
Put all your
energy in to sand
Invest in 100% clean energy
POLAR NIGHT ENERGY

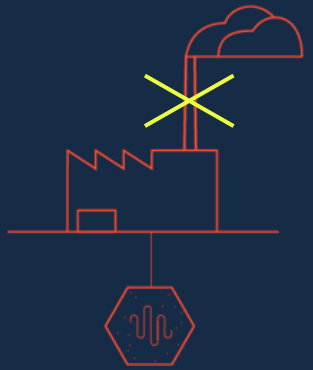
Vision: Cut Emissions, Revolutionise Energy Markets

Patented solution: store wind and solar power as heat in sand

Electricity for users, excess energy into heat, used later during the year

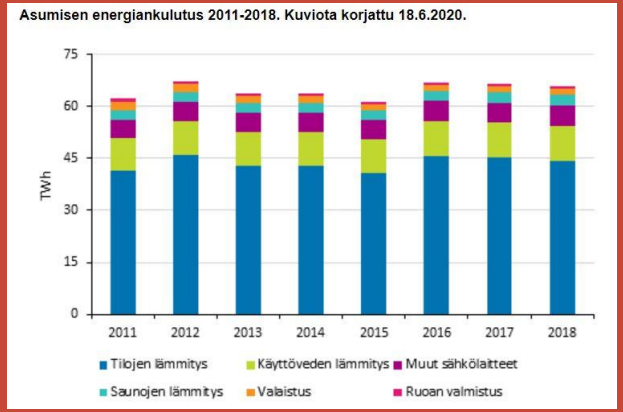
Affordable, safe, scalable, and reliable around the world

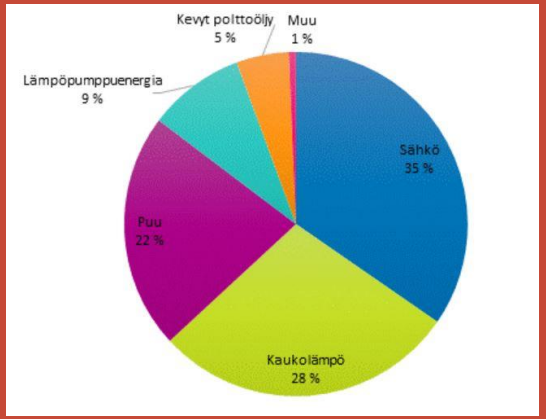
Unit sizes: home, industrial complex, housing district



Buildings: About one Quarter of the Emissions

- Emission reductions in district heating relies on the assumption that burning biomass is considered carbon neutral
- True CO2 reductions require technologies without combustion
- Combining electricity and heating sectors with solar and wind offers a cost-effective way to achieve this
- District scale heating solutions have a huge potential





Lähde: Asumisen energiankulutus 2018, Tilastokeskus

Pilot with the City of Tampere

- Hiedanranta Circular Business Ecosystem
- Part of the city's vision of becoming an international circular business hub
- Final feasibility study of the entire solution in use
- Ready: August 2020
- Storage: 3 MWh
- Input: 30 kW, Connected to solar panels
- Output 50 kW, Integrated to the city district heating system

District scale solution at Hiedanranta

Scope

- Heat demand: 70 GWh/year
- Electricity demand: 50 GWh/year
- Peak heating power: 24 MW
- Peak electric power: 20 MW

- 25 000 habitants and 10 000 jobs
- 1 500 000 m^2 of floor space
- Limited construction space

Solution

- Seasonal heat storage, dimensions:

Capacity: 3.5 GWh
Sand volume: 32 000 m3
Efficiency: 88 to 95 %

- Electricity from the Spot-market
- Connection to the 110 kV distribution grid
- Heat distribution via local grid

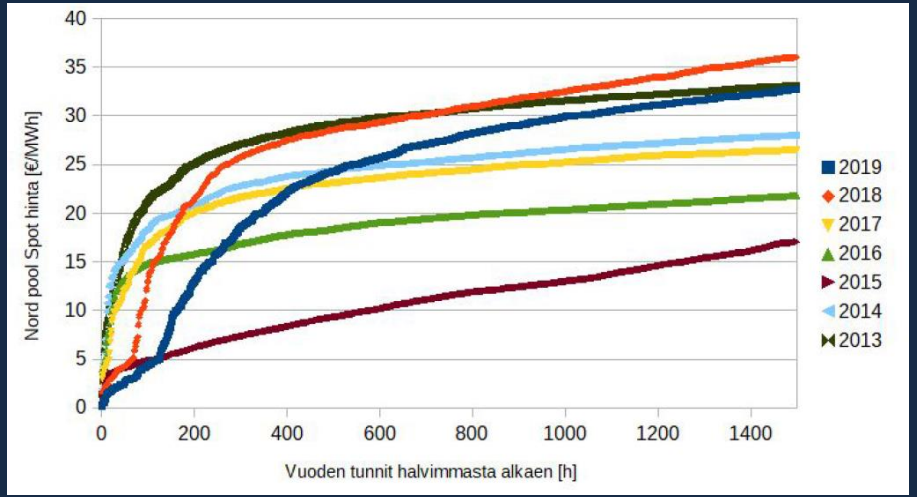
Benefits

- Heat cost: 37 €/MWh + electricity tax (5 €/MWh or 22.5 €/MWh)
- Emissions reduced by 90 to 95 %
- Low maintenance costs

