Flexibility in Energy Systems

4 February 2020, Kolkata

Dr. Claudia Weise

Agenda

1. **About VGB**
2. Status of Thermal Power Plants in Europe/Germany
3. Flexibility of Power Plants
4. Indo-German Energy Forum: Showcasing Flexibility
5. Further Flexibilization Trends
6. Conclusions

1. About VGB

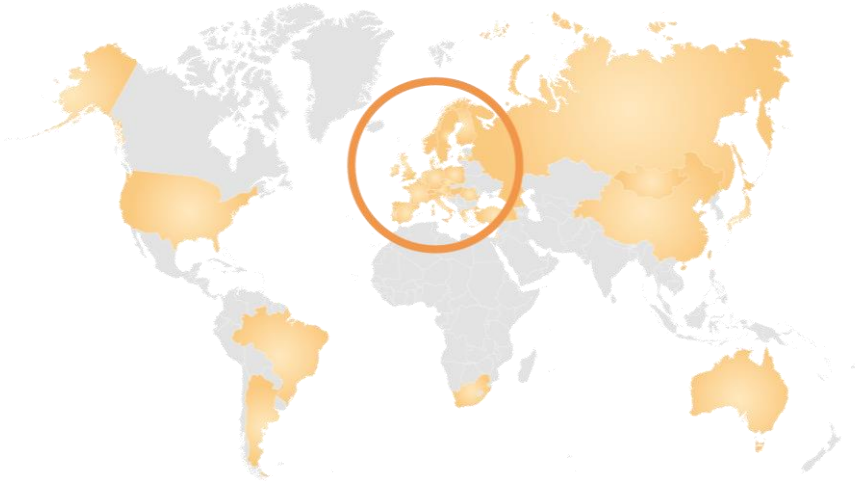
Our mission is…

…to support our members in their operational business.

…to support our members in strategic challenges.

…to be a key contact for international energy stakeholders.

- We have **437 members in 33 countries**, over 90% are European based
- We represent an installed capacity of **302 GW** based on renewable and conventional energy sources.



VGB is the International Technical Association for Heat and Power generation and storage. Founded in 1920 it is based on a voluntary association of companies active in the energy business.

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2. Europe‘s Energy Policy Targets

