Large heat pumps in European district heating systems

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Heat Roadmap Europe

Heat Roadmap Europe I (2012) – quantified advantages of expanding DH to 30% and 50% of the heat demand:

- Reduction of the Primary Energy Supply by 40%
- Reduction of the CO2 emissions
- Enable the use of more renewable energy and waste heat
- Approximately 220,000 jobs to be created

Heat Roadmap Europe II (2014) – synergies between energy savings & DH to cover 50% of the total heat demand

- Cheaper comfort – 100B€ cheaper
- Faster decarbonisation – recycling waste heat
- Better energy – diverse energy supply

The availability of choices

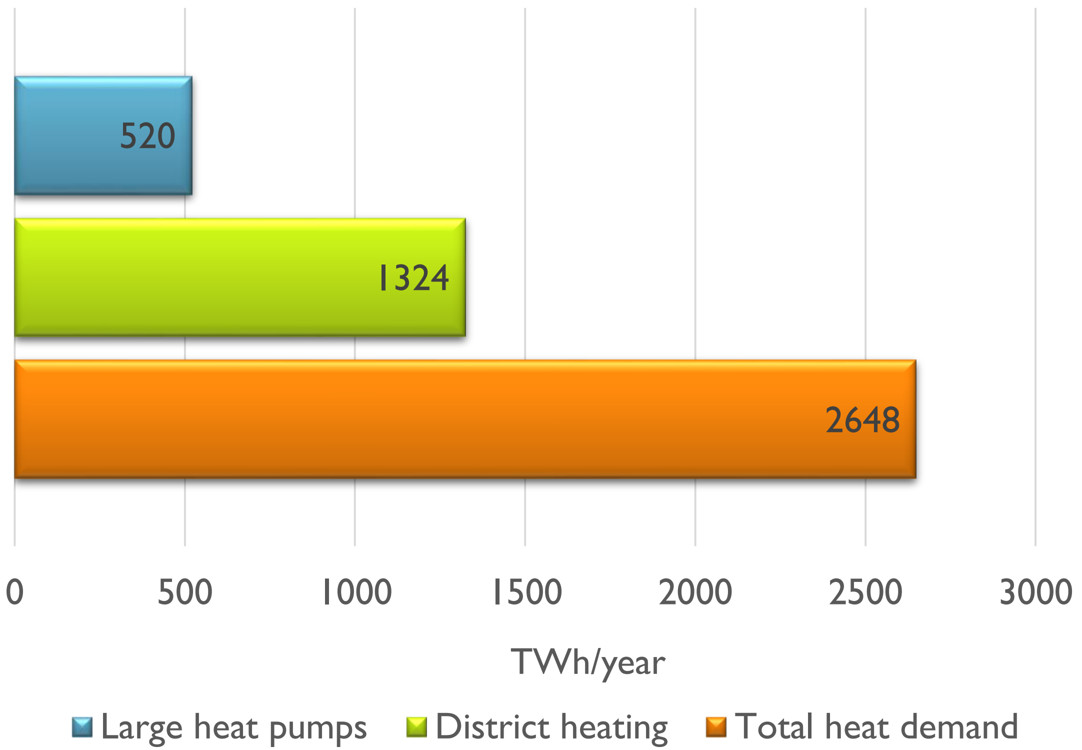
