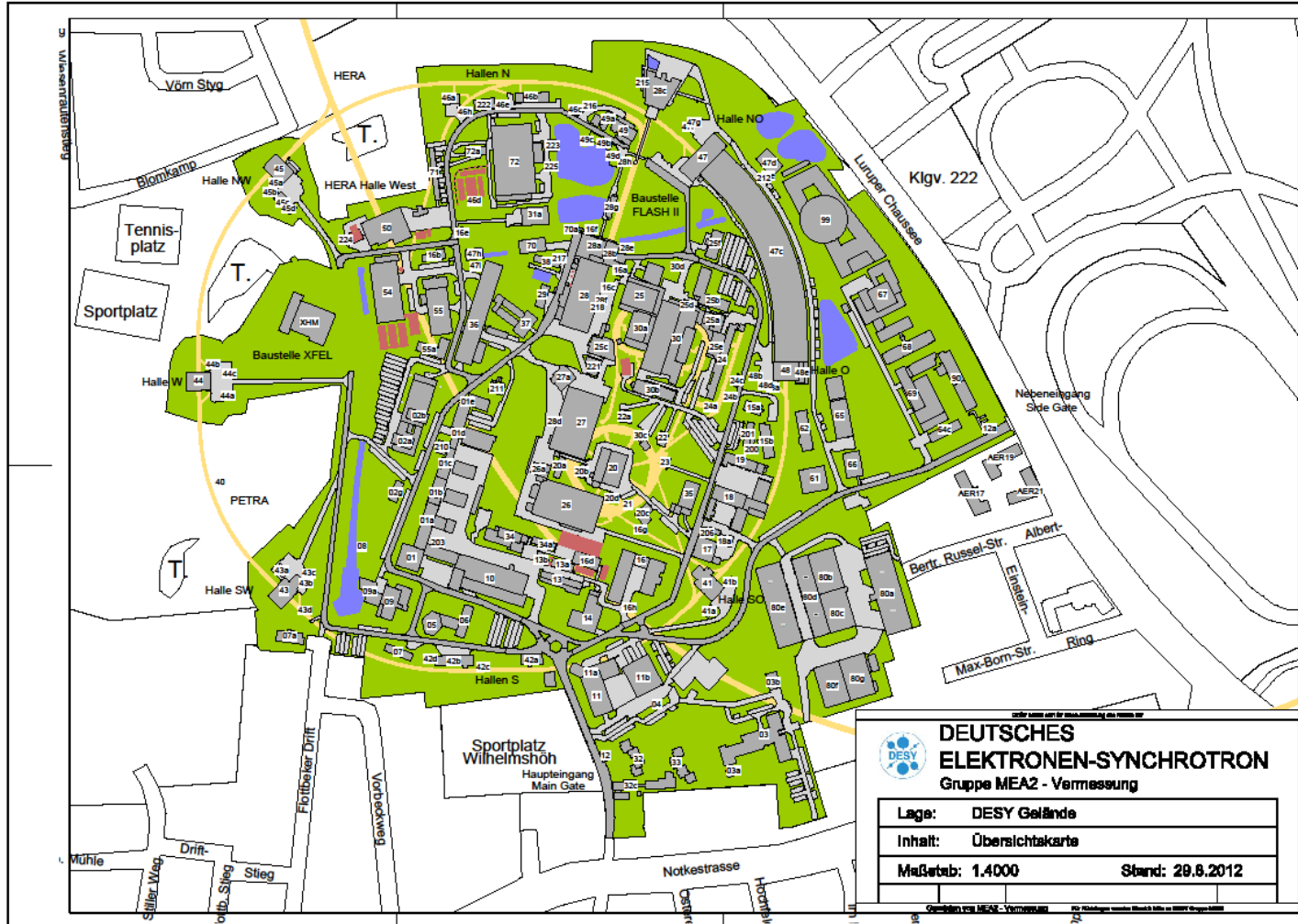


Cryogenik waste heat utilization for DESY and European XFEL

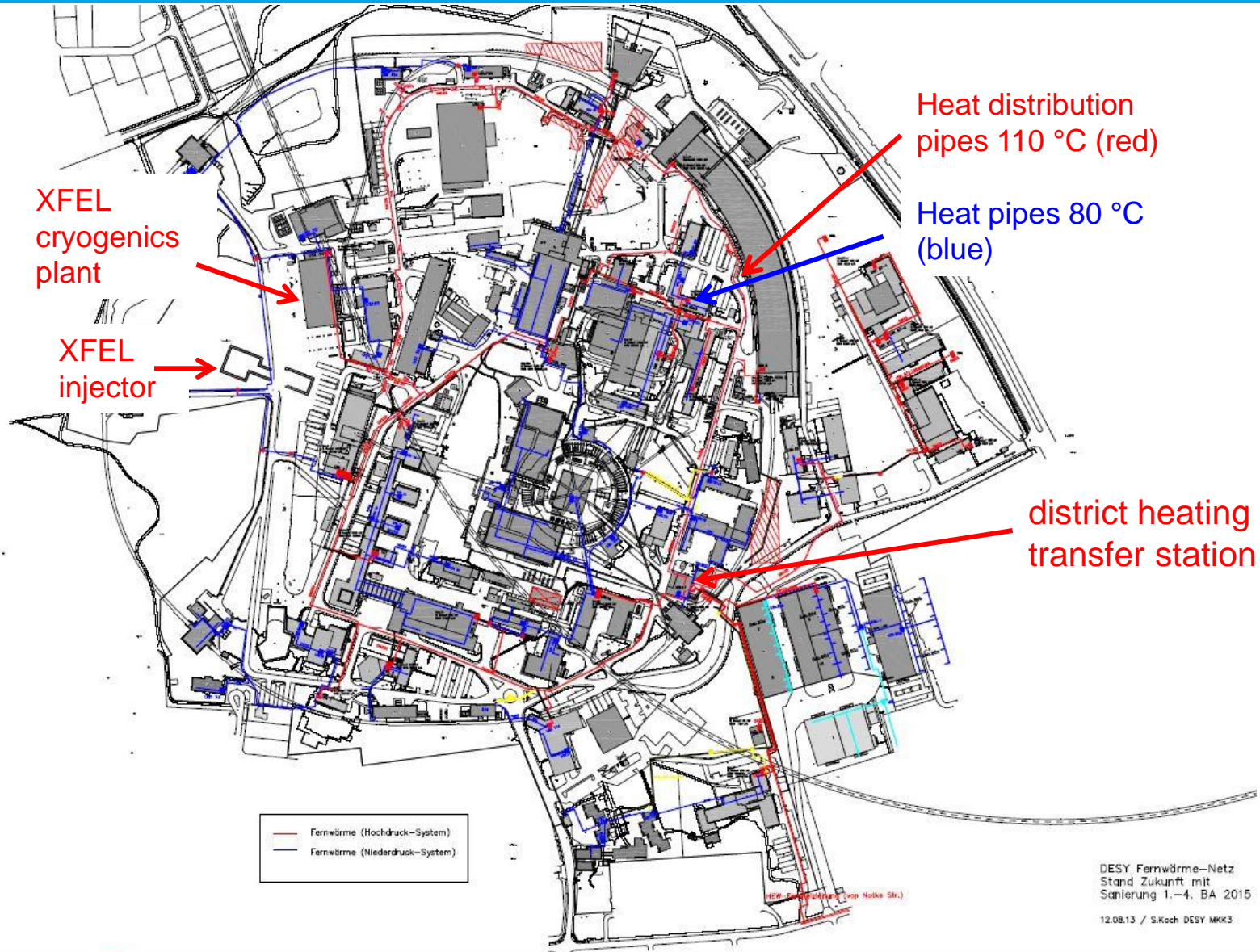
2nd Workshop on Energy for Sustainable Science at Research Infrastructures

