Aalto University
School of Engineering

Seasonal thermal energy storage in Finland

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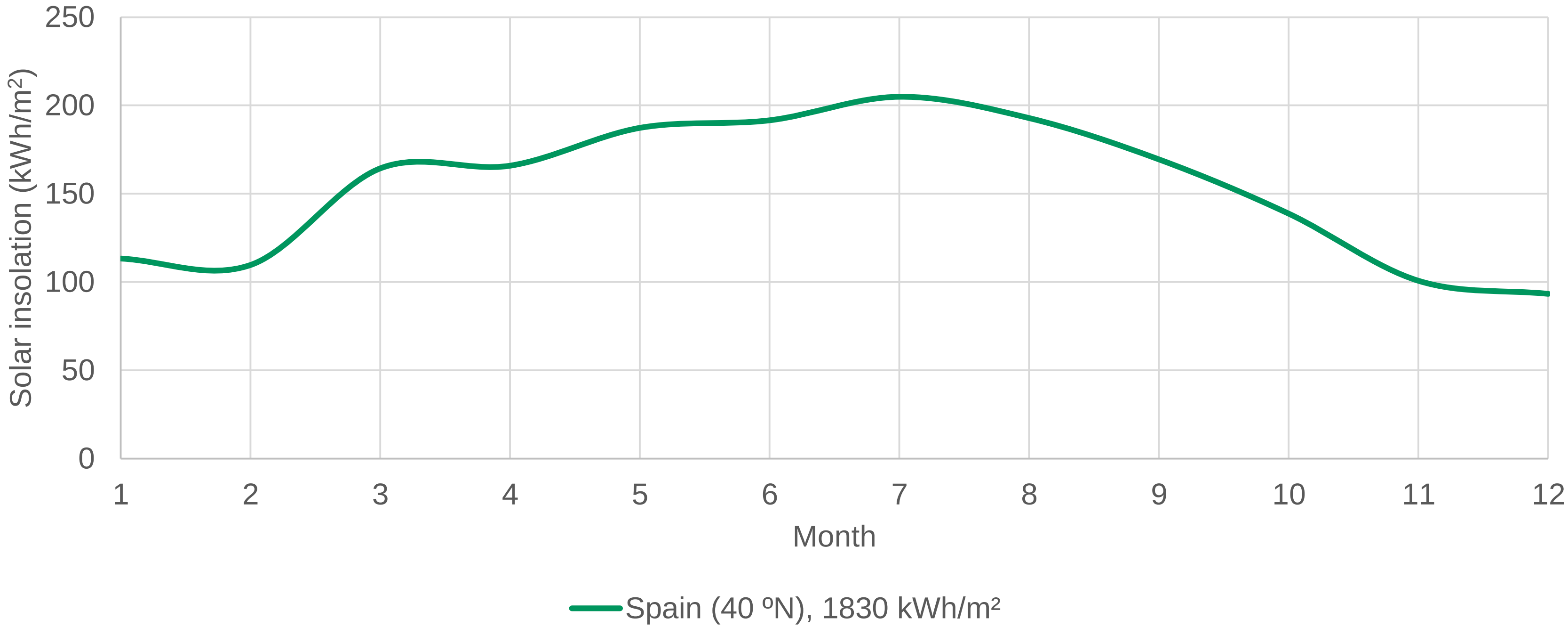
- **Why do we need seasonal energy storage?**
- **How do we store energy for long periods?**
- **What is the future of seasonal energy storage?**

