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Impact of innovation on renewables

Integration on renewables

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Agenda

Different aspects of innovation

More time variant power system in the future

Elements of renewables integration innovation

- Bulk power transmission
- Energy storage
- Digital distribution
- Emerging business innovation

Conclusions

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Different aspects of innovation

BAU[1] is not enough to meet the sustainability challenges

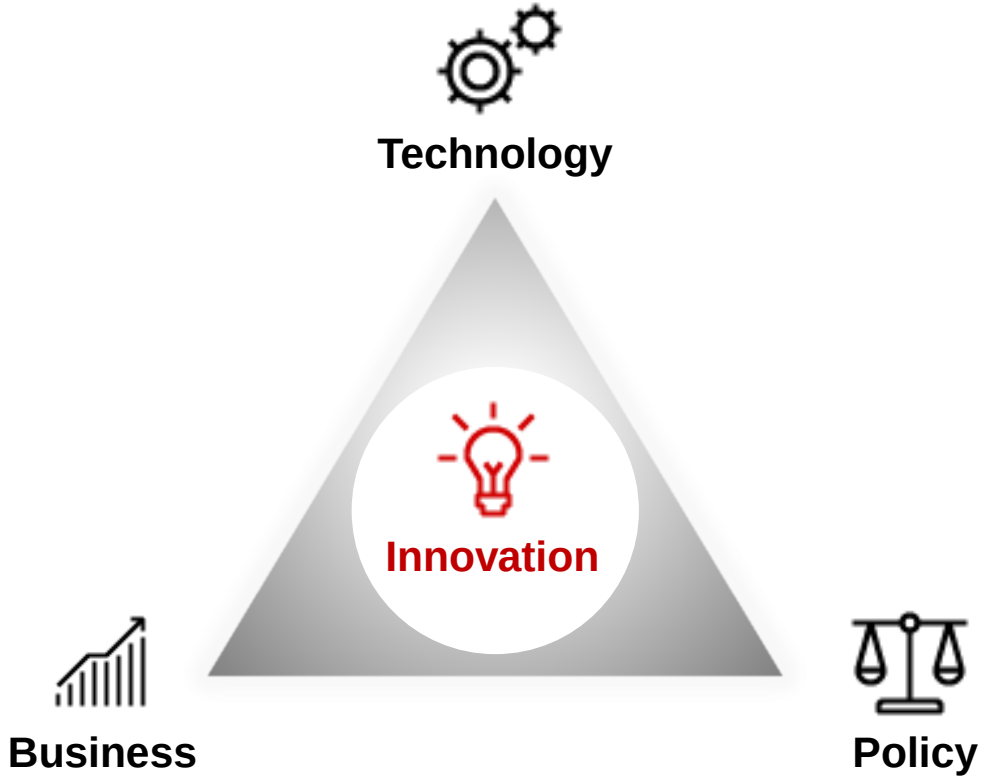
New thinking on how companies can deliver core business strategies is a must.

Innovation covers different areas:

– **Technology:** develop new solutions to reduce cost and increase performance

– **Business:** re-invent and develop new business models and services.

– **Policy:** create a framework for competitive business environment facilitating technologies breakthrough



Innovation is crucial for the new world of sustainability

1. Business as usual

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Innovative policy strategies stimulate technologies and new business models

Why and how to support renewable energy?

Renewable energy sources (RES) are effective technologies to fight against climate change and local air pollution.

In the past, RES deployment was hampered by their high up-front costs.

Numerous policy instruments provide predictability and guaranteed stability for producers and investors with regard to their revenue, e.g.:

– Feed-in tariffs

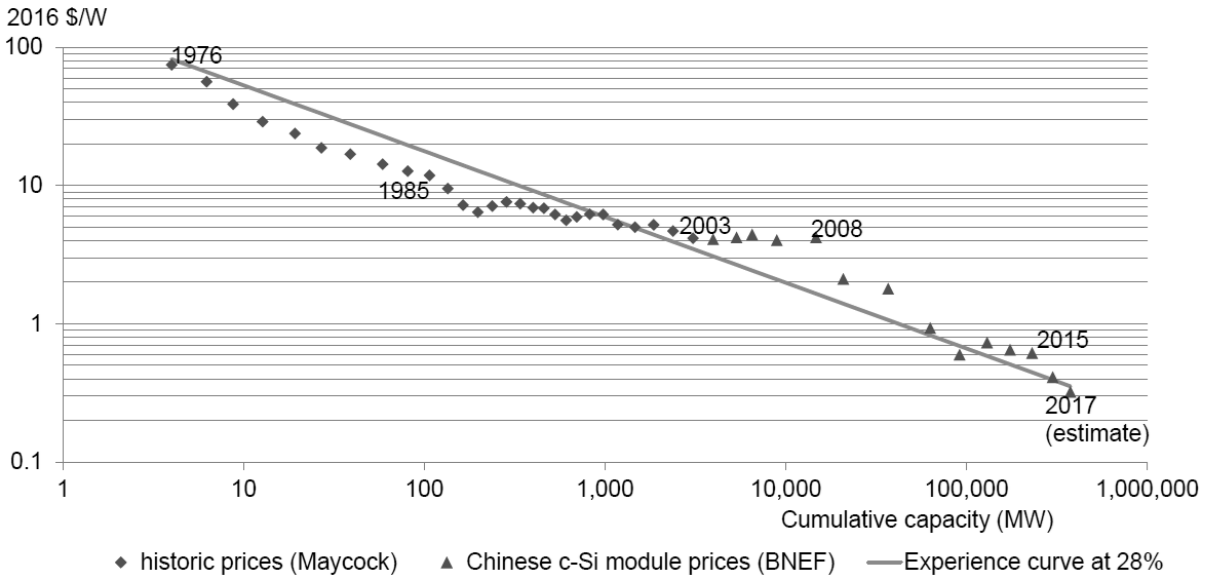
– Long terms power purchase agreements

– Well planned tender or auction schemes

Governments are mobilizing investments in research which plays an important role in stimulating patenting in RE technologies.

