Transmission Has A Critical Role in Clean Power Plan Compliance (and Operating in Other Futures)

PRESENTED TO:
WestConnect PMC Meeting

PRESENTED BY:
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Wednesday, January 20, 2016
Agenda

Fundamentals of the Clean Power Plan

How CPP Affects Transmission Development

Challenge: Planning Under Uncertainties

Solution: Scenario-Based Planning While Considering Costs and Risks of Inadequate Planning
Final Clean Power Plan

**Who:** Existing Generation Units (EGUs) considered affected units under the 111(d) applicability criteria are grouped into two categories:
- *Steam Units:* Coal and oil/gas-fired steam turbine units
- *NGCCs:* Natural gas-fired combined cycle units
- *Not Included:* Combustion turbine units

**When:**
- *Thursday! January 21, 2016:* End of comment period on Federal Implementation Plan and Clean Energy Incentive Program
- *Sept 6, 2016:* Initial submission of State Implementation Plan (SIP), necessary to request extension to 2018
- *Sept 6, 2018:* Final submission of SIP
- *2022 – 2029:* Annual EGU standards, with three interim compliance periods
- *2030 and beyond:* Final EGU standard
GHG Emission Rate Standards in the Final Rule

Rate reductions are phased-in from 2012 Baseline to 2030 goals. The largest reductions in the West are targeted in MT and WY. Next group includes CO, NM, UT, WA and AZ).
Similar pattern to reductions required under Mass-Based Standards

[Bar chart showing emissions reductions for different states, with bars divided into sections indicating emissions reductions from 2012 to 2022, 2022 to 2030, and the 2030 emissions standard.]
CPP-Mandated Emissions Reductions

- States that are most affected by the rule will likely look to lowest cost approach for compliance.
- CPP does not address transmission directly and the requirements themselves do not drive transmission.

However, transmission investments are needed due to:
- Additional need and cost competitiveness of renewable generation
- Carbon pricing will increase desirability of renewable energy
- Reliability needs associated with coal plant retirements
- Likely regional market formation
EPA Projection of CPP Impacts

Compared to the Eastern Interconnection, EPA’s estimated generation retirements for the West is limited.

- But many states are likely to need additional renewable energy resources to comply, particularly CA.

<table>
<thead>
<tr>
<th>Source: FPA CPP Rate-Based Modeling Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Year</td>
</tr>
<tr>
<td>CPP (Rate)</td>
</tr>
<tr>
<td>CPP (Mass)</td>
</tr>
</tbody>
</table>

Cumulative Retirements through 2030 by EGU Type and Region

- CT
- NGCC
- Coal
- Other
Incorporating Clean Power Plan Analyses in Utility Planning

- States would likely choose to comply using the mass-based emissions targets (except for states that have very favorable rate-based standards).
- Trading across states will likely be considered by most.
- Compliance will likely be equivalent to adding an emissions cost (in $/ton) to fossil generation, which will likely increase wholesale electricity prices and fuel switch away from coal generation.
- Thus, most utilities affected by the rule will be assessing the future resource mix in the relevant regions under different future emission costs.
  - This will also require estimating how the coal generation fleet in the relevant region would evolve over the next 20 years.
- Providing access to most cost-effective renewable generation will require transmission investments.
- Important to remember:
  - Transmission is not a “single usage” asset; it is always “multi-value.”
  - Transmission to create lower-cost options and as insurance to avoid risk of high cost outcomes.
Main Drivers for Transmission

- **Serve growing load**
- **Load diversity:** reduce overall reserve margins and generating capacity needed to ensure resource adequacy
- **Congestion relief/production cost savings:** reduce congestion and increase access to lowest-cost generation to reduce fuel costs and wholesale energy prices
- **Access to low-cost renewables:** access to regions with low-cost wind, solar, geothermal, and hydro resources
- **Renewable energy and fuel diversity:** diversify short and long-term variability of wind, solar, and hydro generation; diversify fuel mix and cost variances within and across uncertain futures
- **Increasingly stringent environmental regulations:** increase regional “boundaries” to reduce the cost of environmental compliance in a range of possible futures
Renewable Resource Potential

- Potential for and quality of renewable energy resources vary by region.
- Lowest-cost onshore wind resources are on the edge with Eastern Interconnection and Texas. These resources have a 10-15% capacity factor advantage relative to the rest of the country, which translates to more than $20/MWh reduction in the cost of wind generation.
- Southwest has a tremendous amount of solar resources.
- Some western states have the highest potential for geothermal.
- There is also significant opportunity to increase import from Canadian hydropower.

