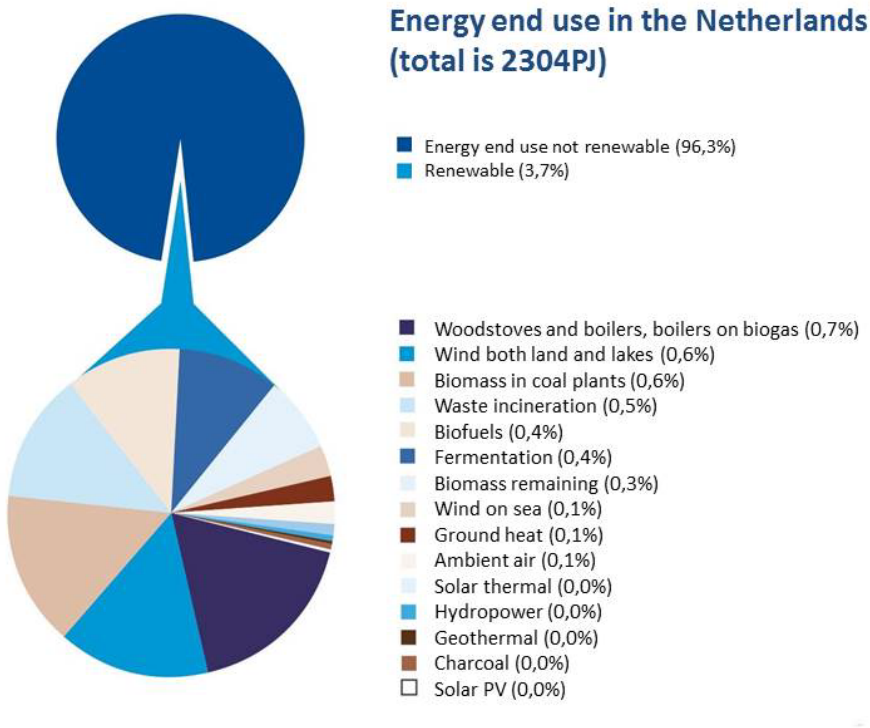
In 2010 the amount of sustainable energy in the total energy end use was 3,7%, and is build up as can be seen in the graph below. For more views on this see paragraph 1.5.

Figure 2 – End use of energy in The Netherlands.



The trends in the transition

In the energy transition, a number of trends are relevant. These trends do impact the three goals (reliable, affordable, sustainable) in some form.
Examples:

- Increase of PV may cause problems in the distribution grid;
- Increased share of intermittent electricity recourses can reduce reliability of electricity supply.

Energy production changes:

- Increasing number of decentral producing source
- Increasing share of renewable energy
- Phase out of nuclear power (Fukushima, Atomausstieg) (Although the electricity generation from nuclear in the Netherlands is insignificantly small)
- Shale gas versus coal, low CO_2 price and demise of ETS
- There is a trend in the Netherlands to choose for coal to generate electricity, because of rising natural gas price, lowering coal and ETS CO_2 prices, to reverse this trend, the Dutch government has set an extra 'coal tax' is enforcing to closedown coal plants (see paragraph 1.5).

Energy consumption changes:

- Global increase of energy consumption
- Electrification of our energy system
- Electricity, gas and thermal energy merge to 1 grid i.e. 1 system

Effects of a free economy

- More small company in the role of providers
- Prosumers (Consumers who also act as producer)
- Local initiatives
- Freedom of choice

The search for flexibility

Flexibility in demand, in production, by means of storage or increasing the size of the system is considered to be the key to the solution.

1.2 NL electricity generation

Source: **http://www.compendiumvoordeleefomgeving.nl/**

Figure 3 – Gross electricity production in The Netherlands (CBS).

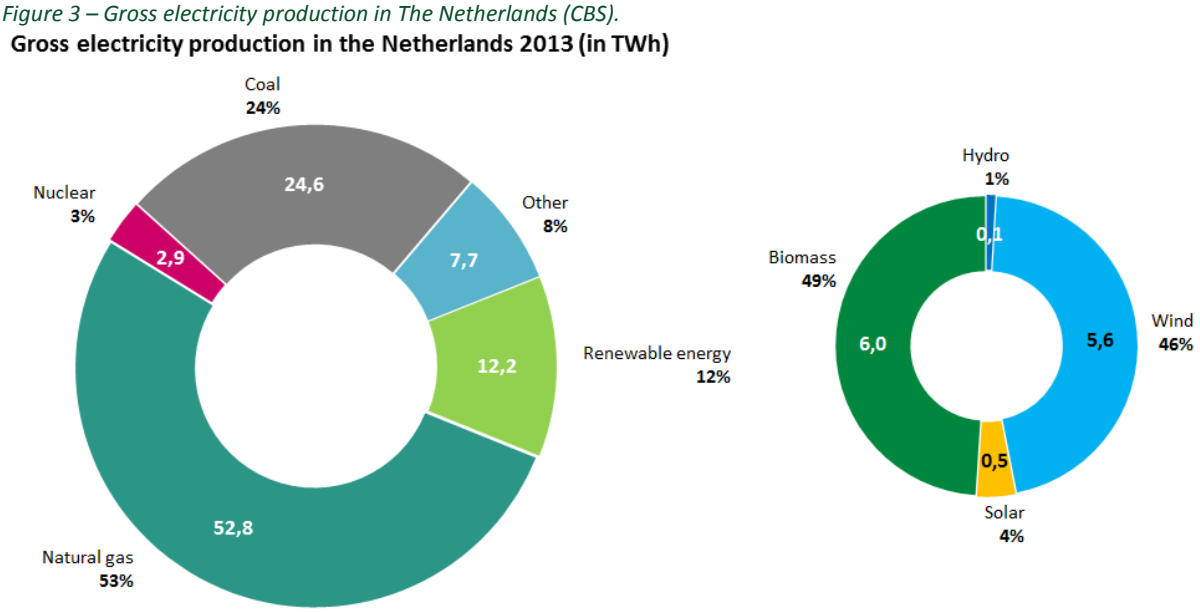


Figure 4 – Energy production, use, import and export in The Netherlands.

