Solar / electric heating systems in the future energy system

Støttet af Det Strategiske Forskningsråd

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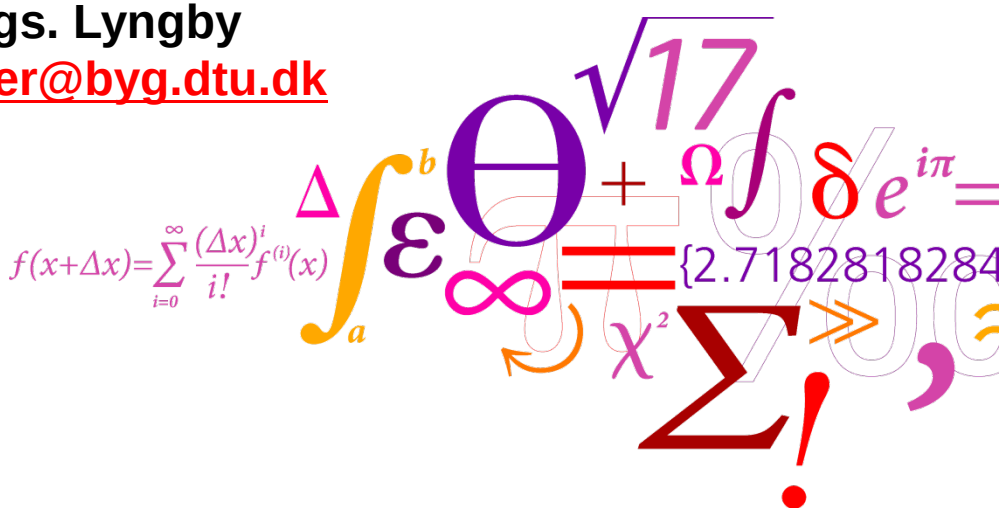


DTU Civil Engineering
Department of Civil Engineering

Project partners

- DTU Byg
- DTU Informatik (incl. PhD)
- DMI (incl. PhD)
- AllSun A/S
- ENFOR A/S

Subcontractors to DTU Byg:

- COWI A/S (Energy system studies)
- Ajva ApS (Smart Tank prototypes)
- Ohmatex ApS (Fabric Stratifier material)

