The Critical Role of Transmission in Clean Power Plan Compliance

PRESENTED TO:

Kinetic Competitive Bidding for Transmission Expansion

PRESENTED BY:

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THE Brattle GROUP

“Pop Quiz”: What do auto insurance and new transmission have in common?

Answer:
Both are expensive to get,
but it can be much very expensive to
<u>not</u> have them when they are needed.

Source: Herman K. Trabish, “3 serious failures in transmission planning and how to fix them: Planners need to think of the cost of not building new lines, a new study urges,” Utility Dive, May 4, 2015.
http://www.utilitydive.com/news/3-serious-failures-in-transmission-planning-and-how-to-fix-them/391504/

Agenda

Fundamentals of the Clean Power Plan

How CPP Affects Transmission Development

Costs of Inadequate Planning and Challenges of Planning Under Uncertainties

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Final Clean Power Plan

Who: Existing Generation Units (EGUs) considered affected units under the 111(d) applicability criteria are grouped into two categories:

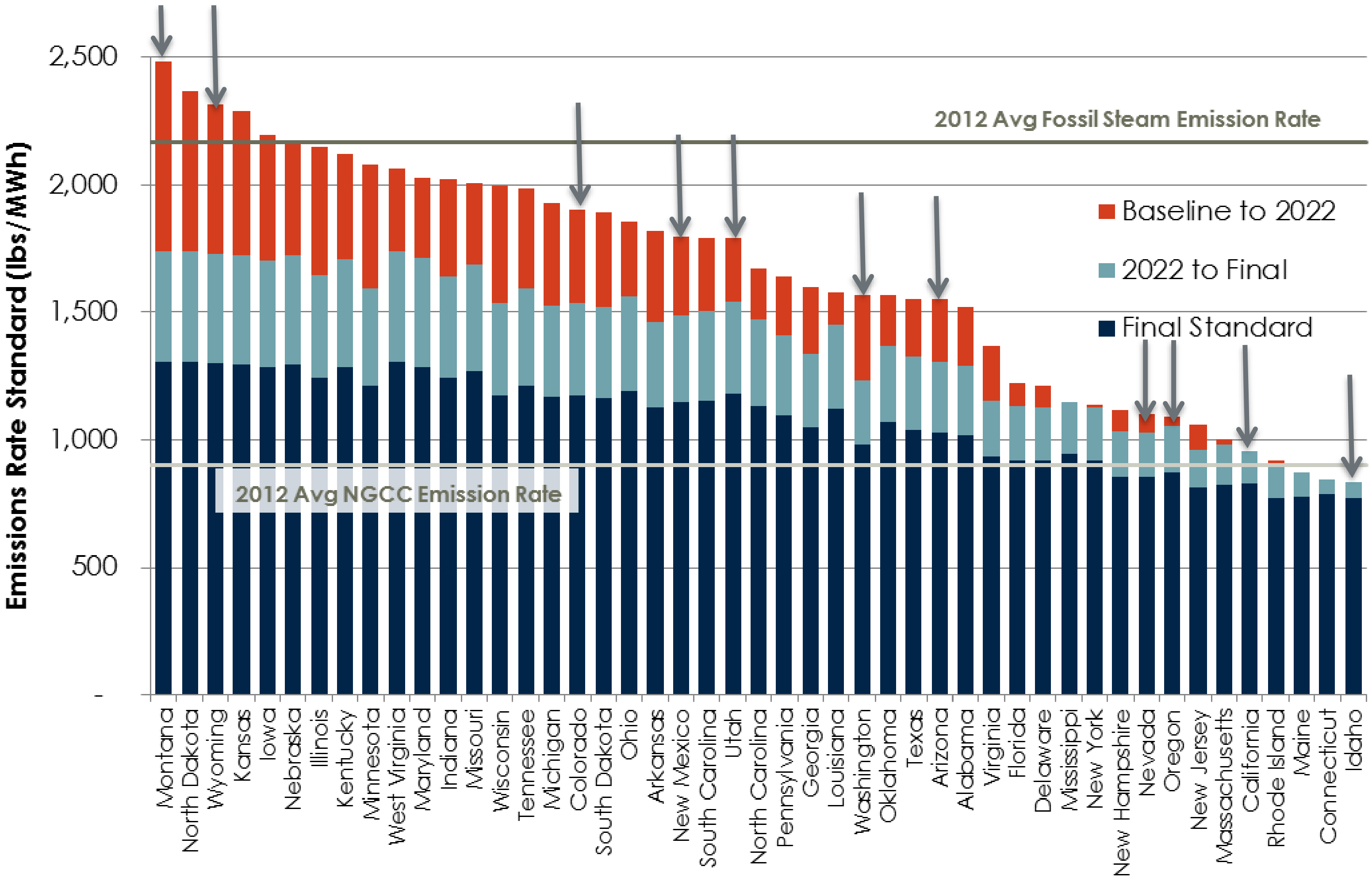
- *Steam Units*: Coal and oil/gas-fired steam turbine units
- *NGCCs*: Natural gas-fired combined cycle units
- <u>Not Included</u>: Combustion turbine units

When:

- *Dec 2015*: End of comment period on Federal Implementation Plan and Clean Energy Incentive Program
- *Sept 6, 2016*: Initial submission of State Implementation Plan (SIP), must 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