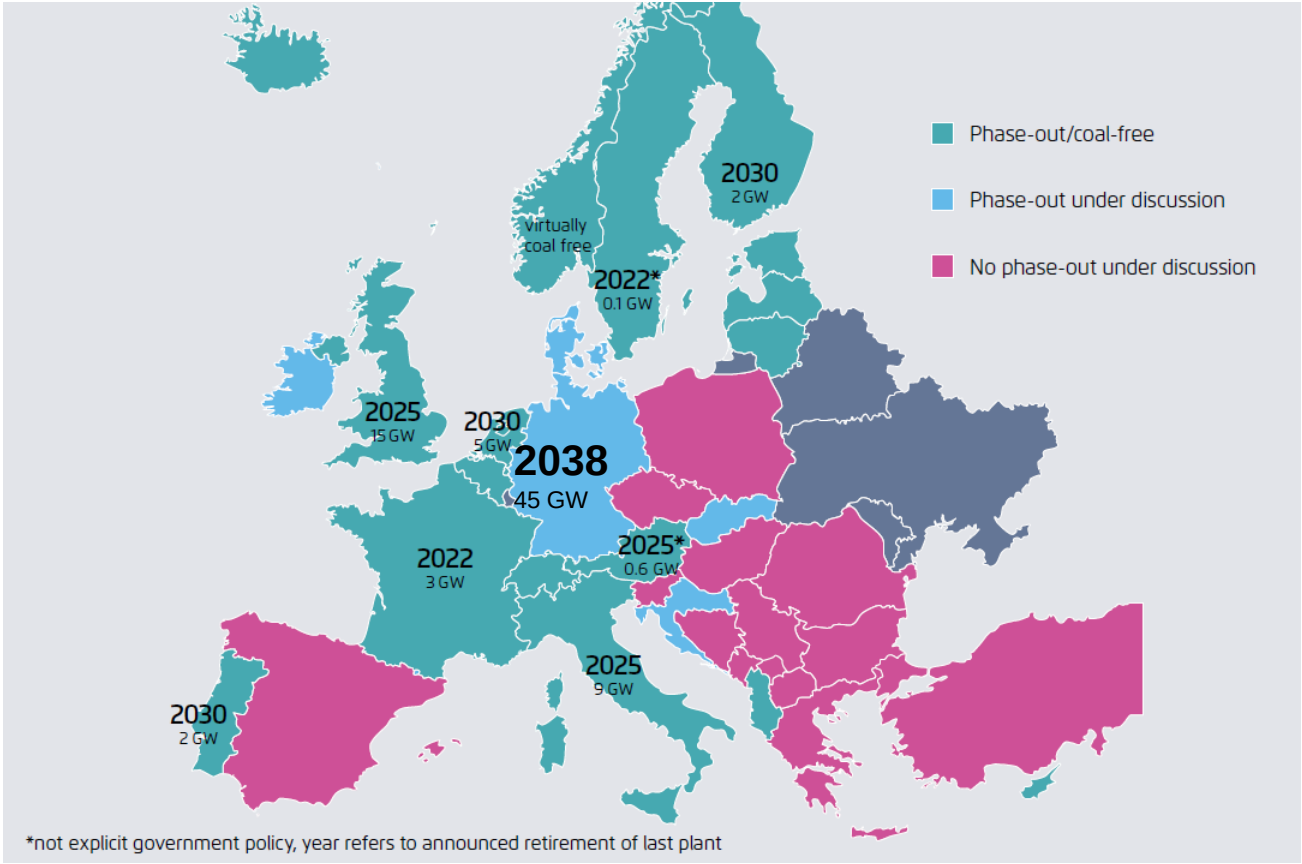
2030

min 40 % Greenhouse Gas Emission Reduction compared to 1990	**min 32 %** Renewable Energy Consumption	**32.5 %** Increase of Energy Efficiency	**min 15%** Interconnection

Phase-out of Nuclear Power Plants in **2022**	**45 %** Share of Renewables in Electricity in **2025**	**40 %** Greenhouse Gas Emission Reduction until **2030** comp. to 1990	**50 %** Less primary energy con-sumption until **2050** comp. to 2008

A 50% reduction of greenhouse gases by 2030 is under discussion in the EU and in different European countries. The EU Green Deal aims at climate neutrality in 2050.

2. Coal phase-out in Europe has started

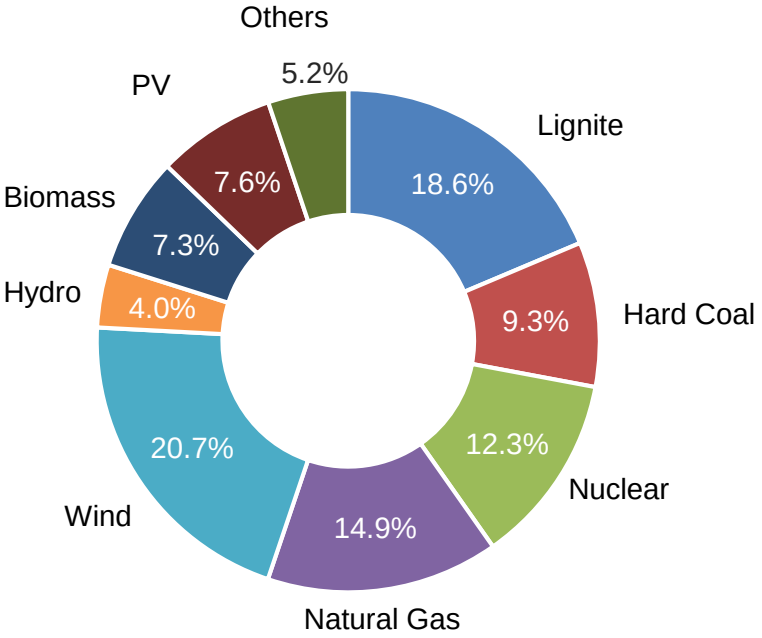


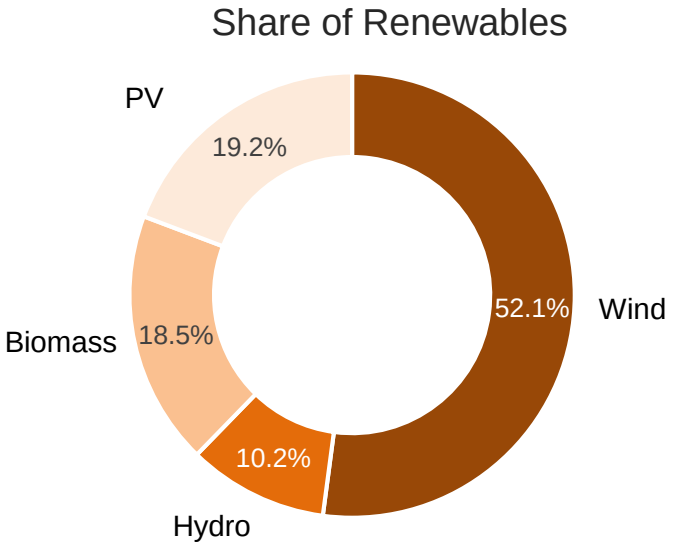
Political acceptance of coal based generation is falling rapidly. Pressure to change to gas and energy storage; push for sector coupling technologies.

Source: Agora Energiewende and Sandbag (2018)

2. German Power Generation in 2019

Gross power production: 611,5 TWh
Installed capacity: 224 GW (120 GW Renewables)

