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4DH
4th Generation District Heating Technologies and Systems

Cost of District Heating and Individual Heating Technologies

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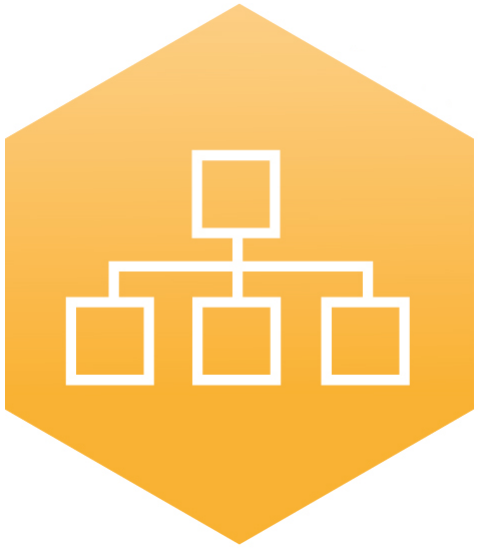

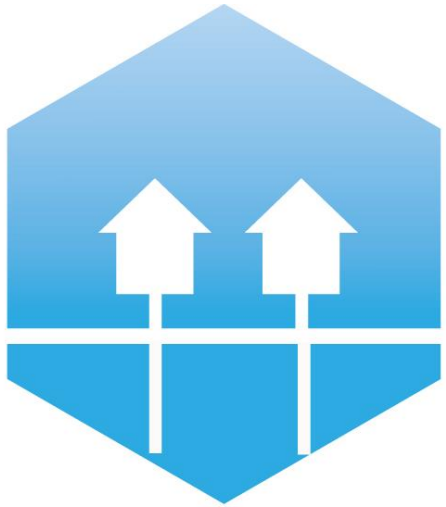

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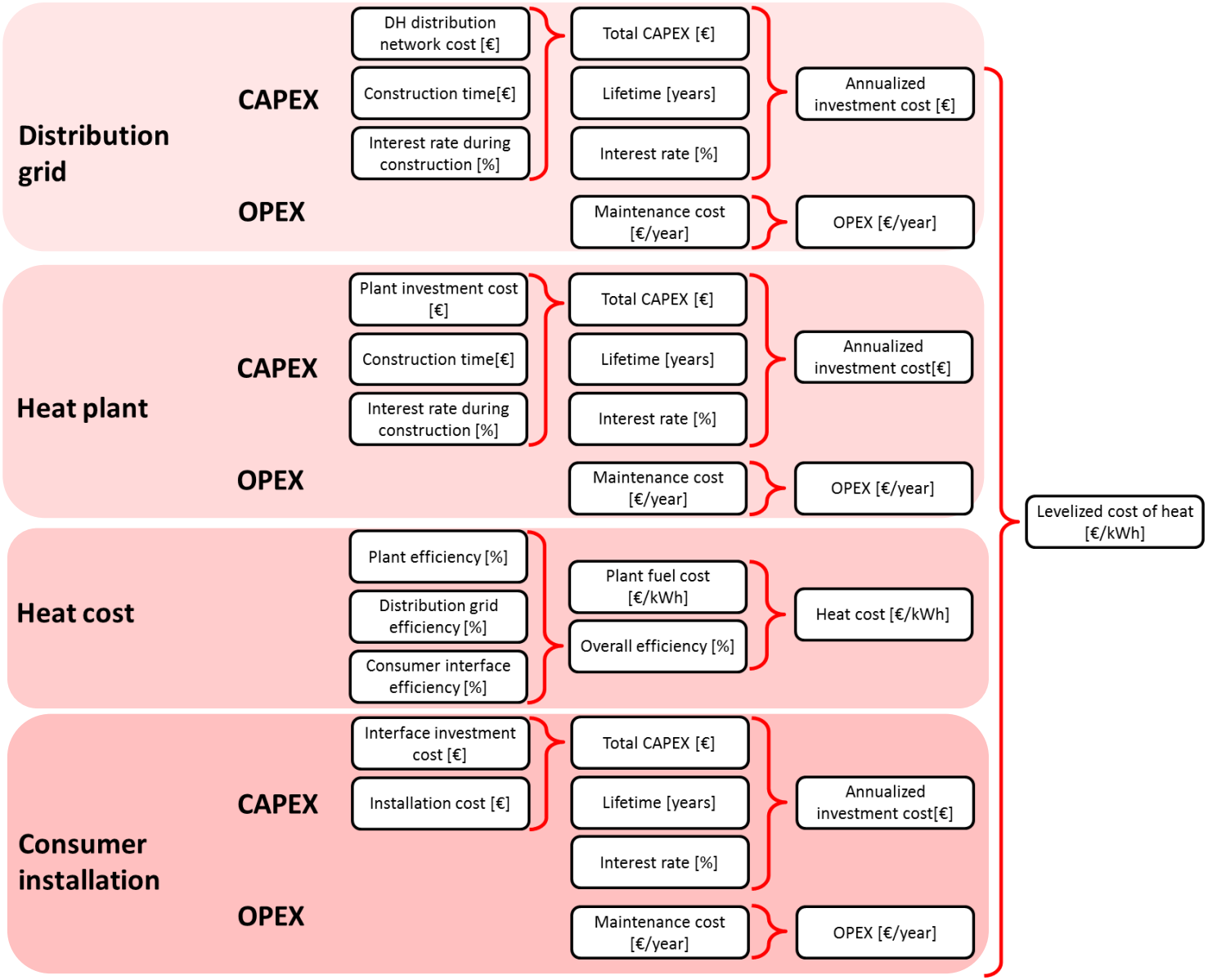
Introduction

