IRENA

International Renewable Energy Agency

Renewable energy technology and infrastructure

19 April 2023

Key enabling technologies: heat pumps and thermal energy storage

Workshop on District Heating and Cooling - Sarajevo

Agenda

Introduction

Heat pumps

Thermal energy storage (TES)

Key takeaways

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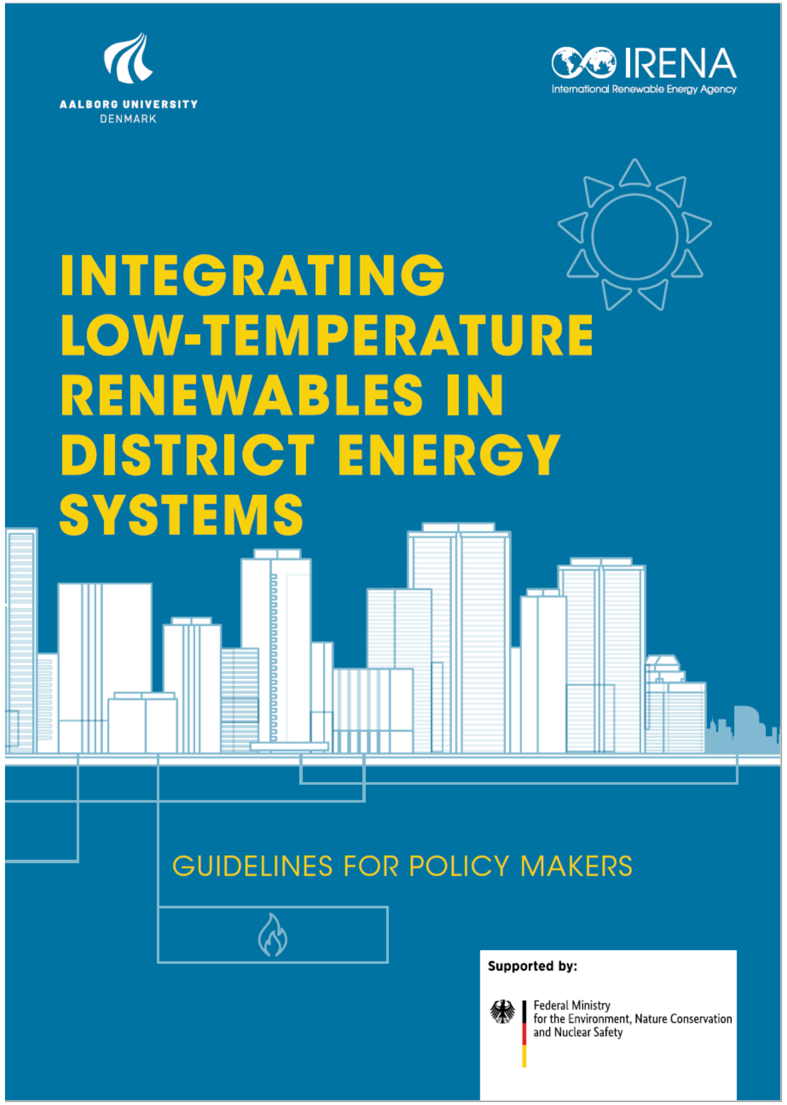
Key enabling technologies

