Sunstore®4 Design of the plant

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PlanEnergi:
Consultant Engineers
30 years years with renewable energy

- biomass
- biogas
- solar thermal
- heat pumps
- district heating
- energy planning

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The SUNSTORE® concept can integrate renewable electricity in heat production. Examples Brædstrup and Marstal

35 – 40 000 m²

HP

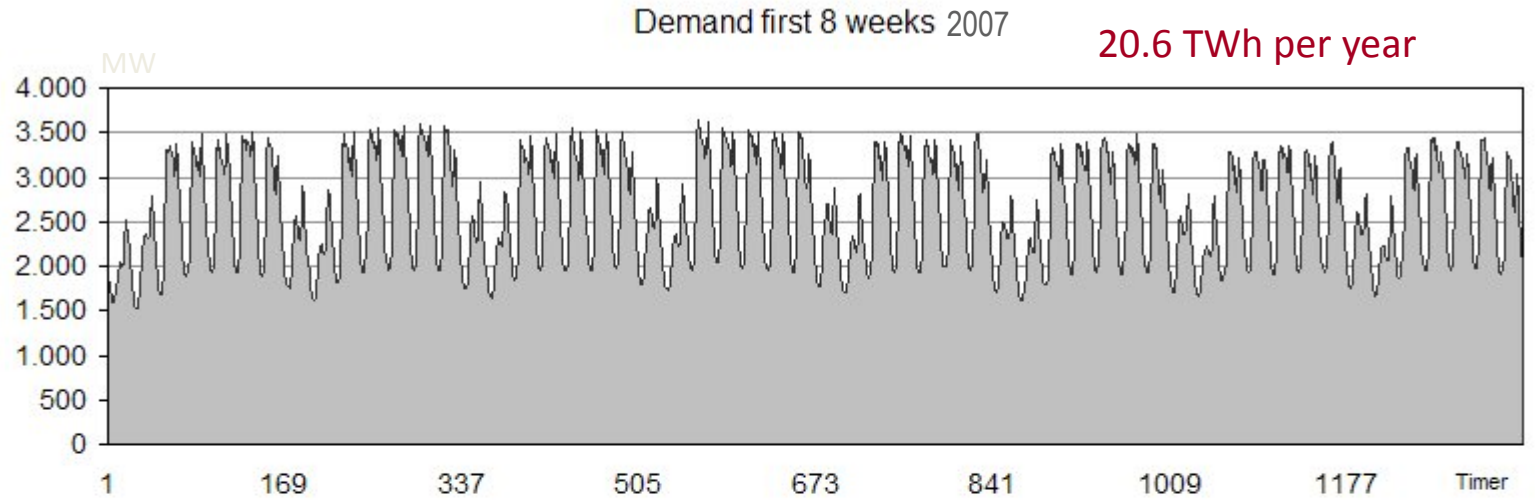
CHP

Boiler

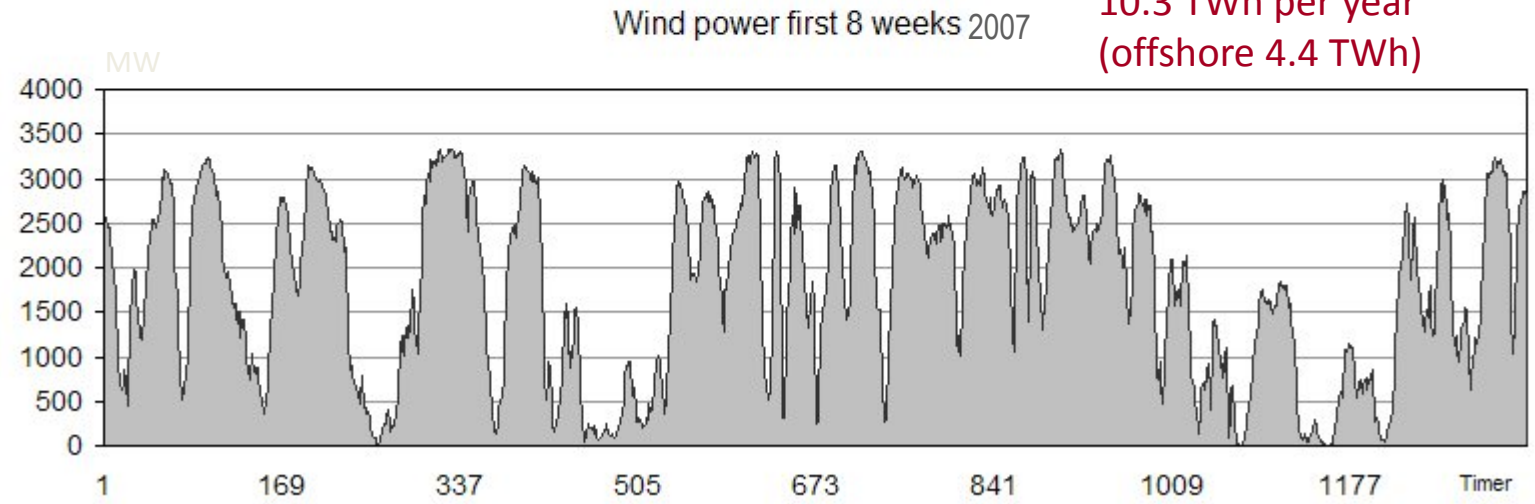
End use

50 – 100 000 m³ Very cost effective heat storage (demonstration)

Balancing the powersystem DK1 ~ 50 % wind?



20.6 TWh per year



10.3 TWh per year
(offshore 4.4 TWh)

Vision of 50 % windpower !

Subtracting wind power from demand leaves a residual demand and an overflow

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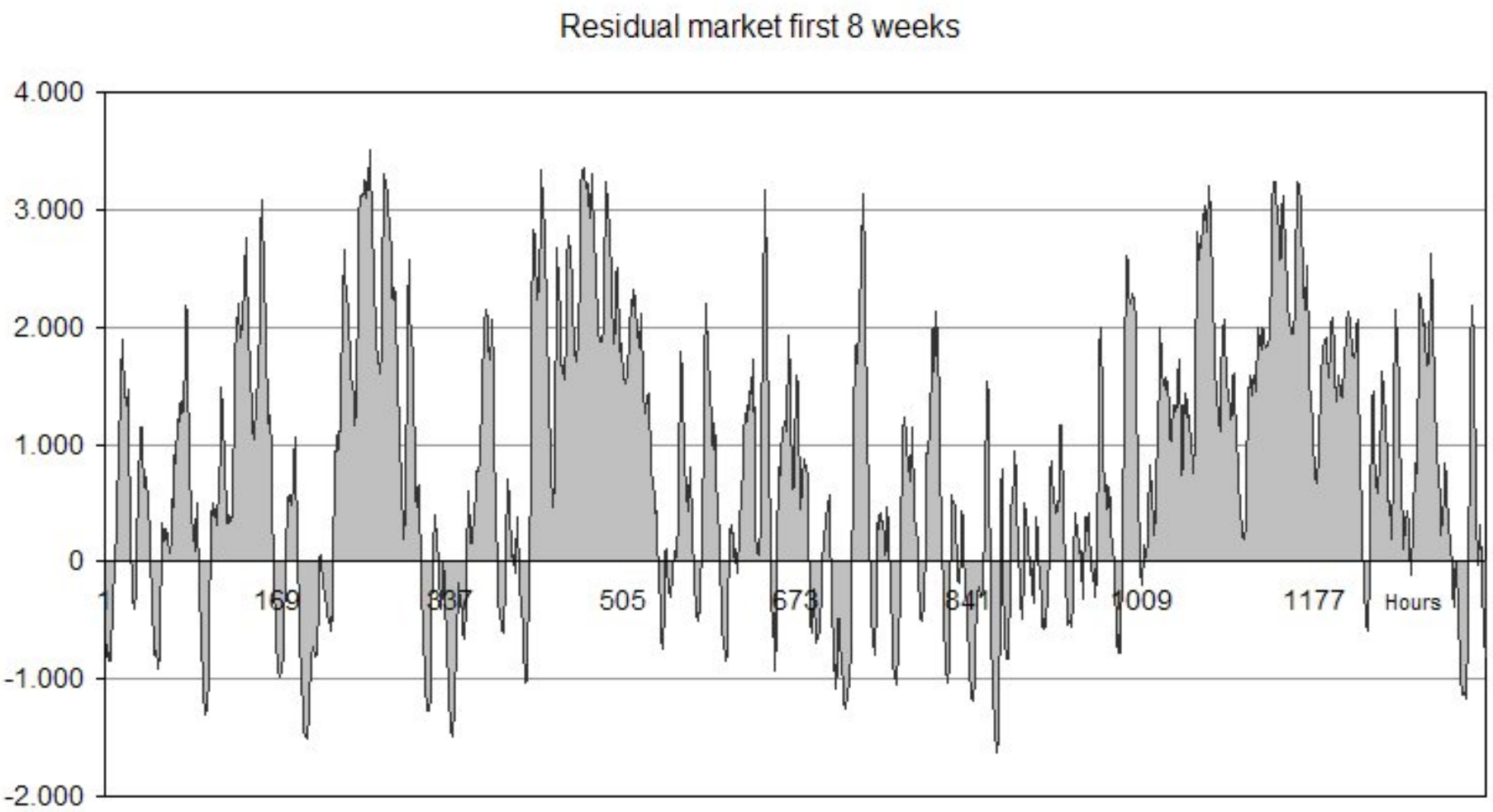

