Toward More Effective Transmission Planning

PRESENTED TO

EEI Energy Delivery Public Policy Executive Advisory Meeting

Boston, MA

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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 more expensive to not 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/

Content

Background: Transmission Benefits and Planning

Toward More Effective Transmission Planning:

Addressing the Costs and Risks of an Insufficiently Flexible Electricity Grid

PREPARED FOR

WIRES

http://wiresgroup.com/docs/reports/WIRES%20Brattle%20Rpt_TransPlanning_042315.pdf

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The Benefits of Electric Transmission: Identifying and Analyzing the Value of Investments

July 2013

http://wiresgroup.com/docs/reports/WIRES%20Brattle%20Rpt%20Benefits%20Transmission%20July%202013.pdf

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Reviewed effectiveness of transmission planning processes and extent to which economic benefits are considered

– Many economic benefits are ignored or understated in traditional planning approaches
– Planners and policy makers do not account for the potentially very high costs and risks of an insufficiently robust/flexible transmission grid
– Interregional planning processes are largely ineffective and unable to identify valuable projects

Transmission's Role in Addressing Major Energy Policy Challenges

- How does the region **decarbonize**?
  - Aggressive targets for the next 2 decades – actions need to begin now.
- How does the country meet the **evolving Renewable Portfolio Standards**?
- 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

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.

These barriers exist across the country, including New England.

Additional challenges related to regional cost recovery and state-by-state permitting processes.

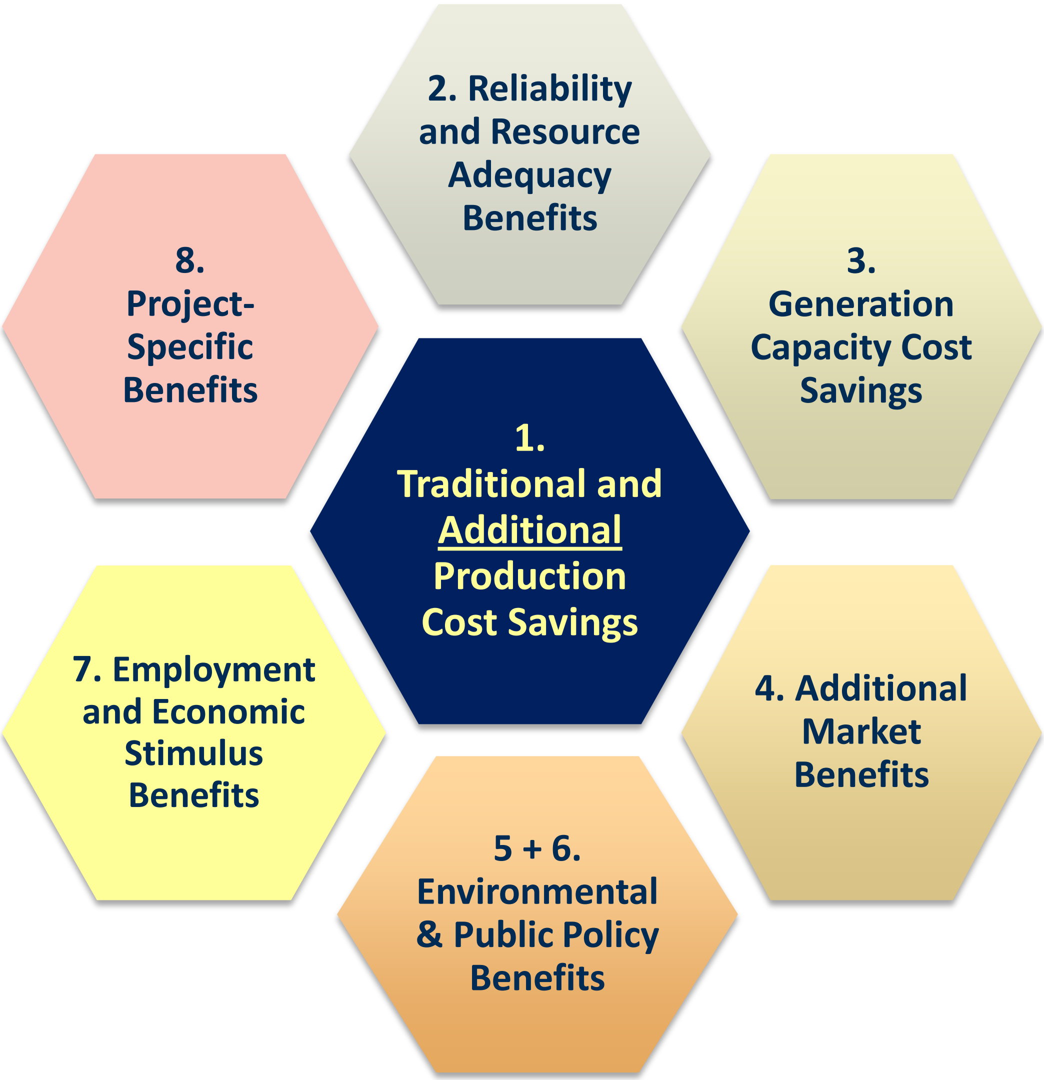
The Need for More Effective Grid Planning

