Training Concepts and Flexibility Toolbox

Dr. Claudia Weise, December 1, 2017, Delhi

1. Work Programme of the Task Force

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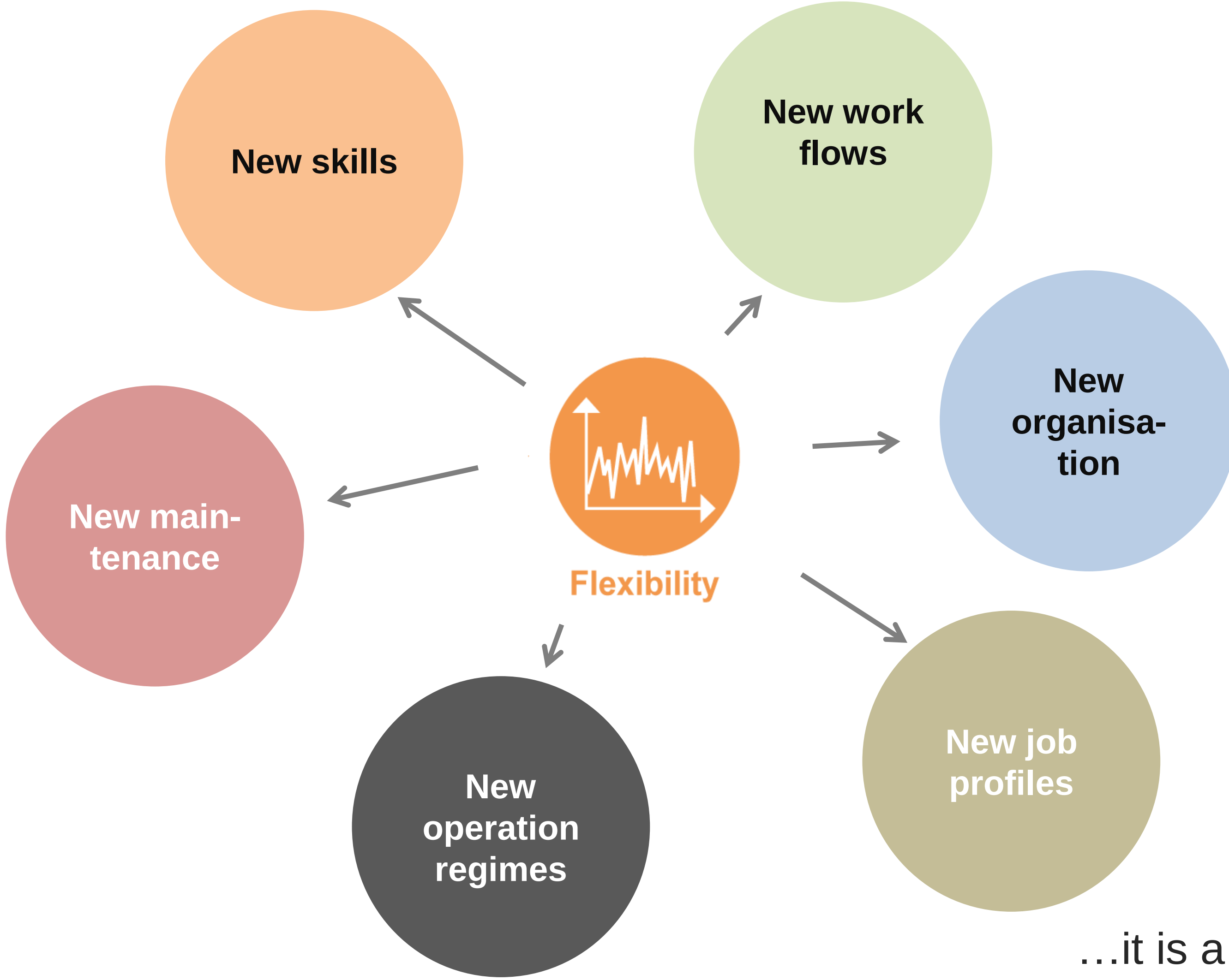
Modules	Technical Study	Capacity Building	Framework
Tasks	Reference plant assessment	Study tour of Indian delegation to Germany	Compile today's frame-work conditions in India
	Study on flexibility potential and accord. Measures	Flexibility workshop for dissemination	Study on an optimized regulatory framework for India
	Toolbox compiling ex-pertise and best practices	Training concepts on flexibility	**Phase 1: 2016/2017**
	Implementation of measures	Trainings / seminars on flexibility	
	Verification and synopsis of results	Long-term-secondment for a flexibility expert	**Phase 2: 2017+**
Results	**Ph 1:** Flexibility Ac-tion Plan + Toolbox **Ph 2:** Flexibility Reference Book	Group of Indian flexibility experts from various institutions	Regulatory Handbook

