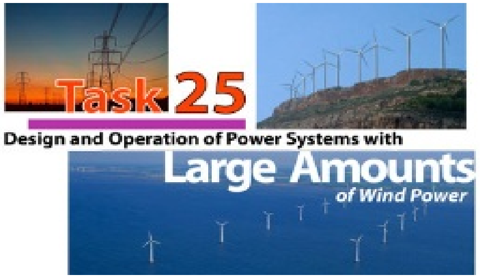


iea wind

Introduction to IEA Wind Task 25 – summary of national integration studies

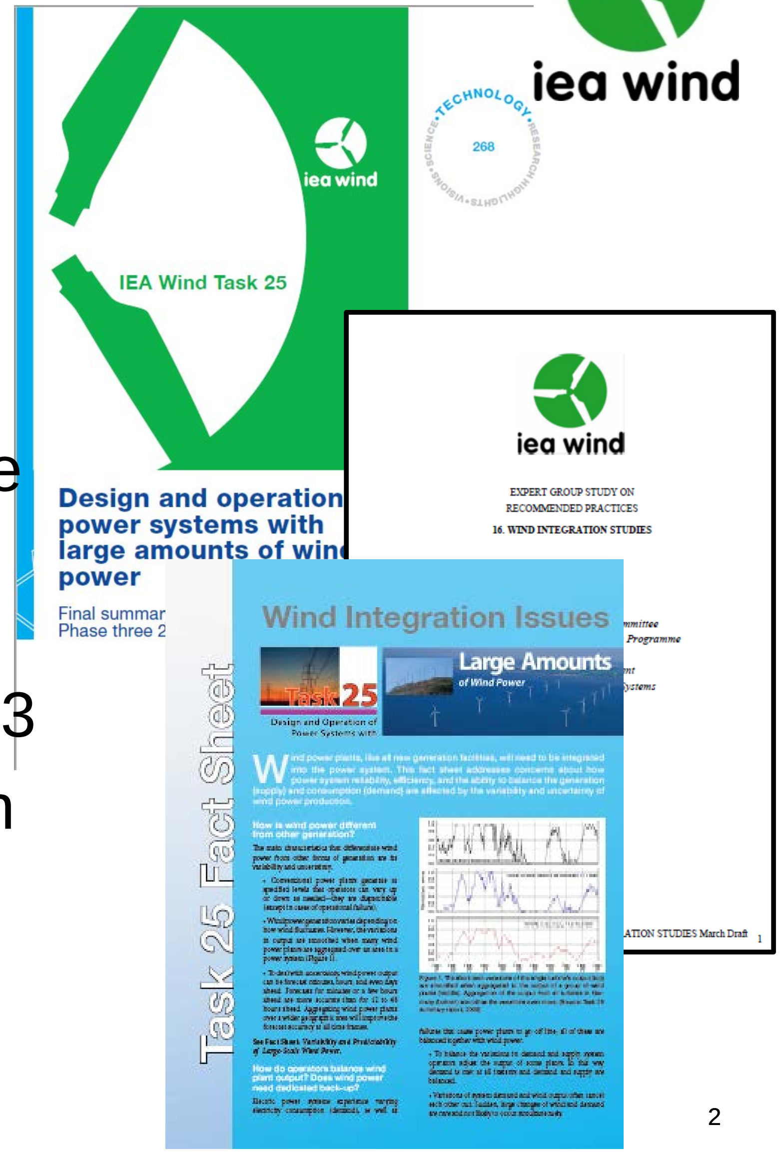
Elkraft Chalmers 18th May, 2017

Hannele Holttinen, Principal Scientist, VTT

Operating Agent, IEA WIND Task 25

IEA Wind Task 25 – What Does It Do ?

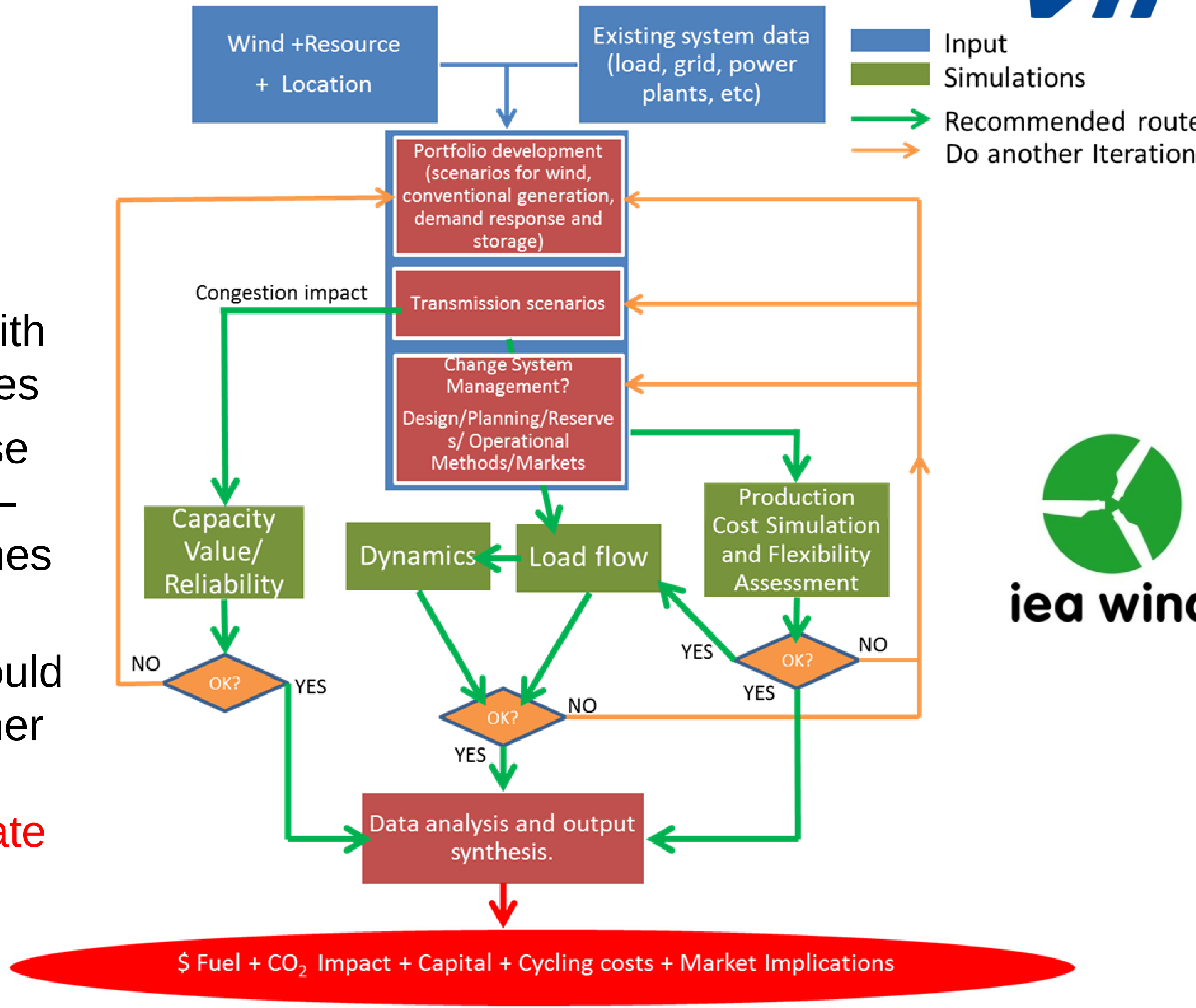
- Started in 2006, now 17 countries + EWEA participate to provide an international forum for exchange of knowledge
- State-of-the-art: review and analyze the results so far: latest report June 2016
- Formulate guidelines- Recommended Practices for Integration Studies in 2013
- Fact sheets and wind power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



