



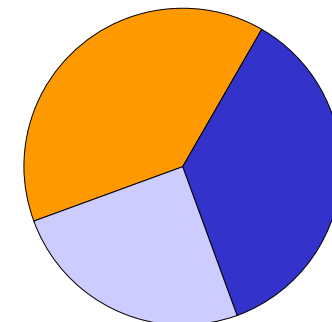
Energy efficient housing in the EU – some ideas from Sweden

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Energy use in Sweden (sectors)

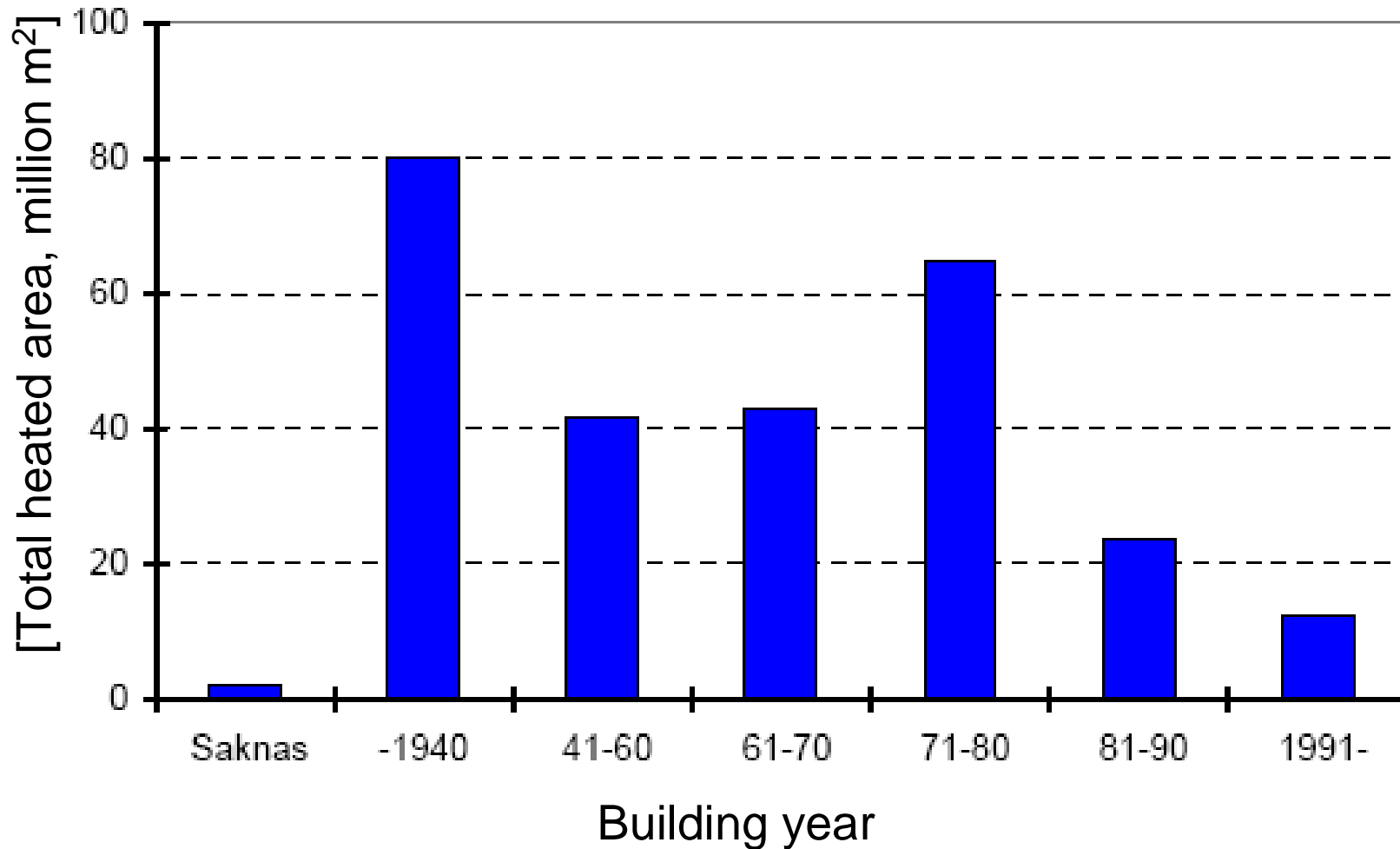


TOTAL FINAL USE PER SECTOR	TWh	PJ
Industri / Industry		
El / Electricity	56	202
Fjärrvärme / District heating	6	20
Oljor / Oil products	20	73
Naturgas, stadsgas / Natural gas, gasworks gas	6	20
Kol, koks / Coal, coke	17	60
Biobränslen, torv, m.m. / Biofuels, peat, etc.	53	190
Totalt / Total	157	565
Transporter / Transports		
El / Electricity	3	11
Oljor / Oil products	96	345
Naturgas / Natural gas	0	1
Etanol / Ethanol	2	7
Totalt / Total	101	363
Bostäder, service m.m. / Residential, services etc.		
El / Electricity	72	260
Fjärrvärme / District heating	42	151
Olja / Oil	15	54
Naturgas, stadsgas / Natural gas, gasworks gas	2	9
Biobränslen / Biofuels	14	50
Totalt / Total	145	523
Total slutlig användning / Total final use	403	1 452



