IEA System integration of Renewables

An Update on Best Practice

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Yokohama, 21 June 2018

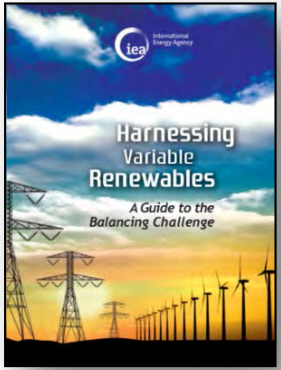
Outline

- **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

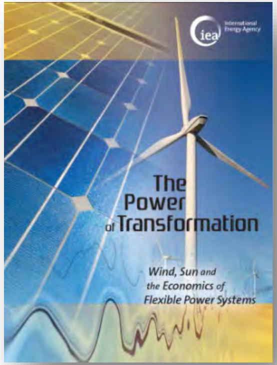
- Over 10 years of grid integration work at the IEA
  - Grid Integration of Variable Renewables (GIVAR) Programme
    - Use of proprietary and external modelling tools for techno-economic grid integration assessment
    - Global expert network via IEA Technology Collaboration Programmes and GIVAR Advisory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

2011



Technical

2014

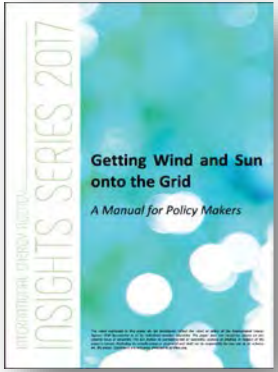


Framework, Technology, Economics

2016

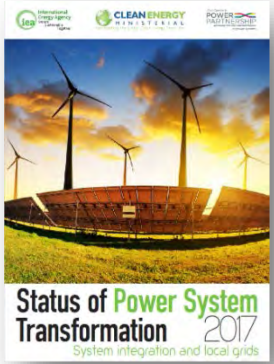
Policy

2017



Implementation

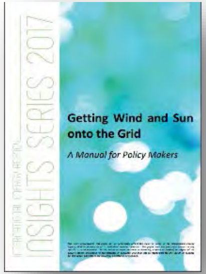
2017



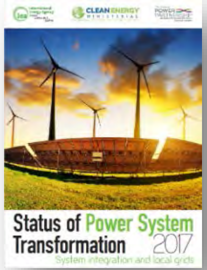
Progress & Tracking

A New English Insight paper of SIR

2016 Policy
- System integration
- System Value (SV)
- System friendly VRE
- Case Studies



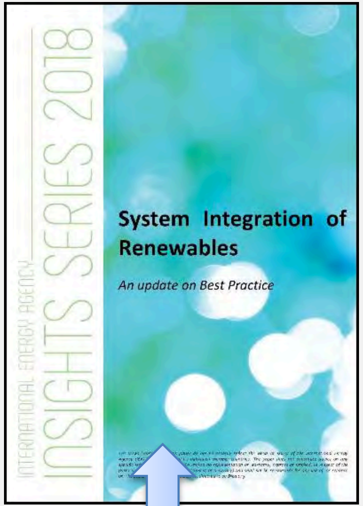
2017 Implementation
- Myths and reality
- Diffrenct phases
- Phase one & two
- Grid code