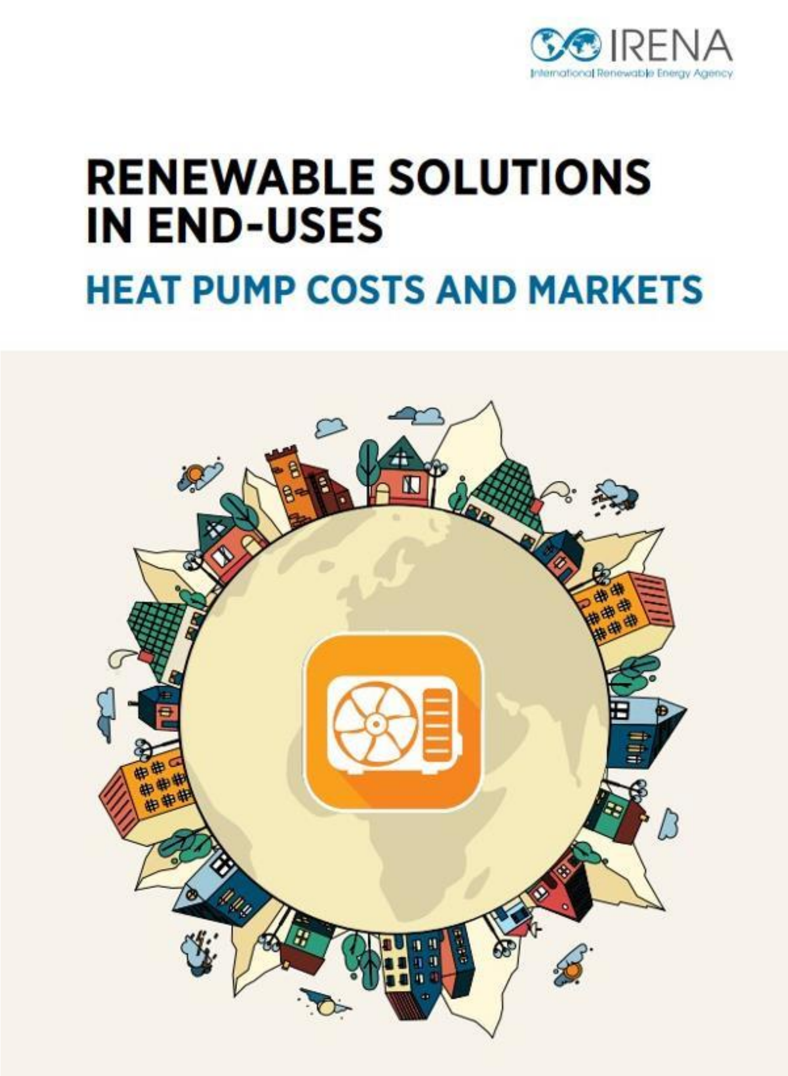
In a future renewable energy system, power-to-heat may shape a significant portion of the heating sector.

- **Electrification** is a straightforward way of using renewable energy and replacing solid fuels in the heating sector
- **Flexible use of power-to-heat** makes it possible to utilise more renewable electricity (for example, during high wind hours) outside of the heating sector only
  - increasing the capacity factor of renewable electricity technologies
  - using more renewables in the heating sector.

- District energy systems can provide this flexibility – key to decarbonization
  - **Heat pumps and thermal storage are key enabling technologies to interconnect electricity and H&C sectors**

IRENA publications





Source: https://irena.org/publications/2021/Jun/World-Energy-Transitions-Outlook

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Heat pump as a key enabling technology

The use of heat pumps in the buildings sector will be crucial to achieving the 1.5°C Scenario pathway, with electrification accounting for around half of the reduction in direct CO2 emissions in the buildings sector by 2050.

Heat pumps in district heating and cooling networks:

- Enable system flexibility
- Contribute to reduced losses in the grid
- Increase heat generation portfolio and flexibility of district systems
- Increase demand-side response potential
- Increase renewable heat generation and enable recovery of heat from low temperature heat sources

Source: IRENA (2022), *Renewable solutions in end-uses: Heat pump costs and markets*, International Renewable Energy Agency, Abu Dhabi.

