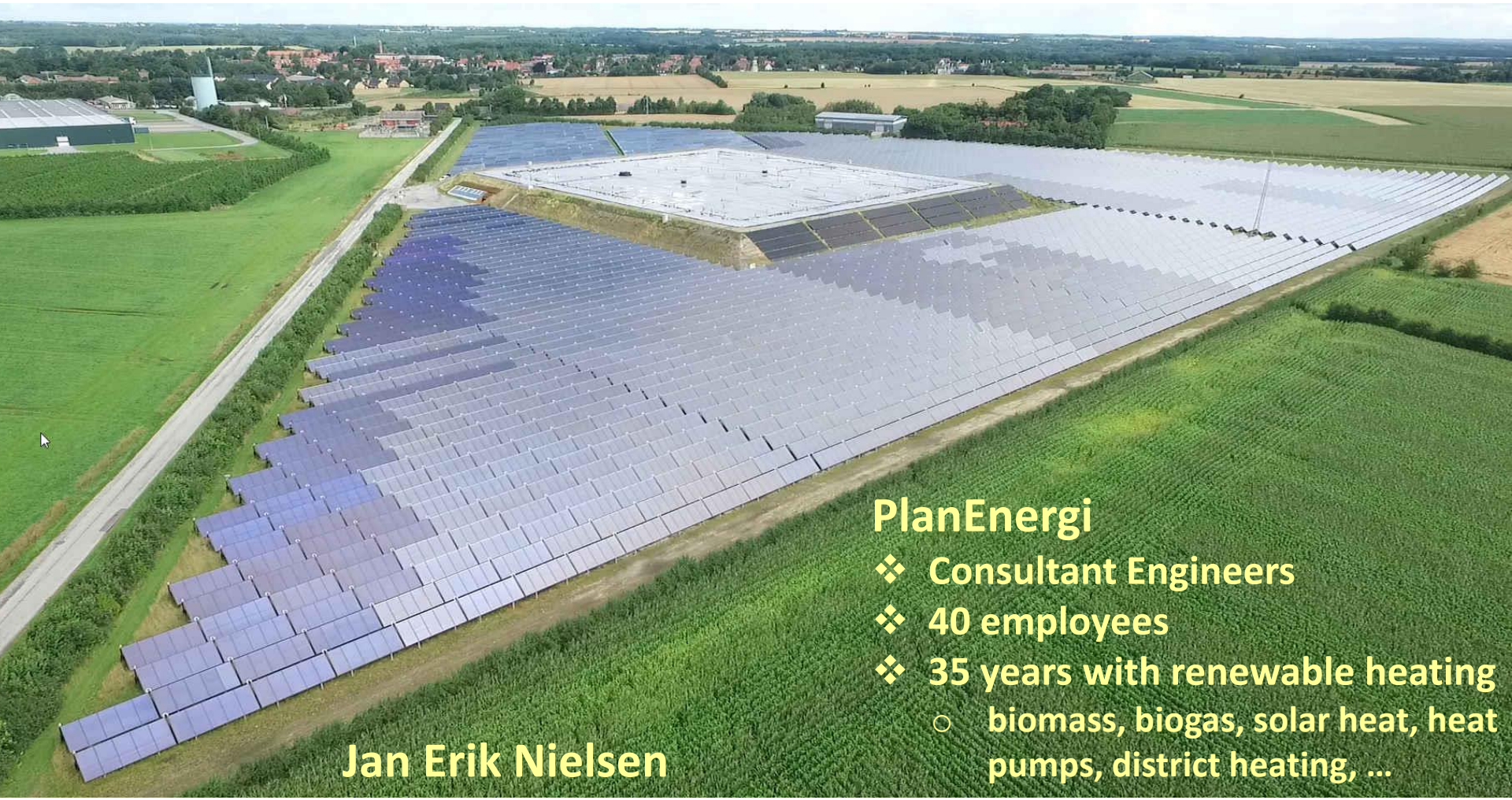
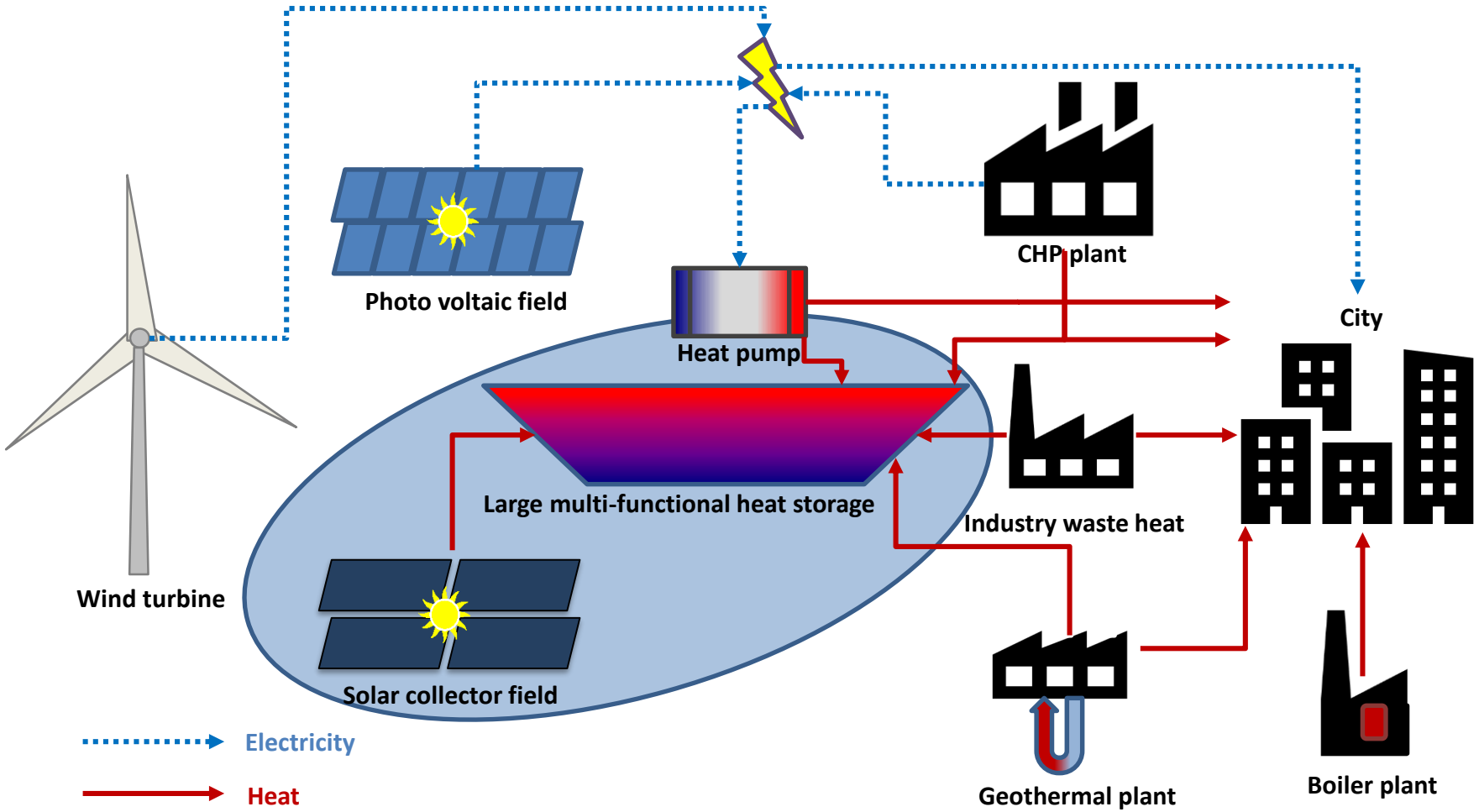
Seasonal Storage for Solar District Heating

