Agora Energiewende

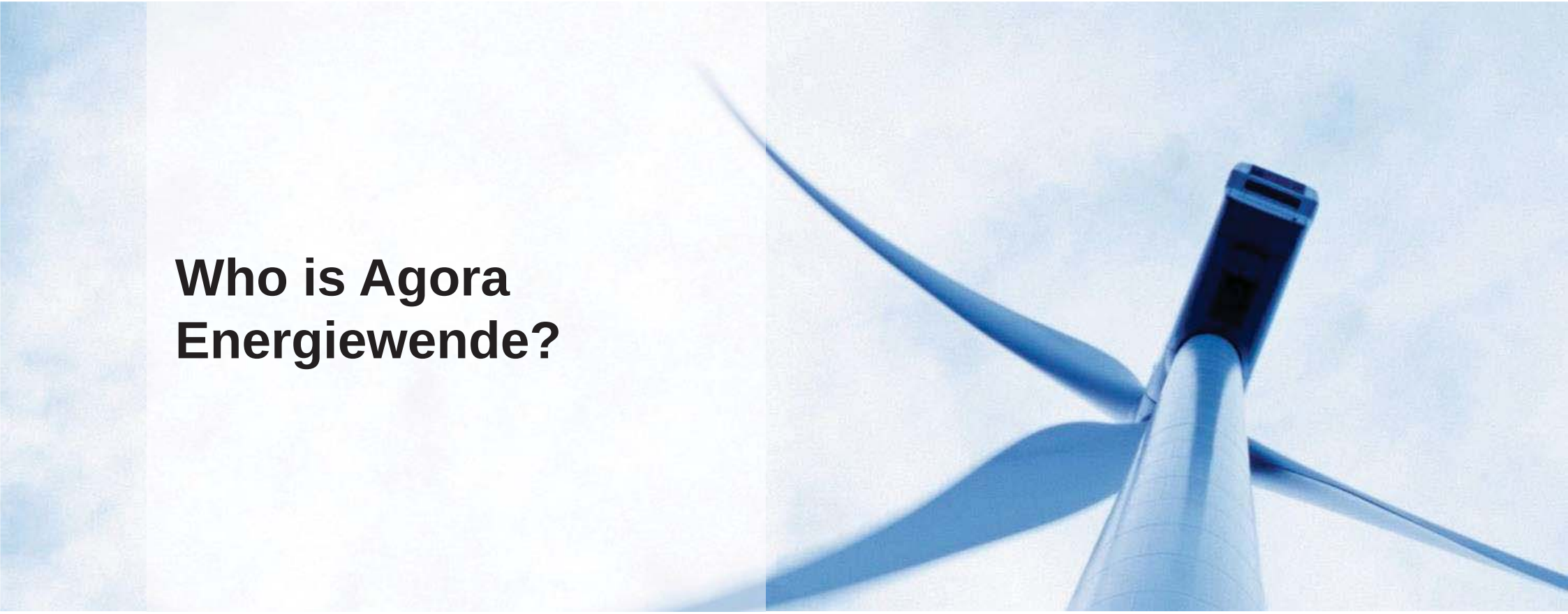
Distributed Energy Resources as the key to a successful Energy Transition

State of the art, trends and challenges

NREL, Golden, Colorado

5 NOVEMBER 2018

Who is Agora Energiewende?



Agora Energiewende – Who are we?

Agora is an independent Think Tank with more than 30 experts with diverse profile & expertise

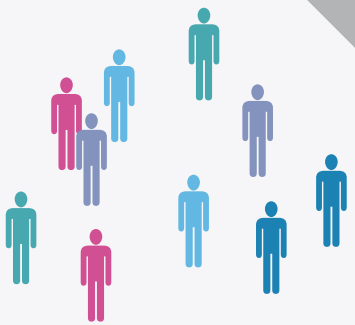
Agora is financed by the Mercator Foundation & the ECF with a budget for 2012 – 2021

Mission: Ensure a successful energy transition in Germany & support our international partners

Method: Engage with stakeholders to define problems and use our expertise to develop solutions

Agora Energiewende – The way we work

Stakeholders



Regular exchange and changing advisory committees in different projects

Impulse

Agora Team

- Director
  - Germany
  - Europe
  - International
  - Administration
  - Communication

Studies, public events, etc.

