System Integration of Renewables

Lessons from International Experience

Simon Müller, Head of Unit – System Integration of Renewables Unit

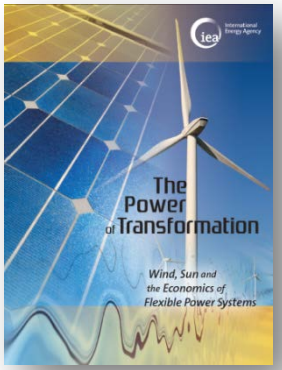
Joint IEA / BMWi Side Event: Grid Integration of Variable Renewables

11 December 2018 – COP24, Katowice, Poland

IEA System Integration of Renewables analysis at a glance

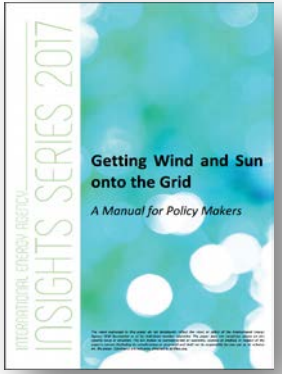
- Over 10 years of grid integration work at the IEA
  - Grid Integration of Variable Renewables (GIVAR) Programme
    - Use of proprietary and external modelling tools for techno-economic grid integration assessment
    - Global expert network via IEA Technology Collaboration Programmes and GIVAR Advisory Group
  - Dedicated Unit on System Integration since June 2016
  - Part of delivering the IEA modernisation strategy