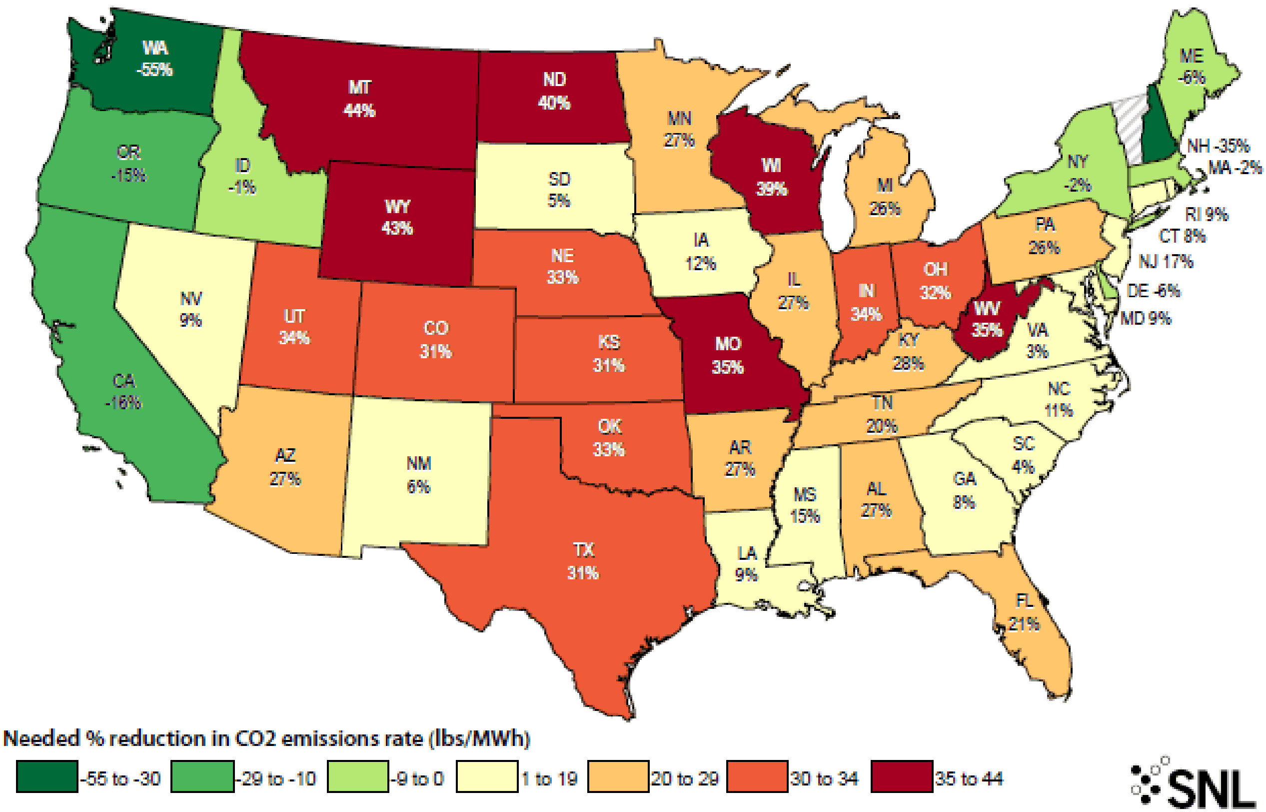
Rate reductions are phased-in from 2012 Baseline to 2030 goals. The largest reductions are in MT, ND and WY.



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 and the requirements themselves do not drive transmission.

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



- The most relevant drivers for transmission investments:
  - Additional need for renewable generation for CPP compliance
  - Increased cost competitiveness for renewable resources due to carbon pricing and possibly higher gas prices
  - Reliability needs associated with coal plant retirements

Clean Power Plan – Analyses in 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 the chosen approach.
- 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 change over the next 20 years.
- Important to Remember: Transmission is not a "single usage" asset. The value of transmission is always "multi-value."

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How will CPP Drive Transmission Development

- Significant uncertainties remain about how CPP will be implemented.
  - National vs regional/local compliance
  - How emissions will be reduced physically: renewables, EE, coal-to-gas switching
- 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.
  - Either through RPS-type mandates or by becoming economically more attractive.
  - A national (vs. regional/local) compliance approach, higher gas prices, carbon prices, or PTC/ITC would have significant positive impact.
- Transmission faces a "chicken-or-egg" challenge.
  - Without transmission, significant amounts of additional renewables cannot be developed in low-cost locations.
  - Without significant development of renewables in low-cost locations, existing planning processes will not identify transmission needs.
- Longer-term transmission planning taking into account future uncertainties can inform developers and regulators.

Main Drivers for Transmission

- **Serve growing load**
- **Load diversity:** reduce overall reserve margins and generating capacity needed
- **Congestion relief/production cost savings:** reduce congestion and increasing access to lowest-cost generation that help reduce fuel costs and wholesale energy prices – likely increasing under CPP due to wind/solar
- **Access to low-cost renewables:** access to regions with low-cost wind, solar, geothermal, and hydro
- **Renewable energy and fuel diversity:** diversify short and long-term variability of wind, solar, and hydro patterns; diversify fuel mix and cost variances
- **Increasingly stringent environmental regulations:** increase regional "boundaries" to reduce the cost of environmental compliance

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

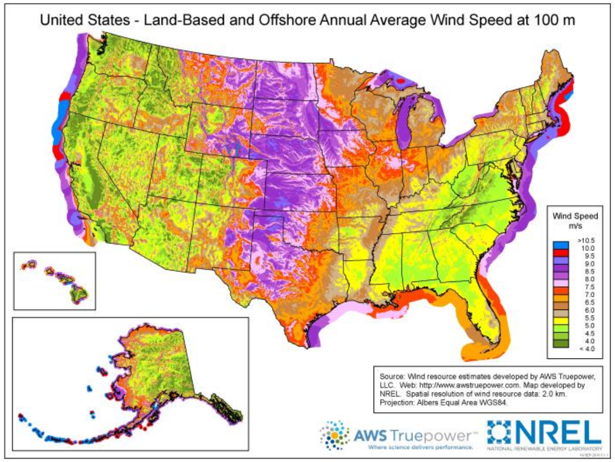
Estimated U.S. Transmission Investment Driven by Renewables and CPP