Due to these expenditures today's RES technologies are increasingly cost-competitive.

PV module prices and learning curve calculation



There is a clear pathway to even lower solar module prices through new wafering processes and more efficiency out of cells.

Source: Bloomberg New Energy Finance, 2017

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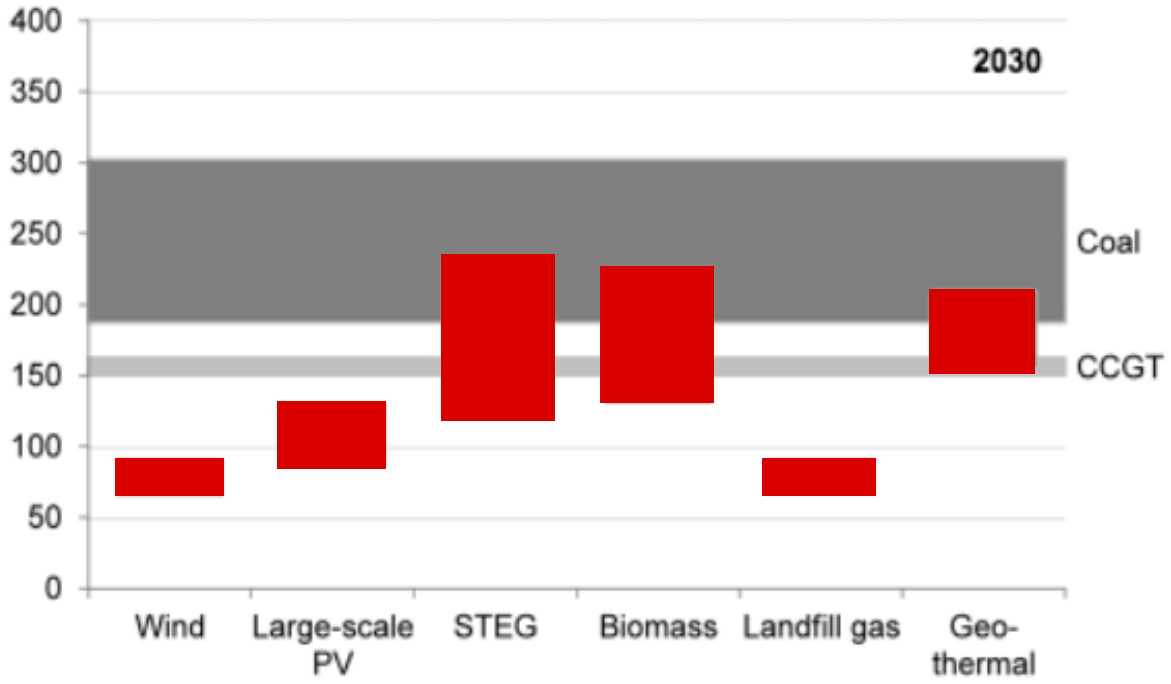
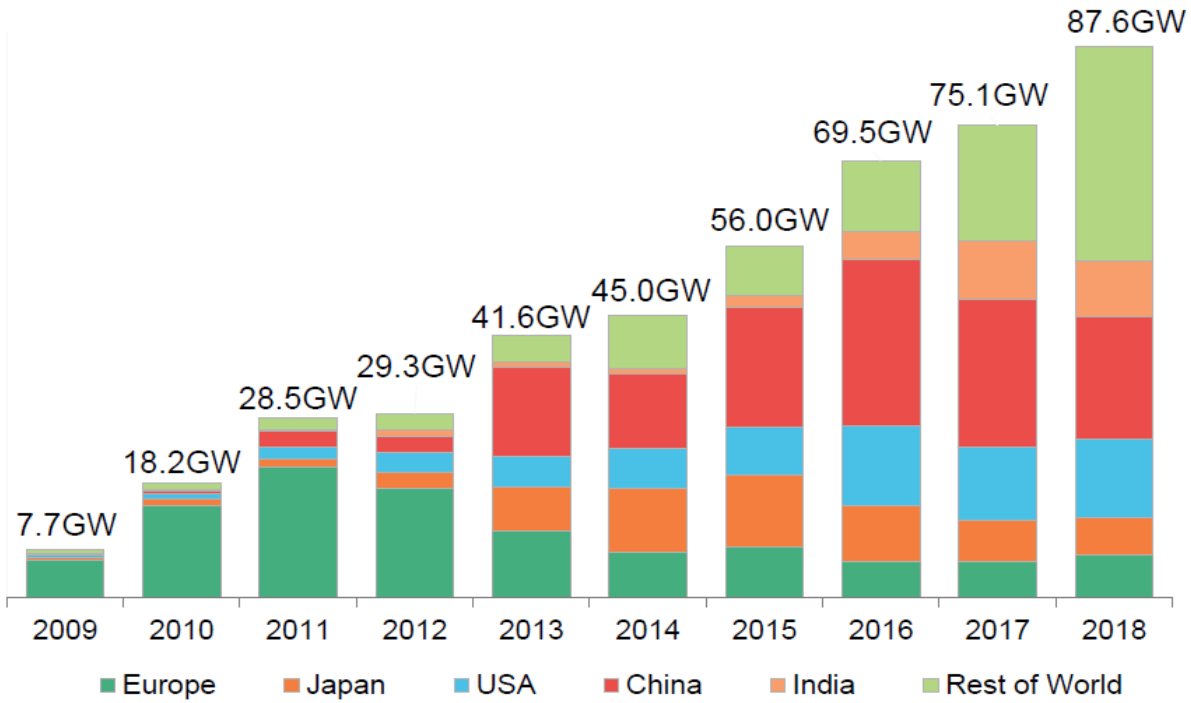
Renewable technologies are getting more competitive than ever

