30 November 2021
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Heat Storage Webinar

KYOS Energy Analytics

Agenda

- Why heat storage?
- What types of heat storage?
- Economics of heat storage
- Outlook
- Q&A

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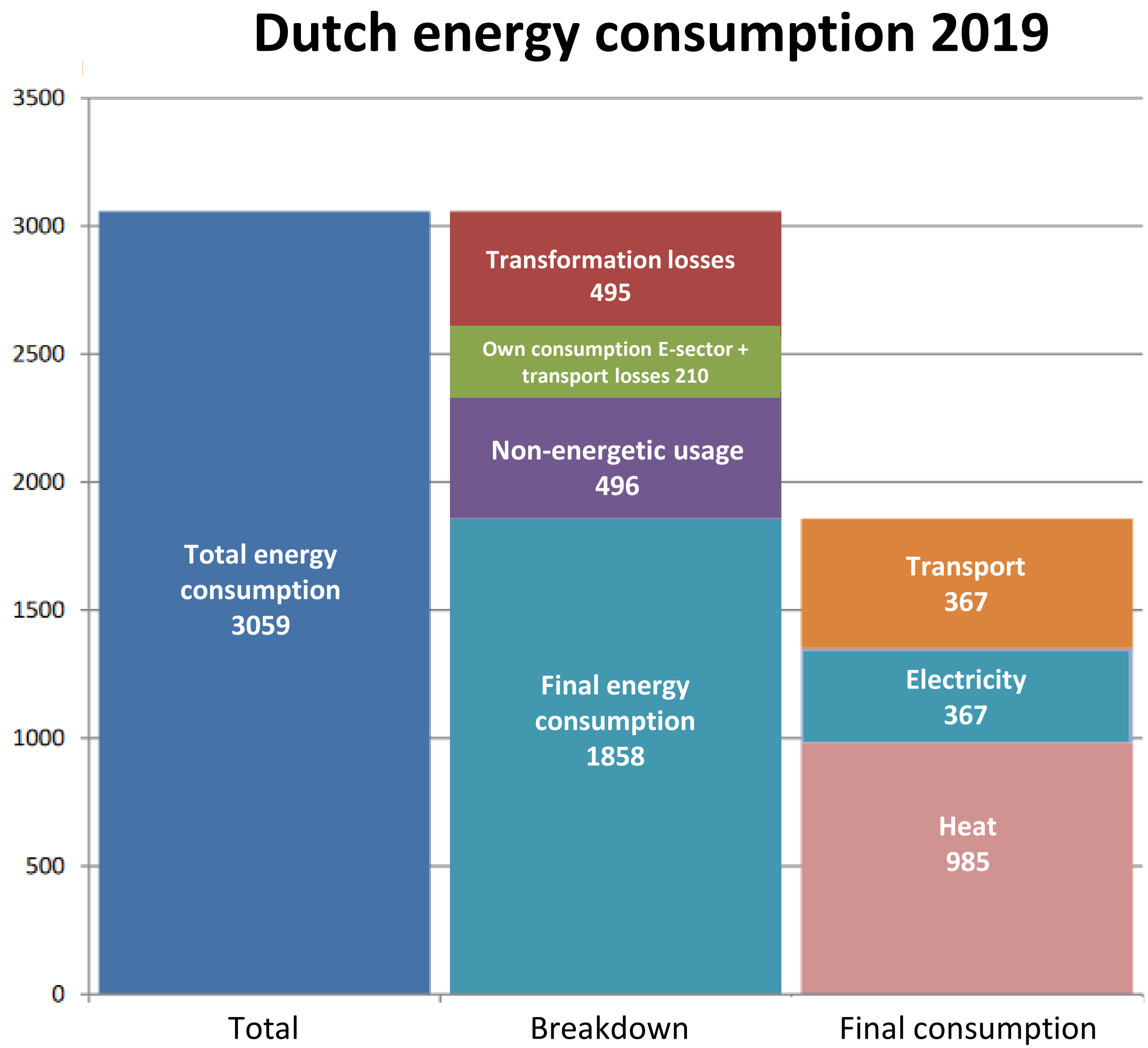
Heat demand is significant



- Heat accounts for >50% of final Dutch energy consumption!
- Electricity only 20%