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

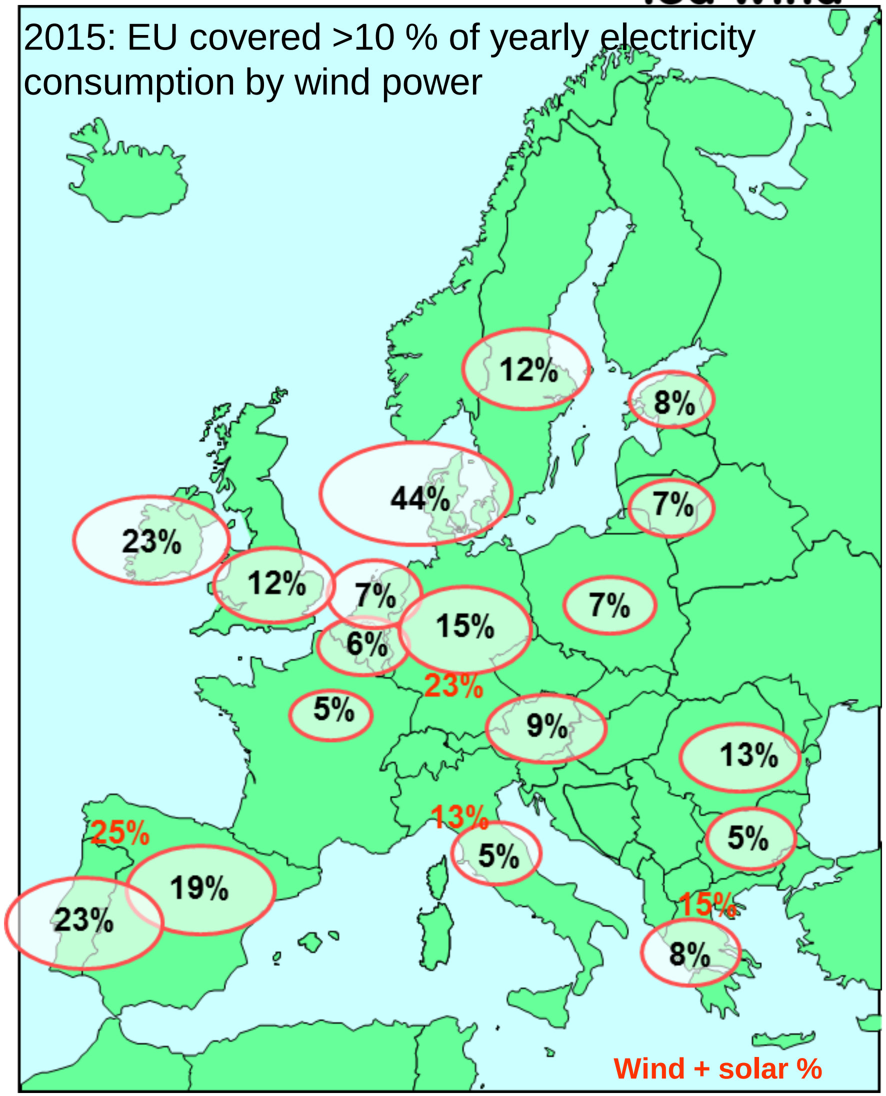
Integration studies – flow chart

- A complete study with links between phases
- Most studies analyse part of the impacts – goals and approaches differ
- Basic structure – could also be used for other generation forms to study impacts: update later in 2017 for wind/PV integration studies



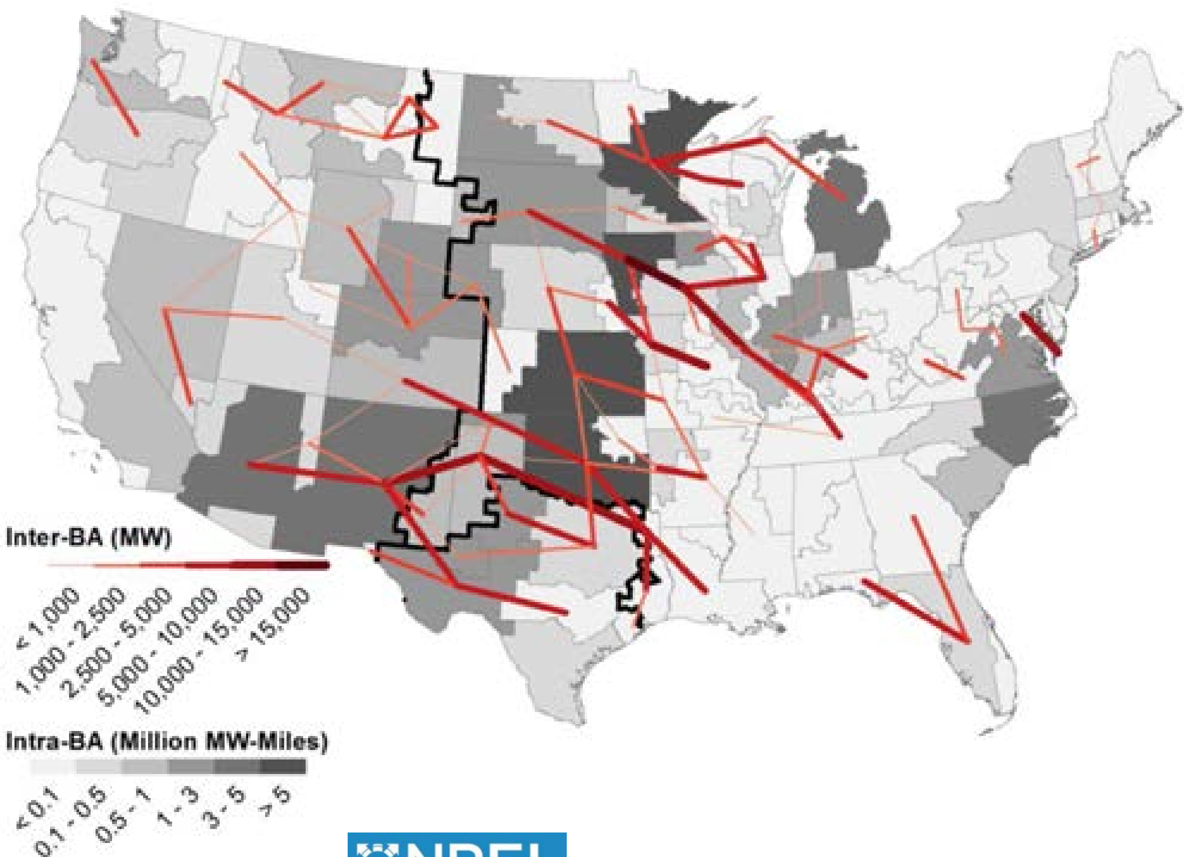
Experience from Wind Power Integration is Growing

