DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

4DH
4th Generation District Heating Technologies and Systems

Conversion of existing District Heating to Low-Temperature operation and extension of new areas of buildings

Soma Mohammadi

smo@et.aau.dk

4DH PhD Seminar

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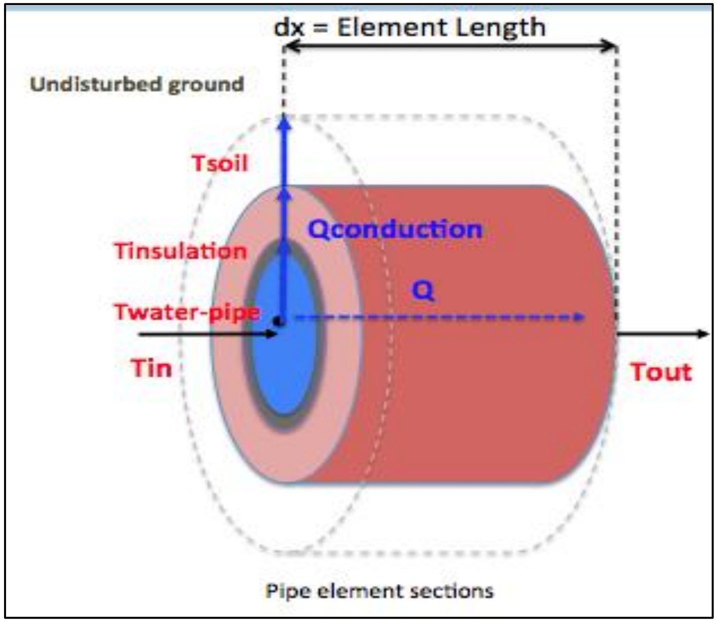
Modeling District Heating Networks

- A model has been developed in MATLAB for thermal dynamic Modeling of DHN
- The model is used for applying several strategies in order to reduce temperature gradient in DHS
- It can be used as a platform to implement low temperature concept for DHS by integrating both consumers and alternative heat sources

Model Description

The main focus is on modeling transient heat transfer in pipe networks regarding the time delays between heat supply unit and consumers, the heat loss in the pipe networks and consumers' dynamic heat loads.

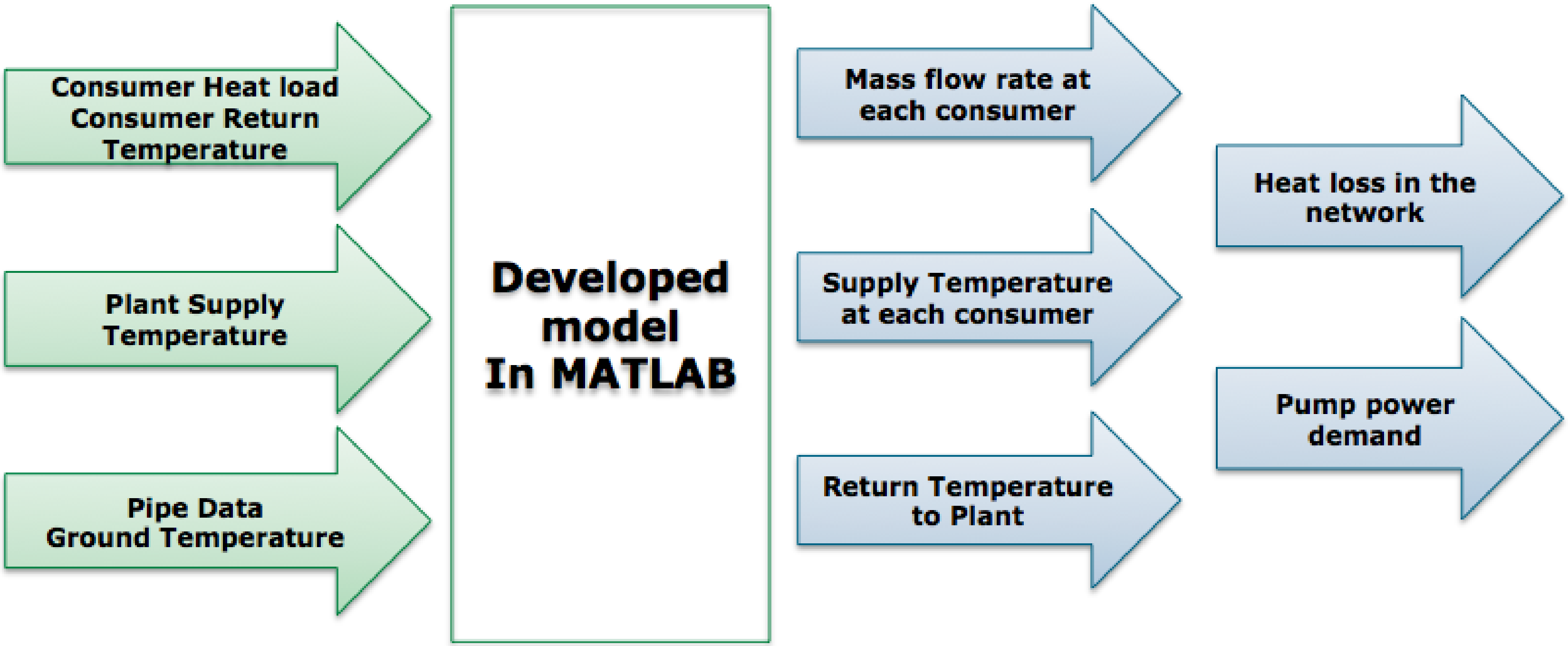
- Pseudo – dynamic approach
- Implicit finite element method to solve heat balance equations



