Power-to-Heat and thermal storage in heat networks

by Thijs Scholten (CE Delft)

CE Delft
Committed to the Environment

Outline

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- Dutch context and the work of CE Delft
- P2H+S: sector coupling electricity, heat and energy storage
  - Background of the study
  - What exactly is P2H+S?
  - Is there a business case for P2H+S?
  - What is the potential of P2H+S?
  - How to fit P2H+S in the energy system? Effects on the energy system
  - Barriers in the Dutch context
- Questions

CE Delft

- Independent research and consultancy since 1978
- Transport, energy and resources
- Know-how on economics, technology and policy issues
- 80+ employees, based in Delft, the Netherlands
- Not-for-profit

Clients

Industries
(Small and medium size enterprises, transport, energy and trade associations)

Governments
(European Commission, European Parliament, regional and local governments)

NGOs

Context Flexible Sector Coupling and Energy Storage

‘Hot topics’ in the Netherlands:

- Heat transition: fossil fuel free built environment in 2050
- Electrification while struggling with electricity grid congestion

A few topics we work on:

- Potential of battery storage systems in the Netherlands
- Smart charging of electric cars
- CO_2-relation of flexible electricity prices
- Future energy infrastructures, e.g. Dutch Regional Energy System Studies and ‘heat transition’
- Scenario studies and fossil free flex
- Smart Thermal Grid ‘Mijnwater’ and **Power-to-Heat and thermal energy storage**

Background of the study

- Goal of the study:

  Give insight into the possibilities and potential of P2H+S in heat networks in the Netherlands

- Scope:
  Existing technologies; large scale collective systems; flexible operation of P2H

- Study was commissioned and funded jointly by:
  - Government agency RVO.nl (Dutch Enterprise Agency)

    english.rvo.nl
  - PPP TKI Urban Energy (Top Consortium for Knowledge and Innovation)

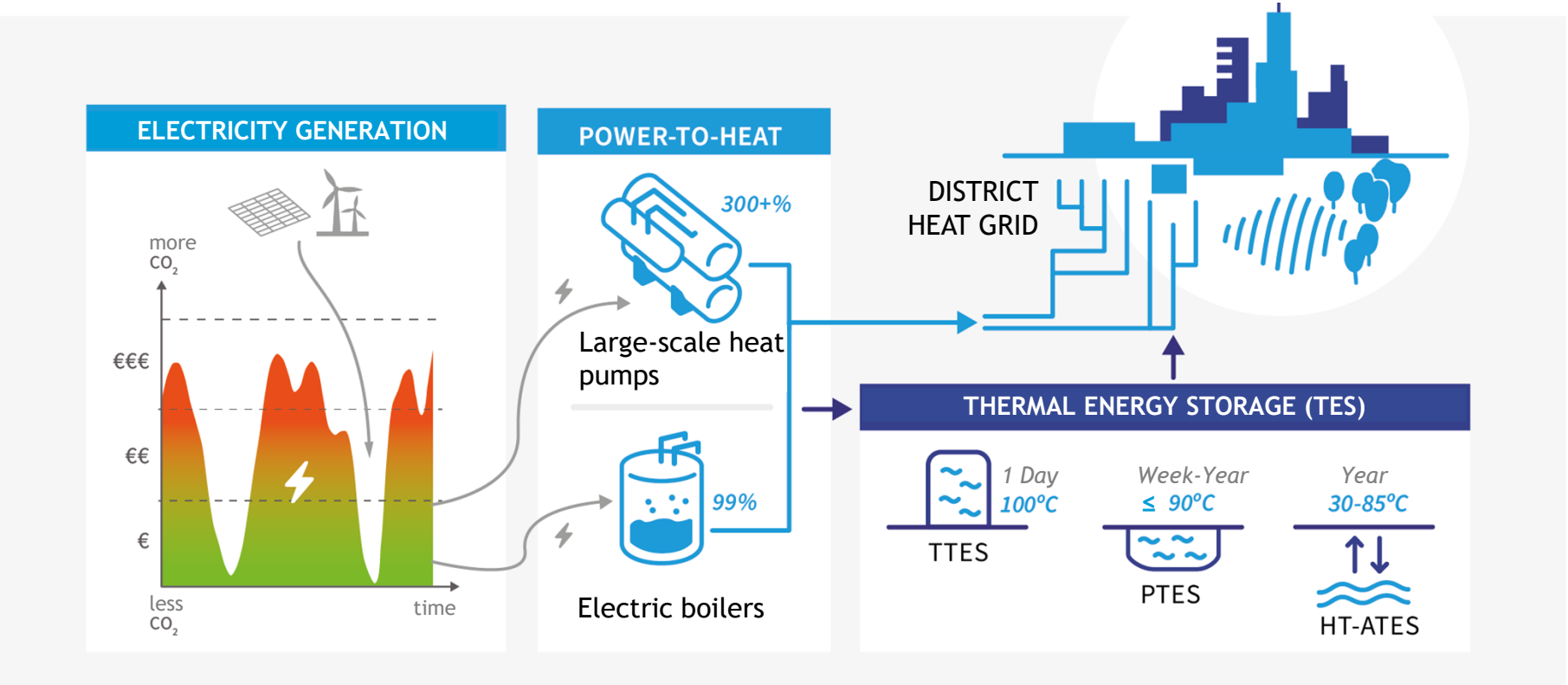
    www.topsectorenergie.nl/en/tki-urban-energy

