IEA DHC/CHP Annex IX

Business from technology

District Heating for Energy Efficient Building Areas

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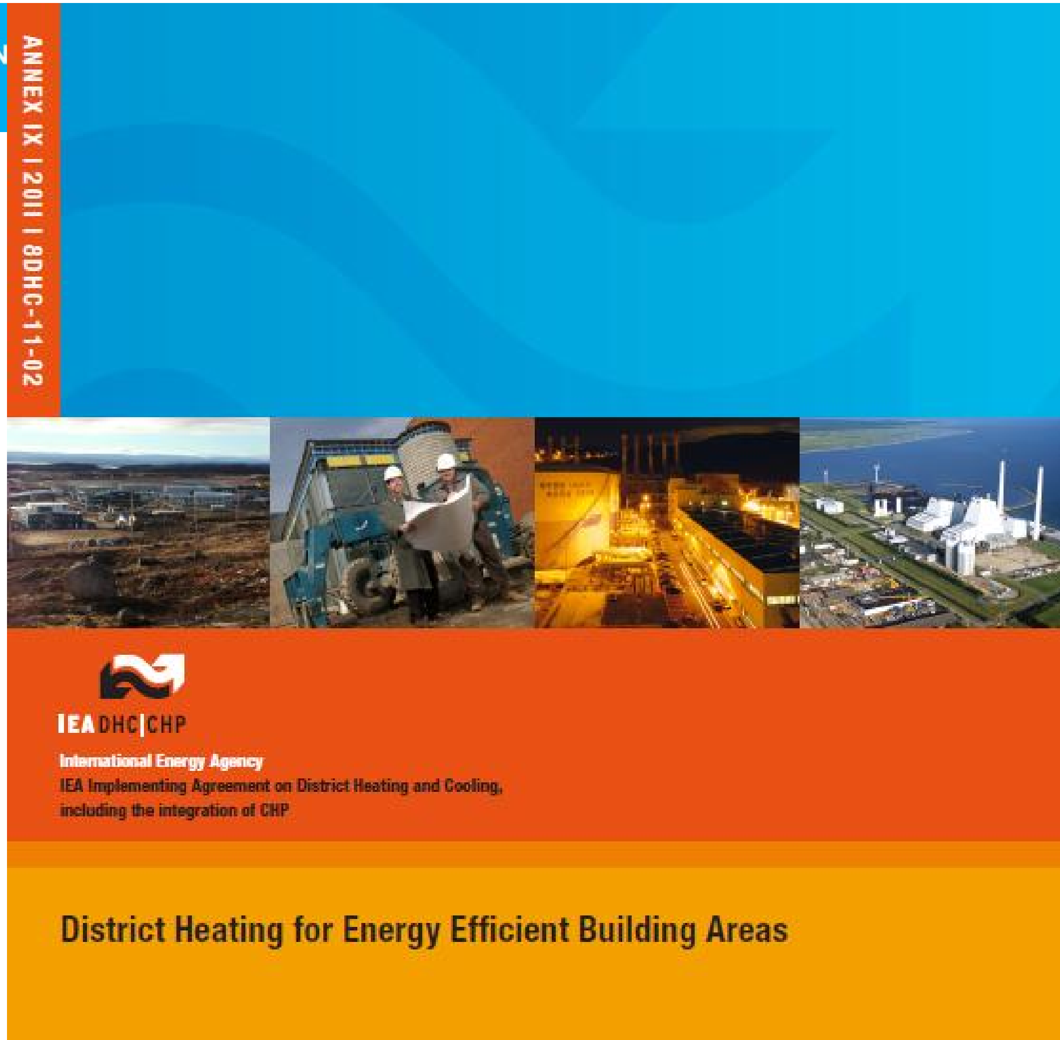

Co-partners:

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The district heating market faces two strong challenges:

1. **Increasing energy efficiency of buildings decreases the heat demand of the customers. Therefore heat distribution will in turn get more costly and less efficient.**

