Pre-Study of WP 1.1.

Heating of Existing Buildings by Low-Temperature District Heating

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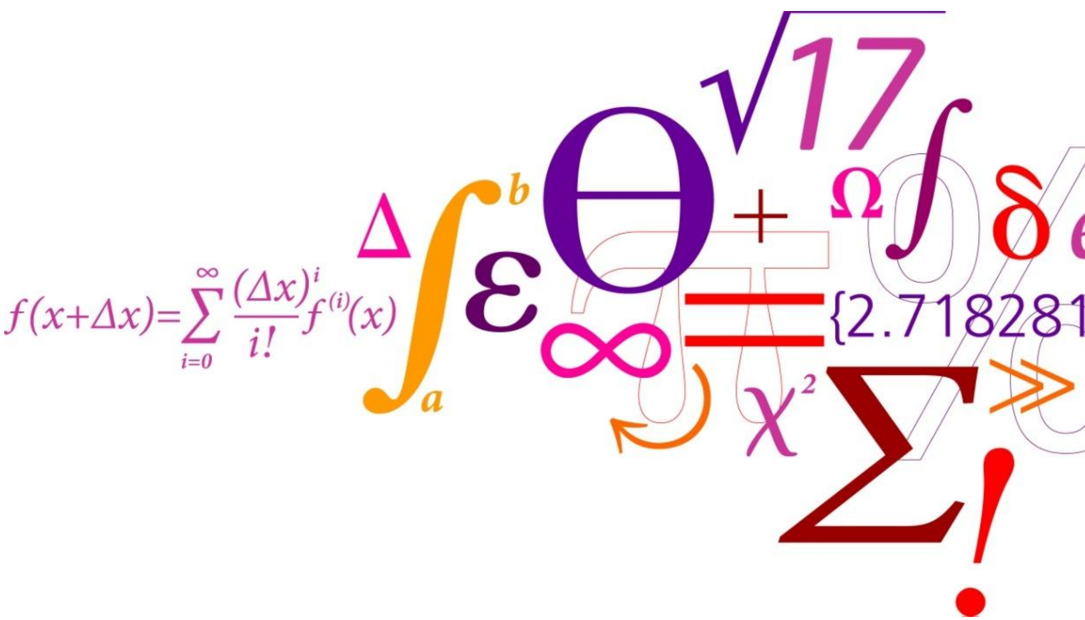
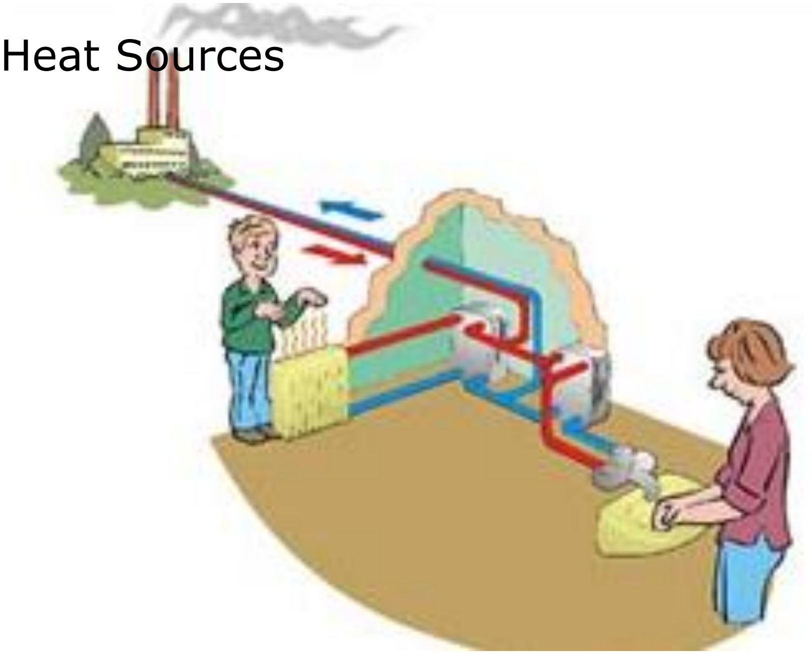
Aalborg, Denmark



DTU Civil Engineering
Department of Civil Engineering

CONTENT

- My Background (Case Studies of my PhD Project)
  - Design of DH network for new settlements – Roskilde Fjernvarme
  - Design of DH network for existing settlements – Gladsaxe Fjernvarme
  - Nominal Capacities for Non-Fossil-Fuel Heat Sources
- Pre-study WP 1.1 (4DH)
  - Focus
  - Relation to Other WPs
  - Issues to be Considered