Source: CBS Warmtemonitor 2019

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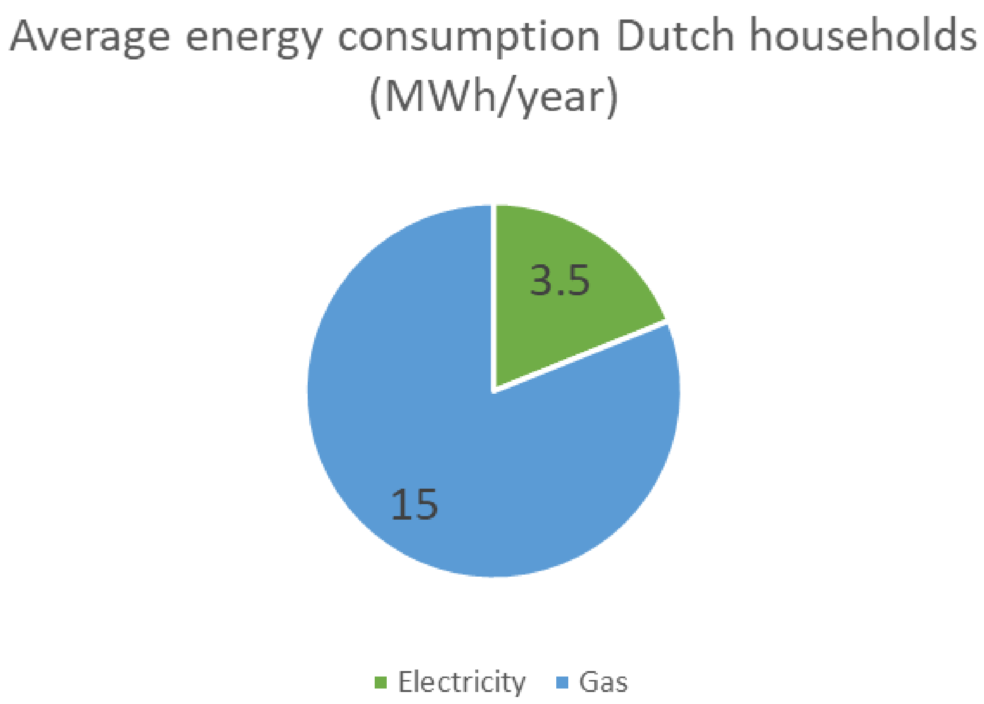