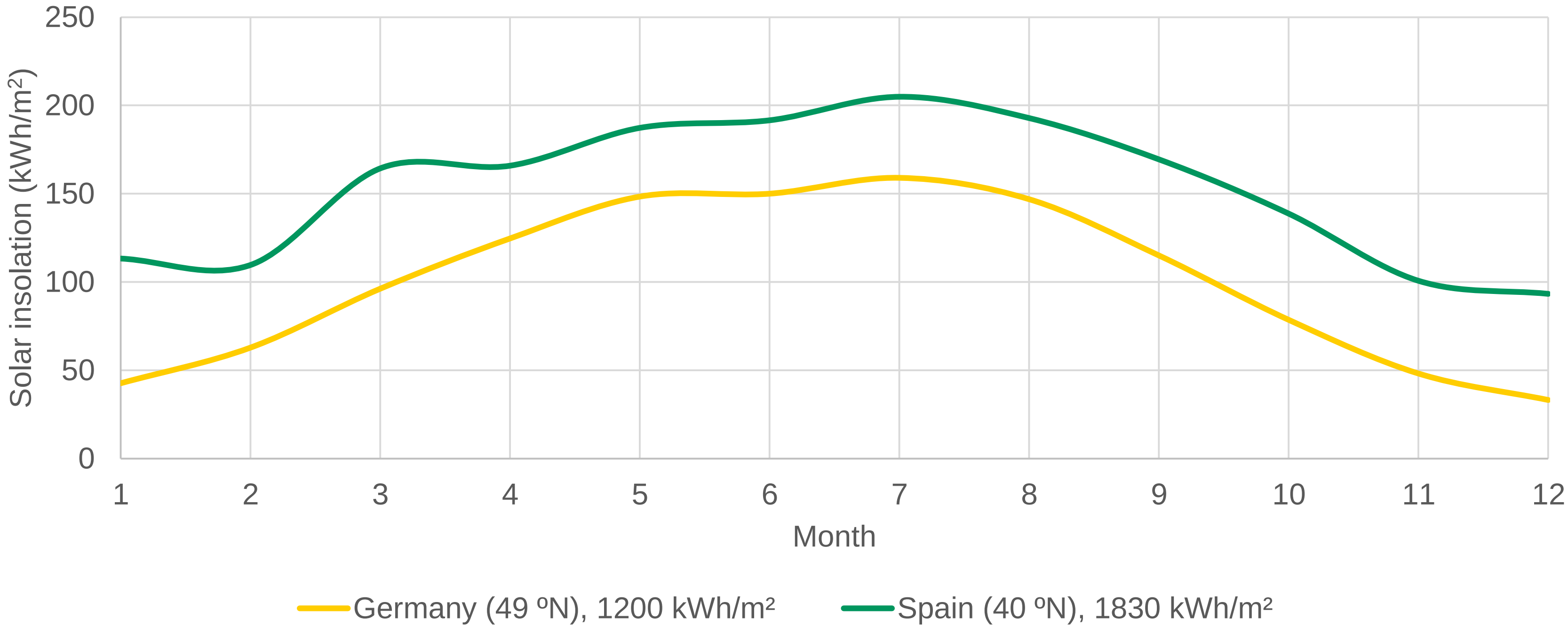
Questions welcome!

Why?