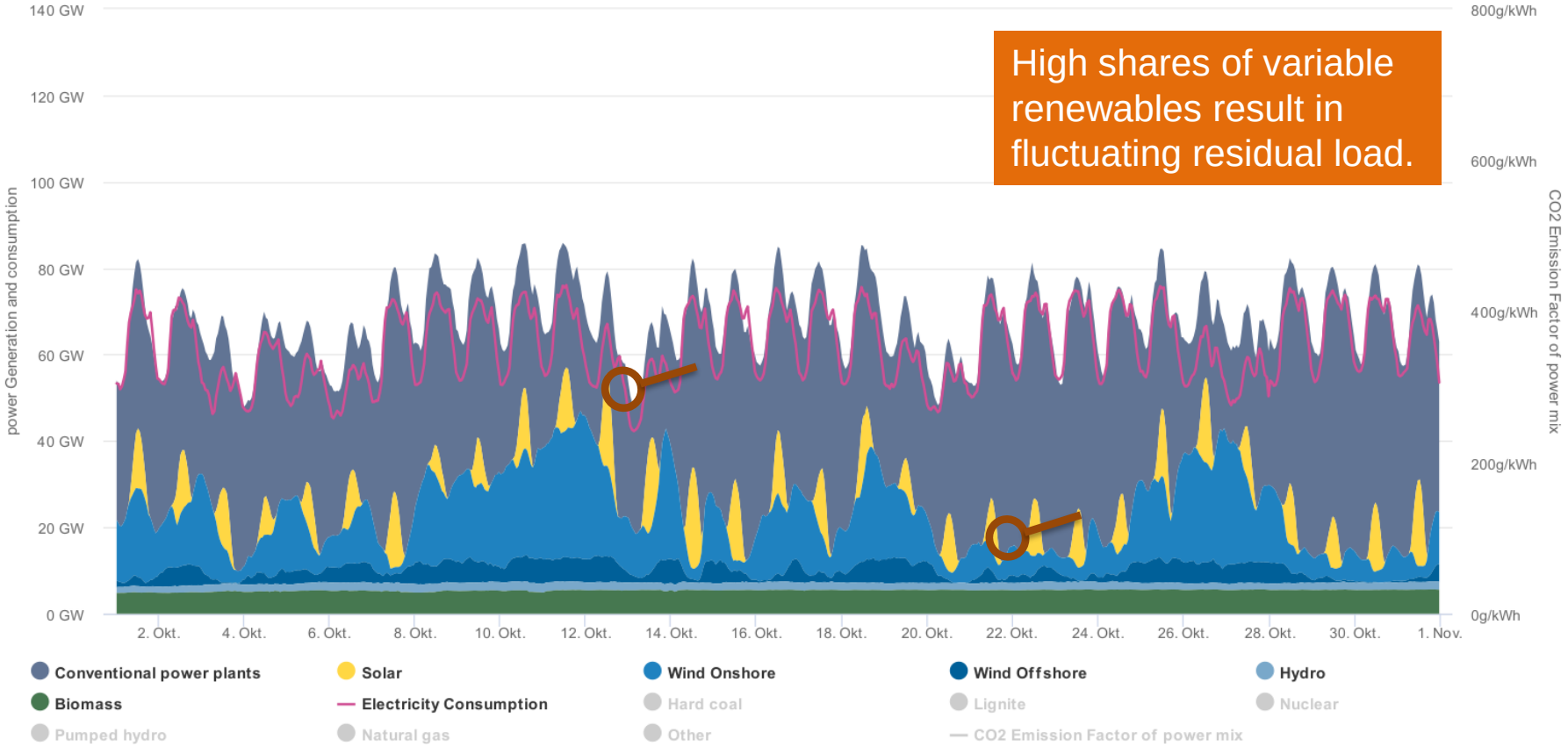




Source: AG Energiebilanzen

The share of renewables accounted for almost 40 per cent – Wind has become the main energy source.

