Integration of VG- Update on Evolution of US & EU Market Designs

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Collaborative Effort

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Outline of Topics

- Introduction
- US market design considerations for operation with high penetration of renewable energy
- EU market design considerations for operation with high penetration of renewable energy
- Comparison of differences
- Conclusions
Background

• Growing deployment of wind and solar variable generation (VG) motivates a formal consideration of current state of markets across three dimensions of reliability:
  – *Resource adequacy* to achieve long-term planning objectives
  – *Resource flexibility* to maintain reliability in real-time operations
  – *Transmission capability* to ensure deliverability of all resources when and where required
Introduction

• Electricity markets have proven to be an excellent vehicle for improving system efficiency while maintaining reliability.

• The issues of resource adequacy, flexibility adequacy, and transmission capability must be addressed within the context of evolving regulatory and market systems.

• Reliability issues interact with other policies and with each other in complex ways, requiring ongoing refinement in policy, market design, and operating practices.
US Market Design and Operation with Variable Resources

• The current structure of the power industry in the US is a mixture of two different approaches:
  – Vertically integrated utilities operating as their own system operators under a cost-of-service regulatory paradigm
  – Competitive wholesale power markets that resulted from the Energy Policy Act (EPACT) of 1992

• Common characteristics of regional markets
  – Sub-hourly energy markets
  – Co-optimized energy and ancillary service markets
  – Large systems with aggregation benefits for generation and load
Resource Adequacy and Market Design

• The organized markets are similar in their energy and ancillary service market designs, but vary widely in approaches for resource adequacy.

• The two primary market alternatives are
  – energy-only market with capacity costs recovered in the energy and ancillary service market (e.g. ERCOT).
  – energy market with a parallel capacity market to recover some portion of the capacity cost (e.g. PJM, NYISO, ISO-NE).

• Either alternative may also have additional regulatory capacity planning margin requirements that require load serving entities to contract for capacity (e.g. CAISO and parts of MISO).
Example of Two Alternatives

• ERCOT and PJM are examples of very different market designs
• ERCOT operates an energy-only market and is close to its reserve margin target of 13.75%
• PJM operates a capacity market with three-year forward procurement using a sloped demand curve that recognizes the value of capacity beyond the installed/planning reserve margin target. PJM is projected to be above its reserve margin target of 15.6% through 2018
Another Option

• A third option is bi-lateral markets
  – stand-alone balancing areas
  – tend to saturate with renewables sooner
  – stand-alone provider tends to have a smaller pool of dispatchable resources available to manage the renewable integration
  – often limited by hourly scheduling protocols
  – may not make full use of load response to provide ancillary services
  – increasing efforts to develop wind integration charges which are allocated to the renewable provider
Operational Flexibility in the US

• Flexibility - the ability to change output rapidly to accommodate rapidly changing system conditions.

• Flexibility measures
  – short start up time
  – ability to ramp up or down quickly
  – more daily start-up and shut down cycles
  – high turn-down ratio

• Sources of flexibility
  – Flexible thermal and hydro
  – VG, DR, and storage
  – 5 min dispatch
  – Co-optimization of energy and A/S at least cost
Transmission Capability in the US

• Major activities covered under transmission capability include
  – Planning
  – Permitting
  – Paying (cost allocation and recovery)

• Many political and regulatory jurisdictions now explicitly recognize that significant amounts of VG cannot be delivered to load without a corresponding expansion of the transmission

• This realization has been enshrined in policy through FERC Order 1000, which requires joint and coordinated transmission planning between neighboring transmission entities, transmission operators and RTOs/ISOs
Transmission Capability Examples

- ERCOT recovers costs for Competitive Renewable Energy Zone (CREZ) projects that enabled wind in west Texas to be delivered to the large load pockets in central and southeastern Texas through the load ratio share mechanism (single state with single regulator)
- $5B of new transmission in the MISO region approved through the Multi Value Project (MVP) process explicitly accounts for the public policy value of delivering renewable resources
European Energy Policy

• Energy policies in Europe are more focused than in US
• EU requirements for sustainable, economic and secure energy supplies fundamentally changing the nature of power systems
• Pan-European Internal Energy Market (IEM) is a significant effort to establish a common trading mechanism
  – to allow the 28 Member States (plus Norway and Switzerland) to make more efficient use of the existing capacity and flexibility in the system
  – to plan for grid adequacy in a coordinated fashion
• This on its own will bring large scale efficiencies
European Energy Policy cont.