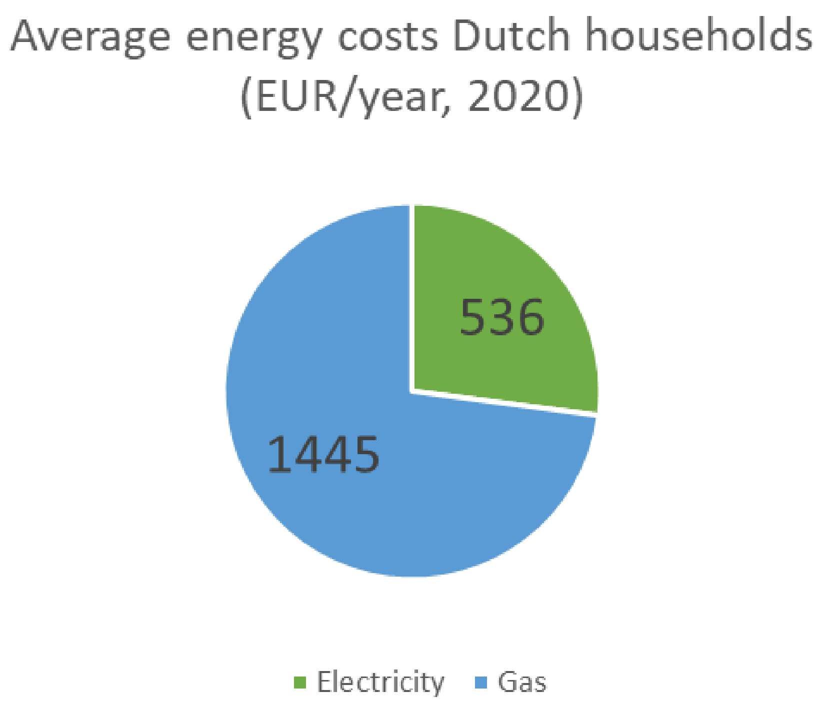
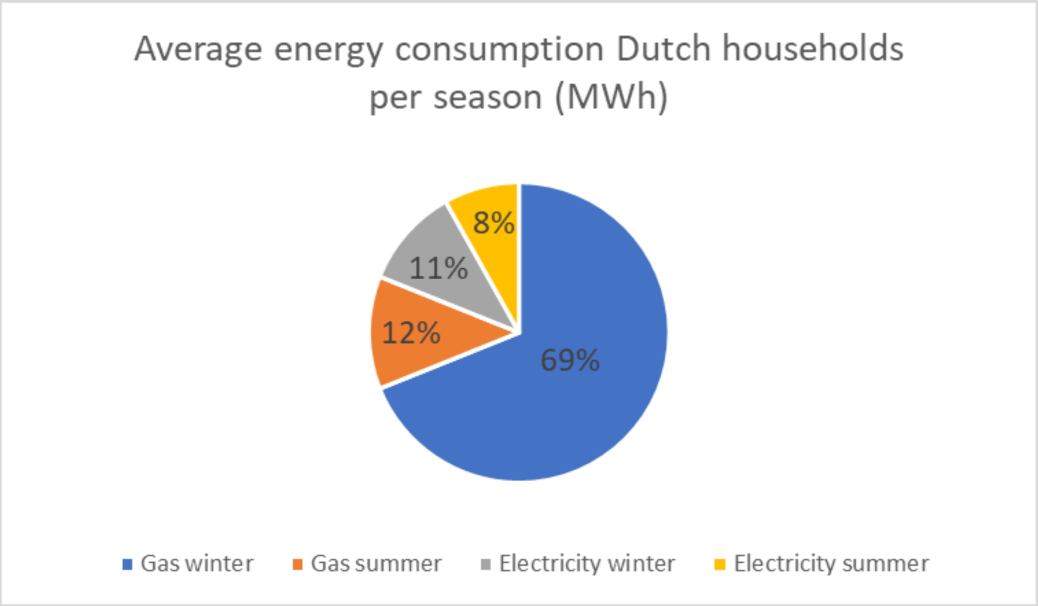
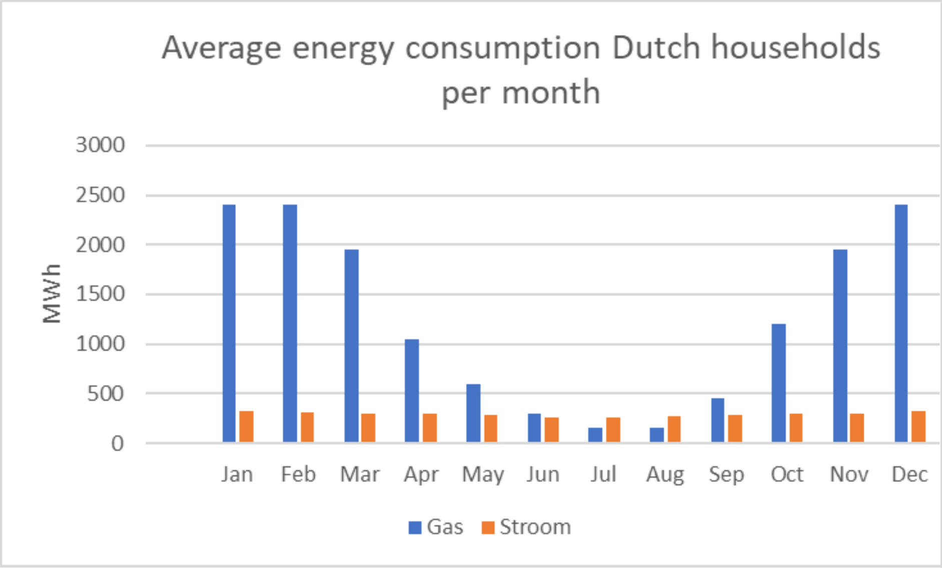
Heat demand for households