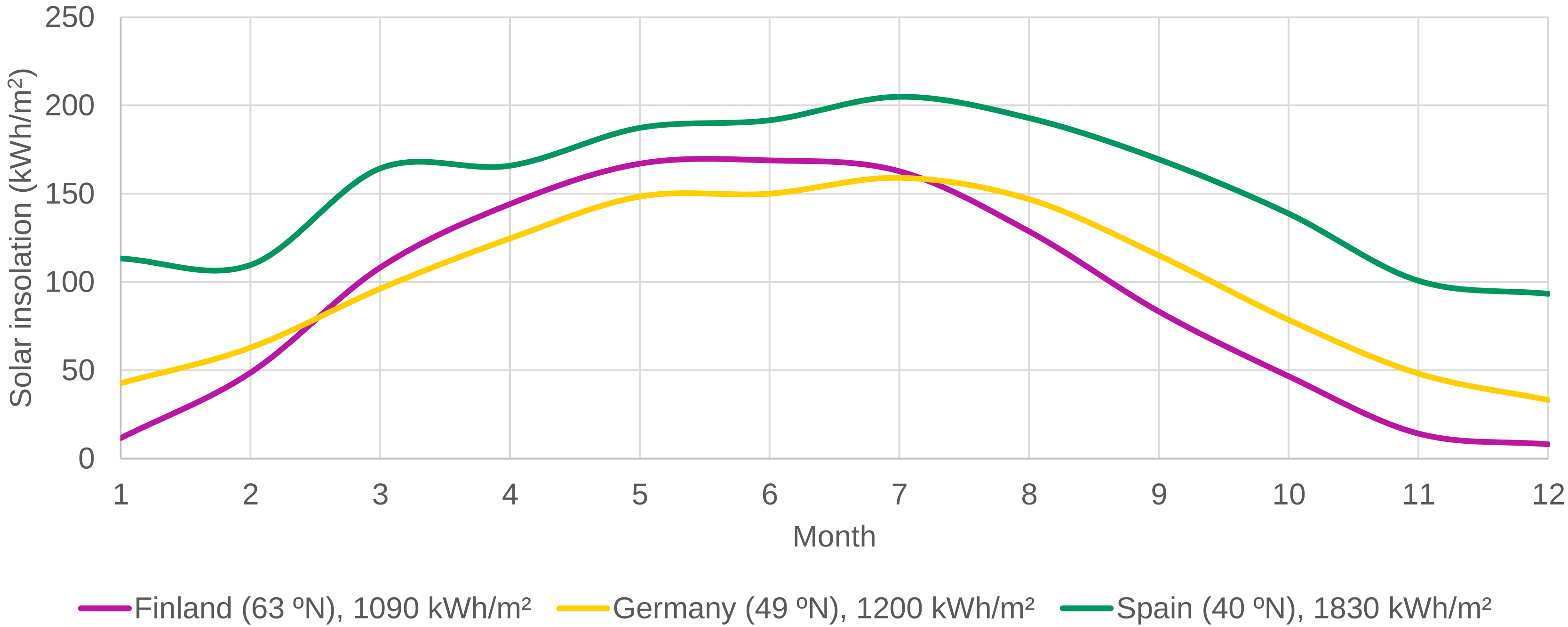
Monthly solar radiation



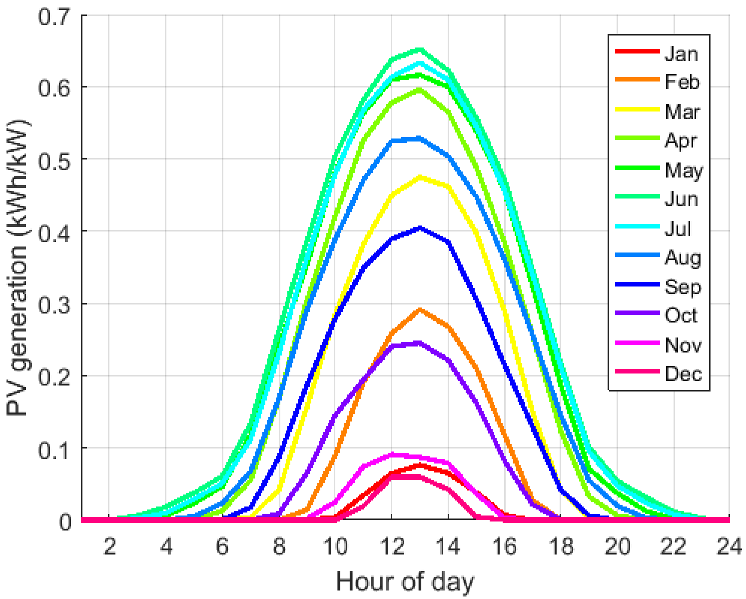
Monthly solar radiation



Monthly solar radiation

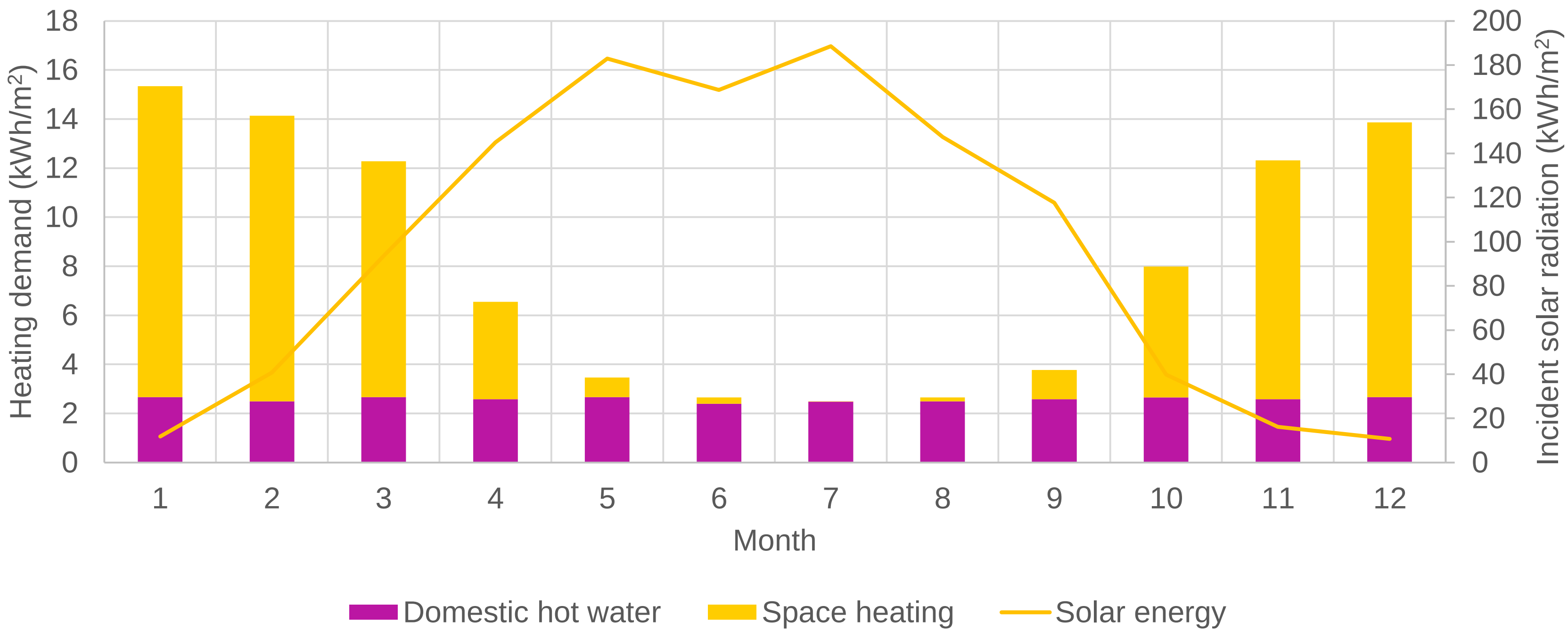


