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District heating in future smart energy systems

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Subjects in presentation

1. Challenges for District Heating (DH) in future energy systems
2. Strengths and opportunities for DH in future energy systems
3. ”Smart grid in DH” – a project proposal
4. District Heating in Odense – short introduction to Fjernvarme Fyn as a test and demonstration site
5. Some wishes for results of CITIES

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Challenges for District Heating (DH) in future energy systems

- **Phase-out of CHP production.**

  Energy scenarios 2020-2050, Energistyrelsen 2014.

  Only waste fired CHP in 2050 in ”wind scenario”

- **Increase in windpower production. 400 MW / year 2020-2050 in ”wind scenario”**

- **Increasing complexity in production composition**

  Production from diverse VE sources.

- **Decreasing heat consumption - energy savings in buildings.**

Strengths and opportunities for DH in future energy systems

- **DH as an energy carrier is flexible in regard to energy sources.**
- **DH can exploit all kind of surplus heat**
- **Use of large heat storages, including distribution network**
- **Utilization of large scale advantages compared to individual heating solutions**

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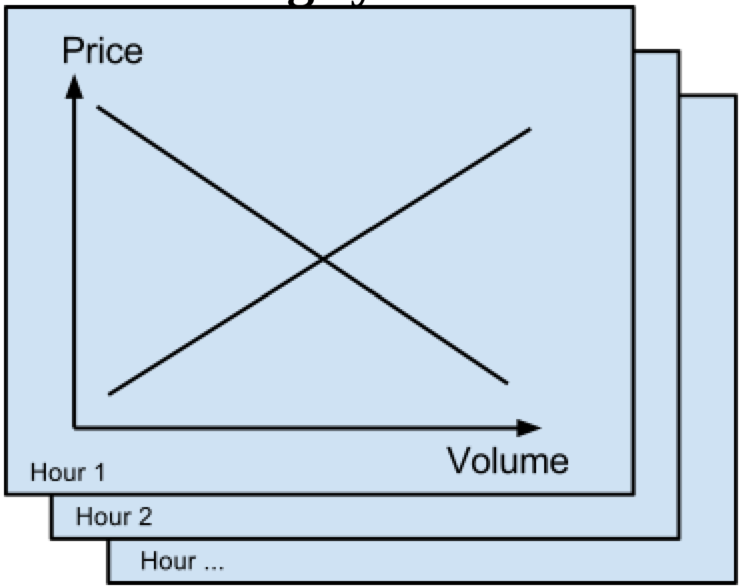
Project proposal ”Smart grid” in District heating

- **In 2013 Fjernvarme Fyn worked together with LEC, AffaldVarme Aarhus, Danfoss, Enfor, DTU, Grontmij, Rambøll, Eurisco and Fjernvarmes Udviklingscenter on an EUDP application ”Smart grid in district heating”**
- **The application was rejected allegedly because of missing business potential Nevertheless, we still think the project idea was good.**
- **The project proposal is about integrated modelling, forecasting and control of 1) production 2) distribution and 3) consumption of district heating**
- **The basic idea is, that information / data can be exchanged between the 3 levels of the entire heating system and in that way avoiding sub-optimization**
- **Integration of the district heating system with the surrounding energy system through the electricity market**

Project proposal ”Smart grid” in District heating

- **DH Production: time varying prices / supply curves**
- **Supply curves on a hourly basis.**
- **Calculated on the basis of electricity price forecasts, CHP production, heat pump production, forecasts for surplus heat, solar thermal and other heat sources in the district heating system**

