

SIMULATION BASED EVALUATION OF LARGE SCALE WASTE HEAT UTILIZATION

Optimized integration and operation of a seasonal storage in the district heating network of Linz (Austria)

Markus Köfinger

Smart Energy Systems and 4th Generation District Heating
September 2017, Copenhagen

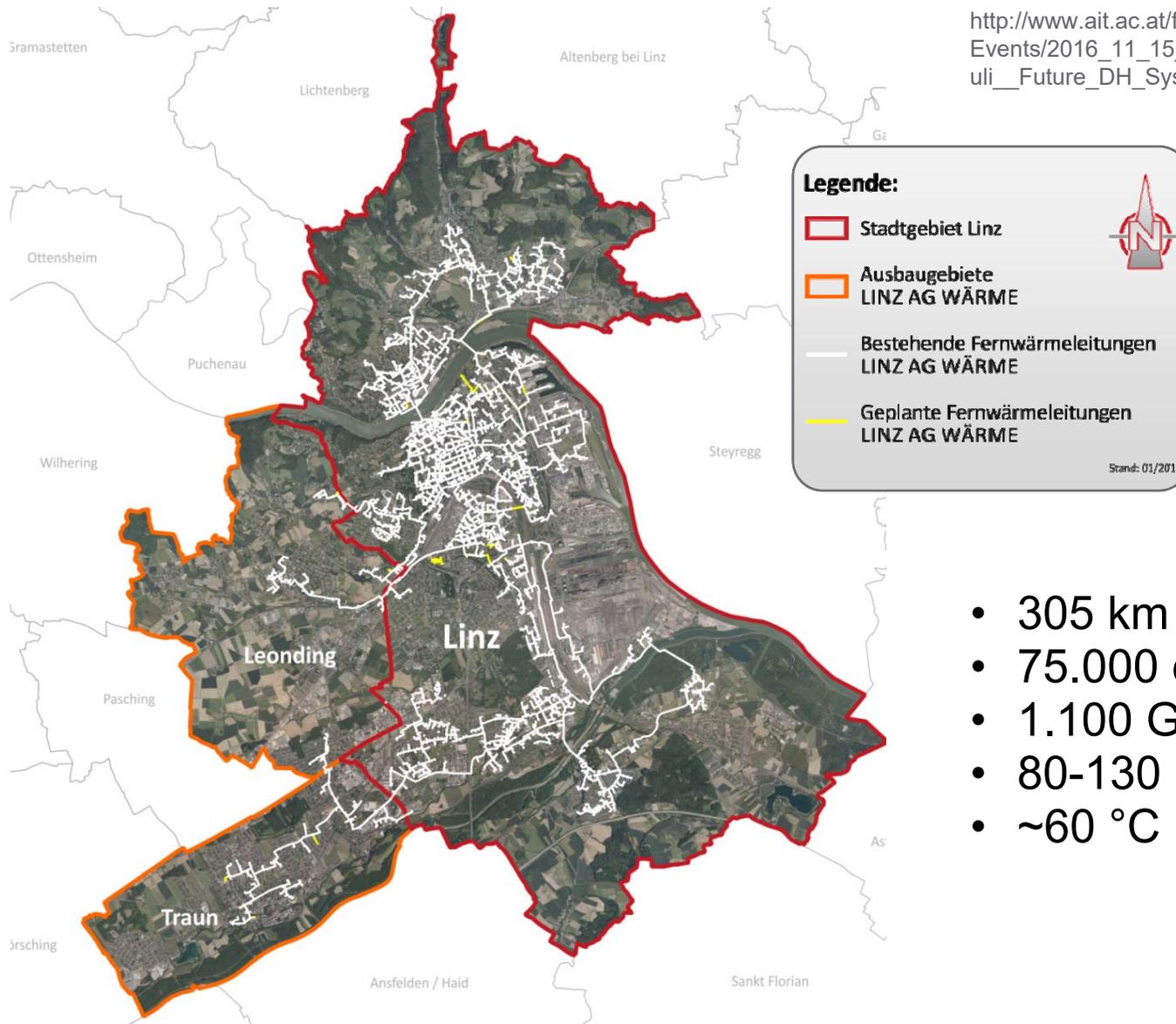


CONTENT

- Introduction of the district heating network of Linz
- Preliminary study for a seasonal storage in Linz
- Future DH System Linz

DISTRICT HEATING NETWORK OF LINZ

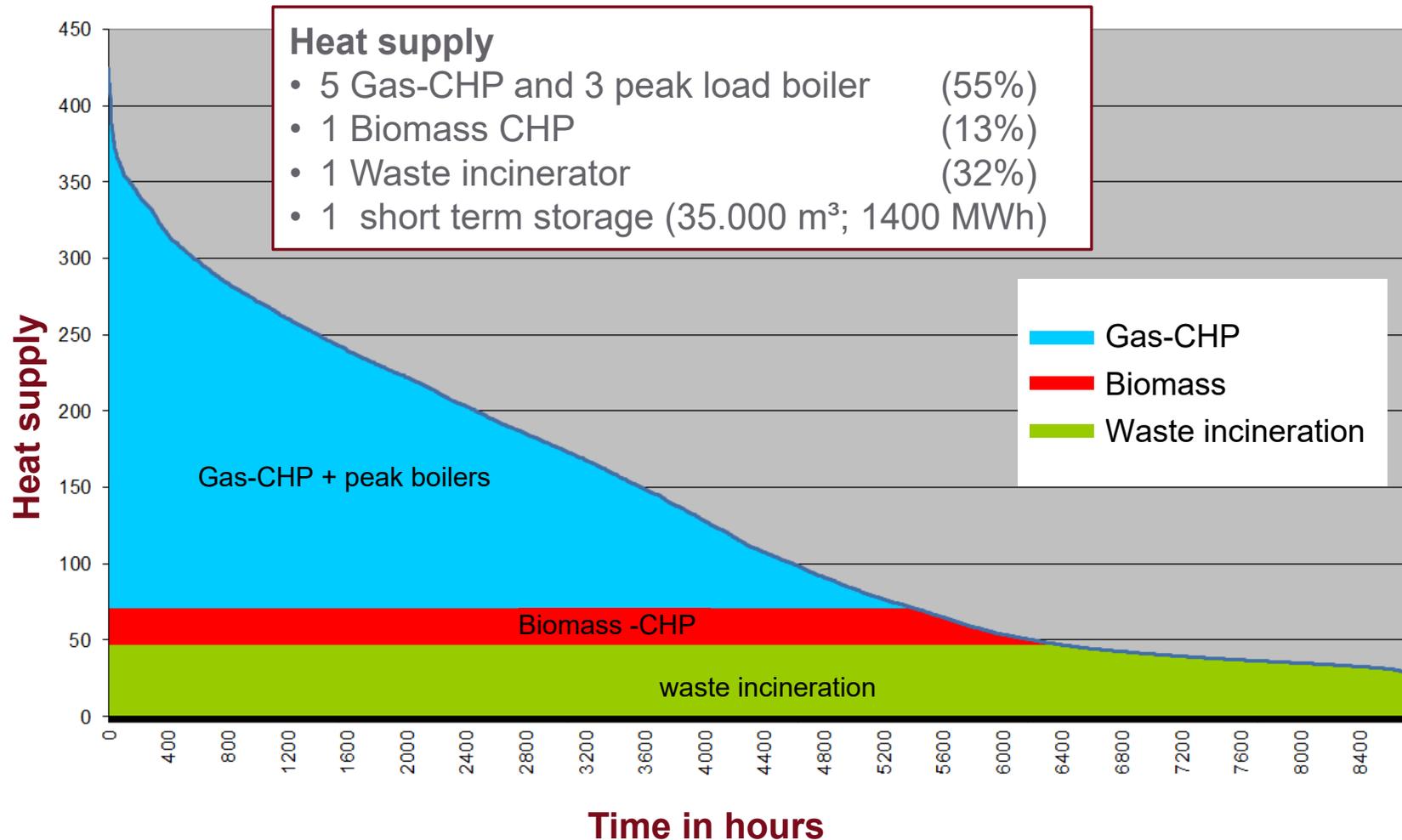
http://www.ait.ac.at/fileadmin/mc/energy/downloads/News_and_Events/2016_11_15_2.Praxis_und_Wissensforum_FWK/B3_Pauli_Future_DH_System_AIT_15_Nov_16_Pauli_V3.pdf