Rijksdienst voor Ondernemend Nederland

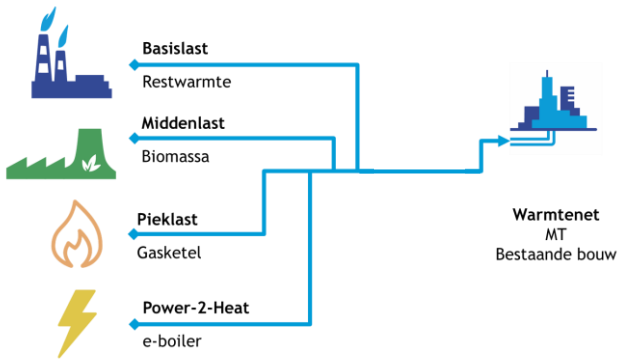
TKI URBAN ENERGY
Topsector Energy

What exactly is P2H+S?

- Flexible Power-to-Heat (P2H) combined with Thermal Energy Storage (S) in district heat grids: P2H+S
- Using low electricity prices for peak demand heat supply



Business case illustrated for a few cases



Flex e-boiler and/or 12h TTES in MT-network

- Flex e-boiler to avoid use of peak gas boiler
  - Payback: negative, high inv. and grid tarifs
  - CO_2-emissions: increase (bio = 0)

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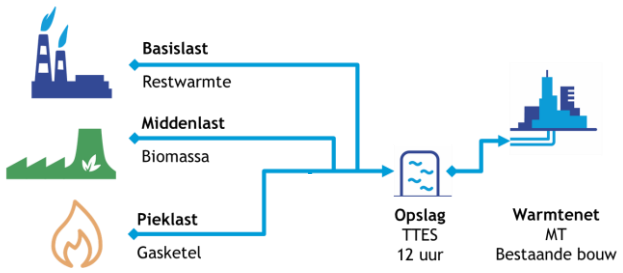

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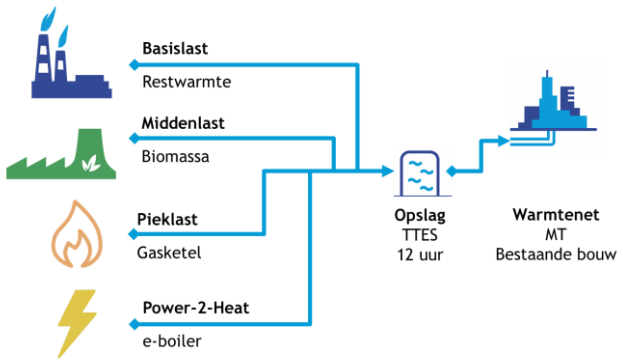