- First 10-20 % share of wind:
  - Updated information from on-line production and forecasts. Possibility to curtail in critical situations
  - Transmission recognized as a key enabler, with regional planning efforts
- Higher shares of wind:
  - Technical capabilities of wind power plants evolving – used in grid support, also stability
  - Generation flexibility and adequacy
  - Market design



Long term planning for grid adequacy

- Transmission planning – towards regional planning

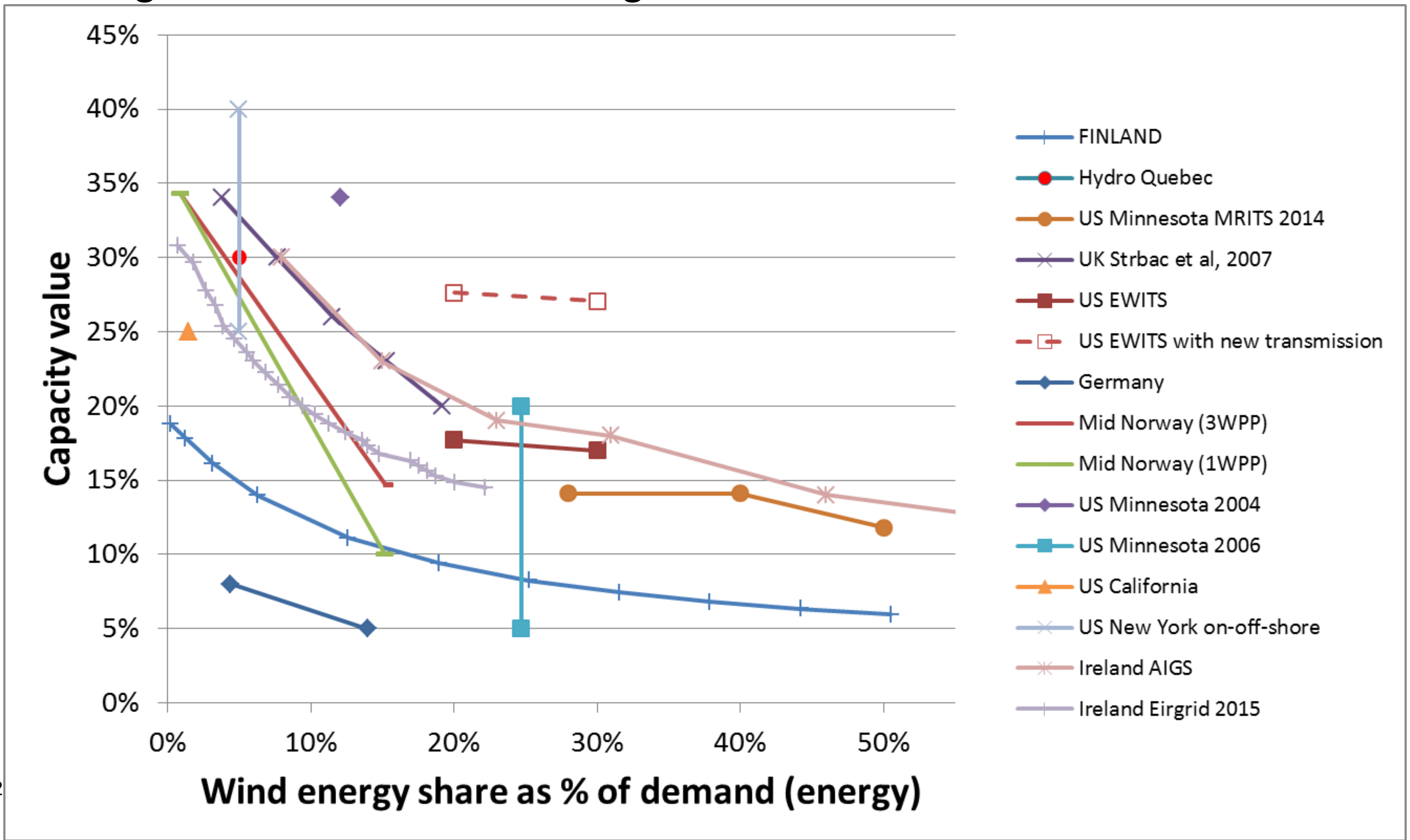


Source TYNDP (ENTSO-E, 2014)

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

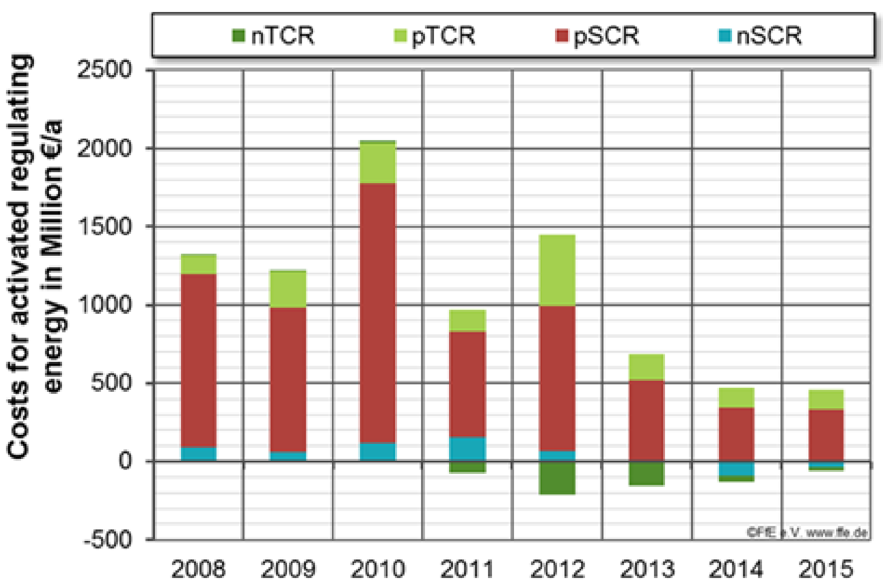
Long term planning for generation capacity adequacy

