

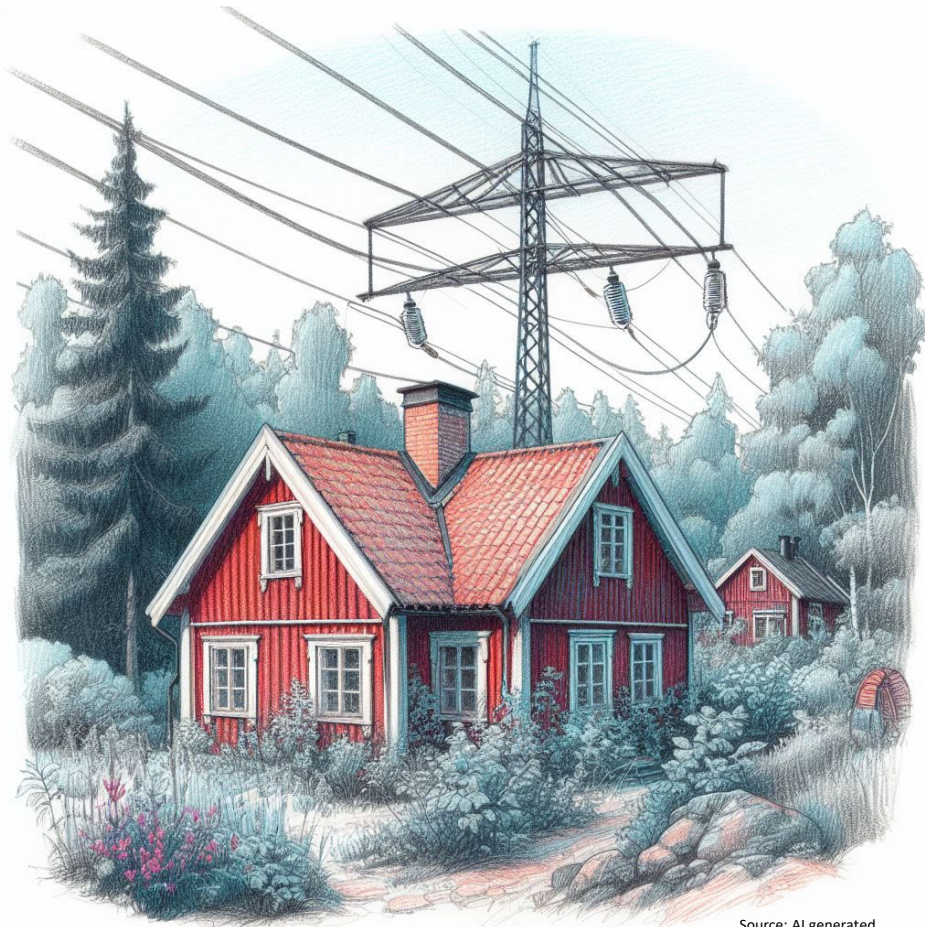
Flexibility from small scale heat pumps

Markus Lindahl, RISE (Sweden)

Marion Bakker, RVO (Netherlands)