Jens-Peter Jensen, Eva Leister
Energy for Sustainable Science
Genf, 24.10.2013

DESY campus



DESY premises heat distribution



Energy foot print of DESY and XFEL

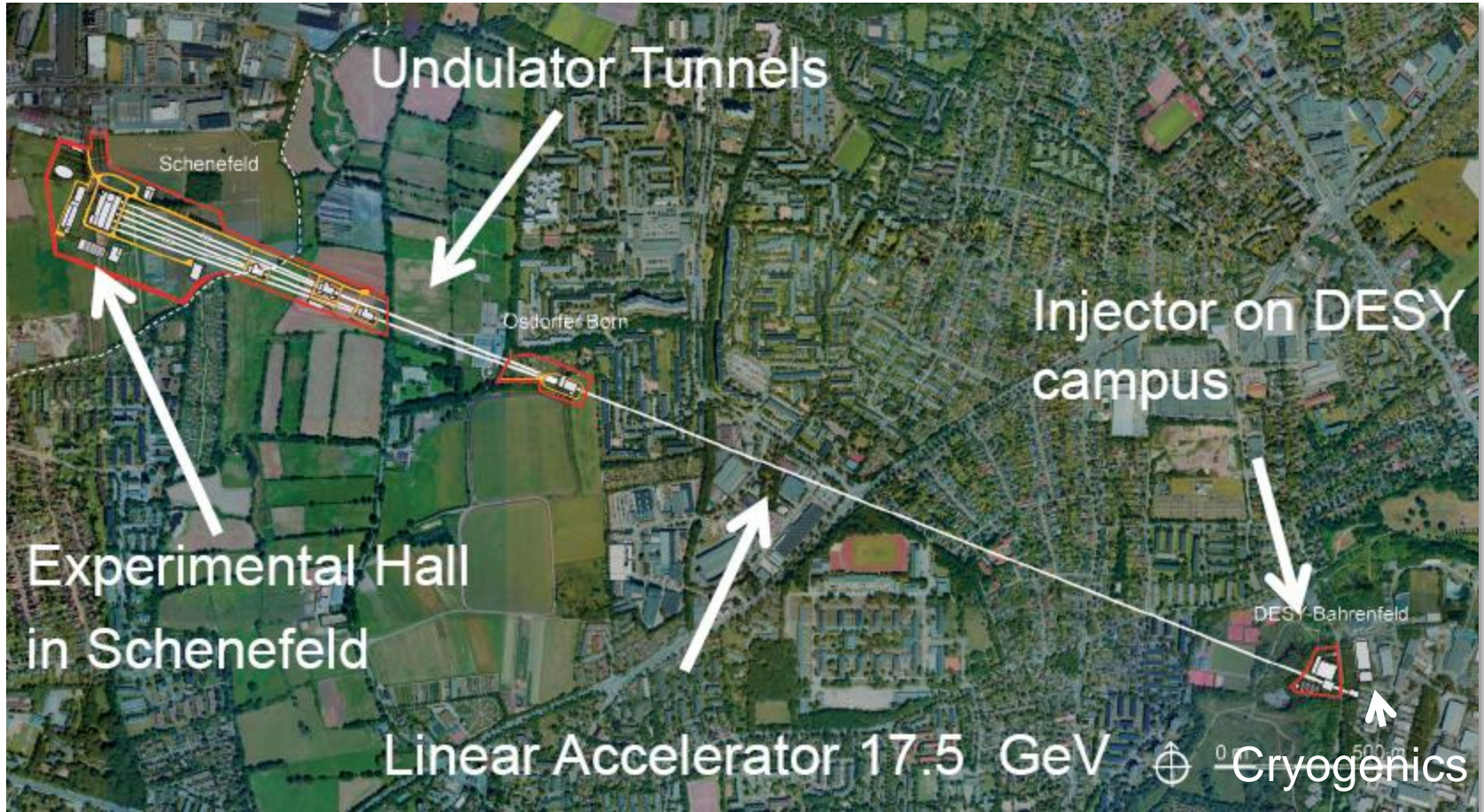
DESY premises in 2015 ff

- > Electrical energy: 160 GWh, 25 MW
- > Heating energy: 20 GWh, 10 MW
- > Dominated by the accelerators and experimental halls