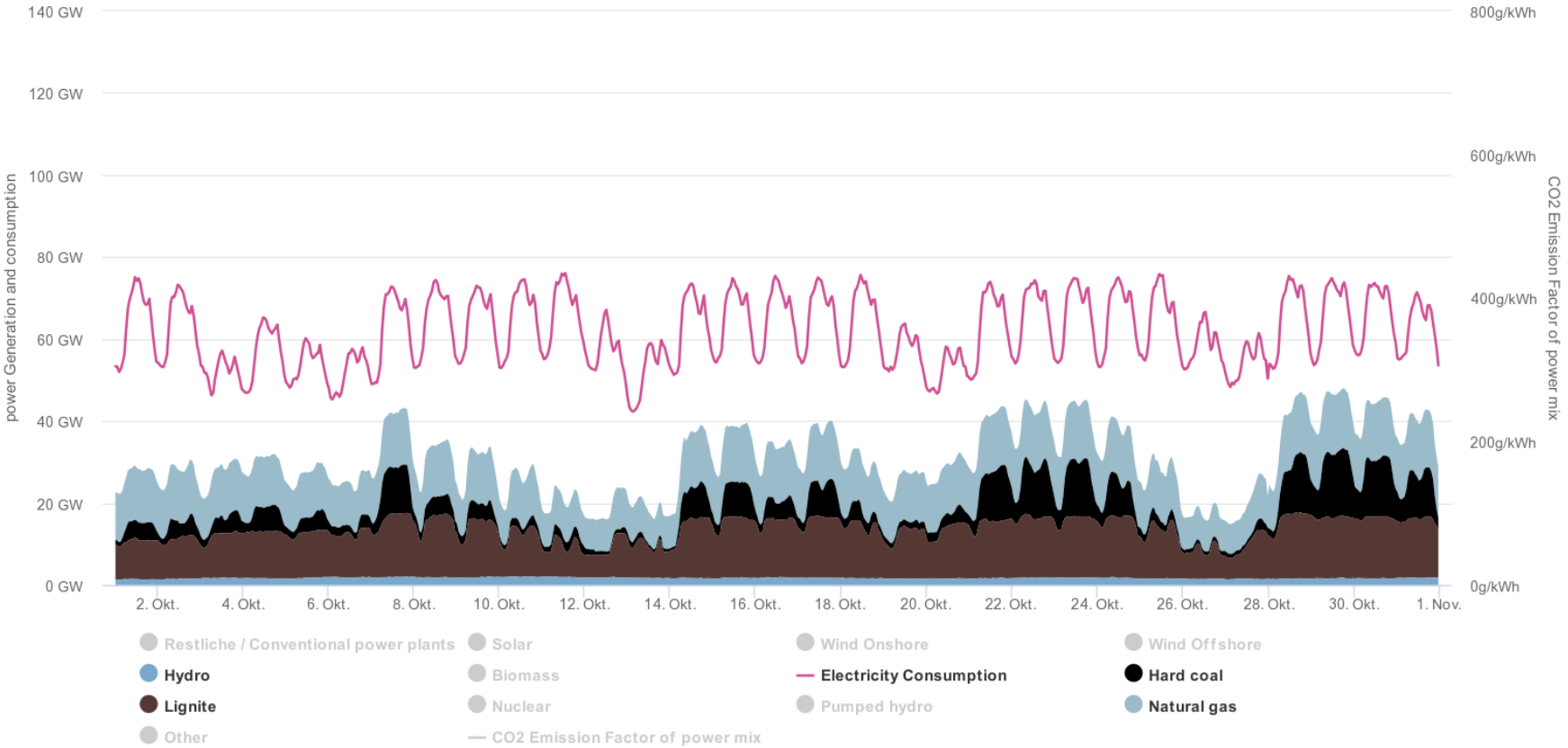
2. Power Generation in Germany



Generation portfolio in GW, Germany, October 2019

Agora Energiewende; Current to: 26.11.2019, 16:10

2. Power Generation in Germany



Generation portfolio in GW, Germany, October 2019

Agora Energiewende; Current to: 26.11.2019, 16:10

2. Future Electricity Supply

Variable generation		Dispatchable generation		Energy storage
Wind and PV	+	e.g. Thermal power plants	+	e.g. Pumped hydro, batteries

Requires flexibility

Deliver flexibility and residual load

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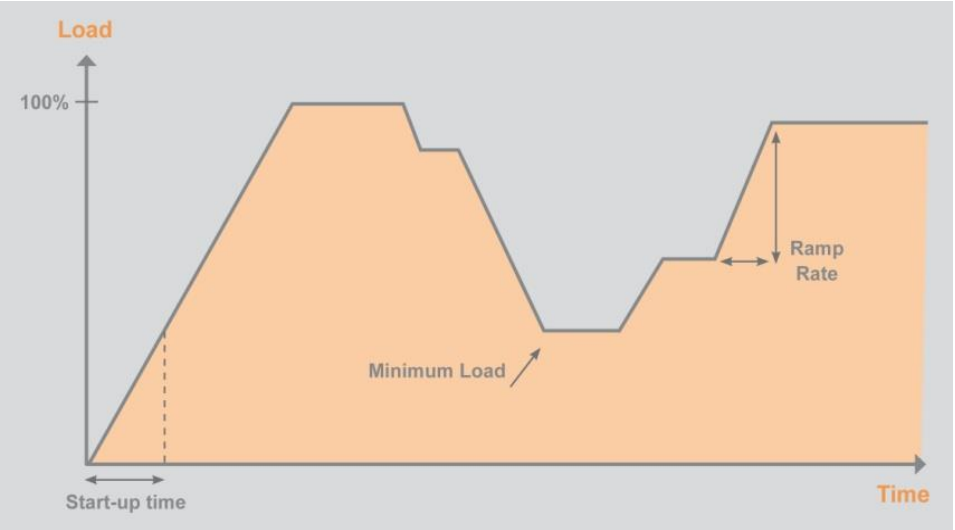
3. Flexibility of Power Plants

Flexible power plant operation:

- is characterized by low minimum load, high ramp rates and fast start-ups and shut-downs.
- requires a complete new way of thinking w.r.t. to the operational philosophy.
- has become a key design criteria for new thermal power plants.



Dispatchable power plants – e.g. thermal power plants – are important facilitators for the system integration of variable renewables.

