Get Ready for Flexibilisation

Indo-German Energy Partnership

November 2023

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Background and Working Programm

A special Task Force on Flexibilisation was constituted in May, 2016 under the Sub-Group of the Indo-German Energy Forum, under the Chairmanship of Director (Operations), NTPC and with following members:

- India: Excellence Enhancement Centre (EEC) – Task Force Secretariat, POSOCO, CEA, BHEL and NTPC
- Germany: IGEF/GIZ, VGB and KWS (Power Plant Training Centre)

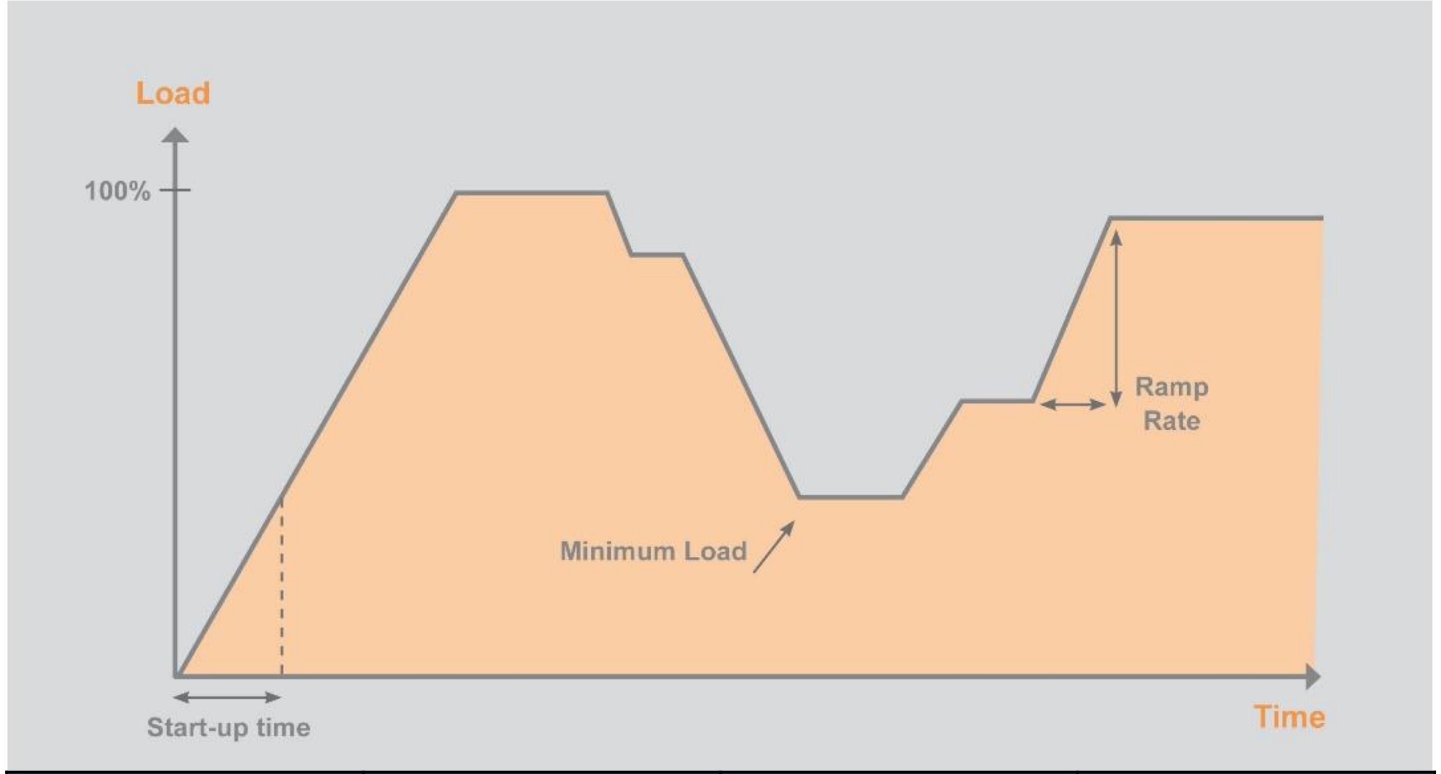
Technical Studies

- Reference plant assessements at Dadri und Simhadri, 2017
- *Flexibility Toolbox*, 2018
- Test Runs in different power plants 2018–2022
- Implementation of measures at Dadri, finished in 2022
- Verification of results → ***Flexibility Field Report***, published in January 2023
- Short ***Study on Thermal Electricity Storage in India***, published in January 2023