Heat Pumps for single family houses

- Aggregation and control of the HP pool



Source: AI generated

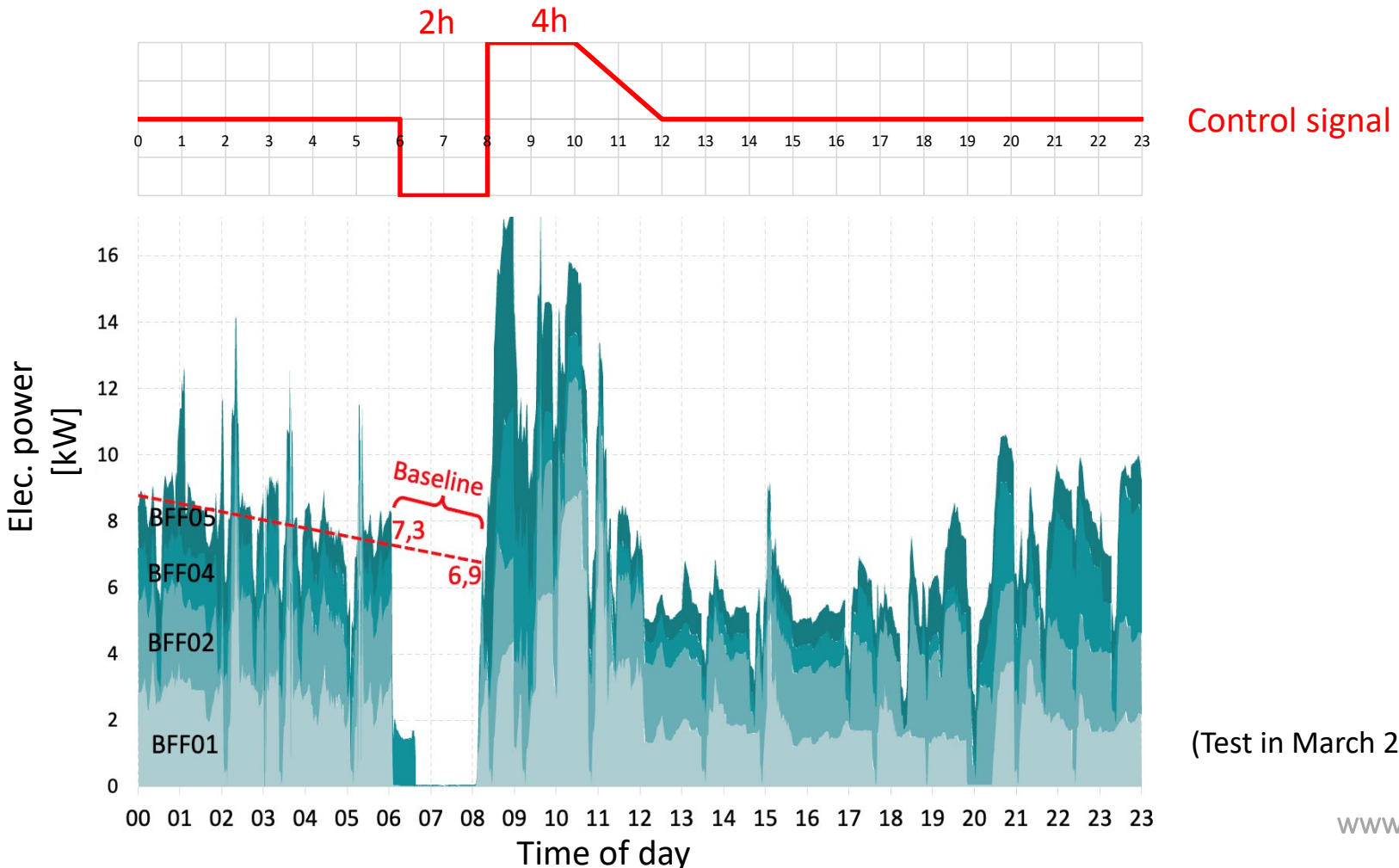
- Focus: HP with hydronic heating systems
 - Ground source-, air to water-, exhaust air-
- A heat pump for a single-family buildings can only deliver a smaller amount of flexibility to the power system.
 - A number of heat pumps must be aggregated and controlled together
- The aggregator uses its pool of heat pumps to deliver services to the power system.
 - Both a decrease and an increase in power consumption can be of interest

Flexibility from heat pumps

- Flexibility is about moving electric loads in time
 - For HP in single fam. building
- When the HP is stopped
 - The HP needs to run harder to compensate for missed heat production
- Important to handle both a decreased and an increased in power consumption in a smart way
 - Keep performance high

4 HP controlled together

- Example from the research project "Homes for Flexibility"

