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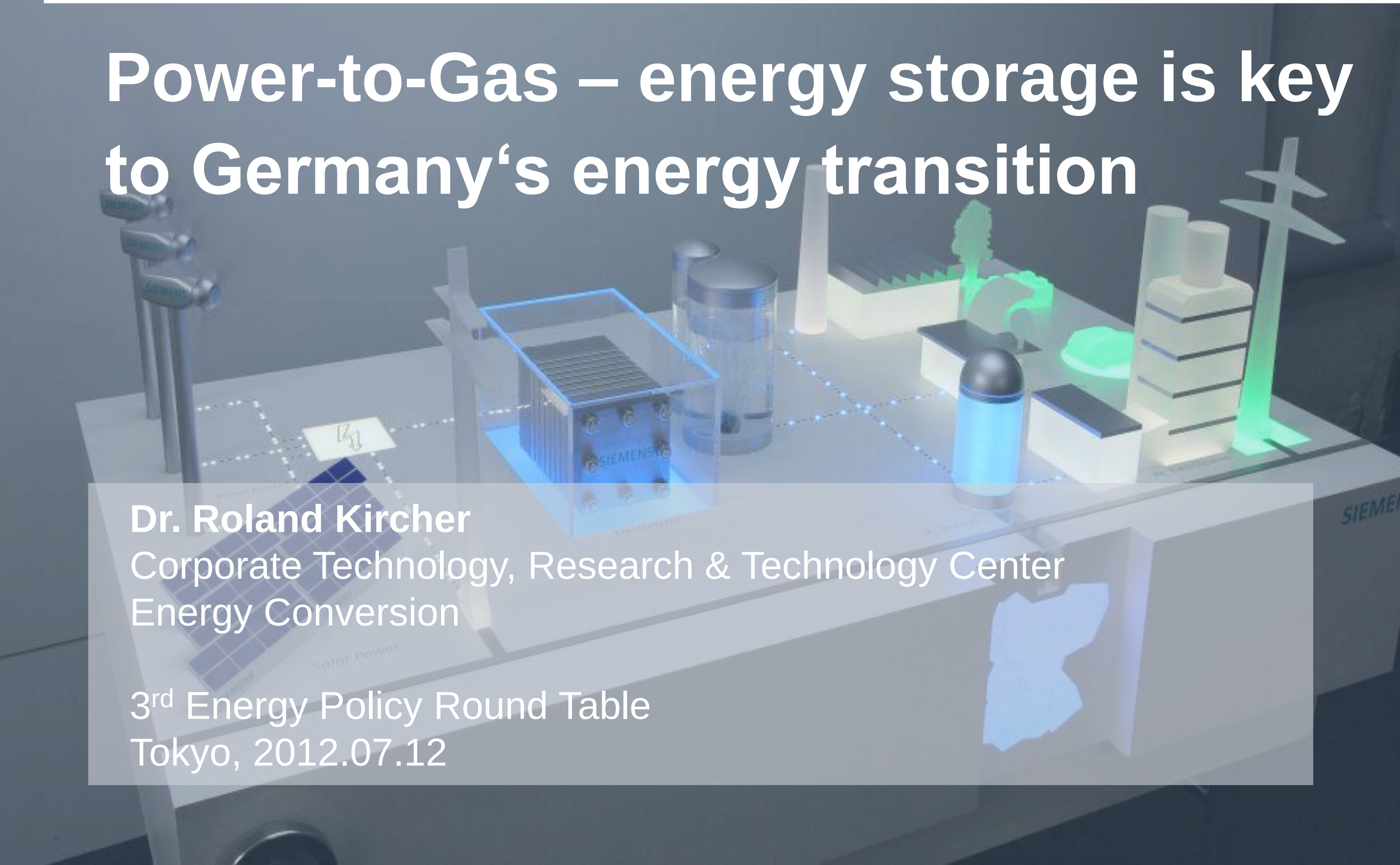
Power-to-Gas – energy storage is key to Germany‘s energy transition



