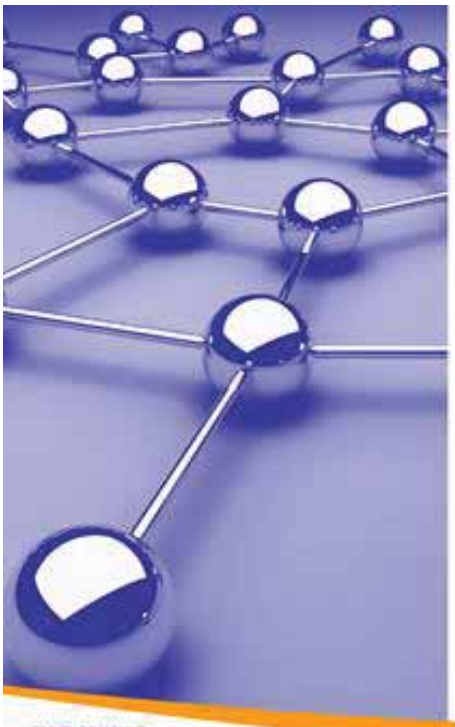

Gas Industry in Germany – Situation and Perspectives

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Days of Natural Gas Application

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TEAM CONSULT

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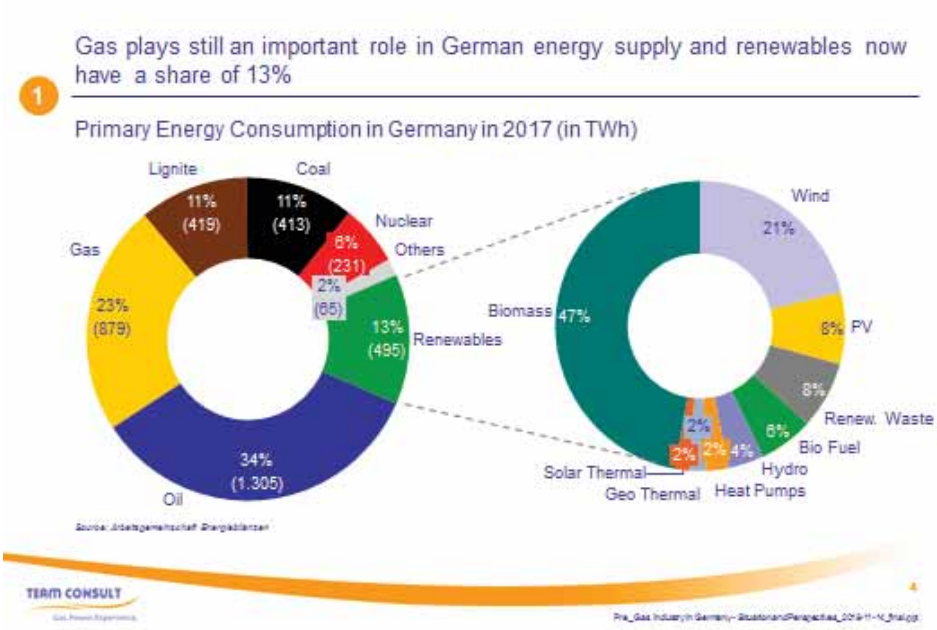
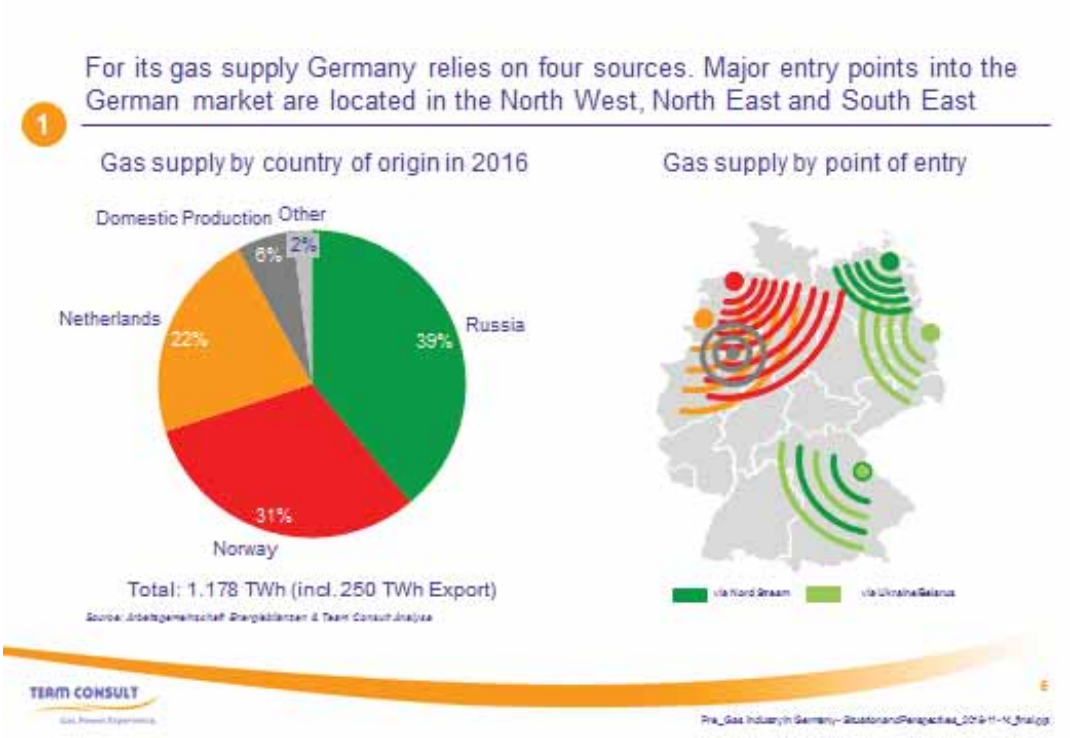
Agenda