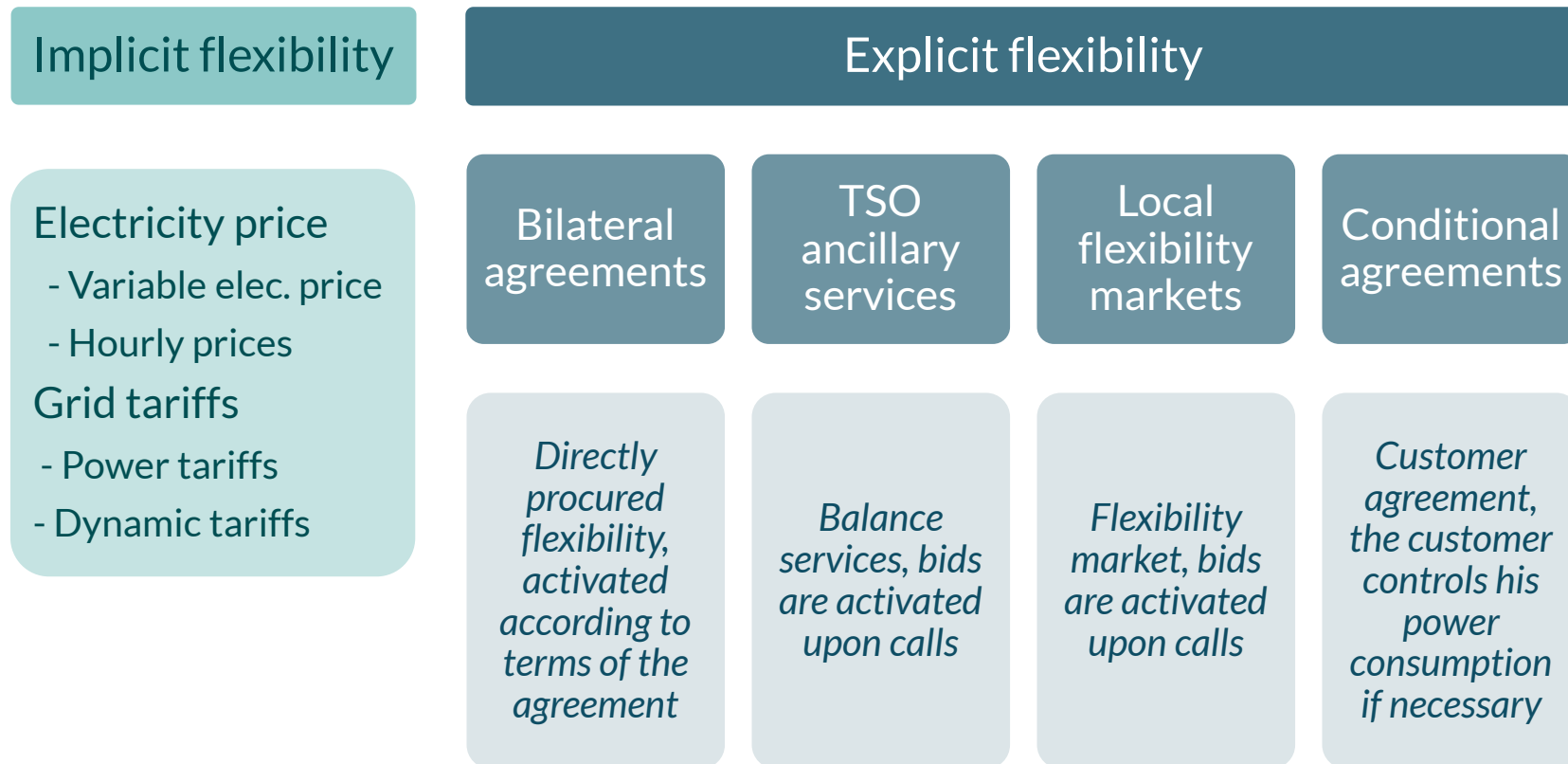


Control signal

(Test in March 2023)



Flexibility services to the power grid



Source: Power Circle, 2022

Interview study with Swedish HP manufacturers

- Four large manufacturers of heat pumps in Sweden
 - Technical experts
- Focus on technical possibilities and constraints
- In general they have a common ground in the technical limitations



Bosch



Enertech



NIBE



Thermia

Reaction time and ramping speed

- Compressor

On/off compressors

- Can be turned off within a second
- The start up procedure is up to 1 min
 - Normally the brine pump needs to start before the compressor can start.
 - Preheating of compressor oil can also delay startup.

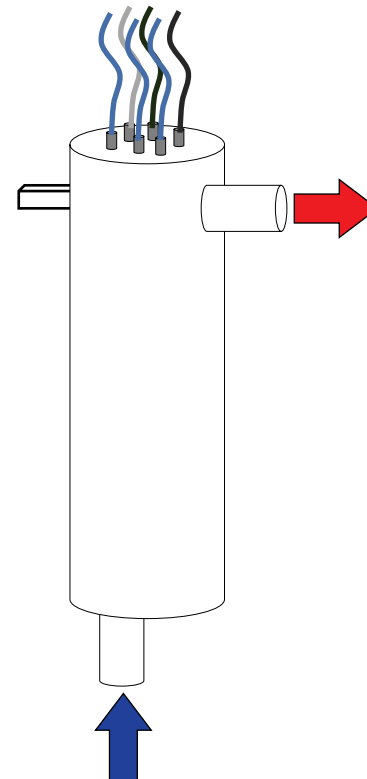
Variable speed drive compressors

- Slow to both start and stop
 - Can take several minutes...
 - Faster to adjust the frequency
- Likely possible to speed up
 - But some technical aspects will still limit what is possible
 - No need in the normal control of the heat pump

