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

THE Brattle GROUP

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:

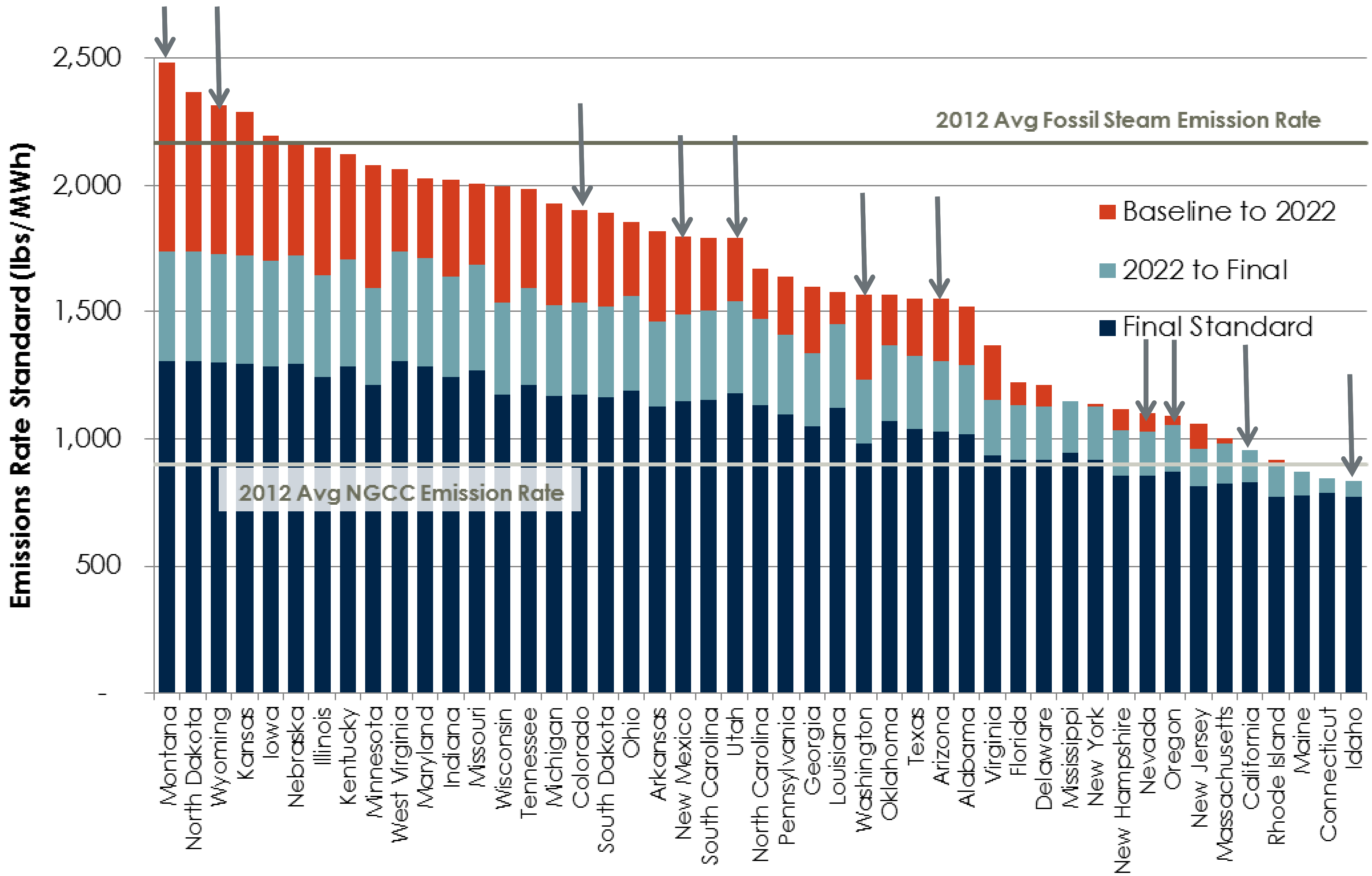
- *Steam Units*: Coal and oil/gas-fired steam turbine units
- *NGCCs*: Natural gas-fired combined cycle units
- Not Included: Combustion turbine units

When:

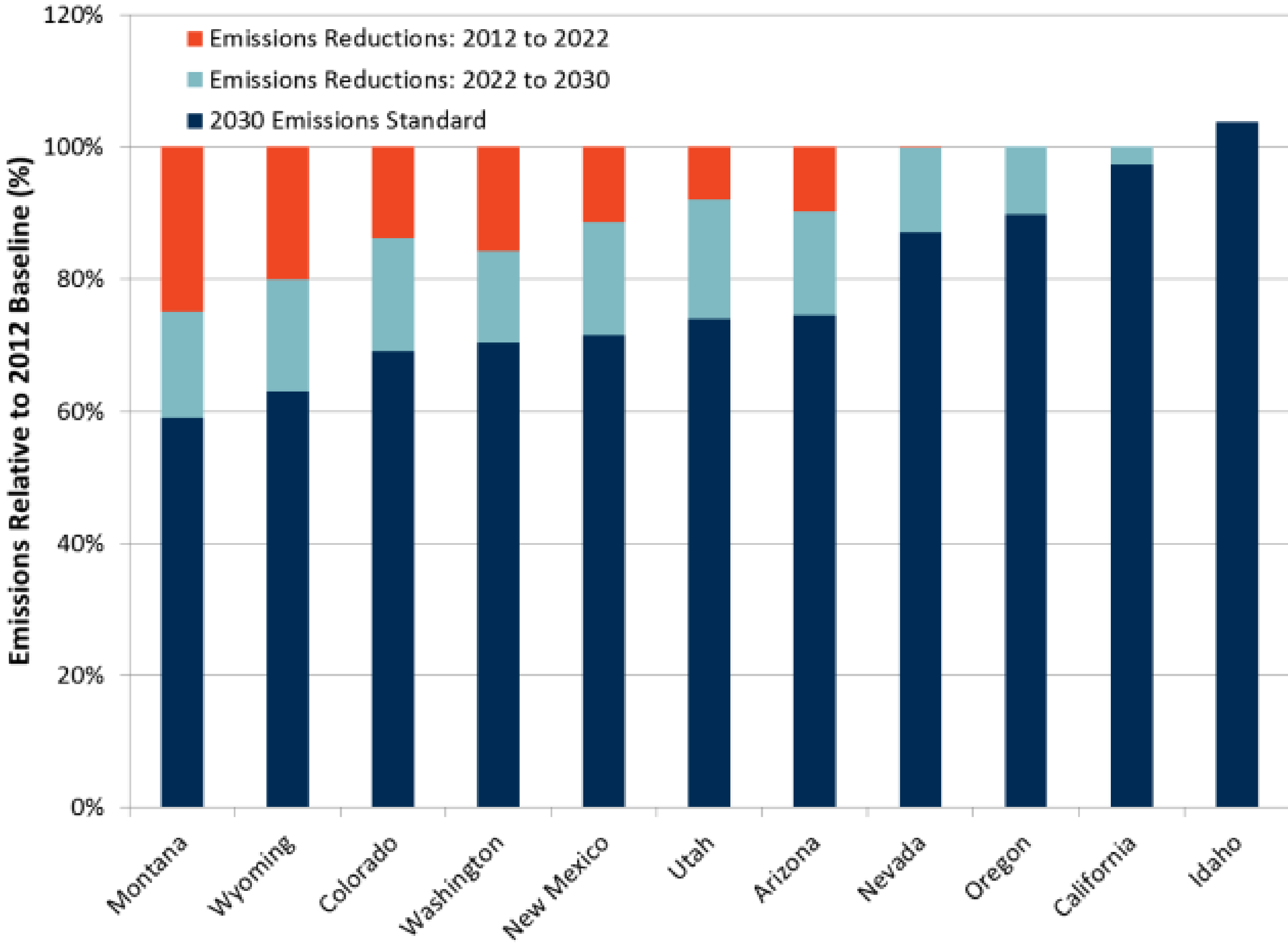
- *Thursday! January 21, 2016*: End of comment period on Federal Implementation Plan and Clean Energy Incentive Program
- *Sept 6, 2016*: Initial submission of State Implementation Plan (SIP), necessary to request extension to 2018
- *Sept 6, 2018*: Final submission of SIP
- *2022 – 2029*: Annual EGU 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).



