DATA CENTERS AND 4GDH IN PRACTICE - THE CASE OF VIBORG

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Viborg Fjernvarme
EASY COMFORTABLE LOW COST

AGENDA

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1. Viborg District Heating in figures
2. Historic focus on low temperature
3. Enabling surplus heat

VIBORG DISTRICT HEATING PURPOSE

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- **The company's main goal is to give our customers more value for less money.**
- The strategy consists of four main areas.
  - **Competitiveness of product** to gain more customers.
  - Customer support to **reduce customers consumption** of energy.
  - More efficient **low temperature district heating system** to reduce heat loss.
  - A **more efficient administration** to be able to include more customers.

VIBORG DISTRICT HEATING

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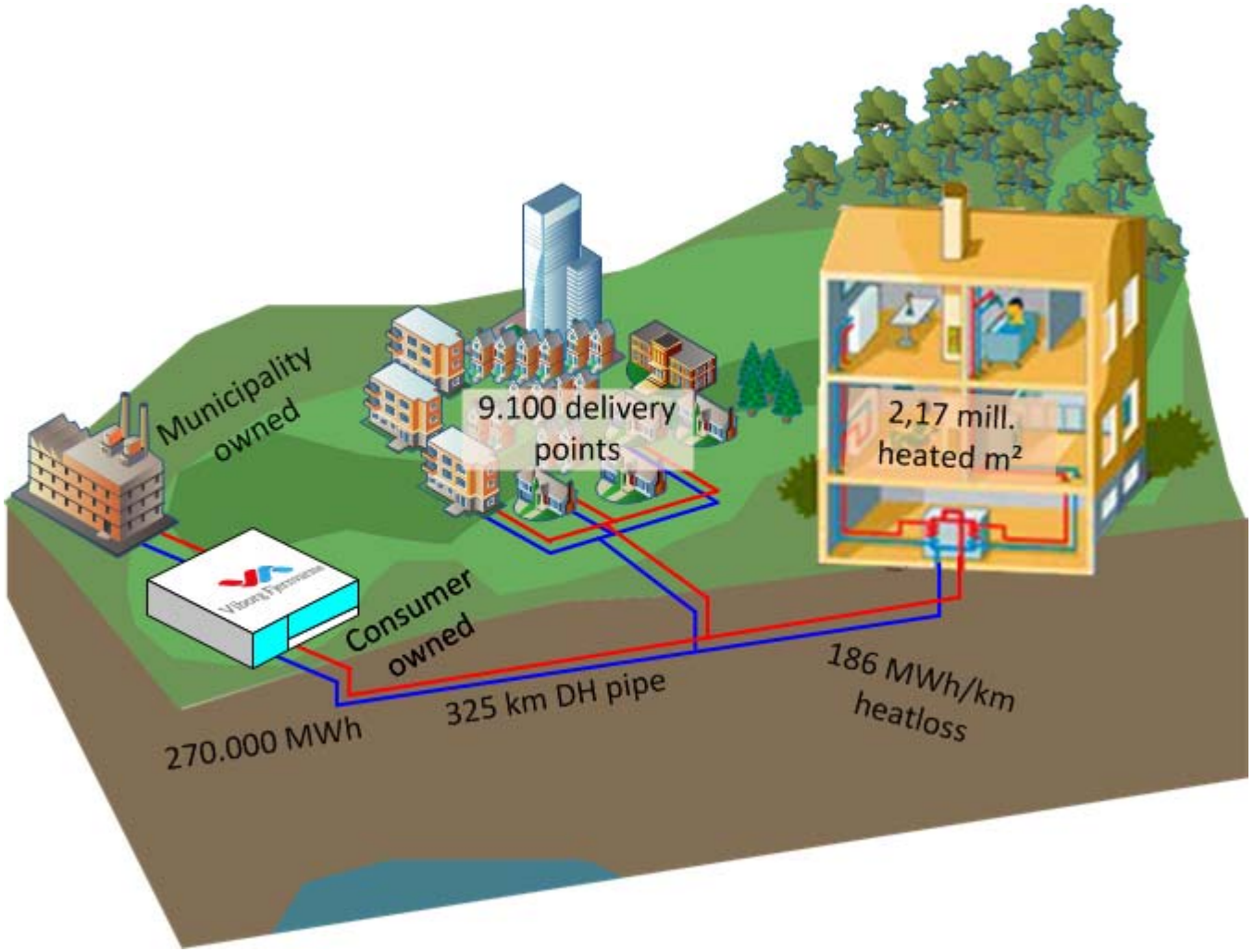

DISTRIBUTION
FOCUS ON 50 % REDUCTION OF HEAT LOSS

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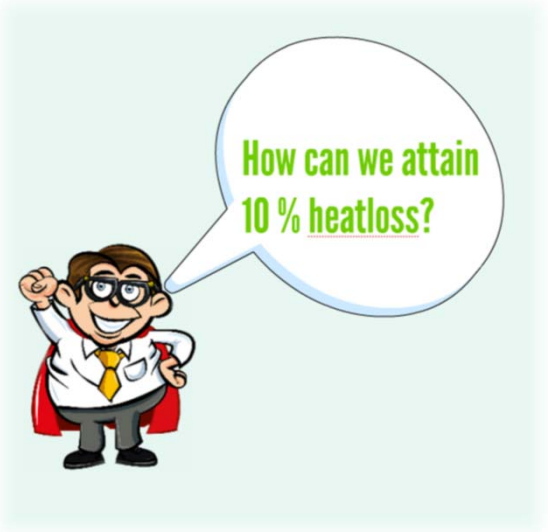
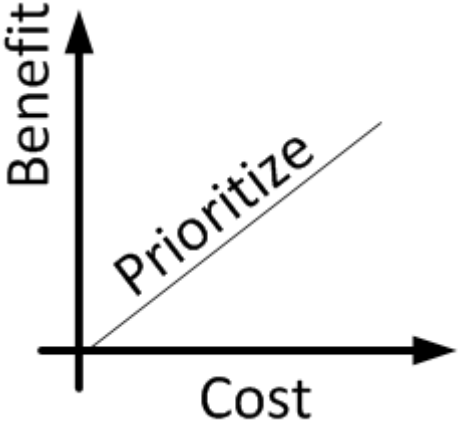


48 projects



The ideas of the employees is now a part of the investment plan

TOP 5

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- Online hydraulic program (Termis) to set the temperature
  - Reduces temperature 5 degree from 68 to 63 degree annual avg.
- Insulation before meter at consumer and service of consumers installation
  - Savings in heat loss and reduced return temperature
- Prioritized consumer support on return temperature
  - 300 consumers – 3 degree better overall return temperature
- New consumer installation – rental model
  - Makes it possible to reduce supply temperature 10 degree and gives a return temperature 5-10 degree lower and gives consumer internal savings that pays the rent.
- Cut-off network circles that's found unnecessary
  - 40 network circles within the distribution grid

