



Regulatory roadmaps for large-scale integration of electricity from intermittent resources in national power systems

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Renewable Electricity Supply interactions with conventional
POwer generation, Networks and Demand

Intelligent Energy  Europe

Outline



1. Why Regulatory Road Maps?
2. Regulatory Road Map Methodology
3. Illustration of Road Map Scheme
4. Example of German Road Map
5. Main regulatory road map recommendations for five countries
6. Concluding remarks



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1. Why Regulatory Road Maps?



In short: we need directions in order to undertake the right actions!



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1. Why Regulatory Road Maps?

- Regulatory road maps as analogy to technological road maps
- For a less costly integration of intermittent RES-E in the power system
 - To comply with EU RES-E target for 2020
 - To identify regulatory actions required for a smooth system transformation towards target year 2020
 - Including most urgent actions for the short-term
 - To attribute actions to different electricity system actors
 - Given context and electricity system specific conditions



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2. Regulatory Road Map Methodology

- **Two dimensions of intermittent RES-E/DG integration**
 - Market integration
 - I.e. impact on markets (wholesale, balancing)
 - Network integration
 - I.e. cost of connection, costs of network use
- **Increasing impacts of intermittent RES-E/DG**
 - System impact (among other factors) dependent on penetration level
 - Different market and network integration issues emerging at different levels
- **‘Ingredients’ for road map methodology**
 1. Overview of response options for different levels of RES-E/DG integration
 2. Different stages of **network** integration of intermittent RES-E/DG
 3. Different stages of **market** integration of intermittent RES-E/DG



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2. Regulatory road map methodology

- Overview of response options

*Impact of intermittent
DG/RES-E*

Impact of intermittent DG/RES-E	High	• Sophisticated large-scale energy storage • More complex differentiation in support scheme payments	• Introduce advanced load control • Real-time pricing • Interruptible contracts for all actors • Introduce smart metering	• Time of use dependent UoS charges • Locational UoS charges • Dynamic reserves	• Cross-border balancing • Abolish priority dispatch RES-E/DG • Lower prequalification criteria for provision of ancillary services
	Moderate	• Adaptation of generation: heat storages to CHP units • Differentiation support scheme payments • Small-scale energy storage	• More complex differentiation end-user prices (basic meters) • Interruptible contracts for large consumers	• Regulated (shallowish) connection charges • UoS charges generation • Evaluate n-1 rules • Explicit innovation incentives (IFI type)	• More complex time-dependent tariffs • One national balancing market with BRP • Market-based congestion management
	Low	• Adaptation of generation mix (GT / Hydro / CCGT) • Basic differentiation in support scheme payments • Implementation capacity mechanism	• Metering on yearly basis • Basic differentiation in end-user prices • Interruptible contracts for large consumers	• Shallow / shallowish connection charges • Improve interconnections • Basic congestion management	• Basic time-dependent tariffs • Efficient balancing market ◦ Liquidity, signals, etc. • Shorten gate closure time
		Generation	Demand	Networks	Markets

Response options per segment

2. Regulatory road map methodology

- Stages of market integration

	Stage	Description	Criteria (market integration issues)	Recommendations
A	Protected niche market	• Low penetration level of RES-E/DG • RES-E/DG outside the markets	• Wholesale market access • Variable RES-E/DG negligible impact on markets	• Focus on economic viability RES-E/DG, priority dispatch, feed-in tariff regime
B	RES-E/DG in the market	• Moderate penetration level of RES-E/DG • RES-E/DG participates partly in supply side of ancillary services market. • RES-E/DG has little to moderate effect on market prices.	• Wholesale market access, limited access to other markets • Moderate impact in system balancing costs • Need for differentiated market prices to reflect system conditions	• Move to feed-in premium • Introduce basic interval metering • Regime of balancing responsible parties • (Regional) market-based congestion management
C	Active RES-E/DG	• High penetration level of RES-E/DG • RES-E/DG provides all kind of ancillary services when profitable • RES-E/DG has moderate to high effects on market prices	• RES-E/DG enters other markets (ancillary services, balancing) • Substantial increase in system balancing cost • Demand-side involvement in balancing and ancillary services market	• Implementation of smart metering • Facilitate interruptible contracts • RES-E/DG involvement in all markets

