Wind integration - global trends, challenges and solutions

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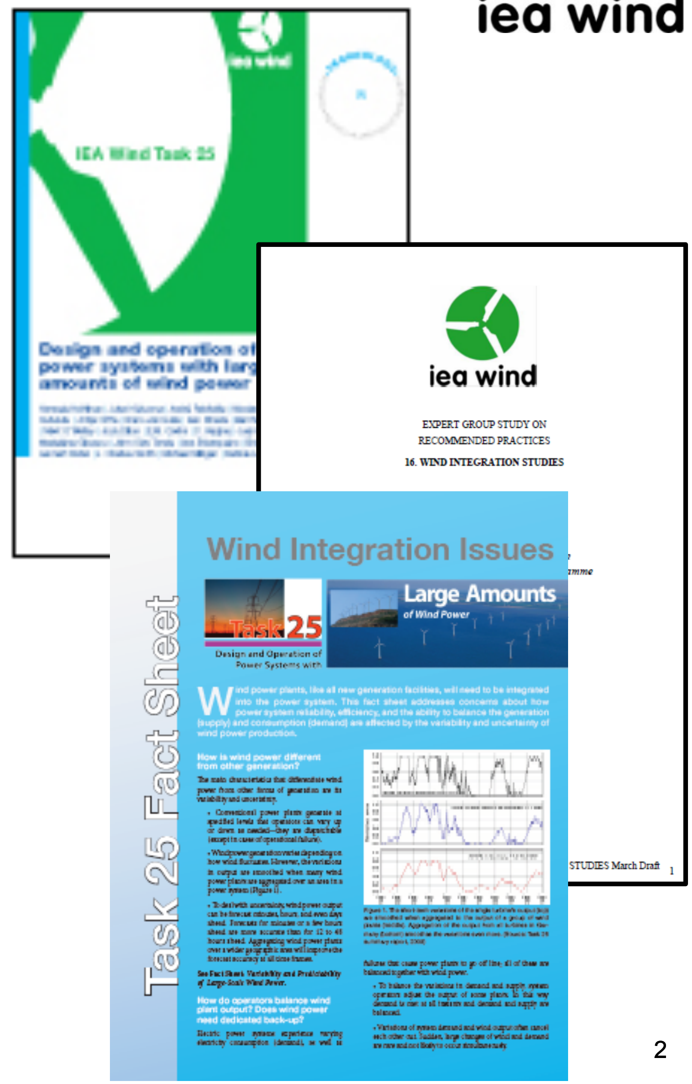
IEA Wind Task 25 – What Does It Do ?

- 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 studies and results so far
- Formulate guidelines- Recommended Practices for Integration Studies in 2013
- Fact sheets and wind power production time series