- The cost of heat is dependent on the utilization of the heat plant
- Investment expensive heat sources can produce the cheap heat, given high enough utilization of the heat source
- To minimize the heat cost it is necessary to optimally choose the heat sources

Calculation model



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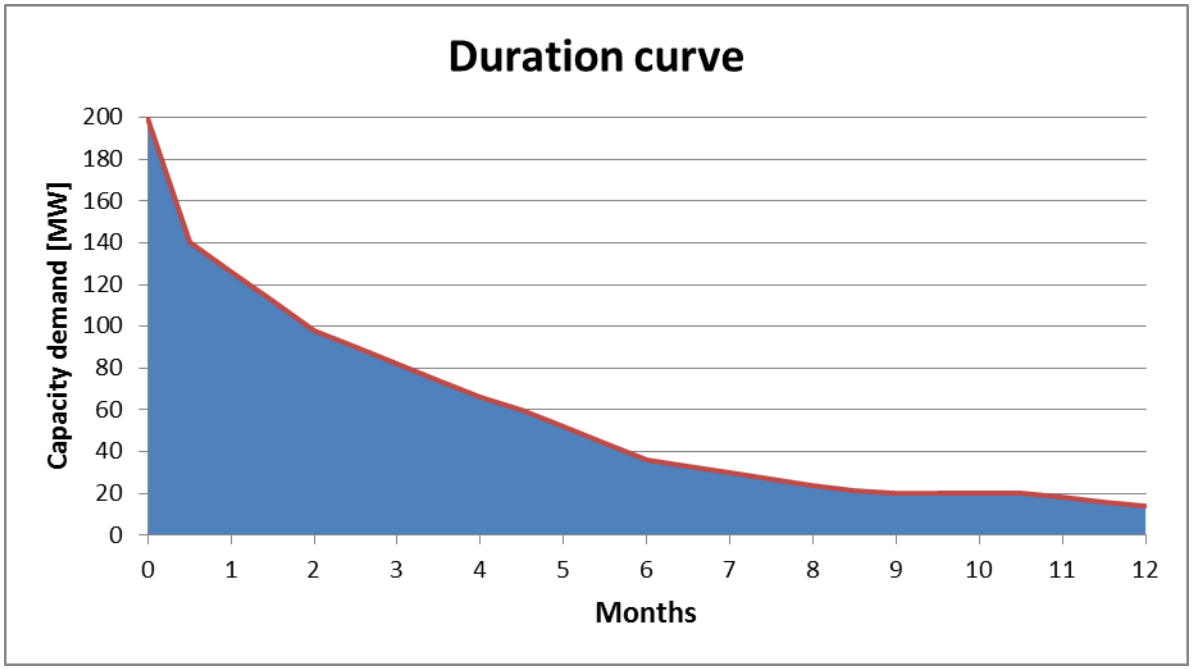
Impact of heat demand on heat source utilization

- If we look on the heat load curves from district heating we typically have something like the following:



One **200 MW** plant would have approximately **29% yearly utilization**

- How to choose the right heat source or mix of heat sources for the given heat demand profile?