3. Flexibility parameters of dispatchable generation

Plant type	Hard Coal	Lignite	CCGT	Pumped Storage
Ramp rate [% / min]	2 / 4 / 9	2 / 4 / 8	4 / 8 / 12	> 40%
in the load range [%]	40 to 90	50 to 90	40* to 90	
Minimum load [%]	40 / 25 / 10	60 / 40 / 20	50 / 40 / 30*	10
Start-up time hot start <8 h [h]	3 / 2 / 1	6 / 4 / 2	1.5 / 1 / 0.5	< 0.2
Start-up time cold start >48 h [h]	7 / 4 / 2	8 / 6 / 3	3 / 2 / 1	< 0.2

Source: VDE and own studies
Conservative / state of the art / very advanced; *as per emission limits for NO_x and CO

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4. Flexibility Test at Dadri Power Plant 1/2

Achievements:
Stable operation at 200 MW (40% load) for 4 hours at Dadri unit 6 achieved on 21 June 2018

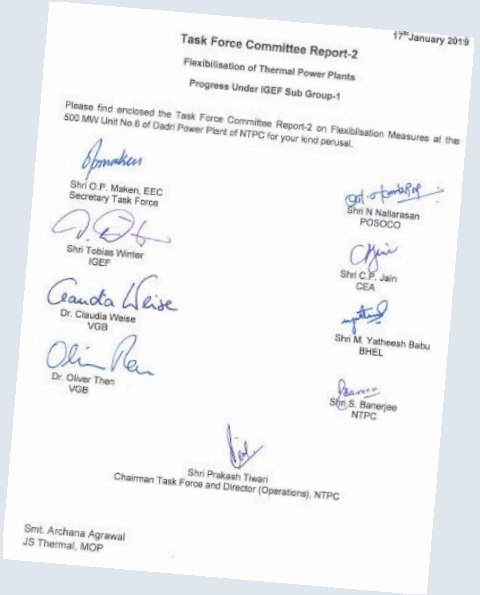
Successful ramping tests on June 22, 2018:

- 500 MW to 200 MW to 500 MW at 5 MW/min
- 500 MW to 200 MW to 500 MW at 15 MW/min

4. Flexibility Test at Dadri Power Plant 2/2

Recommendations for measures to ensure stable min load operation are included in the Task Force Report No 2, handed over in March 2019

1. **Optimization of existing controls**
   - Automatic Mill Operation (Mill Scheduler)
   - Main Steam Temperature Control
   - Reheat Steam Temperature Control
   - Automated Start of Fans and Pumps
   - Flue Gas Temperature Control
2. **Transparency about process conditions**
   - Thermal feasibility study
   - FEM analysis
   - Condition monitoring
3. **Installation of a modulating mechanism type recirculation valve** across the boiler feed pump to enhance the controllability of the process



Task Force Committee Report-2

17th January 2019

Flexibilisation of Thermal Power Plants

Progress Under IGEF Sub Group-1

Please find enclosed the Task Force Committee Report-2 on Flexibilisation Measures at the 500 MW Unit No.6 of Dadri Power Plant of NTPC for your kind perusal.

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Secretary Task Force

Shri N Nallarsan
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Shri C.P. Jain
CEA

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Shri M. Yatheesh Babu
BHEL

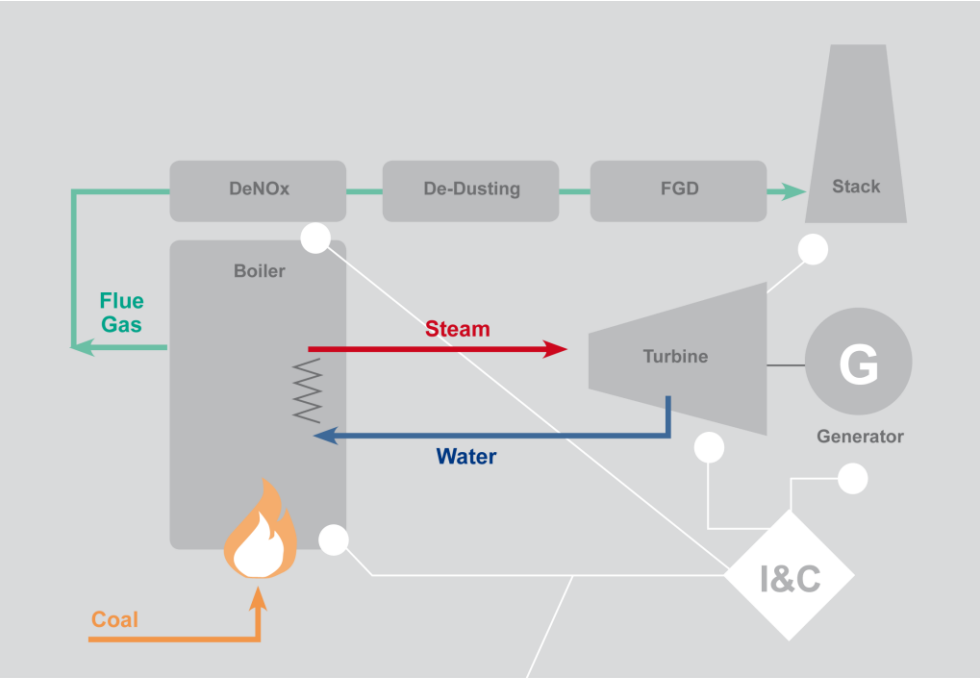
Dr. Oliver Then
VGB

Shri S. Banerjee
NTPC

Shri Prakash Tiwari
Chairman Task Force and Director (Operations), NTPC

Smt. Archana Agrawal
JS Thermal, MOP

4. Flexibility Toolbox



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

The toolbox includes 40 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.