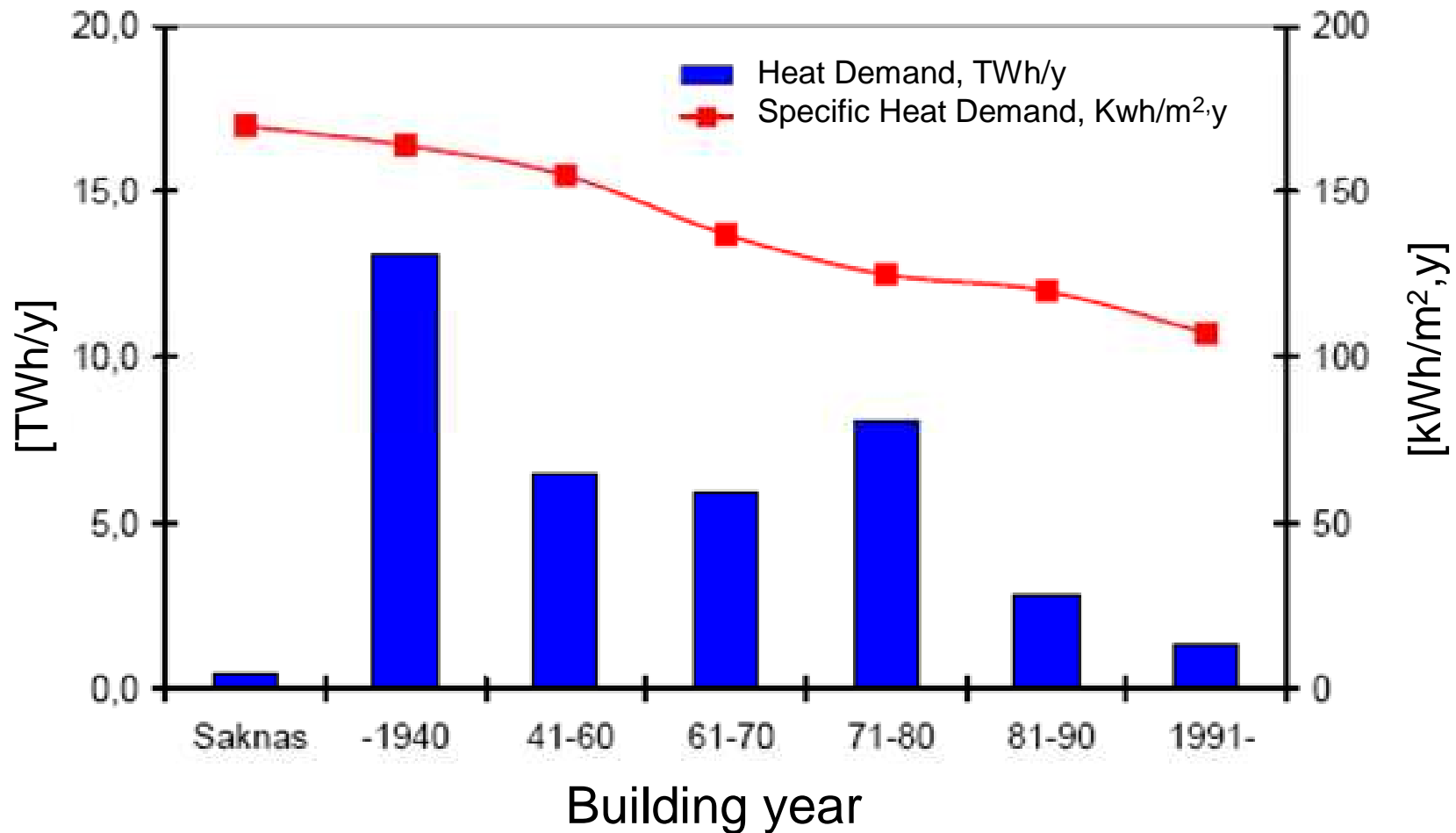
The building stock (example single family dwellings)

Heated area, single family dwellings



Total Heat demand and specific heat demand

Net energy need for single family dwellings



Some initial conclusions

Buildings use about 40% of the energy in the EU

Most buildings already exist

It is hard to lower the 40% share by building more buildings even if they are passive houses, zero energy buildings or minergie buildings and so on...



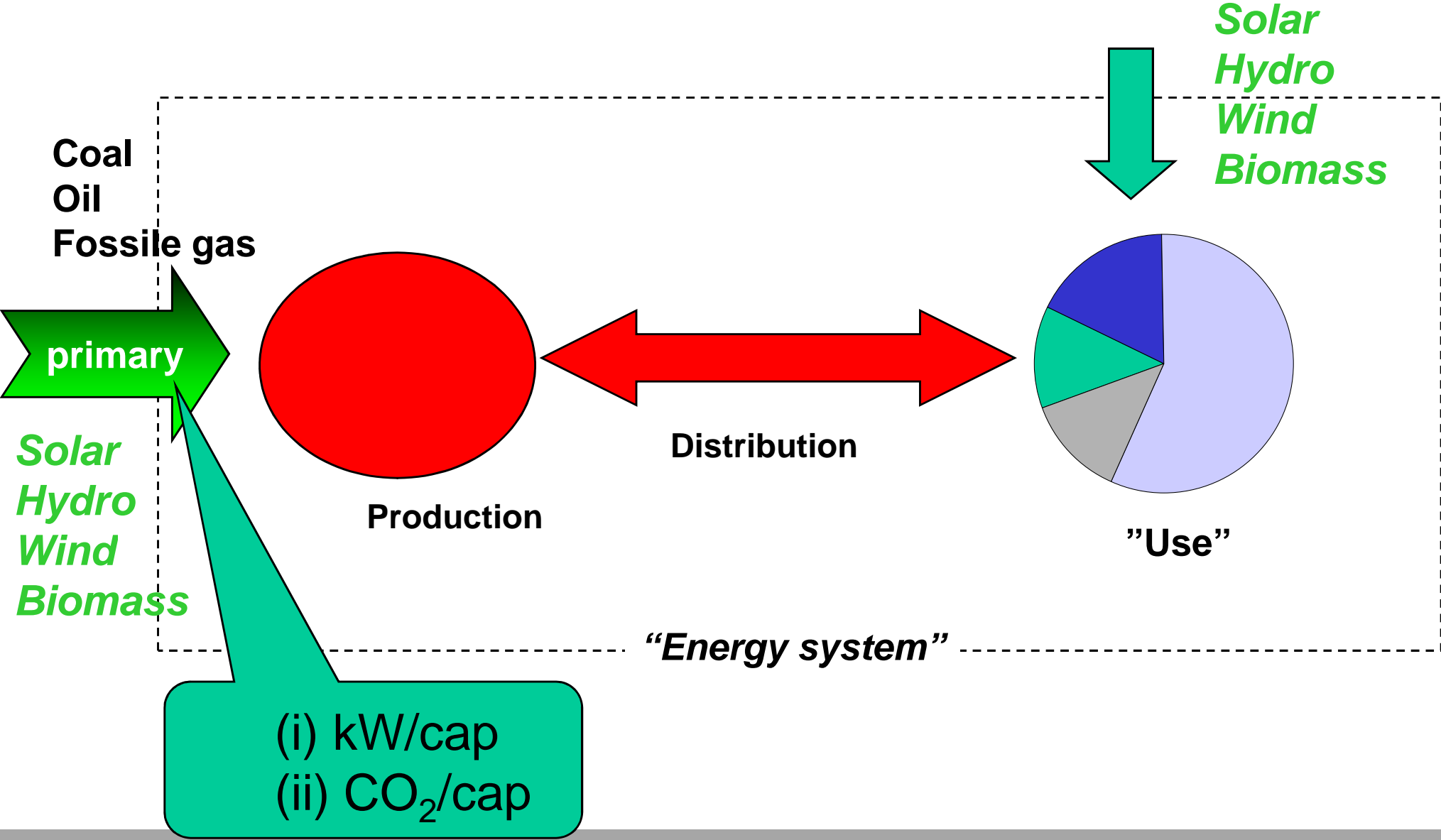
Therefore refurbishment of existing buildings is important

Three basic strategies are typically proposed:

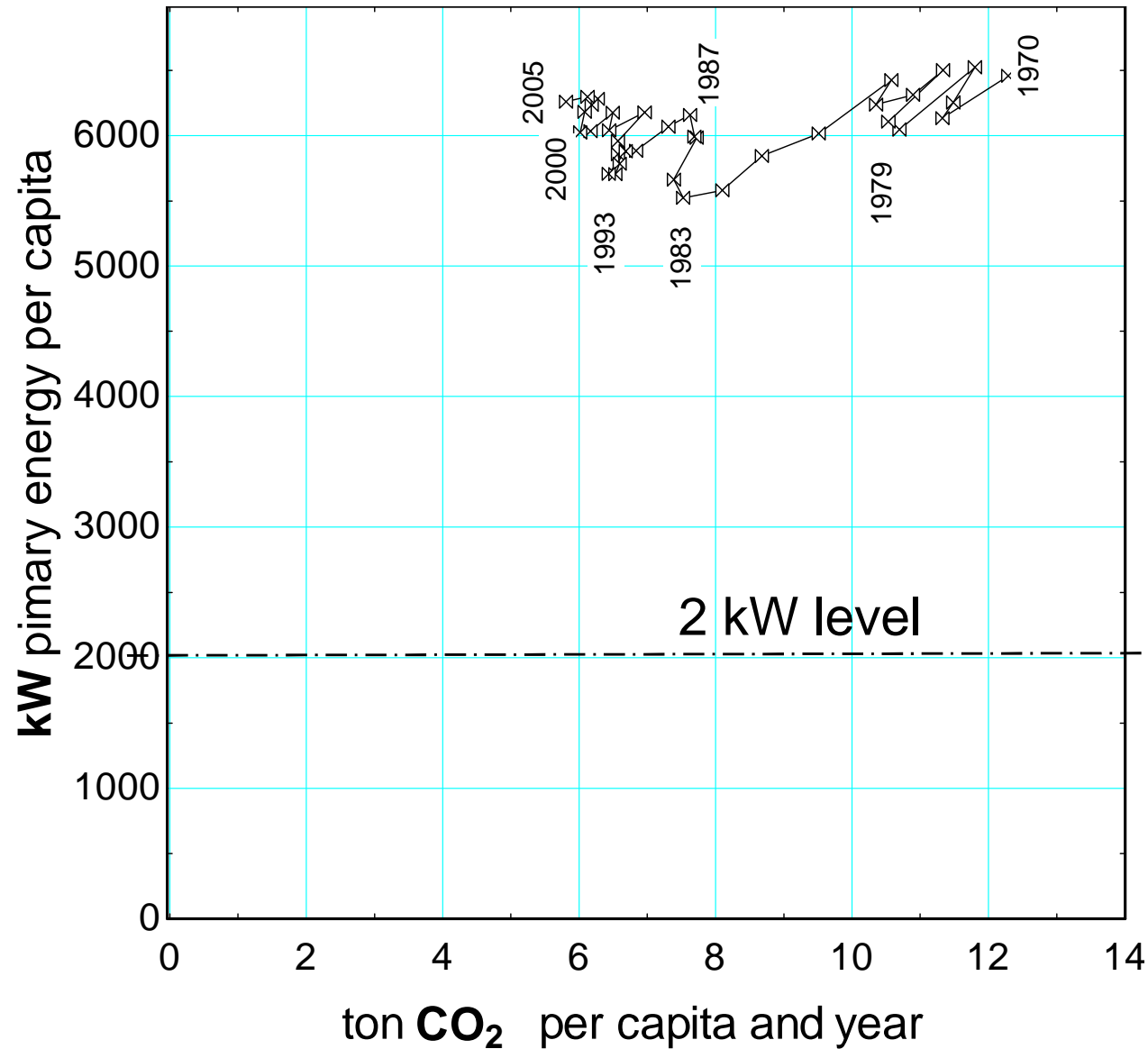
- (i) renovate to better energy standard (building shell, appliances, lighting, shadings etc)
- (ii) use efficient heating or cooling systems (and so on)
- (iii) use renewable energy

The order is important!!!

Primary energy and CO2 emissions



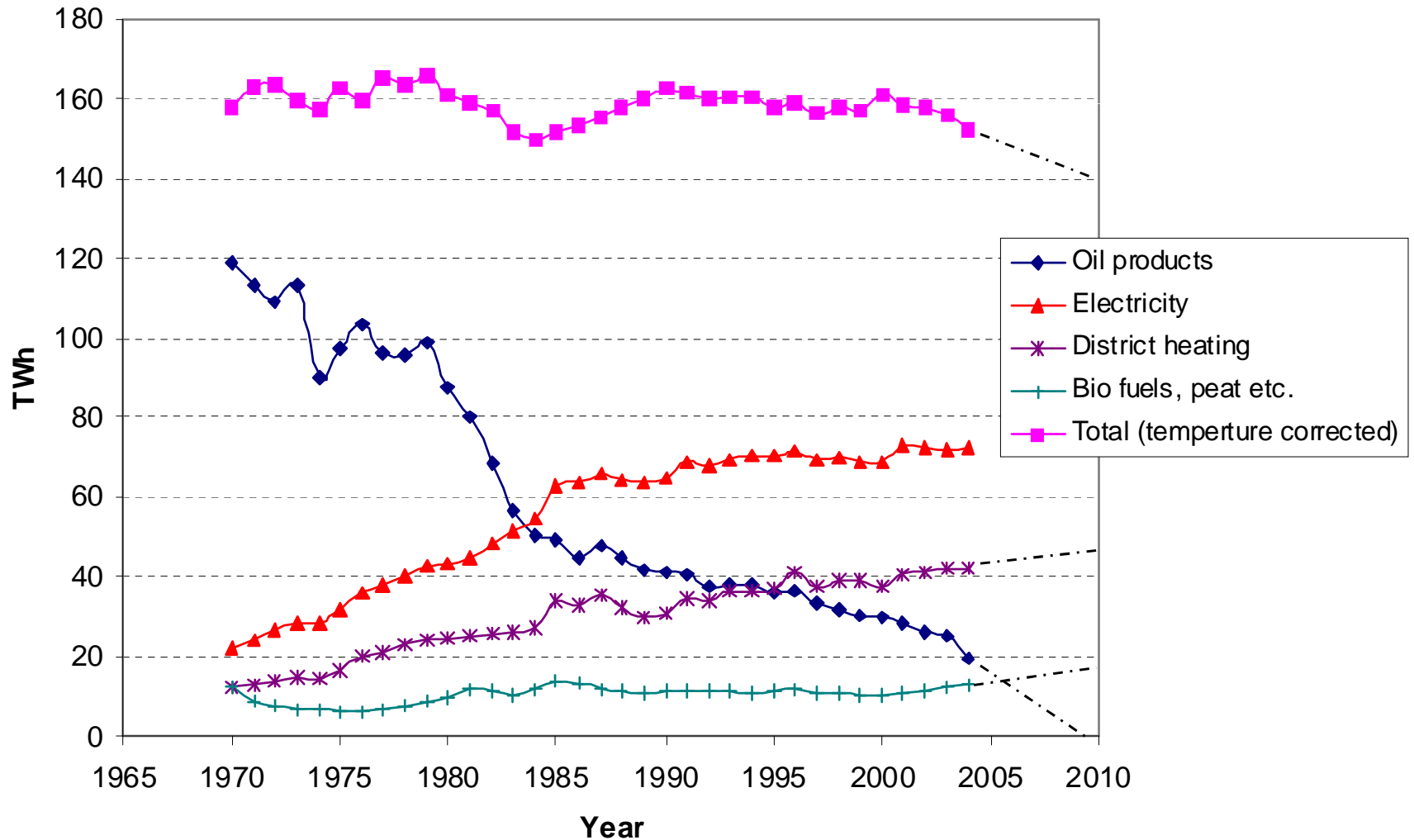
Sweden – from 12 to 6 ton CO₂ in 30 years...