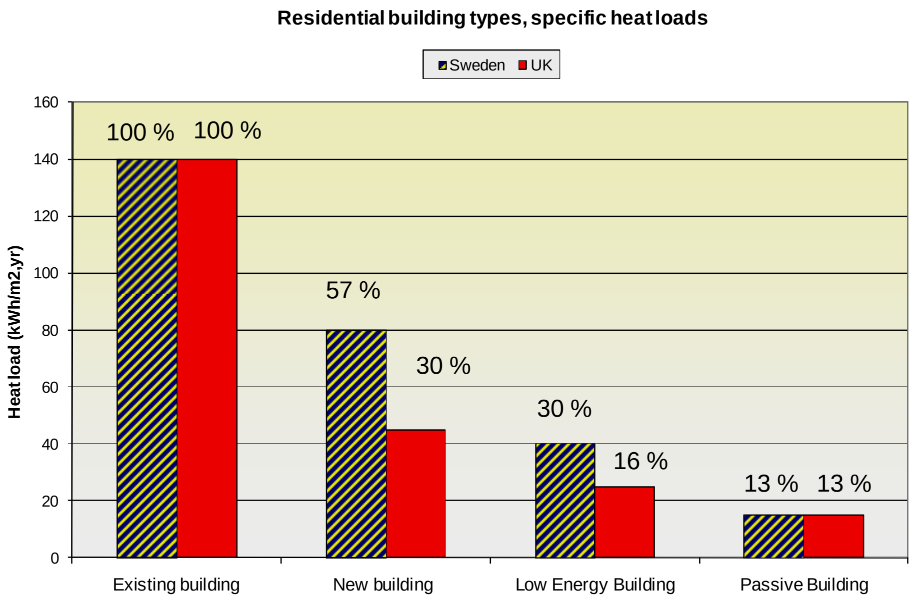
2. **Furthermore, customers in new areas also wish to use their own heat sources based on renewable energy such as solar energy or heat pumps, which accentuates the difference between summer and winter loads.**

