The Rise and Fall of Big Transmission

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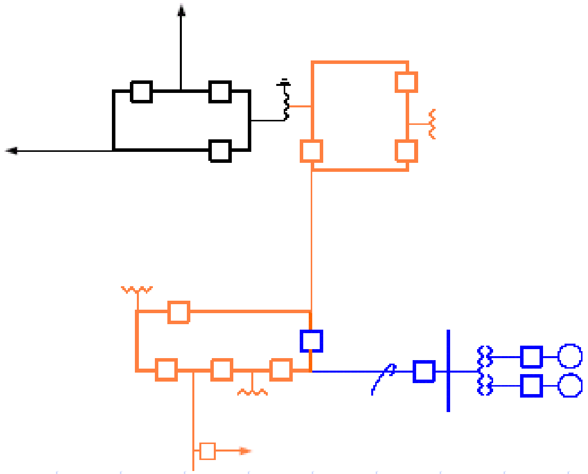
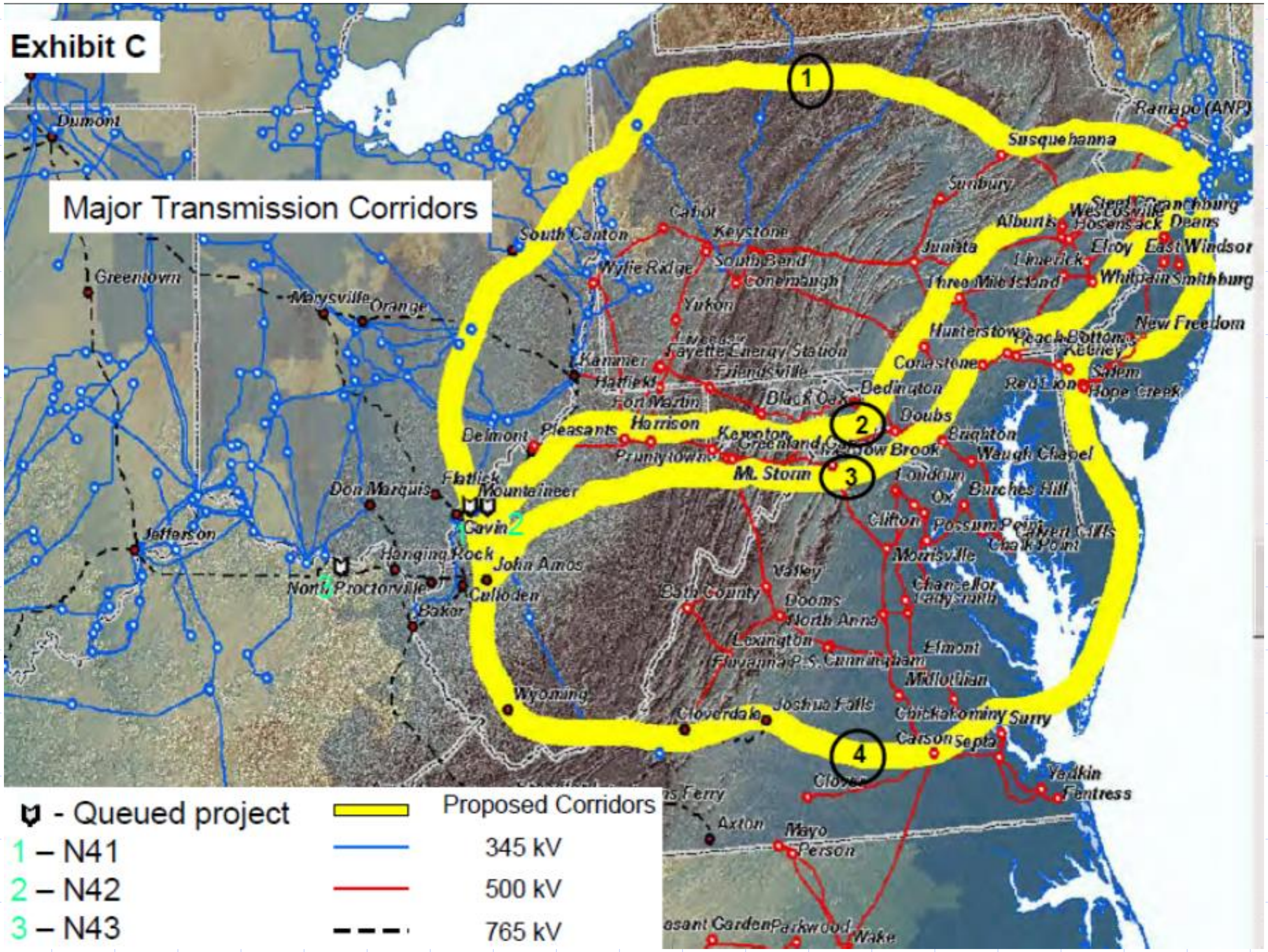