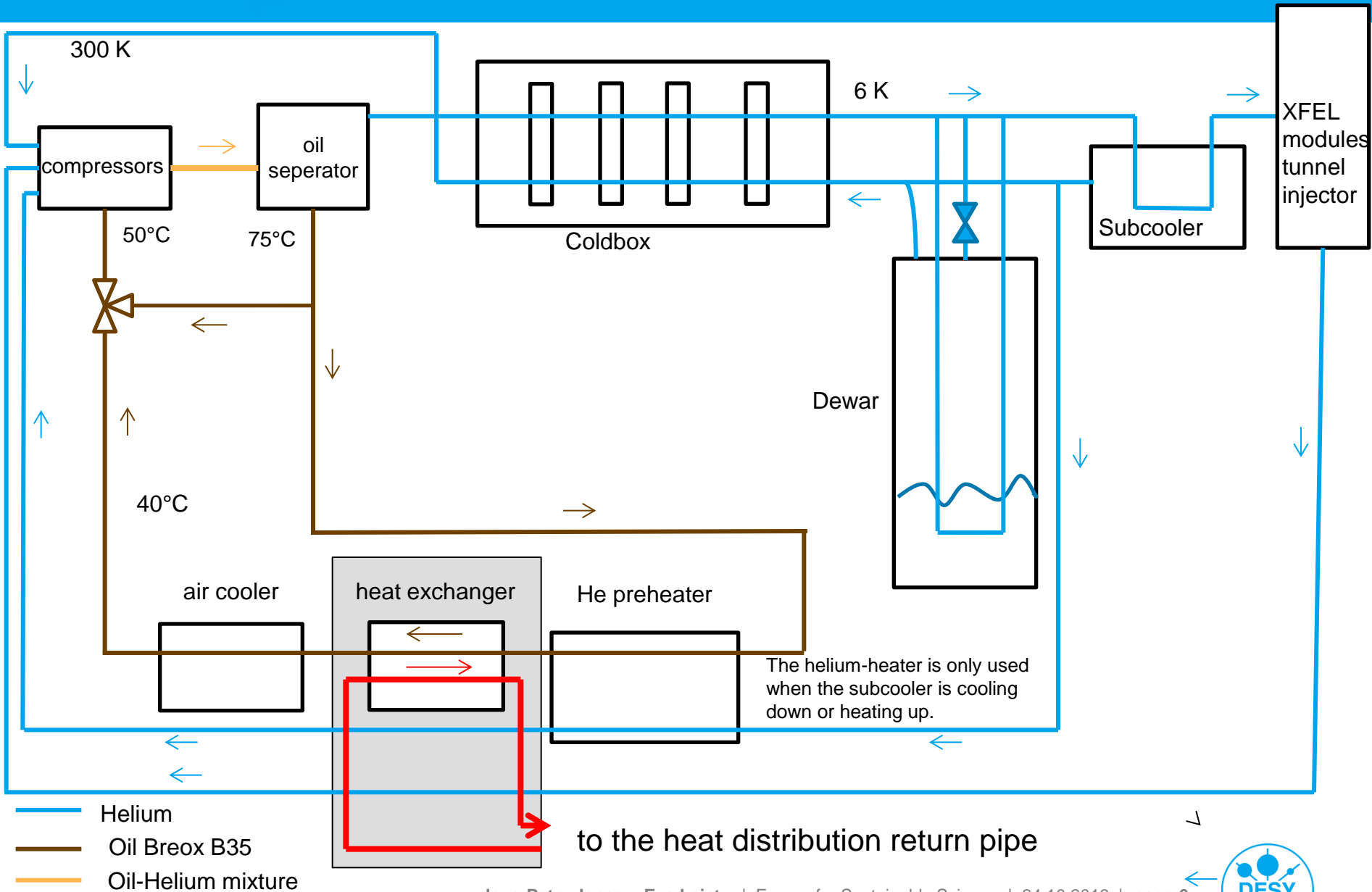
XFEL operation at 10 Hz in 2016 ff

- > Electrical energy: 120 GWh, 20 MW
- > Heating energy: 10 GWh, 5 MW Schenefeld premises
- > Cryogenics electrical energy at 10 Hz: 24 GWh/a
 - Heating demand is predominant on the Schenefeld and Osdorf premises
 - XFEL cryogenic plant is on the DESY premises, ex HERA cryogenics plant
- > XFEL cryogenics waste heat utilization possible for DESY premises