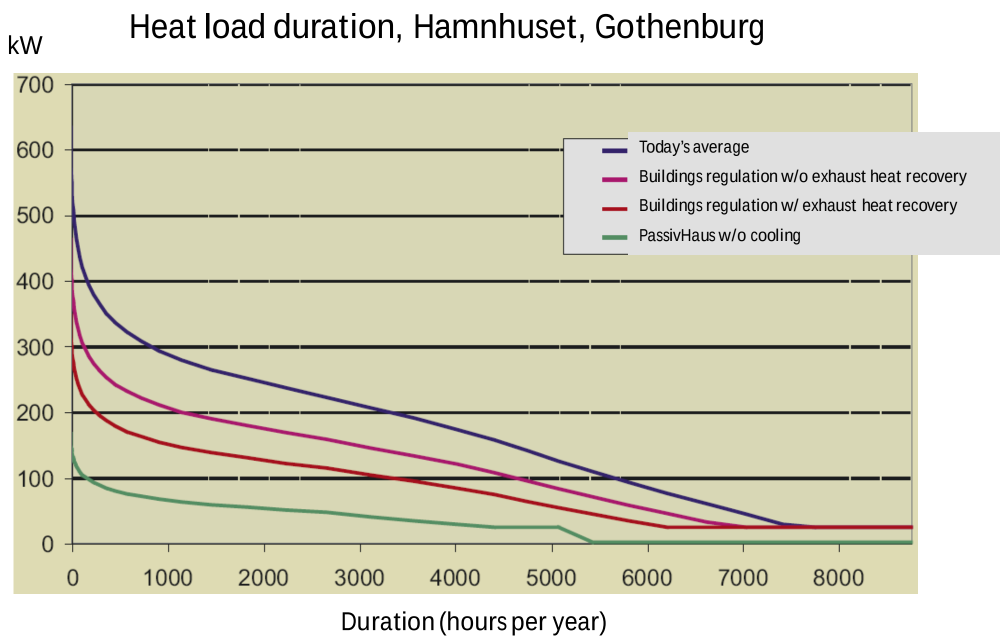
Project objectives

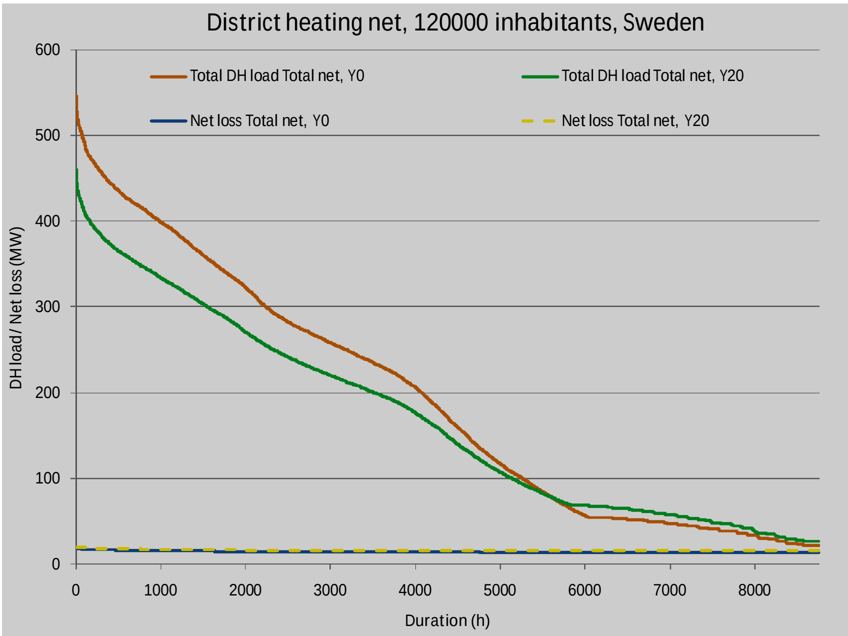
Strategies for securing and widening the district heating market by offering district heating to housing areas with increasingly Improved energy efficiencies and use of renewable energy sources (CO_2 neutral).

Future DH loads and trends

- Low energy buildings
- Towards lower heat density and lower heat-line density in DH areas
- Solar and other renewable sources in building side
- Increase relative heat losses in DH systems
- DHW will have a larger share of the total load. DHW is dominating district heating load nowadays in the summer time
- Annual load demand curves will become flatter (other sources) and peak loads will stay and shorten max. peak load hours
- Challenge to CHP production


Residential building types, specific heat loads
Sweden
UK
Heat load (kWh/m2,yr)
160
140
120
100
80
60
40
20
0
100 %
100 %
57 %
30 %
30 %
16 %
13 %
13 %
Existing building
New building
Low Energy Building
Passive Building


Heat load duration, Hamnhuset, Gothenburg
kW
700
600
500
400
300
200
100
0
Today's average
Buildings regulation w/o exhaust heat recovery
Buildings regulation w/ exhaust heat recovery
PassivHaus w/o cooling
0
1000
2000
3000
4000
5000
6000
7000
8000
Duration (hours per year)

