2nd Project meeting
Rottenburg, 29.11.2019

First Train the Trainer session:

Getting started and key factors for success

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PRE-FEASIBILITY STUDY

Objective of Pre-Feasibility:

- Identify areas of interest and make a first assessment on the technical and economical feasibility of a district heating project.
- Get an idea, if DH project could be feasible and further activities (search for investors and DH consumers, detailed feasibility study,…)

- Areas of interest are, those with…
    - existing renewable heat source (e.g. waste heat from industry)
    - high heat demand (existing or to be build)
    - Existing DH grids
    - microgrids

DISCLAIMER !

A pre-feasibility study is just a first step !

It does not cover a detailed feasibility study!

It does not cover a detailed engineering!

A comprehensive planning is essential. Mistakes made during the planning process often cannot be corrected later on (without a lot of money).

Of course, there is a difference between large and small projects, but small projects need a careful planning too!!

BASIC CONSIDERATIONS I

- Heat supply for…
  - ... a single object (apartment or office building, hotel, hospital)
  - ... district heating system
  - … process heat (industrial plant,…)
- Current type of heating system
  - Central heating system based on hot water system
  - Others
- Basic data of key objects
  - Heat capacities, annual heat demand
- Are stakeholders interested in the project?
  - Heat customers
  - Local authorities
  - Investors

BASIC CONSIDERATIONS II

- Is biomass fuel available?
- Local farmers, forestry, wood industry
- Are there any other know sources?
- Area map / cadastral map / satellite picture

Image source: GIS Steiermark

- Other relevant basic conditions
- Local development concepts / land use plan
- Existing district heating systems / existing boilers

SUM UP THE SITUATION

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Example:

- school in “Smalltown” need a new heating system
- Municipality want to install a biomass boiler
- local farmers had the idea to enlarge the project
- Approx. 40 potential heat customers: mainly single family homes, apartment buildings, a few shops/factories, school, nursing home
  - school 400 kW, office building 200 kW, nursing home 300 kW
- objects have mainly central heating systems fired by oil
- cooperative of farmers is willing to provide fuel and operate the plant
  - cooperative is willing to invest
  - no experience in biomass projects
- Is the project technically and economically feasible?

PRE-FEASIBILITY STUDY

Data acquisition

Define the area to be studied and gather relevant information: Yearly heat demand of the consumers (MWh/a), required heating power (MW), …

Scenario definition

Define which consumers are likely to be connected and sketch the necessary district heating system (only pipe length)

Intermediate evaluation

Calculate linear heat densities and compared it with reference values

Do a first economic check

IDENTIFICATION OF INTERESTING AREAS

- Two typical criteria (demand oriented) are,
  - Heat density $\left[\frac{kWh}{a.m^2}\right]$
  - Linear $heat\ density \left[\frac{kWh}{a.m}\right]$
- Main needed information is,
  - Annual heat demand of your potential consumers [kWh/a] (different methods to obtain it)
  - possible location(s) for the heating plant
  - Feasible route of district heating network
- The starting point could be also heat source oriented (e.g. starting from industry with residual heat). In this case the location of the heating plant is defined, the above criteria and needed information are still relevant.

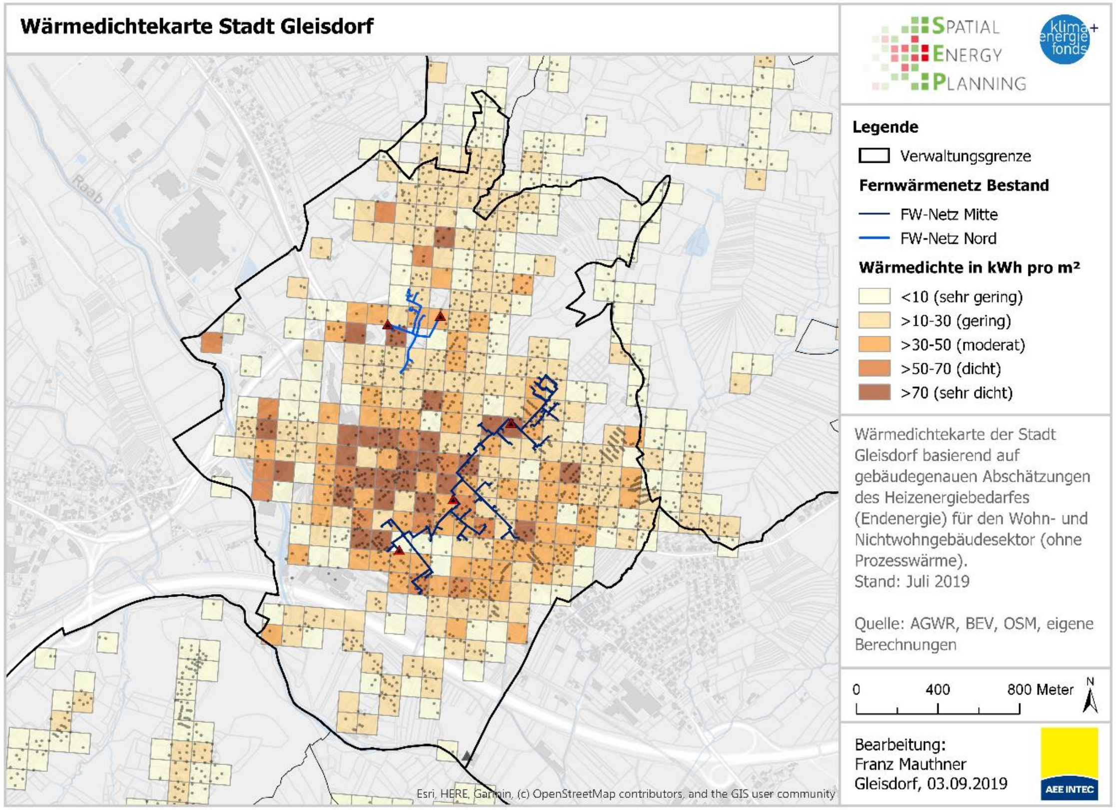
HEAT DENSITY OF THE AREA

- $heat\ density\ \left[\frac{kWh}{a.m^2}\right] = \frac{annual\ heat\ sale\ [\frac{kWh}{a}]}{grid\ area\ [m^2]}$