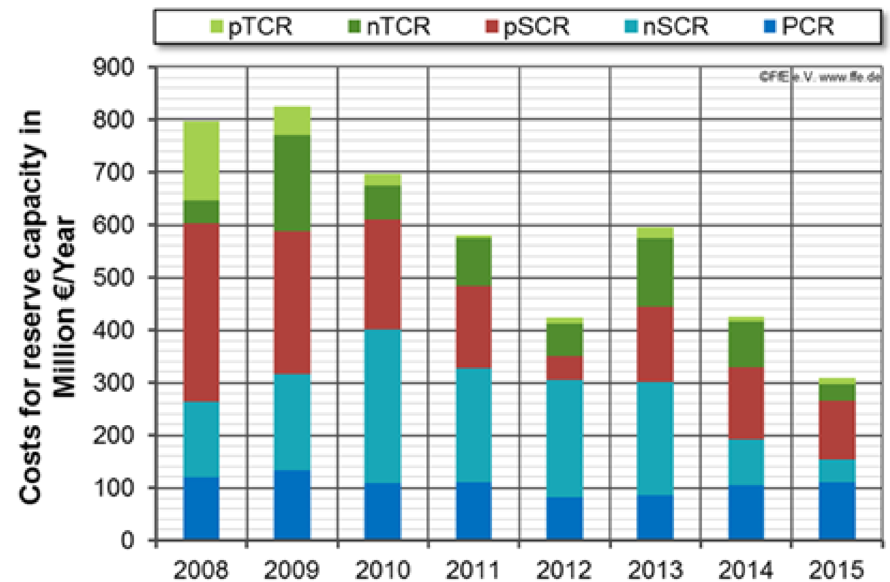
- Decreasing capacity value of wind power – reducing more slowly with larger areas – towards regional assessment



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

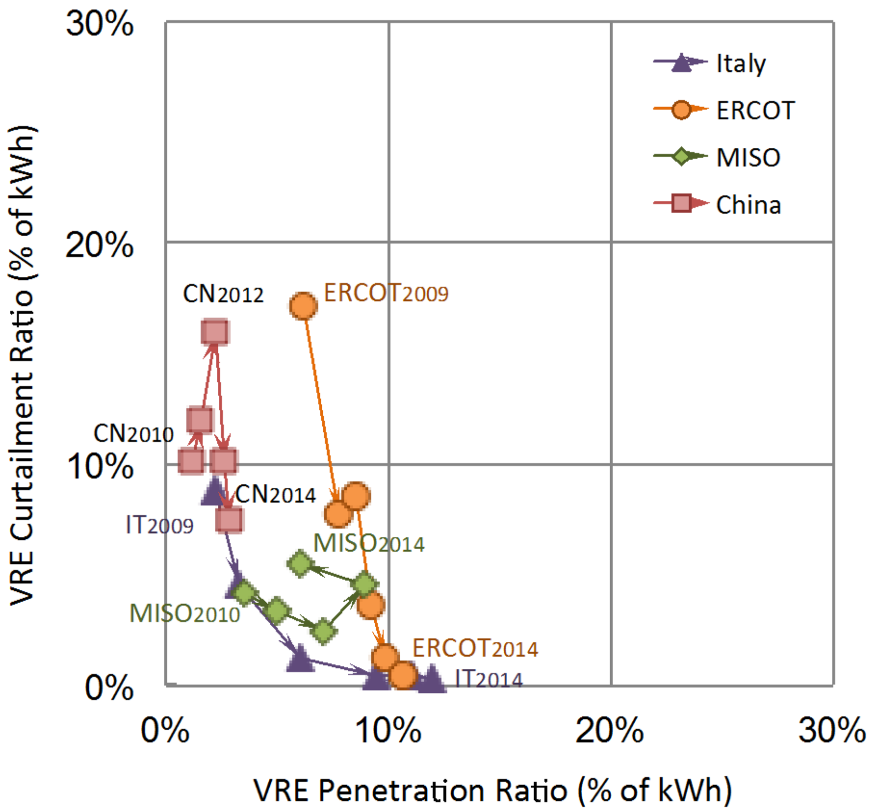


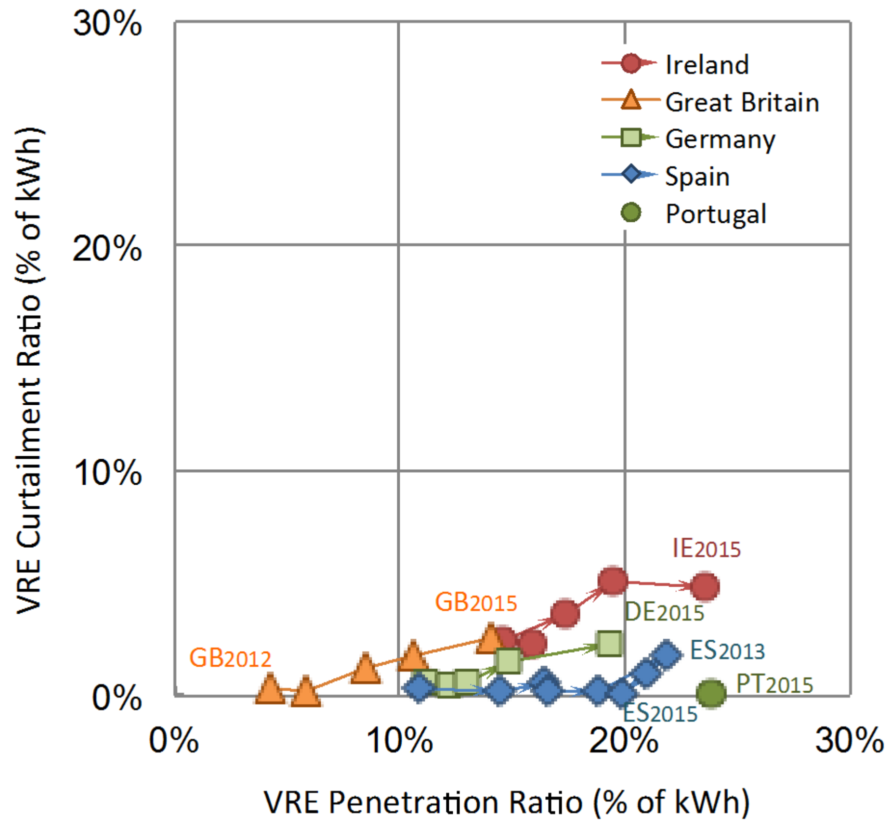


PCR Primary, SCR Secondary and TCR Tertiary control, p for positive and n for negative. Costs for activated energy (left) and reserved capacity (right)

Source Hirth, L., Ziegenhagen, I. Balancing Power and Variable Renewables: Three Links. Renewable & Sustainable Energy Reviews.