Capacity Building

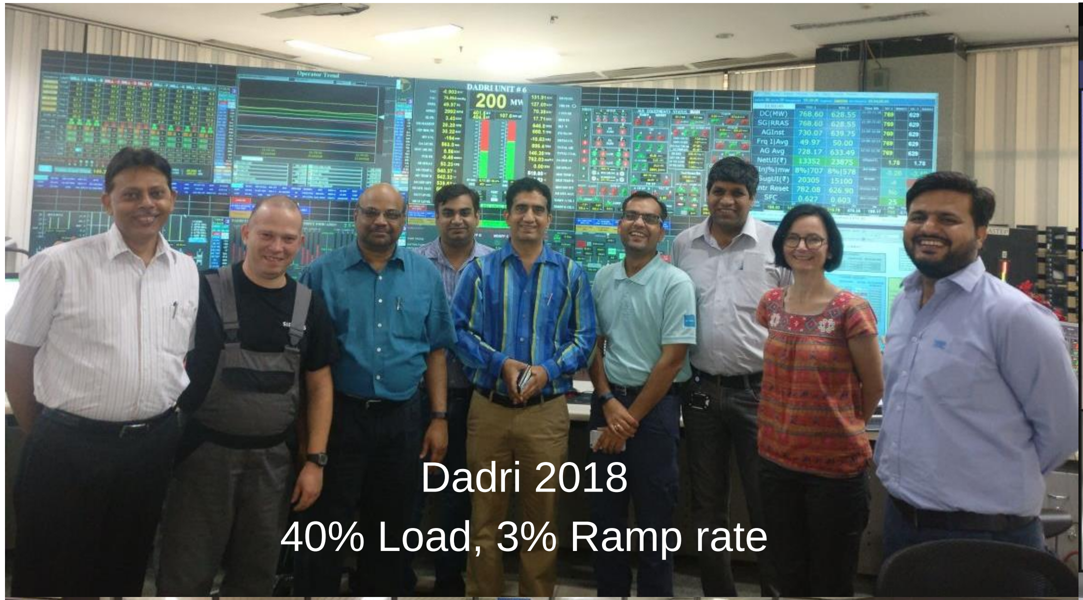
- > 200 Indian delegates visited Germany for training, study tours and experience exchange
- > 20 National conferences, seminars and workshops
- Development of a flexibility simulator and training programme for power plant personnel
- **1-week simulatior training** with STEAG India – first batch was successfully concluded on 7 Oct
- Set-up of a flexibility simulator at STEAG India
- Study tour to Germany planned for November 2023 and March 2024

Technical Flexibility Parameters



	Dadri Unit 6	Maithon Unit 2	Andal Unit 2
Capacity	500 MW	500 MW	500 MW
Operator	NTPC	Tata	DVC
Date	June 2018	July 2021	April 2022
Minimum Load	40%	36%	30%
Ramp Rate	2.0 –3.0%/min	1.5– 2.0%/min	2.0%/min