Image source: google maps

HEAT DENSITY OF THE AREA

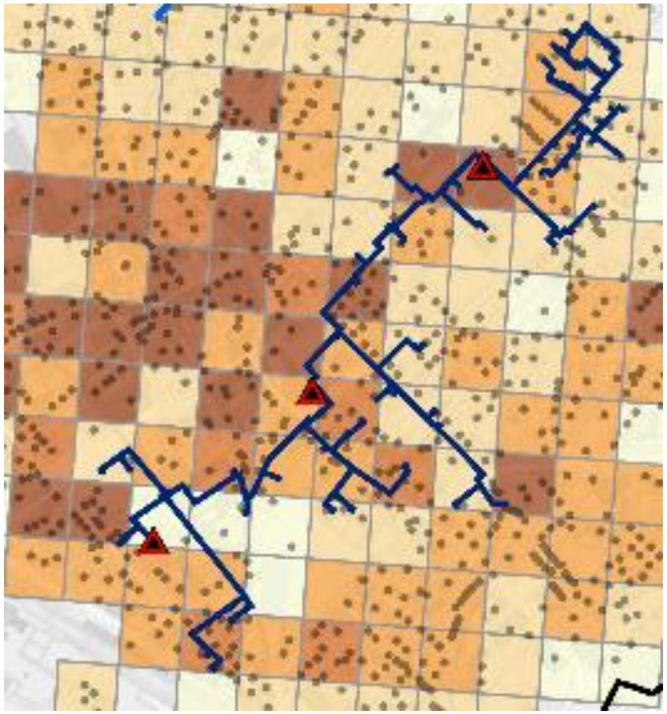
- $$heat\ density\ \left[\frac{kWh}{a.m^2}\right] = \frac{annual\ heat\ sale\ [\frac{kWh}{a}]}{grid\ area\ [m^2]}$$



$^{*}grid\ area\ [m^2] = 100\ m \cdot 100\ m$

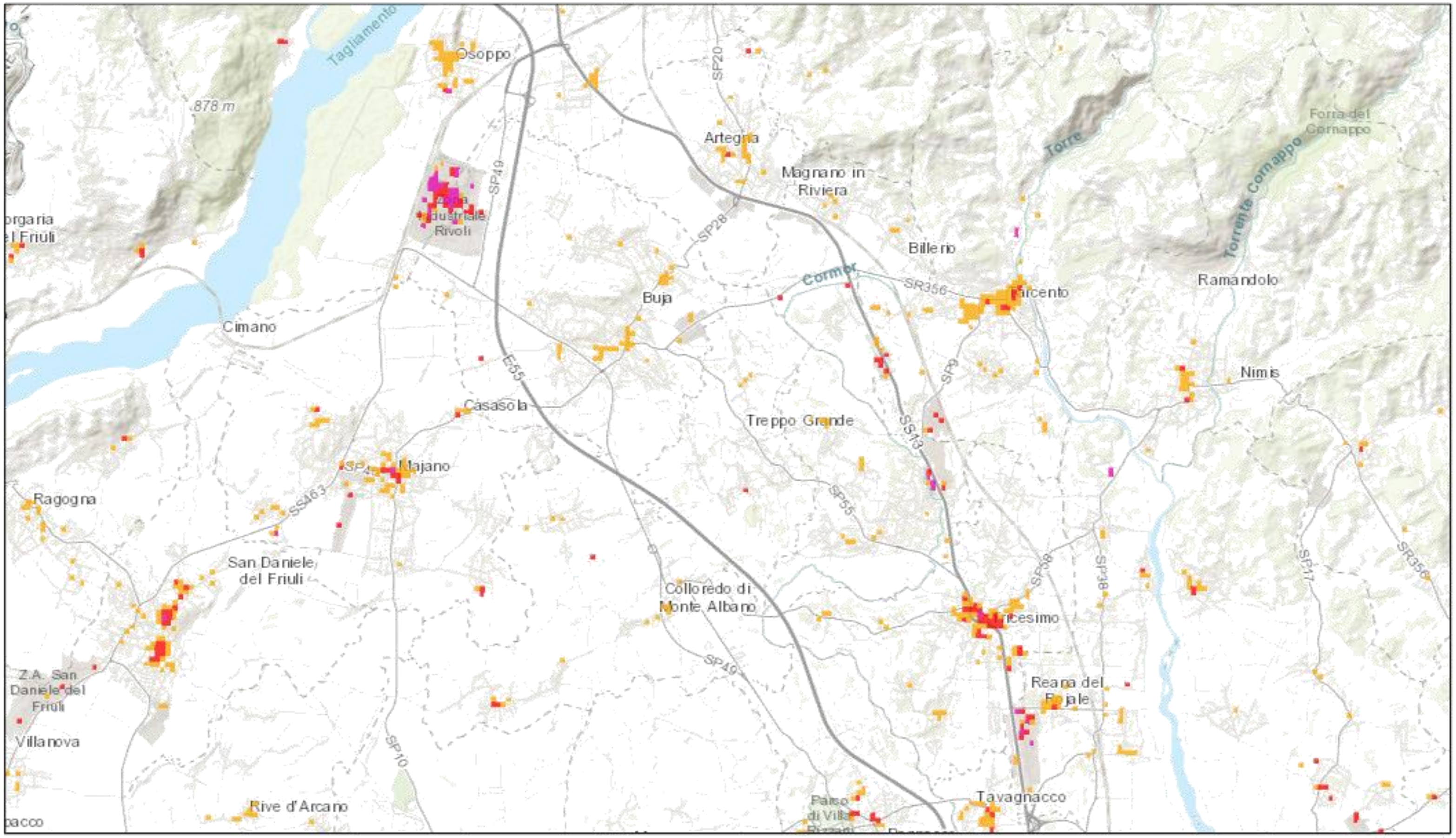
HEAT DENSITY

- Use existing tools and data sources
  - e.g. Pan-European Thermal Atlas
- Limited for small supply areas!!
  - Grid of 100 x 100m



HEAT DENSITY OF THE AREA

Heat Roadmap Europe - Peta 4 version 3



29.11.2019, 05:44:11

1:144,448

0 0.75 1.5 3 mi

0 1.25 2.5 5 km

2017 Flensburg, Halmstad and Aalborg universities, Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Flensburg, Halmstad and Aalborg Universities, www.heatroadmap.eu