2017 Progress & Tracking
- Phase three & four
- local grids
- Case Studies

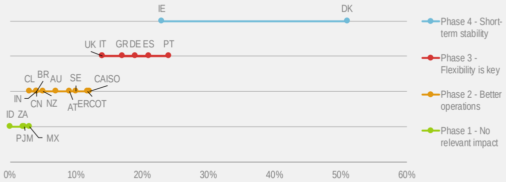
1. combined

2017 New SIR insights paper
released Dec 2017 or Jan 2018



2. Updated

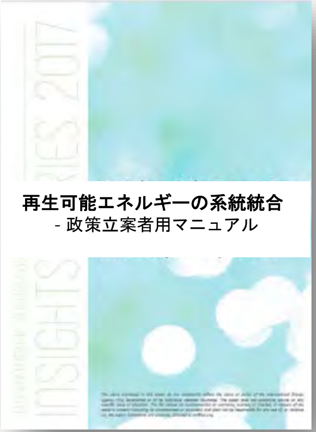
The phases of System integration



3. Translate Into Japanese

By NEDO, Japan

Japanese Translation
released June 2018



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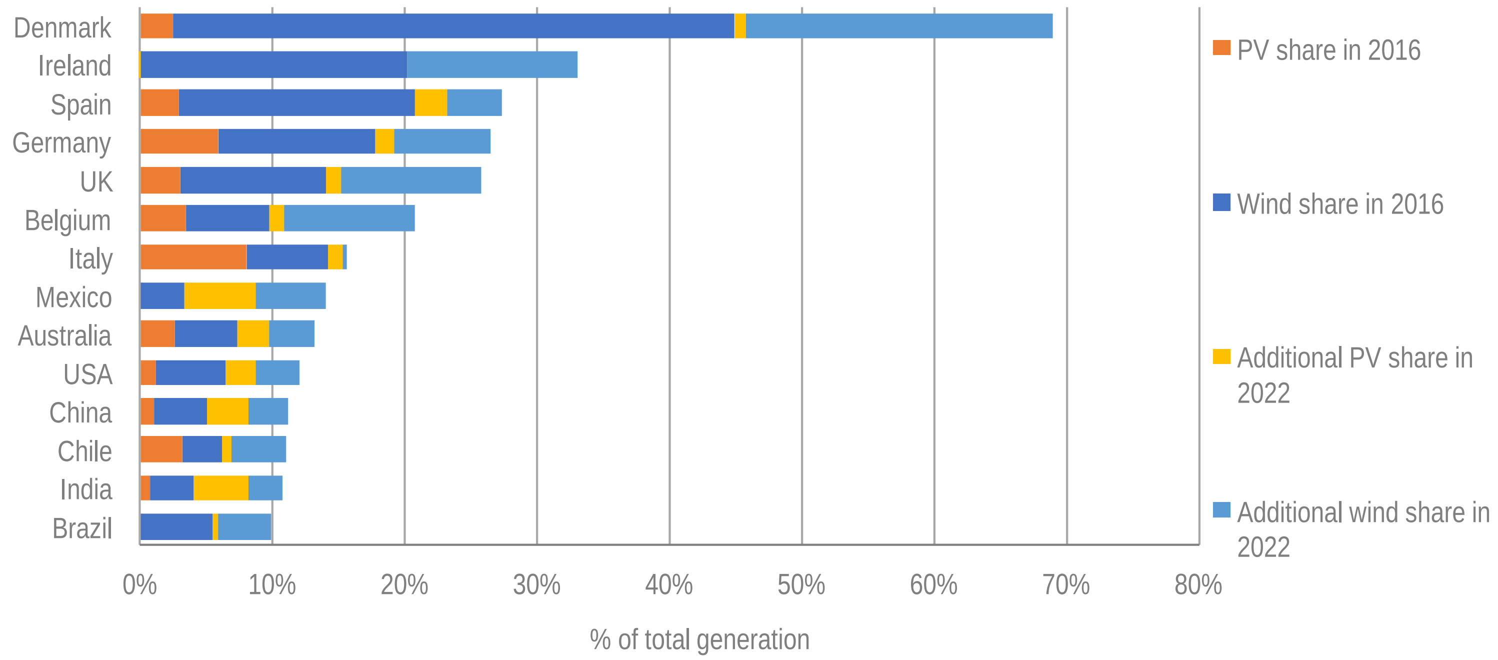
Launch event
in Japan, June 2018