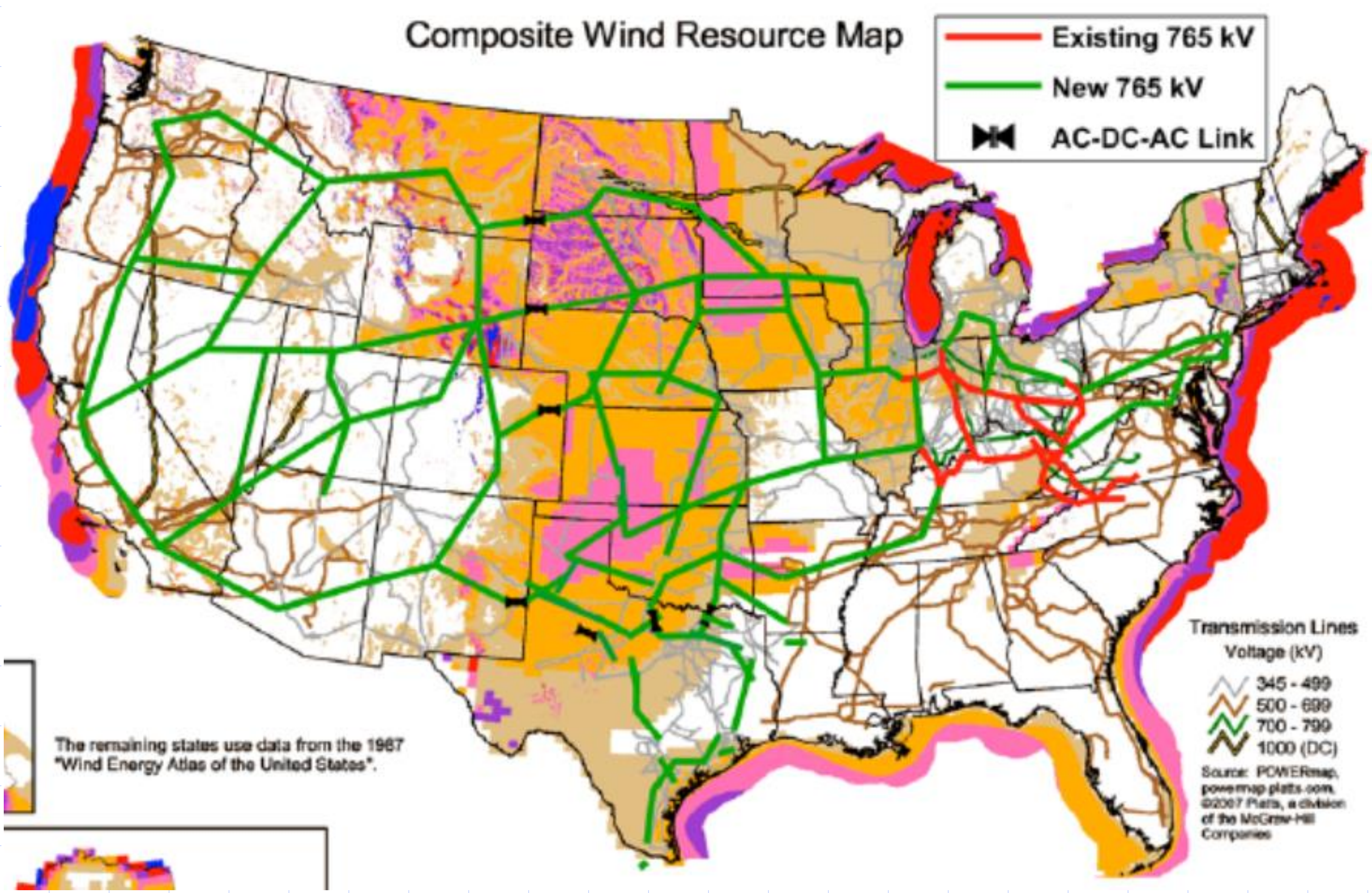
Key Points

- None of the Big Transmission projects proposed over the last 10 years have been or are likely to be built.
- None of them *should* be built.
- The Clean Power Plan, like past supposed drivers of Big Transmission, doesn’t change the first two points.
- We should stay the course with incremental transmission expansions.