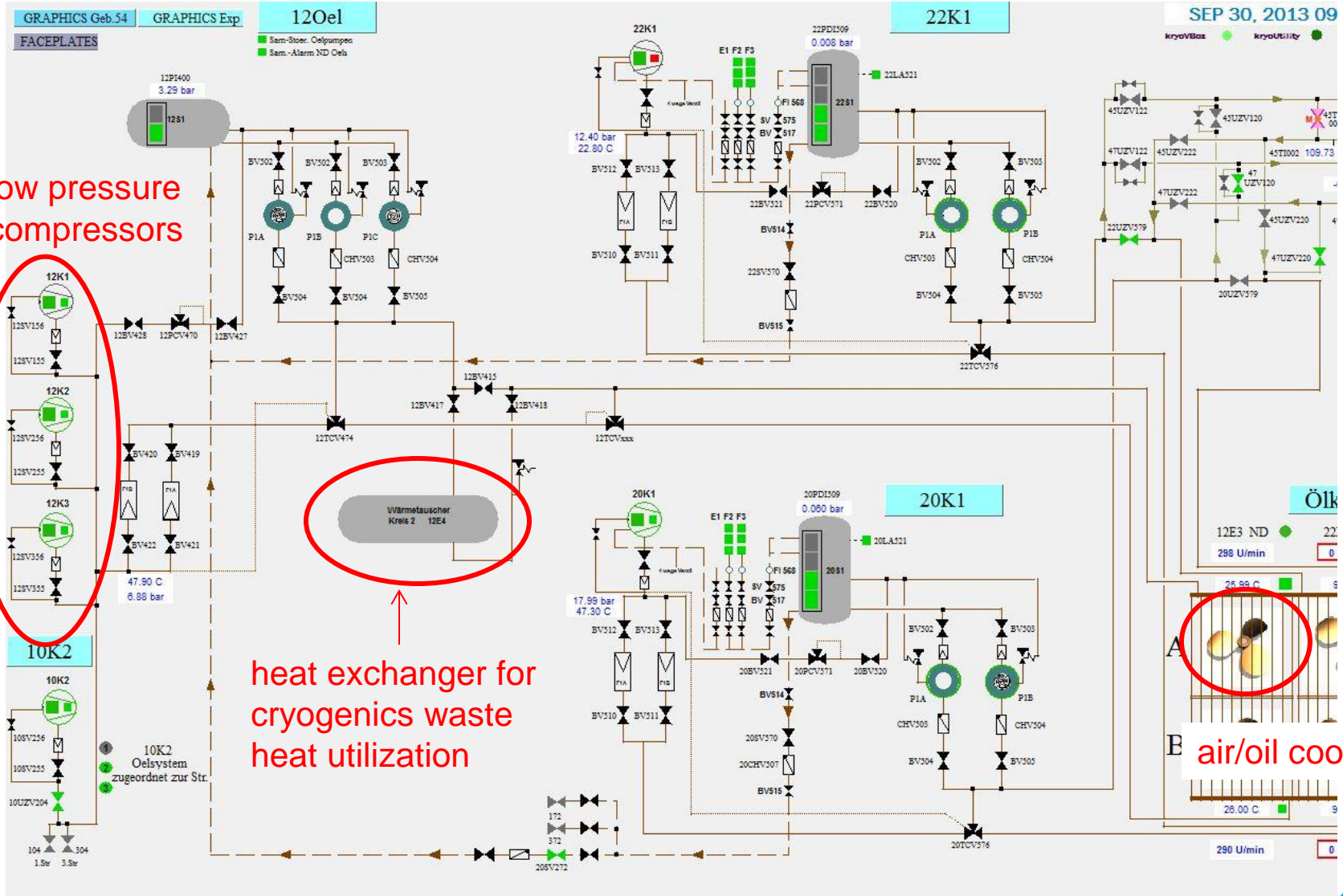




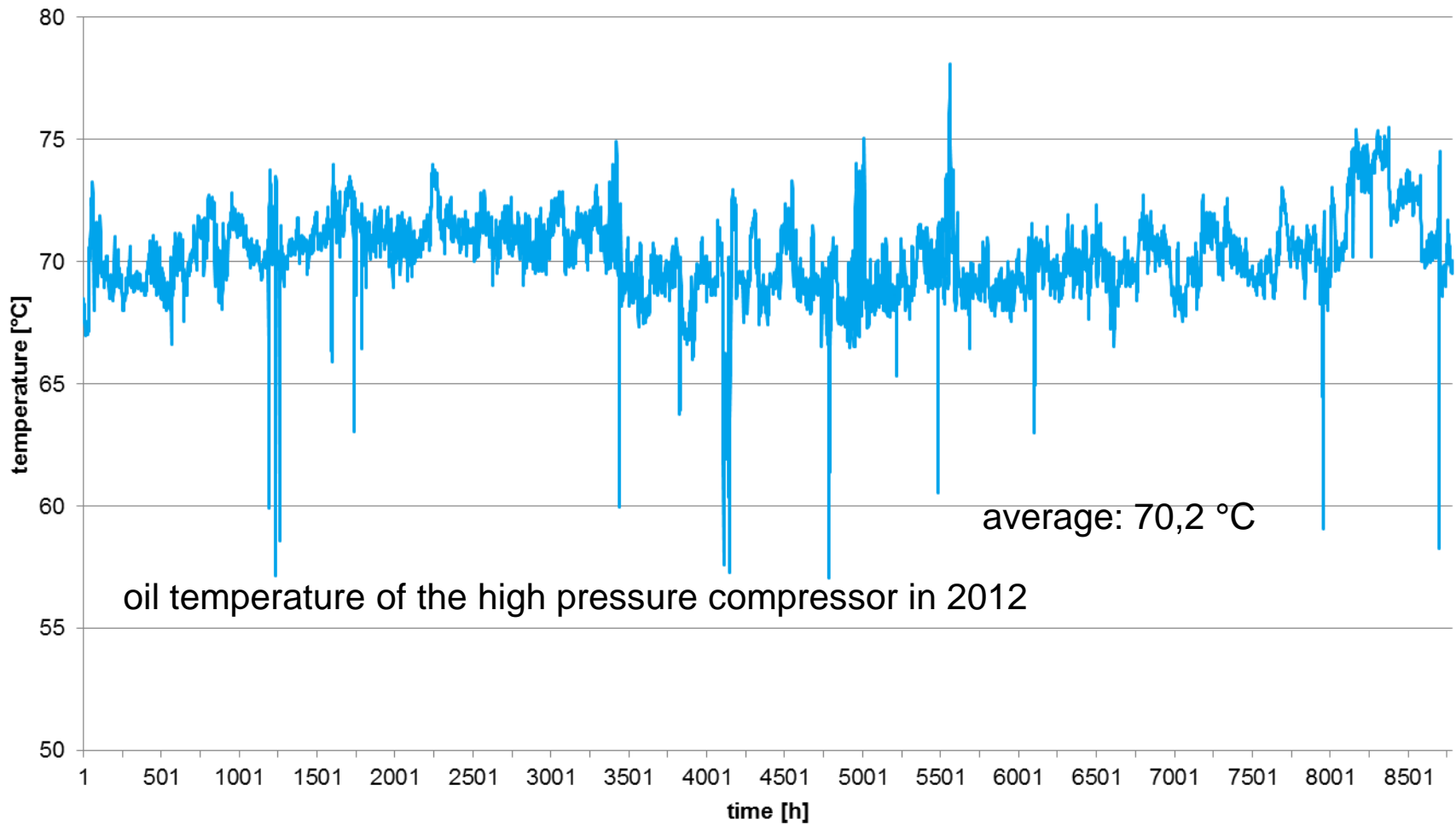
Cryogenic Plant Functionality



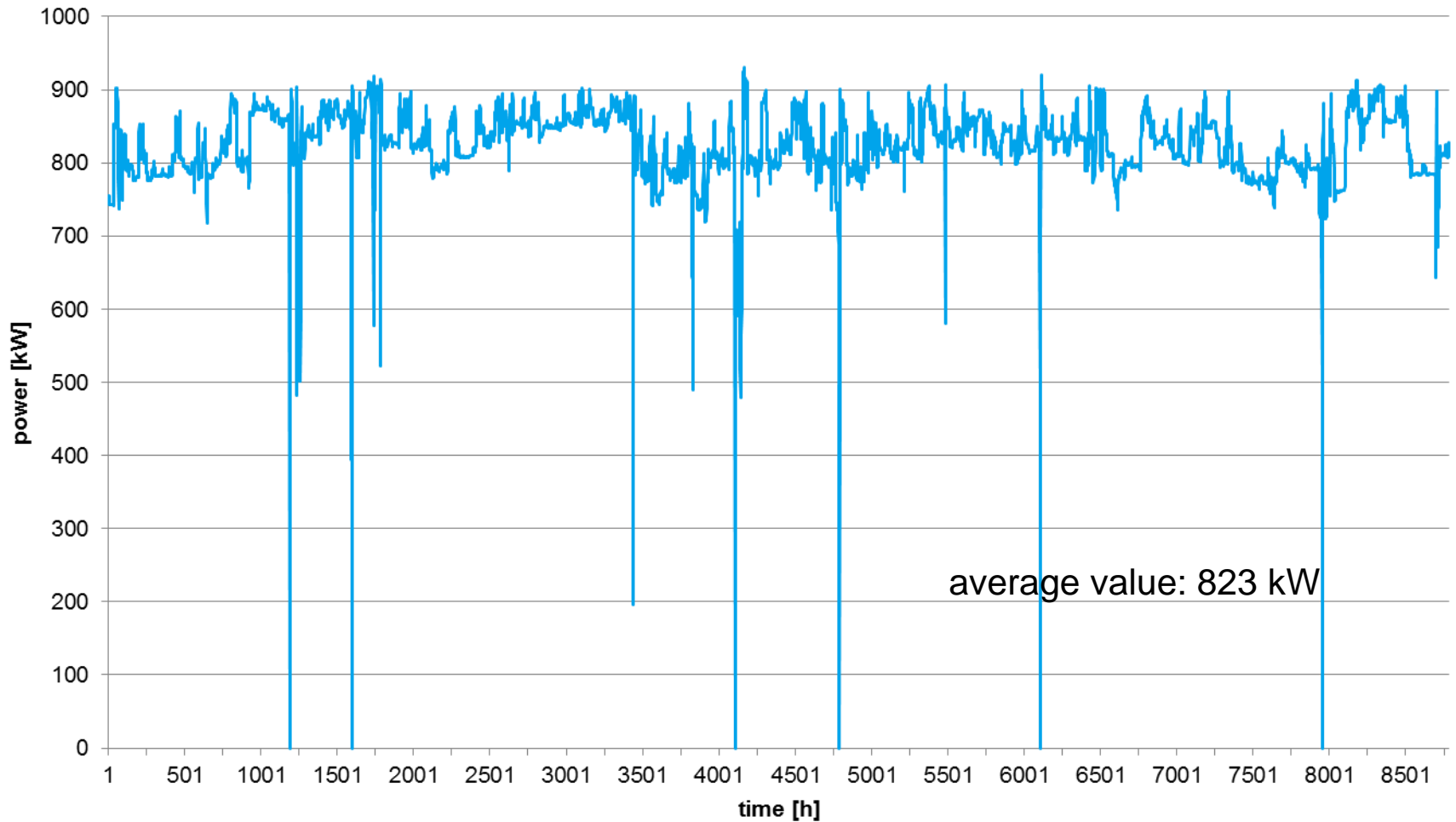
Oilsystem of the XFEL Cryogenic Plant



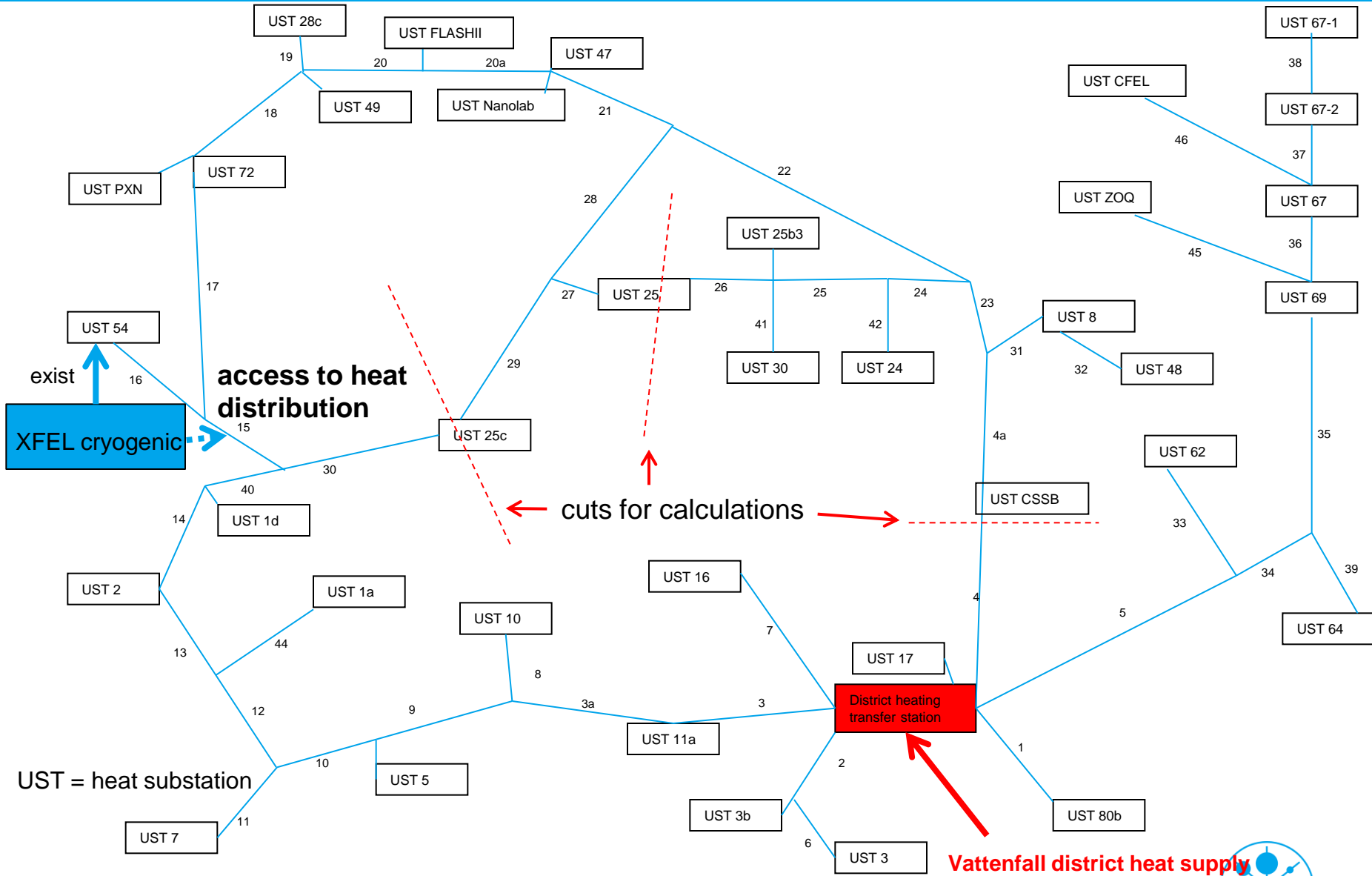
