

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

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WIRES

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July 31, 2013

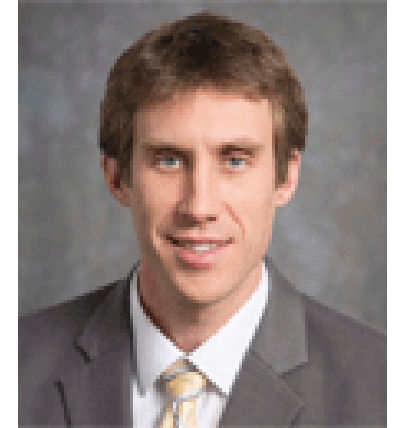
Introduction – Speakers



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This presentation is based on the report with the same title posted here: <http://wiresgroup.com/docs/WIRES%20Brattle%20Rpt%20Benefits%20Transmission%20July%202013.pdf>

Agenda

- A. Importance of Considering all Benefits**
- B. Evolving RTO and non-RTO Experience**
- C. Checklist of Transmission Benefits**
- D. Proposed Framework for Incorporating Benefits**
- E. Comparing Uncertain Benefits and Costs**
- F. Interregional Planning**
- Appendix: Details on Benefit Metrics in Checklist**

A. Importance of Considering All Benefits

- ◆ Not all proposed transmission projects can (or should) be justified economically
- ◆ Transmission projects can provide a wide range of benefits—economic, public, and reliability—to a range of market participants and regions
- ◆ Narrow or conservative evaluation of transmission benefits risks rejection of valuable projects
 - Transmission benefits in large part are a reduction in system-wide costs
 - Not considering the full economic benefits of transmission investments means not considering all costs and the potentially very-high-cost outcomes that market participants would face without these investments
- ◆ Production cost simulations have become a standard tool to assess “economic benefits” of transmission, but only considers short-term dispatch-cost savings under very simplified system conditions (e.g., no transmission outages)
 - Simplified simulations reflect incomplete production cost savings, thus only a smaller portion of the overall economy-wide benefits

B. Evolving RTO and non-RTO Experience

- ◆ Planners and regulators increasingly recognize importance of considering the wide range of transmission benefits
- ◆ In recent years, some RTOs—in particular the SPP, MISO and CAISO)—gradually expanded transmission planning beyond addressing reliability and load serving concerns to include economic and public-policy drivers.
- ◆ Other RTOs and most non-RTO regions still rely primarily on the traditional application of production cost simulations estimate economic value of transmission
- ◆ Despite the differences among regions in how they consider transmission benefits in planning, the same set of potential transmission benefits applies in all of them

B. Benefits in RTO Regional Planning

RTO Planning Process	Estimated Benefits	Other Benefits Considered (without necessarily estimating their value)
CAISO TEAM (as applied to PVD2)	<ul style="list-style-type: none"> • Production cost savings and reduced energy prices from both a societal and customer perspective • Mitigation of market power • Insurance value for high-impact low-probability events • Capacity benefits due to reduced generation investment costs • Operational benefits (RMR) • Reduced transmission losses • Emissions benefits 	<ul style="list-style-type: none"> • Facilitation of the retirement of aging power plants • Encouraging fuel diversity • Improved reserve sharing • Increased voltage support
SPP ITP Analysis	<ul style="list-style-type: none"> • Production cost savings • Reduced transmission losses • Wind revenue impacts • Natural gas market benefits • Reliability benefits • Economic stimulus benefits of transmission and wind generation construction 	<ul style="list-style-type: none"> • Enabling future markets • Storm hardening • Improving operating practices/maintenance schedules • Lowering reliability margins • Improving dynamic performance and grid stability during extreme events • Societal economic benefits
Additional benefits recommended by SPP's Metrics Task Force	<ul style="list-style-type: none"> • Reduced energy losses, • Reduced transmission outage costs • Reduced cost of extreme events • Value of reduced planning reserve margins or loss of load probability • Increased wheeling through and out revenues • Value of meeting public policy goals 	<ul style="list-style-type: none"> • Mitigation of weather uncertainty • Mitigation of renewable generation uncertainty • Reduced cycling of baseload plants • Increased ability to hedge congestion costs • Increased competition and liquidity