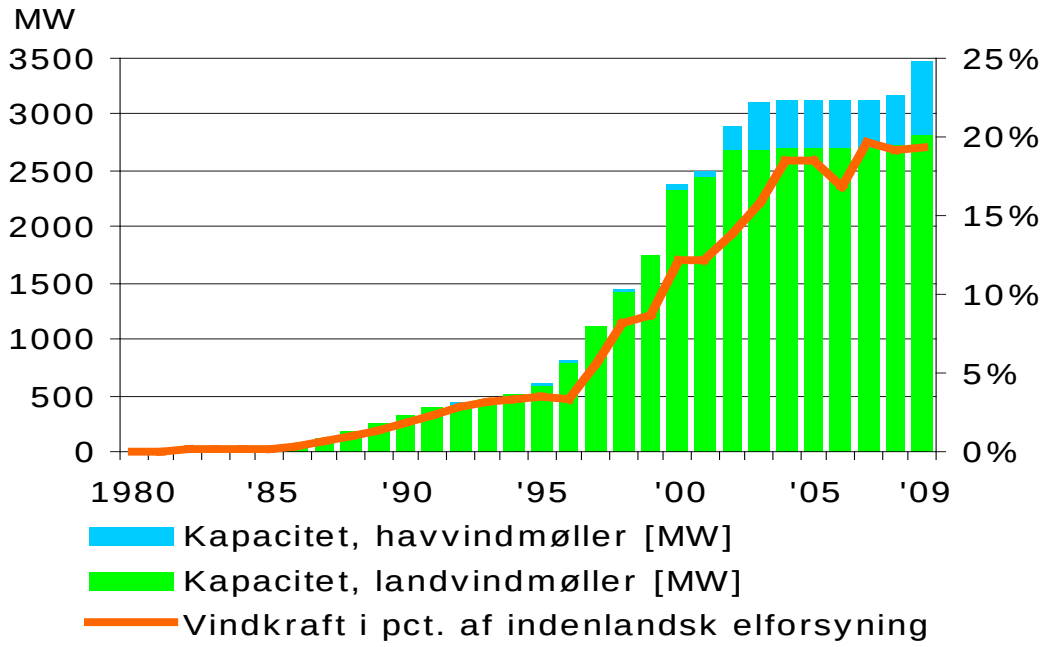
- Project period 2008 - Dec 2012

Background

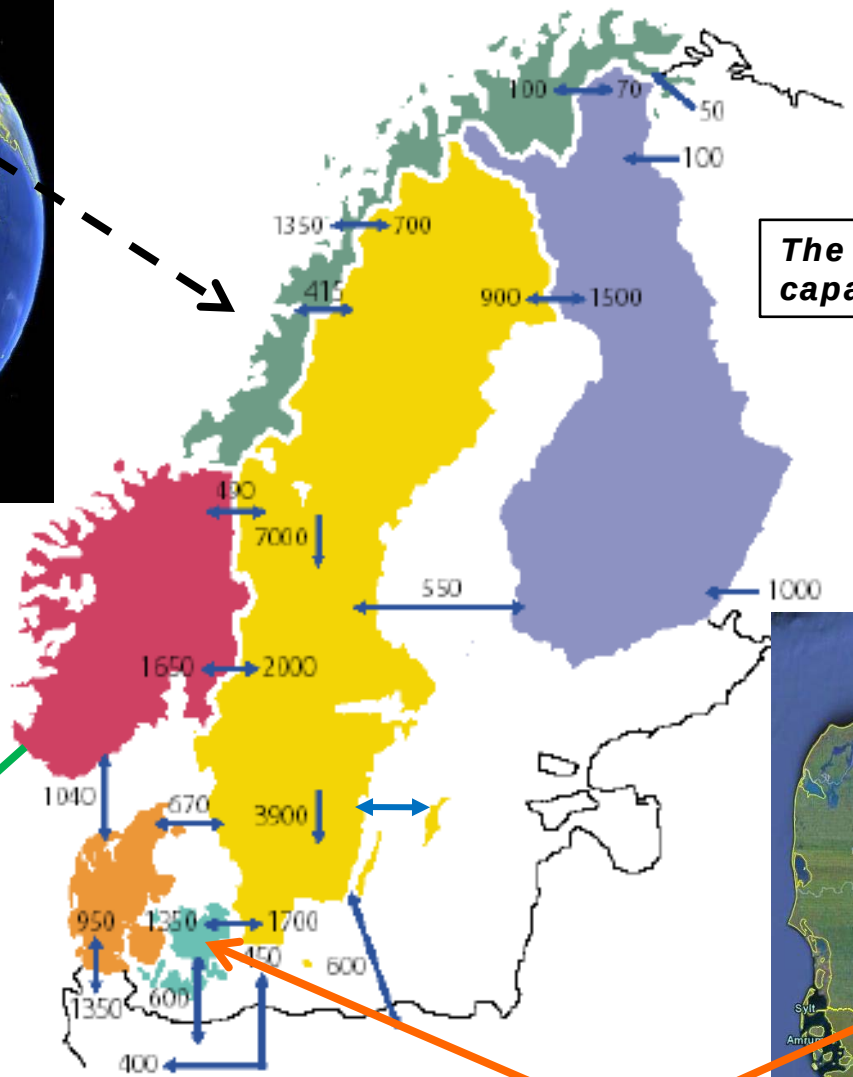
- More and more of the electricity consumption will be covered by wind power
- This will result in an increased number of periods with low electricity prices
- Small individual solar electric heating systems can use electricity in periods with low prices.
- This can help integrating wind power in the energy system and contribute to an increased share of RE

Aim of the project:

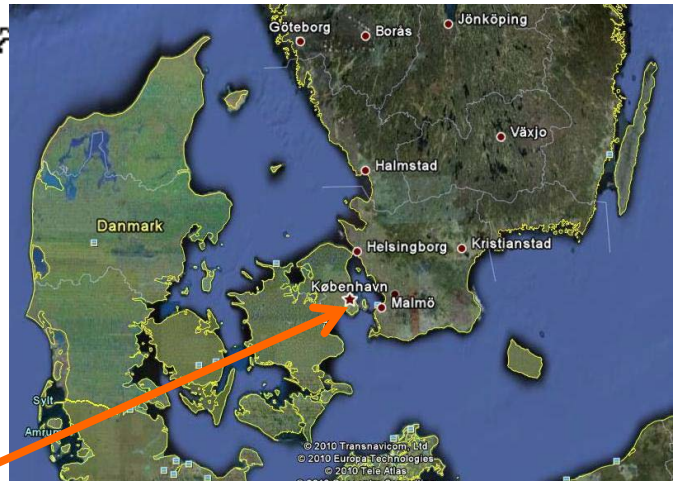
"To establish the basis for the development of a future energy system based on Solar and Wind energy"



Nordpool Electricity Market Area



The figures give transfer capacities in MW.