Flexibility Test Runs at 500 MW Units

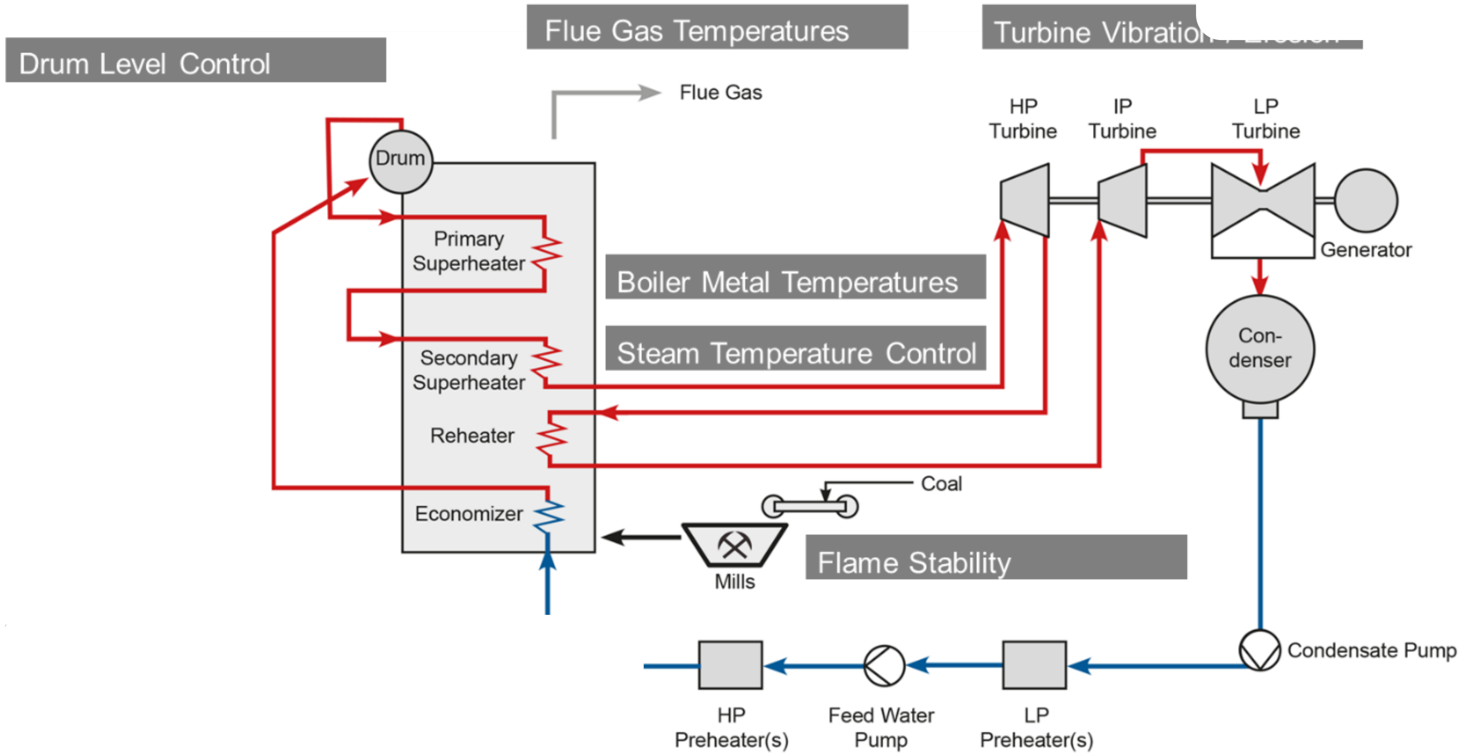


Way to Steady Flexible Operation: Technical Dimension

How to flexibilize the plant

1. **Pre-Test Phase**
   Initial Plant Assessment
2. **Test Run**
   Flexible operation check
3. **Flexbilization Plan**
   Concept for steady flexible operation
4. **Deployment**
   Implementation of flexibility measures

Main Fields of Action



Learnings and Recommendations

- Conduct own test runs to in order to enhance your knowledge about the plant behaviour in part load
- Collect your own best practices – e.g. for start-up, shut-down, mill scheduling and frequency control – and identify new procedures for your plant
- An automized start-up and shut-down sequence of main equipment is beneficial for flexible operation → check, if your DCS system has such sequences which were never commissioned
- Develop a concept for condition monitoring in order to mitigate the consequences of flexible operation
- Simulator training is very useful to obtain practical skills in flexible operation as well as to try out different operational concepts

Way to Steady Flexible Operation: Skill Dimension

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How to become a FLEXPERT

Study

e-learning, awareness workshops and professional seminars

Target: acknowledge the need for flexibility, understand principles of flexible power plant operation

4 weeks

Try

a) Simulator training to try out flexible operation at an Indian reference plant

b) Test runs at own plant (according to IGEF procedure) guided by own senior or external experts