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Relevance of the SUNSTORE concept

The concept is adaptable to different regions with different types of conditions. This includes:

- **Able to integrate power and heat production (power to heat in periods with high production from wind and solar and CHP production in periods with low production from wind and solar)**
- **Energy output in terms of heat, cooling, electricity and even desalination according to the demand in the region and with 100% RES**
- **Flexibility in the mix of solar, biomass energy, geothermal energy, excess heat and electricity (heat pump) related to availability and cost of resources**
- **Flexibility in the types of biomass (able to use wet and not very homogeneous resources)**

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Marstal 2010

- 9,000 m^2 solar collectors Arcon HT_{1996}
- 2,100 m^3 steel tank
- 8,019 m^2 Arcon HT_{2002}
- 881 m^2 GJ-$Teknik_{2002}$ (Now Sunmark)
- 103 m^2 Wagner roof elements
- 108 m^2 Termomax evacuated tubes
- 211 m^2 IST CSP-collectors
- 10,340 m^3 pit heat water storage
- 400 kW_{heat} heat pump using propane as refrigerant

1,460 end users and a yearly heat production of 28,000 MWh

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Choice of elements in Marstal

1. The reference system
2. The reference system with the following additional components: 15,000 m^2 solar collectors, 35,000 m^3 pit heat storage, 1.5 $MW_{thermal}$ heat pump using CO_2 as refrigerant, 5 MW wood chip boiler
3. As 2) but 75,000 m^3 pit heat storage and 4 MW wood chip boiler
4. As 2) but 750 kW_{el} ORC (3,500 running hours)
5. As 3) but 750 kW_{el} ORC (6,500 running hours)

Conclusion: heat production prices at same level but 5 is most innovative and most flexible.

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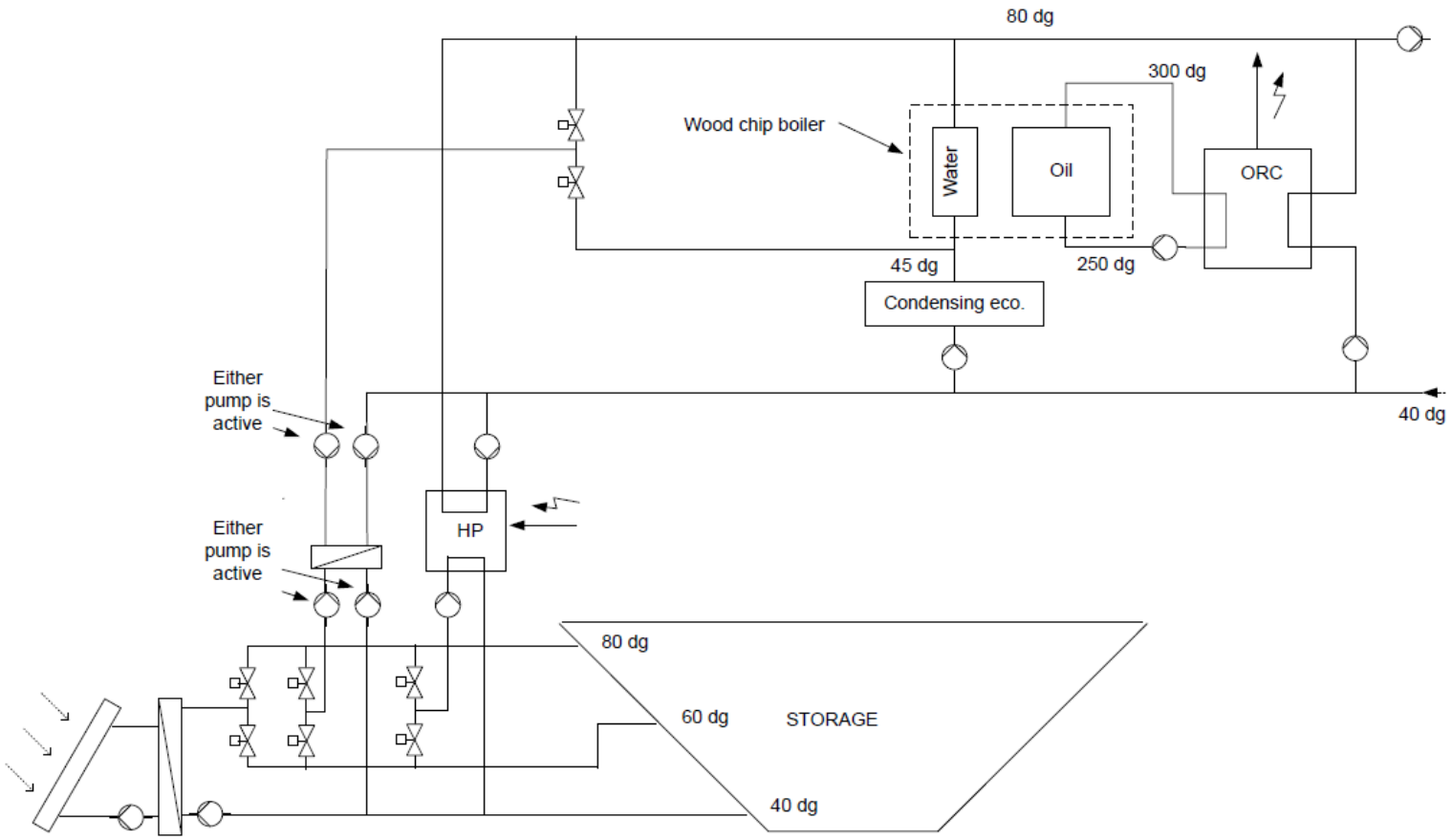
Principle diagram



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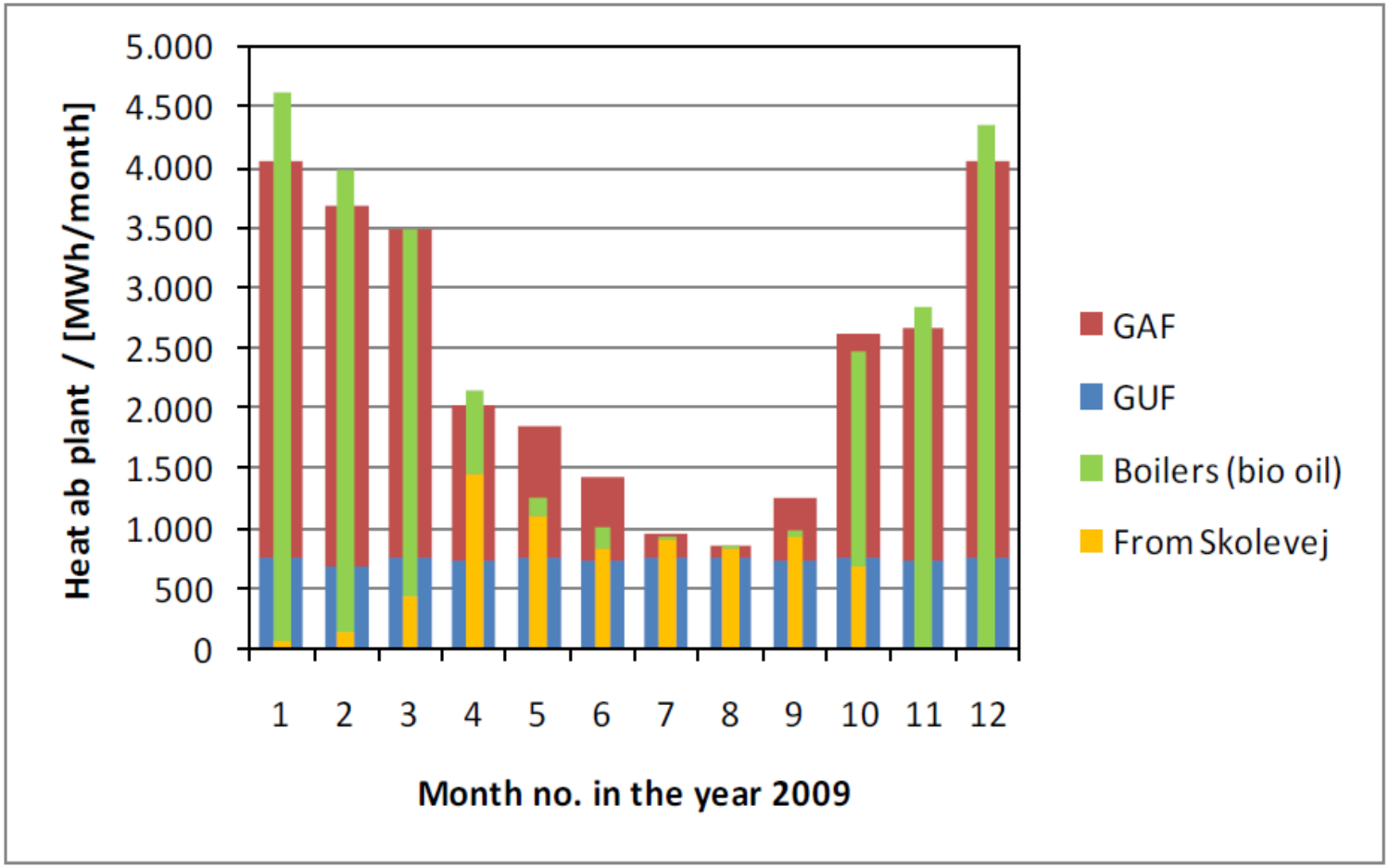
Marstal design procedure – heat demand
Normal year 30,364 MWh + Ommel = 32,000 MWh/year!



