R&D Overview
Netherlands

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R&D Overview – Netherlands

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1 History of development – How systems have changed?

The first heat pumps for domestic hot water were developed in the period 1981 – 1984 by Inventum.

- An enamelled storage tank of 150 litres and a fined copper heat exchanger as condensor inside the tank
- The heat pump part was manufactured by Refac as an air source heat pump on ventilation air

It was no success!

Then in 1991/93 a new start was made by the Ministry with a first idea of a governmental heat pump program and the 4th IEA Heat Pump Conference was staged in Maasticht. The focus was changing from single DHW Heat Pumps to space heating, combined with DHW. The first Dutch manufacturers came slowly to the market with Techneco and Inventum as pioneers in the domestic market and later on ITHO-Daalderop.

The market then seems to be changing to large systems for commercial buildings and greenhouses, supported by the success of seasonal storage systems.
2 System technologies

Since there are no real Original Equipment Manufacturers in Netherlands the focus for R&D is in using heat pumping technologies supplied by other manufacturers optimally into the heating systems normally built in Netherlands.

This has been the basis of some interesting innovations, being:

- Hybrid Heat Pump
- Booster Heat Pump for DHW

Remarkable is also that the double function heat pump has become the standard for heat pumping technologies in new domestic buildings, often combined with summer cooling. Stand alone DHW Heat Pumps are rare.

The main developments have been on installer focused technologies making heat pumps as Plug & Play technologies available.
3 Component technologies, Kind of refrigerant

Since there are no real Original Equipment Manufacturers (OEM’s) for traditional electric driven compression heat pumps in Netherlands the focus for R&D is in using heat pumping technologies supplied by other manufacturers optimally into the heating systems normally built in Netherlands.

OEM’s for DHW are in Netherlands those companies manufacturing storage water tanks. Inventum and ITHO-Daalderop are from the historic background the only ones active in the domestic market.

Developments in the non traditional and sorption area of technologies could be qualifies as OEM’s, being:

- Thermo acoustic technology from Blue Heart
- Adsorption Heat Pump from Cooll Sustainable

The manufacturers with electric driven compression heat pumps follow the European legislation for refrigerants.
4 Installer focused technologies

A number of manufacturers have developed Plug & Play solutions which makes it more easy to install following the traditional installation procedures as much as possible and also to make the technology more economical viable.

At the first WM we visited the Soesterberg project, where in newly built energy zero houses the complete construction was Plug & Play. No intermediaries were involved in the process where the manufacturers dealed directly with the building company.

Other examples can be found in the first Dutch Heat Pumping Technologies Journal.
4 Installer focused technologies
5 Innovations from the Dutch Innovation Program

• High Temperature Heat Pump
• Thermo Acoustic Heat Pump for domestic application
• Adsorption Heat Pump for domestic application
• Combination with solar concepts
• Energy-Pads™ - thermo chemical storage
• Building Integrated Energy for Prefab Production
• Heat Infrastructure Netherlands with reduced System Temperature
5a High Temperature Heat Pump

Technology developed by Linthorst under the TKI program for renovation in Multi Family buildings.

DHW can be generated at 65°C.

There is a number of heat pump designs capable of achieving high temperature outputs, including:

- Products with optimised design for specific refrigerants.
- Cascade systems with two separate refrigeration cycles.
- Enhanced Vapour Injection (EVI).
- Use of natural refrigerants and sorption products.

Whilst these products have been specifically designed for high temperature operation, the designs of “conventional” heat pumps are increasingly being improved to reach 60-65°C at reasonable efficiency.
Blue Heart heat pumps are closed systems that are filled with Helium under pressure.

1. Electrical driven drivers send an acoustic wave through the pump.
2. At the point where Helium is compressed heat is exchanged by a heat exchanger.
3. Between the two heat exchangers a regenerator is located. Within the regenerator a thermal cycle arises. In this way the regenerator creates a temperature difference or a so called thermal pump or heat pump.
4. At the point where the helium is expanded, heat from the source is added using a second heat exchanger.

The heat exchangers (2) and (4) are connected to either the source or heatsink, depending on the demand of the consumer. Either heating or cooling.
5b Thermo acoustic heat Pumps

With a thermal capacity of 1 – 100kW’s the heat pumps of Blue Heart are developed for residents and offices. Special applications are as:

• Hybrid application with gas boilers.
• Domestic hot water generating. The thermo acoustic technology is especially suitable as an application for domestic hot water. Because there is no maximum temperature for thermoacoustics, it is extremely suitable for upgrading from low temperature (for example heating networks) to tap water temperature.
• Replacement of gas-boilers
• Small office buildings
• NzEB’s
• Air Conditioning in buildings

Blue Hart Energy B.V will produce the thermos acoustic as OEM supplying the component to heat pump manufacturers.
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Status Q4 2017

1. Ready and existing
2. Prototype ready Q2 2018
3. Planned for 2018 - 2019
4. Planned for 2018 - 2019
5. Planned for 2019 - 2020

'Works as Real' prototype
- New driver concept, low cost concept
- Up scaling to 1 kW
- Optimized thermo acoustic loop

'Looks as Real' prototype
- Mass production layout
- Integration of loop and driver
- Compact
- Production techniques

Product: 1kW Single Unit

Field Demonstrations
- Field test
- Different real life conditions
- Endurance

Production
- Production method
- Production line
- Logistics and suppliers

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The thermally driven adsorption heat pump can be used as a compact and highly efficient gas heat pump, but in the long run also as a (solar) thermally driven cooling unit.