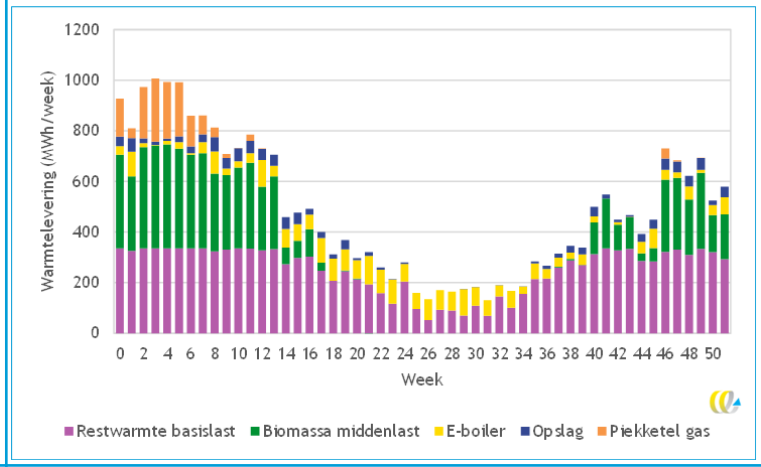

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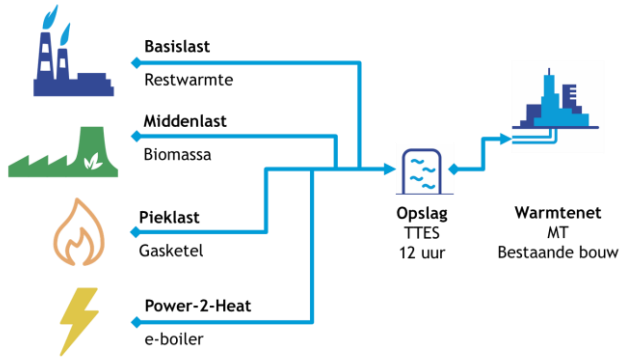