4 weeks

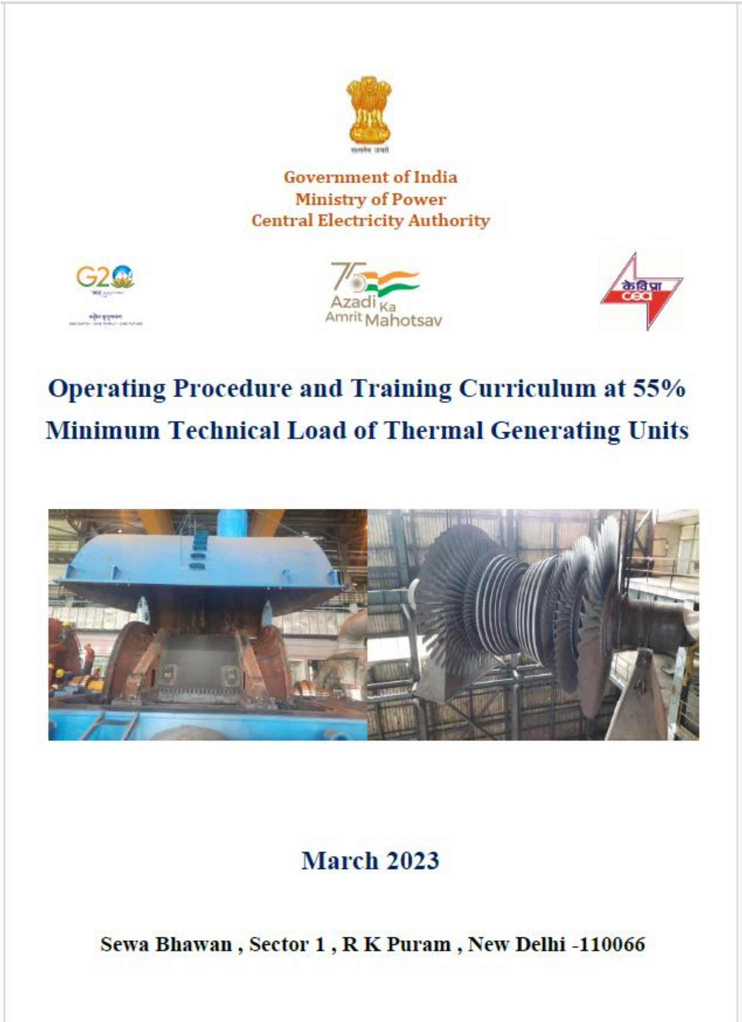
Apply

Implement new procedures in the operational scheme (e.g. mill sequences, switch over of pumps and fans)

- Increase level of automation for routine sequences and optimize subordinate controls
- Optimize main control loops and implement advanced control solutions

Continuous improvement process

CEA Notification



Government of India
Ministry of Power
Central Electricity Authority

Operating Procedure and Training Curriculum at 55% Minimum Technical Load of Thermal Generating Units

March 2023

Sewa Bhawan , Sector 1 , R K Puram , New Delhi -110066

- Standard Operating Procedures for safe operation at 55% load
- Training Curriculum
- Collates and synthesizes learnings from various flexibility initiatives

→ Outline for the Flexibilization of Indian Power Plants

→ Provides guidance and recommendation for the practical implementation

Simulator for Flexperts

Simulator

- Simulator model of an 500 MW coal-fired unit for flexibility trainings for operating personnel
- Development of a full-fledged training programme for flexible power plant operation
- Implementing partners are Steag India and ProTrax (USA) with support from GIZ and vgbe
- Nucleus for pan-Indian training initiatives

Important Milestone:

One-week simulator training conducted by STEAG at Mahagenco's Koradi Training Center