Indian members	German members
NTPC (K.K. Sharma, Director Operations = Chairman), EEC, CEA, POSOCO, BHEL	GIZ, VGB, KWS

2. New requirements for personnel

Training



…it is a new culture

2. New requirements for personnel

Training

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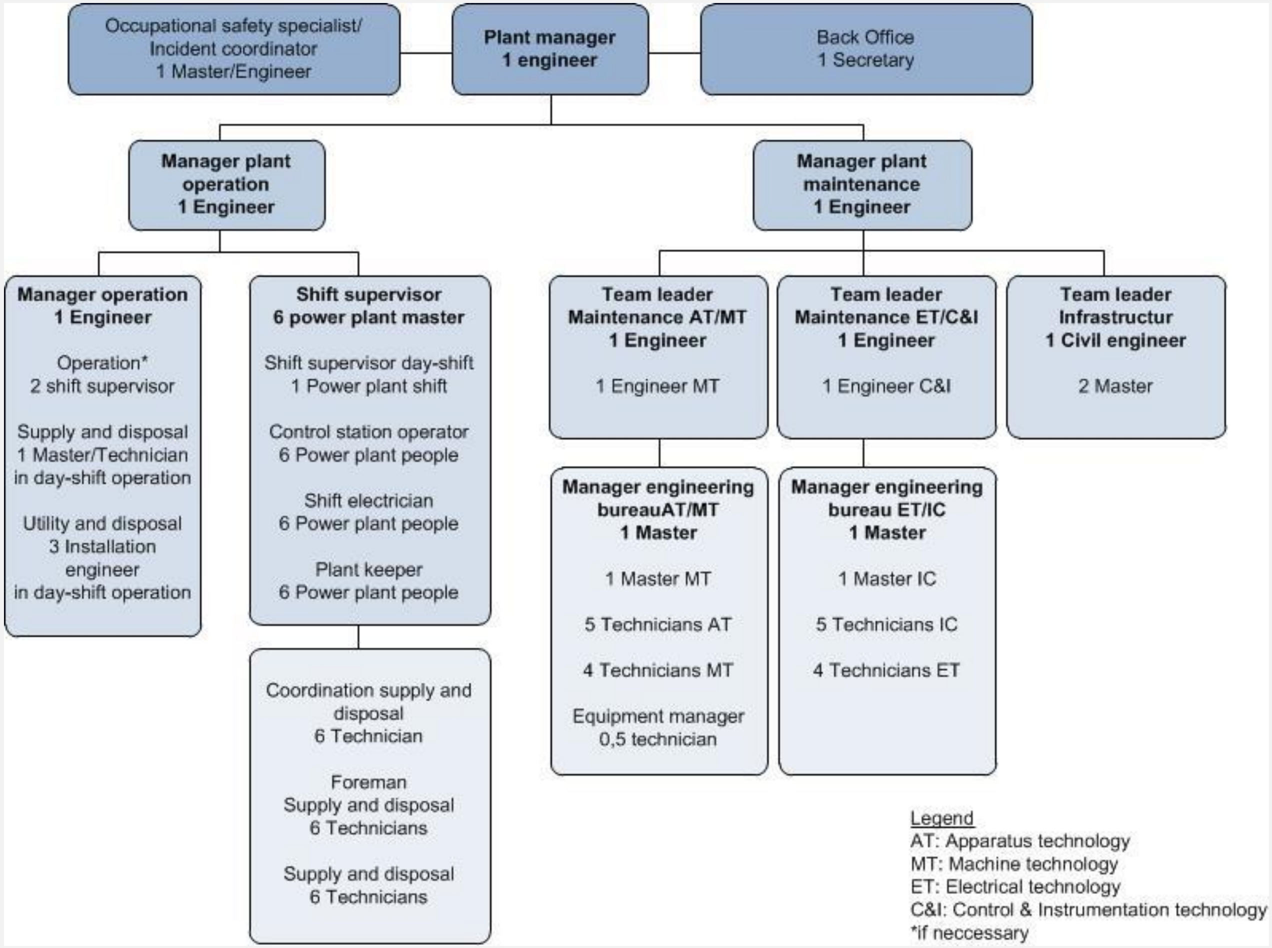