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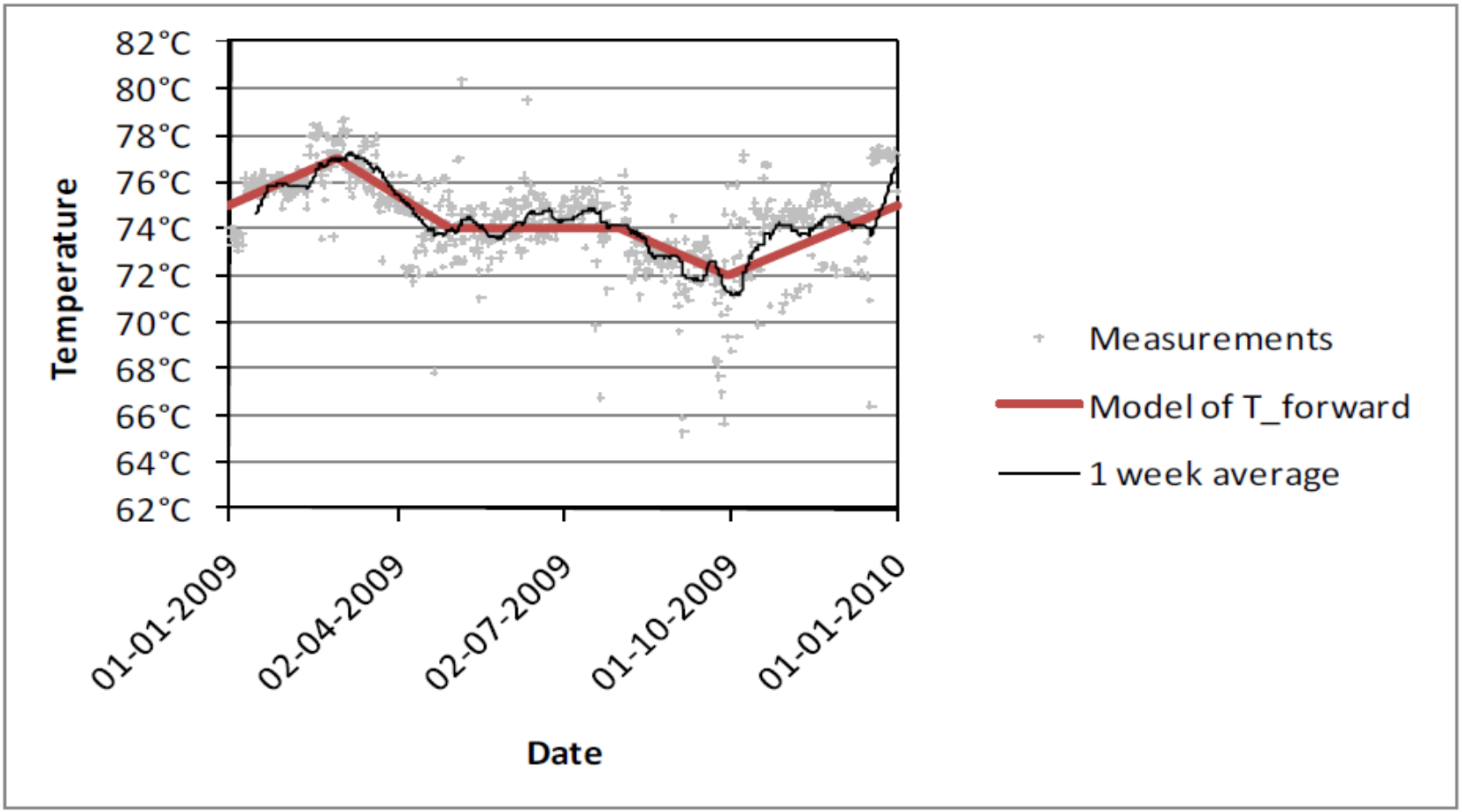
Forward temperature



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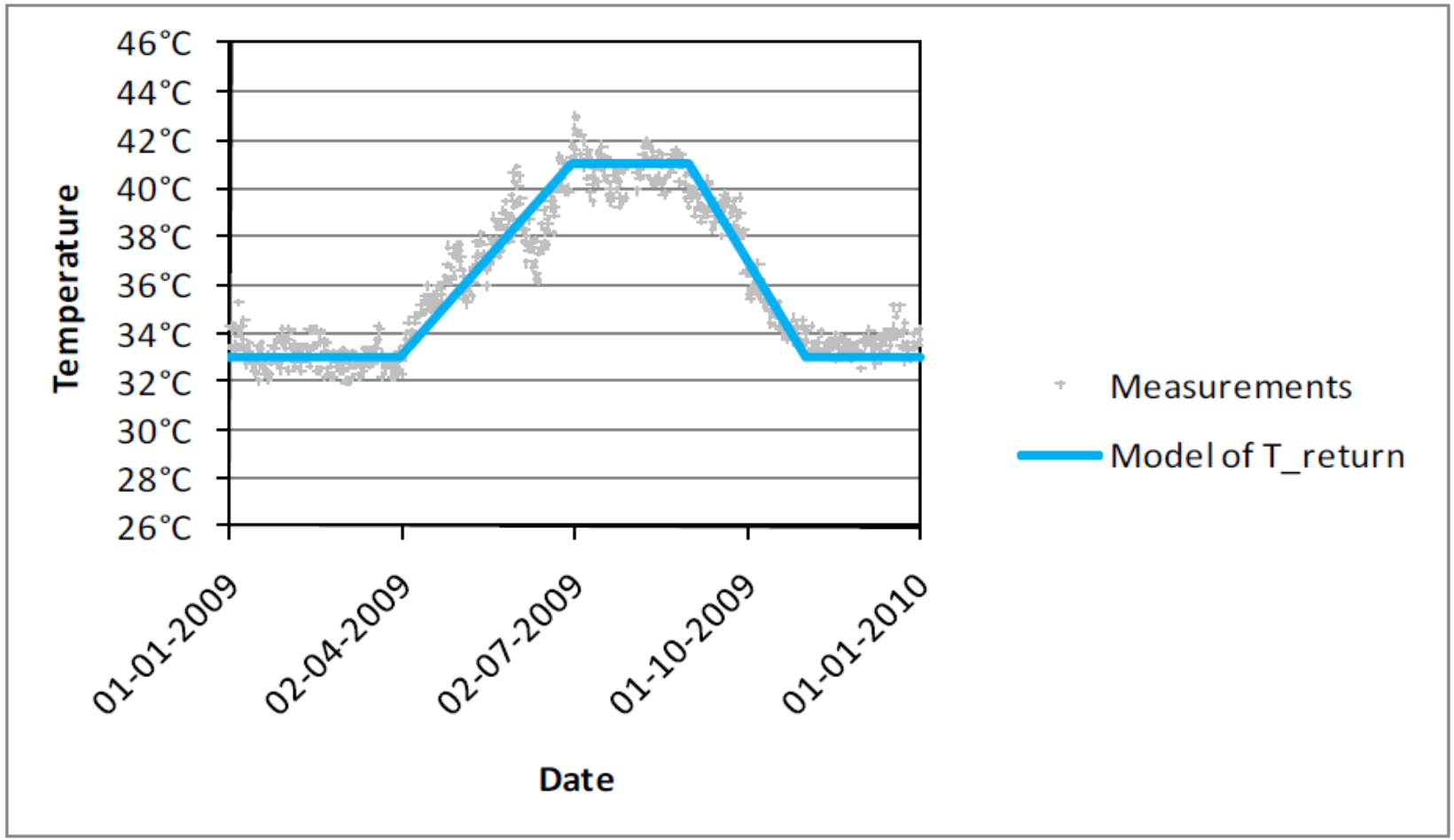
Return temperature