Allocated time: 15 minutes

My Background

Case Studies of PhD Project

TREKRONER LOW-ENERGY DH SYSTEM

ROSKILDE FORSYNING

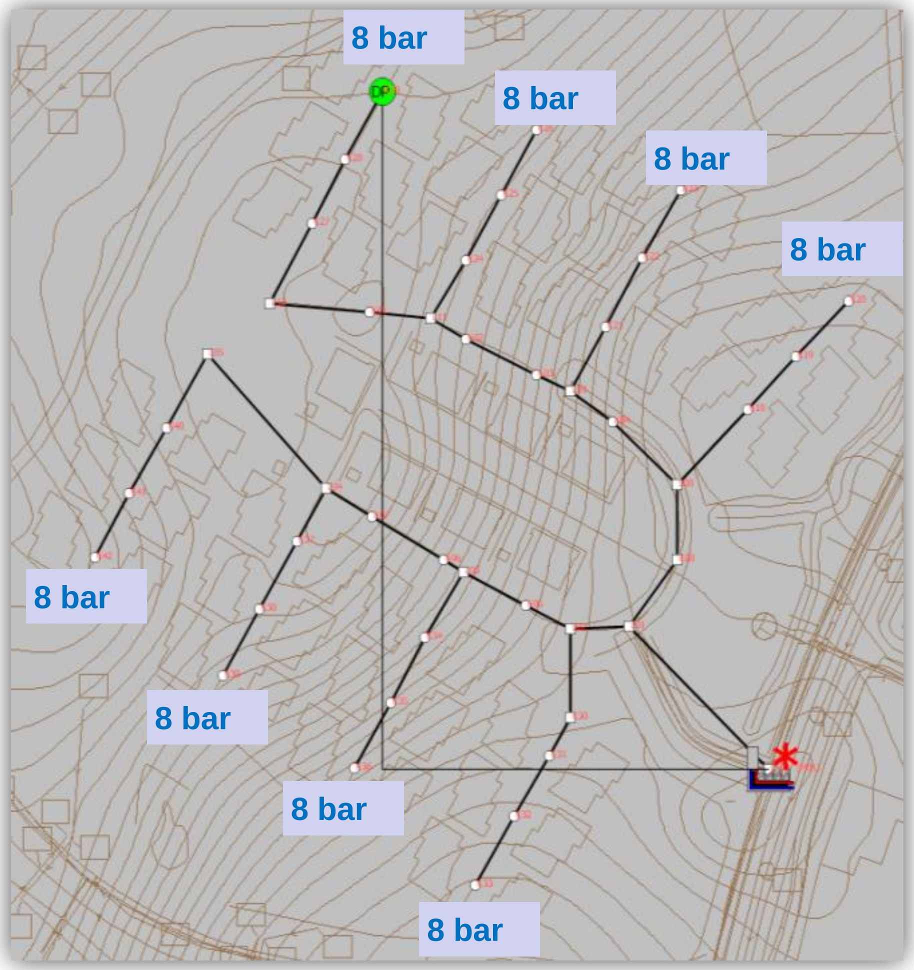
SEMI-DETACHED SINGLE FAMILY HOUSES

- Number of Houses
  - 165
- Low Energy House (Class I)
  - 3 kW Space Heating
  - 3 kW Domestic Hot Water (120 l buffer tank)

NEW LOW ENERGY DH SYSTEM

- Static Pressure
  - 10 bar
- Max Allowable Pressure Drop
  - 8 bar
- Total Length of Network
  - ~1 km
- Pipe Type (Class I)
  - AluFlex Twin Pipe
    - DN14 – DN32
  - Steel Twin Pipe
    - DN32 – DN80

DIMENSIONING METHOD
(NOT A RULE-OF-THUMB)



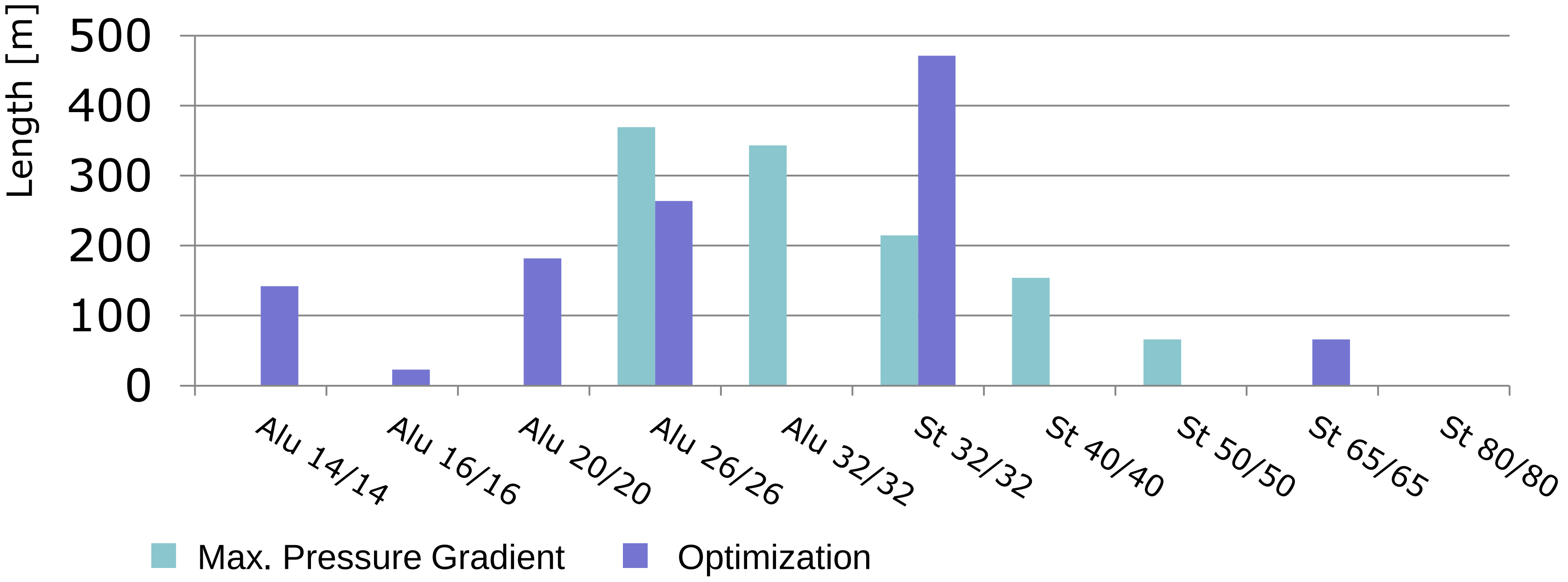
Nonlinear Constraint Function Optimization

