RE Grid Integration: International Perspective

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

1ST INT'L RE GRID INTEGRATION CONFERENCE INDIA , Delhi, 6 Sep 2017

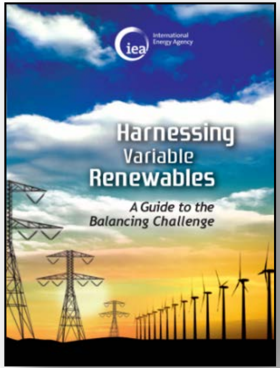
Outline

- **Overview of IEA work and introduction**
- Handling challenges during initial phases
- Mastering higher shares – system transformation
- Distributed energy resources – the future of local grids

IEA System Integration of Renewables analysis at a glance

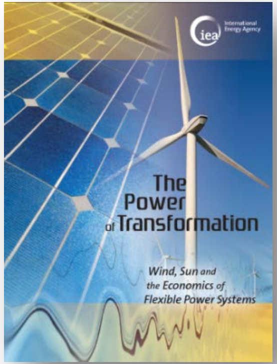
- Over 10 years of grid integration work at the IEA
  - Grid Integration of Variable Renewables (GIVAR) Programme
    - Use of proprietary and external modelling tools for techno-economic grid integration assessment
    - Global expert network via IEA Technology Collaboration Programmes and GIVAR Advisory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

