

Overview of Wind Energy Grid Integration in USA

ADB Wind Energy Grid Integration Workshop

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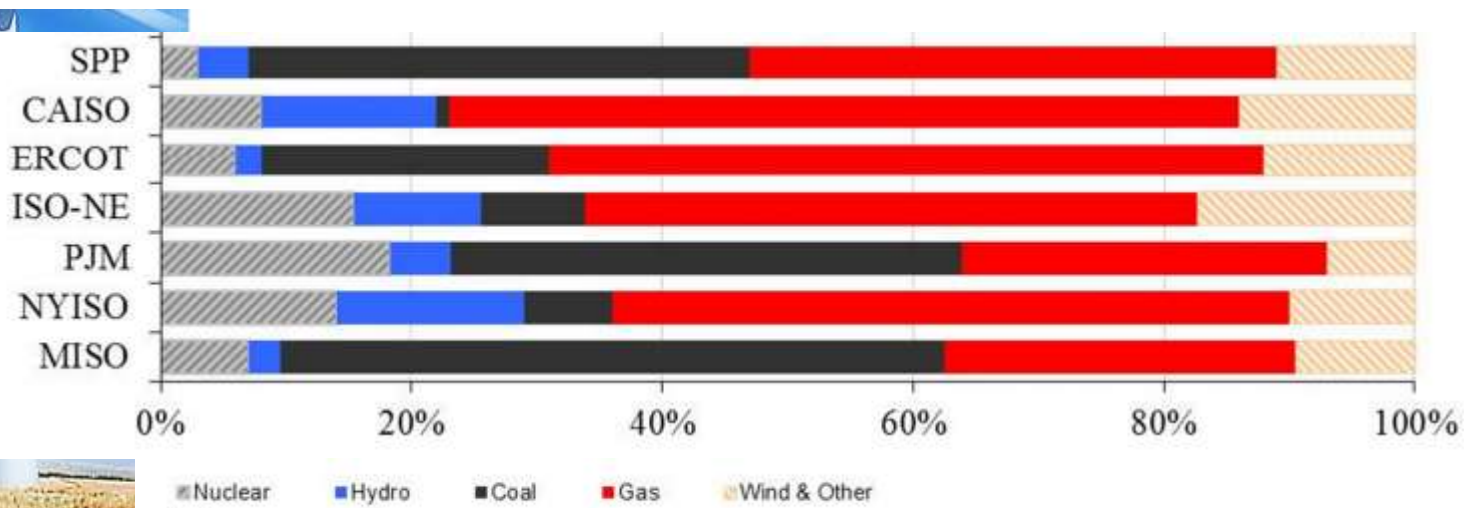
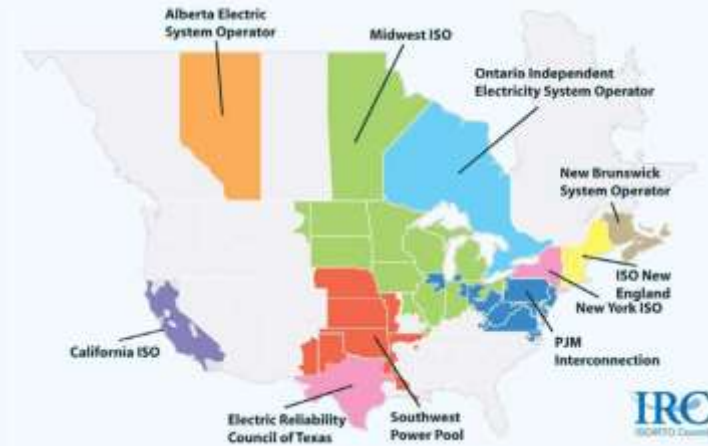
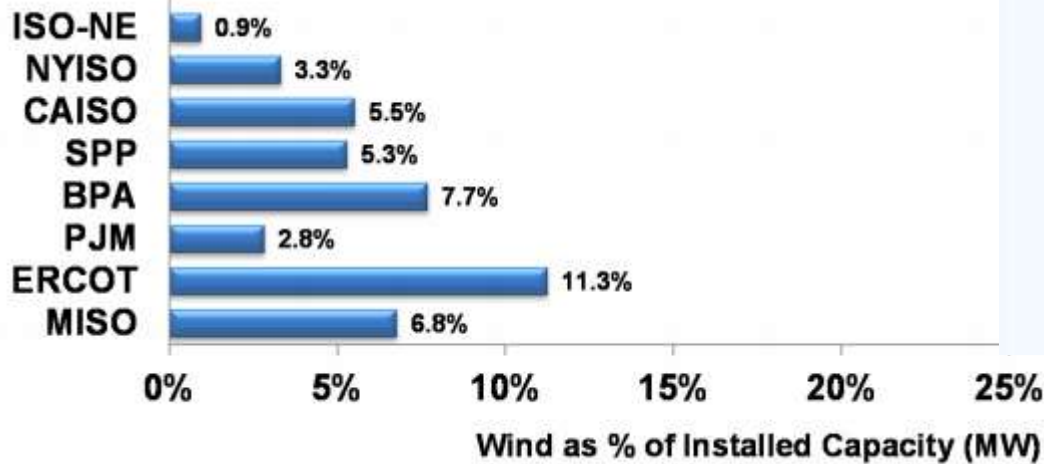
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Wind Energy Status