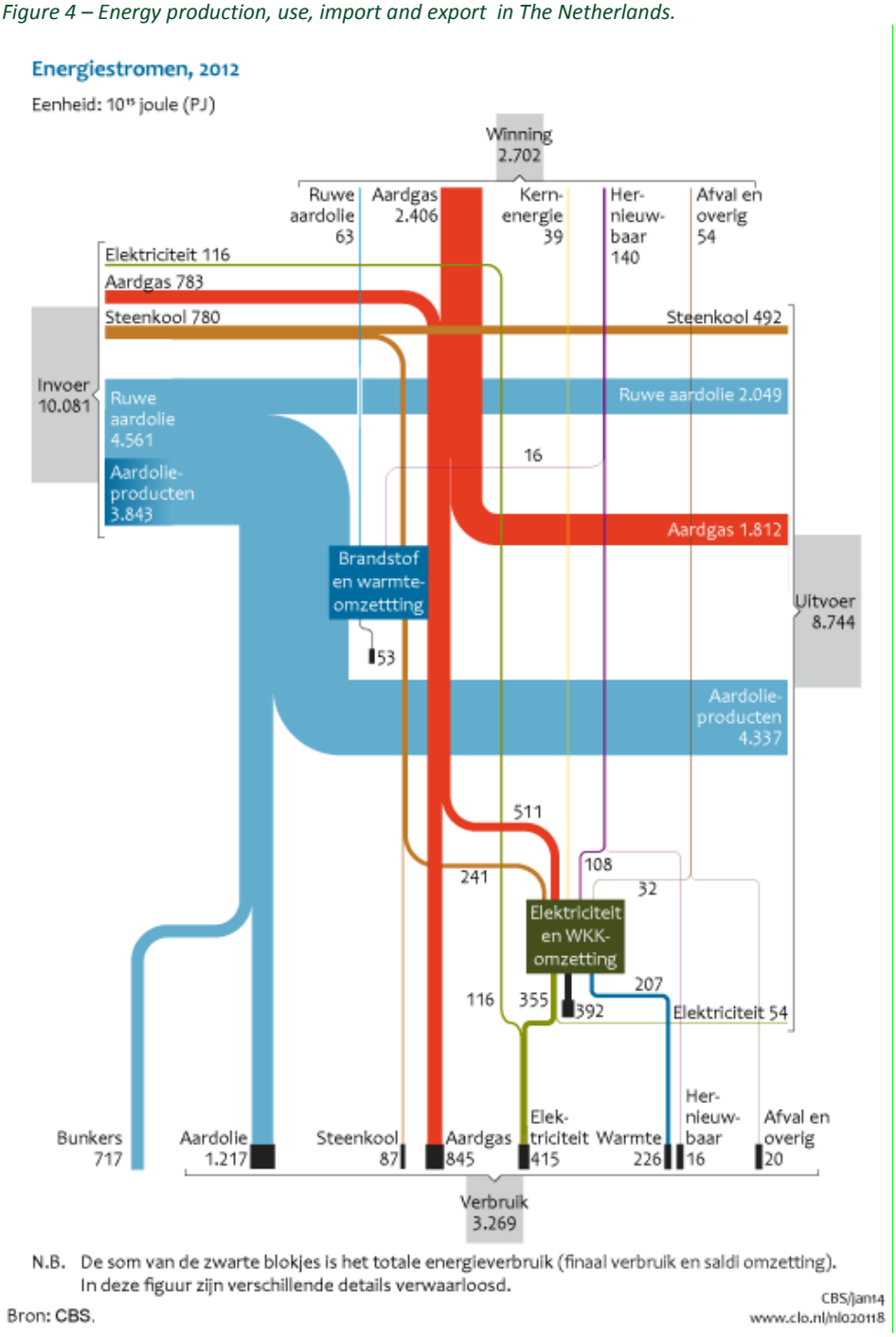


Figure 5 – Fuel use for electricity production.