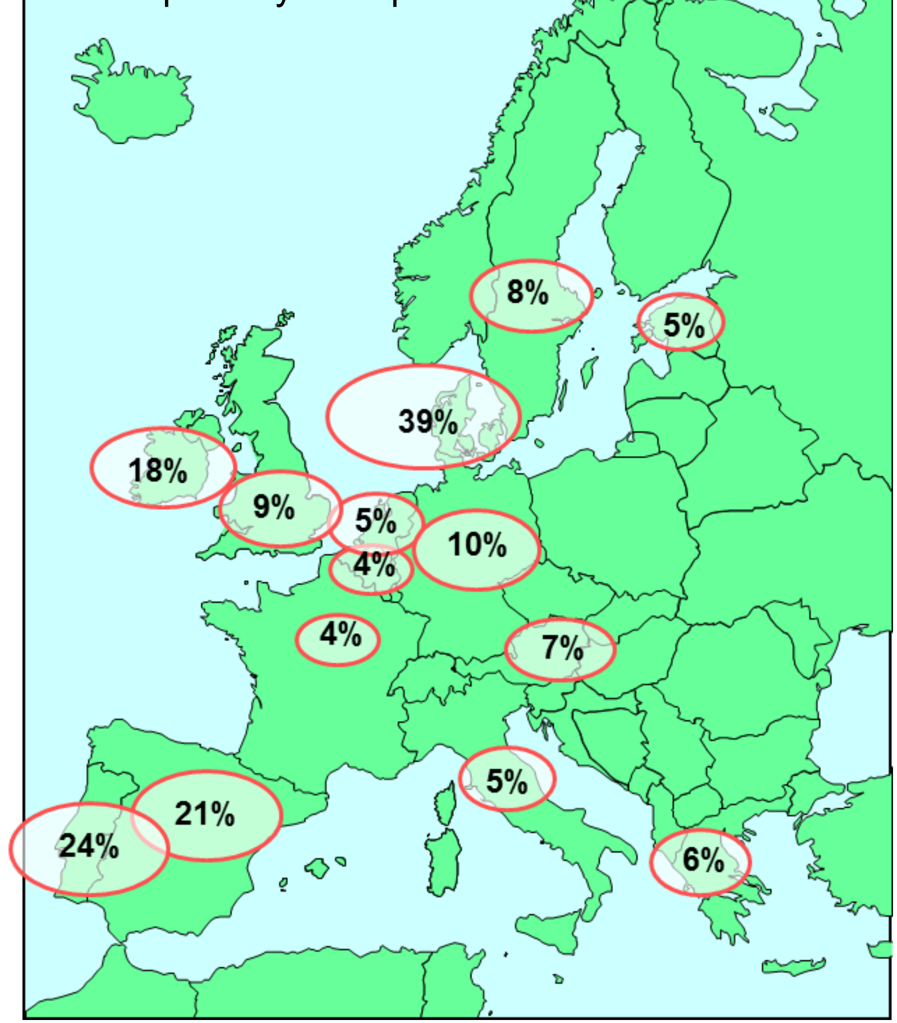


http://www.ieawind.org/task_25.html

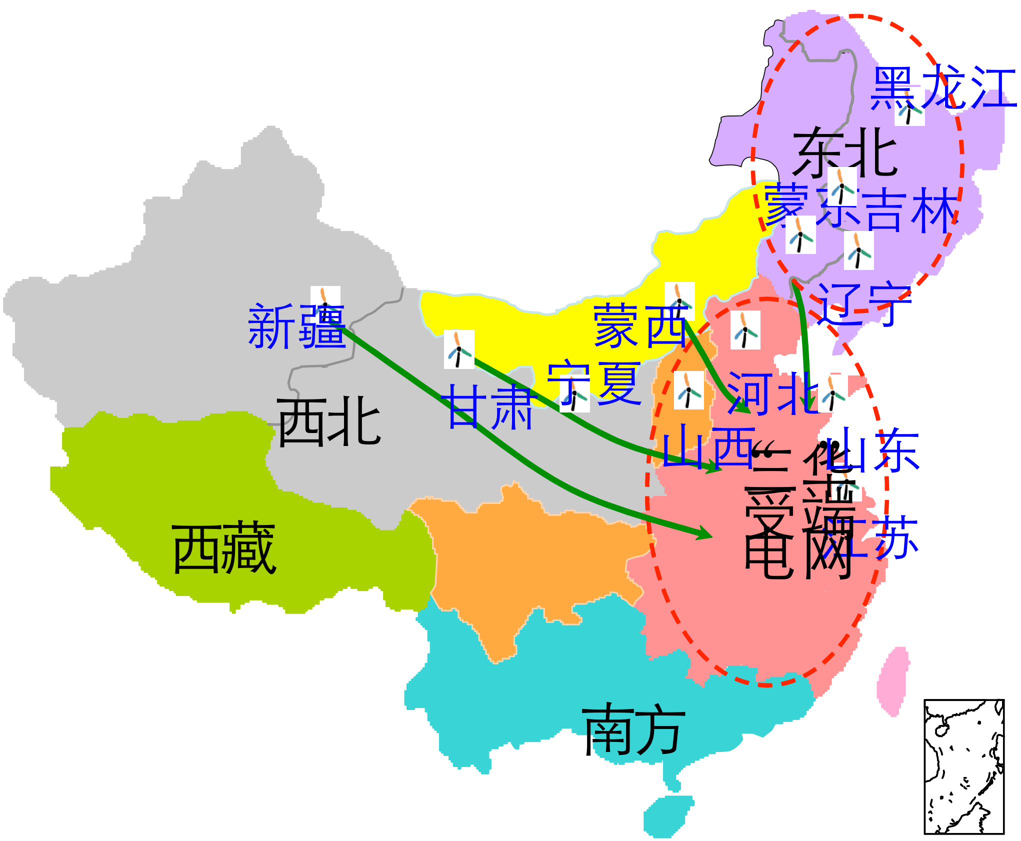
Experience from Wind Power Integration is Growing

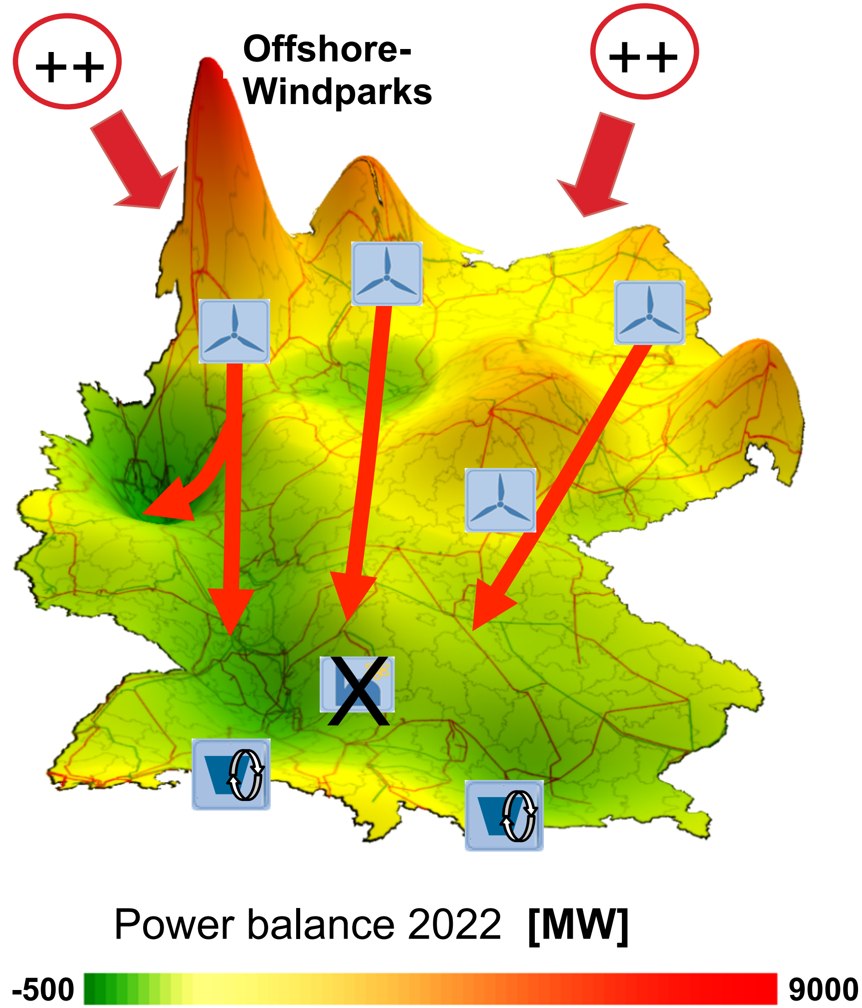
- Updated information from on-line production and forecasts. Possibility to curtail in critical situations
- Increase in use of short term reserve/load following capacity
- Technical capabilities of wind power plants evolving
- Operational strategies for > 20-30 % shares of wind developed
- Transmission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