Impulse

Agora Council

Internal discussion and exchange among the permanent members

Agora Energiewende – The Agora Council

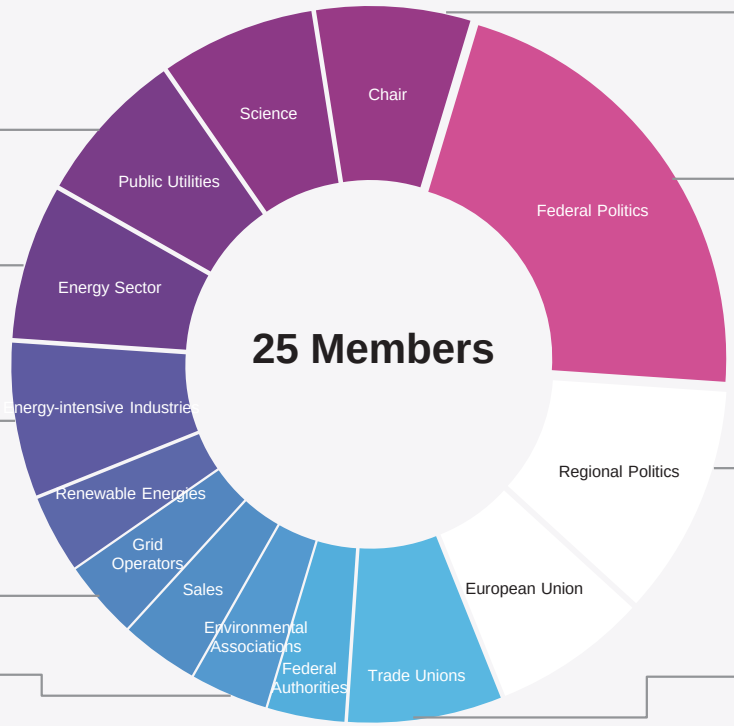
Vera Brenzel

Stefan Kapferer

Dr. Martin Iffert

Dr. Boris Schucht

Antje von Brook



Dr. Hans-Joachim Ziesing

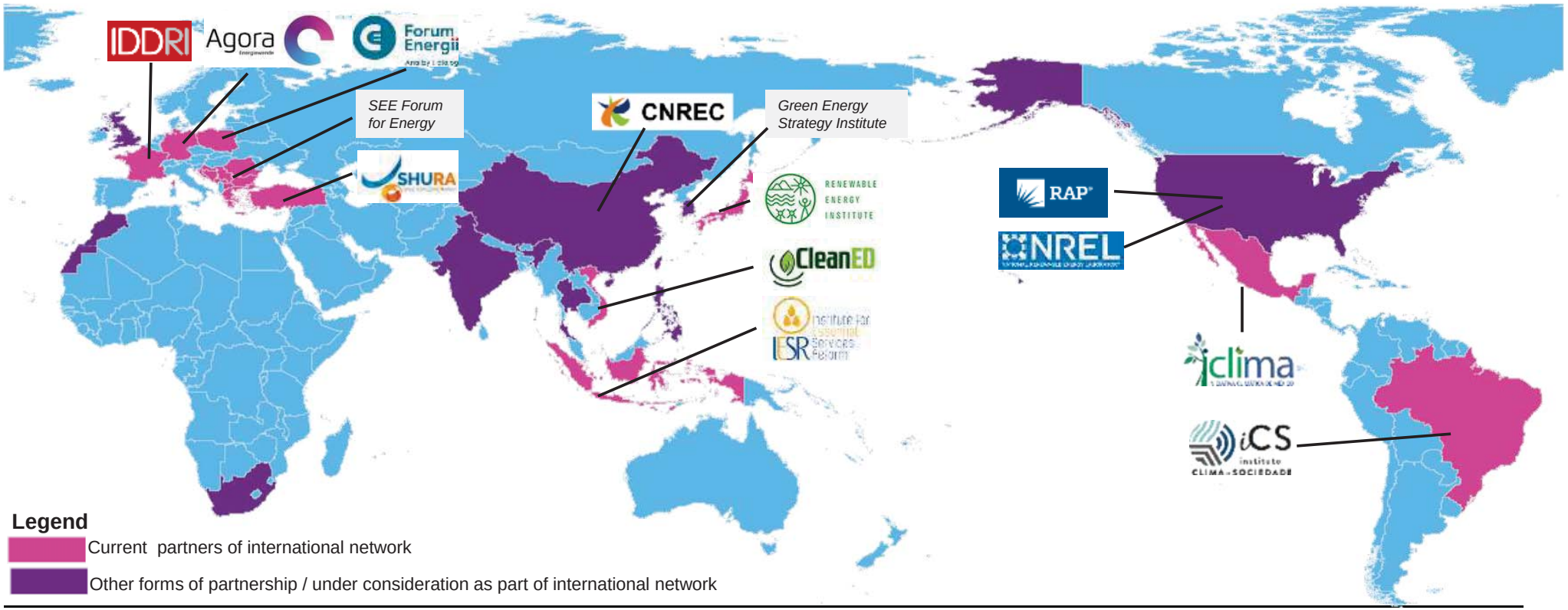
Dr. Patrick Graichen

StS Rainer Baake

Mechthild Wörsdörfer

Wolfgang Lemb

Agora Energiewende – Our International Network



The „Energiewende“ – A German perspective

Motivations for the Energiewende: The use of nuclear power is strongly rejected by the German population

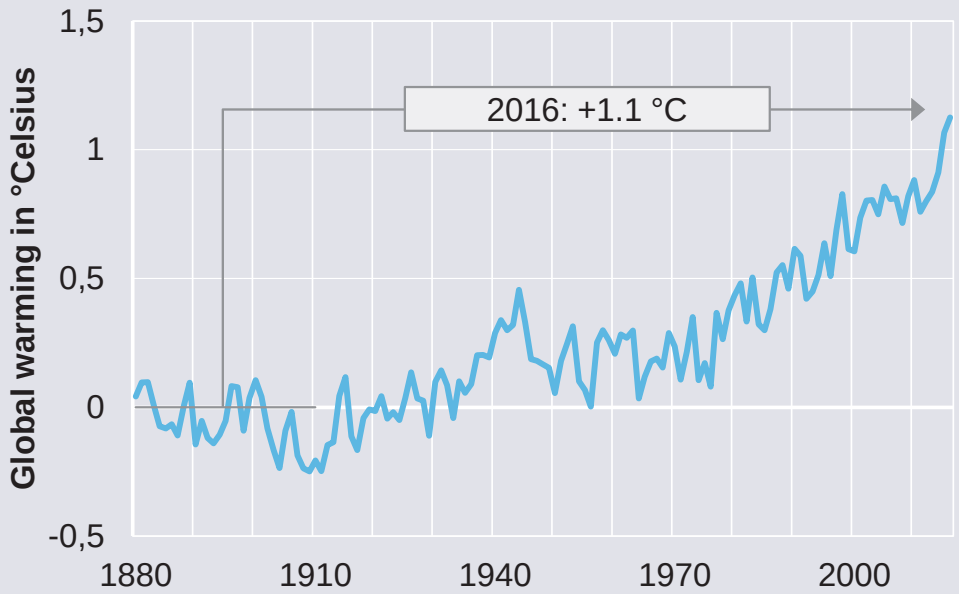
Anti-nuclear-power-demonstration at the Bonner Hofgarten, October 14, 1979