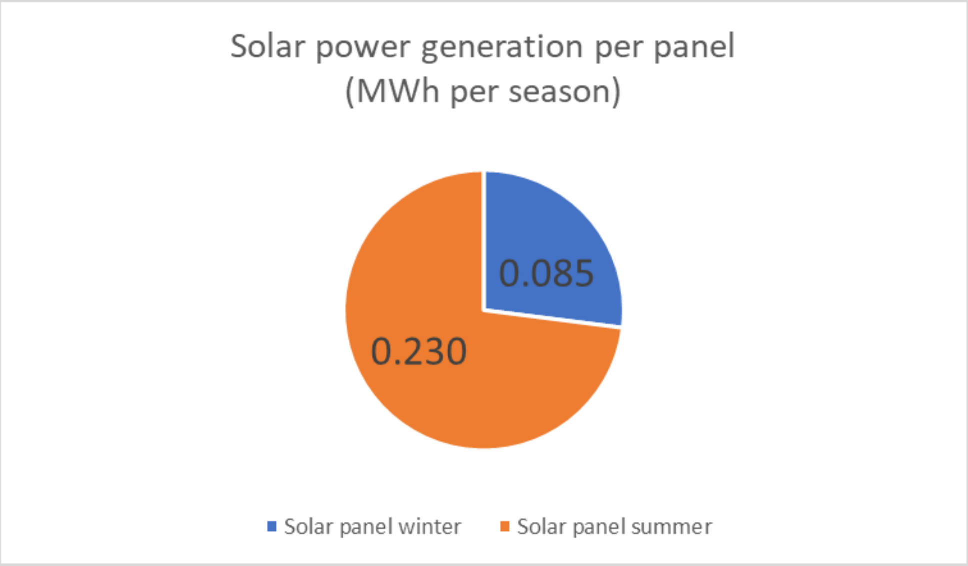




Heat demand per season







Heat transition

- Heat forms a major component of our energy consumption
  - Higher than electricity consumption
  - Mainly in winter, especially for households
- Natural gas is currently the main source of heat. In order to reduce CO2 emissions, we need alternatives
- Energy transition very much focused on electricity
- Less focus on initiatives to create renewable heat
- Renewable electricity may be converted to heat
- Challenge: time scales = storage

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Heat transition: options to leave gas behind

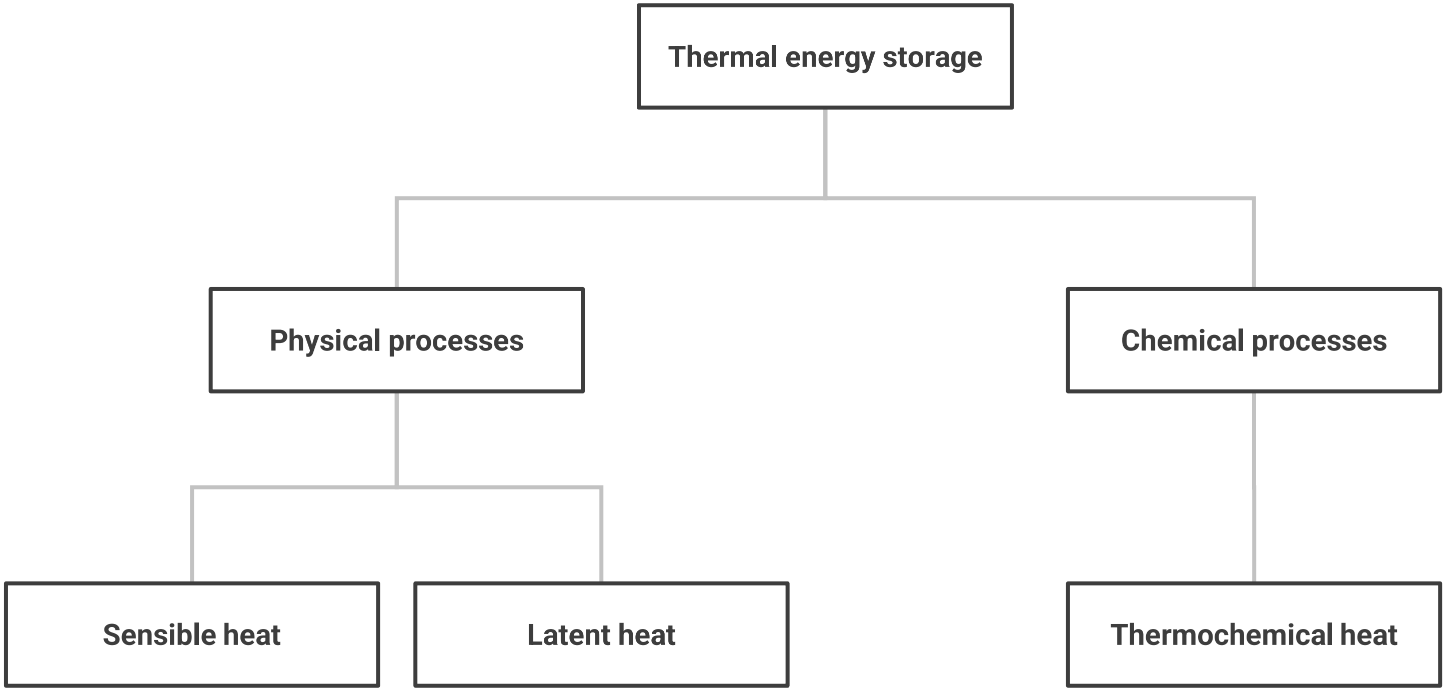
1. Geothermal:
   - Efficient use of natural resource
   - But: applicability is limited
2. Heat pumps:
   - Efficiently transform electricity into heat (300% efficiency)
   - But: leads to peak in electricity consumption in the winter
3. District heating:
   - Efficient use of residual heat (e.g. industry), also creating dependency
   - But: must be centrally planned
4. Green hydrogen:
   - Relatively easy to transport and store
   - But: inefficient use of renewable electricity (35-40% efficiency)