Objective Function:
Min Heat Loss from DH Network

By Means of:
Reducing Each Diameter

Constraint Functions:
Max Allowable Pressure Loss in each Route (8 bar)

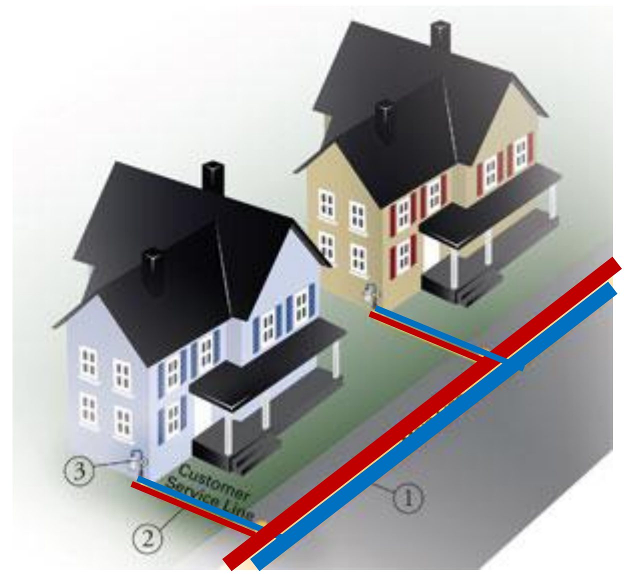
LENGTH OF PIPE TYPES



%14 Less Heat Loss with Optimization Applied

CASE STUDY IN AN EXISTING AREA

Natural Gas
Heating System



Low-Energy District
Heating System

LOW-ENERGY DH SYSTEM

GLADSAXE FJERNVARME

FJERNVARME

DETACHED SINGLE FAMILY HOUSES

- Number of Houses
  - 780
- Heat Demand [kW]

Heat Demand Type	CS	FS
Space Heating	5.1	2.9
Domestic Hot Water	3.0	3.0
Total=	8.1	5.9

PIPE TYPE (CLASS I)

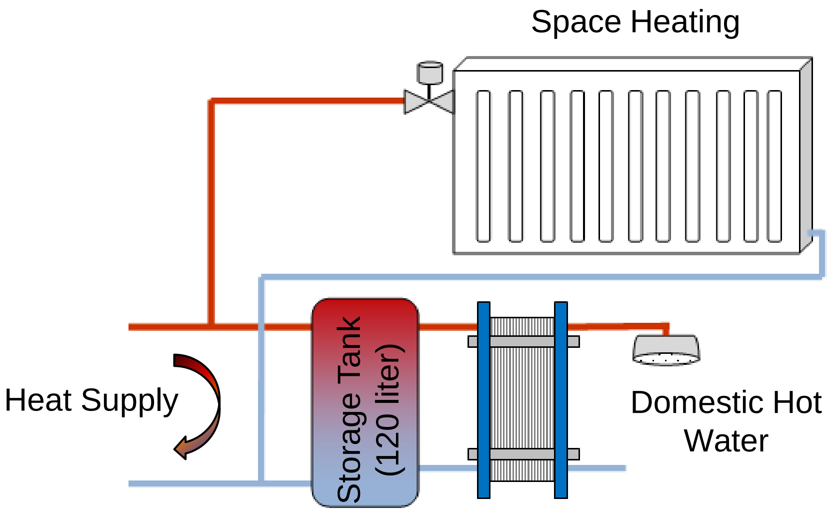
- AluFlex Twin Pipe : DN14 – DN32
- Steel Twin Pipe : DN32 – DN80
- Single Pipe : DN100 – DN200

LOW-ENERGY DISTRICT HEATING NETWORK

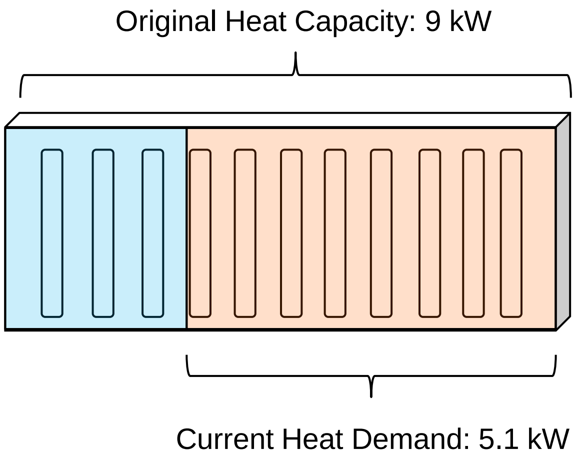
- Max Static Pressure : 10 bar
- Max Pressure Drop : 8 bar
- Total Length of Network : 9.3 km