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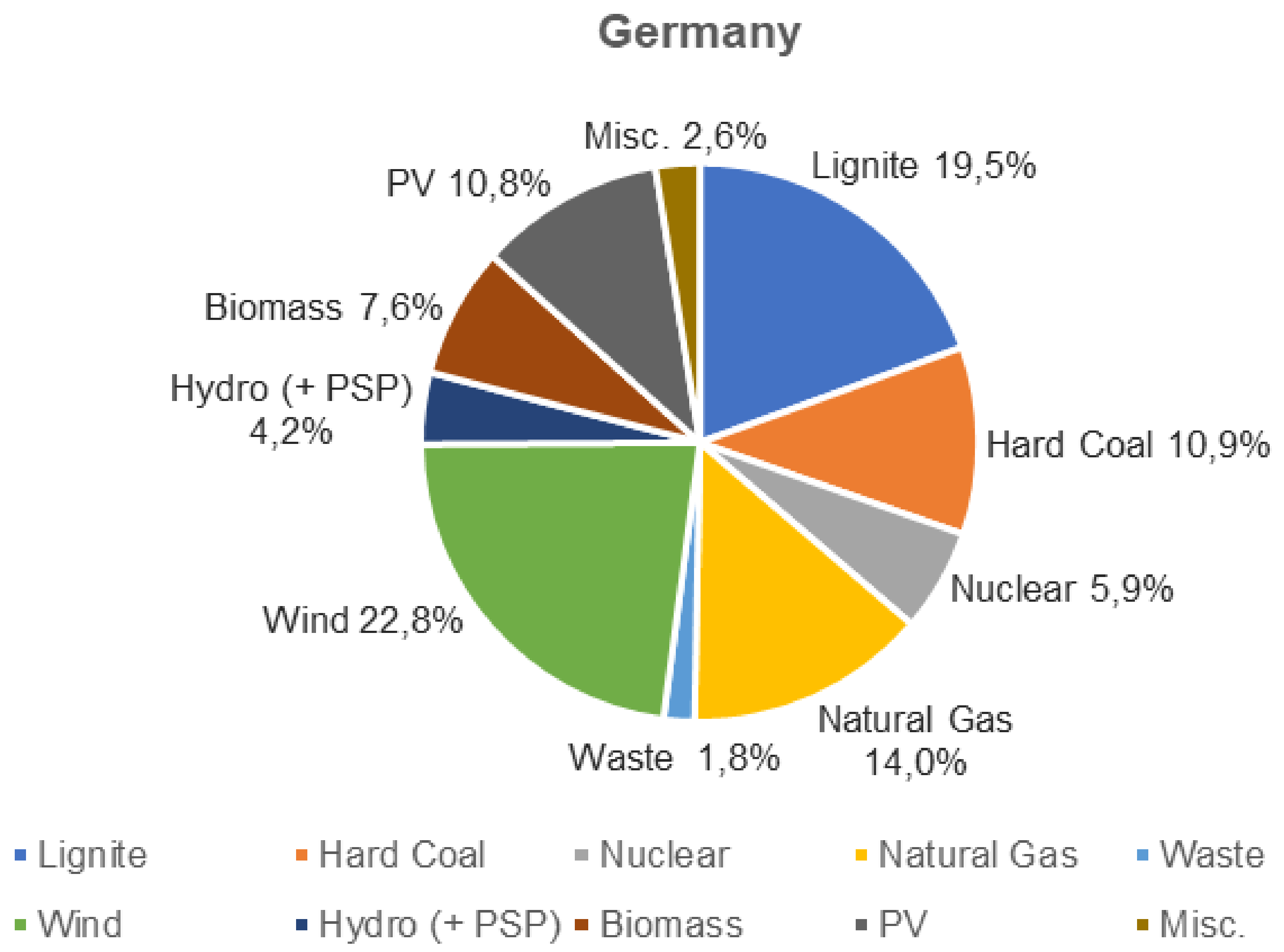
Electricity Mix in 2022



Net electricity production:	**551 TWh**
<u>Installed Capacity:</u>	
Lignite:	**17.7 GW**
Hard Coal:	**18.1 GW**
Natural Gas:	**31.8 GW**
Wind:	**65.7 GW**
PV:	**63.0 GW**

Coal Phase-out in 2038 (2030)