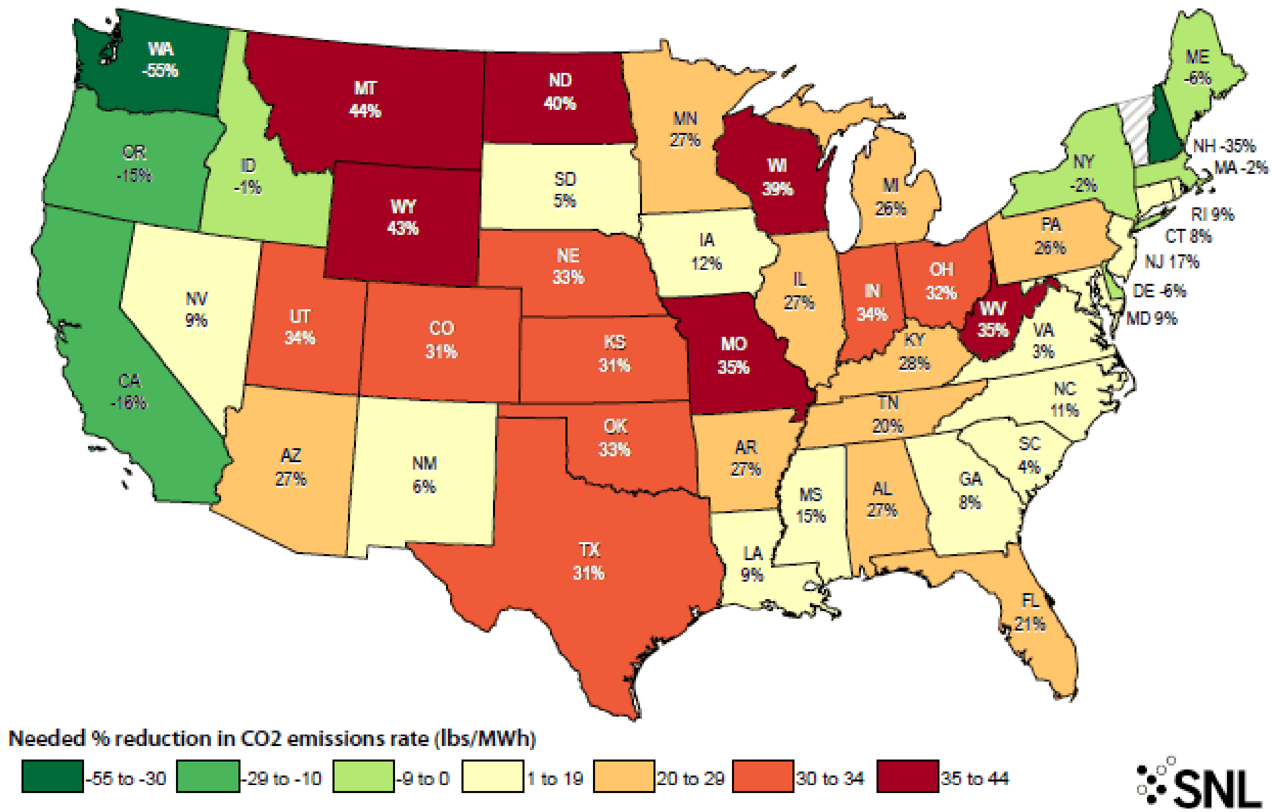
Similar pattern to reductions required under Mass-Based Standards