Heat pump technologies

Heat pumps

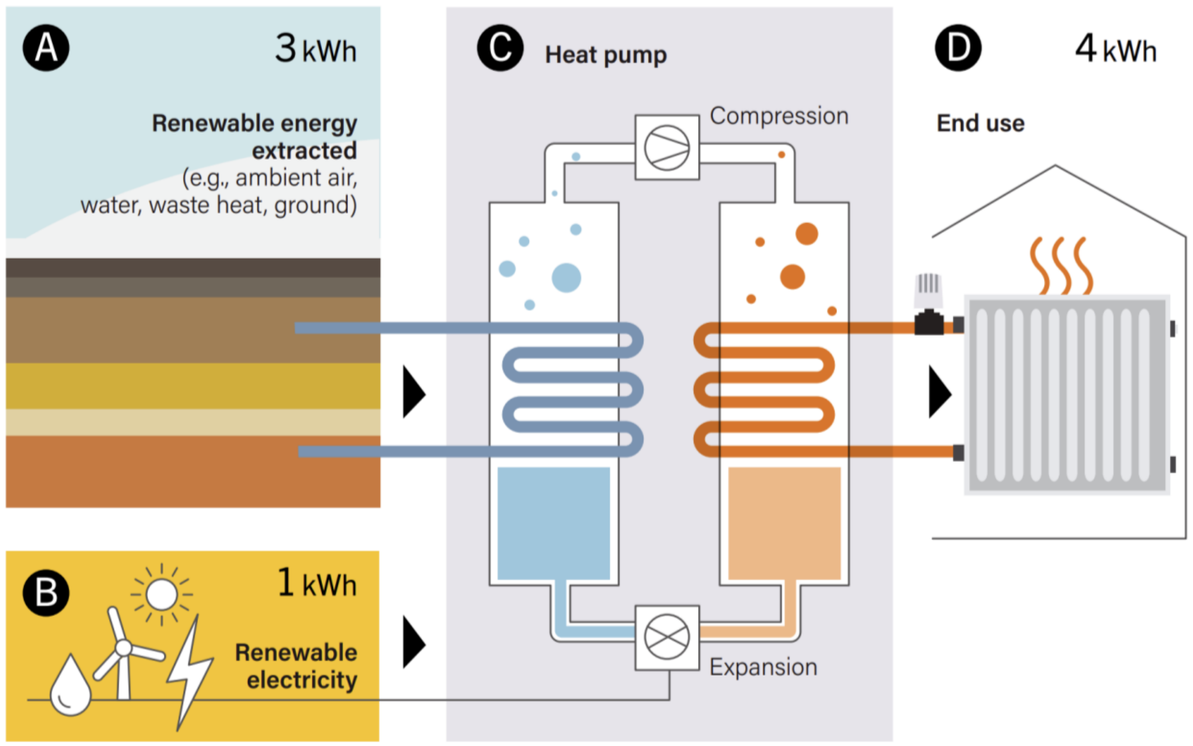
- Able to convert one unit of electricity into 2.5 to 5.5 units of heat (efficiency of 250% to 550%)

Fossil fuel boilers

- Efficiency of 80-85% with new condensing boilers up to 95%

Heat pumps can use electricity or thermal energy as their primary energy source

➢ Focus on electric heat pumps



Note: heat pumps can be integrated centrally in district H&C systems or deployed locally (end-user)

Source: IRENA (2022), *Renewable solutions in end-uses: Heat pump costs and markets*, International Renewable Energy Agency, Abu Dhabi.

Heat pump technologies & applications for space and water heating

- Stand-alone space heating units (hydronic or "forced air" distribution).
- Stand-alone sanitary hot water units.
- Combi-heat pumps providing space heating and sanitary hot water.
- Hybrid systems, combining a heat pump with a direct electric resistance heater, a fossil/biomass boiler or a solar thermal system.
- **Large industrial heat pumps for district heating networks**