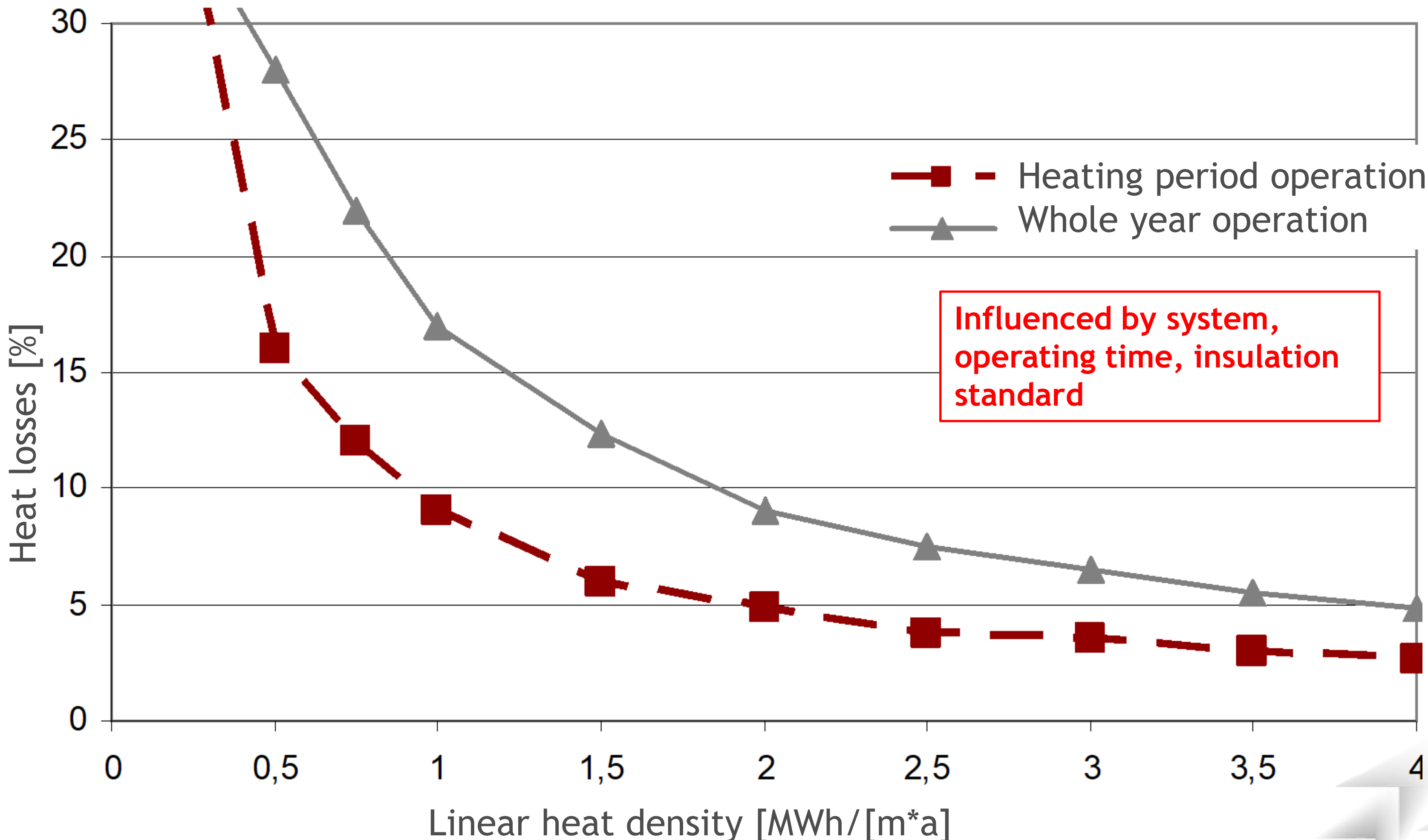
LINEAR HEAT DENSITY

- $$Linear\ heat\ density\left[\frac{kWh}{a.m}\right]=\frac{annual\ heat\ sale\ [\frac{kWh}{a}]}{network\ length\ [m]}$$

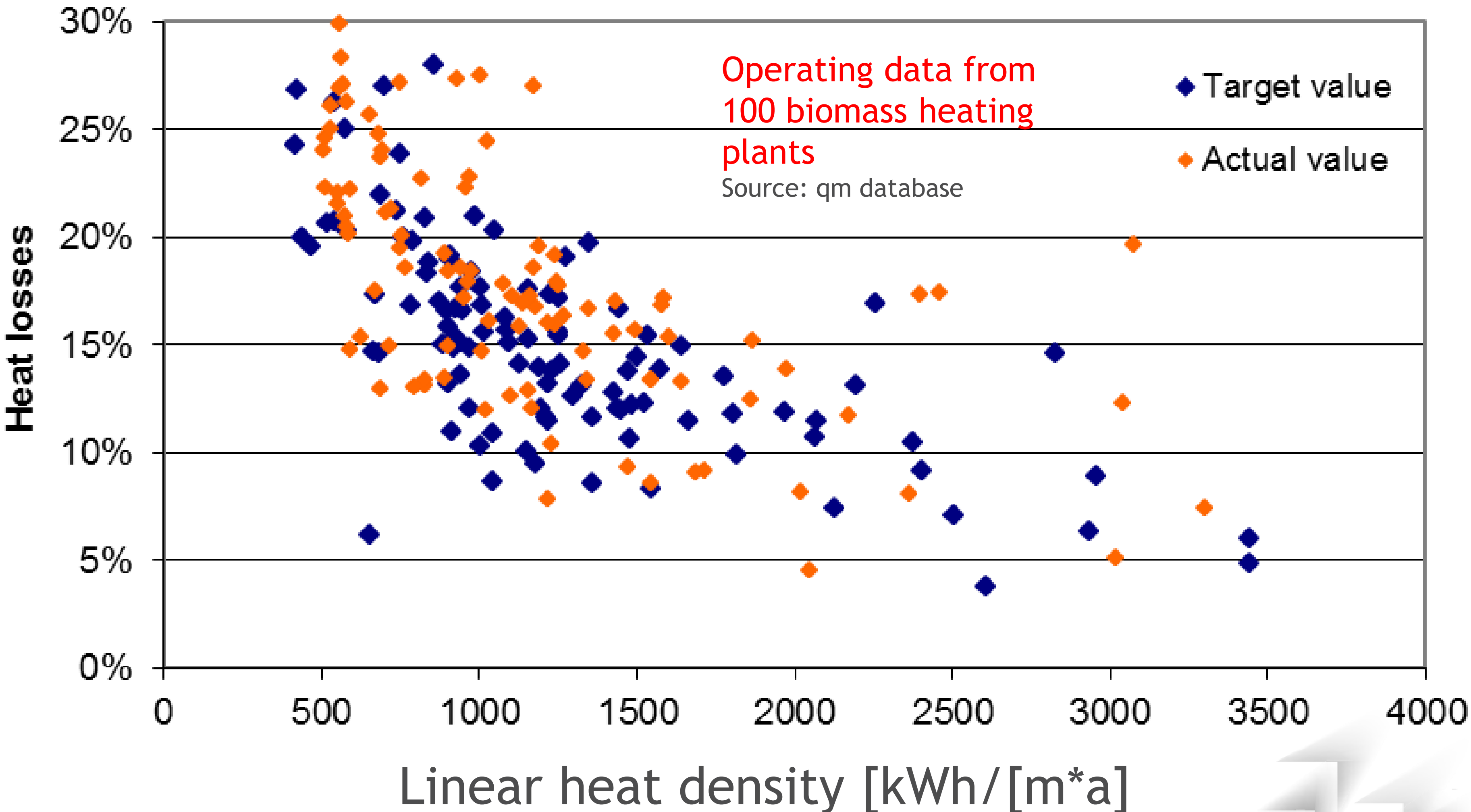
QM heizwerke:
> 1000 kWh/m*a

- Low linear heat density …
  …means high heat losses
  …low utilisation of investment
- DH with low linear heat densities will hardly be technical/economically feasible
- Linear heat density can be calculated for
  - a whole DH grid
  - only a part of the grid (e.g. a new enlargement)
  - a single consumer