• Level of consistency between EU-wide market mechanisms and country-specific policy objectives uneven
  – Security of supply and sustainability are explicitly being achieved by the use of supports for indigenous fuels and renewable sources of electricity (RES-E)
  – These distortions to the market outcome lead to market inefficiencies

• Based on EU 2050 Energy Framework, the European power system will have at least 55% of electricity from RES by 2050, of which 37% will come from variable RES-E

• Given the low variable cost of production of RES-E, this volume of generation is likely to reduce average prices in the markets
European Capacity Adequacy

• Lower energy prices appear to be good for consumers, but ... 
• Lower energy prices and increased variability could undermine the market’s ability to simultaneously incentivise RES-E growth and conventional capacity adequacy 
• Current approach to this issue is the significant use of support schemes for RES-E (with priority dispatch) and an increasing trend in Member States for Capacity Remuneration Mechanisms (CRMs) to ensure capacity adequacy for reliability purposes. 
• However, the aggregate impact of supports, priority dispatch and capacity mechanisms is increasing the cost of achieving the policy objectives and could undermine the efficacy of the energy market
Capacity Remuneration Mechanisms

• As a response to the growing concern of future generation adequacy, a variety of capacity remuneration mechanisms (CRMs) have been proposed

• Approach chosen by the different European countries is shown in next figure
  – some countries have implemented CRMs
  – some are considering doing so
  – and some are not considering CRMs
Capacity Remuneration Mechanisms in Europe

GB: Centralised capacity auction (1st auction late 2014)

IE&NI: Capacity payments since 2007

BE: Tenders for new CCGT plants -> strategic reserves

FR: Capacity obligations (since late 2014)

PT: Capacity payment for new units (reduced in 2013)

ES: Capacity payment for new and existing units (level of support reduced in 2013)

DE: Whitebook from 07/2015 aims at strategic reserves

IT: Capacity payments -> reliability options

GR: Capacity payment

LV&LT: Capacity payment since 2011

PL: Operational and strategic reserves

source: Energinet.dk
ACER’s View on CRMs

• The Agency for the Cooperation of Energy Regulators (ACER) points out the diversity in national solutions of CRMs poses severe problems
  – The challenge of insufficient capacity in the integrated European energy market should be addressed as a pan-European issue
  – The present lack of coordination is detrimental to the market integration process being pursued, and has the potential to create market distortions
  – Growing recognition that regional or European solutions are needed for CRMs and renewable support schemes, as opposed to simply national solutions

• The future of capacity adequacy and DR in Europe was addressed at recently concluded ACER annual conference
Operational Flexibility in Europe

• EU target model is critical for operational flexibility
• The purpose of the EU target model is to harmonize and integrate existing regional electricity markets in Europe so that they evolve towards a single European market, thus enabling the maximum extraction of flexibility over the largest region. This includes a common approach for:
  – calculating cross border transmission capacity
  – defining market bidding areas
  – creating efficient pan-European trading mechanisms across the four market time-frames: forward, day-ahead, intraday and balancing
Transmission Capability in Europe

• The international transmission planning takes place within the framework of the European Network of Transmission System Operators for Electricity (ENTSO-E),
• ENTSO-E was formed in 2008 and includes 41 TSOs from 34 European countries.
• Every two years, ENTSO-E issues a Ten Year Network Development Plan (TYNDP).
• The latest TYNDP calls for 50,000 km of grid corridors to be built or refurbished by 2030, which requires a total investment of about 150 billion Euros.
• Connection and transport of new renewable generation over larger distance across Europe motivates about 80% of the investment needs
Projects of Common Interest

• New EU guidelines for trans-European energy infrastructure (adopted in April 2013) support building transmission lines of regional or pan-European importance, referred to as Projects of Common Interest (PCI).