Experiences from Denmark



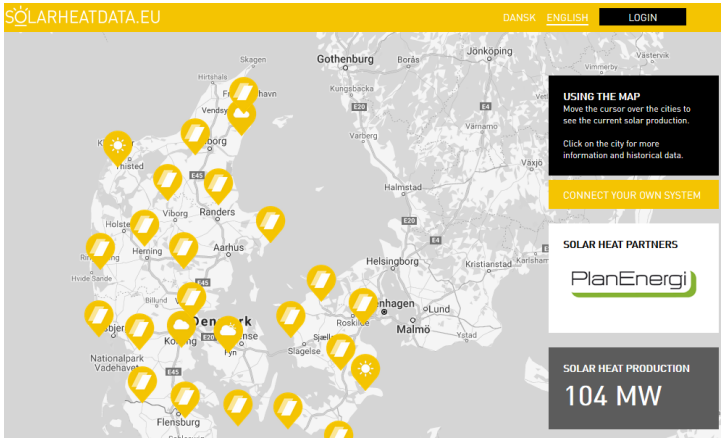
Seasonal Storage for Solar District Heating



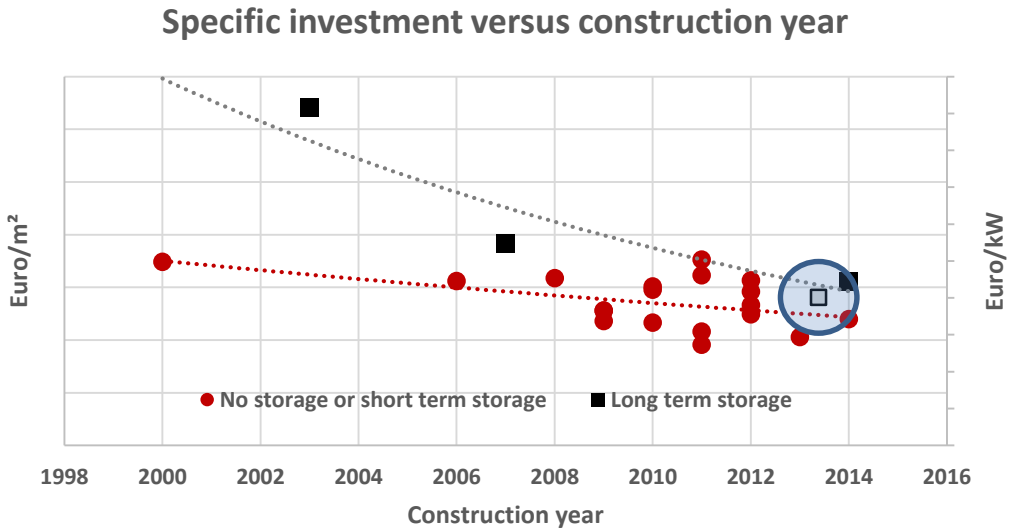
Sector coupling with multifunctional heat storage