Hans Weingartz/Wikipedia

- In the 1970s the anti-nuclear movement in Germany developed. Its supporters strongly opposed the military and civil use of nuclear energy.
- Discussions regarding the risks and consequences of nuclear energy were of great societal importance and among the most pressing issues during the 1980s and 1990s in Germany.
- The social and political movement mobilized resources and efforts for R&D that were instrumental for the development of modern and cost effective renewable energy technologies.
- Today, when it comes to the nuclear phase-out by 2022 there is a broad societal consensus.

Reasons for the energy transition: Accelerating climate change calls for a phase-out of coal, oil and gas

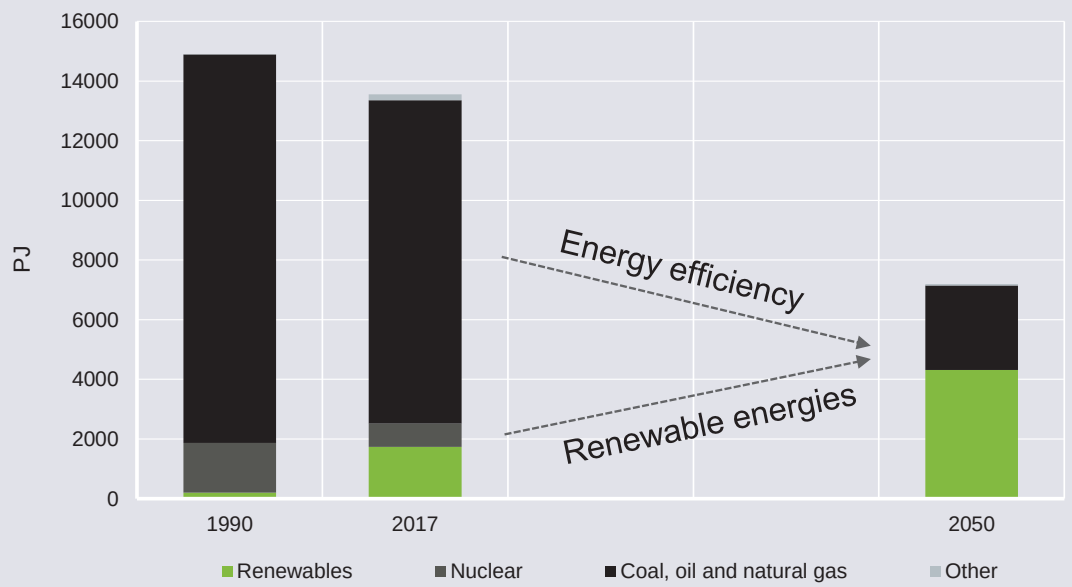
Global temperature rise from the time of industrialisation to 2016



- Until the year 2016 there has been an increase of the global temperature by 1,1 °C compared to the pre-industrial level.
- In the 2015 Paris climate agreement the international community has agreed to limit global warming to a maximum of 2 °C, if possible even to 1,5 °C.
- In order to be successful, all states have to significantly reduce their GHG emissions.
- As a large part of the emissions originates from burning coal, oil and gas, the transformation of the energy system is crucial.

The Energiewende is a long-term energy strategy, aiming to phase out nuclear power and reduce greenhouse gas emissions significantly

Primary energy consumption 1990, 2017 und minimum target 2050



AG Energiebilanzen, own calculations

Primary targets

- **Climate mitigation:** Reducing greenhouse gas emissions until 2050 by 80 to 95% towards 1990 levels.
- **Nuclear phase out:** Shut down of all nuclear units until the end of 2022.

Secondary targets

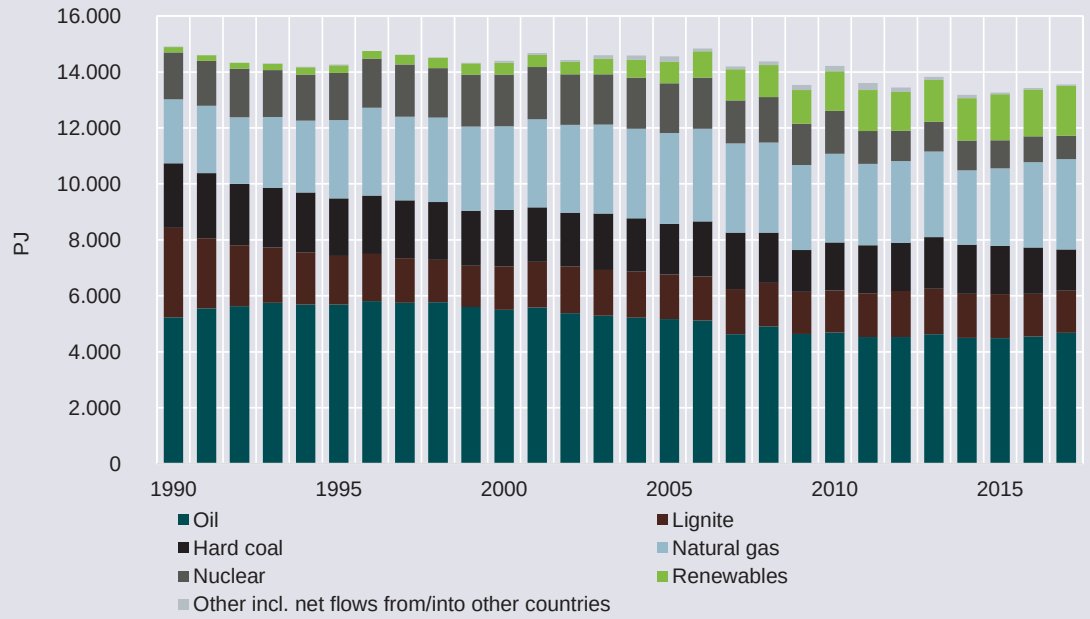
- **Energy efficiency:** Reducing primary energy consumption until 2050 by 50% towards 2008 levels.
- **Renewable energy:** Increasing the share of renewable energy in gross final energy consumption until 2050 to 60%.