Assumptions:

- No Hydraulic dispersion
- No Interaction between return and supply pipe
- No axial heat transmission
- No dissipation

Model structure



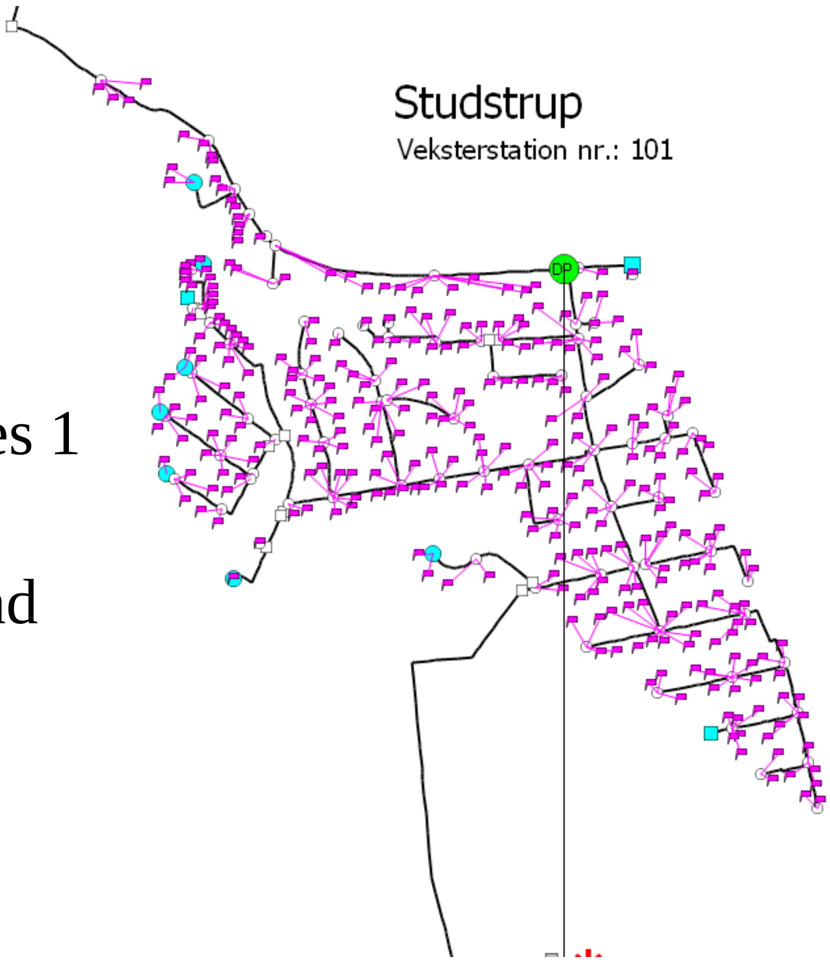
Model validation

- In order to validate the model, the model is applied for a DHN in Studstrup.

