65TH CONFERENCE AND EXHIBITION OF THE HUNGARIAN ELECTROTECHNICAL ASSOCIATION, SEPTEMBER 12-14, 2018, VISEGRAD

A political project or the new normal?

The energy transformation goes global

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What is driving the transformation?

A short look at the environment

The European environment

Development of political targets

2020 climate and energy package (March 2007)

- 20 % reduction of climate gas emissions compared to 1990
- 20 % share of renewable energy by 2020 (meaning 30 % for the electricity sector)
- 20 % increase of energy efficiency

2030 framework for climate protection and energy policy (January 2014)

- > 40 % reduction of climate gas emissions compared to 1990
- > 27 % share of renewable energy (meaning 43…49 % for the electricity sector)
- > 27 % increase of energy efficiency

Clean energy for all Europeans (2017)

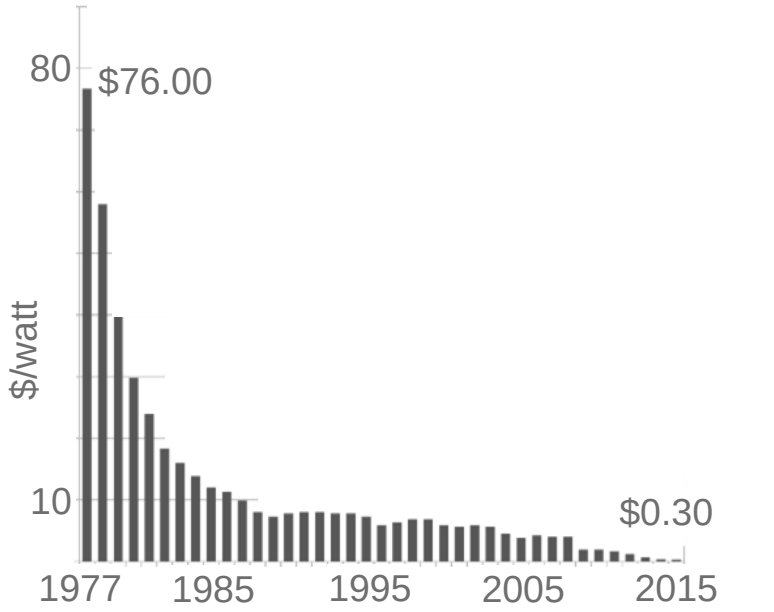
- 30 % energy savings compared to 1990 by 2030 (binding target)
- 30 % share of renewable energy on EU level by 2030 (meaning ≈ 50 % for the electricity sector)
- Increased European view at grids (new DSO body, Regional Operation Centres, expanded role of ACER)

Focus on efficiency and renewable energy has been increasing since more than a decade.

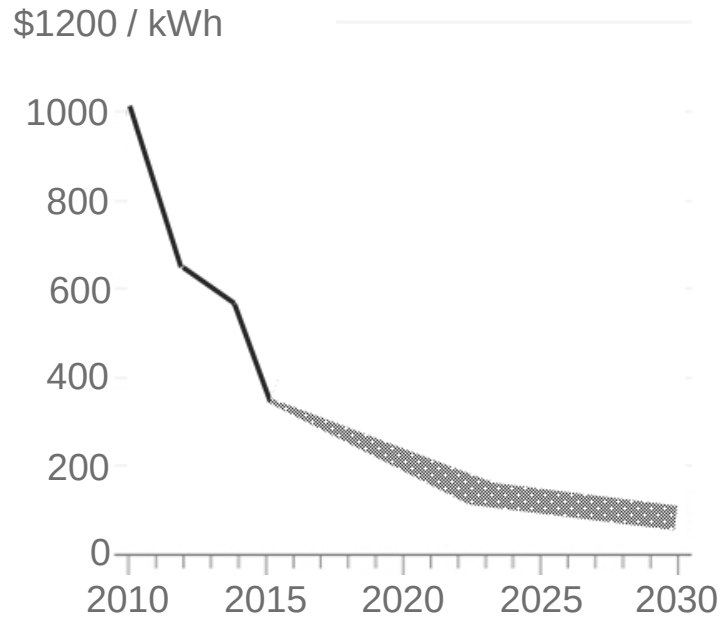
Beyond policies: The other driver of change