4. Generation District Heating

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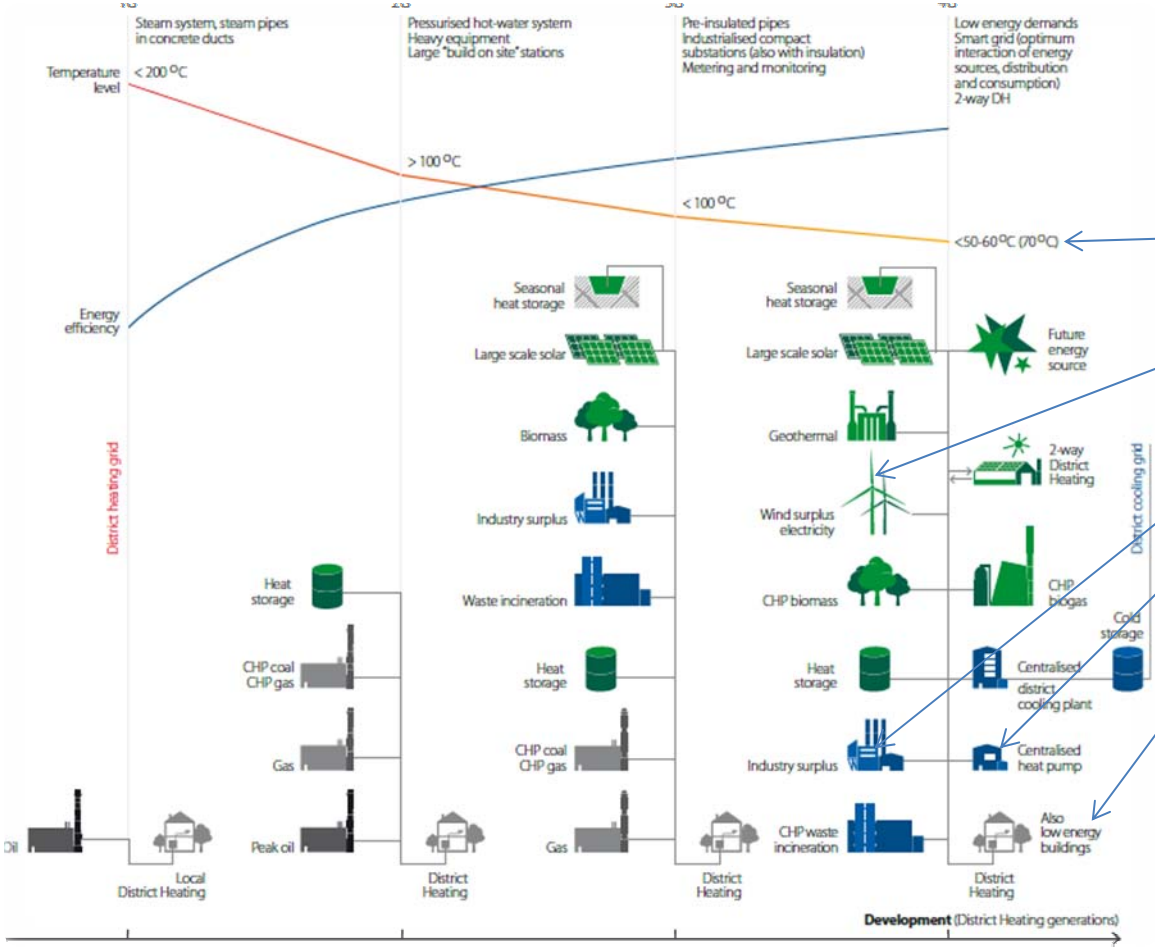

The Datacenter Project (Apple)

FUTURE ENERGY SOURCES

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- Apples new Data Facility

- Situated 10 km outside Viborg
- 55 MW surplus energy at 30 degree is planed to be used in Viborg District heating.
- Electrical heat pumps to boost temperature

- Other surplus energy sources
  - Local hospital, Supermarkets, industrial process

- Existing Gas boilers backup

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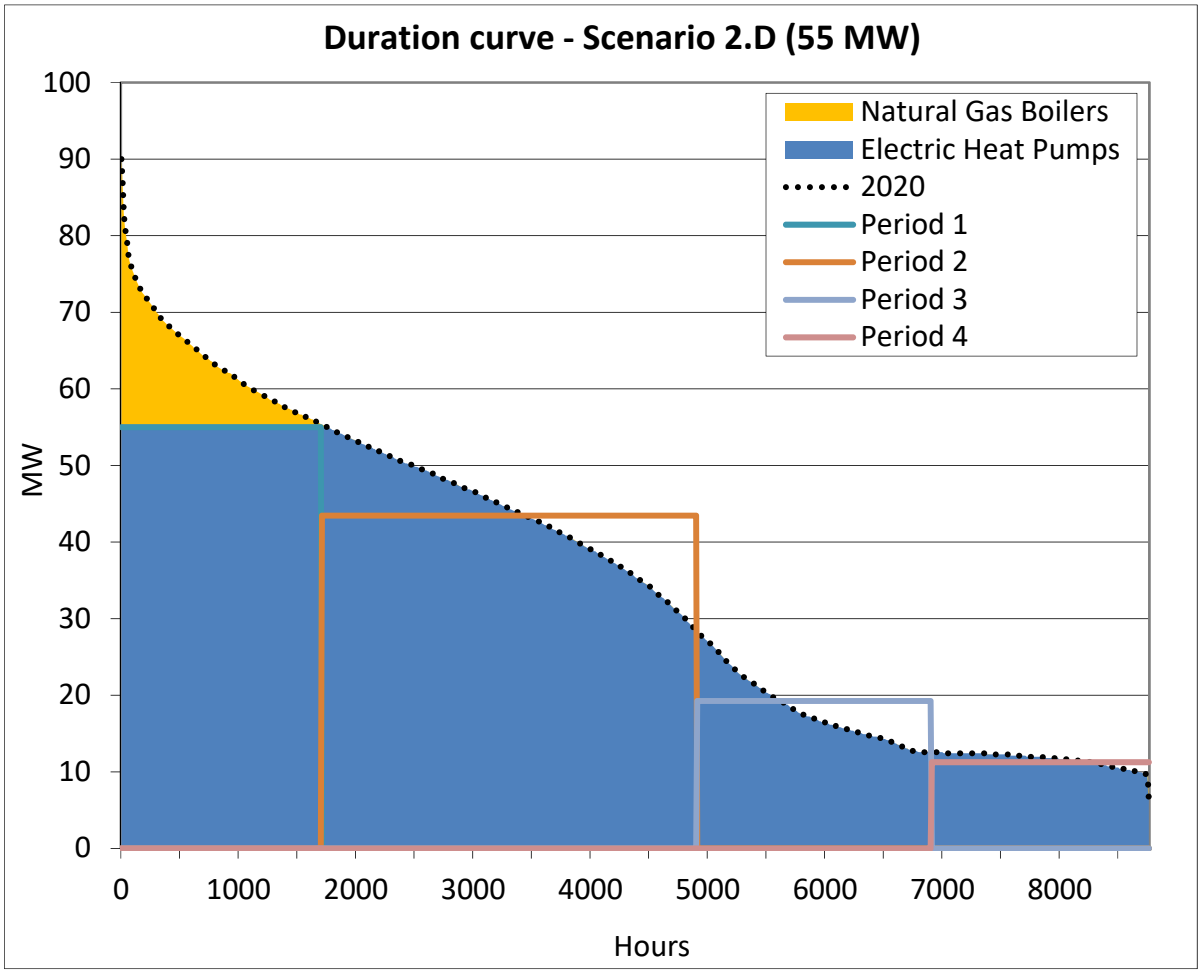