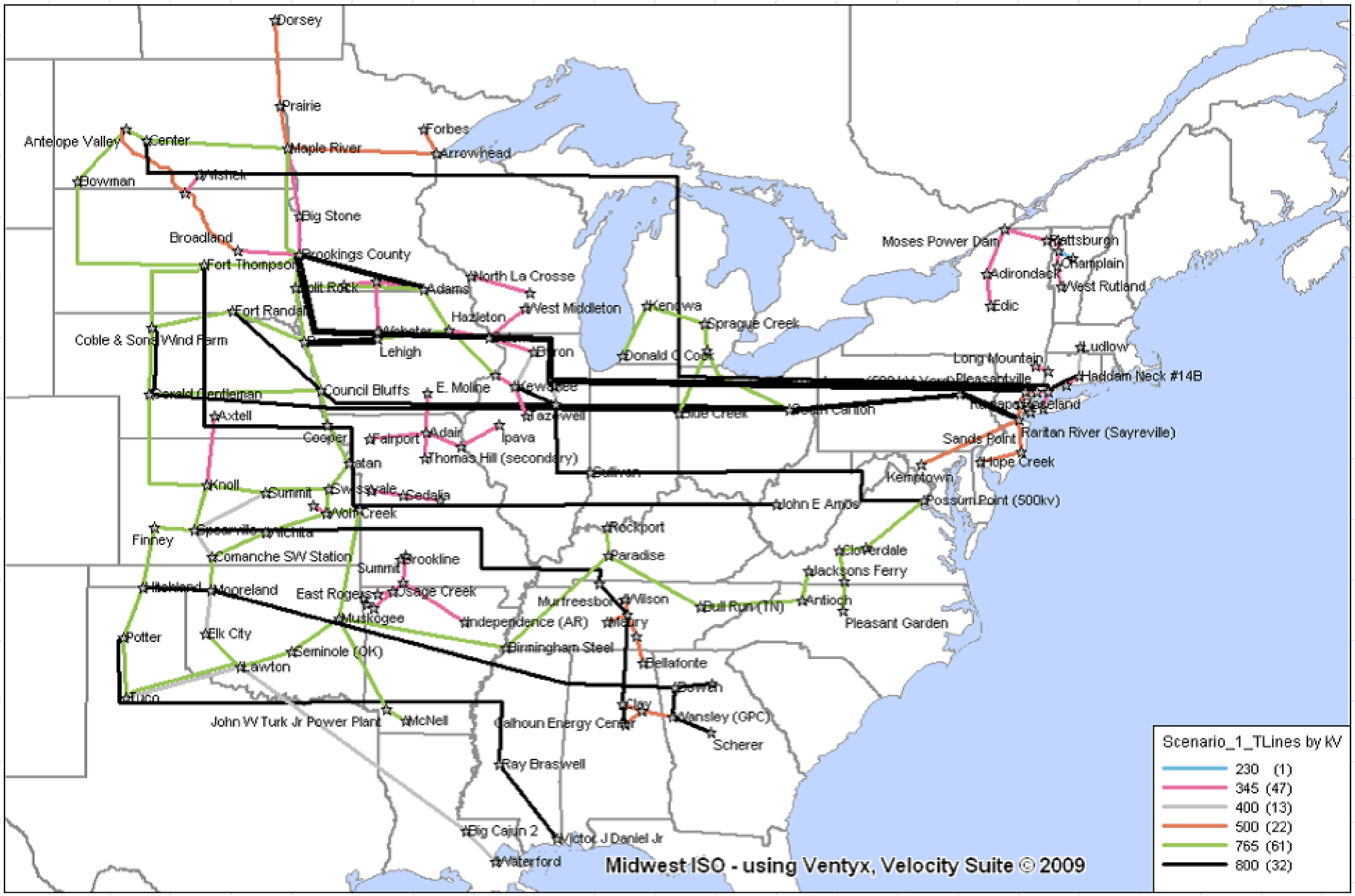
PJM Kicked Things Off in 2005



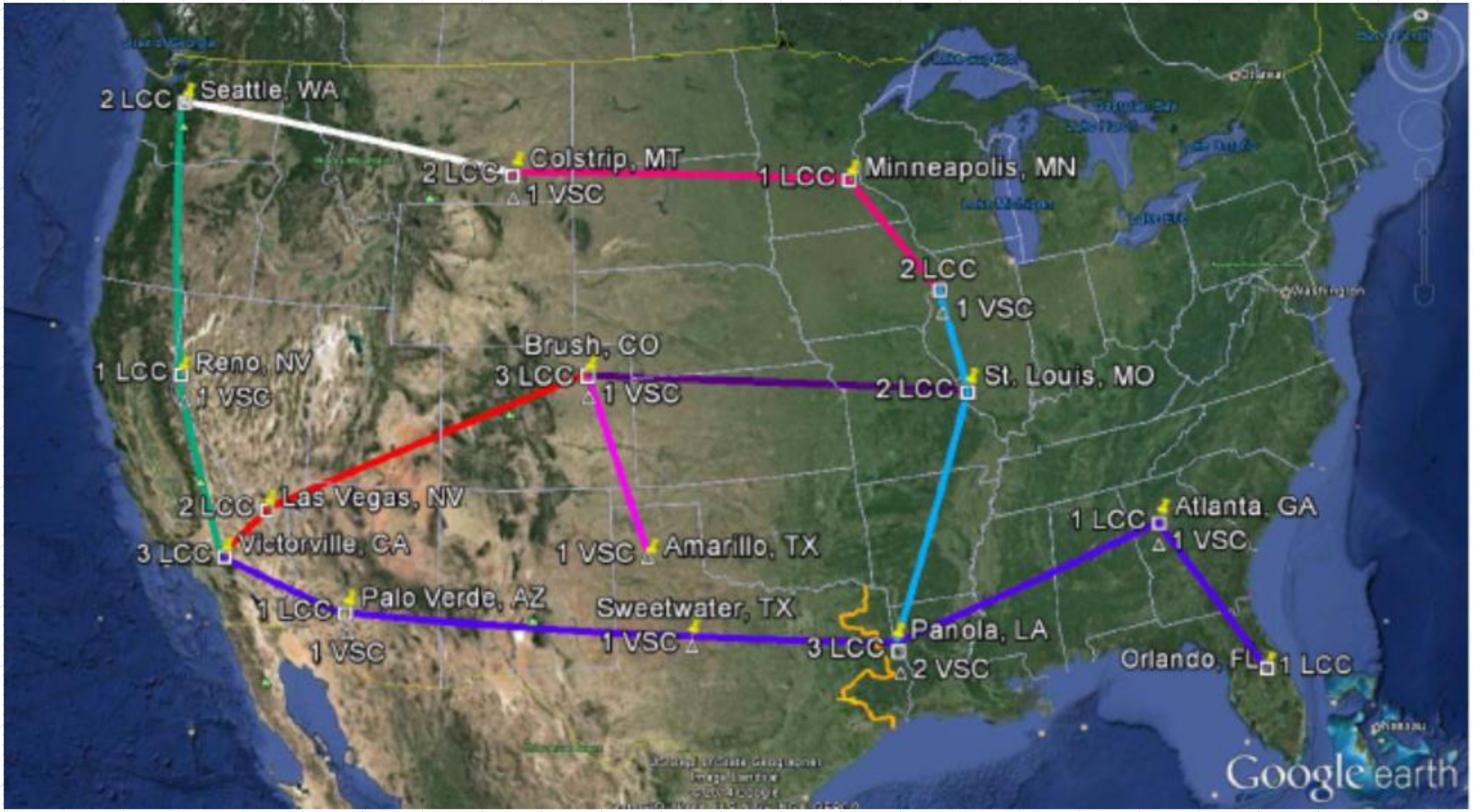
FERC Gets On Board in 2008



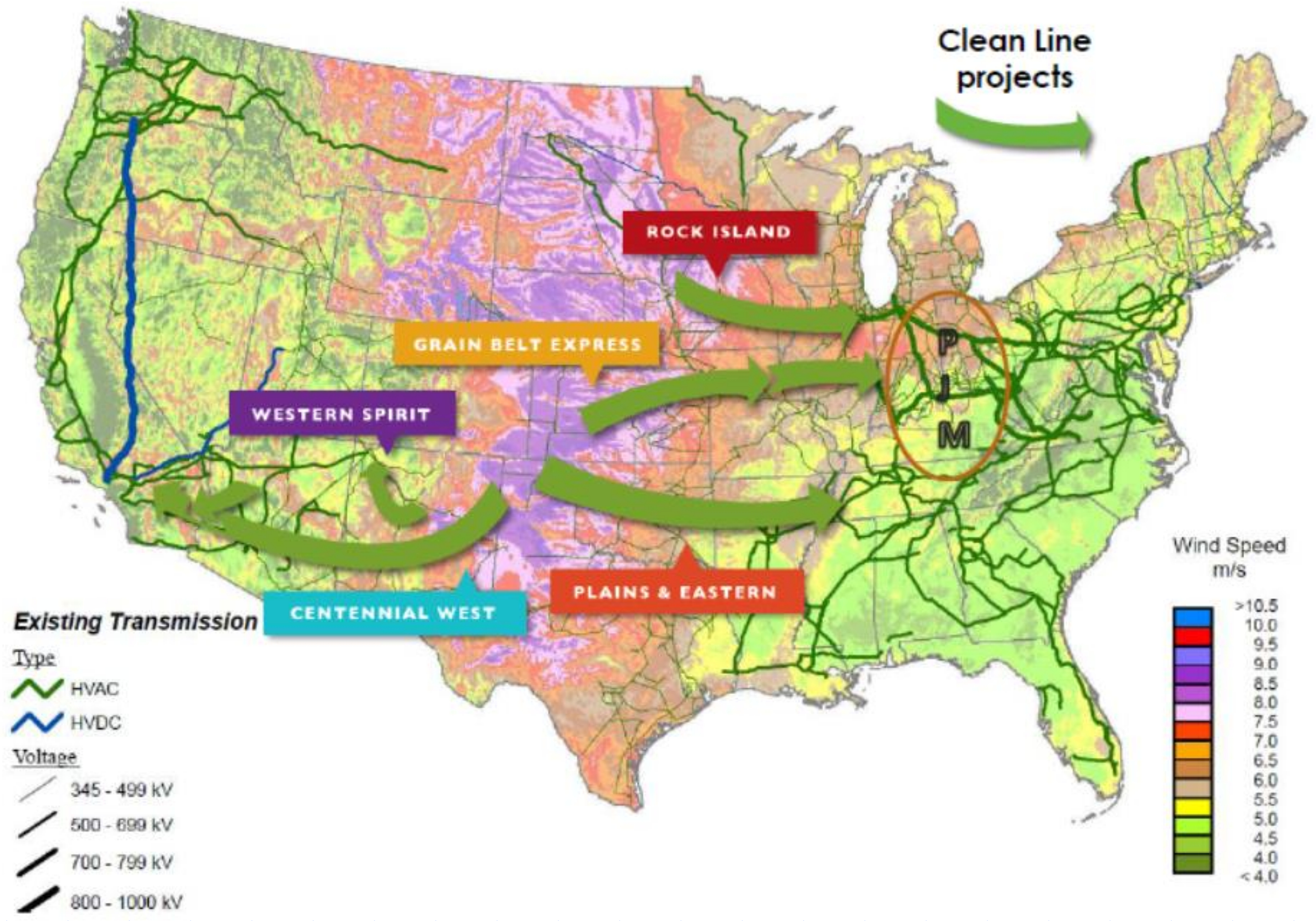
MISO in 2009: Go East



MISO in 2014: Go West and South



Clean Line: Go East and West



Atlantic Wind: Go Way East

Downsize? Drop Wind?

The Fall

- Ten years after PJM announced Project Mountaineer and many followed, no Big Transmission project has been built, has begun construction, or has been approved to be built in the future.
- Meanwhile PJM has approved $25.6 billion in new transmission, MISO $20.2 billion, and Southwest Power Pool $8.8 billion.
- But not a dollar for Big Transmission.

Not a Tragedy.

- Big Transmission has never made sense.
- Six major reasons:

  1) the laws of physics,

  2) more reliability risk,

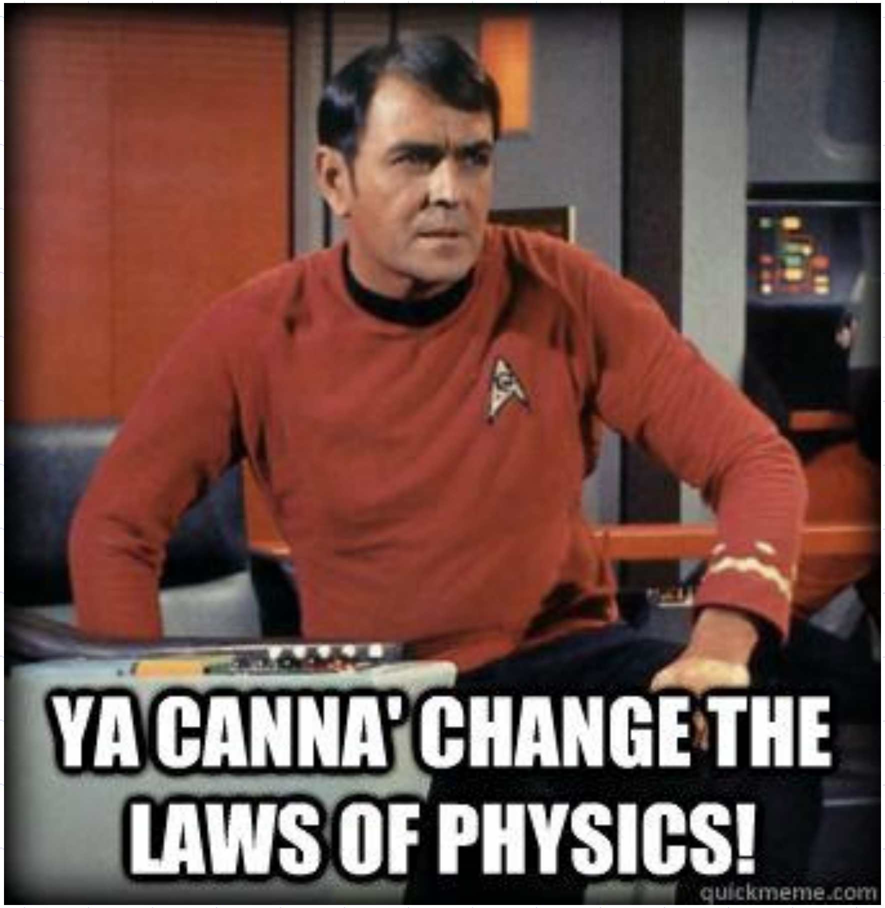
  3) contingency limits on operations,

  4) lumpiness and investment risk,

  5) rigidity of source and sink, and

  6) better alternatives emerge.

The Laws of Physics



Implications of Physics

- Electricity flows as an electromagnetic wave (not electrons) in all possible paths (disproportionately in the paths of lesser resistance) – not from A to B in a single path.
- Thus it is generally so that the most efficient way to "move" more electricity a long distance from A to B is to reinforce the existing network with incremental upgrades, not to build a new transmission line from A to B.

More Reliability Risk

- Electricity is dispatched across transmission lines when economic to do so.
- Big Transmission often would have a price difference between A and B.
- Big Transmission is inherently a Big Target for adverse weather (by far the biggest single cause of transmission outages).
- The grid would be relying on an inherently more vulnerable transmission line.

More Operating Limits

- The grid must be able to survive the loss of any single element (“contingency”) without overloading other elements.
- Big Transmission, by virtue of its size relative to the other transmission lines it is interconnected with, poses a large overload potential for interconnected lines.
- This can mean limits on operation below otherwise full utilization.

Lumpiness and Investment Risk

- Big Transmission entails big and lumpy cost, going from 0% to 100% in-service overnight.
- If reliability-based, reliability criteria must be met up to the day before Big Transmission goes in service, so on the in-service date the system is inherently overbuilt.
- If market-based, the project must match up generators, purchasers and investors with a level of commitment (to the exclusion of alternatives) for many years. Tough sell.

Rigidity of Source and Sink

- Big Transmission is inherently rigid in source and sink.
- Reinforcements may be required at both of these points, at significant additional cost.
- Problem is particularly acute with DC transmission because each AC-DC converter station can cost hundreds of millions of dollars, making it prohibitively expensive to locate substations along the route (in addition to the ones at each end).