Variable Renewable Energy (VRE) on the rise

VRE share in annual electricity generation, 2016-22

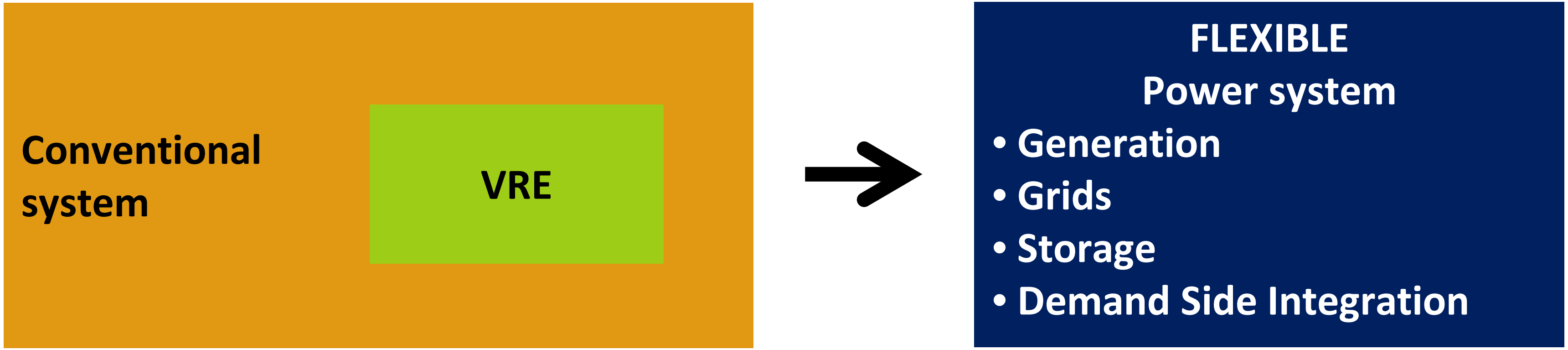


Also in emerging economies and in large power systems the share of VRE is expected to double to over 10% in just five years.

Source: Renewable Energy Market Report, 2017

Three main messages on system integration

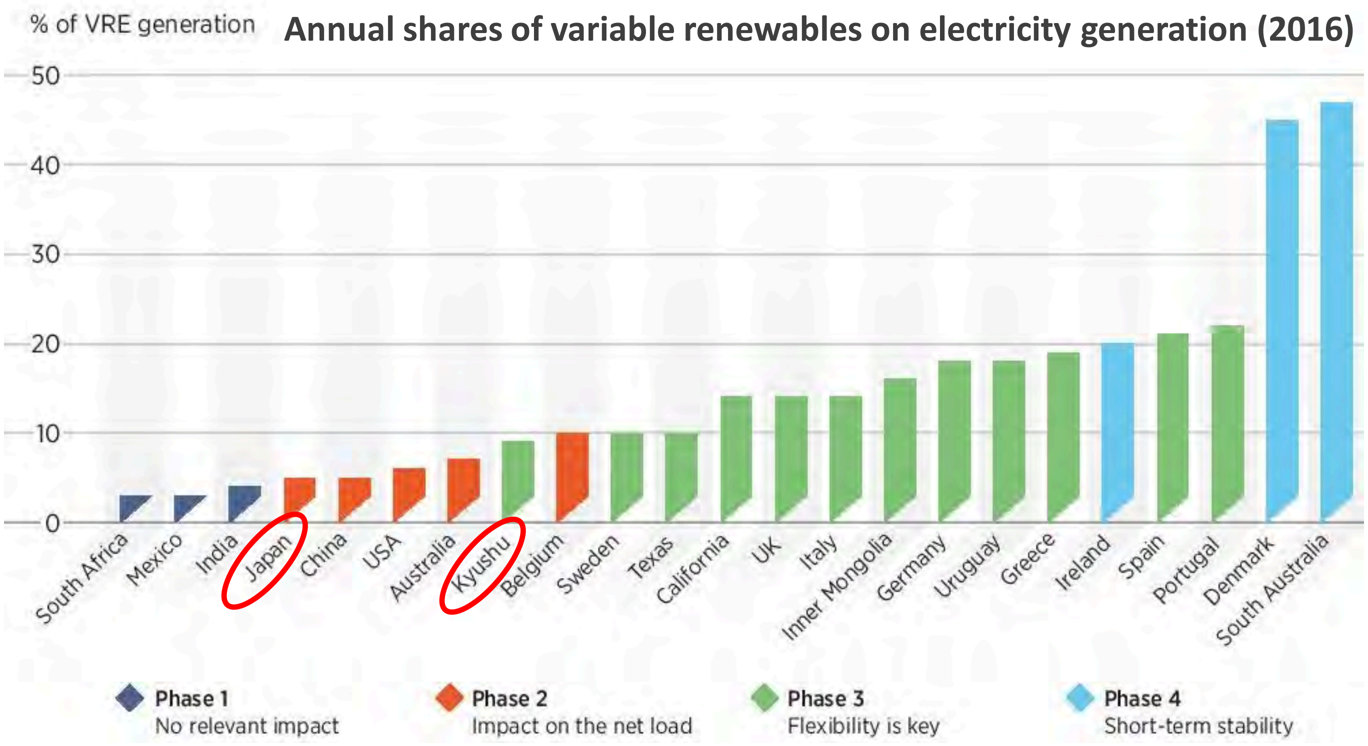
1. Very high shares of variable renewables are technically possible
2. No problems at low shares, if basic rules are followed
3. Reaching high shares cost-effectively calls for a system-wide transformation