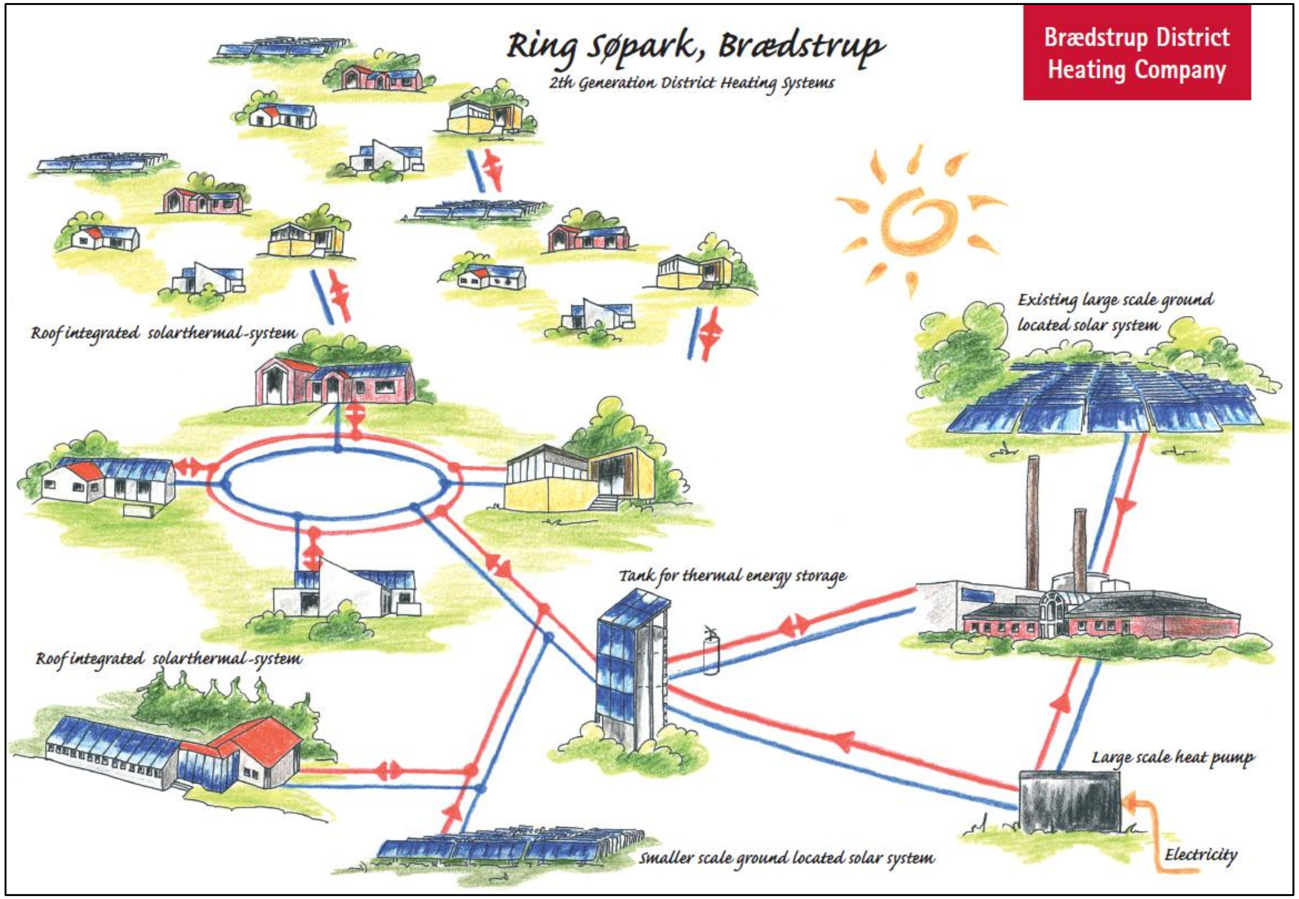

District heating net, 120000 inhabitants, Sweden
DH load / Net loss (MW)
600
500
400
300
200
100
0
Total DH load Total net, Y0
Total DH load Total net, Y20
Net loss Total net, Y0
Net loss Total net, Y20
0
1000
2000
3000
4000
5000
6000
7000
8000
Duration (h)

Future DH trends

- Future network must be operated at lower temperature (60-70 ºC) with high temperature drop in buildings
- Limit is DHW temperature 55 ºC or lower if aloud
- Radiator or wall heating as low temperature as floor or air heating in buildings
- Absorption cooling in summer needs at least 80 ºC (in future lower)
- RES sources as solar or wind stipulate to use heat storages in DH-net or buildings. Green house gas neutral future!
- Hybrid heating systems like DH with heat pumps or solar collectors requires more flexible and adaptable DH distribution system
- Increased producer/consumer interaction
  - Heat on demand
  - Heat when available