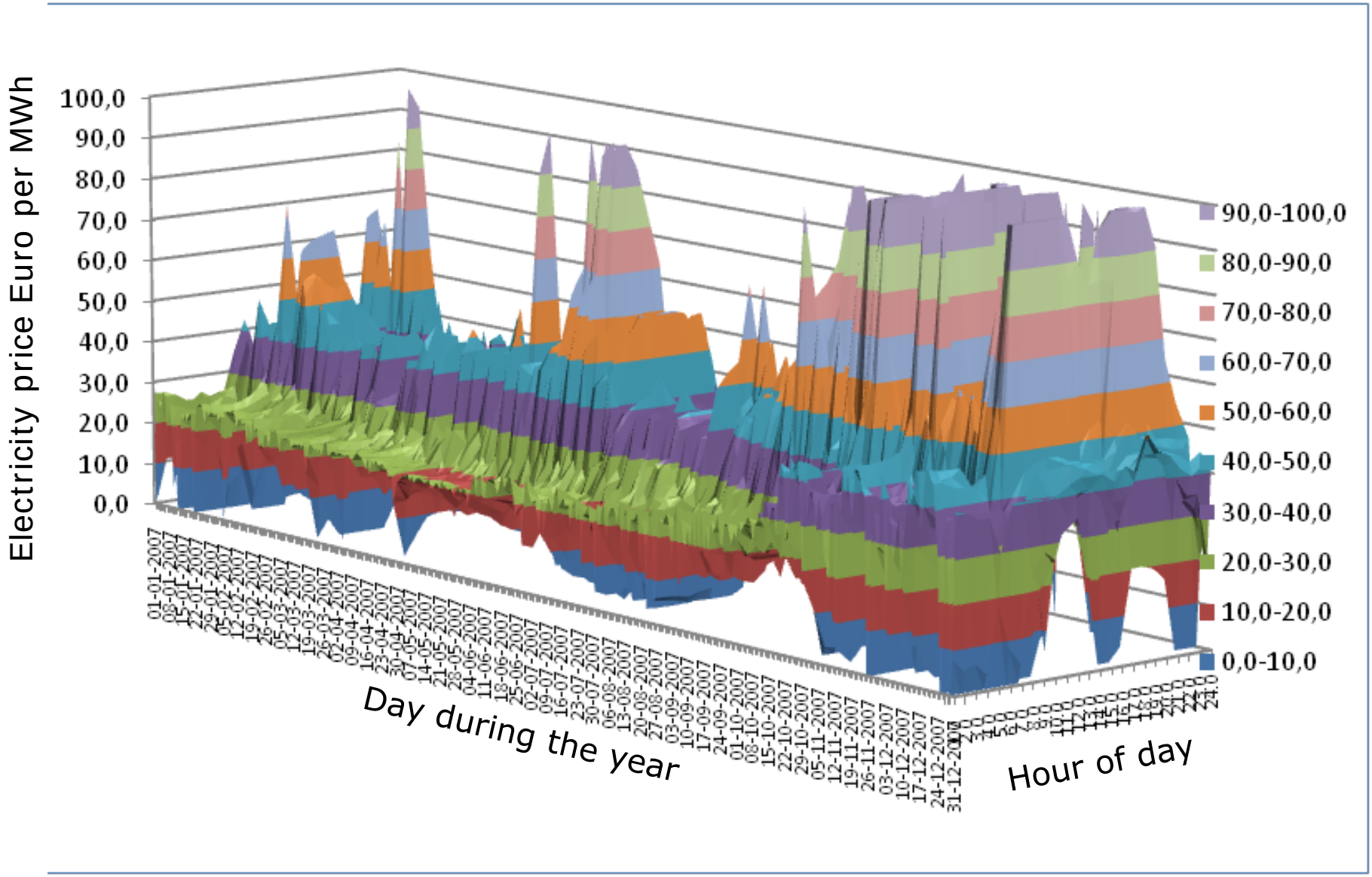


Great Britain

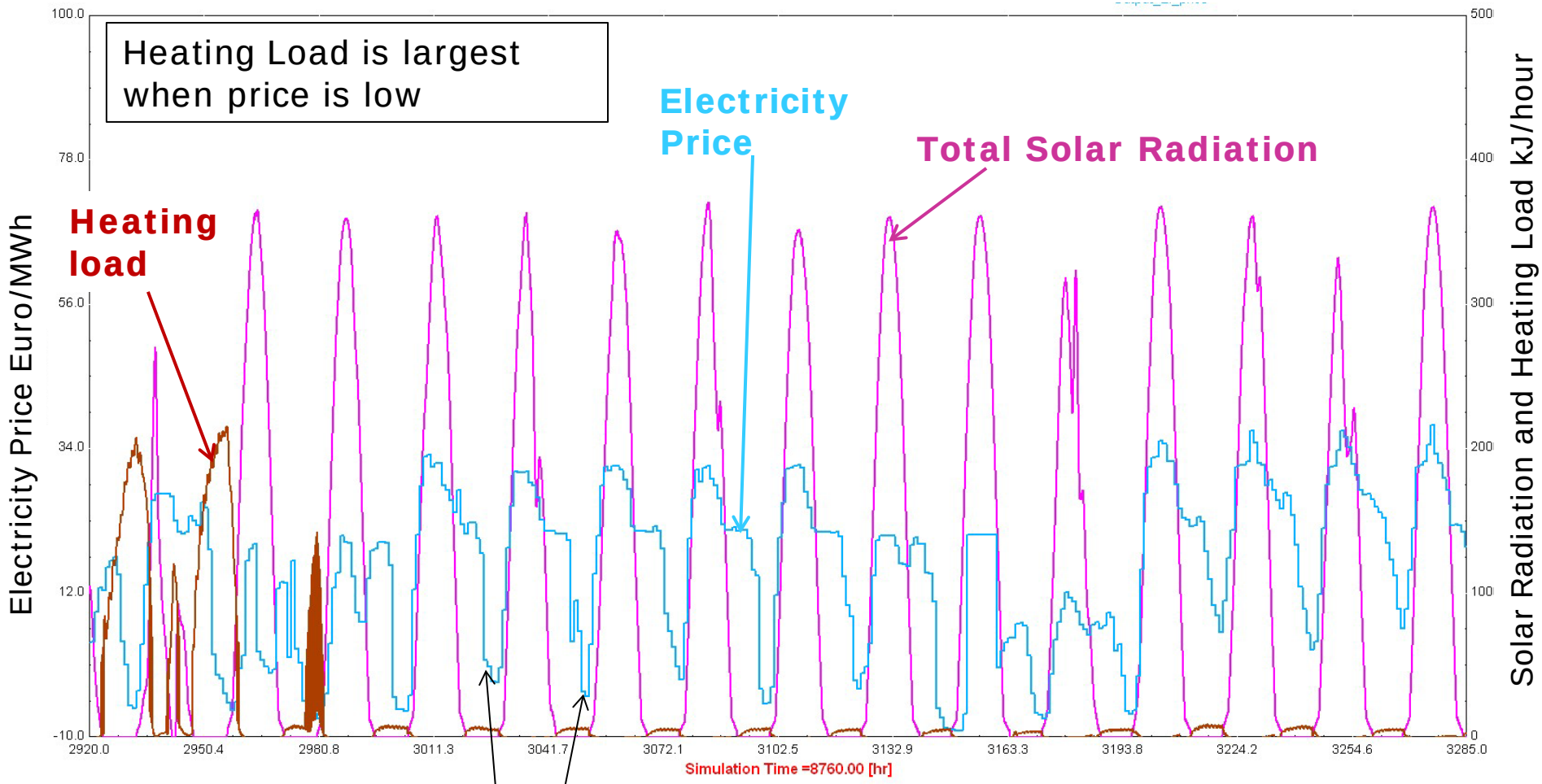
DK2 Denmark East (this presentation)

Example of electricity price variations.

Data from Nordpool.



