Grosskraftwerk Mannheim AG

GKM – Operating a coal fired CHP-power plant in an urban area

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Flexibility-Workshop / VGB Power Tech - IGEF-Study-Tour

September 19, 2016 in Berlin

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Mit Energie überzeugen

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3. New GKM heat storage system / optimization of CHP Process
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GKM history: the beginnings

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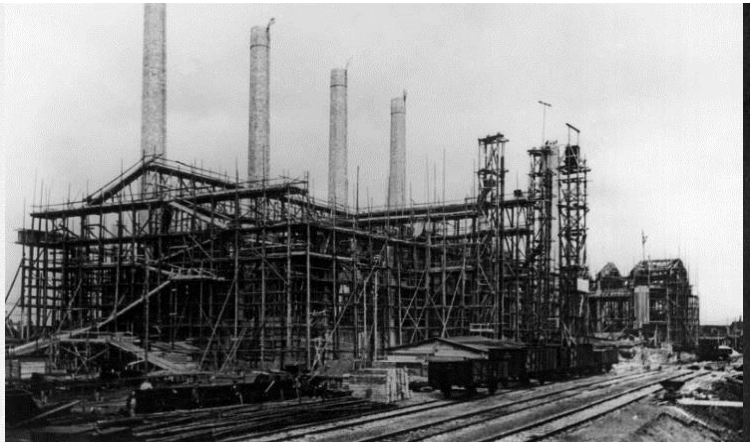

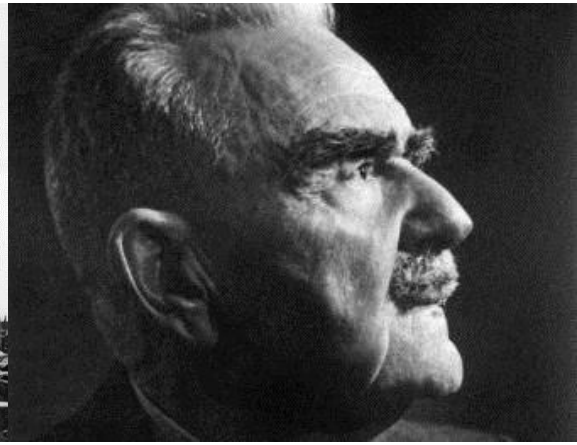

1921

GKM is founded on 8th of November

Start of construction work at a good location: close to town of Mannheim and directly sited at river Rhine; start of electricity generation in 1923

Mastermind: Dr. Karl Friedrich Marguerre, Executive Direktor

GKM – founded 1921 … new unit 9 in erection …

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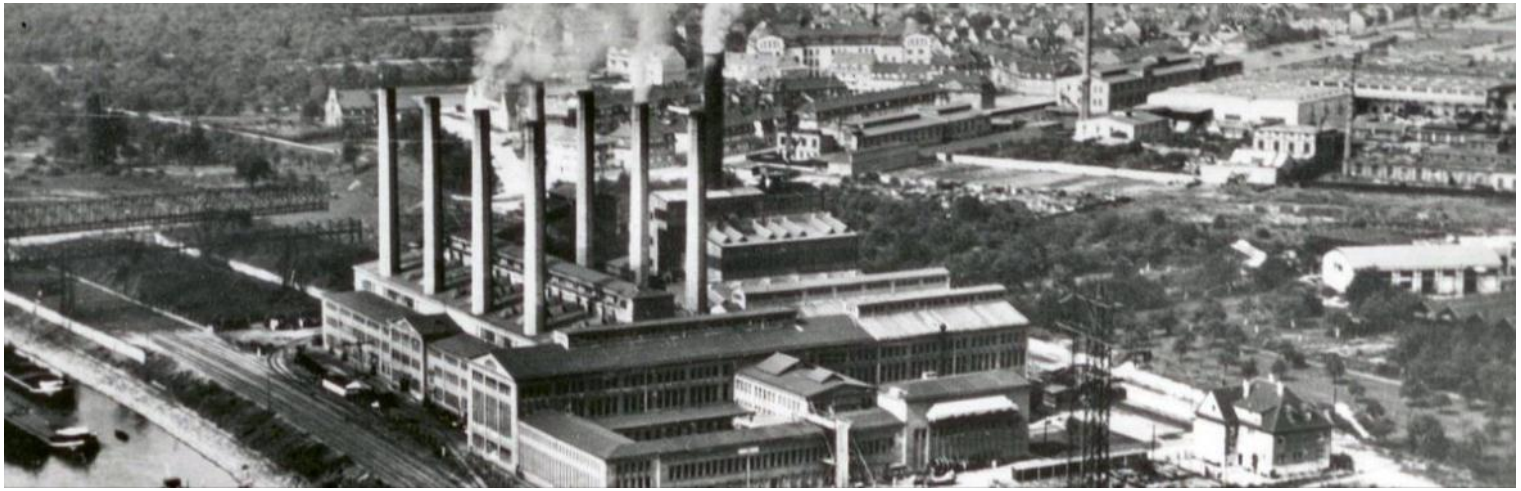

GKM plant today

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CHP process (combined heat and power) in GKM

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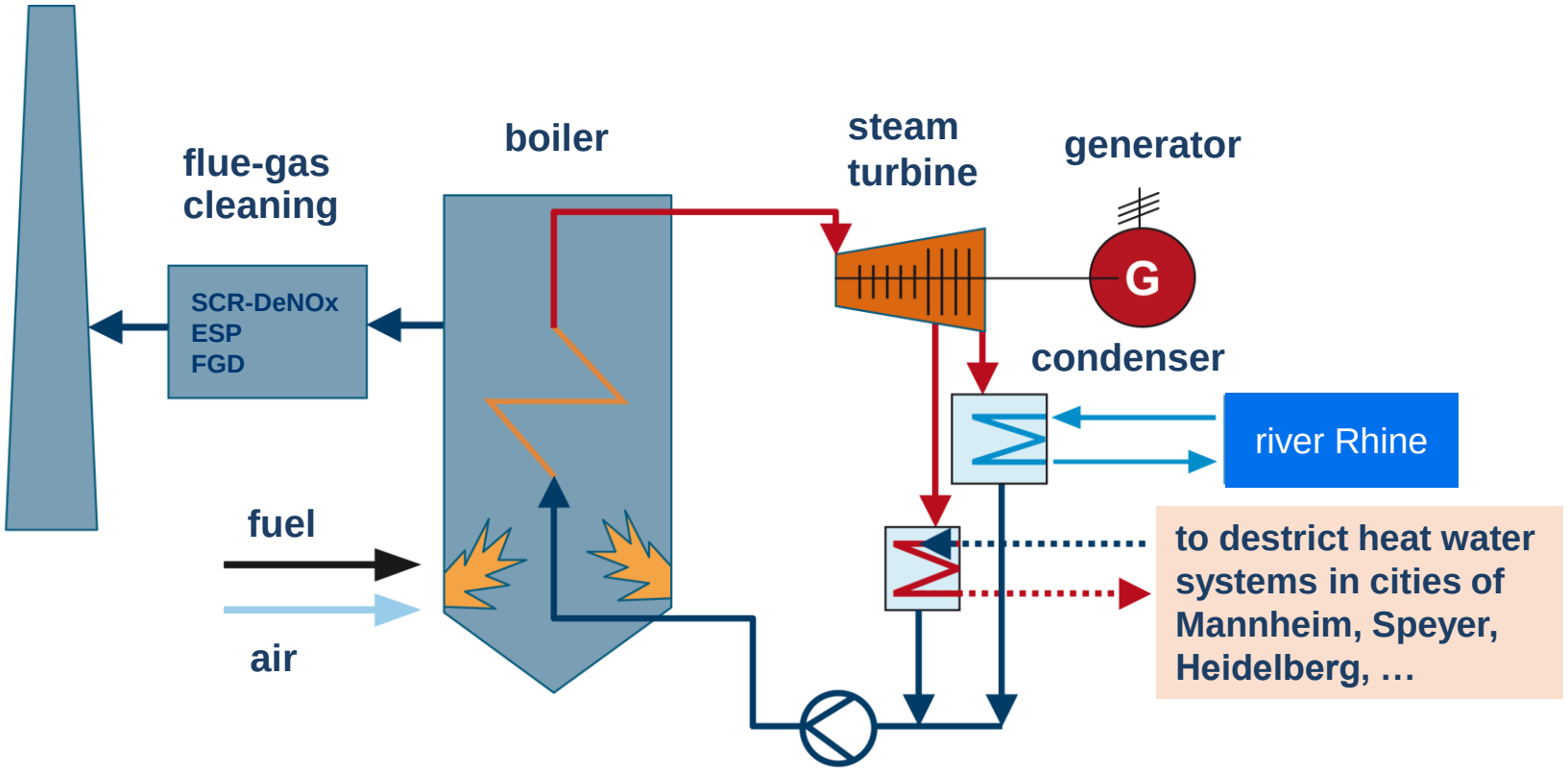

GKM power generation (electricity)