B. Benefits in RTO Regional Planning (cont'd)

RTO Planning Process	Estimated Benefits	Other Benefits Considered (without necessarily estimating their value)
MISO MVP Analysis	<ul style="list-style-type: none"> • Production cost savings • Reduced operating reserves • Reduced planning reserves • Reduced transmission losses • Reduced renewable generation investment costs • Reduced future transmission investment costs 	<ul style="list-style-type: none"> • Enhanced generation policy flexibility • Increased system robustness • Decreased natural gas price risk • Decreased CO₂ emissions output • Decreased wind generation volatility • Increased local investment and job creation
NYISO CARIS	<ul style="list-style-type: none"> • Reliability benefits • Production cost savings 	<ul style="list-style-type: none"> • Emissions costs • Load and generator payments • Installed capacity costs • Transmission Congestion Contract value
PJM RTEP	<ul style="list-style-type: none"> • Reliability benefits • Production cost savings 	<ul style="list-style-type: none"> • Public policy benefits
ERCOT LTS	<ul style="list-style-type: none"> • Reliability benefits • Production cost savings • Avoided transmission project costs 	<ul style="list-style-type: none"> • Public policy benefits
ISO-NE RSP	<ul style="list-style-type: none"> • Reliability benefits • Net reduction in total production costs 	<ul style="list-style-type: none"> • Public policy benefits

B. Benefits in Non-RTO Regional Planning

Non-RTO Planning Organization	Benefits Considered in Regional Planning
WECC	<ul style="list-style-type: none">• Avoided local transmission project costs• Production cost savings• Reduced generation capital costs