Hourly solar insolation in Finland

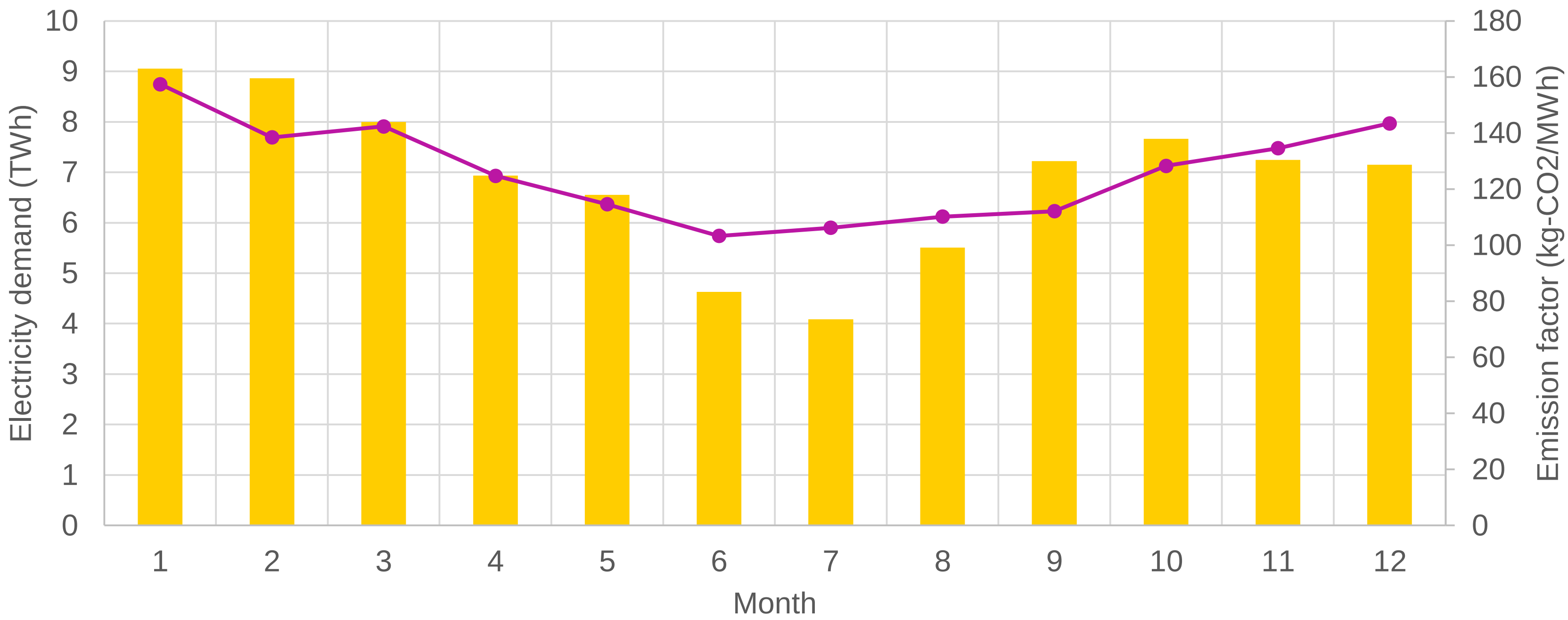


- **Summer**
  - High power
  - Long duration
- **Winter**
  - Low power
  - Short duration

