4DH
4th Generation District Heating Technologies and Systems

LOW TEMPERATURE DISTRICT HEATING SYSTEM A MODELLING APPROACH

3rd 4DH Annual Conference

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DEPARTMENT OF ENERGY TECHNOLOGY
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Outline

- What is the **problem**
- Main **idea**
- The **approach**
- Results, Conclusion and discussion
- Next **steps**

What is the problem

In order to apply **low-temperature** concept for an existing district heating network:

1. Winter Time, Peak heat load periods

2. Summer Time, Low heat load periods

There is need for new strategies in District Heating System.

Main idea

Develop a model for **thermo-hydraulic** calculation of District Heating Networks (DHN)

- Optimal supply temperature in existing DHS

  Heat loss in DHN, Pump power demand, Return temperature to the plant

- Apply different solutions in developed model

  Local heat pump for DHW temperature boosting,
  Include individual heating systems
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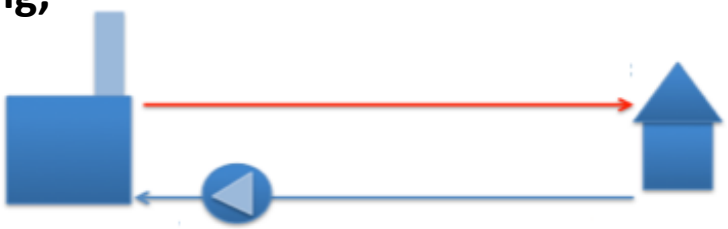
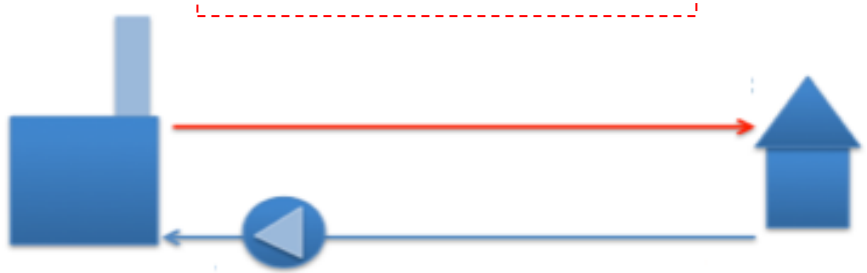


DHN modeling

Time delay

- Transportation time from the power plant to the consumers and back again
- Distance
- Flow velocity
- Pipe heat capacity

Distribution Network Dynamics



DHN modeling

Heat loss

- Difference between the DH water temperature and the surrounding soil temperature
- Insulation material and thickness
- Pipe material and size
- Pipes configurations

Pressure loss

- Pipe material, Pipe length, Pipe size
- Flow velocity

Distribution Network Dynamics

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Dynamic of Consumers

DHN modelling

Fully Dynamic modelling

- Both temperature and flow are simulated dynamically
- Very short time steps (0.5 – 2 s)
- Very large computer capacity
- Long calculation time

Pressure and flow changes are spreading around 1,000 times faster than temperature fluctuations.