Maximising the value of wind power – minimising curtailments



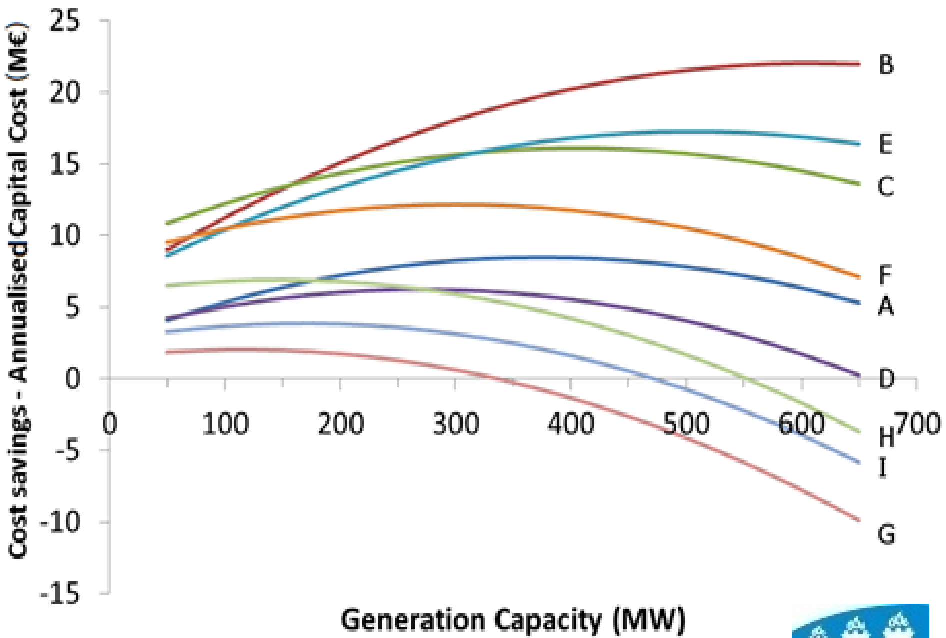


- Curtailments, mitigated by transmission build-up, in some cases
- Most European countries still experience little/moderate curtailments

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

Storage flexibility for wind curtailments

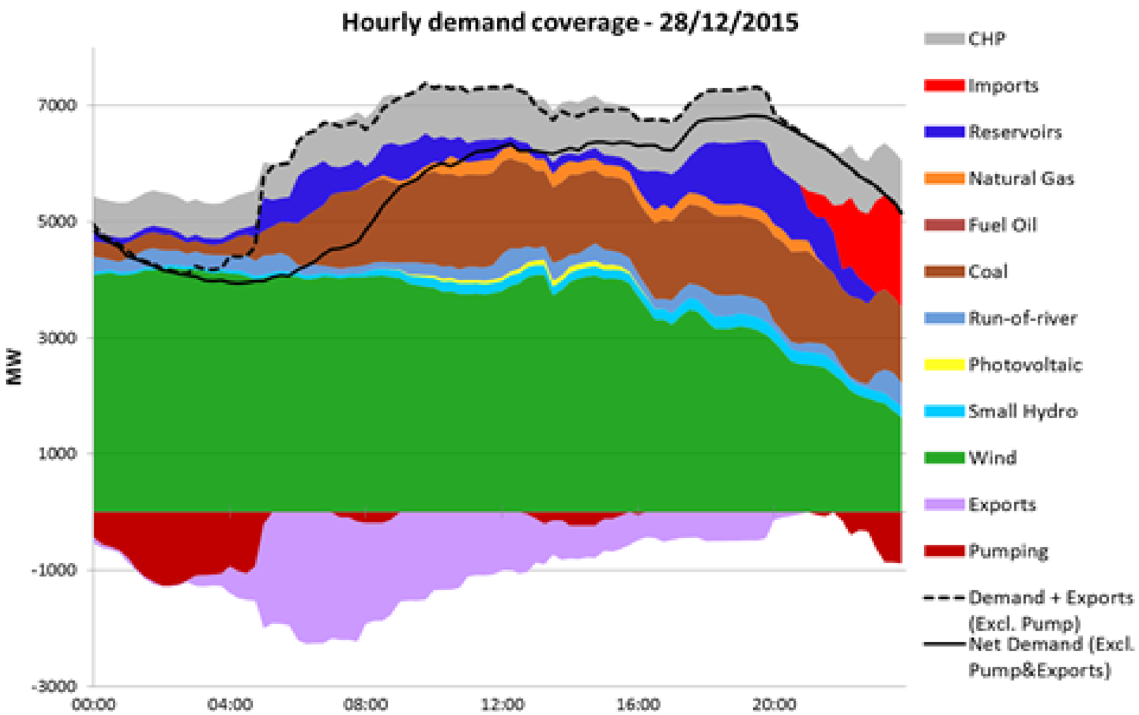
- Case Ireland: reducing curtailed wind at close to 40 % share
- Benefits of pumped hydro storage in Ireland with increasing pumped hydro capacity in year 2025. Most cost effective are the ones with only 2 hour storage (with high wind B, and medium wind E)
- The scenarios A…I are with different options of storage size (2 and 10 hours), installed wind and limit for instant wind penetration (50 or 75%).



Source: O'Dwyer, C., Flynn, D. Pumped Hydro and Compressed Air Energy Storage at High Wind Penetrations. WIW13, London

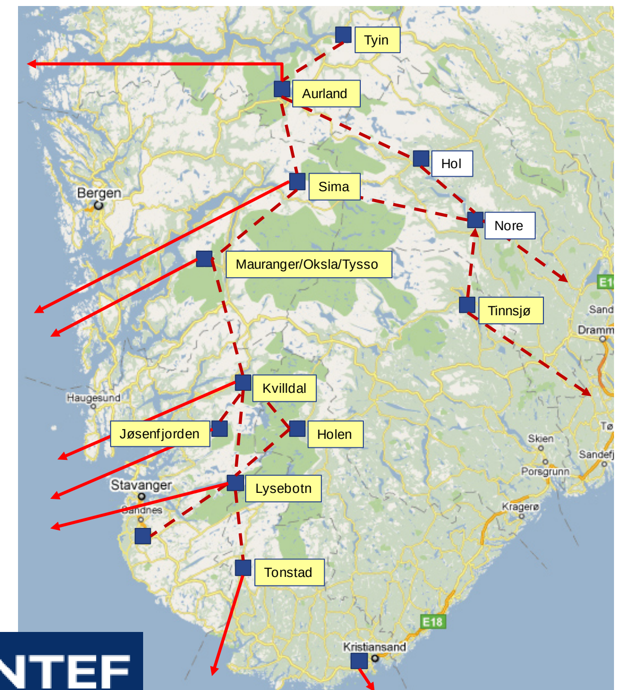
Hydro power flexibility

Portugal: managing close to 100% wind share.



Source for data REN: http://www.centrodeinformacao.ren.pt

Norway, building transmission to manage North Sea wind.