- Real alternatives

- Promotion of clear technological alternatives

- End-of-pipe solutions → Continuity approach → Discontinuity approach

Photos: GE, Zoonar, GEA, reddit.com, Wikipedia.com

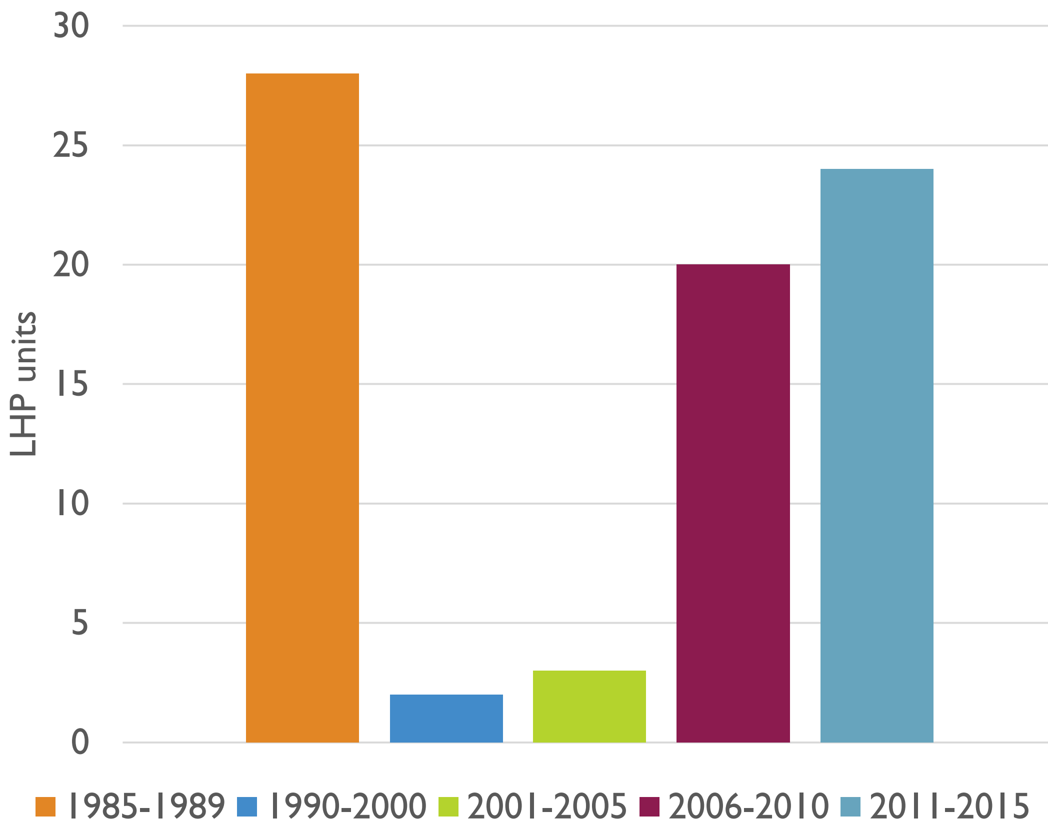
The role of large heat pumps



The share of large heat pumps in 2050 according to HRE scenario

Large heat pumps as critical enablers for the integration of the **heating, cooling and electricity** sectors

Market development



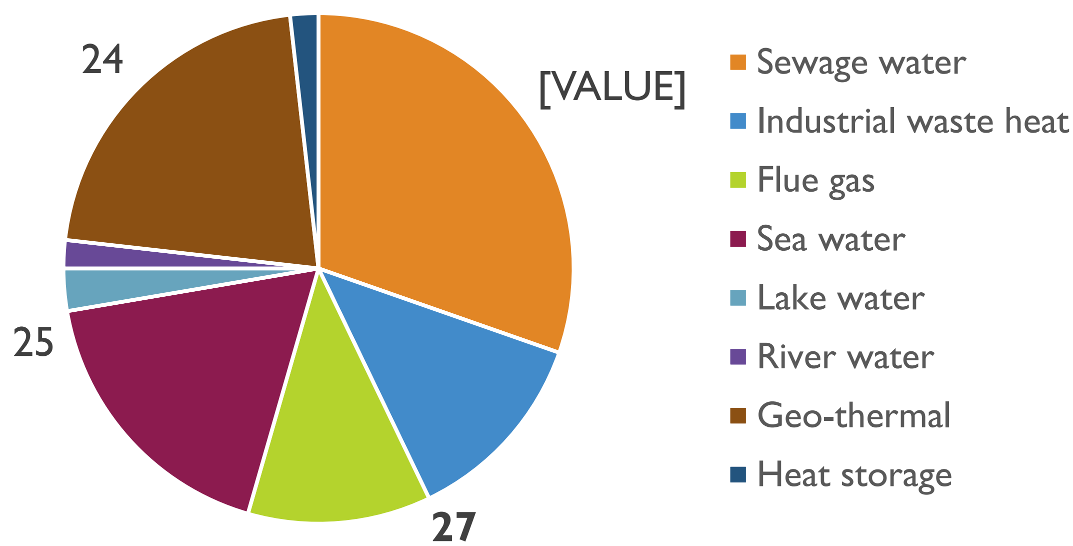
- 106 compressor + 6 absorption units > 1 MWth
- Total power output 1346,5 MWth representing 5,9 to 8,8 TWh/year (if operated 50-75% of the time)
- Covering 2% of the DH capacities
- More installed units starting with mid-2000