Source: AG Energielanzen, https://ag-energiebilanzen.de/

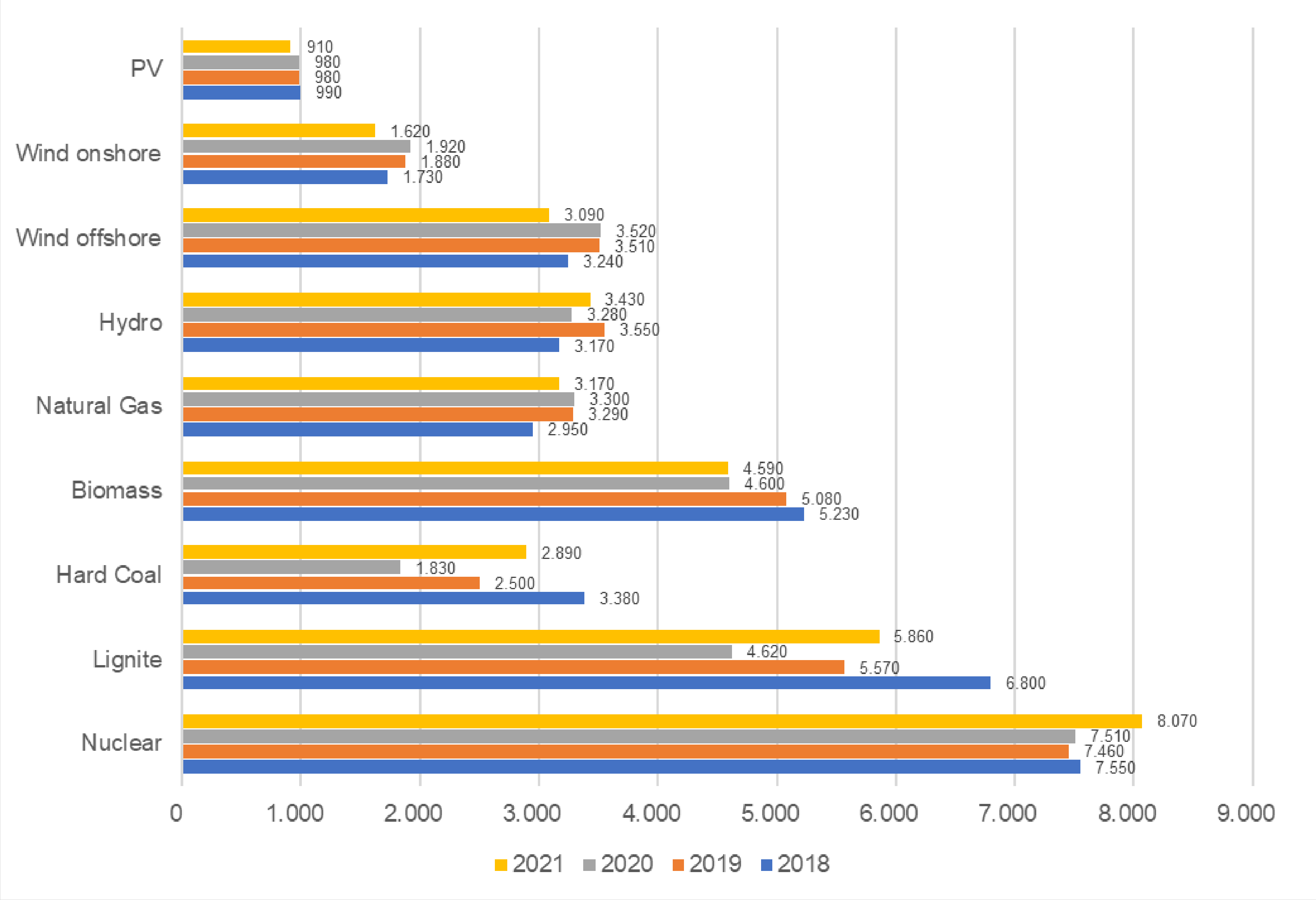
Flexibility Parameters of Thermal Power Plants

Plant type	Hard Coal	Lignite	CCGT
Ramp rate [% / min]	2 / 4 / 9	2 / 4 / 8	4 / 8 / 12
in the load range [%]	40 to 90	50 to 90	40* to 90
Minimum load [%]	40 / 25 / 10	60 / 40 / 20	50 / 40 / 30*
Start-up time hot start <8 h [h]	3 / 2 / 1	6 / 4 / 2	1.5 / 1 / 0.5
Start-up time cold start >48 h [h]	7 / 4 / 2	8 / 6 / 3	3 / 2 / 1

Source: VDE and own studies
Conservative / state of the art / very advanced; *as per emission limits for NO_x and CO
CCGT = Combined Cycle Gas Turbine Plant