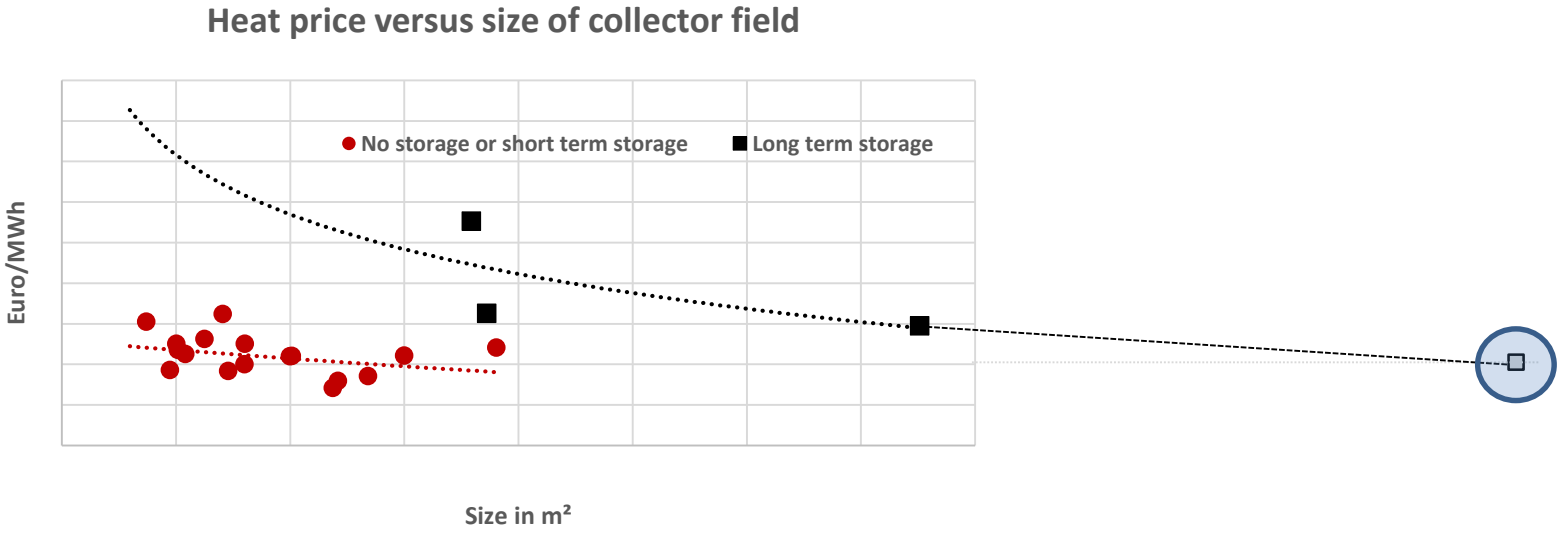
https://pngtree.com/free-icon

Seasonal Storage for Solar District Heating



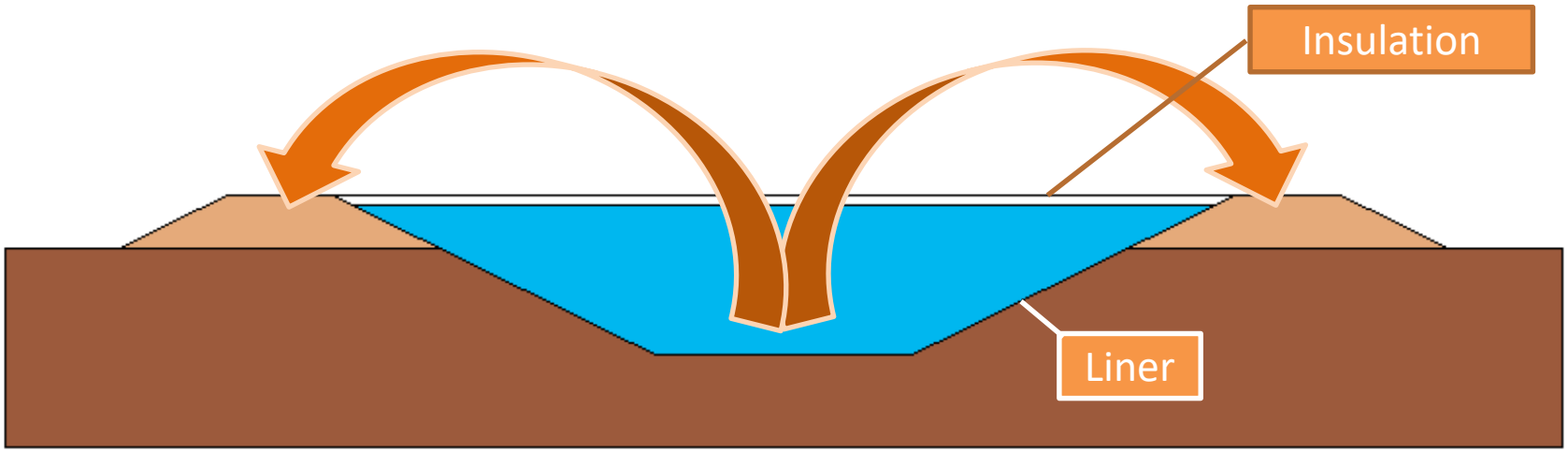
Real heat prices solarheatdata.eu





Design of the water pit storage

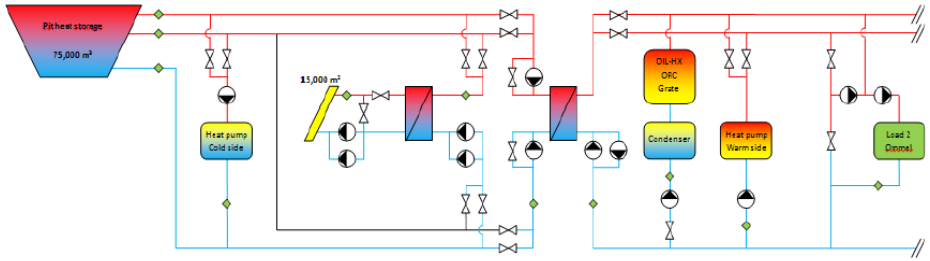
The soil excavated from the bottom part of the storage is used as embankments around the upper part of the storage.