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3rd Energy Policy Round Table
Tokyo, 2012.07.12

Germany's energy transition – Three different scenarios for securing the necessary capacity

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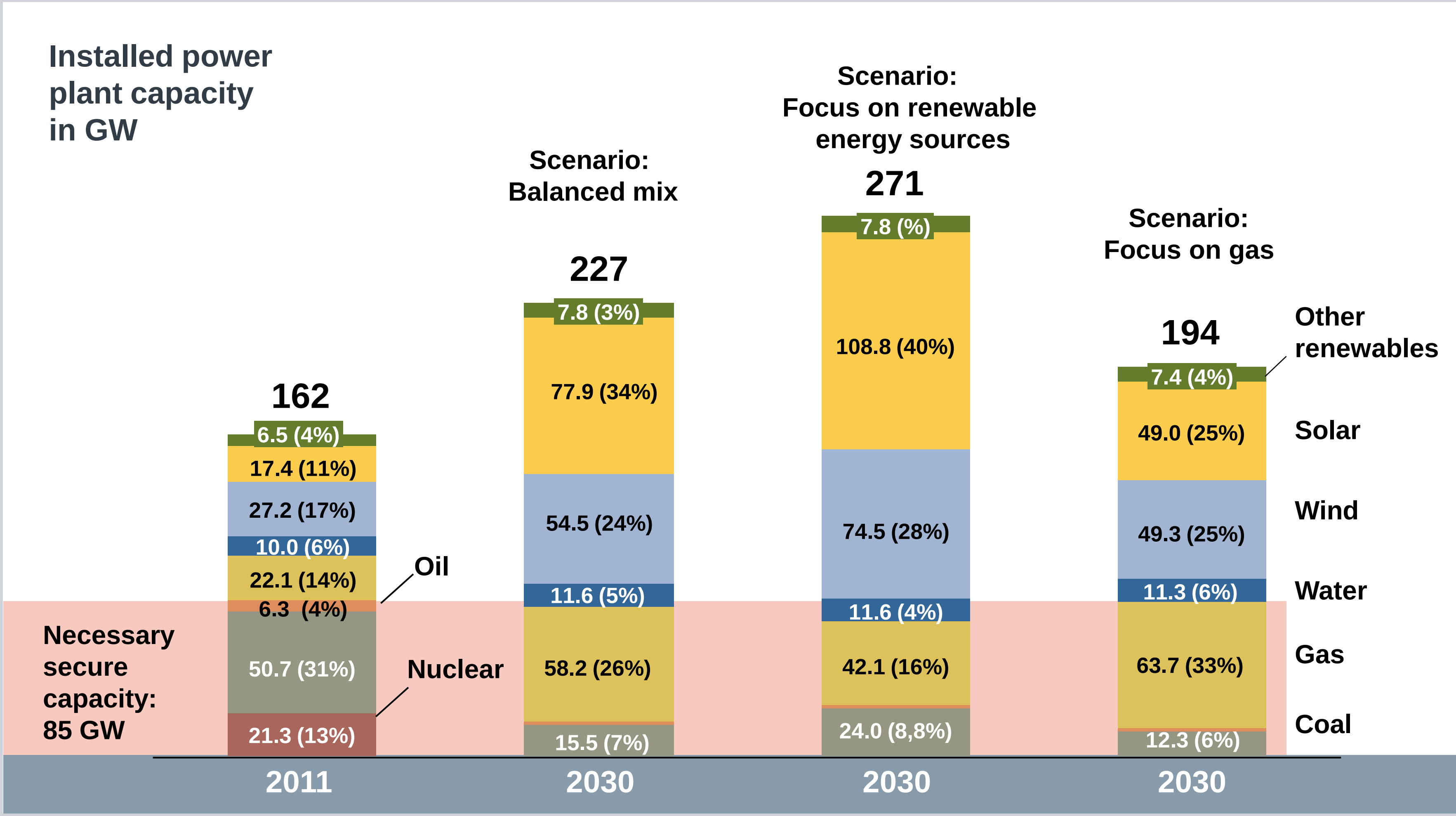