SUBSTATION & IN-HOUSE INSTALLATION

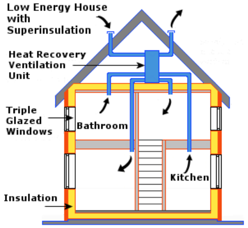
Substation



Existing Radiator System

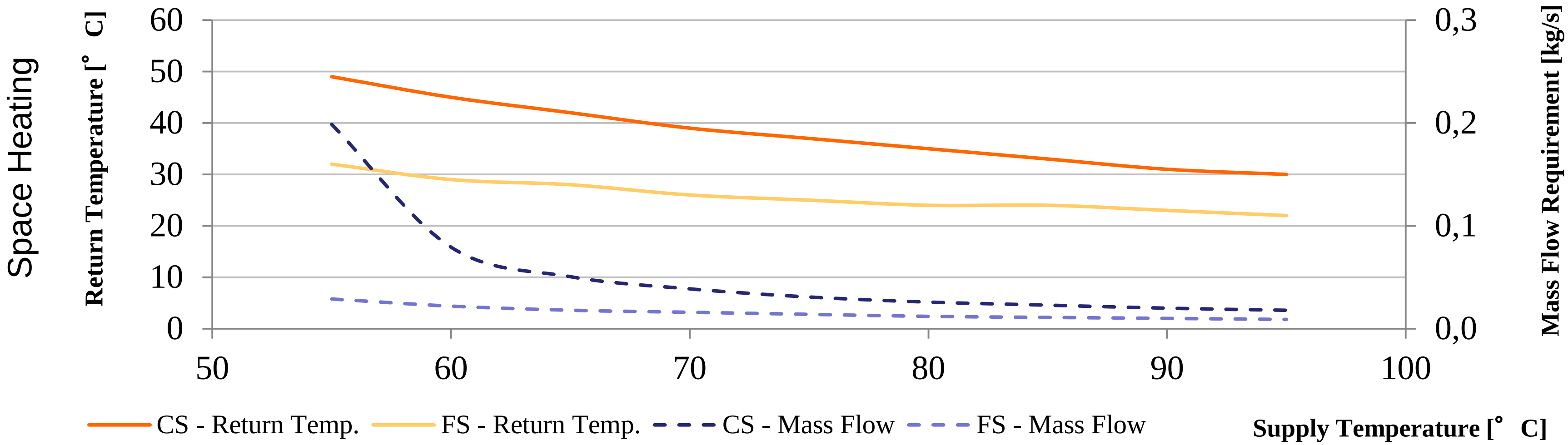