DHN modelling

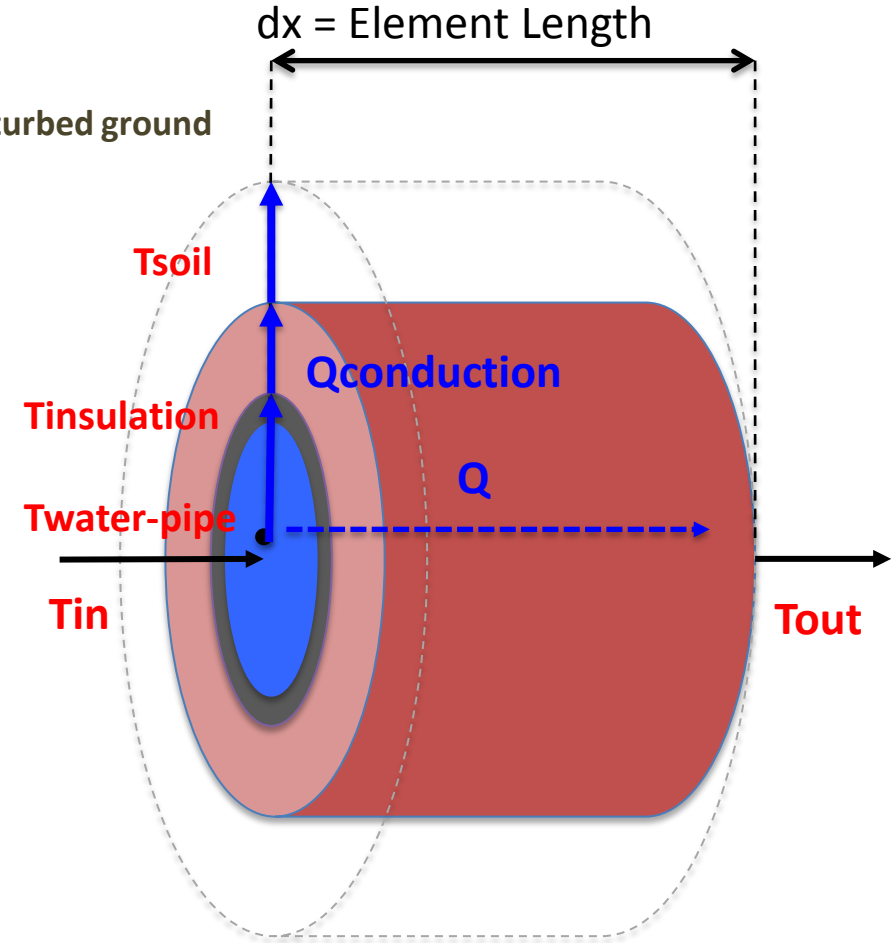
Pseudo- Dynamic modeling

- The network is modelled in regular time intervals (hourly or less time intervals).
- Flow and pressure are modelled steady state.
- Transient temperature is calculated dynamically.