Temperature Plot of the Breox Oil in 2012



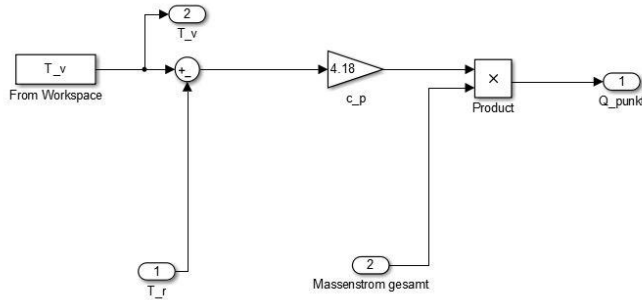
Heat emission of 1 street of the cryogenic plant in 2012



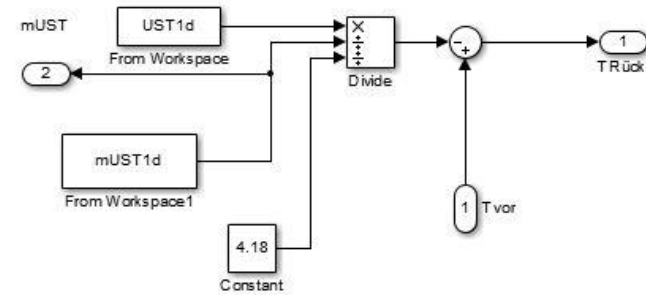
Heat Distribution Scheme of DESY Premises