2011



Technical

2014

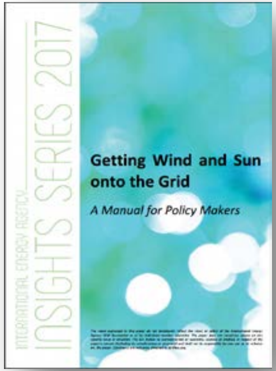


Framework, Technology, Economics

2016

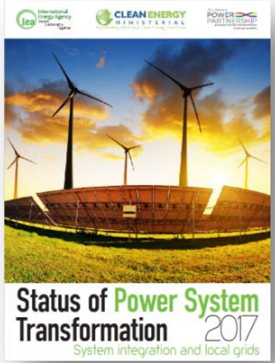
Policy

2017



Implementation

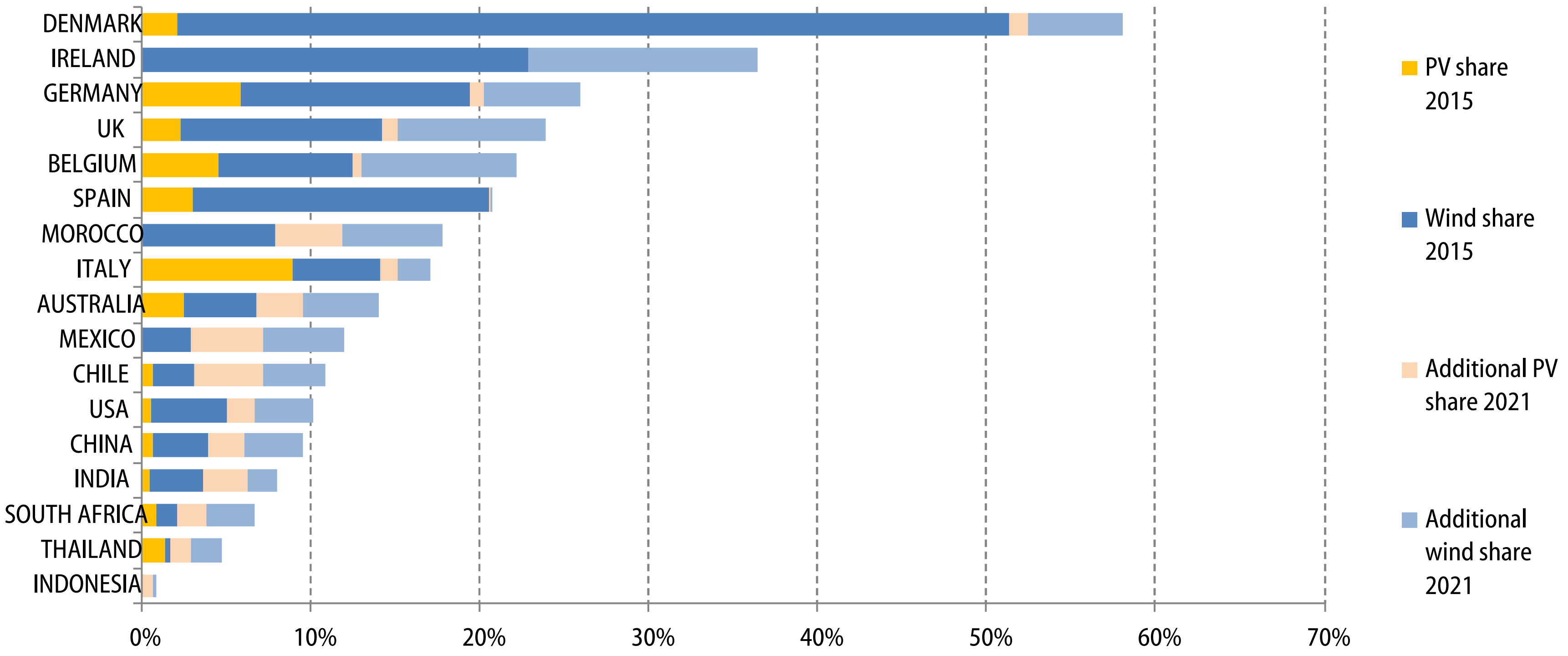
2017



Progress & Tracking

Variable Renewable Energy (VRE) on the rise

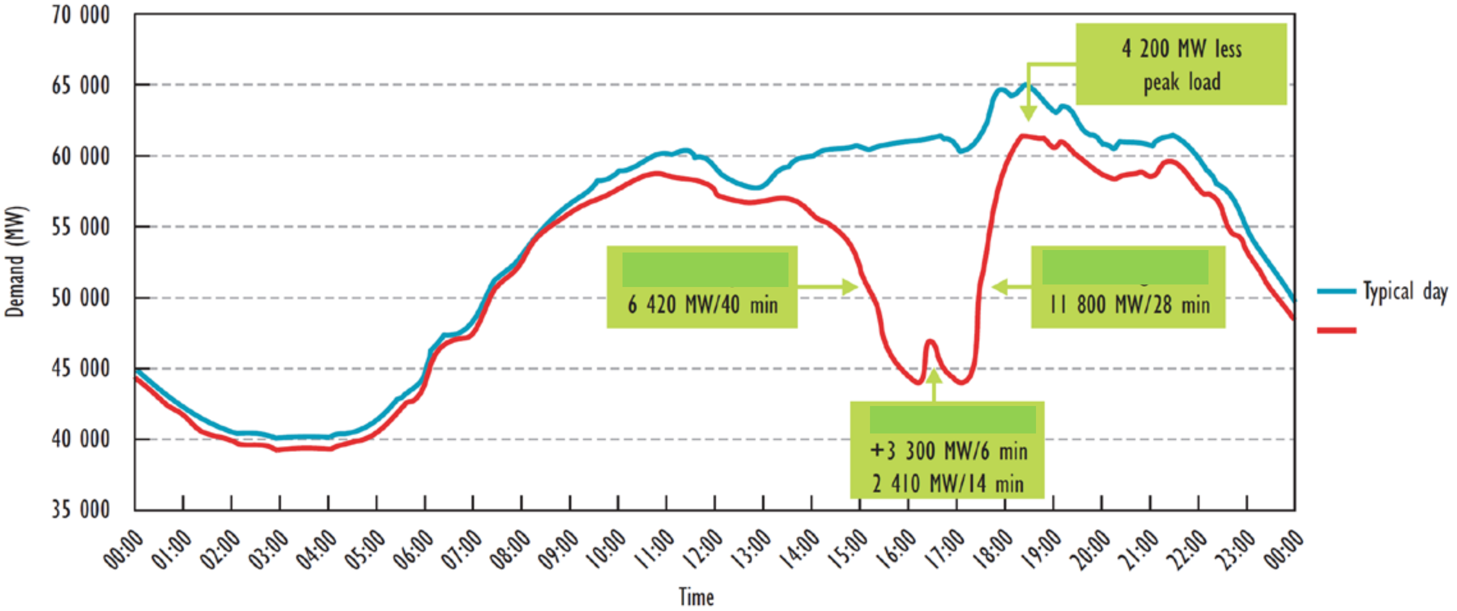
VRE share in annual electricity generation, 2015-21