Source: NREL
Some uncertainties remain about how CPP will be implemented.

- How emissions will be reduced physically: renewables, EE, coal-to-gas switching
- Each state seems to be focused internally first

Coal retirements or coal-to-gas switching likely will be only a modest driver for regional transmission needs and even less of a driver for interregional need

Most significant (though uncertain) driver for transmission will be the extent to which low-cost renewable resources are relied upon for emission reduction

- A national (vs. regional/local) compliance approach, higher gas prices, carbon prices, and PTC/ITC will have significant impact on the economics of renewables

Transmission continues to face the “chicken-or-egg” challenge

- Facilitating low-cost renewable development will require new transmission
- But without the renewable development occurring, existing transmission planning processes will not identify transmission needs

To overcome this challenge, planning must anticipate future uncertainties and planners must inform regulators and policy makers
Key Barriers to More Effective Grid Planning

Three key barriers to identifying and developing the most valuable transmission infrastructure investments:

- Planners and policy makers do not consider the full range of benefits that transmission investments can provide and thus understate the expected value of such projects.

- Planners and policy makers do not account for the high costs and risks of an insufficiently robust and insufficiently flexible transmission infrastructure on electricity consumers and the risk-mitigation value of transmission investments to reduce costs under potential future stresses.

- Interregional planning processes are ineffective and are generally unable to identify valuable transmission investments that would benefit two or more regions.

- Additional challenges related to regional cost recovery and state-by-state permitting processes.
The Need for More Effective Grid Planning

If not addressed, barriers to effective regional and interregional transmission planning will lead to:

- **Lost opportunities to identify and select infrastructure solutions** that are lower-cost or/and higher-value in the long term than the (mostly reliability-driven) projects proposed by planners.

- **An insufficiently robust and flexible grid that exposes customers** and other market participants to higher costs and higher risk of price spikes.

Higher cost of delivered electricity and meeting long-term public policy goals.
### “Checklist” of Transmission Benefits