Case: BRÆDSTRUP in Denmark

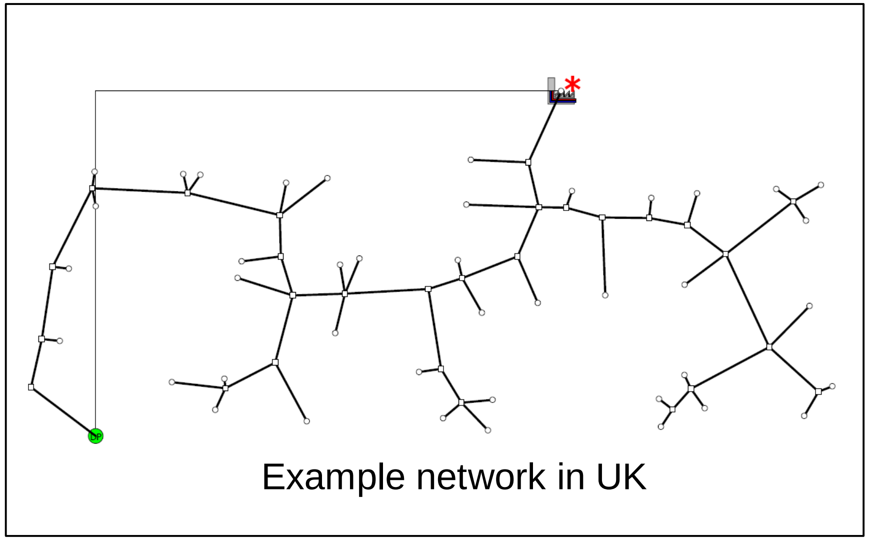
Solar heating + Heat pump

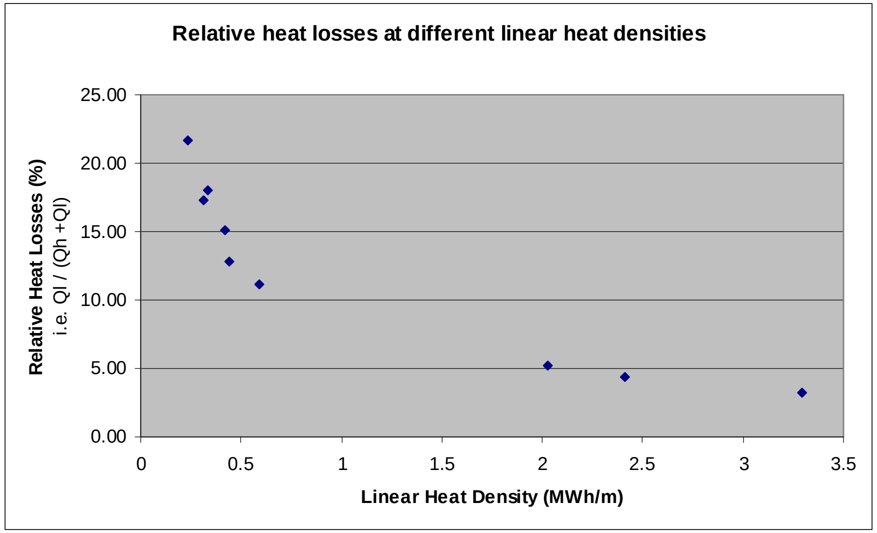


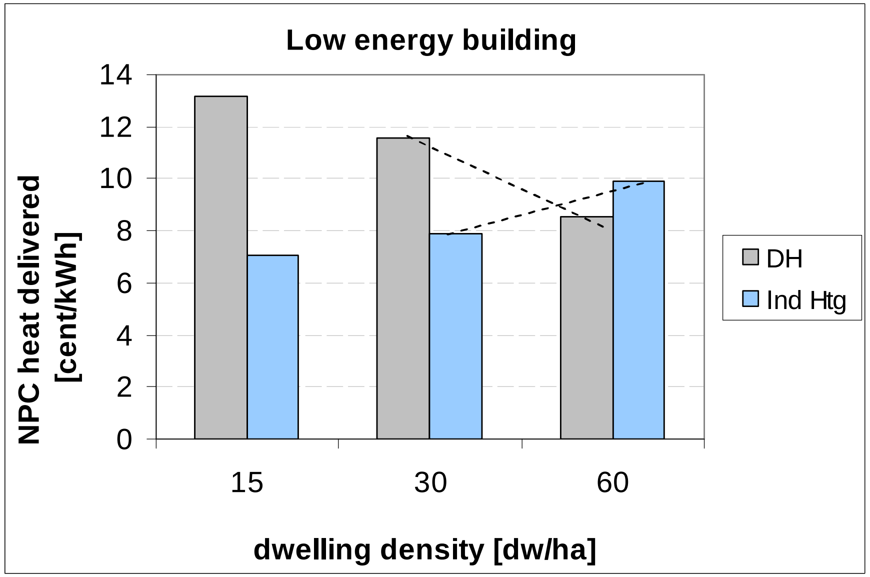
Roof integrated solar collectors on new buildings are connected to a 2-way DH network, in addition to the existing solar field next to the CHP plant

