Transmission: Energy without Borders

Cost Support for the Right Solutions…

National Energy Policy Institute

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American Electric Power

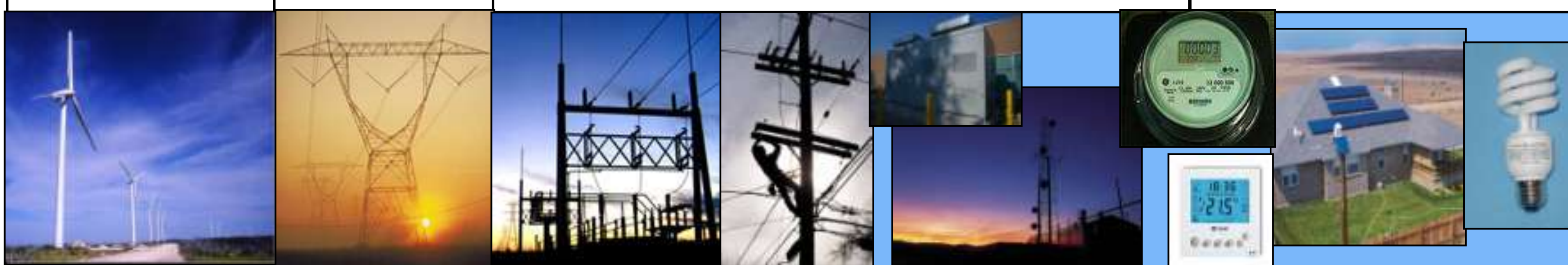
AEP AMERICAN ELECTRIC POWER

American Electric Power

Strength & scale in assets & operations

- ❖5.1 million customers in 11 states.
- ❖Largest Transmission Owner in the US with 2,100 miles 765kV

Asset	Size	Industry Rank
Domestic Generation	~38,400 MW	#2
Transmission	~39,000 miles	#1
Distribution	~208,000 miles	#1



Generation	Transmission	Distribution	Customers

• Environmental Projects
• Wind
• IGCC
• Carbon Capture & Storage
	• I-765™
	• Electric Transmission Texas JV
	• Electric Transmission America JV
	• AEP-ABB Alliance
		• Distribution automation
		• Self-healing distribution circuits
		• Advanced metering
		• Communications infrastructure
		• Mobile workforce
		• Internal energy efficiency
		• Integration platform for advanced visualization and analytics
		• Distributed generation and energy storage
			• Customer programs and incentives
			  • Energy efficiency
			  • Direct load control
			  • Peak demand reduction
			• Energy storage

Existing generation and transmission control systems	**gridSMART**℠: bridging the gap to provide integrated two-way communications & control across the electricity value chain	Home energy automation

Today's Challenges….

UNITED STATES*

Population

303 Million

Square Miles

3,119,884 sq mi

Peak Load

782 GW**

Annual Energy Consumption

3,890 billion kWh

Wind Connected

25,105 MW installed

49 TWh produced

Wind Capacity Potential***

300 GW

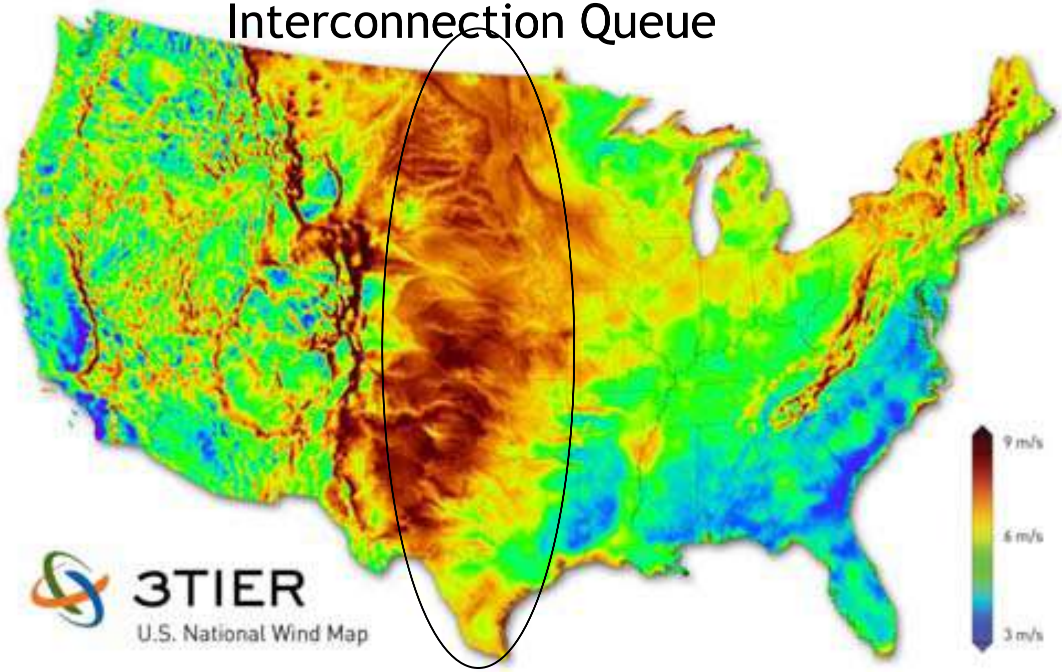
5.8 billion MWh by 2020 (20% Scenario)