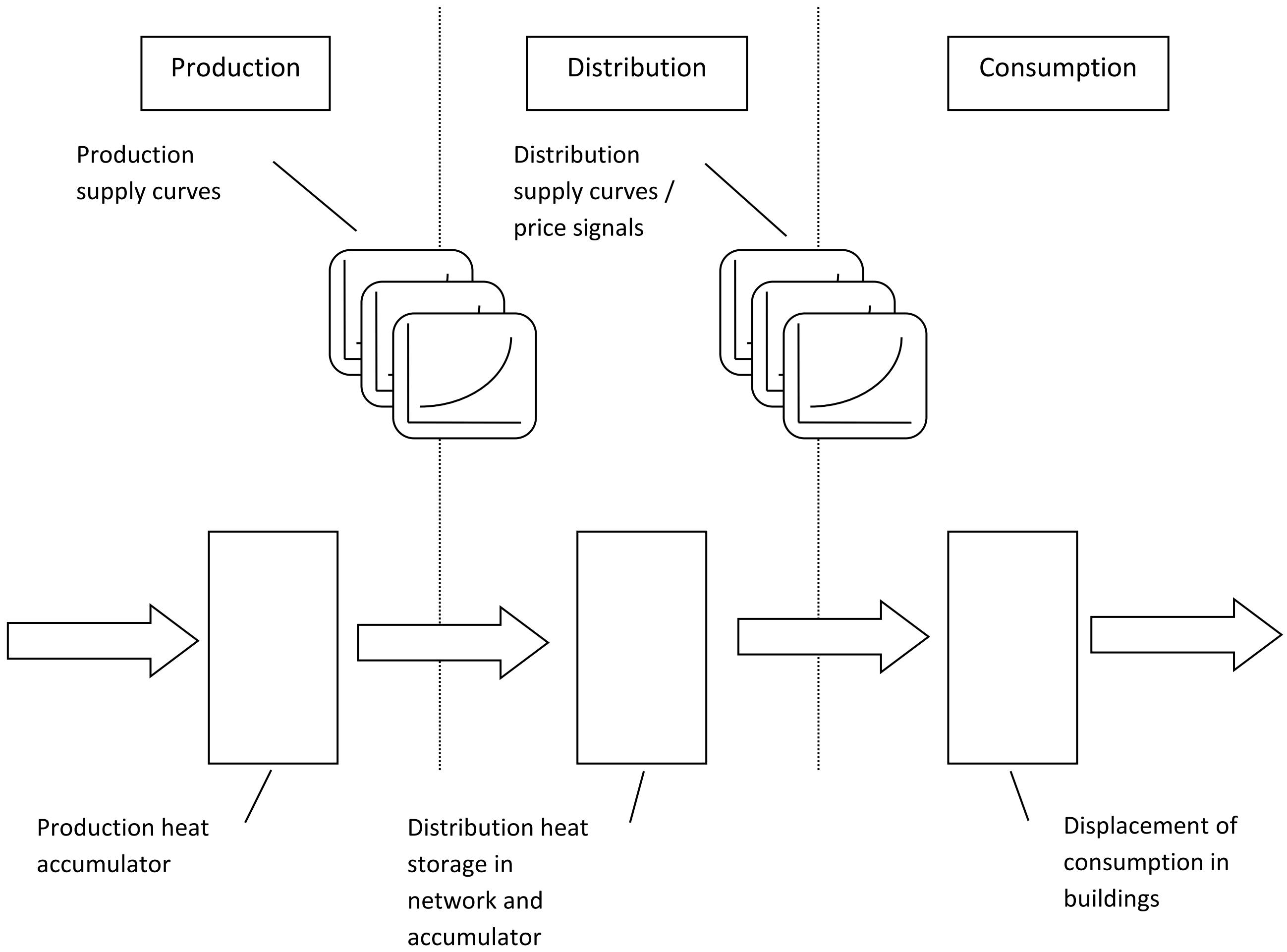


Project proposal ”Smart grid” in District heating

- **DH Consumption: Development of a new building heat controller:**
- **Cost optimization of heating of buildings based on forecast of consumption and time varying prices / price signals. Utilization of heat capacities in buildings to time shift the consumption without exceeding comfort limits for indoor temperature**

- **DH Distribution: Optimization of supply temperature and price signals. Minimizing the total costs which is not necessarily the same as minimizing the energy loss because of time varying production prices.**

Project proposal ”Smart grid” in District heating



Key Figures – FvF

- **Max demand** **780 MJ/s**
- **Numbers of connections** **61.000**
- **Yearly production** **2.1 Mio MWh**
- **Temperture** **60-95 °C**
- **Max pressure**
  - Transmission 25 bar
  - Distribution 6 bar
- **Pipe length**
  - Transmission 50 km tracé
  - Distribution 2.000 km tracé
  - Peak load plants 22
  - Boilers 56