Economies are taking over

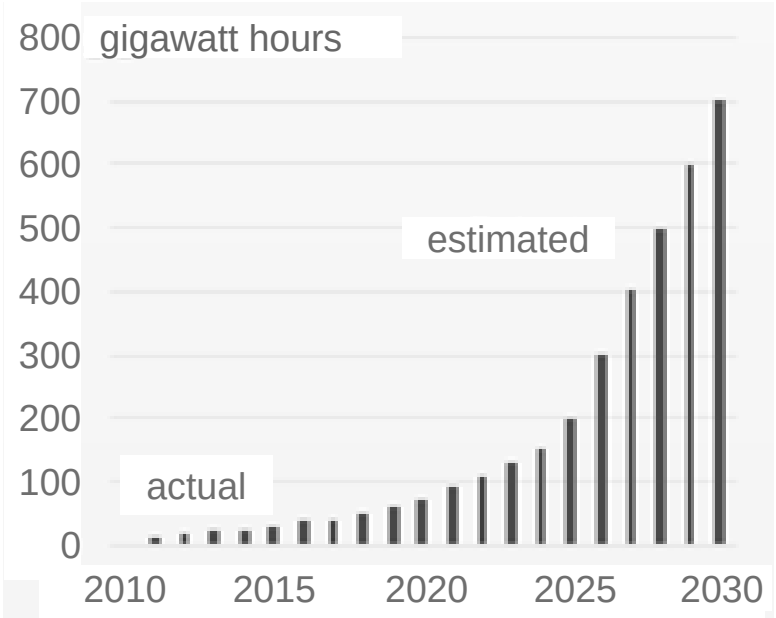
Silicon PV cells[1]



Lithium-ion battery packs[2]



Demand for EV battery power[2]



Dramatic cost reduction, scalable technologies, consumer investment behavior – highly disruptive potential!

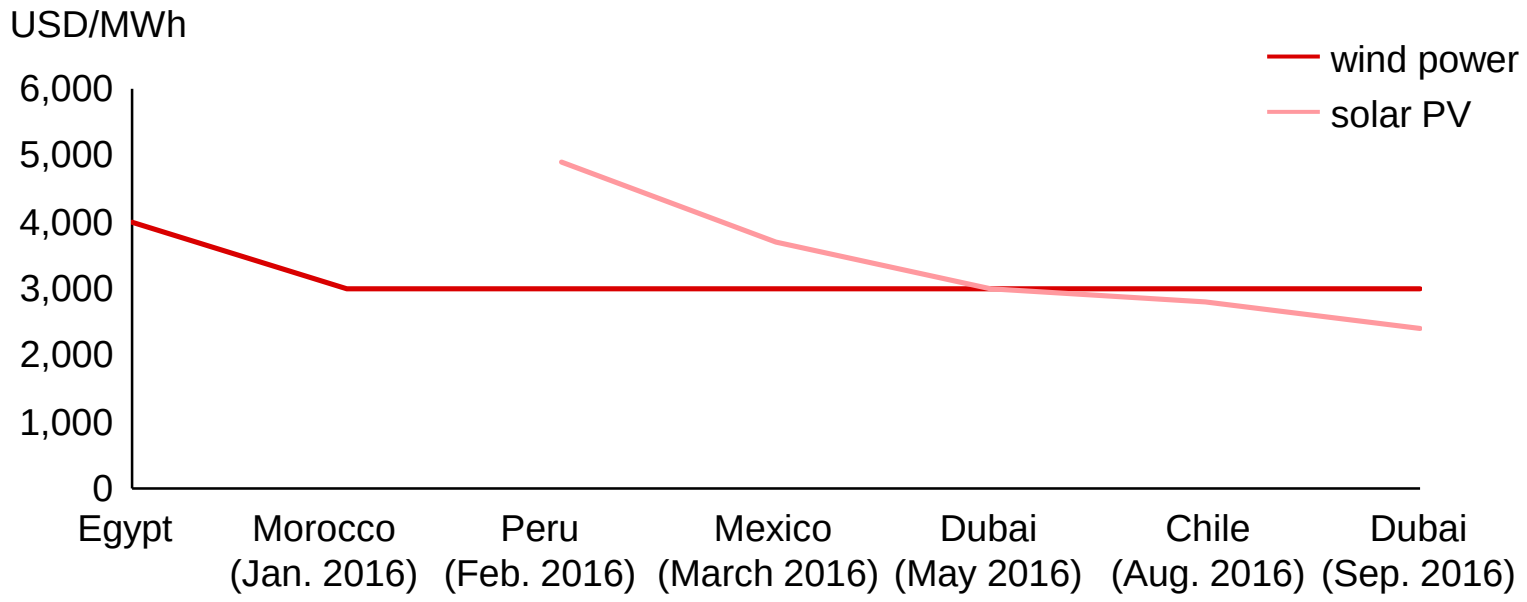
[1] Source: Bloomberg New Energy Finance & pv.energytrend.com
[2] Source: Data compiled by Bloomberg New Energy Finance

