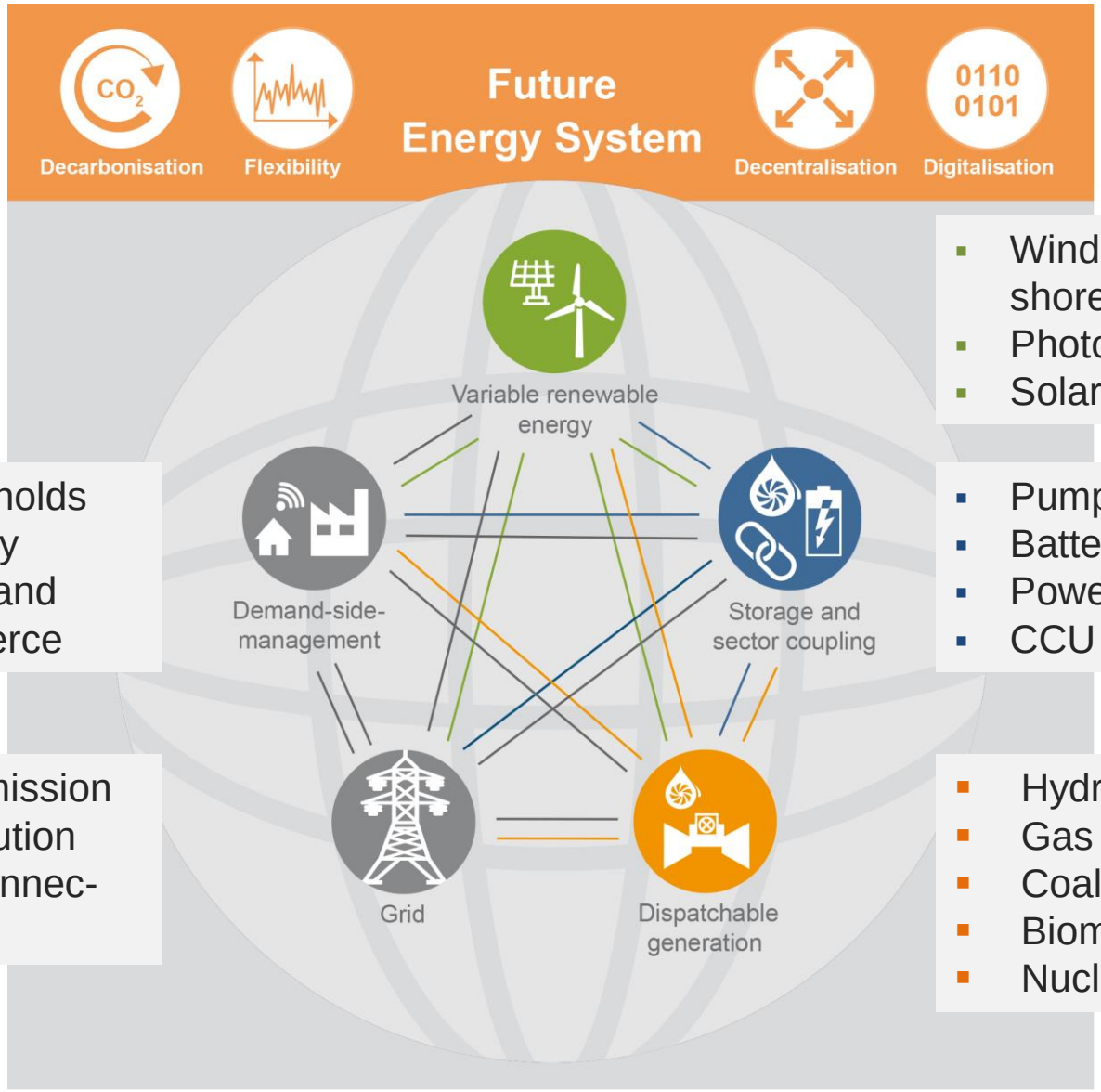
Indo-German Energy Forum

New Delhi, 1 November 2019

How does VGB support the grid integration of variable renewables?