Monthly heating need and solar potential for a house

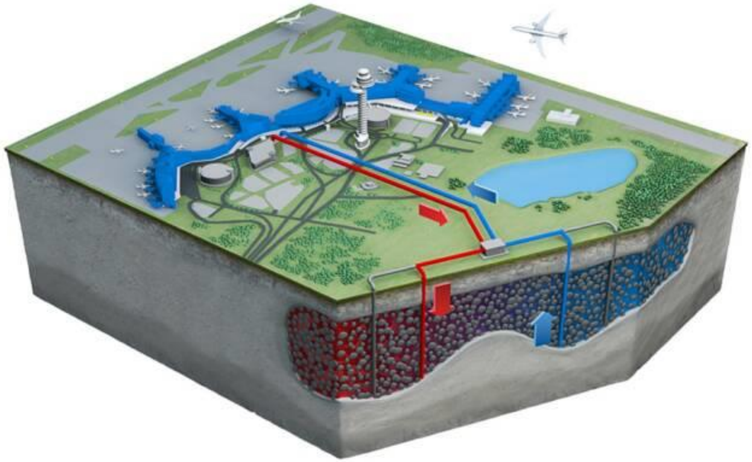


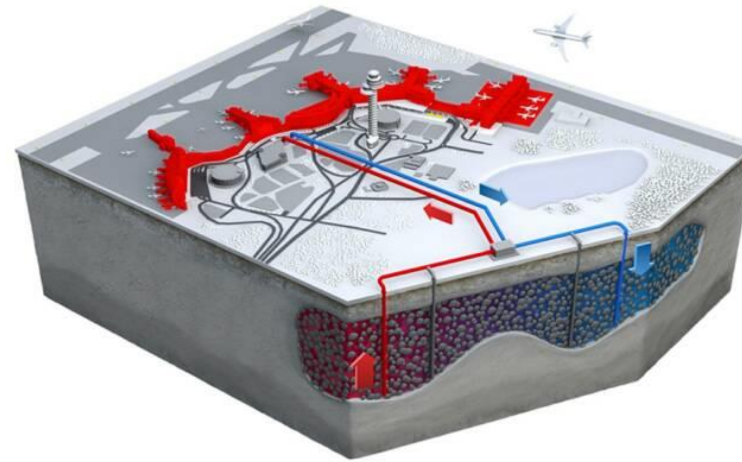
Finnish electricity consumption and CO_2 emissions



How?

Aquifer Thermal Energy Storage (ATES)





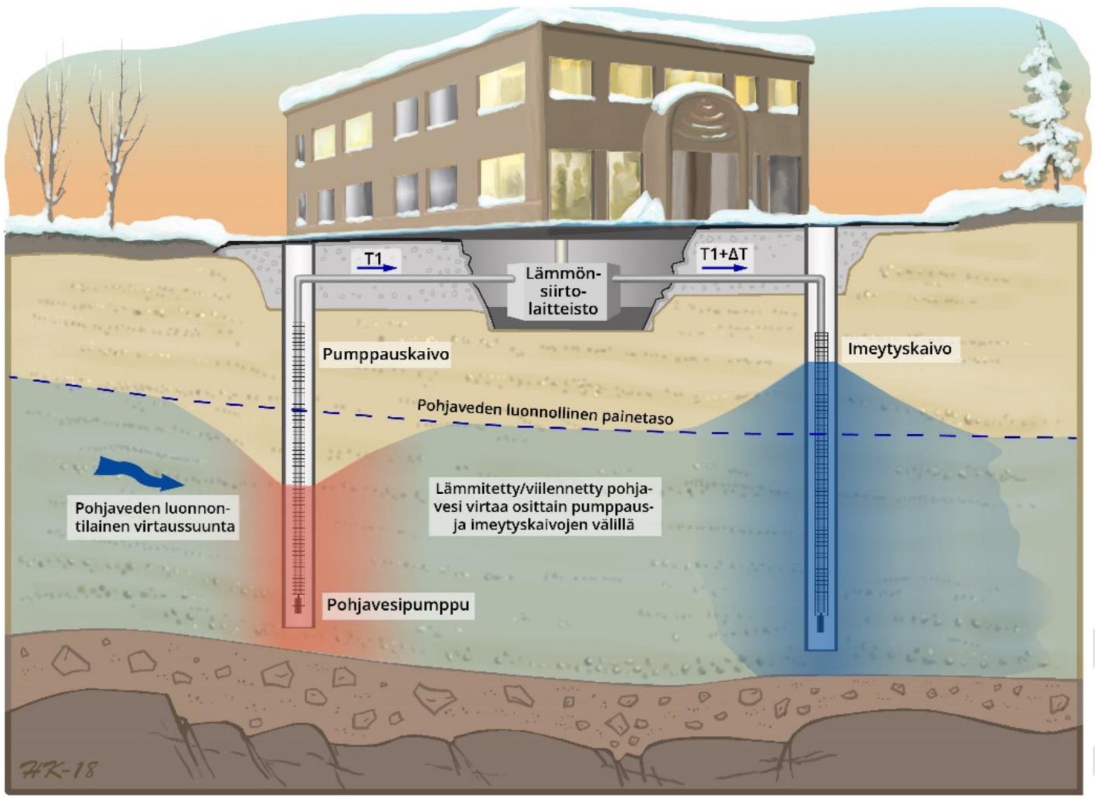
Waste heat from cooling stored in underground water.
Used as a heat pump energy source (2 – 20 ºC).