Figure 4-8 Duration curve for scenario 2.D including 55 MW from Apple

HEAT PUMPS IN 2 PLACES

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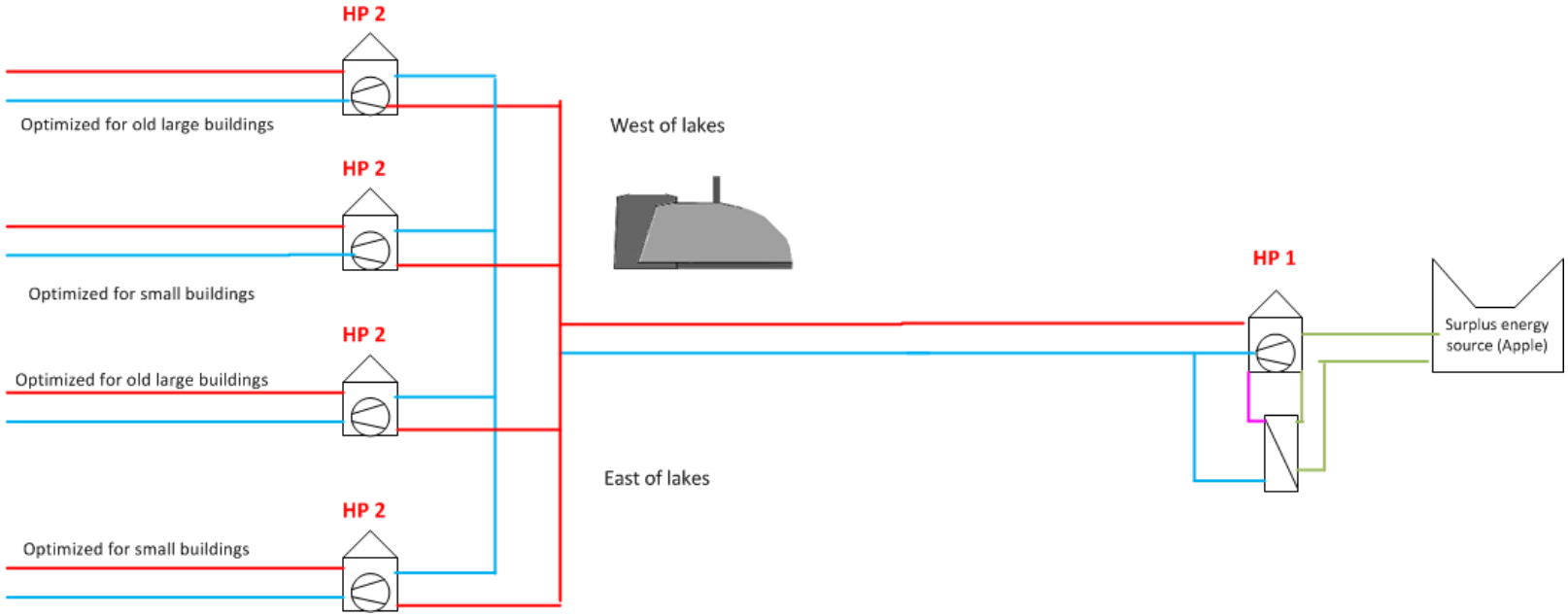
- Heat pumps both at the Datacenter and at the gasboilers in Viborg



- Reduces installations outside Viborg
- Makes it possible to use other surplus sources in Viborg
- Can differentiate the temperature in different sections