What does this mean for the cost of generation from renewables?

Cost of electricity from onshore wind and utility-scale PV – 2016 tenders

- The cost of energy production with renewable energies has declined massively over the past years
- The cost-competitiveness of renewable power generation technologies has reached historic levels
- Some renewable energy projects are already below the lowest cost of fossil fuel power production and have surpassed grid parity

Strike price of the latest solar and wind energy tenders



Renewables energies are cost competitive and therefore a pillar of the future energy production

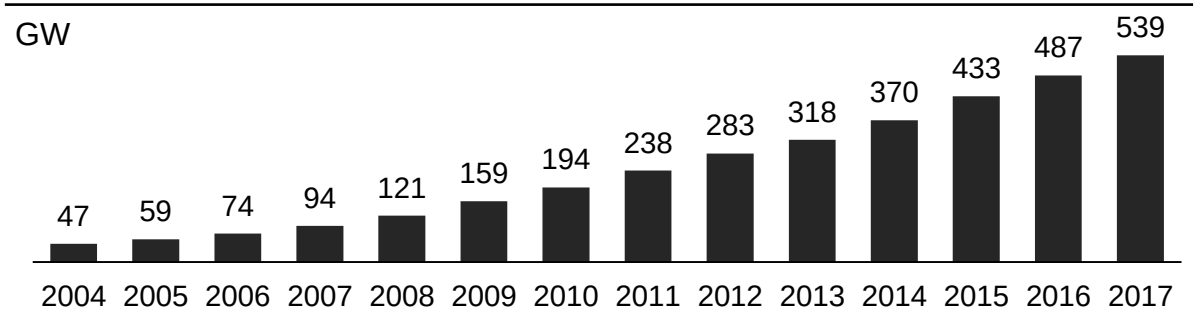
Source: Make Consulting

And what does it mean globally? Wind and solar deployment in 2017

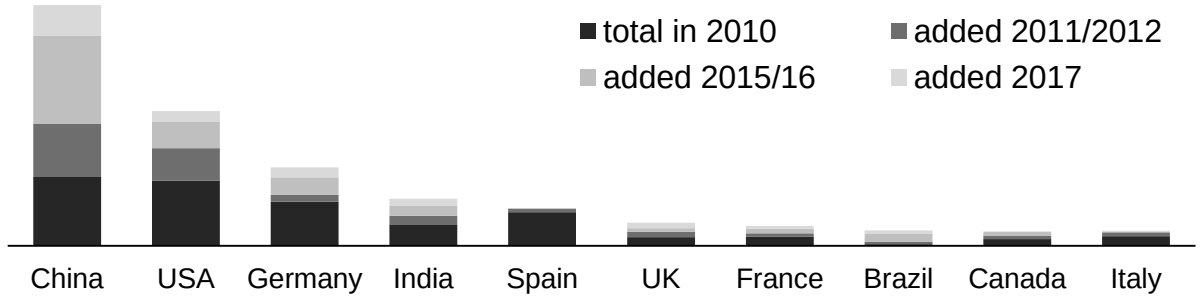
Again a record year of installation of new renewables