2. Regulatory road map methodology

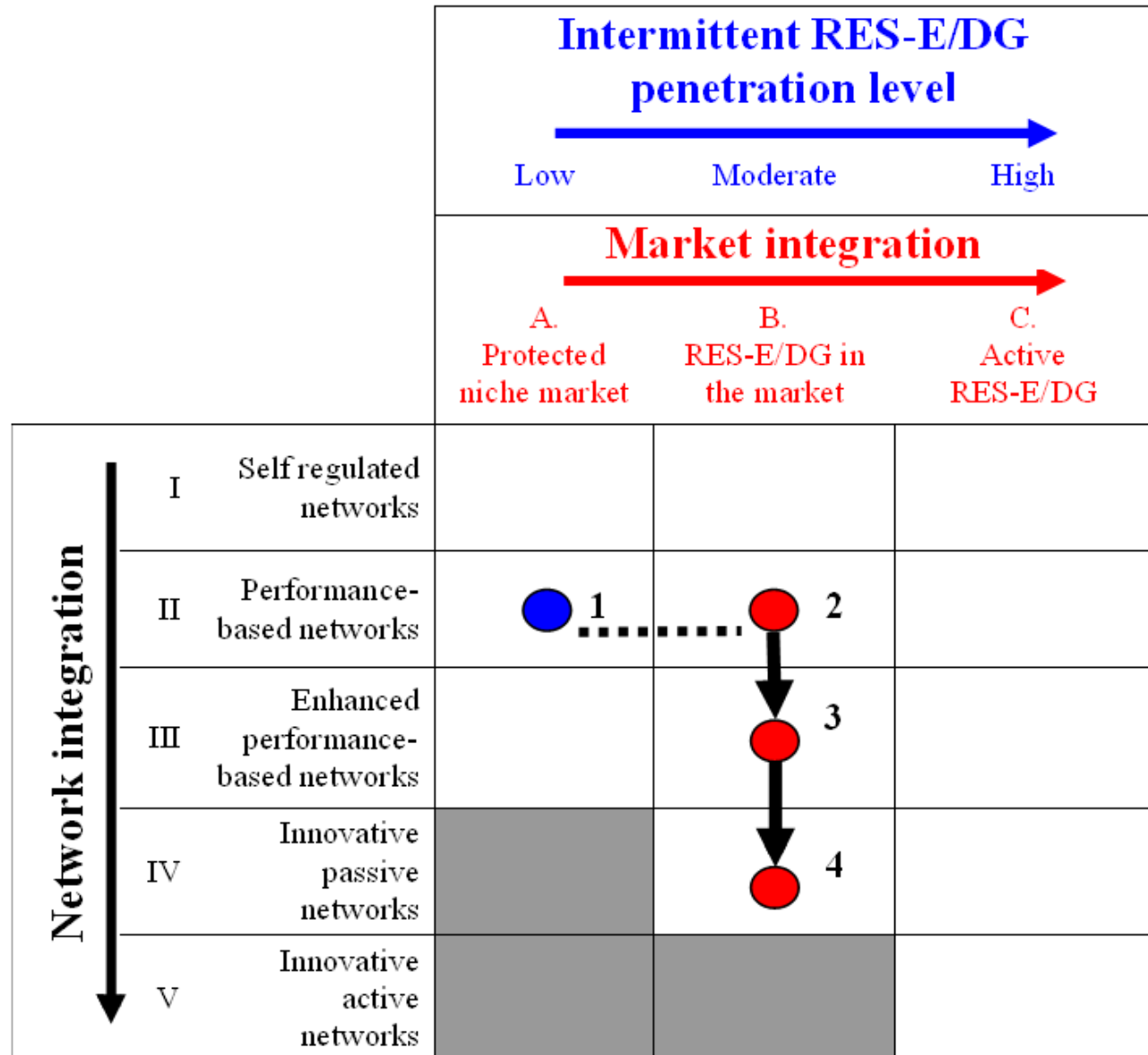
- Stages of network integration

	Stage	Description	Criteria (network integration issues)	Recommendations
II	Performance-based networks	Regulated network access , cost-driven, incentives for efficiency improvements	• Negotiation on connection costs • Limited network reinforcements • Limited congestion due to variable RES-E/DG	• Shallow regulated connection charges (mandatory access) • Basic congestion management
III	Enhanced performance-based networks	Regulated network access, incentives for efficiency , incl. quality incentives & basic innovation aspects.	• Increasing network integration costs (especially distribution) • Differential impact across distribution networks • Increasing congestion	• Shallow regulated connection charges plus basic use of system charges • Account for differential RES-E/DG impact across networks
IV	Innovative networks	Innovative distribution network (monitoring and limited control possibilities), incentives for innovation, active transmission network	• Increasing network integration costs (upward flows) • Proper incentives for network operators and generation / load • Increasing congestion	• Basic time/location differentiated connection & use of system charges • RES-E/DG in network planning • Market-based congestion management
V	Active networks	Holistic approach, fully active networks , regulation incl. active role generators & load	• Increasing network integration costs • Proper incentives network operators & generation and load • Increasing congestion	• Time and locational differentiated connection & use of system charges • Smart meters • Active network management

3. Illustration of Road Map Scheme

Legenda

- 1: **Current** level/impact of intermittent RES-E/DG penetration
- 2: **Current** stage of market and network integration w.r.t intermittent RES-E/DG
- 3: **Intermediate step**, intermediate stage of market and network integration in the future
- 4: **Final stage** of market and network integration in the future (e.g. 2020)



4. Example of German roadmap

- Impacts of intermittent RES-E on markets and networks in 2020



- Moderate penetration level of DG/RES-E (<30%)

Markets

- Higher need for balancing services, especially secondary and tertiary regulation
- Higher price variability in balancing, intraday and day-ahead markets

Conclusion: higher demand for market flexibility in order to limit system costs

→ stage B: RES-E/DG in the market

Networks

- Increasing flows from excess intermittent supply in the North to main load centres in West and South
- Substantial network congestion both on distribution and transmission level (including interconnections), on transmission level 5,000 MW in 2015