LCOE in Australia 2030 (real 2012 AUD/MWh)



Solar PV annual installations, historic and forecast



Source: Bloomberg New Energy Finance, Earth Policy Institute

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Renewable technologies are getting more competitive than ever

New wind power concepts and technologies

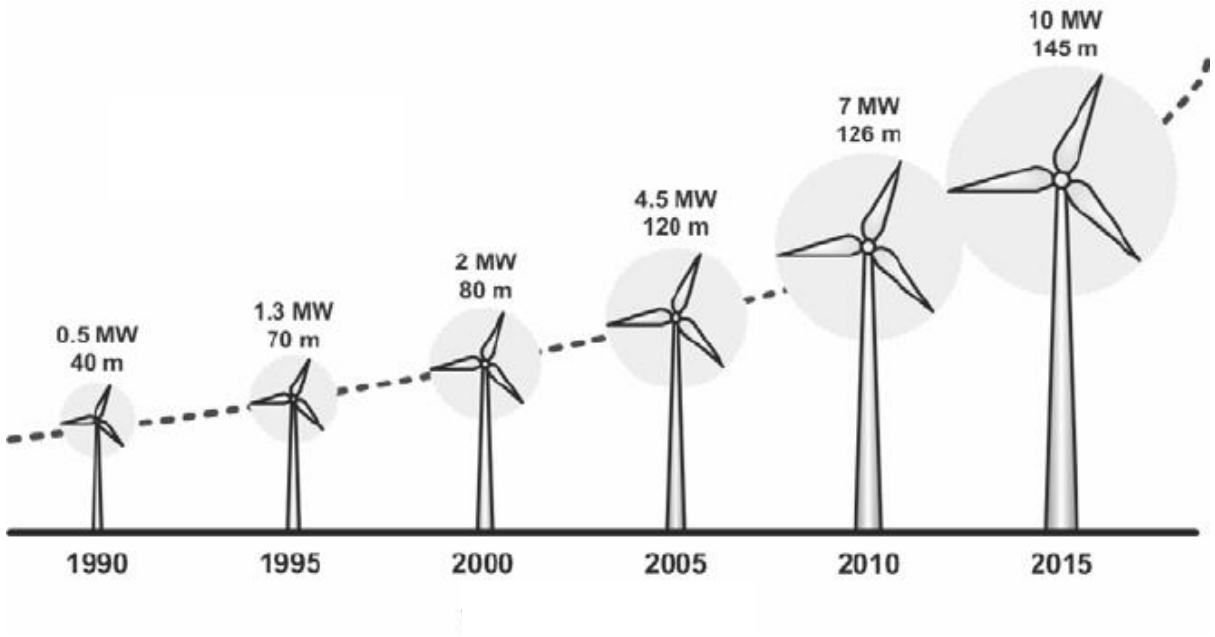
Innovation in materials and shape of blades.

Wind turbine capacity continuously grow. Today the largest units are at the level of 10 MW and with projections for even higher capacities.

66 kV collector system is emerging for large wind farms to save costs associated with cables.

Decentralized compact substations attached to the turbine tower to reduce the need for offshore platforms.