Why?

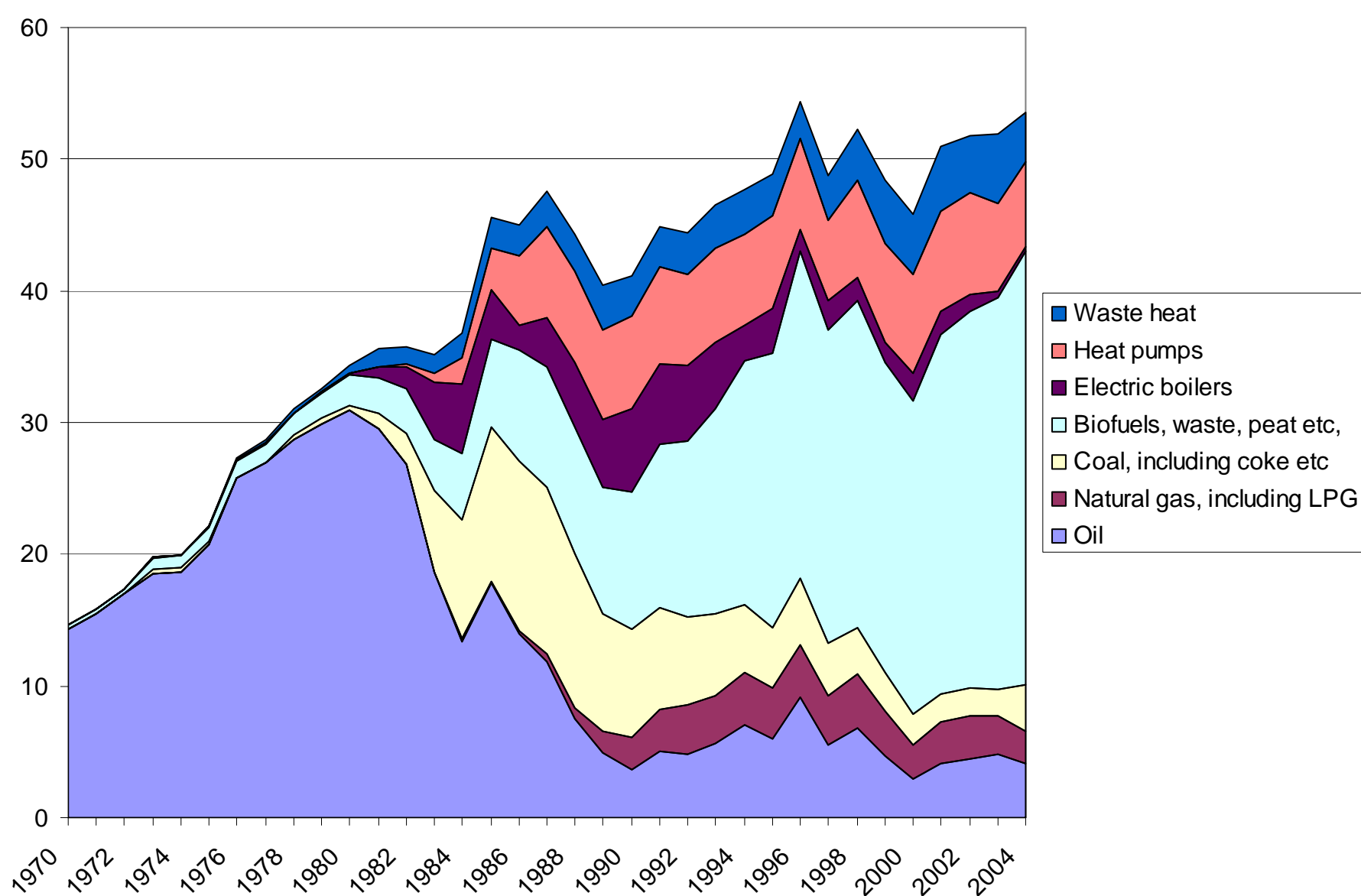
Heat Pumps and District Heating have contributed to dramatic changes in Energy Use and Fuels 1970 - today

Final energy use in residential and service sector



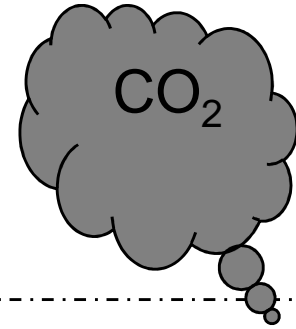
HP contribute to "Primary" energy in district heating

TWh



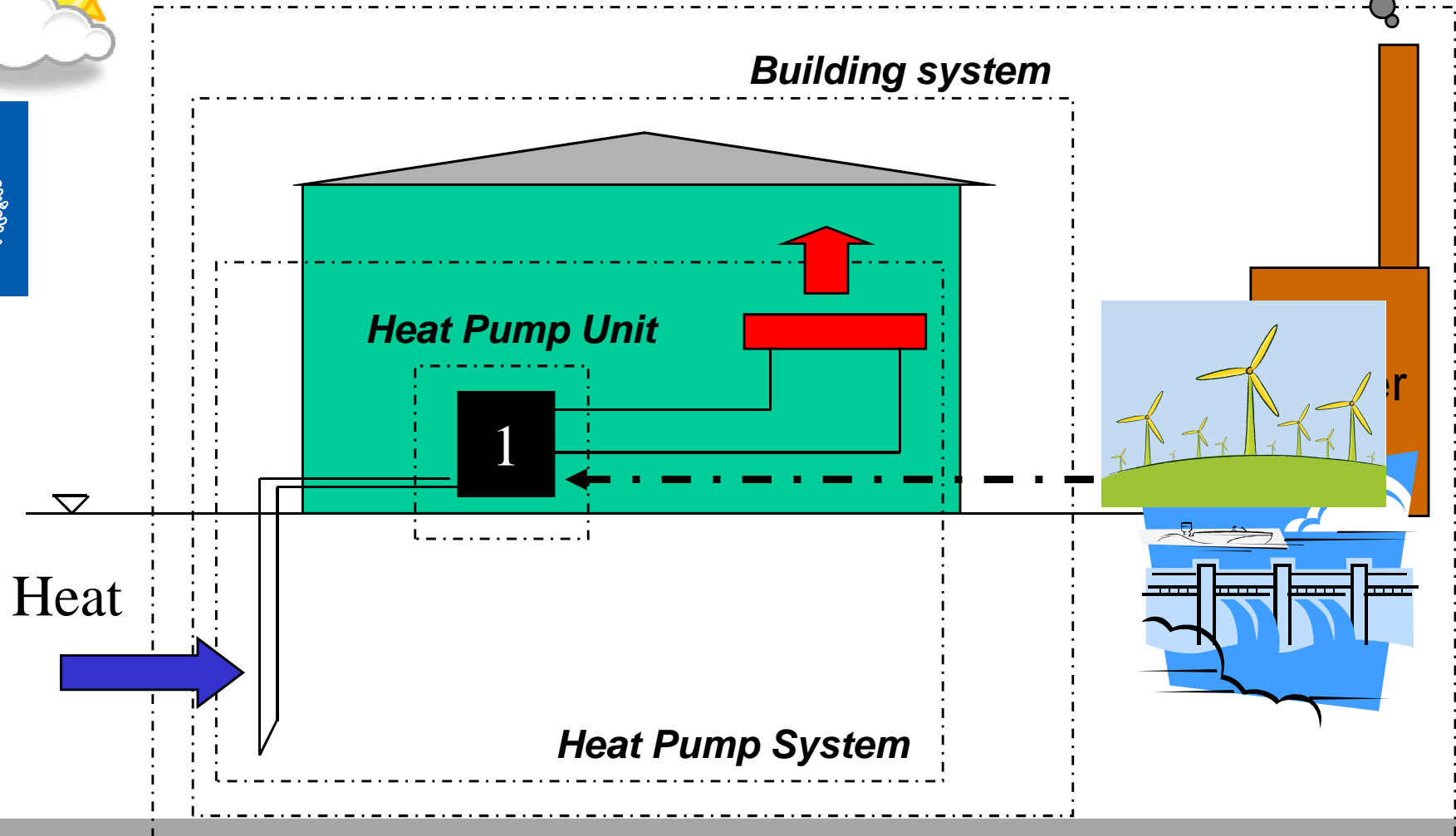
Efficient Heat Pump systems require systems thinking