THEORETICAL TREND OF THE HEAT LOSSES AS FUNCTION OF THE LINEAR HEAT DENSITY



EVALUATION OF OPERATING DATA



LINEAR HEAT DENSITY AND INVESTMENT

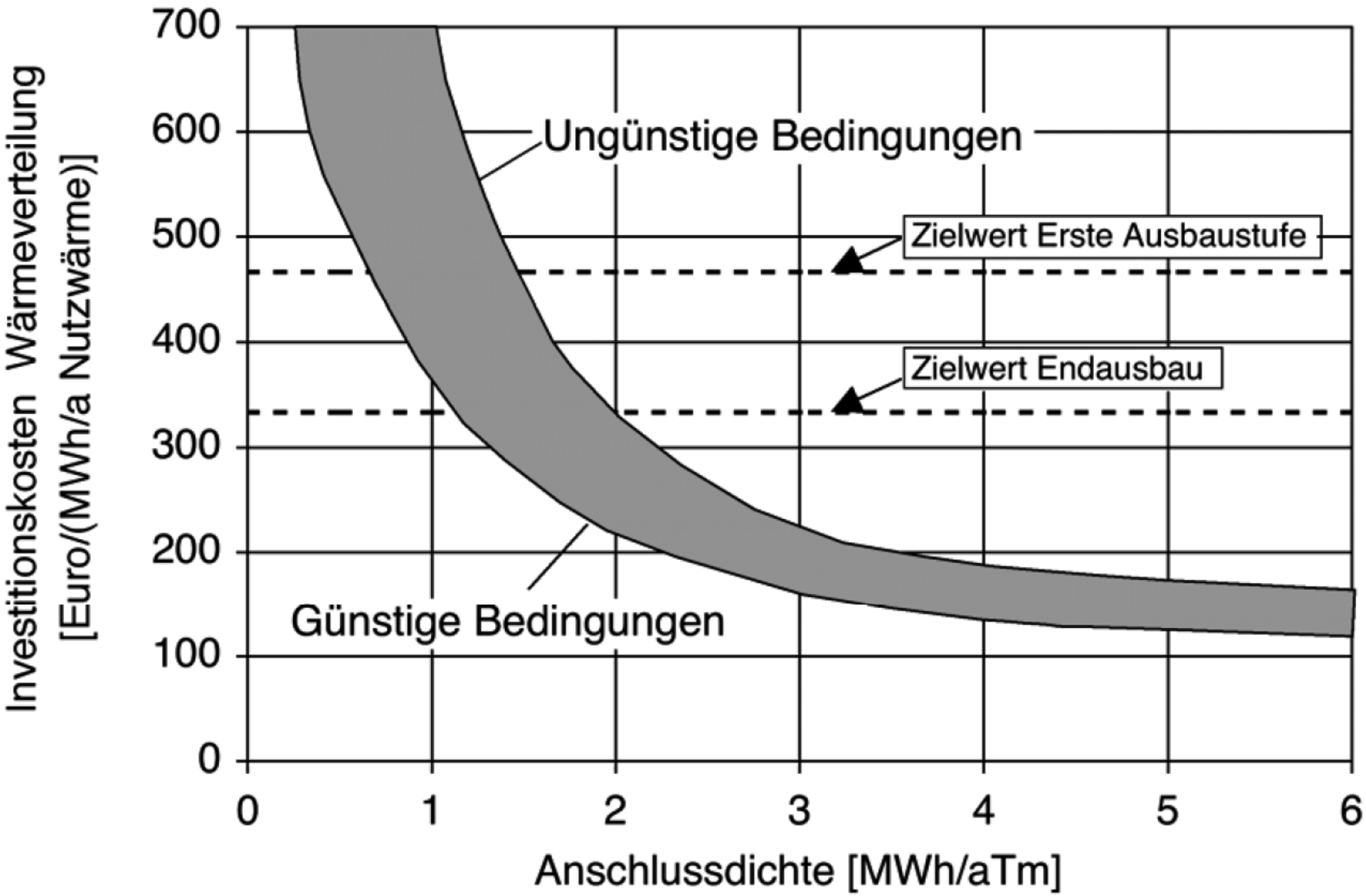


Image source: QM Holzheizwerke Planning guidelines

LINEAR HEAT DENSITY OF A HOUSE CONNECTION PIPE

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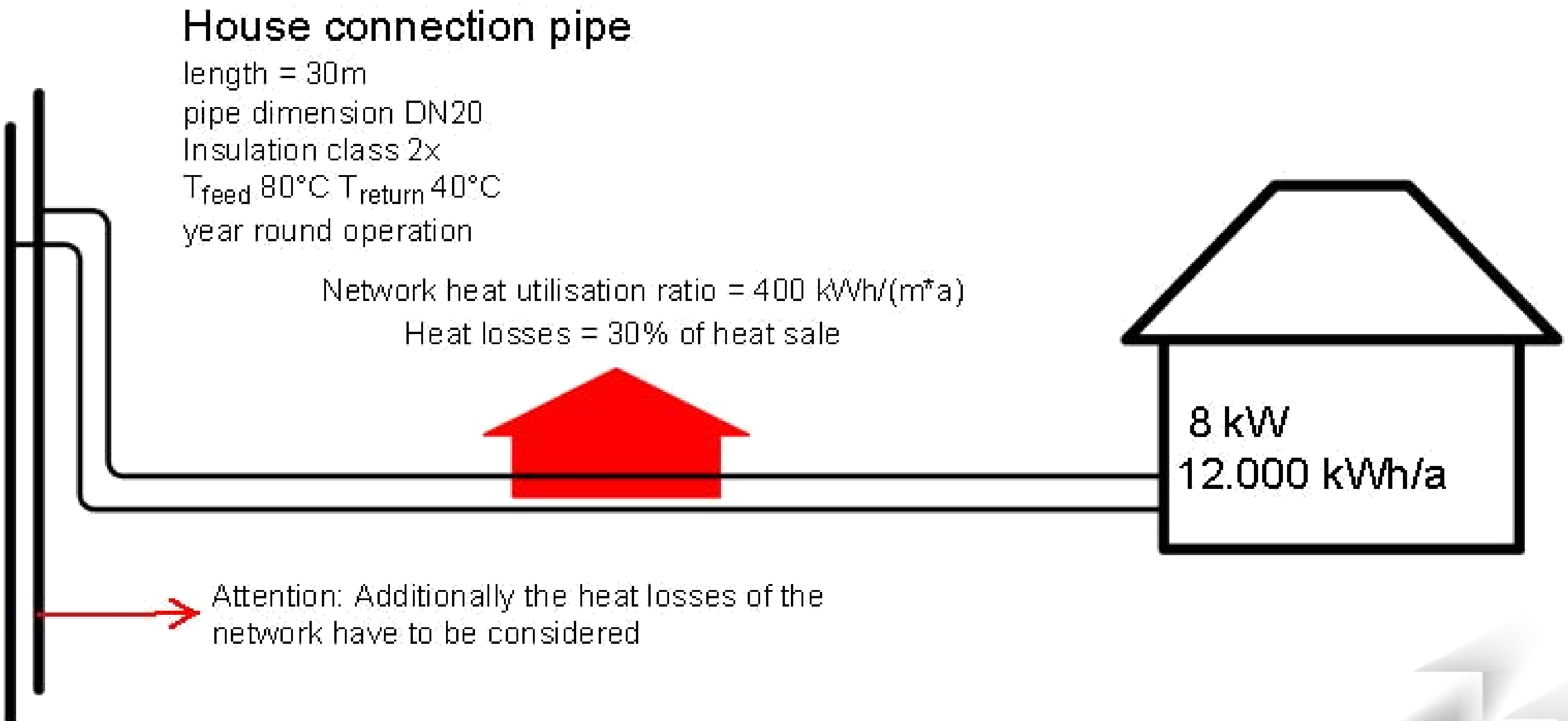