2014 2016 2017 2017 2018

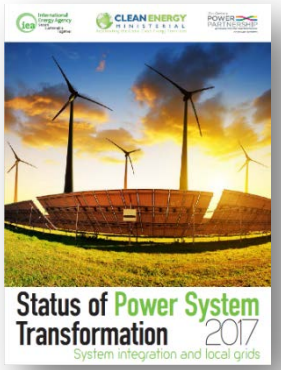


Framework, Technology, Economics

Policy



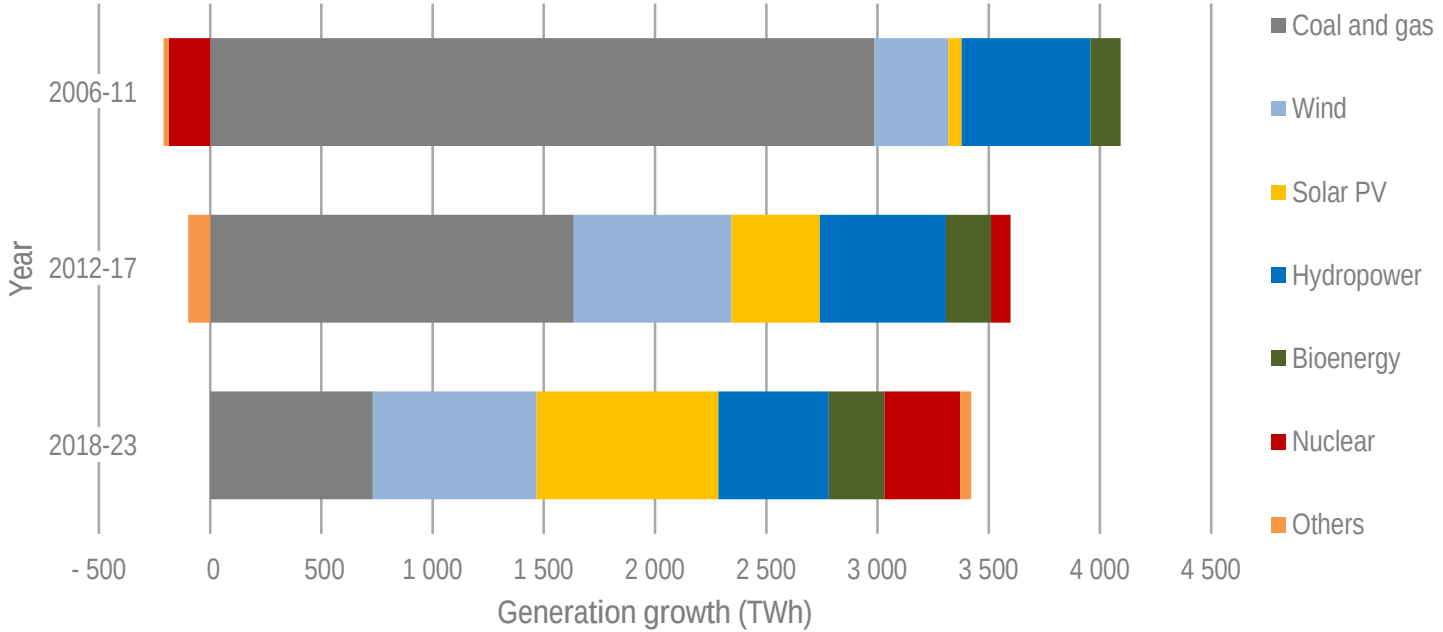
Implementation



Progress & Tracking

Country Engagement

Electricity generation growth by fuel

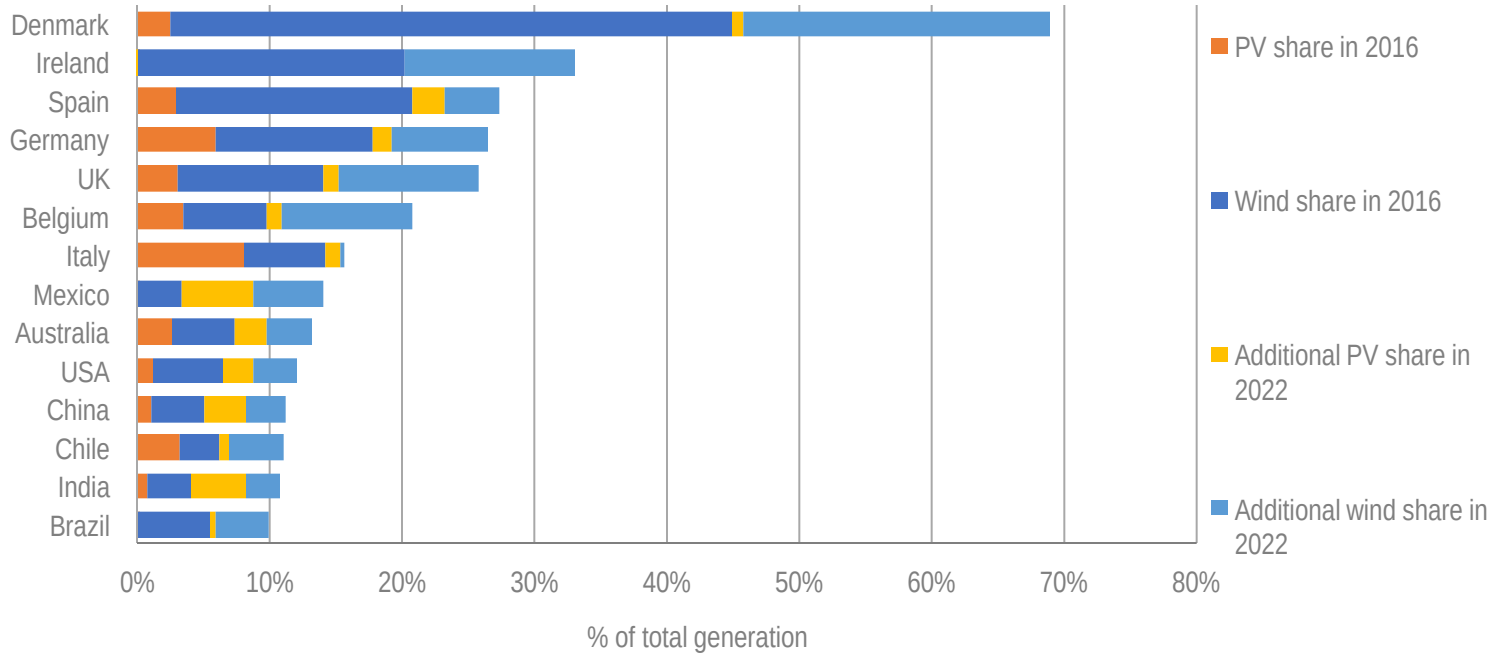


Renewable generation leads the growth of electricity among different technologies. Expansion of fossil fuel is expected to decline considerably.

Source: Renewable 2018: Analysis and Forecasts to 2023