Source: Luis Sánchez-García

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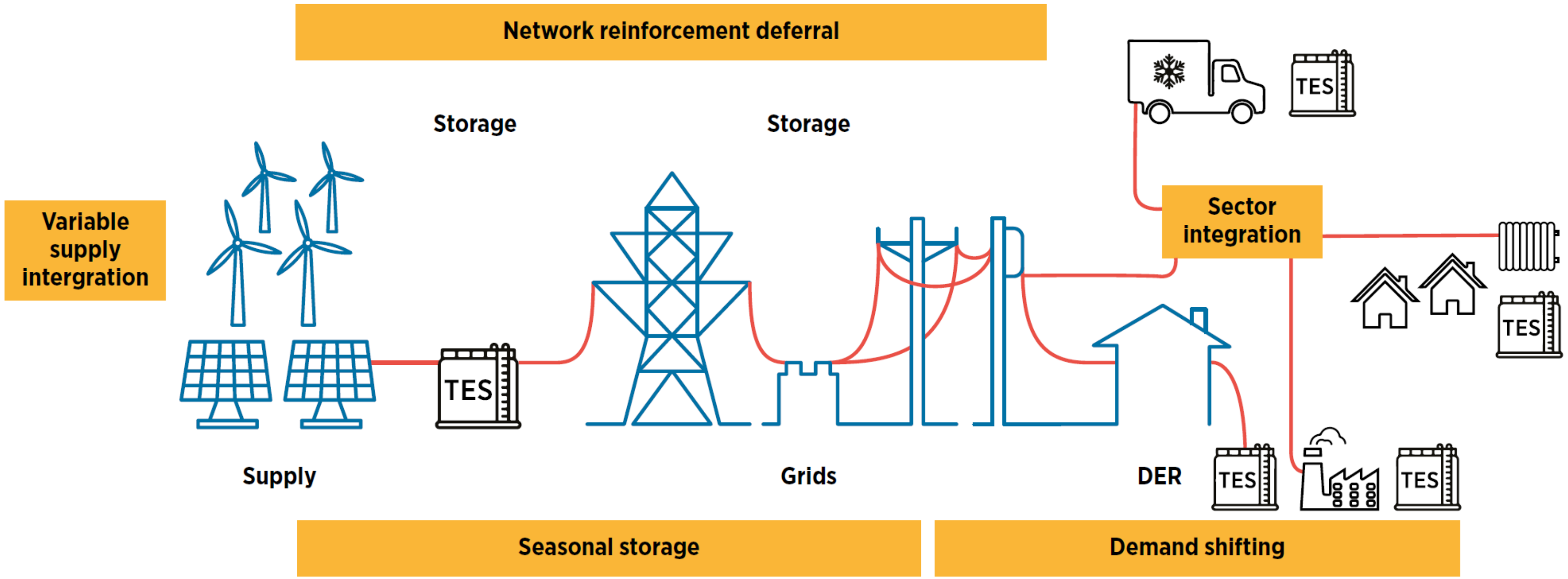
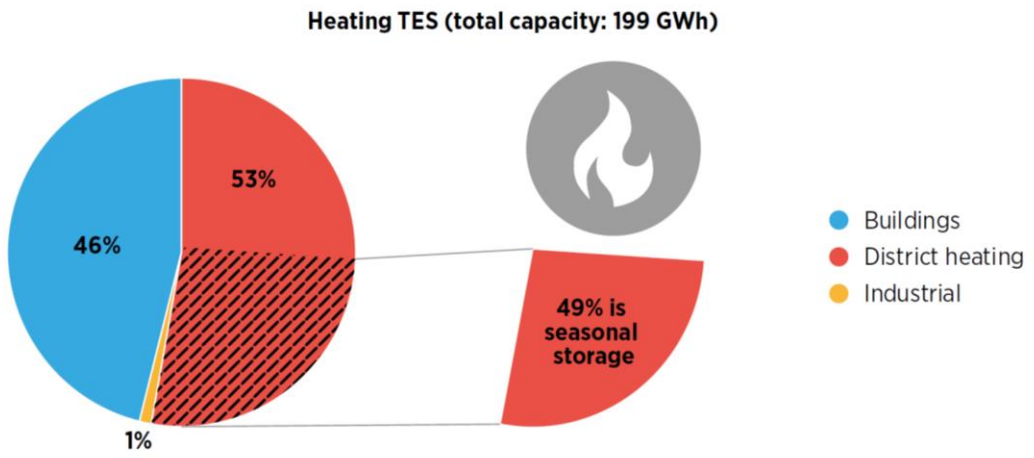
Thermal energy storage as a key enabling technology

Thermal energy storage as an important role in decarbonizing heating and cooling.

Thermal energy storage (TES):

- Enables system flexibility
- Addresses seasonal variability in supply and demand
- Facilitates integration of different sectors
- Demand-side response potential