2014: EU covered 9 % of yearly electricity consumption by wind power



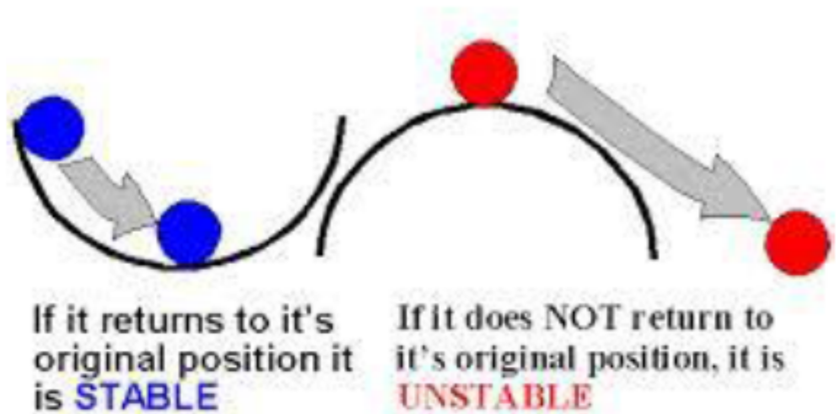
Challenges – transmission grid build-out





Challenges: stability

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



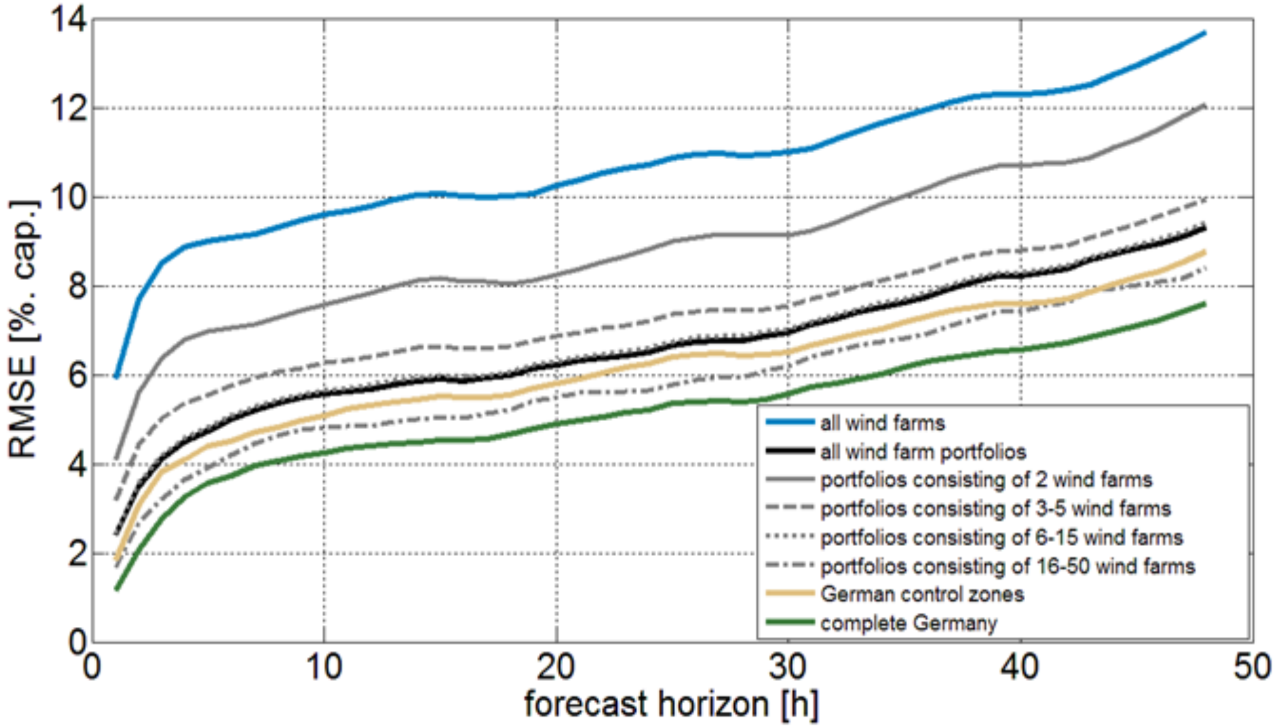
- Wind power plant supporting the grid shown to help stability issues

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

Challenge - Variability and Uncertainty

- Variability
  - Large smoothing impact for fast variabilty (minute-hourly changes)
  - Price impacts – near zero prices when high wind and low demand
- Uncertainty
  - Forecasting improving, 3-4 % mean error in Germany