Flexibility Options in the Future Energy System



- Households
- Industry
- Trade and commerce

- Transmission
- Distribution
- Interconnec-tions

- Wind on-shore/offshore
- Photovoltaik
- Solar thermal

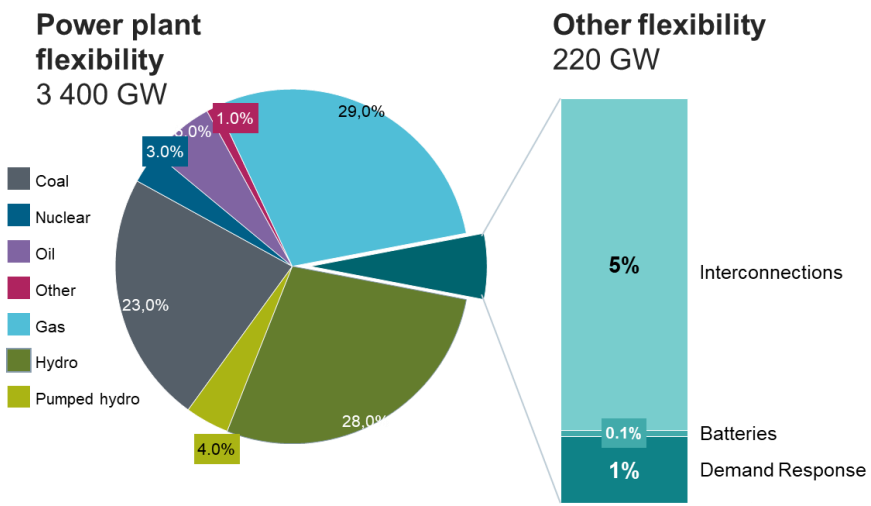
- Pump storage
- Batteries
- Power-to-X
- CCU

- Hydro
- Gas
- Coal
- Biomass
- Nuclear

Flexibility Projections according to WEO2018

Source: WEO 2018

2017



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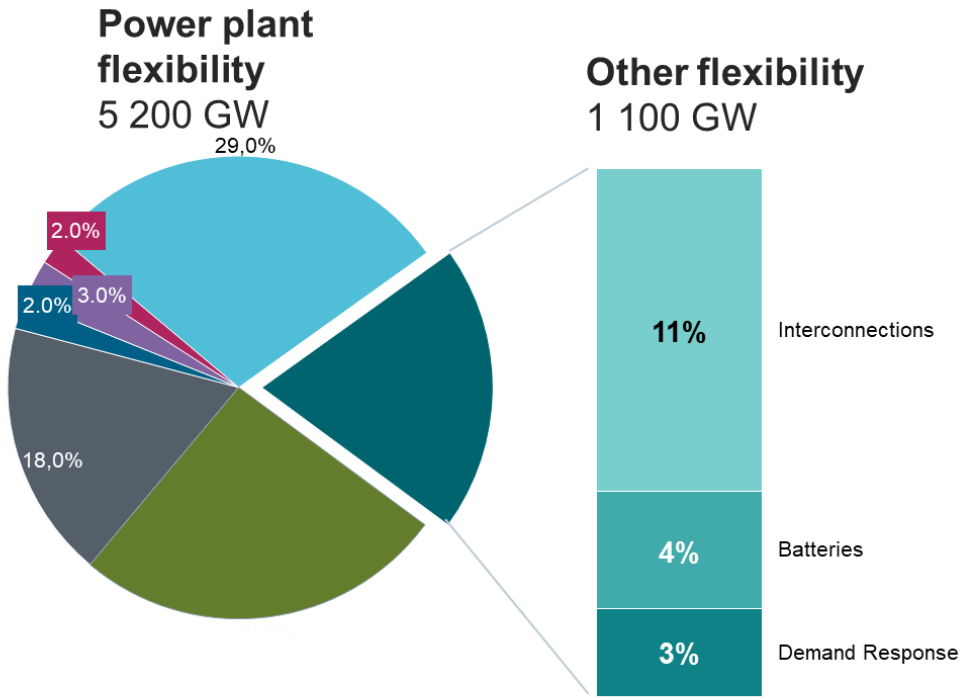
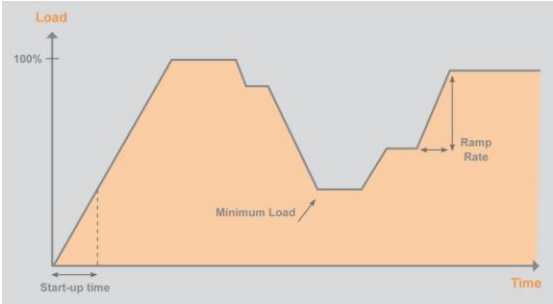


Dispatchable generation is and remains the most important flexibility option to offset the volatile characteristics of VRE. Development of alternative technology pathways is required.