Conclusion: massive network capacity extension is required

→ stage IV: Innovative networks



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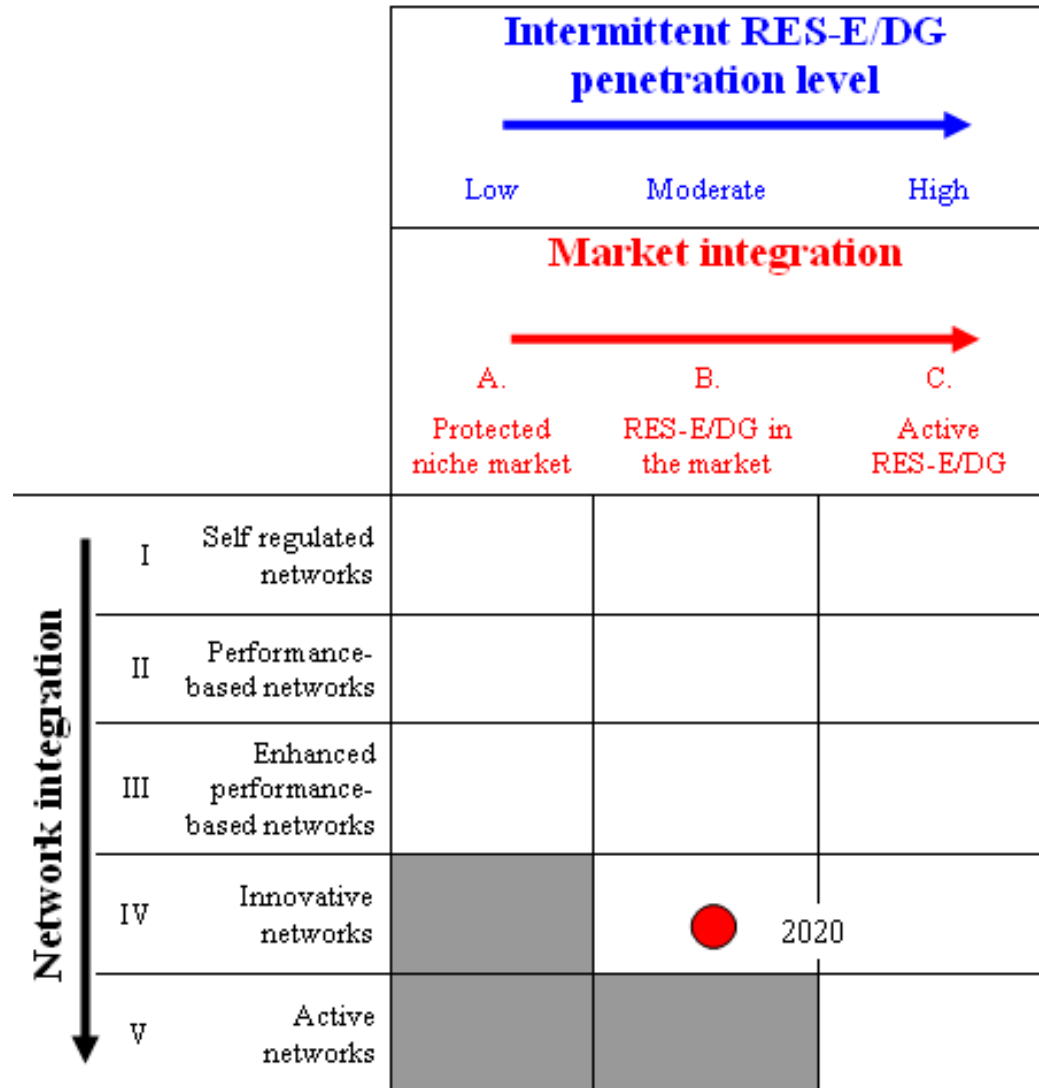
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4. German roadmap

– Coupling impacts with general recommendations for market integration

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C	Active RES-E/DG	• High penetration level of RES-E/DG • RES-E/DG provides all kind of ancillary services when profitable • RES-E/DG has moderate to high effects on market prices	• RES-E/DG enters other markets (ancillary services, balancing) • Substantial increase in system balancing cost • Demand-side involvement in balancing and ancillary services market	• Implementation of smart metering • (Regional) market-based congestion management • RES-E/DG involvement in all markets