Seasonal Storage for Solar District Heating

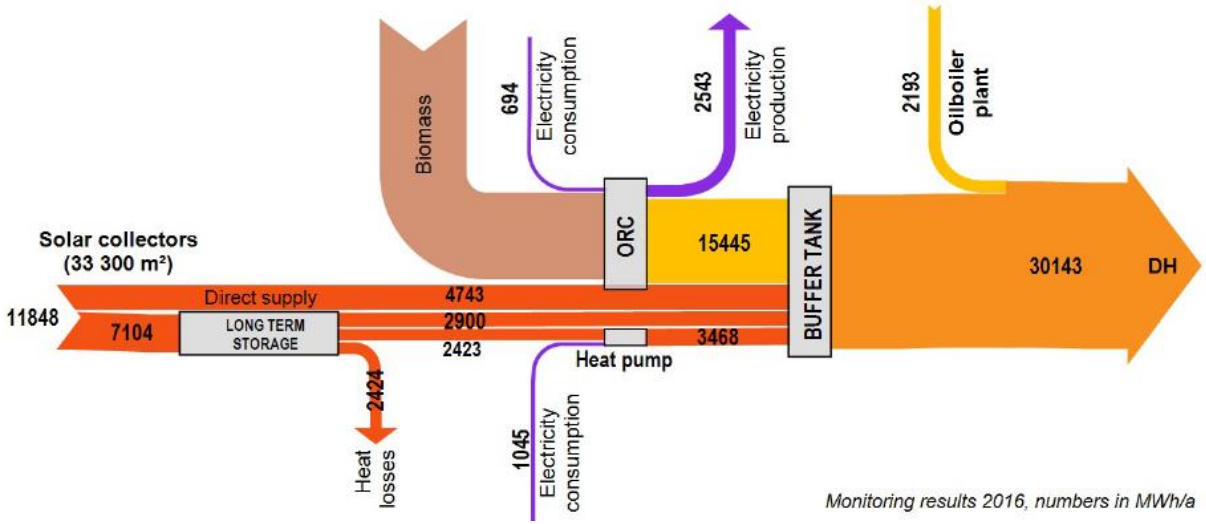
Marstal: 33 000 m² & 75 000 m³ pit heat storage

- 4,0 MW wood chip boiler (willow)
- 750 kW_{el} ORC
- 75.000 m^3 pit heat storage
- 1,5 MW heat pump using CO_2 as refigerant

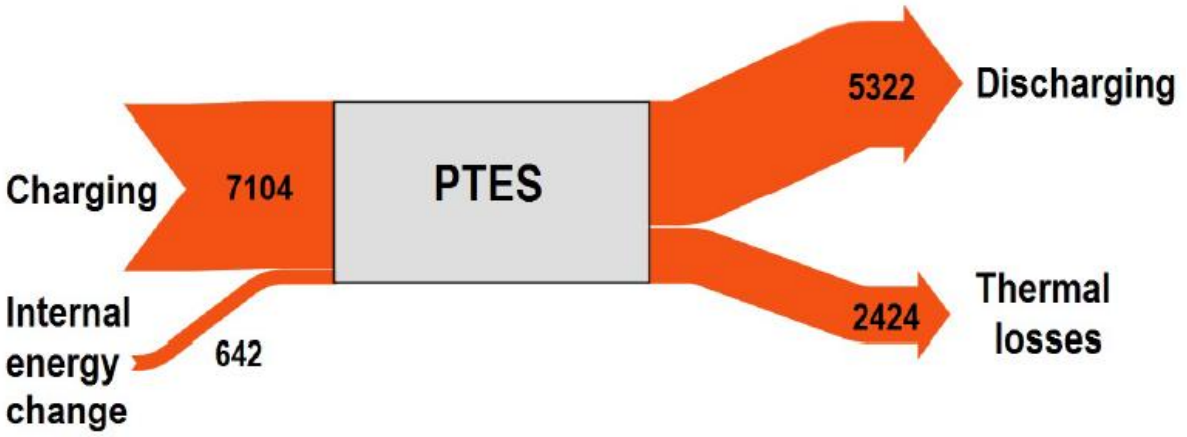


Marstal | Energy flow diagrams 2016

- Solar fraction: 35 %
- RE fraction: 100 %



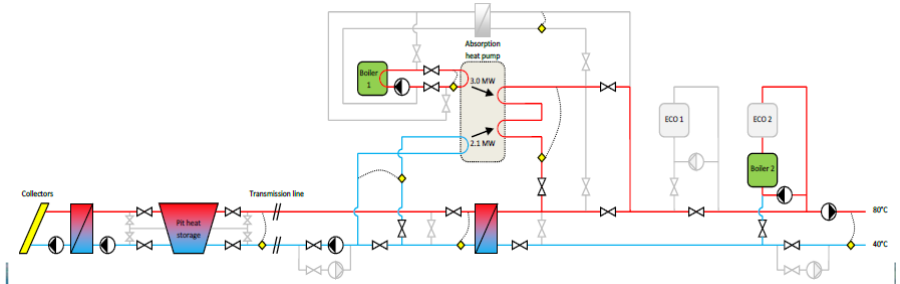
- Storage efficiency: 66 %
- T-min: 20 °C
- T-max: 82 °C



Seasonal Storage for Solar District Heating

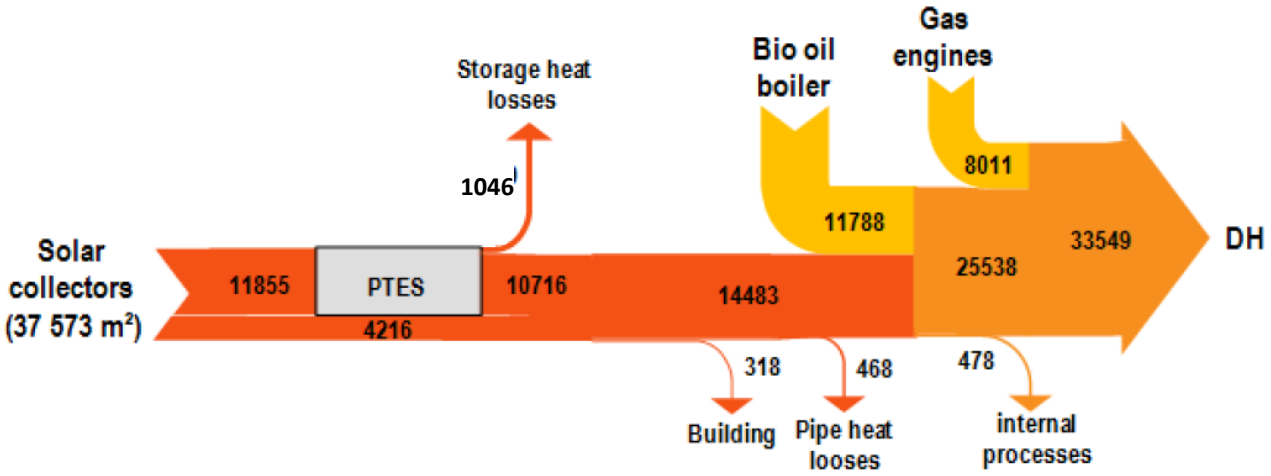
Dronninglund: 37 500 m² & 60 000 m³ pit heat storage