	Onshore	Offshore
Wind Power Potential in the Country	28,000 GW	4,000GW
Wind Power Installations (MW) as of 2012	60,000	0
Wind Power Installations (MW) by 2015	14% annual	
Wind Power Installations (MW) by 2025	6% annual	
% Wind Power in Grid as of 2012	~4%	
% Wind Power in Grid by 2015	~5%	
% Wind Power in Grid by 2030	~14%	
Tariff for wind energy (range)	\$40/MWh in 2011/12	
Incentives for wind energy	\$23/MWh, 10 yrs	
Maximum penetration of wind energy into grid (if this has been studied)	20% by 2030	

Wind Penetration & Generation Mix by Region



Total electricity demand in 2010: 3,749 TWh, annual growth rate of 0.8%

Source: Brattle Group



Grid Integration Issues

Issues	Comments
Lack of Transmission	Significant transmission has been and is being built. Fast track approvals have helped
Lack of spinning reserves	Sufficient gas-fired turbines are available as spinning reserves
Demand is low at off-peak hours	infrequent
Lack of flexibility in current generation	Gas and hydro provide flexibility
Lack of flexibility in demand	Demand response and smart grid rollouts are picking up steam

[Texas/ERCOT](#) wind curtailment has dropped from 17.1% in 2009 to 2.5% in 2012
Next highest curtailment was 2% in 2009 in MISO
You may choose to talk about different regions of country.

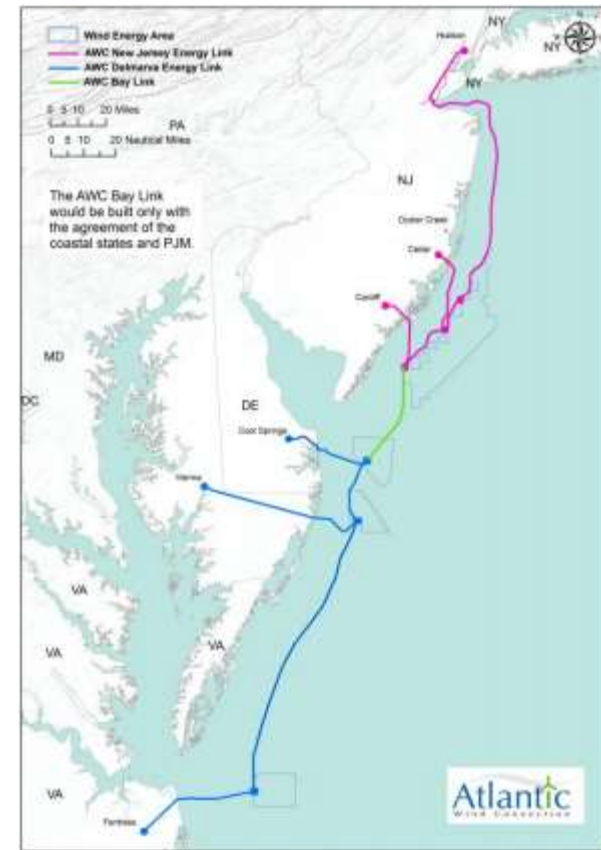
Transmission Lines to Support Wind Projects



New transmission lines, part of RRTT, total of about 50GW



Texas: 345kV lines to deliver 6GW of wind energy from West Texas to South and East Texas



6GW of grid backbone for offshore wind

<http://trackingsystem.nisc-llc.com/etrans/defaultmap.pdf>

<http://www.atlanticwindconnection.com/ferc/Jan2013/TCG-Atlantic%20Wind%20Connection%20Report%20JAN%2009.pdf>



Grid Code for Wind Energy Integration

Issues	
Active Power Control	
Fault Ride Through	✓ *
Voltage, Reactive Power control	✓ *
Power quality	
Protection	
Communication and data requirements	✓ *
Forecasting	

Federal Energy Regulatory Commission (FERC) issued grid code in 2005. It forms basis for minimum requirements. Each RTO has additional requirements.




Grid Operations/Wind Power Dispatching

Scheduling timeframe	Depends on region. Hourly scheduling in West
Curtailement of wind power	Depends on region. 2 to 2.5%
At peak supply of wind energy, which source of generation is reduced	Gas-based generators, Hydro
Is Wind Energy Forecast required?	Yes, in most RTOs
How is rapid ramping up/down of wind energy managed?	Gas-based generators
What are integration costs?	<u>For 40% of peak load penetration, various studies predict cost of \$5/MWh or less</u>

Present logic for dispatching wind: Is wind considered source with low marginal cost?





Solutions to Increased Wind Energy Penetration in US

- Revising rules in both the operations and planning horizons, by changing the way to procure and price services/products
- Increasing balancing area coordination
- Improving interconnection and transmission planning processes

Source: Judy Chang, Brattle Group