4. German roadmap - end point



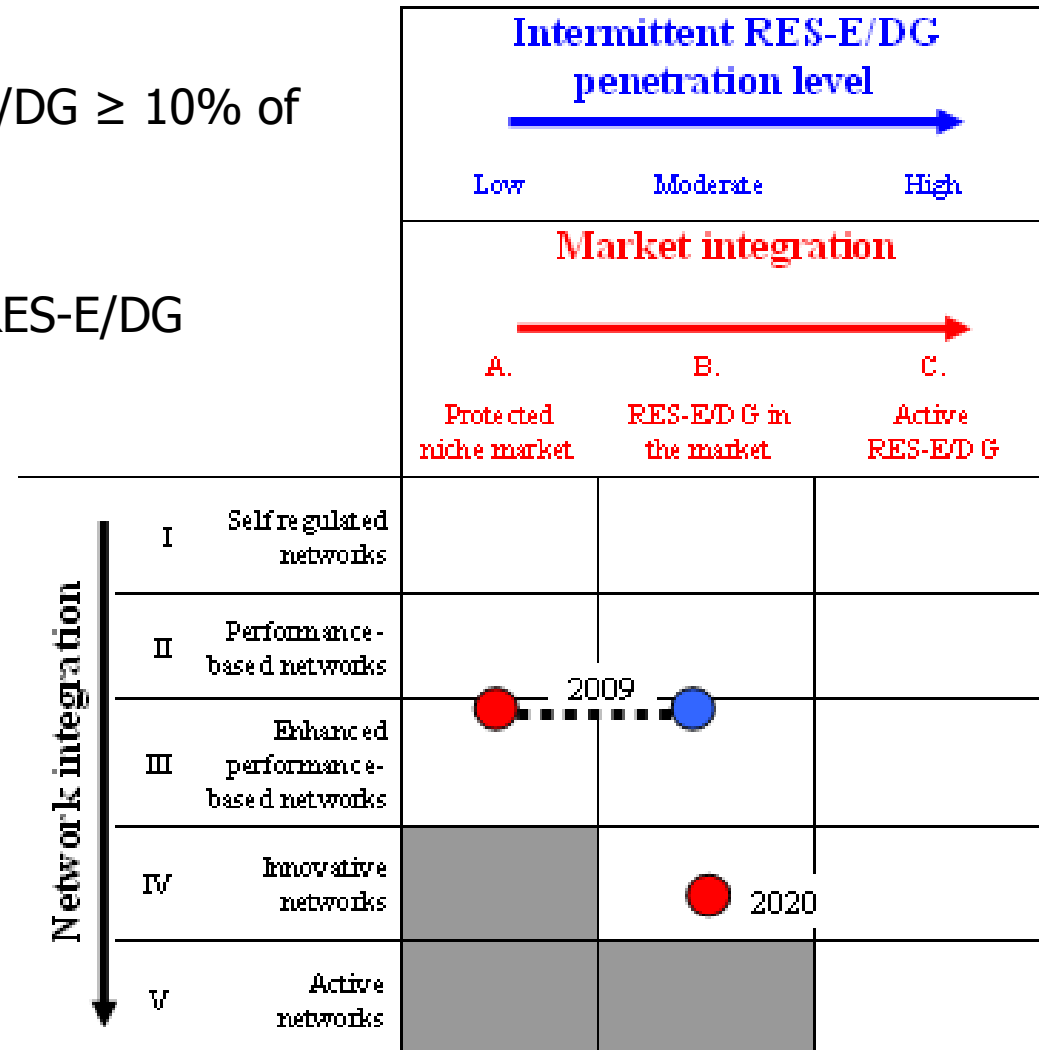
4. German roadmap ... including starting point

Market integration

- Moderate penetration: RES-E/DG $\geq 10\%$ of total E-production
→ Stage B
- Focus on economic viability RES-E/DG
- Priority dispatch
- Feed-in tariff
→ Stage A