Surroundings (climate)

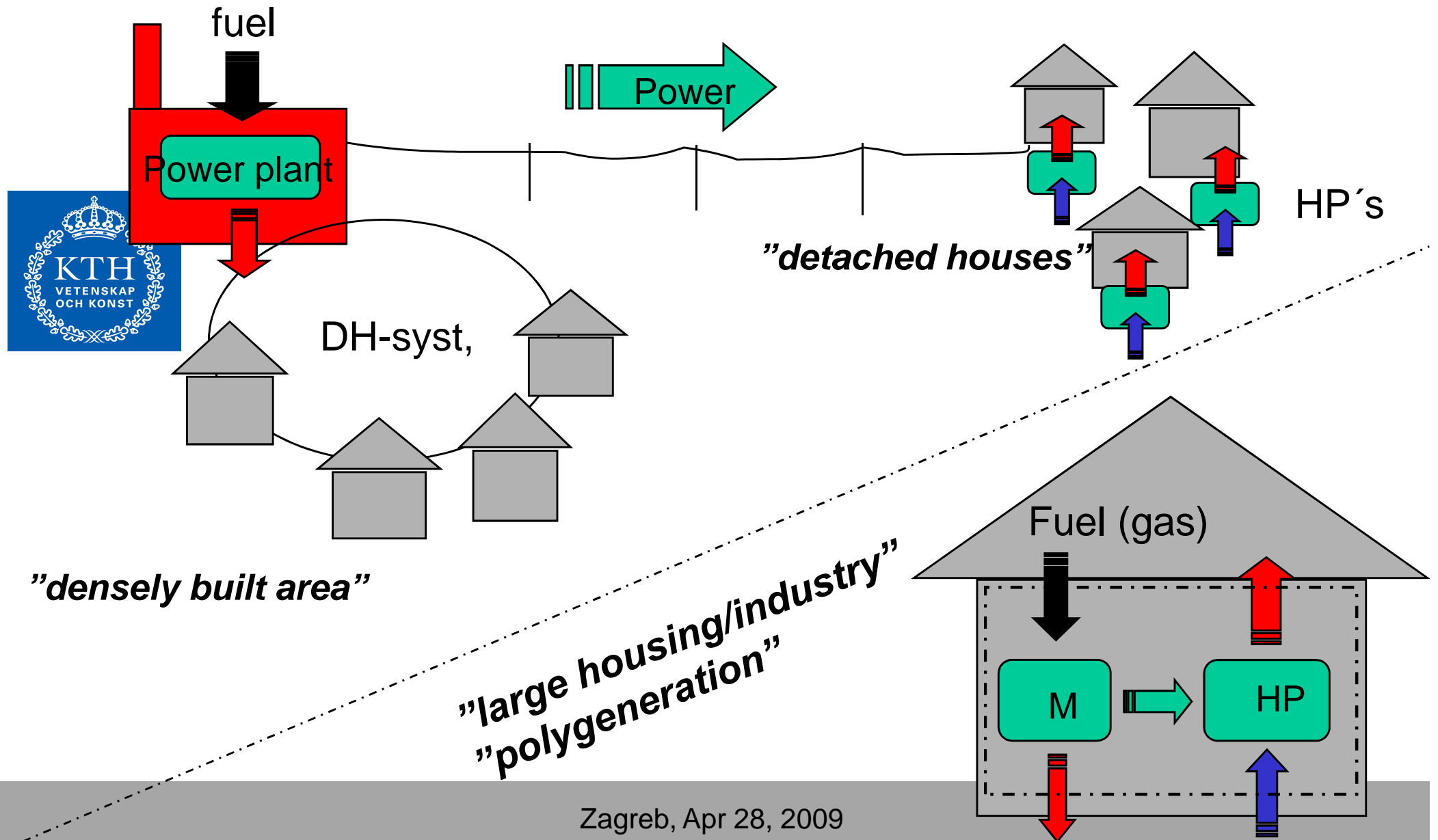


The energy system

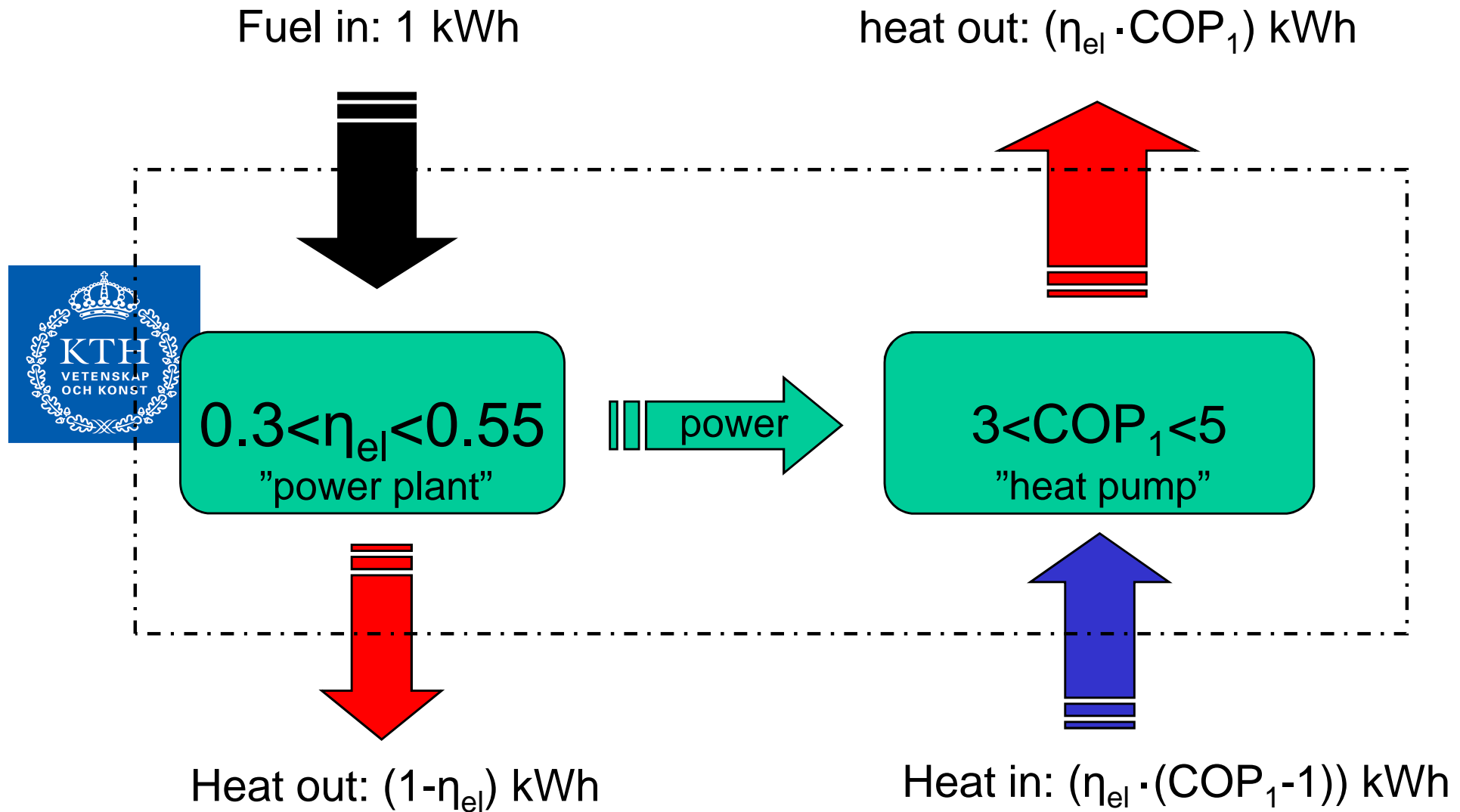
Building system