Reaction time and ramping speed

- Auxillary heater / backup heater

- Controlled within a second
 - Both for decreased and increased power consumption
- In normal operation the use of the auxiliary heater is minimized
 - To keep performance up
- Dedicated reprogramming of the control system needed for rapid control
 - Almost always possible to use for increased power consumption.
 - Can be used to reduce power consumption during cold spells
- Clear economic incentives are needed
 - To compensate for lower COP



- The technical requirements for the ancillary services FCR-N and FCR-D seems possible for HPs to fulfill.
 - FCR-D activation time: 50% within 5s (In Sweden)
 - FCR-N activation time: 63% within 60s

Measurement of power consumption

- To provide demand response the power consumption needs to be measured or estimated with high accuracy
 - At least at an aggregated level.
- Today's heat pumps for single family buildings normally lack electricity meters
- The interviewed HP manufactures estimates the uncertainty of the power consumption
- VSD compressors has relatively high accuracy on power consumption measurements
 - $\pm 2-10\%$ (measurement in the inverter)
- On/Off compressors has low accuracy on power consumption measurements
 - $\pm 10-20\%$ (no real measurement done)
- Auxiliary heater has relatively high accuracy on power consumption measurements
 - $\pm 0,5-5\%$ (lower if unknown voltage)



Cyber security

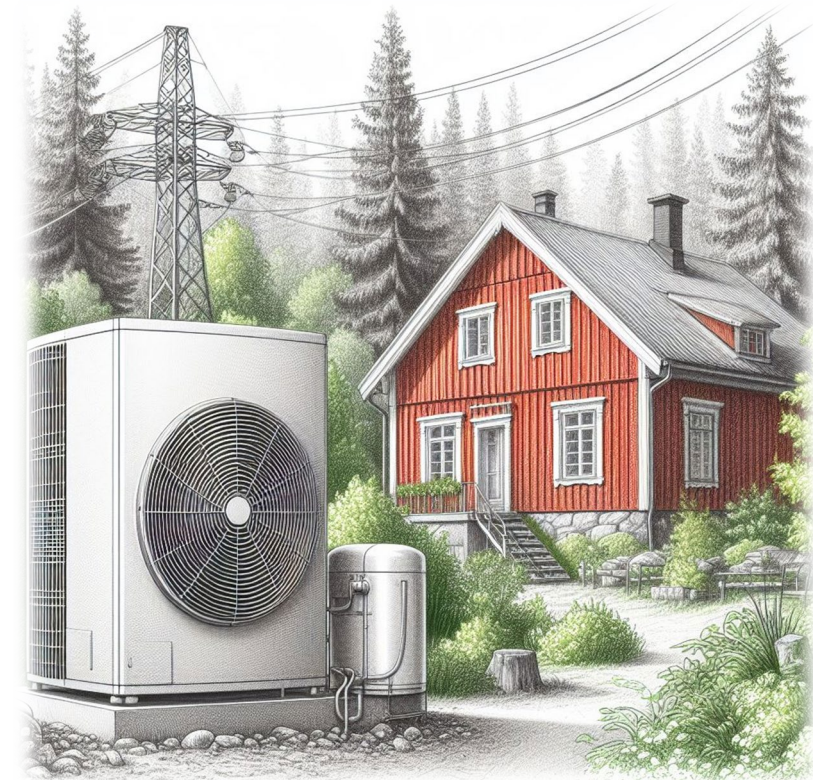
- HP controlled over the Internet
 - Vulnerable to cyberattacks
 - (as for all internet-connected devices...)
- The HPs long lifespan is an additional challenge
 - New cyber threats will demand updates for many years
- Hacked HPs can cause severe problems
 - HP owner
 - Power system
- A large pool of hacked/manipulated HPs can lead to significant disturbances in the national power system



Source: AI generated

Conclusions

- Flexibility is about moving electric loads in time
 - HP in single family building
- A heat pump for a single-family buildings can only deliver a smaller amount of flexibility
 - Aggregation is needed
- The HP manufactures has common ground in how fast their HP can be controlled.
 - On/off comp: Stop: seconds, start: 1 min.
 - VSD comp: minutes
 - Auxiliary heater: start/stop seconds
- Today's heat pumps lack electricity meters
 - Risk for low accuracy to measurements of demand response delivered.
- Don't forget the cyber security risk!