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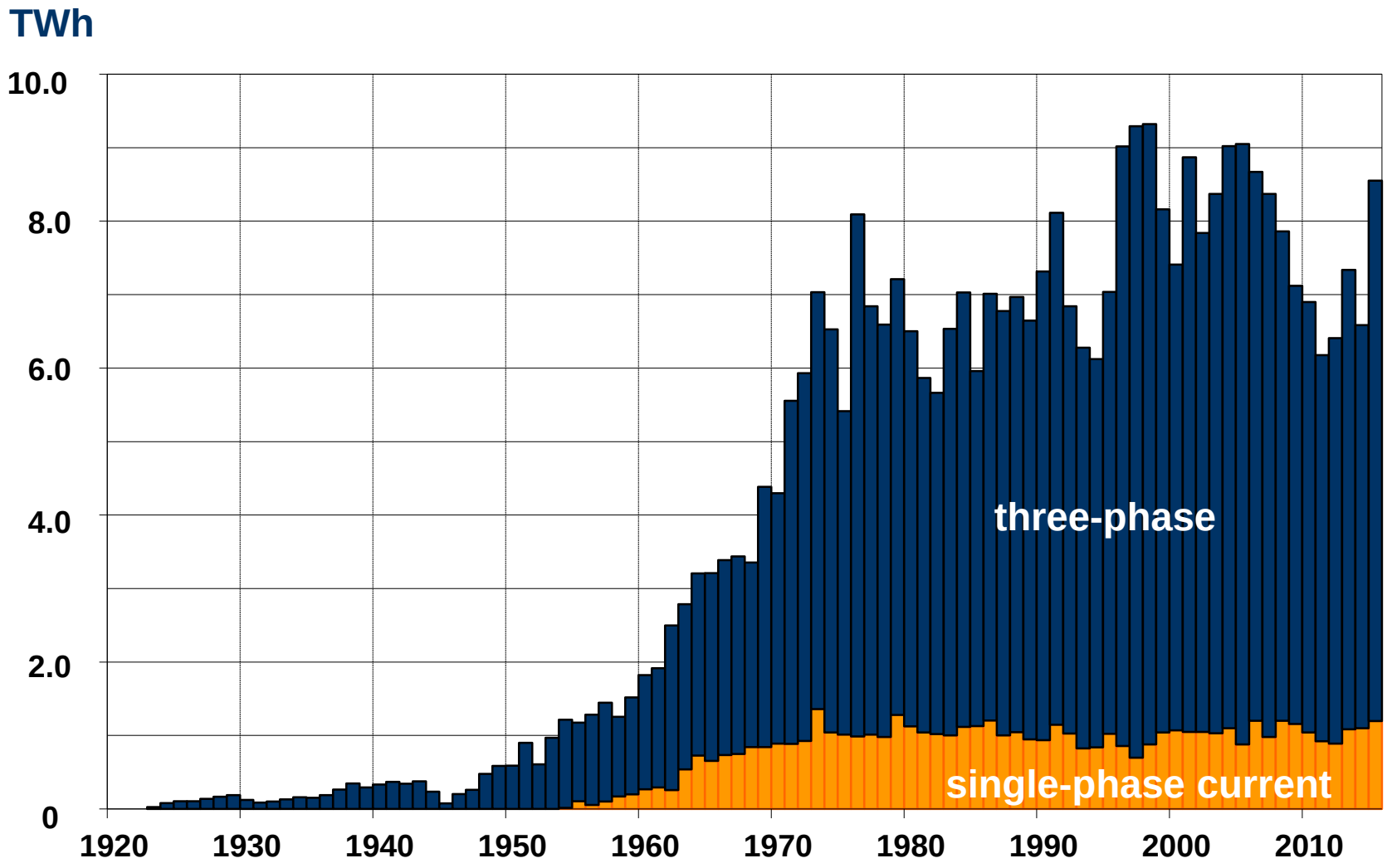

GKM district heat generation

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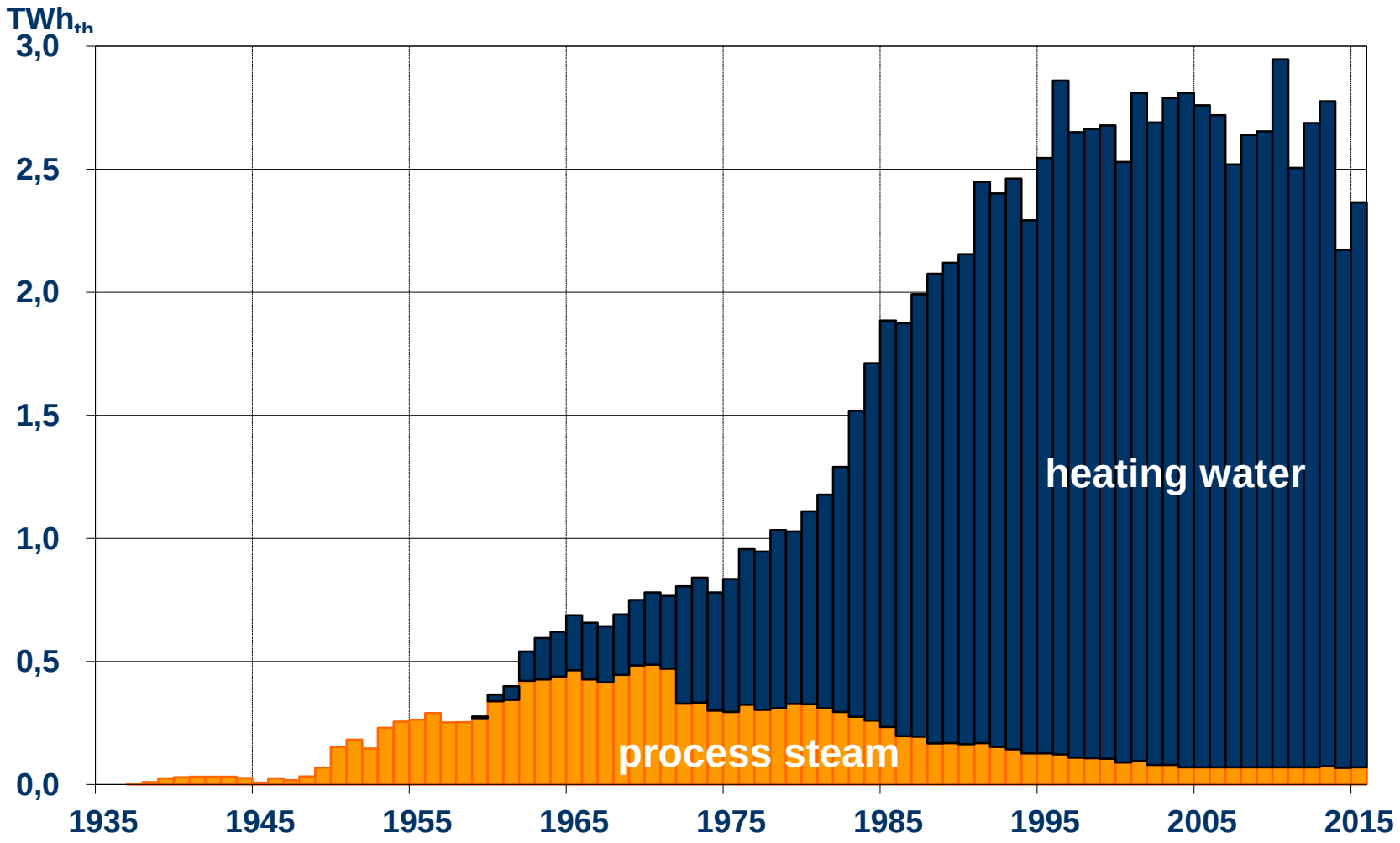

efficient generation of electricity and district heat

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energy for share holders and German Railway: reliable, cost-effective and friendly to environment

50 Hz three-phase alternating current
(share holders of GKM AG)

RWE Generation SE **(40 %)**
EnBW AG **(32 %)**
MVV RHE GmbH **(28 %)**

16.7 Hz single-phase alternating current

DB Energie GmbH
(German Railway)

District heat

MVV RHE GmbH
Mannheim

GKM plant in 2016

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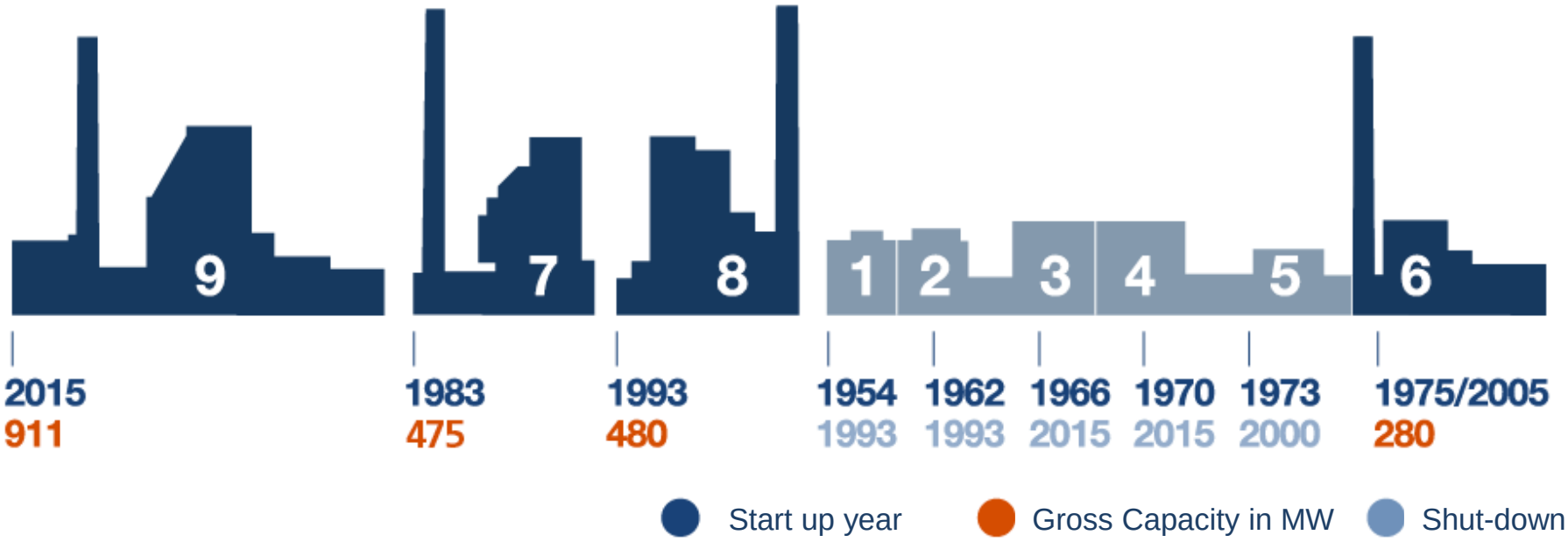
GKM plant: Installed capacity: 2.146 MW_{el} (units 6,7,8,9)