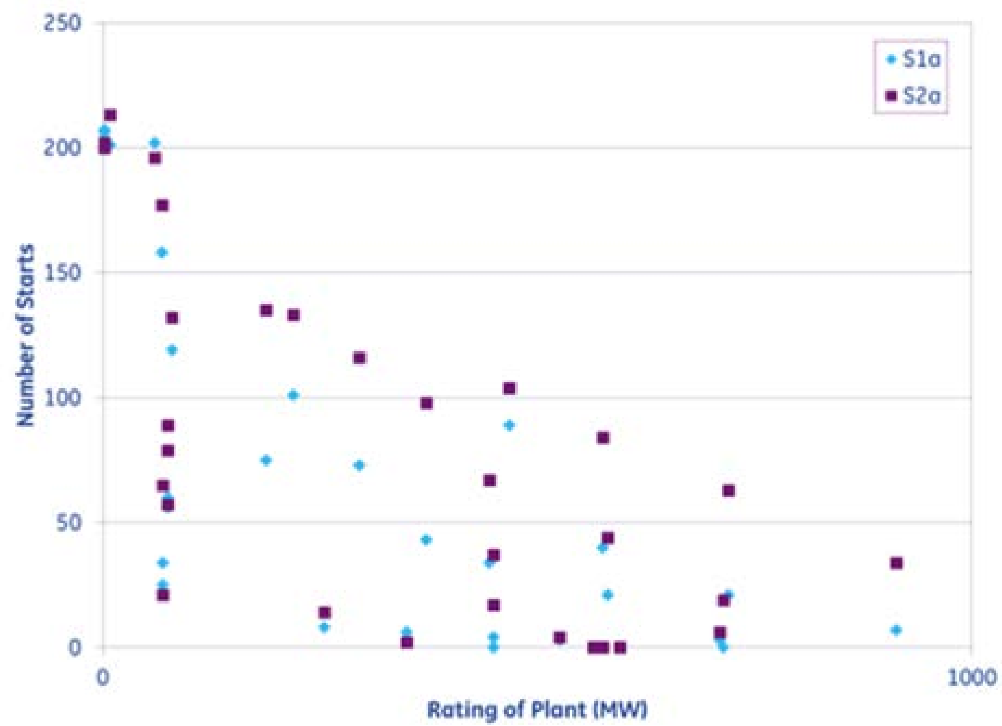
Source: Farahmand, H. et al. Nordic hydropower flexibility and transmission expansion to support integration of North European wind power. Wind Energy 2015, 18: 1075–1103

Cycling impacts - not much impact on emissions

- More detailed analyses of impacts to thermal power plant tear and wear: more start-ups and ramping, but little impact on emission reductions

	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 WWSIS2

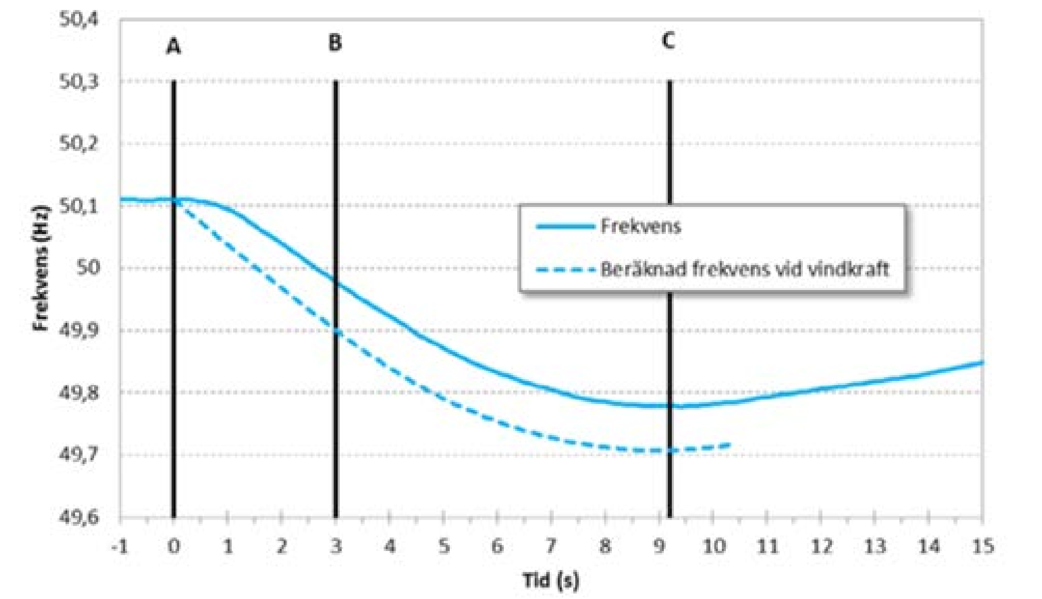


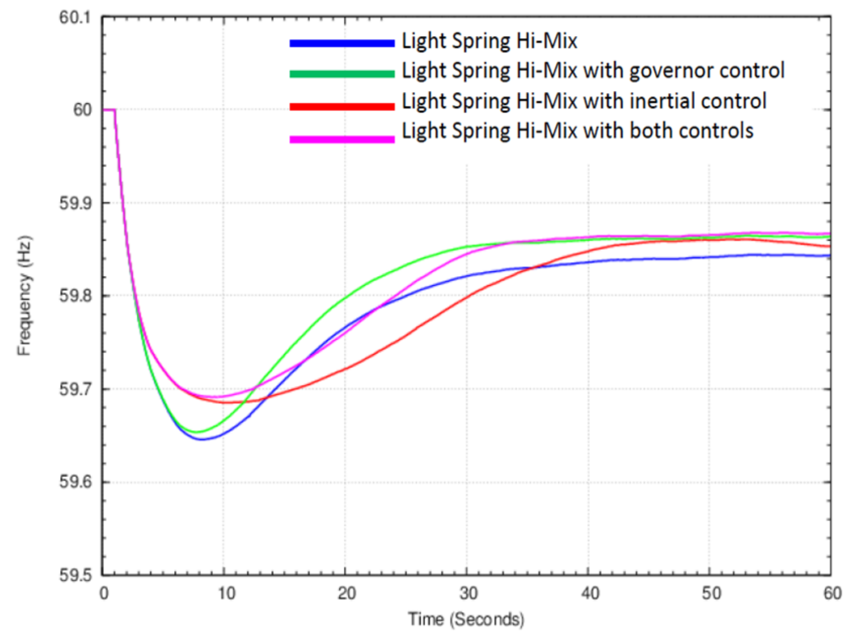
S1a has 40 % and S2a 50 % share of wind and solar