Source: AI generated

Dutch Climate policy transition

Marion Bakker RVO

Dutch existing building stock: the challenge

- 7.9 million existing homes 90% with individual gas boilers
- 0.57 million non-residential buildings (production halls, offices etc.)
- End of national gas production in Groningen
- Climate targets
- Energy crisis, fluctuation of price of natural gas
- Netting arrangements for solar panels and load infrastructure
- 6% district heating
- Deployment of (hybrid) heat pumps
- **Grid congestion!**



Nation action programme for Grid congestion

Capaciteitskaart invoeding elektriciteitsnet
Bijgewerkt: 20-12-2023 10:11

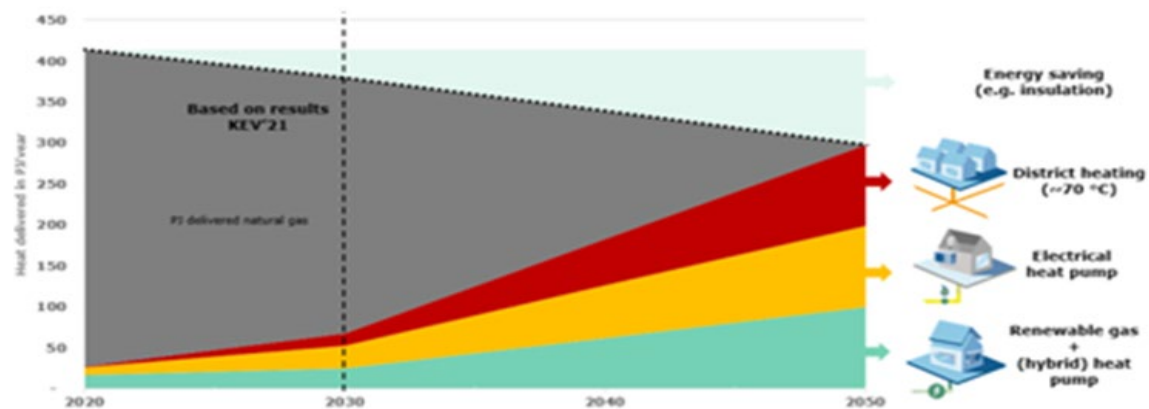


1. Faster construction and faster realisation of grid expansions;
2. Stronger efforts to make better use of the grid;
3. Increasing flexible capacity: public-private actions for smart solutions;
 - Smart setting of installations in non-residential buildings.
 - Enforcing the ban on electric boilers (not to be confused with all-electric heat pump)
 - Drawing up a protocol for grid-efficient installation of heat pumps in large-scale renovations and new constructions. Installers across the country will be urged to implement these manual.
 - **Development of smart controllable (hybrid) heat pumps**
4. Smart EV charging and smart sustainable homes.
 - Agreements with corporations and other landlords on retrofitting to avoid peaks

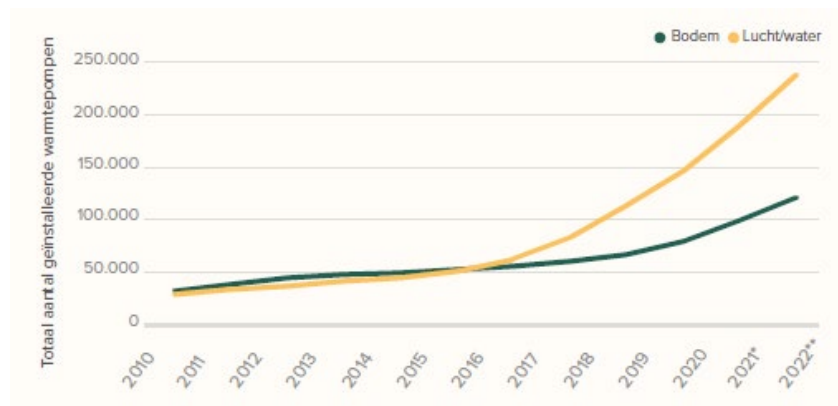
Actual capacity figures from grid operators can be found on de following website, grid lower than 110 kV: <https://capaciteitskaart.netbeheernederland.nl/>

Congestion area priorities in line with climate policy transition?

Policy - The Challenge



www.heatpumpingtechnologies.org



Code decision on prioritization space for transport requests from October 2024, grid operators will be obliged to use the prioritization framework in congestion areas.

From 'first come first served' (FCFS), to prioritize according to social interest.

