An Energy System with Seasonal Storage

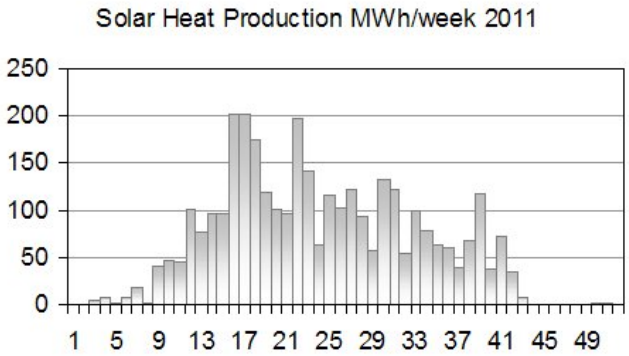
Energy storages have often been suggested as the solution of the wind power integration problems. Unfortunately there are no easy ways to construct energy storages, particularly not for electricity.

Denmark has poor natural conditions for the establishment of pump storage plants, but Denmark has another option. The district heating systems (DH) and the combined heat and power systems (CHP) normally include hot water storage tanks. If a CHP system actively is using the electricity market the hot water storages can add highly needed flexibility to the electric power system.

The Brædstrup Total Energy Concept

Brædstrup District Heating Company is a cooperative supplying heat for 1,450 consumers. A CHP plant produces heat and electricity. The annual production is 41GWh heat and 21GWh electricity.

In 2007 Brædstrup District Heating installed 8,000 m^2 solar panels with an annual heat production so far between 3.0 and 3.4 GWh depending on weather.



The solar panels have their maximum production during the summer when the heat demand is low. Therefore the annual heat production from solar panels cannot exceed about 10% of the annual heat demand without waste of heat unless a seasonal storage is available.

By adding 10,600 m^2 solar panels, a 5,500 m^3 storage tank, a seasonal storage, a heat pump and an electric heater in 2012 the Brædstrup CHP system has taken an important step into the future.

Brædstrup District Heating Production Facilities:

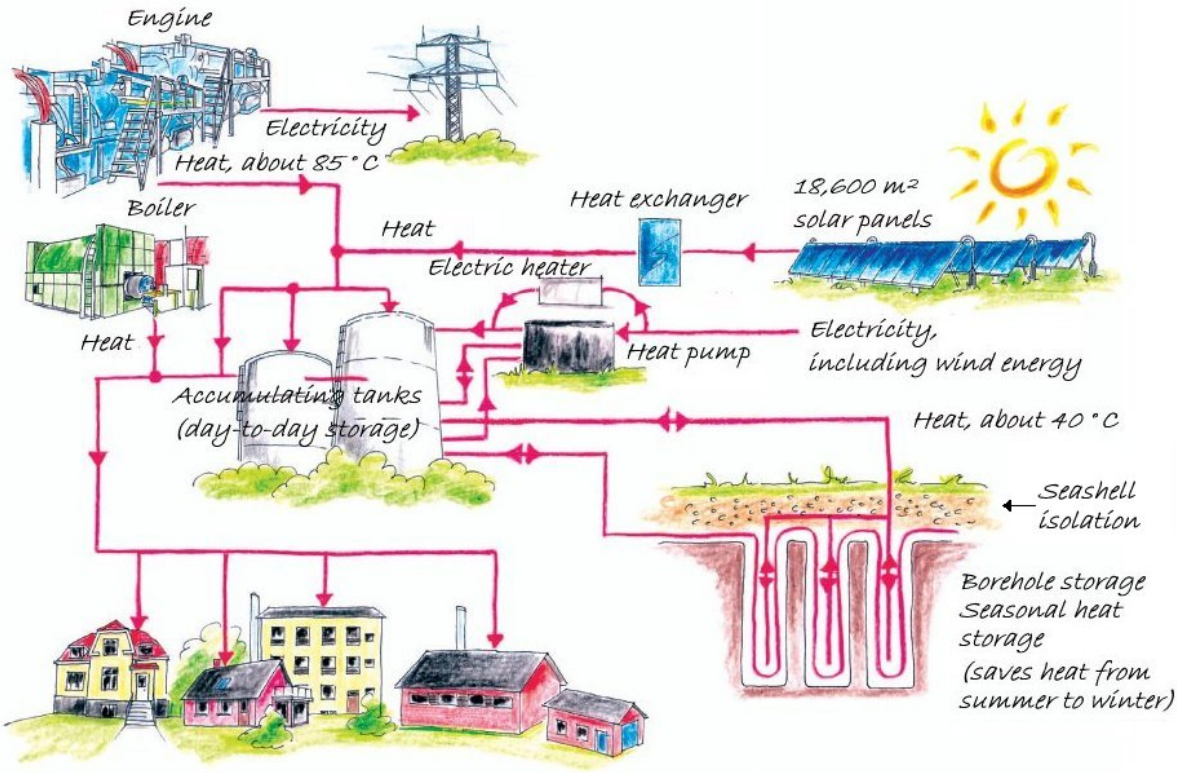
Gas engines, generator	MW	2 × 3.65
Gas engines, heat capacity	MJ/s	2 × 4.0
Boilers, heat capacity	MJ/s	13.5+10.0
Storage tanks	m^3	2,000+5,500
Seasonal borehole storage	Depth Holes	45 m 48
Solar panels	m^2	18,600
Heat pump	MJ/s	1.5
Electric heater	MJ/s	10.0

The seasonal storage

The seasonal storage is a borehole storage. 48 holes have been drilled to a depth of 45 metres. Each hole is supposed to work like a heat exchanger. 19,000 m3 of soil is supposed to keep the heat. The top is isolated with a layer of seashells.

The 847 new solar panels can produce up to 7.4 MW. The total capacity of the storage tanks is about 400 MWh heat. In the summer time they can absorb a few days' heat production from the solar panels. Surplus heat can be moved from the storage tanks to the seasonal storage.

During the winter season heat can be moved back from the borehole storage. The temperature must be boosted, either by the heat pump or by the electric heater.



The system is now fully operational and the borehole storage is being charged with solar energy for the next winter.

Interaction with the Electricity Market

Wind power has changed the electricity supply situation in Denmark. During the cold seasons the electricity demand is insufficient for both wind power and electricity from the CHP schemes. Therefore the electricity production from local CHP plants has been decreasing since 2004.

Most CHP-plants are supposed to sell their electricity production in the electricity market. A range of products and services are traded in the electricity market:

- Energy: day-ahead market, intra-day market and real time market
- System services: Primary reserve, secondary reserve, manual reserve and black start capability

The transmission system operator, Energinet.dk, purchases system services for about one billion DKK per year.

Large storage and conversion capacity give CHP systems new business opportunities and allow them to trade most of the products in the electricity market and to accommodate efficiently with changing market conditions

The wind power variability creates periods with surplus and other periods with shortage of power. The concept allows cheap electricity to be converted to heat for consumption or storage. During shortage of electricity the combined production of heat and power can be maximized. If heat production exceeds heat demand the surplus can be stored for future consumption.

There will be international competition in the markets for balancing power and system services. The supply side will include large European producers and traders including the owners of the Norwegian hydro power systems.

On the other side the European wind power expansion plans will require much more balancing power within the next few years.

It remains to be seen if the new opportunities can justify investments by local CHP systems in storages and conversion facilities.