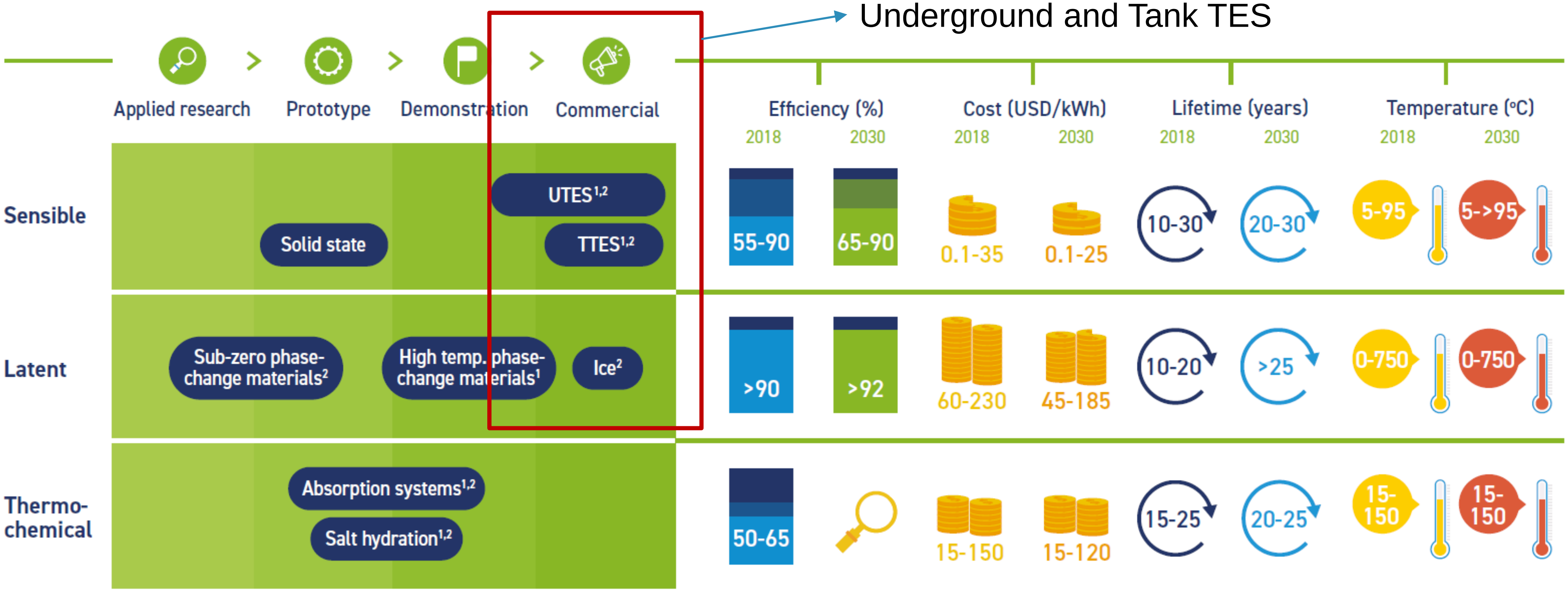




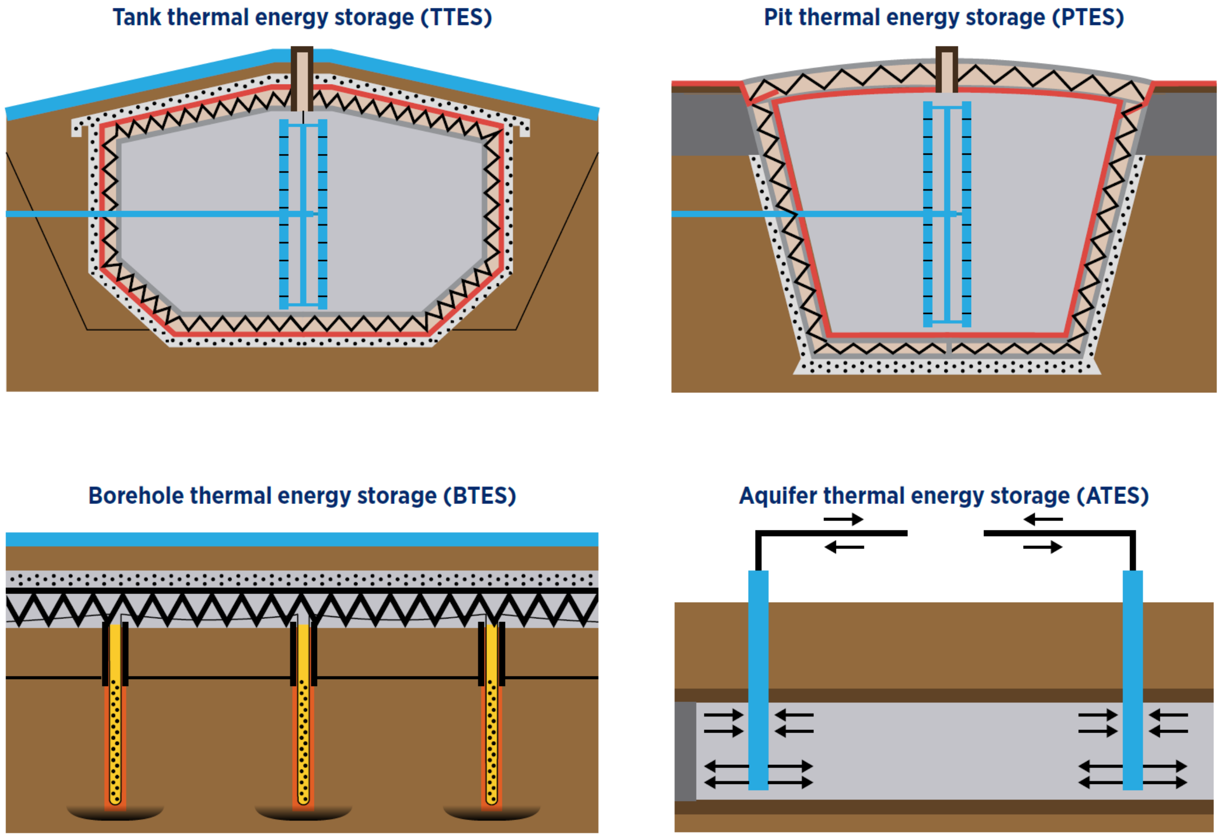
TES in District Heating and cooling

Storage capacity linked to district heating and cooling networks serves to decouple their generation requirements from consumption.