Capacity 740 MJ/s

- Supply coverage in supply area
- District heating 98 %
  - Natural gas and others 2 %

Heat production 2013

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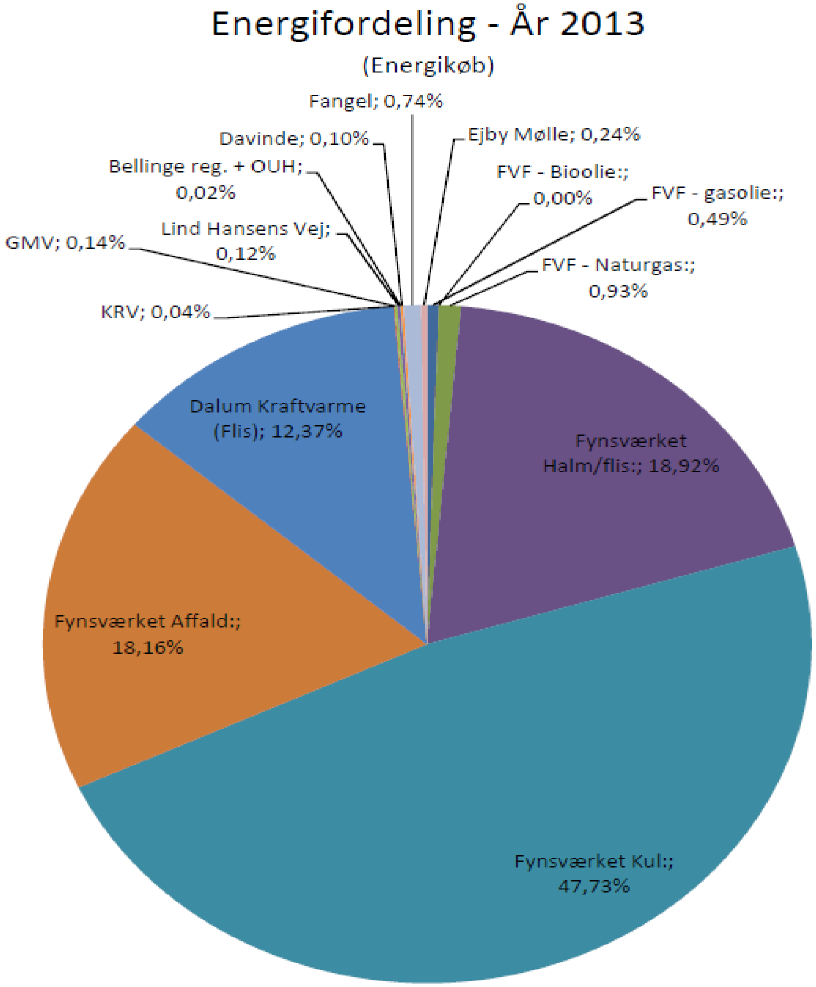

Leverandør	År 2013	
	GJ	%
FVF - gasolie:	38.006	0,49%
FVF - Bioolie:	0	0,00%
FVF - Naturgas:	72.351	0,93%
Fynsværket Halm/flis:	1.477.598	18,92%
Fynsværket Kul:	3.726.907	47,73%
Fynsværket Affald:	1.418.239	18,16%
Dalum Kraftvarme (Flis)	965.712	12,37%
KRV	3.375	0,04%
GMV	10.911	0,14%
Lind Hansens Vej	9.045	0,12%
Bellinge reg. + OUH	1.676	0,02%
Davinde	8.082	0,10%
Fangel	57.714	0,74%
Ejby Mølle	18.800	0,24%
Total:	7.808.417	100%