Option 1-3 can become more efficient with seasonal heat storage

An average household needs 5-10 MWh heat stored per season

Different types of heat storage

Types of heat storage



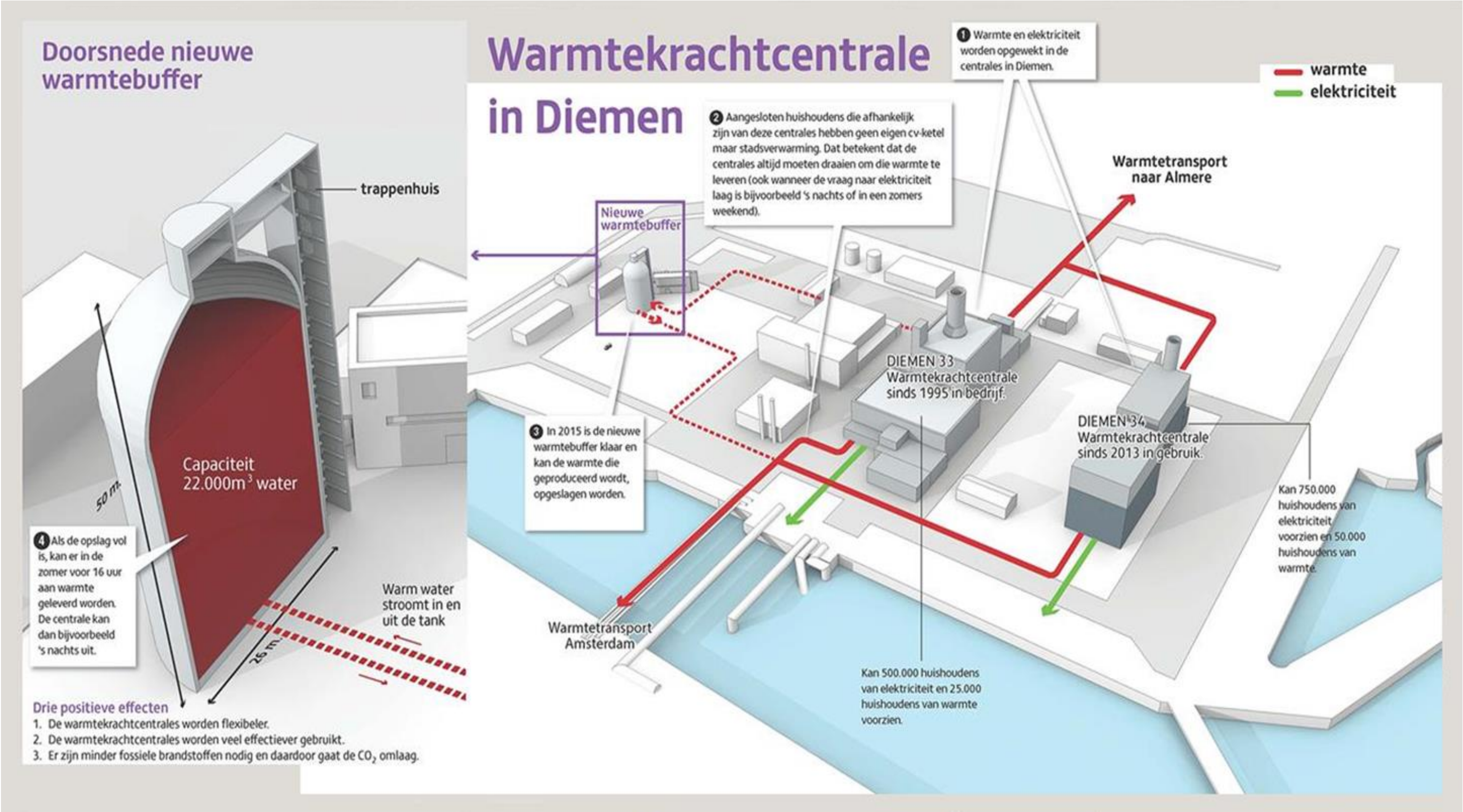
Source: Latent thermal energy storage technologies and applications: A review.pdf