- 305 km network length
- 75.000 connected apartments
- 1.100 GWh heat sales
- 80-130 °C supply line
- ~60 °C return line

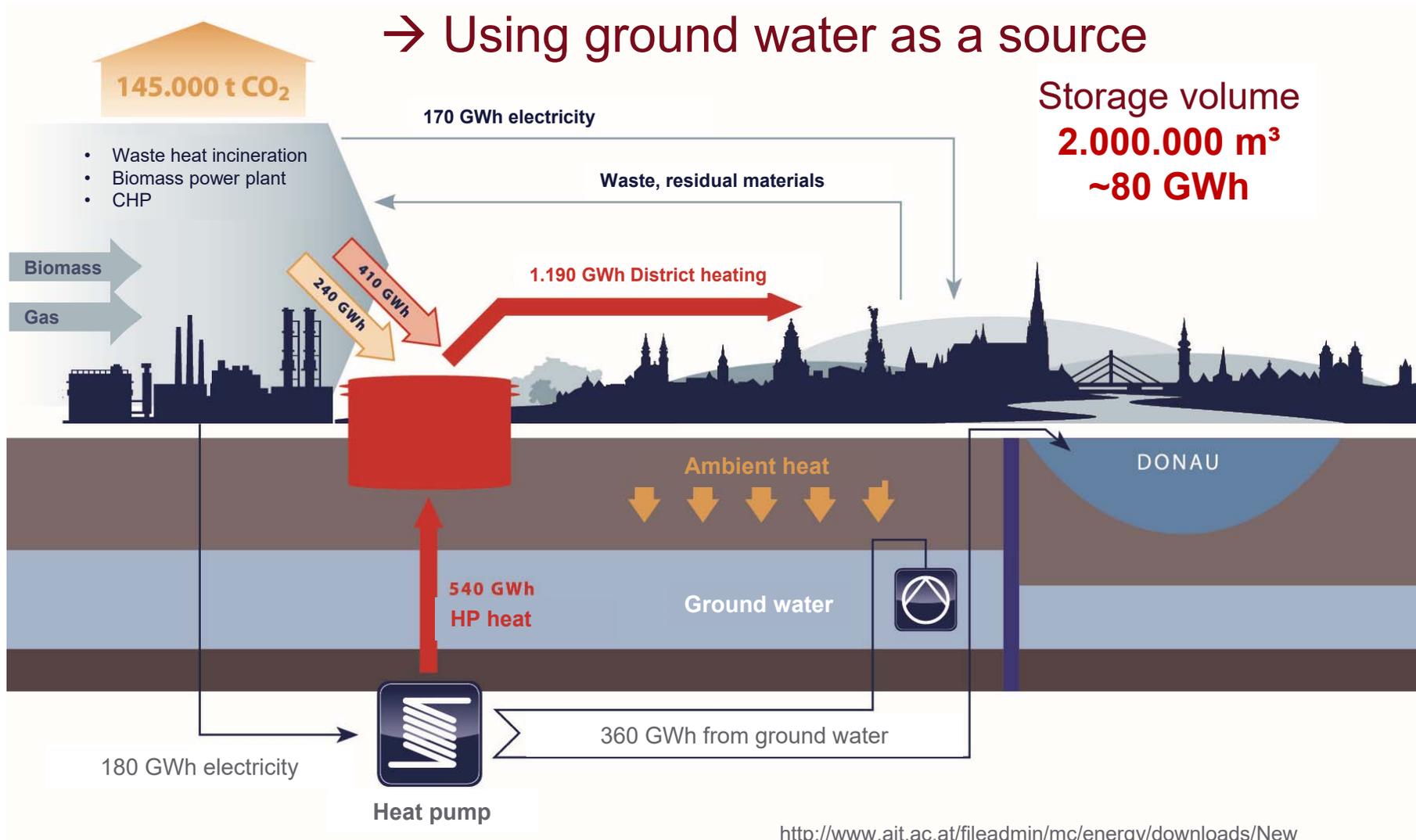
DISTRICT HEATING NETWORK OF LINZ

http://www.ait.ac.at/fileadmin/mc/energy/downloads/News_and_Events/2016_11_15_2.Praxis_und_Wissensforum_FWK/B3_Pauli_Future_DH_System_AIT_15_Nov_16_Pauli_V3.pdf