<table>
<thead>
<tr>
<th>Benefit Category</th>
<th>Transmission Benefit (see 2013 WIRES paper)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traditional Production Cost Savings</strong></td>
<td>Production cost savings as currently estimated in most planning processes</td>
</tr>
<tr>
<td>1. Additional Production Cost Savings</td>
<td></td>
</tr>
<tr>
<td>a. Impact of generation outages and A/S unit designations</td>
<td></td>
</tr>
<tr>
<td>b. Reduced transmission energy losses</td>
<td></td>
</tr>
<tr>
<td>c. Reduced congestion due to transmission outages</td>
<td></td>
</tr>
<tr>
<td>d. Mitigation of extreme events and system contingencies</td>
<td></td>
</tr>
<tr>
<td>e. Mitigation of weather and load uncertainty</td>
<td></td>
</tr>
<tr>
<td>f. Reduced cost due to imperfect foresight of real-time system conditions</td>
<td></td>
</tr>
<tr>
<td>g. Reduced cost of cycling power plants</td>
<td></td>
</tr>
<tr>
<td>h. Reduced amounts and costs of operating reserves and other ancillary services</td>
<td></td>
</tr>
<tr>
<td>i. Mitigation of reliability-must-run (RMR) conditions</td>
<td></td>
</tr>
<tr>
<td>j. More realistic “Day 1” market representation</td>
<td></td>
</tr>
<tr>
<td>2. Reliability and Resource Adequacy Benefits</td>
<td></td>
</tr>
<tr>
<td>a. Avoided/deferred reliability projects</td>
<td></td>
</tr>
<tr>
<td>b. Reduced loss of load probability or c. reduced planning reserve margin</td>
<td></td>
</tr>
<tr>
<td>3. Generation Capacity Cost Savings</td>
<td></td>
</tr>
<tr>
<td>a. Capacity cost benefits from reduced peak energy losses</td>
<td></td>
</tr>
<tr>
<td>b. Deferred generation capacity investments</td>
<td></td>
</tr>
<tr>
<td>d. Access to lower-cost generation resources</td>
<td></td>
</tr>
<tr>
<td>4. Market Benefits</td>
<td></td>
</tr>
<tr>
<td>a. Increased competition</td>
<td></td>
</tr>
<tr>
<td>b. Increased market liquidity</td>
<td></td>
</tr>
<tr>
<td>5. Environmental Benefits</td>
<td></td>
</tr>
<tr>
<td>a. Reduced emissions of air pollutants</td>
<td></td>
</tr>
<tr>
<td>b. Improved utilization of transmission corridors</td>
<td></td>
</tr>
<tr>
<td>6. Public Policy Benefits</td>
<td>Reduced cost of meeting public policy goals</td>
</tr>
<tr>
<td>7. Employment and Economic Stimulus Benefits</td>
<td>Increased employment and economic activity; Increased tax revenues</td>
</tr>
<tr>
<td>8. Other Project-Specific Benefits</td>
<td>Examples: storm hardening, fuel diversity, flexibility, reducing the cost of future transmission needs, wheeling revenues, HVDC operational benefits</td>
</tr>
</tbody>
</table>
Considering All Transmission Benefits is Important

Estimated Annual Base-Case Benefits and Costs of CA Palo Verde-Devers 2 Line

With current economic transmission planning approaches the project is rejected

Adding other savings significantly increases overall benefits

- Competitiveness
- Reduced Emissions/Losses
- Operational
- Generation
- Production Cost

Annual Benefits (millions/yr)

Production Cost Savings - Base Case

$0

$20

$40

$60

$80

$100

$120

All Savings - Base Case

$71 Million
Ineffective Inter-Regional Transmission Planning

Divergent criteria result in “least-common-denominator” planning approaches create significant barriers for transmission between regions

- Experience in the East already shows that very few (if any) interregional projects will be found to be cost effective under this approach
- Multiple threshold tests create additional hurdles

Planning processes need to be improved to avoid this “least common denominator” outcome by evaluating interregional projects based on their combined benefits across all regions
Ineffective “Compartmentalized” Planning

Experience from the Eastern RTOs shows that most planning processes compartmentalize needs into “reliability,” “market efficiency,” “public policy,” and “multi-value” projects – which in turn fails to identify valuable projects.

- Compartmentalizing creates additional barriers at the interregional level by limiting projects to be of the same type in neighboring regions (see MISO-PJM example).
- It eliminates many projects from consideration simply because they don’t fit into the existing planning “buckets.”

<table>
<thead>
<tr>
<th>Project Type in RTO-1</th>
<th>Projects Considered in MISO-PJM Planning: (as Ordered by FERC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>Yes no no no</td>
</tr>
<tr>
<td>Market Efficiency</td>
<td>no Yes no no</td>
</tr>
<tr>
<td>Public Policy</td>
<td>no no Yes no</td>
</tr>
<tr>
<td>Multi Value</td>
<td>no no no no</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project Type in RTO-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability</td>
</tr>
<tr>
<td>Market Efficiency</td>
</tr>
<tr>
<td>Public Policy</td>
</tr>
<tr>
<td>Multi-Value</td>
</tr>
</tbody>
</table>
Inadequate Transmission Imposes High Risks

Most transmission planning efforts do not adequately account for short- and long-term risks and uncertainties affecting power markets

- Economic transmission planning generally evaluates only “normal” system conditions and typically ignores the high cost of short-term challenges and extreme market conditions triggered by weather, outages, fuel supply disruption, unexpected load growth