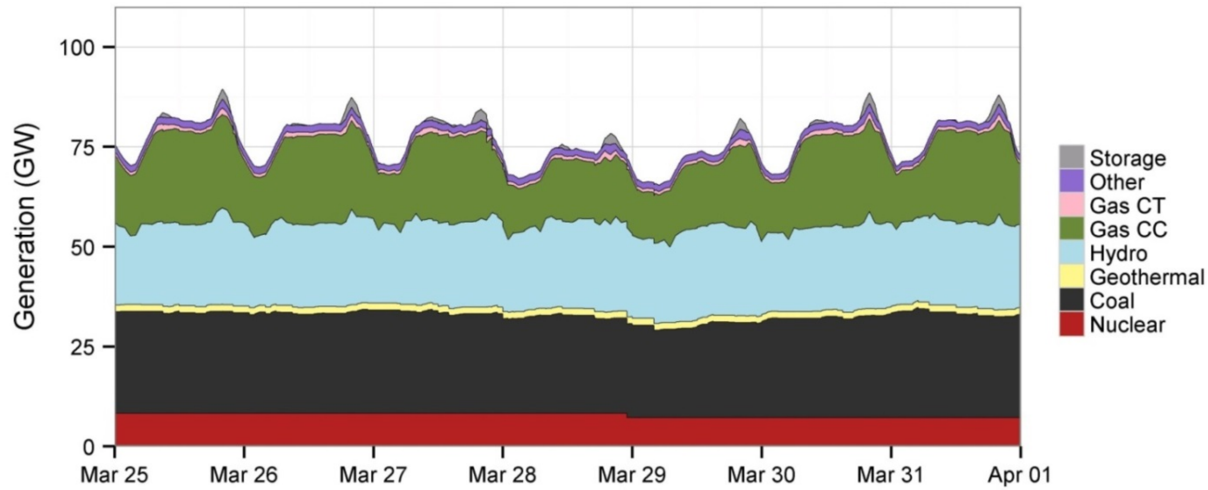


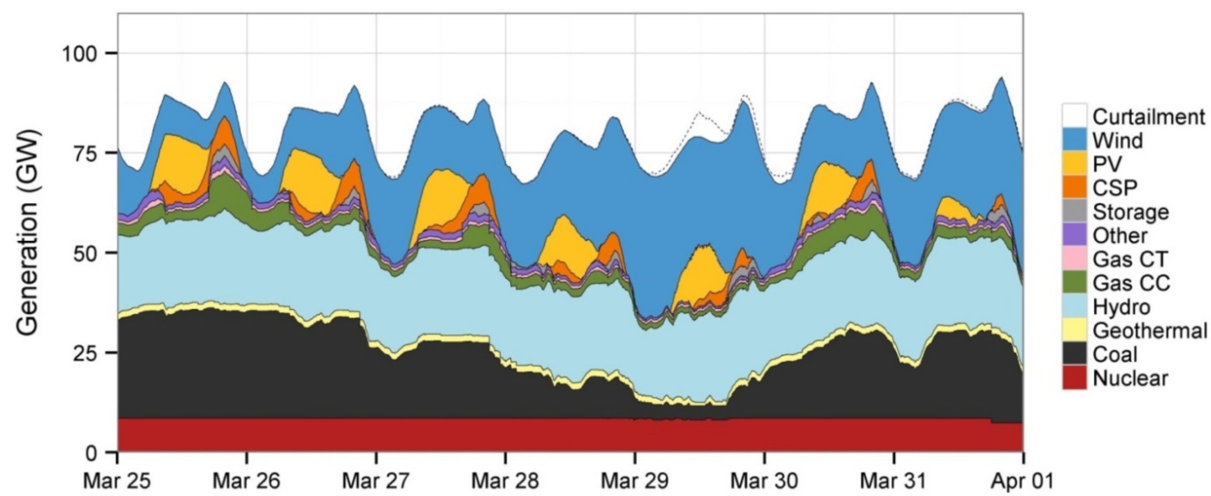
(Source: Fraunhofer IWES)

Challenge- managing variability and uncertainty

- Increasing variability and uncertainty: more balancing – ramping and cycling (starts/stops)
- Cycling costs and impacts on emissions are low

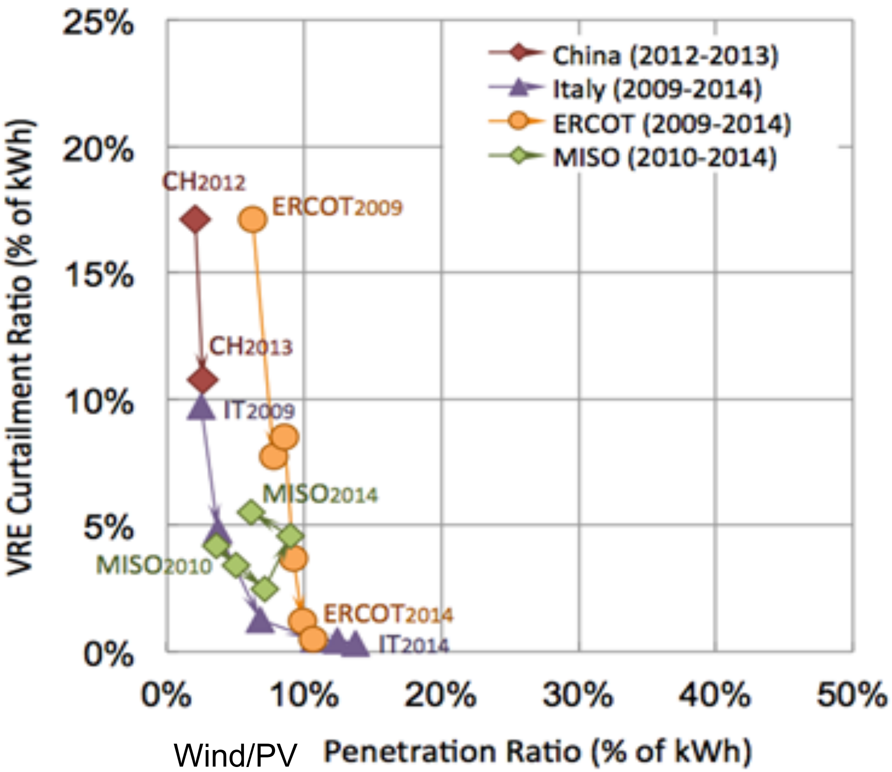
	Emission Reduction Due to Renewables	Cycling Impact
CO_2	260–300 billion lbs 29%–34%	Negligible Impact
NO_x	170–230 million lbs 16%–22%	3–4 million lbs
SO_2	80–140 million lbs 14%–24%	3–4 million lbs