Fynsværket – Vattenfall

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Fynsværket - Vattenfall

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IRON diagram blok 7 FV

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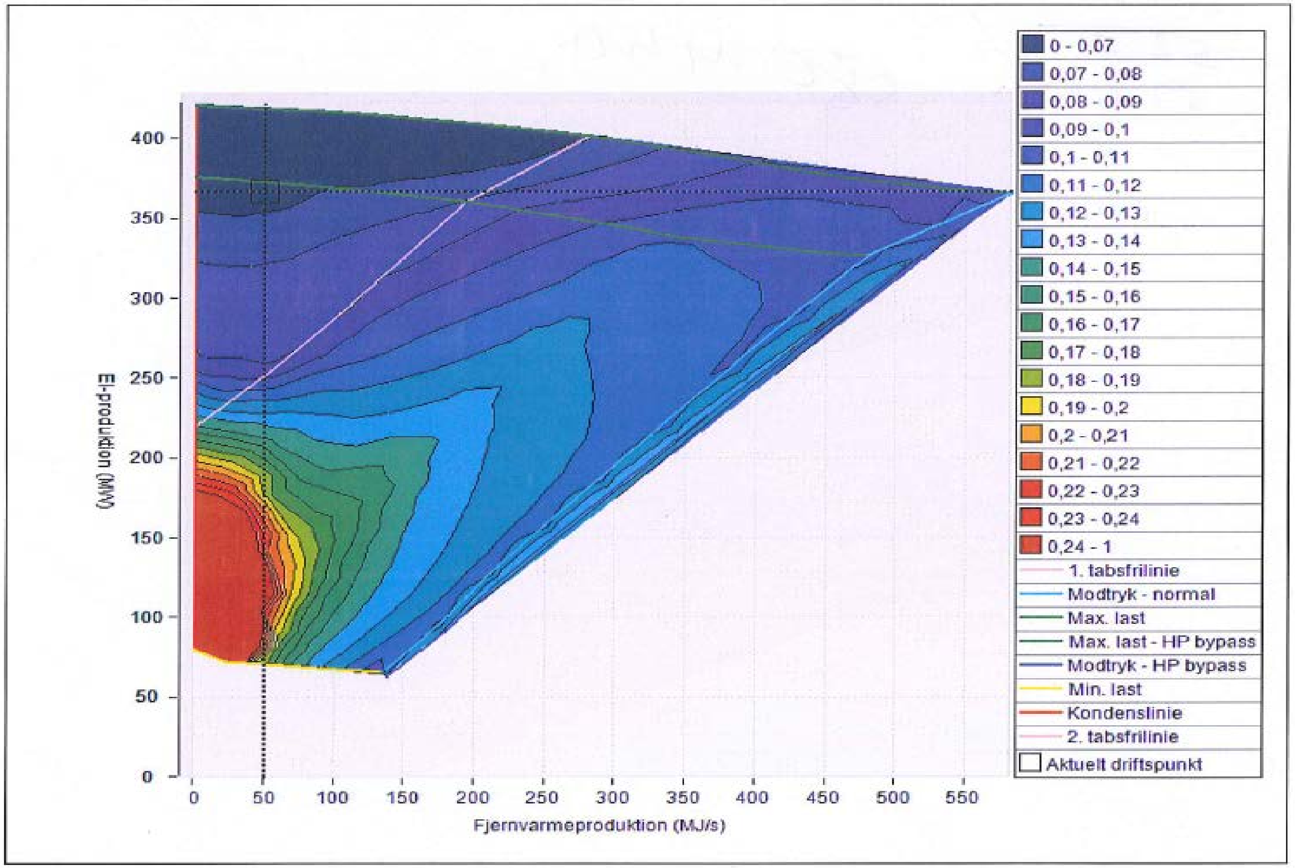

1The Iron Diagram for Odense CHP station – the relationship between its power output and the heat output. MWe electrical power vertical axis, MWth heat on the horizontal axis

Unloading of straw

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Waste Incineration.

- **284.000 ton Waste/year ~ 100.000 t coal**
- **ODV 11 Comm. 1996, 5 MWe 14.5 MJ/s**
- **ODV 12 Comm. 1996, 5 Mwe 14.5 MJ/s**
- **ODV 13 Comm. 2000, 29 MWe 35 MJ/s**
- **Total 32 t Waste/h.**
- 22 % of total heat demand.
- CO_2 reduction: 200,000 t per year.