GKM plant overview

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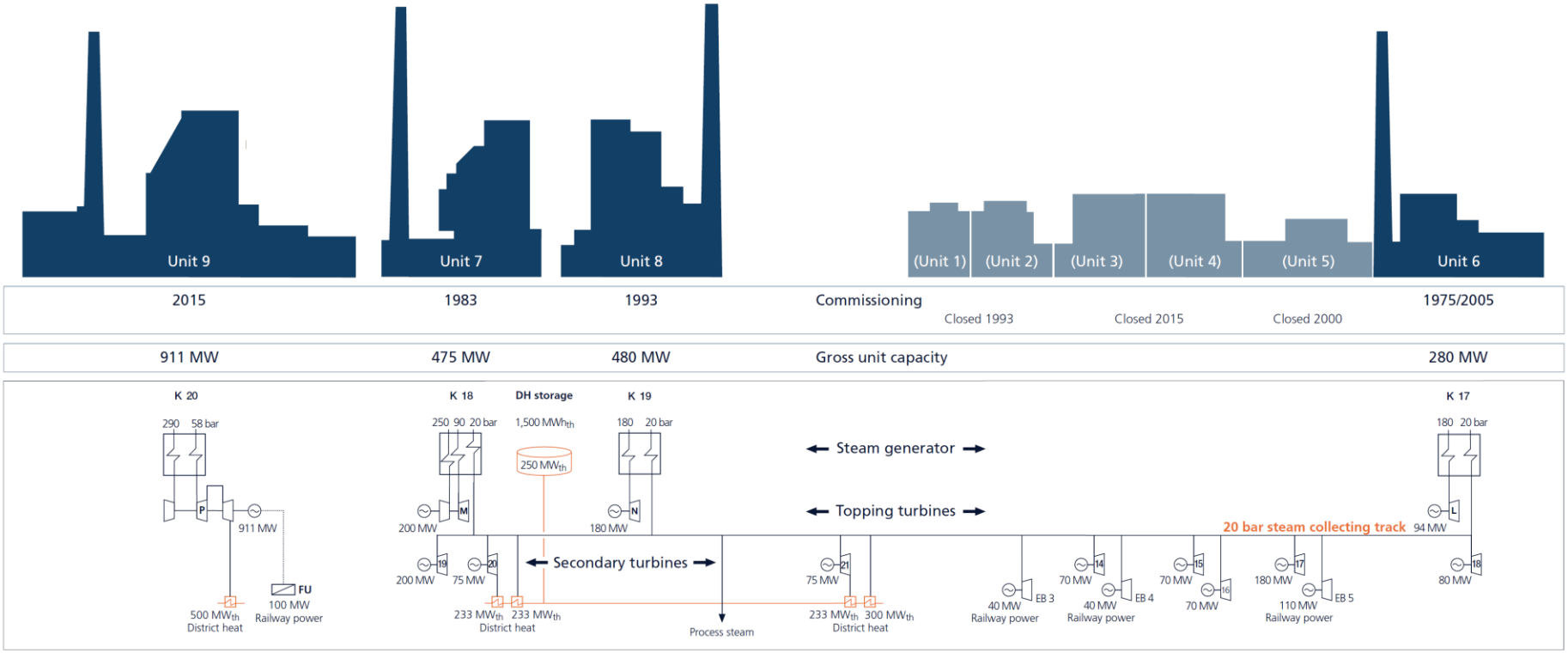

flow sheet of GKM unit 6 (CHP)

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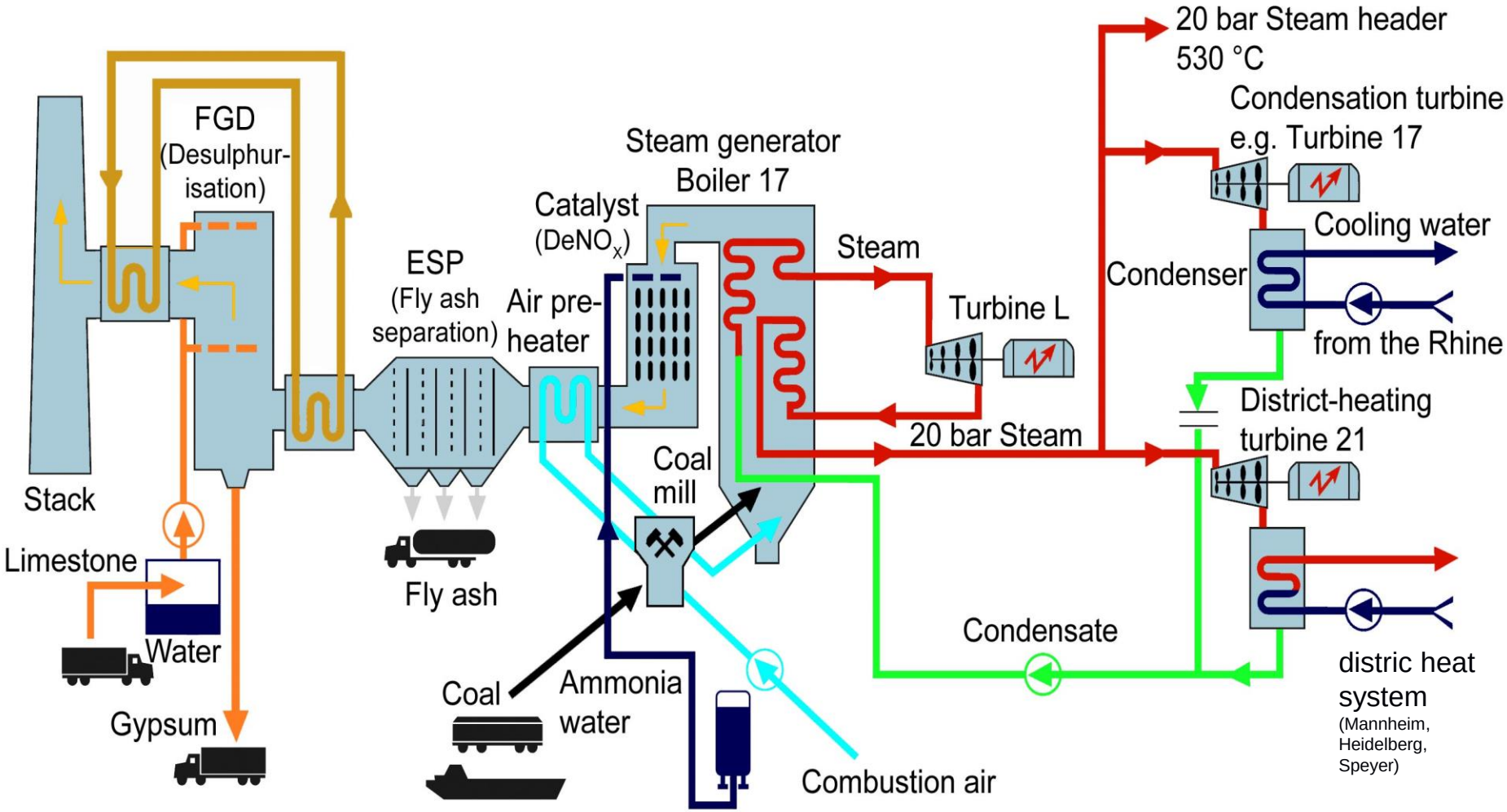

new unit 9

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unit 9 – flow sheet

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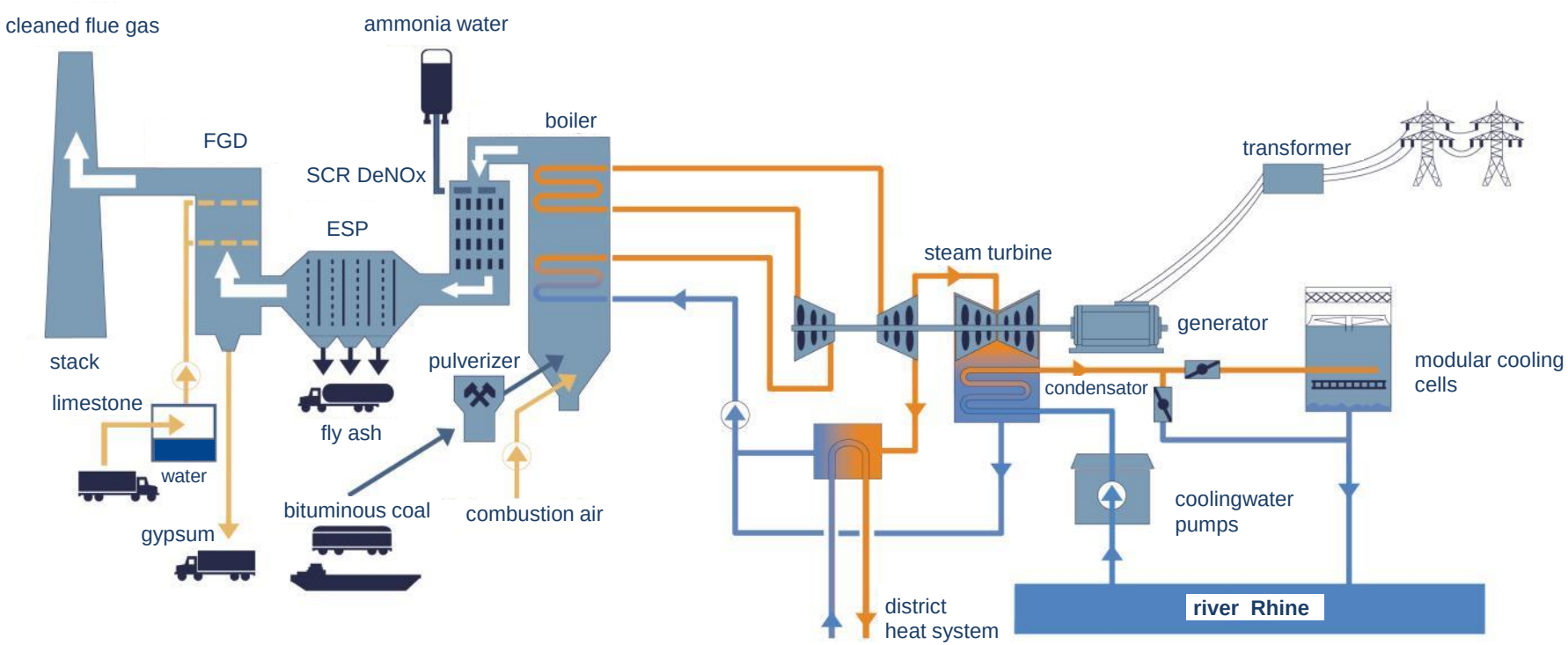
combined heat and power unit 9 (CHP)



unit 9

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facts and figures

Commissioning/start of commercial operation	1st May 2015
Investment volume	1.2 bil. €
Gross output	911 MW_{el}
Electrical net efficiency	46.4 %
District heat generation with CHP	max. 500 MW_{th}
Fuel utilization for CHP	max. 70 %
Railway electricity (16.7 Hz) (per transverter)	100 MW

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electricity generation / actual situation in Germany
(example)