Source: Medium Term Renewable Energy Market Report, 2016

Variability – a familiar challenge

Exceptionally high variability in Brazil, 28 June 2010

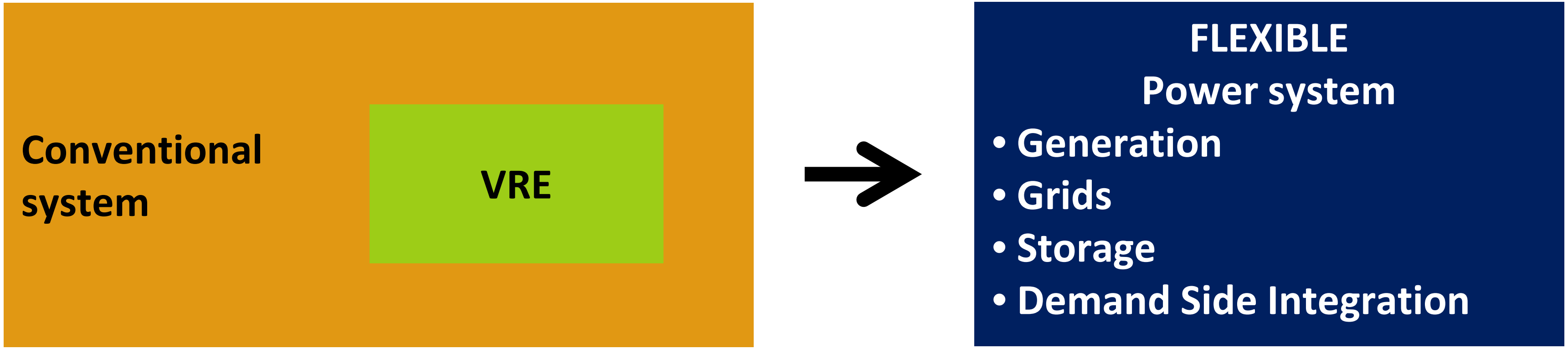


Power systems already deal with demand variability; they have flexibility available from the start.