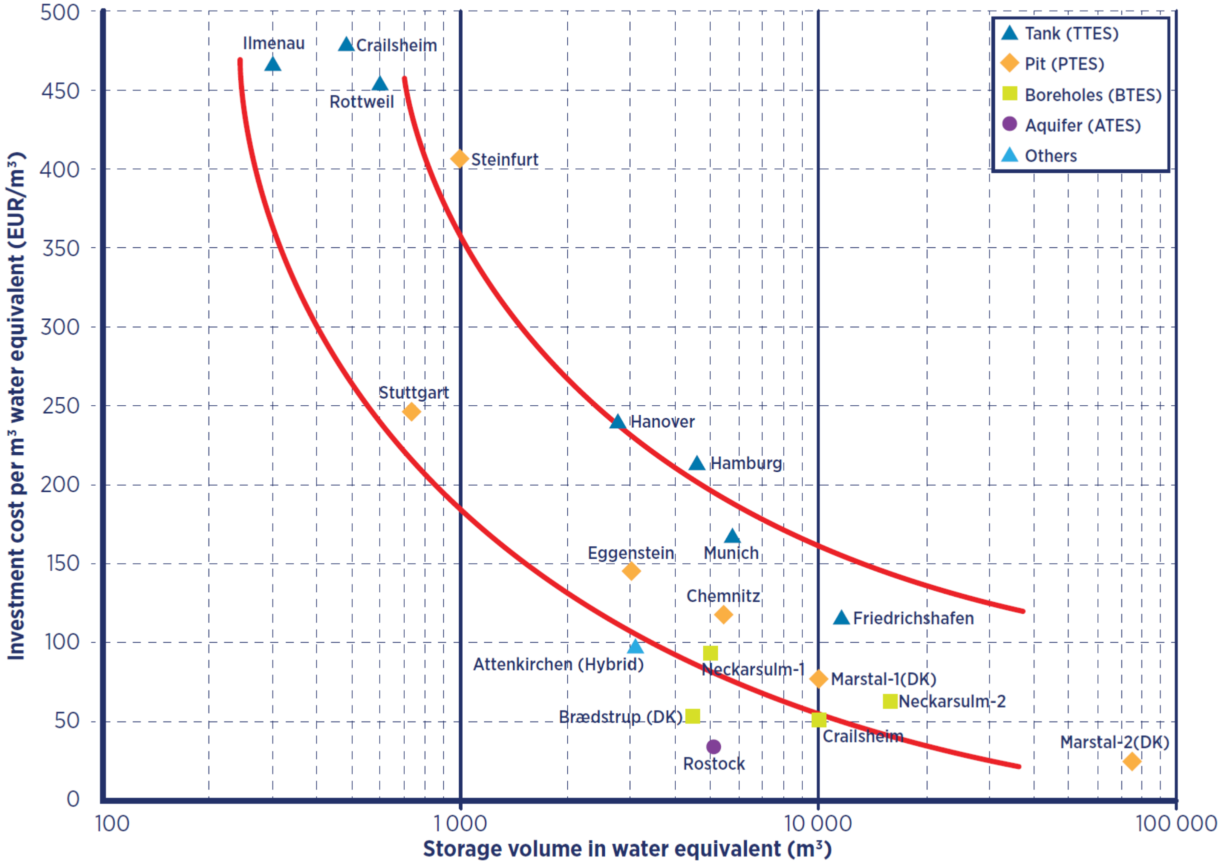
Underground and Tank TES



Large scale seasonal storage

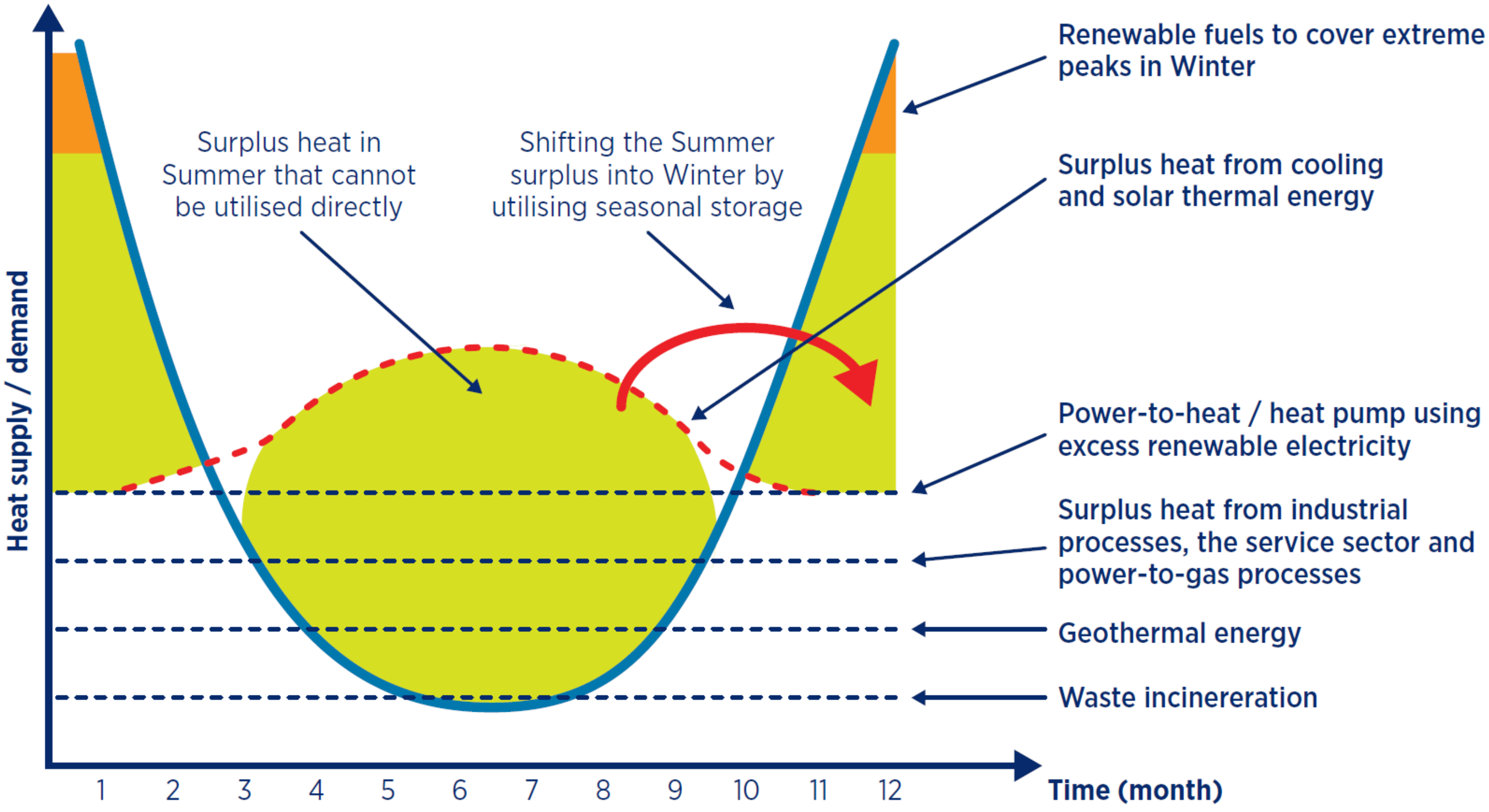


Source: Schmidt and Miedaner (2012)



Source: Schmidt and Miedaner (2012)

The importance of seasonal storage



Source: AIT (2020) (Schmidt, Geyer and Lucas, 2020)

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Enabling technology	Advantages	Potentials	Role in the energy system
Heat pump (large scale)	• Capacity to use renewable energy and waste heat from buildings	Everywhere	• Can act as the conversion technology between electricity and heating sector • Can upgrade low-temperature heat sources to higher temperature levels or to produce cold
Thermal storage (large scale)	• Costs less in terms of investment per unit of storage capacity than electricity storage • Economies of scale	Everywhere where space is available and geological conditions are favorable	• Integration of variable renewable energy production


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Thank you!
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