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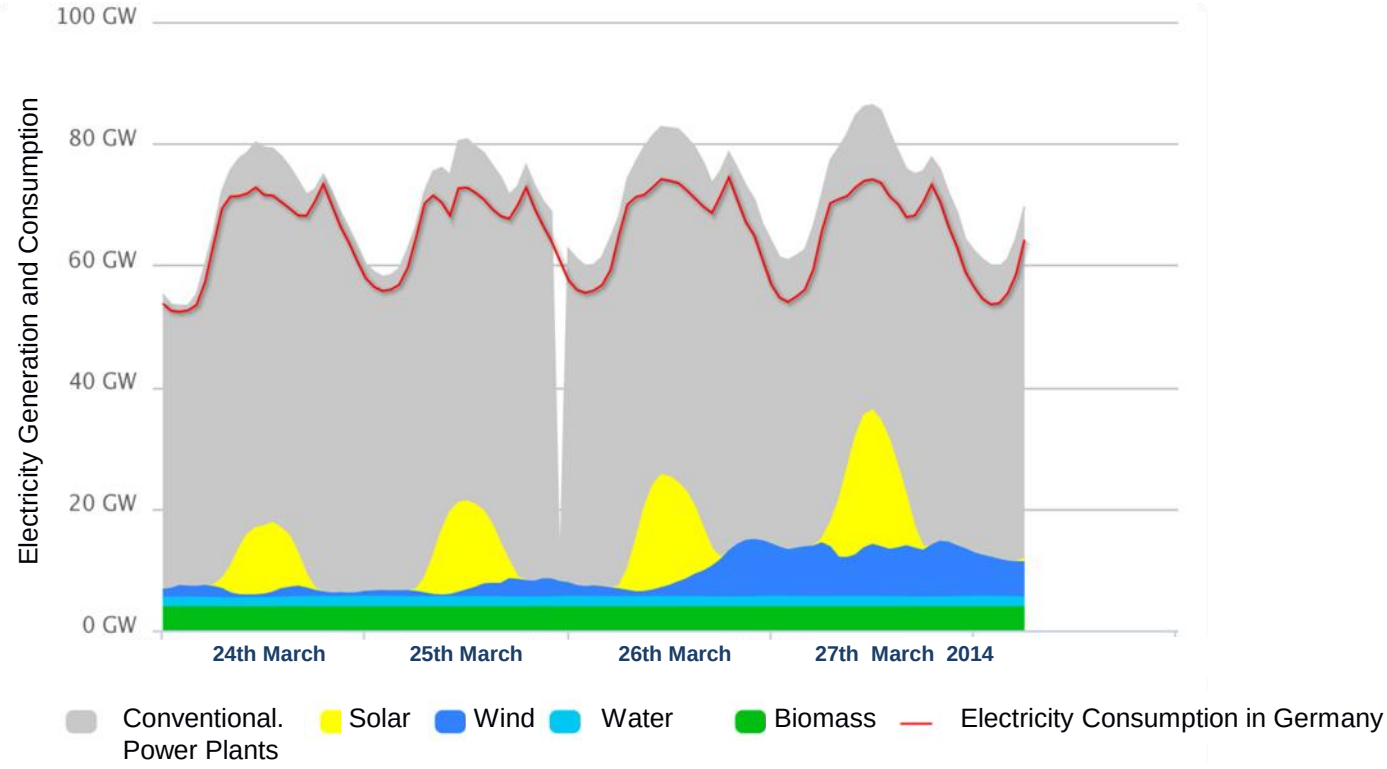

remarkable export of electricity from Germany to neighbour countries during high generation of solar and wind power

GKM / daily operation situation 2007 vs. today

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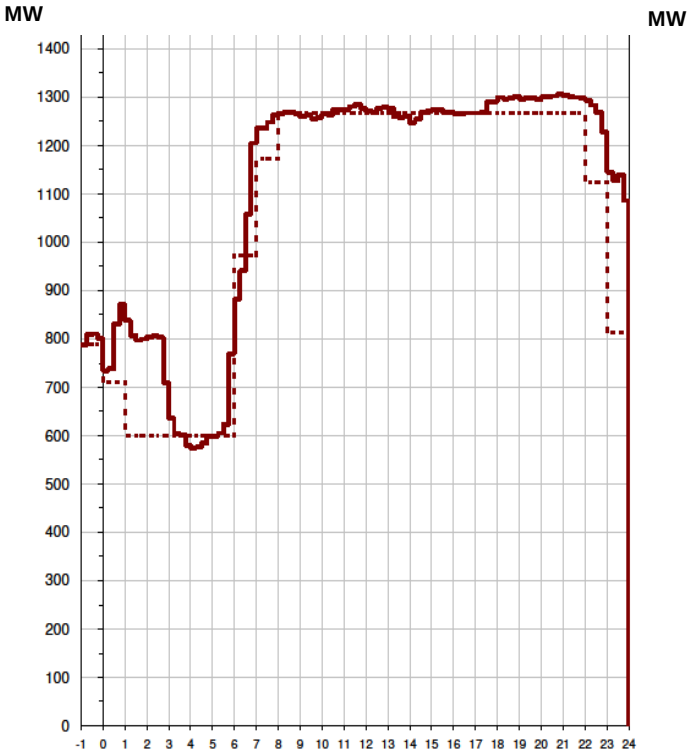
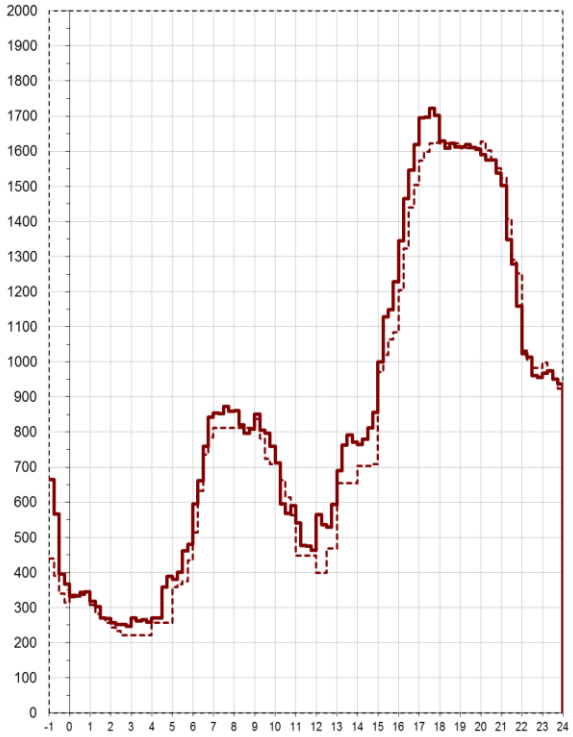
GKM Operation in 2007 and today (planned and real output)

Wednesday, March 21, 2007



Monday, March 16, 2015



real output **planned output** („day ahead“)

today‘s requirements in electricity market mean high demands on equipment and personell in GKM: high flexibility in load changes and timing

GKM / unit 8 load diagram (example)

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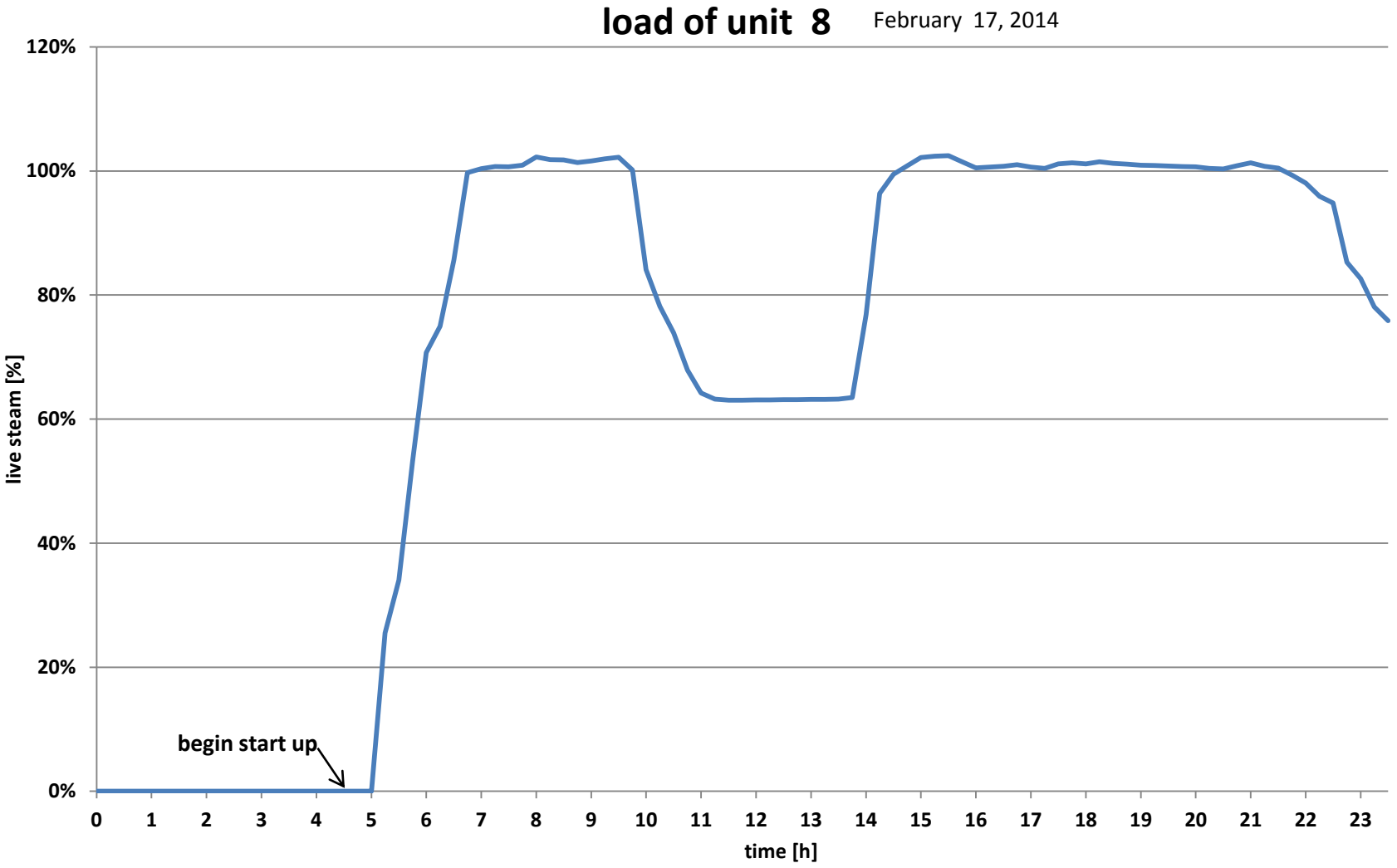