If not addressed, barriers to effective regional and interregional transmission planning (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

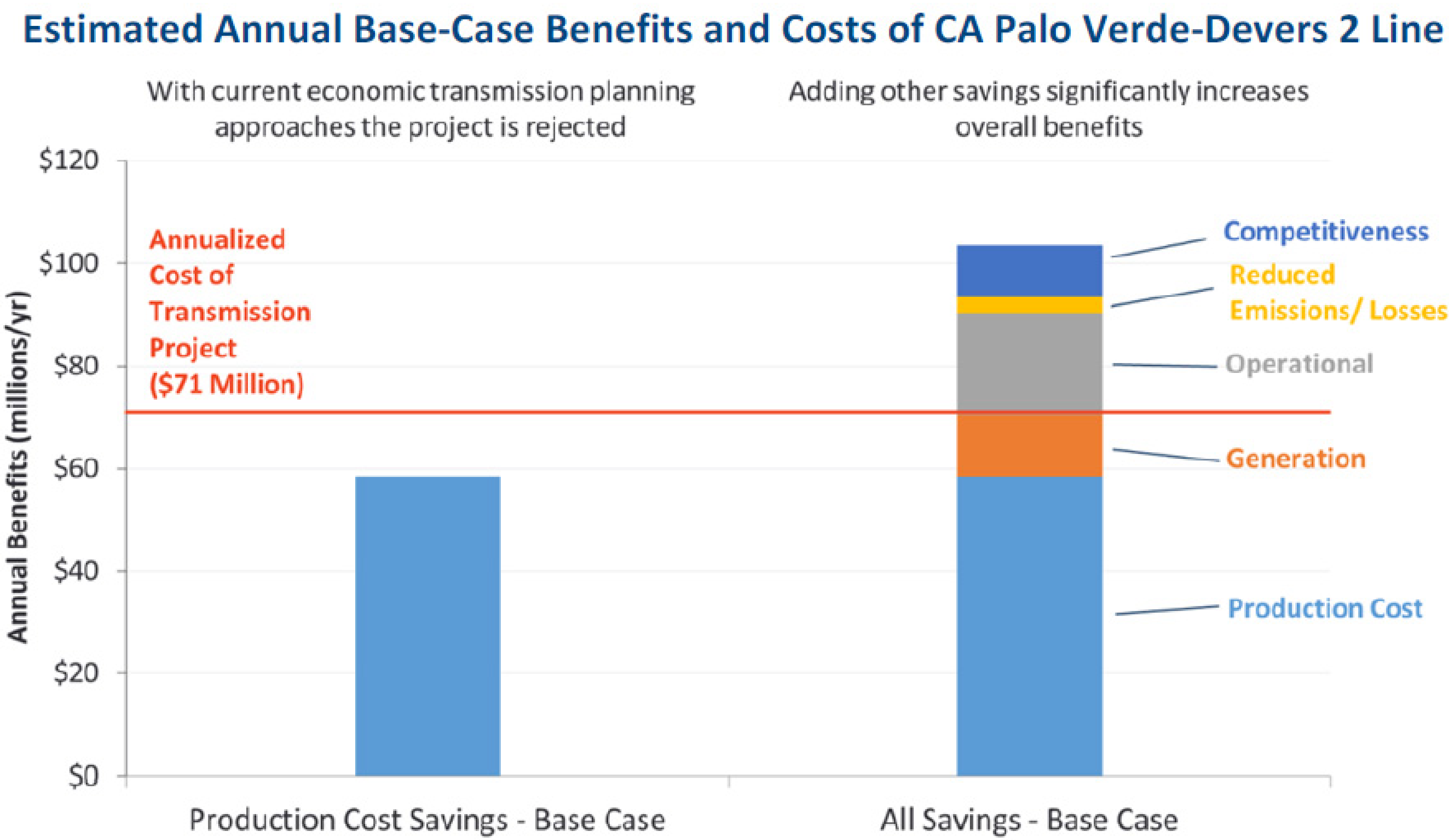


- Transmission accounts for 10% of customer bills but greatly affects at least half of the other 90%
- Omitting many transmission-related benefits (or assuming they are zero) ignores the costs and risk imposed on customers through a higher overall cost of power