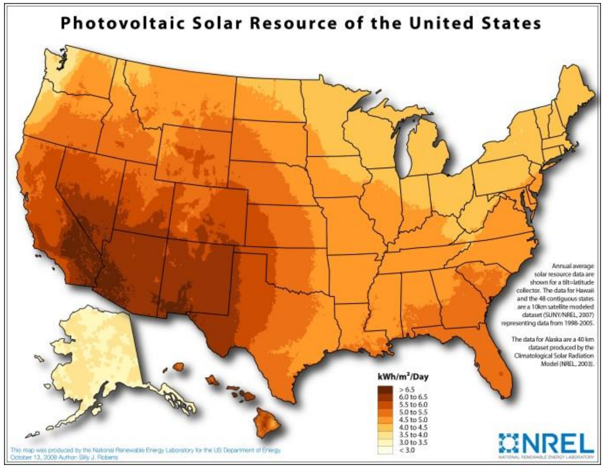
		Ramp up of Existing State RPS	EPA Estimate w/ CPP	Brattle Estimate w/ CPP
Estimated Wind Capacity	GW	**50-70**	**85**	**110**
Regional Transmission	**$billion**	**20-33**	**40**	**50**
Interconnection related	$billion	5-7	9	11
Total Transmission	**$billion**	**25-40**	**50**	**60**

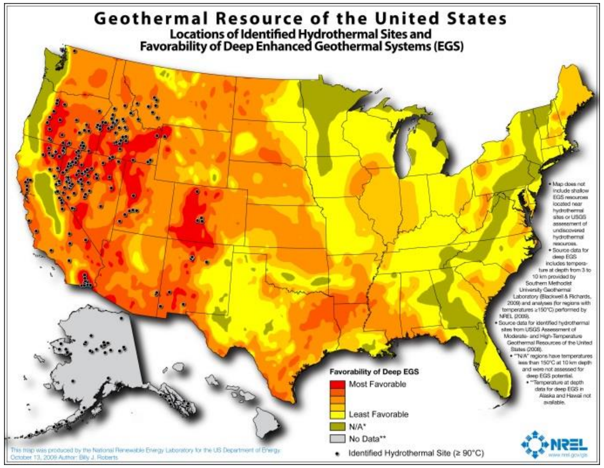
Sources and Notes:
Brattle Estimate with the CPP assumes 50% of required emission rate reduction achieved through added wind generation.

Renewable Resource Potential

- Potential for and quality of renewable energy resources vary by region.
- Lowest-cost onshore wind resources in the Upper Midwest, Southwest Power Pool, and Texas have a 10-15% capacity factor advantage to other parts 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.
- Western states have the highest potential for geothermal.
- There is also significant opportunity to import (or expand exchange trades with) Canadian hydropower.