The survey

Country	Power (MWth)	Heat plants	LHP units
Norway	84,5	8	15
Sweden	1022,3	13	43
Denmark	45	9	11
Finland	154,6	4	9
Italy	36,6	5	9
Switzerland	35,4	9	13

Country	Power (MWth)	Heat plants	LHP units
Austria	10,1	2	3
Lithuania	15	1	1
Slovakia	1,8	1	1
Czech Republic	6,4	1	1
Poland	3,7	1	2
France	5,5	2	3
Netherlands	1,2	1	1

Heat sources



#1 – Sewage water

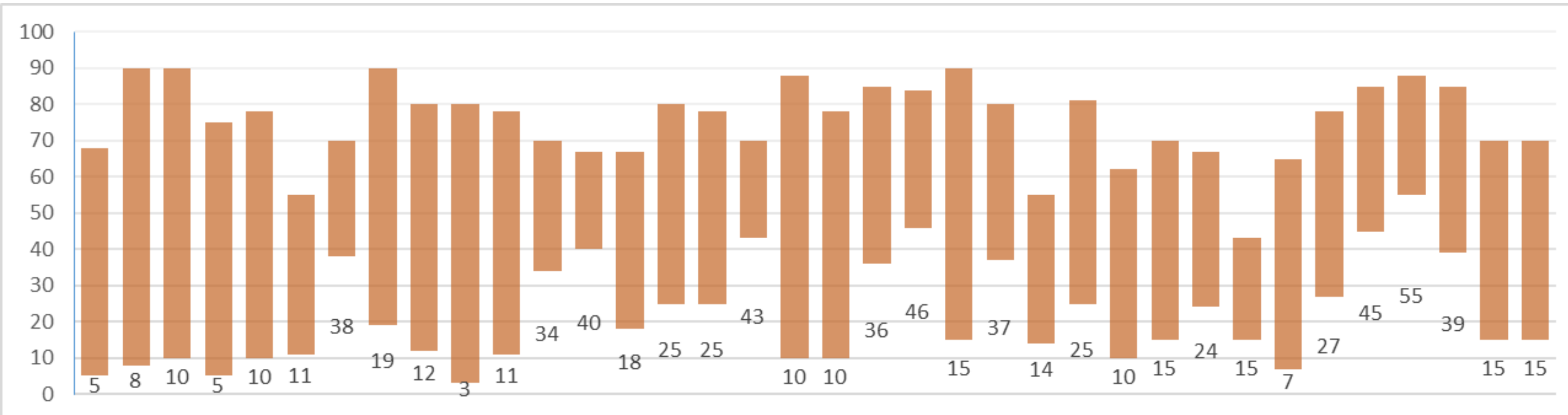
#2 – Waste heat (including flue gas)

#3 – Sea, lake, river

#4 – Geo-thermal

2-9°C	10-20°C	11-40°C	14-46°C	10-40°C	15-74°C
Sea water	Sewage water	Flue gas	Waste heat (diverse industrial processes)	Heat storage (solar)	Geothermal (ground source)
Lake water					
River water					