- 2,1 MW absorbtion heat pump
- Gas engine
- Bio oil boilers



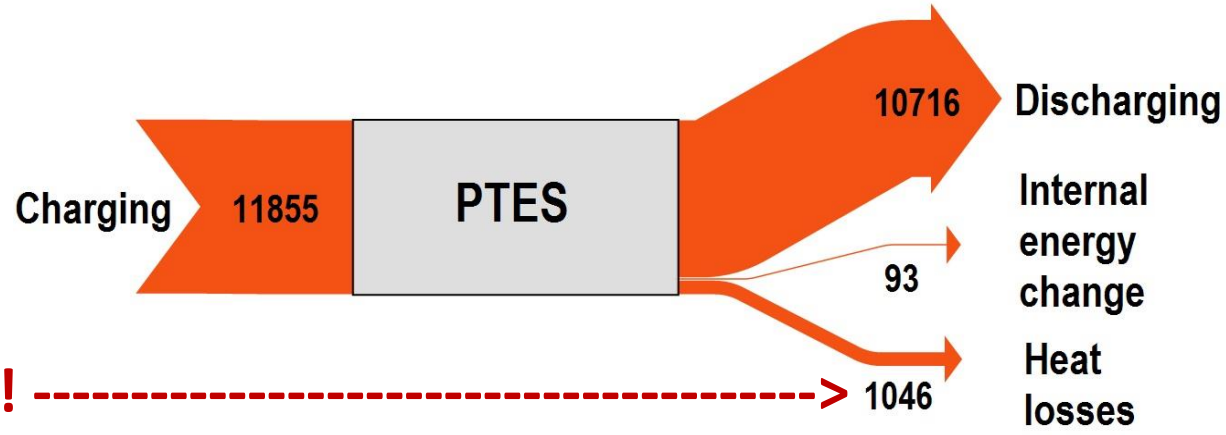
Dronninglund | Energy flow diagrams 2016

- Solar fraction: 40 %



Monitoring results 2016, numbers in MWh/a

- Storage efficiency: 91 %
- T-min: 12 °C
- T-max: 87 °C



Storage losses < 10 % ! ----------> 1046

Jan Erik Nielsen

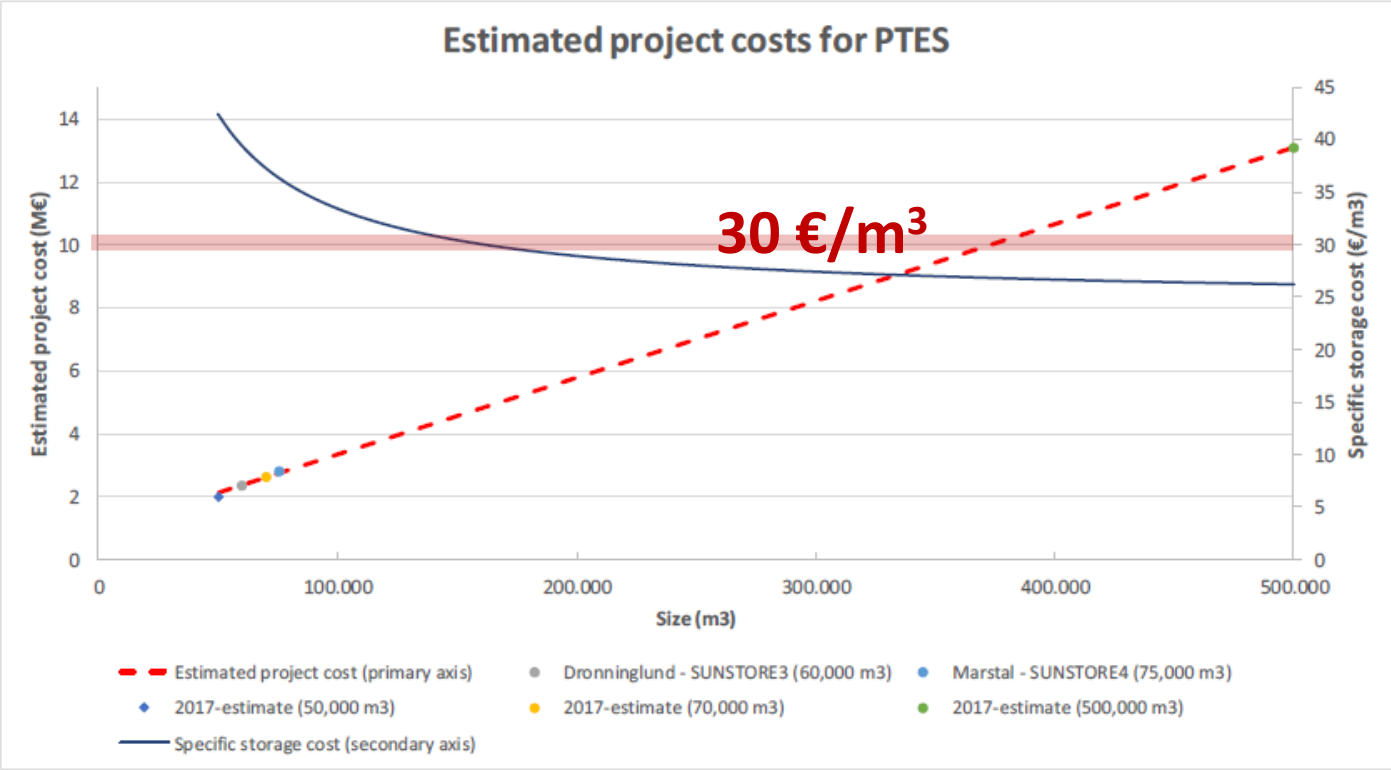
Seasonal Storage for Solar District Heating