Source http://www.minnelectrans.com/documents/MRITS-report.pdf

Short term impacts – stability

- Frequency stability studied more – with wind turbine capabilites



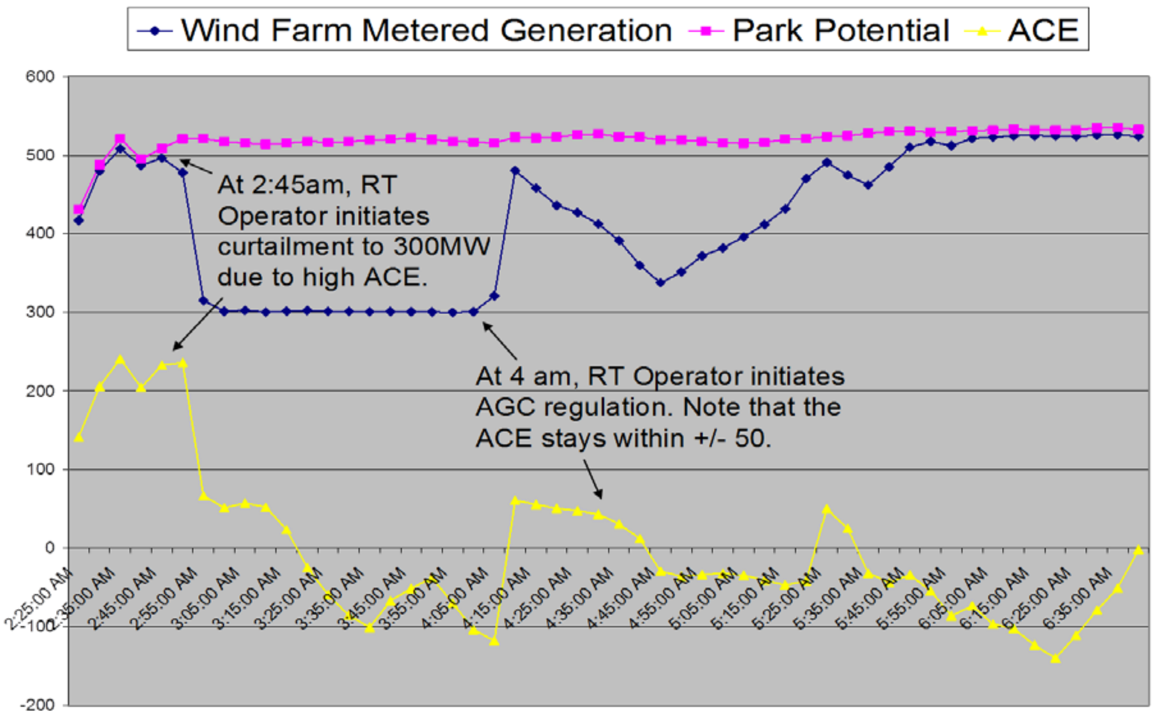


(Beräknad frekvens vid vinkraft = Estimated frequency with wind power)
Source: Svenska Kraftnät, Perspektivplan 2025.

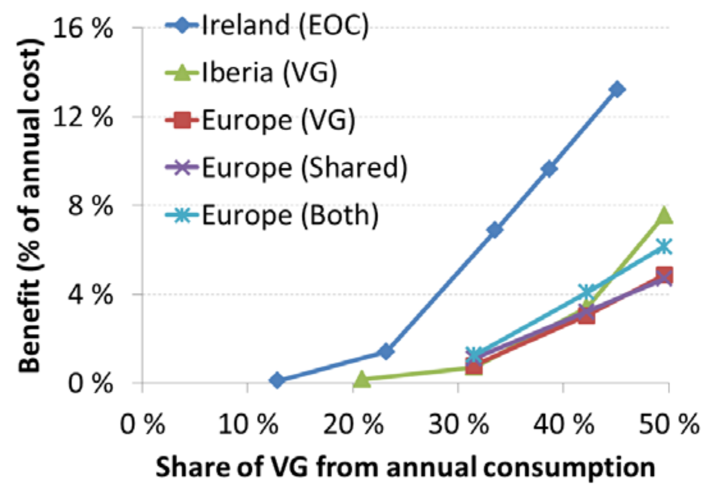
Source WWSIS 3

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.