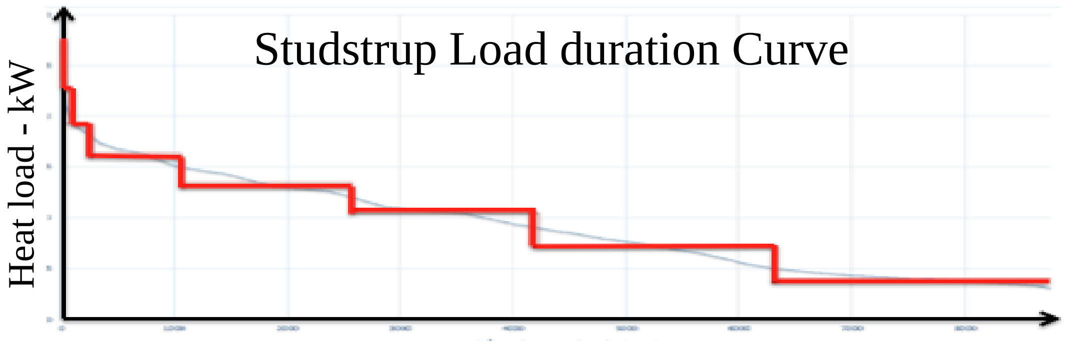
- The obtained results are compared with TERMIS model of the Studstrup which is based on real time measurement.

Studstrup DHN

- 321 Consumers are connected to DHN (reduced to 107 Nodes)
- Approximately 13,850 m pipe networks(supply and return)
- Single pipes with Insulation series 1 and 2 are used in DHN
- 26 Bypass with 60^{o}C set point and 2.5^{o}C Deadband