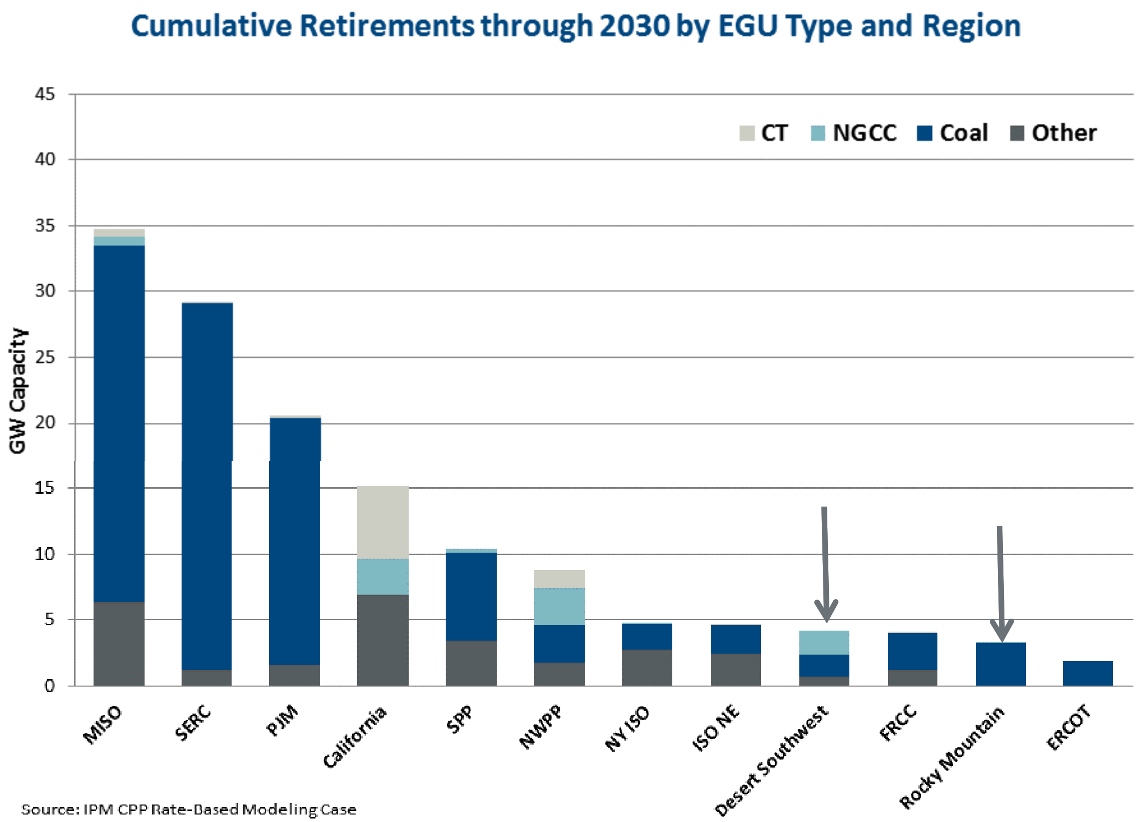
CPP-Mandated Emissions Reductions

- 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 <u>need</u> and <u>cost competitiveness</u> of renewable generation
  - <u>Carbon pricing</u> will increase desirability of renewable energy
  - <u>Reliability needs</u> associated with coal plant retirements
  - Likely regional market formation

EPA's required CO2 emissions rate reductions versus projected levels
Compares 2020 projections with 2030 Clean Power Plan goals



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

		Base Year	Base Year Source	Base Capacity RE (excluding hydro)	Incremental RE to Base (including new hydro)	Total 2030 RE Capacity (including new hydro)	Incremental Energy Efficiency (2030)	Cumulative Coal Retirements in 2030
				(GW)	(GW)	(GW)	(GW)	(GW)
CPP (Rate)	[1]	2012	CPP	98	84	182	132	97
CPP (Mass)	[2]	2012	CPP	98	81	179	132	108

Incorporating Clean Power Plan Analyses in Utility Planning

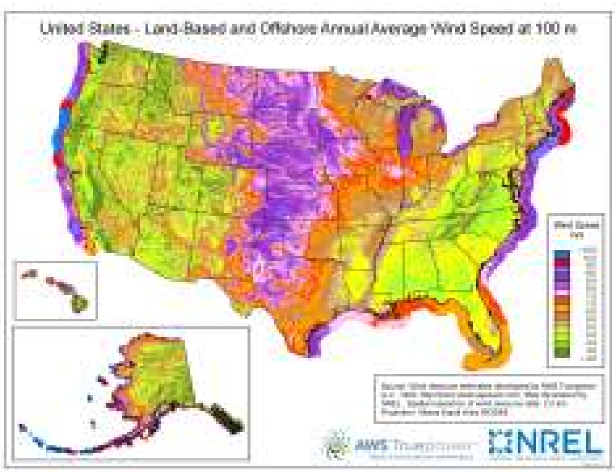
- States would likely choose to comply using the mass-based emissions targets (except for states that have very favorable rate-based standards).
- Trading across states will likely be considered by most.
- Compliance will likely be equivalent to adding an emissions cost (in $/ton) to fossil generation, 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

How will CPP Drive Transmission Development

- 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 <u>extent to which low-cost renewable resources are relied upon</u> 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.