Continuous growth of wind turbine capacity



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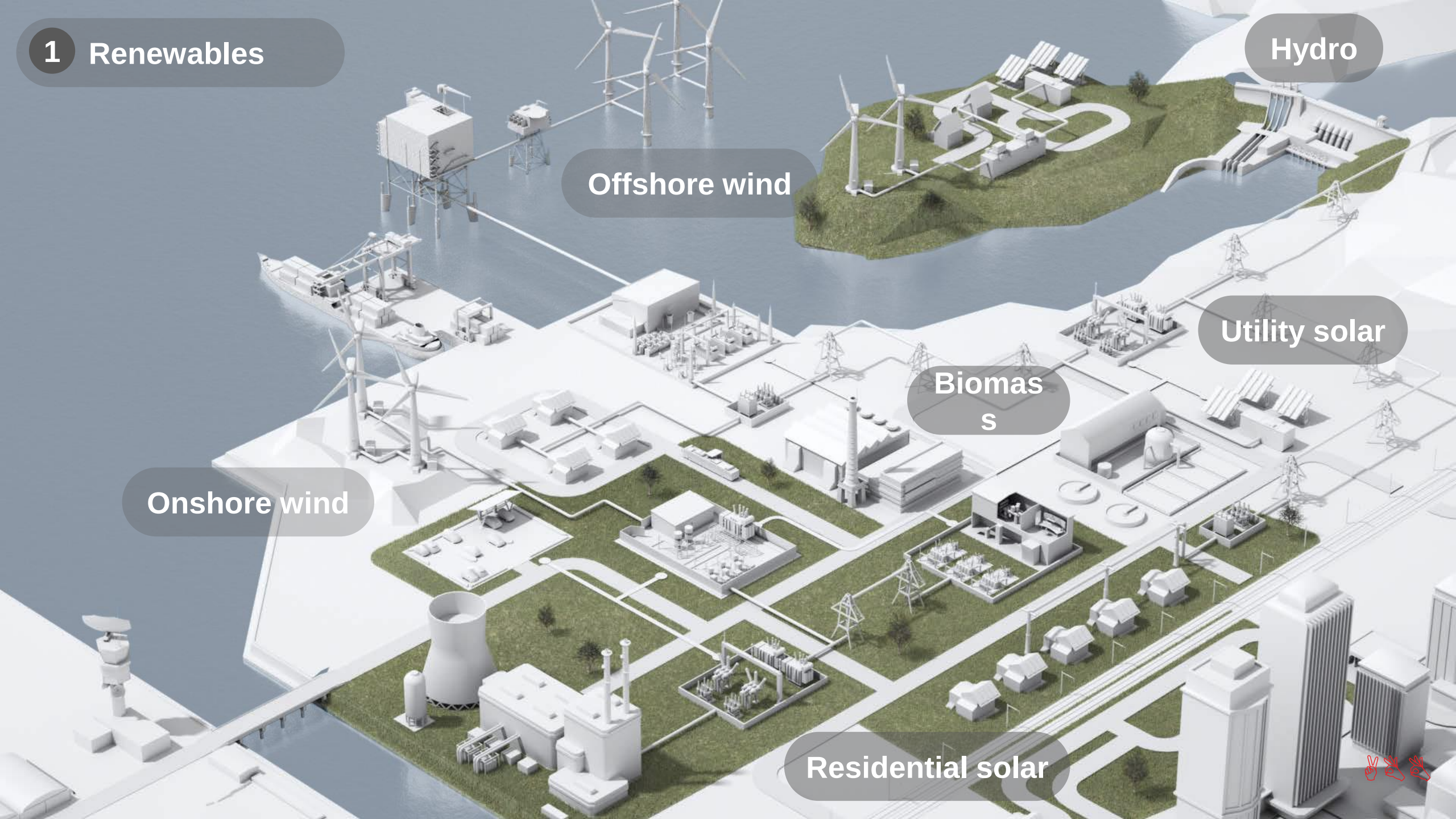
Wind turbines combined with energy storage.

Visions to build artificial islands with substations and converter stations, operation and maintenance facilities and energy storage.

Source: http://www.greenpowerisland.dk/


1 Renewables
Hydro
Offshore wind
Utility solar
Biomas
s
Onshore wind
Residential solar

The energy transition

Renewables are becoming an important source of electric power

Changing power generation mix

Power balance tipping towards renewables, driven by policy and sharp technology cost reduction (spend the same, get more).

Main growth in variable renewables energy sources (V-RES) such as wind and solar.