1. **The current situation**
2. Motivation and Goals of the "Energiewende"
3. Challenges of the "Energiewende"
4. Reaching the goals - Sector coupling & Power-to-Gas
5. Summary



Primary Energy Consumption in Germany today

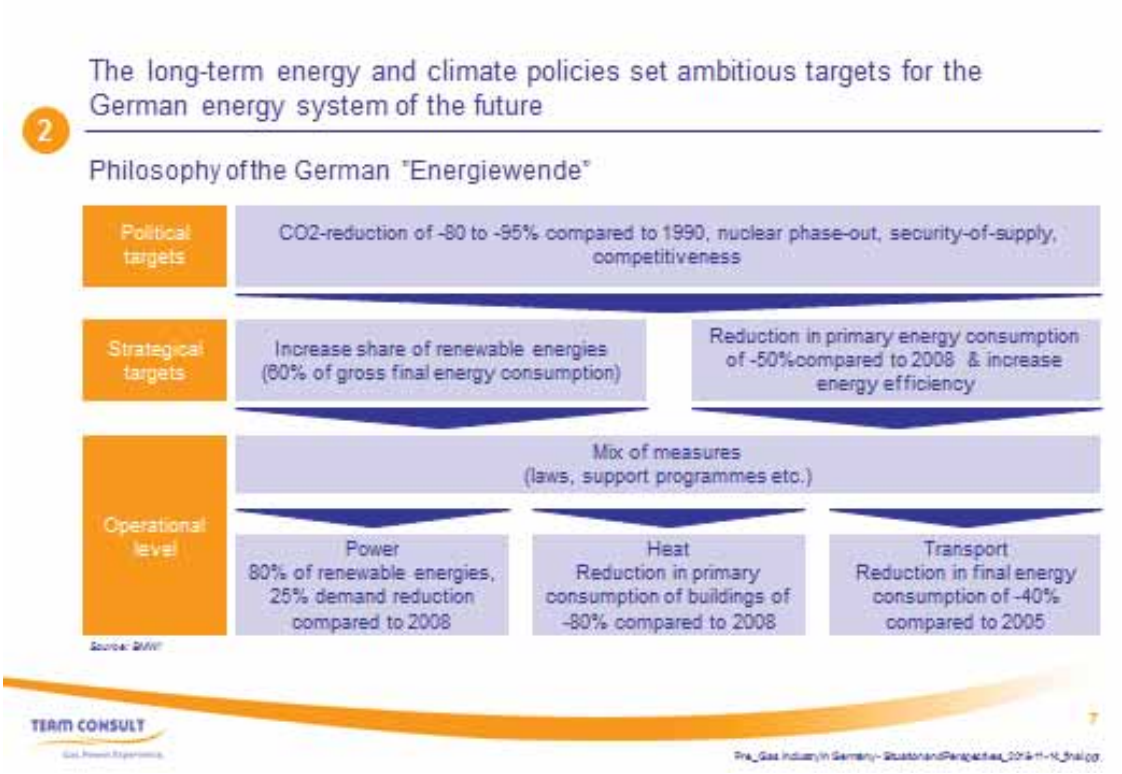
- Nuclear power will be shut down soon and is of minor evidence now
- Power generation from coal is in strong political discussion and will at least decrease in the next future.
- Mineral oil consumption is decreasing but is still high especially in the transport sector.
- Renewables have now a share of 13 percent and are strongly growing - mostly biomass, wind and photovoltaics.
    - biomass is a baseload but limited
    - wind and photovoltaics have a big potential but are volatile
- Natural gas consumption is called as a „Bridge Energy“ and will probably increase in the energy mix.



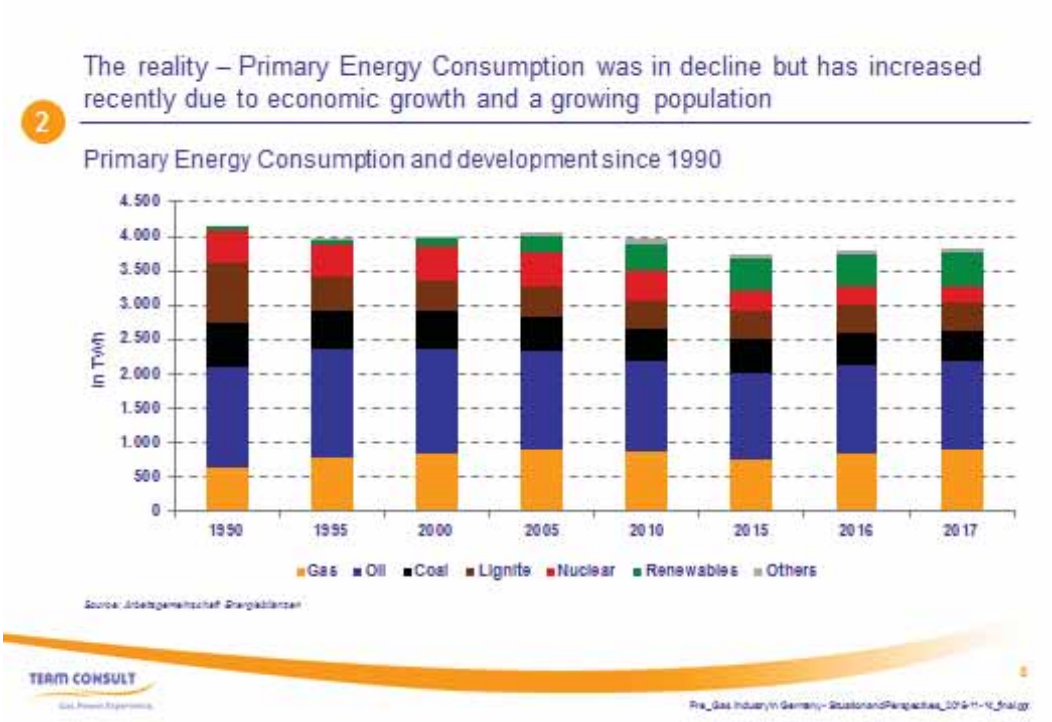
For its gas supply Germany relies on four sources. Major entry points into the German market are located in the North West, North East and South East.