GKM / start up diagrams of unit 8

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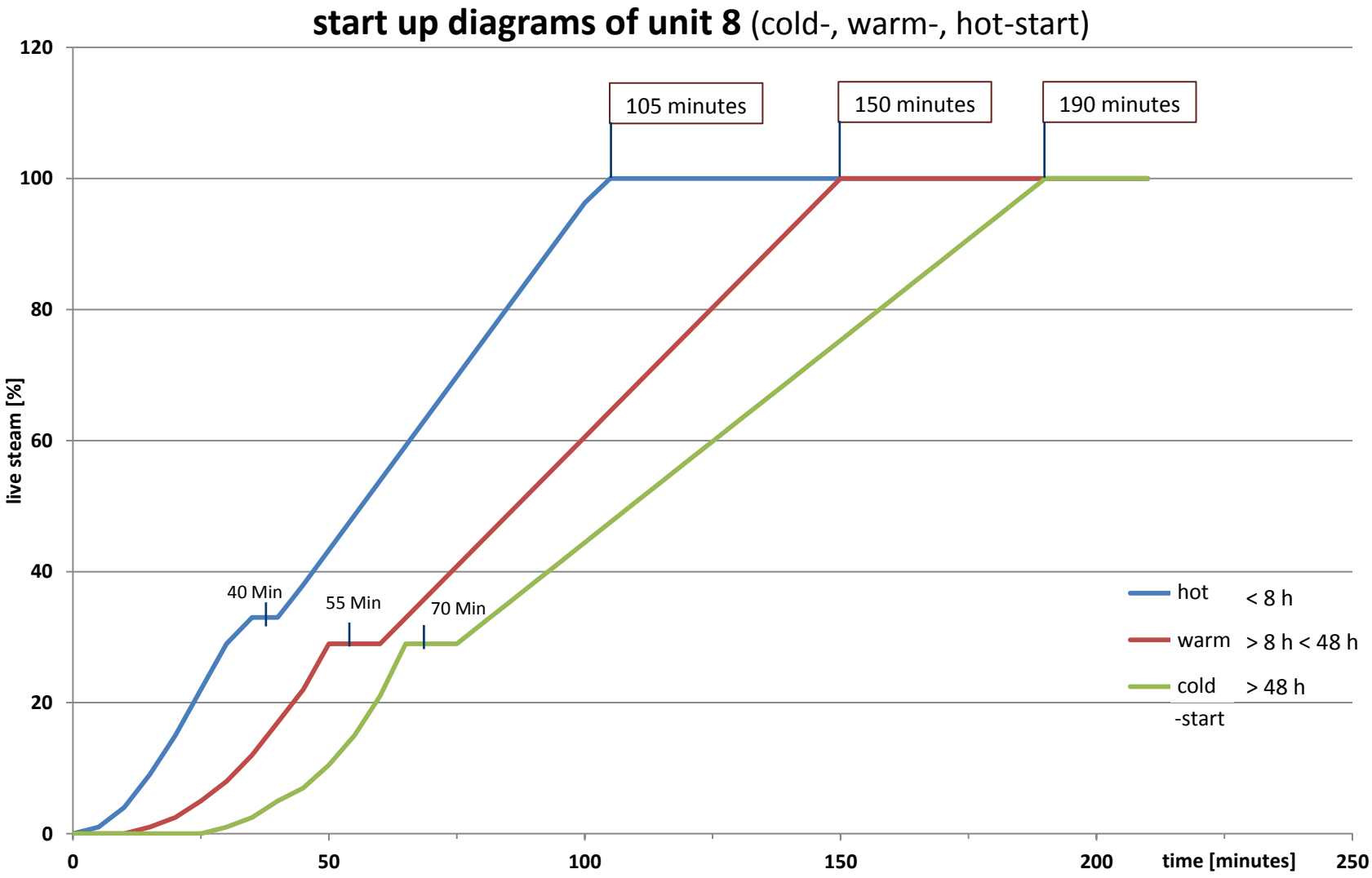

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Mannheim district heat system / GKM CHP Plant

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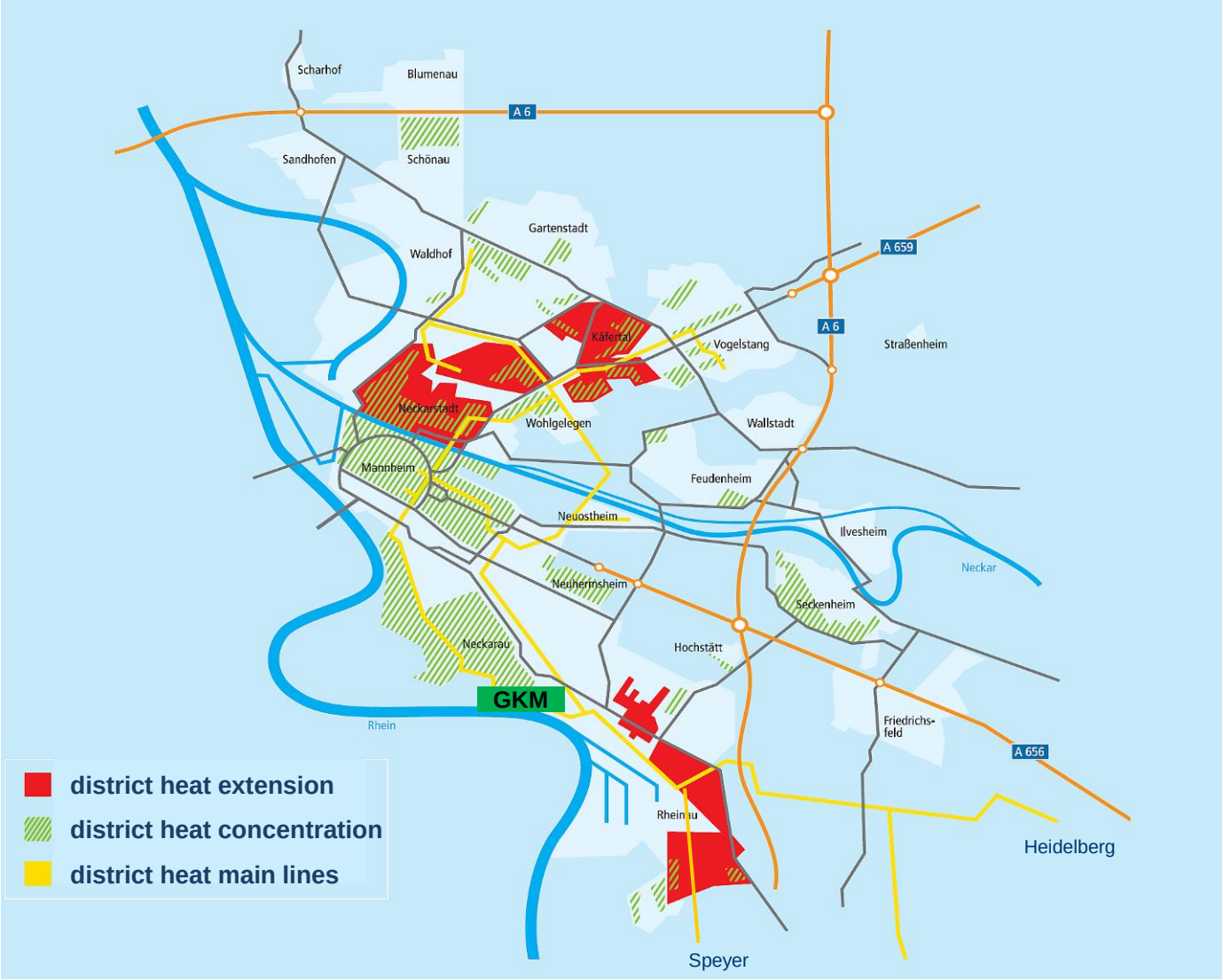

GKM Plant / district heat system until 2013

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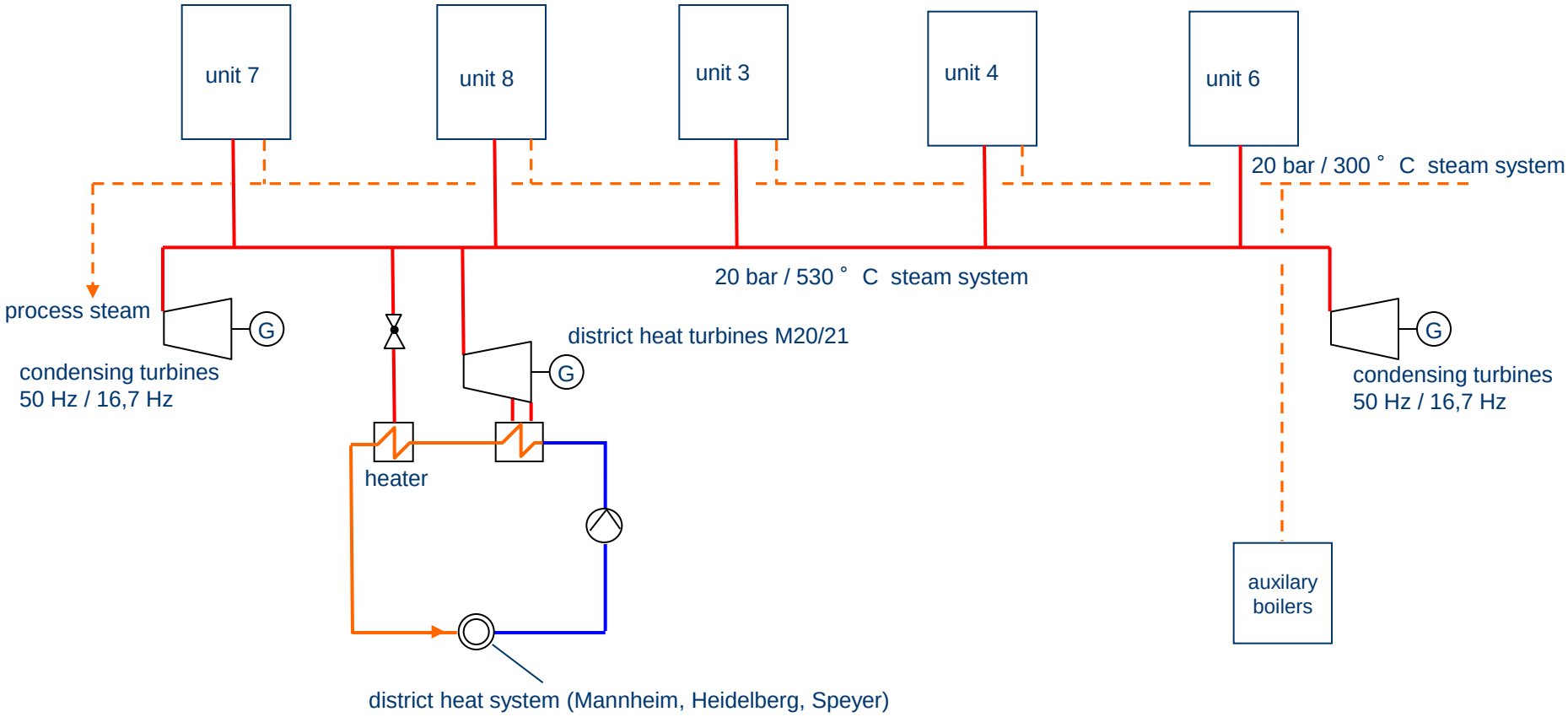
GKM „2-units-operation“ necessary at minimum load because of need for secure supply of district heat system (until end of 2013)



