Integration of Clean & Green Energy – Learnings for India

Integrating Clean and Green Energy in Power

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2015: a record year for renewables

Renewable additions (2014-15) and cumulative installed power capacity

Cumulative renewable capacity surpassed coal at the end of 2015
Record low price announcements

Recent announced long-term contract prices for new renewable power to be commissioned over 2016-2019

Best results occur where price competition, long-term contracts and good resource availability are combined

Note: Values reported in nominal USD includes preferred bidders, PPAs or FITs. US values are calculated excluding tax credits. Delivery date and costs may be different than those reported at the time of the auction.
Large shares of VRE in some countries

- Experience in a number of countries available how to integrate significant shares of VRE

- According to latest available forecasts in 2021:
  - VRE is forecasted to exceed 20 % of annual generation in at least 6 countries
  - Double-digit shares becoming new normal for many power systems

Global electricity mix changes in the 2DS

A shift reversal is needed with renewables providing over 60% of global electricity by 2050 or before
Electricity mixes by 2050 in the 2DS vary widely

Resources and shape of the demand explains the variations
Complementary roles of PV and STE

Possible power mix in a sunny country, 2030

Thanks to thermal storage, STE is generated on demand when the sun sets while demand often peaks and value of electricity increases

Source: IEA Technology Roadmap (2014)
System Integration of Renewables analysis at the IEA at a glance

- Global expert network covering policy making, engineering and modelling analysis, including IEA Technology Collaboration Programmes
- Analysis based on extensive research on current global state of play and dedicated modelling tools
  - Covering four continents and over 25 countries
  - India case study on grid integration in 2014, several expert workshops held since
- Fostering exchange in international fora (G20, CEM) and capacity building (regional trainings)
Main messages

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

Remaining system  VRE  →  FLEXIBLE Power system
• Generation
• Grids
• Storage
• Demand Side Integration
Optimising generation time profile

The design of wind and solar plants can be optimised to increase value
- Spreading the energy on more hours
- Making generation match the demand more closely

Policy mechanisms need to signal difference in value depending on time
- Partial exposure to market prices via premium systems
- Power purchase agreements adjusting remuneration to time of delivery (TOD)
- Premiums for system friendly deployment choices

Policy example: California, USA
- West-facing PV systems produce closer to peak demand and receive payments up to 15% higher than south-facing systems
- TOD factors integrated into PPAs for large scale solar systems

DC to AC ratio by mounting type and installation year, United States
Grid extensions and distribution solutions

Optimal shares by 2040

In the long run various combinations of on-grid, mini-grid and off-grid technologies will subsist
Super-grids or mini-grids? Both

• Most solar and wind capacities connect to the low and medium voltage distribution grids

• Distributed energy solutions can substitute to grid extensions in providing access

• They can also strengthen the grids and improve the quality of truly intermittent power in some markets

• Super-grids enlarging balancing areas are also helpful in facilitating the integration of variable renewables

• Mini- and super- grids all need to be «smart» - convey information as well as energy, both ways, and coupled with other energy forms/networks
Conclusions for India

- System integration no show stopper for reaching ambitious wind and solar targets
  - But a co-ordinated approach is crucial for managing integration challenges

- India has an opportunity to transition to a clean energy system

- IEA has long-standing expertise on strategies to integrate renewable energies into the grid
  - Possible collaboration on sharing best practices, expert consultations for policy implementation and regional capacity building
  - Relevant topics includes:
    - Unlocking thermal power plant flexibility
    - Optimising power system dispatch
    - Power market design
    - Deploying distributed energy systems cost-effectively

- The IEA is “opening its doors” to emerging economies