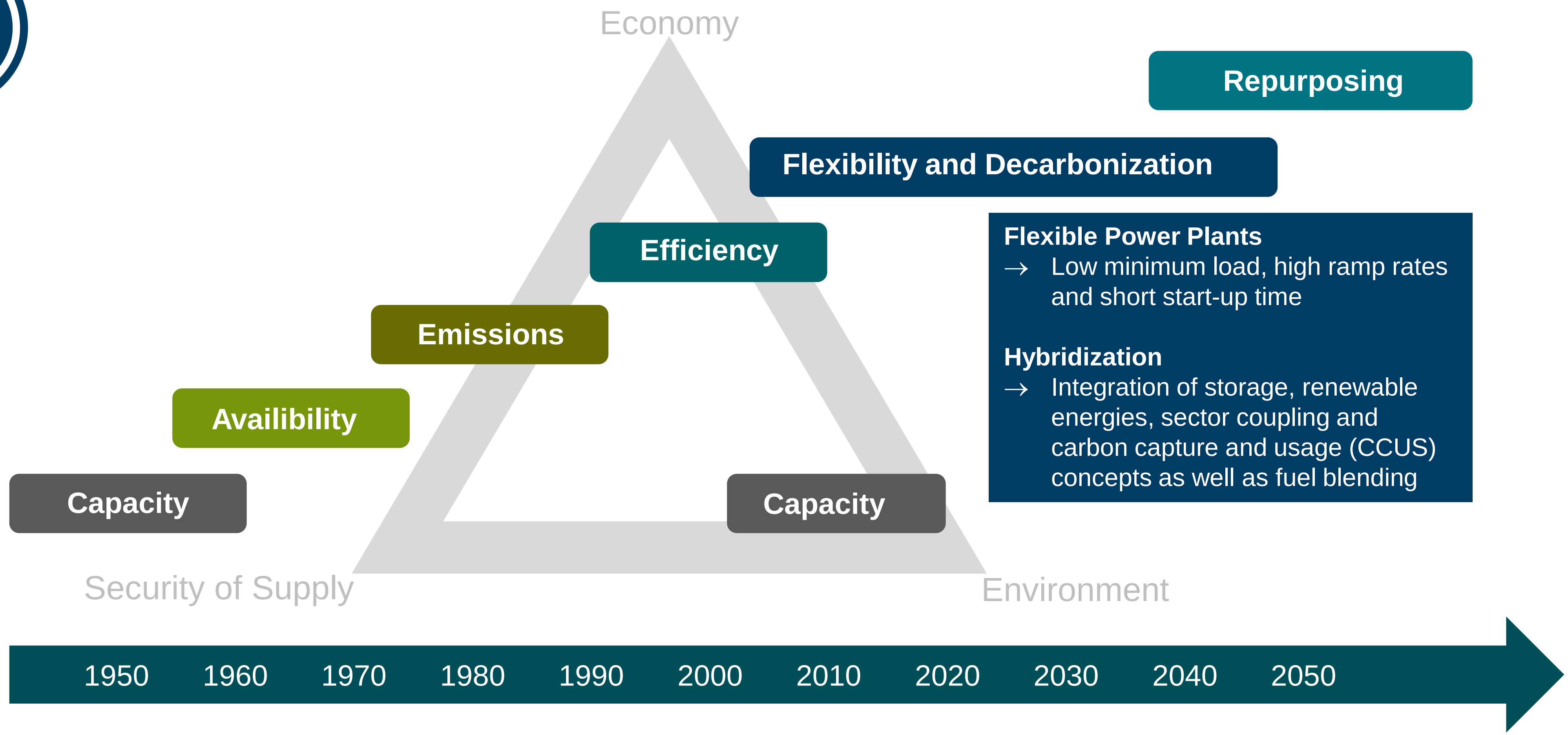
Type of coal	Calorific value [kJ/kg]	Ash content [%]	Water content [%]	Sulphur content [%]
Indian coal	11,715 – 20,900	25.0 – 60.0	10 – 20	0.30 – 0.80
German lignite	7,800 – 11,300	2.5 – 20.0	40 – 60	0.15 – 3.00
Imported hard coal used in Germany	~25,000	7.0 –15.0	9.0 – 12.0	< 1.0

Full-load Hours of German Power Plants



Source: BDEW

Development of Power Plant Technology Drivers



Benefits by Repurposing Coal Plant Sites

Well developed infrastructure

External – access to:

- Grid
- Transport: harbour, roads and railway
- Gas network
- Water
- District heating

Miscellanea

- Highly qualified personnel
- Availability of space
- Existing permits
- Saving decom-missioning cost

Well developed infrastructure

Internal

- Digitalized site
- Cooling systems
- Water treatment
- Heating systems
- Steam systems

Consumption near-by

- Households and offices
- Business and agriculture
- Industry

Options for Hybridization of Power Plants

Renewable Energies

Capacity extension with PV and/or wind energy plants

Sector Coupling

From heat and steam provision to the integration of H_2 production and CCUS as well as the production of green gases and/or biofuels

Storage

Source of picture: Steag GmbH

Integration of storage systems such as large scale batteries as well as thermal and mechanical storage

Fuel Blending

Partial fuel substitution with biomass or green gases

Repurposing of Power Plants: Example 1

Need for dispatchable capacity – fuel switch activities

Stuttgart-Münster

- **Gas turbine plant with 124 MW_{el}** and waste heat steam generator Decommissioning of coal-fired boilers and gas turbines