- Local heat source: protected from increases in energy price
- Market opportunities in auxiliary services for the electric grid

Large Energy Storages in Hiedanranta

- District scale operation requires electricity grid connection
- The lowest prices in the Spot-market are often the cleanest (high wind fraction)
- High input power enables low transfer prices for electricity
- High input power also opens possibilities to act in the frequency reserve and balancing capacity markets

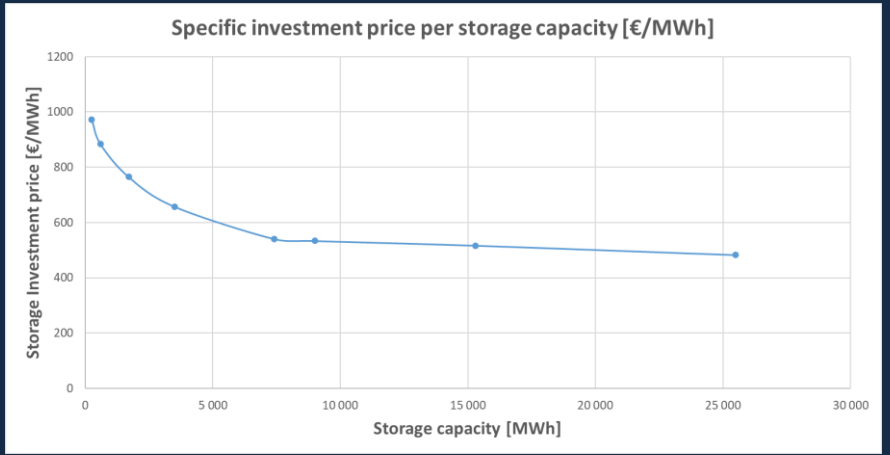


Market prices sorted from lowest to highest price: the first 1000 hours of the year

Large Energy Storages in Hiedanranta: Economy

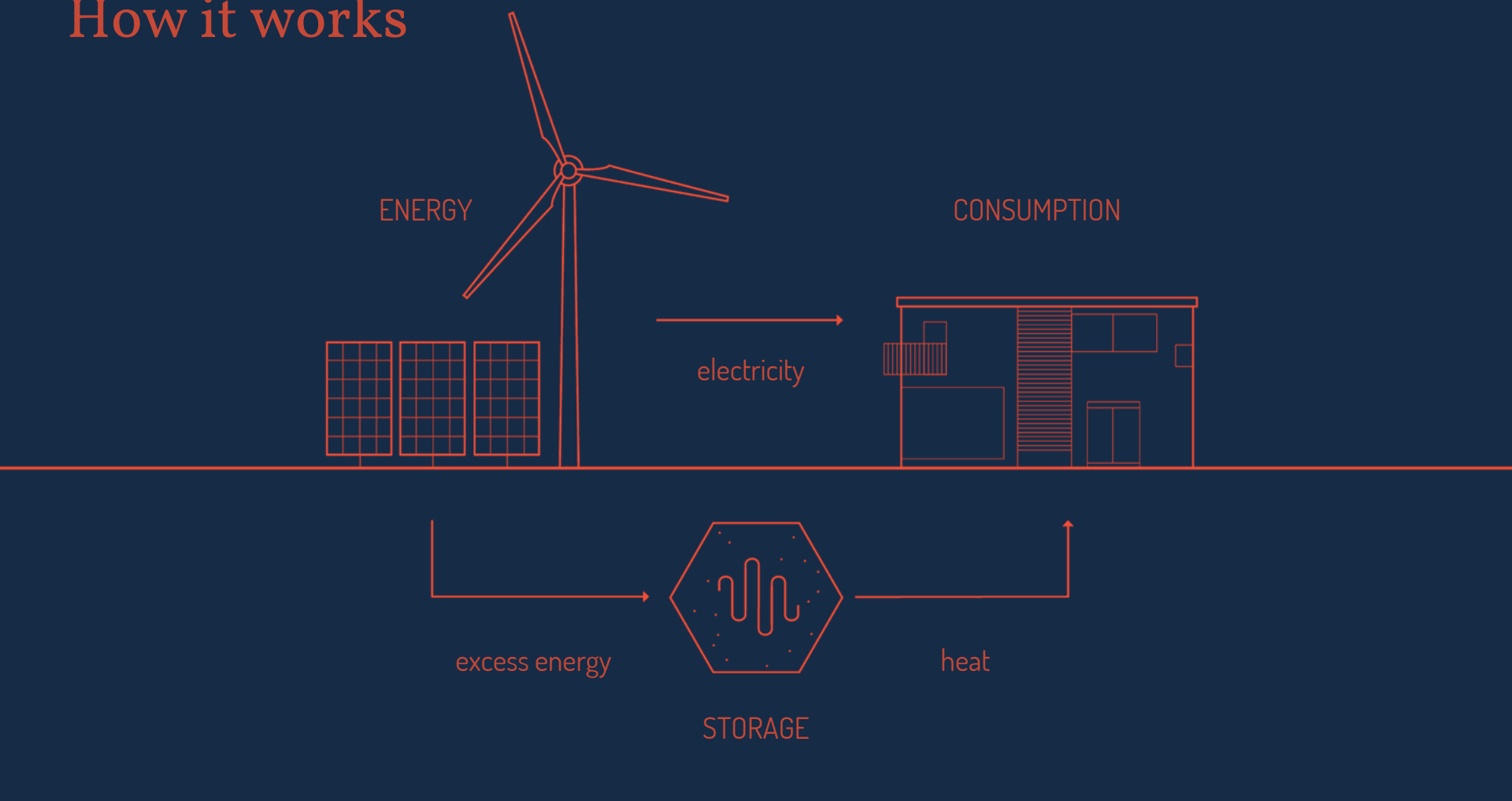
The investments for the storage are relatively low – it enables flexible connection of the electricity and heat sectors:

Average electricity price:	21 €/MWh
Electricity transfer:	7 €/MWh
Investment: electricity connection	0.6 €/MWh
Investment: heating network	3.1 €/MWh
Investment: heat storage	6.1 €/MWh
Pre-tax sum:	37.1 €/MWh
Electricity tax, industry:	5 €/MWh
Electricity tax, general:	22.5 €/MWh
Total heat price:	37.1 to 59.6 €/MWh



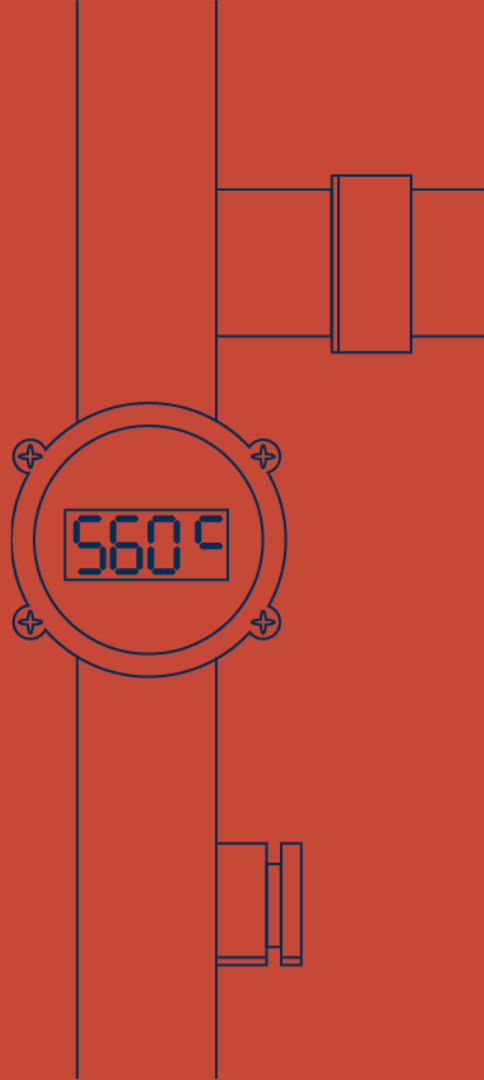
Storage specific investment price reduces and then settles to relatively constant level

How it works


ENERGY
CONSUMPTION
electricity
excess energy
heat
STORAGE

Better Profits by Better Energy

- Stable product prices
  - Fixed energy prices for 30 years and beyond
- Optimal process temperatures
  - High storage temperature allows flexible operation
- Sand as storage medium
  - Clean, non-toxic and environmentally friendly
  - Allows high storage temperatures
  - Optimal for seasonal heat storages
  - Low thermal conductivity and low heat losses
- Minimal land usage
  - Allows construction on-top in high valued city spaces



Hot sand. Do you dig it?

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