Transmission Planning for Wind Energy: Status and Prospects

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Outline of Topics

♦ Current Transmission Situation
♦ Transmission Planning with Wind Energy
♦ Transmission Planning in the US in the Eastern Interconnection and ERCOT
♦ Transmission Planning in Spain and Portugal
♦ Cross-border and North Sea Transmission Planning In Europe
♦ High-level Transmission Policy
Current Transmission Situation

♦ Current system maintained at minimum level necessary to meet reliability criteria
♦ System is reliable, but heavily stressed
♦ System is congested for energy market purposes and inter-regional energy transfers
♦ System not designed to operate with energy markets or large energy resources like wind
♦ Results in high-cost load pockets and low-cost generation pockets, with economical energy transfers limited by transmission congestion
Evolving Transmission Situation in the US

♦ Recent studies indicate an opportunity to significantly expand the transmission system to serve both the energy markets and wind generation potential
  – MTEP 06, MTEP 08, Joint Coordinated System Plan (JCSP), DOE 20% by 2030, Texas CREZ, EWITS, WWSIS

♦ DOE 20% scenario stimulated conceptual 765 kV EHV overlay examined by AEP
  – Investment of $60 billion over next 20 years for 19,000 mi of line to deliver additional 200-400 GW
  – Current transmission investment $8 billion/yr and growing

♦ Building an inter-regional high voltage overlay to address the needs identified in recent studies is unprecedented

♦ No previous investigation or understanding established through business models, energy policy, or federal or state regulation
Total potential congestion for the Eastern Interconnection from MTEP ‘08 20% Renewable Scenario- $24B/yr in 2021 $
  - Reduction of only about half will be achievable
  - Requires high power transfer capability, low delivery cost with multiple lines self-providing for contingencies

Transmission planning must take place on a broad regional basis-
link lowest cost areas to highest priced areas

Economies of scale in transmission necessary to realize the benefits

Revenue from energy transactions pays for the cost of the line

Techniques pioneered in MISO Transmission Expansion Plan (MTEP) and JCSP (20% wind energy in Eastern Interconnection)

Techniques applied in EWITS
Full Constrained Case
Annual Load Weighted LMP

Source: MISO
Overlays for 4 Scenarios: 6 HVDC Lines in Common
Texas CREZ Transmission
Offshore grid: combining offshore wind power connection and upgrade of interconnection
Spain

- Currently 19,000 MW wind capacity
- Target 45,000 MW by 2020
  - 40,000 MW onshore
  - 5,000 MW offshore
- TSO REE has 8 billion Euros investment plan for transmission network for 2007-16
- Also required:
  - compliance with current and new grid code
  - dynamic voltage and frequency control from wind plants
- Challenges in low load situations foreseen
Planned Spanish Transmission System in 2016

- Wind power plants
- Solar power plants
Portugal

- Currently almost 4000 MW, high targets proposed
- Transmission planning for adding wind power to mostly mountainous areas
- Transmission planning elements:
  - N-1 criteria at 220 kV and below
  - N-2 criteria at 400 kV
  - transient stability studies conducted on resultant plans
- Transmission needs for wind power have been estimated in the overall Plan of Investments
RES Driven Transmission Lines: PT RNT Plan of Investments

- Transmission planning for 4,750 MW wind in 2010; 8,050 MW by 2019
- During 2006-2010, 16 % of network investments were for wind power (159 M€)
- 2009-2014 plan, 9 % of network investments for wind power (120 M€)
EU-Tradewind Results

- Increasing cross-border capacity in several corridors will enable the wind energy targets (25% in 2030)
- Large economic benefits in terms of reduced operational costs of power generation
- 42 interconnector upgrades identified (wind integration for 2030)
- Establishment of intra-day markets for cross-border trade

TradeWind Stage 1
TradeWind Stages 2 and 3
EU-EWIS Results

♦ Coupled a year-round market analysis of impact of wind with detailed representations of the networks (reliability/limitations)

♦ Pan-European modeling should be further developed and used when assessing the future developments – significant TSO effort

♦ 10 B € investment (4 €/MWh wind) required to relieve existing loop flows – but will give benefits to other market participants as well

♦ Additional cross-border reinforcements of 12 B € identified where congestion benefits > capital cost
EWIS: Cross-border Reinforcements with Strong Economic Benefits

CROSS-BORDER LINKS IDENTIFIED WITH STRONG ECONOMIC EXPANSION BENEFITS
ENHANCED NETWORK SCENARIO - OUTLOOK BEYOND 2015

It is likely that strengthening these priority cross-border interconnections will give fuel savings and CO₂ emission benefits exceeding the reinforcement capital costs.
Optimal Grid Example for North Sea Region

- Tool developed in Norwegian NOWITECH programme, accounting for wind stochasticity
- Optimising the network offshore will result in a meshed grid
High Level Transmission Policy

- Transmission is key to wind integration: aggregation benefits, electricity markets and larger balancing areas
- Critical issues which must be addressed in the US:
  - interconnection-wide transmission planning
  - interconnection-wide cost allocation for high voltage backbone transmission line costs
  - federal backstop authority for transmission line siting
- Growing consensus at the European political levels that increased transmission is essential for reaching the renewables targets
Conclusions

♦ Wind energy different from conventional sources of energy and requires different approach to transmission planning
♦ Transmission has become recognized as a key enabler to reach renewable energy goals and carbon reduction goals
♦ Policy initiatives underway at the national level in the US to:
  ♦ establish interconnection-wide transmission planning
  ♦ enable interconnection-wide transmission cost allocation
  ♦ provide federal backstop transmission line siting authority
♦ The European Commission is preparing to release later in 2010 its Energy Infrastructure Package including a first outlook on a blueprint for offshore grids in Northern Europe