ColumbiaGrid	<ul style="list-style-type: none">• Avoided local transmission project costs
NTTG	<ul style="list-style-type: none">• Avoided local transmission project costs• Reduced energy losses• Reduced reserve costs
WestConnect	<ul style="list-style-type: none">• Avoided local transmission project costs• Production cost savings• Reserve sharing benefits
SERTP	<ul style="list-style-type: none">• Avoided local transmission project costs
NCTPC	<ul style="list-style-type: none">• Avoided local transmission project costs
Florida Sponsors	<ul style="list-style-type: none">• Avoided local transmission project costs

C. “Checklist” of Economic Transmission Benefits

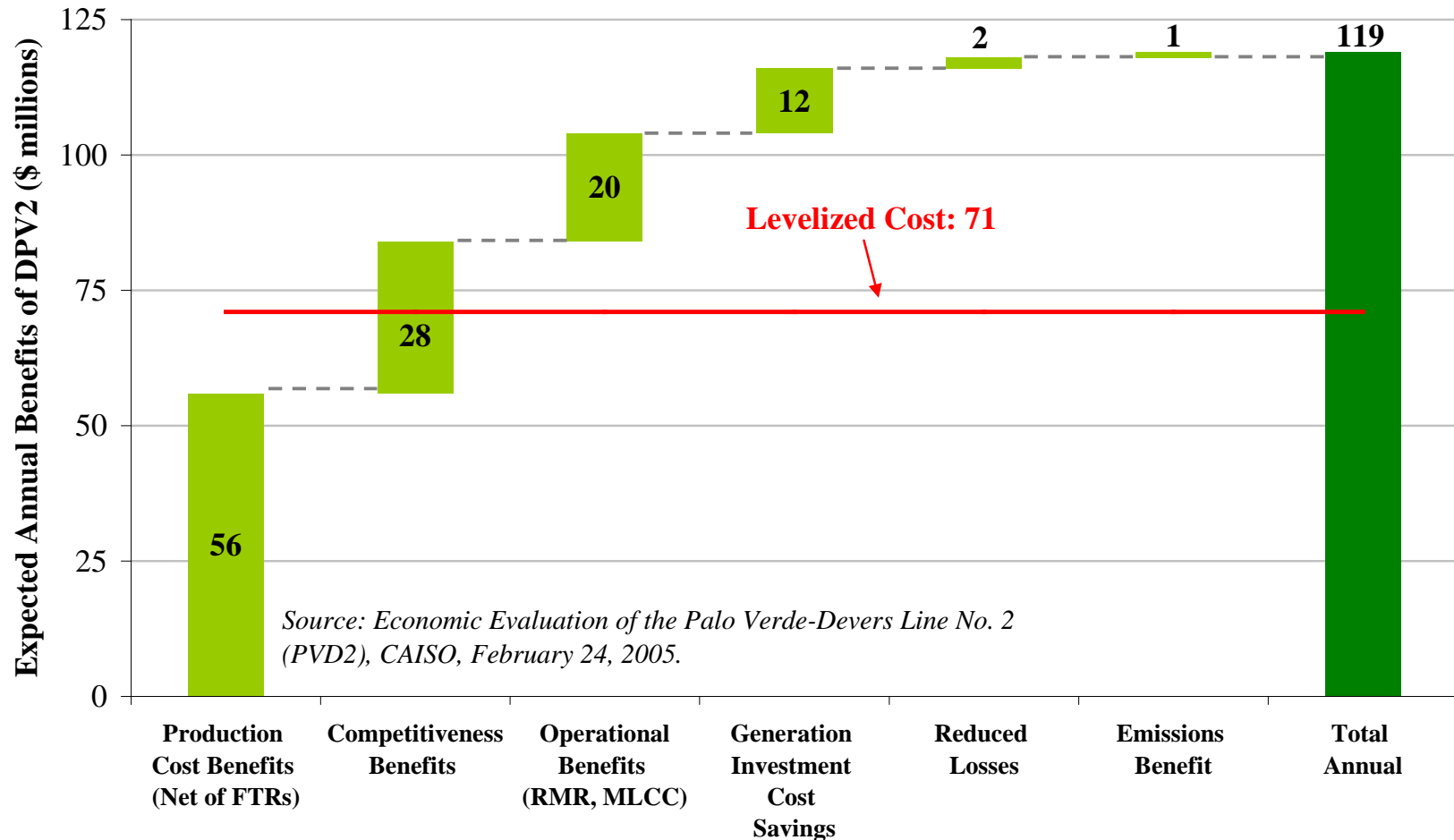
- ◆ Compiled a “checklist of economic benefits” from a detailed review of industry practices and our own experience
 - Can be used to help identify the potential benefits of transmission investments
 - Recommend policy makers and planners use this checklist to document, evaluate, and communicate a comprehensive “business case” for transmission projects.
- ◆ How to estimate the monetary value of benefits in checklist?
 - Some benefits should be measured routinely with existing tools and metrics (such as “Adjusted Production Cost” savings)
 - Other potentially-significant, but difficult-to-estimate benefits should be analyzed by calculating their likely range and magnitude
 - Omitting consideration of such difficult-to-estimate benefits inherently assigns a zero value and thereby results in a systematic understatement of total project benefits