Examples: Arlanda Airport, Stockholm
Nivos district heat, Pukkila (Oleg Todorov, M.Sc. Thesis)
Askonalue, Lahti

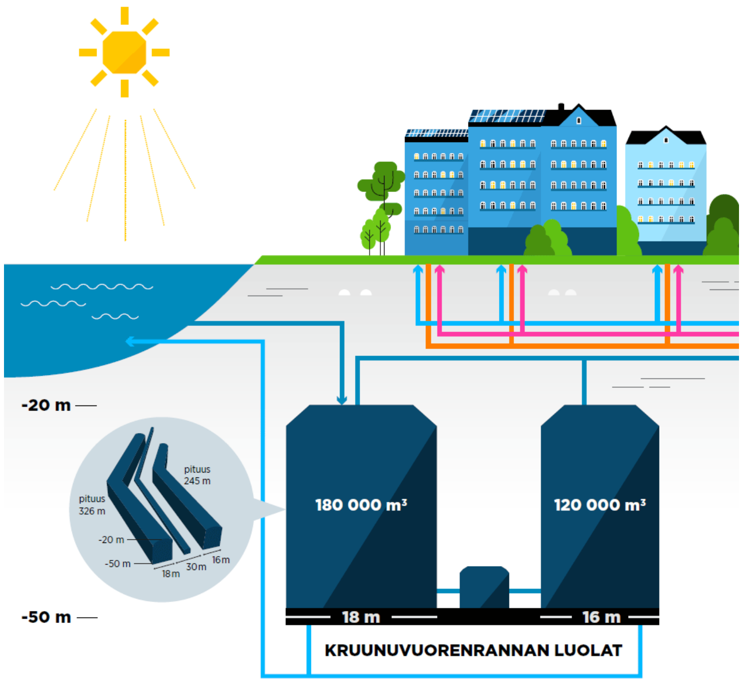
ATES in Askonalue, Lahti, Renor Oy

- 0.3 MW power
- 160 MWh cooling
- 1900 MWh heating

- 2 wells
- 43 m deep



Cavern Thermal Energy Storage (CTES)



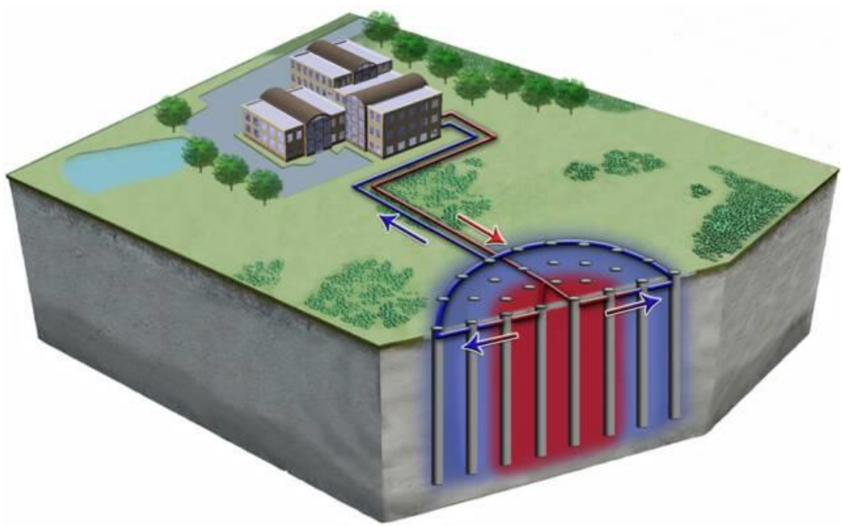
Helen Oy, Kruunuvuorenranta

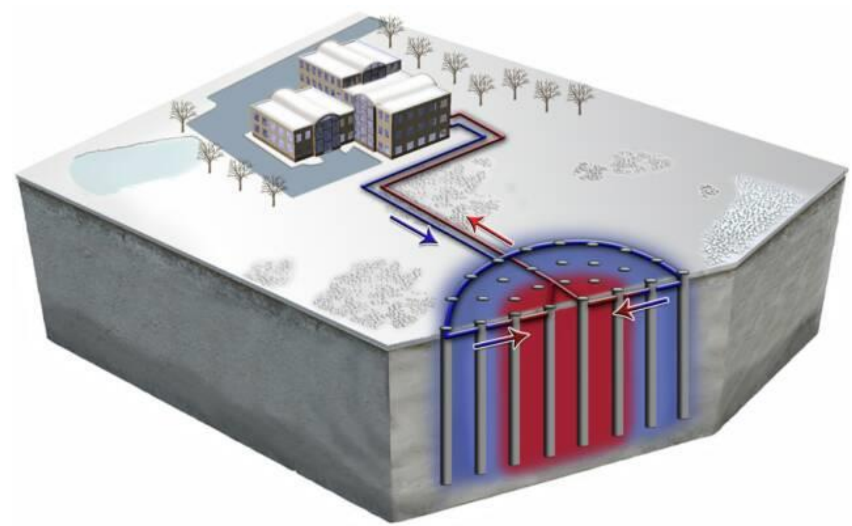
Seawater storage

- Passive solar heat
- Heat source for heat pumps

- 300 000 m³, old oil storages
- 2 – 24 °C
- 6 – 7 GWh (Helen total 6600 GWh)
- 3 MW