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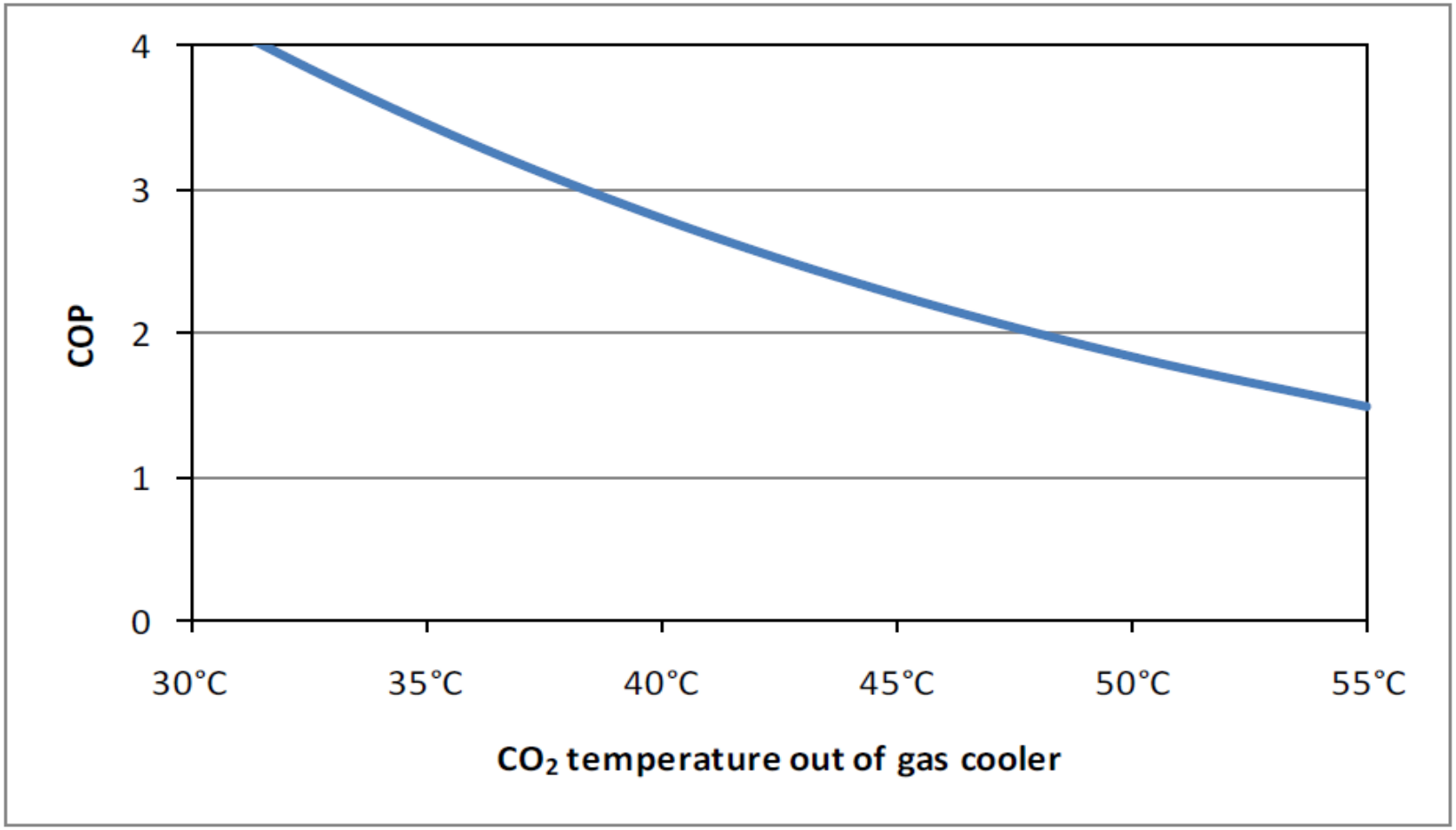
Efficiency of heat pump



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Efficiency of wood chip boiler