Variable Renewable Energy (VRE) on the rise

VRE share in annual electricity generation, 2016-22

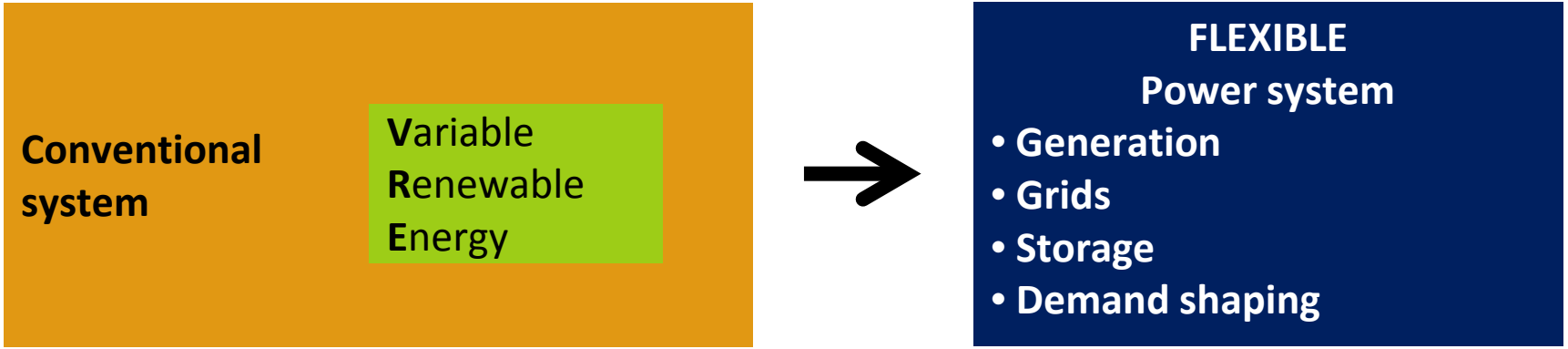


A substantial increase of VRE will occur over the next five years across the globe.

Source: Renewable Energy Market Report, 2017

Three main messages on system integration

1. Very high shares of variable renewables are technically possible
2. No problems at low shares, if basic rules are followed
3. Reaching high shares cost-effectively calls for a system-wide transformation