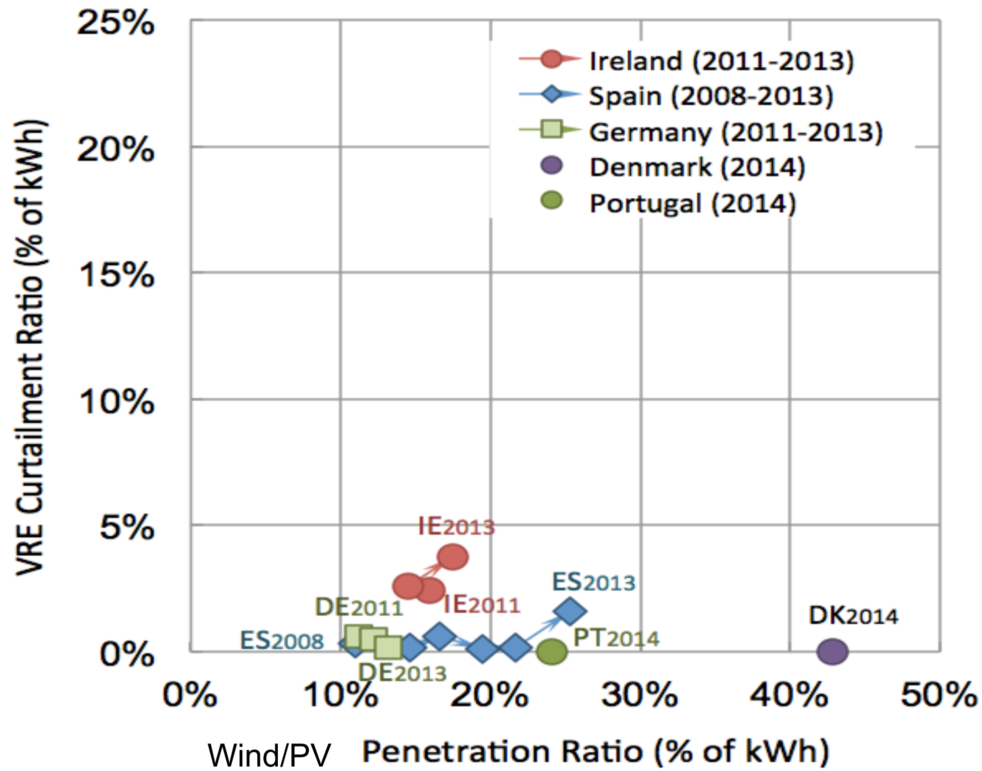




Source NREL / WWSIS II study

Challenge: curtailments from wind



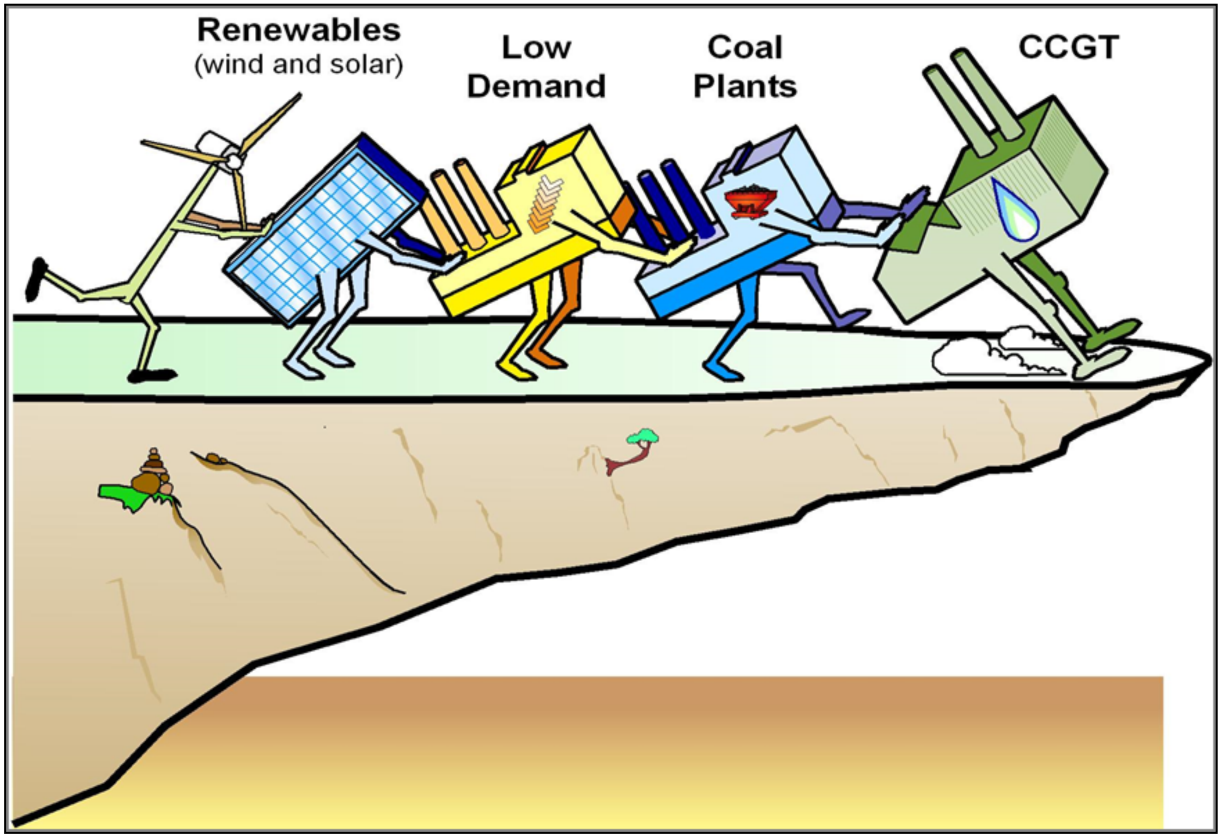


- Curtailments, mitigated by transmission build-up, in some cases
- Most European countries still experience very little curtailments

Source: Yasuda et al, International Comparison of Wind and Solar Curtailment Ratio. Proceedings of WIW2015, Oct 19-22 2015 Brussels.