Heat storage

- Sensible thermal energy storage (STES)
  - The most matured and straight-forward method
  - Stores heat by increasing/decreasing the temperature of some substance (e.g. water/rocks)
  - Most commercially available
- Latent thermal energy storage (LTES)
  - Makes use of phase change material (PCM) that can absorb and release heat during phase transitions.
  - Storage capacities are higher compared to STES
  - System requires careful design in order to avoid loss of heat
- Thermochemical energy storage (TCES)
  - TCES relies on thermochemical materials that can react in reversible endothermic/exothermic reactions
  - Allows for even higher storage capacity than LTES

Combined Heat and Power plant Diemen

By generating electricity, heat is used to heat water up to 125 °C. This heated water acts as a buffer to supply warmth for 75.000 houses in Amsterdam, Amstelveen and Almere.



Source: Vattenfall

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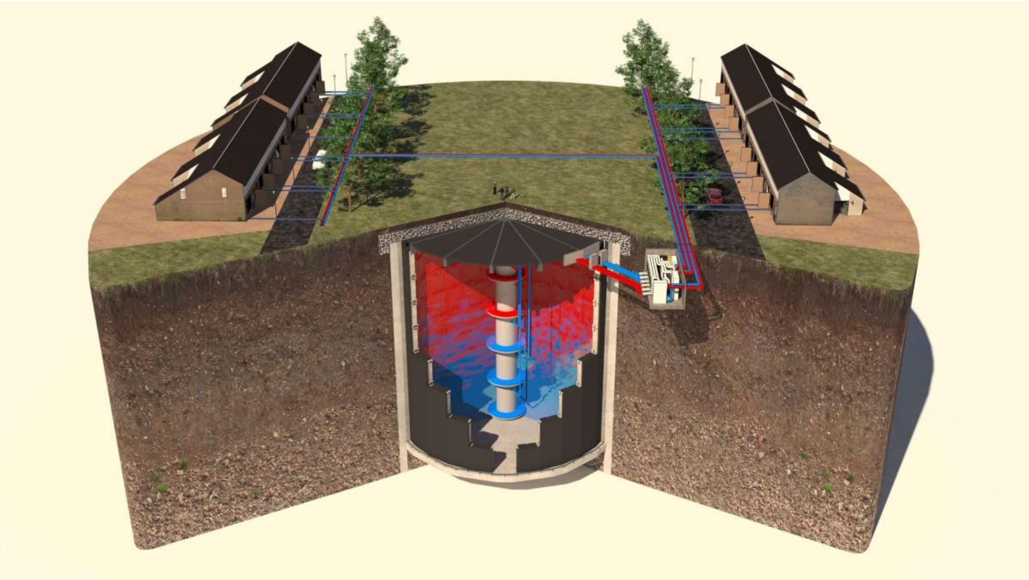
Ecovat

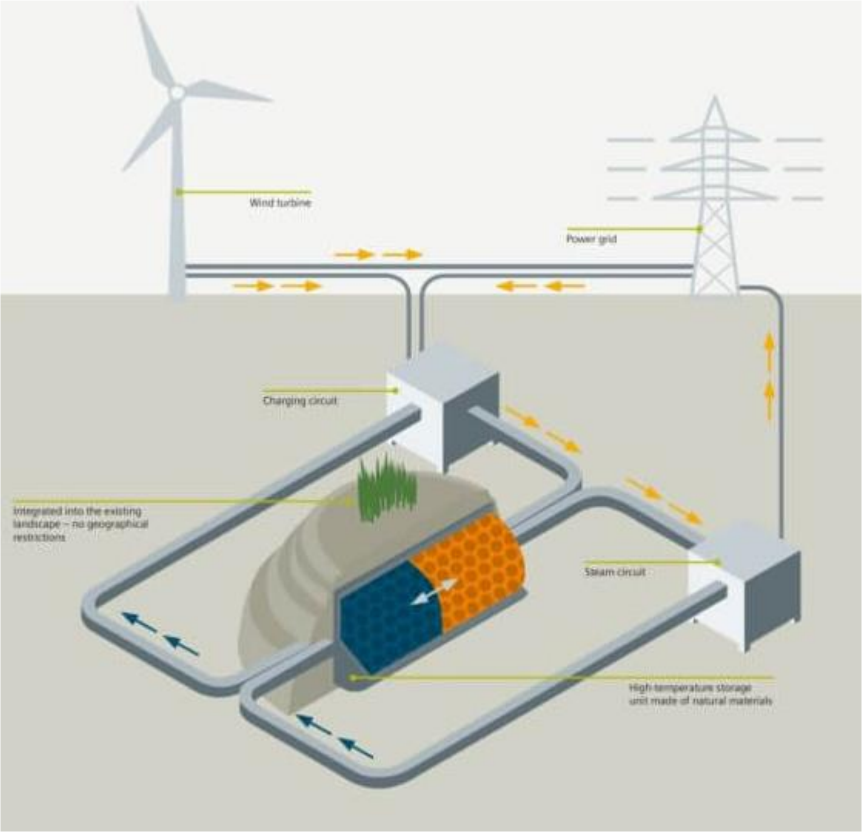
- Large underground water containers
- Longer term heat storage to supply heat to residential customers