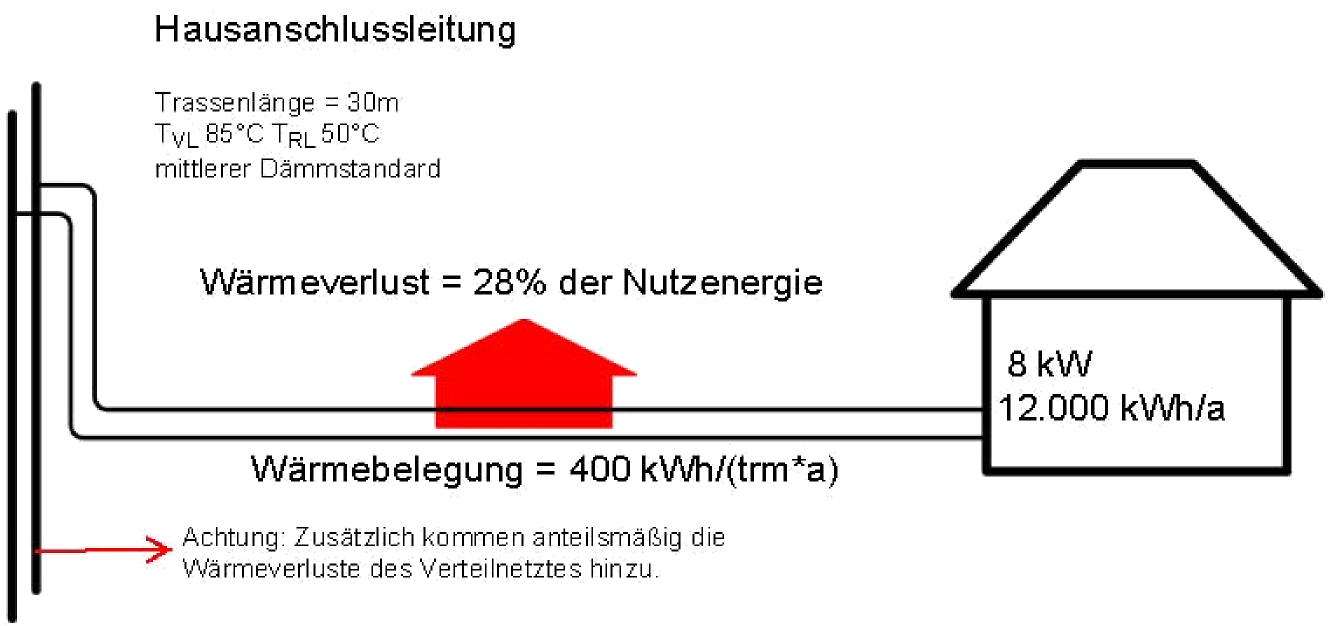

	System temperature (flow/return)					Cold DH
	85/50	80/45	75/40	70/35	65/30	<20°C
Single pipe, medium insulation standard	28%	26%	23%	21%	18%	0 - 2%
Twin pipe, high insulation standard	18%	16%	15%	13%	12%	

Reduced temperatures helps, but…

…still high specific investment!

… high linear heat density mandatory!

Cold DH could offer alternatives

ESTIMATION OF THE HEAT DEMAND

- Should…
  - Keep the effort low
  - Focus on the important consumers
    - Consumers with high heat demand
    - Consumers that are likely to be interested to connect to the grid (old heating system, already have a centralized heating system, …)

- Proposed method
  - Estimate heat consumption of the others consumers based on “experience” or literature values (different information sources / methods available)
  - Detailed method description see “ENTRAIN planning guidelines”
  - Direct contact to large consumers (Questionnaire)

ESTIMATION OF THE HEAT DEMAND (QUESTIONNAIRE)

Data of heat consumer			
Number		Object name	
Adress			
Postal code		City	
State		Layout plan no.	
Owner		Phone	
Mobil phone		Email	
Contract date		Beginning of heat sale (date)	
Stage of expansion	Year	End of heat sale (date)	
Type of heat demand			
Typ of heat cosumer			
Distance to heating plant [m]		Length of house connection pipe [m]	
Object description			
Year of construction		Type of building	
Number of floors	Number of flats	New building ☐	
Single home ☐		Heated floorspace [m2]	
Remedial actions			
Heat demand space heating [kWh]		Heating power space heating [kW]	
Heat demand domestic hot water [kWh]		Heating power domestic hot water [kW]	
Heat demand process heat [kWh]		Heating power process heat [kW]	
Correction factor heat demand		Correction factor heating power	
Contracted heating power [kW]		Year of boiler construction	
Feed temperature [°C]		Return temperature [°C]	
Current fuel	Amount		incl. hot water ☐
Explanations			

ESTIMATION OF THE HEAT DEMAND (LITERATURE VALUES)

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- Specific heat demand for heating purposes in kWh/(a.m^2) based on building type and year of construction.