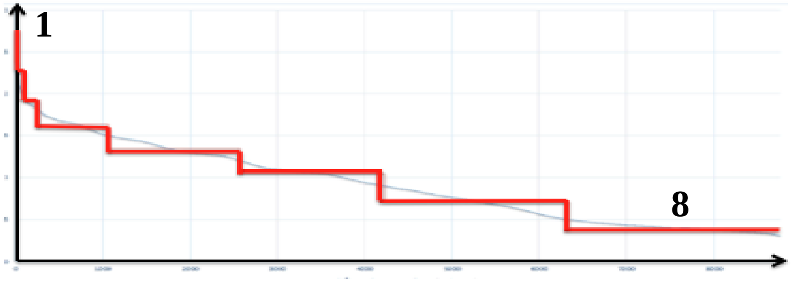
Modeling Studstrup DHN



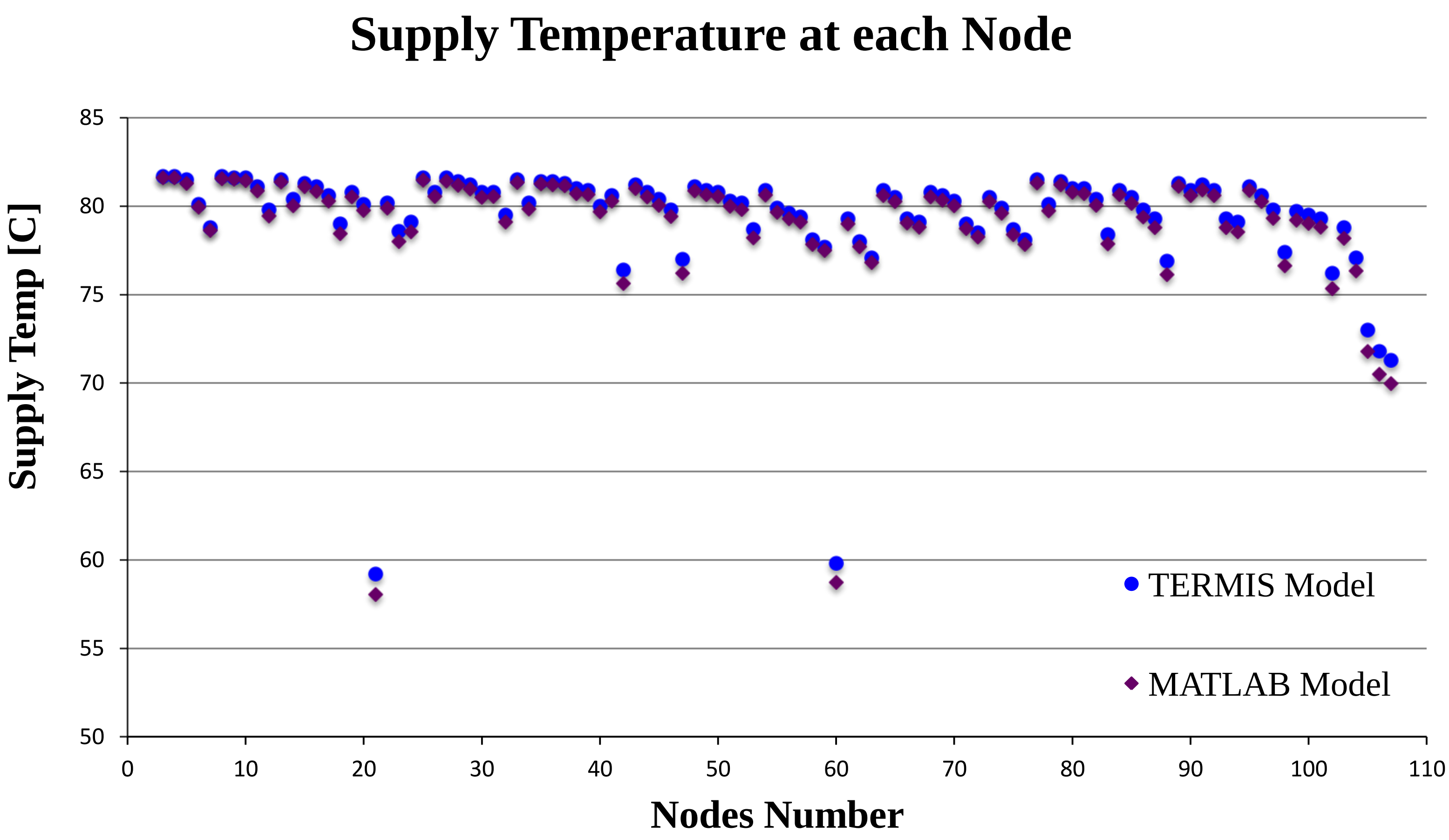
	1	2	3	4	5	6	7	8
Hours	1	21	247	783	1523	1653	2116	2441
Soil Temp [C]	1.8	1.9	2.4	2.9	3.5	5.4	9.9	16
Supply Temp [C]	82	79.1	74.2	73.2	73	72.9	72.9	72.6
Return temp [C]	37.2	36.9	36.6	36.3	36	36.7	39.1	43.7
Load factor	1.33	1.07	0.862	0.727	0.580	0.432	0.247	0.132
Return Temp offset [C]	-2.6	-2.8	-3.1	-3.2	-3.3	-2.5	0	5.7