80 to 90 employees typically work in a 1-unit hard-coal power plant

Management
- Senior Engineers
- Trainer

Operational Staff
- Supervisor
- Operator

Maintenance Staff
- Mechanical
- Electrical

Coordinators
- Operation
- Grid

2. Training – Overview of Modules

Training

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Preparation → Flexibility → Simulator → Competency

Examples:

- ✓ Boiler (once through and circulation)
- ✓ One-Mill operation
- ✓ Turbine
- ✓ Electrical components
- ✓ Instrumentation and control
- ✓ Renewables
- ✓ Power plant design and operation
- ✓ Post black out
- ✓ Economical aspects
- ✓ Simulator training (power plant, grid)
- ✓ Train the trainer
- ✓ Maintenance coordination
- ✓ Grid coordination

2. Training – Set-up

Training

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Flexibility-Training-Program "Operational Staff"			
Types	Preparation Operation Training	Flexibility Operation Training	Simulator Training
Target group	Operating personnel (local and control room)	Control room personnel, shift supervisors and shift engineers	Control room shift groups
Achievement	Qualified Prep-op-certificate (compulsory for the Flexibility Training modules) (optional: recommendation for further promotion)	Qualified Flex-op-certificate (compulsory for the Simulator Training modules) (optional: recommendation for further promotion)	Sim-Flex-certificate (optional: recommendation for further promotion)

Training

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Examples:

Flexibility

<u>Fast start-up and shut down procedures (FS)</u>

- Limiting systems their components and limitations
- boiler conditions prior to startup (hot, intermediate, cold)
- typical startup procedures for hot, intermediate, cold conditions
- steam flow vs. pressure development during startup
- temperature development in the boiler (pipes inside and outside)
- operation of bypass station during startup
- fueling strategies (coal vs. oil, preparations procedures for mill start up processes, pre heating of mill and classifiers, preparation and readiness of feeders)
- smooth and rapid change of operation modes low load circulation to Benson mode
- behavior of the evaporator system, shifting of the evaporation zone in the evaporator system (h-p diagram, feedwater control system i.e. enthalpy control mechanism
- Impacts on the plant safety, boiler safety chain
- new O&M procedures (e.g. preservation measures, reduction of heat losses during stand-still)
- economic background: minimizing of startup costs, staff needed for startup procedures, fuel management and fuel consumption regime

<u>Minimum load operation (MLO)</u>

- Limiting systems, their components and limitations
    - steam production and temperature behavior of Benson type boilers
    - characteristics of supercritical benson type boilers
    - economizer (minimum flow, pre-evaporation)
    - evaporator (minimum flow, evaporation conditions)
    - superheaters (steam temperatures and sprays)
    - reheater (cooling, sprays, pressure)
    - feedwater system, feedwater tank and pumps
    - start-up vessel circulation pump and system (Once through)
    - Benson- and circulation conditions (mode change upwards and downwards)

2. Training – Simulator Training

Training

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- ✓ Efficiency optimization of the power plant
- ✓ Fast start up and shut down procedures
- ✓ Identification of limiting systems, processes and components
- ✓ Exercises: Anticipation of critical process parameters for fast ramp conditions and minimum load conditions (e.g. levels, temperature, flows, water composition)
- ✓ Development and exercises of new operation procedures (e.g. 1-2-mill operation, preservation of equipment, operation without supporting fuel, risk-based maintenance with changed inspections regimes)
- ✓ Operation of the power plant during load ramps
- ✓ Operation of the power plant under minimum load conditions