Source: ONS, Brazil

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

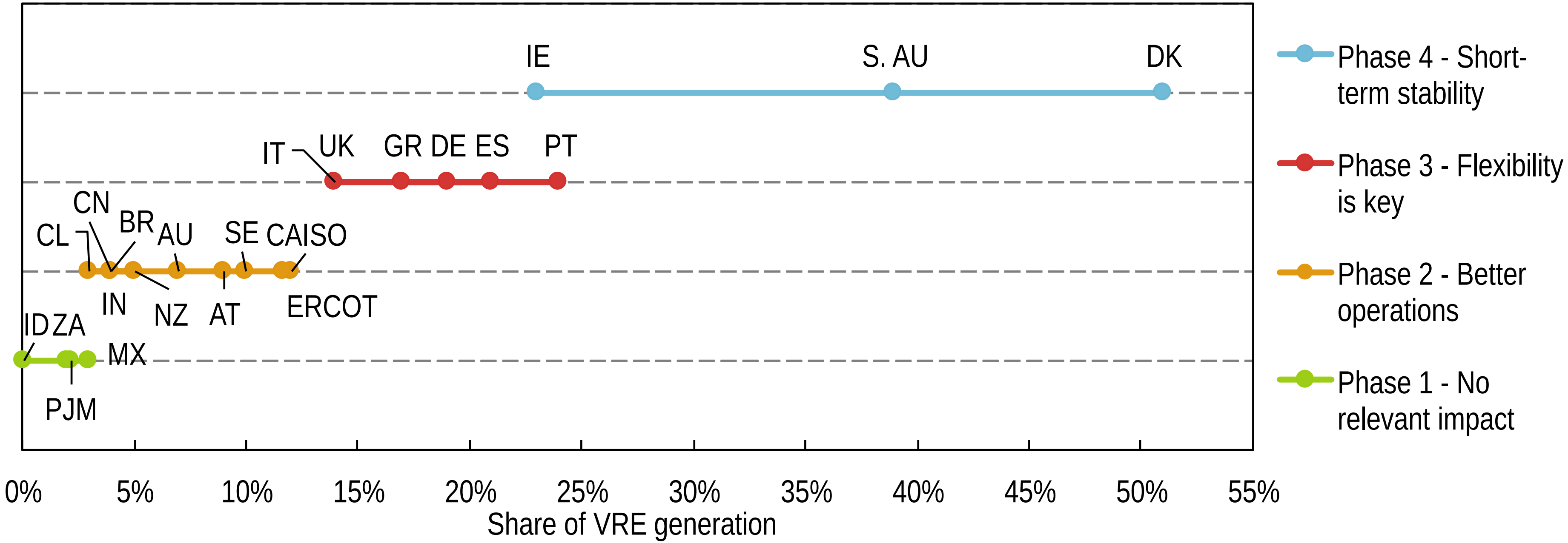


Different Phases of VRE Integration

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 output can cover most 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

VRE deployment phase in selected countries

VRE share in annual electricity generation and system integration phase, 2015



Each VRE deployment phase can span a wide range of VRE share of generation; there is no single point at which a new phase is entered

AT = Austria; AU = Australia; BR = Brazil; CL = Chile; CN = China; DE = Germany; DK = Denmark; ES = Spain; GR = Greece; ID = Indonesia; IE = Ireland; IN = India; IT = Italy; MX = Mexico; NZ = New Zealand; PT = Portugal; S.AU = South Australia; SE = Sweden; UK = the United Kingdom; ZA = South Africa. PJM, CAISO and ERCOT are US energy markets in California and Texas, respectively.

Outline

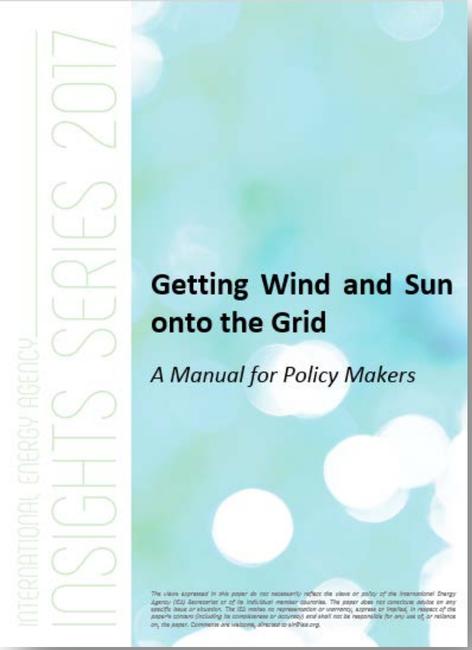
- Overview of IEA work and introduction
- **Handling challenges during initial phases**
- Mastering higher shares – system transformation
- Distributed energy resources – the future of local grids

Phases 1 & 2: Getting Wind and Solar Onto the Grid

Myths related to wind and solar integration

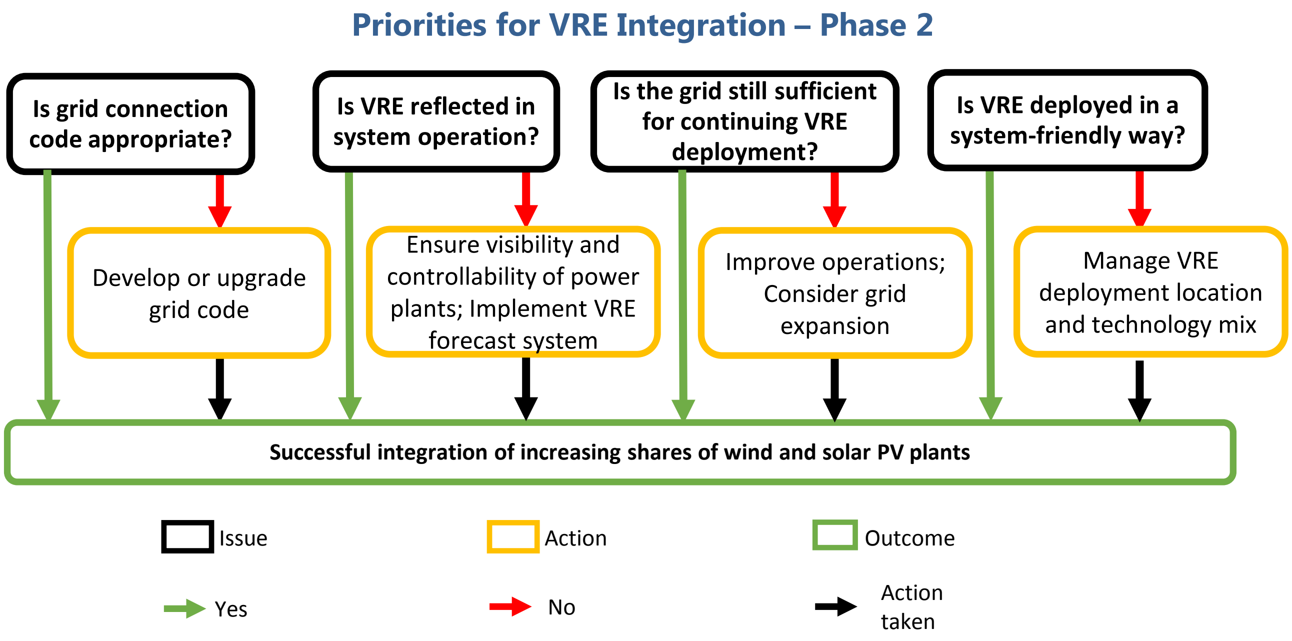
1. Weather driven variability is unmanageable
2. VRE deployment imposes a high cost on conventional plants
3. VRE capacity requires 1:1 "backup"
4. The associated grid cost is too high
5. Storage is a must-have
6. VRE capacity destabilizes the power system