SECTIONING THE CITY

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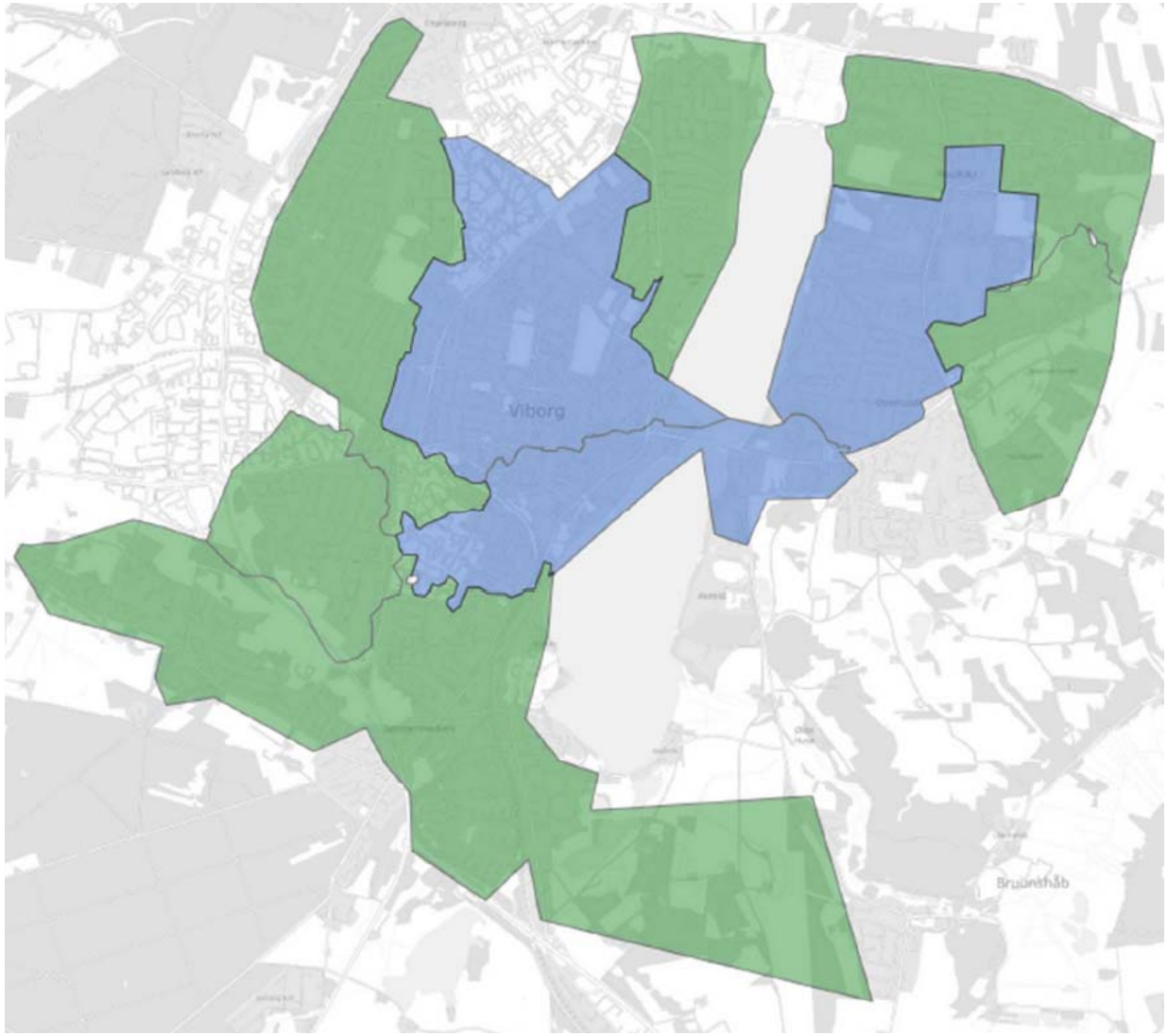

Green areas
optimized for small buildings
(50 °C minimum)

Blue areas
optimized for large older buildings
(58-60 °C minimum)

TEMPERATURE NEEDS

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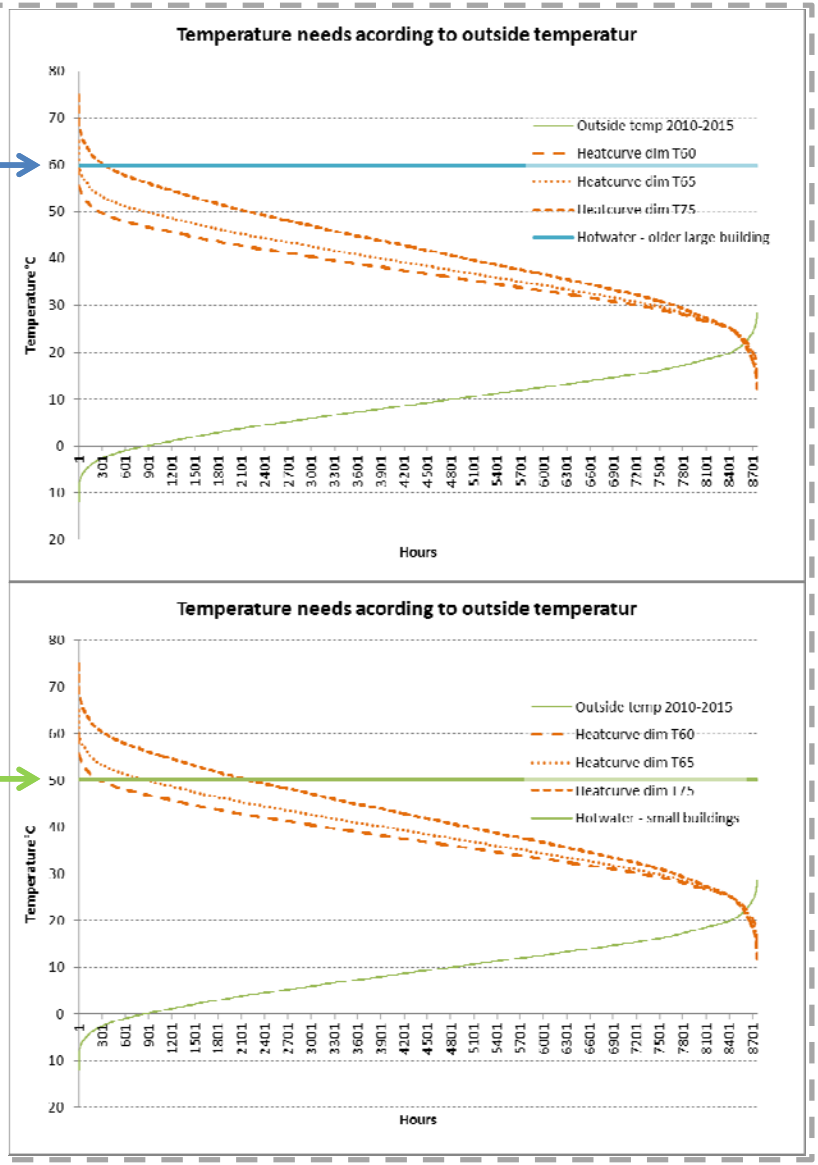
- Older larger buildings
  - Circulation systems on the hot water
  - According to age a heat demand for the radiator from 60 to 75 °C when it's -12 °C outside
- Small buildings
  - Heat exchanger on hot water and no circulation