Integration of renewable energy sources in 2020 - effects on the transmission grid

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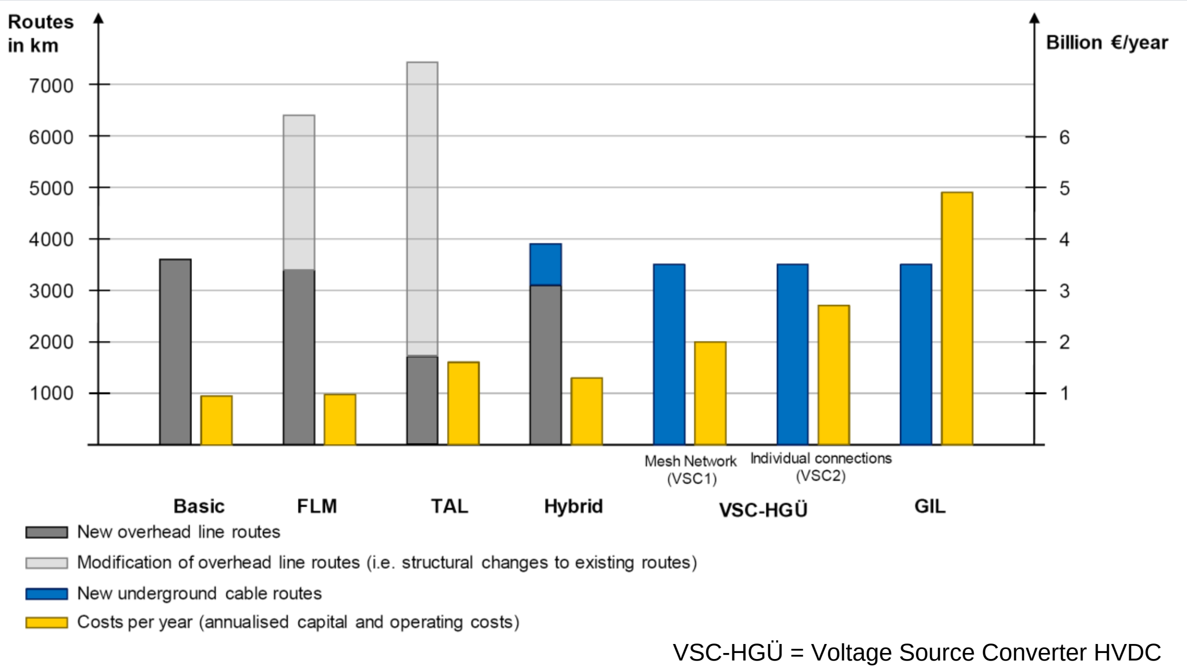
Scenarios:

(1) Basic grid with standard transmission capacity, without additional storage

(2) New HV routes with Flexible Line Management (FLM)

(3) High-temperature conductors (TAL)

Scenario	Need for construction of additional routes	Route length to be modified	Costs
(1)	3600 km	0 km	€ 0.946 bill. pa
(2)	3500 km	3100 km	€ 0.985 bill. pa
(3)	1700 km	5700 km	€ 1.617 bill. pa



Source: dena Grid Study II (2011)

Transmission technologies:

- Conv. 380 kV AC overhead lines
- 800 kV AC overhead lines
- Underground 380 kV cables
- HVDC transmission based on overhead lines
- Underground HVDC cables
- Gas-insulated lines (GIL)

What is the energy storage needed for a 85% RE scenario in Germany?