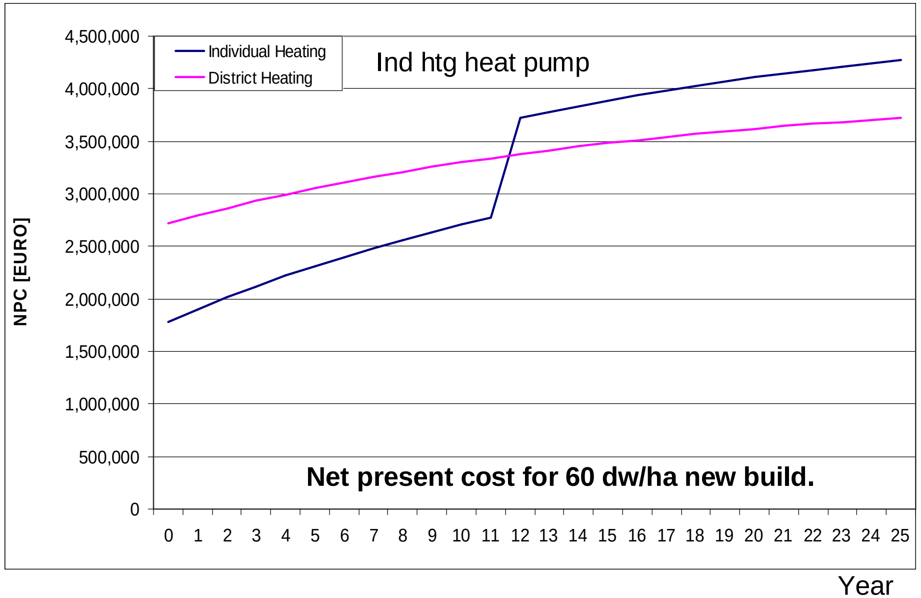
Future DH trends

- Online measurement helps to follow consumption in real time and two-way interface interaction with consumer and two-way heat transport producer to/from consumer
- Lower demand density should be compensated with tighter town plan and more floors in buildings
- Cross-over point for DH's linear heat density should be lower
  - 1,0 MWh/m,a city area pipelines (Scandinavia)
  - 0,5 MWh/m,a for enlarging to new areas in 0,5 -1,0 km dist.
  - 1,5 MWh/m,a new areas constructed DH systems (UK)

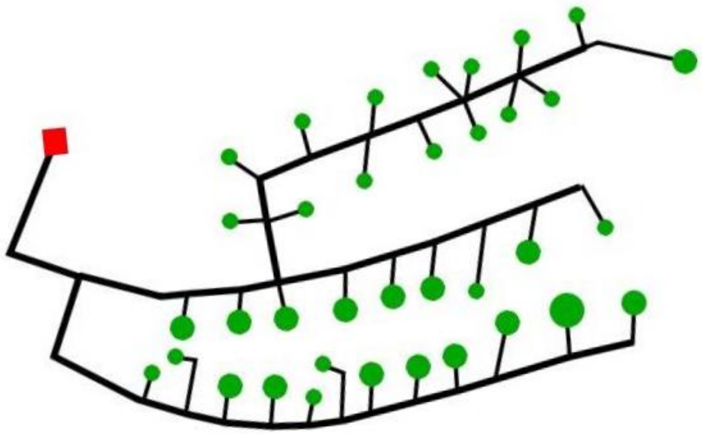

Example network in UK


Relative heat losses at different linear heat densities
Relative Heat Losses (%)
i.e. Ql / (Qh +Ql)
25.00
20.00
15.00
10.00
5.00
0.00
0
0.5
1
1.5
2
2.5
3
3.5
Linear Heat Density (MWh/m)


Low energy building
NPC heat delivered [cent/kWh]
14
12
10
8
6
4
2
0
15
30
60
dwelling density [dw/ha]
DH
Ind Htg


NPC [EURO]
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
Individual Heating
District Heating
Ind htg heat pump
Net present cost for 60 dw/ha new build.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
Year