SECTIONING ON MAIN STATIONS

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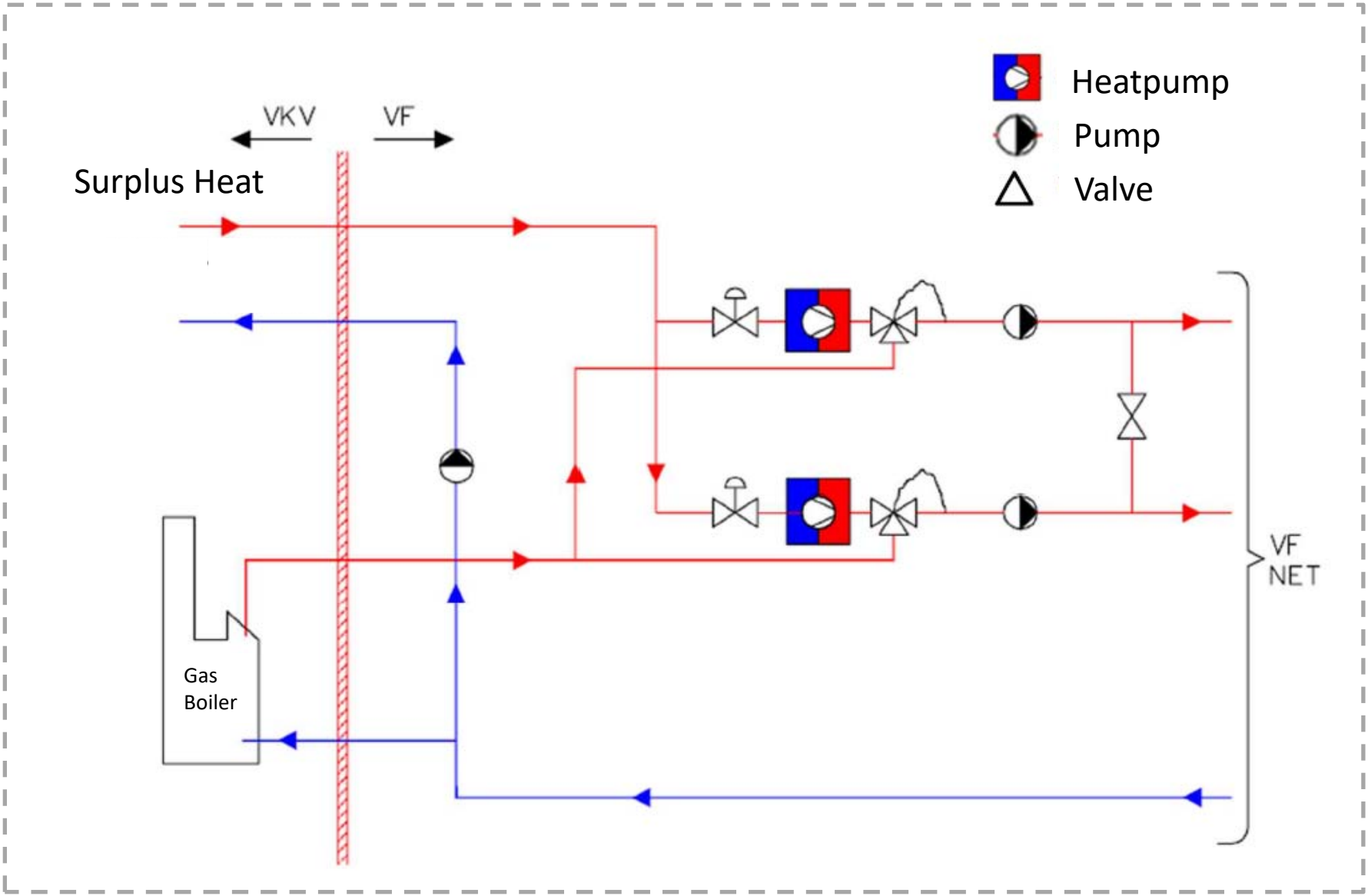

TEMPERATURE FROM MAIN STATIONS IN A NEW PERSPECTIVE

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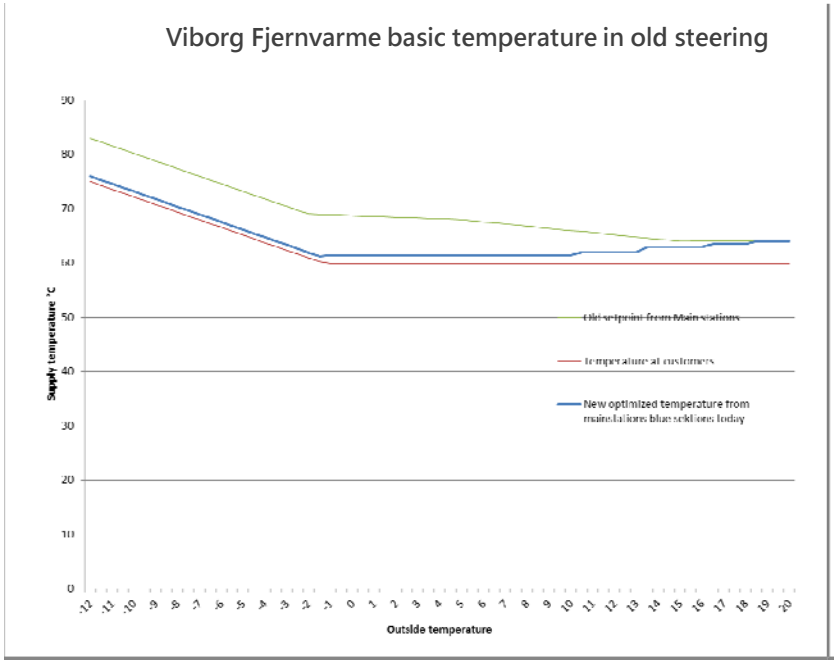
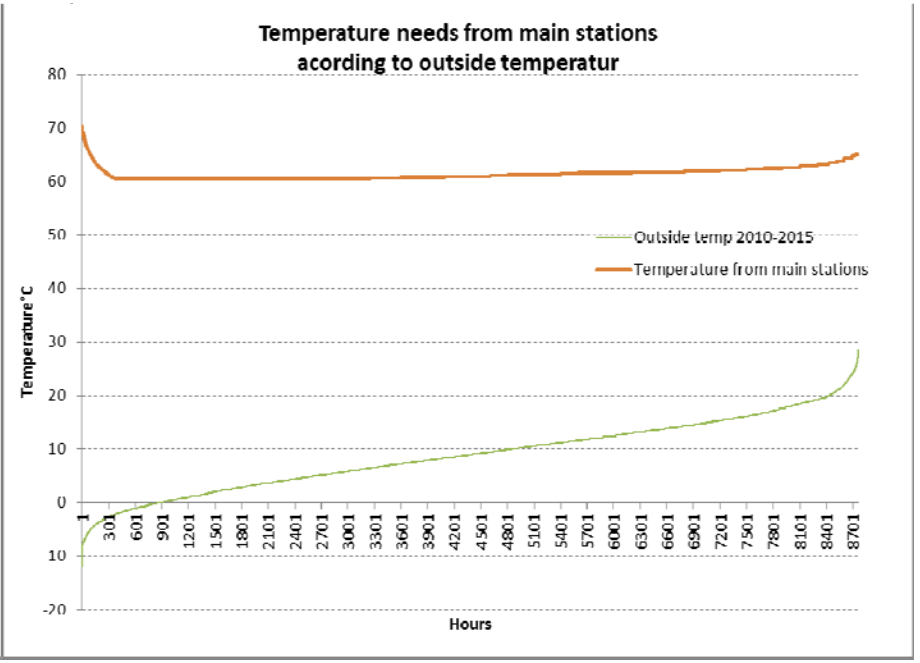
- Temperature still high when its cold
- Temperature in midseason's is lower than the summer temperature





INVESTMENT IN DISTRIBUTION GRID

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- To be able to section the distribution net, a few changes is needed:
  - 4 km distribution net needs to be upgraded
  - 2 new pump stations needs to be established

- Investments14 mio. kr.
- Pipes from 1980-95
- Annual renovation budget in pipes 8 mio. kr.