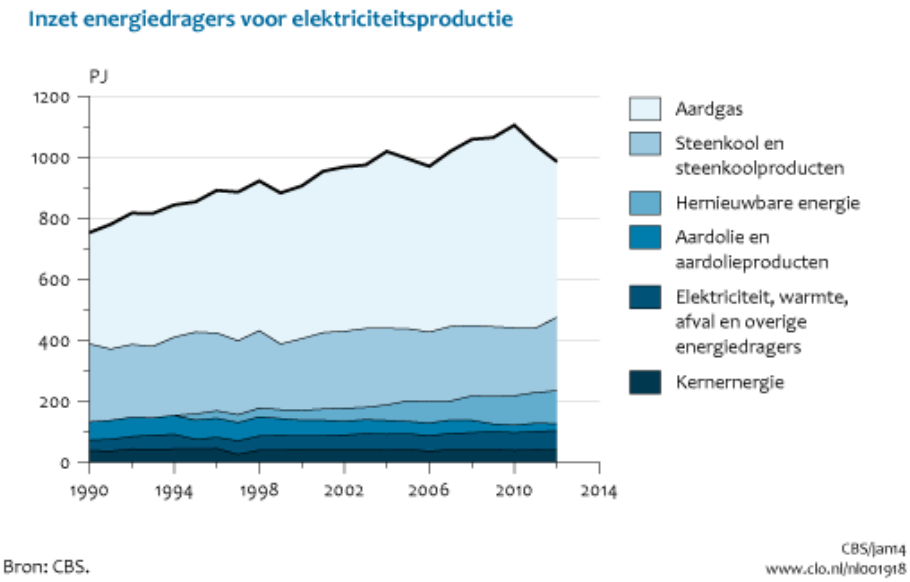
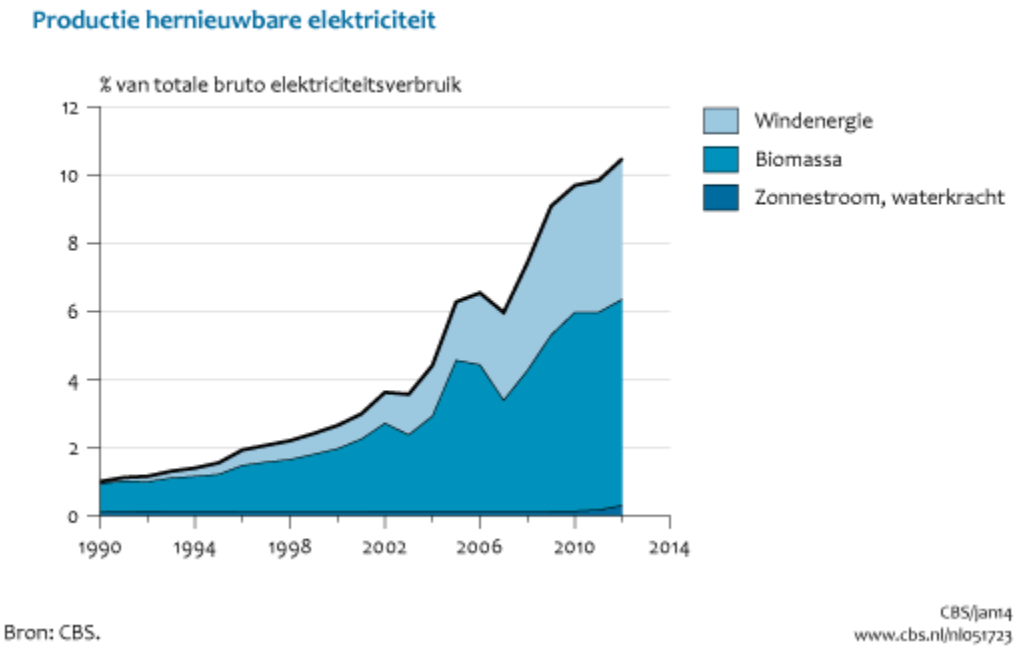
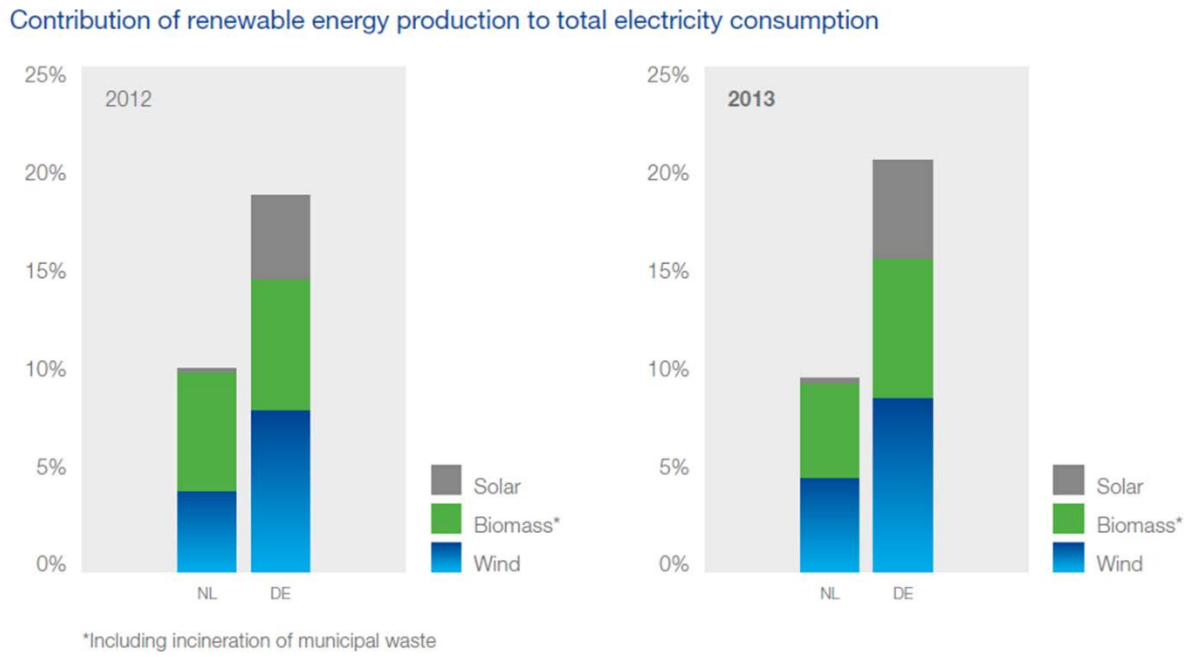


Figure 6 – Renewable electricity production.



The next figure compares renewable electricity generation in the Netherlands and Germany. The figure shows the contribution of wind, solar and biomass as they are the main contributors in Germany and are virtually the only contributors in the Netherlands.

Figure 7 – Comparison of renewable energy production NL & DE.



Source: *Electricity production from wind, solar and biomass divided by the national electricity consumption for Germany and for the Netherlands. Source: Berenschot (data CBS; AGEB).*

Table 1 – Historic development and outlook of renewable generation capacities, production and market share.

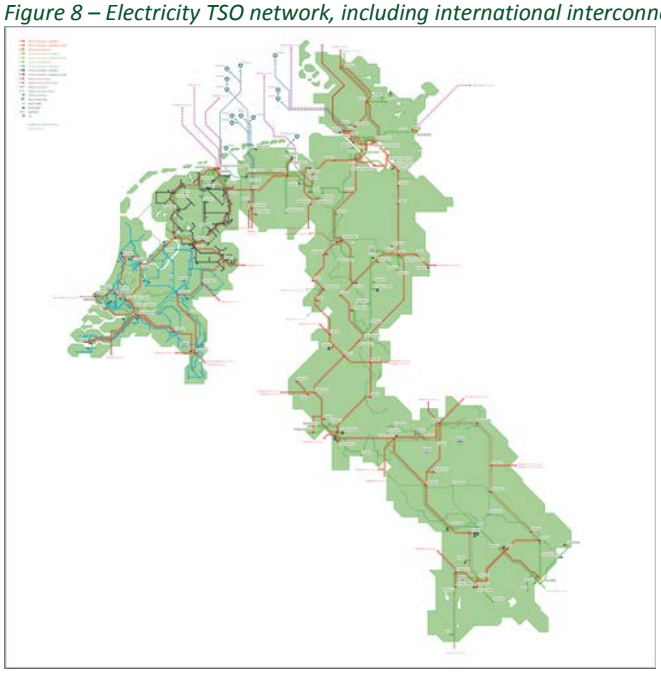
Year	*Total share renewables*	*Share RES for electricity*
2013	4.5%	~10%
2020	14%	~50-60%
2023	16%	~50-60%

Table 2 – Total generation capacity for electricity.

Quarter	*Installed*	*Usable*	*Reserve*
Q1-2014	17 GW	14-17 GW	~5-10GW, variable
Q2-2014	24 GW	…	variable
Q3-2014	24 GW	…	variable
Q4-2014	23 GW	…	variable