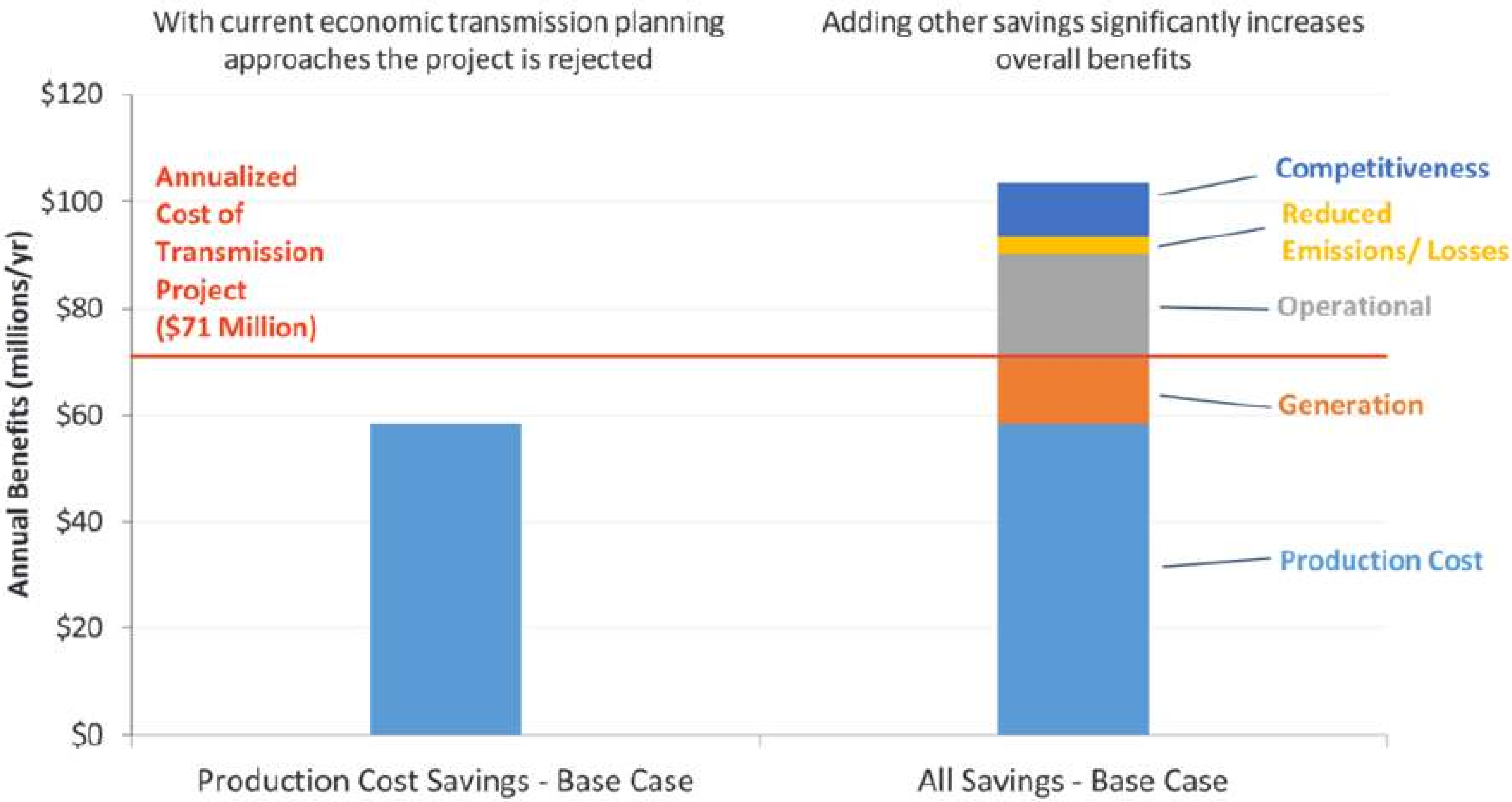
Higher cost of delivered electricity and meeting long-term public policy goals.

"Checklist" of Transmission Benefits

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

Considering All Transmission Benefits is Important

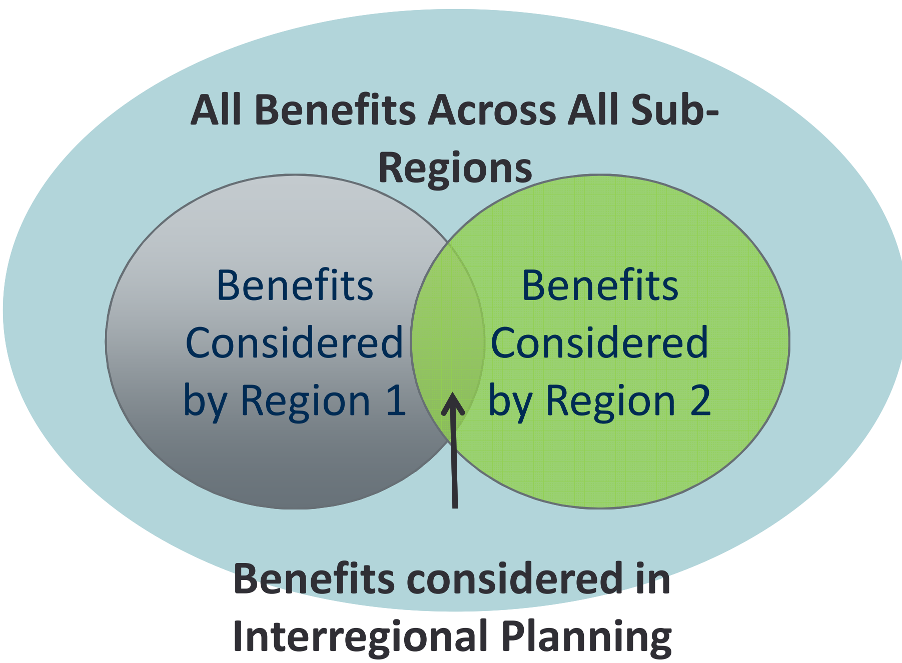
Estimated Annual Base-Case Benefits and Costs of CA Palo Verde-Devers 2 Line