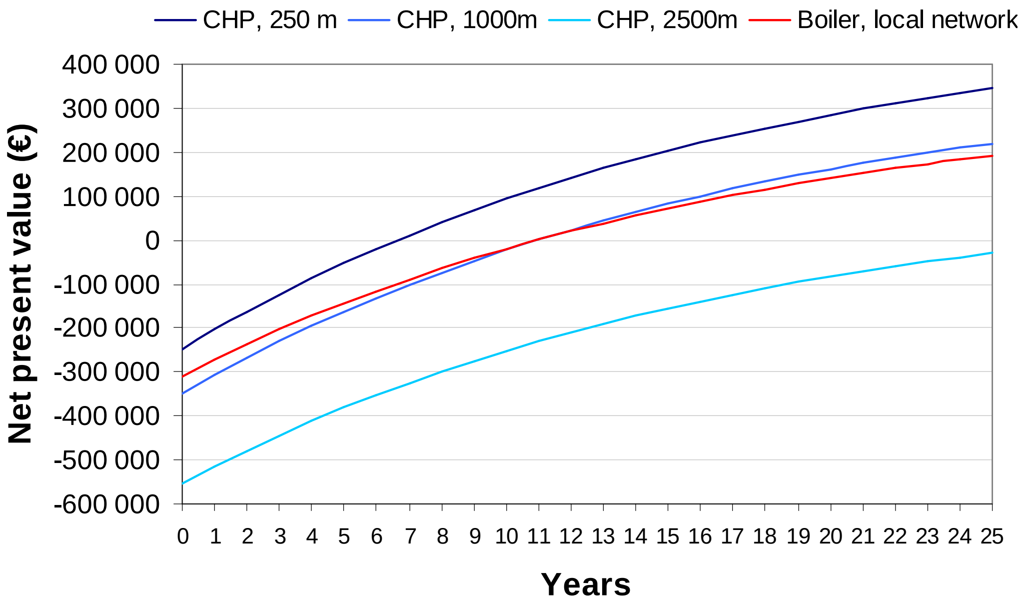
Marja-Vantaa case area in Finland

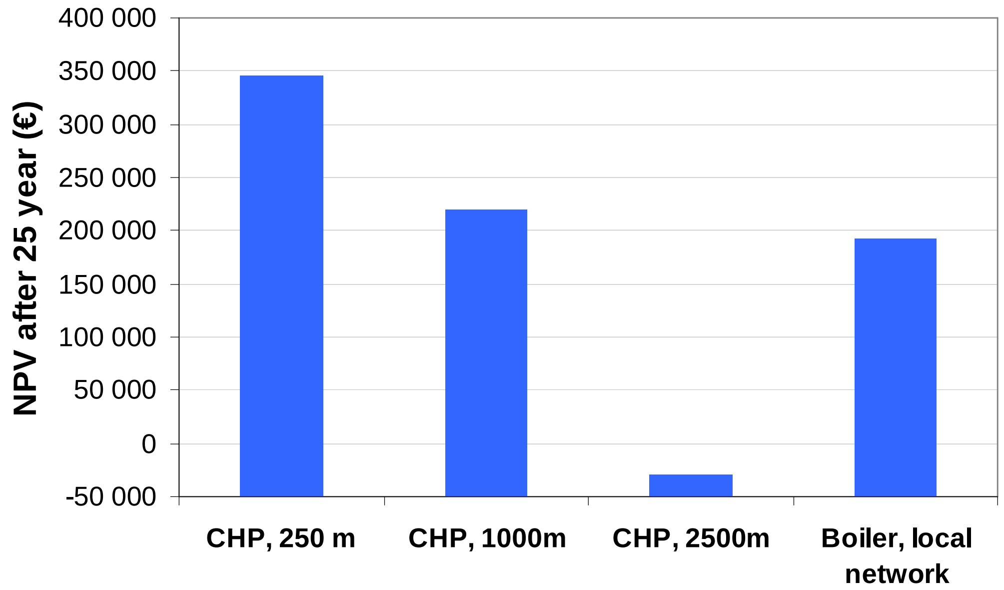


- 56 detached houses, each with a floor area of 200 m^2 and a specific consumption of 125 kWh/m^2 (including 25 kWh/m^2 for DHW)
- Only 37 connections, a few connections serve more than one dwelling
- Total trench length of 2 390 m
- Service pipes DN 15 or DN 20
- Area characteristics:

Attribute	Value
Estimated area	6.27 ha
Number of dwellings	56 dwellings
Dwelling density	8.9 dwellings/ha
Average pipe length per dwelling	42.6 m/dwelling
Heat density (plot area)	22.3 kWh/m^2
Linear heat density (pipe)	0.59 MWh/m
Maximum demand per pipe length	0.28 kW/m

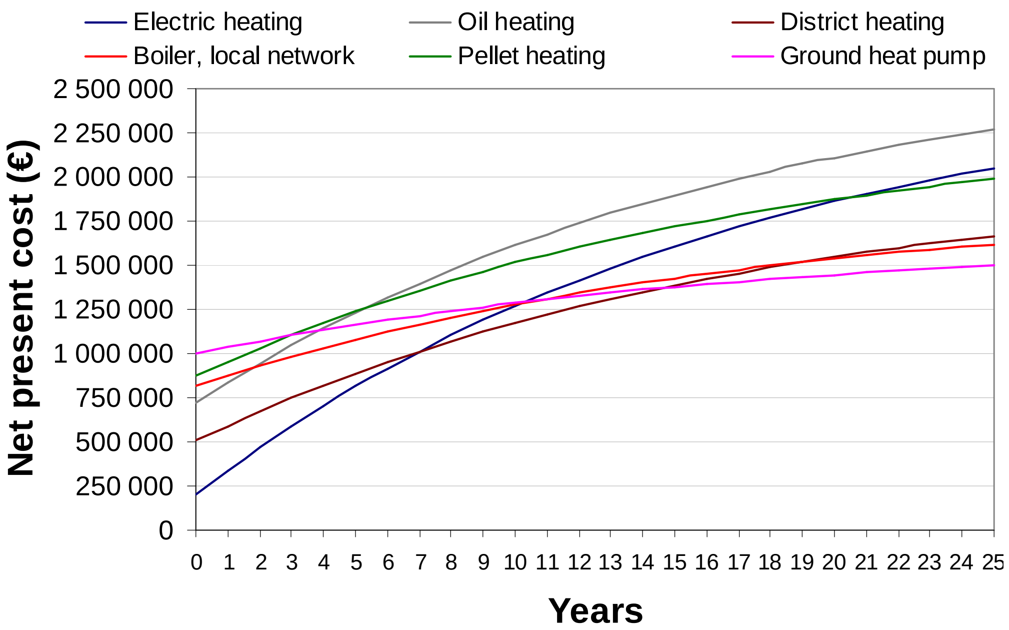
NPV calculations, producer point of view