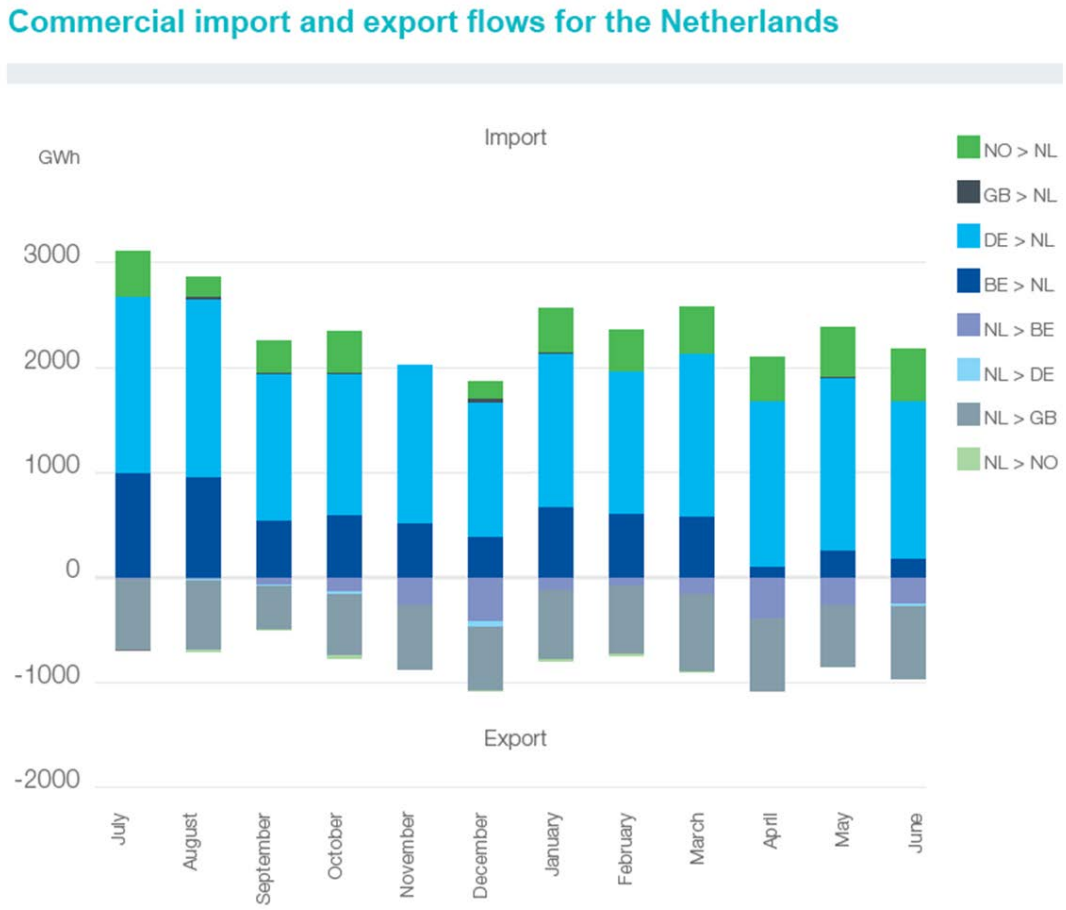
Source: *Dutch TSO Tennet, actual data from site.*

Figure 8 – Electricity TSO network, including international interconnectors.



In the graph below, commercial import and export flows are outlined to illustrate the Dutch system connections.

Figure 9 – Monthly import and export of electricity from/to surrounding countries.



Source: ENTSO-E; TenneT.

The Netherlands, on the other hand, is a net importer, with the exchange with Belgium going in both directions. The flow on BritNed is directed towards the UK, contrary to flows from Norway and Germany, which are predominantly directed towards the Netherlands.

The installed generation capacity exceeds the peak demand, see table below.

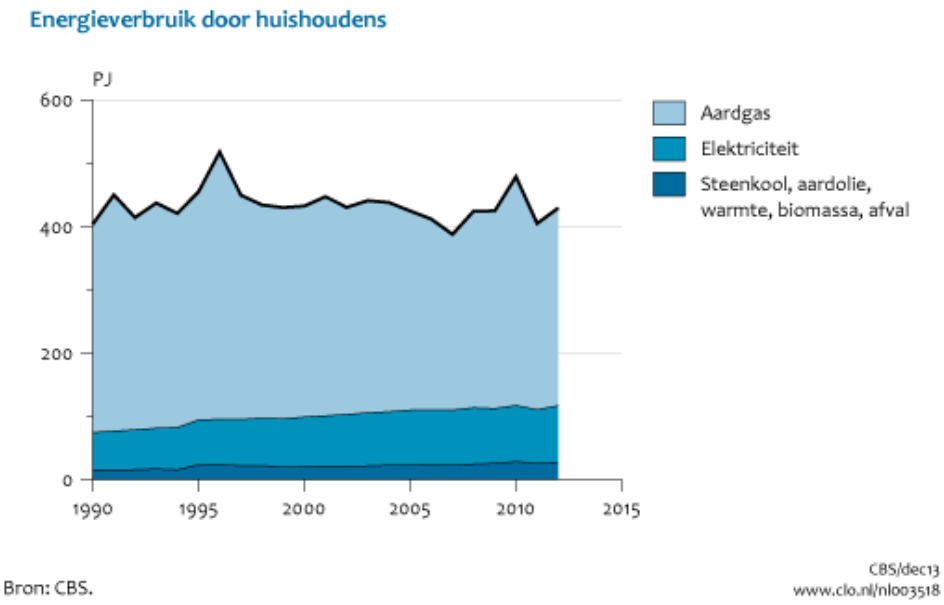
Table 3 – Peak demand and reserve capacity above peak.

Year	*Peak demand (GW)*	*Ratio Reserve capacity*[1]
2011	18.3	1.46
2012	18.2	1.51
2013	18.4	1.66
2016	19.2	1.89
2019	20.1	2.03

Source: Tennet, report monitoring security of supply 2011-2027, june 2012.

1.3 NL Energy Demand

Figure 10 – Energy use by households, by fuel type. [Natural gas, Electricity, Others].



Note: Natural gas mostly used for heating (78%) and DHW (19%) in the domestic sector. Cooking amounts to 3%.

1.4 Dutch Energy Infrastructure

1.4.1 Electricity networks

Current status

TenneT is the national high-voltage grid (TSO) operator and there are about 8 main distribution grid operators (DSO's) in the Netherlands (see below). TenneT is responsible for the quality and capacity of the national high-voltage grid and it is responsible for the balancing of demand and supply of electricity. The national grid operators are only responsible for the quality and the capacity of the distribution grids. The distribution of electricity is decoupled from the production of electricity in 2006.

Tariffs

The costs of the grids are socialized between the connected consumers. The tariff of a typical household connection is about €400 per year.

[1] Ratio is installed capacity vs peak demand.

Figure 11 - High voltage-grid in the Netherlands with its interconnections.