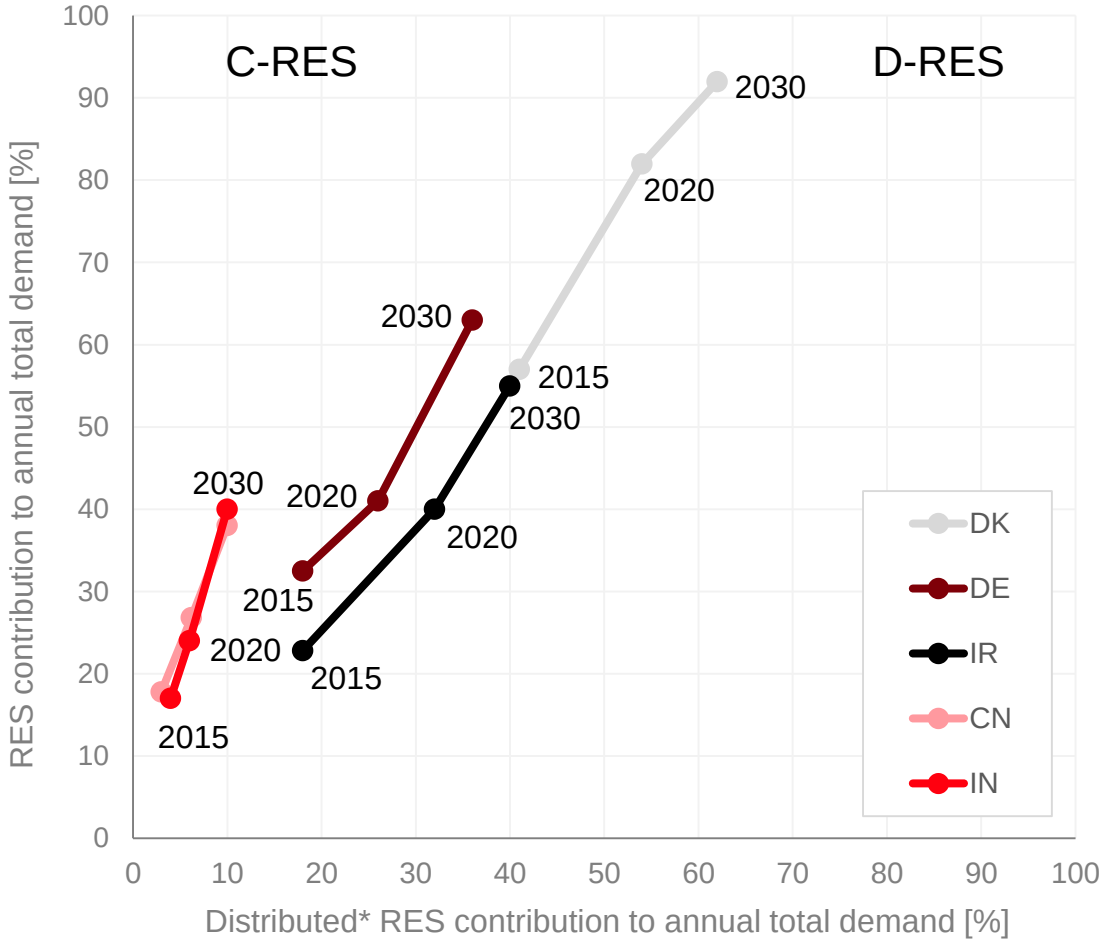
Two growth paths

– Mainly centralized renewables (C-RES)

– Mainly distributed* renewables (D-RES)

Fundamentally new challenges for power systems due to V-RES attributes such as:

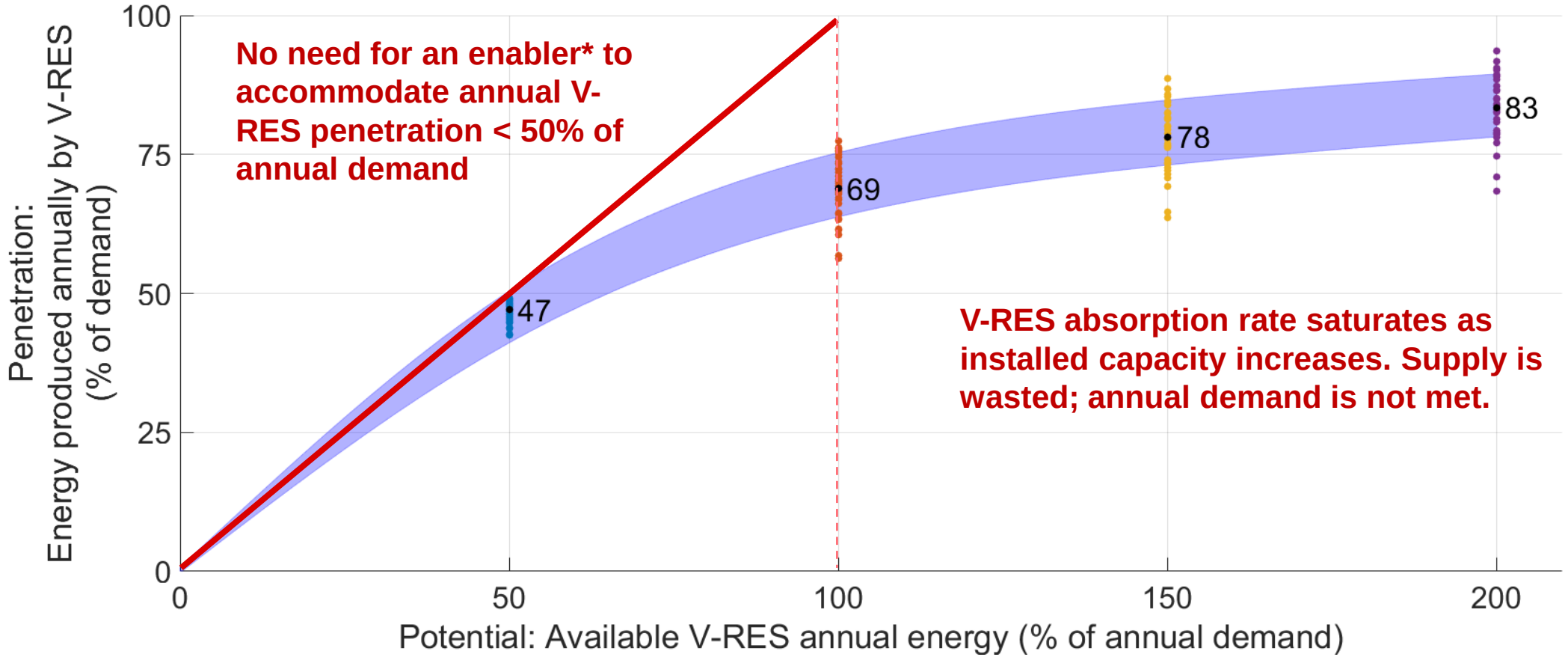
1. Volatile generation output
2. Reduced inertia and short circuit capacity
3. Remoteness from load centers
4. Distributed-ness