Gram: 41 000 m²; 110 000 m3 water pit storage

Vojens: 71 500 m² & 200 000 m³ pit heat storage

Costs of pit heat storages

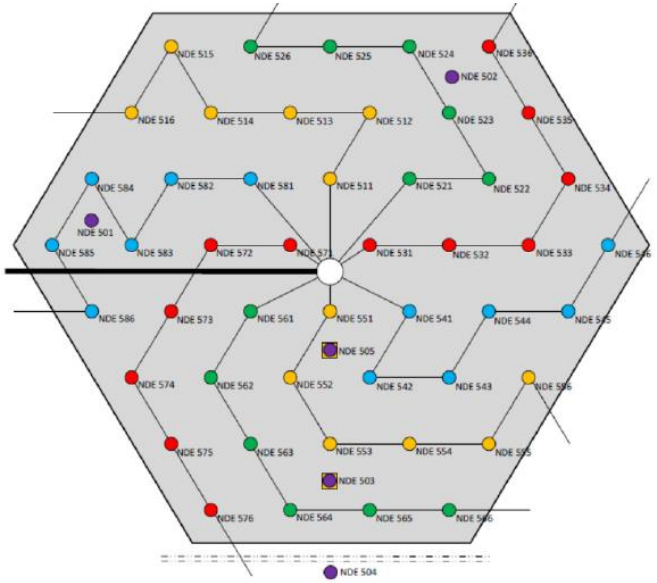
> 100 000 m3 → costs approx. 30 €/m³:

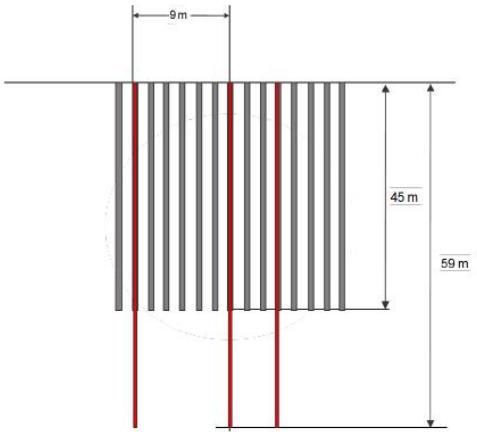


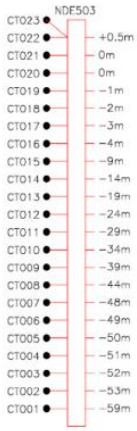
Project cost for PTES … (PlanEnergi)

Design of the borehole storage

A large volume of earth is heated/cooled by a matrix of regularly spaced vertical u-tubes.



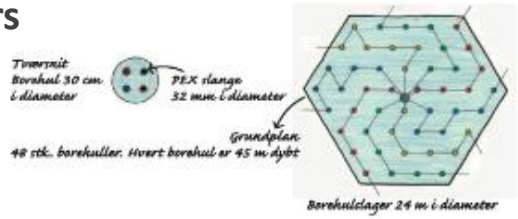


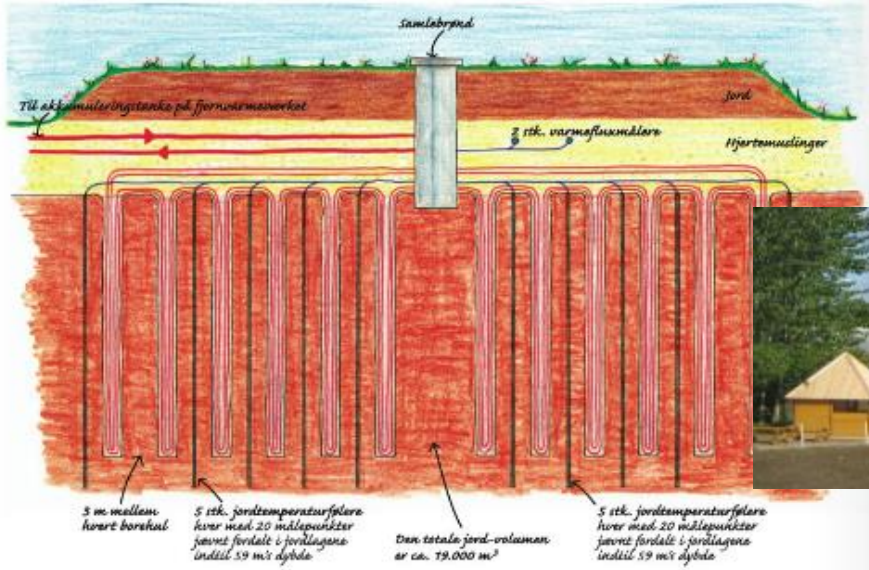


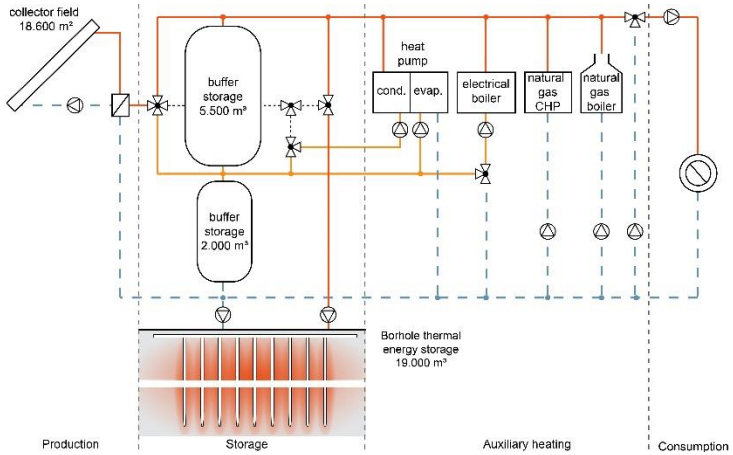
Seasonal Storage for Solar District Heating