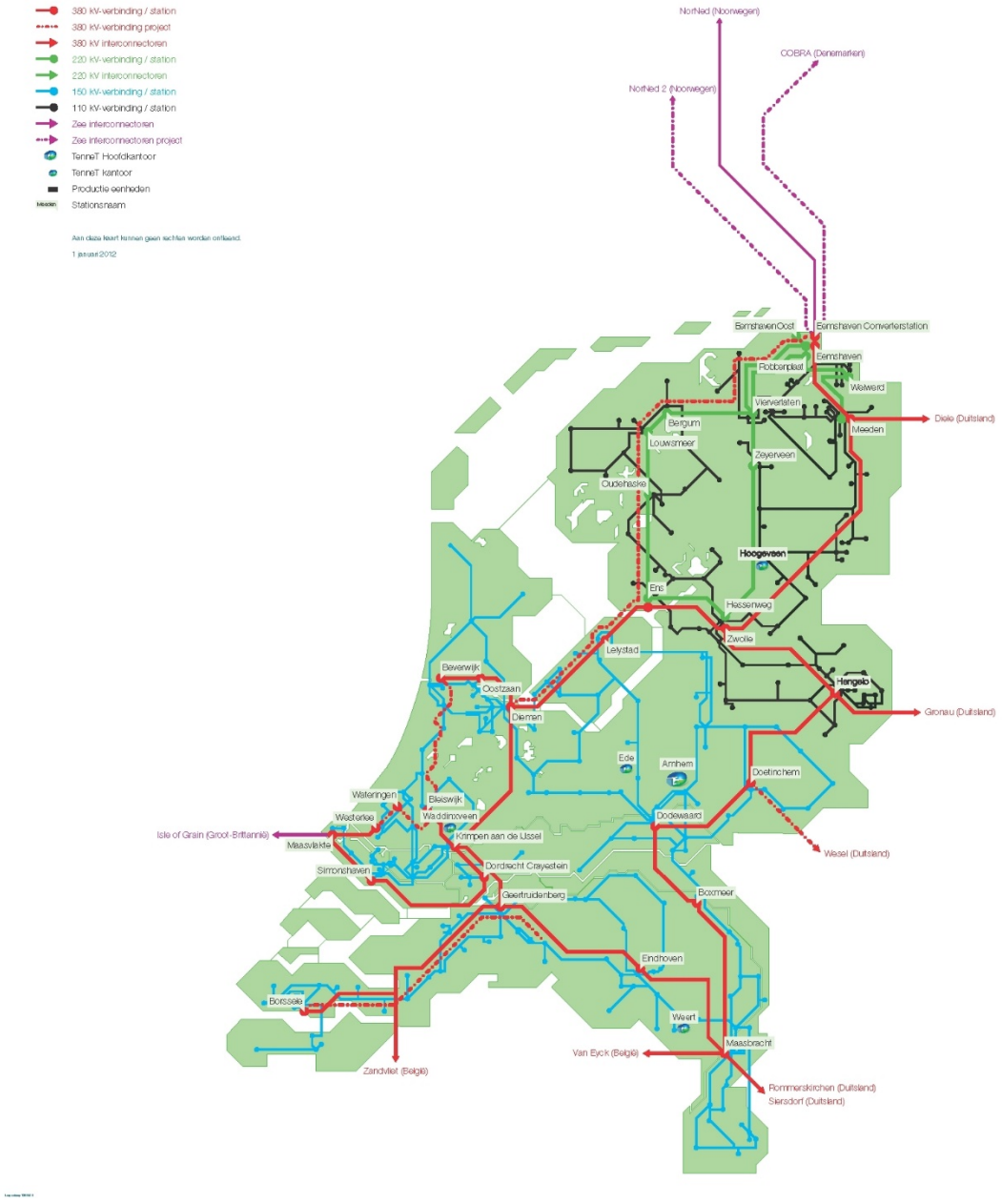


Figure 12 – Regions of the Dutch electricity DSOs.

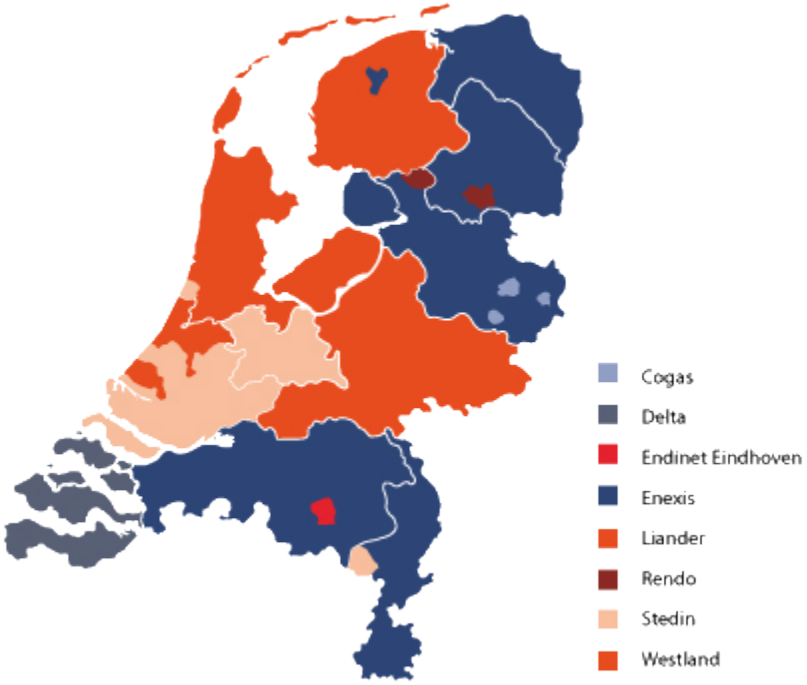


Table 4 – Characteristics of the Dutch electricity grid.

Total length of cables	340.000 km
Lenght of High Voltage lines	12.000 km
Length of Medium Voltage cables	103.000
Length of Low Voltage cables	222.000
Amount of distribution transformers	122.000
Amount of customers connected	8.100.000
Average customer minutes lost	28 minutes

Yearly, about € 1,5 billion is spend on expansion, maintenance and replacement in the electricity grid.

Future outlook

The two themes that have the attention of the grid operators are:

- Replacement of old components
- Deal with the high loads on the grids due to the (expected) growth of electric vehicles, heat pumps and PV installations

The themes demand for high investments up to € 100 billion until 2050. Grid operators are looking for alternatives to avoid those costs. The alternative which is looked at intensively is demand response.

1.4.2 Gas network

The gas network covers almost all area's in the Netherlands and 98% of all buildings is connected to it. Since the discovery of the natural gas reserves in the '60s, the gas network grew rapidly.

The national high pressure grids are owned and operated by Gasunie transport services (GTS). The medium and low pressure distribution grids are operated by local distribution grid operators (DSO).

The main themes for the gas grids are:

- the expected other types of gas (high caloric value gas from other countries and biogas from digestion and gassification).
- the decreasing consumption of natural gas
- the replacement of the first gas grid components from the '60s.