Flexibility Parameters of Dispatchable Generation

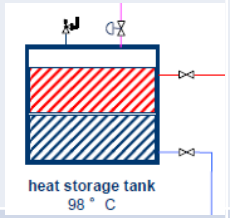


Plant type	Hard coal	Lignite	CCGT	Pump Storage
Load ramps [% / min]	2 / 4 / 8	2 / 4 / 8	4 / 8 / 12	> 50%
Load range [%]	40 to 90	50 to 90	40* to 90	
Minimum load [%]	40 / 25 / 10	60 / 40 / 20	50 / 40 / 30*	10
Start-up time hot start <8 h [h]	3 / 2 / 1	6 / 4 / 2	1.5 / 1 / 0.5	< 0.2
Start-up time cold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

Source: VDE and own studies; average/ state of the art / potential

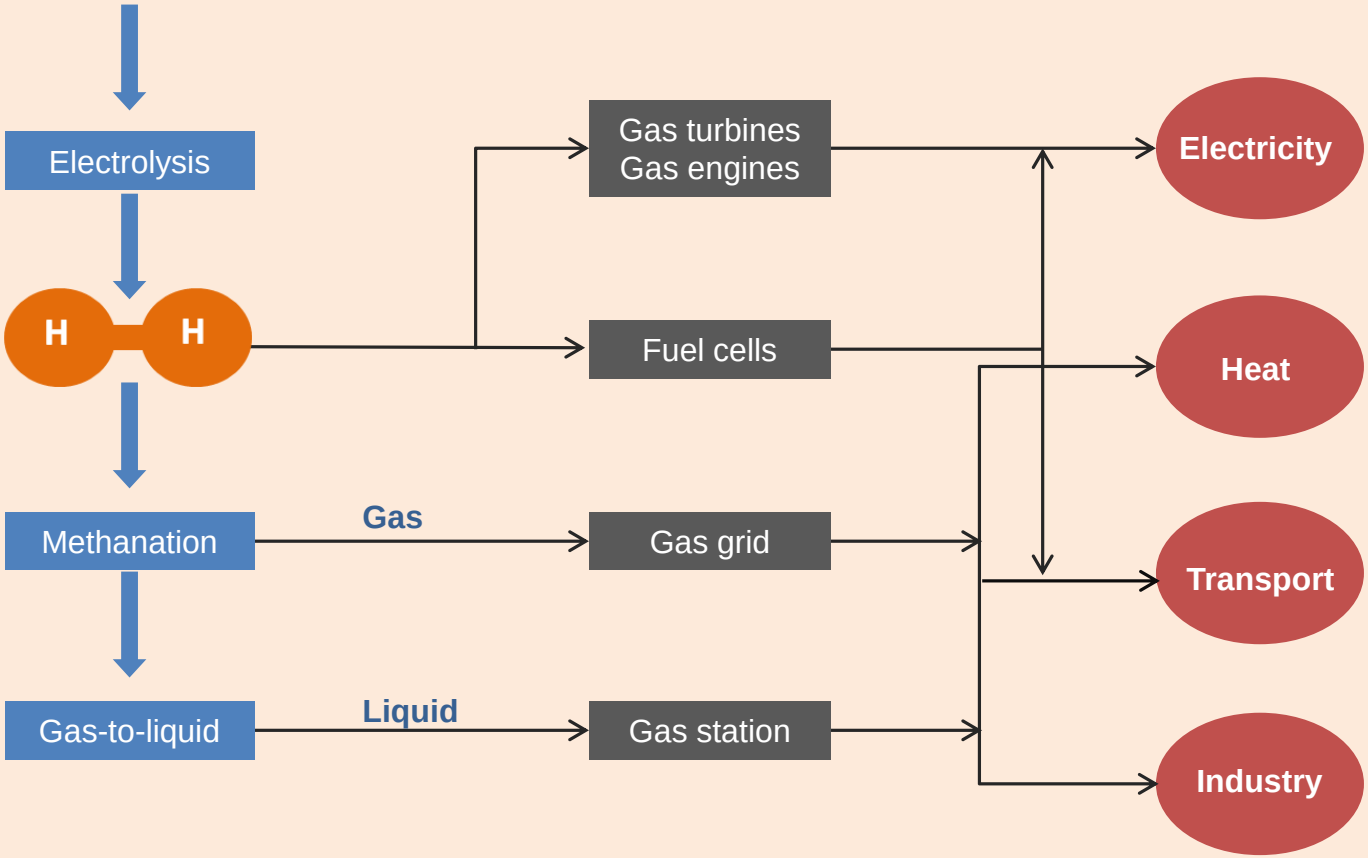
The flexibility characteristics of dispatchable power plants could be significantly improved. The potential for retrofits is significant worldwide.