* <50 MW and connected to distribution grid

Towards a 100% wind & solar future

Annual: V-RES utilization vs. available V-RES production

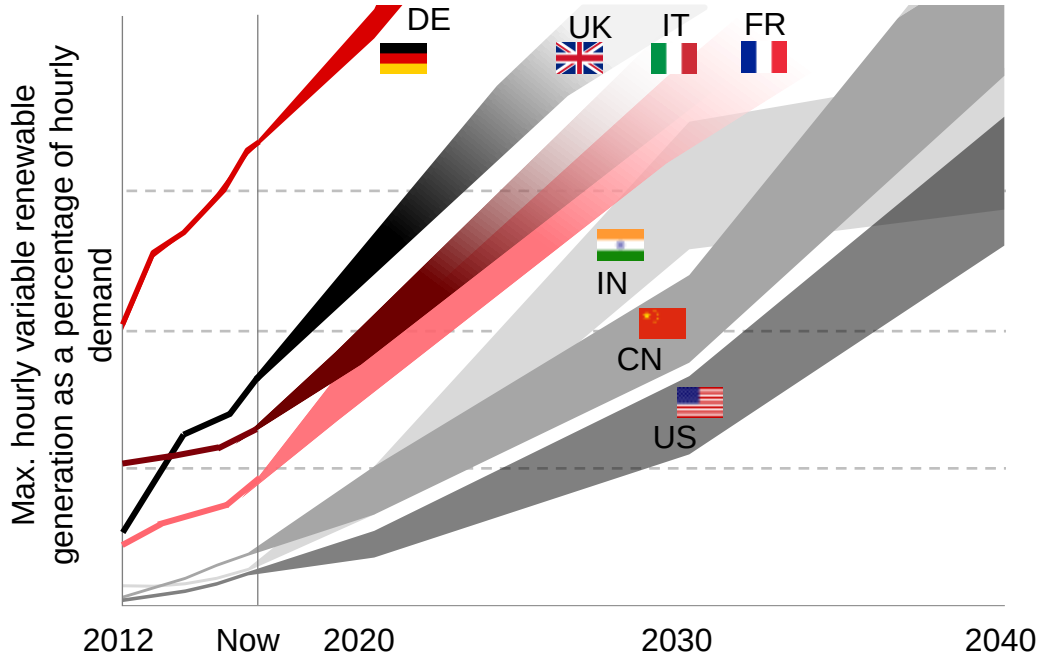


* Enabler – interconnector, energy storage, flexible demand, etc.
We have not used the same mix for all regions, but … (wind / solar mix intuitively chosen per region according to its potential)
Source: ABB analysis

Towards more flexible supply of electricity

What may happen when variable renewable sources have a high, instantaneous share?

Technical challenges renewable energy adopters encounter



Short circuit capacity & V-RES utilization

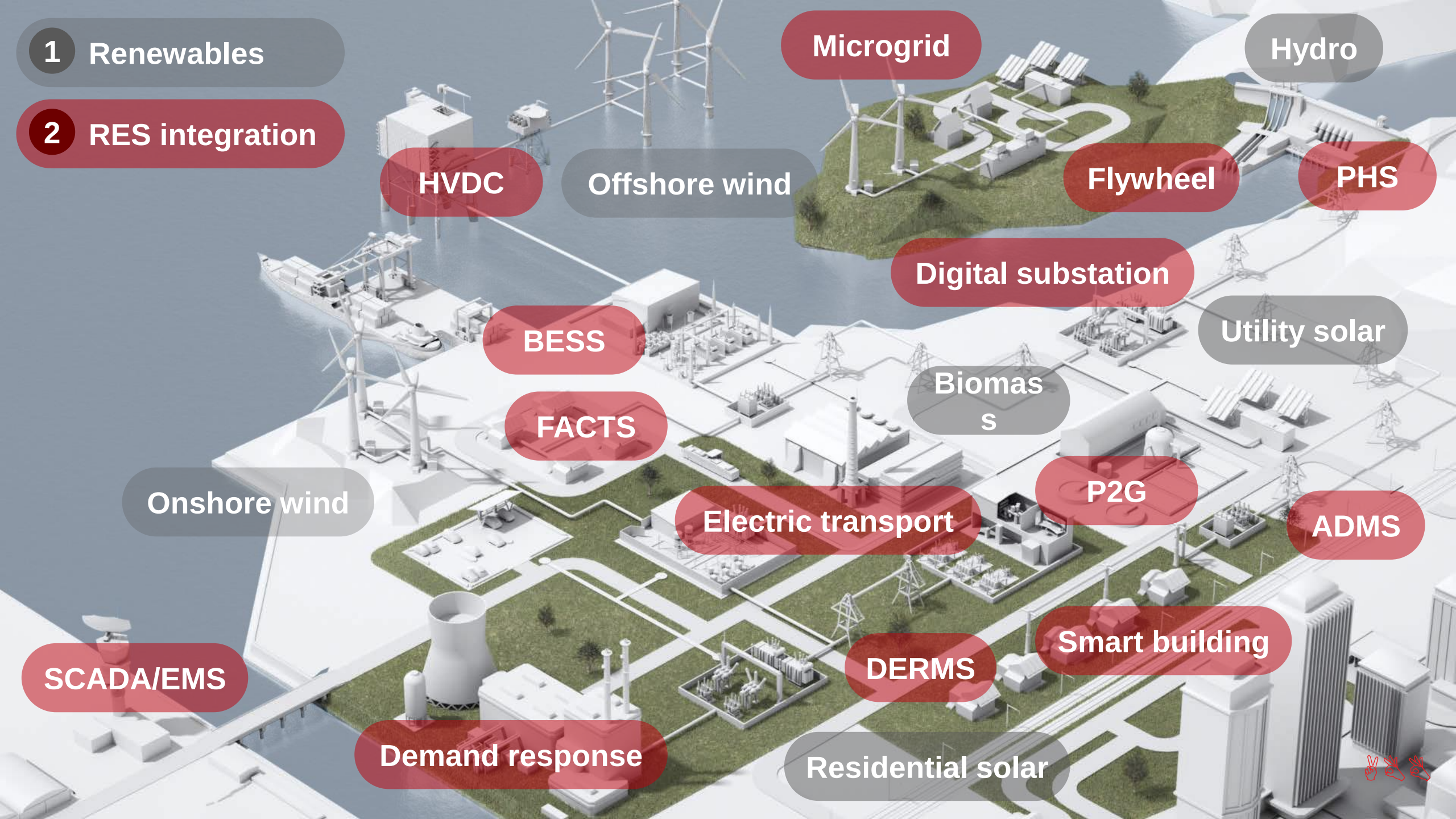
System inertia & grid voltage

Grid capacity & reserve

Conventional operation

Increasing system flexibility is a key for the reliable operation of future power systems with high levels of V-RES

Source: ABB analysis, data from different TSOs.