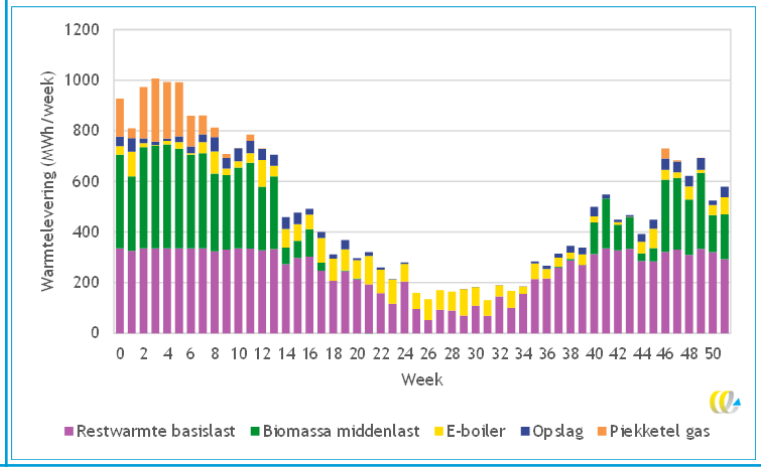

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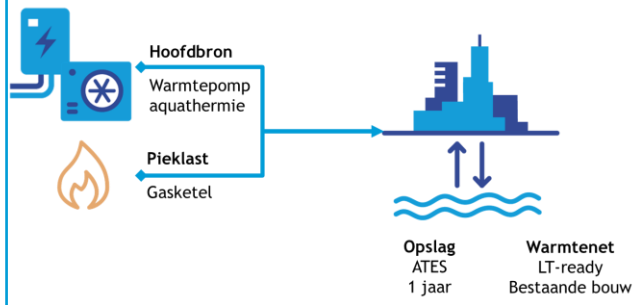
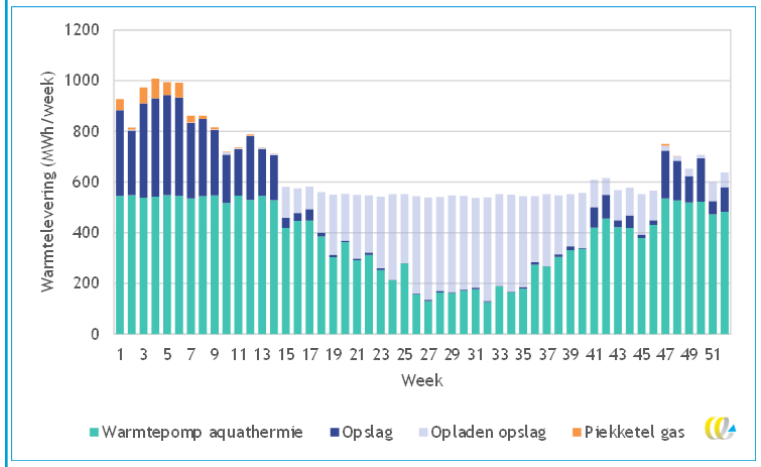




Seasonal storage in LT-network

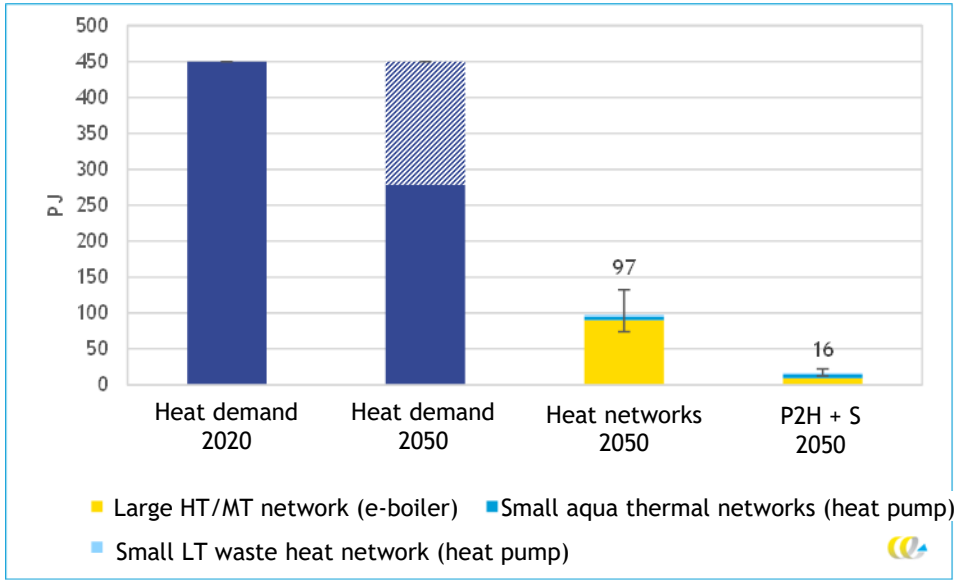
- Store heat pump energy in summer to reduce use of peak gas boiler in winter
  - Paback: about 7 years
  - CO_2-emissions: decrease (better use HP)
- Nearly continious use of heat pump

Technical potential in The Netherlands

- E-boilers in large MT-heat networks for flexible peak load:
  - Power: 0,6 GW (2030) → 1,9 GW (2050)
  - High power, few operating hours:
    supplying only 10% of the heat demand (2-9 PJ/j)

- Flexibile use of the residual capacity of heat pumps in LT-heat networks:
  - Power: 150 MW (2030) → 250 MW (2050)
  - Low power, high efficiency and operating hours:
    supplying 7% of the heat demand (4-7 PJ/j)

- Thermal energy storage in addition to P2H:
  - Capacity: 0,6 PJ (2030) → 1,4 PJ (2050)
  - Multiple cycli per year
  - Significant effect