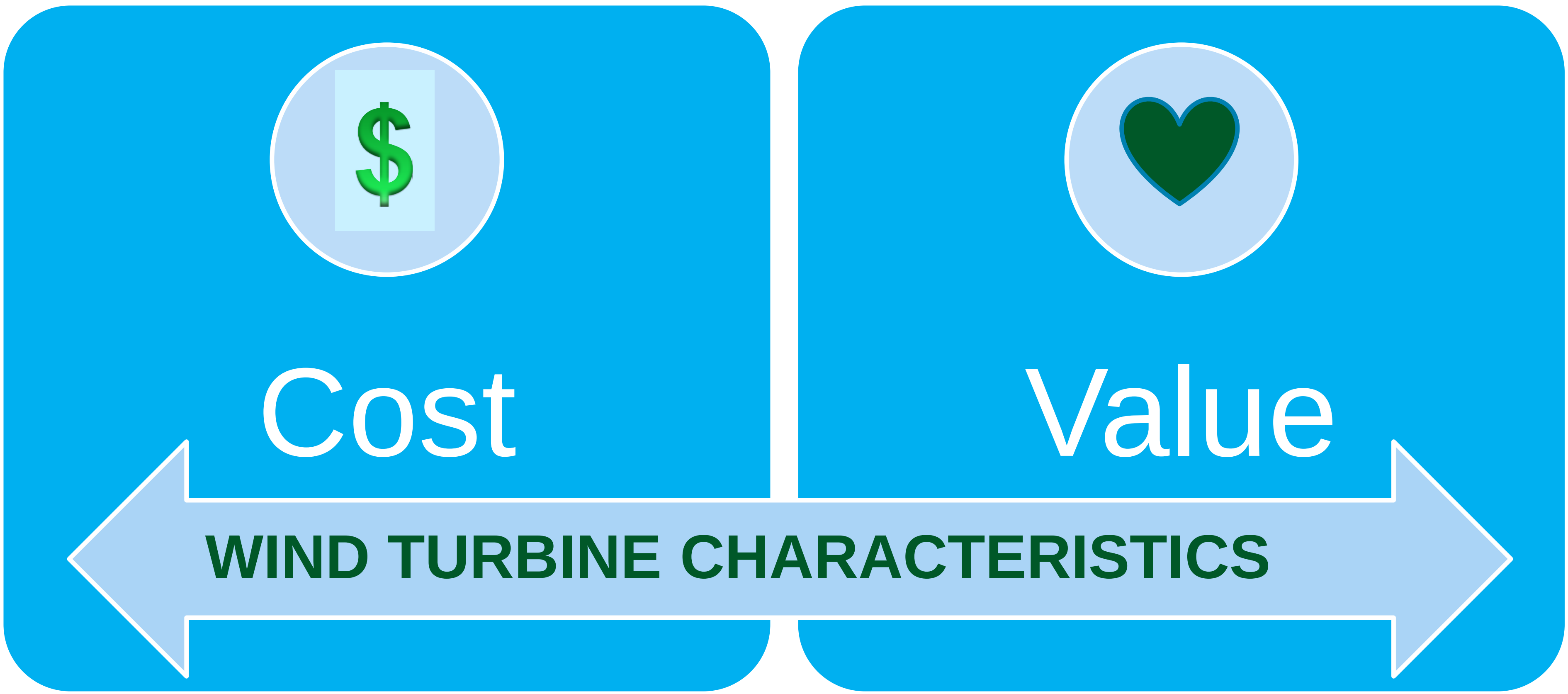


Source: US Xcel/PSCo Wind power providing AGC



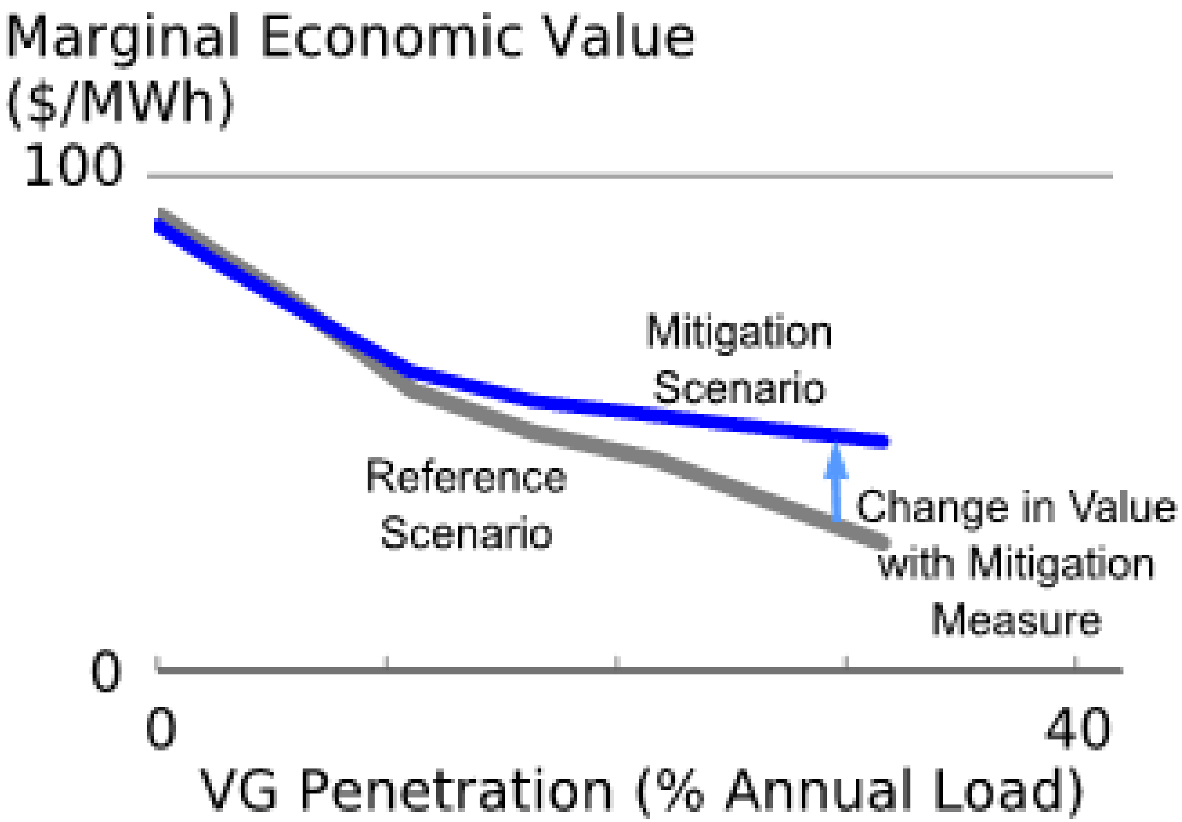
System benefits for frequency support from wind and PV. Source: ReServiceS, VTT D5.5

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



The mitigation measures considered include:

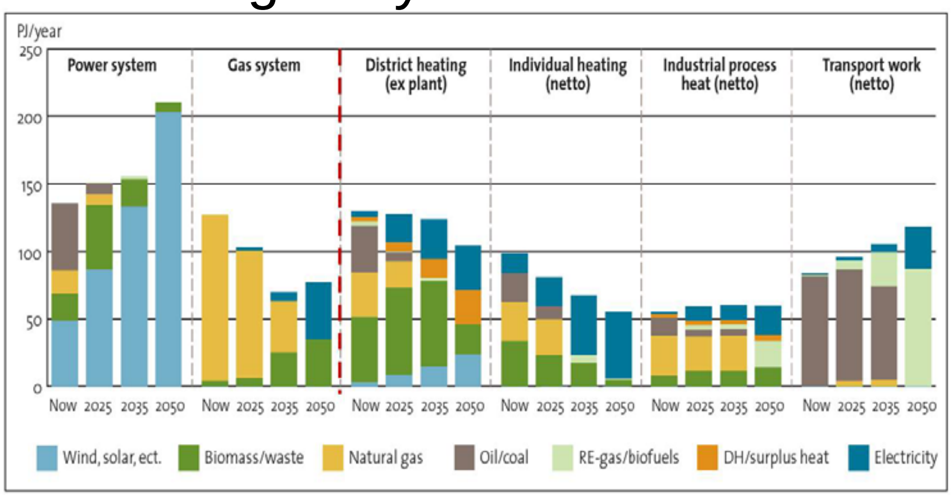
- increased geographic diversity
- technological diversity
- lower-cost bulk power storage
- price elastic demand subject to RTP

Transition towards renewable future means adaptation

Integration challenge is easier if

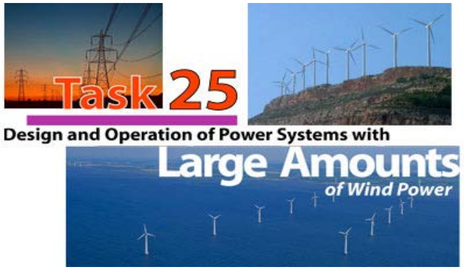
- variable generation is built dispersed to larger area – smoothing
- **power system operation** enables aggregation benefits from larger area: strong transmission/distribution grid and sharing balancing
- there is **flexibility** in the generation fleet – and in demand

Integration effort and costs will be different for different systems and adaptation will greatly reduce the costs.



Electrification and integration between energy sectors helps integrating large amounts of wind power (>50 %)

Source: Energinet.dk. 2015. Energy Concept 2030 – Summary. An analysis of concepts and development paths to sustain a competitive and strong RE based energy system.



IEA WIND Task 25: Design and operation of power systems with large amounts of wind power

www.ieawind.org

17 countries + Wind Europe participate

	Country	Institution
	Canada	Hydro Quebec (Alain Forcione, Nickie Menemenlis)
	China	SGERI (Wang Yaohua, Liu Jun);
	Denmark	DTU Wind (Nicos Cutululis); TSO Energinet.dk (Antje Orths)
	Finland	VTT (H. Holttinen, J. Kiviluoma) – **Operating Agent**
	France	EdF R&D (V. Silva); TSO RTE (E. Neau); Mines (G. Kariniotakis)
	Germany	Fraunhofer IWES (Jan Dobschinski); TSO Amprion (Peter Tran)
	Ireland	SEAI (John McCann). UCD (Mark O'Malley, Jody Dillon)
	Italy	TSO Terna Rete Italia (Enrico Maria Carlini)
	Japan	Tokyo Uni (J.Kondoh); Kyoto 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 (G. Strbac, Imperial; O. Anaya-Lara, Strathclyde)
	USA	NREL (M.Milligan); UVIG (J.C.Smith); DoE (C. Clark)
	WindEurope	Wind Europe (Daniel Fraile)

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