Sources: https://www.ecovat.eu/ecovat/thermal-energy-storage/?lang=en

Siemens Gamesa / Hamburg Energie

- Heat exchangers transform electricity into heat
- Recovered via steam turbine
- Stored in vulcanic rock
- Test project (launched 2019) can store 130MWh for 1 week



Sources: https://www.ecovat.eu/ecovat/thermal-energy-storage/?lang=en

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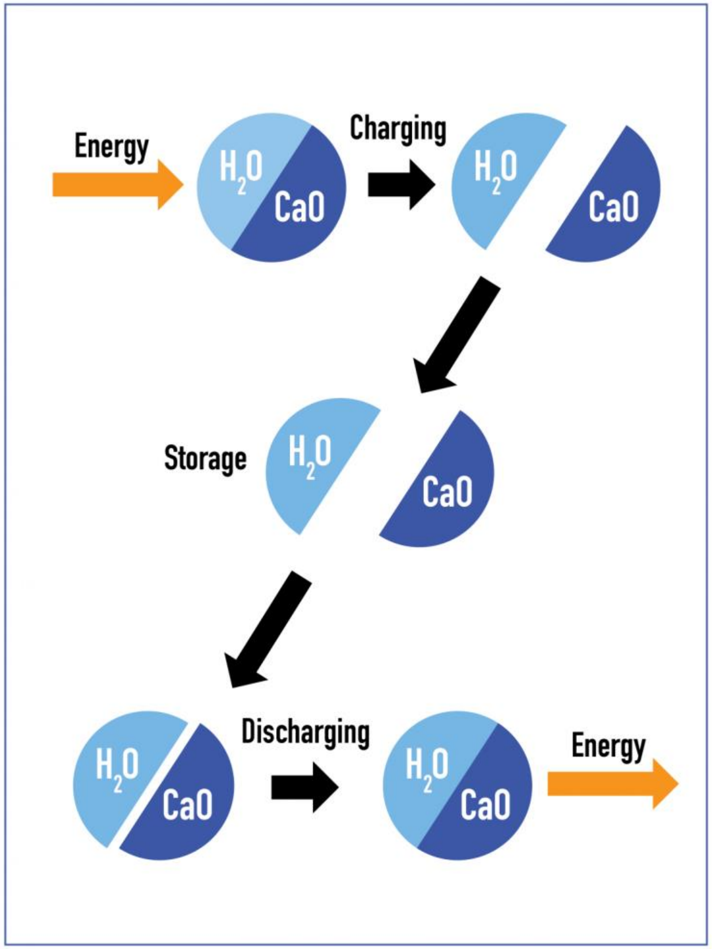
Technology behind SaltX energy storage



- SaltX makes use of a thermochemical storage
  - Salt gets charged using an endothermic process.
  - Salt can get discharged by mixing it with water.
- SaltX patented nanocoated salt makes it possible to repeat this process many times.

Source: https://saltxtechnology.com/technology/

The size of the challenge!