"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 or 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



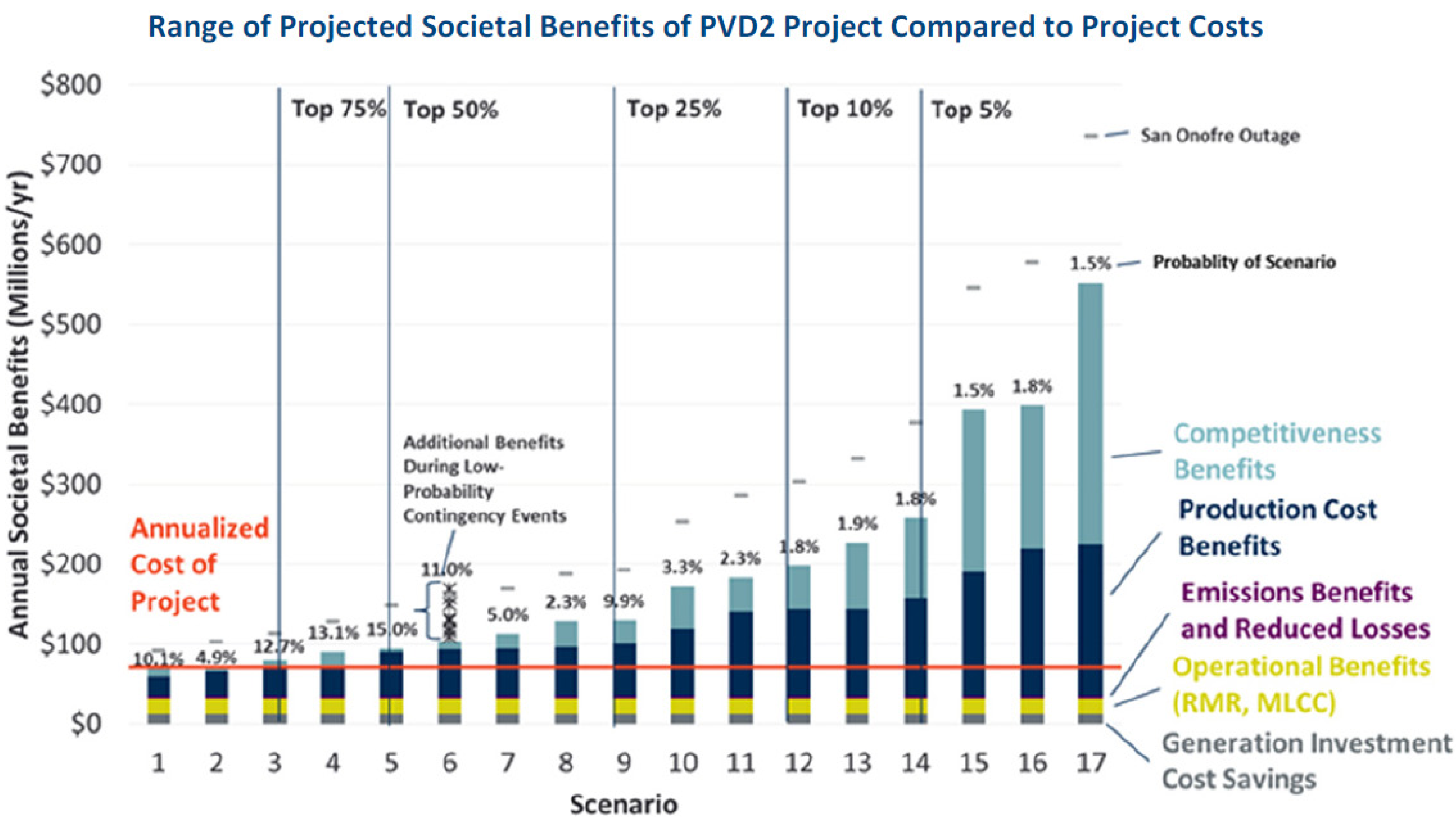
Inadequate Transmission Imposes High Risks