CONSUMER

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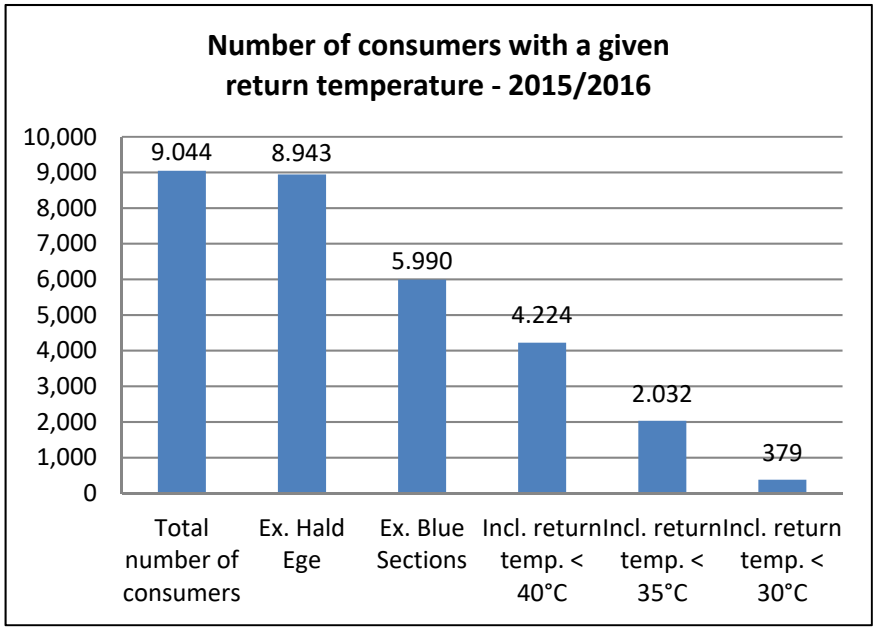
- Most focus on consumers in the green zones
  - 5990 customers
  - 90 customers is larger buildings with circulation systems
  - The others is small buildings with heat exchanger for hot water



UNIT TO RENT

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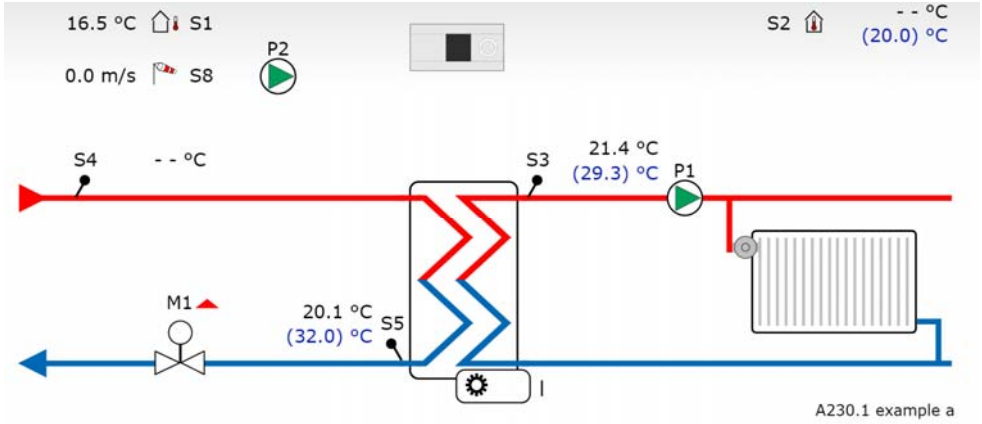
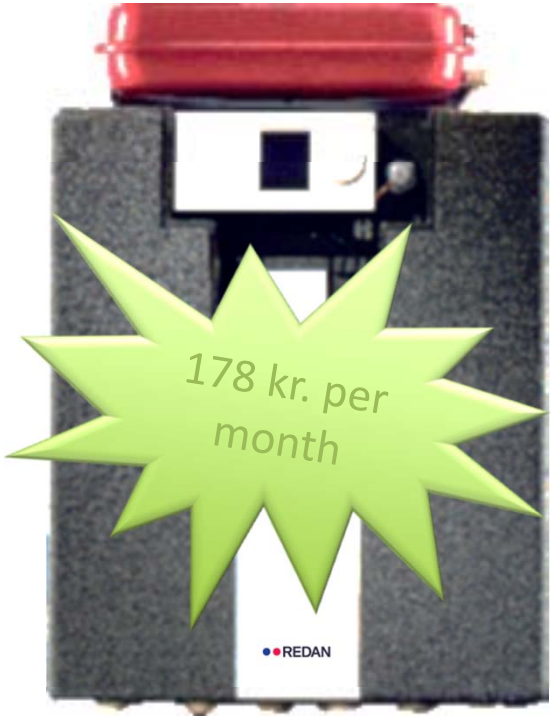
- New project – helps consumers to a new efficient house installations.
- Low monthly rent which pays back in internal savings
- Makes hot water (45°C) at 50 °C supply temperature
- Online access to data at settings





LARGER BUILDINGS

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- Two systems to free circulation systems from legionella
  - Heat pump to produce heat to circulation losses
  - Chemical treatment to get rid of biofilms in system
- A heat pump is a cost for the consumer
- Chemical treatment have the possibility to lower the temperature in circulations systems and there by give an energy reduction and will be paid back

ECONOMICAL AND ENVIROMENTAL CONCLUSIONS

INVESTMENT IN TOTAL

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Scenario	Temperature	Mio. kr.
Reference – Natural Gas CHP	80/40 °C	29
0 – Heat Pumps at Apple	80/40 °C	312
1.A – Heat Pumps at Apple	60/30 °C	270
2.D – Heat Pumps at Apple and at Peak Load Plants in Viborg	55/30 °C	316