The storage tank at the power plant – one of the largest in Europe

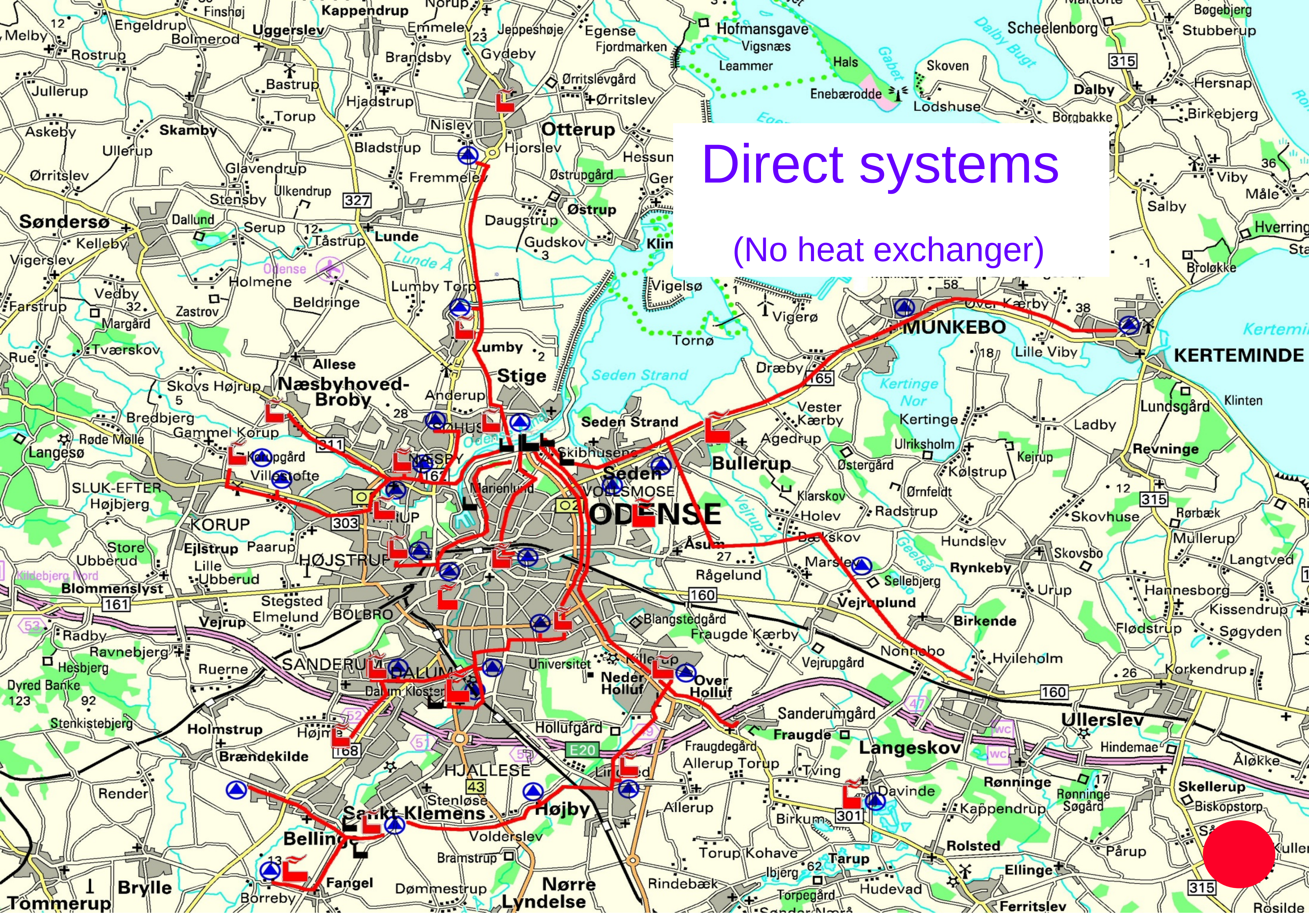
- **Gross Volume: 75.000 m3**
- **Net Volume: 66.000 m3**
- **Net Energy Content: 4.145 MWh (92°C) – i.e. 9 hour rated maximum heat production from Unit 7**
- **Max discharge: 10.000 m3/h or 627 MJ/s - i.e. about 75% of rated maximum heat production from Unit 7**
- **This tank make it possible to planing stop at the plant and we have time enough to start boilers.**