**Contiguous US*

***Non-Coincident*

****Based on feasibility studies*

47% of Nation's Generation Interconnection Queue



GERMANY

Population

82 Million

Square Miles

137,847 sq mi

Peak Load

80 GW

Annual Energy Consumption

550 billion kWh

Wind Connected

23,903 MW installed

39.5 TWh produced

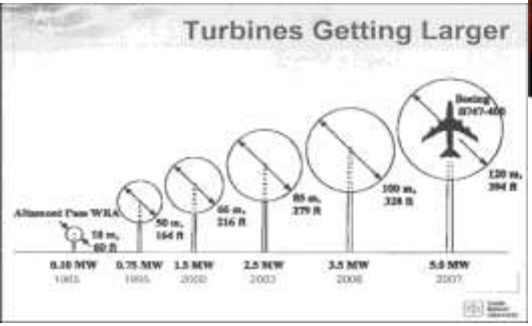
Wind Capacity***

55 GW

150 TWh by 2020 (25% Scenario)

"Change is the law of life. And those who look only to the past or present are certain to miss the future." *John Fitzgerald Kennedy*

Today's Challenges….



Why change now?

- ❑ Generation profile is shifting and will continue to shift dramatically:
  - New large scale renewables need to be interconnected that are today largely electrically isolated
  - Environmental requirements may require retirement of large fossil units, potentially at a magnitude never before faced in this country
- ❑ Generation needs to be <u>deliverable</u> to load not simply interconnected. Attention must be focused on the robustness of the grid.
- ❑ The search for a "bright line" between reliability and economic projects is increasingly artificial.

What needs to change?

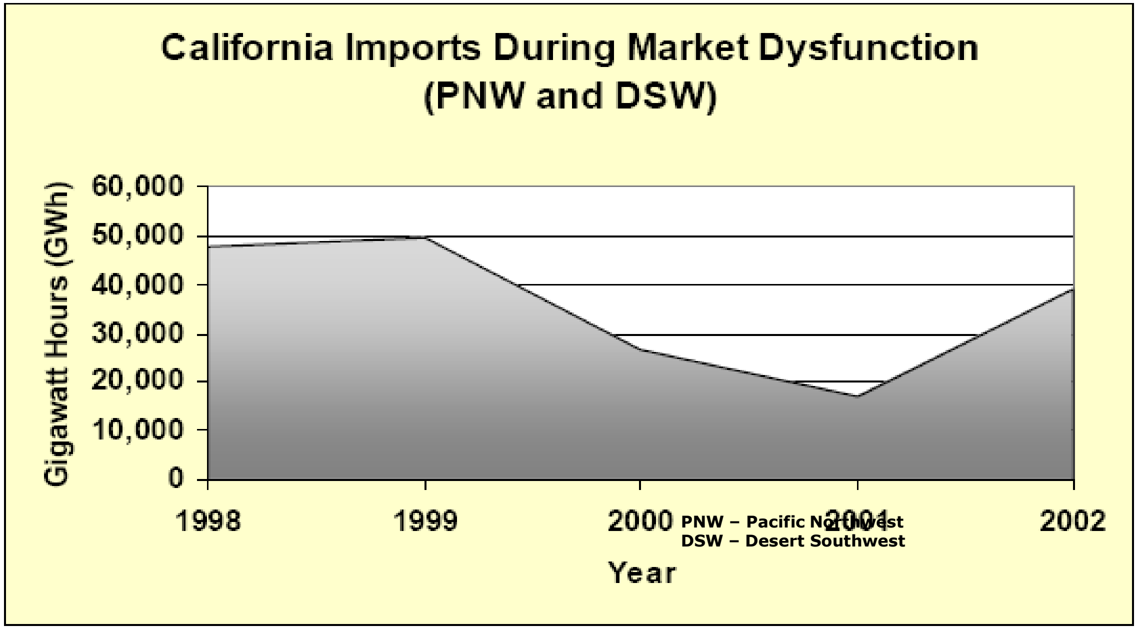
- ❑ A new energy supply paradigm requires a different type of transmission planning to enable greater capacity and flexibility.
- ❑ Cost allocation principles must be broadened to encompass this strategic new build.
- ❑ Siting processes which are aligned with state, regional and national energy policy objectives.