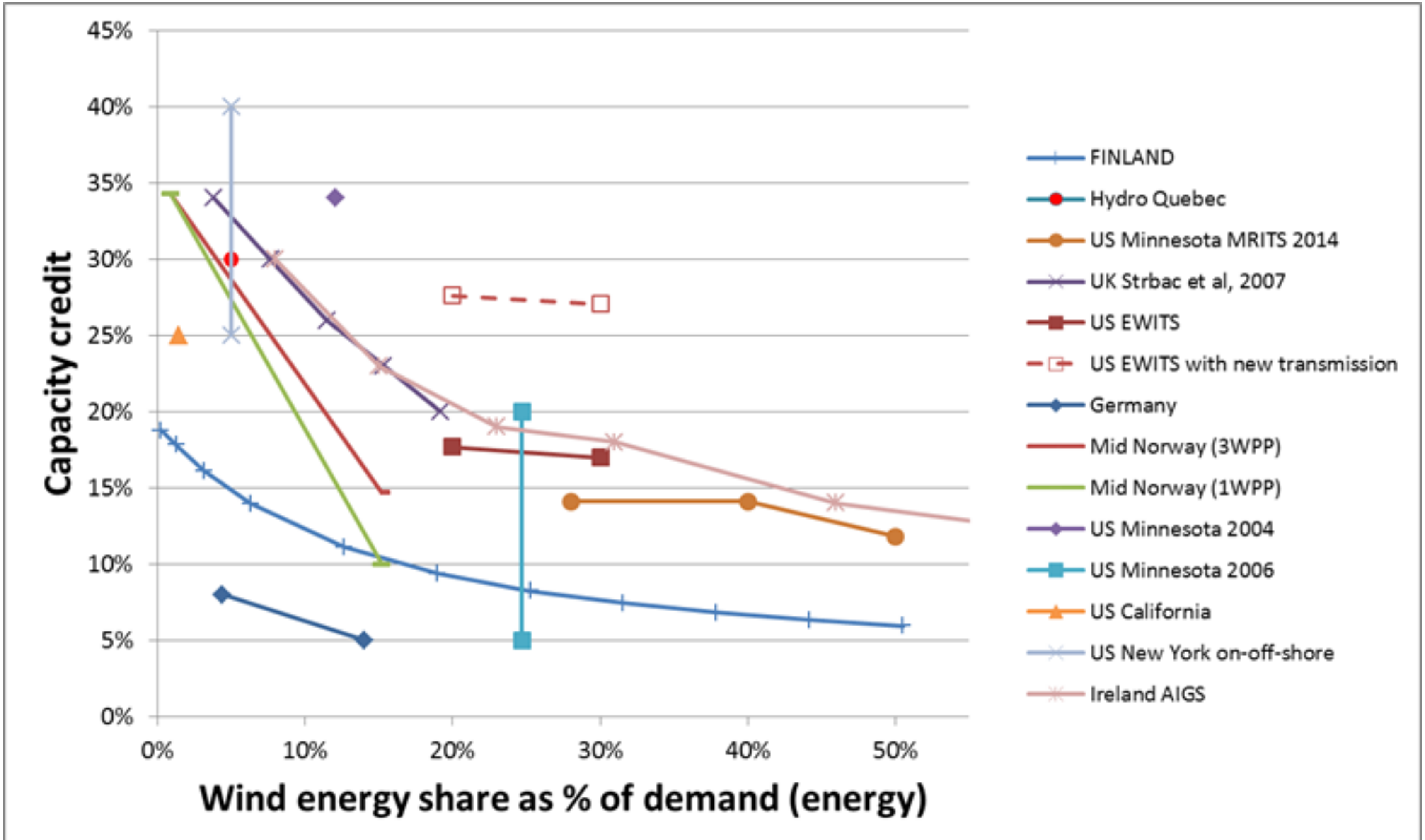
Challenge- conventional power plant retirement

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



(Source: Amprion)