- Planning does not adequately consider the full range of long-term scenarios and does not capture the extent to which a less robust and flexible transmission infrastructure will foreclose lowest-cost options

Costs of inadequate infrastructure typically are not quantified but, under some circumstances, can be much greater than the costs of the transmission investments
Transmission Can Mitigate Very High-Cost Outcomes, Particularly if Future is Uncertain

Range of Projected Societal Benefits of the PVD2 Project and Probabilities that Total Benefits Exceed Certain Values
Scenario-Based Transmission Planning

1. Identifying Future Trends, Drivers and Uncertainties
   – Industry experts from within and outside of the power industry develop views on a range of future trends, drivers, and uncertainties

2. Developing Future Scenarios
   – Develop future scenarios based on the trends, drivers and uncertainties identified
   – Ensure that each scenario is internally consistent and captures a sufficiently wide range of future states of the world

3. Transforming Future Scenarios into Planning Assumptions
   – Translate the qualitative descriptions of the future scenarios to specific assumptions that are used in transmission planning

4. Simulate the Grid under each Future Scenario
   – Develop power flows for each future scenario
   – Compare the size and timing transmission needs across scenarios
## Example: ERCOT Long-Term System Assessment

### Table 3.1: 2014 LTSA Key Drivers Developed by ERCOT Stakeholders

<table>
<thead>
<tr>
<th>Key Drivers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Conditions</td>
<td>U.S. and Texas economy; regional and state-wide population, oil &amp; gas, and industrial growth; Liquefied Natural Gas (LNG) export terminals; urban/suburban shifts; financial market conditions; and business</td>
</tr>
<tr>
<td>Environmental Regulations and Energy Policy</td>
<td>Environment and justice, (e.g., 316(b)), renewable mandates</td>
</tr>
<tr>
<td>Alternative Generation Resources</td>
<td>Capital costs and capacity (DG) cost of new generation options</td>
</tr>
<tr>
<td>Natural Gas and Oil Prices</td>
<td>Gas price and LNG export prices as spread affect demand</td>
</tr>
<tr>
<td>Transmission Regulation and Policies</td>
<td>New policy and regulatory changes</td>
</tr>
<tr>
<td>Generation Resource Adequacy Standards</td>
<td>Economic flexibility and capacity</td>
</tr>
<tr>
<td>End-Use/New Markets</td>
<td>End-use demand increase</td>
</tr>
<tr>
<td>Weather and Water Conditions</td>
<td>May affect technological and economic weather patterns</td>
</tr>
</tbody>
</table>

### Table 3.2: 2014 LTSA Scenarios Developed by Stakeholders

<table>
<thead>
<tr>
<th>Candidate Scenarios</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current Trends</strong></td>
<td>Trajectory of what we know today (e.g., LNG export terminals and West Texas growth, prolonged high oil prices)</td>
</tr>
<tr>
<td><strong>Global Recession</strong></td>
<td>Significant reduction in economic activities in the U.S. and abroad</td>
</tr>
<tr>
<td><strong>High Economic Growth</strong></td>
<td>Significant population and economic growth from all sectors of the economy (affecting residential, commercial, and industrial load)</td>
</tr>
<tr>
<td><strong>High Efficiency/High DG/Changing Load Shape</strong></td>
<td>Reduced net demand growth due to increase in distributed solar, cogeneration and higher building and efficiency standards</td>
</tr>
<tr>
<td><strong>High Natural Gas Prices</strong></td>
<td>High domestic gas prices</td>
</tr>
<tr>
<td><strong>Stringent Environmental Regulation/Solar Mandate</strong></td>
<td>On top of current regulations, the Environmental Protection Agency (EPA) also regulates GHG emissions. Federal or higher Texas renewable standards. More stringent water regulations. Texas legislative mandate on utility-scale and distributed solar development.</td>
</tr>
<tr>
<td><strong>High LNG Exports</strong></td>
<td>Significant additional construction of liquefied natural gas (LNG) terminals (beyond Current Trends)</td>
</tr>
<tr>
<td><strong>High System Resiliency</strong></td>
<td>Severe climate and system events leading to more stringent reliability and system planning standards</td>
</tr>
<tr>
<td><strong>Water Stress</strong></td>
<td>Low water availability</td>
</tr>
<tr>
<td><strong>Low Global Oil Prices</strong></td>
<td>Sustained low oil prices</td>
</tr>
</tbody>
</table>
Interpretation and Uses of the Scenario-Based Transmission Planning