But things may change in the future

- Reducing availability of gas from northern Germany and Netherlands
- Political discussions on pipeline gas from Russia
- LNG may play a more important role in future for diversity and due to pollution advantages

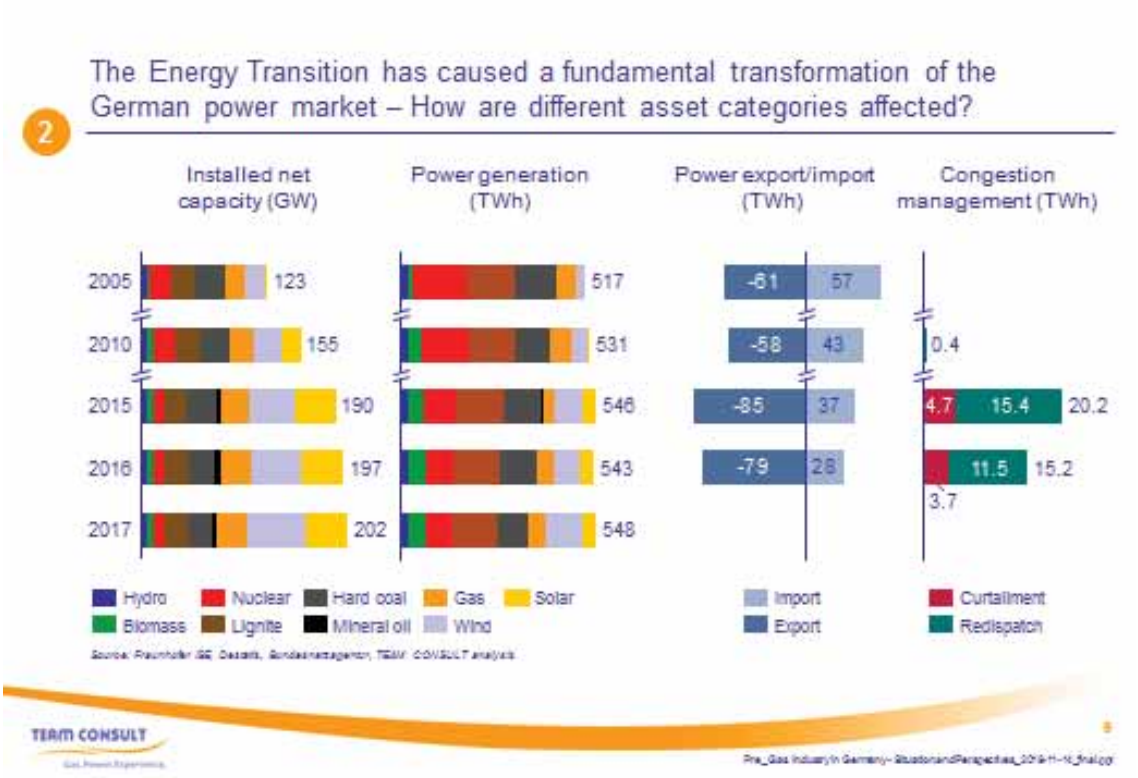


- Germany started the “Energiewende” in 2010
- Until today the political targets are CO2-reduction of -80 to -95% compared to 1990, nuclear phase-out , but also security-of-supply and competitiveness.
- The strategy is
    1. Increase share of renewable energies (60% of gross final energy consumption)
    2. Reduction in primary energy consumption of -50% compared to 2008 & increase the energy efficiency
- With a mix of measures the overall CO2-reductions in all energy sectors together shall be realized.



The recent situation is

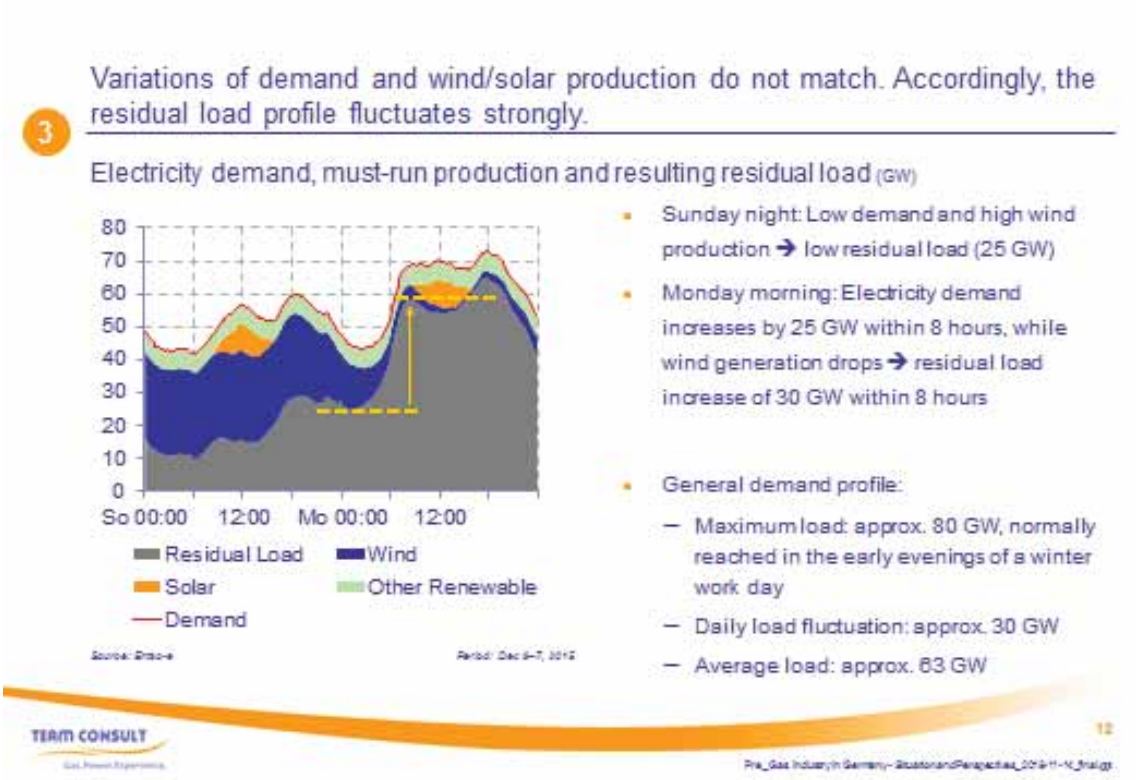
- Primary Energy Consumption was in decline in the last ten years but has increased recently due to economic growth and a growing population.
- Renewables are growing whereas nuclear electricity production is declining.
- The share of natural gas was rather stable in the past and is increasing recently.