Construction year	Building type			
	Single family house (SFH)	Terraced house (TH)	Multi Family House (MFH)	Apartment Block (AB)
… 1945	245,1	91,4	122,4	140,6
1945 … 1970	117,9	100,8	105,5	141,8
1970 … 1980	93,7	86,4	112,6	117
1981 … 2001	92	75,1	100,6	101
2001 … 2008	58,9	74,5	78,2	48,3
2009 …	77	72,7	52,2	57,1

- E.g. data for Slovenia retrieved from the TABULA WebTool: http://webtool.building-typology.eu/#bm

INTRODUCE DATA ON MAP

DEFINE SCENARIOS

Red: 1.000 m, 1.350 MWh/a → 1.350 kWh/(a.m)

Orange: 300 m, 49 MWh/a → 163 kWh/(a.m)

Green: 150 m, 126 MWh/a → 840 kWh/(a.m)

DEFINE SCENARIOS

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Red: 1.000 m, 1.350 MWh/a → 1.350 kWh/(a.m)

Red + Orange : 1.300 m, 1.399 MWh/a → 1.076 kWh/(a.m)

Red + Green: 1.150 m, 1.476 MWh/a → 1.283 kWh/(a.m)

SATISFACTORY INTERMEDIATE EVALUATION

Load duration curve

Estimate the “non weather depend heat demand” e.g. Domestic hot water and DH heat losses (MWh/a) to obtain the load duration curve

Sizing of the main components

Estimate the necessary boiler size and a roughly value for the main diameter

“Final” evaluation

Estimate the yearly costs (O&M, investment) and calculate the heat costs €/MWh. Carry out a sensitivity analysis (change fuel price, …) and compared the results with reference values

HEAT LOSSES

- Though heat losses depends on many factors, such as
  - Operating temperatures
  - Pipe diameter and length
  - Insulation material

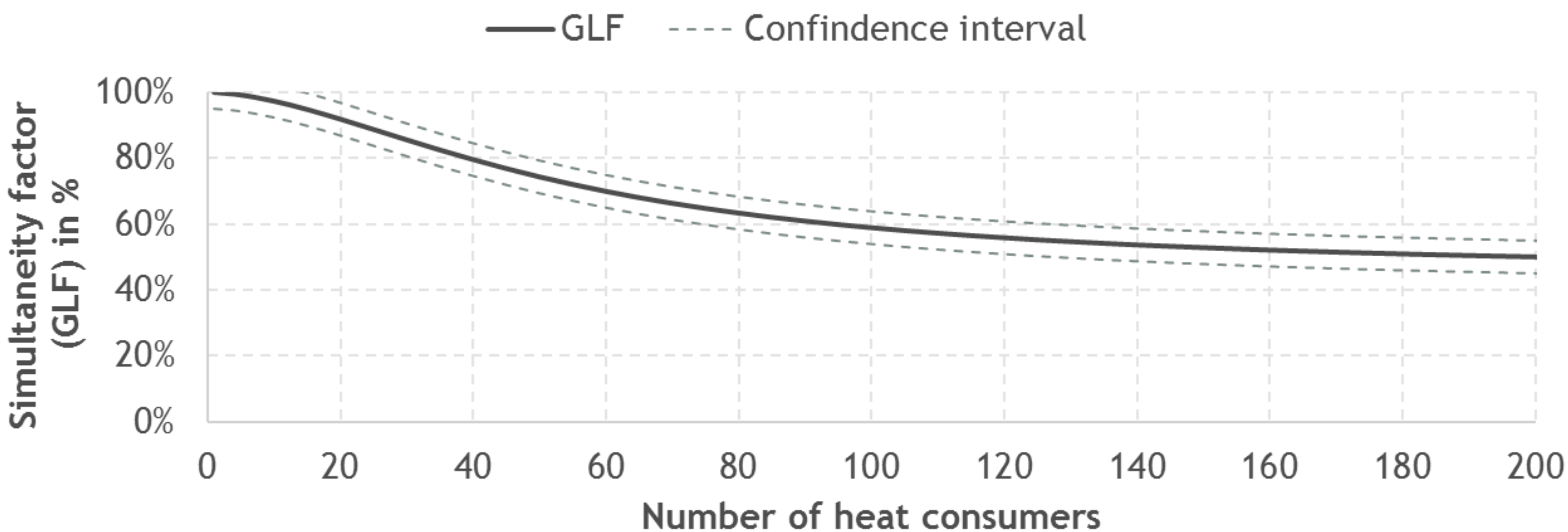
- We estimate them to be constant and 15 % of the supplied heat

- For the scenario “red + green”, where 1.476 MWh/a heat are supplied, it yields heat losses equal to 221,4 MWh/a, i.e. a constant heat losses of 25 kW

- Theoretical max heating demand = 990 kW + 25 kW

CORRECTION OF THE NECESSARY HEAT CAPACITY

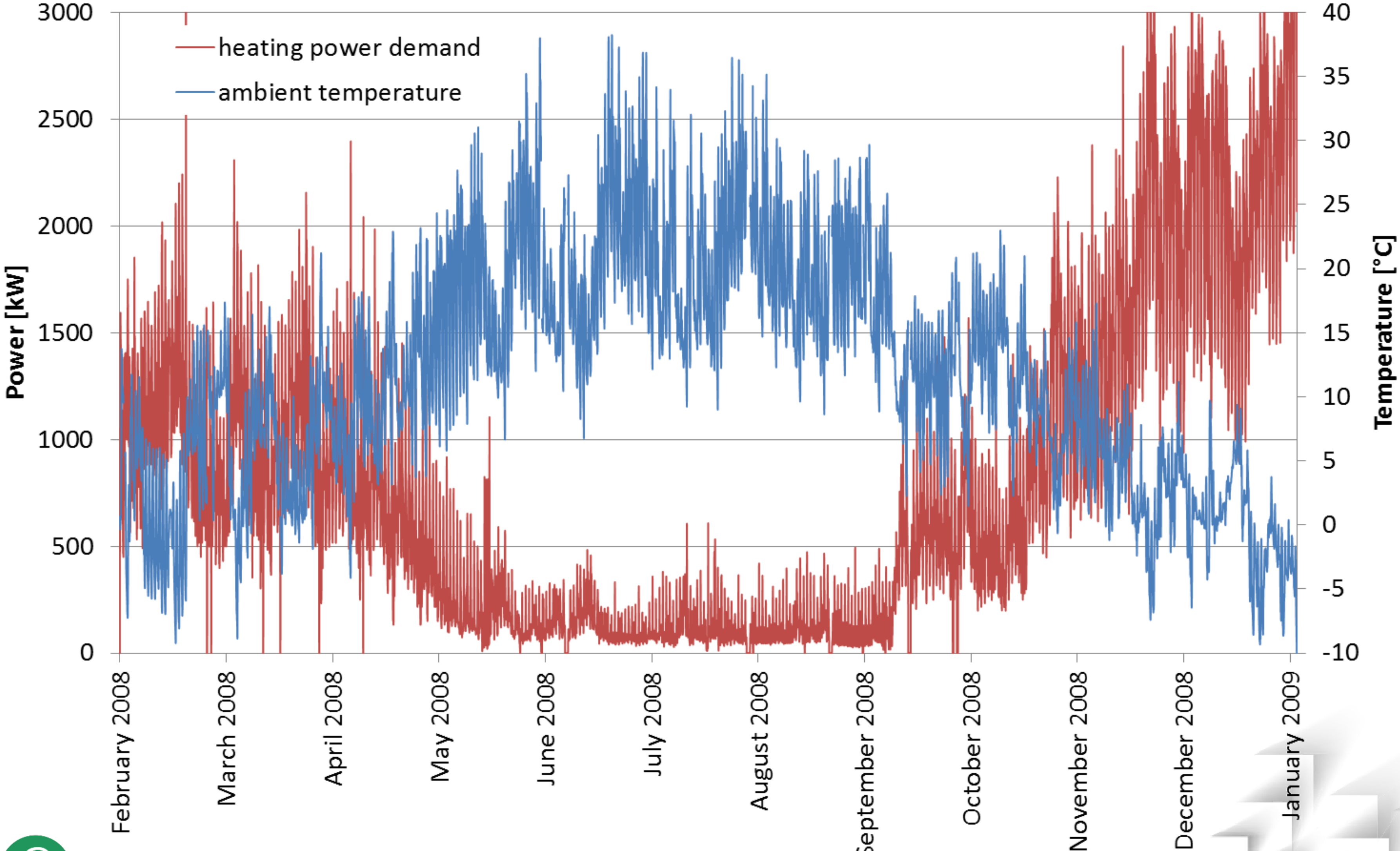
- The necessary heat capacity is equal to the installed capacity multiplied by a simultaneity factor. It is based on the fact that not all consumer will request their full capacity at the same time