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

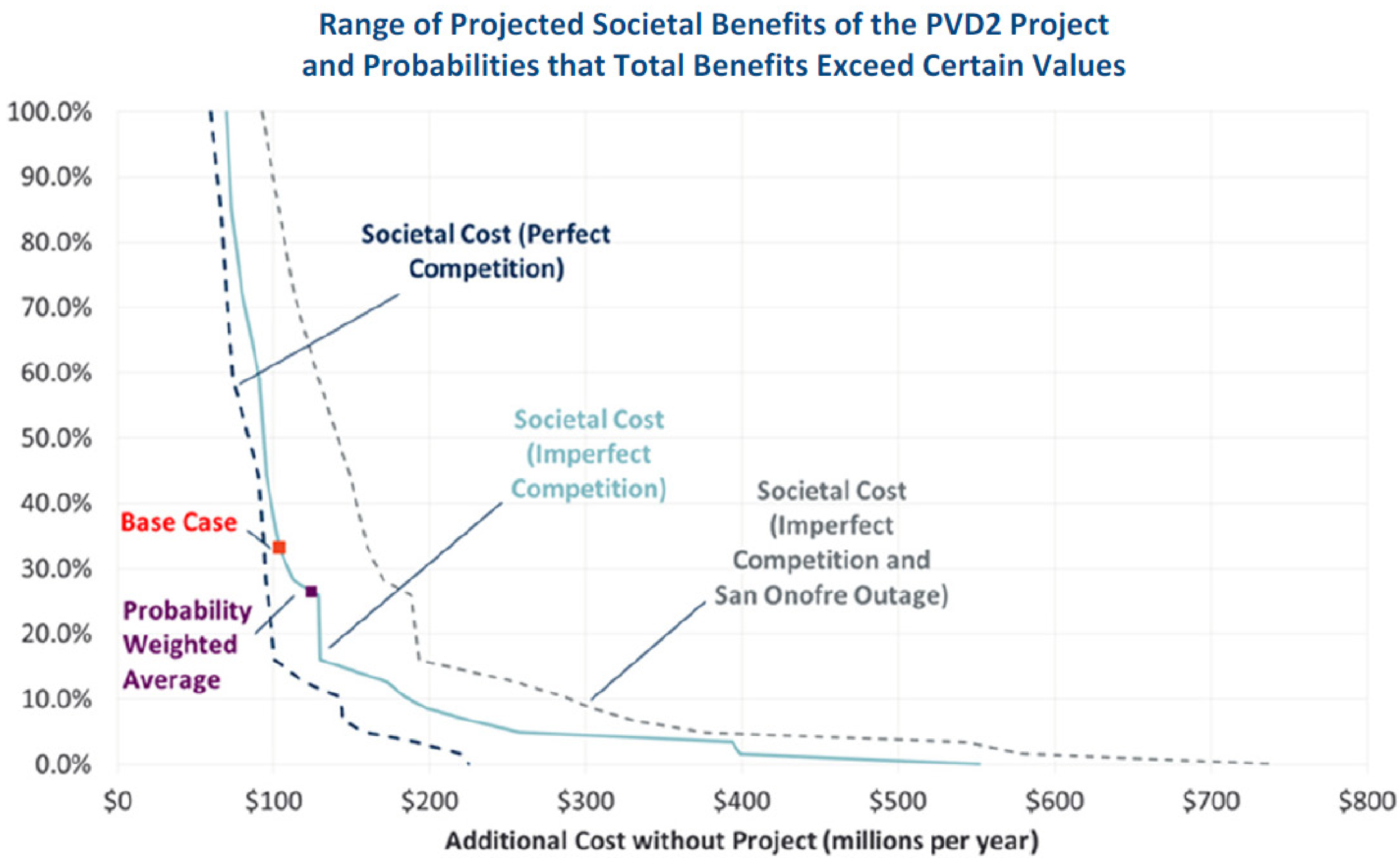
- Economic transmission planning generally evaluates only "normal" system conditions.
  - Planning process typically ignores the high cost of short-term **challenges and extreme market conditions** triggered by weather, outages, fuel supply disruption, unexpected load growth.
- Planning does not adequately 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.