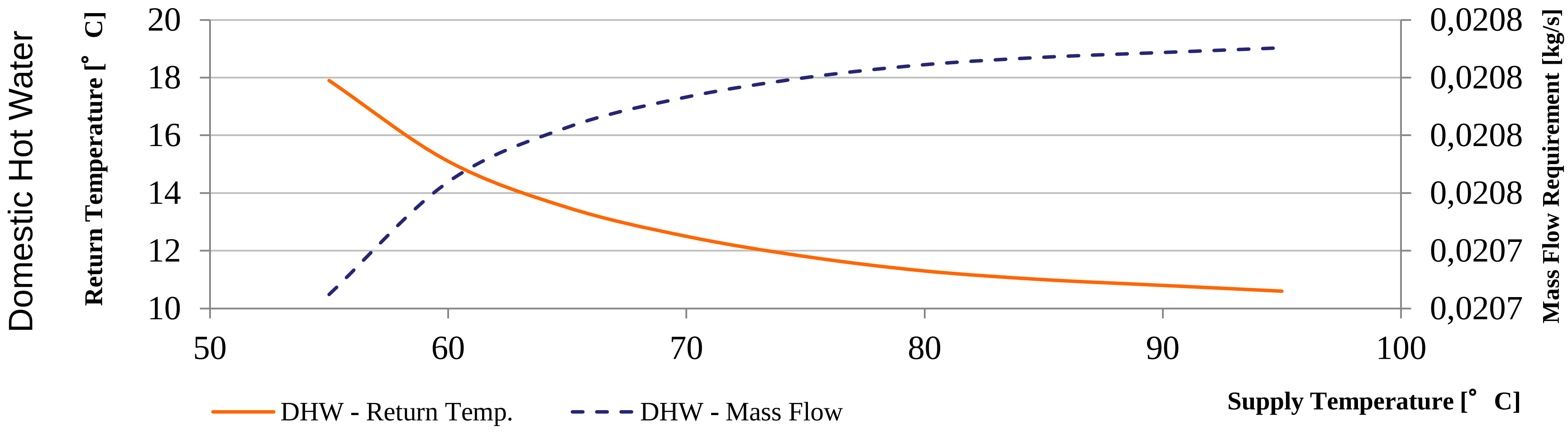
After Renovation



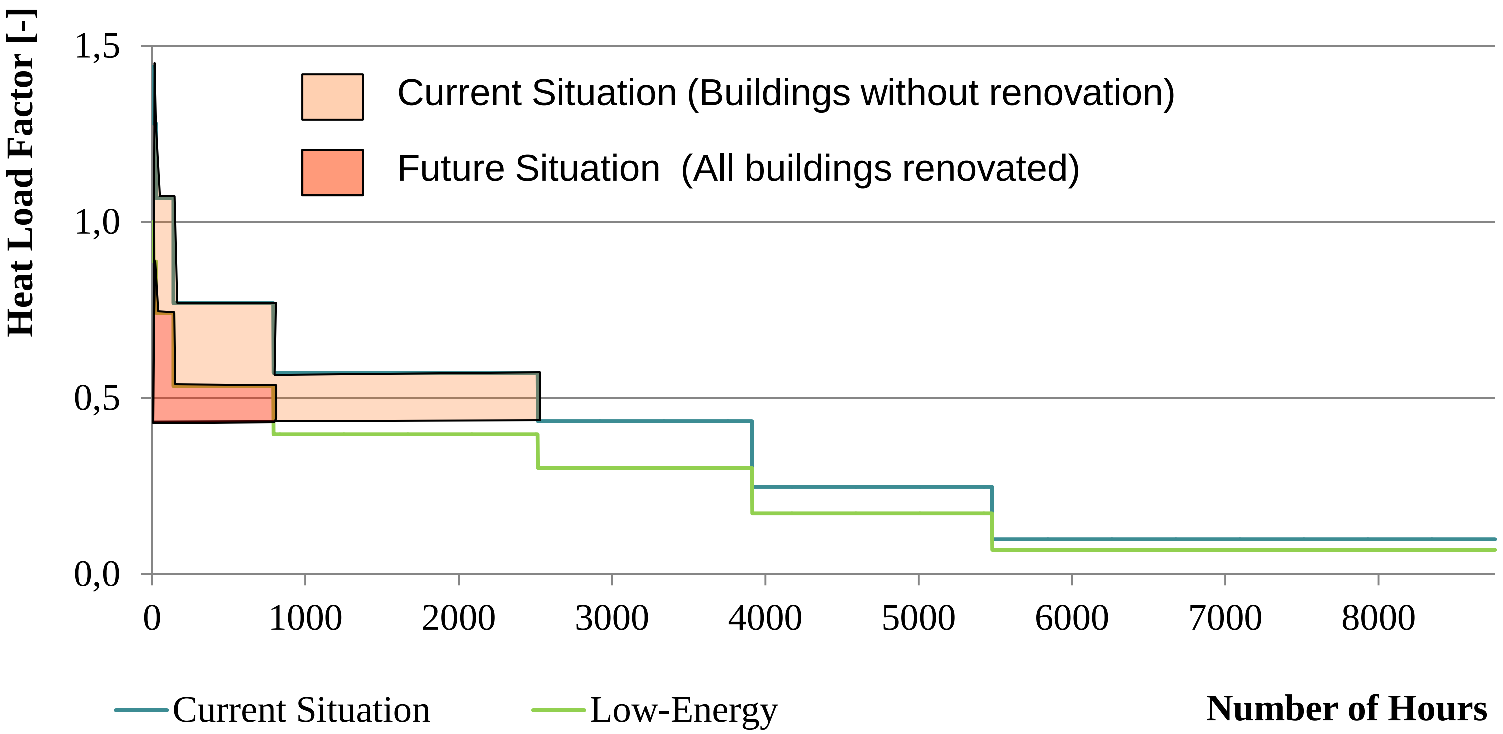
- 3 kW Space Heating
- 3 kW Domestic Hot Water