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.

Projects Considered in MISO-PJM Planning:
(as Ordered by FERC)

Project Type in RTO-1 \ Project Type in RTO-2	Reliability	Market Efficiency	Public Policy	Multi-Value
Reliability	Yes	no	no	no
Market Efficiency	no	Yes	no	no
Public Policy	no	no	Yes	no
Multi Value	no	no	no	no

- 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."

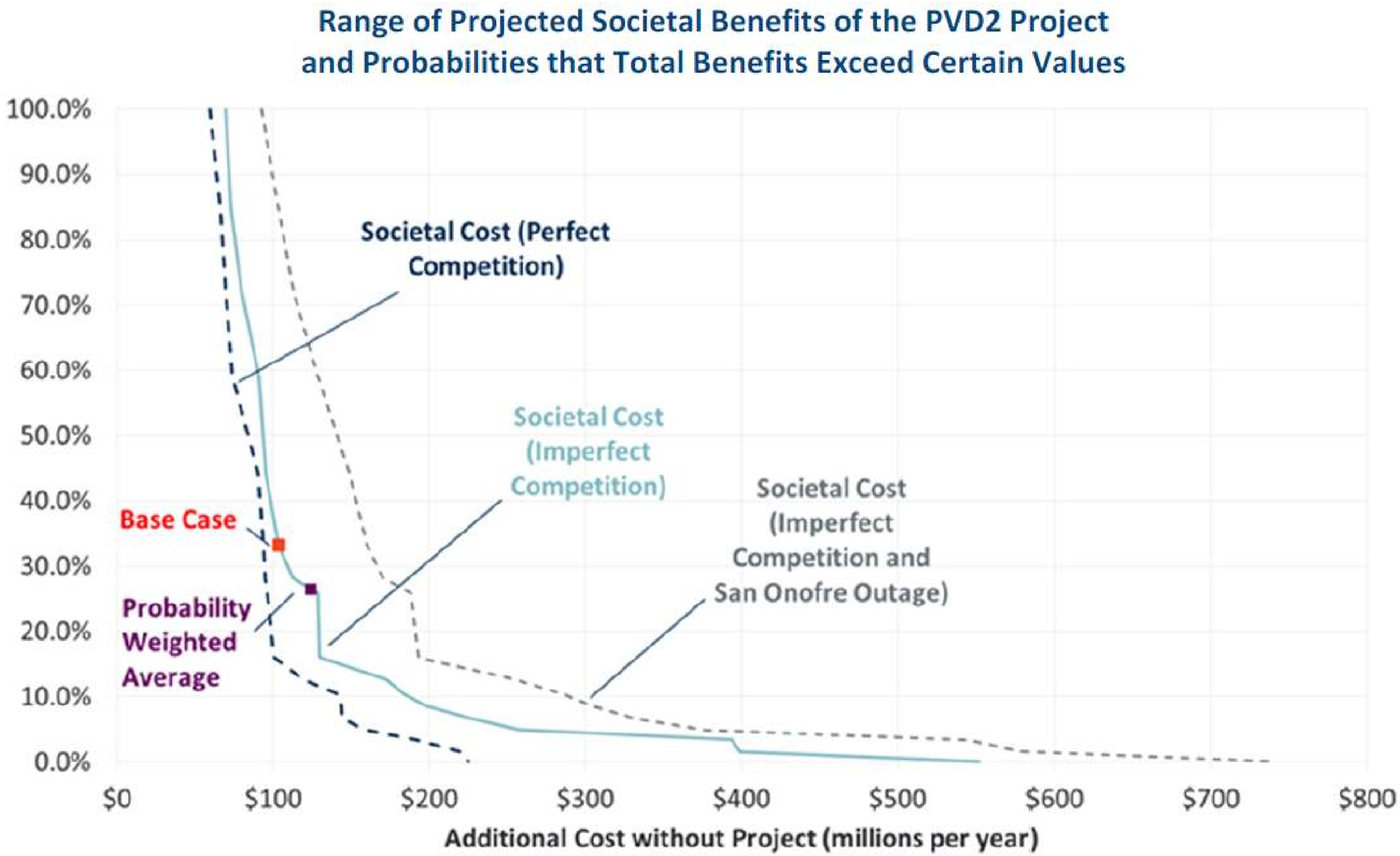
Inadequate Transmission Imposes High Risks