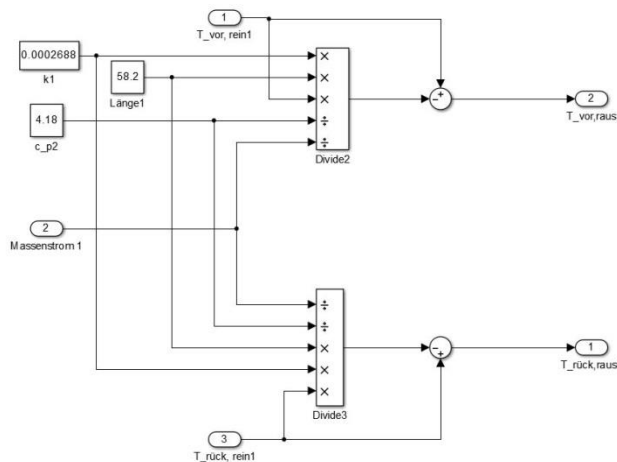
Simulation Models for MATLAB/Simulink



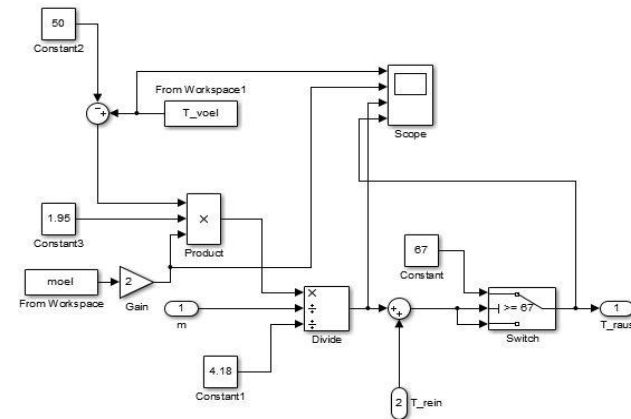
district heat transfer station



heat substation



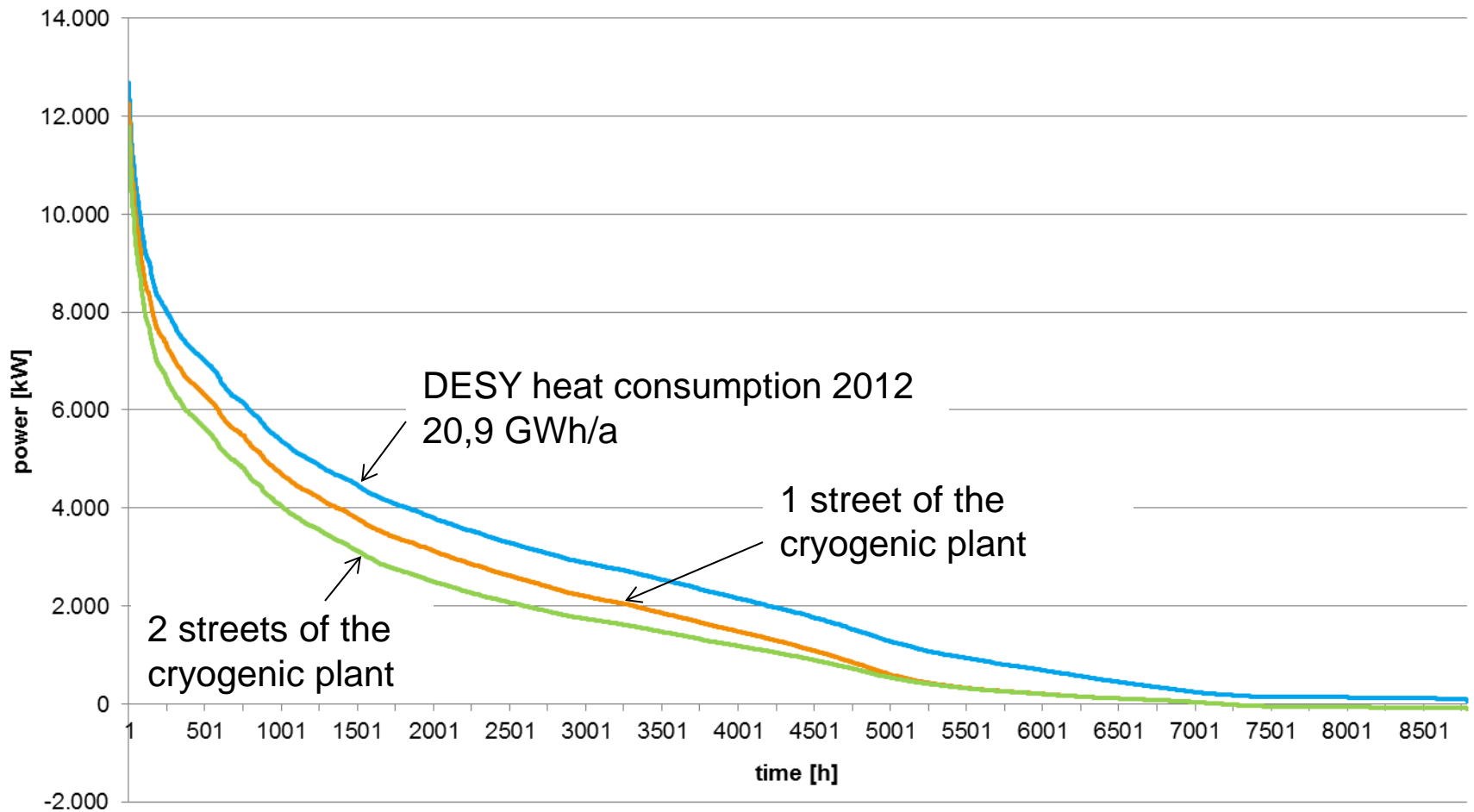
heat pipes



heat exchanger of the cryogenic plant



Classified Heat Load Curve of 2012



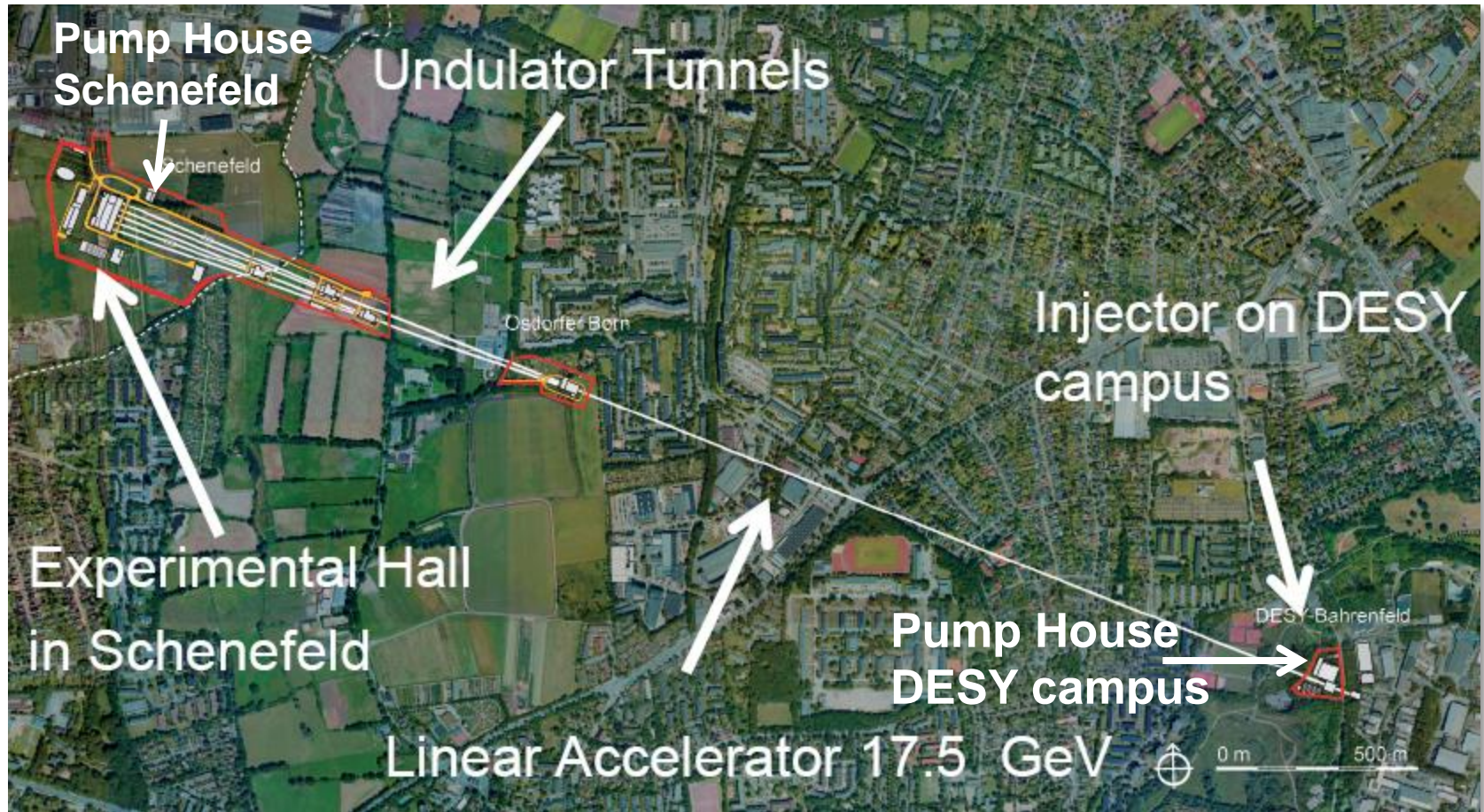
Results of Cryogenic Heat Utilization