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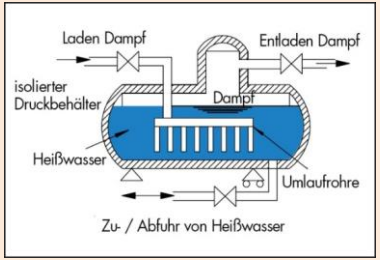
5. Integration of Thermal Storage Technologies

Liquid salt: indirectly integrated into the water-steam cycle

Solid material: indirectly integrated into the flue gas path

Ruth: directly integrated into the water-steam cycle



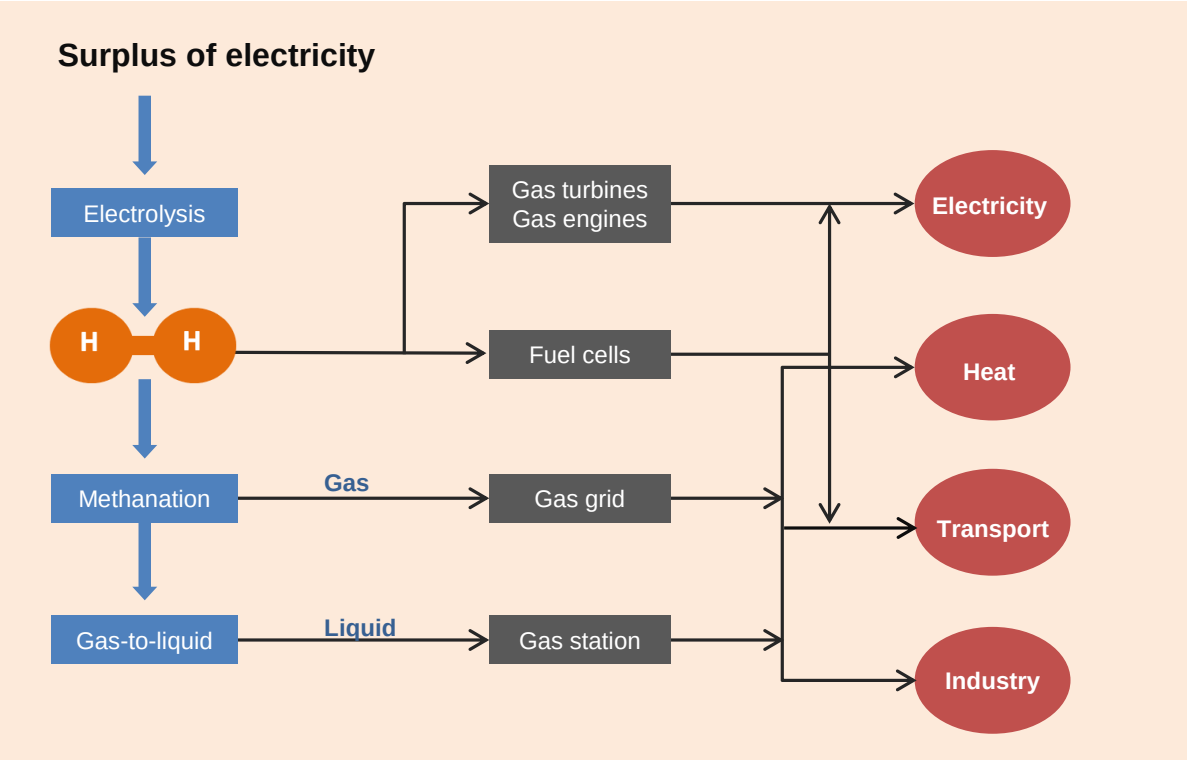
Integration of a **thermal storage system** into a coal fired power plant „Flexi-TES“

- Duration from January 2017 to December 2019
- Assessment of different storage concepts and their integration into new built and existing plants
- Specification of a cost-efficient and low-risk design

Project Consortia

Source: R&D project Flexi-TES

5. Sector Coupling by Power-to-X



"National Hydrogen Strategy" was just announced by the German Government

Basic processes for Power-to-x are well known. Key issues are large-scale commercial operation, flexibility and system integration.

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6. Conclusion

- European energy politics aim at an energy system mainly based on variable renewable energies (VRE).
- The phase-out of coal has been started in some European countries; new build will be very unlikely in the future.
- R&D activities in coal-fired power plants are mainly focused on flexibility enhancements.
- Sector coupling is gaining importance – Power-to-X is one the key R&D themes.
- VGB is eager to share experiences and lessons learnt with international partners.

6. VGB's – Flexibility Landing Page

- Facts and figures about flexibility provided by dispatchable generation
- Reports and publications as downloads available – e.g. "Flexibilty Toolbox for coal-fired power plants"

धन्यवाद

Thank you
for your interest!