- Future scenarios are used to **evaluate the potential future transmission needs** (including location, size and timing).
- A scenario **does not represent a deterministic future** that will occur. Instead, together the **scenarios cover the range of plausible futures**.
- Some planners are inclined to assign “probabilities” to each future scenario, inevitably assigning “Current Trends” the highest probability because it is developed **with “known and knowable facts” today**.
- Best to not assign probabilities, instead, **carry all scenarios to market simulations** and evaluate the transmission projects needed under all scenarios.
- Assess if certain projects
  1. Are needed in multiple/most scenarios;
  2. Mitigate the risk of very high cost outcomes;
  3. Are better long-term solutions than smaller-scale projects that only address the most immediate needs.
- Scenario-based transmission planning can also help **evaluate the types of public policies** that transmission planners may want to support.
Final Word

- Clean Power Plan is only one of many futures where transmission solutions can help regions to comply with regulation in a cost effective manner.
- Ultimately, all transmission investments are multi-purpose and multi-value.
- Much work is needed in considering:
  - The full value of transmission when considering a cleaner power sector in the future.
  - The risk (and regret) of high-cost outcome in a range of uncertain futures.
- Policy makers need to focus more on the higher cost of delivered power if transmission investments are not made.
- Scenario-based planning can help planners, policy makers, and other stakeholders develop lower-cost and more robust long-term solutions.
- Transmission takes time to develop, so improved planning has to start now.
Additional Slides from San Diego Conference
Additional Renewables Need to Meet CPP

- We estimate $25-40 billion of transmission is still needed nationwide to accommodate ramp-up of existing state RPS requirements.
- EPA estimates about 85 GW of new wind/renewables to meet CPP needs, implying almost $50 billion of likely additional transmission needs.
- With alternative assumptions, 110 GW of new wind generation and $60 billion of transmission could be needed to achieve the CPP’s emission rate reductions.

Estimated U.S. Transmission Investment Driven by Renewables and CPP

<table>
<thead>
<tr>
<th>Estimated Wind Capacity</th>
<th>Ramp up of Existing State RPS</th>
<th>EPA Estimate w/ CPP</th>
<th>Brattle Estimate w/ CPP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Wind Capacity</td>
<td>GW</td>
<td>50-70</td>
<td>85</td>
</tr>
<tr>
<td>Regional Transmission</td>
<td>$billion</td>
<td>20-33</td>
<td>40</td>
</tr>
<tr>
<td>Interconnection related</td>
<td>$billion</td>
<td>5-7</td>
<td>9</td>
</tr>
<tr>
<td>Total Transmission</td>
<td>$billion</td>
<td>25-40</td>
<td>50</td>
</tr>
</tbody>
</table>

Sources and Notes:
Brattle Estimate with the CPP assumes 50% of required emission rate reduction achieved through added wind generation.
Transmission Investments Driven by Coal Retirements: Likely Relatively Modest

- 60-70 GW of coal retirements have been projected even without EPA’s CPP
- EPA estimates 100-110 GW of total coal retirements due to CPP by 2030
- PJM’s “local upgrades” approach spent only $2.4 billion for 14 GW of coal retirements
- U.S. transmission needs driven by coal retirements based on PJM experience
  - $10 billion without CPP
  - $20 billion with CPP
- A more forward-looking regional, interregional, or multi-value approach would likely be more cost-effective in the long run.