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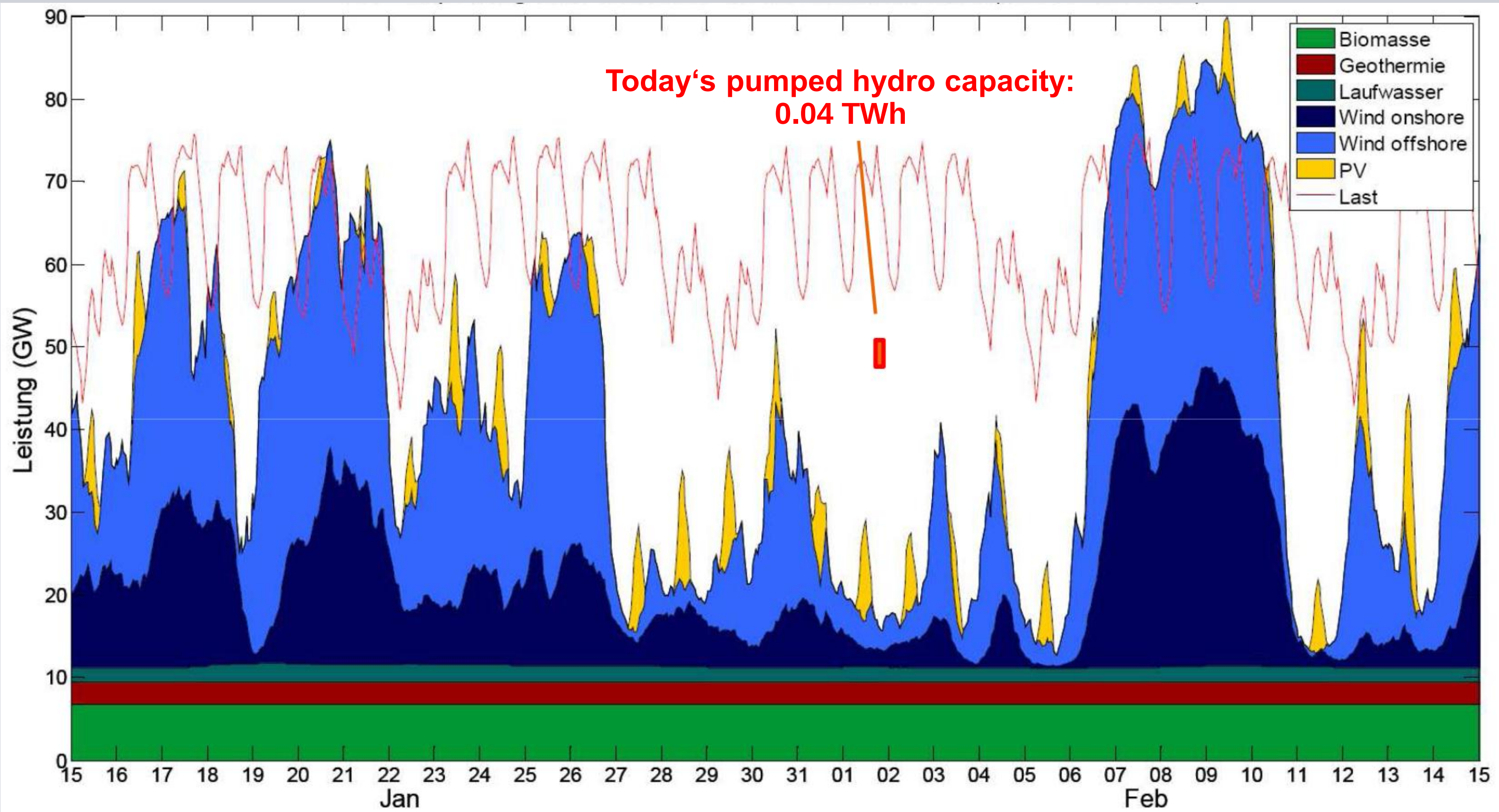

PV: 65 GW
$Wind_{on}$: 40 GW
$Wind_{off}$: 40 GW

In case of 85% renewable energy supply, transport and storage will be the main issues.
For a reliable power supply the energy demand of 20 days defines the required capacity of 30 TWh.