Where do we actually stand with the Energiewende?

State of the art in 2017

The structure of the primary energy consumption has only slightly changed since 1990 – with a shift from coal and nuclear to renewables an gas

Primary energy consumption by energy source Energieträgern 1990 - 2017

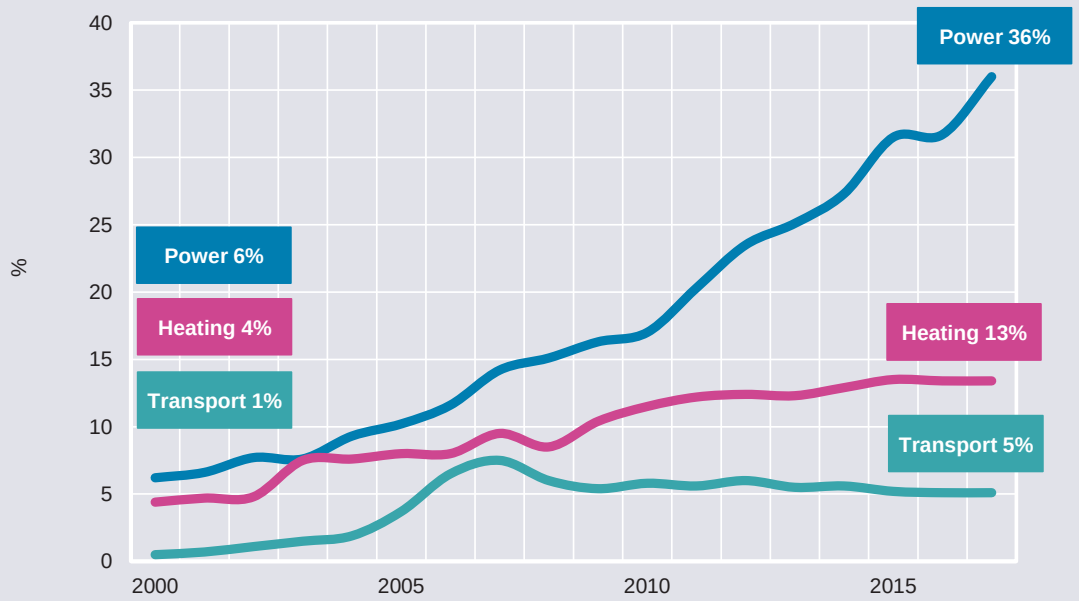


AG Energiebilanzen

- In 2017, Germany‘s primary energy consumption reached a total of 13.500 PJ.
- Around 80 per cent of Germany‘s primary energy consumption uses fossil fuels.
- Nuclear energy accounted for 6, renewable energy for 13 per cent.
- The primary energy consumption has decreased by 1600 PJ (9%) since 1990.
- In the same period, Germany‘s GDP has increased by 50 percentage points. i.e. an average of 2 per cent per year.
- The structural shift is the result of energy policies that promote energy efficiency and renewables, as well as structural changes related to the German reunification and the modernisation of the heating sector.

The expansion of Renewable Energy Sources (RES) is mainly taking place in the power sector