Validation results

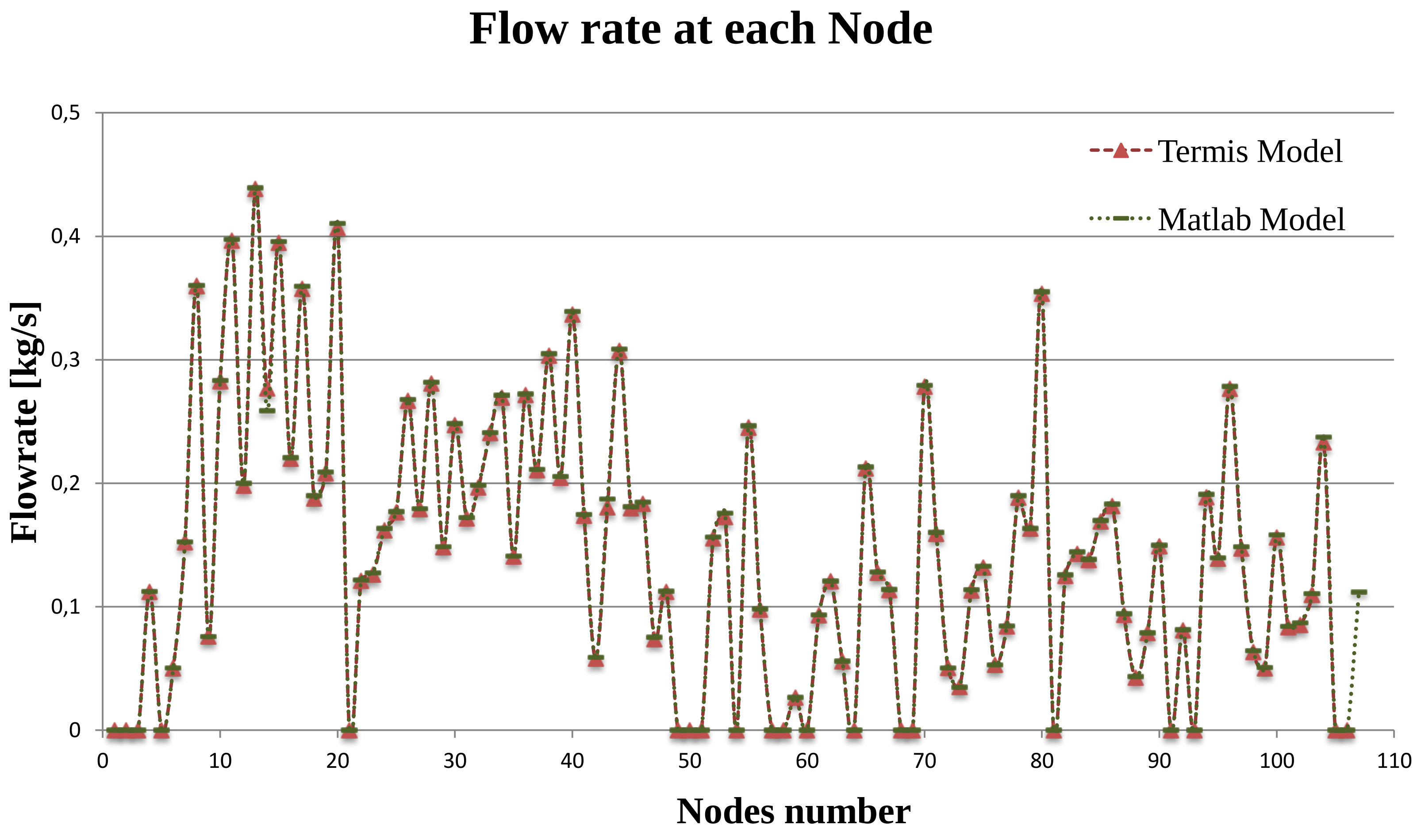
- In the developed model the same pipe data as TERMIS has been used
- The Bypass set point temperature is 58^{o}C
- The model is validated for winter time - full heat load period (step 1)
- The model is validated for summer time – low heat load period (step 8)