• Under the EU Projects of Common Interest approach, the criteria for PCI status include;
  – significant importance regarding cross border effects
  – significant contributions for
    • market integration
    • security of supply
    • integration of renewables
Comparison of US and EU Capacity Approaches

• Due to political sensitivities between state’s rights and federal responsibilities, resource adequacy questions have not been directly addressed at the national level in the US

• However, the PJM and ERCOT experiences indicate that multiple approaches to providing capacity adequacy will likely be followed in the US
Comparison of US and EU Capacity Approaches

• Europe has followed a variety of country-level approaches for capacity adequacy until now
• Increasing number of countries contemplating some kind of capacity compensation mechanism or capacity market in the wake of increasing renewable energy penetration
• EU also faces an urgent need for a common resource adequacy mechanism due to plans for an integrated energy market which can help absorb higher variable generation penetrations in a reliable manner.
• Failure to agree upon a common capacity mechanism will make it more difficult to integrate additional renewable energy
Comparison of US and EU Flexibility Approaches

• Europe is focused on increasing its supply of flexibility in many ways, the most important of which is rationalizing energy and ancillary service markets across borders.
• The US has done many similar things, and has relied more on market mechanisms applied to renewables than has Europe.
• One important concept that is in widespread use in the US but which has not been adopted in Europe is the use of nodal prices, or Locational Marginal Price (LMP). In the US, LMPs are very effective in sending price signals for managing network congestion in real-time operations and identifying where additional transmission investment is needed.
Comparison of US and EU Transmission Approaches

• Plans for grid adequacy are moving forward in both the US and Europe.
  – US has a federal regulator, FERC, to enforce a certain level of consistency across the many jurisdictions,
  – Europe has the EU, which has put the PCI process in place for important projects and has given the necessary cost allocation authority to ACER.

• The PCI process is similar to the concept of Multi Value Projects (MVPs) that are currently being built in the large MISO region of the US, with broad cost allocation

• The concept is also being emphasized through FERC Order 1000, which requires regional transmission planning and cost allocation that considers economic and policy benefits in addition to reliability benefits.
Capacity Conclusions

• The integration of low marginal cost renewable energy is driving numerous approaches to providing capacity adequacy in the US and Europe, including:
  – energy-only markets
  – capacity markets
  – hybrid approaches involving a regulatory capacity planning reserve margin requirement

• The US and Europe are similar in this regard, although the need to address this problem is more urgent in Europe.
Flexibility Conclusions

• Operational flexibility comes from several sources. One is in the optimization of dispatch over a larger area, as the EU is trying to do with the integrated market concept and as is happening in the US with physical and virtual consolidation of balancing areas.

• Another is the use of ramping capability in the dispatch process (and even including wind in the 5-minute dispatch as is done by several ISOs/RTOs in the US) with the use of reserves to manage more extreme events while co-optimizing energy and reserves.

• Additional measures are also in evidence, such as more stringent grid codes for improved performance and demand side participation.
A New Paradigm for Future Capacity and Flexibility Adequacy?

Revenue mix will change, but paths and values are uncertain

- Capacity markets vs. long-term contracts vs. rate-based plants…
- Ample supplies of services may lead to low values
- New sources of services and flexibility are likely

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Transmission Conclusions

• Policies for transmission build-out and cost allocation are explicitly needed for renewable integration.
  – The EU has a system in place for doing this
  – The US is moving in this direction.
• There is no single correct policy or market design or planning process.
• Many different approaches
• Much can be learned by examining the differences in approaches, understanding what works and what doesn’t, and continually searching for new and improved approaches to get the job done
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