International Experience on Grid Integration of Large Amounts of Wind and Solar

Large scale grid integration of RE in India, 7th Sep 2017, New Delhi
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Presenter: Antje Orths, IEA Task 25 (DK member)
IEA Wind Task 25 – What Does It Do?

- Started in 2006, now 17 countries + EWEA participate to provide an international forum for exchange of knowledge
- State-of-the-art: review and analyze the results so far: latest report June 2016
- Formulate guidelines- Recommended Practices for Integration Studies in 2013
- Fact sheets and wind power production time series

http://www.ieawind.org/task_25.html
Experience from Wind Power Integration is Growing

- Updated information from on-line production and forecasts. Possibility to curtail in critical situations
- Increase in use of short term reserve/load following capacity
- Technical capabilities of wind power plants evolving
- Operational strategies for > 20-30 % shares of wind developed
- Transmission recognized as a key enabler, with regional planning efforts

2015: EU covered >10 % of yearly electricity consumption by wind power

Wind + solar %
Challenges – transmission grid build-out

Offshore-Windparks

Power balance 2022 [MW]

-500

9000
Long term planning for grid adequacy

- Transmission planning – towards regional planning

Source: http://www.nrel.gov/analysis/re_futures/

Source: TYNDP (ENTSO-E, 2014)
Challenge - Variability and Uncertainty

- **Variability**
  - Large smoothing impact for fast variability (minute-hourly changes)
  - Price impacts – near zero prices when high wind and low demand

- **Uncertainty**
  - Forecasting improving, 3-4 % mean error in Germany

(Source: Fraunhofer IWES)
Balancing impacts - experience

- Italy – increase in operating reserves and frequency control
- Germany - decrease in frequency control reserves, due to sharing of balancing between balancing areas in Germany

PCR Primary, SCR Secondary and TCR Tertiary control, p for positive and n for negative. Costs for activated energy (left) and reserved capacity (right).

Challenge: curtailments from wind

- Curtailments, mitigated by transmission build-up, in some cases
- Most European countries still experience very little curtailments

Challenge—conventional power plant retirement

- Total operating time reduces, but capacity still needed
  - Challenges differ for high-growth systems and where load growth no longer substantial

(Source: Amprion)
Capacity challenge - value of wind power important to assess

Ireland and ERCOT figures based on 1 year’s data for 2010
Australian figures based on 6 months’ data Nov. 2010 to Apr. 2011
Capacity challenge - value of wind power important to assess

(Source: Task 25 summary report, 2015)
Cost and value of wind are equally important in decision making, but cannot be considered fully independent because they are linked by wind technology.
How Much Would the Value of VG Change if Mitigation Measures Were Implemented?

Use the same model and data to estimate the degree to which different mitigation measures can stem the decline in the marginal economic value of variable generation.

Marginal Economic Value ($/MWh)

100

VG Penetration (% Annual Load)

0 40

The mitigation measures considered include:
- increased geographic diversity
- technological diversity
- lower-cost bulk power storage
- price elastic demand subject to RTP
Solution - flexibility

- Increase / incentivise flexibility in generation and demand, with flexible operational methods (transmission/grid as an enabler)

(Source: Task 25 fact sheet)
Examples from national studies – hydro power flexibility

Portugal: managing close to 100% wind share.

Flexibility from wind power

- Ancillary services provision from wind power plants: voltage and frequency support – Spain, Nordic countries, US.
- Fast and slow frequency response possible, with loss of energy. Also up-regulation, used during curtailments.

Source: US Xcel/PSCo Wind power providing AGC
Challenges: stability

- Dynamics of power systems need to be studied at higher shares of wind power

- Wind power plant supporting the grid shown to help stability issues
Challenges: stability

- Ireland – small synchronous system, voltage and frequency stability issues to be mitigated for 40 % wind share with moderate curtailments of wind
  - Working to operate the system with up to 75 % instant share
Transition towards renewable future means adaptation

- Integration challenge is easier if:
  - Variable generation is built dispersed way to larger area
    - Smoothing effect of variability and forecasting/uncertainty
  - **Power system operation** enables aggregation benefits from larger area
    - Transmission/distribution grid is strong enough
    - Operational practices of balancing allow for sharing between neighbouring areas
  - There is **flexibility** in the generation fleet – and in demand
- Integration effort and costs will be different for different systems and adaptation will greatly reduce the costs.
IEA WIND Task 25: Design and operation of power systems with large amounts of wind power

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