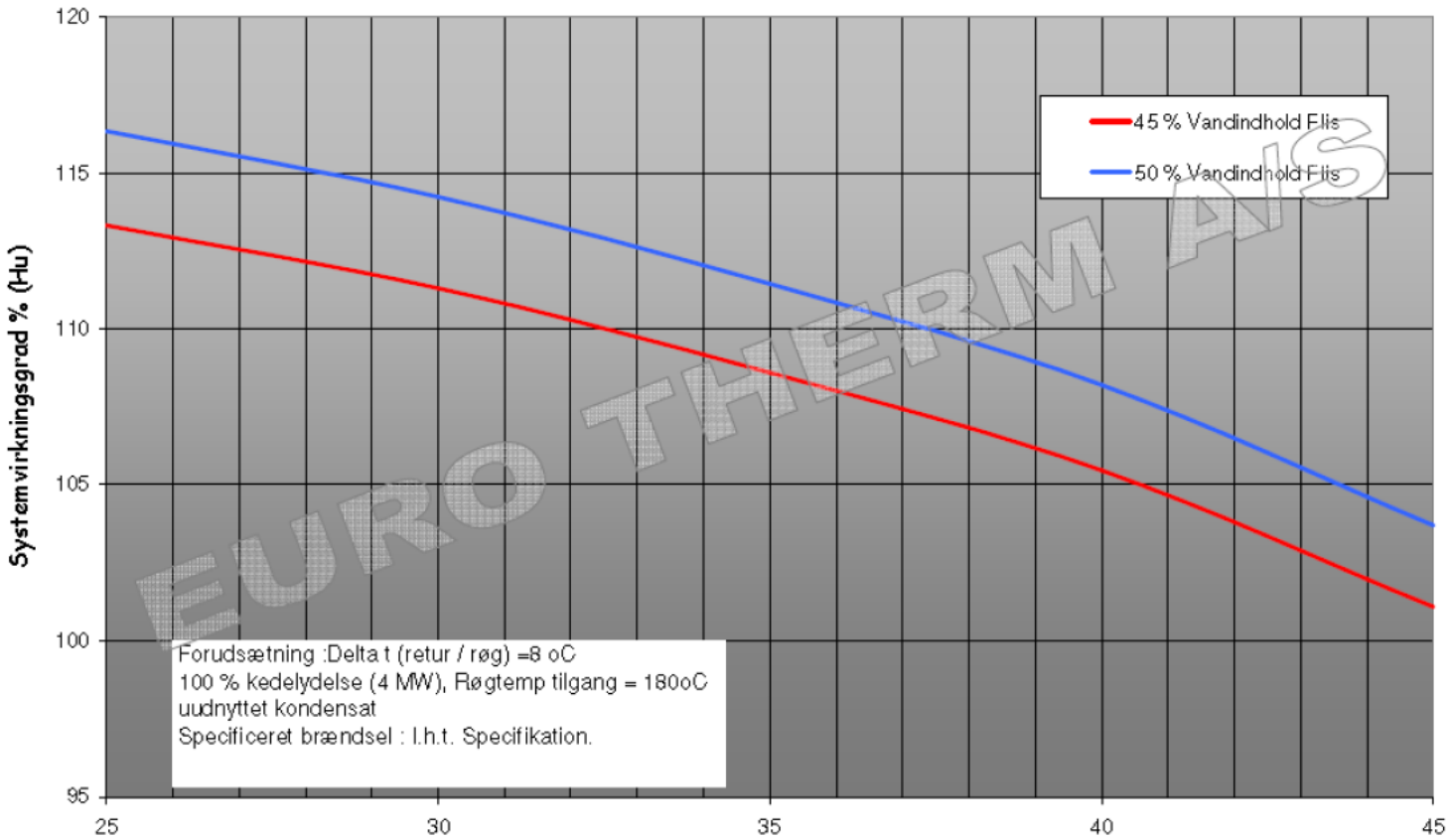

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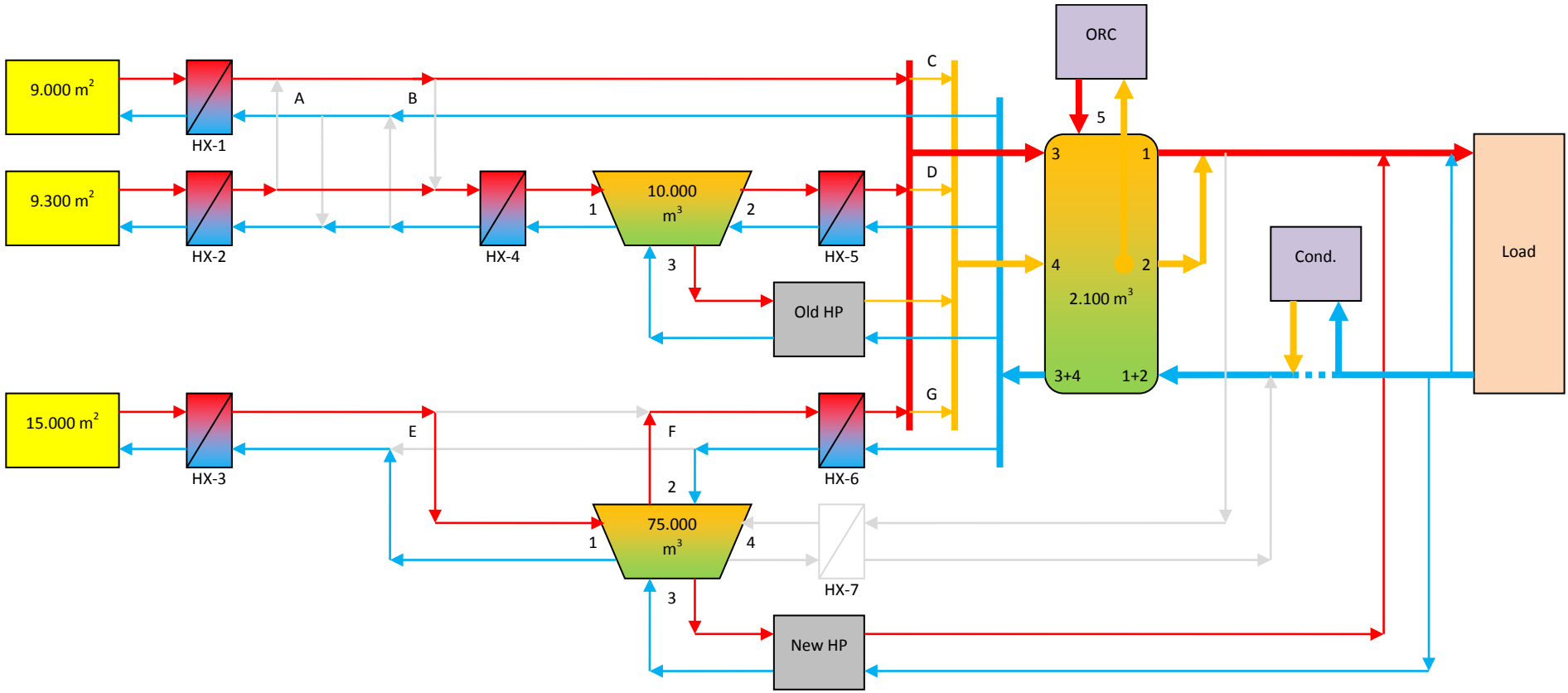
Diagram for TRNSYS calculations



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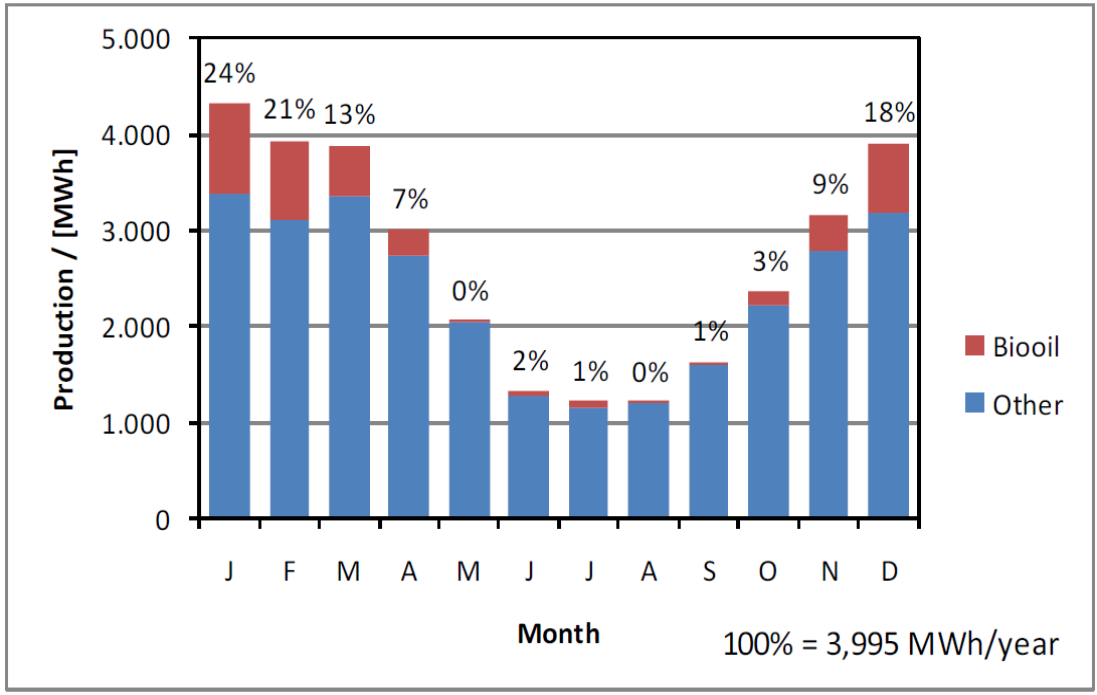
Production – first calculation

	MWh/year
9,000 m2	3,383
9,300 m2	3,727
15,000 m2	6,435
Collectors total	**13,545**
Propane heat pump	214
CO2 heat pump	1,043
Heat pump total	**1,257**
ORC	12,023
Scrubber	4,008
Wood chip total	**16,031**
2,100 m3	-119
10,000 m3	-520
75,000 m3	-2,193
Store losses total	**-2,833**
Bio oil	4,000
Total	**32,001**



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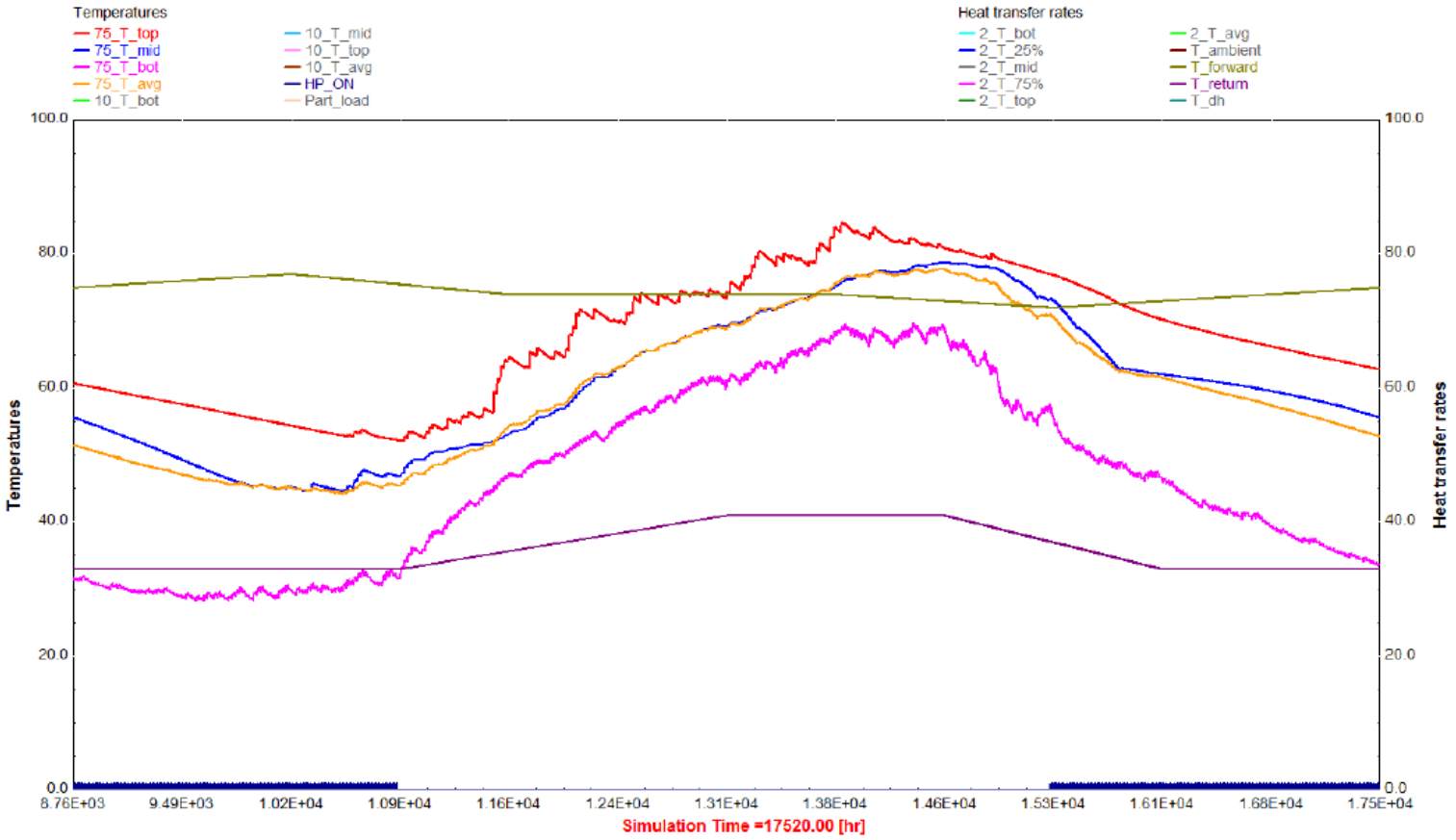
Temperatures in pit heat storage – year two