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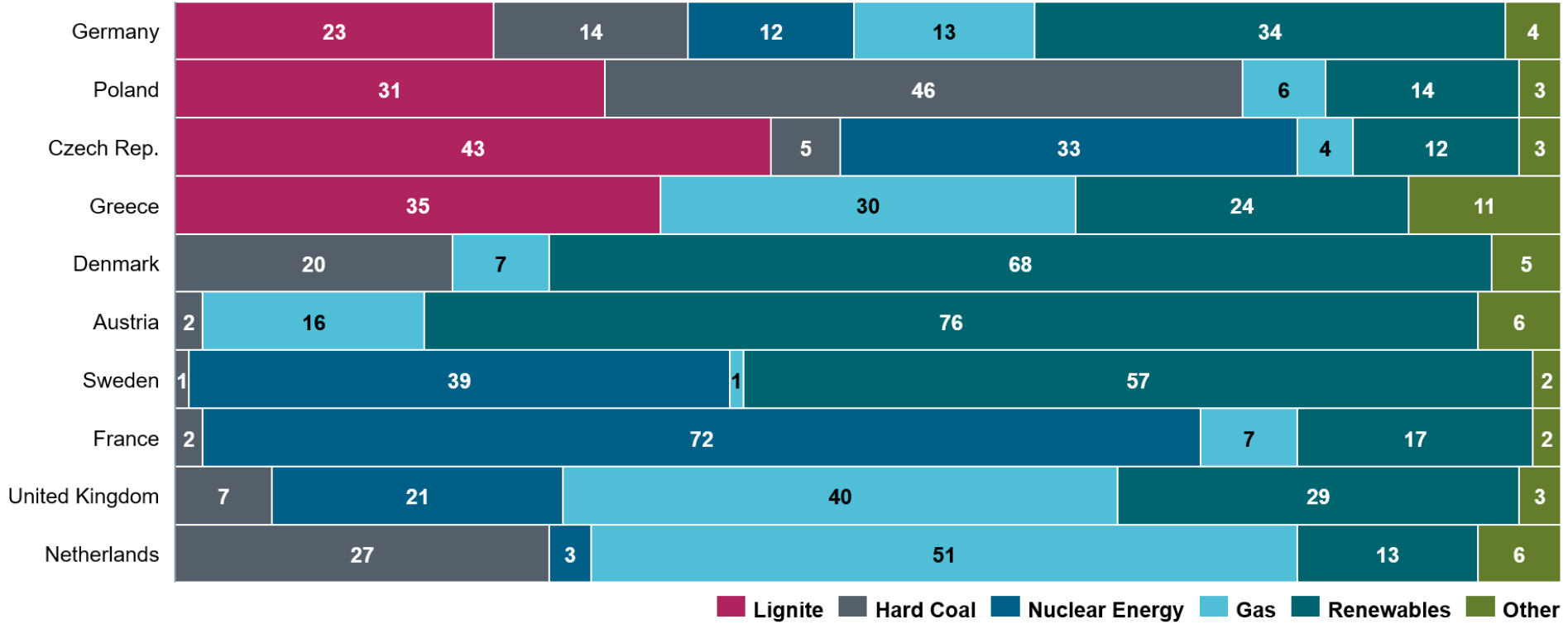
BACK-UP