New Publication released March 2017



Focus on Phase 2 of VRE integration

- First instances of grid congestion
- Incorporate VRE forecast in scheduling & dispatch of other generators
- Focus also on system-friendly VRE deployment



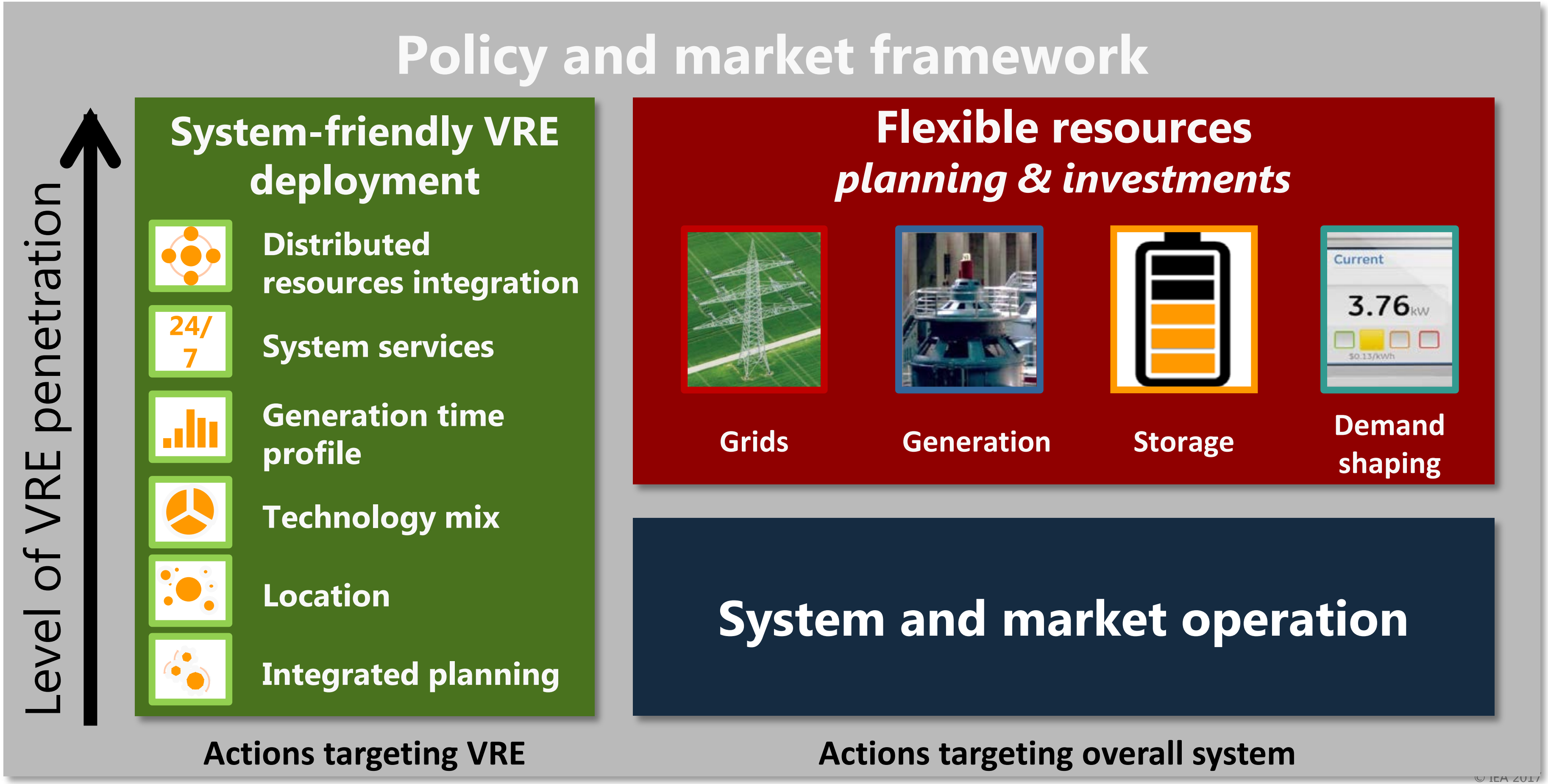
Source: IEA 2017, *Getting wind and sun onto the grid*