Storage Technologies

	Short-term storage < 30 min	Medium-term storage 1 – 5 hours	Long-term storage > 1 day up to months
Small scale & modular storage **1 kW – 1 MW**	mobile storage (Lithium) 	home storage + PV (Lithium) 	
Medium scale & modular storage **1 kW – 100 MW**	stationary storage (Lithium / lead-acid) 	heat and stationary storage (redox flow) 	
Large scale & central storage **100 MW – 1 GW**		pumped storage 	Power to X - gas - liquid - chemicals 

Source: VGB based on Prof. Sauer, RWTH Aachen

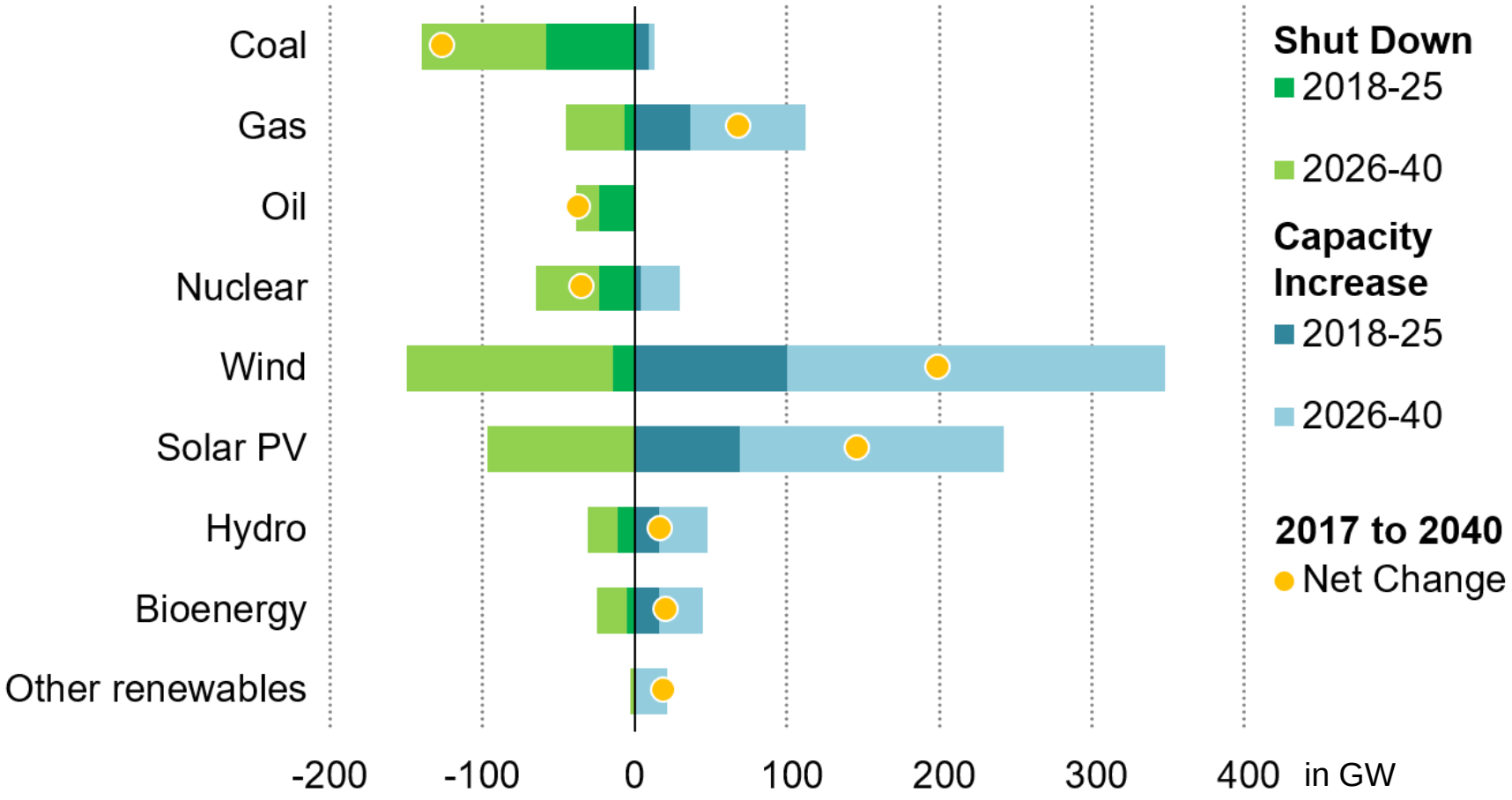
Storage technologies of different Technology Readiness Levels (TRL) are available. Cost reduction and commercialization of new technologies are necessary.



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

Ensuring Security of Energy Supply

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).