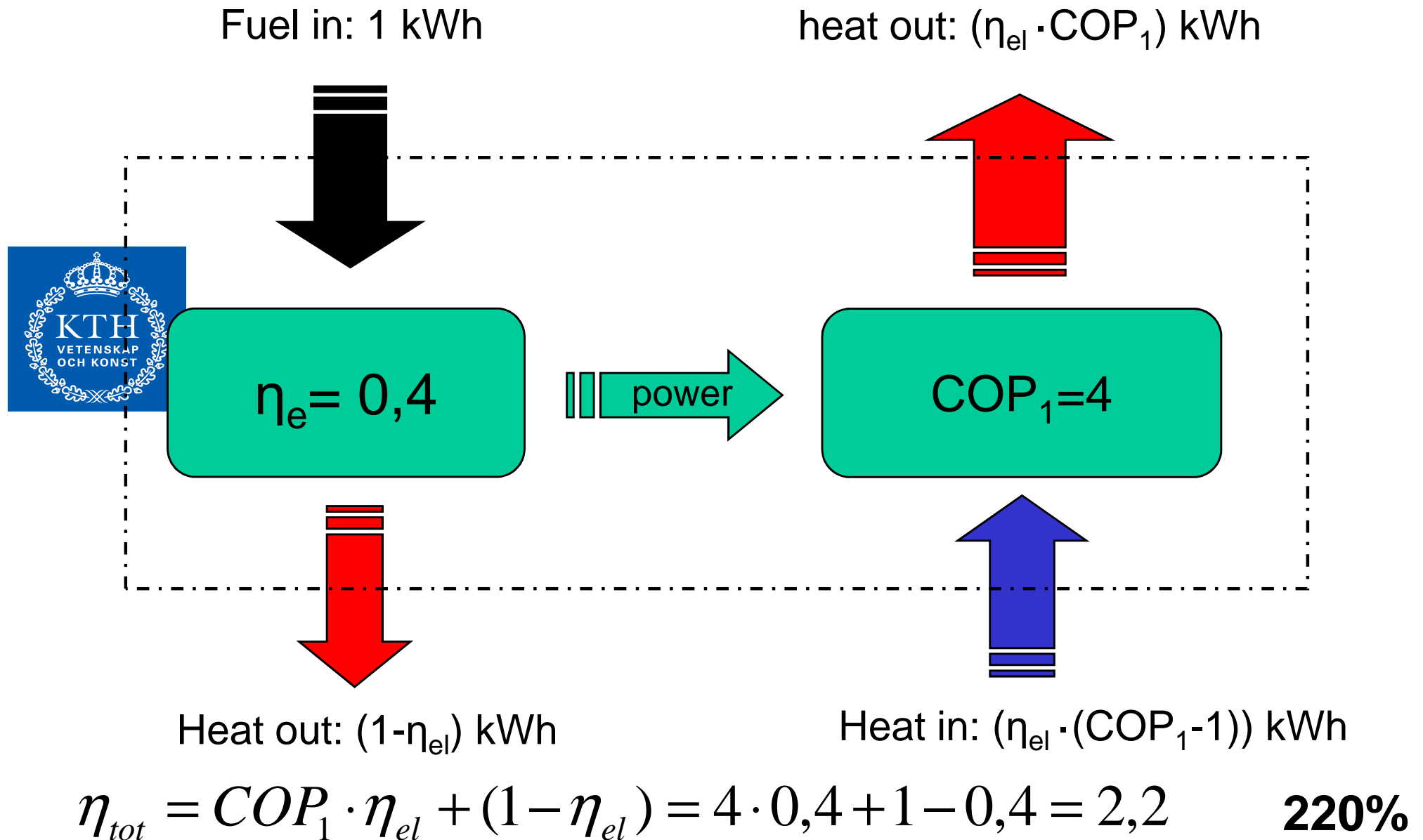
Heat pump in the energy system: two thermodynamically equivalent systems



The fuel utilization of the system:



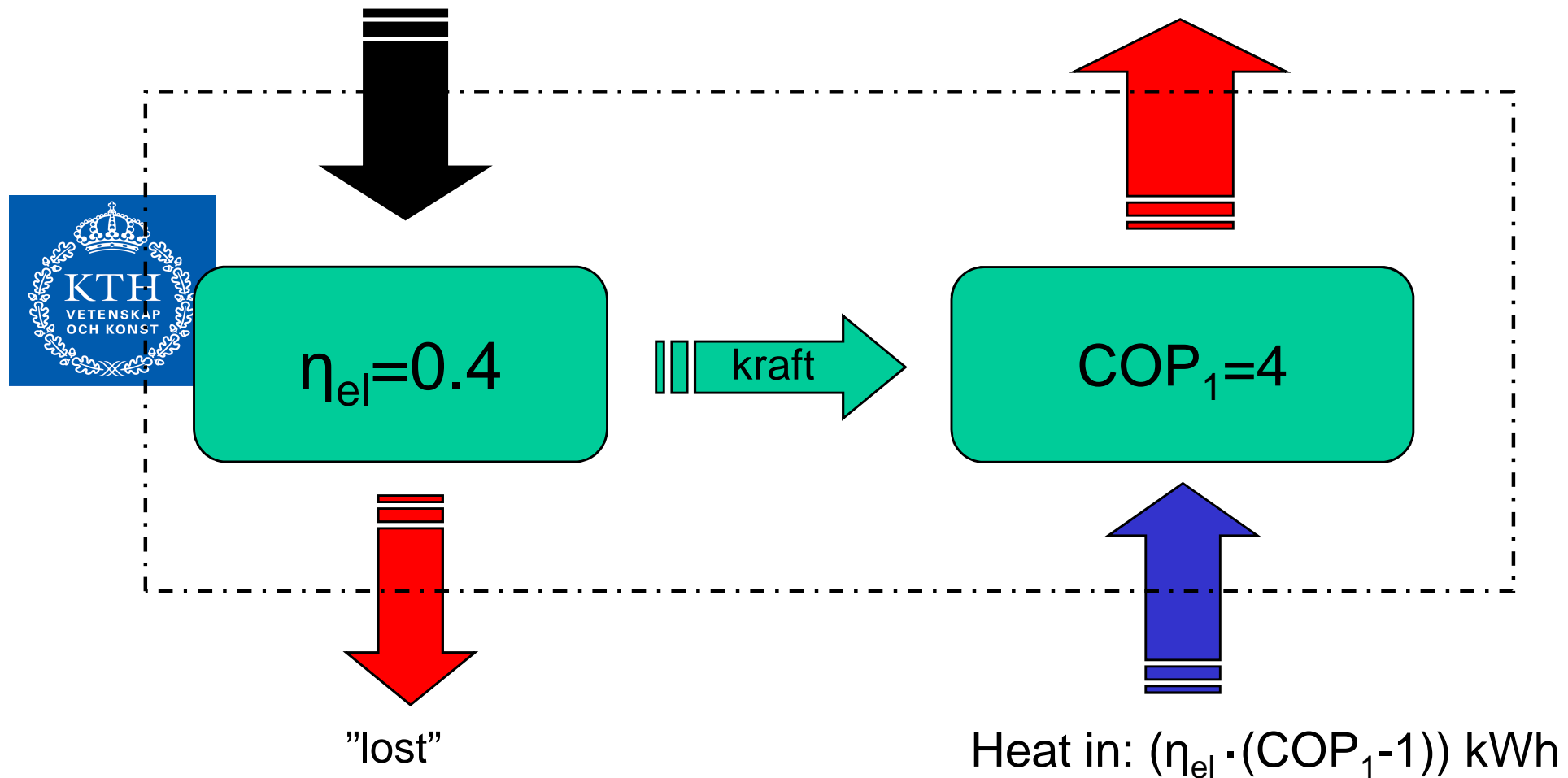
The fuel utilization of the system:



But the HP gives good fuel utilization Even without the DH!