Updated system operations, sufficient visibility & control of VRE output becomes critical in Phase II

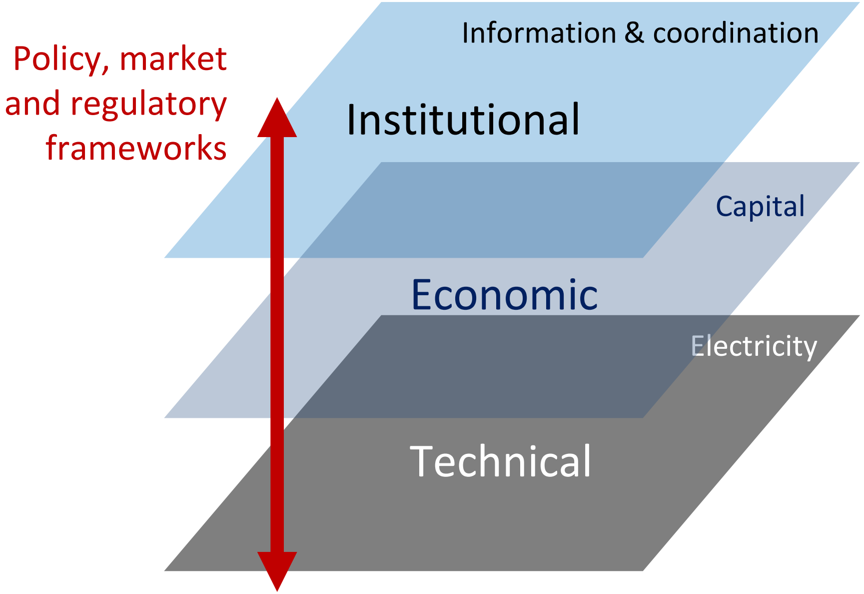
Outline

- Overview of IEA work and introduction
- Handling challenges during initial phases
- **Mastering higher shares – system transformation**
- Distributed energy resources – the future of local grids