source: *Winter, W., Haslauer, T., & Obernberger, I. (2001). Untersuchungen der Gleichzeitigkeit in kleinen und mittleren Nahwärmenetzen. Euroheat & Power, 1-17.*

- Assume we have 25 consumers, GLF = 0,89 and the required heating capacity yield = 990 kW * 0,89 + 25 kW ≈ 900 kW

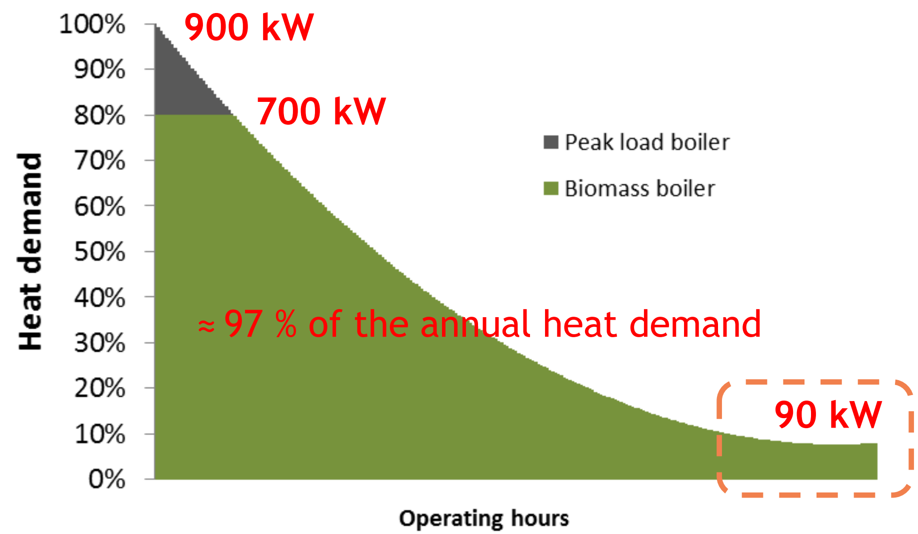
LOAD CURVE OF A DH GRID



SIZING OF THE BIOMASS BOILER

Biomass boiler to cover up to 80 % of the heat demand, i.e. 700 kW

The few operating hours at high power (>80 %) are usually not worth the higher investment of a bigger biomass heating plant



Be aware! Minimum head demand < minimum boiler load → Biomass boiler to run above 25 % of its nominal load, i.e. >175 kW !

Calculate the full load operating hours of the boilers

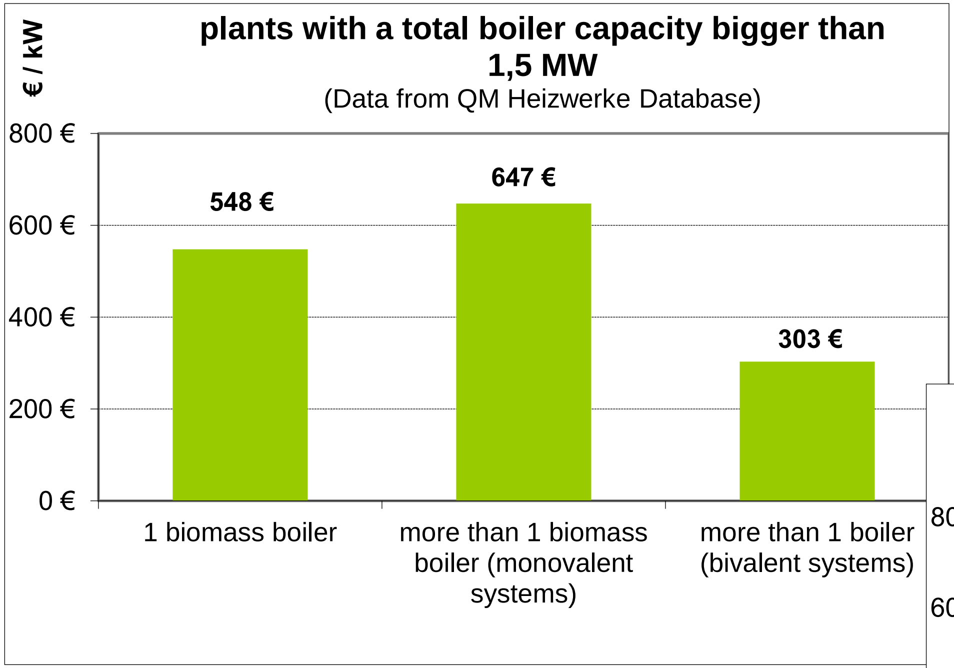
$$Full\ lead\ operating\ hours\left[\frac{h}{a}\right] = \frac{annual\ heat\ production\ [\frac{kWh}{a}]}{nominal\ boiler\ capacity[kW]}$$