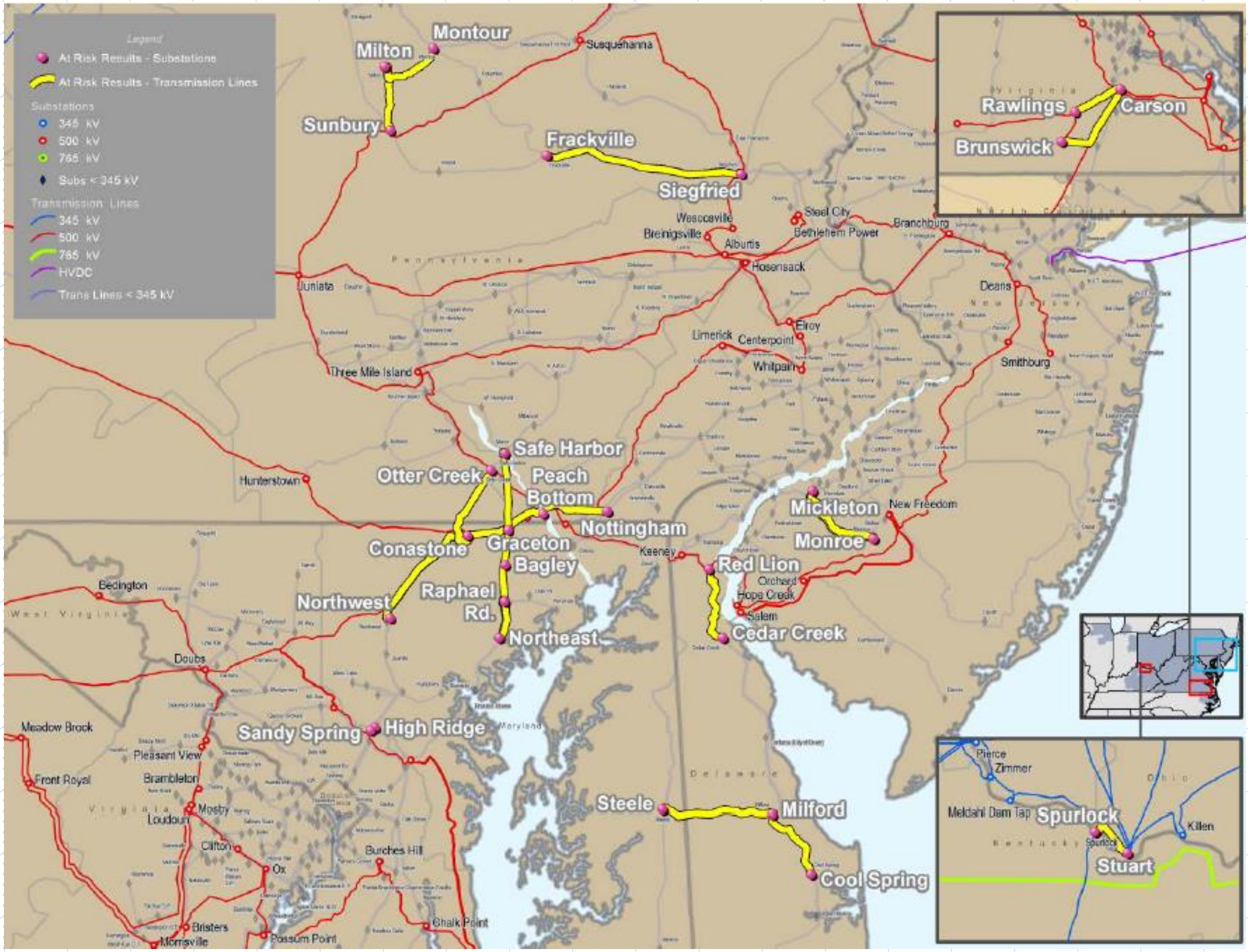
Better Alternatives Emerge

- Transmission planning is much more robust.
  - Pressure and transparency of RTO stakeholder process.
  - Increased competition among sophisticated transmission providers.
- Tens of billions in incremental expansion have bested Big Transmission.
- PJM example: Mt. Storm-Doubs rebuild.
- SPP example: Build out for wind resources.

Clean Power Plan a Game-Changer?

- Brattle: "Transmission planning processes are adequate due to the significant build out expected regardless of CPP standards."
- CPP Final Rule: "The potential range of new transmission construction is within historical investment magnitudes. … Incremental grid infrastructure needs can be minimized by repurposing existing transmission resources."
- PJM shows small transmission need under worst-case generation retirement of 32 GW.

PJM Reliability Need for CPP Is Small.



Conclusions

- Big Transmission has not been, and should not be, built.
- Past supposed drivers of Big Transmission have not materialized.
- The Clean Power Plan is no exception.
- The electric industry, under FERC oversight and prodding, continues to improve with incremental transmission expansions that make sense.

And ....

Mandatory Reliability Standards

- Mandatory reliability standards for Bulk Power System imposed by Energy Policy Act of 2005 in wake of Northeast Blackout of 2003.
- Standards developed and enforced by North American Electric Reliability Corporation ("NERC") under FERC oversight.
- Little attention on efficacy and value, raising questions about whether resources are being used efficiently and most important reliability threats are being addressed.

NERC Metrics Inconclusive

- Only one metric identified by NERC as showing "significant improvement":

Table 4.2: Metric Trends		
Metric	**Description**	**Trend Rating**
M-2 (ALR1-4)	BPS Transmission-Related Events Resulting in Loss of Load (modified in early 2014)	●
M-3 (ALR1-5)	System Voltage Performance (discontinued in 2014)	N/A
M-4 (ALR1-12)	Interconnection Frequency Response	◑*
M-5 (ALR2-3)	Activation of Underfrequency Load Shedding (discontinued in 2014)	N/A
M-6 (ALR2-4)	Average Percent Non-Recovery Disturbance Control Standard Events	◑*
M-7 (ALR2-5)	Disturbance Control Events Greater than Most Severe Single Contingency	◑
M-8 (ALR3-5)	Interconnected Reliability Operating Limit/System Operating Limit (IROL/SOL) Exceedances (modified in 2013)	◑*
M-9 (ALR4-1)	Correct Protection System Operations	◑
M-10 (ALR6-1)	Transmission Constraint Mitigation	◑**
M-11(ALR6-2)	Energy Emergency Alerts (modified in 2013)	◕
M-12 (ALR6-11)	Automatic AC Transmission Outages Initiated by Failed Protection System Equipment (modified in late 2014)	◑**
M-13 (ALR6-12)	Automatic AC Transmission Outages Initiated by Human Error (modified in late 2014)	◑**
M-14 (ALR6-13)	Automatic AC Transmission Outages Initiated by Failed AC Substation Equipment (modified in late 2014)	◑**
M-15 (ALR6-14)	Automatic AC Transmission Outages Initiated by Failed AC Circuit Equipment (modified in late 2014)	◑**
M-16 (ALR6-15)	Element Availability Percentage (APC) and Unavailability Percentage (modified in 2013)	◑**