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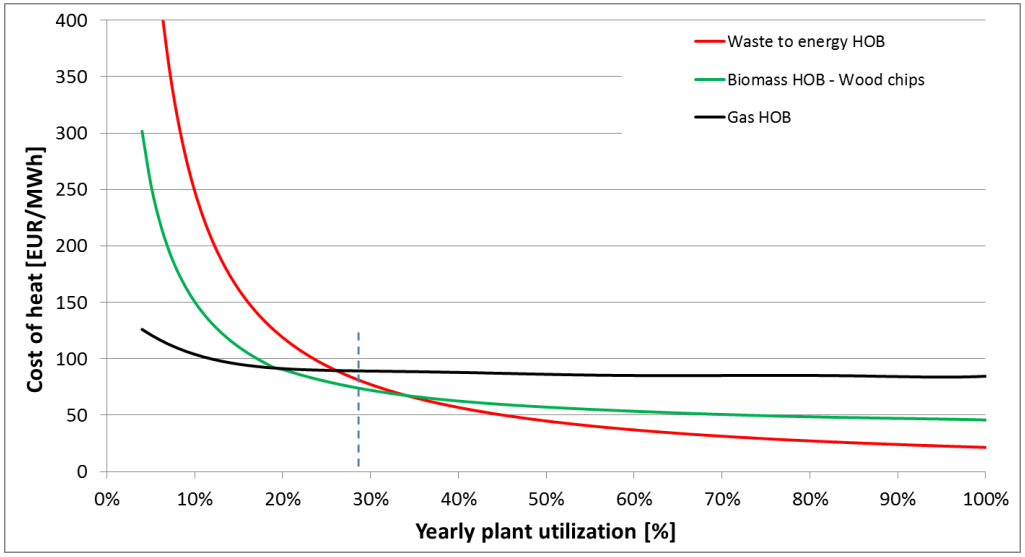
Cost of heat from different sources

- Example of available heat sources:
  - Waste incineration HOB – Sizes 15-50 MW (minimum 60% down regulation)
  - Biomass HOB – Sizes 1-50 MW (minimum 25% down regulation)
  - Natural gas HOB



- It is clear that the base load provide should be the waste to energy plant

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Sources:
Generation of Electricity and District Heating, Energy Storage and Energy Carrier Generation and Conversion - TECHNOLOGY DATA FOR ENERGY PLANTS, Danish Energy Agency, 2012
Waste gate fees: https://stateofgreen.com/files/download/275 (-27€/ton)
DH fuel prices: Danish District Heating Association. Heating fuel price statistics.