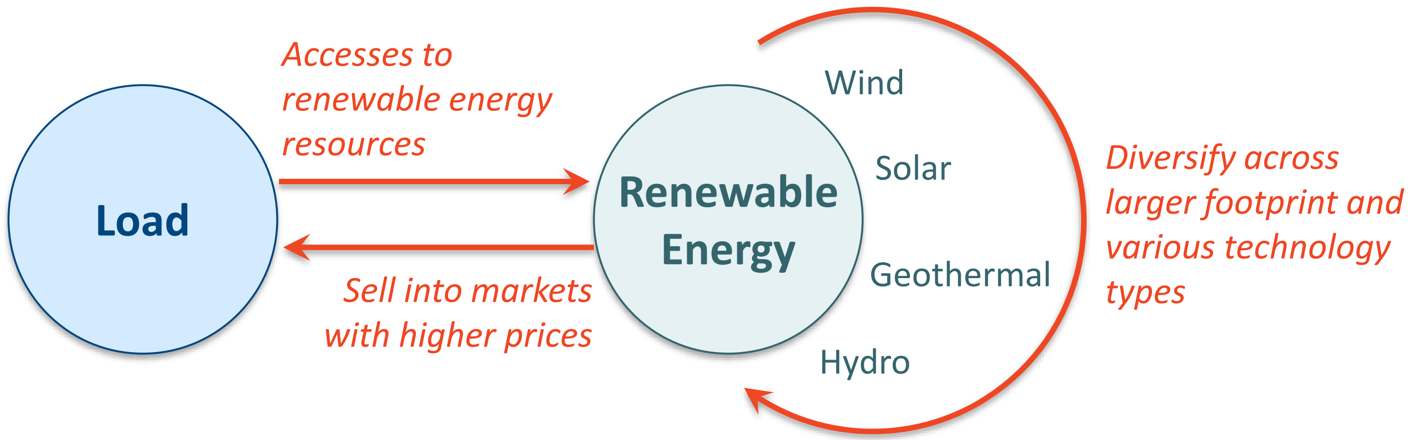


Source: NREL

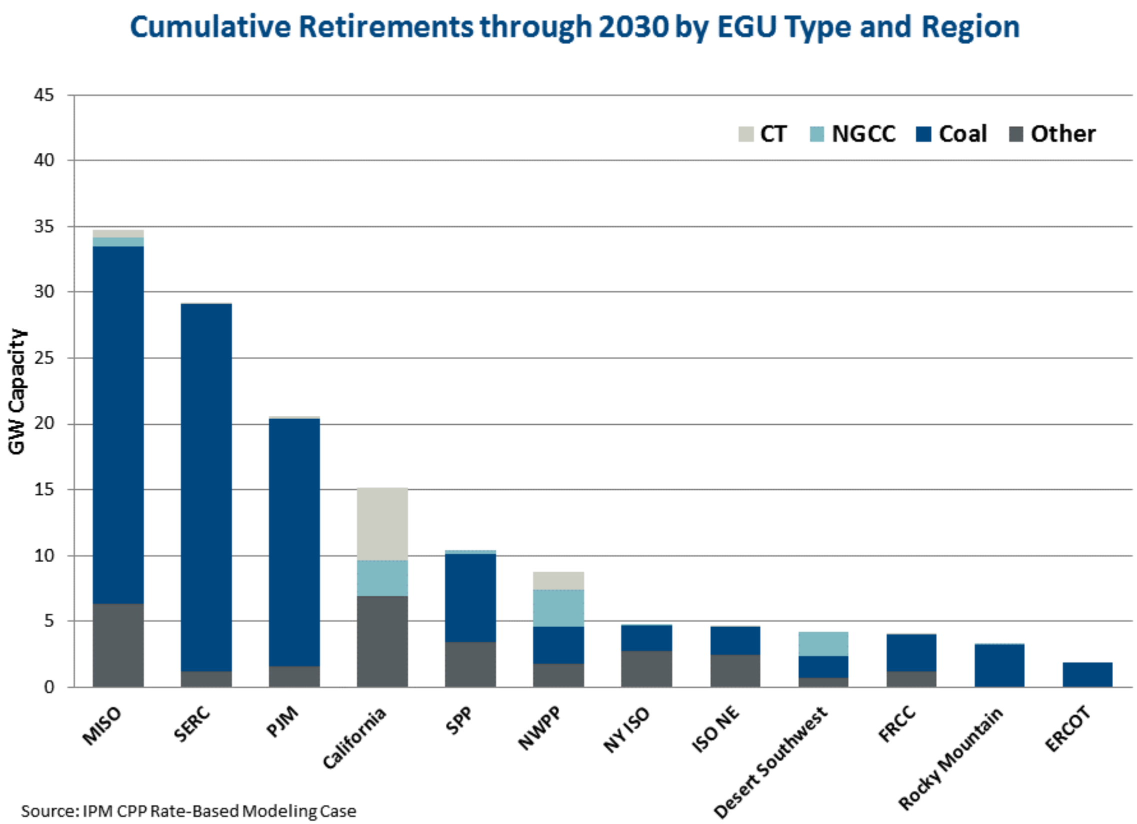
Increasing Access to and Value of Renewables

Transmission development in conjunction with renewable energy faces a "chicken-and-egg" problem

- Transmission increases the value of renewable sources, and renewables add to the benefits of transmission
  - Ability to sell energy into markets with higher prices and fewer curtailments
  - Transmission can allow for diversification of renewable generation; higher capacity value due to increased geographic footprint and diversified resource mix
  - Reduce ancillary service needs for system balancing



EPA Projection of CPP Impacts



EPA's CPP analysis estimates:

- 100-110 GW of coal plant retirements
- 130 GW of energy efficiency
- 80-85 GW of renewables

		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

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.

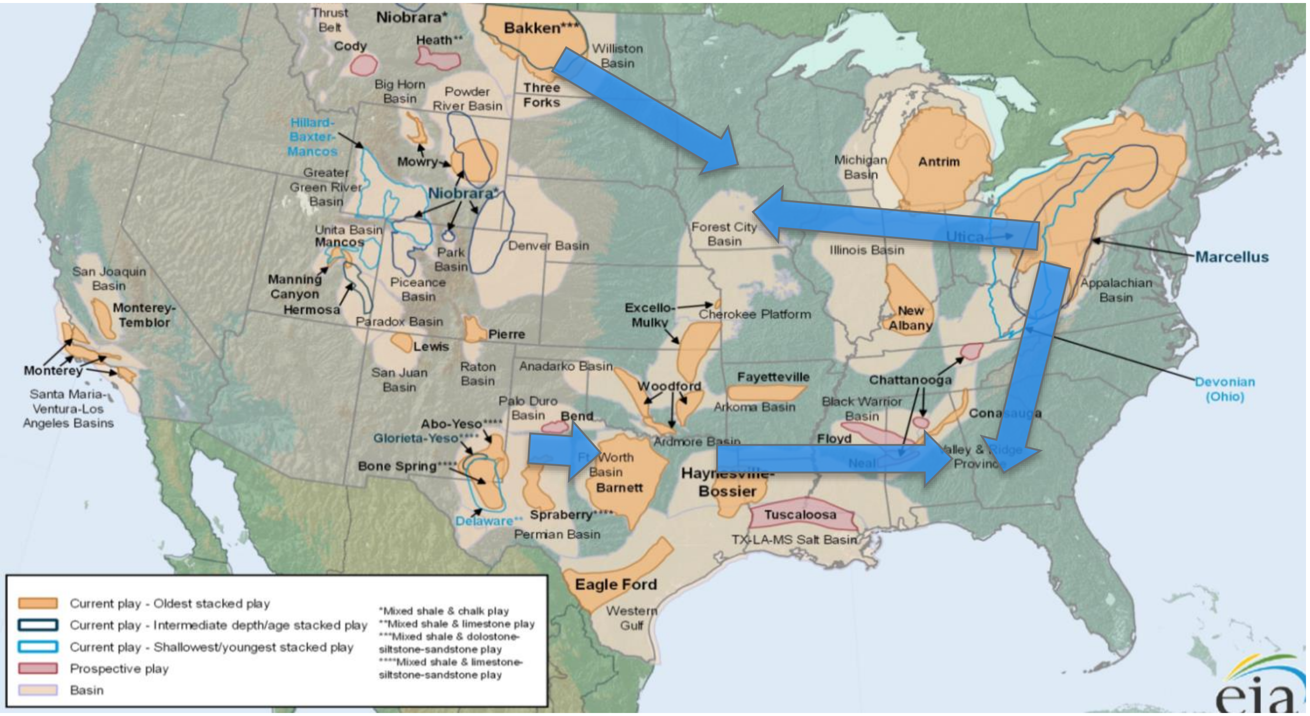
Estimated Transmission Needs Driven by Coal Retirements through 2030

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

Transmission Needs from Gas Capacity Additions

Cheaper to site gas capacity near shale plays – no pipeline needed, low-cost fuel

- Early experience in PJM: CCs built close to gas
- Gas-fired generation needed in areas with high coal retirements but little shale gas
- Benefits from connecting with renewables-rich areas; gas-fired generation can be used for system balancing



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Key Barriers to More Effective Grid Planning

There are 3 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.