Operating temperatures



DH t°C	41-50	51-60	61-70	71-80	81-90	91-100
# LHP units	1	2	22	36	35	1

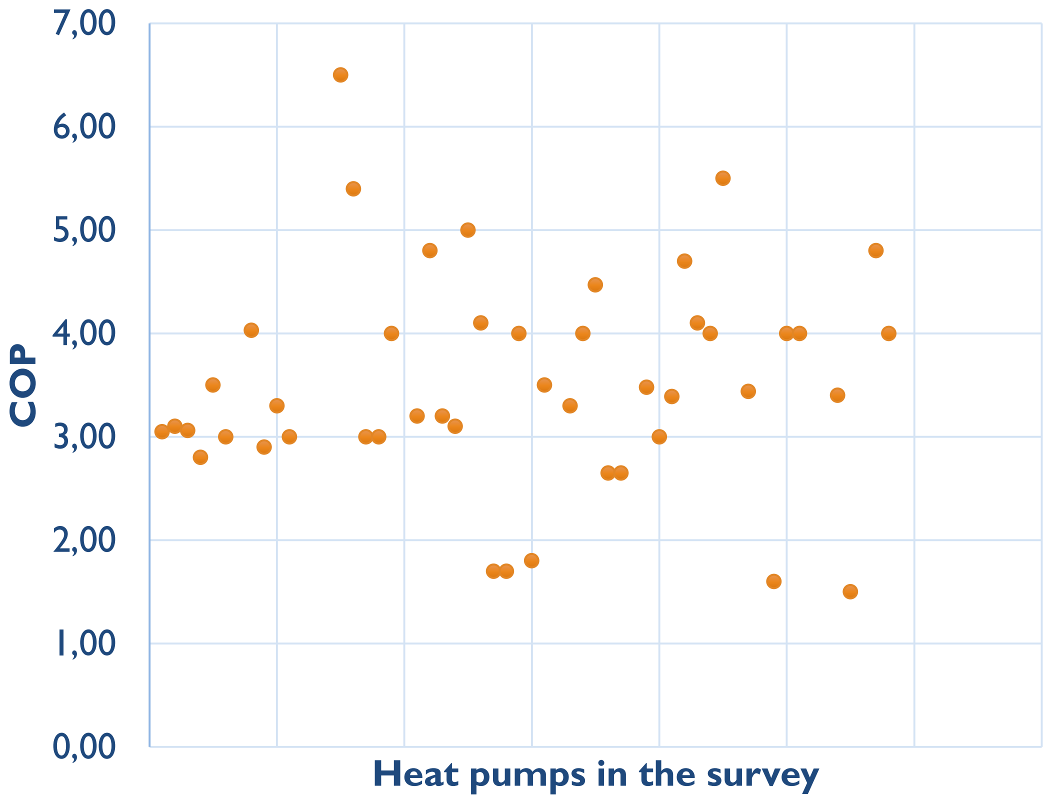
- Dependent of the type of district heating => not standardized
  - 70 - 80°C – most common range of temperatures
  - < 70°C – low temperature systems
  - > 80°C – some of the best examples: Drammen, Milan, Helsinki, Mantsala

- Low return temperatures
- Low supply temperatures
- Less heat losses
- Less stress on components