Covariation between Heating Load, Solar radiation and Electricity Price



Lowest Electricity Prices in the morning before sunrise

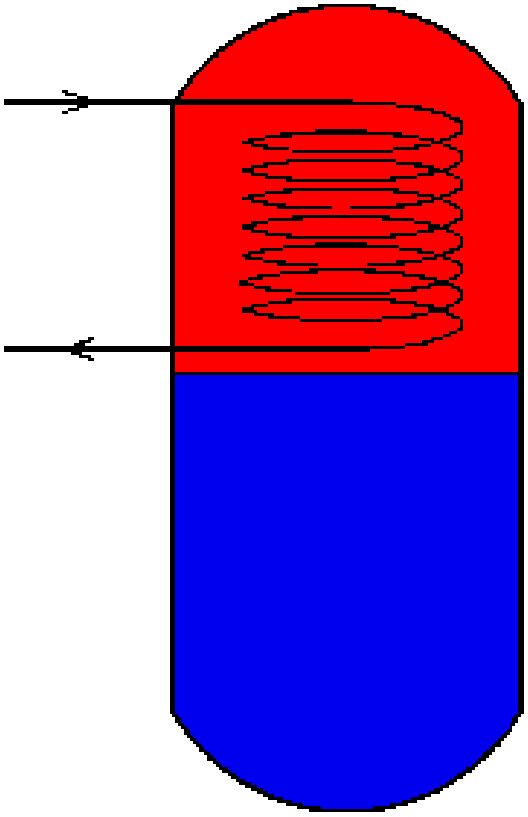
Activities

The project includes five main activities:

- Design of a smart heat unit based on a solar heating system, heat storage and electric heating elements / heat pump. **DTU Byg**, Ajva ApS & Ohmatex ApS
- Development of a detailed weather forecast model to predict solar radiation, temperatures and other important weather parameters. **DMI**
- On line forecasting of heat demand, solar heat production and auxiliary charging need. **DTU Informatics, ENFOR A/S**
- Development of control system that can communicate with DMI and Nordpool and operate the solar-electric unit in the best possible way. **AllSun A/S**
- Analysis of how the developed heat unit, if used in large numbers, will fit into the overall energy system **COWI**

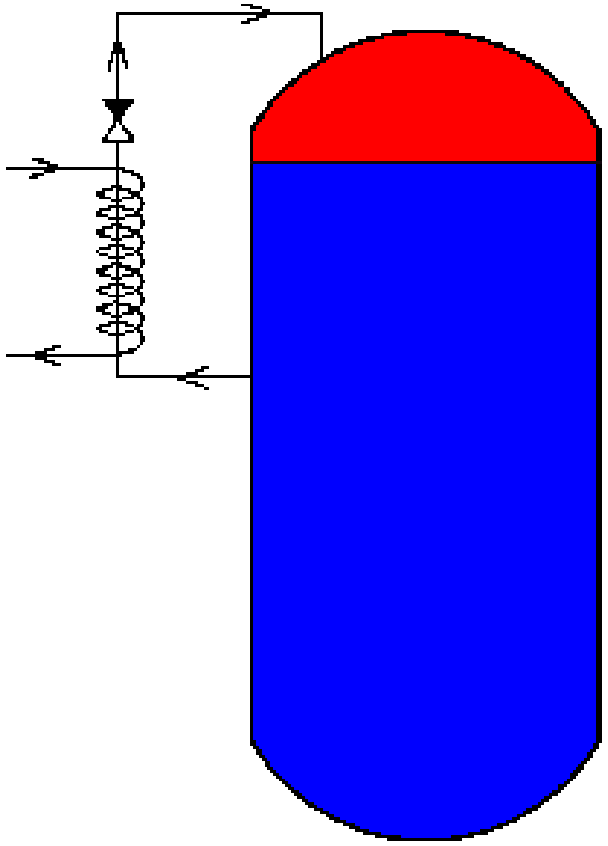
Tank Design Principles

MARKETED SOLAR TANK



Fixed Volume
Fixed temperature control

SMART SOLAR TANK



Tank Heated From The Top
Individual Smart Control System

Solar / electric heating system

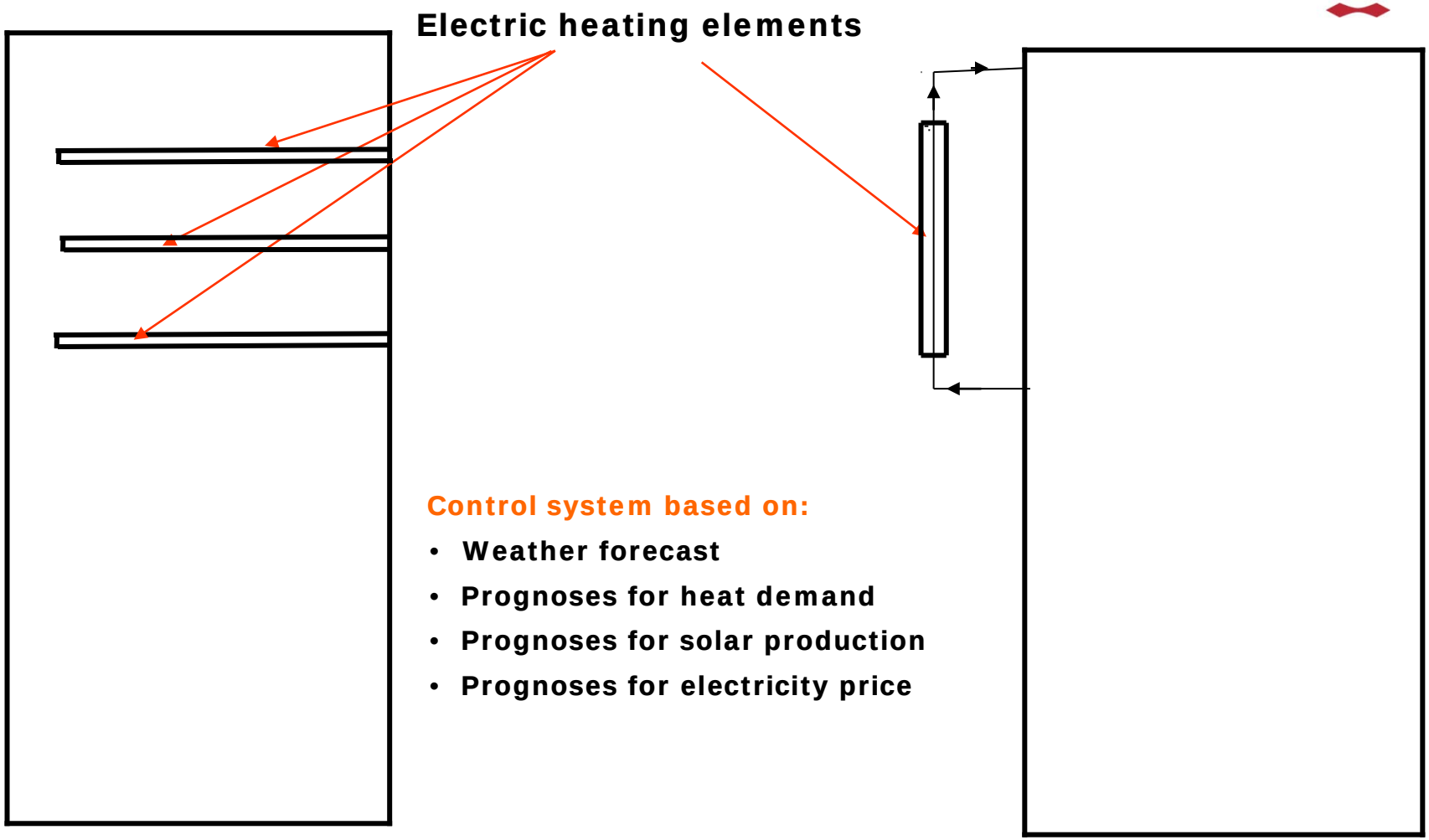
Improved cost efficiency due to:

☺ Use of low cost electricity (ie. wind overproduction)

☺ Decreased heat losses

☺ Increased solar heat production

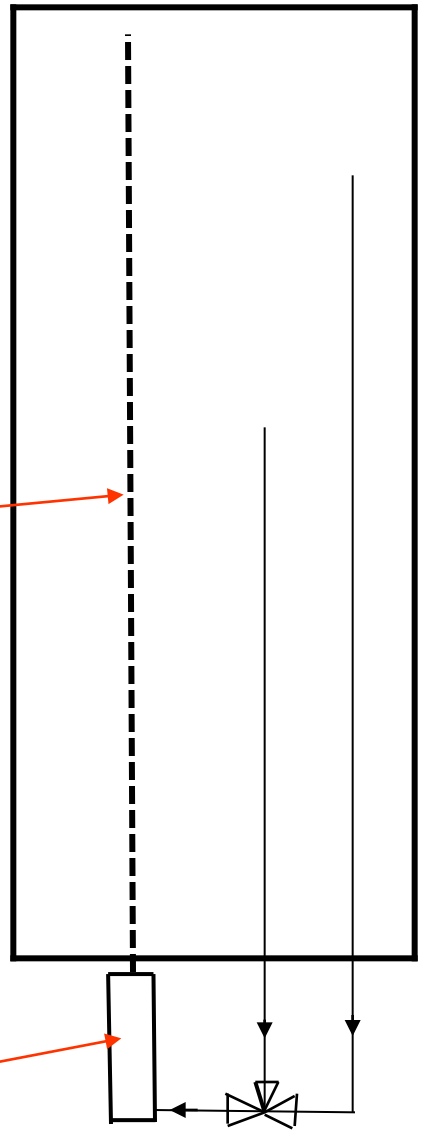
Smart solar tanks - principles for electric heating



Control system based on:

- **Weather forecast**
- **Prognoses for heat demand**
- **Prognoses for solar production**
- **Prognoses for electricity price**