Borehole Thermal Energy Storage (BTES)





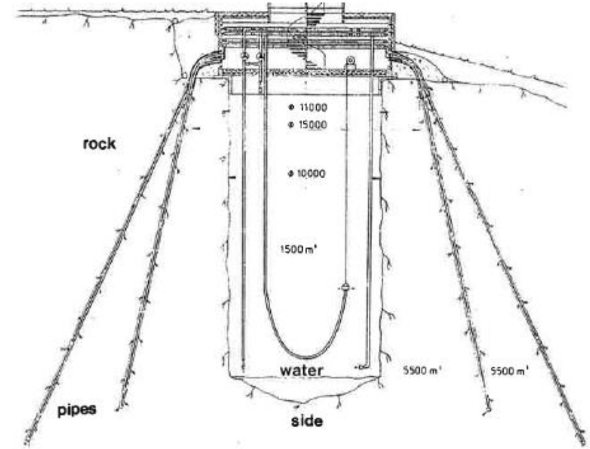
Examples: Okotoks (CAN), Crailsheim (DE), Anneberg (SE), Braedstrup (DK), Toholampi (FI)

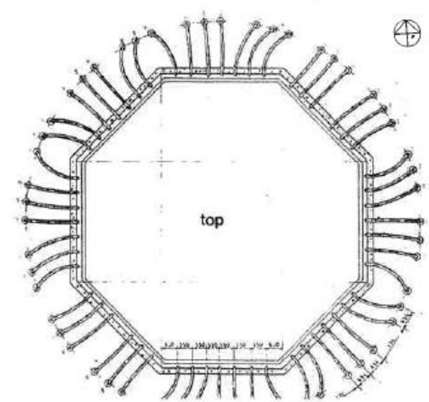
Kerava solar community Finland

Ground-embedded thermal storage

- 1500 m^3 water tank
- 11 000 m^3 surrounding rock
- 2 rings of boreholes
- In operation 1983 – 1985

- Tank undersized
- Replaced by district heating
  - DH company did not allow keeping the solar collectors