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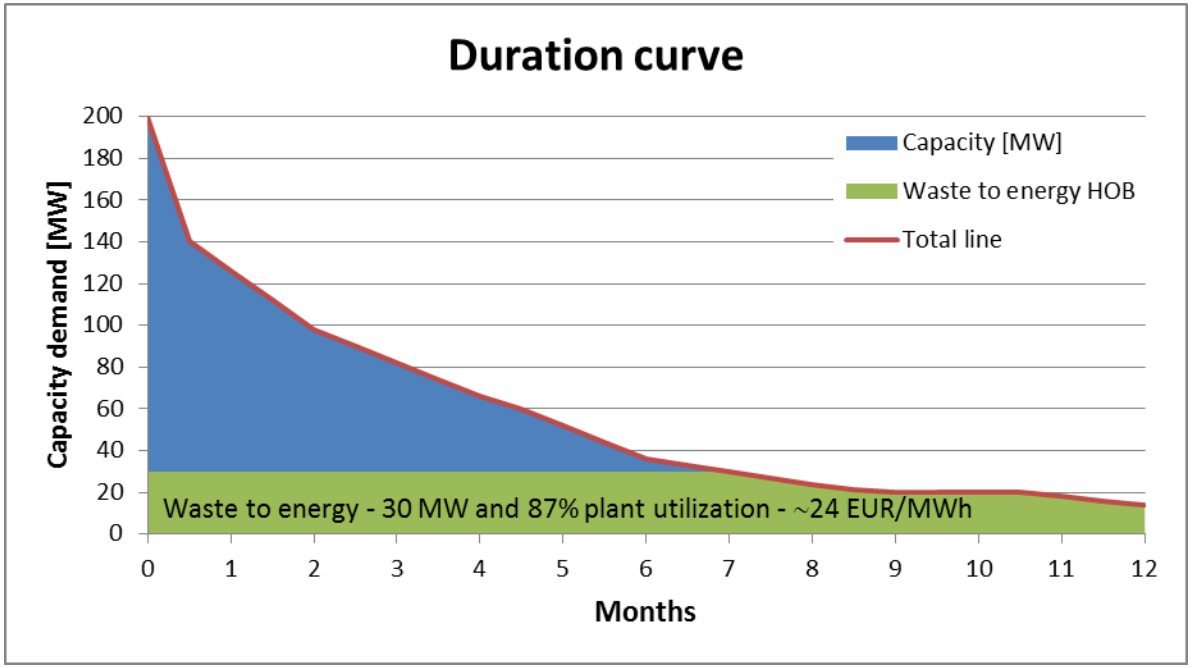
Pooled heat sources

- If we assume that we have possibility to run 30 MW waste to energy plant to cover baseload we get the following:



- Now the remaining issue is to dimension the biomass HOB

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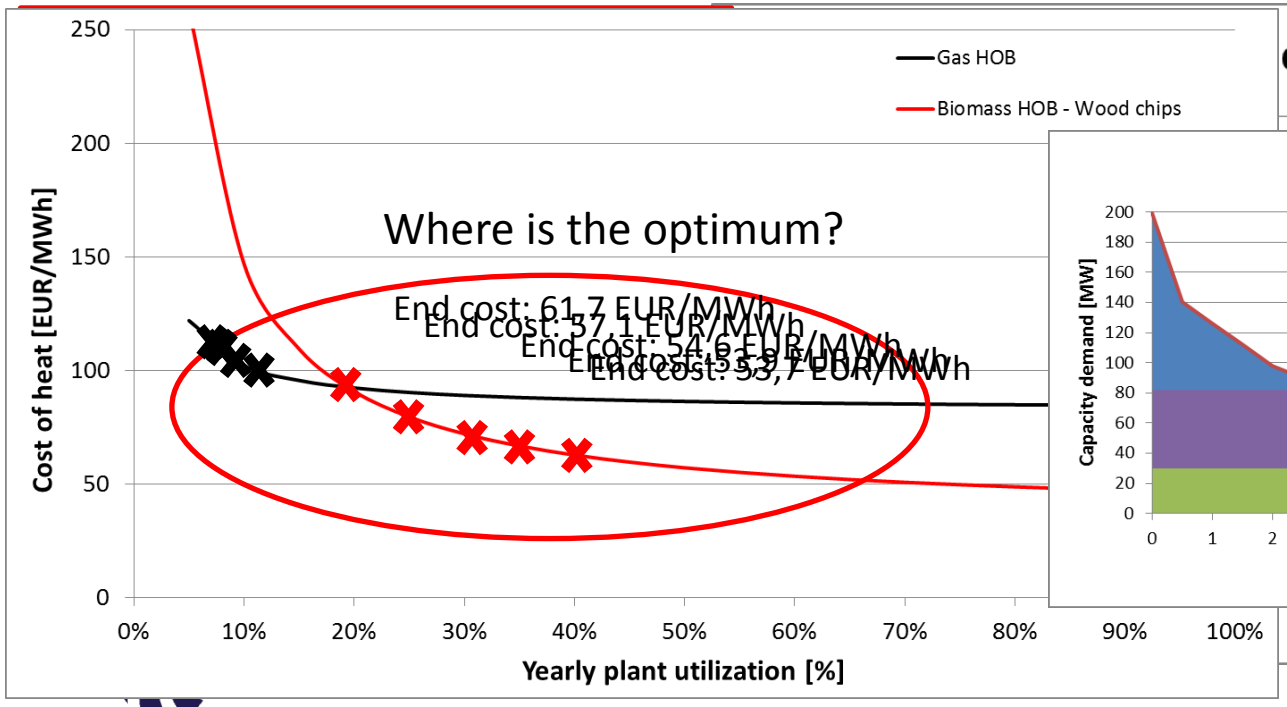
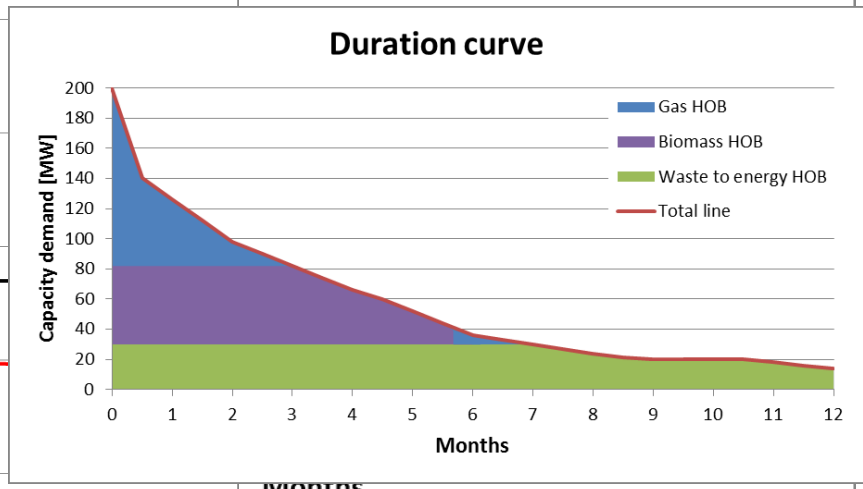
Pooled heat sources