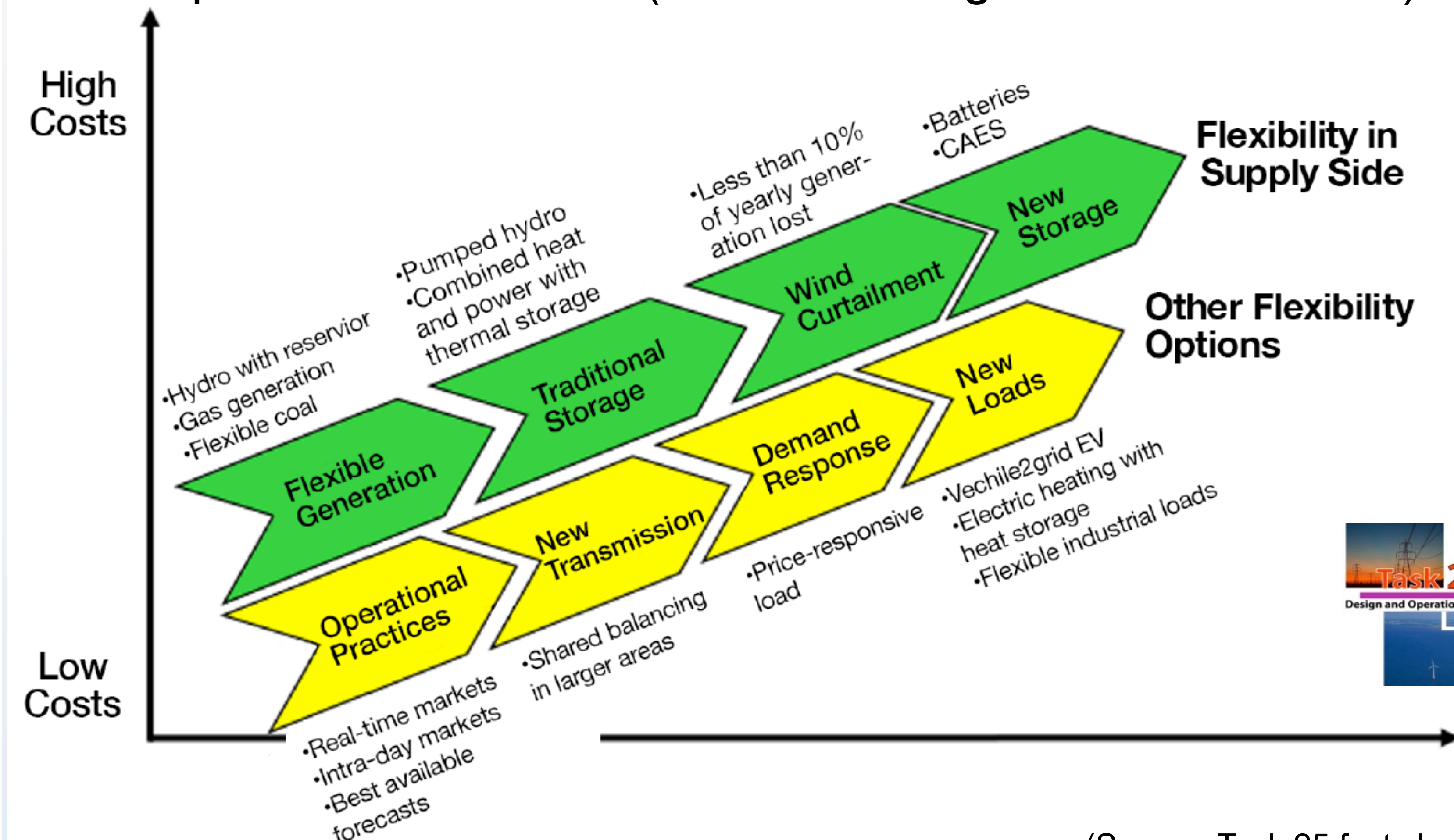
Capacity challenge - value of wind power important to assess



(Source: Task 25 summary report, 2015)

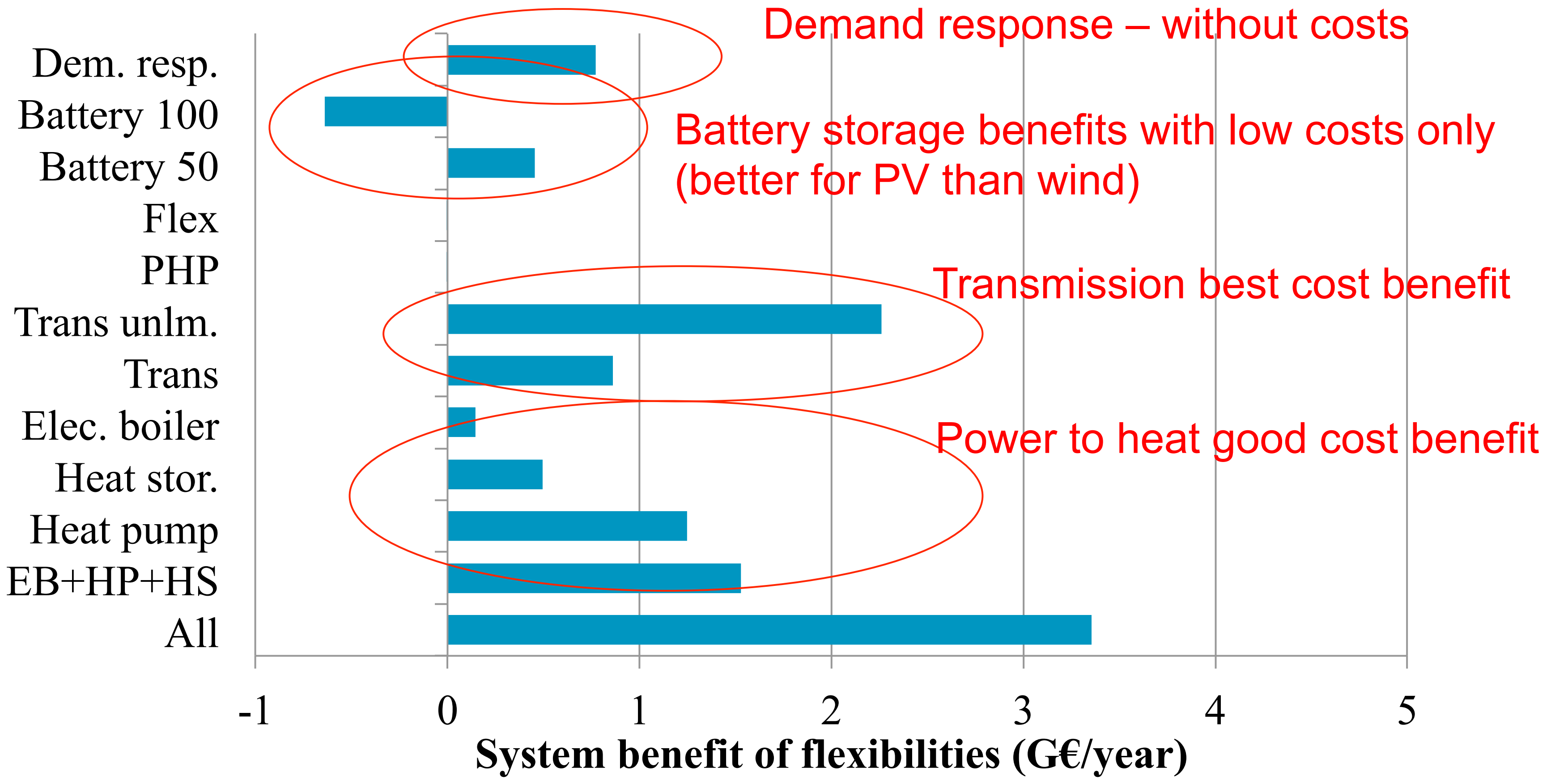
Solution- flexibility

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



(Source: Task 25 fact sheet)