Network integration

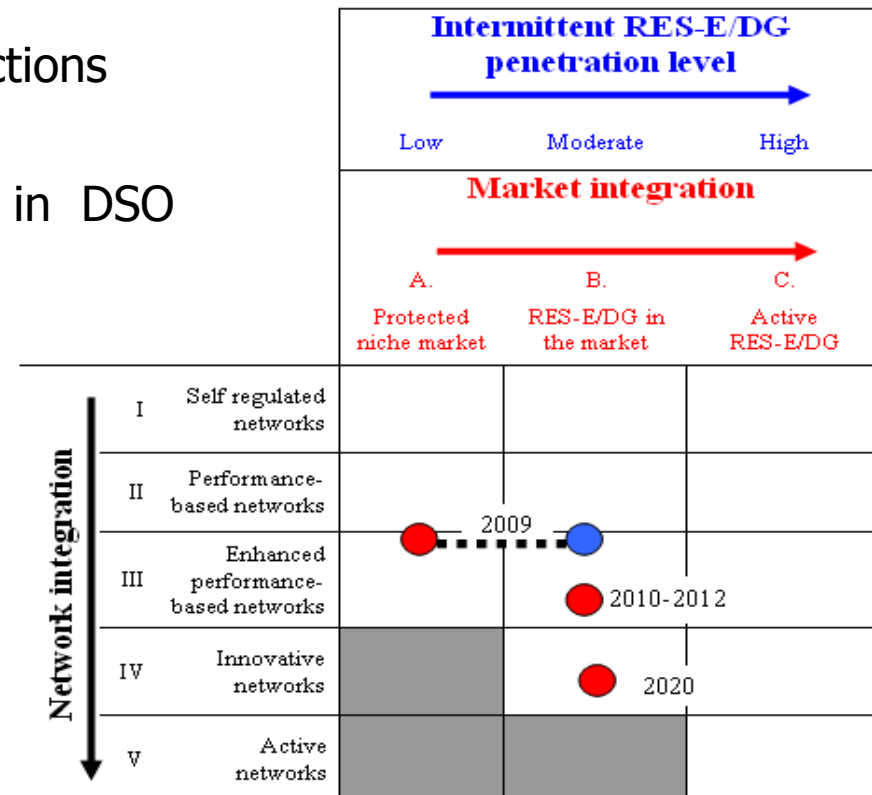
- Active TN
- Passive DN
- Only incentives for efficiency improvements not for quality and innovation
- DG acknowledged as cost factor in regulation
→ Stage II/III



4. German roadmap ... including intermediate step

Main short term recommendations (2010-2012):

- Introduce feed-in premium market scheme besides feed-in tariffs
- Allow for paid curtailment of RES-E/DG
- Introduce balancing responsible parties and shorten gate closure time of BM
- Prepare for future demand response actions
- Introduce UoS charges for generators
- Introduce explicit innovation incentives in DSO regulation
- Evaluate current network planning standards