1.4.3 Heating networks

Heating networks are not common in the Netherlands. There are 13 large heating networks, which serve 230.000 customers. The waste heat of large electricity plants feeds most of these networks. The largest heating network is in Rotterdam and serves 44.000 customers.
Besides, there are about 7.000 small-scale grids, which serve in total 336.000 customers. The costs for heating by a heating network are legally not allowed to exceed the costs for heating by gas.

Figure 13 – High pressure TSO gas grid in the Netherlands.

Figure 14 – Regions of the Dutch natural gas DSOs.

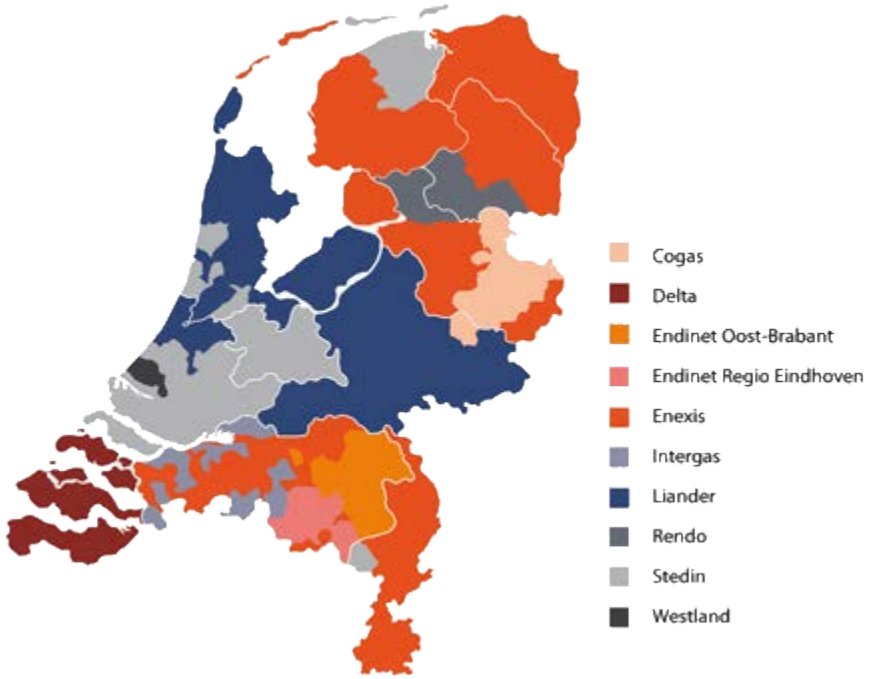


Table 5 – Characteristics of the Dutch natural gas grid.

Total length of main pipes	133.000 km
Number of customers connected	7.127.000
Average customer minutes lost	1 minute

1.5 Dutch Energy Policy

The Netherlands is unfortunately extremely lagging in fulfilling its obligations related to the targets on use of renewable energy and energy consumption reduction as defined by the EU for 2020. To bridge the enormous gap between the now achieved approx. 4% (Status 2013) renewable of the primary energy consumption, and the target of 14% in 2020 a nationwide energy agreement has been made. More than 40 organisations, large companies, provinces and NGO's have signed of the 'SER Energieakkoord' (the new energy coalition agreement from end of 2013) which implementation must lead us to the obliged 14% in 2020. The main agreements in this Energieakkoord:

- Final energy savings of 1,5% per year
- Final energysavings of 100PJ in 2020 compared with 2012
- 14% renewable energy in 2020, 16% in 2023;
- 15.000 full time job creation in the energy savings sector

A major role in this agreement is foreseen for wind power, off- and onshore, but also solarPV. Also, biomass in large and small applications has an important role. Heat pumps are in this context strongly recognised to have a huge potential as an instrument to increase the amount of renewable energy used in the building stock. Commercial buildings, as well as domestic housing.
The outroll of heat pumps and e-mobility alone are already justification enough to deploy firm smart grid initiatives. Heat pumps and e-mobility in combination with electricity from intermittent production like wind and solarPV, makes smart grid technology/applications an unavoidable necessity. Governmental policy, and foremost consistency in policy keeping are considered to be stronger drivers for the increase of use of renewables, besides the financial context. The Netherlands, a land with the most extensively spread gasnetwork second to none, is in combination with the lowest prices for gasboilers in Europe, a challenging environment for the out roll of renewables. Clear and consistent policy making in this situation is crucial. The 'SER akkoord' is at least a platform to address the case of renewables, e.g. heat pumps relentlessly.

Our building regulations demand an energy neutral design for domestic housing after 2020. Since permits granted under less strict requirements might have to dove out, it might take until 2022 before no permit will be turned into brick and mortar then with a energy neutral design.
Major policies affecting the heating business in the existing building stock can be expected from the actions taken in the wake of the a.m. energy agreement. Housing corporations committed themselves to an average energy label 'B' on their respective building stock. Untill now such measures are not present in the private owned housing stock, but lure on the backburner already with our policymakers.
It is clear recognised that permissiveness is killing, if we want to make significant progress in each segment of our building stock.

The 'SER akkoord' implies also permanent shutdown of several old-fashioned coal fired power plants, which capacity assumingly will be replaced by the combination of renewable electricity and power from gasfired plants. Under ETS there is still no incentive for firm CO2 emission reduction measures in fossil powered power production. Carbon capture storage (CCS) is more or less dead in NL.
Due to weakening the 2020 CO2 targets by Brussel, the Dutch government sticks more or less to one major objective, which is the earlier mentioned 14%.

The Dutch government has a bad reputation in consistently executing incentive programs, mostly due to discontinuation in budgets for this kind of programs in successive administrations. The heat pump sector by means of the Dutch Heat Pump Association is a strong advocator for a reduced energy tax grade for heat pump users i.s.o. incentives.

1.6 Energy Prices, Tariffs & Structures

Electricity prices consist of three parts: supply costs, network charges and taxes. For electricity and gas the following applies (as of Jan. 2014, source: nuon.nl)

Table 6 – Price structure of electricity.