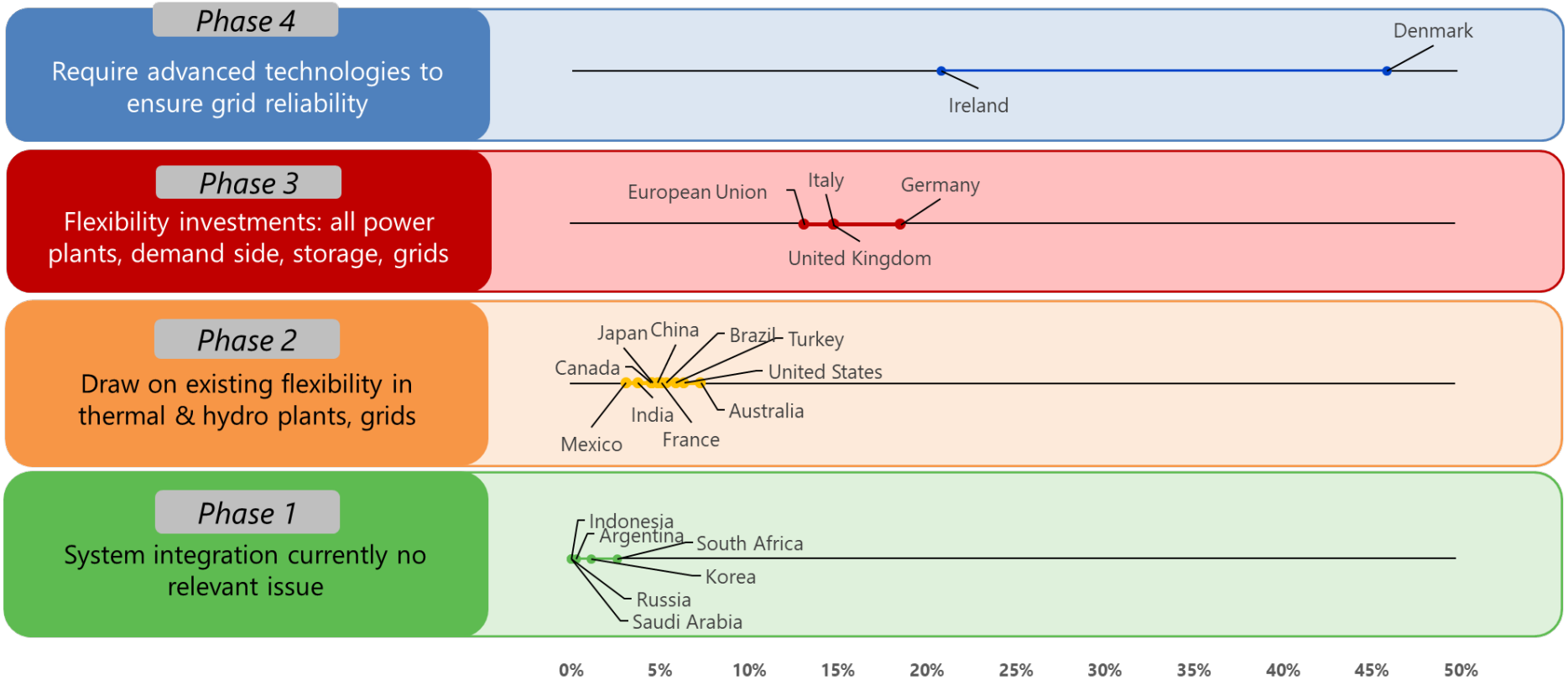


Different Phases of VRE Integration

Phase	Description
1	VRE capacity is not relevant at the all-system level
2	VRE capacity becomes noticeable to the system operator
3	Flexibility becomes relevant with greater swings in the supply/demand balance
4	Stability becomes relevant. VRE capacity covers large majority of demand at certain times
5	Structural surpluses emerge; electrification of other sectors becomes relevant
6	Bridging seasonal deficit periods and supplying non-electricity applications; seasonal storage and synthetic fuels

Wind & solar making strong inroads, but new challenges may emerge

Four phases of wind and solar integration



System transformation

Policy and market framework

Level of VRE penetration

System-friendly VRE deployment

- Distributed resources integration
- System services
- Generation time profile
- Technology mix
- Location
- Integrated planning