- The Energy Transition has caused a fundamental transformation of the German power market
- The question is: How are the different asset categories affected?

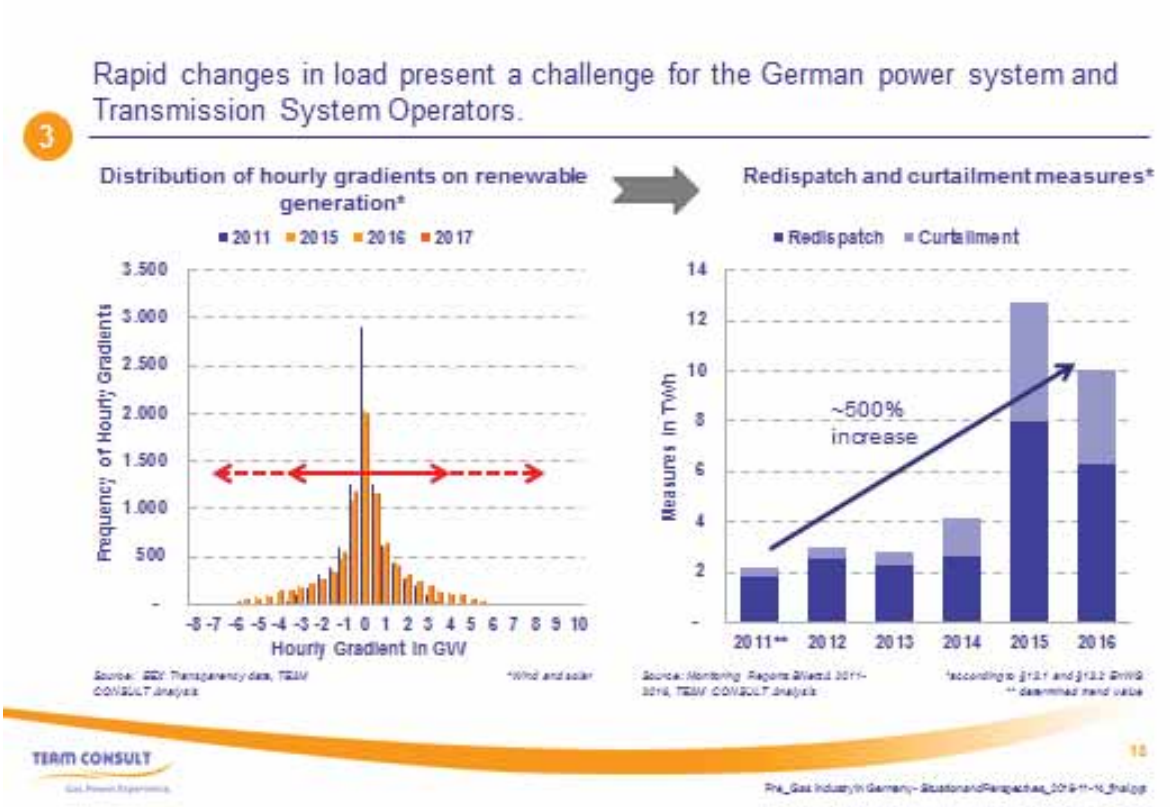
We can see here:

- There has been nearly a doubling of installed electricity capacity in the last ten years, mainly caused by photovoltaics and wind energy
- Biomass has been increased too and nuclear power plants have been shut down.
- The tendency with Gas power plants is not really clear but seems to develop now.
- In total power generation has been increased only a little bit in contrary to the nearly doubling of installation.