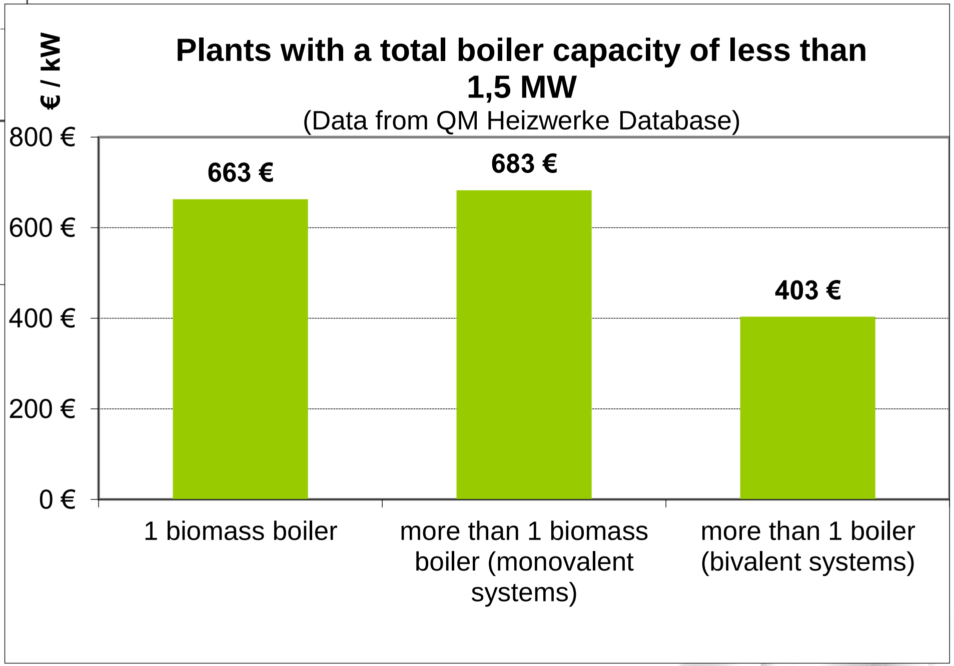
HEAT COSTS

- $$Heat\ costs = \frac{\sum annual\ costs}{\sum heat\ delivered\ to\ the\ consumers}\left[\frac{€}{MWh}\right]$$

- Annual costs includes, costs related to …
  - Investment (incl. imputed capital interest rate, i.e. interest rate and expected lifetime of the component)
  - Maintenance
  - Fuel and auxiliary energy
  - Personnel costs (cleaning, operation, maintenance and inspection)
  - Concession fees
  - …
  - Subsidies ?

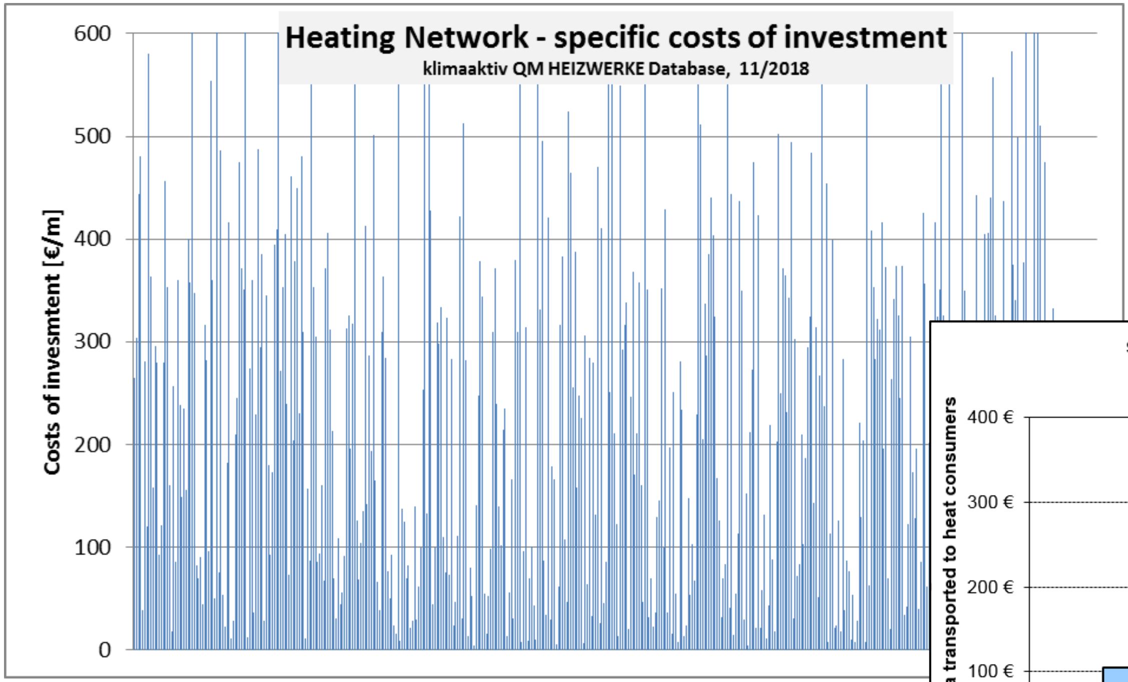
INVESTMENT COSTS OF BIOMASS HEATING PLANTS

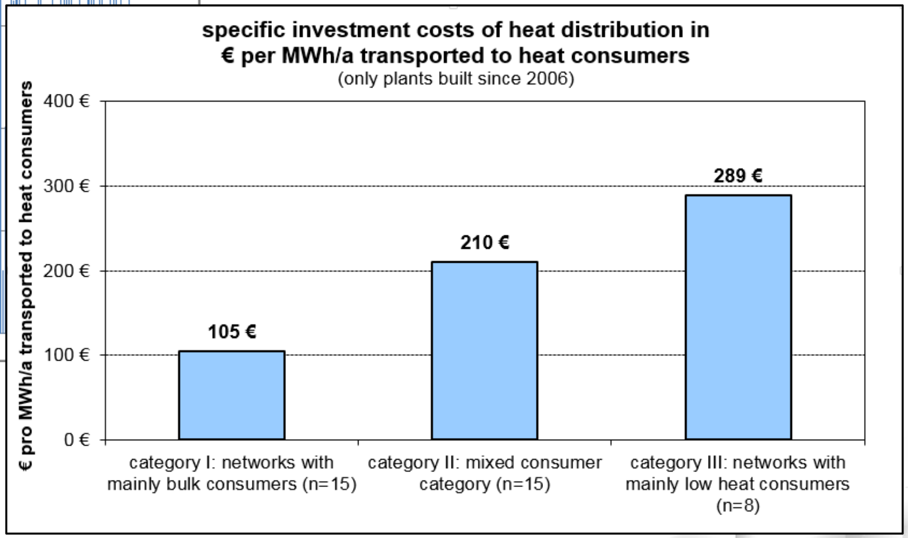




INVESTMENT COSTS HEATING NETWORK

- Investment costs of the heating network vary from 200-400 €/m (route length)





HEAT COST REFERENCE VALUE

- Typical/Existing heating system to be substituted
- E.g. oil heating system
  - Annual utilisation rate of boiler: 75 %
  - Net calorific value of heating oil: 10 kWh/l
  - Oil price: 0,08 €/kWh
  - Heat price: 0,08 €/kWh · 0,75 = 0,106 €/kWh ! (Fixed costs, e.g. Investment for the boiler and necessary oil tank not considered)

  - Annual utilisation rate of electric heaters: 100 %
  - Electricty price = Heat price: 0,2 €/kWh ! (Fixed costs, e.g. Investment for the heaters not considered)

THANK YOU!

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