Changing the Way we *Plan*….

- ❑ Evolution in EHV Transmission planning: to advance a "System-Based" approach to planning.
- ❑ Transmission grid should be adaptable to address:
  - policy driven goals to interconnect and ensure deliverability of renewables
  - enable the retirement of aging and expensive resources
  - regional availability of the resources and other changing operational requirements of the grid.
- ❑ EHV planning is needed both "within and between" traditional planning regions
  - Consistent planning criteria to be applied to EHV transmission
  - Focus between regions to be as important as transmission within regions

A strategically planned EHV grid can provide the required transmission capacity and operating flexibility while drawing on diverse resources that will insulate consumers from resource shortages and catastrophic events.

Cost of Failure: Historical Perspective



Source: CERTS

California Energy Crisis

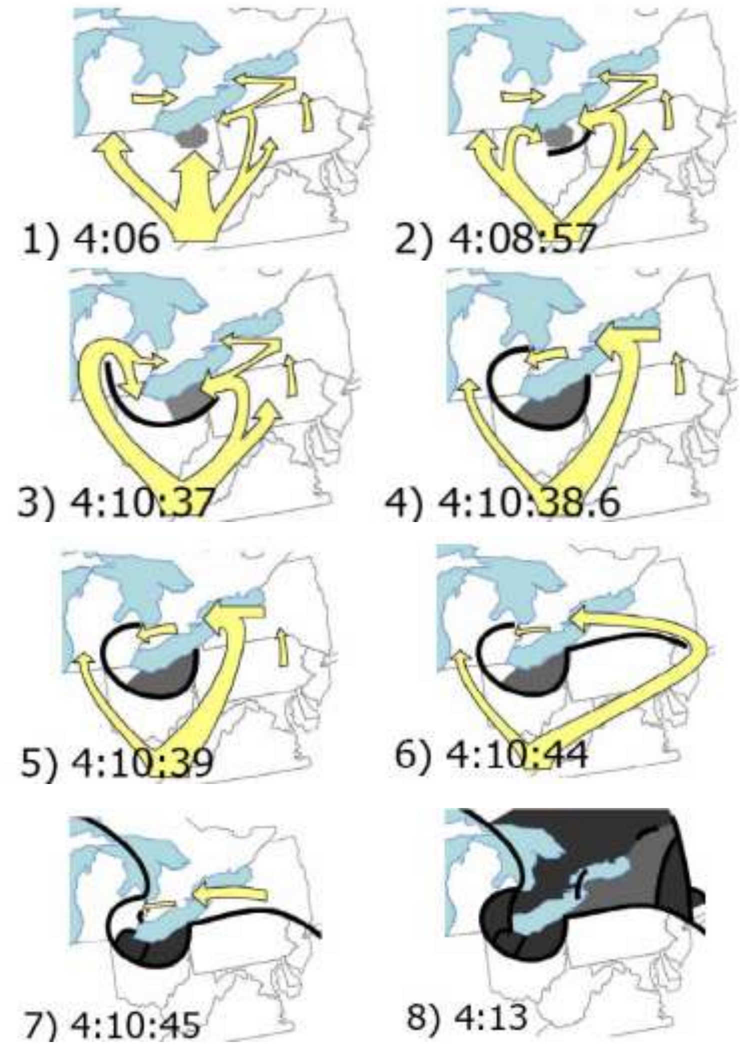
- Situation: Reduced availability of hydro generation out of the northwest, shift in generation flows and generation sources.
- Catalyst: Transmission system designed for specific power flow patterns.
- Result: Emergency conditions that resulted in rotating blackouts, major congestions and high generation costs.