DHN modelling

Temperature Dynamic simulation

- Finite element method
- Implicit numerical approximations



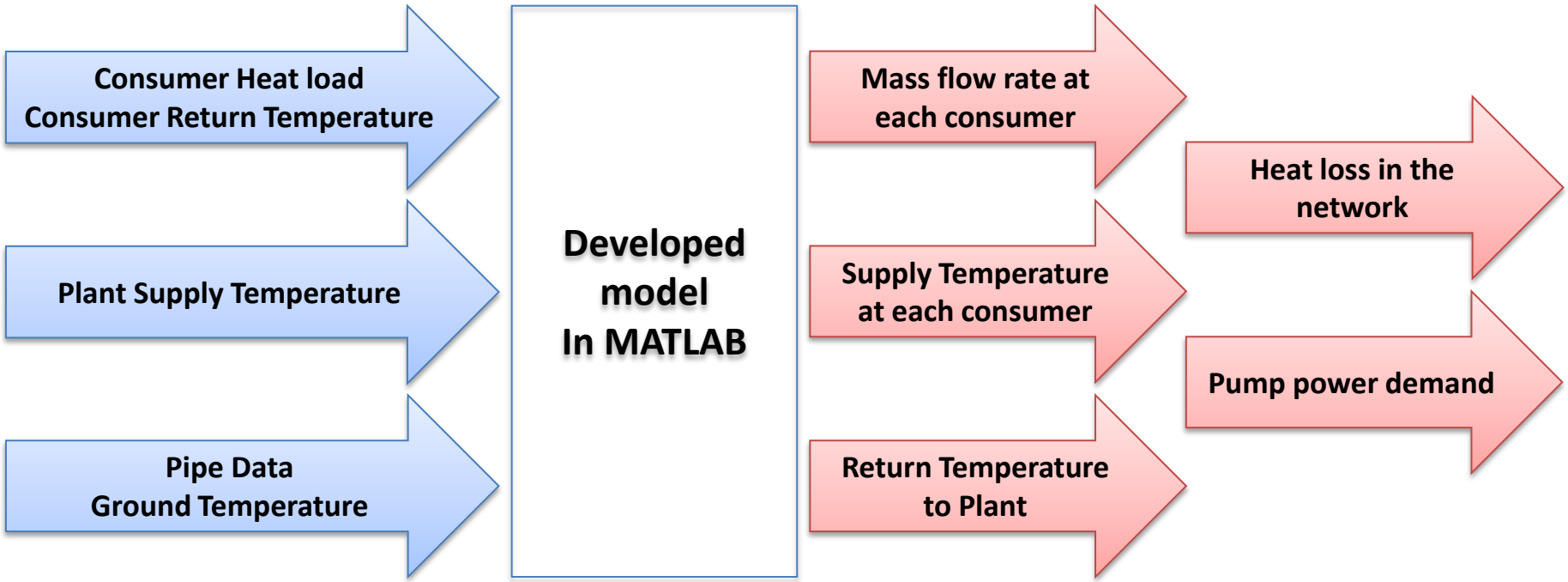
Pipe element sections

DHN Modelling

Main assumptions

- Slug flow- Uniform velocity in radial direction
- Axial heat transmission is neglected.
- No temperature rises due to friction losses by converting pump energy into heat
- No Interaction between return and supply pipe
- Constant water properties

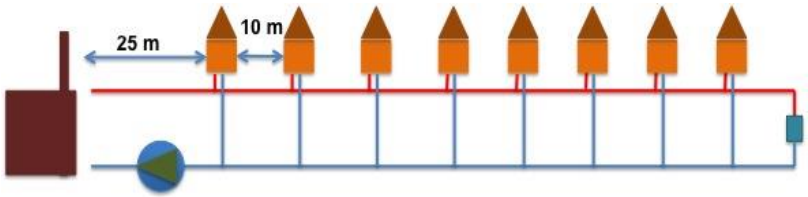
Model structure



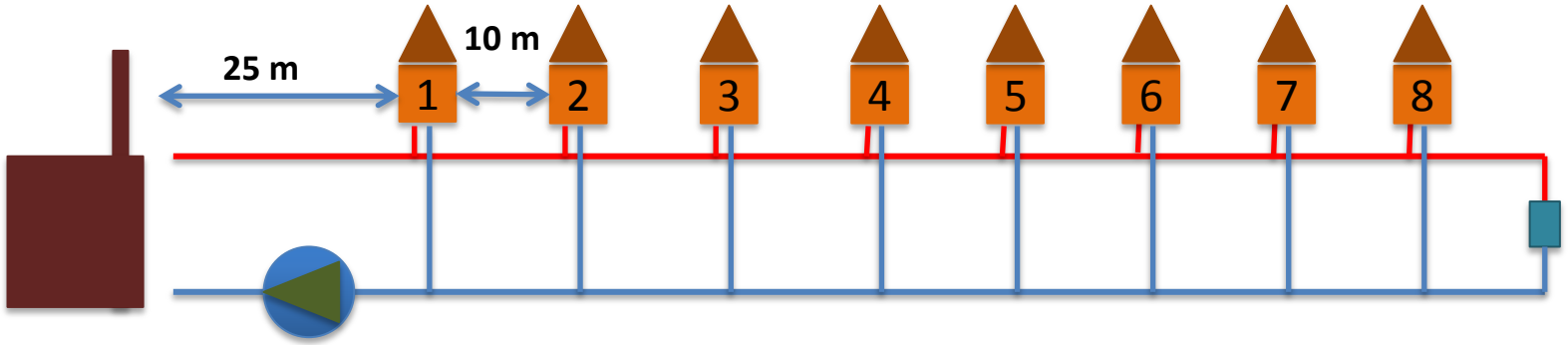
Developed model

The model is applied for a typical summer and winter day by using Hourly data :

- A District Heating system with 8 Consumers
- Plant supply temperature = 75 °C
- Soil temperature = 4 – 14 °C