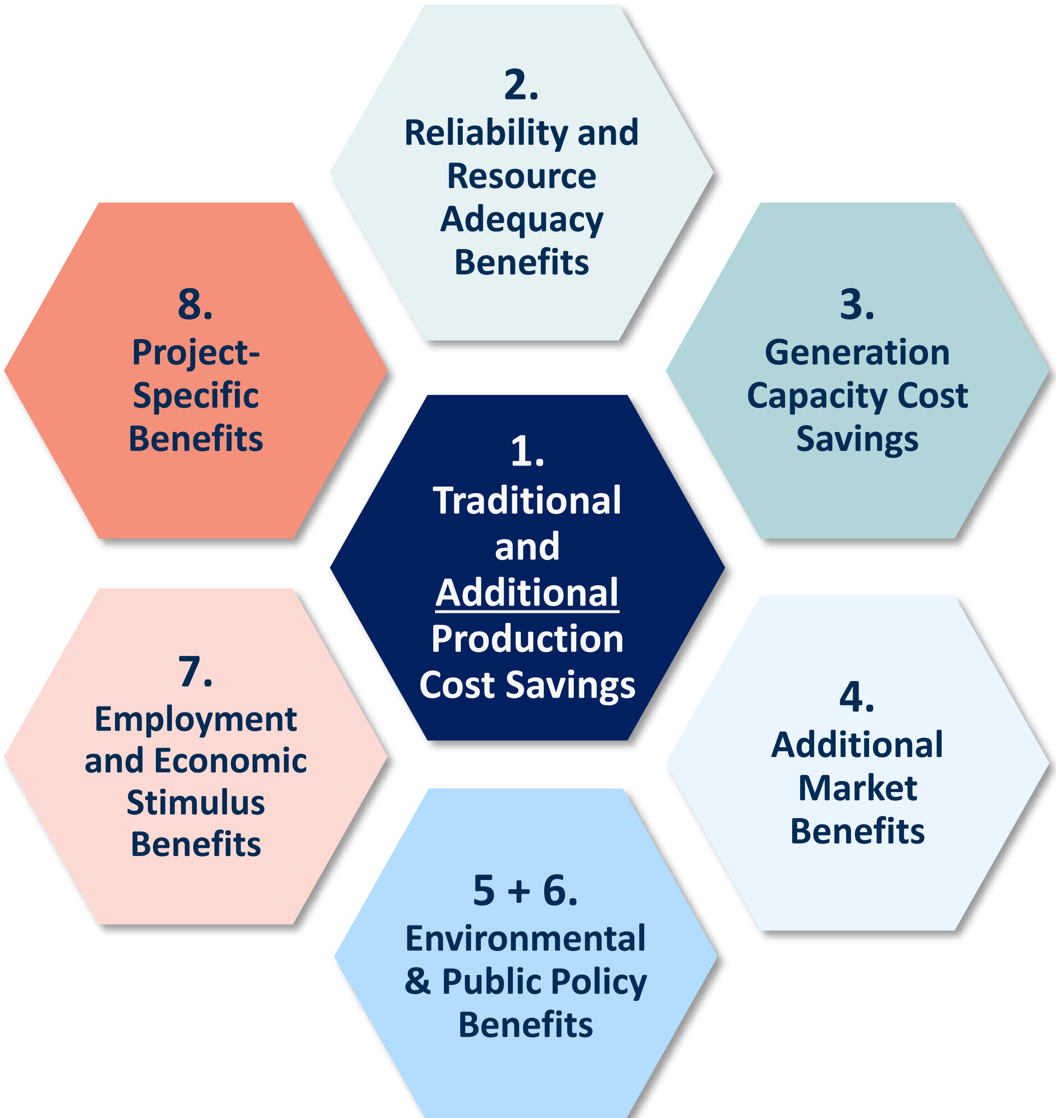
Key Barriers to More Effective Grid Planning

If not addressed, barriers to effective regional and interregional transmission planning (faced nation-wide) will lead to:

- **Lost opportunities to identify and select alternative infrastructure solutions** that are lower-cost or 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 overall cost of delivered electricity and public policy goals from underinvestment in transmission infrastructure