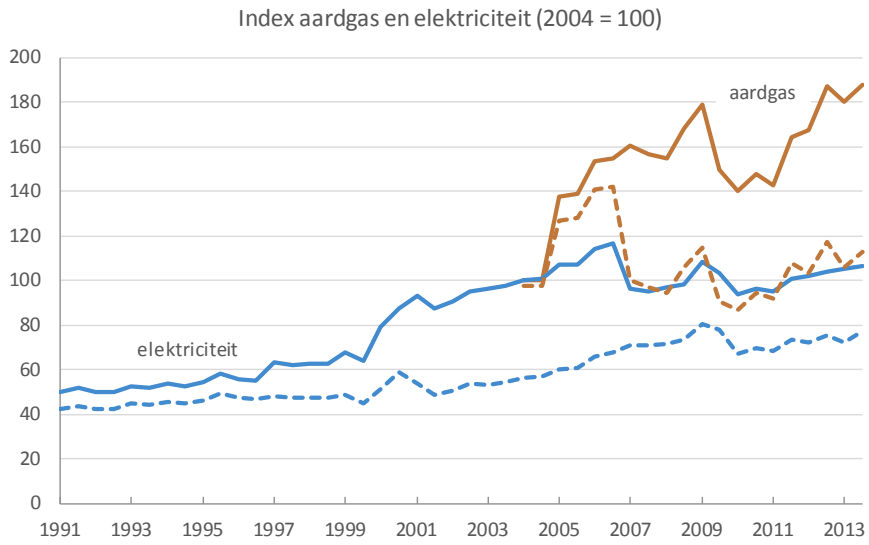
Price component	*% of total*	*Variable / Fixed*
Supply	44%	Variable
Network Charge	17%	Fixed, dependent on type of connection and user
Taxes	39%	Fixed

Underneath the price structure for Dutch households compared to German households. This figure illustrates how wholesale prices ("the market part") are only a small part of end-user prices, taking Germany and the Netherlands as examples.

Figure 15 – Average household electricity prices in The Netherlands and Germany.

Source: *CBS; BDEW, EPEX.*

Figure 16 – Price index for electricity and natural gas.



Source: *Strategic outlook of natural gas use for households – scenario's for the social housingsector by BDH in commissioned by Gasterra.*

These developments favor electric heat pumps for heating, but the difference in price per MJ is still in favor of natural gas.

For domestic use, day and night tariffs are available. The difference in tariffs is small. At least 40% of yearly usage should be during low tariff periods (usually at night) to break even. For example, if you use 50% in low tariff, it will save you a little over €7 on a yearly basis. It seems suppliers (retailers) are discouraging the use of night and day tariffs.
At the moment, there are no known plans to change the tariff structure. But this is not a legal barrier. Retailers are free to offer different pricing schemes. But without the full rollout of smart meters, the options are still limited.
Network costs are socialized. This means that a certain type of connection with a certain distribution grid operator has a fixed tariff, independent of location or amount and time of energy throughput. Discussions are

currently ongoing to change the tariff structure of the grid operators to facilitate sustainable energy at lower grid costs. Location and time differentiation in tariffs are being discussed.

Table 7 – Stakeholders on the Dutch electricity market.

Stakeholder	*Role / Responsibility*
Supplier	End users have supply contracts with suppliers.
Distribution Network Operator	The regional DNO is a regulated company, responsible for transport of electricity (gas), and access to the grid for everybody. More than 20 regional DNO's are active in the NL, with four large DNO's.
Transmission system operator	One TSO (Tennet) is responsible for the transmission network and balance in the system
Balance Responsible party	Every supplier is associated with a BRP. The BRP is responsible for levelling volumes of energy between supply and demand for the suppliers' customers.
'Meter data' company	Responsible for meter reading and providing data to the DNO's (who in return make this data available to suppliers). Also responsible for the installation and maintenance of (smart) meters.

Table 8 – Trading platforms for electricity.

Platform	*Description*
Over the counter (OTC)	Long term bilateral contracts between producer and consumer
ENDEX	Trading floor for long term contracts
APX	Spot market for hourly prices for the current and next day. Prices are typically about 0,03 €/kWh during night-time and 0,05 €/kWh during daytime with peak from about 0,07€/kWh
Unbalance market	Single buyer market in which TenneT can buy increased or decreased production to match the supply and demand. Prices for electricity are very volatile and can be even negative.

Households have no direct entrance to these markets. The day/night tariffs represent the APX prices during night-time and daytime and are transferred to the households through the supplier. Theoretically, it is possible to aggregate multiple domestic heat pumps to offer the flexibility to the unbalance market. However, the risks are high, the aggregated power should be able to reduce *and* increase and the minimum amount of aggregated installed power should be 5 MW. This is not realistic with domestic heat pumps.

2 Analysis of the Dutch housing stock & heating market

2.1 Netherlands Housing Stock Characteristics

Building ownership

- owner-occupier approx. 3,8 mio
- private rented approx. 1,0 mio
- social housing approx. 2.4 mio

Building stock & heat pumps

Table 9 – Dutch building stock & heat pumps.

Housingtype	Buildingstock	Total installed heat pumps	Hybrids	Electric air-water	Electric water - water	Final heat demand for space heating in GJ
Free standing	1.018.251	17.000	500	1.500	15.000	61
2^1 roof	861.520	26.000	2.500	2.500	21.000	39
Terraced	3.037.564	21.000	1.500	2.500	17.000	31
Multi family	2.322.665	14.000	500	5.000	8.500	16
Total tm 2012	7.240.000	78.000	5.000	11.500	61.500	38

Source: Positioning paper heat pumps and economy by BDH commissioned by The Netherlands Enterprise Agency (RVO).

2.2 Trends in the Heating Market

- Central heating per dwelling by a wall hung natural gas fired condensing boiler is, and will remain the standard for space heating and DHW production in NL for the next decades.
- Apart from new build homes which have a strict maximum energy use by design set by the government (A+++ of and energy index lower than o,4). For these homes the choice will for the large part be heat pumps.
- Heating systems types: previously described situation will not change significantly in the next 10 years.
- Fuel types: Natural gas, bio gas and wood pellet (niche).

In new buildings, underfloor heating is the primary choice nowadays for reason of efficiency and comfort. The efficiency is related to low temperature fed hydronic systems, by a condensing boiler, or an electrical heat pump.
In existing housing floor heating is generally applied when in-depth renovation is the case.
Therefore, transfer systems in new building are in general perfectly suitable for heat pump operation. An educated guess on the areal of floor heating in domestic housing comes up to approx. 6 million square meters.
The originally on 90/70 dimensioned radiators in a vast part of the domestic housing stock are due to application of massive insulation programs, very often operating at much lower supply/return temperatures due to the reduced transmission value of the building. And therewith opened up a huge window of opportunity for heat pumps, particularly hybrid heat pumps, in the existing building stock.

2.3 Customer Preferences

Indication how users tend to use their heating systems, e.g. on a constant temperature level, day/night difference or in “blasts” of high temperature when needed. Constant temperature during day, several degrees lower at night. Sometimes adding one to one and a halve degree, in the evening. But this largely depends on the building type and heating system; poor insulated houses with high temperature heating will have a heating pattern that looks like the English pattern. Newer homes and better insulated buildings with low temperature heating more or less have a constant temperature setting.