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 nearly 100% 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

System integration: different phases



Japan: phase2, Kyushu: phase3

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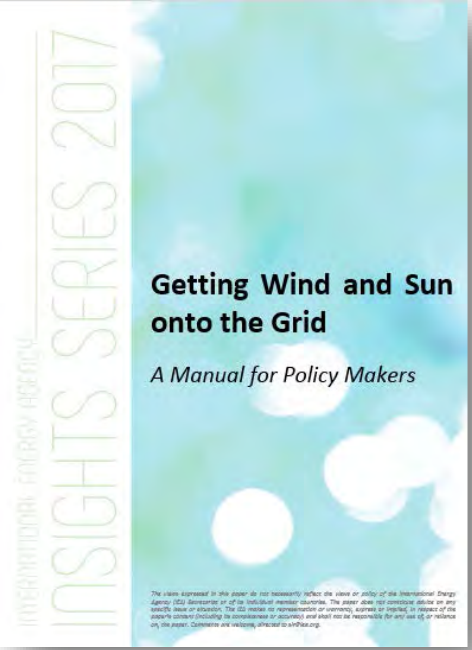
Phases 1 & 2: Getting Wind and Solar Onto the Grid

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 dedicated "backup"
4. The associated grid cost is too high
5. Storage is a must-have
6. VRE capacity destabilizes the power system