Braedstrup: 18 600 m² & borehole heat storage (demo size)

- Gas CHP engine
- Heat pump
- Boilers



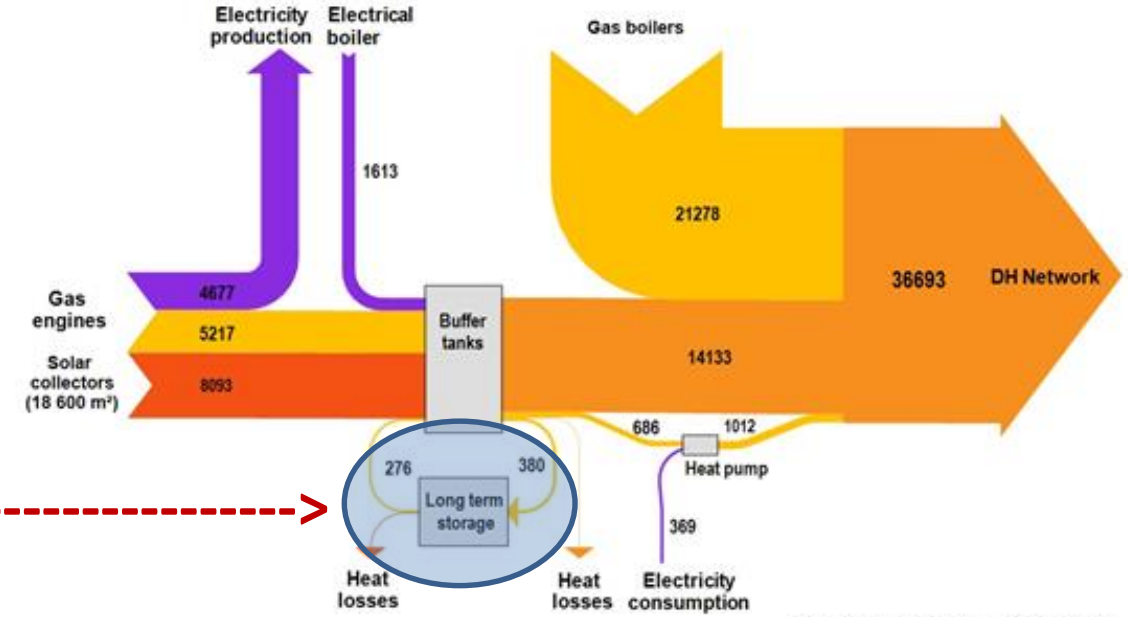




Seasonal Storage for Solar District Heating

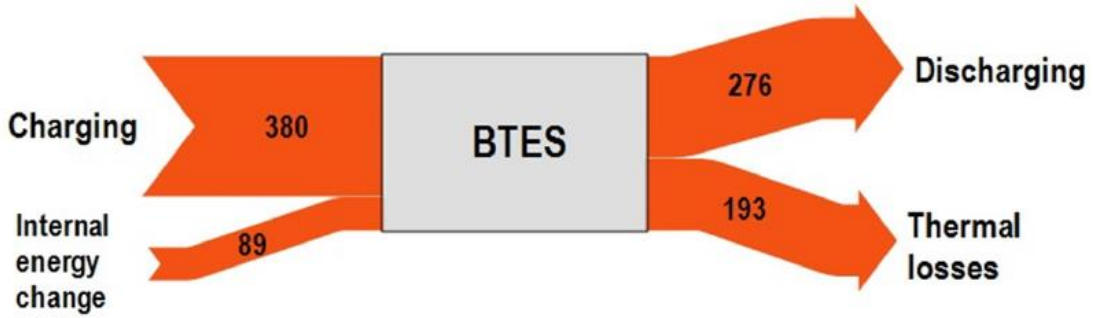
Braedstrup | Energy flow diagram 2014

Solar fraction: **22 %**



Demo size only ---------->

Storage efficiency: **49 %**
T-min: **10 °C**
T-max: **56 °C**



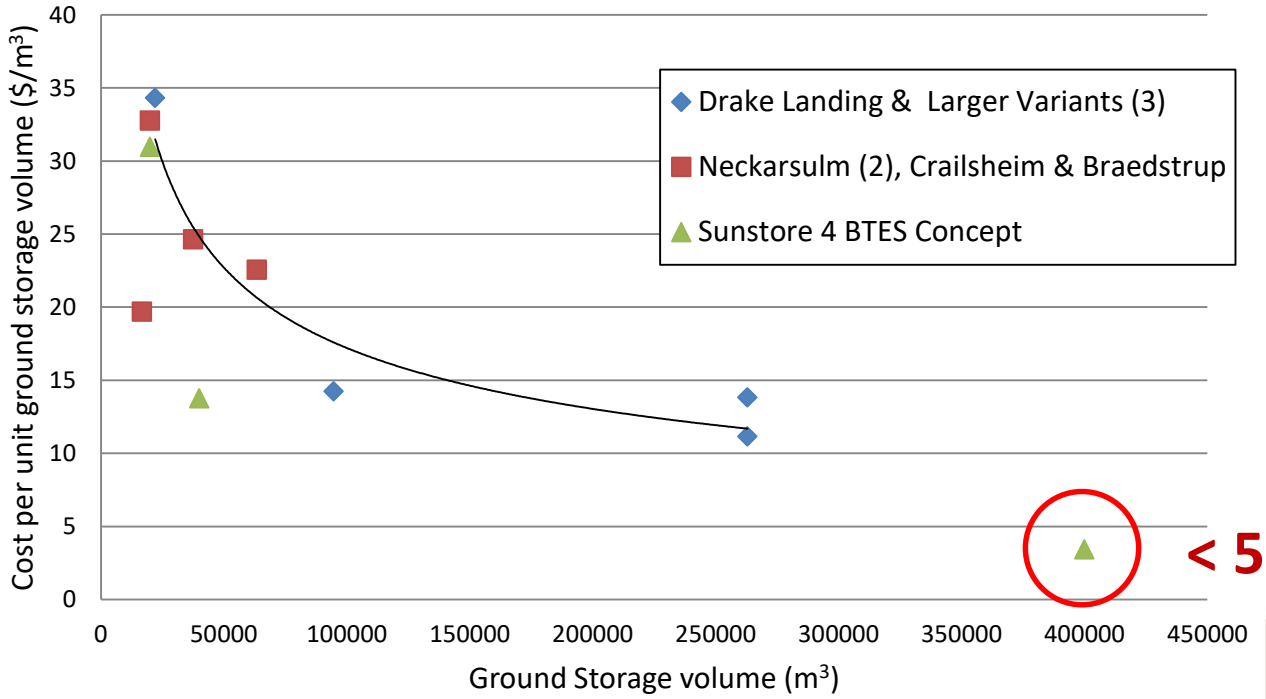
Seasonal Storage for Solar District Heating

BTES cost