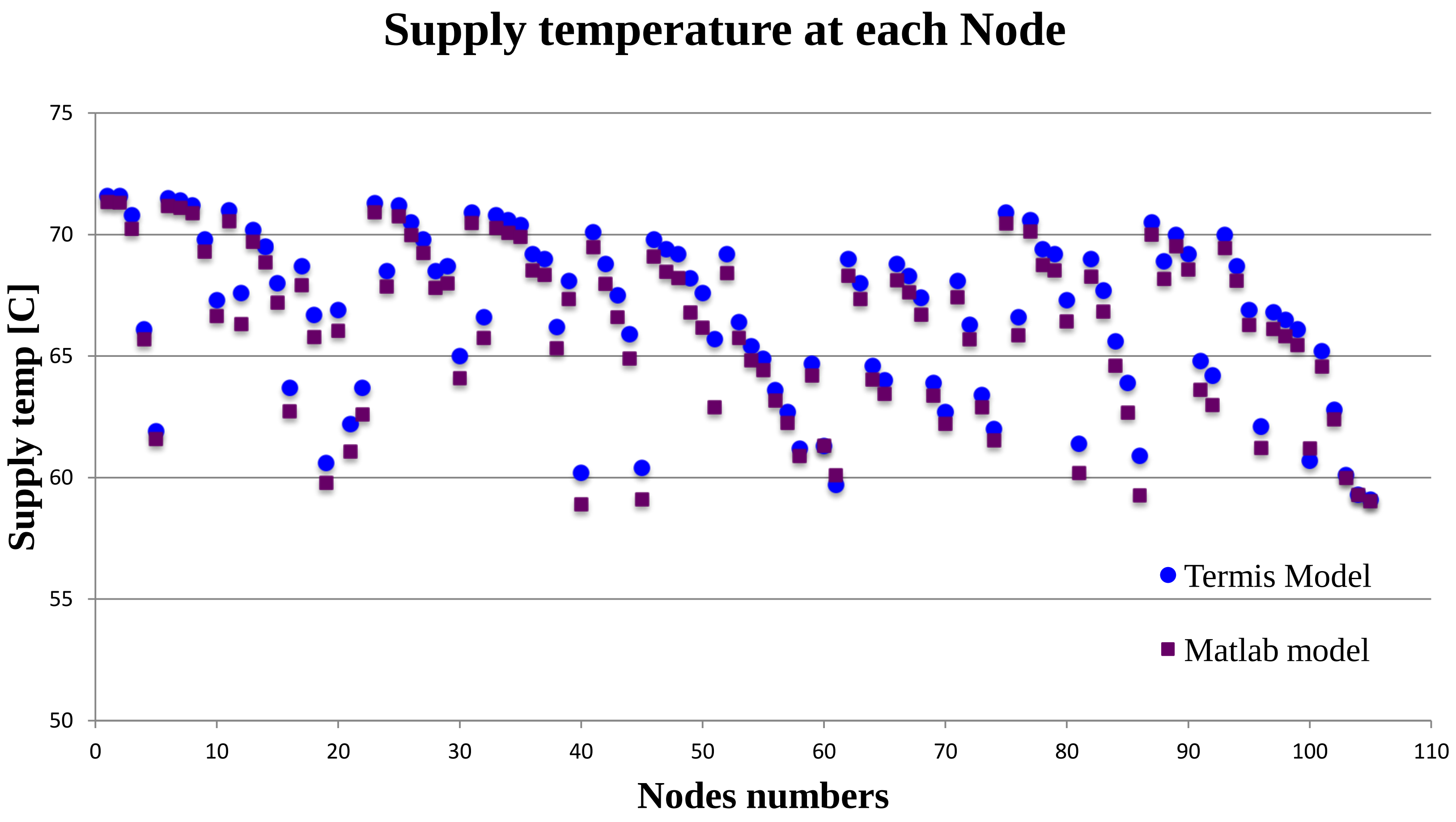
Validation Results – Full load period



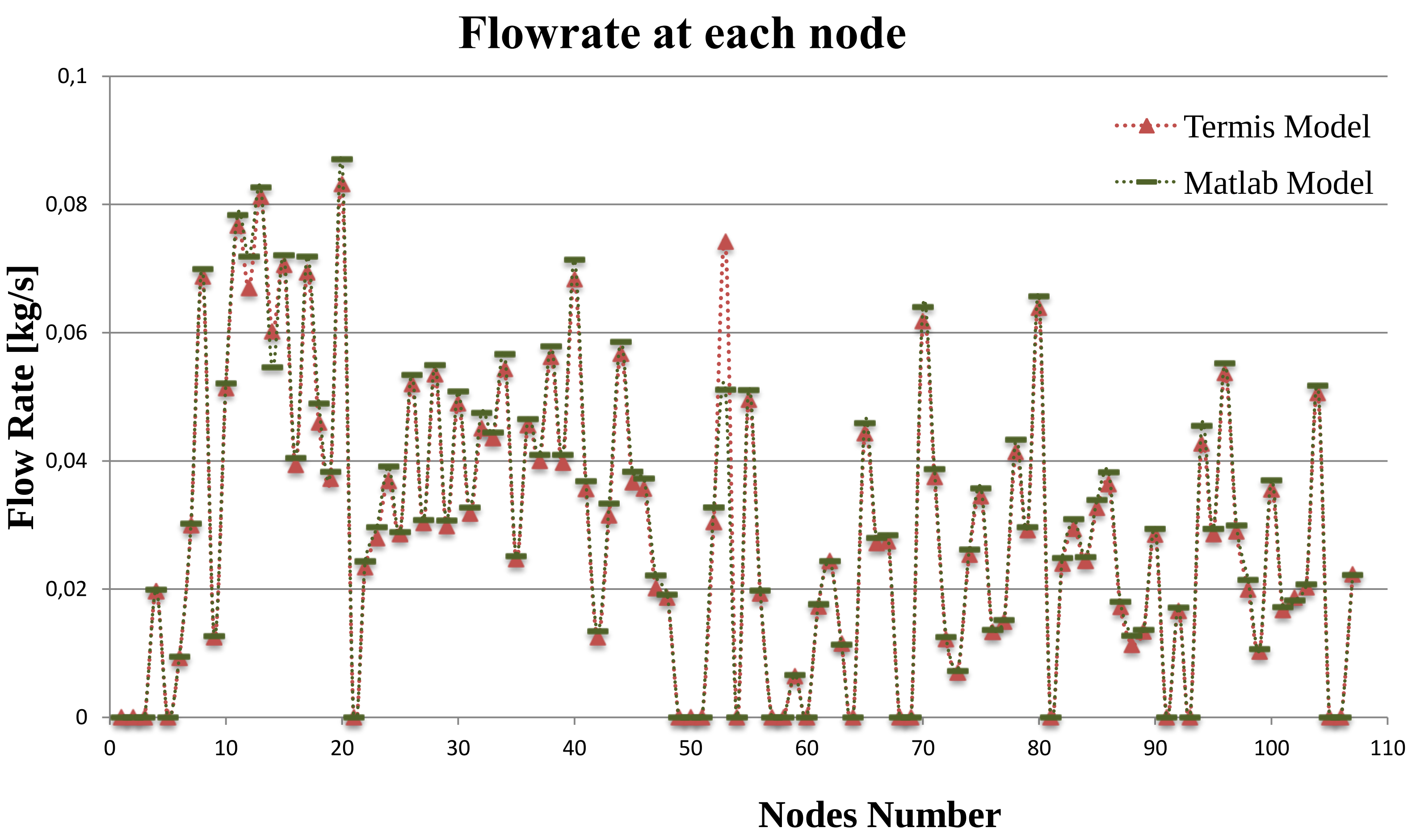
Validation Results – Full load period



Validation Results – low heat load period



Validation Results – low heat load period



Collaboration

- Collaboration with AffaldVarme Aarhus (AVA) – 3 Months – 1st November 2014 – 31 January 2015

- Validation of developed model for a real DHN
- looking into reducing the temperature gradient and consequently temperature level in existing DHS by changing the pipe insulation series (2, 3 and 4) and integrating alternative technologies as heat supply (heat pump – flue gas condensation) – Feasibility study

- Future Plan: Collaboration with VTT Technical Research Center of Finland – 3 Months – Spring 2015

4DH Conference abstract

- Looking in to replacing single pipes by twin pipes – Heat loss and temperature gradient reduction
- Integrating with alternative heat sources
- Techno – economic analysis

Thank you