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



Illustrative Example: Considering the Distribution of Transmission Benefits is Important as Well (cont'd)



Inadequate Transmission Imposes High Risks

Planning processes largely ignore the risk mitigation and insurance value of transmission infrastructure

- Given that it can take a decade to develop new transmission, delaying investment can easily **limit future options** and result in a **higher-cost, higher-risk** overall outcomes.
  - “Wait and see” approaches limit options, so can be very costly in the long term.
  - The industry needs to plan for short- and long-term uncertainties more proactively – and develop "anticipatory planning" processes.
- “Least regrets” planning today mostly focuses on identifying those projects that are beneficial under most circumstances.
  - Does not consider the many potentially “regrettable circumstances” that could result in very high-cost outcomes.
  - Focuses too much on the cost of insurance without considering the cost of not having insurance when it is needed.

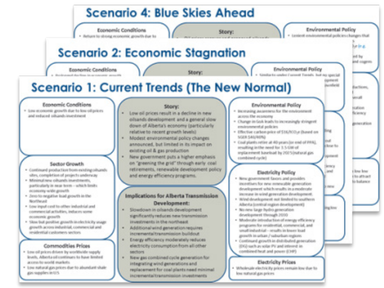
Scenario-Based Transmission Planning

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



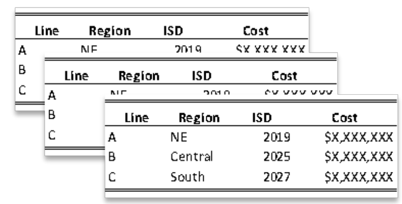
3. Transforming Future Scenarios into Planning Assumptions

- 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



Interpretation and Uses of the Scenarios

- The 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 for more immediate needs.
- Scenario-based transmission planning can also help **evaluate the types of public policies** that transmission planners may want to support.

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, industri 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