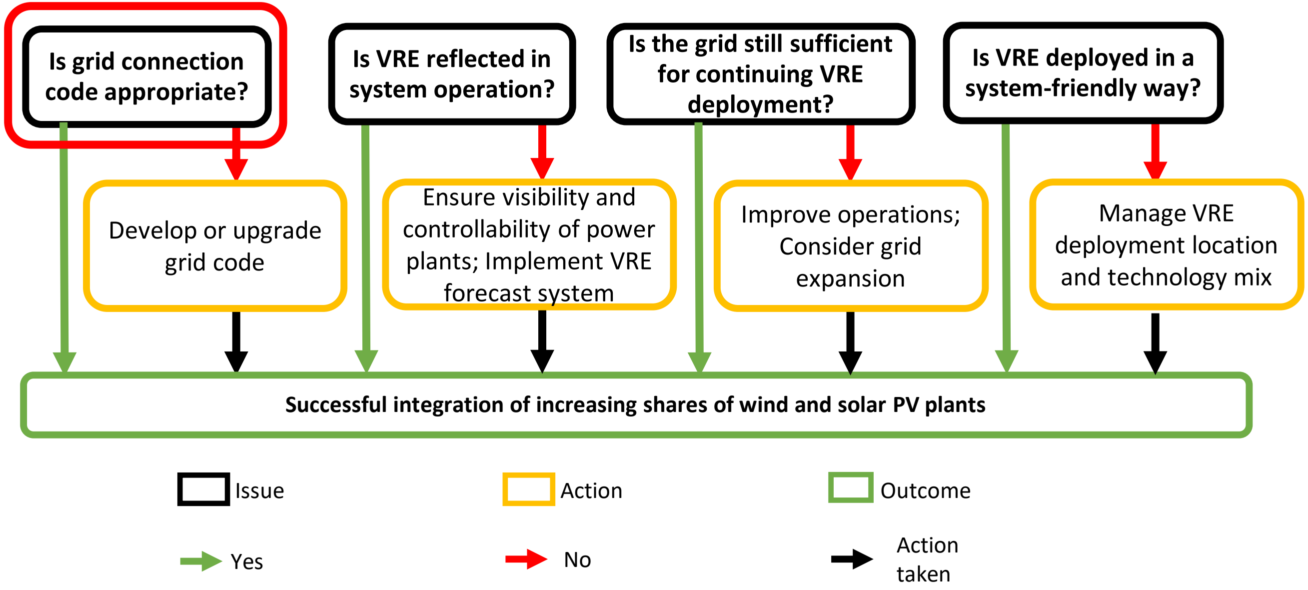
New Publication released March 2017



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

Priorities for VRE Integration – Phase 2



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