Comparing different energy storage techniques

Total underground gas storage capacity in NL:
13 billion m³ (125 TWh)

Type	Energy Density	Volume required	Surface area required
Heat storage in water	7×10^{-8} TWh/m³	1.8 km³	Half of IJsselmeer
Heat storage in rock	3×10^{-8} TWh/m³	4.5 km³	Province of Brabant covered by 1m

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Economics of heat storage

Current status

- Various technologies, but mostly not mature yet
- Positive: large cost reductions still possible

- Example Ecovat:
    - 15 mln EUR installation cost for 90,000 m3 = 8,000 MWh
    - Sufficient for around 1,000 households
    - 15,000 EUR installation cost per household
    - Based on Ecovat numbers; extra costs not considered

Advantages / disadvantages

- A system based on electricity storage only is not efficient or not even possible (for heat demand)
- A system based on hydrogen is not efficient either: requires far too much renewable generation
- Fewer MWh of renewable electricity are needed when we produce heat directly and are able to store it
- Fewer investments in networks are needed too

	Electricity storage (heat pump)	Water storage (heat pump)	Rock storage (heat pump)	Hydrogen (electrolyser)
Efficiency	++	++	++	--
Transport / networks	--	+	+	++
Space for storage	++	-	--	+
Cost for storage	--	+/-	+/-	++

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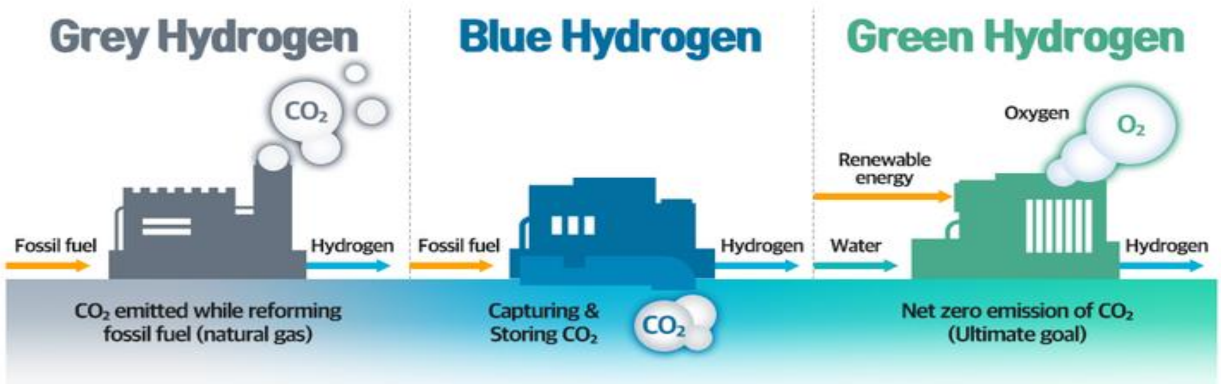
Conclusion

Too much attention for hydrogen

- The EU Hydrogen Strategy (July 2020) indicates hydrogen as a key contributor in the race for decarbonization by 2050.
- Germany is planning to increase its hydrogen capacity to 5 GW by 2030 and 10 GW by 2040. This will be achieved by investing EUR 9 billion (35.1 %) of its recovery spending in renewable hydrogen.
- France will spend EUR 7 billion to reach 6.5 GW of renewable hydrogen by 2030.
- The US and Japan also see hydrogen as a key factor to carbon neutrality by 2050



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Funding heat storages Europe

- The recovery and resilience facility unlocks EUR 672.5 billion to support Member States recovery from the COVID-19 pandemic, of which 37 % (around EUR 250 billion) shall be spend on the green transition
- The Just Transition Fund, worth EUR 17.5 billion, will also finance investments in renewable energy and energy storage technologies.
- Horizon Europe, worth EUR 95.5 billion for 2021-2027, shall among other things support the research in all different types of energy storage technologies.
- The Innovation Fund, launched in 2020, will create financial incentives to decarbonize future projects. Up to EUR 10 billion from the EU Emission Trading System will be invested up to 2030.

What does KYOS do?

- We provide analytical tools and consulting for energy markets, especially flexible assets
- Example applications related to energy storage
  - KyPlant: power plant valuation/optimization
    - Combined heat and power
    - Including optimization of heat storage and (electric/gas) boilers
  - KyStore: natural gas storage valuation/optimization
  - KyBattery: for battery energy storage and pump-hydro
- All our software assumes market trading
  - Electricity and gas: traded commodities
  - Hydrogen: larger hydrogen networks and trading facilities under development. Might become a tradable commodity with similar type of commodity as natural gas
  - Heat: future (local) larger networks with market-based principles?

Thank you

Time for Q&A

We look forward to supporting you in the rapidly changing energy sector!

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