3. Work Programme of the Task Force

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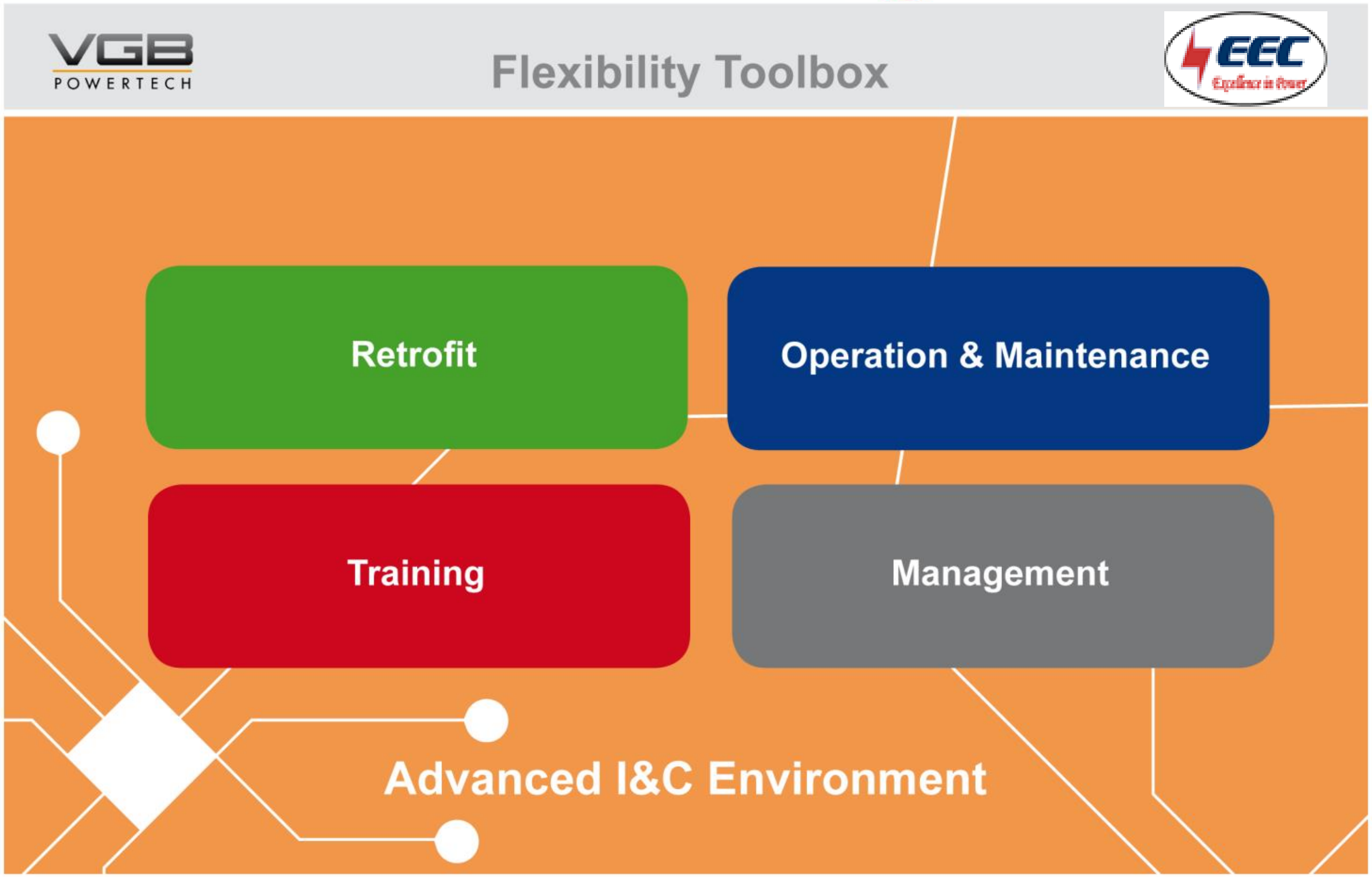
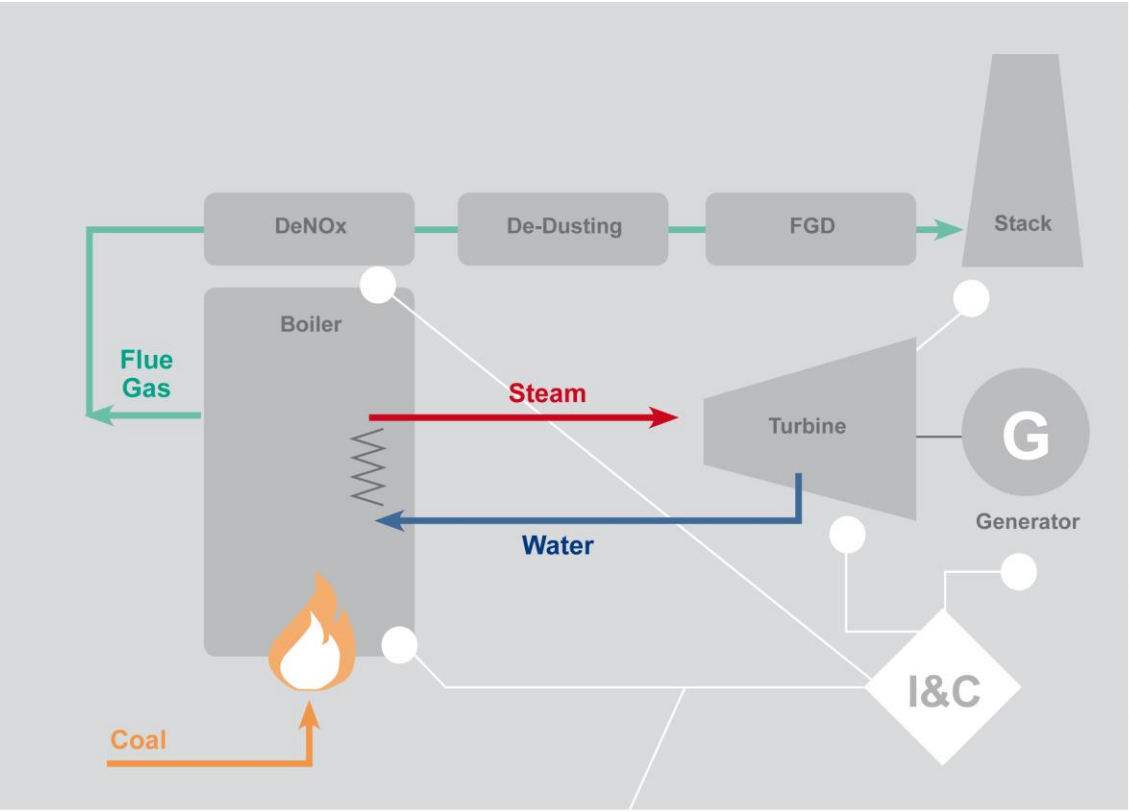
4. Flexibility Toolbox – the Approach