Energy market regulator mentions three categories:

1. Congestion “solutions” will receive accelerated transport capacity because of the contribution to the increase in transport capacity of others
2. Safety facilities such as fire brigade, ambulance, police, defense and emergency aid are of course also given priority
3. Basic needs such as drinking water, education, housing (up to a maximum of 3 times 35A) **and also collective heating facilities (and hybrid hps)**



Hybrid heat pump (HHP) action plan

Main goal

- Remove barriers for further increase of HHP
 - 1 mln hybrid heat pumps in 2030

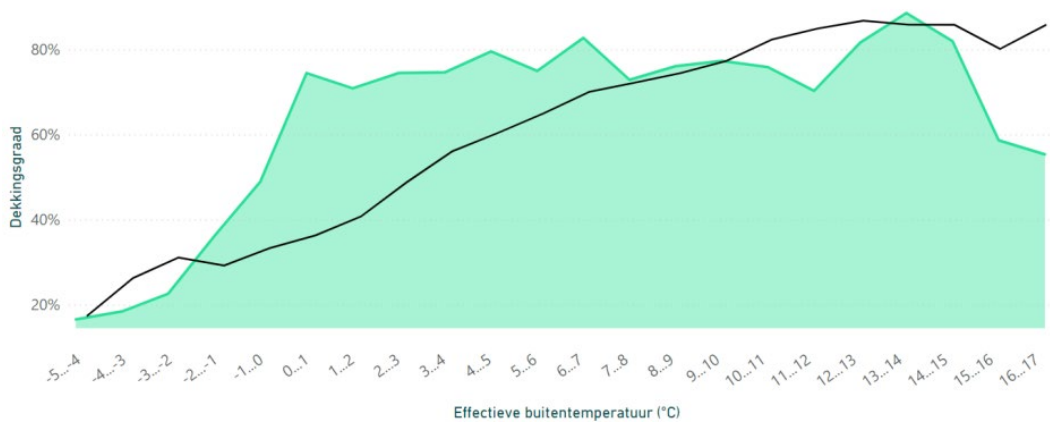
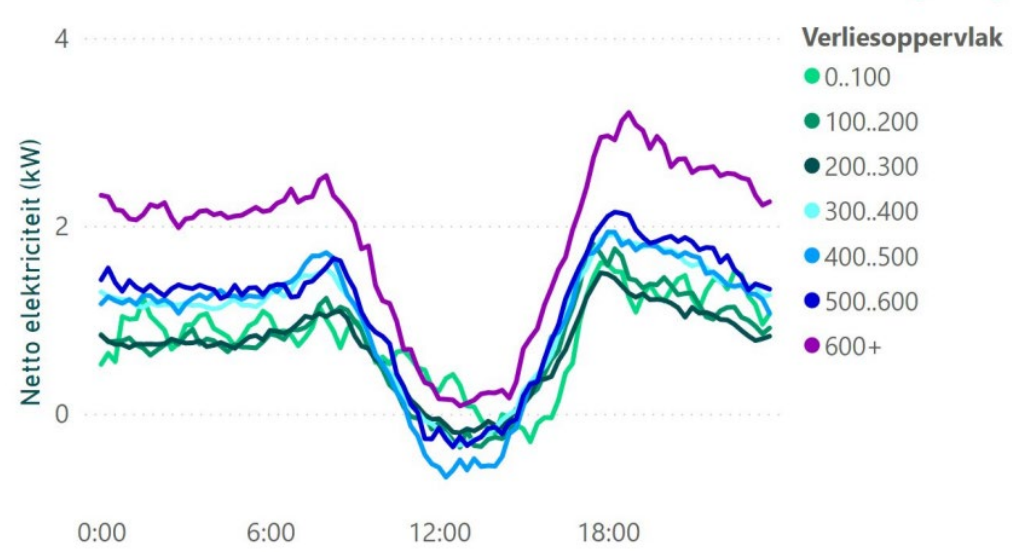
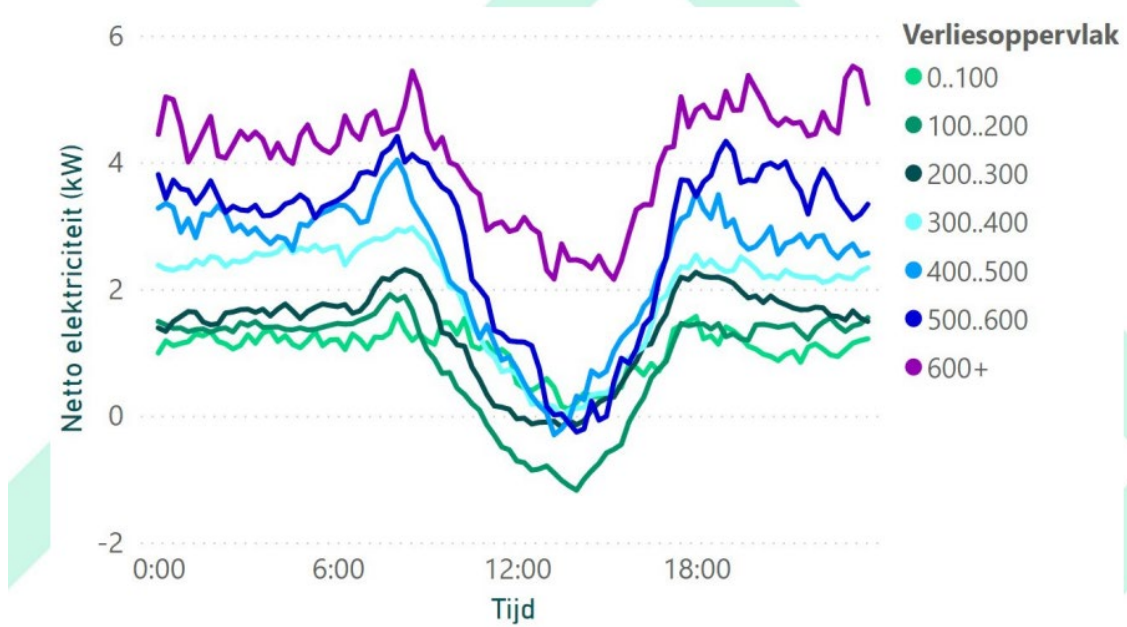
Main actions