Dalum CHP

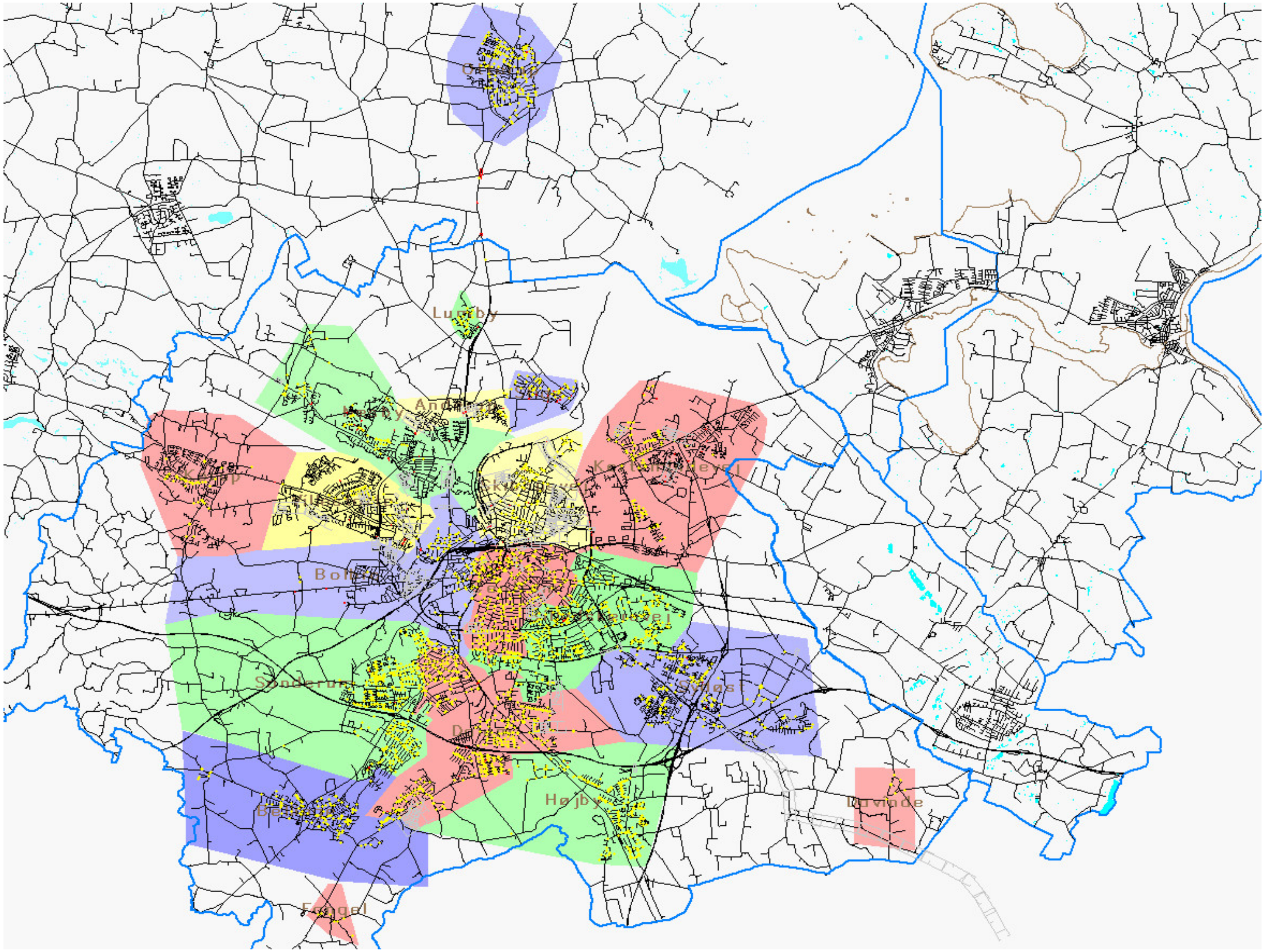
- Former paper factory
- 48 MJ/s thermal
- Wood chip fired

Direct systems

(No heat exchanger)