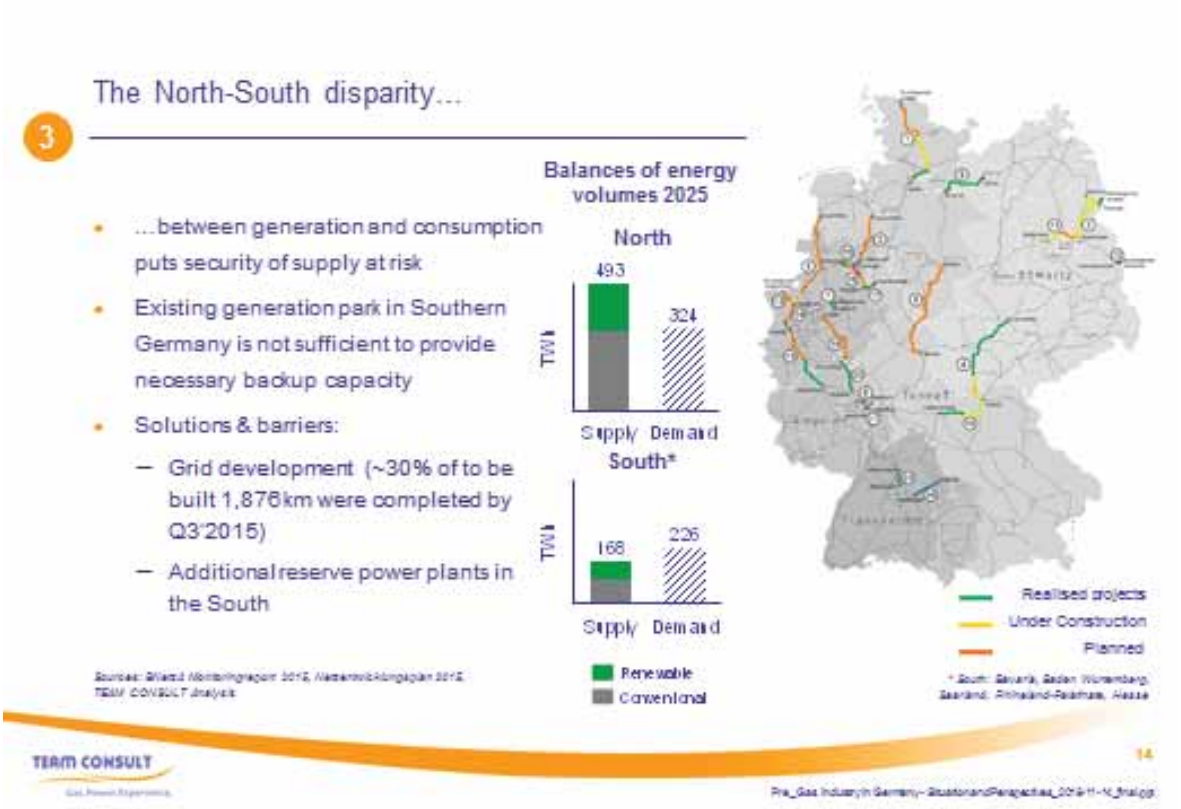


Renewable Energy with exception of bioenergy is strongly volatile. Variations of demand and wind/solar production do not match. Accordingly, the residual load profile fluctuates strongly.

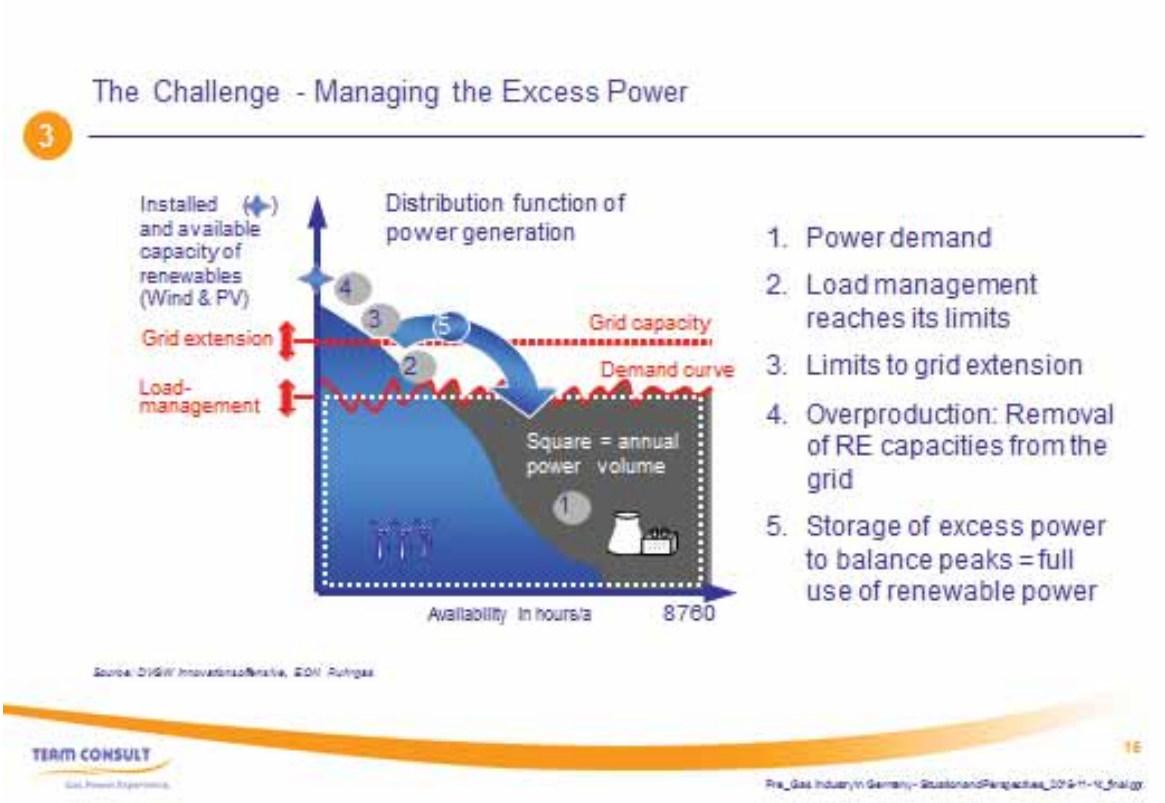
- Wind energy fluctuates erratically, but reliable forecasts within two days are possible.
- Variations of demand and wind/solar production do not match. Accordingly, the residual load profile fluctuates strongly.
- High production periods (>20 GW) are normally reached in the winter months.
- Solar power follows a more predictable daily and seasonal pattern.
- The main increase is between 8 am and noon, the main decrease between 2 pm and 6 pm.