Limited cost data is available for the implementation of borehole thermal energy storages.

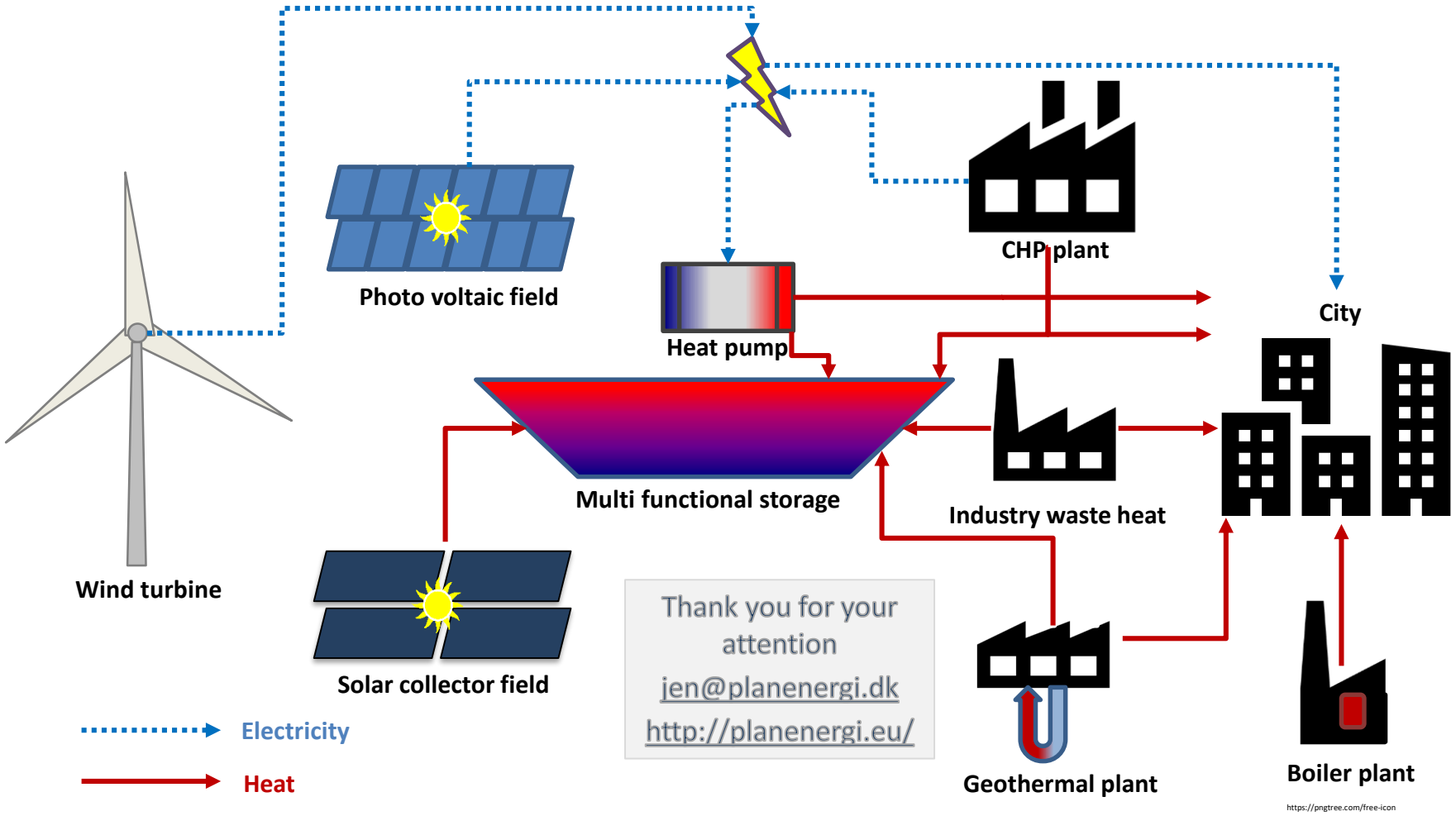
The figure shows the specific cost for installed and conceptual BTES.

It is clear that the specific cost drops significantly as the size increases.



Heat capacity of soil is significant lower than for water (factor around 4)

Seasonal Storage for Solar District Heating



http://task45.iea-shc.org/fact-sheets http://task55.iea-shc.org/fact-sheets