	1 street	2 streets
heat extraction	4,6 GWh/a	7,0 GWh/a
cost savings ¹⁾	228.450 €/a	350.600 €/a
payback period ²⁾	2,6 a	1,7 a
cash value after 10 years ³⁾	807.740 €	1.558.298 €
CO ₂ -Emission ⁴⁾	1.087 t-CO ₂ /a	1.669 t-CO ₂ /a

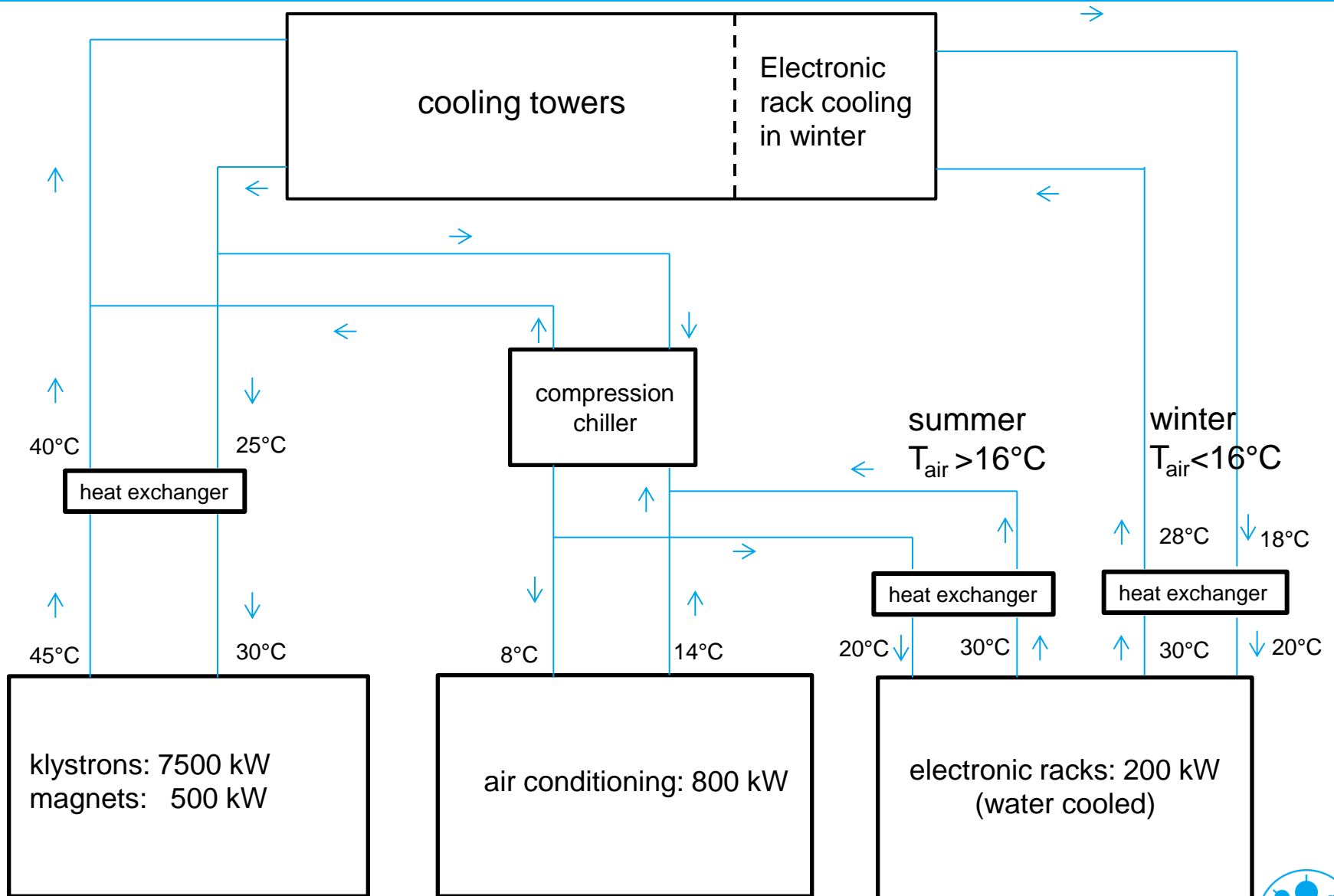
- 1) price for district heat: 0,05 €/kWh
- 2) investment costs: 592 k€
- 3) refunding rate: 10 %
- 4) district heat: 238 g CO₂/kWh