- The big and strongly increasing of volatile power generation leads to rapid changes of load in the power grid.
- These rapid changes in load present a challenge for the German power system and Transmission System Operators.
- In the last 5 years redispaching and curtailment measures have increased by about 500 % and this will be ongoing with further building of wind and photovoltaic plants without additional measures.

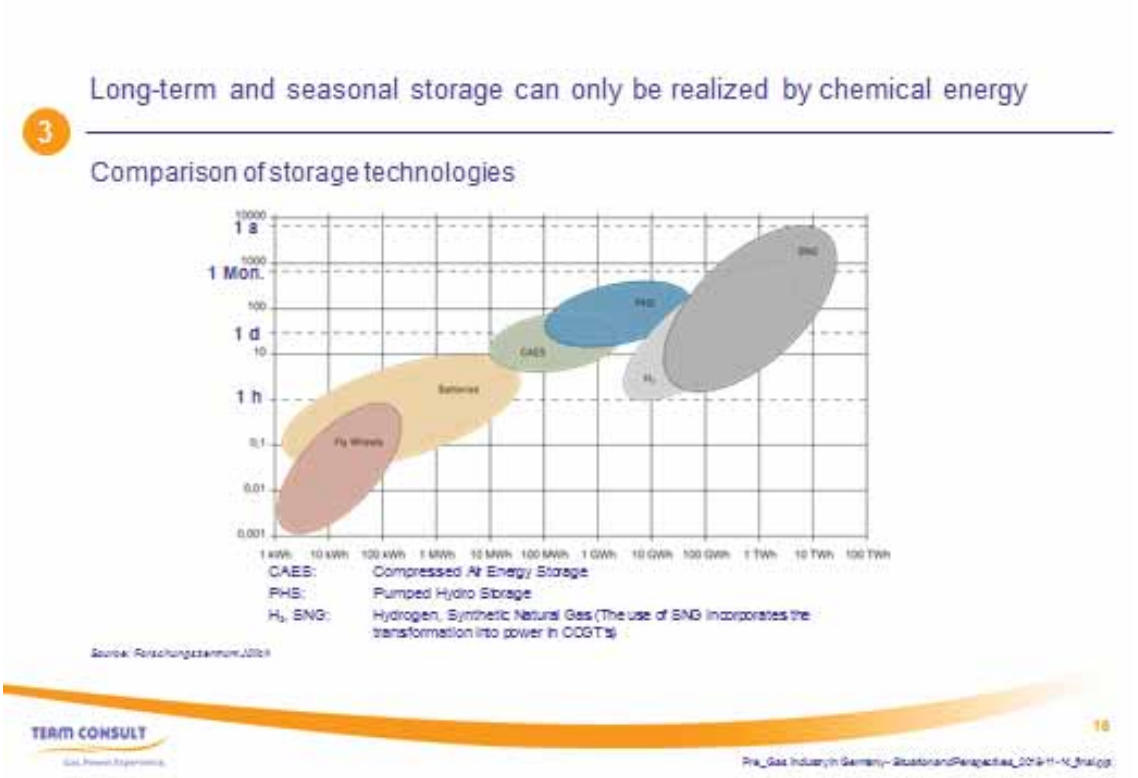


- The North – South disparity between generation and consumption puts security of supply at risk.
- The existing generation park in Southern Germany is not sufficient to provide necessary backup capacity
- Solutions & barriers are:
    - Grid development (~30% of to be built 1,876 km were completed by Q3'2015)
    - Additional reserve power plants in the South



The overall challenge is:

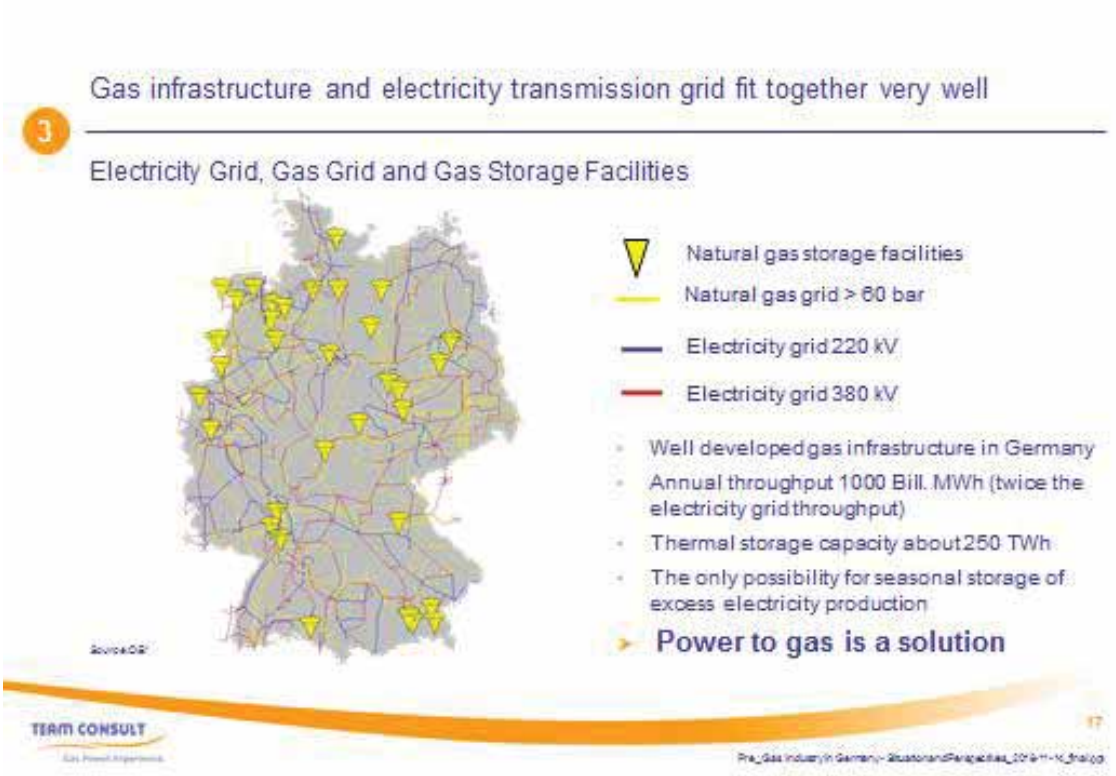
- Managing the amount of excess power. And this amount will exceed in the future dramatically.
- A possible solution is: Storage of excess power to balance peaks and so to come to a full use of renewable power.



