PBL Netherlands Environmental Assessment Agency

Transmission's key role in energy transition

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Electricity market design issues in energy transition perspective

	now	Next generation
RE generation	Capacity growth	System interaction; cost decrease
Adequacy	Liberalisation	Search for new paradigm
Flexibility	Emerged from conventional power system	Search for new solutions and incentives with more intermittent renewable energy (IRE)
Grid infrastructure	Cost decrease; capacity growth	Connection with flexibility issues; cost allocation; coordination with generation

Source: Adapted from IEA-RETD, RES-E-Next, 2013

Network costs become more important (% of total costs)

		Renewable generation	Overall generation	Network
Germany	2010-12	86%		14%
	2013-20	74%		26%
United Kingdom	2011-19		80%	20%
Netherlands	2013-20	58%		42%

Source:DIW Wochenbericht 26, 2013; Green Alliance 2013; CE Delft and Netbeheer Nederland 2011

Think about finance: equity, reduction of risks (regulation, standardisation, transformation from banks to e.g. pension Funds), shorter time lags.

Network most vulnerable part of power system

Black outs in past 40 years due to:

- Transmission 65%
- Transmission and distribution 10%
- Generation 15%

Black outs mainly weather-related.

Source: A Boston, Delivering a secure electricity supply on a low carbon pathway, Energy Policy 52 (2013) 55-59

Does ‘network follows generation’ still makes sense? (1)

3 Scenarios developed for clean power system in 2050 in the Netherlands:

- ‘Energetic society’ (A) with wind, solar-PV, green gas CHP
- ‘Gas remains’ (B) with gas CCS
- ‘Large scale strikes back’ (C) with nuclear, coal CCS, green gas CHP

- No central coordination, ‘market will decide’

- All scenarios have vulnerabilities, no one is certain
- But impacts for grids completely different and before 2020 choices have to be made, including gas/power networks
- Acceptance of congestion part of efficient approach (cp. highways)

➡ More coordination generation/grids necessary

Does 'network follows generation' still makes sense? (2)

	A	B	C
High voltage	+++	+	++
Medium voltage	+++	++	++
Low voltage	+++	+	++
Low pressure gas	-	=	--
Network investment costs 2015-50	65 – 79 bln EUR	23 – 31 bln EUR	39 – 50 bln EUR

Source: CE Delft, Net voor de Toekomst, 2010

Flexibility needs urgent in North West Europe

- Somewhere before 2030 share IRE larger than flexible capacity (e.g. scenario 45 vs 25% in 2030 in Germany and the NL)
- More flexibility in order of increasing costs: demand response; interconnection; storage; back-up; curtailment; outage
- But all need different regulatory and market regimes
- Up to share of 45% IRE costs could be relatively modest, but will increase strongly with even higher shares
- More scope for demand response and interconnection will reduce flexibility costs most

Source: Lise et al, Assessment of the required share for a stable EU electricity supply until 2050, Energy Policy 59, 2013, 904-913

Some flexibility issues under discussion could lead to new roles for TSOs

- From feed-in tariff to feed-in premium to prepare ground for more market-based regime

- Balancing markets become more relevant:
  - All generation has to become balance-responsible (not yet in e.g. Germany)
  - Short-term markets for operating reserves may be linked with energy and balancing markets
  - German Minute reserve markets offer possibilities for virtual power plants
  - Gate closure time gets closer to production
  - New markets will develop and income from balancing increases; better balancing diminishes need for capacity market

- Coordination generation/grids and locational price could lead to change in regional investments

Order of magnitude of costs of larger shares intermittency (EUR per MWh)

	Gross, UK 20%	Crassous et al IRE 10-15%		UK Wind, NEA		UK Solar, NEA	
	wind	wind	solar	10%	30%	10%	30%
adequacy	4-6	4-15	10-15	3	5	20	20
balancing	2-4	2-5	2-5	6	11	6	11
grid		4	10	6	6	18	23

Source: Gross et al, Costs and impacts of intermittency, 2006; Cassous, Roques, Couts associes a l'insertion des ENR intermittentes dans le systeme electrique, 2013; NEA, Nuclear energy and renewables, System effects in low-carbon electricity systems, 2012

Compare CoE onshore wind plm 60 Eur/Mwh and solar 130 Eur/Mwh in 2020 in Germany

Conclusions

- Intermittent renewable energy starting point of considerations
- Grids become more important
  - Flexibility/balancing issues due to IRE
  - Grid extensions relatively more costly
- More system coordination and markets needed
  - 'Grids follows generation' becomes too expensive, as different generation pathways are equally feasible
  - Balancing and power markets will be linked
  - At some moment (IRE 45%) costs will even increase further, if no demand-side response and storage have been developed
- Regulatory learning becomes even more important than technology learning