CHP plants in Germany / need for energy storage

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In energy supply systems for heat and power energy storage sytems help to bring **energy consumption and energy generation into balance**

Actual need for higher and more energy storage capacities in Germany:

- increasing capacities of „renewables“ (esp. solar (PV) and wind) for power (electricity) and heat supply
- combined heat and power plants (CHP) „struggle with economics“: low EEX-prices for electricity and „must run production of electricity“ because of need to produce heat continuously

energy storage systems / thermal storage

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Thermal energy storage: heat storage: worldwide use of different types in large scale

- different substances (e.g. water, salts, sand, concrete, aquifer, …)
- different temperature / pressure
- different technical types / functions
- integrated in different systems e.g. power plants; CHP; district heat systems; local heat systems, industrial systems, …
- activities in research and developement: to develop systems with higher capacities (MWh, MW) and improvement of the technical systems
- focus: better integration of renewables in existing energy supply systems **(heat and power)**

heat storage systems / overview

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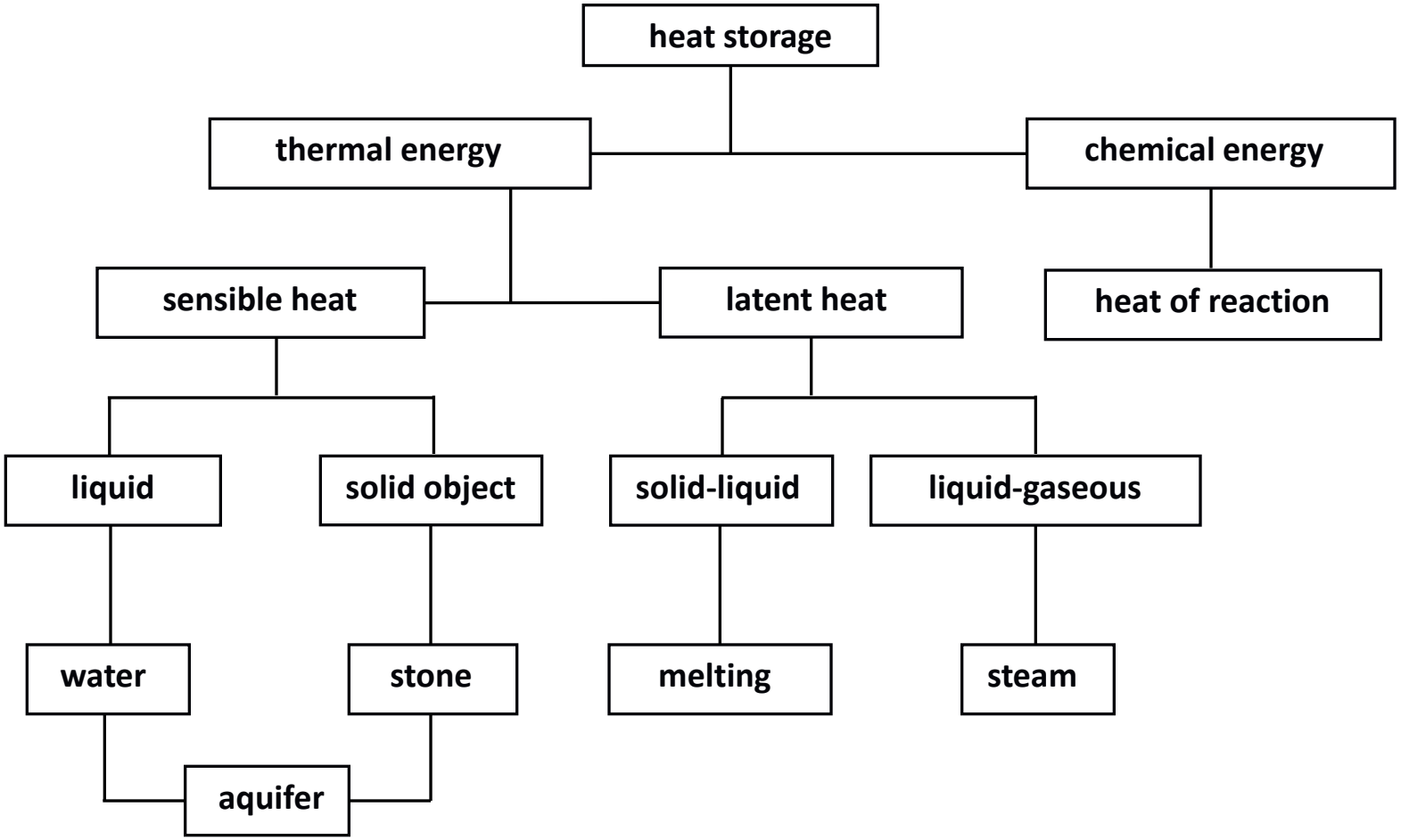

thermal storage systems / water not pressurized

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Water energy storage systems / not pressurized: worldwide use since long time in power plants, industry, and heating systems

- simple constructions / different types / easy to integrate in power plants
- storage system type „Dr. Hedbäck“ >80 tanks worldwide, most in Europe and South Korea
- water system (well known)
- positive long time experiences
- limited temperature level (<100 ° C), atmospheric pressure, high volumes (up to 50,000m^3 per tank) and capacities (up to 300 MW, up to 1500 MWh)
- reasonable investment costs (depending on system integration demand)

heat storage systems / conclusions

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- thermal energy storage (heat): worldwide use of different types in large scale
- water is most common storage substance (easy to handle, cheap, not corrosive, high heat capacity, friendly to environment, …)
- research and developement for other storage substances (e.g. salts, sand, concrete, aquifer, metals, …) and process optimization ongoing
- better integration of renewables and other sources (e.g. waste heat) in existing energy supply systems (heat and power) needed
- focus: energy storage systems with high capacities (MW, MWh), high load flexibility and gradients
- **actual: difficult commercial conditions for large storage systems and installations**

task / functions of new GKM heat storage system

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Load demands on CHP Plant GKM

- 50 Hz Electricity Generation for RWE, EnBW, MVV
- 16,7 Hz Electricity Generation for DB Energie
- Distric Heat Generation and **secure supply** of Mannheim, Heidelberg and Speyer

Situation at German Eletricity Market

- GKM Plant Load corresponding to EEX Prices (Spot-Market „day-ahead and intraday“): volatile and often not fitting to district heat energy consumption

Functions of new heat storage system in GKM

- in times of low EEX Prices the GKM Electricity Generation must be as low as possible (minimum technical load)
- the new heat storage tank enables GKM to operate **only 1 unit** during minimum load (**instead of 2 units before**)
- during minimum load the heat content in the tank is sufficient to supply the district heat nets at least for 2 hours
- additionally the heat storage tank is used to optimize the plant operation depending on EEX Prices (e.g. **charging at night, discharging by day**)