PRELIMINARY STUDY: SEASONAL STORAGE IN LINZ

→ Using ground water as a source



PRELIMINARY STUDY: SEASONAL STORAGE IN LINZ

- Size comparison for the seasonal thermal storage



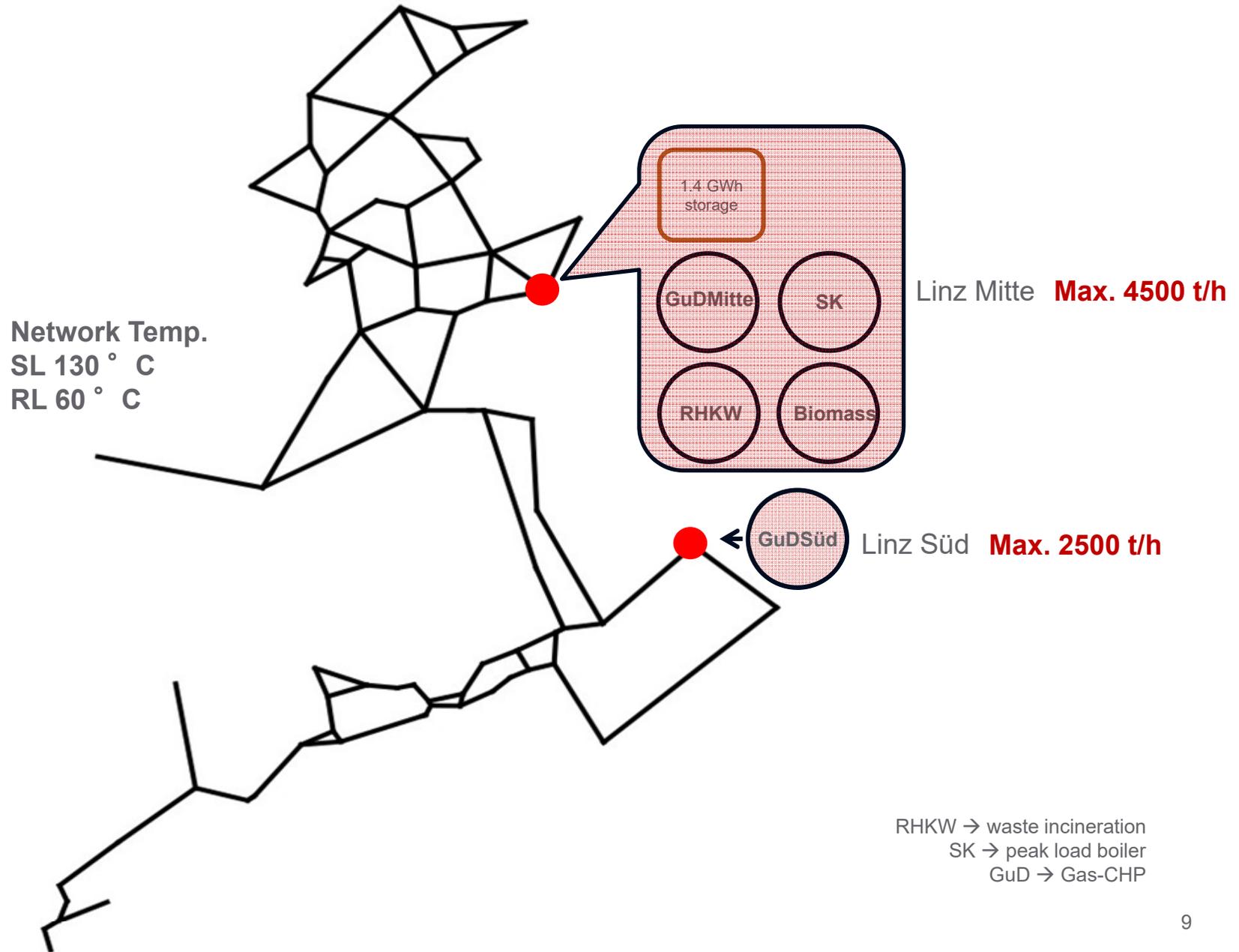
FUTURE DH SYSTEM LINZ

- **Objectives:** using untapped waste heat from industries despite current (renewable) overproduction during summer times
- Main focuses is on the **integration of a large heat storage**
- **Method and results:** simulation of the optimal technical integration, economic assessments
- **Partner:**
 - Energieinstitut an der Johannes Kepler Universität
 - Austrian Institute of Technology (AIT)
 - Linz AG

SIMULATION OF THE OPTIMAL TECHNICAL INTEGRATION

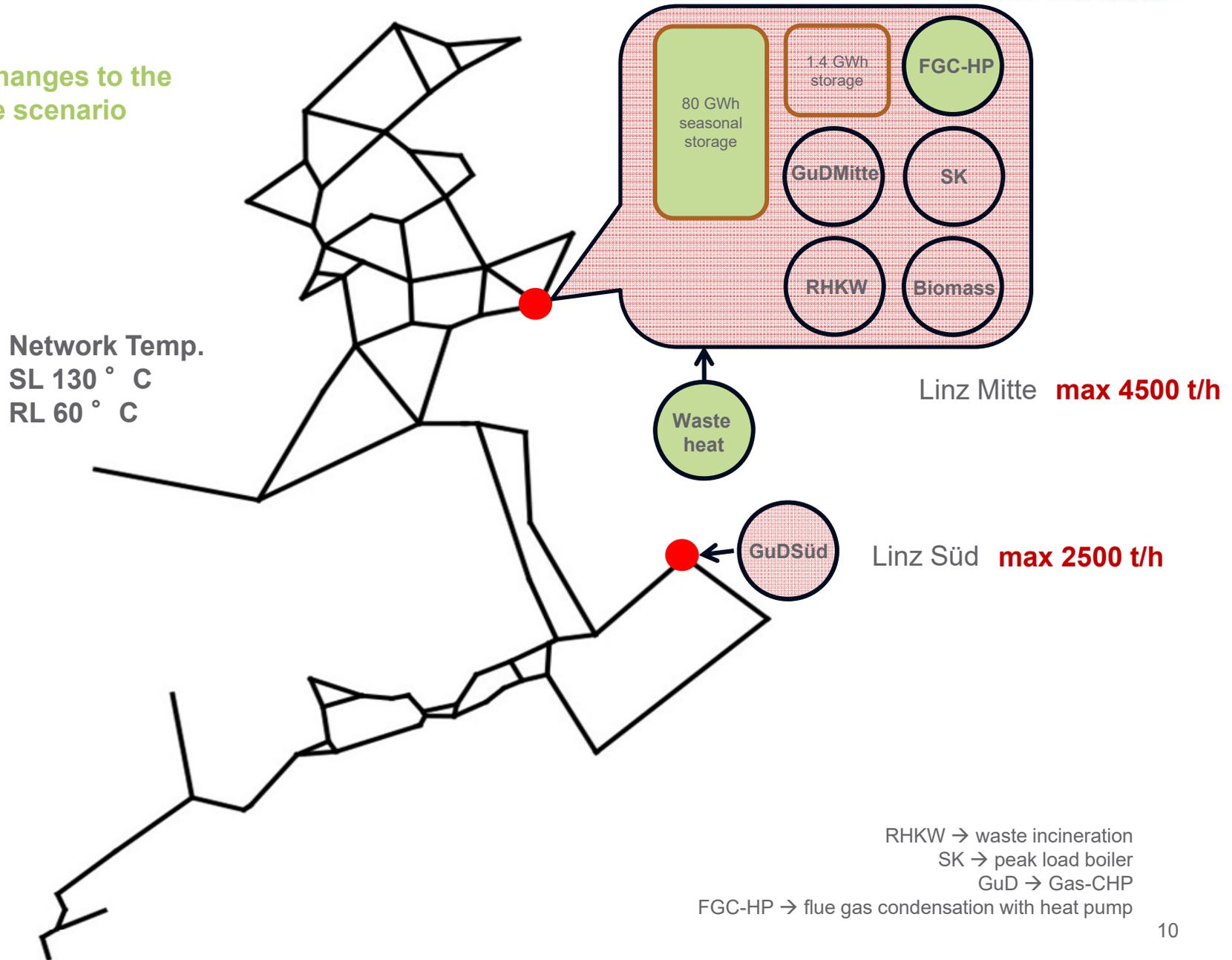
- **Aim:**
 - **feasibility study** using simulation based assessment of the **technical, energetic and ecologic performance** for the integration of waste heat with a seasonal storage
- **Method:**
 - Development of **scenarios**
 - Definition of **boundary conditions** (network restrictions, storage locations, characteristics of the existing power plants, current plant scheduling, energy prices ...)
 - Integration of the seasonal storage and **operational optimization** (considering the effect on the other supply units)