Sources: FhG IWES (2010); DLR; Nitsch, Sterner, et al. 2010 (BMU Leitszenarien Zwischenbericht)

Hydrogen as storable energy carrier –
Green production from excess renewable energy

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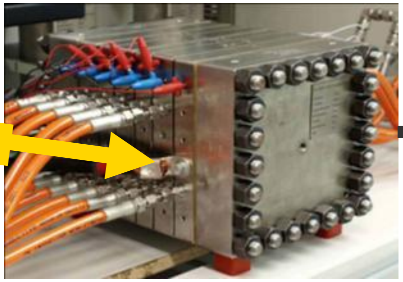
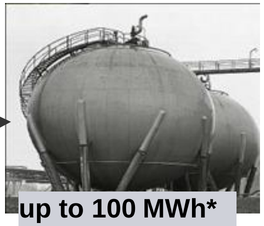
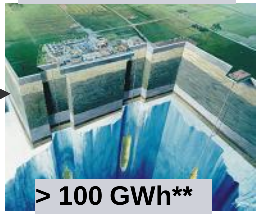
Generation → **Conversion** → **Storage** → **Application**



O_2

H_2





1. Industrial use (semiconductor, metals, float glass, food hydrogenation)
2. Re-electrification via gas turbine (saving of CH_4)
3. Heating for households and industry (additive to CH_4)
4. Fuel for vehicles (combustion engines or fuel cells)
5. Synthesis of bio-fuels and chemical raw materials via CO_2 fixation (e.g. MeOH, CH_4, ...)

* on the basis of 50 bar
** on the basis of 50 bar; more than 300 bar demonstrated

Hydrogen is a multi-functional and easily storable energy carrier

German gas and power grid

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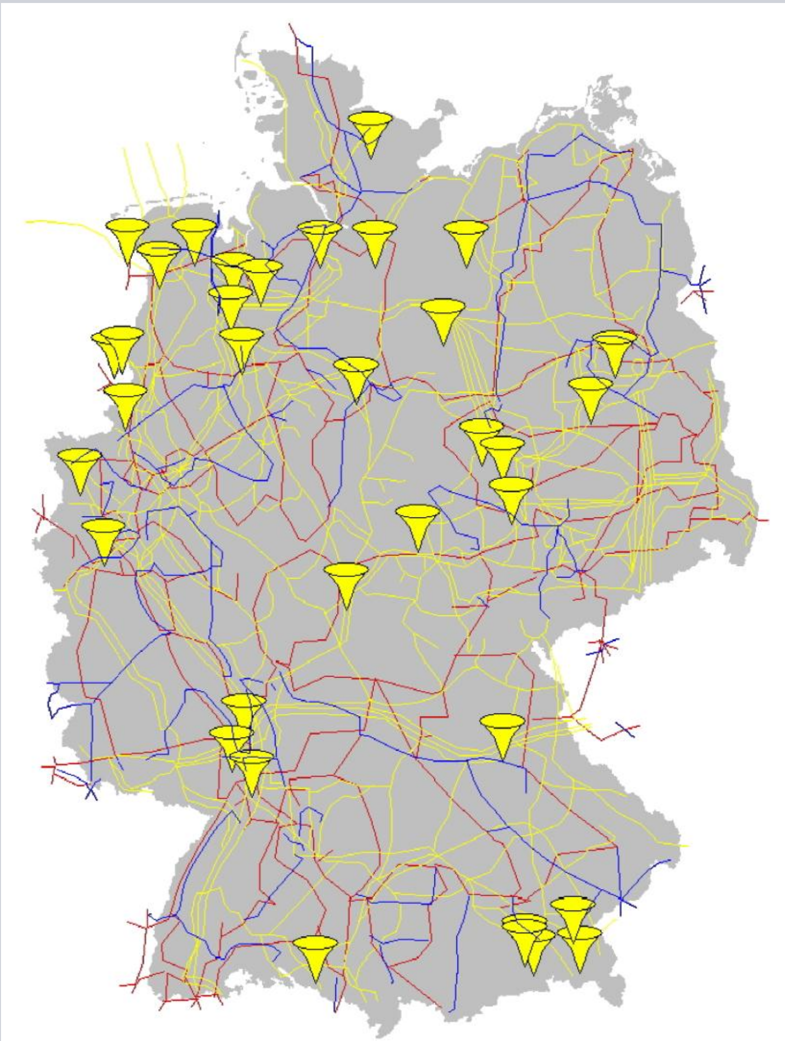
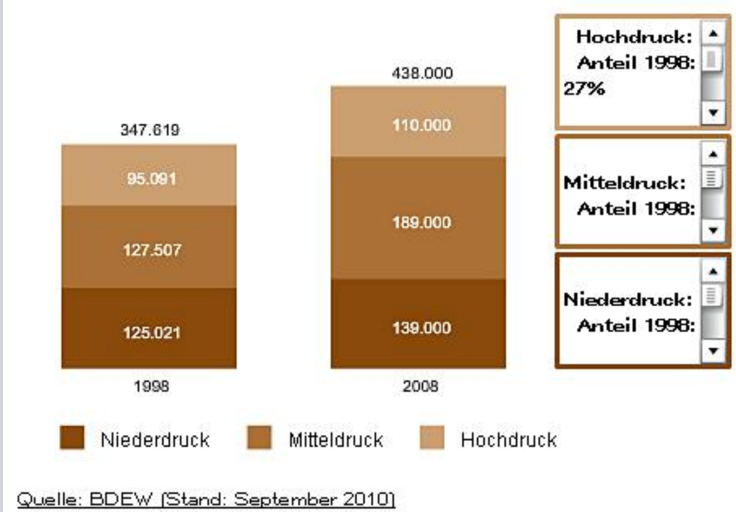