Zone overview



Hydraulic and thermal modelling of the network

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- Fjernvarme Fyn A/S use TERMIS software for hydraulic and thermal modelling
- Models are build from GIS data (pipes, consumers)
- Network models used for:
  - design of network
  - What if scenario calculations, planning
  - Operation monitoring with realtime simulation models (intergration with SCADA system)
  - Optimazation of suply temperature
  - Pump optimazation

Temperature optimization. Target

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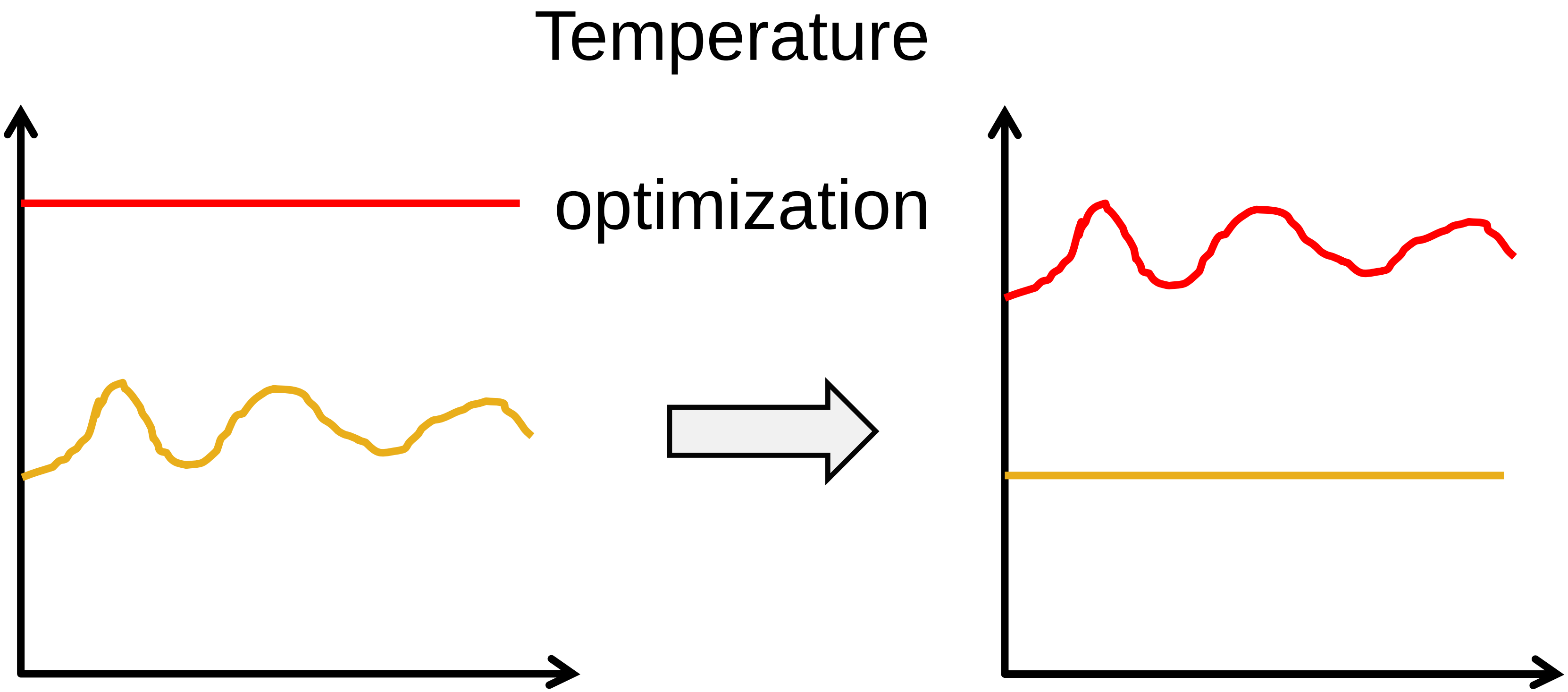
Purpose: To reduce energy consumption (heat loss and pumping energy)