Energy Mix in Europe

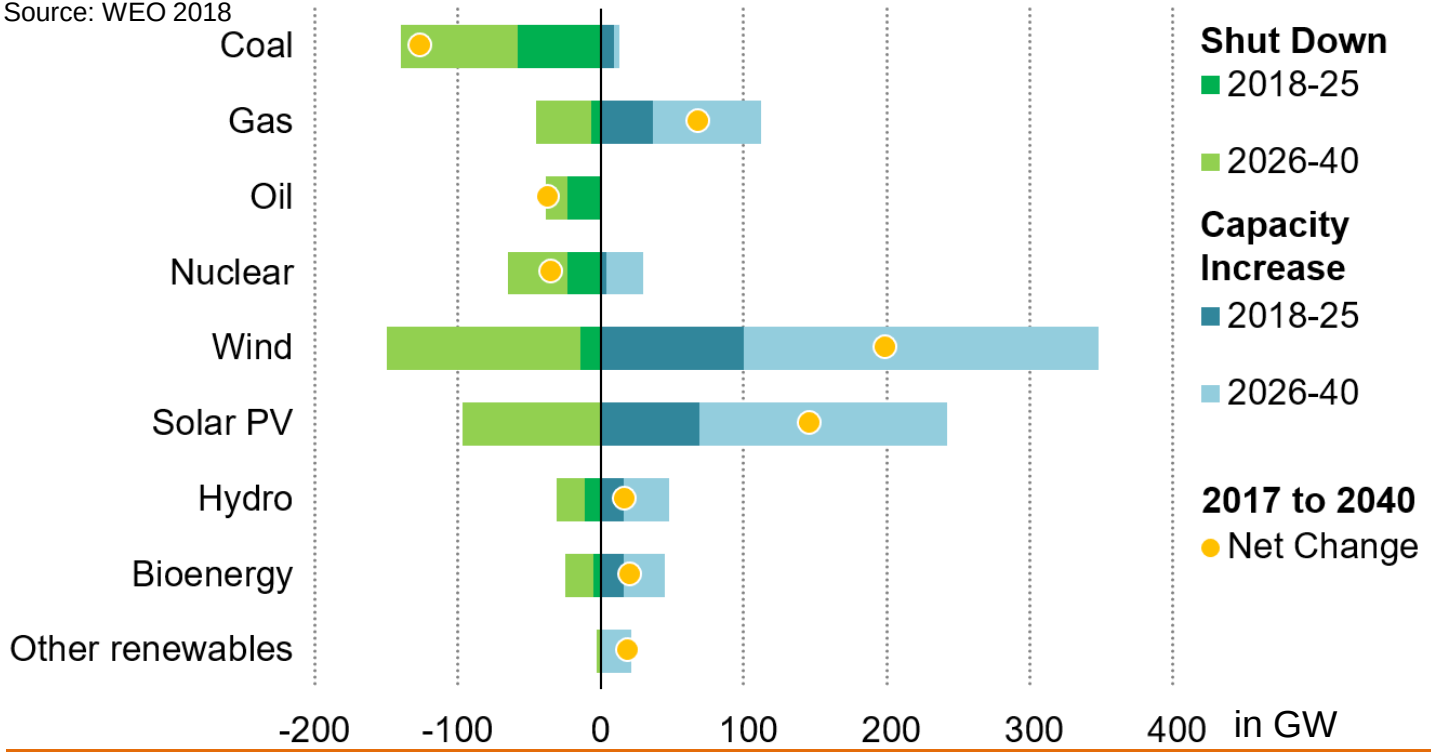
Energy mix in % based on 2017 data



Source: IEA, Electricity Information 2018

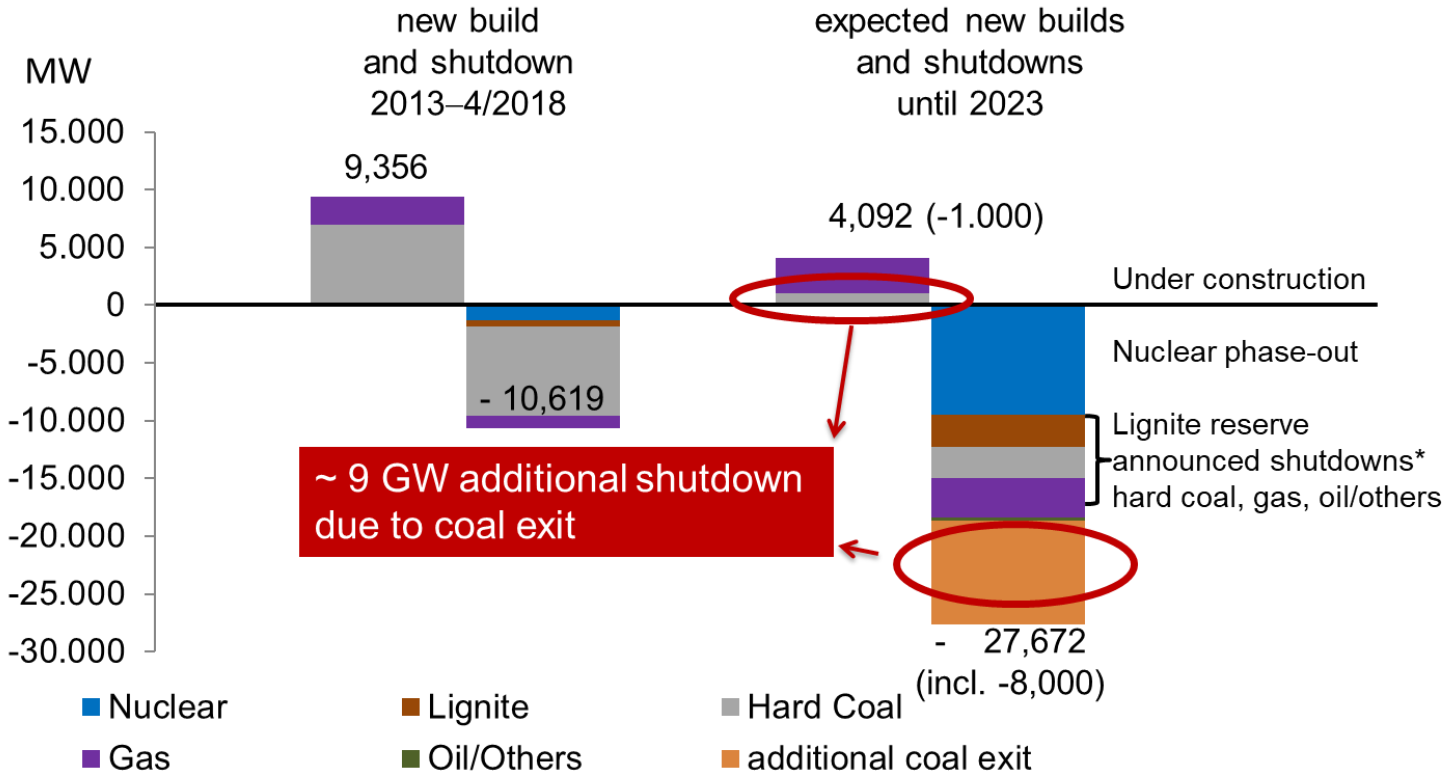
3. Capacity Development in EU28

Source: WEO 2018



In the absence of commercially viable energy storage solutions dispatchable resp. secure generation capacity is essential to cover the European electricity demand (peak load is about 540 GW).

3. Development of Fossil Capacity in Germany



* Subject to decision of Bundesnetzagentur on system relevance, Source: BNetzA, BDEW

The significant shutdown of dispatchable conventional generation will not be covered by capacity additions except on basis of VRE. There is no business case for additional gas fired generation so far (except for CHP).