A joint endeavor of the Excellence Enhancement Centre (EEC) of India and VGB in the frame of the Indo-German Energy Forum

Indo-German Energy Forum



Flexibility needs technology, people and leadership



Measure
Flexibility impact
Limitation addressed by the measure
Description
Investment estimation
Time for implementation
Best practice

The toolbox includes technical retrofit measures for main systems of the power plant – combustion, water-steam cycle, turbine, I&C, flue gas cleaning and auxiliaries – as well as storage technologies.

Combustion

Coal stockyard – Thermographic detection system	
Flexibility impact	Minimum load reduction
Limitations	Self ignition of coal on coal stockyard
Description	▪ A reduction of the minimum load together with a more frequent operation in minimum load leads to an increased storage period of the coal favouring its self-ignition. ▪ Beside installing a detection system, an appropriate coal handling of the stockyard (compaction) is recommended to avoid self-ignition.
Investment	A /B and additional O&M costs
Timeline	1 – 3 months
Best Practice	▪ M. Nolte, H. Brüggendick und K. Brosch, „Kohlekraftwerke im Energiemix mit den erneuerbaren Energien – Der Schwachlastbetrieb und seine Auswirkungen auf das Kohlekraftwerk,“ in Kraftwerkstechnik - Sichere und nachhaltige Energieversorgung - Band 3, TK-Verlag, 2011, pp. 699-707 ▪ Anne M. Carpenter, Management of coal stockpiles, IEA Coal Research 1999, ISBN 92-9029-333-0

4. O&M – Practical Tips

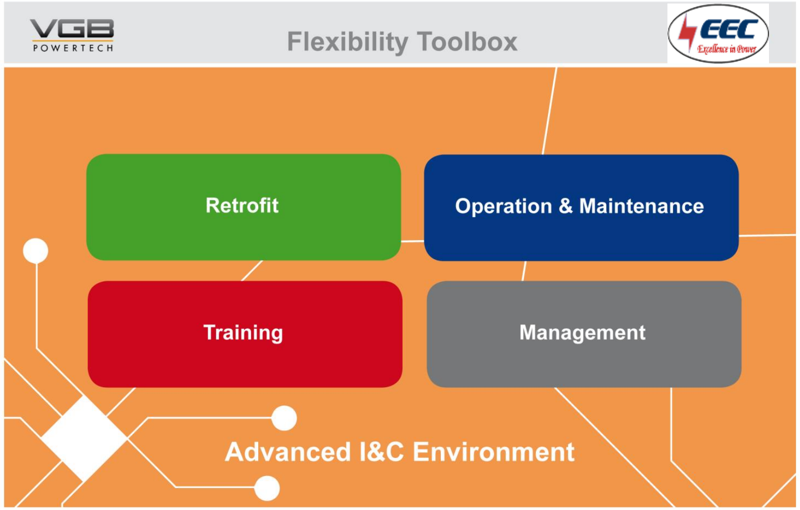
Plant Area	Issue / Special focus	Mitigation
Water-Steam Cycle		
Water chemistry	▪ Proper water and steam quality at all load conditions in order to avoid corrosion ▪ Cycling results in peak demands on condensate supply and oxygen controls	Strict adherence to proven quality standards such as VGB-S-010-T-00; 2011-12.EN "Feed Water, Boiler Water and Steam Quality for Power Plants/Industrial Plants"
Evaporator	▪ Differences of wall temperatures and material stress ▪ Avoidance of overheating	▪ Ensuring sufficient steam flow ▪ Optimize operation procedures or methods to reduce the ramp rate to the required or necessary minimum ▪ Check for design buffer in minimum feedwater flow ▪ Use circulation mode ▪ Condition monitoring
Super-heater	▪ Differences of wall temperatures and material stress ▪ Temperature spread at live steam discharge	▪ Ensuring sufficient steam flow ▪ Condition monitoring