Wind power

Global capacity 2004 – 2017

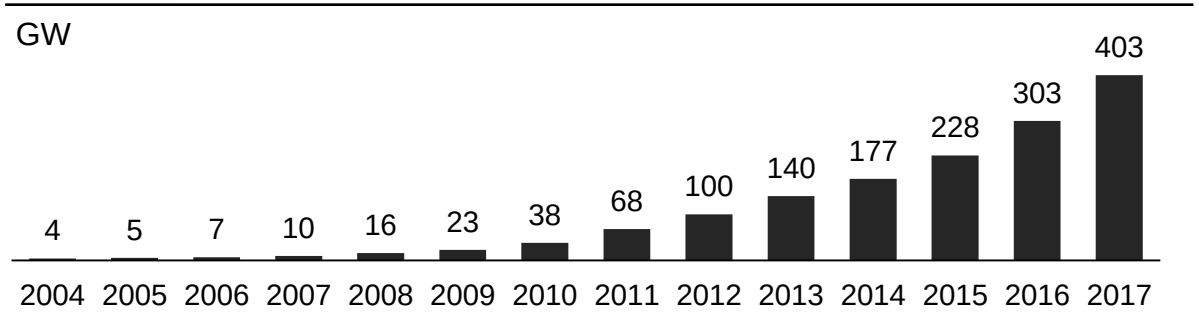


Top 10 countries, capacity 2017



Solar PV

Global capacity 2004 – 2017



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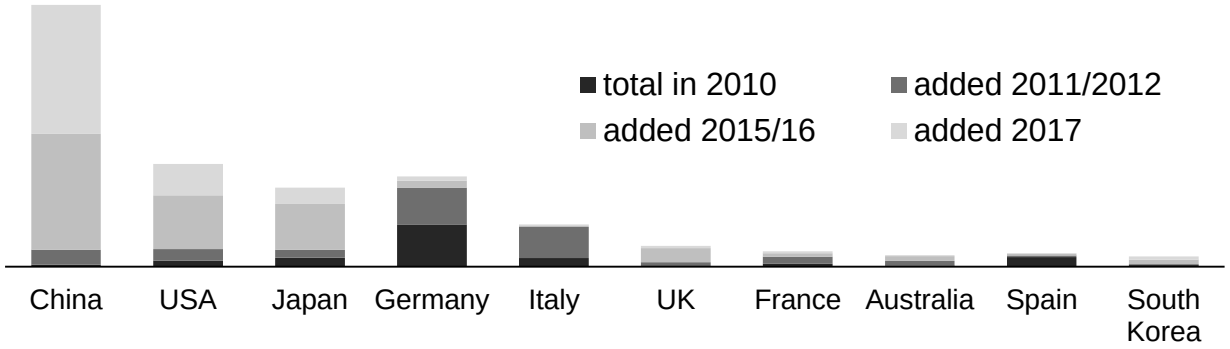


Source: IRENA Statistics

Power systems of the future

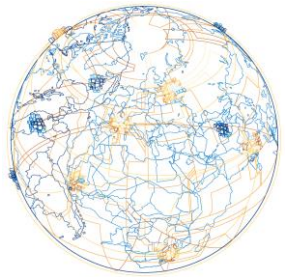
New renewables have become a natural pillar

The new normal

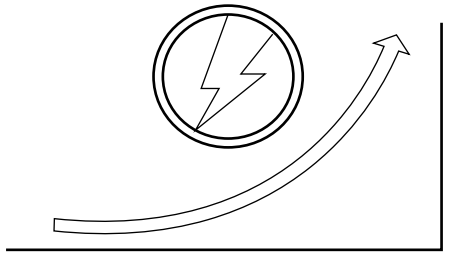
- Wind and solar power increasingly competitive
- Continuous growth in all regions of the world will result in further cost decrease
- Political focus moving from subsidizing to integration into power markets
  US: Reforming the Energy Vision (NY)
  EU: Clean Energy Package
  CN: Power market reform