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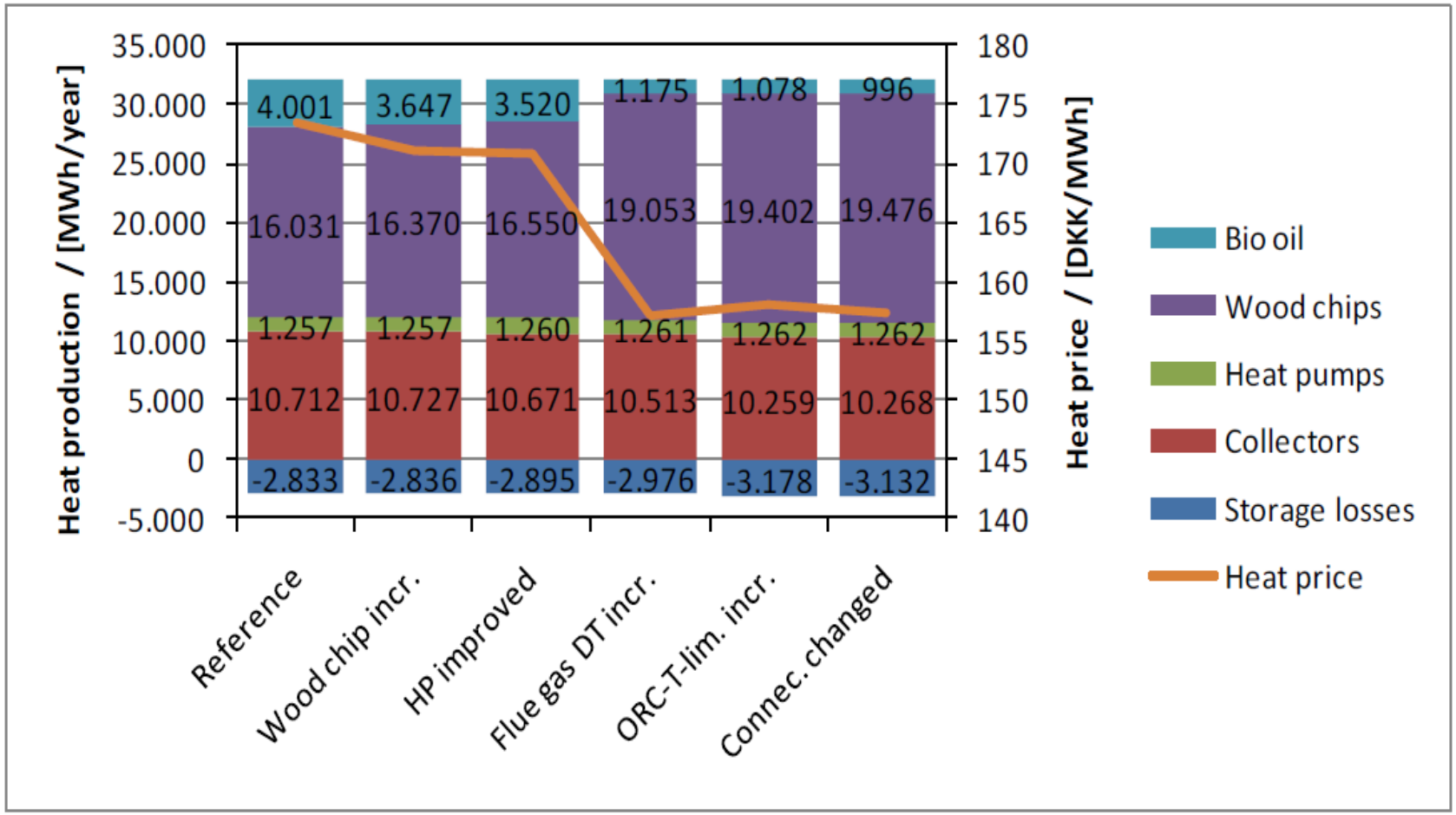
Optimising the plant



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Result of optimisation

Unit	Design calculation (MWh/year
Solar collectors	13,400
Heat pump	1,262
Wood chip boiler	19,476
Existing bio oil boiler	996
Heat loss, storages	- 3,132
Total heat production	**32,002**
Electricity production	3,175