HEATING | COOLING | CHP

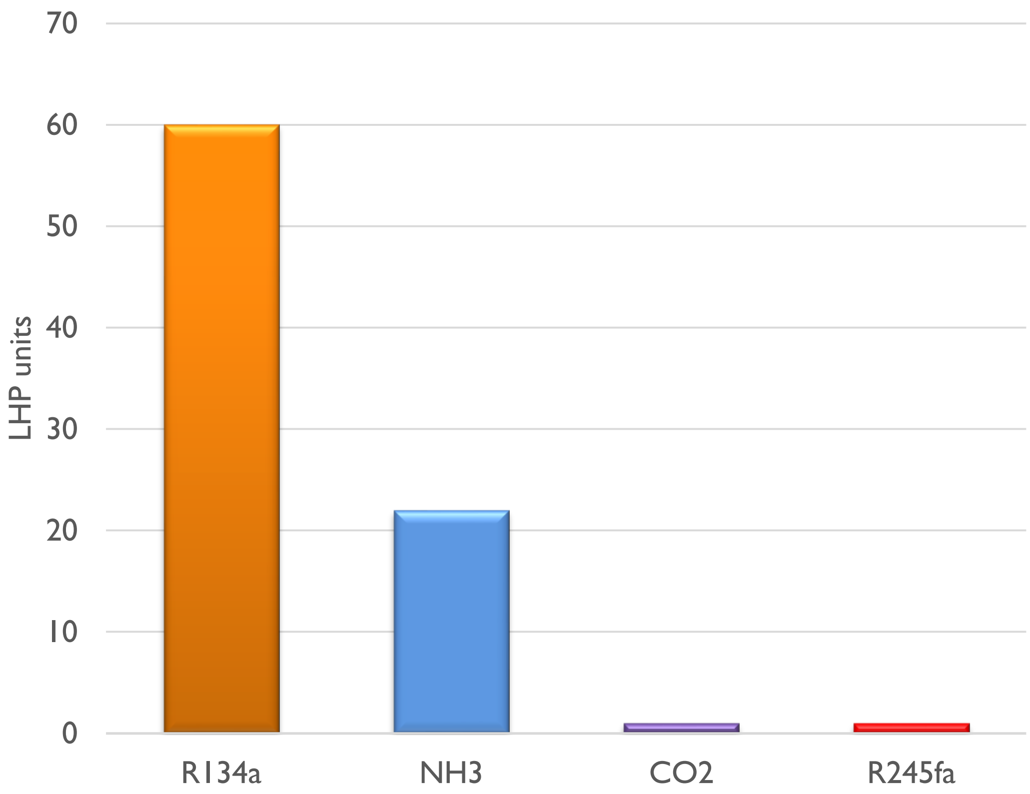
TECHNOLOGY PLATFORM

Coefficient of performance



- The average COP is 3,74
- COP 6,5 and 5,4 for 2 heat pumps in Sweden which increase the return water temperature
- COP 5,5 for heat pump in low temperature DH network
- The lowest COP belongs to the absorption heat pumps

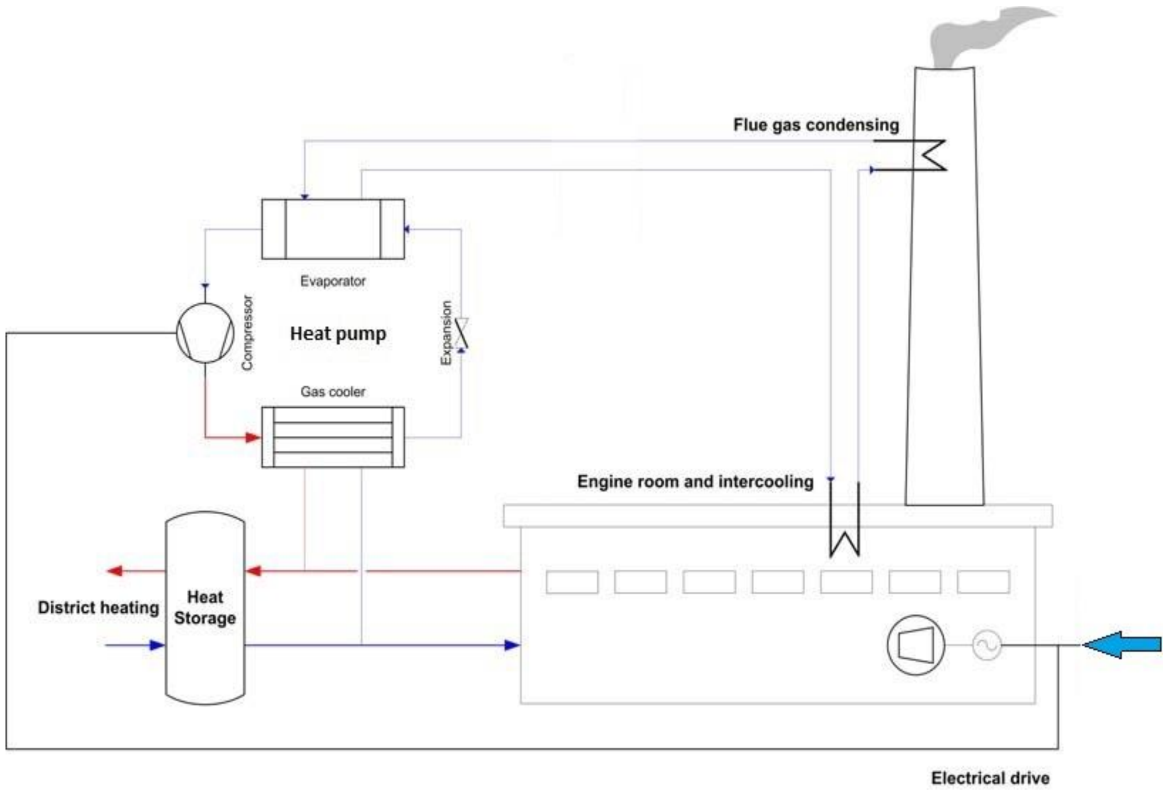
Refrigerants



- R134a is the most popular
- Used to retrofit the heat pumps in Sweden
- Restrictions in Denmark and Switzerland
- Natural refrigerants are picking up
- NH3 the most promising
- CO2 still requires more development for high capacities