Building blocks of power systems of the future

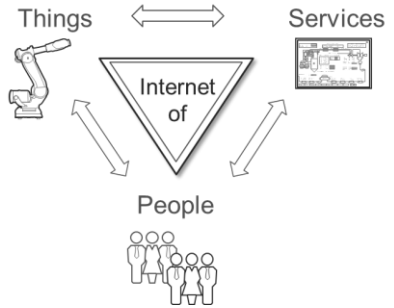
Global super grids



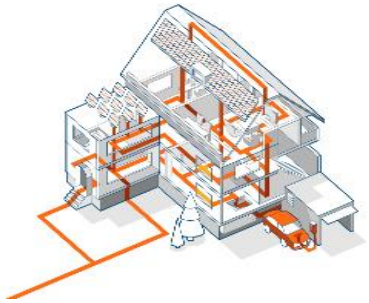
Power quality & demand management



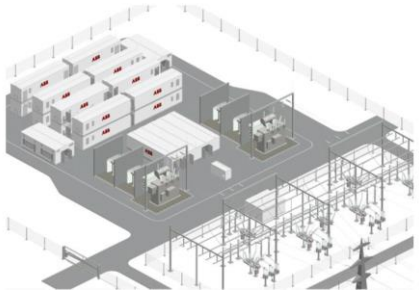
Digitalization



Residential roof top solar plus micro-and nanogrids



Energy storage



New business models

UBER

airbnb

NETFLIX

Power systems of the future

Building blocks available already today

Power systems of the future

Grid interconnection: Ultra High Voltage

World’s most powerful UHVDC link

Chiangji-Guquan, China

1.100 kV DC

12.000 MW

>3.000 km

World’s first multi-terminal UHVDC link

North-East Agra, India

800 kV DC

6.000 MW

>1.700 km

UHVAC transmission

Bina Substation, India

1.200 kV Circuit breaker & transformer

Power systems of the future

Microgrids and integration of renewables

Resilient and cost-effective technology

Grid code compliant integration of wind & solar

Stabilizing weak grids

Microgrids acting as one controllable generator or load

Access to power in remote locations

Marble Bar, Australia

- Photovoltaic (300 kW)
- Diesel (1.280 kW)
- Flywheel (500 kW)

Johannesburg, South Africa

- Photovoltaic (750 kW)
- Diesel (2x600 kW)
- Battery (1 MVA/ 380 kWh)

Power systems of the future

Power quality & demand management

Distributed renewables

Line voltage regulator

On-load tap-changers for distribution transformers

Extended control algorithms

Line voltage regulator
for medium voltage grids
with RESIBLOC® technology

Bulk renewables

Extremoz substation (BR): Static Var Compensator to connect wind energy (>1.000 MW) to 230kV level

Demand response management

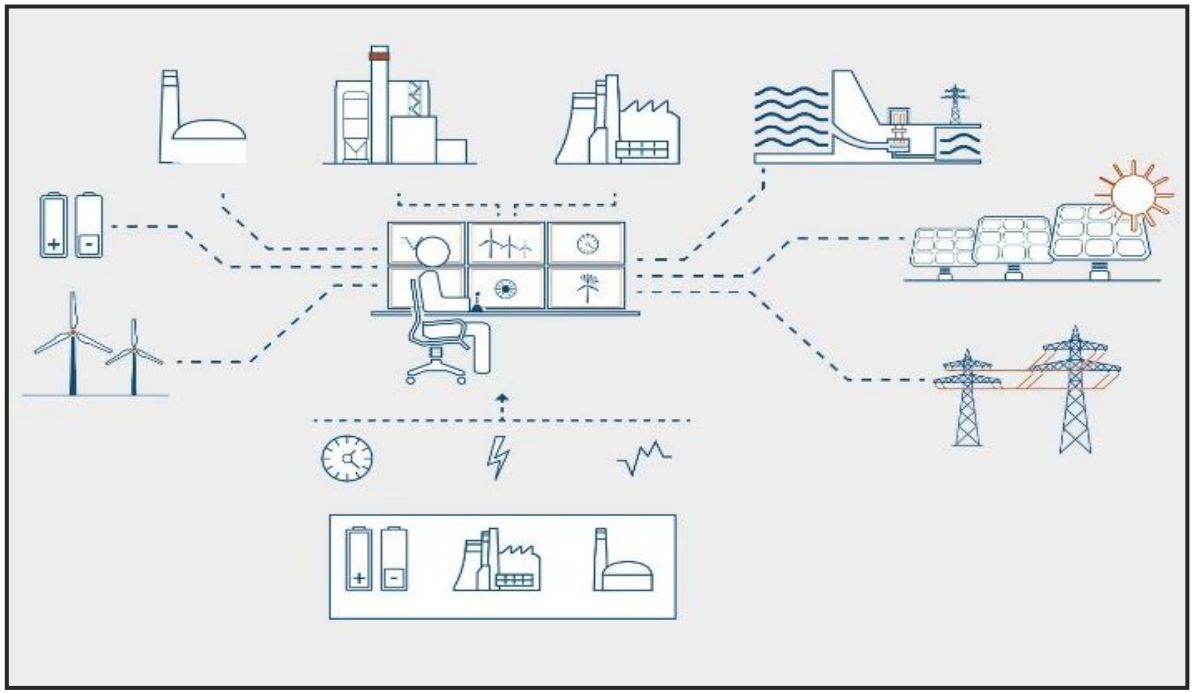
Frequency regulation through short term balancing of supply and demand