System transformation



System transformation requires holistic approach

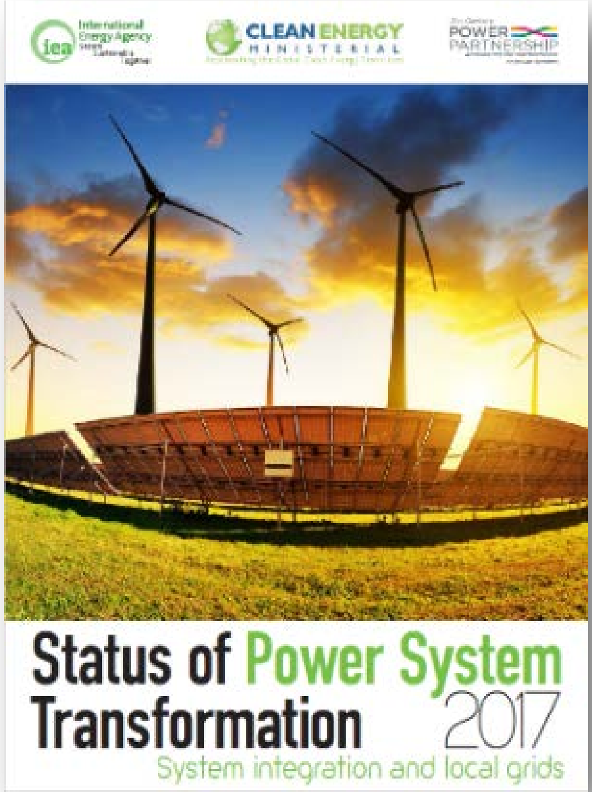


- **Institutional** – defining roles and responsibilities
- **Economic** –market design, regulation, planning frameworks
- **Technical** – operation of power system, safeguarding reliability

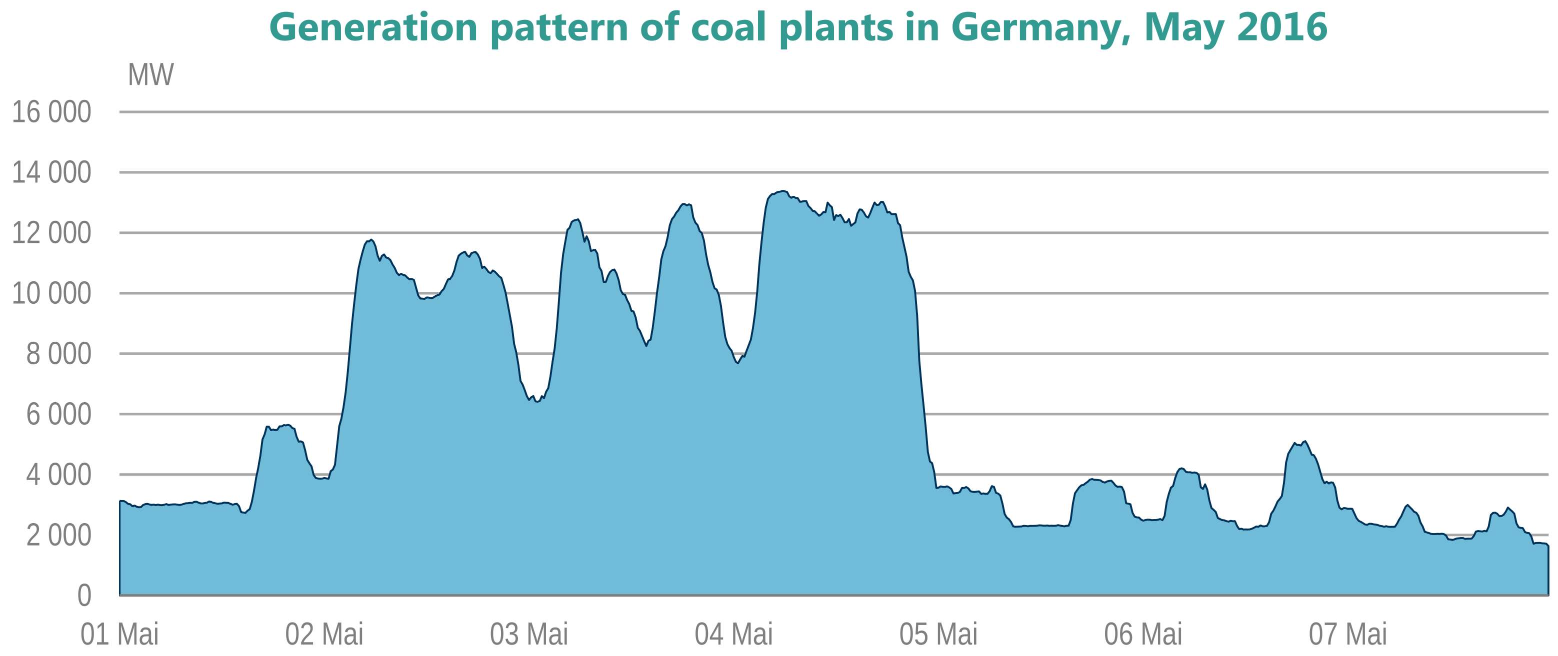
Policies, markets and regulatory frameworks link technical, economic and institutional aspects

Recent publication: Status of Power System Transformation 2017

- Overview of trends and developments in the power sector
  - System Integration of Renewables
  - Future of local grids
- Provides over two dozens of best practice examples for integrating wind and solar power
- Introduces a framework for assessing power system transformation



Example: power plant flexibility



Power plants are an important source of flexibility, evident in countries such as Germany, Denmark, Spain, the United States

Why focus on power plant flexibility?