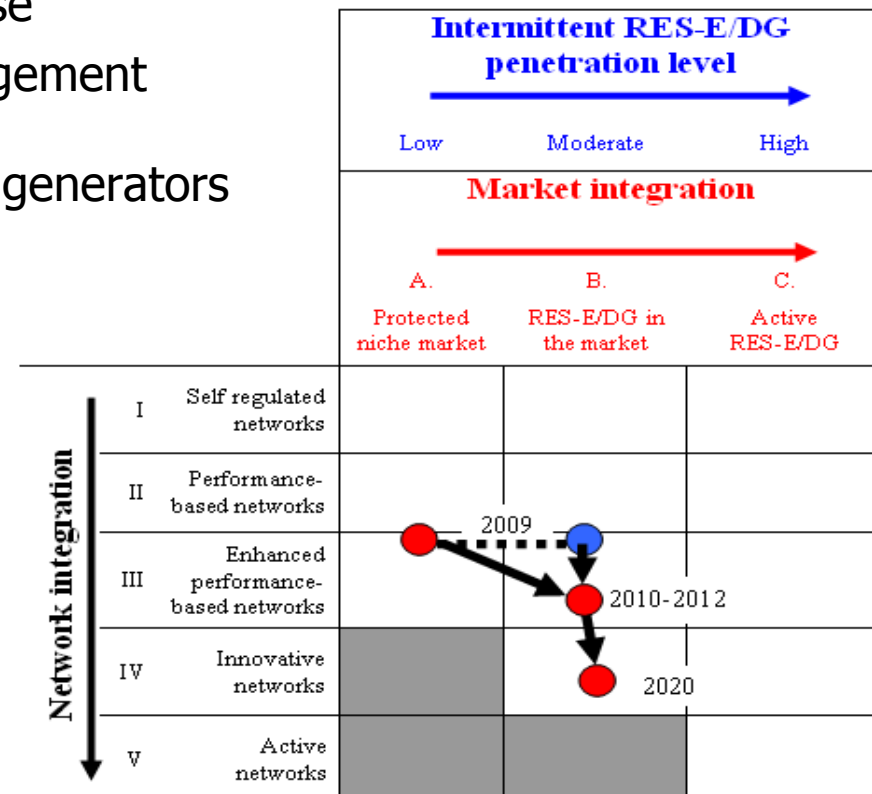


4. German roadmap

– Full roadmap including complete route 2009-2020

Main medium term recommendations:

- All eligible RES-E/DG under feed-in premiums scheme
- RES-E/DG enabled to provide all ancillary services (when technically feasible)
- Further development of demand response
- Market based national congestion management method
- Time-differentiated network charges for generators
- Network planning method should use dynamic reserves
- Further development of regional market coupling



4. German roadmap – Action plan for stakeholders



Actor	2010-2012	2020
Government	• Feed-in premium besides feed-in tariffs • Allow for paid curtailment of RES-E • Minimum functional requirements to smart meters & more frequent meter reads • One-stop shop approach for flexible generation • Coordination procedure to overcome objections against new lines	• Oblige feed-in premium system
Regulator	• Innovation incentives for DSOs • Evaluate network planning standards • All generators balancing responsible	• Market-based national CM • Network planning with dynamic reserves • Network simulation tool for network planning & investments
TSO	• Rolling gate closure time for balancing market • Cross-border balancing • Contract additional balancing power outside the market • Use-of-System charges for generators • Fine-tune system services bonus	• Reduce prequalification criteria for balancing • Reduce minimum VPP size to 5 MW • Enable wider possibilities for provision of ancillary services by DG • Interruptible contracts for medium size loads • Time-differentiated UoS charges
DSO	• Demonstration projects about smart grids, smart metering and advanced load control • Demonstrate smart home area networks for advanced load control	• Pilot projects for testing communication infrastructure for hourly/quarterly smart metering
Suppliers	• Introduce simple time-differentiated prices at wider scale	• Oblige time-differentiated prices
RES-E opera-		• Add heat storages or back-up boilers to CHP units

5. Main regulatory roadmap recommendations for five countries

Topic	Recommendation	Country				
		Denmark	Germany	The Netherlands	Spain	United Kingdom
Network integration						
Network charging	Shallow connection charges for all generators			✓	✓	✓
	Cost-reflective use of system charges for generators	✓	✓	✓	✓	
Network planning	Implement dynamic reserve requirements	✓	✓	✓	✓	✓
	Introduce explicit innovation incentives in network regulation	✓	✓	✓	✓	
Congestion management	Implement market-based congestion management	✓	✓		✓	✓
Market integration						
Demand response	Establish common standard for functionality of smart meters	✓	✓	✓	✓	✓
	Implement basic time-differentiated prices for all consumers	✓	✓	✓	✓	✓
Balancing market	Introduce shorter gate closure times		✓		✓	
	Introduce balancing responsible parties		✓		✓	
Ancillary services	Possibilities for DG/RES-E to provide ancillary services	✓	✓	✓	✓	✓



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6. Concluding remarks

- Policy recommendations in action plans need to be considered and implemented in order to meet EU RES-E targets for 2020
 - Without additional policy measures high cost impacts impede utilization of benefits of higher RES-E penetration level
 - Policy can accelerate implementation of efficient response options
- Most important challenges are related to network integration
 - For some countries market integration issues equally important
- Regulatory roadmaps are essential for
 - Structurizing recommendations in time and for stakeholders
 - Enabling country-specific approach to RES-E integration issues
- Road map derived action points are indicative
 - No quantification of response options → future research
- General road map methodology applied to five countries and applicable to other countries as well



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Thank you for your attention!
Questions?

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