Renewables share in power, heating and transport 2000 - 2017

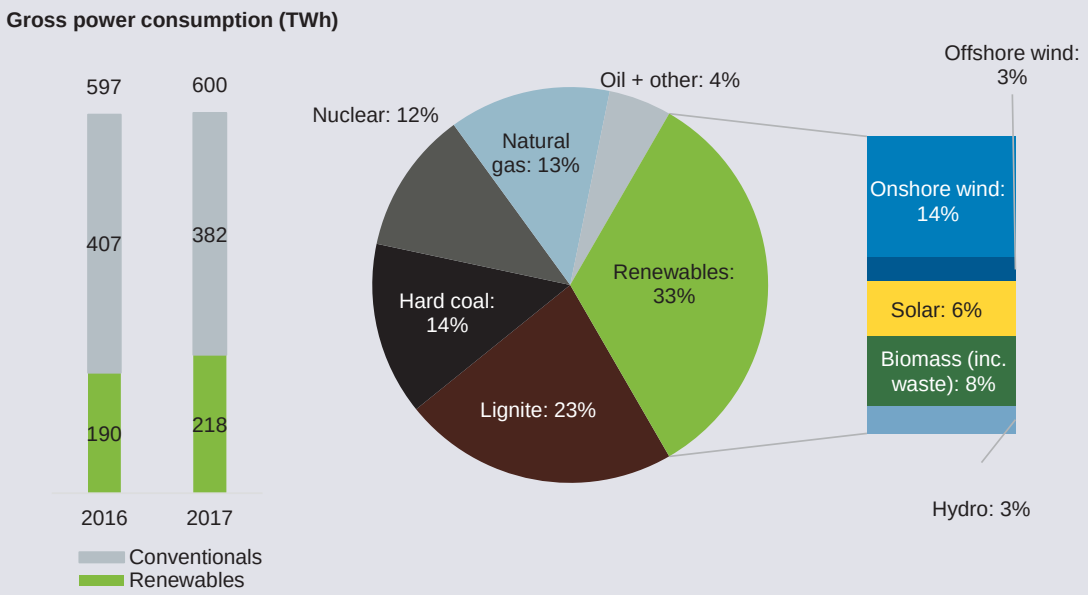


Umweltbundesamt

- Since 1990, the share of RES in primary energy consumption was increased from 1% to 13% in 2017.
- Most progress regarding renewable energies has been made in the power sector: Since 2000, the share of renewables increased from 6% to 36%. Wind and solar contributed with two thirds of this share.
- In the heating sector, renewables increased from 4% in 2000 to 13% in 2017 - most of it being biomass.
- In the transport sector, progress has been limited, with biofuels only reaching a share of around 5%.

In the power sector, RES are the biggest source of electricity, providing around a third of total generation

Share of energy sources in gross power production 2017 (2016 in brackets)

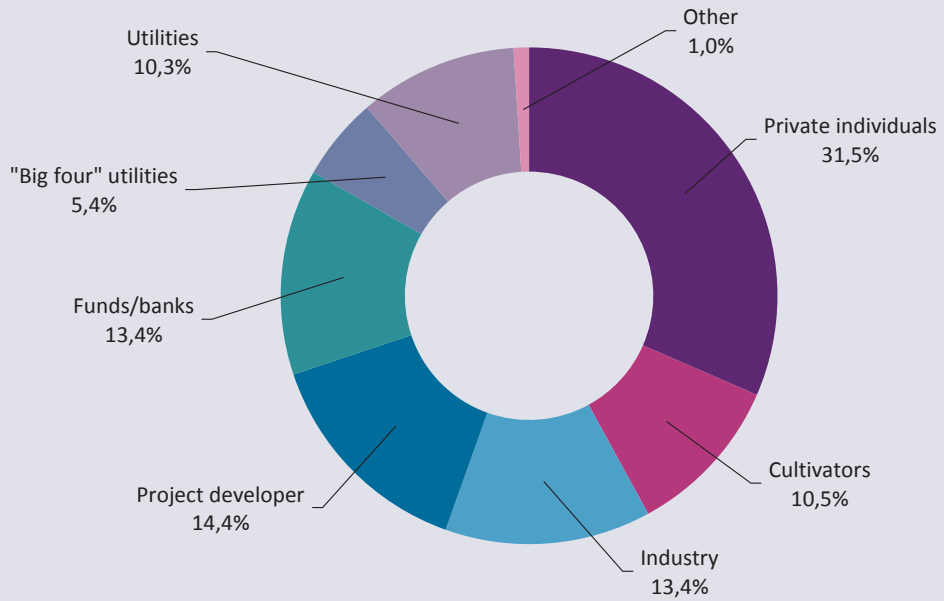


AG Energiebilanzen

- In 2017, renewable energies accounted for 33% in power production.
- Within the renewables wind is number 1: On- and offshore-wind have generated 107 TWh of power in 2017.
- Biomass provided 21% of renewable power in 2017 and is thus the number 2 of renewable power sources.
- Solar covered 18% of the renewable power generation.
- Lignite still accounts for 22.6%, hard coal contributes 14.4% to total power generation, natural gas 13.1%.
- Due to the managed phase out, nuclear today only accounts for 11.6%.

Renewable energies in possession of citizens

Ownership structure of Renewable Energies 2016



Agentur für Erneuerbare Energien

- The penetration of renewable energies change the ownership structure in the power sector.
- Private individuals hold almost one third of renewable energy generation capacities.
- Utilities, especially the Big Four, have not caught up so far.
- The democratisation has been important for broad social support, mobilizing capital and broadening economic benefits.

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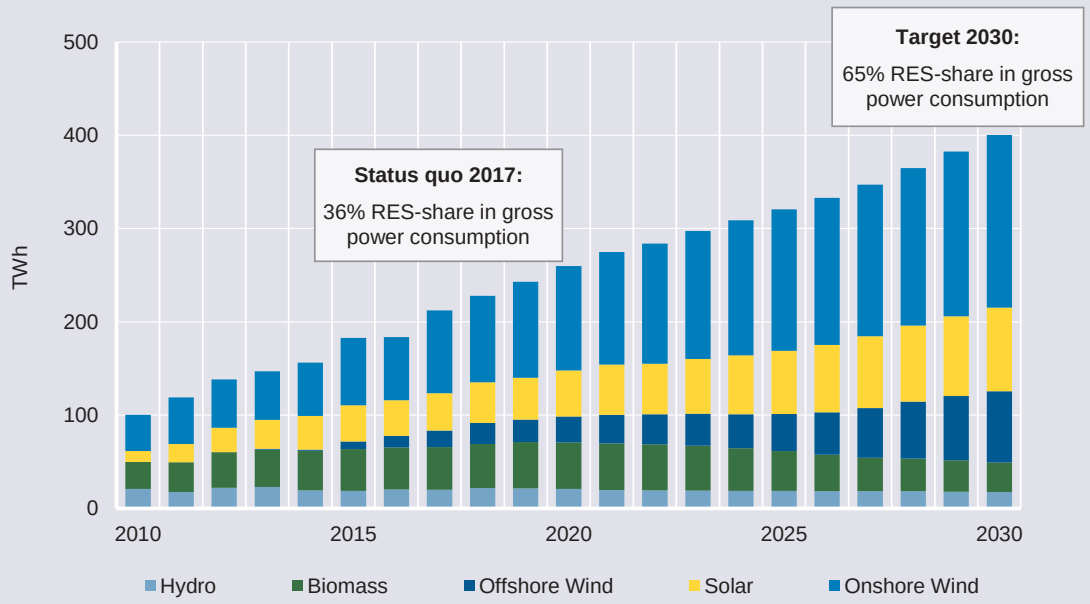
How does the Energiewende change our energy system?