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

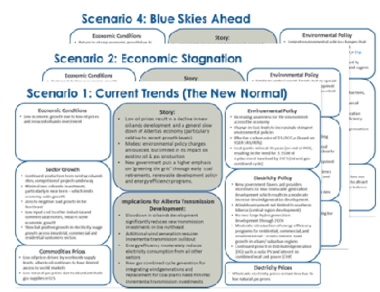
Transmission Can Mitigate Very High-Cost Outcomes, Particularly if Future is Uncertain



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

Key Driver	Current	Stagnation	Blue Skies
Economic Conditions	Base	Low	High
Sector Growth	Base	Low	High
Commodity Prices	Base	Low	High
Environmental Policy	Base	Low	Low
Electricity Policy	Base	Base	Low

3. Transforming Future Scenarios into Planning Assumptions

- Translate the qualitative descriptions of the future scenarios to specific assumptions that are used in transmission planning

Line	Region	ISD	Cost
A	NE	2019	$X,XXX,XXX
B	Central	2025	$X,XXX,XXX
C	South	2027	$X,XXX,XXX

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

http://www.brattle.com/news-and-knowledge/news/brattle-consultants-assist-ercot-in-scenario-planning-and-improving-its-long-term-transmission-planning-process

Table 3.1: 2014 LTSA Key Drivers Developed by ERCOT Stakeholders

Key Drivers	Description
Economic Conditions	U.S. and Texas economy; regional and state-wide population, oil & gas, and industrial growth; Liquefied Natural Gas (LNG) export terminals; urban/suburban shifts; financial market conditions; and business
Environmental Regulations and Energy Policy	Environn ozone, N 316(b)), renewab mandate
Alternative Generation Resources	Capital c improver capacity (DG) cos
Natural Gas and Oil Prices	Gas price LNG exp prices ar spread c affect dri
Transmission Regulation and Policies	New pol neighbor
Generation Resource Adequacy Standards	Economi flexible r
End-Use/New Markets	End-use demand- increase
Weather and Water Conditions	May affe technolo extreme

Table 3.2: 2014 LTSA Scenarios Developed by Stakeholders

Candidate Scenarios	Description
Current Trends	Trajectory of what we know today (e.g., LNG export terminals and West Texas growth, prolonged high oil prices)
Global Recession	Significant reduction in economic activities in the U.S. and abroad
High Economic Growth	Significant population and economic growth from all sectors of the economy (affecting residential, commercial, and industrial load)
High Efficiency/High DG/Changing Load Shape	Reduced *net* demand growth due to increase in distributed solar, cogeneration and higher building and efficiency standards
High Natural Gas Prices	High domestic gas prices
Stringent Environmental Regulation/Solar Mandate	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.
High LNG Exports	Significant additional construction of liquefied natural gas (LNG) terminals (beyond Current Trends)
High System Resiliency	Severe climate and system events leading to more stringent reliability and system planning standards
Water Stress	Low water availability
Low Global Oil Prices	Sustained low oil prices

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 <u>not</u> 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

		Ramp up of Existing State RPS	EPA Estimate w/ CPP	Brattle Estimate w/ CPP
Estimated Wind Capacity	GW	**50-70**	**85**	**110**
Regional Transmission	**$billion**	**20-33**	**40**	**50**
Interconnection related	$billion	5-7	9	11
Total Transmission	**$billion**	**25-40**	**50**	**60**

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.