The Full Range of Transmission-Related Benefits



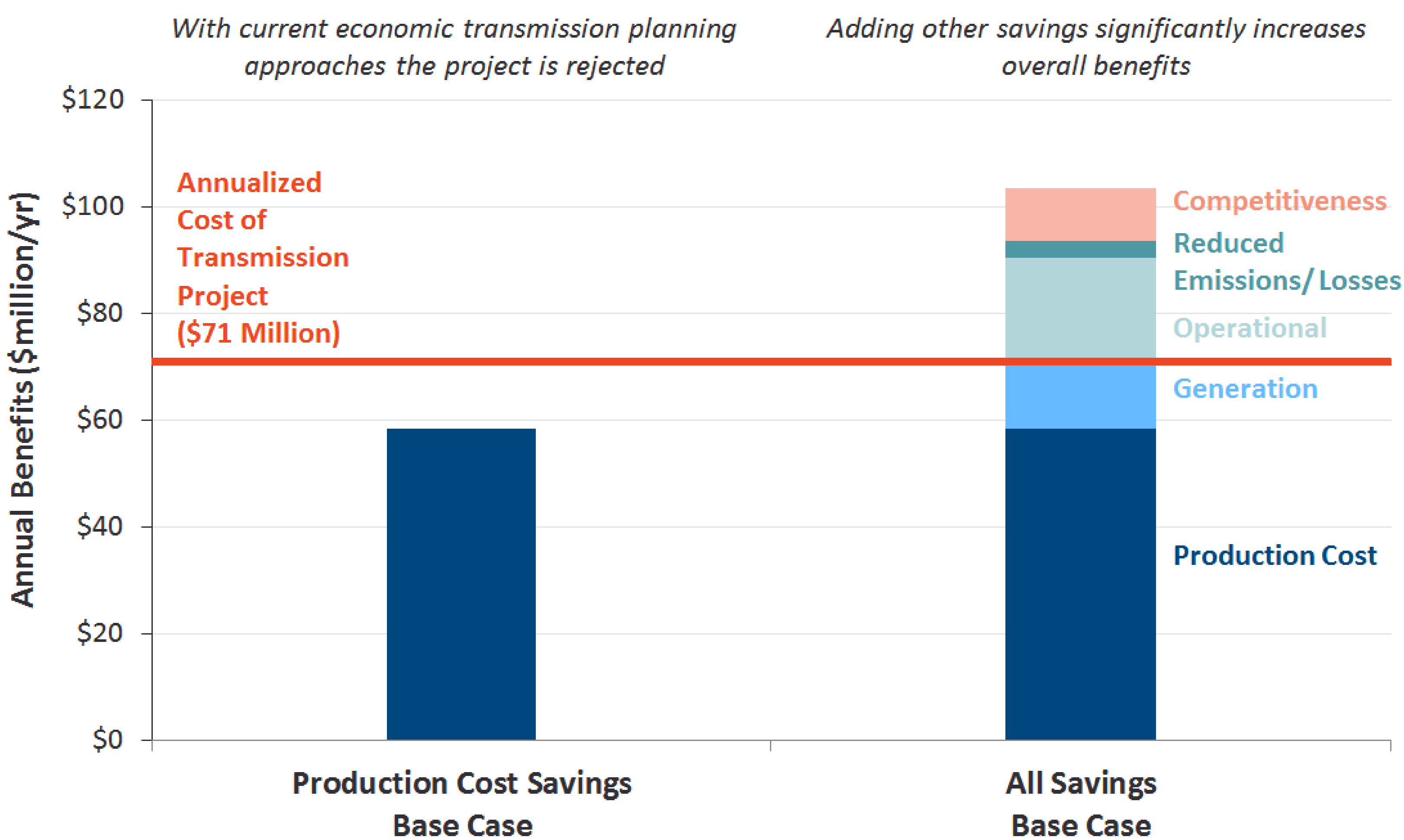
- Transmission accounts for 10% of customer bills but greatly affects at least half of the other 90%
- Omitting many transmission-related benefits (or assuming they are zero) ignores the costs and risk imposed on customers through a higher overall cost of power