Cost of Failure: Historical Perspective

<u>August 2003 Blackout</u>

- <u>Situation</u>: A local problem and resulting overloads on the broader grid began an unstoppable cascade.
- <u>Catalyst</u>: Transmission system was not robust enough to sustain the drastic change in power flow patterns.
- <u>Result</u>: 50 million people were left in the dark within minutes. Unaffected was the PJM 500 and 765 systems, which are better able to absorb voltage and current swings.

Cascade Sequence Summary
August 14, 2003



Source: NERC

Changing the way we *Support Transmission*…

- RTOs need to ensure their systems are robust, efficient and capable of meeting their long term energy needs
- We should plan our EHV system and support the cost of it in a manner that – encourages:
  - regional flexibility,
  - inter-regional compatibility
  - inter-regional efficiency and use
  - regional and inter-regional cost support.
- “Beneficiary based” models which consider a line by line cost benefit analysis for EHV are not in keeping with today’s needs to build and support a robust backbone grid and results in failing to capture the full system benefits afforded by such facilities. If this approach is followed, it will result in a narrow and prescriptive approach to transmission planning and development; delay EHV development; increase congestion; adversely effect system reliability and unduly increase ROW consumption.
- We have seen that broad based regional cost allocation methodologies have resulted in projects that provide regional benefits.
- Similarly, interconnection wide cost allocation can result in a system that provides inter-regional benefits.

EHV Solutions: Striking the Right Balance

Maintaining a commitment to designing and building safe, reliable systems in balance with the impact on the environment is critical.

Right: Appearance of darkened steel tower and low visibility line route > >

< < Left: Post construction view of Right of Way after reseeding; allowance made for habitats and certain tree species in other rights-of-way

Siting transmission projects has not gotten easier over the years and is not likely to get any easier into the future. We need to minimize our footprint while maximizing the benefits to the system.

EHV Solutions: Striking the Right Balance

Description	Line Voltage (kV)			
	765	500	345	345
Circuits per Tower	1	1	1	2
Conductors per Phase	6	3	2	2
Surge Impedance Loading (SIL) in MW	**2400**	910	400	800
No. Lines Required for 2400 MW Capacity	**1**	3	6	3
ROW per line (ft)	200	200	150	150
Total ROW (ft)	**200**	600	900	450
ROW utilization factor	**100%**	38%	22%	44%
Typical Height (ft)	130+	120+	110+	150+
Cost/Mile ($MM) for 2400 MW capacity	**2.6**	6.9	6.6	4.5
Outage rate (per 100mi-yr)	**1.0%**	1.4%	1.6%	1.6%
"Reach" in mi (@1500 MW w/o compensation)	**550**	140	50	110
Combined Loss @ SIL/100 mi	**0.41%**	1.28%	4.32%	1.18%

* Cost in 2007 $US, based on average terrain.

** SIL is a relative capacity measure, thermal capacity is over 4000 MW for 765 kV and over 2000 MW for 500 kV.

Striking the right balance….

- Transmission development rests on:
  - Transmission Planning; a robust grid is critical to ensuring the system that is flexible and adaptable to changes in our generation fleet and consumption
  - Cost allocation: Broad regional and inter-regional cost support
  - Siting: Effiicent use of ROW's
- Transmission is three things:
  - Critical to virtually every energy policy goal – national and state
  - Critical to well-functioning markets and system reliability.
  - A very small part of the customer bill and inherently tied to the delivered cost of energy!

Recognizing the value of transmission to the "system" and its effect on the delivered cost of energy is essential. The cost of insufficient transmission can have a devastating impact on the economy.