Supply temperature from central

Supply temperature at consumer

Temperature distribution

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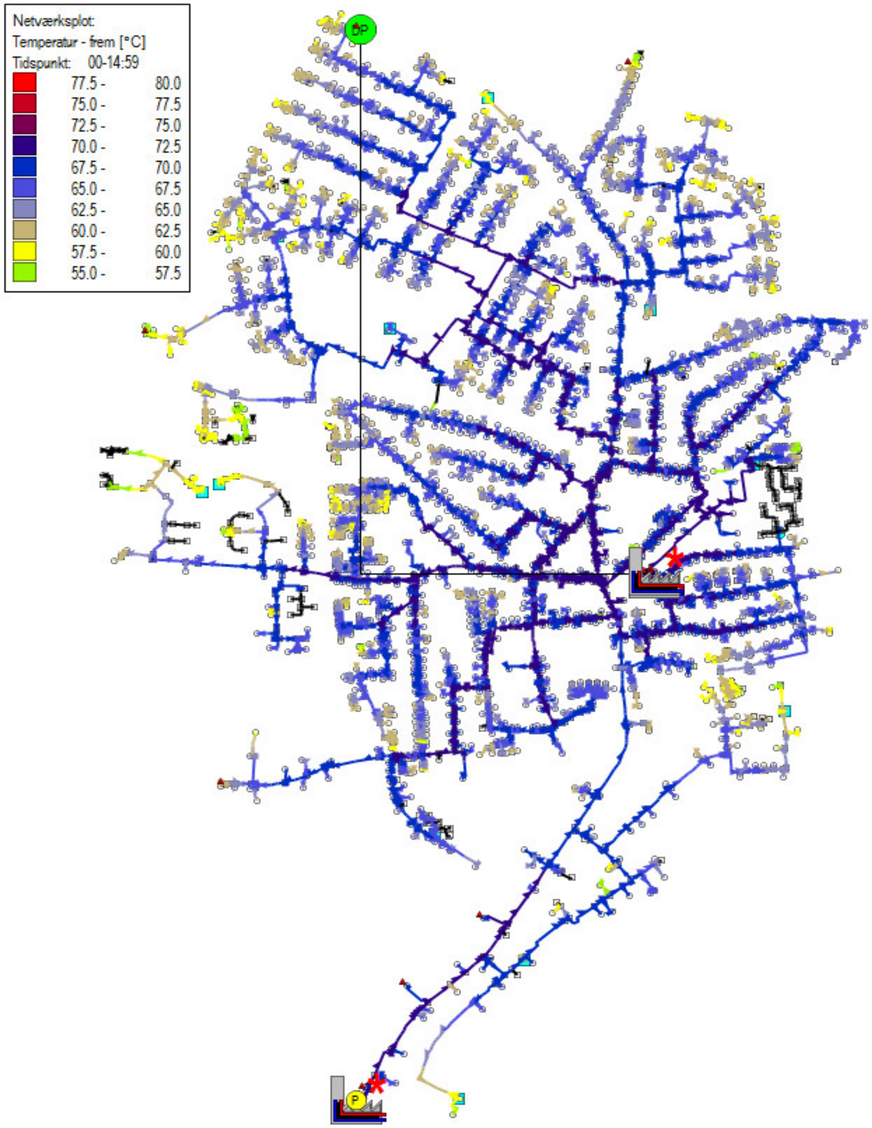

To reduce loss we use temperature optimization in the network, we have 18 shuntpumps for this

Roules

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Restrictions

- **Media velocity < 2 m/s**
- **Max pressure < 60 mVS**
- **Max pressure difference : 3,5 bar**
- **Min pressure difference : 0,5 bar**
- **Temperature in distribution pipes> 60 °C**

Temperature optimization. Load forecast

- **In the DH system of Fjernvarme Fyn A/S the optimal supply temperature is the lowest possible that meets, either:**

  1. **the required minimum temperature of 60 degrees C in the distribution pipes in all parts of the network (summer and transition periods), or**

  2. **the demand for heat in cold periods without exeeding the pressure limits in the pipes and pumping capacity.**

- **By the end of 2012 temperature optimazation has been impelented in all supply zones.**

- **The reduction of heat loss was approximately 10 %.**

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Some wishes for results of CITIES regarding district heating in future smart energy systems

- **Improved modeling of consumption / heat demand. For both operation and design of district heating network and production facilities.**

- **Tools for integrated optimization of operation of district heating systems, heat production, distribution and consumption**

- **Tools for long term energy / investment planning**