Fuel in: 1 kWh

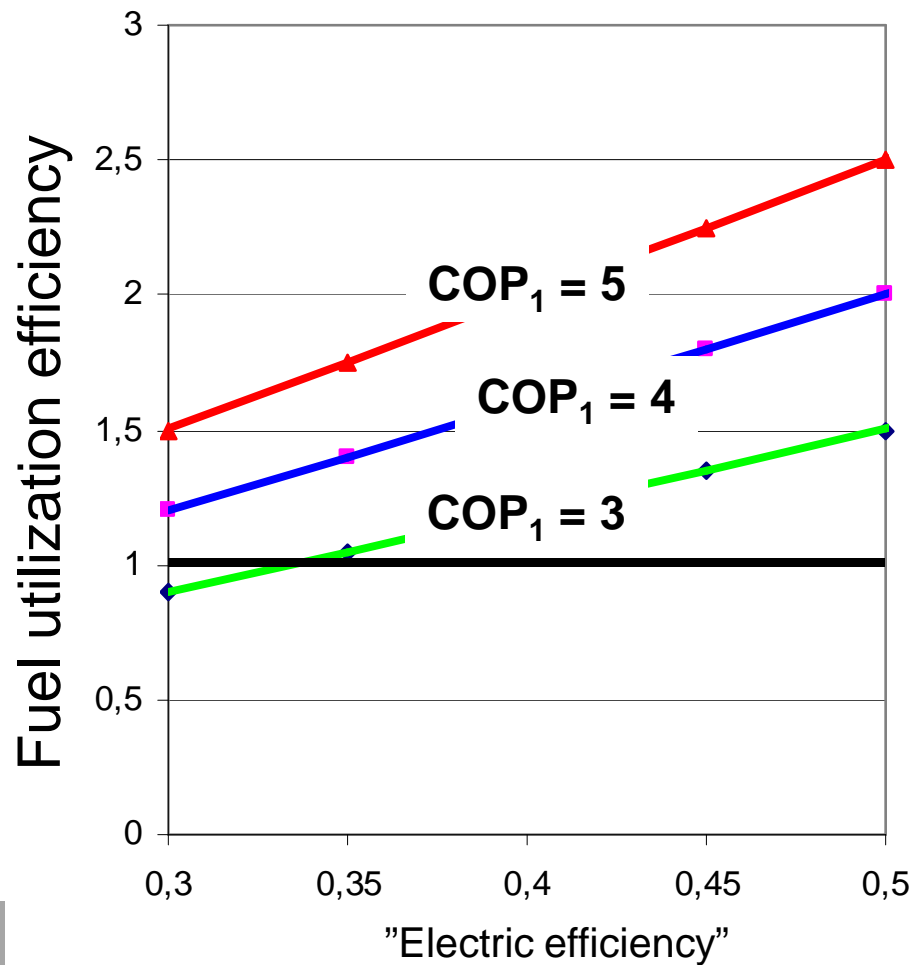
heat out: $(\eta_{el} \cdot COP_1)$ kWh



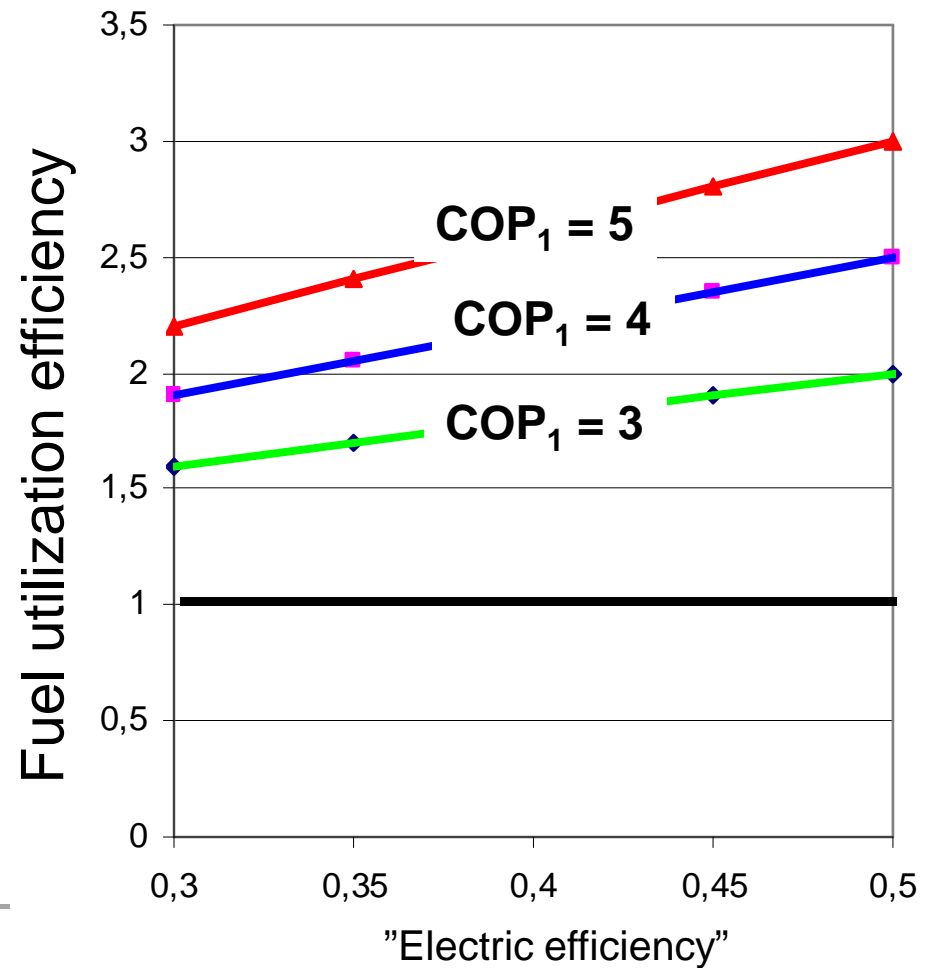
$$\eta_{tot} = COP_1 \cdot \eta_{el} = 4 \cdot 0,4 = 1,6 \quad \mathbf{160\%}$$

Fuel utilization for heating, summary

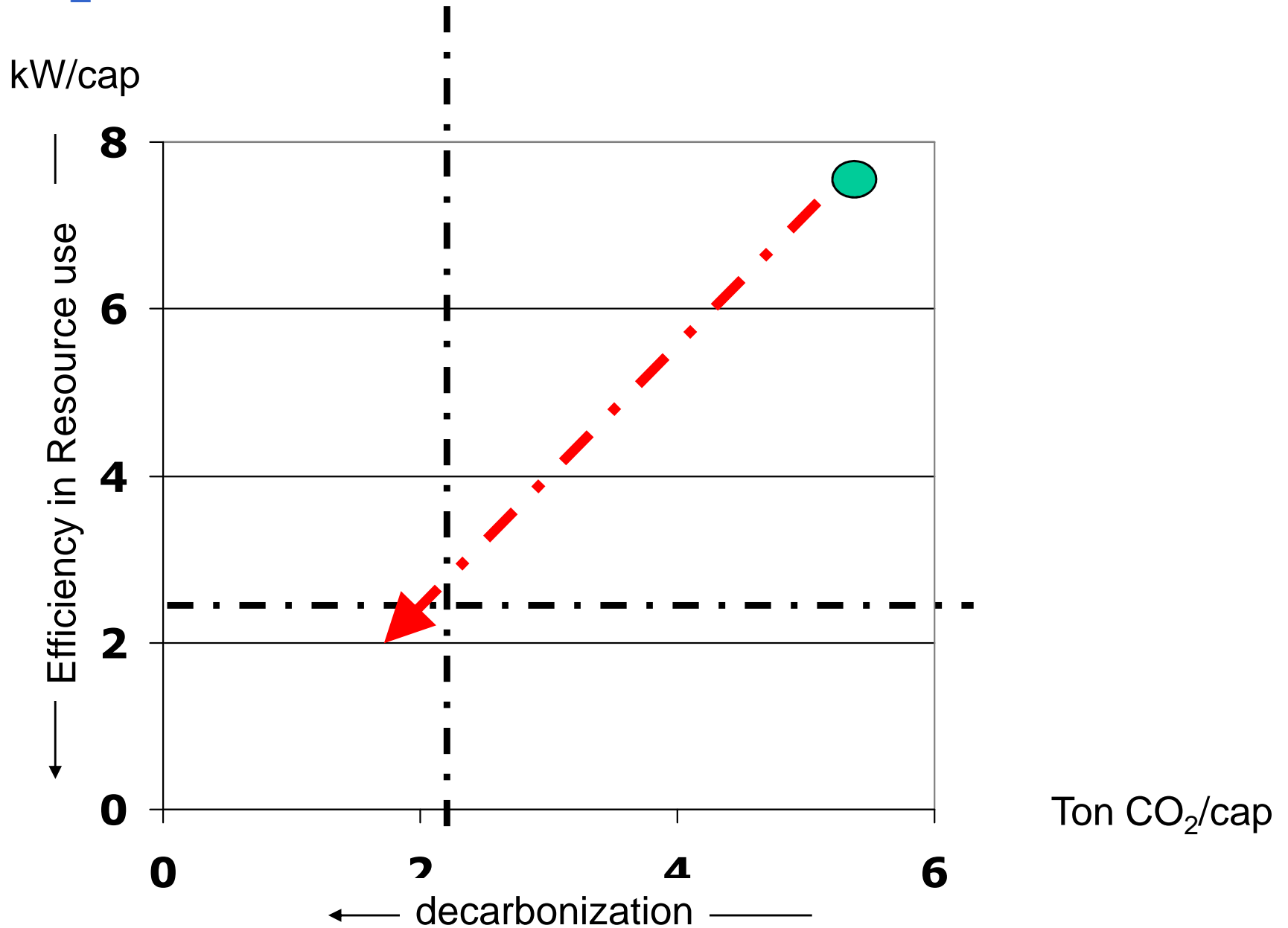
No district heating



With DH system



Heat Pumps Minimize energy use and CO₂ emissions at the same time



**HP research has been
acknowledged by Swedish
Government as "...well invested
research money..."**



Today >15 TWh of heat are collected from the nature with heat pumps at a value for the tax payers of about 1.3-1.5 G€/year (y2007).

All the money that the taxpayers have invested through the governmental financed heat pump research over 30 years is thus repaid in only 4 – 5 days by free renewable energy...

Thank you!



Questions?