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

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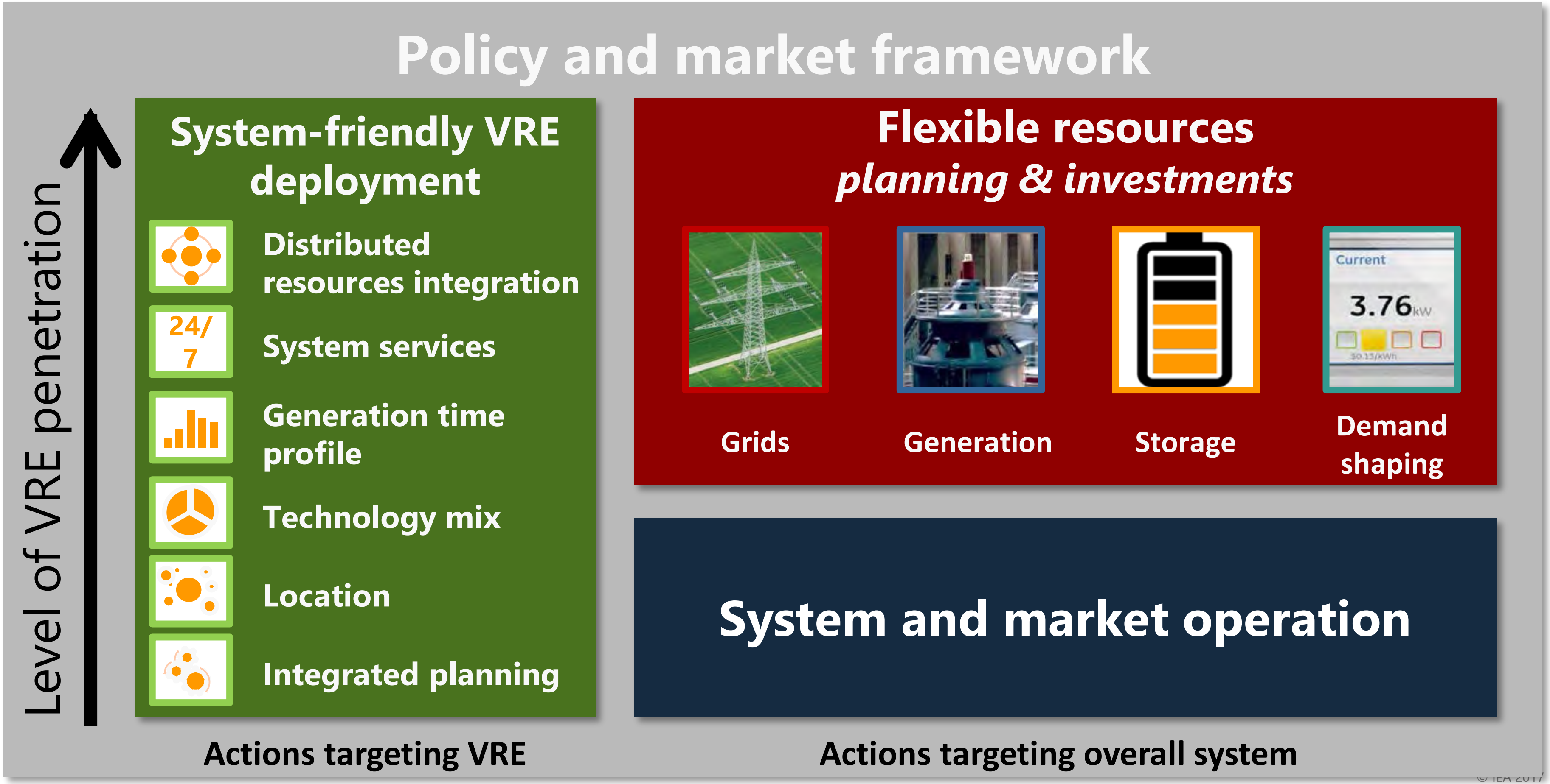
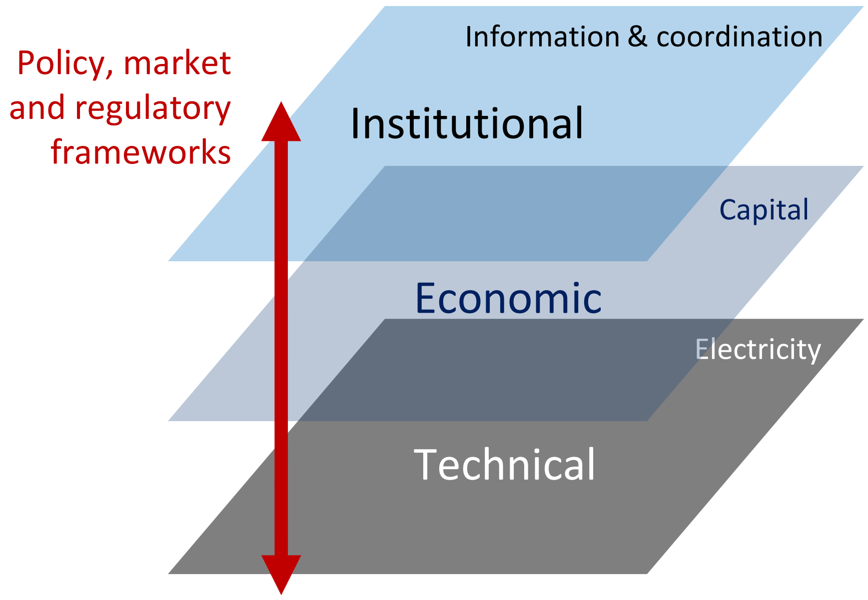
System transformation