System operation

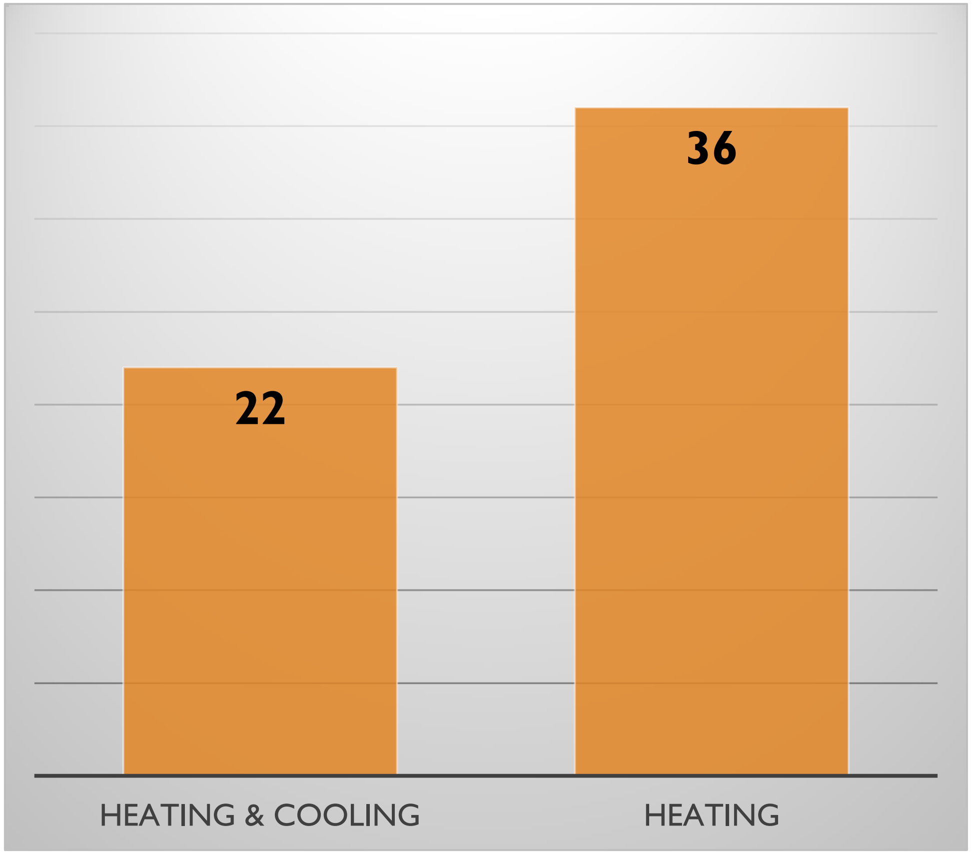
- 20 base load suppliers
- 33 secondary load suppliers – 18 working in combination with CHP
- CHP-HP combination can take advantage of the flexibility of fuels and the low prices of electricity
- Open District Heating



Heat pump as part of CHP operation. Replication (Blarke & Lund, 2007)

District cooling

- 22 of heat pump plants
- It is seen as an opportunity to increase the efficiency of plants (trigeneration)
- Good practice examples: Helsinki (Kari Vala), Oslo (Sandvika), Stockholm (Nimrod)
- In Sandvika, individual cooling electricity requirements would have been 10 times higher than for using DC (Friotherm)



Technology is already available to be replicated!

BECAUSE LARGE HEAT PUMPS CAN:

- Capture many types and temperatures of heat sources
- Deliver required district heating temperatures
- Take advantage of natural refrigerants
- Balance the heating, cooling and electricity grids

BUT…

- Technology faces lack of experience and know-how
- Policy makers prefer to remain "technology neutral"
- Fossil fuel subsidies do not help
- Spatial planning is usually ignorant to available heat sources

Thank you for your attention!