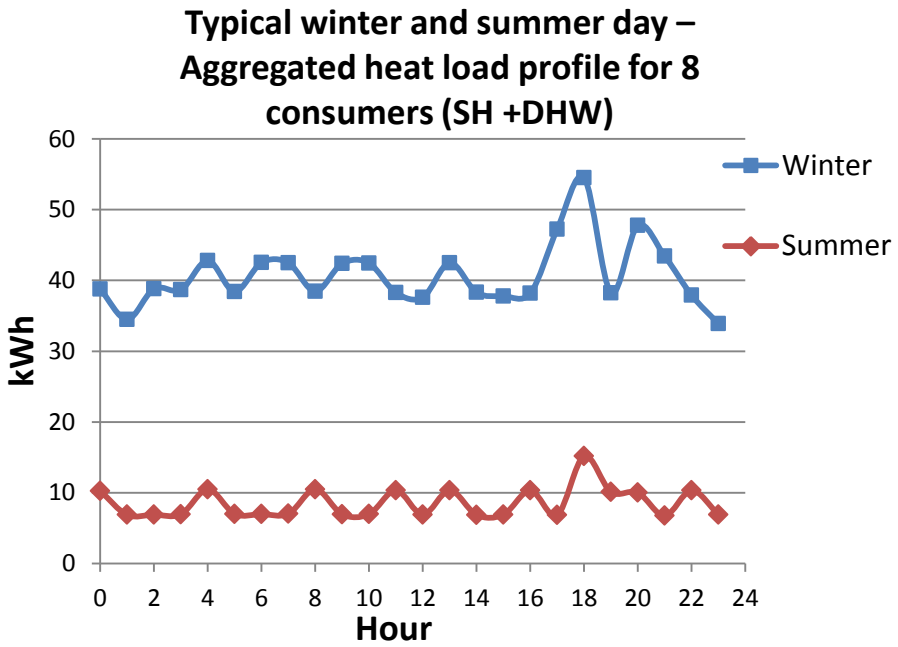


Developed model



Pipe Type	Aluflex Single pipe
Supply Temp	75°C
Element length	1 m
Time interval	1 hour – 3600 s

*Aluflex : PEX/PUR



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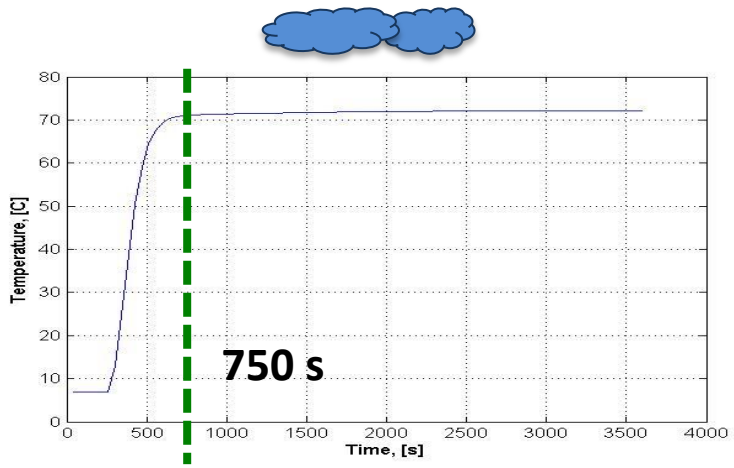
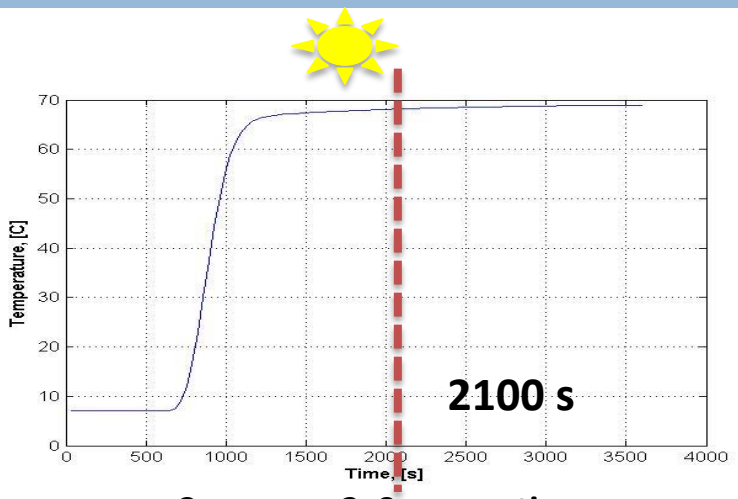
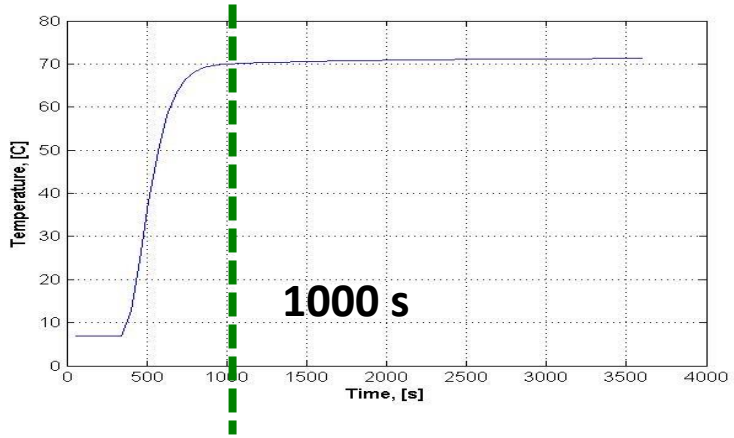
Developed model