Renewable energy - Use *wind and solar* to increase the share of RES to at least 60% of the power sector and 30% of primary energy consumption.

Gross power generation from renewables, 2015 - 2030

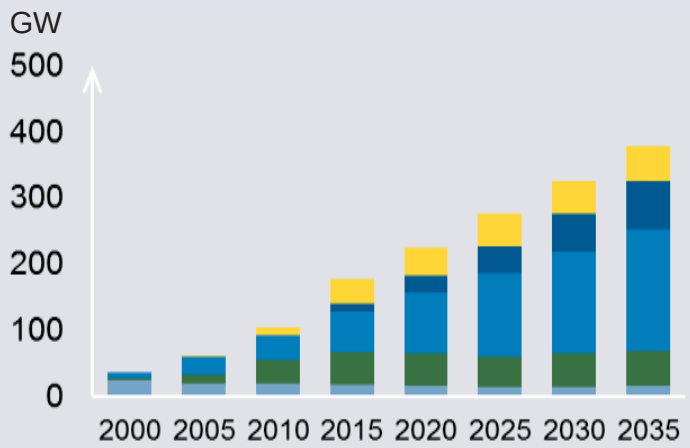


AGEB, own calculations based on Öko-Institut

- The government has defined a target to increase the share of RES consumption to 65% by 2030.
- Variable Wind and Solar PV are the least-cost RES options in Germany
- The potentials for other RES is constrained:
  - In Germany, biomass is relatively expensive and is subject to land-use constraints and sustainability concerns.
  - Hydro cannot be expanded massively due to topographical circumstances.

With wind and solar, the new power system will be based on two technologies that completely change the picture

Gross electricity generation of renewable energies 2000 - 2035

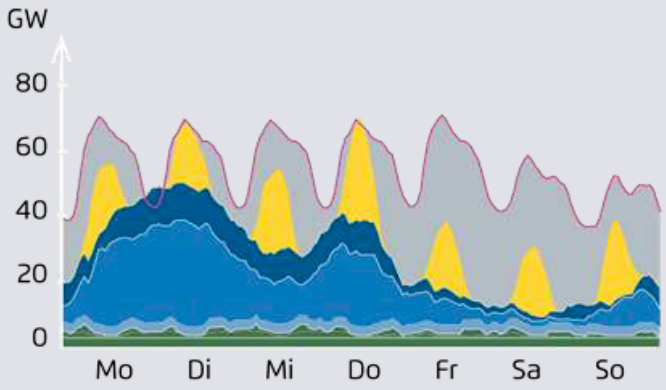


AGEB (2015a), BNetzA (2014), BNetzA (2015b), own calculations

Specific characteristics of Wind and Solar PV

1. Intermittent
2. High capital costs
3. Very low variable cost

Electricity generation and consumption in a sample week 2023



Fraunhofer IWES (2013)

Germany is among the top users of variable RES worldwide

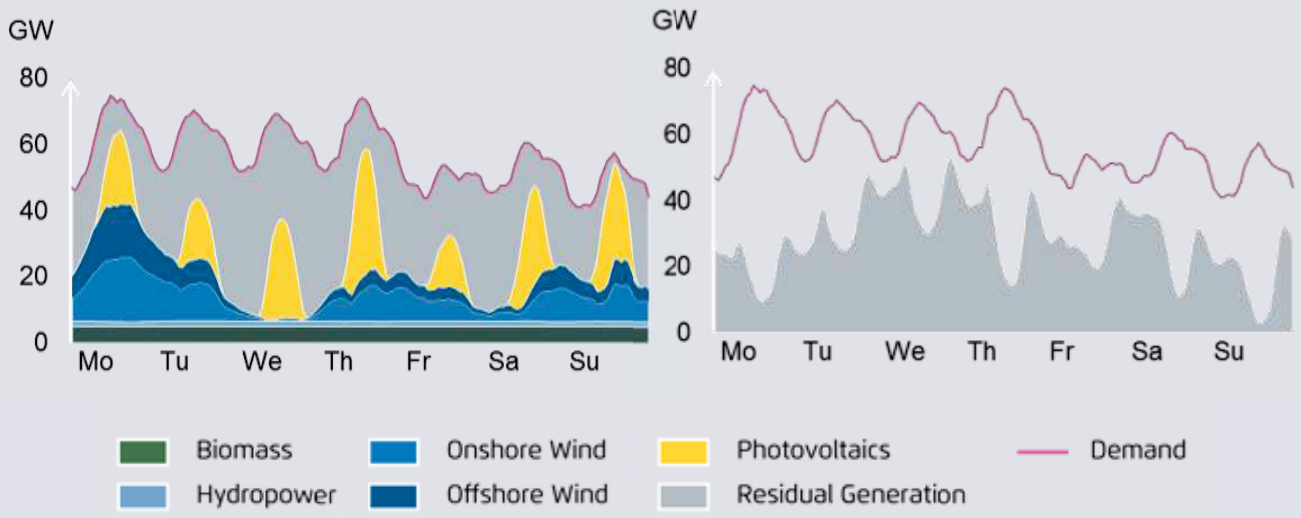
Variable-RES-shares in the power generation 2016

Own illustration based on World Energy Council, IEA, EIA

- Only in a few regions of Europe and North America power generation from variable RES, solar and wind, exceeds a share of 20%.
- In countries with access to large hydropower potential, like e.g. in Central and South America as well as in parts of Asia and Europe, hydro plays a more important role.
- Brazil has shown that biomass from agricultural and forest residues can play an important role.