GKM Plant / district heat system since 2015

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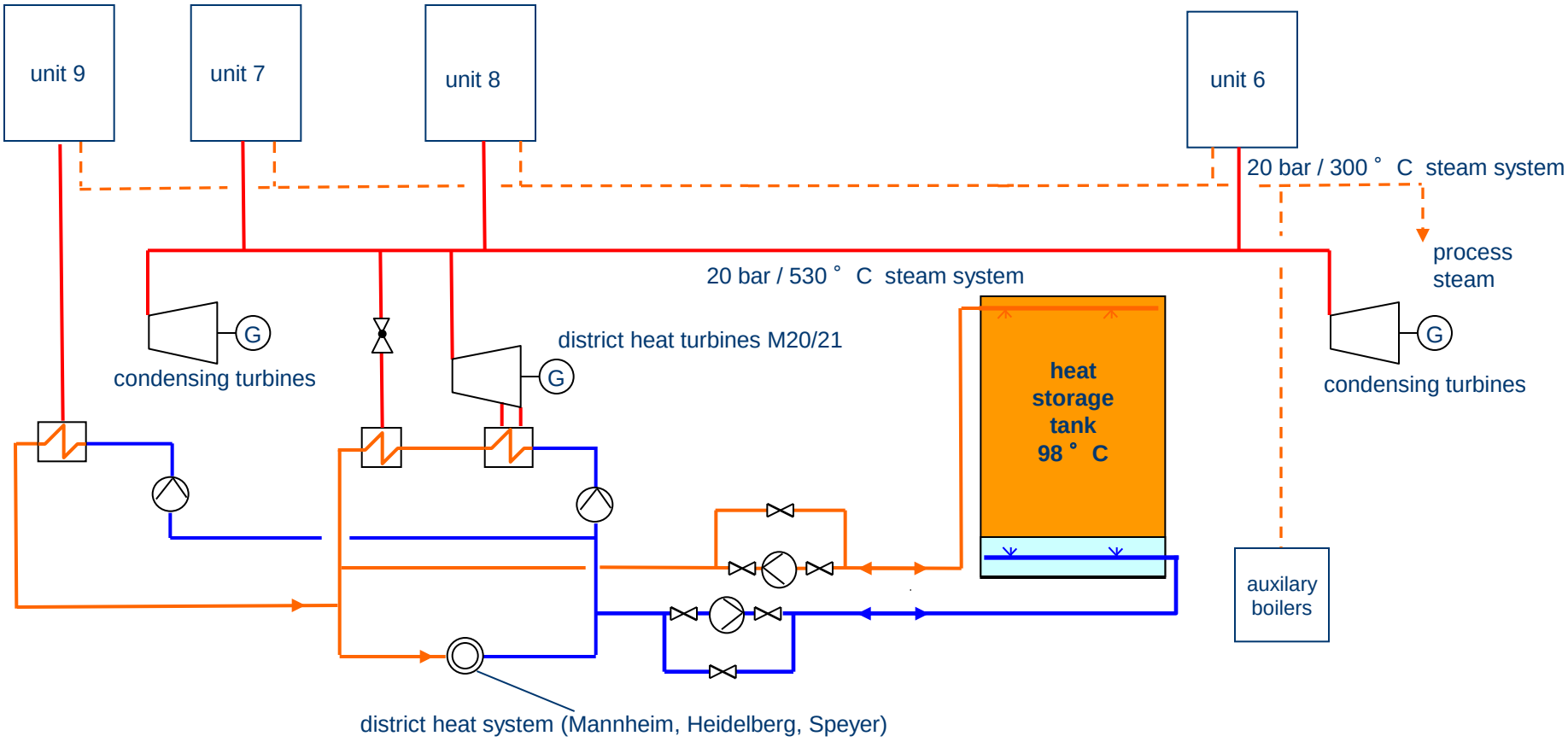
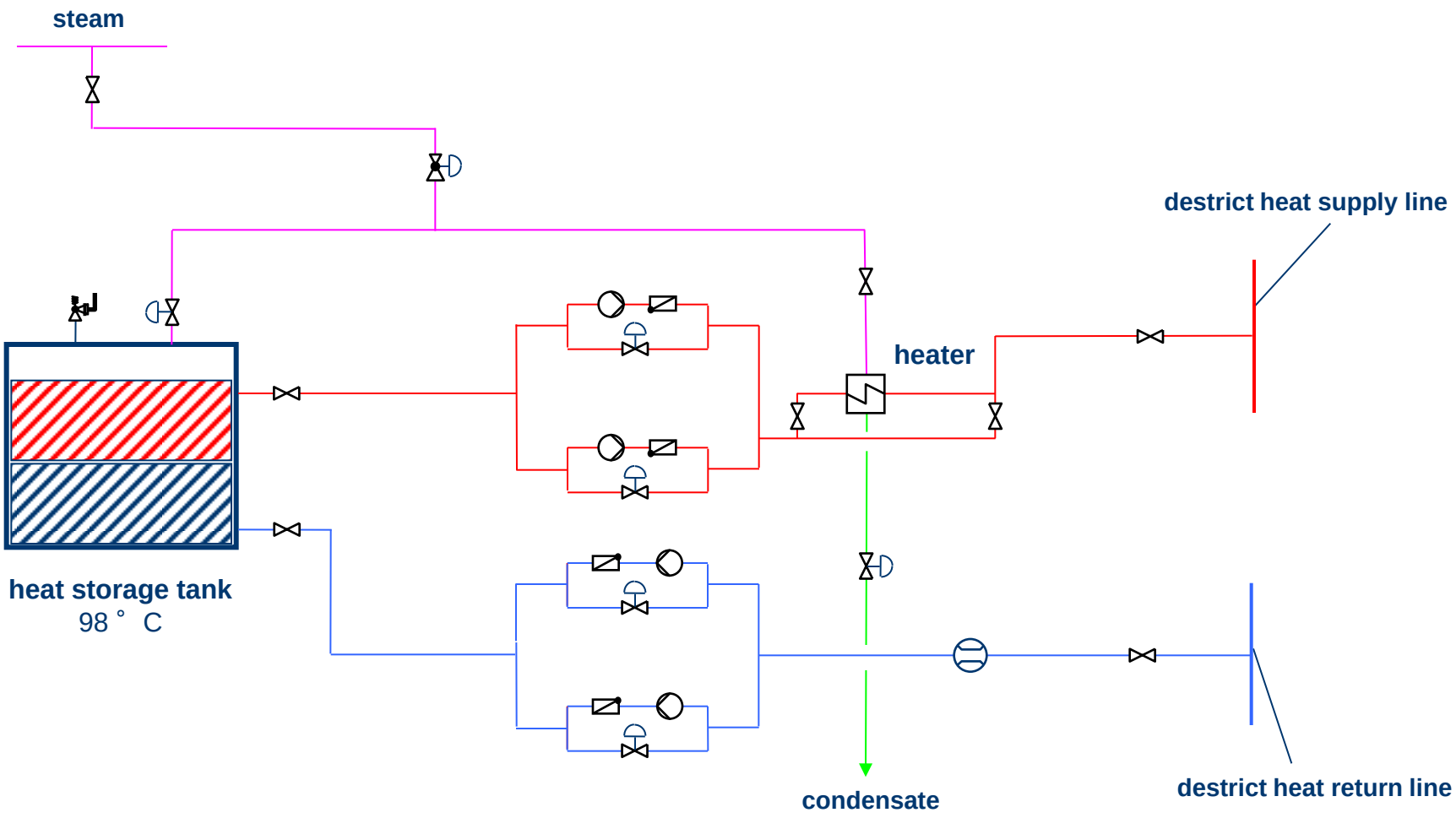
GKM „1-unit-operation“ possible at minimum load / if district heat load < 250 MW (since heat storage system finished: end of 2013)



new heat storage system enables GKM CHP plant to reduce the minimum load significantly

GKM water heat storage system / not pressurized



heat storage tank / integration district heat system

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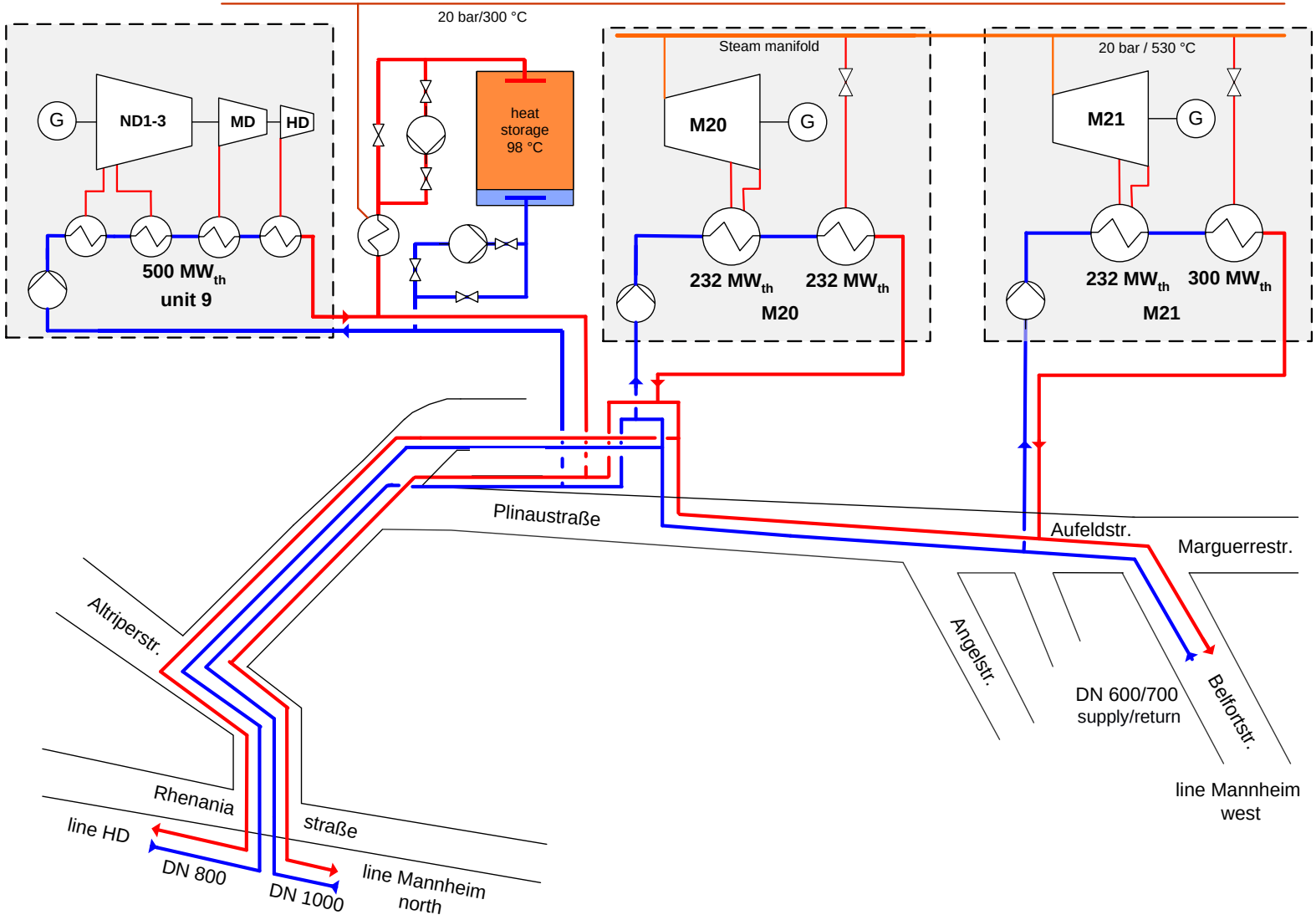
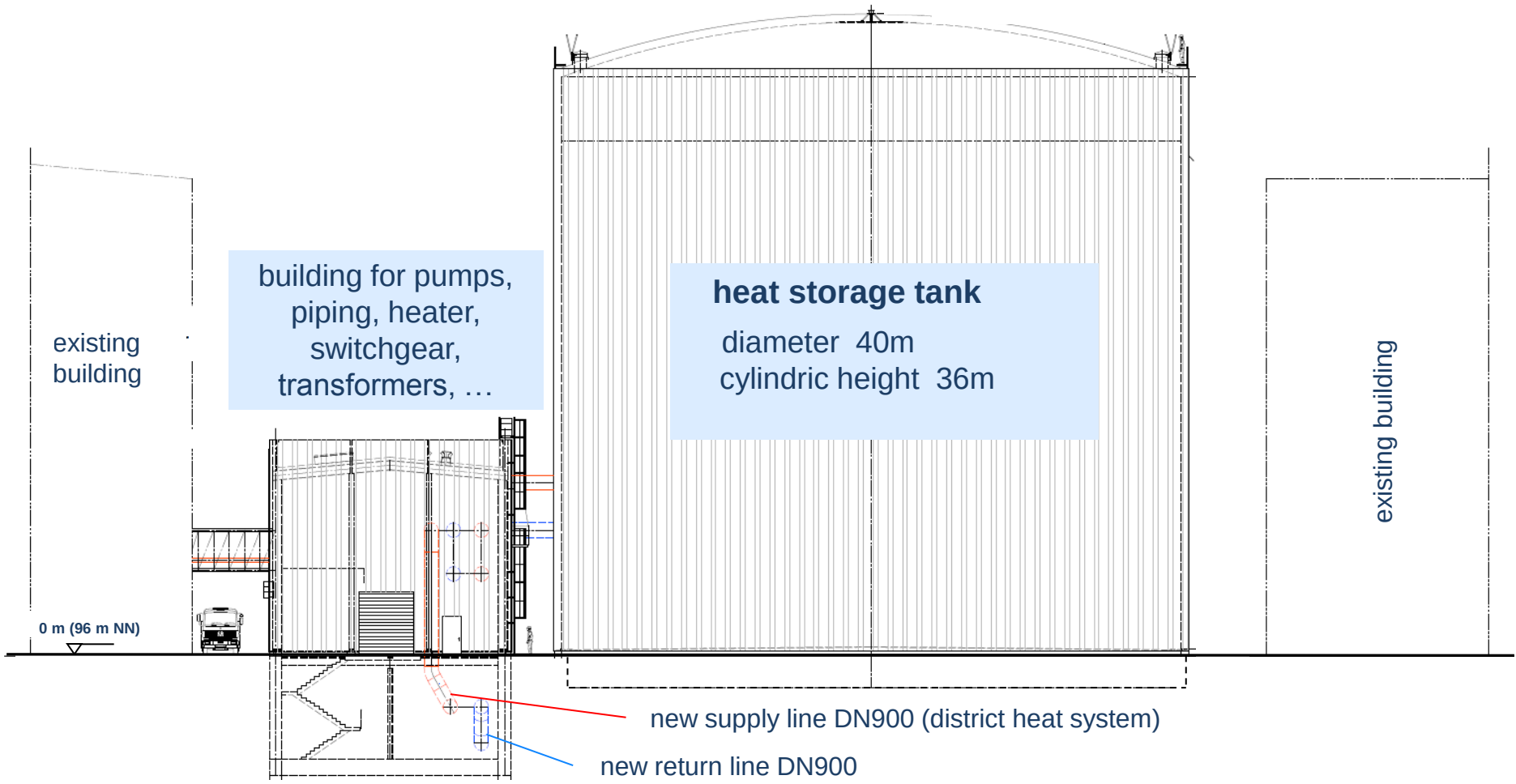