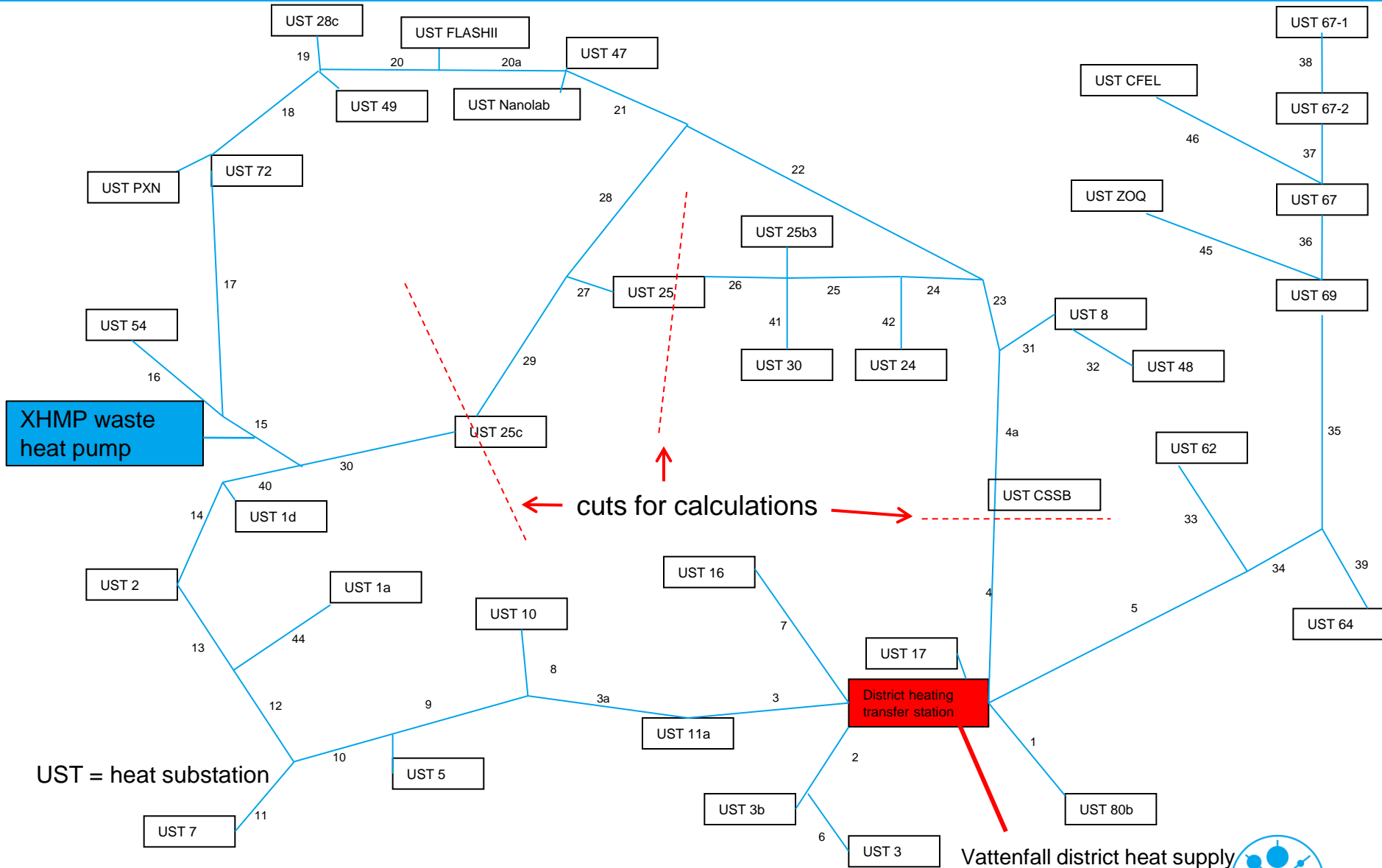
Waste Heat Utilization from the XFEL Water Cooling



Water Cooling of XFEL Injector and Main Linac XTL



Heat Distribution Scheme of DESY Premises



Waste Heat Pump Calculation

- > Heat pump: 630 kW, $T_{\text{cond}} = 85 \text{ }^\circ\text{C}$, $T_{\text{vap}} = 40 \text{ }^\circ\text{C}$
- > Heat is transferred into the heat distribution return pipe
- > Investment costs are 725 k€
- > Without heat utilization from the cryogenics

	1 heat pump
heat economy	4,6 GWh/a
cost savings ¹⁾	74.300 €/a
payback period ²⁾	9,8 a
Cash value after 10 years ³⁾	- 270.222 €
CO ₂ -Emission ⁴⁾	745 t-CO ₂ /a

1) price for district heating: 0,05 €/kWh electricity: 0,15 €/kWh

2) investment costs: 725.000 €

3) adequate target rate: 10 %

4) district heating: 238 g-CO₂/kWh electricity: 336 g-CO₂/kWh



Conclusion

Cooling water waste heat utilization with heat pump

- The most waste heat goes into the cooling water
- The cooling water temperatures are too low for direct transfer into the heat distribution pipes
- One needs a heat pump to boost the temperature
- The savings do not pay back the investment and service costs

and

- The XFEL pump house XHMP is near the cryogenics hall
- The heat pump is in competition with the cryogenics
- This makes it even more uneconomic



Conclusion

XFEL Cryogenic oil waste heat utilization

The utilization of the oil waste heat pays back after 2 – 3 years

Heat pump utilization to boost low temperatures does not pay