- Flexible power plants currently major source of flexibility in all power systems

- Technical potential is often poorly understood and/or underestimated

- Significant barriers hinder progress:
  - Technical solutions not always known
  - Market design favors running 'flat-out'
  - Inflexible contracts with manufacturers

- IEA coordinating new initiative to promote enhanced power plant flexibility

Example North-America
From baseload operation to starting daily or twice a day (running from 5h00 to 10h00 and 16h00 to 20h00)
Source: NREL

ADVANCED POWER PLANT FLEXIBILITY
A Clean Energy Ministerial Campaign

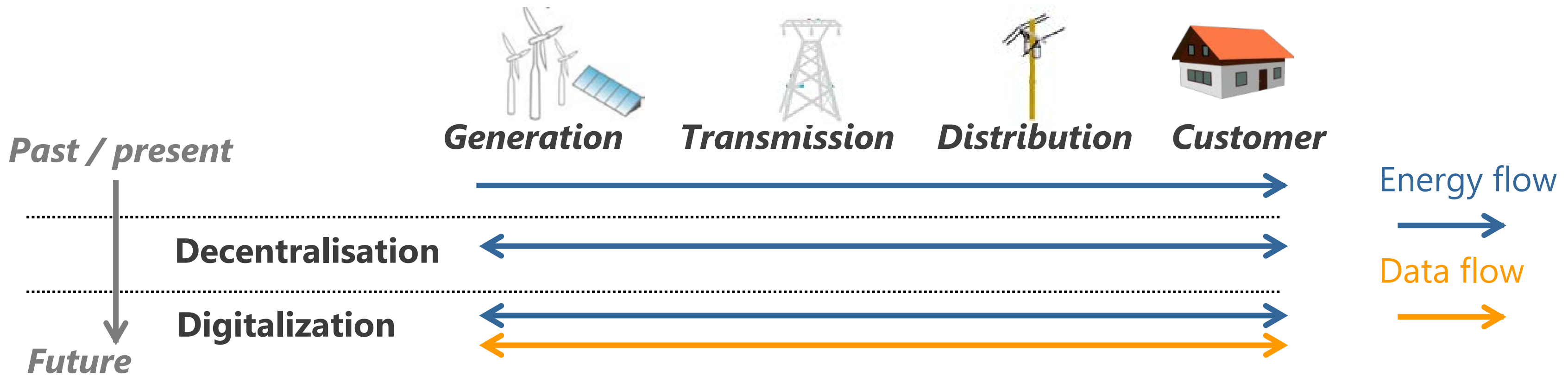
System operation and market design

Efficient operation of the power system	• Ensuring least-cost dispatch • Trading close to real time • Market integrations over large regional areas
Unlocking flexibility from all resources	• Upgrade planning and system service markets • Generation, grid, demand-side integration and storage
Security of electricity supply	• Improve pricing during scarcity/capacity shortage • Possibly capacity mechanisms mechanism as safety-net
Sufficient investment in clean generation capacity	• Sufficient investment certainty • Competitive procurement (with long-term contracts)
Pricing of externalities	• Reflecting the full cost (i.e. environmental impacts)

Outline

- Overview of IEA work and introduction
- Properties of variable renewable energy (VRE) and impact; system integration phases
- Handling challenges during initial phases
- Mastering higher shares – system transformation
- **Distributed energy resources – the future of local grids**

A paradigm shift - local grids in future energy systems



- High uptake of DERs are changing the way local grids are planned and operated
- Successful transition rests on changes in three dimensions
  - **Technical** – more dynamic (bi-directional) energy flows require changes in system operations
  - **Economic** – High uptake of DERs raise the need for retail tariff reform. Consideration of time and place can foster greater flexibility
  - **Institutional** - roles and responsibilities are changing. Better co-ordination between local grid and transmission system operators is key

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
- Challenges can be minimized via system friendly deployment
  - Integrated planning is the foundation for long term success
- To reach high shares cost-effectively, a system-wide approach is indispensable

simon.mueller@iea.org