"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

Illustrative Example: Considering All Transmission Benefits is Important

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

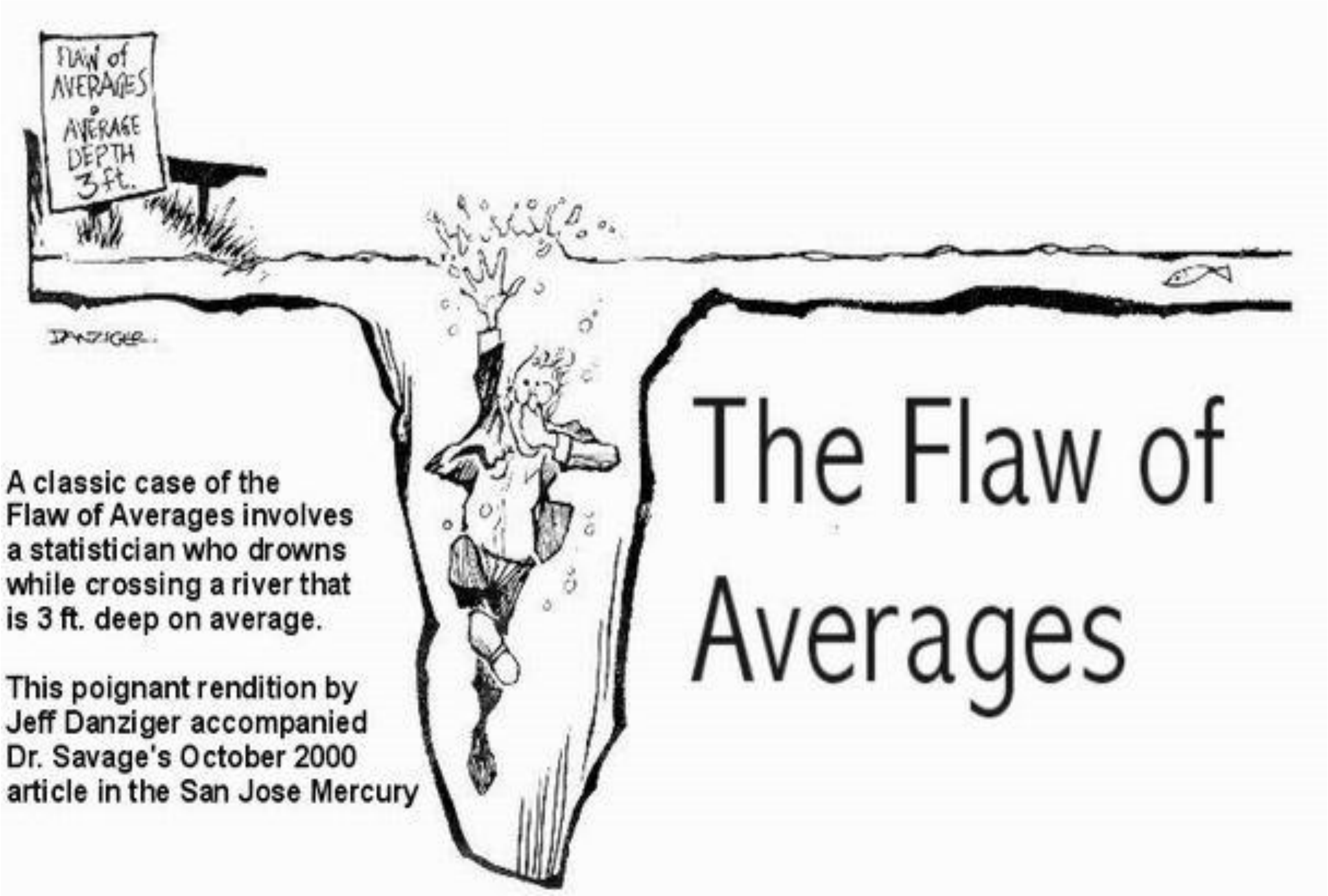


Inadequate Transmission Imposes High Risks

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.
  - Planning process 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.

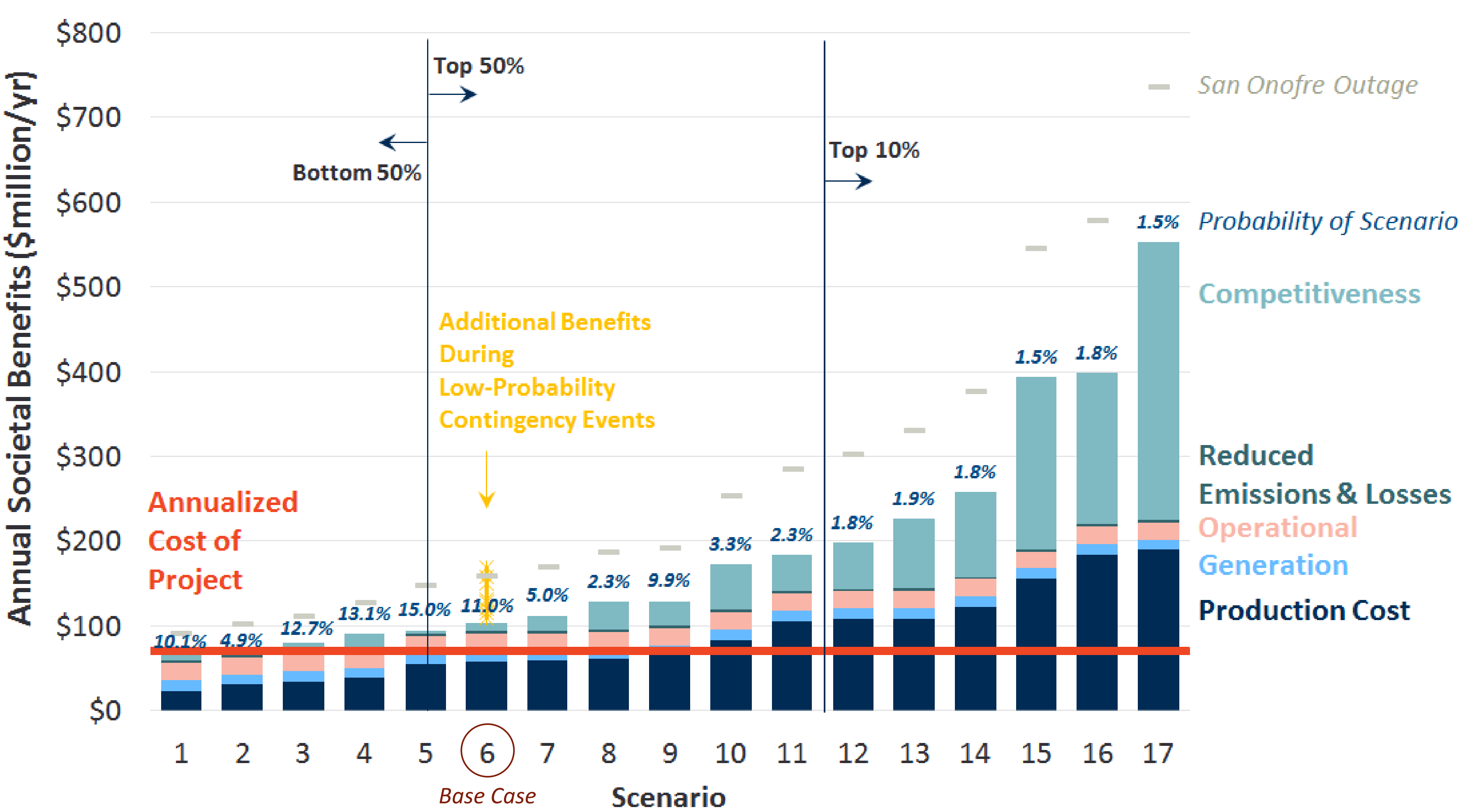
Planning for “Average” Conditions Can Lead to Very Disappointing Results



- See below for details and examples on why we underestimate risks at the face of uncertainty:
  http://web.stanford.edu/~savage/flaw/Article.htm
  http://flawofaverages.com/