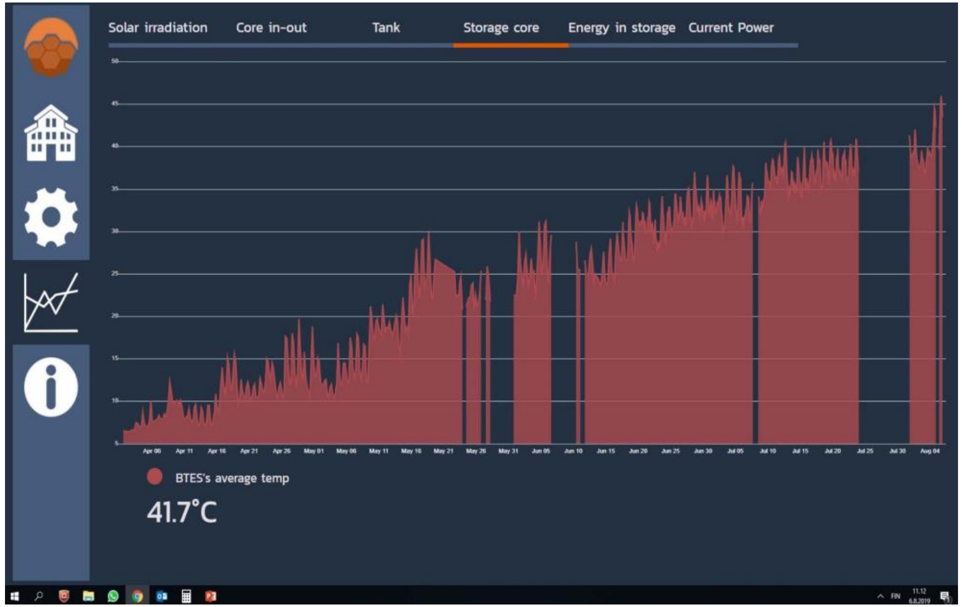


Finn Spring process heat storage, Heliostorage

- **61 boreholes in Toholampi**
- **~50 m depth**

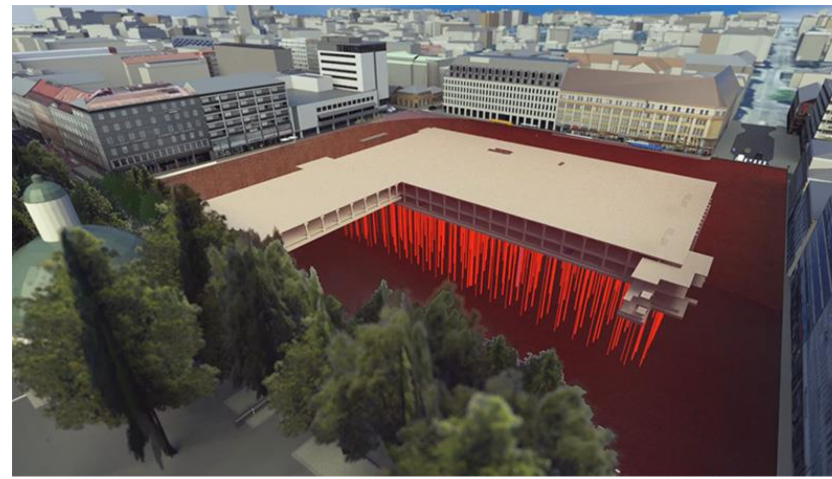
- **Bottling plant process heat stored in summer**
  - Some solar heat as well
  - Used to heat a swimming pool and offices in winter
- **Targeting 60 – 70 ºC**

6 to 40 ºC in 4 months



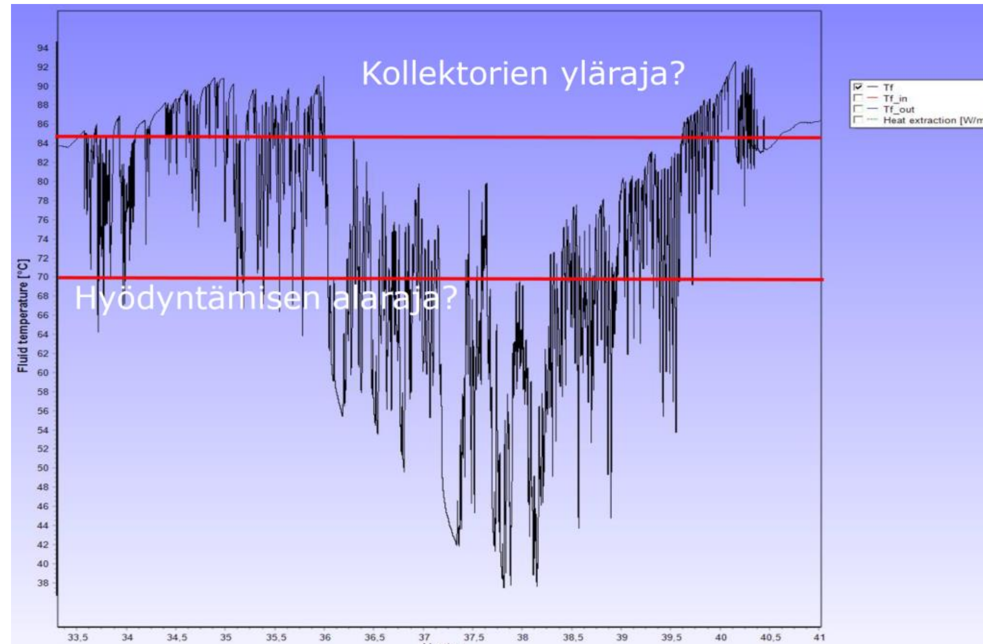
Energy piles in Turku Toriparkki, nollaE

- **Support piles double as heat exchangers**
  - 50 m depth
- **Store passive solar heat from the market square into wet clay**
  - Used to heat parking hall and keep the market square free of snow
- **11.2 GWh storage capacity**
- **6.6 MW maximum power**



Waste incineration facility in Korvenmäki, Lounavoima

- **Waste heat integrated to district heating with BTES**
- **Temperature 70 – 80 ºC**
- **Initial plan**
  - 530 boreholes
  - 150 m
- **Current plan**
  - 6 boreholes
  - 2000 – 3000 m



Pit Thermal Energy Storage (PTES)

Water-filled pit with an insulated floating cover.
For sandy and even ground.
High temperature potential (up to 90 ºC).
No examples in Finland (yet).

Vojens: 200 000 m^3

Examples: Marstal & Vojens (DK), Graz (AT)

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The future of seasonal storage?

The future of seasonal storage

- **Solar community with independent heating system**
  - High solar fraction
- **Seasonal storage in the district heating grid**
  - Energy source?
    - *Solar? Waste heat?*
  - Many storages located in different districts?
  - Usage type?
    - *Main heating*
      - Temperature level?
        - Heat pumps?
    - *Pre-heating*
    - *Peak shaving*