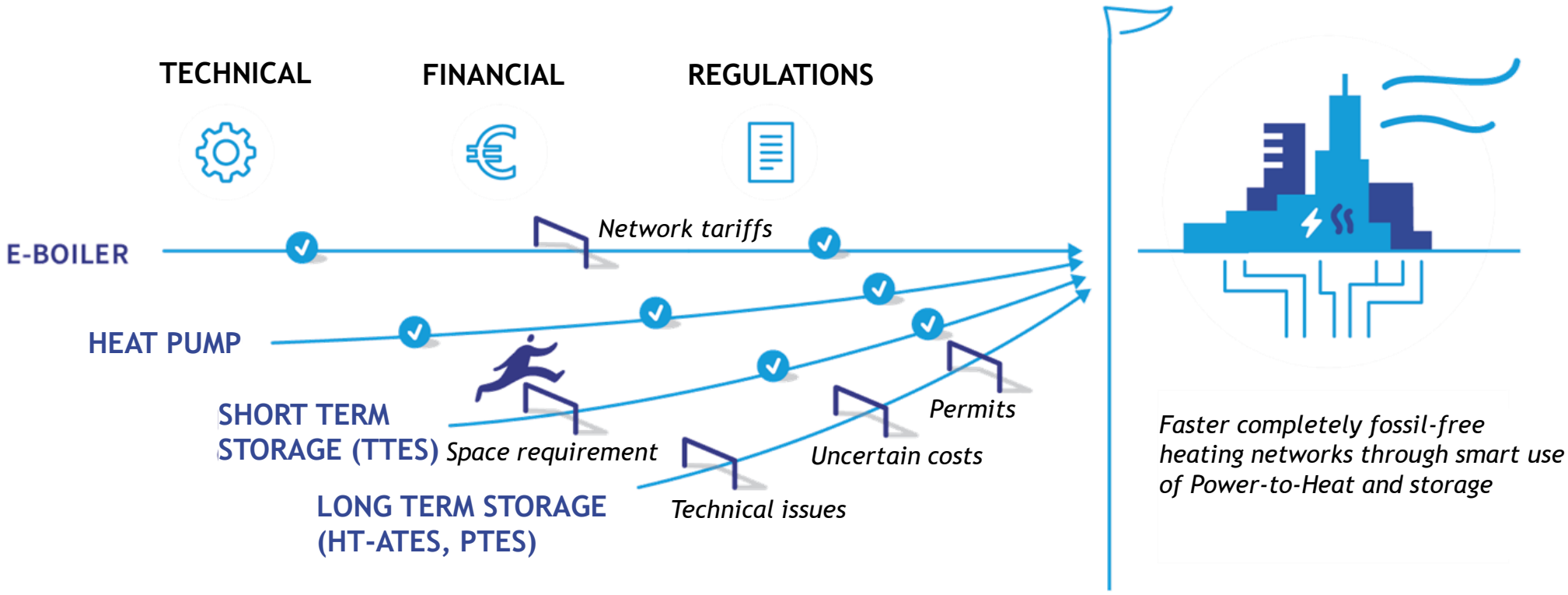
Effects on the energy system

- Important distinction:
  - *Price driven* deployment, i.e. ‘flexible’ e-boiler with thermal energy storage
  - *Demand driven* deployment, e.g. e-boiler replacing a gas boiler

Parameter	Price driven deployment	Demand driven deployment
Correlation with renewable electricity availability	Good	Limited
Curtailment solar and wind	Can significantly reduce curtailment	Can hardly reduce curtailment
Electricity from conventional generation	Is partly avoided	Not avoided → need for additional conventional generation units to match demand
Effect on CO_2-emissions	Depending on replaced technology, but price driven results in lower CO_2-emissions than demand driven deployment	

Storage has almost always a positive effect on the energy system, heat pump and e-boilers depending on the deployment

Barriers for P2H+S in the Dutch context



Thanks for your attention.
Any questions? Your opion on the subject?

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Read the P2H+S report online: https://ce.nl/publicaties/power-to-heat-en-warmteopslag-in-warmtenetten/
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