Reference scenario



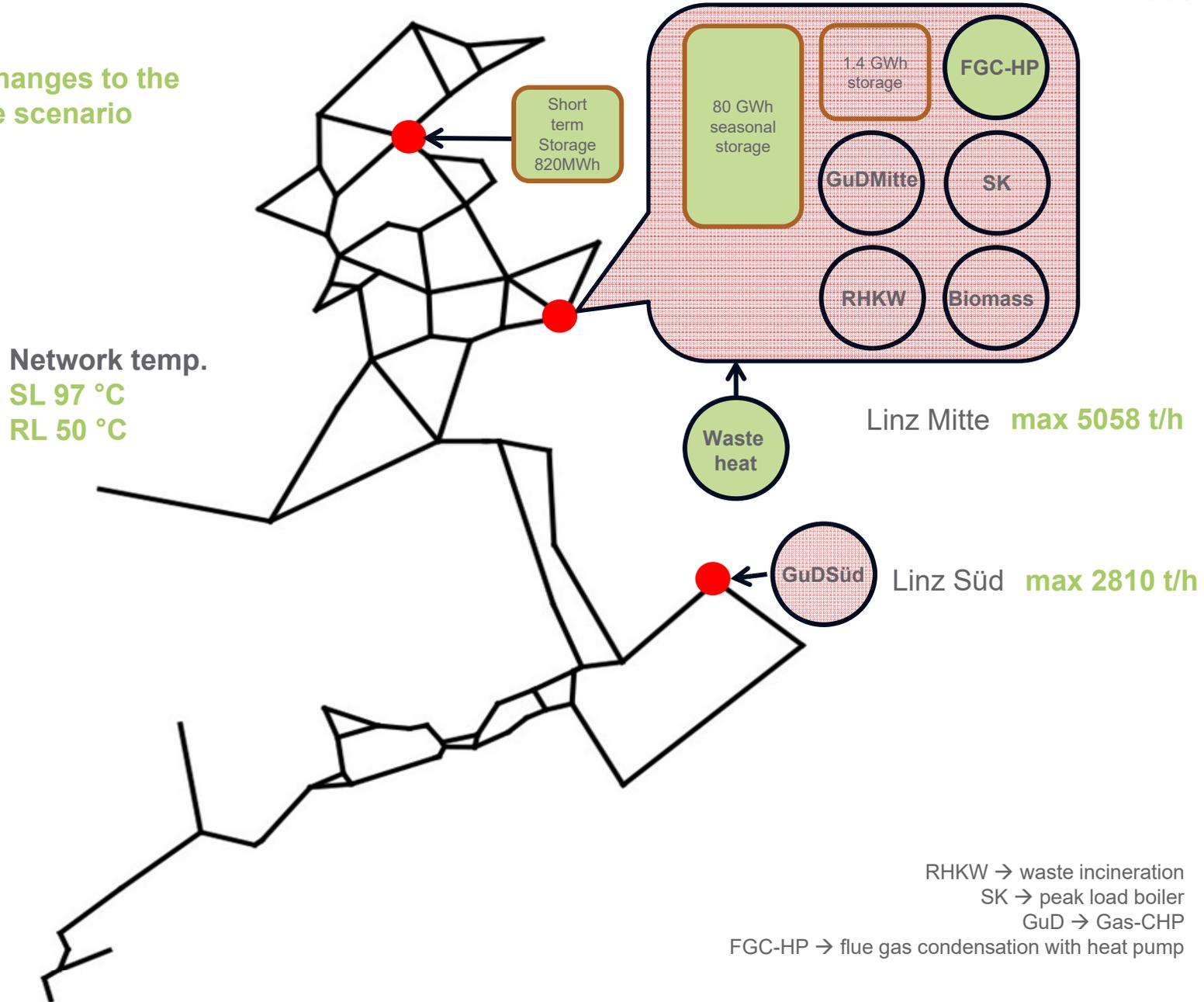
Scenario HT

Green: changes to the reference scenario



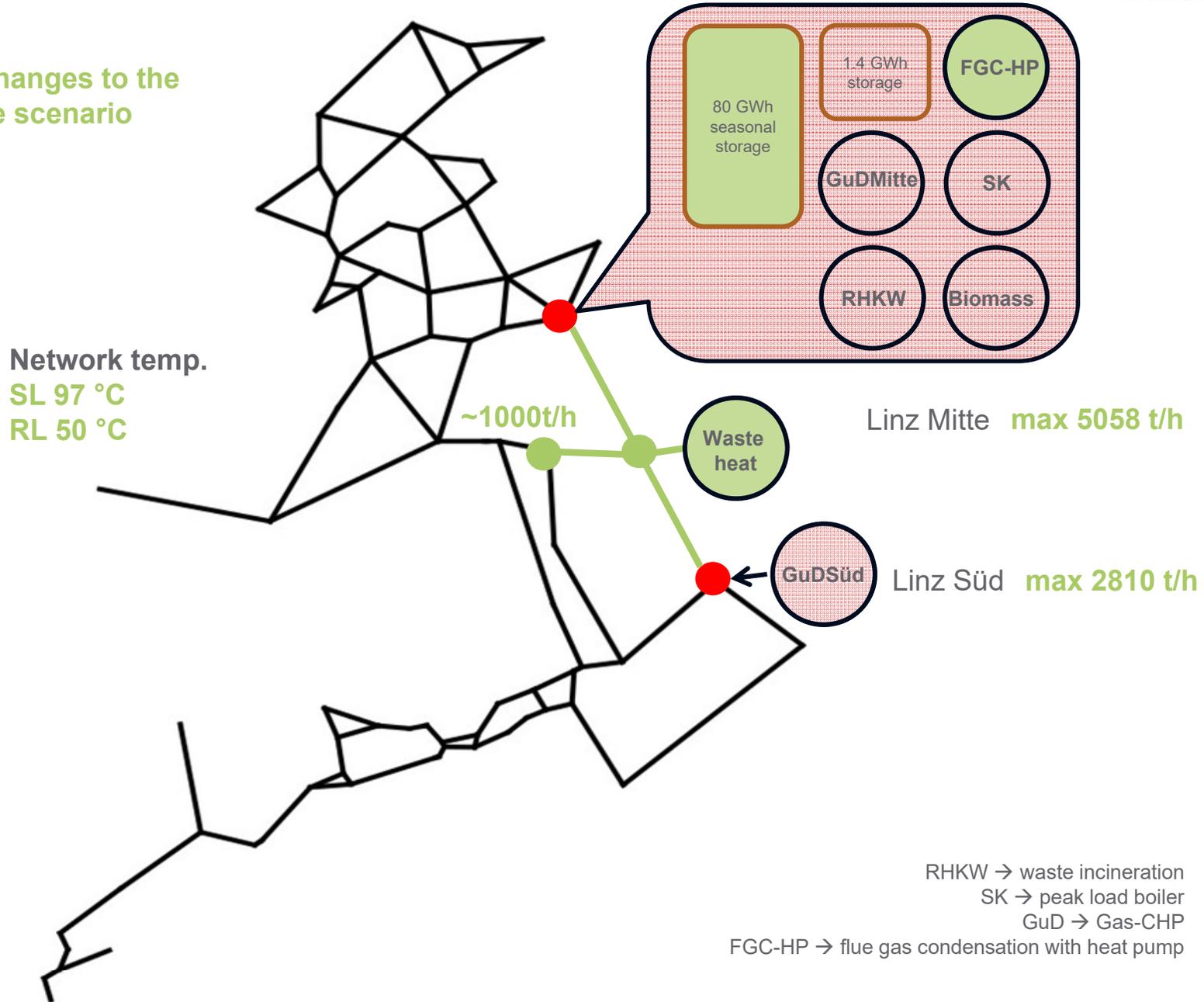
Scenario LT + short term storage

Green: changes to the reference scenario



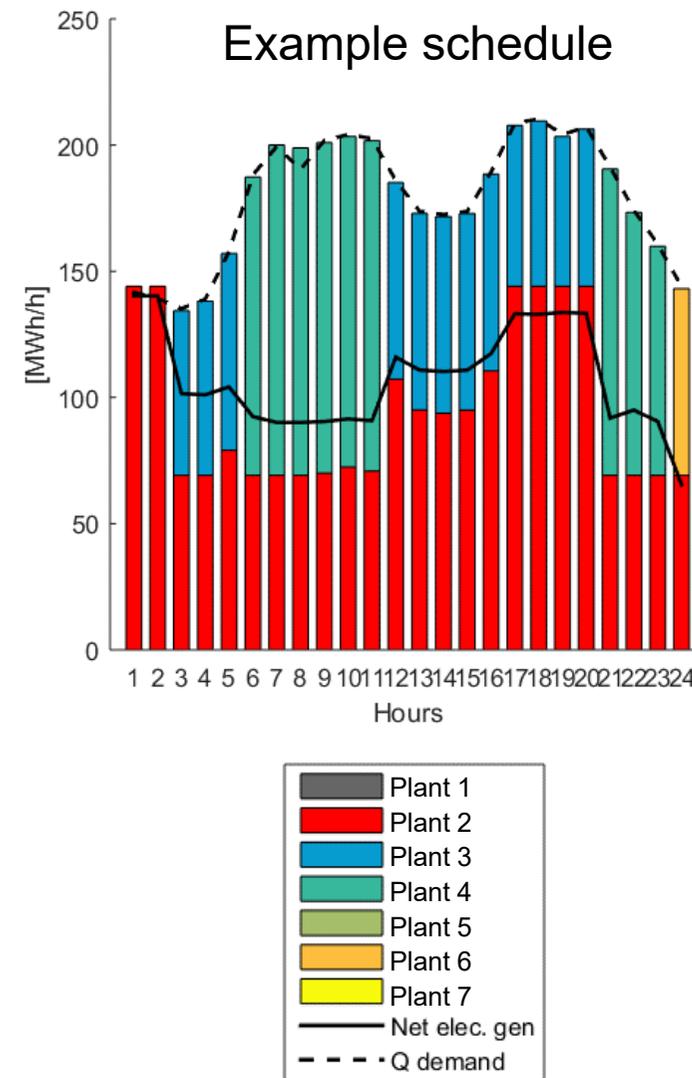
Scenario LT + grid enhancement

Green: changes to the reference scenario



OPERATIONAL OPTIMIZATION

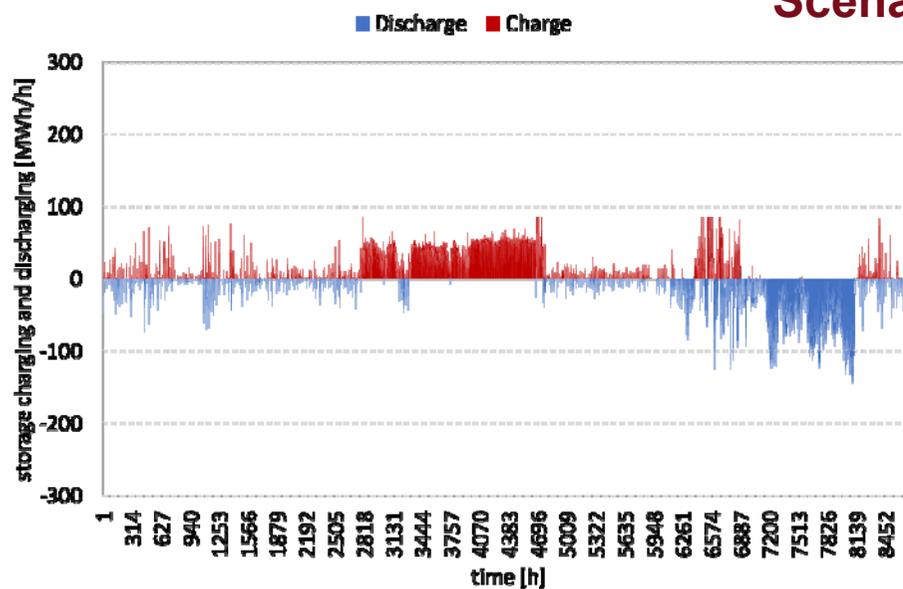
- Optimization of the scheduling of all supply units and storages on hourly basis (Mixed integer linear programming)
- Target function: minimization of OPEX for heat production
- Main boundary conditions: Heat demand, Electricity prices, Hydraulic limitations ...
- Simple operation of the seasonal storage
 - Charging mainly in summer times, discharging in the autumn
- Strategic operation of the seasonal storage:
 - short term charging/ discharging is possible
 - reduction of the fossil supply units GuDSüd and the peak load boiler