Flexibility is the paradigm of the new power system – baseload capacities are not needed any more

Electricity generation and consumption in a sample week with 50% RES share



Key flexibility options

- Flexible fossil and bioenergy power plants (incl. CHP)
- Grids and transmission capacities for exports/imports
- Demand Side Management
- Storage technologies (Batteries, Pump storage, Power-to-Gas)
- Integration with industry, heat and transport sectors.

Own calculations on basis of Agora Energiewende (2015b)

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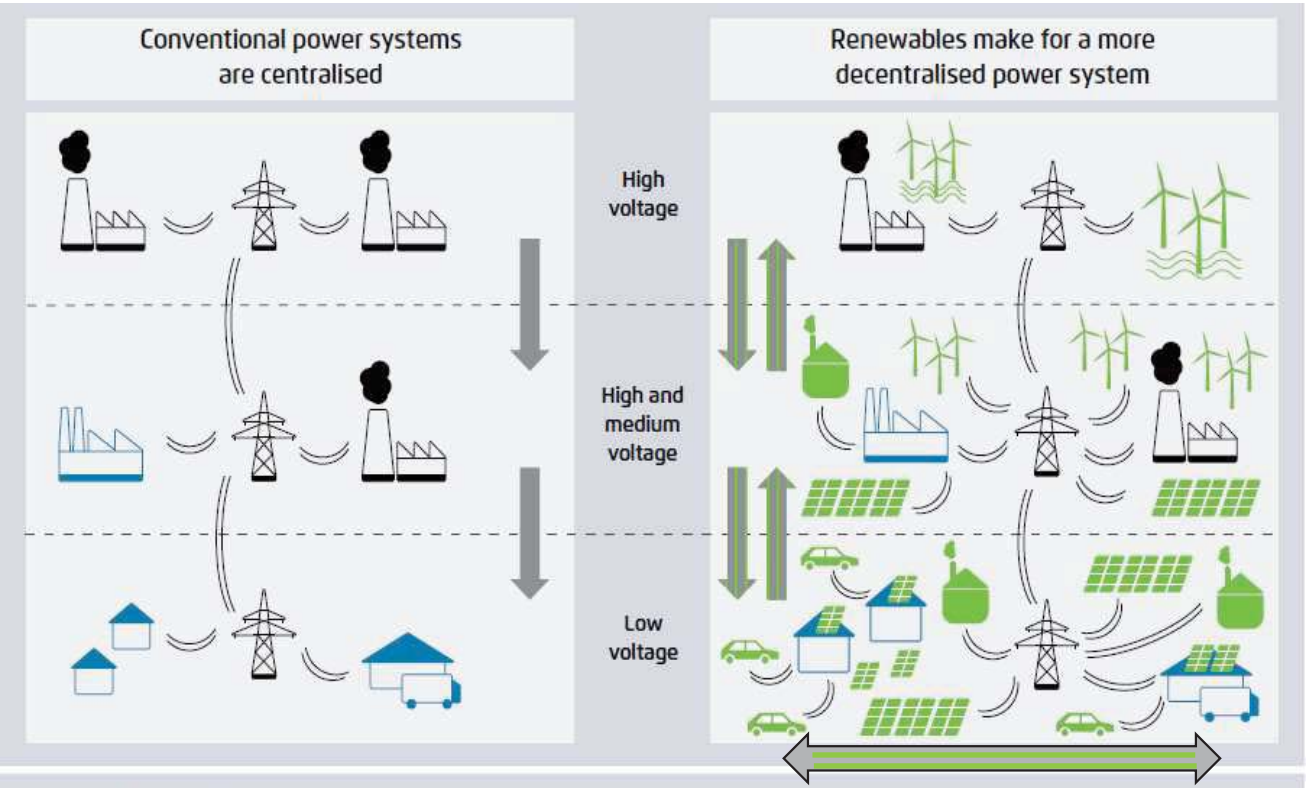
Aspects of Distributed Energy Resources