- ▽ **Natural gas storage facility**
- (yellow line) **Natural gas transportation grid >60 bar**
- (black line) **Power grid 220 kV**
- (red line) **Power grid 380 kV**

Source: DVGW Innovation initiative (2011)

The gas grid in Germany is growing

Length of the gas grid in Germany (in km)



Situation of the energy supply system - a comparison of the situation in Japan and in Germany

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Japan	Germany
no or negligible resources	no or negligible resources
after Chernobyl: increase of nuclear power generation (reduce dependency on imports)	no additional NPPs (vanishing acceptance), increase of renewable power generation
after Fukushima: stress test of the remaining 50 NPPs, review of safety concept	Review of Germany‘s energy future by the Ethics Commission for a Safe Energy Supply: recommendation for withdrawal from nuclear energy within 10 years Decision of government: to shut down all NPPs until end of 2022
Island with 2 independent electricity grids (Higashi-Nihon 50 Hz, Nishi-Nihon 60 Hz)	Germany is one of the 34 members of the European ENTSOE grid system (electricity transfer, balance, EEX)
Japan increased fossil PP operation during safety review of NPPs; increase of energy efficiency, peak shaving measures; still holding on to nuclear power	Increase of renewable power generation (PV, wind), concepts for acceleration of energy transition funding programs (national and states level) still electricity net exporting country

Other countries too decide to stop / not use nuclear power (Austria, Belgium, Italy, Kuwait, Switzerland; some countries rapidly expand renewable energy use (e.g. large scale wind park in China)

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Consequences and need for actions

Germany‘s energy transition triggered by abandoning nuclear energy requires

- utilization of reasonable **energy saving measures through increased efficiency** in industry and households
- a further expansion of **renewable power generation** (wind, solar, ...) until 2022
- top priority to the **extension of the existing power grid** for optimized feed in of renewable power generation
- additional construction of **flexible power plants**
- a practically relevant evaluation of various **storage technologies suitable for grid applications**. Special focus should be on **hydrogen as energy carrier** (flexible use, easy to store)
- a step by step introduction of **intelligent grid technologies** („Smart Grid“) for stabilization of local distribution grids, and last but not least …
- ... a broad **consens in the society** regarding the conversion of the ambitious goals, e.g. by involving local communities