Flexible resources
planning & investments


Grids


Generation


Storage

Demand shaping

System and market operation

Actions targeting VRE

Actions targeting overall system

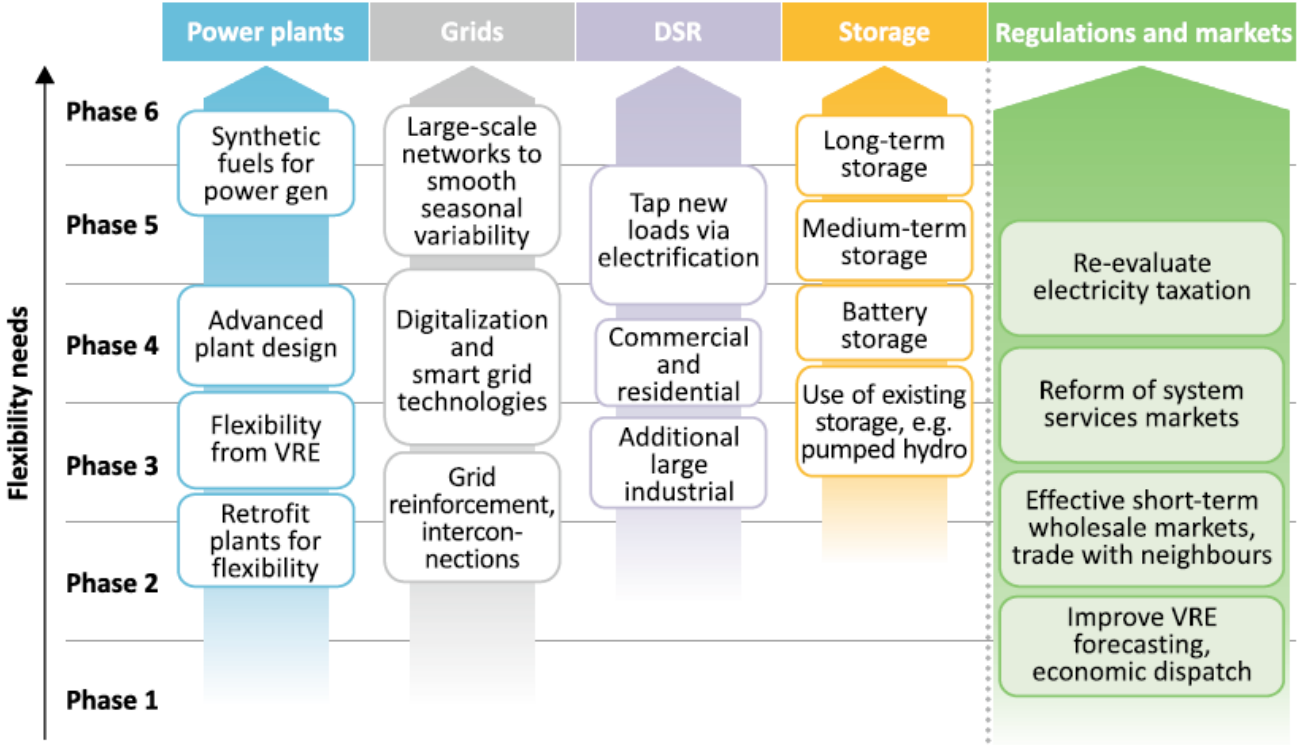
Large-scale Interconnection Crucial Flexible Resource

- Inter-regional planning across different jurisdictions have emerged over time towards electricity market integration
  - ASEAN
  - South Asia (SARRC)
  - ENTSO-E
  - the United States

- Cross-border arrangements can be complex and difficult to achieve.
  - Political, commercial and technical challenges

Source: ENTSO-E (2016), Ten-Year Network Development Plan 2016.

Flexibility options for different phases of VRE integration



Flexibility resources can mitigate the challenges from VRE integration in different phases and allowing the system to integrate more VRE

Summary

- Challenges for integrating wind and solar are often smaller than expected at the beginning
  - Power systems already have flexibility available for integrating wind and solar
- Challenges and solutions can be group according to different phases
  - Measures should be proportionate with the phase of system integration
  - Making better use of available flexibility is most often cheaper than 'fancy' new options
  - Barriers can be technical, economic and institutional, all three areas are relevant
- Mix of flexible resources needed to achieve system integration
  - Grid infrastructure crucial part of any flexibility strategy
- To reach high shares cost-effectively, a system-wide approach is indispensable

simon.mueller@iea.org