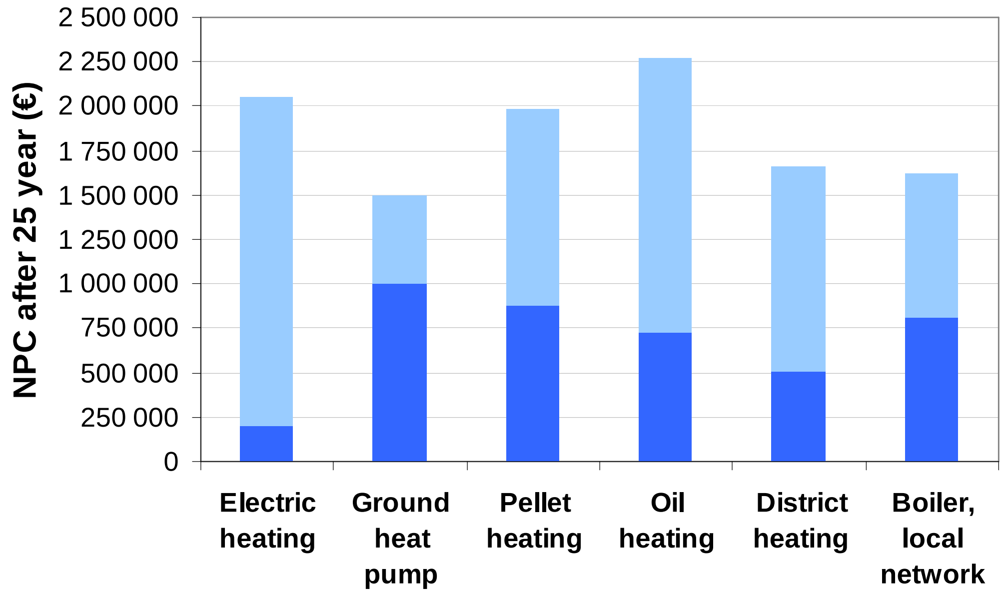




- The development of NPV of the investment, shows a reasonable borderline for a network connection being close to 1 km (left)
- The NPV at 25 years from the investment (right)
- Interest rate of 6 % used

NPC calculations, consumer point of view





- Development of NPC for different heating system alternatives (left)
- The NPC at 25 years from the investment (right)
- No significant need for renovation during the 25 years assumed (a bold assumption for boilers and especially for the heat pump)

What to do

- The future DH system should be mixture of hybrid production system based on RES energy sources
- Temperature level as low as possible based on DHW and high enough drop in consumer side
- New pumping strategy; divided pumping capacity into the network
- Heat production from third parties or open DH network and operation strategy how does it works
- Operation cost/distributed energy lower with more effective operation
  - new systems components: plastic pipes, super insulation, heat storages, customer/production substation, ”free” heat sources, etc.
  - lower maintenance cost

What to do

- Investment cost lower with new components: low depth pipelines, developed construction methods
- Heat driven cooling for building, integration of heating and cooling
- CHP production integrated to new DHC systems, new design, more electricity, more driven hours, etc.
- Smart control systems: On-line operation software for more effective and inter-active system operation
- Energy consulting and management supporting customer to find suitable heating solution, using it right and control his energy consumption. Mobile services.
- Guidelines and directives for applications of new components
- Methods for enabling to smooth blend of new and old technologies