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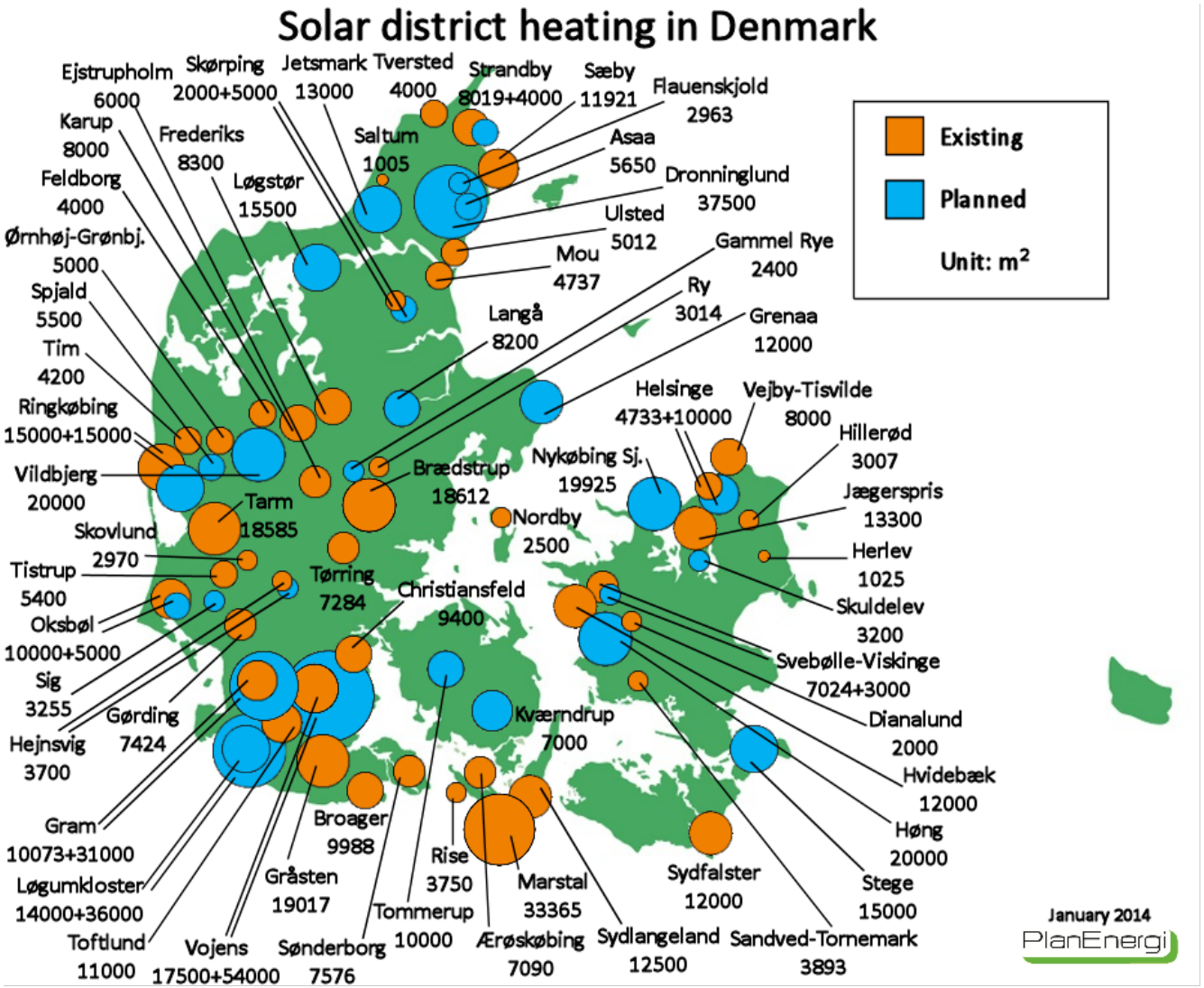
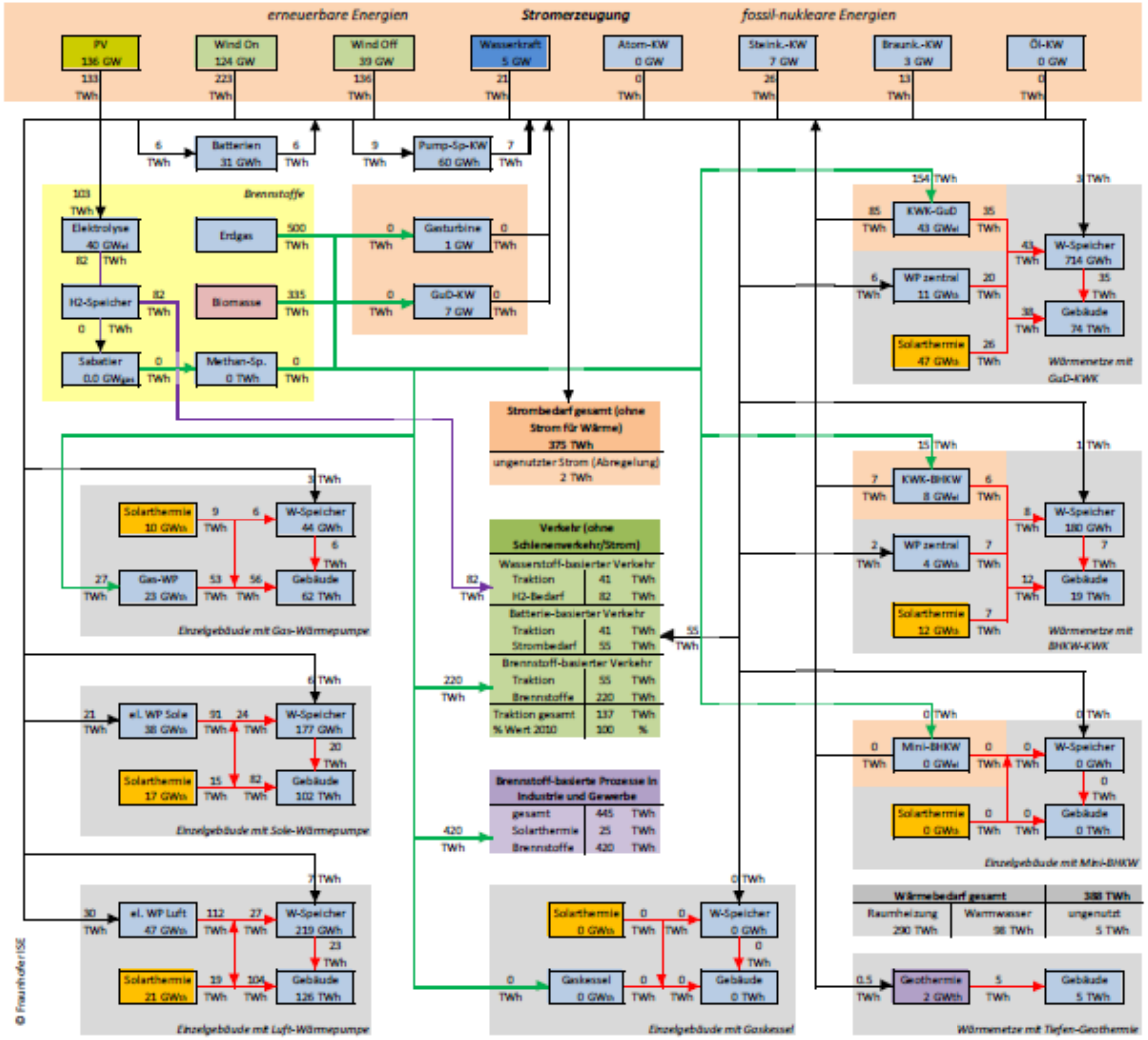


Modellierung

Der Versuch eines Blicks in die Zukunft –

mögliche Struktur eines Energiesystems mit hohem Anteil erneuerbarer Energien



Schema Regenerative Energien Modell – Deutschland REMod-D

Fraunhofer ISE

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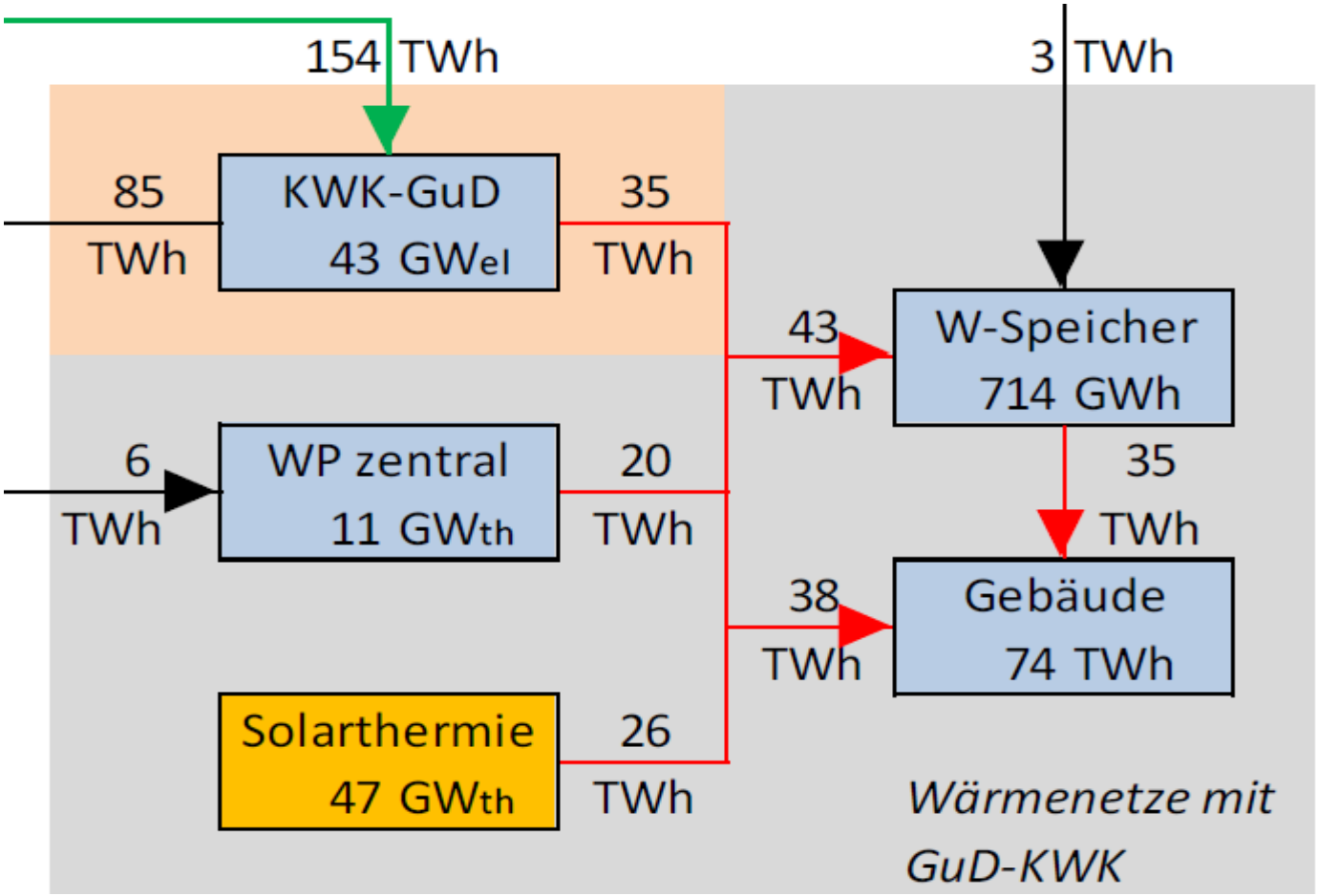
District heating with combined cycle in Germany