- To dimension the second heat source we need to consider that the optimum will depend on:
  1. The heat demand curve
  2. The heat cost given plant utilization





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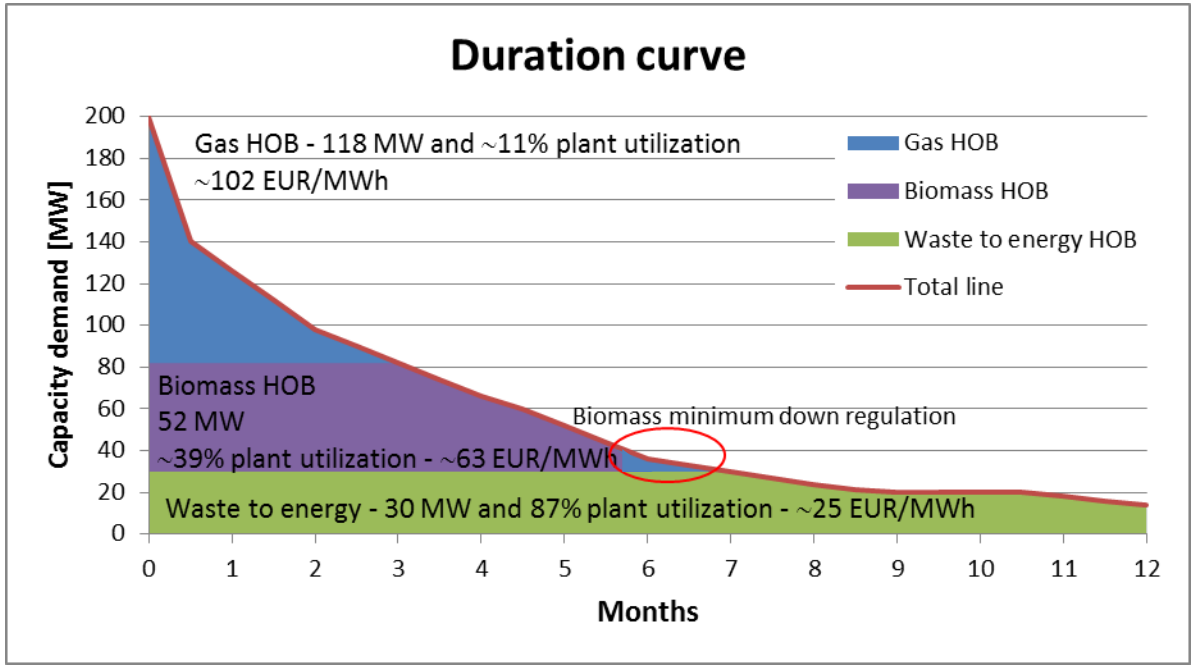
Pooled heat sources