If you compare different storage methods you will find:

- Batteries are suitable for short time storage with smaller amounts.
- Gas, that can be synthetic methane fuel or hydrogen, are the best for long time storage and big amounts.

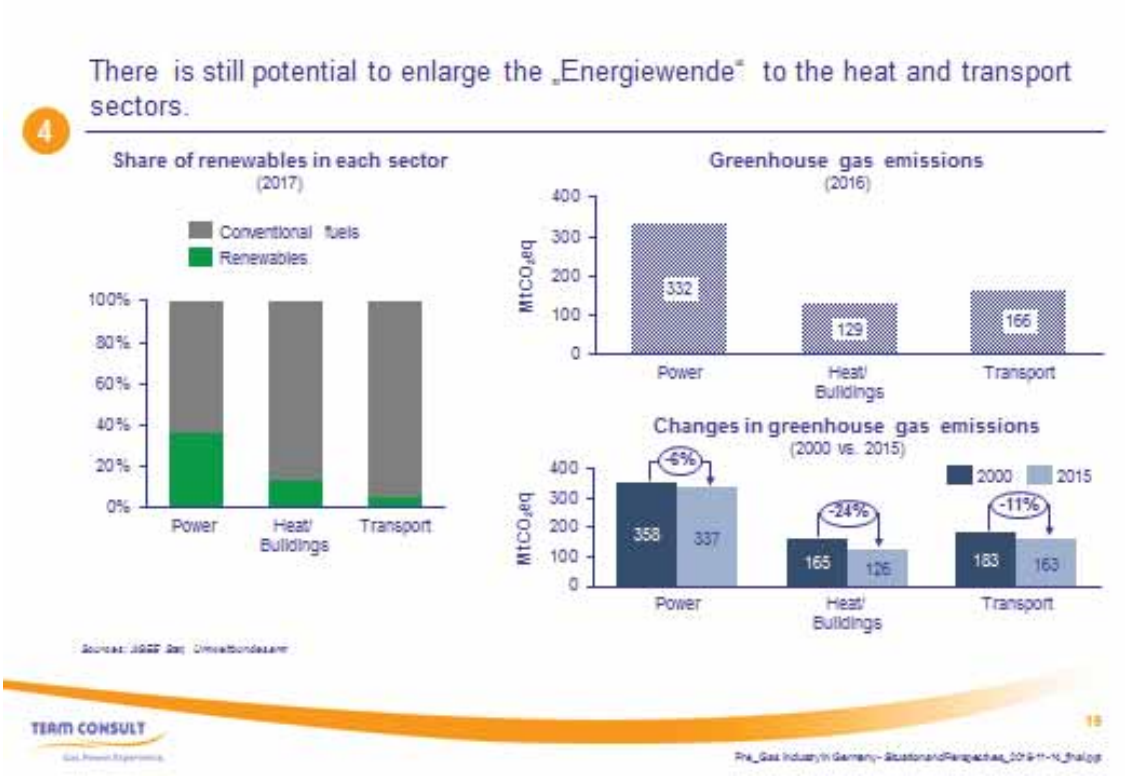
- The only possibility for seasonal storage of excess electricity production is transformation of excess electricity to hydrogen or methane.



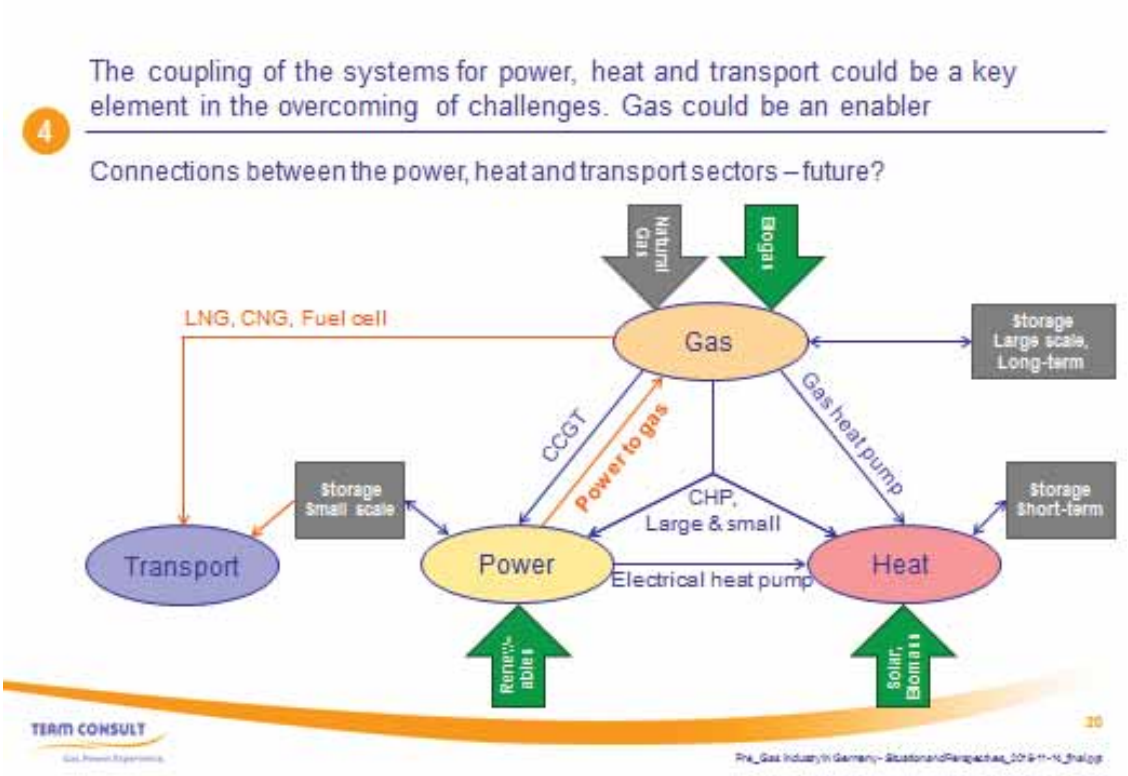
Gas infrastructure and electricity transmission grid fit together very well in Germany.