Estimated Transmission Needs Driven by Coal Retirements through 2030

<table>
<thead>
<tr>
<th>EPA Projected Coal Retirements (GW)</th>
<th>Potential Transmission Investment ($ billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Case (w/o CPP)</td>
<td>60</td>
</tr>
<tr>
<td>Under the CPP</td>
<td>130</td>
</tr>
</tbody>
</table>
Broader Picture: Transmission’s Role in Addressing Major Energy Policy Challenges

- How does the region or the country **decarbonize**?
  - Aggressive targets for the next 2 decades – actions need to begin now.
- Do we need to agree on the **“optimal” mix** of supply and demand-side resources? If so, how?
- How to **work together to plan regional and inter-regional infrastructure**?

**• Transmission Provides Answers to a Significant Portion of the Questions**

- To reliably gather and deliver new clean energy resources, transmission will be needed.
- Transmission provides significant **additional value**:
  - Opens and expands future supply and demand-side choices
  - Mitigates the impact of extreme weather events
  - Reduces cost of generation
  - Reduces cost of integrating renewable energy
  - Reliability and sustainability
Illustrative Example: Transmission Can Mitigate Very High-Cost Outcomes if Future is Uncertain

Range of Projected Societal Benefits of PVD2 Project Compared to Project Costs
Ms. Judy Chang is an energy economist and policy expert with a background in electrical engineering and 20 years of experience in advising energy companies and project developers with regulatory and financial issues. Ms. Chang has submitted expert testimonies to the U.S. Federal Energy Regulatory Commission, U.S. state and Canadian provincial regulatory authorities on topics related to transmission access, power market designs and associated contract issues. She also has authored numerous reports and articles detailing the economic issues associated with system planning, including comparing the costs and benefits of transmission. In addition, she assists clients in comprehensive organizational strategic planning, asset valuation, finance, and regulatory policies.

Ms. Chang has presented at a variety of industry conferences and has advised international and multilateral agencies on the valuation of renewable energy investments. She holds a BSc. in Electrical Engineering from University of California, Davis, and Masters in Public Policy from Harvard Kennedy School, is a member of the Board of Directors of The Brattle Group, and the founding Director of New England Women in Energy and the Environment.

Note:
The views expressed in this presentation are strictly those of the presenter and do not necessarily state or reflect the views of The Brattle Group, Inc.
Johannes (Hannes) Pfeifenberger is an economist with a background in power engineering and over 20 years of experience in the areas of public utility economics and finance. He has published widely, assisted clients and stakeholder groups in the formulation of business and regulatory strategy, and submitted expert testimony to the U.S. Congress, courts, state and federal regulatory agencies, and in arbitration proceedings.

Hannes has extensive experience in the economic analyses of wholesale power markets and transmission systems. His recent experience includes reviews of RTO capacity market and resource adequacy designs, testimony in contract disputes, and the analysis of transmission benefits, cost allocation, and rate design. He has performed market assessments, market design reviews, asset valuations, and cost-benefit studies for investor-owned utilities, independent system operators, transmission companies, regulatory agencies, public power companies, and generators across North America.

Hannes received an M.A. in Economics and Finance from Brandeis University and an M.S. in Power Engineering and Energy Economics from the University of Technology in Vienna, Austria.
Additional Reading

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The Brattle Group provides consulting and expert testimony in economics, finance, and regulation to corporations, law firms, and governmental agencies around the world.

We combine in-depth industry experience, rigorous analyses, and principled techniques to help clients answer complex economic and financial questions in litigation and regulation, develop strategies for changing markets, and make critical business decisions.

Our services to the electric power industry include:

- Climate Change Policy and Planning
- Cost of Capital & Regulatory Finance
- Demand Forecasting & Weather Normalization
- Demand Response & Energy Efficiency
- Electricity Market Modeling
- Energy Asset Valuation & Risk Management
- Energy Contract Litigation
- Environmental Compliance
- Fuel & Power Procurement
- Incentive Regulation
- Market Design & Competitive Analysis
- Mergers & Acquisitions
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- Regulatory Strategy & Litigation Support
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- Resource Planning
- Retail Access & Restructuring
- Strategic Planning
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