Comparing the flexibility options

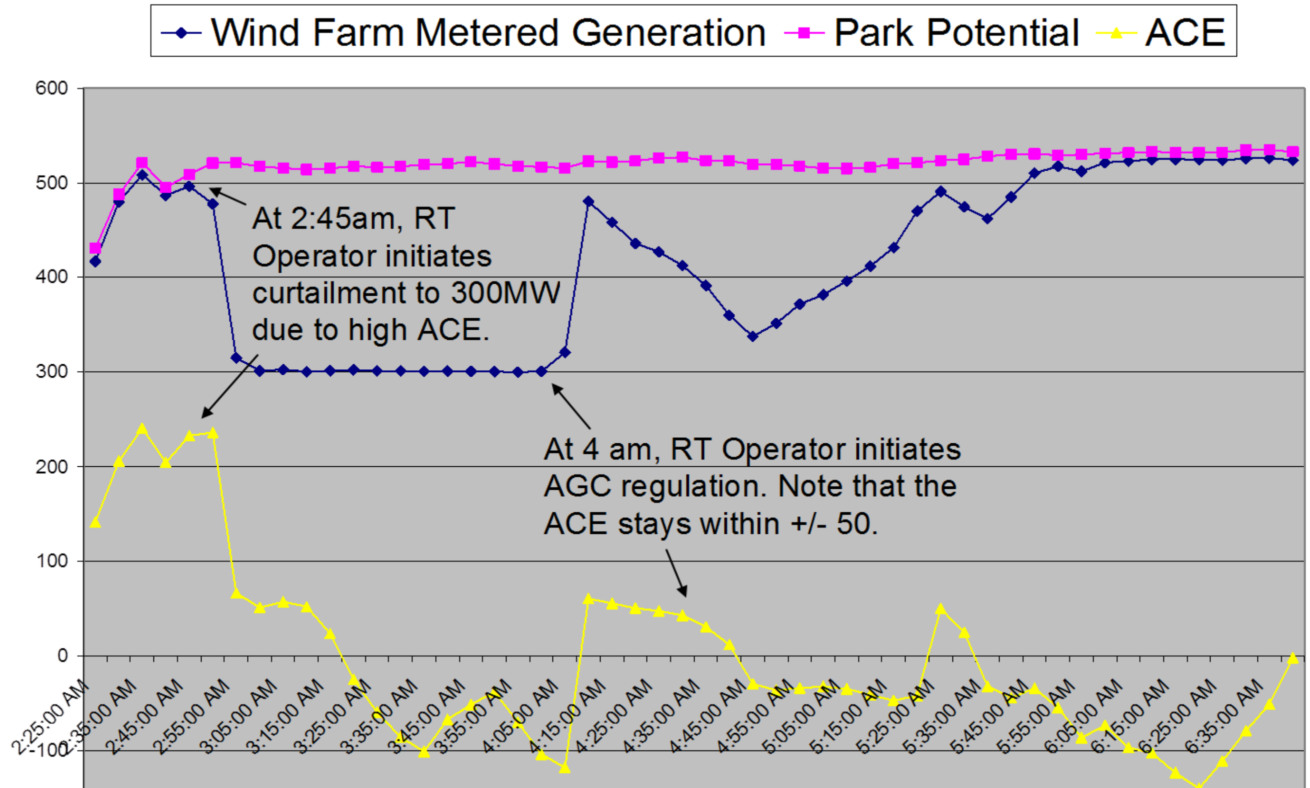


- Relative value of new flexibility options for Northern Europe, scenarios with lot of wind power: 42-55% of energy
- For wind, transmission, heat sector flexibility and demand response most important

(Source: Kiviluoma et al, VTT)

Flexibility from wind power

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



Source: US Xcel/PSCo
Wind power providing AGC

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

www.ieawind.org

17 countries + EWEA participate

Country	Institution
Canada	Hydro Quebec (Alain Forcione, Nickie Menemenlis)
China	SGERI (Bai Jianhua, Liu Jun);
Denmark	DTU Wind (Nicos Cutululis); TSO Energinet.dk (Antje Orths)
EWEA	European Wind Energy Association (Ivan Pineda)
Finland	VTT (H. Holttinen, J. Kiviluoma) – **Operating Agent**
France	EdF R&D (V. Silva); TSO RTE (E.Neau); Mines (G.Kariniotakis)
Germany	Fraunhofer IWES (J. Dobschinski); TSO Amprion (P. Tran)
Ireland	SEAI (J.McCann). UCD (Mark O'Malley)
Italy	TSO Terna Rete Italia (Enrico Maria Carlini)
Japan	Tokyo Uni (J.Kondoh); Kansai Uni (Y.Yasuda); CRIEPI (R.Tanabe)
Mexico	IIE (Favio Perales)
Norway	SINTEF (John Olav Tande, Til Kristian Vrana)
Netherlands	TSO TenneT (Ana Ciupuliga), TUDelft (Jose Rueda Torres);
Portugal	LNEG (Ana Estanquiero); INESC-Porto (J. Pecas Lopes);
Spain	University of Castilla La Mancha (Emilio Gomez Lazaro)
Sweden	KTH (Lennart Söder)
UK	DG&SEE (Goran Strbac, Imperial; O. Anaya-Lara, Strathclyde)
USA	NREL (M.Milligan); UVIG (J.C.Smith); DoE (C. Clark)