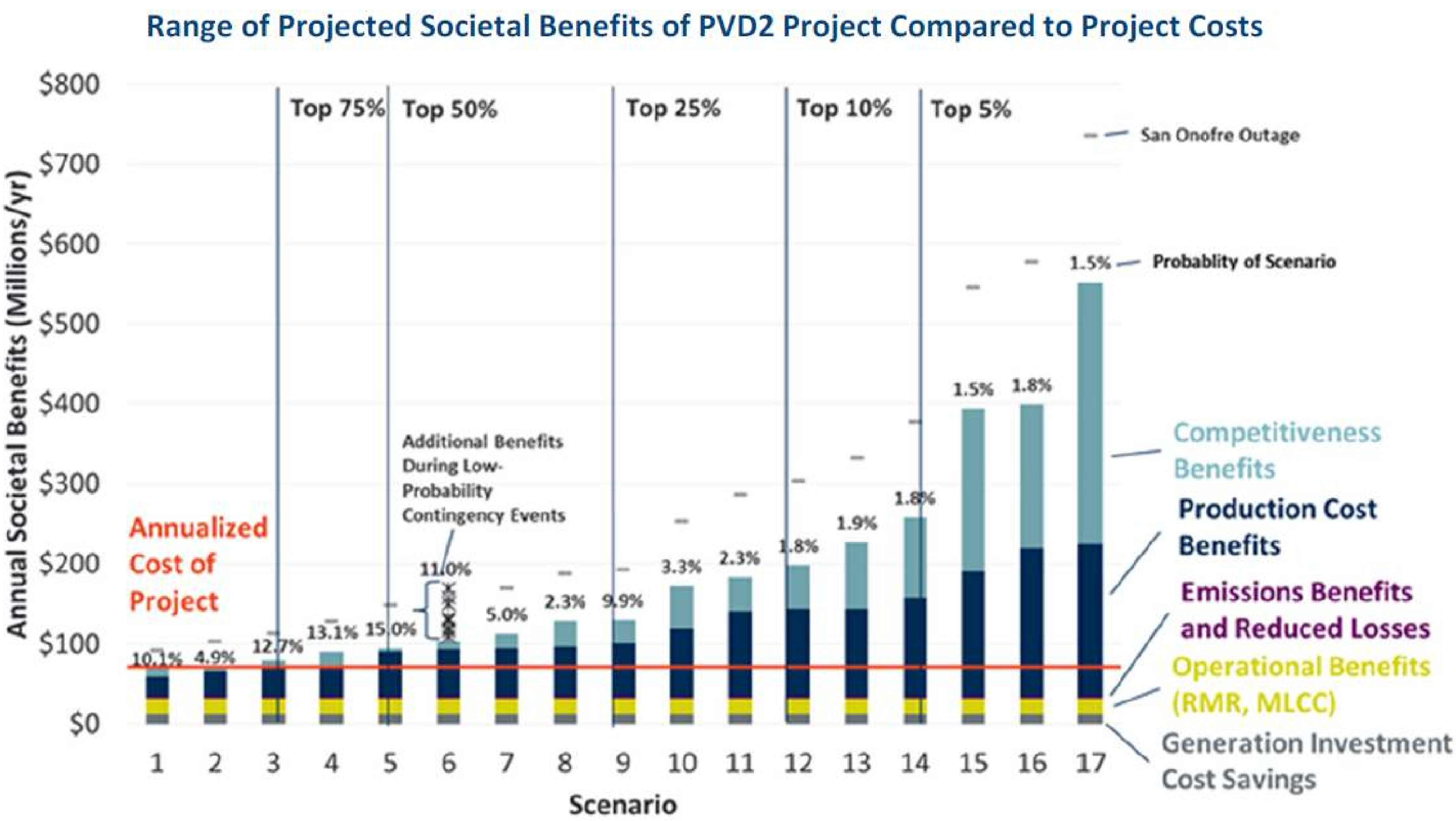
Estimated Transmission Needs Driven by Coal Retirements through 2030

	EPA Projected Coal Retirements (GW)	Potential Transmission Investment ($ billion)
Base Case (w/o CPP)	**60**	**$10**
Under the CPP	**130**	**$20**

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 <u>additional</u> 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



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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*.

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.

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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

- Pfeifenberger, Chang, and Sheilendranath, "Toward More Effective Transmission Planning: Addressing the Costs and Risks of an Insufficiently Flexible Electricity Grid," WIRES and The Brattle Group, April 2014, at www.wiresgroup.com
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- Pfeifenberger, Hou, Employment and Economic Benefits of Transmission Infrastructure Investment in the U.S. and Canada, on behalf of WIRES, May 2011, online at: http://www.brattle.com/system/publications/pdfs/000/004/501/original/Employment_and_Economic_Benefits_of_Transmission_Infrastructure_Investmt_Pfeifenberger_Hou_May_2011_WIRES.pdf?1378772110

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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.

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Our services to the electric power industry include:

- Climate Change Policy and Planning
- Cost of Capital & Regulatory Finance
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- Demand Response & Energy Efficiency
- Electricity Market Modeling
- Energy Asset Valuation & Risk Management
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