EXISTING RADIATOR SYSTEM



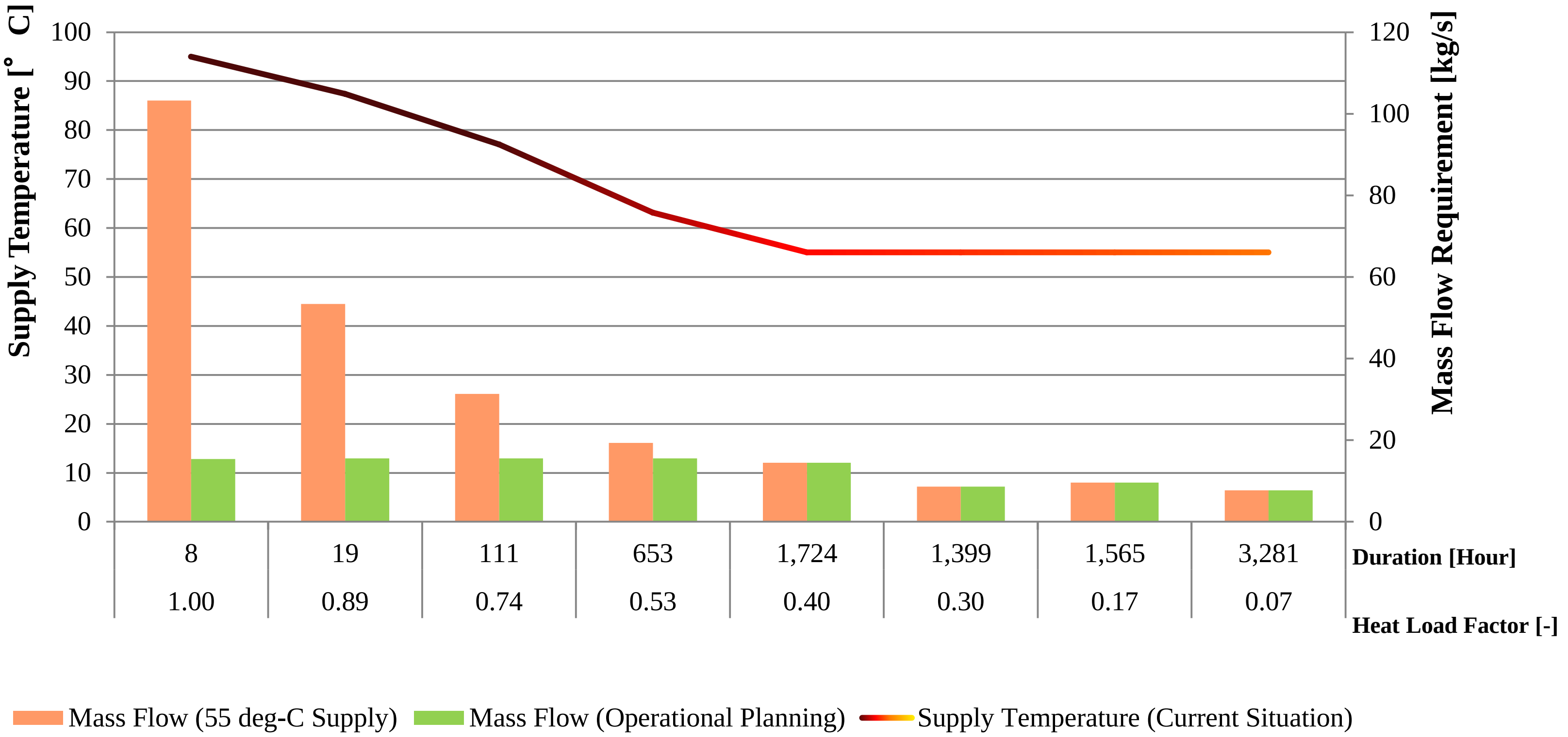


LOAD DURATION CURVE



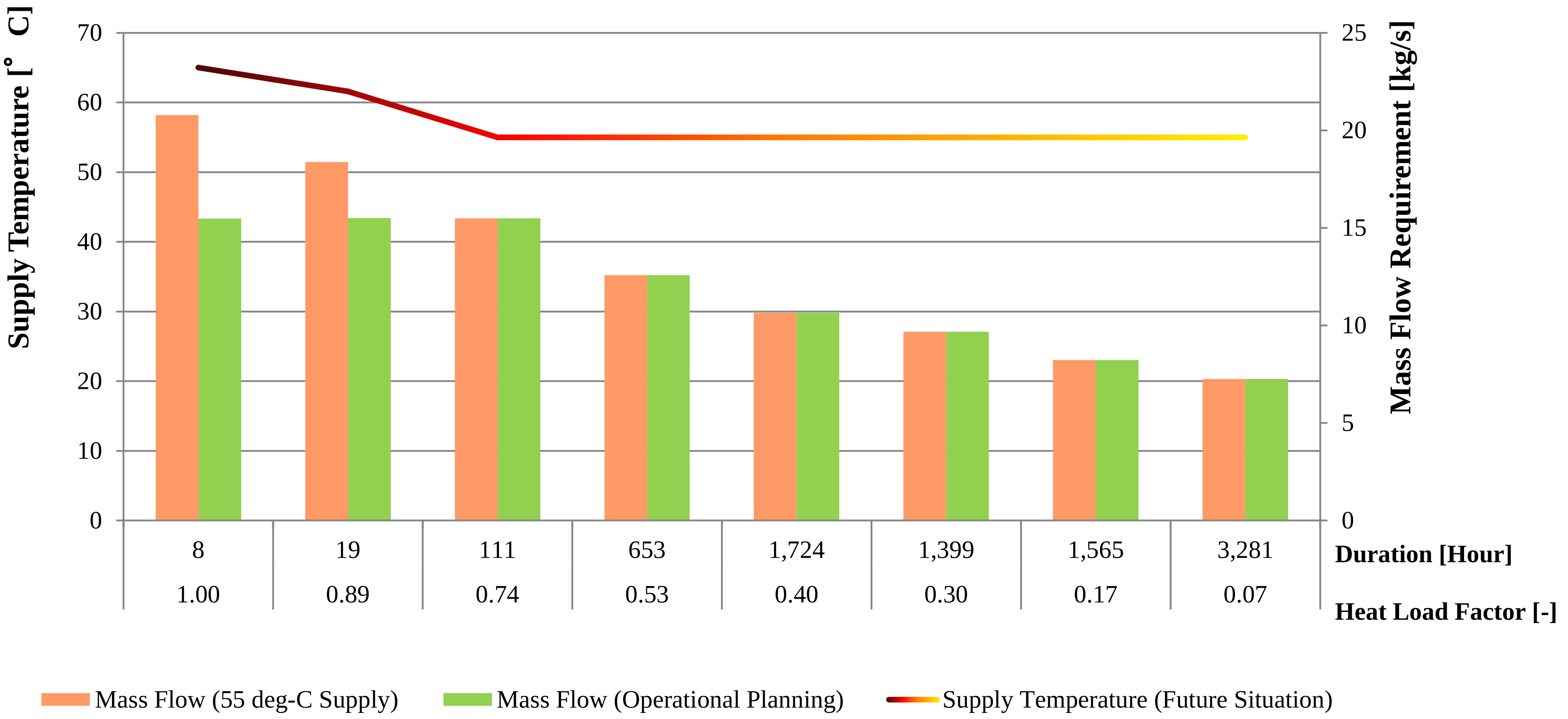
BOOSTING THE SUPPLY TEMPERATURE

CURRENT SITUATION

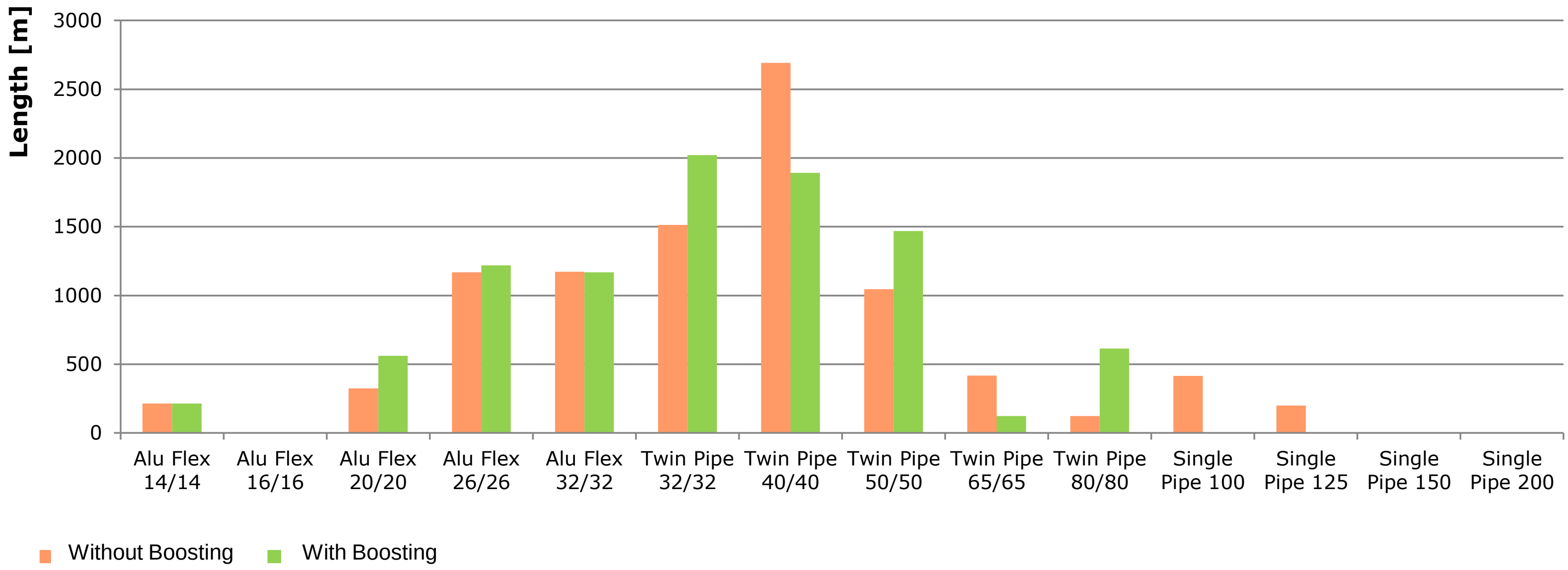


BOOSTING THE SUPPLY TEMPERATURE

FUTURE SITUATION



COMPARISON OF LENGTH OF PIPE TYPES



40% of Pipe Investment Cost can be saved with boosting supply temperature in peak periods

NON-FOSSIL FUEL HEAT SOURCES

	Ratio in Overall Heat Produced	
Heat Source	**2002[1]**	**2007[2]**
Biomass	15%	41.1%
Natural Gas	30%	26.4%
Coal	24%	22.4%
Oil	7%	4.6%
Wastes, Non Renewable	23%	5.6%

Overall Heat Demand of Denmark

220 PJ

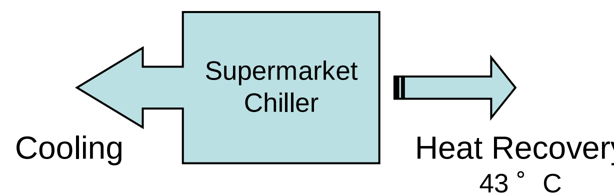
WASTE HEAT FROM INDUSTRY [3]

Theoretical potential of 139 PJ/year

GEOTHERMAL SOURCE [4]