Figure 5-12 Investment costs for 55 MW Heat Pumps

VARIOUS PRODUCTION PRICES

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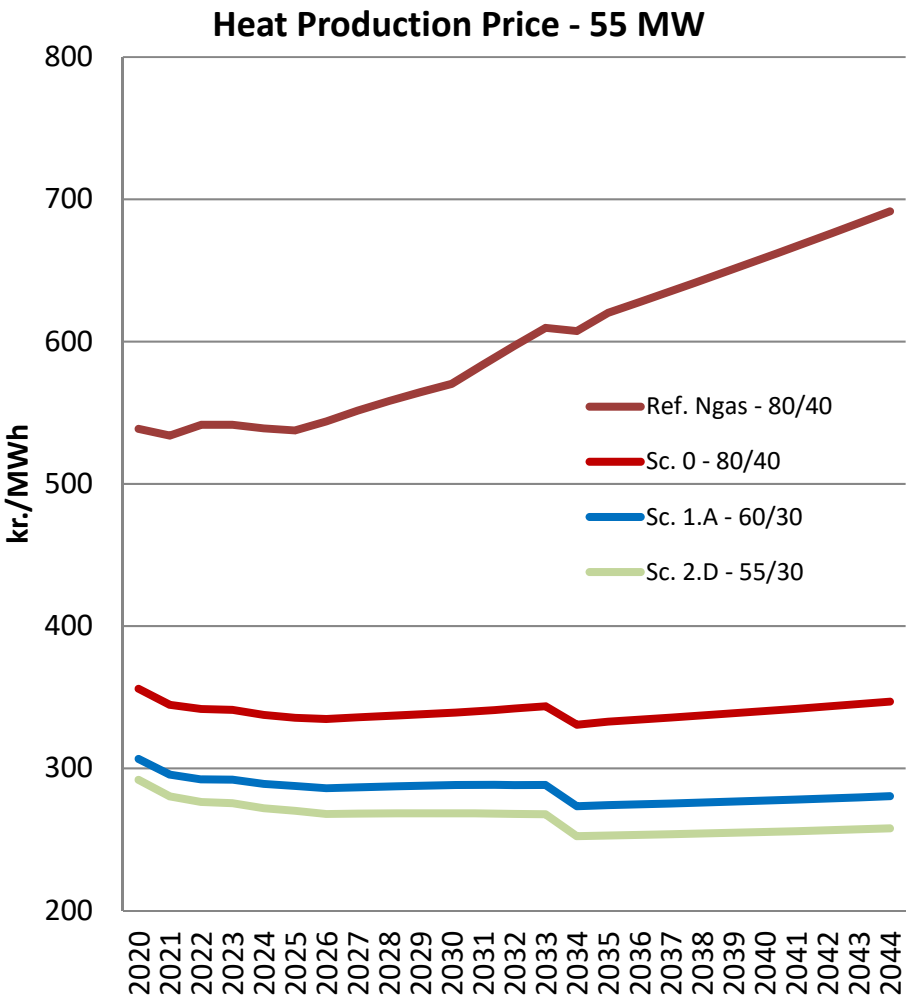
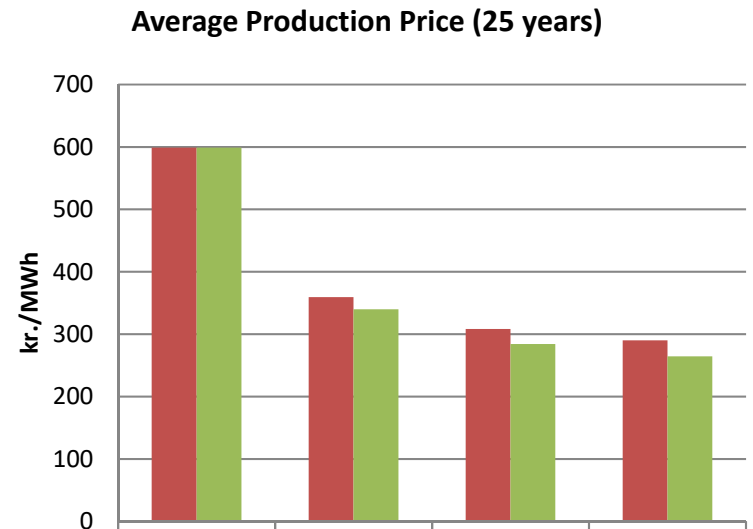


Figure 8-1
Heat Production Price in reference and scenarios at 55 MW



	-	65/40	60/30	50/26
	Ngas	HP at Apple	HP at Apple	HP Apple & multi HP Viborg
	80/40	80/40	60/30	55/30
	Ref.	Sc. 0	Sc. 1.A	Sc. 2.D
45 MW	599	359	308	290
55 MW	599	340	284	265

Figure 8-2
Average Prod. Price (25 years) for 45 and 55 MW from Apple

TOTAL COST OF OWNERSHIP

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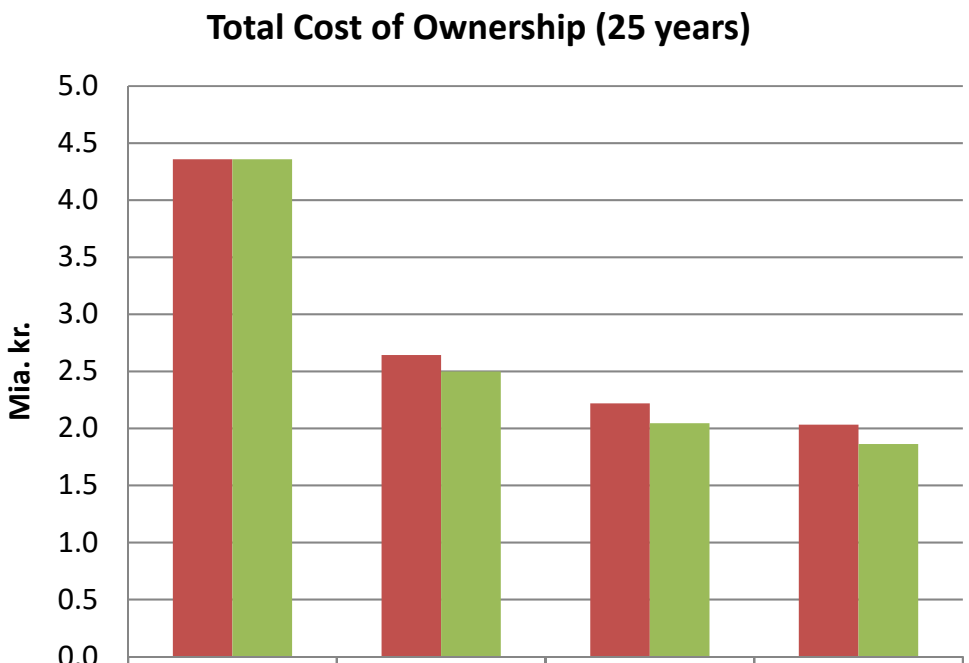