System transformation requires holistic approach



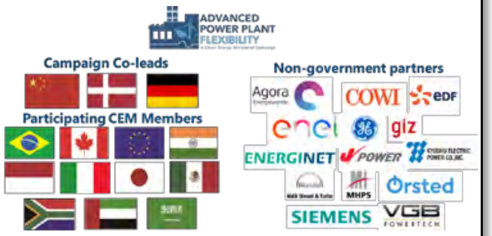
- **Institutional** – defining roles and responsibilities
- **Economic** –market design, regulation, planning frameworks
- **Technical** – operation of power system, safeguarding reliability

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

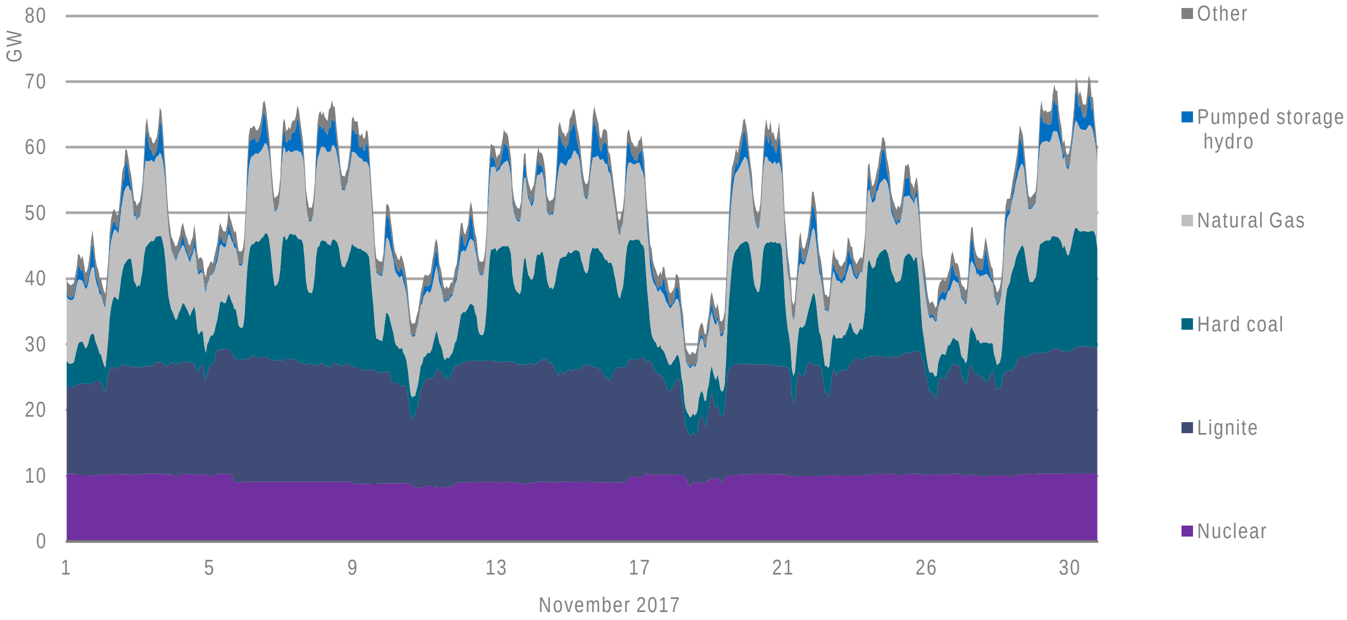
Power plants – a cost-effective source of flexibility

Advanced Power Flexibility

- Clean Energy Ministerial Campaign,14 partner countries and 14 industry and NGO partners
- Results published at CEM9
- Continued with broader scope: Power System Flexibility



Conventional electricity generation in Germany in November 2017



Significant system flexibility lies latent in many power plants; a range of strategies are available to unlock low-cost flexibility, many non-technical.

Source: Agora (2018b), Die Energiewende im Stromsektor: Stand der Dinge 2017

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)

Unlocking system friendly deployment

	Traditional approach	Next generation approach
When is electricity produced?	Not considered	Optimised: best mix of wind and solar; advanced power plant design; strategic choice of location
Where is electricity produced?	Best resources, no matter where	Optimised: trade-off between cost of grid expansion and use of best resources
How is electricity produced?	Do not provide system services	Optimised: better market rules and advanced technology allow wind and solar power to contribute to system services

Next-generation wind and solar power require next generation polices.