1 Renewables
2 RES integration
Microgrid
Hydro
HVDC
Offshore wind
Flywheel
PHS
Digital substation
BESS
Utility solar
Biomas
s
FACTS
Onshore wind
P2G
Electric transport
ADMS
Smart building
SCADA/EMS
DERMS
Demand response
Residential solar

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Bulk power transmission technologies

Renewables integration across regions

Transmission grids are essential globally for renewables integration:

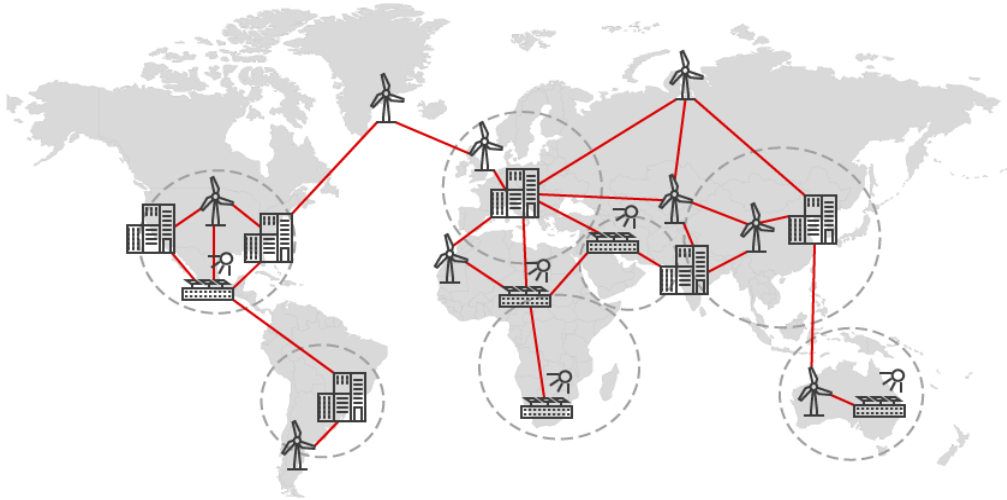
– To exploit locations with best capacity factors

– To profit from resource complementarity

The grids will need to be increasingly more accommodating to dynamically changing generation profiles.

HVDC and FACTS technologies are ready for bulk, long distance power transmission. E.g. HVDC may transfer 12 GW over 3’500 km at very low losses, control active and reactive power at multiple terminals.

Next step is to fix political and economic frameworks and globally harmonize standards, grid codes and operational practices.



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Energy storage technologies

Increase regional utilization of renewables

Li-ion battery cost reduction due to continuous innovation in product design, manufacturing process and capacity.

Annual installed BESS capacity has increased[1]:

– From 60 MW in 2010 to 530 MW in 2016

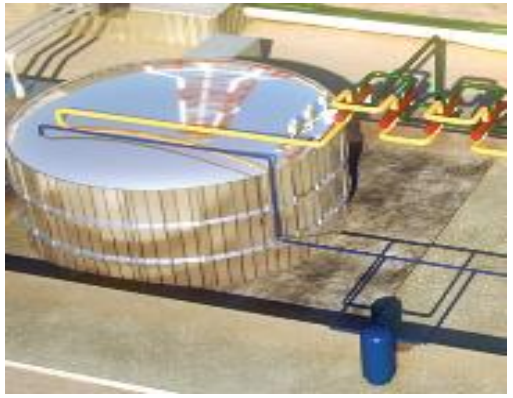
– From 100 MWh in 2010 to 750 MWh in 2016

Average size of single BESS project has increased in 2010-2016 by:

– More than 10 times in terms of installed capacity

– More than 4 times in terms of discharge time.

Research community focuses on development of new bulk, long duration (seasonal) storage to complement existing pumped hydro storage.



1. Source: DOE energy storage database.

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Management of distributed energy resources