- Given underlying assumptions and data the optimum plant combination in respect to heat cost would become



- Average heat cost: 53.7 EUR/MWh

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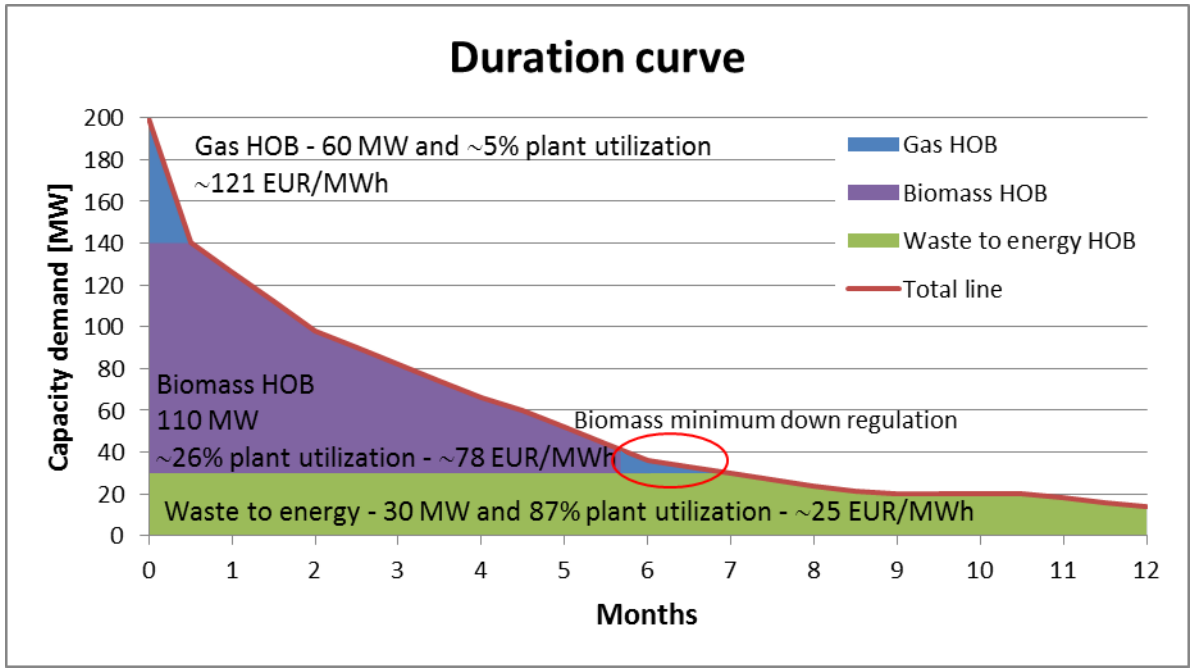
Pooled heat sources

- However by accepting 2,6 EUR/MWh higher heat costs the use of the gas HOB could be reduced by 76%