Smart home and building management

Electric vehicle (charging) infrastructure

Digitalization as facilitator to benefit from distributed resources

Example: Virtual power plant - frequency control with distributed energy resources



Customer:
Next Kraftwerke – a rapidly growing start-up in Germany

Remote management of more than 4.800 distributed units with 3,4 GW of installed capacity[1]

Optimal power dispatching to turn the plants into a Virtual Power Plant

Intraday energy planning using integration with power forecasting system

Provides balance power support to all transmission system operators in Germany (40 MW primary, 761 MW secondary and 813 tertiary reserve)

We are thinking in bits and watts. We are using latest possibilities of digitalization for connecting thousands of power producers and consumers in our virtual power plant.[2]

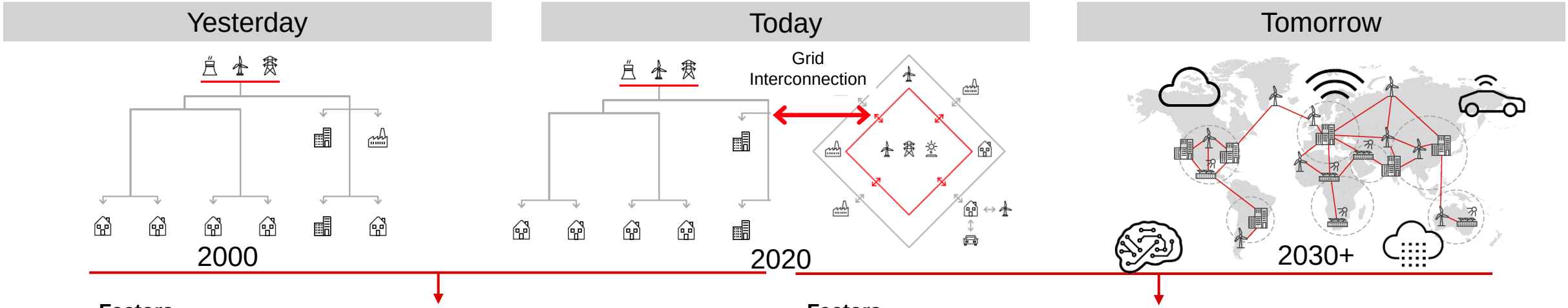
1 all figures as of September 2017
2 Hendrik Sämisch, founder and Managing Director

Power systems of the future

Outlook

Power systems of the future

Grid evolution today and in the future



Factors:

- Global warming – ecological threats
- Stimulated, regional introduction of renewables
- Exponential reduction of photovoltaics & battery storage costs
- Consumer to Prosumer development
- Digitalization trend
- Interconnection technology development

Factors:

- Full scale deployment of renewables across all regions
- Increased share of energy by wire
- Massive introduction of grid connected Electrical Vehicles
- Utilities re-inventing themselves with new business models
- Power exchange with related data transfer («Internet of Energy»)
- Artificial Intelligence enabling complex autonomous processes

New opportunities & challenges require new ideas – evolutionary & revolutionary


ABB