- There is a well developed gas infrastructure.
- The annual throughput is about 1000 Bill. MWh (twice the electricity grid throughput).
- Thermal storage capacity is about 250 TWh. And not to forget the grid itself.
- Natural gas storages are often situated at the crossings of the electrical and the gas grid.

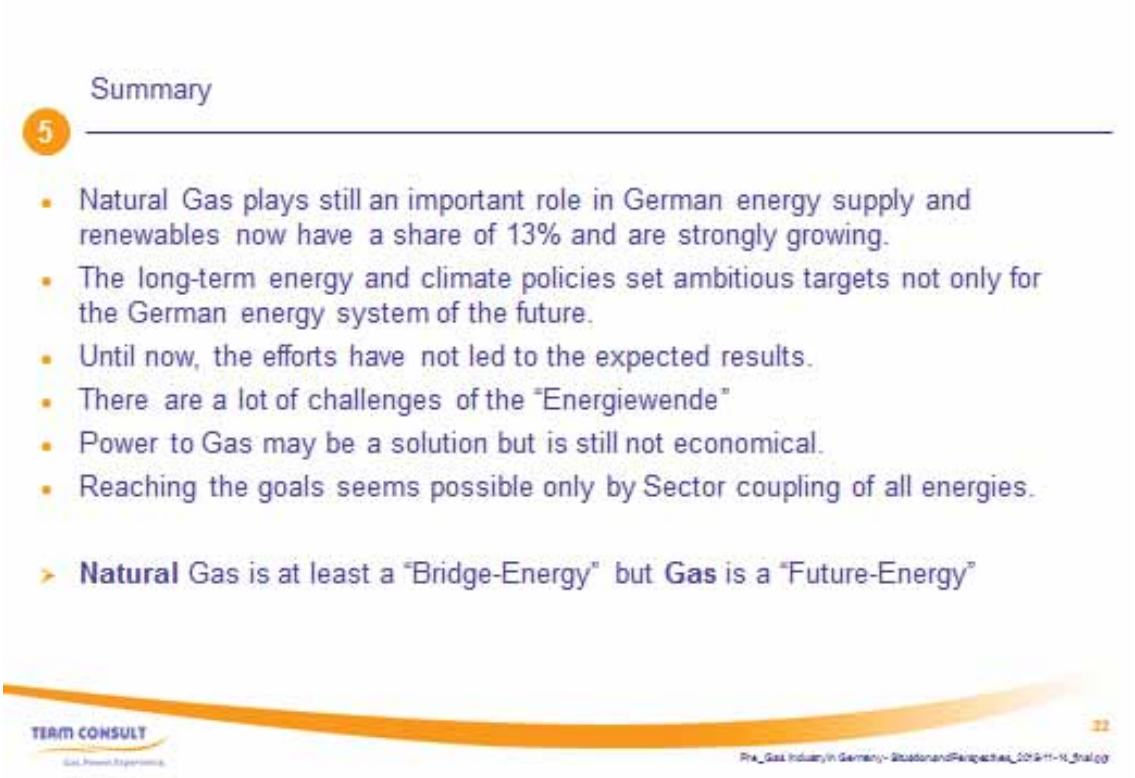
➢ **Power to gas is a solution**



- But the potential in the power sector alone is not high enough to reach the ambitious goal of about 90 % CO2 reduction.
- And there is still potential to enlarge the „Energiewende“ to the heat and transport sectors as you see in the graphics very well.



- The solution is sector coupling by combining all energy sectors with power transformation.
- This is not only Power to gas but Power to X, that means transformation of electricity to gas, heat and synthetic fuels not only in one direction but vice versa.



- Natural Gas plays still an important role in German energy supply and renewables now have a share of 13% and are strongly growing.
- The long-term energy and climate policies set ambitious targets not only for the German energy system of the future.
- Until now, the efforts have not led to the expected results.
- There are a lot of challenges of the "Energiewende"
- Power to Gas may be a solution but is still not economical.
- Reaching the goals seems possible only by Sector coupling of all energies.

➢ The german energy concept of 2010 did not take gas into account, anywhere !

➢ Today gas is the enabler for renewable energy and an indispensible part of the future energy system.

➢ **Natural** Gas is at least a "Bridge-Energy" but **Gas** is a Future-Energy.

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