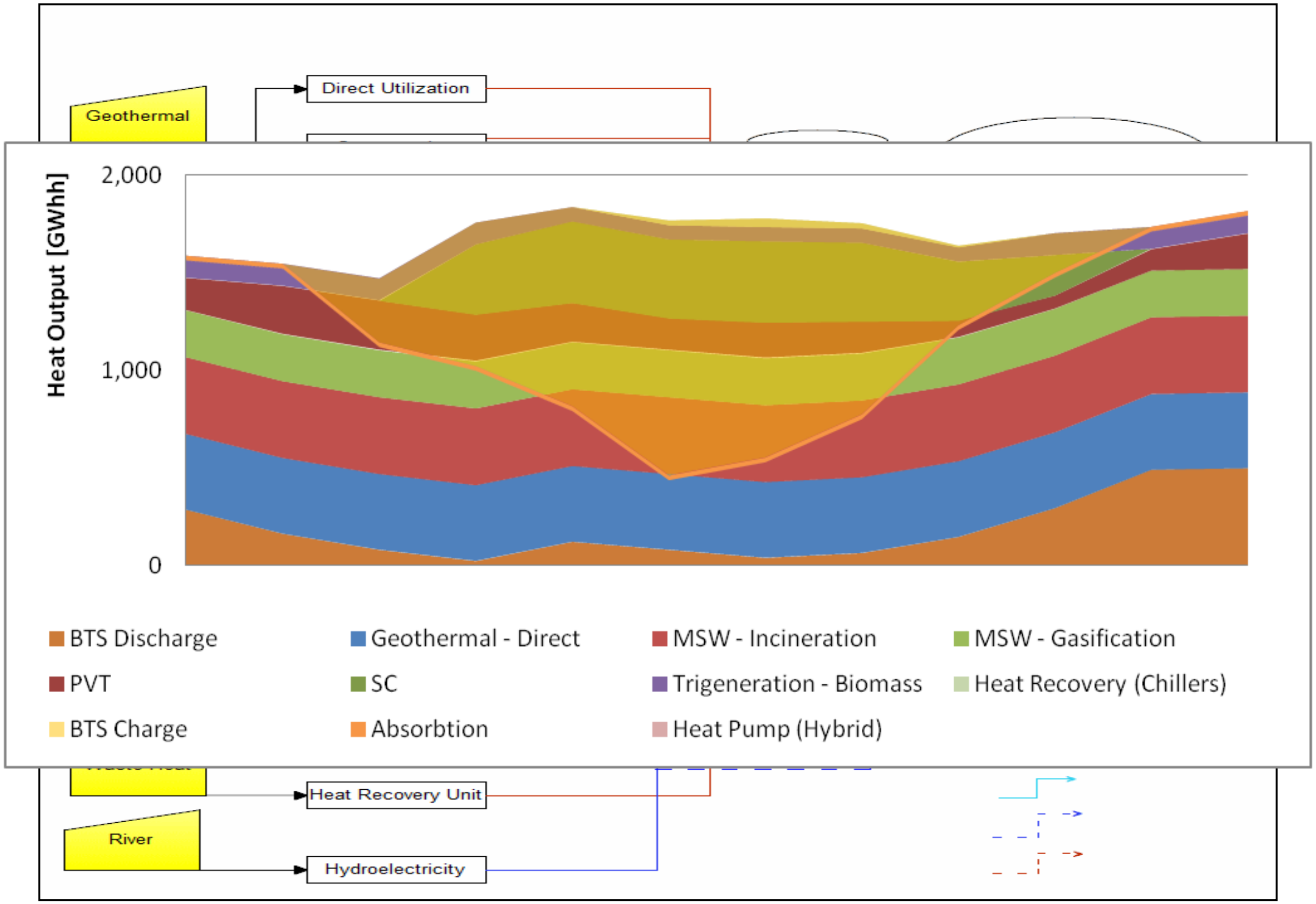
Potential: 25 – 40 PJ/Year at 70 ° C

CONDENSER HEAT FROM CHILLERS [5]



[1]http://www.trainenergy-iee.eu/cms/upload/Download-Docs/english/tradesman/Module%205.6%20-%20District%20Heating.pdf
[2] http://www.ens.dk/en-US/supply/Heat/Basic_facts/Sider/Forside.aspx
[3] http://www.skm.dk/public/dokumenter/publikationer/overskudsvarme.pdf
[4] http://www.geothermal-energy.org/pdf/IGAstandard/WGC/2005/0130.pdf?
[5] http://www.johnsoncontrols.com/content/dam/WWW/jci/be/integrated_hvac_systems/hvac_equipment/chiller_products/centrifugal-packaged/PUBL-6317_(510).pdf

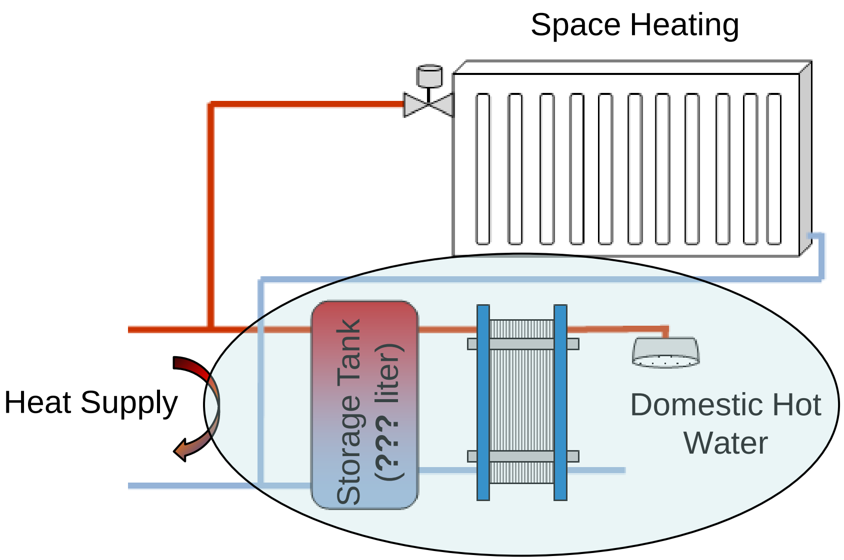
OPTIMAL NOMINAL CAPACITIES

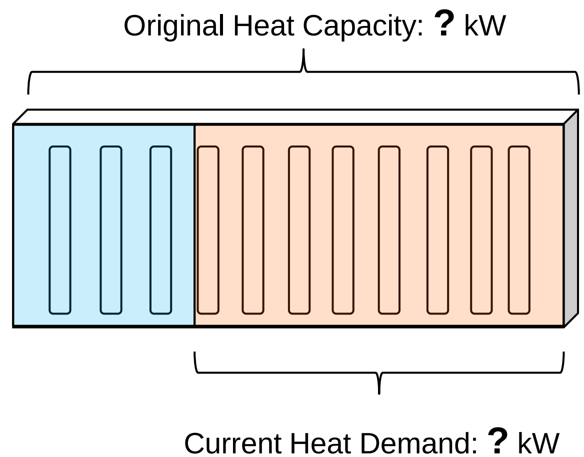


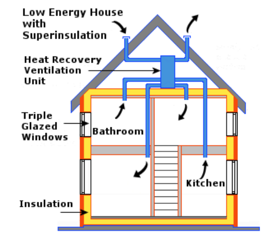
4DH

RESEARCH ACTIVITIES

DETAILED SIMULATION FOR WP 1.1. (4DH)







- ? kW Space Heating
- ? kW Domestic Hot Water

WP 1.2.
Various methods to avoid legionella
(boundary condition to WP 1.1.)

WP 1.1.
Dynamic simulations for typical buildings
-with various supply temperature levels
-with various levels of radiator sizes/heat demand

WP 1.3.
Input data from both WPs
Required Mass Flow (heat demand)

THANK YOU!