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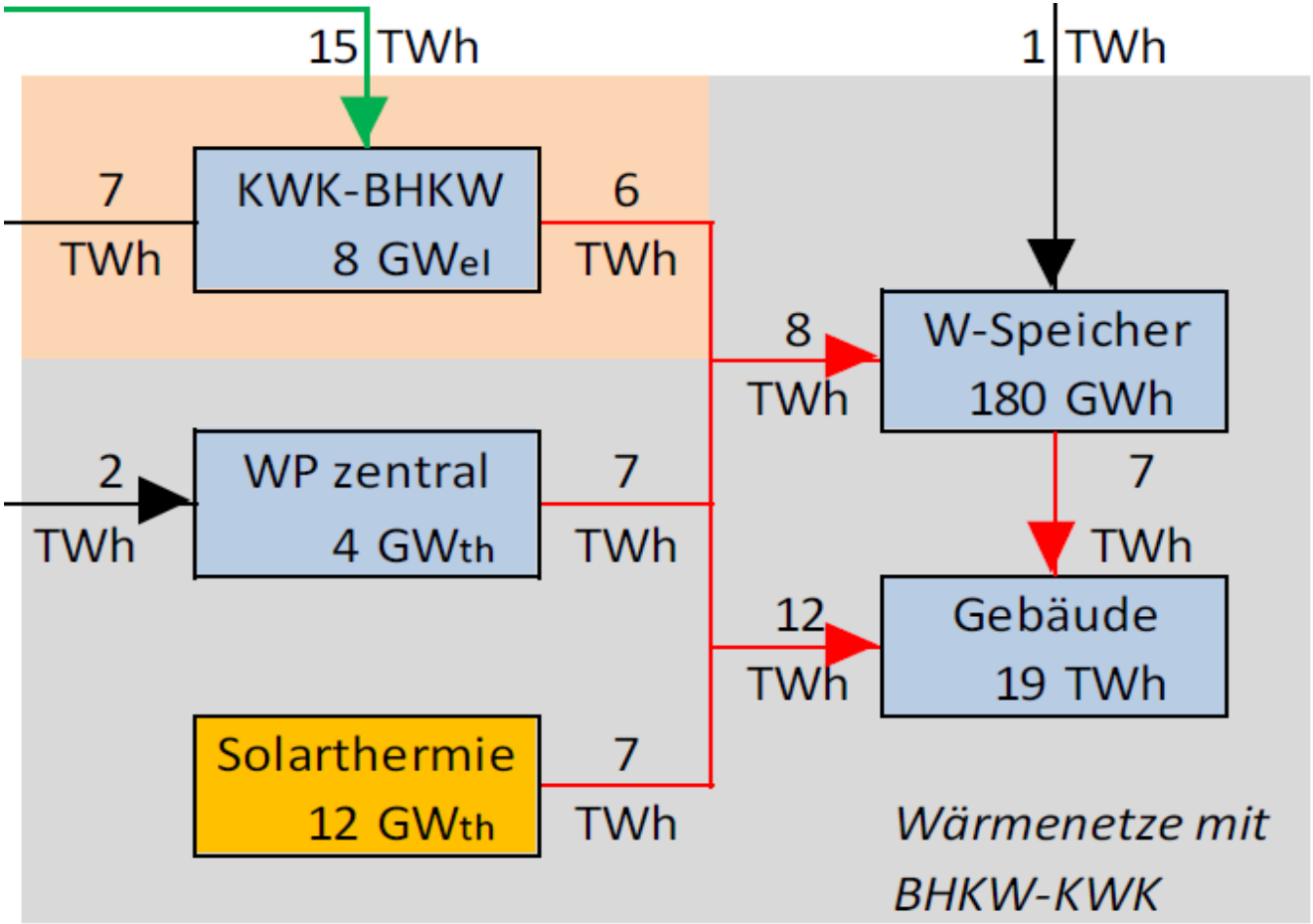
Block heating in Germany



Sunstore in Germany?

- 894 GWh heat storages (150 storages each 50.000 m^3)
- 15 GW_{heat} heat pumps (15.000 MW)
- 59 GW_{heat} solar thermal (84 mio. m^2)

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The future ?! Renewable district heating and cooling!?

- ✓ Flexible
- ✓ Renewable
- ✓ CO_2-neutral
- ✓ Cost effective

Thank you for your attention

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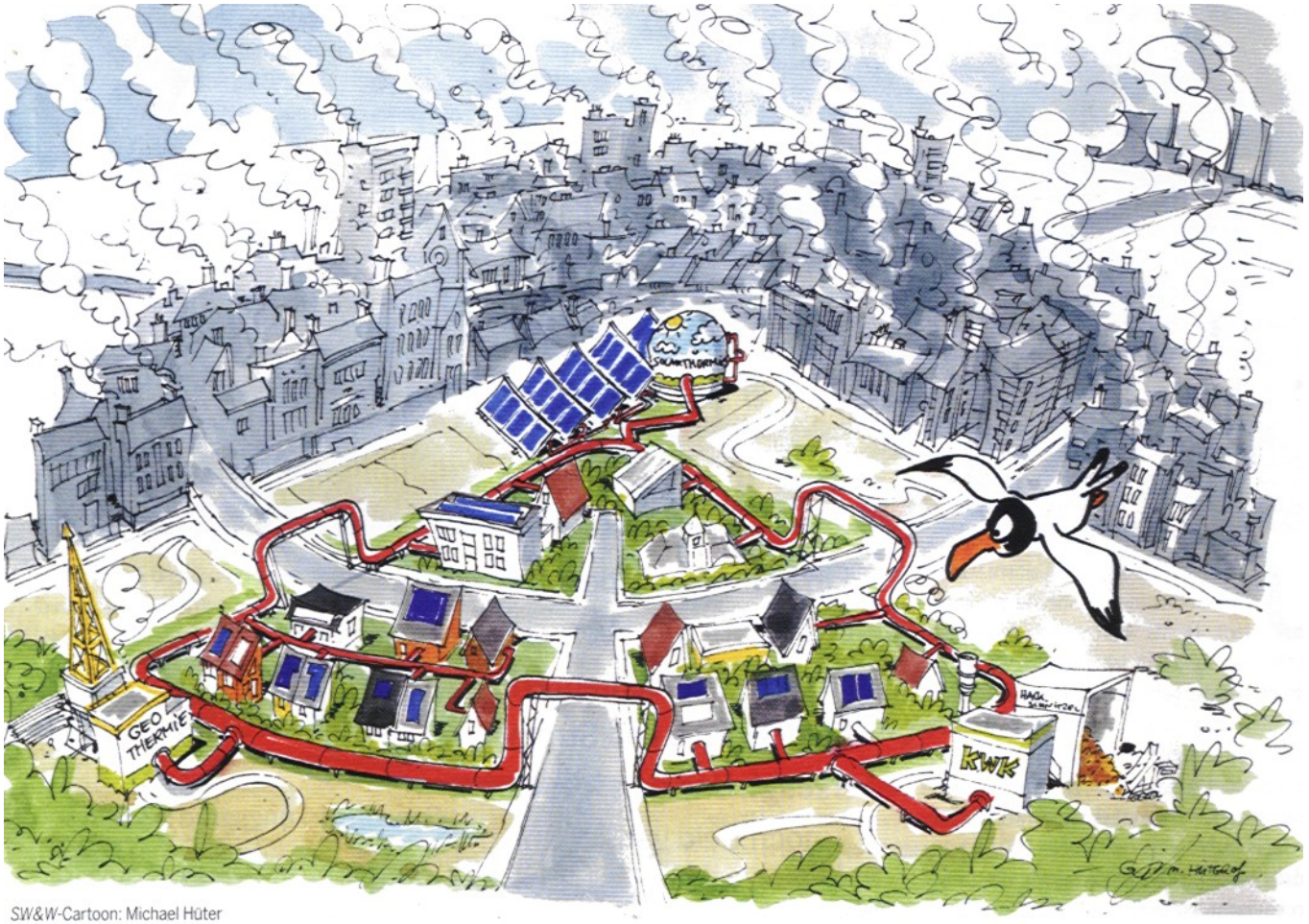

SW&W-Cartoon: Michael Hüter

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More information on

www.planenergi.dk

www.solarmarstal.dk

www.braedstrup-fjernvarme.dk

www.sunstore4.eu

www.solar-district-heating.eu

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