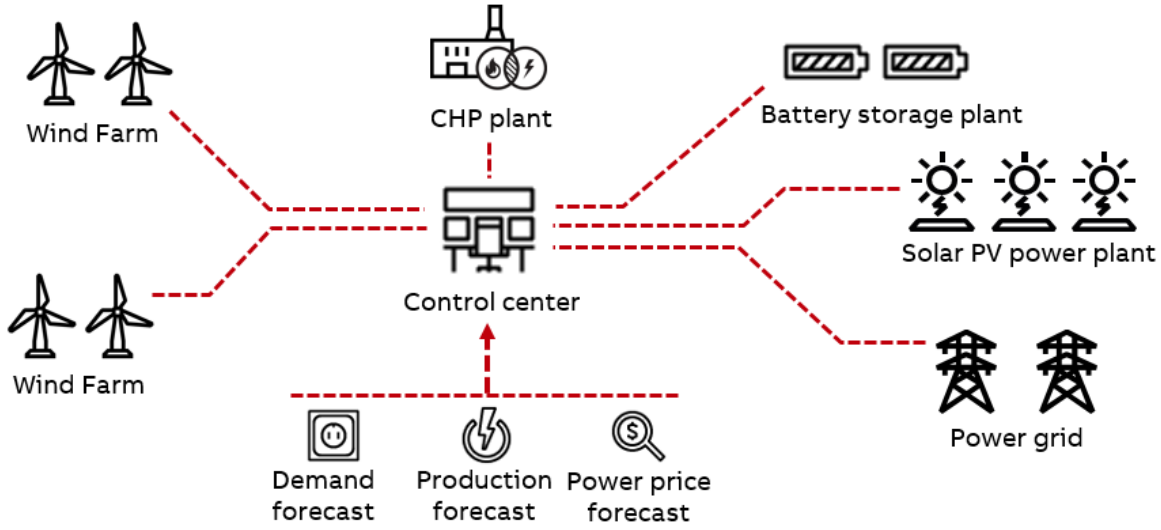
Digital distribution

Aggregation of distributed energy resources (DER):

- Allows to deal with the ever increasing system complexity
- Connects thousands of assets
- Facilitates market participation of smaller generators and consumers
- More accurate forecasting of energy production from distributed renewable sources
- Improves operations and stability of power system with high shares of V-RES through better controls

Mini- and micro-grids are another effective technologies to manage locally connected DER. They allow:

- Grid code compliant integration of wind & solar
- Stabilizing weak grids
- Sustainable power supply in remote locations



Next Kraftwerke virtual power plant (VPP) links more than 4,500 distributed energy resources (DER) with a total capacity of 3’200 MW in 8 European countries

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Emerging business models

Towards platform based services

The traditional commodity-based business via sales in kWh undergoes changes.

'DER'-centered environment creates new markets for new players.

There will be a need in platform based solution for:

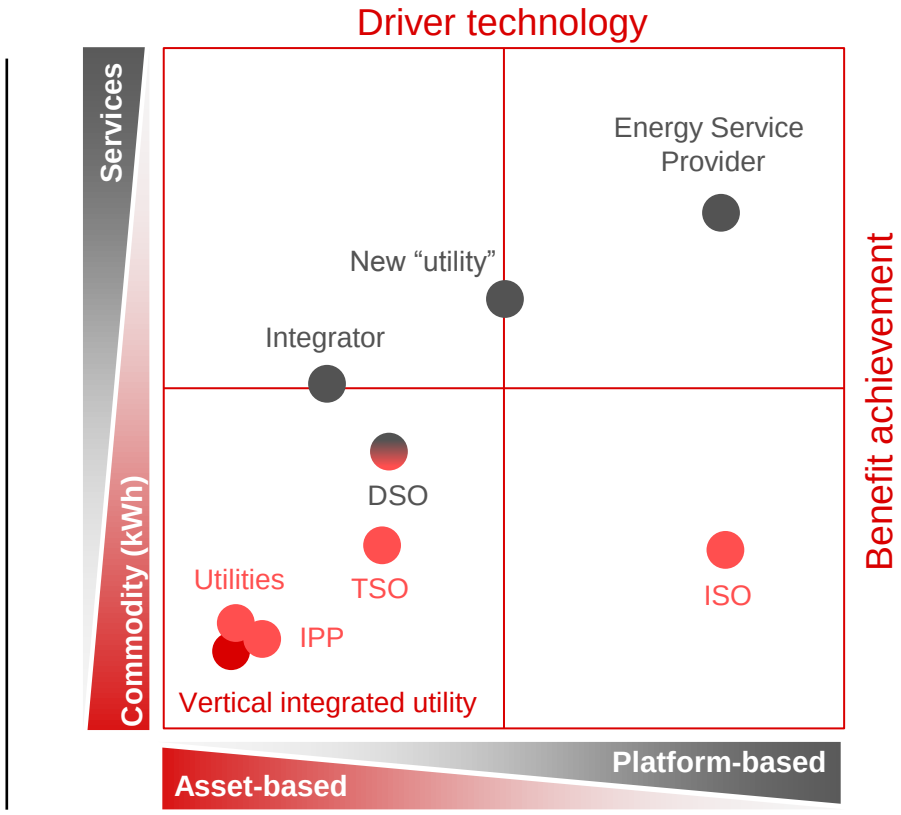
- aggregating DER locally or over large territories,
- enabling the prosumer and consumers to participate in a local restructured retail markets.

Recent examples of emerging business models:

- VPP: NextKraftwerke, Clens
- P2P markets: Powerpeers, Vandebron

Regulation plays an important role on the ability of these players to become innovative and change their business models.

Market design and rules should be changed to fairly integrate new players.



Mainly in developing and in few industrialized regions
Unbundled G, T, D: adopted in industrialized & in few developing regions
Unbundled D: emerging in industrialized regions

Key take away messages

1. Well designed policy instruments stimulate proliferation of renewable energy sources as well as ensure necessary systemic changes in adaptive way. Regulation should be more pro-active.
2. New renewable sources (wind and solar) are cost competitive in many regions but their large scale proliferation may pose operational challenges.
3. Technology innovation should focus on grid integration and grid flexibility to accommodate high shares of variable renewables energy sources.
4. Business model innovation should focus on a reduction of complexity of managing myriads of distributed assets and seamlessly integrating them in energy markets and grid system services.
5. All stakeholders (policy makers, regulators, technology vendors, utilities, etc.) need to work together to achieve a cost effective energy sector decarbonization.