- Facilitate more supply by scaling up production
- Training of more qualified professionals
- Reduce costs for production and installation of heat pumps
- Communication (3 year public campaign)
- Monitoring
 - Number of heat pumps installed
 - Number of qualified professionals
 - Development of heat pump prices and installation costs
- Collect, validate and share knowledge
- **The impact on the energy grid (monitoring and smart application)**

Partners



The impact on the grid: EHP / HHP (5 coldest days)



[Eindrapportage-Installatiemonitor-v2.1.pdf](#)



Potential flex heat pumps to be unlocked

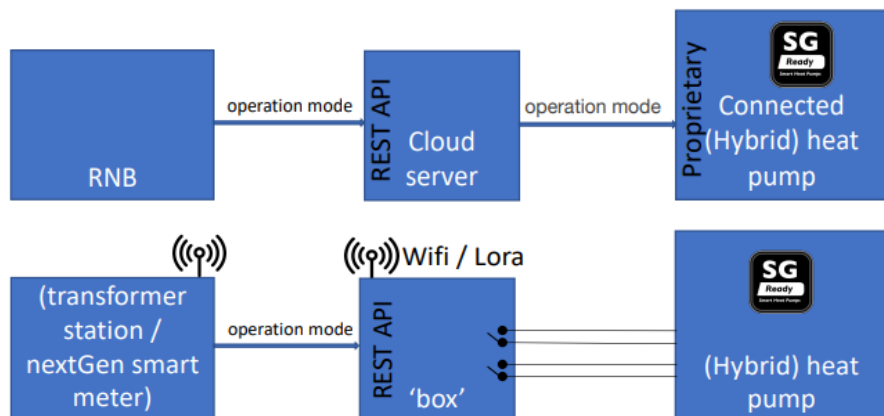
Dutch TSO states in report -based on figures 2020- that the extra electricity consumption of heat pumps in the Netherlands in non solar/wind winter periods can grow to at least 3 GW in 2030. With flexible control, heat pumps can contribute significantly to absorbing peaks and off-peak in sustainable generation.

OEMS survey (2024):

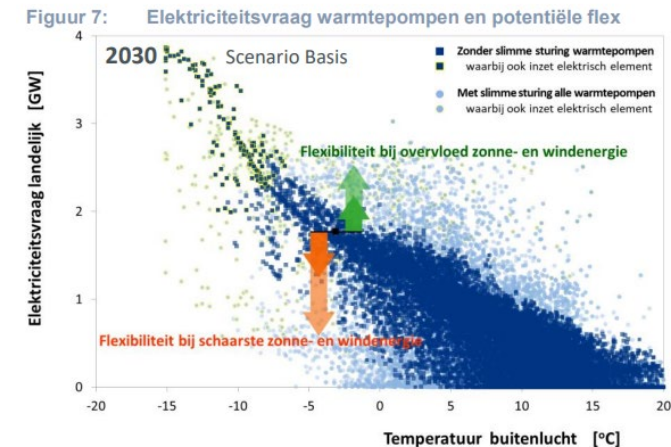
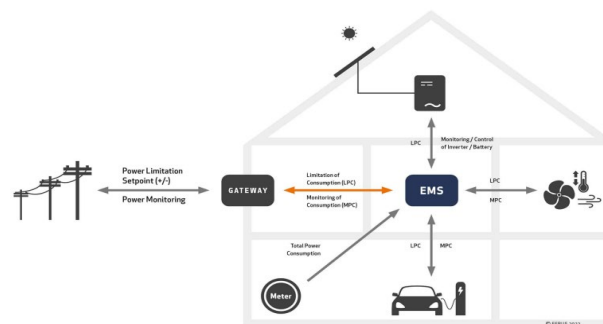
Use of heat pumps for flexibility might be done in two steps:

- 1) use digitally available variant of SG-ready and prepare
- 2) use S2/EEBUS/etc. (two way traffic)

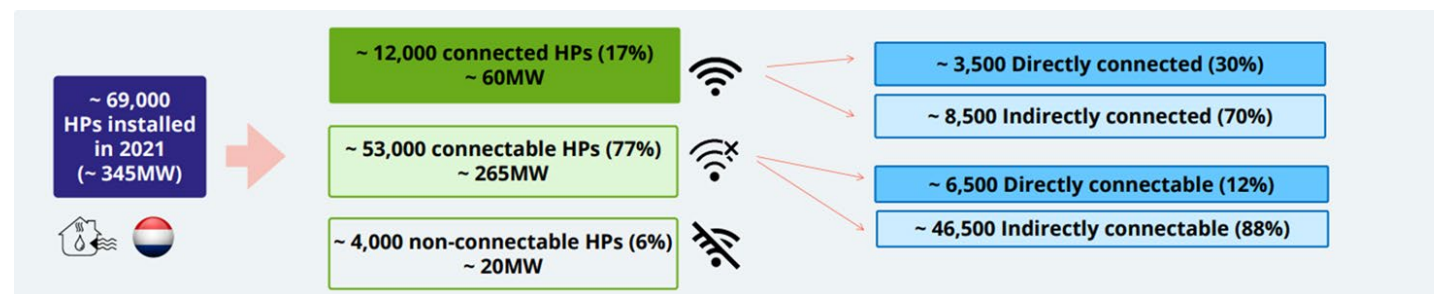
[Two-Steps-To-Using-Heat-Pumps-For-Enrgy-Flexibility-DEF-1.pdf \(cicwp.nl\)](#)



Display of the set-up of (non) connected heat pumps



[Een lokale duurzame warmtevoorziening speelt een belangrijke rol in het nationale energiesysteem \(tennet.eu\)](#)



European policy on energy management related interoperability of Energy Smart Appliances: Code of Conduct

EU Code of conduct covers the following electrical appliances that have an energy label:

- White goods: washing machines, tumble driers, washer-driers, dishwashers;
- **Heating, ventilation, and air conditioning (HVAC), including water heating;**

and the following use cases:

- Flexible start
- Monitoring and Limitation of Power Consumption
- Incentive Table based Power Consumption Management
- Manual operation (provisioning of necessary information in case of user driven manual Operation of Energy Smart Appliances)

Launch EU Code of Conduct First 10 companies' commitment (2024 April 23)

<https://ses.jrc.ec.europa.eu/development-of-policy-proposals-for-energy-smart-appliances>



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VAILLANT GROUP

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“Grid efficient” heat pumps To Do (DSO perspective)

Clarity Provide clarity about the system perspective for grid-efficient deployment; the method of control (e.g. locally to the HP itself or via an API to a management platform of the HP).

EU standard Look at solutions/choices in other countries and pursue a European solution.

Robust Provide local connectivity as well. 'Cloud-only' (i.e. only a connection of the HP to the manufacturer's management system might not be desirable in case of outdated technology or bankruptcy).

Platform Provide a flexible platform/solution in the HP (controller in the WP with control options). This platform must also be able to support new standards and requirements with software updates.

Interchangeability Implement control for grid-efficient use, it is also worth considering interoperability from the perspective of the integrability / interchangeability of HPs with other systems, so that consumers can easily integrate their products into existing solutions.

Cyber security Include upcoming legislation such as the RED 3.3, CRA and NIS2, which will include cyber security requirements for 'anything with a modem'.

Learning platform Support and learn from open source and the early adopters. *However, do not wait for complete clarity about this system perspective to start with work out the standards for control.*

Thank you

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