GKM new heat storage tank and system



GKM Plant / location for new heat storage tank

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technical data GKM heat storage system

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Heat storage tank ("system Dr. Hedbäck")

diameter tank	m	40
cylindric height tank	m	36
storage capacity	m^3	43.000
max. flow to / from tank	t/h	6.200
max. storage water temperature	°C	98
effective heat storage capacity	MWh	1500
max. load (water flow)	MW	250

heat storage tank / beginning of mantle erection
(floor already finished, January 2013)

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heat storage tank / built by „spiral method“
(roof already finished, March 2013)

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heat storage tank / „spiral method“
(April 2013)

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heat storage tank / „completely welded“
(during water pressure test in June 2013)

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heat storage tank / heat insulation of mantle
(September 2013)

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heat storage sytem / building for pumps, piping and heater in erection (July 2013)

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heat storage system / new district heat lines DN900

supply and return lines in erection (July 2013)

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GKM heat storage tank completed (September 2013)

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operation of heat storage tank (7 days, example)

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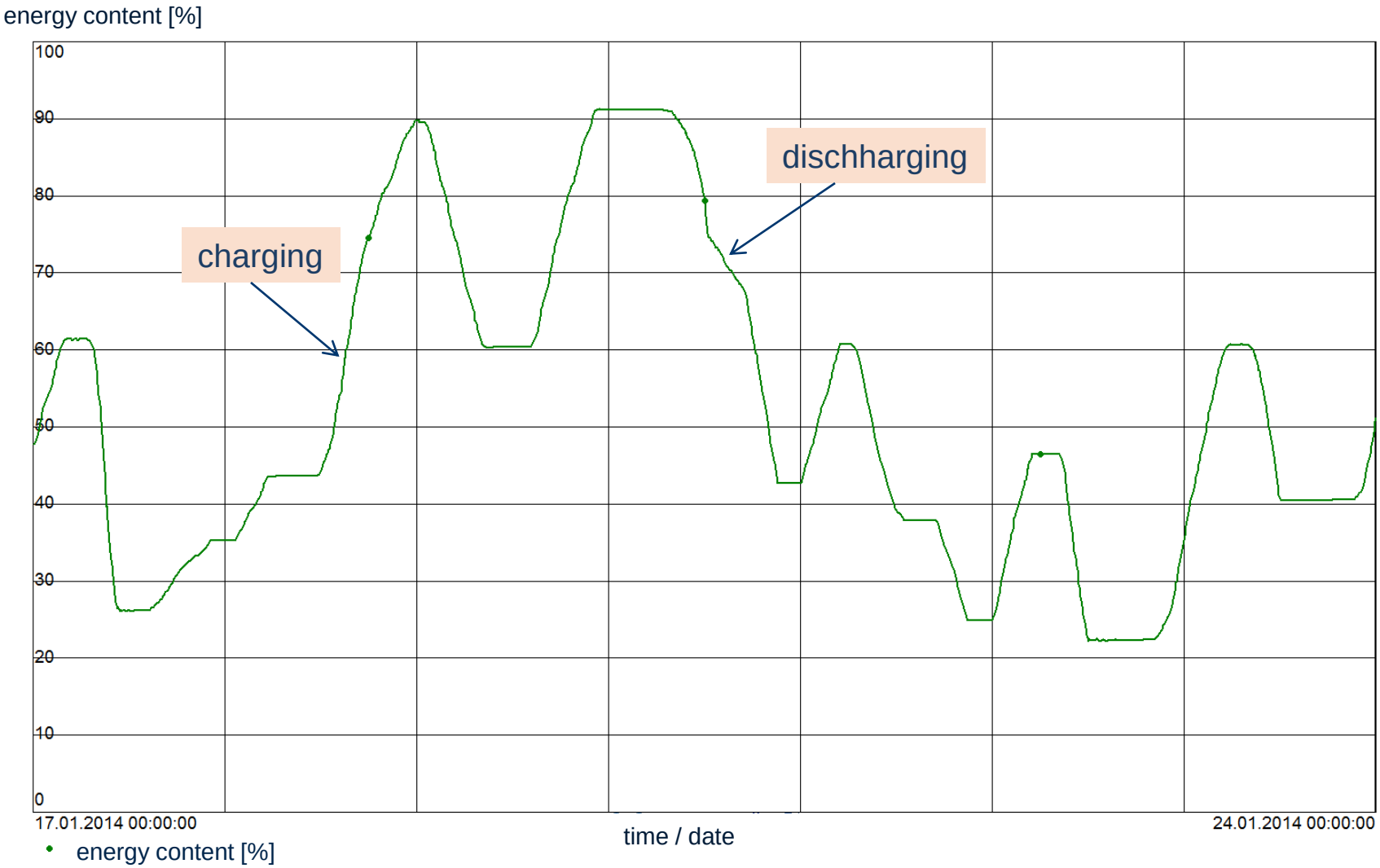

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GKM / reduction of minimum load 2005 vs. today

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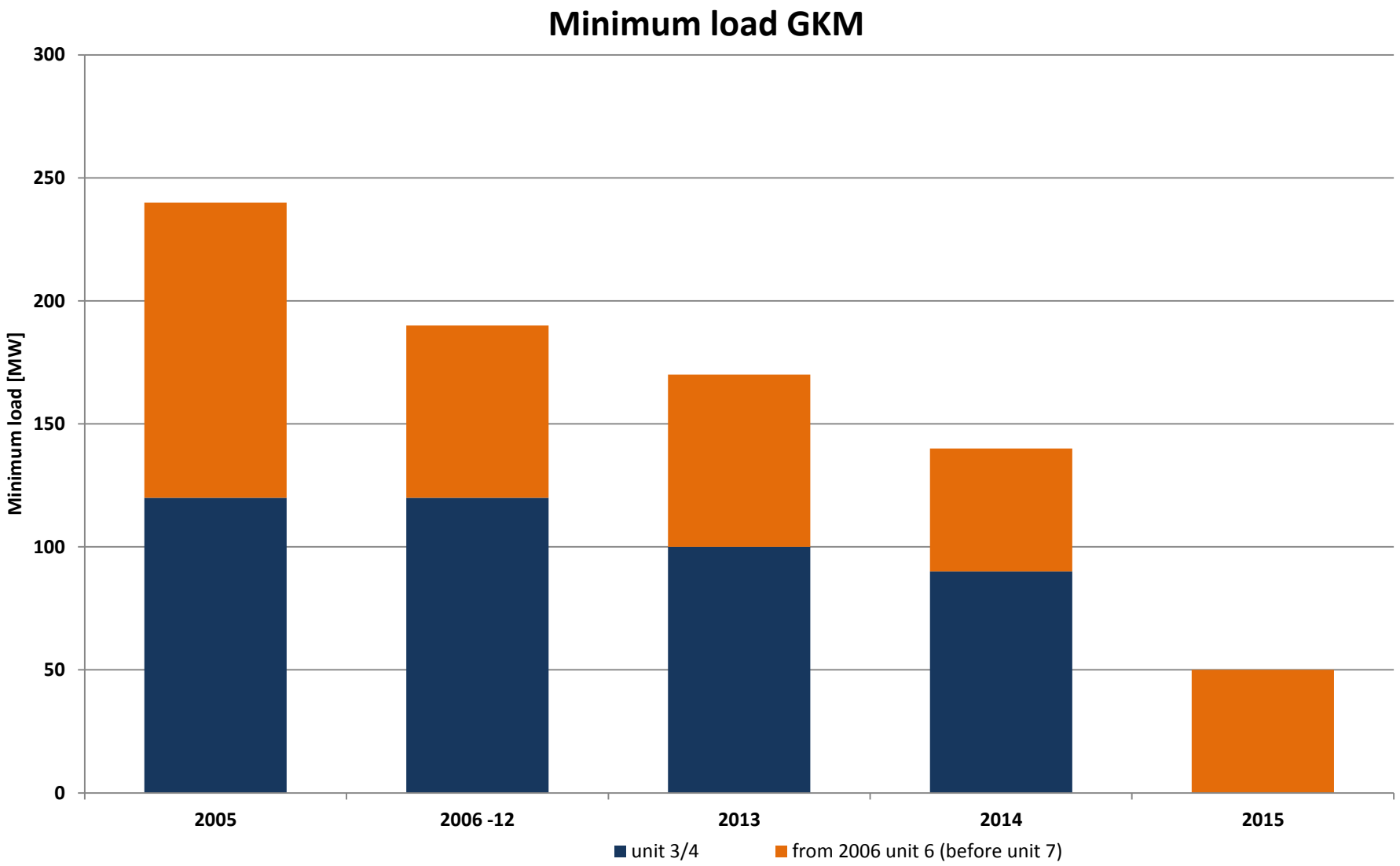

Conclusions

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Actual situation of CHP Plants in Germany / „Energiewende“

- increasing and high capacities of „renewables“ (esp. solar (PV) and wind) for electricity generation with fixed and governmental garanteed compensation
- since more than 4 years constantly decreasing and volatile EEX Prices

Situation at GKM

- GKM Plant load corresponding to EEX Prices (Spot-Market „day-ahead and intraday“), production volume and operation hours of units are decreasing
- need for permanent Distric Heat Generation and secure supply of Mannheim, Heidelberg and Speyer
- combined heat and power plants (CHP) „struggle with economics“

Functions of new heat storage system in GKM

- new heat storage system enables GKM to operate **only 1 unit** during minimum load (instead of **2 units before**)
- heat storage system is used to optimize the plant operation depending on EEX Prices (e.g. storage tank charging at night, discharging by day)

GKM Plant in Mannheim

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