Example: ERCOT Long-Term System Assessment

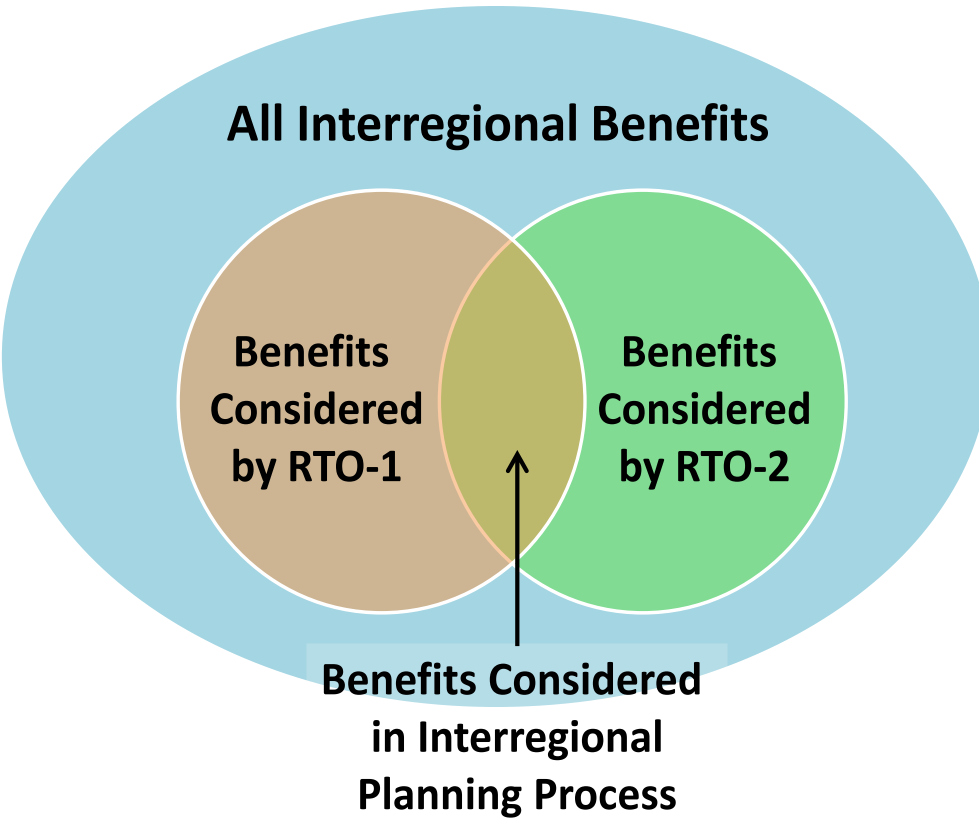
Input Assumptions	1. Current Trends	2. Global Recession	3. High Econ Growth	4. High Efficiency/DG	5. High Gas Price	6. Stringent Environmental	7. Low Global Oil Prices	8. High LNG Exports	9. High System Resilience	10. Water Stress
Economic Growth										
System Load Growth (Peak and Total Energy)	Med	Low	High	Low	Med	Med	Low	High	Med	Low
Local Load Growth (deviations from system growth)										
I-35	Med	Low	High	Low	Med	Med	Med	High	Med	Med
Houston	Med	Low	High	Low	Med	Med	Med	High	Med	Med
Midland/Odesaa	Med	Low	High	Med	Med	Low	Low	High	Med	Low
Lower Rio Grand Valley	Med	Low	High	Med	Med	Med	Low	High	Med	Low
Dry Gas Basins	Low	Low	High	Low	High	Low	High	High	Low	Med
Capital availability/business environment	Med	Low	High	High	High	High	Med	Med	Med	Med
Env Regs/Energy Policy										
Fossil plant retirements	Med	High	Low	High	Low	High	Med	Med	Med	High
GHG Regulations	Flexible	Flexible	Flexible	Flexible	Flexible	GHG Standard	Flexible	Flexible	Flexible	Flexible
Renewable incentives	Med	High	Med	Med	Med	High	Med	Med	Med	High
Nuclear relicensing	Med	Low	High	Low	High	Med	Med	Med	Med	Med
Limits/regulations on oil & gas development	Med	Med	Low	High	High	High	Med	Low	Med	High
Alternative Generation										
Renewable and storage capital cost reductions	Med	Low	High	High	High	High	Med	Med	Med	High
Annual renewable capacity total additions	Econ.	Subsidized	Econ.	Econ.	Econ.	Subsidized	Econ.	Econ.	Econ.	Subsidized
Natural Gas/Oil Prices										
NG price forecast	Low	Low	Med	Low	High	Med	Med	Low	Low	Med
Oil price forecast	Med	Low	Med	Med	Med	Med	Low	High	Med	Med
Transmission Regulation										
DC-tie capacity increases	Med	Low	Med	Med	Med	High	Med	Med	High	High
Transmission costs per mile	Med	Low	High	Med	Med	High	Med	Med	Med	Med
CREZ-like program	No	No	No	No	No	Solar	No	No	Load-Based	Solar
Generation Resource Adequacy										
Reserve margin	None	None	Yes	None	None	None	None	None	Yes	Yes
End Use/New Markets										
DG Growth	Med	Low	High	Very High	High	High	Med	Med	Med	High
EE Growth	Med	High	Med	Very High	High	High	Med	Med	Med	High
DR Growth	Med	Med	High	Very High	High	High	Med	Med	High	High
Water/Weather										
Climate Impacts	Med	Med	Med	Med	Med	High	Med	Med	Med	High
Water Stress/Costs	Med	Low	High	Med	High	High	Med	Low	Med	High

Planning Across Seams

- **Divergent criteria create barriers** for transmission between RTOs.
  - For example, cross border tariffs should not narrowly defined economic drivers in neighboring systems.
  - New England needs to work closely with New York and Canadian provinces to identify the most valuable infrastructure, considering the benefits to all neighboring systems.
- **Planner need to consider the combined benefits** to find transmission projects that benefit across regions.
- **Planners need to avoid this "least common denominator" outcome** by evaluating interregional projects based on benefits.

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.

Ineffective "Compartmentalized" Planning

Experience from around the country shows that most planners 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 Mid-Atlantic/Midwest example).
- It eliminates many projects from consideration simply because they don't fit into the existing planning "buckets."

Recommendations for Policy Makers

Policy makers and regulators play a key role in influencing the scope of regional and interregional transmission planning efforts. We therefore recommend that they encourage planners to:

- Consider the full range of transmission-related benefits.
- Better understand and estimate the high risks and high costs of an insufficiently robust and flexible grid.
- Move from compartmentalizing projects into "reliability," "economic," and "public policy" projects to developing projects that can provide multiple values at lower combined overall costs.
- Improve interregional planning processes to avoid least-common-denominator approaches and consider the multiple but different values that projects can provide to individual regions.

All of these steps are necessary to meet regional and national energy and public policy needs.

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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 18 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 Massachusetts Clean Energy Center, and the founding Executive 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.

About The Brattle Group

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:

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- Energy Contract Litigation
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- Renewables
- Resource Planning
- Retail Access & Restructuring
- Strategic Planning
- Transmission

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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 23, 2015 at www.wiresgroup.com
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