Heilbronn

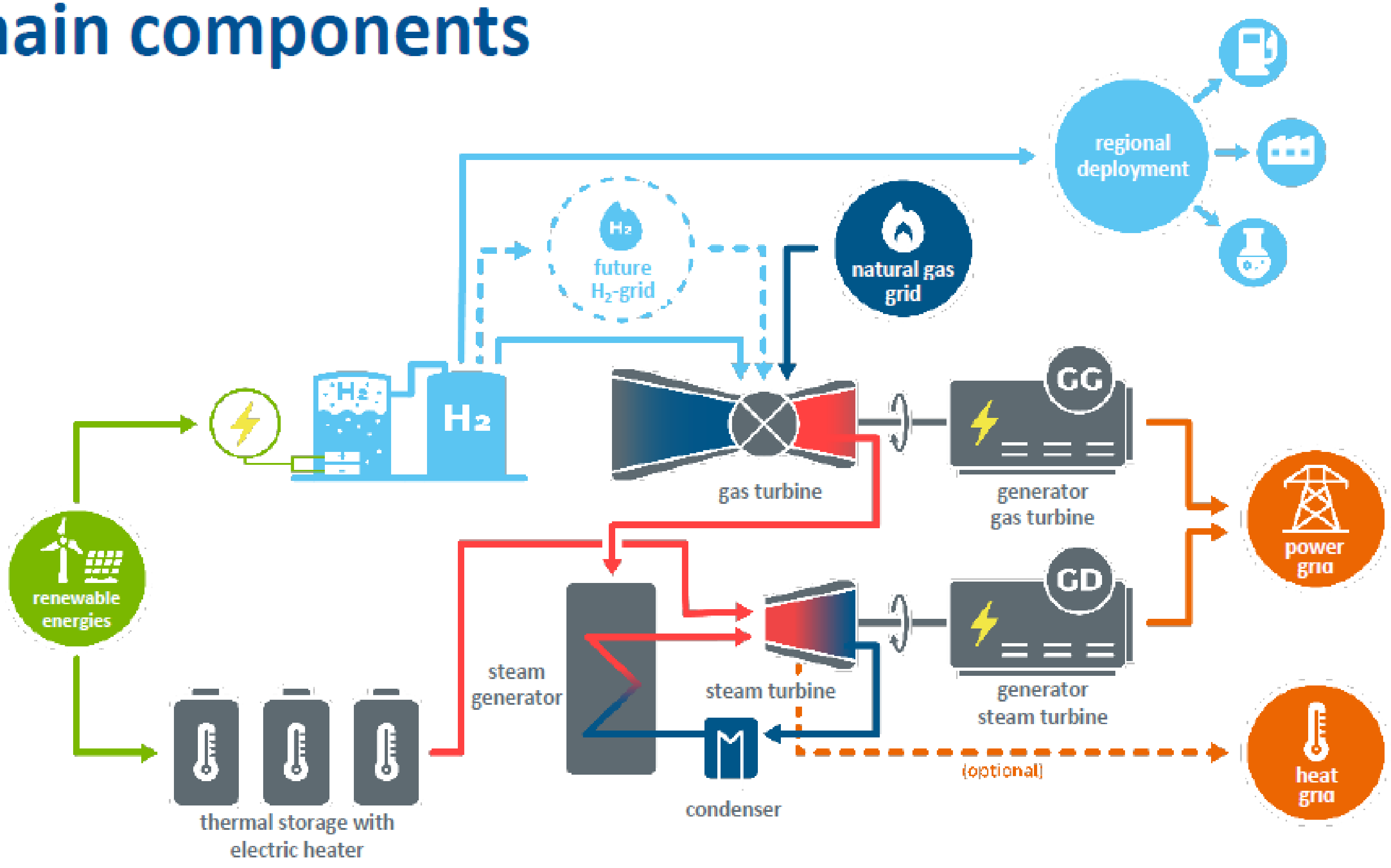
- **H_2-ready CCGT plant with 675 MW_{el}** and up to 190 MW heat output Decommissioning of HLB7 coal unit with 778 MW_{el}

Altbach/Deizisau

- **H_2-ready CCGT plant with 665 MW_{el}** and up to 180 MW heat output Decommissioning of HKW2 coal unit with 401 MW_{el}

The double fuel switch (from coal to gas and then to H_2) helps build a balanced portfolio of renewables and dispatchable capacity and is in line with EnBW's 2035 climate neutrality target

Innovative storage power plant Jänschwalde – main components



- high-efficient **H_2-ready CCGT plant**
- **thermal energy storage** with electric heater for storing renewable electricity
- production, storage and energetic utilisation of **green hydrogen**
- green hydrogen supply for **industry and mobility**

Thank you for your attention.

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Contact

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