No Clear Trend in Transmission Events

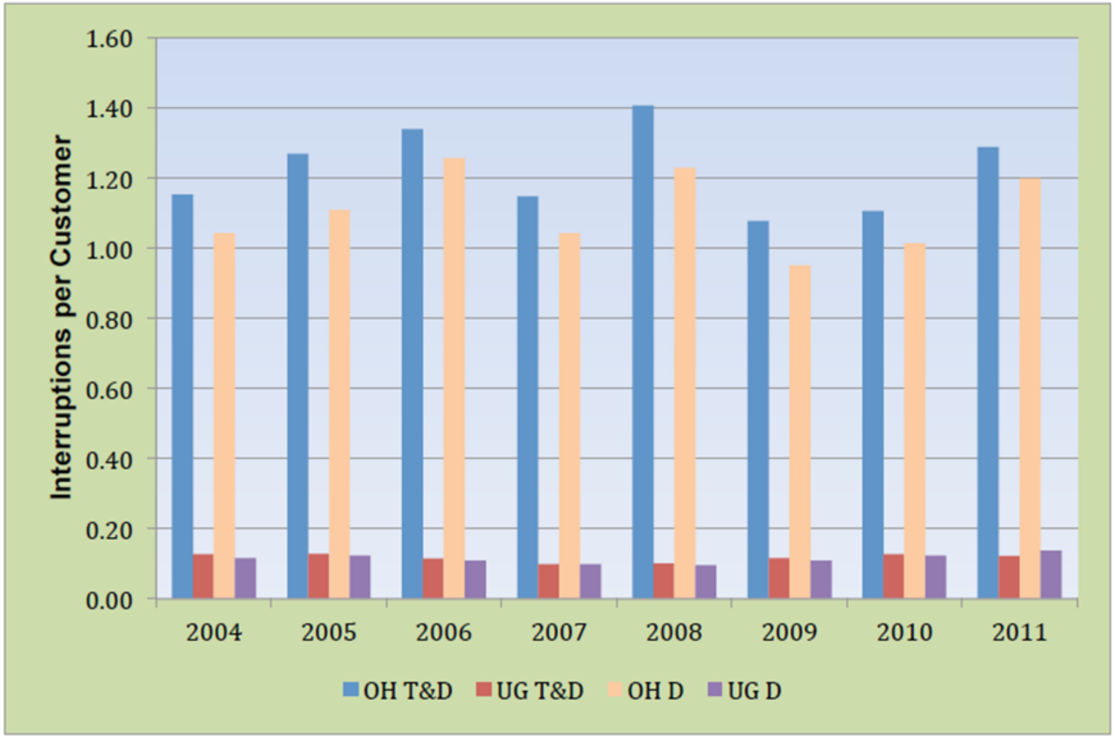
- Data also show vast majority of transmission events are beyond control of standards.

Table 3.1: TADS Outage Events by ICC (2009–2013)					
Initiating Cause Code	**2009**	**2010**	**2011**	**2012**	**2013**
Lightning	789	741	822	852	814
Unknown	673	821	782	710	712
Weather Excluding Lightning	534	673	539	446	434
Human Error	291	305	291	307	280
Failed AC Circuit Equipment	257	277	306	261	248
Failed AC Substation Equipment	266	238	289	248	192
Failed Protection System Equipment	229	234	234	226	188
Foreign Interference	199	173	170	170	181
Contamination	96	145	132	160	152
Power System Condition	112	74	121	77	109
Fire	92	84	63	106	130
Other	107	84	91	104	64
Vegetation	29	27	44	43	36
Vandalism, Terrorism, or Malicious Acts	4	6	5	10	9
Environmental	5	11	5	4	8
Failed AC/DC Terminal Equipment	1	2	0	0	0
All TADS Events	**3705**	**3917**	**3934**	**3753**	**3557**

And Distribution Outages Dominant

- Vast bulk of all service interruptions arise on the distribution -- not transmission -- system.

Figure 3.3 System Average Interruption Frequency Index



Shortcomings

- Standard development and compliance have not focused on cost-benefit analysis.
- No estimated value of avoided load loss for standards overall, or for individual standards.
- NERC's "Cost Effective Analysis Process" assumes a standard is needed.
- Resources devoted to standards of limited value may detract from critical risks like cyber.
- Comprehensive, independent study overdue.

Thank You!

- Full articles in *Fortnightly* on Big Transmission and on mandatory reliability standards are available by request, huntoon@energy-counsel.com.

- Comments? Questions?