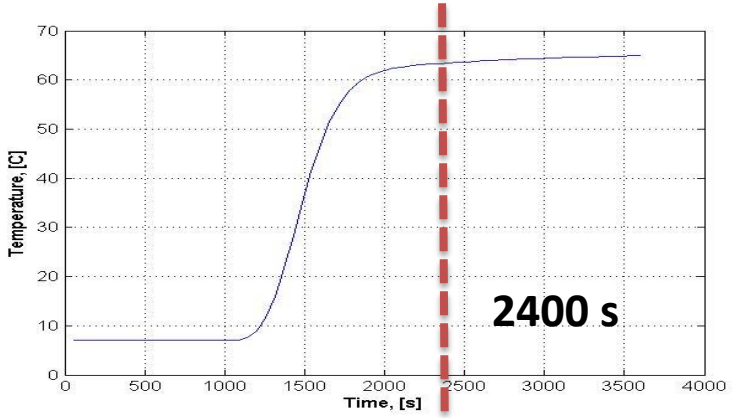
Consumer 2, Winter time



Consumer 2, Summer time



End consumer, Winter time



End consumer, Summer time

Developed model

	Summer Time	Winter Time
Total Heat supply (kWh) - Qs	227	1000
Total Heat loss in DHN (kWh) - Qhl	19	24
Pump power demand (kWh)	0,0083	0,66
Qhl/Qs %	8,3	2,4

Next Steps

- Validation
- Optimal Supply Temp for an existing DHN – Energy consumption cost

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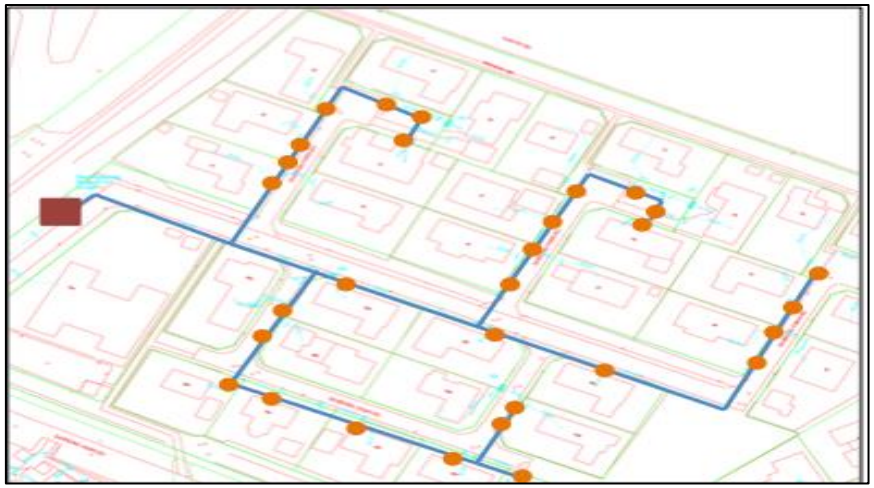

GIS data for part of Skæring

Questions?

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