Energy systems – Moving from centralized to decentralized structures

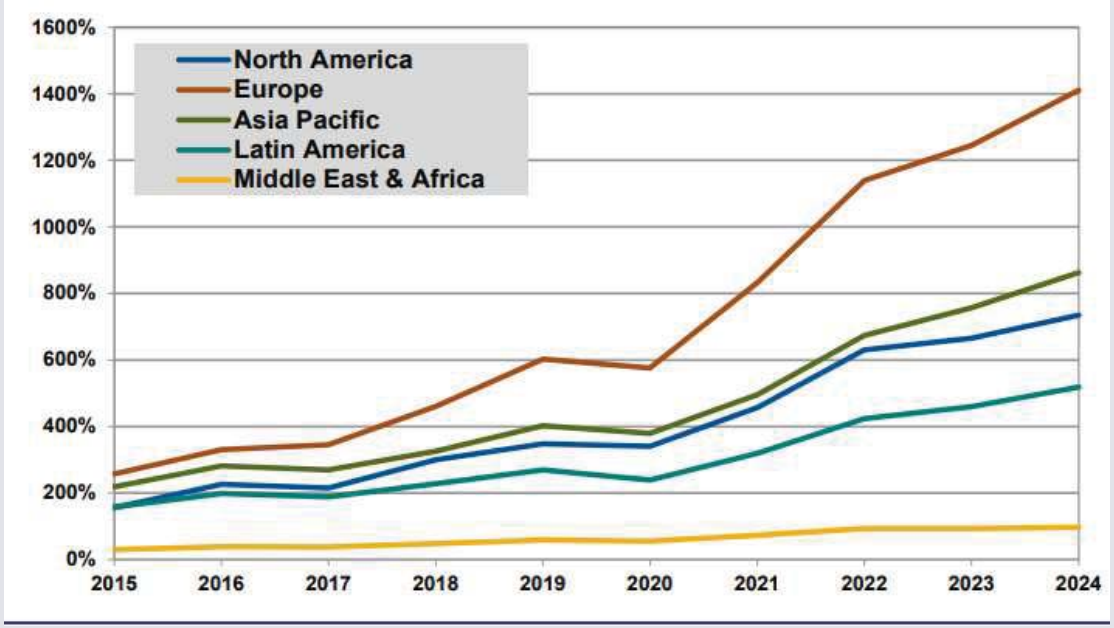
Illustration of the old and the new electricity system



- An energy system based on renewables tends to move towards small, decentralised structures.
- The reason is that energy from sunlight and wind is less concentrated than energy from coal, oil and gas.
- The new technologies have changed the traditional distribution of roles in the energy system.
- This fundamental shift in the energy system has produced a variety of new business models and players in the power, heating and transport sectors.
- The success of the Energy Transition depends on the success of a **vertical and horizontal integration** of the power system.

A smart and efficient decentralized energy system is the consequence or the condition of a successful energy transition?

DER Capacity Installments and estimates as a percentage of new centralized generation (regional averages) 2015-2024



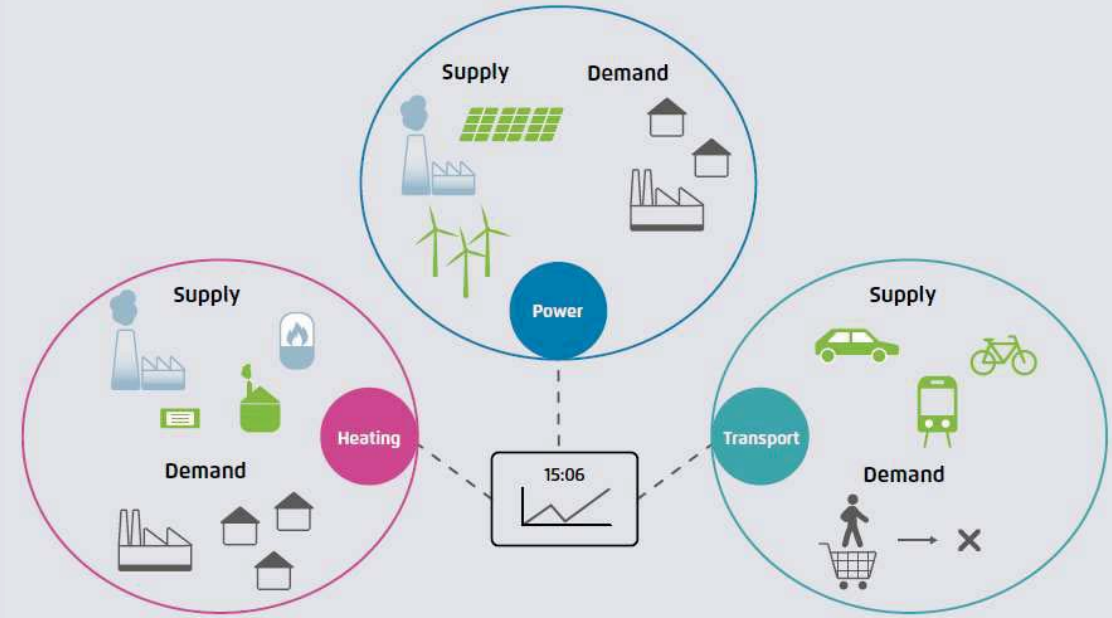
Navigant Research, U.S. Energy Information Administration

The following DER technologies are included in this report:

- Distributed Generation (DG)
  - Distributed Solar PV (<1 MW)
  - Small and Medium Wind Turbines (<500 kW)
  - Microturbines
  - Stationary Fuel Cells
  - Natural Gas Generator Sets (<6 MW)
  - Diesel Generator Sets (<6 MW)
- Distributed Energy Storage Systems (DESSs)
- Microgrids
- Electric Vehicle (EV) Charging Load
- Demand Response (DR)

Smart power markets - Organise a flexible, digital power market that incentivises DER investments that minimize costs at the level of the energy system

The cost-efficient power market of 2030 is digital and flexible and provides a high degree of security of supply



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Where do we stand in Germany?

→ The power market 2.0 is competitively organised; balancing energy and flexibility are derived form fossil power plants; RES are financed via the EEG; the system is characterized by a high level of supply security.

Where we want to get by 2030

→ The power market is digital and operates at short notice; Investments in diverse DERs are financed via the power market; the level of supply security remains high.

What is necessary for that

→ Roll-out of Smart Meters and rates that vary along the time of the day and with location; introduction of an appropriate CO_2-price; transition form RES-auctions to performance; capacity reserves to support supply security.

More information and relevant studies available at our website www.agora-energiewende.org

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Thank you for your attention!

Questions or Comments? Feel free to contact me:

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Agora Energiewende is a joint initiative of the Mercator Foundation and the European Climate Foundation.