	-	65/40	60/30	50/26
	Ngas	HP at Apple	HP at Apple	HP Apple & multi HP Viborg
	80/40	80/40	60/30	55/30
	Ref.	Sc. 0	Sc. 1.A	Sc. 2.D
45 MW	4.36	2.64	2.22	2.03
55 MW	4.36	2.50	2.05	1.86

Figure 8-3 Total Cost of Ownership (25 years) for 45 and 55 MW from Apple

CONSUMER PRICES

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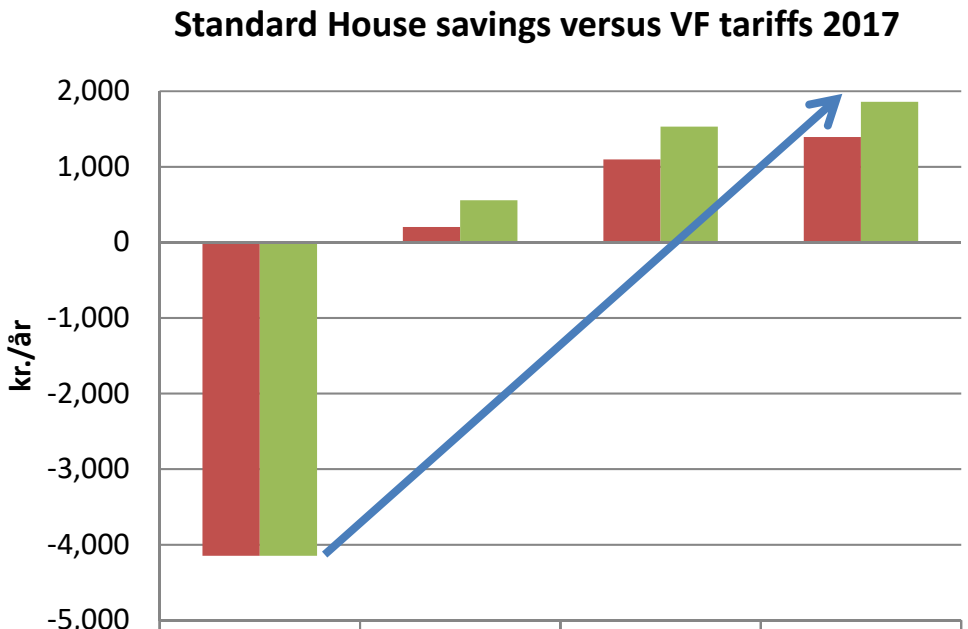

	-	65/40	60/30	50/26
	Ngas	HP at Apple	HP at Apple	HP Apple & multi HP Viborg
	80/40	80/40	60/30	55/30
	Ref.	Sc. 0	Sc. 1.A	Sc. 2.D
45 MW	-4,147	203	1,097	1,392
55 MW	-4,147	557	1,532	1,860

Figure 9-2 Standard House savings versus VF tariffs 2017 for 45 and 55 MW

CO2 REDUCTION

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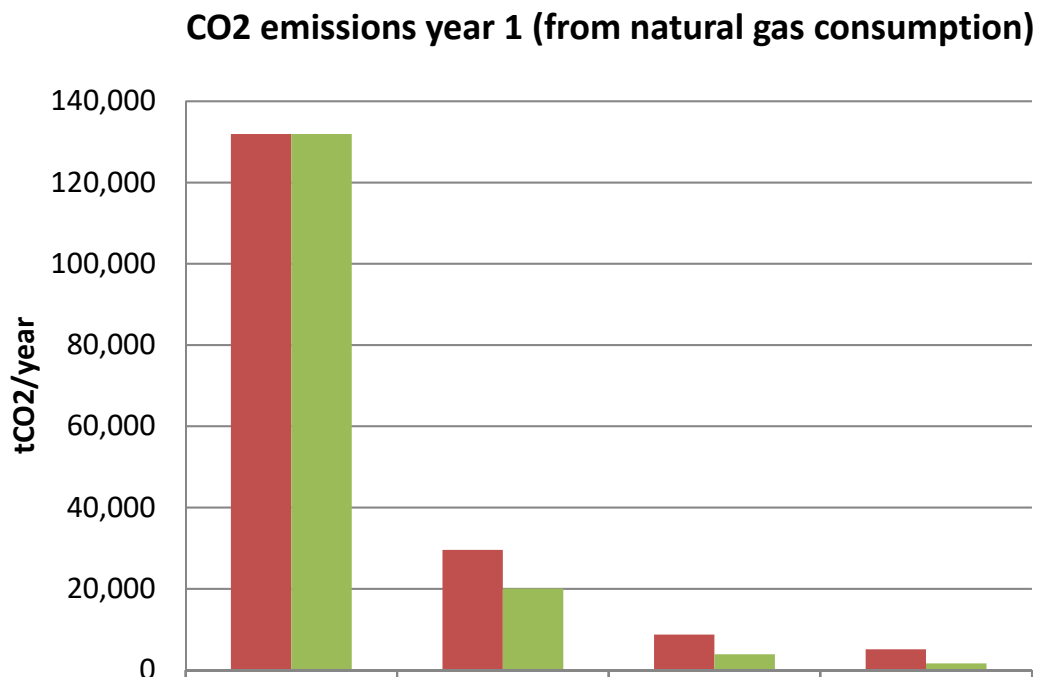

	-	65/40	60/30	50/26
	Ngas	HP at Apple	HP at Apple	HP Apple & multi HP Viborg
	80/40	80/40	60/30	55/30
	Ref.	Sc. 0	Sc. 1.A	Sc. 2.D
45 MW	131,921	29,572	8,721	5,095
55 MW	131,921	20,086	3,861	1,646

Figure 11-3 CO2 emissions from natural gas consumption for 45 and 55 MW from Apple

4DH IN PRACTICE

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- Conclusions
  - We can built and operate a district heating grid based on low temperature - thereby enabling surplus heat from Apple in a cost effecient and competitive way.
  - Having all costs and investments included we are able to do a significant reduction in CO2 emmissions - at the same time lowering the cost of heat to the end consumer…
  - When implemented, this shows, that 4DH is not only a study but a proven model how to built, convert and operate district heating in the future.