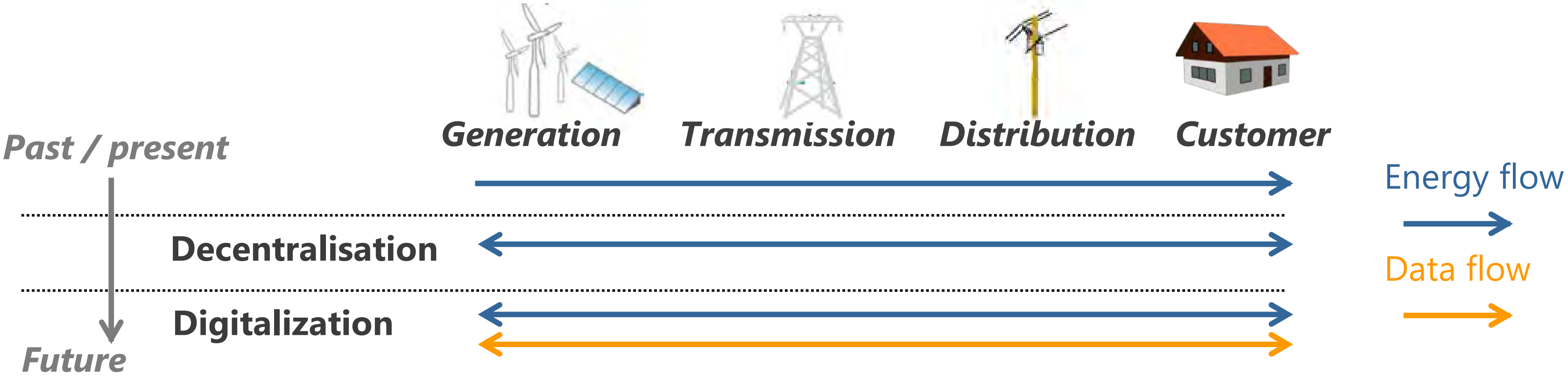
Key action areas and policy examples

Action area	Policy example
Integrated planning: wind and solar embedded in energy strategy	**Denmark:** integrated energy strategy
Location: siting VRE closer to existing network capacity and/or load centers	**Location:** new auction design for wind and PV
Technology mix: balanced mix of VRE resources can foster lasting synergies	**Technology mix:** Integrated Resource Plan
Optimising generation time profile: design of wind and solar PV plants	**California:** incentive to produce at peak times
System services: wind and sun contribute to balance system	**System services:** wind active on balancing market
Local integration with other resources such as demand-side response, storage	**Australia:** incentives for self-consumption

Outline

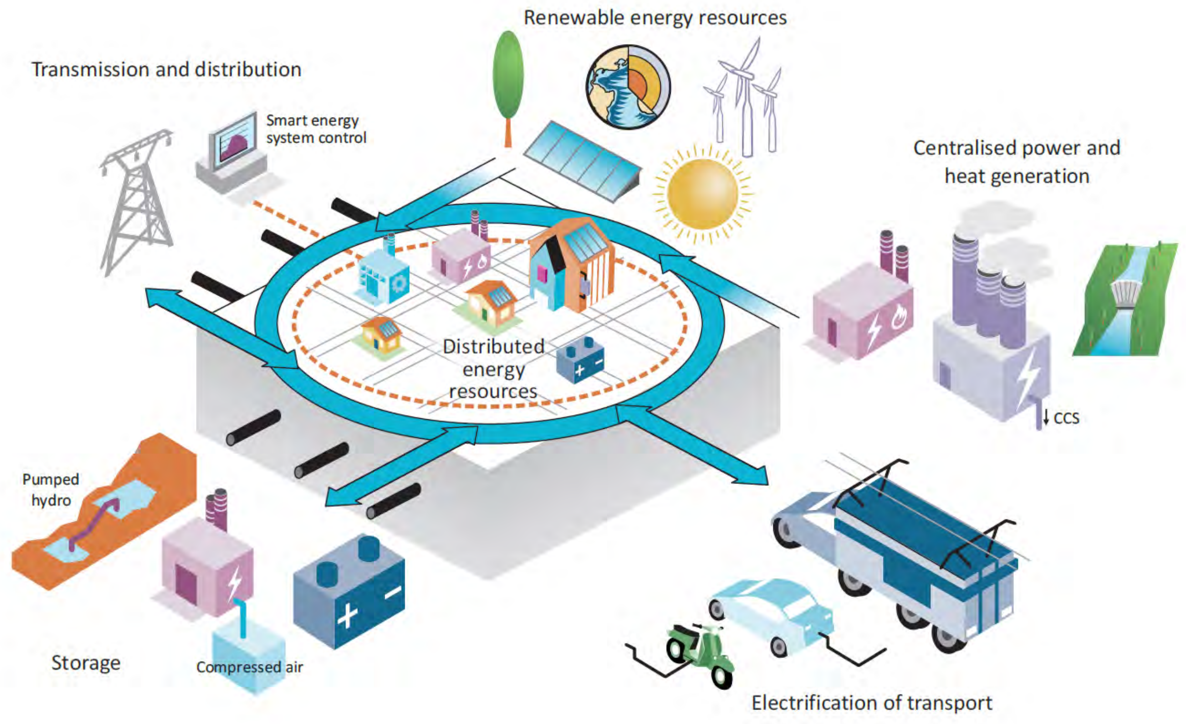
- Overview of IEA work and introduction
- Properties of variable renewable energy (VRE) and impact; system integration phases
- Handling challenges during initial phases
- Mastering higher shares – system transformation
- **Distributed energy resources – the future of local grids**

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

Putting together the pieces – towards a new paradigm?



Smart local grids, linking a diverse set of distributed resources across different sectors, may emerge as main pillar of future energy systems.

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

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