Illustrative Example: Considering the Range and Distribution of Transmission Benefits is Important as Well

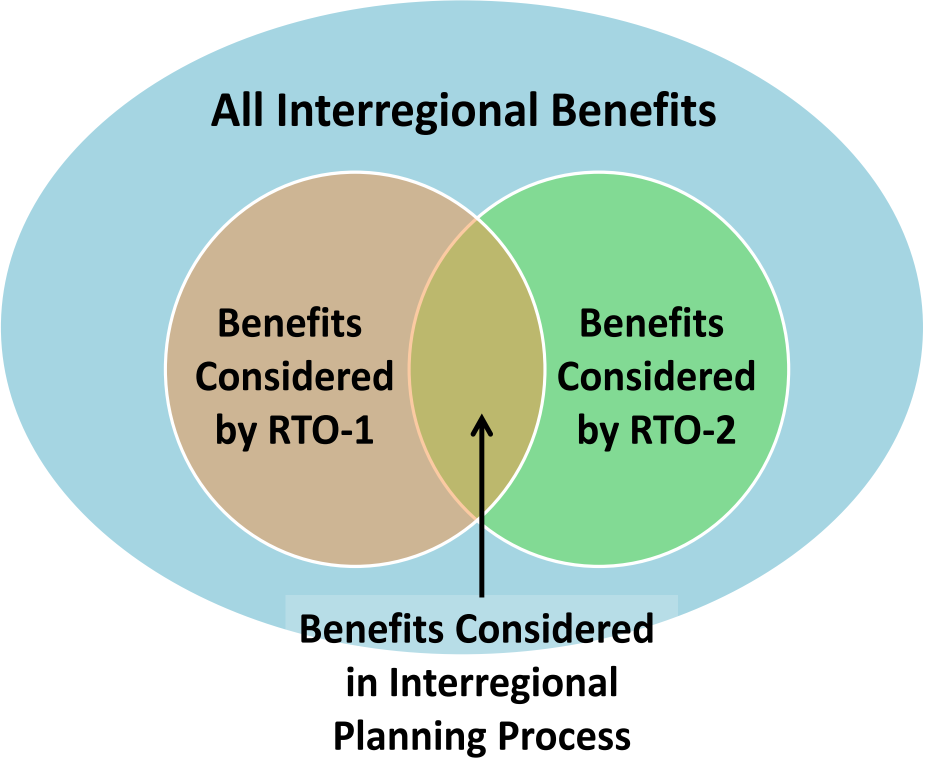
Range of Projected Societal Benefits of PVD2 Project Compared to Project Costs



Ineffective Inter-Regional Transmission Planning

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

- Experience already shows that 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 around the country 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."

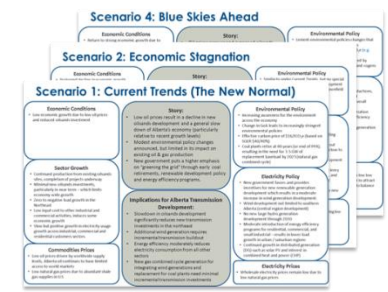
Scenario-Based Transmission Planning

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



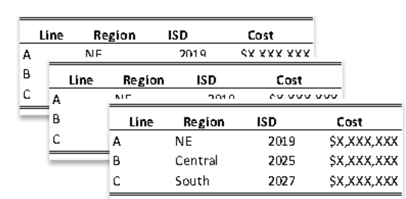
3. Transforming Future Scenarios into Planning Assumptions

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

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

4. Simulate the Grid under each Future Scenario

– Develop power flows for each future scenario
– Compare the size and timing transmission needs across scenarios



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

Example: ERCOT Long-Term System Assessment

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 environment
Environmental Regulations and Energy Policy	Environmental regulations, including air emissions standards (e.g., ozone, MATS, CSAPR), GHG regulations, water regulations (e.g., 316(b)), and nuclear safety standards; energy policies including renewable standards mandated fuel mix, sol
Alternative Generation Resources	Capital cost trends for improvements affectin capacity additions, st (DG) costs, and financi
Natural Gas and Oil Prices	Gas prices are a functi LNG exports, industria prices are dependent spread of horizontal d affect drilling locations
Transmission Regulation and Policies	New policies around t neighboring regions, a
Generation Resource Adequacy Standards	Economically determin flexible resource requir
End-Use/New Markets	End-use technologies demand-response; ch increase interest in mic
Weather and Water Conditions	May affect load growt technology mix, aver extreme weather event

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

Table 3.2: 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 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 a version of the future where transmission solutions could help regions to comply with the rule in a cost effective manner.
- Ultimately, **transmission are multi-purpose and multi-value.**
- **Much work is needed** in considering all of the value of transmission when considering a cleaner power sector for the future, so must start now.
- **Regulators should consider the cost of delivered power without the needed transmission**.
- **Scenario-based planning could help all stakeholders** develop the long-term lowest cost solution.

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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*.

Mr. John Tsoukalis is an Associate at The Brattle Group with experience across a board range of issues in electric utility economics. These include electric utility strategic planning, manipulation across electricity markets, and electric transmission development. He has assisted electric utility clients in developing their strategic plans for participation in wholesale markets and in confronting regulatory uncertainty. John is engaged with utility clients to determine their regulatory exposure due to bidding practices in the wholesale electricity markets. He has helped develop tests to detect the presence of uneconomic behavior and to assess the potential price distortion caused by this behavior. He is assisting several clients in defending against investigations or enforcement actions for allegedly manipulative behavior. He has supported the development of testimony to assist regulatory agencies with their design of appropriate tariff provisions to properly allow for adequate cost recovery while identifying and mitigating potentially manipulative behavior.

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