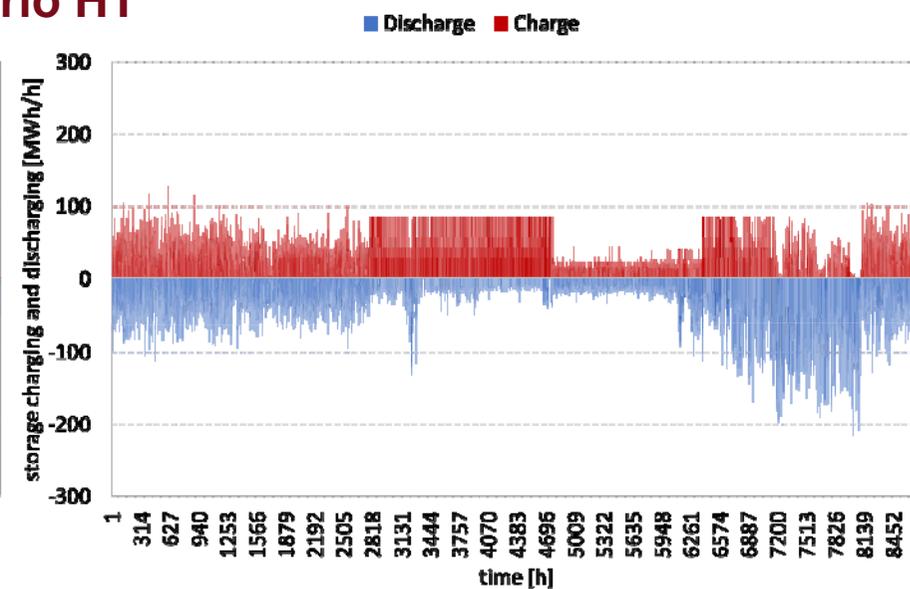
OPERATIONAL OPTIMIZATION

- Simple operation → Utilization of **1.8-fold** storage capacity (~143 GWh)
- Strategic operation → Utilization of **4.4-fold** storage capacity (~348 GWh)