4. Conclusions

→ Specific trainings for all types of power plant personnel are an important flexibility enabler.

→ Training is one aspect of the "Flexibility Toolbox".

→ The toolbox addresses all areas of activity which are relevant for enhancing power plant flexibility.



→ The Toolbox is a joint endeavor of EEC and VGB in the frame of the Indo-German Energy Forum – it will be finalized at the end of 2017.

Flexible power plant operation implies many challenges: technically and organizationally. A holistic approach is needed to address the complex tasks and requirements.

धन्यवाद

Thank you
for your interest!

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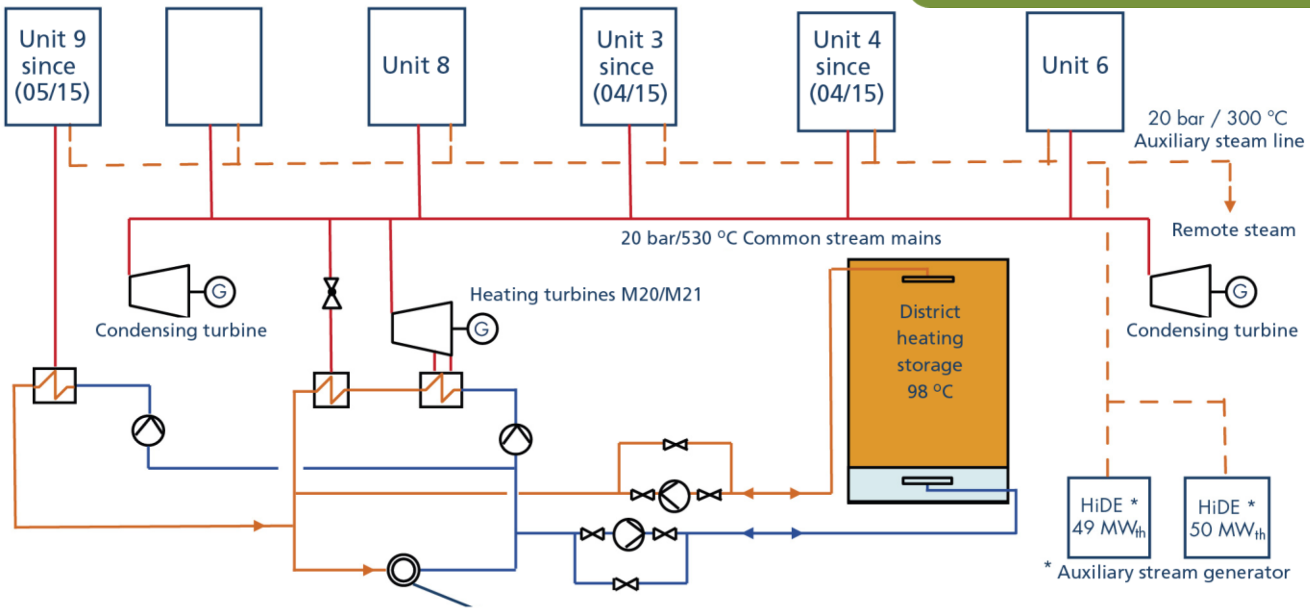

Not-pressurized flat bottom tank Hedbäck design:

- Simple design
- Water/steam as medium
- Max. temperature < 100 °C
- High voluminas (> 1000.000 m³)
- High output and capacities up to 300 MW , > 2.000 MWh per tank)