3 Analysis of the Dutch domestic heat pump market

3.1 Trends in the Heat Pump Market

Figure 17 – Projected heat pump sales by house type.

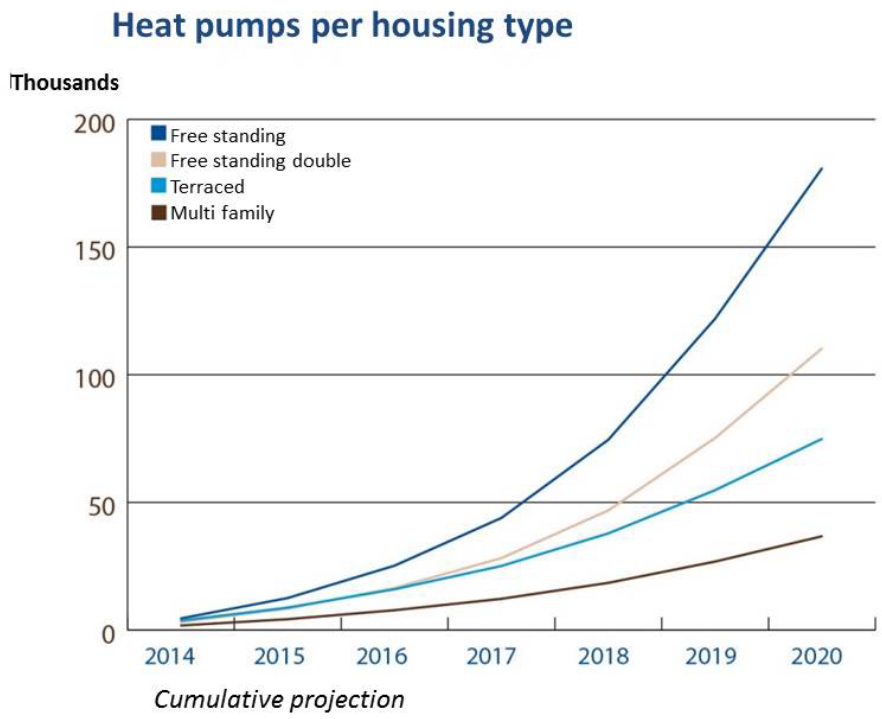
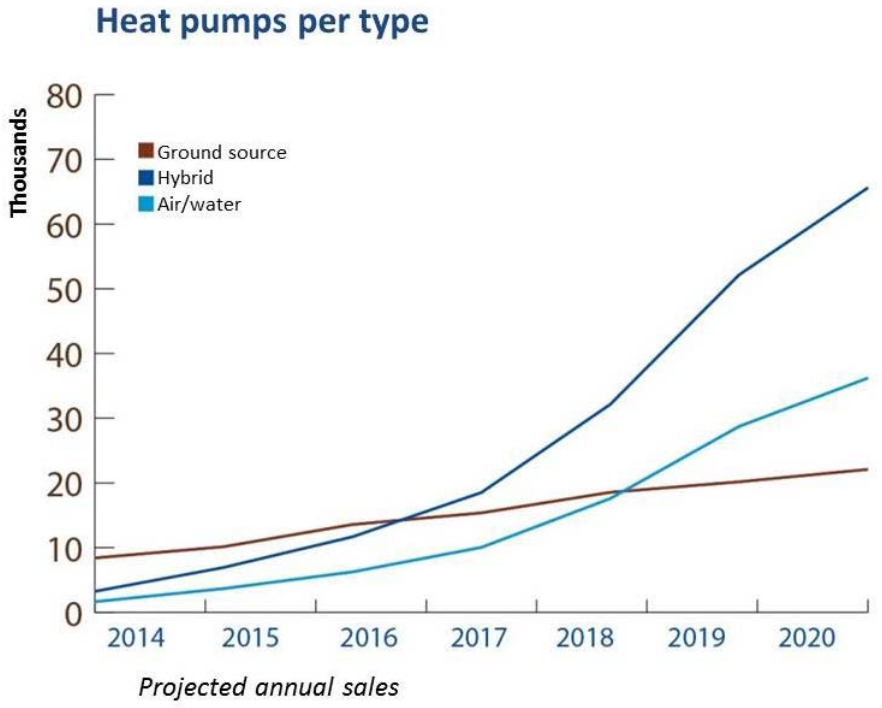


Figure 18 – Projected heat pump sales by HP type.



3.2 Market Drivers

- Energy savings

- National goals 2020 on use of renewables, energy saving and emission reduction.
- Reduction of energy cost per household (mainly a topic for social housing companies)

3.3 Market Barriers

- Adaptability of installers to new technology;
- Hearts and minds of installer not on heat pumps;
- Technology experience of installer;
- Extreme low purchasing prices for condensing boilers;
- Higher upfront investment for hp compared to boiler;
- Confidence in performance of the technology;

4 List of smart heat pump projects in the NL

- Field trial Heerhugowaard in which 70 heatpumps are planned to be controlled based on market data and grid load.
- Field trial Couperus
- PowermatchingCity II

5 Analysis of smart-ready products

5.1 Criteria for 'Smart-Ready': Analysis of Full Range of "Smart" Capabilities

5.2 Defining the Minimum Capabilities for Smart-Ready Heat Pump Systems

5.3 Review of NL Products which meet these Smart-Ready Criteria.

At the moment, there is no real view in the Netherlands in terms of legislation, technical developments or standard communication protocols on the aspect of heat pumps connected to a smart electricity grid. For this reason, BDH produced a positioning paper for Alliander, a large DSO in the Netherlands. This positioning paper ('Positioning paper load management with heat pumps in domestic housing') will address the load management potential and barriers for smart heat pump connections and is to be released at the end of 2014.
It is clear that if large housing projects are installed with heat pumps it is important that the DSO is involved at the planning stage, so integral choices can be made regarding whether or not to install gas connections and subsequently which type of heat pump installation. The grid design of Dutch electricity connections is based on an average power uptake that is too small to have a whole district supplied with heat pumps. Moreover, if the heat pumps use resistance heating as an emergency backup.

It is eminent that hybrids will be a very popular heat pump type in the future to replace gas boilers, since almost all the houses in the Netherlands are connected to the gas grid. In terms of future electricity problems overloading because of heat pumps, PV panels and E-mobility, Heat pumps can provide flexibility since they can switch to gas.

Flexibility in terms of absorbing more intermittent renewable generated electricity, heat pumps can be connected to a thermal storage buffer or use the inertia of the building mass. The potential for this is still unknown in the Netherlands. The installation of a large water tank of PCM's will be a challenge, since in general there is not enough room in the technical room.

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