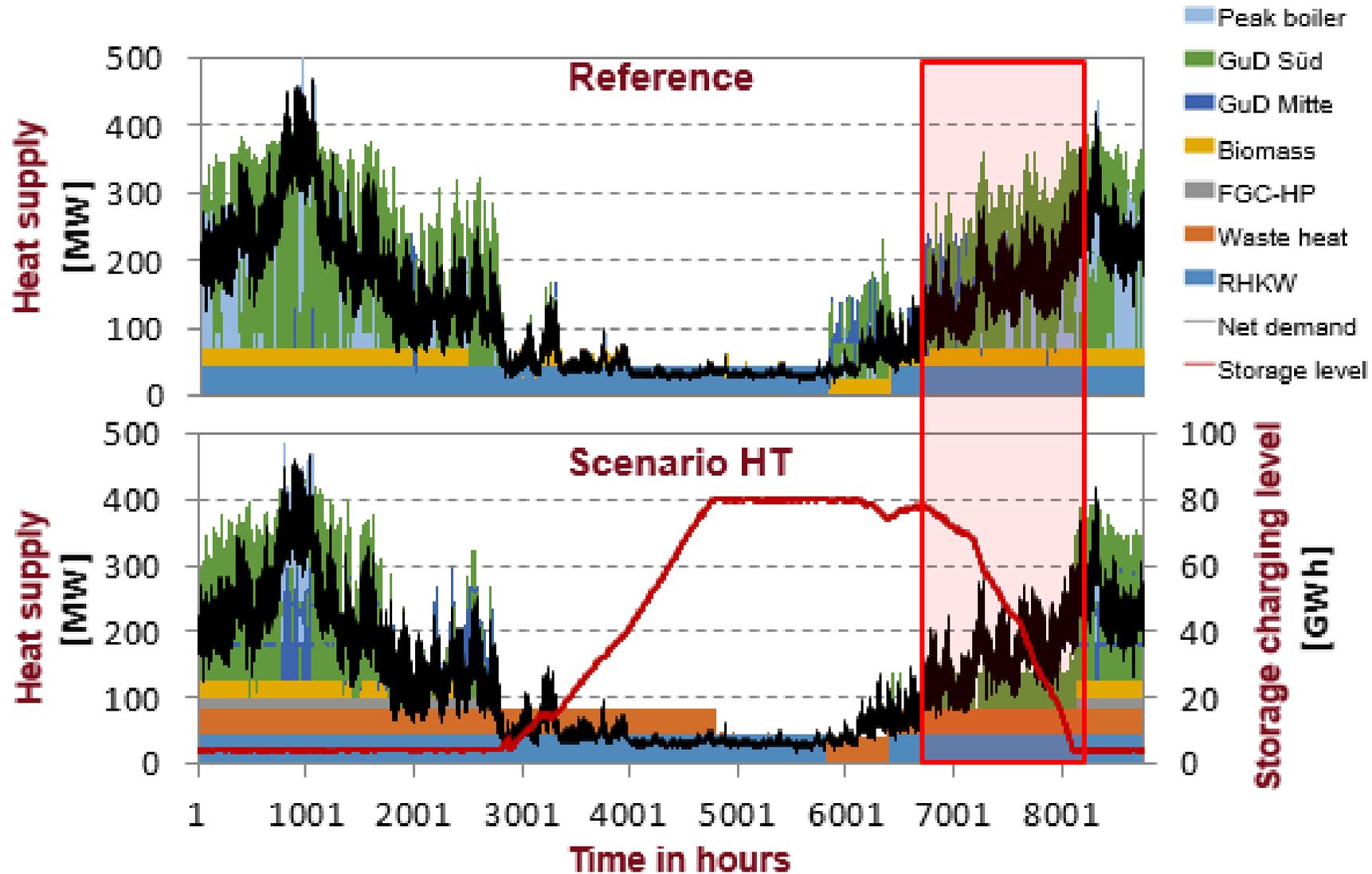
Simple operation



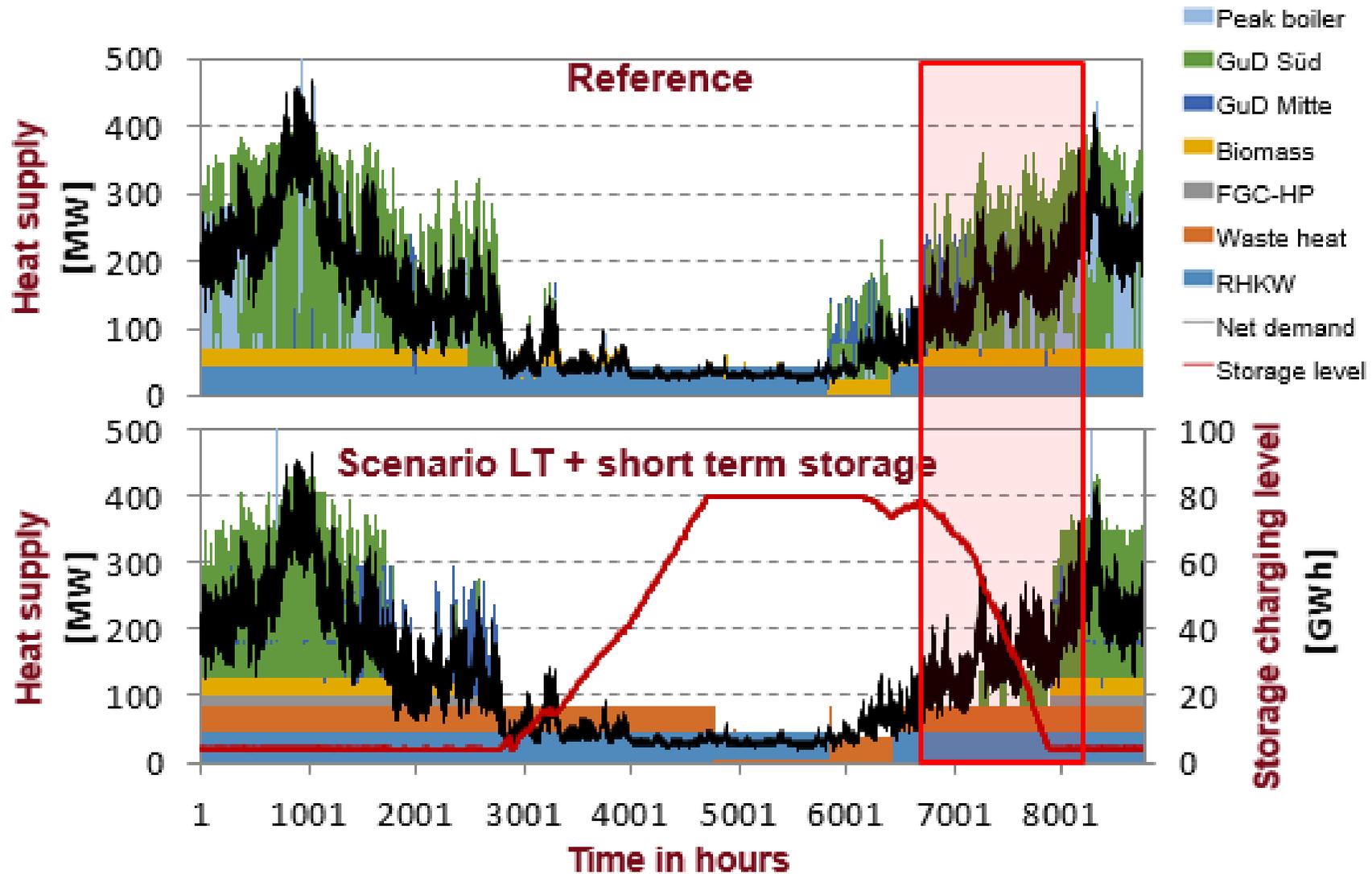
Strategic operation



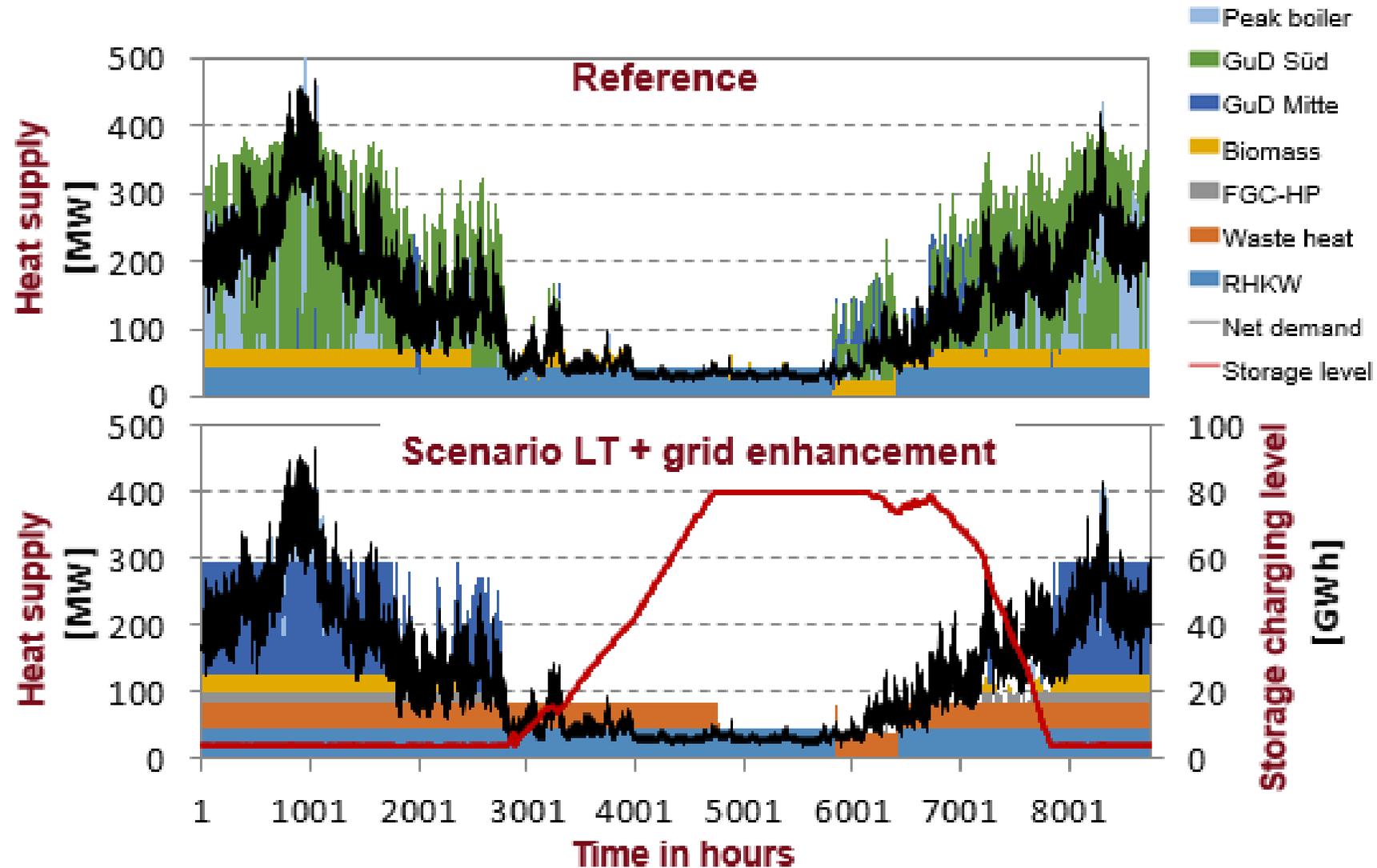
OPERATIONAL OPTIMIZATION



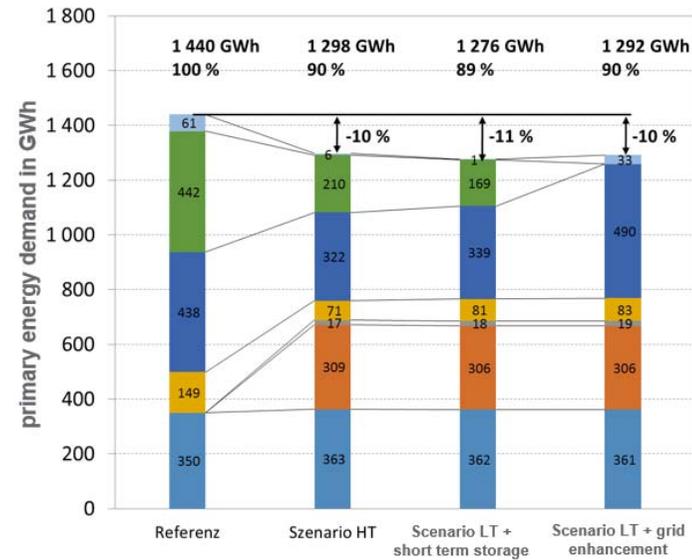
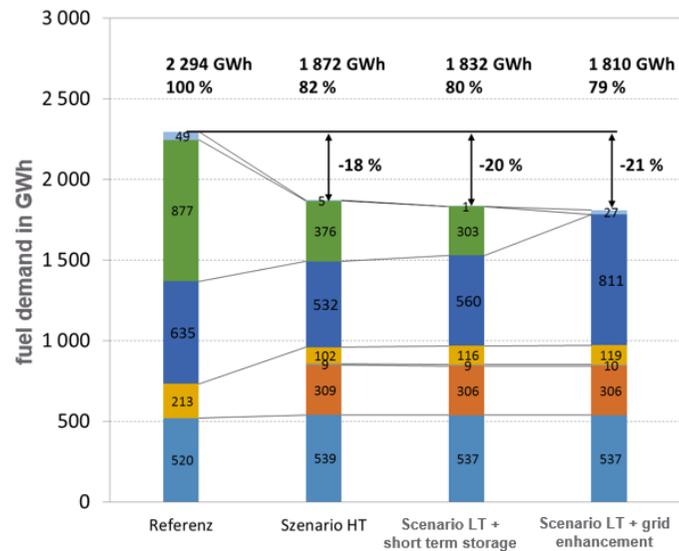
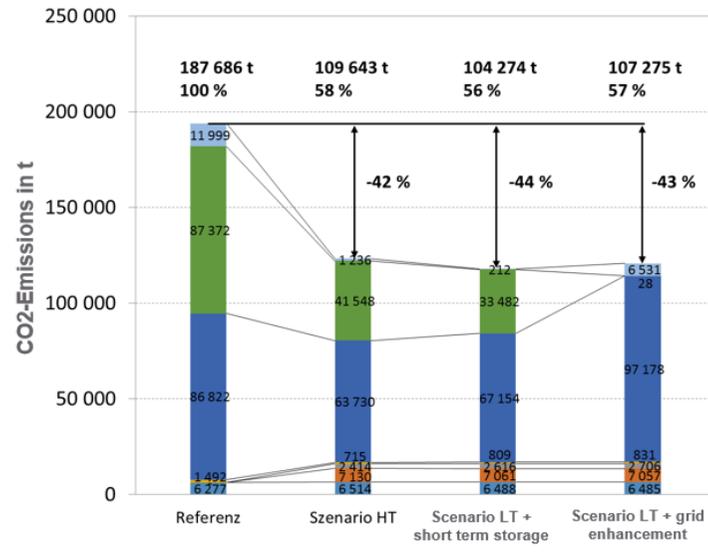
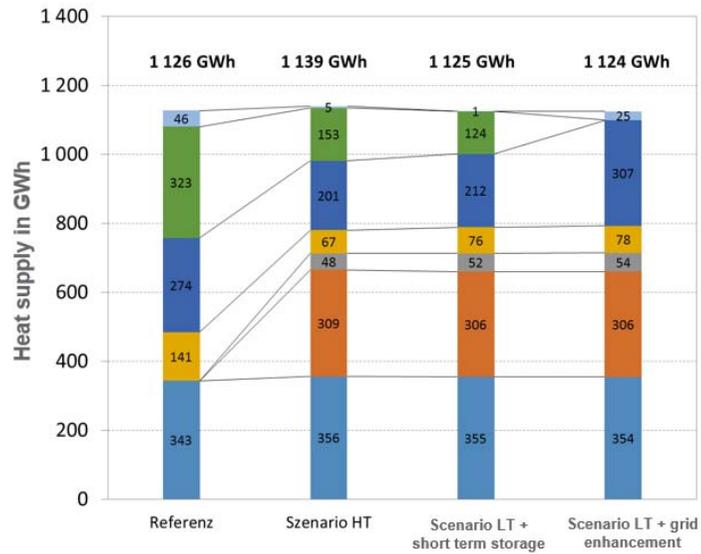
OPERATIONAL OPTIMIZATION



OPERATIONAL OPTIMIZATION



COMPARISON



- Peak boiler
- GuD Süd
- GuD Mitte
- Biomass
- FGC-HP
- Waste heat
- RHKW

ECONOMICS

- Total investment for **storage and land ownership ~106 Mio. €** without any funding
- For LT-scenarios additional costs for network and storage extension as well as cost for customer stations must be included
 - Only rough estimations possible at this time
 - → **LT-scenarios not feasible within the next decades**
- A **payback time** of HT-scenario depending on market development with strategic storage operation **~20 years** is possible
 - No payback in simple seasonal operation
 - Big uncertainties for costs and lifetime of materials
- **Further research must be done on**
 - Lifetime of materials
 - Detailed costs and concepts for lining and construction

SUMMARY

- industrial waste heat cannot be used in summer due to **must-run condition of the waste incineration**
- More than $\frac{1}{4}$ **of the energy can be supplied by waste heat** incl. large storage
- **simple charging strategy 1,8-fold** storage capacity can be used
- **strategic charging strategy 4,4-fold** storage capacity can be used
- **Payback of ~20 years** possible but with big uncertainties

THANK YOU!

Markus Köfinger

T +43(0) 50550-6248 | M +43(0) 664 235 19 43

Markus.Koefinger@ait.ac.at | <http://www.ait.ac.at>