The thermally driven adsorption heat pump can be used as a compact and efficient gas-fired heat pump, but in the long run also as the heart of an energy-efficient integrated system for heating and solar thermal cooling. The envisaged gas heat pump is a potential successor to the HR boiler in the existing building, because:

- The low weight makes the system suitable for indoor installation, the dimensions are comparable to those of a large boiler;
- The heat pump can use outside air as a heat source from solar thermal collectors. No ground source is needed;
- It can be connected to traditional HT radiators.

Cooll works closely together with a large number of international high-tech companies and universities. Business partners are: BDR Thermea Group B.V., Reith Laser B.V. The business development is supported by a network of professionals around the team of Cooll. Cooll uses a number of patented technologies.
5d  Combination with solar concepts

Packaging DHW HPs with PV – significant market potential in some countries, & offers a new route to market via PV providers. – emphasising the economic benefits of the combination with PV is critical.

The PVT inSHaPe project focuses on the unused market opportunities for PVT heat pump systems in the current renovation and new-build market for energy-efficient homes and NzEB’s.

- WP2, the functional requirements for integrated PVT heat pump systems are drawn up after an inventory benchmark study. Based on this, a number of systems are designed and energy performance is simulated in a number of iterations.
- WP3, the various system components are optimized for the best system performance and an arrangement is also designed.
- WP4, the various components are tested in the lab and in outdoor conditions before they are characterized as integrated systems for energy performance.
- WP5 provides the non-technical preconditions for the successful rollout of PVT heat pump systems

The result of the project is the optimization of three PVT collectors, a modulating heat pump, three optimized and verified system designs for PVT heat pump systems for space heating and DHW and three pilot projects to demonstrate the energy performance.
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5 e  Energy-Pads ™ - thermo chemical storage
The project develops a technology that stores excess renewable electricity as thermal energy in a highly compact and cost-effective system. The energy storage density of the system will be up to six times higher than that of thermochemical storage, while being an order of magnitude cheaper than batteries.

5f  Building Integrated Energy for Prefab Production
This project concerns the development of a prefabricated system on the one hand and the functional and aesthetically integrated energetic elements BIPV (SCX Solar) and solar collector and heat pump (HRsolar) on the other.

5g  Heat Infrastructure Netherlands with reduced System Temperature
Making the technical / economic feasibility and consequences / limitations of an innovative heat infrastructure visible for the Netherlands, based on a low temperature heating network with a supply temperature between 30°C and 60°C and with which sustainable are provided for the heat demand of the Dutch built environment.
6 Water quality management technologies

Two general categories for practices designed to increase water efficiency:

- Behavioural practices refer to changing users’ habits irrespective of the technology being used.

- Technologies designed to passively reduce water irrespective of the user’s behaviour, such as: water saving shower heads, low-flow toilets, etc.

- This binary focus overlooks the conceptual area where technology and behaviour influence each other—an area that has seen much less attention, and is ripe for development.
6 Water quality management technologies

Water saving shower head

Shower heat recovery
6 Water quality management technologies

A more advanced system is introduced by Hamwells Europe B.V. with the ‘E-shower’ which is a shower that recirculated and cleans the used water during showering.

https://www.youtube.com/watch?v=cOD-9iwbiG8
6 Funding support

Support comes from the governmental program TKI Urban Energy. This program has five main lines:

- Solar power technology (PV);
- Heat and cold installations;
- Multifunctional components;
- Flexible energy infrastructure;
- Energy control systems and services.

The 2018 program has set specific goals:

- More explicit attention for embodied energy and circularity;
- Explicit attention to domestic hot water;
- Explicit attention to digitization and industrialization in building processes;
- Strengthening geothermal energy, not just 'shallow' geothermal energy;
- System integration at the decentralized level;
Many innovations can be found on the Dutch market already, although the main Dutch heat pump manufacturers are not Original Equipment Manufacturers.

R&D in Netherlands is mostly ‘application development’ focusing on the application boundaries of the existing and future markets and customer needs and preferences.

The main technologies for domestic hot water are:

- Hybrid heat pumps, where the gas boiler is delivering instantaneous hot water
- Double function gas driven or all electric heat pumps, generating space heating/cooling ad domestic hot water.
- Collective high temperature heat pumps for space heating and domestic hot water distributed in multifamily buildings
- Collective low temperature heat pumps in multifamily buildings with individual booster heat pumps for domestic hot water
- Low temperature district heating with individual booster heat pumps for domestic hot water

Assuming that government regulation will not decree storage tanks in all houses, a technical option is required that are compact, appealing to consumers, economically viable and deliver DHW with much reduced energy consumption/carbon emissions.
Thank you for your attention!
ご清聴ありがとうございました！

質問?

小野