- Average heat cost: 56.3 EUR/MWh

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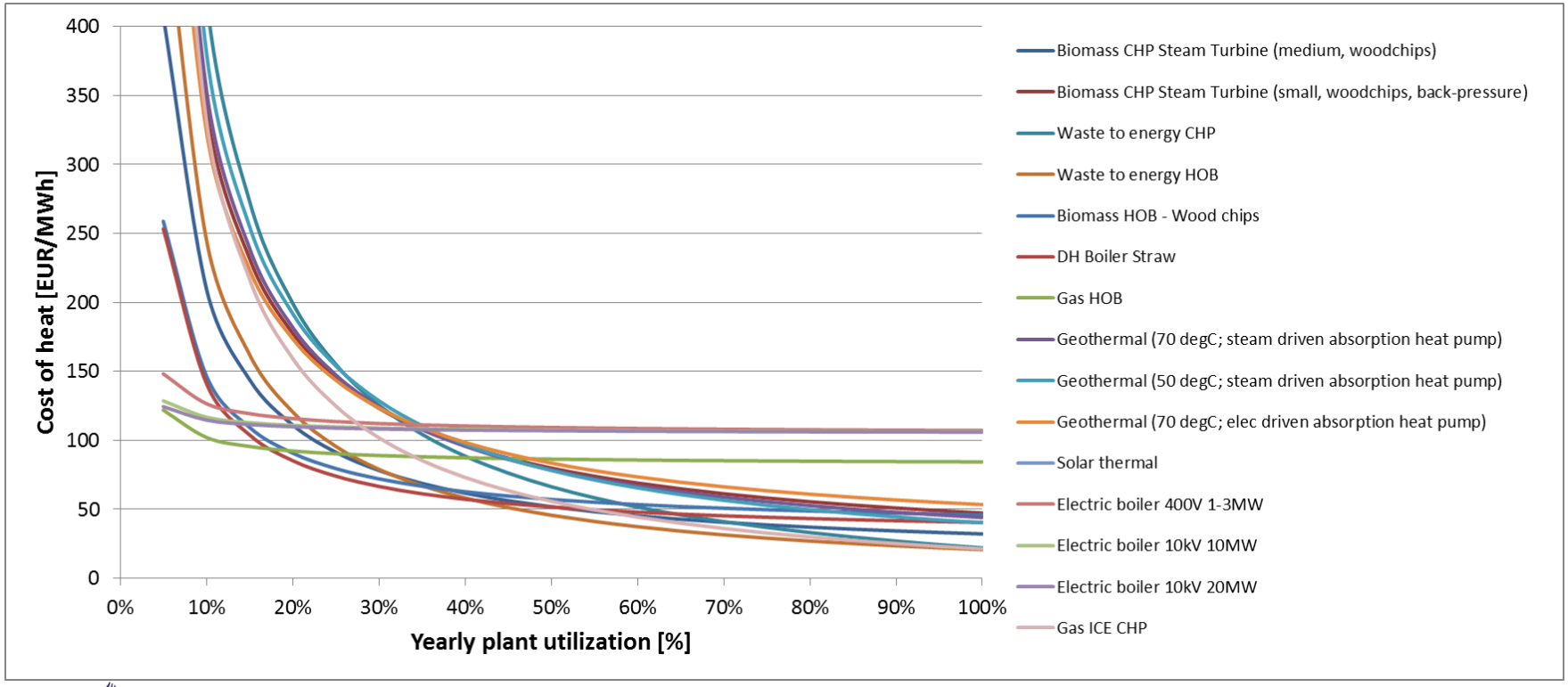
Other plants

- This approach can be used for all heat sources:



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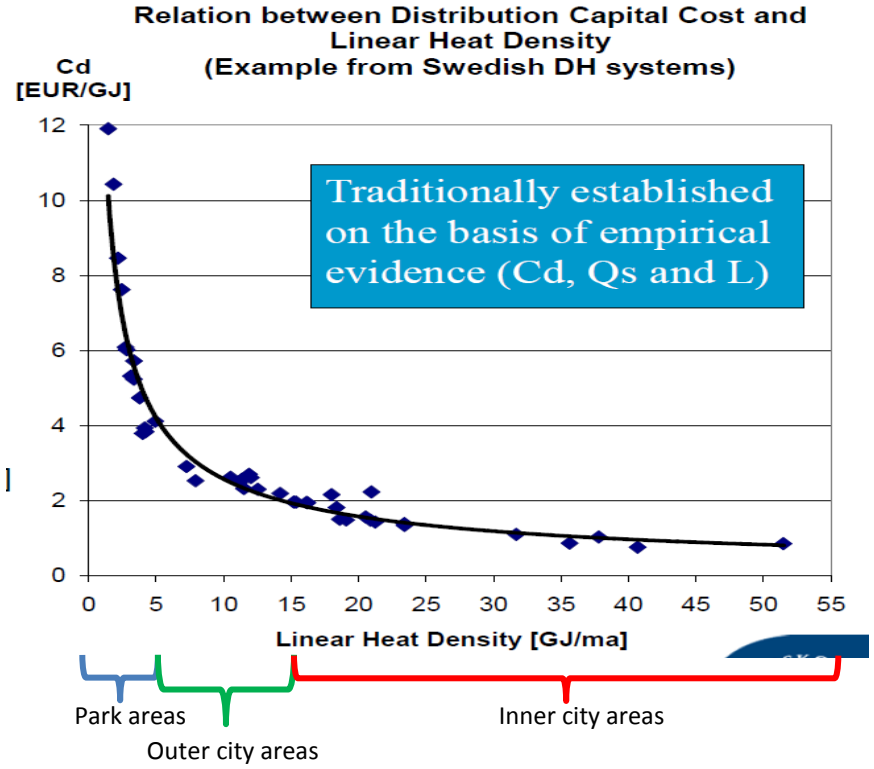
Cost of the distribution grid