Smart solar tanks - principle for electric heating



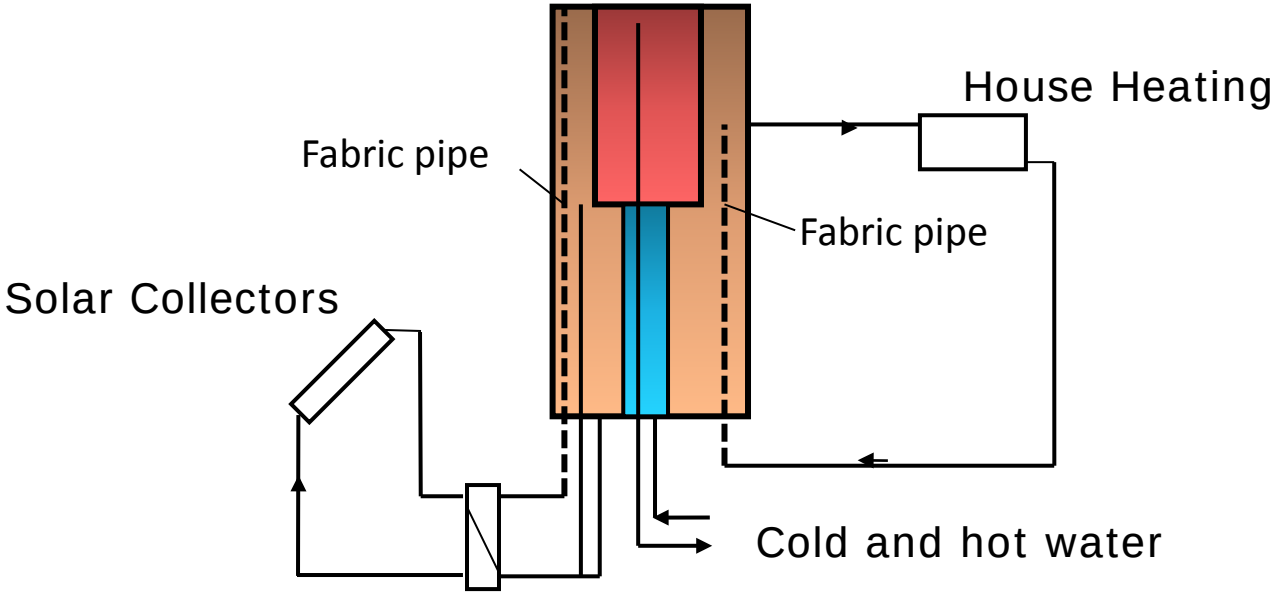
Inlet stratifier

Electric heating element

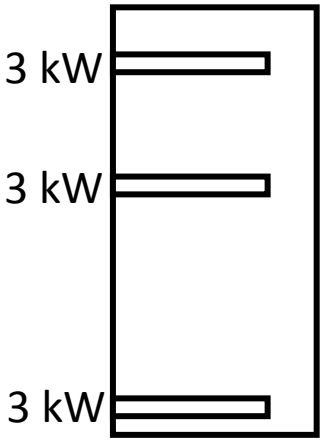
Control system based on:

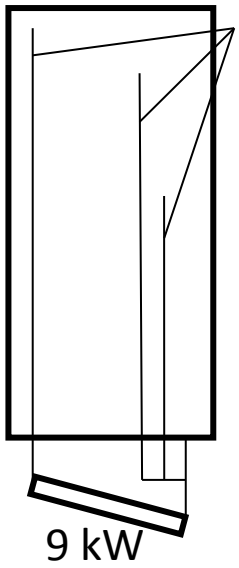
- Weather forecast
- Prognoses for heat demand
- Prognoses for solar production
- Prognoses for electricity price

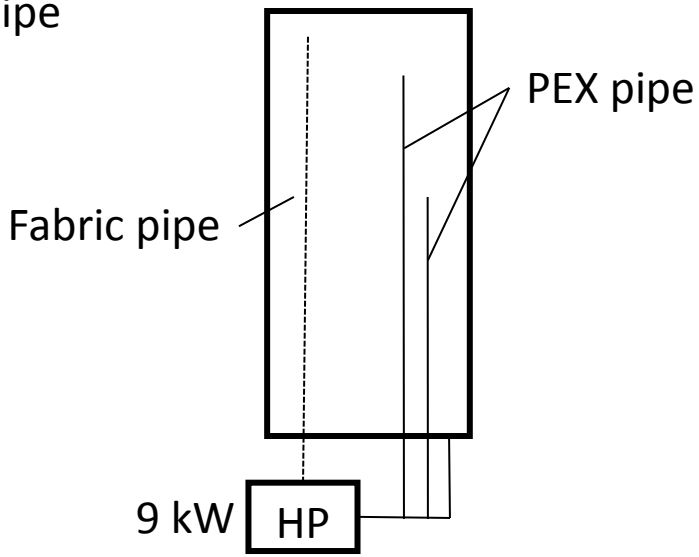
Solar collector loop & discharge loops



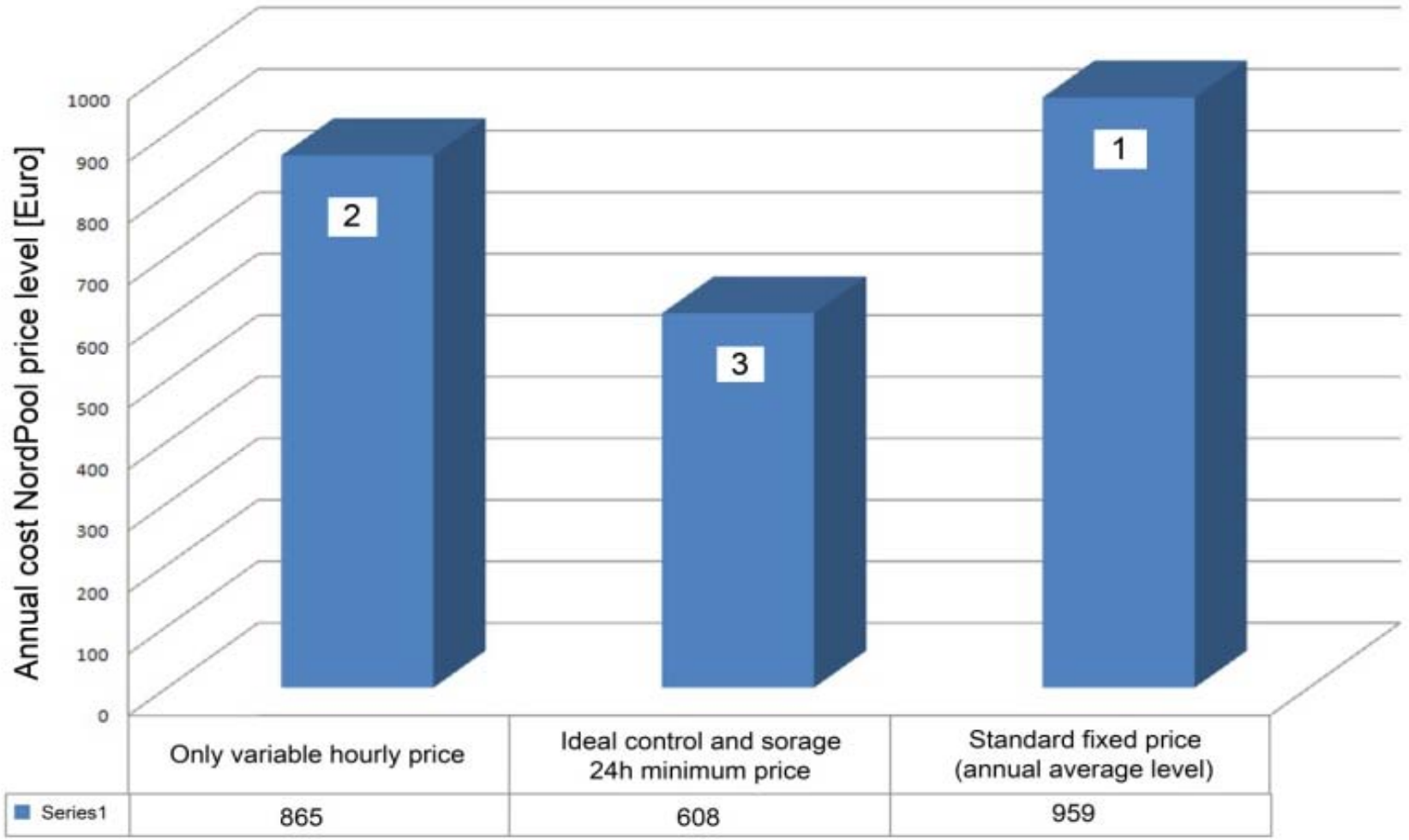
Auxiliary heating principles in DTU test systems







Auxiliary cost reduction potential with ideal control and daily storage



Conclusions

With smart control and a daily thermal storage, the variations in electricity price can be used to reduce the auxiliary cost by up to 37 % under east Denmark conditions.

Further auxiliary cost reductions can be achieved by adding solar thermal collectors in the system.