- Estimating the cost of establishing district heating distribution grid can be difficult
- This can be done using data gathered in Sweden by Urban Person and Sven Werner at Halmstad University



The Distribution Capital Cost – empirical approach;

$$C_d = \frac{a \cdot (C_1 + C_2 \cdot d_a)}{\left(\frac{Q_s}{L}\right)}$$

a = Annuity	[1/a]
C_1 = Construction cost constant	[EUR/m]
C_2 = Construction cost coefficient	[EUR/m^2]
d_a = Average Pipe Diameter	[m]
Q_s = Annually sold Heat	[GJ/a]
L = Total Trench length	[m]
Q_s /L = Linear Heat Density	**[GJ/ma]**

Source:
Urban Person and Sven Werner. Effective Width - The Relative Demand for District Heating Pipe Lengths in City Areas. The 12th International Symposium on District Heating and Cooling, 5th -7th September, 2010, Tallinn, Estonia

Cost of distribution grid and consumer interfaces

- Using the distribution cost data from Urban and Sven, estimation of the cost of a service pipe and the average cost of flat stations the total investment cost can be estimated

		Home installation / Substation					Distribution grid				
Type	Linear heat density GJ/(m y)	Investment cost	Installation cost	Lifetime	Substation O&M €/year	Substation efficiency	Investment cost	Service pipe	Lifetime	Grid O&M €/MWh	Grid efficiency
Inner city area	15	1.000	1.500	20	66	98%	1.400	500	50	0,9	90%
Outer city area	10	1.000	1.500	20	66	98%	1.500	1000	50	0,9	80%

*Assumptions:
Outer cities have high share of single family houses while inner cities have high share of multi apartment buildings.
Individual household interfaces are installed at all households
The cost of the service pipe reflects the building mixture.
*For estimating the cost per kWh the following heat demand is used:
Heat demand in outer city areas: 15.000 kWh/house
Heat demand in inner city areas: 7.000 kWh/apartment

- Cost of heat delivered to consumers: **Outer city areas: 91 EUR/MWh**
  Inner city areas: 106 EUR/MWh – **Cost is divided on fewer kWh**

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Individual solutions

- By applying the same cost calculation approach as presented earlier it is possible to estimate the cost of individual heating solutions

Heating technology	Gas boiler	Air source heat pump	Ground source heat pump	Electrical boiler	District heating
Inner city EUR/kWh	0,18	0,26	0,30	0,29	**0,11**
Outer city EUR/kWh	0,14	0,17	0,19	0,26	**0,09**

- From this it is clear that district heating with multiple heat sources has bright future

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Sources:
Individual Heating Plants and Energy Transport - TECHNOLOGY DATA FOR ENERGY PLANTS, Danish Energy Agency, 2012

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Conclusion

- From the analysis above it is clear that district heating systems with multiple heat sources can achieve very favorable heat prices for its consumers
- The heat cost curve is relatively flat and can further optimized to reduce unwanted emissions
- Individual heating solutions should only be used in park areas where the district heating distribution and heat loss cost becomes too high
- Low temperature district heating would give a better case through lower network heat losses

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Thank you for the Attention

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