“Checklist” of Economic Transmission Benefits

<u>Benefit Category</u>	<u>Transmission Benefit (see Appendix for descriptions and detail)</u>
Traditional Production Cost Savings	Production cost savings as currently
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

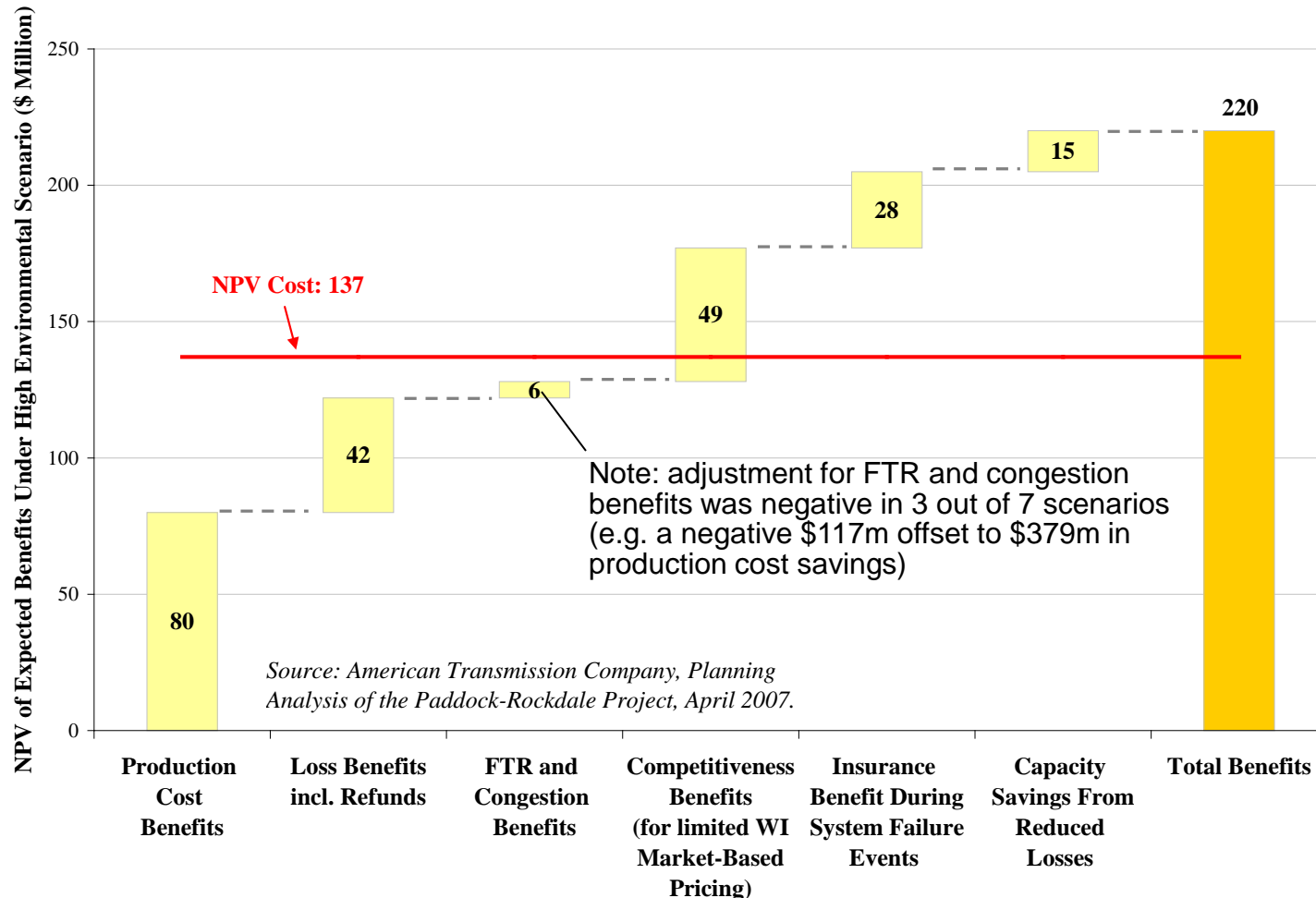
Example: Range of Project Benefits vs. Costs

Total electricity market benefits of SCE's DPV2 project in CAISO exceeded project costs by more than 50%



Example: Range of Project Benefits vs. Costs

ATC's Paddock-Rockdale study: Significant net benefits (production cost savings alone exceeded costs in some scenarios)



D. Proposed Framework for Incorporating Benefits

1. System planners and stakeholders to identify potentially valuable transmission projects and develop a comprehensive list of likely benefits
2. Perform unbiased evaluation of proposed projects to estimate the value of as many of the identified benefits as practical without regard to how the benefits would be distributed
3. Determine whether the projects would be beneficial overall by comparing estimated economy-wide (often referred to as “societal”) benefits with estimates of total project costs
4. Address cost allocation last—and for portfolio of beneficial projects—to reduce incentives to minimize benefits and avoid premature rejection of valuable projects

E. Comparing Uncertain Benefits and Costs

- ◆ Long life of assets requires comparison of long-term benefits and costs:
 - Either on a present value or levelized annual basis
 - Over a time period, such as 40 or 50 years, that approaches the useful life of the physical assets
- ◆ How benefits and costs accrue over time and across future scenarios will help optimize the timing of investments
- ◆ Near- and long-term uncertainties need to be addressed to develop robust plans and least-regret projects:
 - Long-term uncertainties (industry structure, new technologies, fundamental policy changes, and shifts in fuel market fundamentals) can be addressed through scenario-based analyses
 - Near-term uncertainties within long-term scenarios (uncertainties in loads, fuel prices, transmission and generation outages) should be evaluated through sensitivity or “probabilistic” analyses

F. Interregional Planning

- ◆ Interregional planning and cost allocation is especially challenging
- ◆ Neighboring regions tend to evaluate interregional projects based only on the subset of benefits that are common to the planning processes of both regions
 - Results in the consideration of a narrower set of benefits in interregional projects than are considered for region-internal projects
 - Results in “de-militarized zones” between regions
- ◆ To avoid this “least common denominator” outcome, we recommend that each region, at a minimum, evaluate interregional projects based on all benefits that they consider for their regional projects
- ◆ Without recognizing all potential benefits, interregional planning will not find many projects that would benefit two or more regions

Additional Reading

- Chang, Pfeifenberger, Hagerty, "The Benefits of Electric Transmission: Identifying and Analyzing the Value of Investments," prepared for WIRES, July 2013.
- Pfeifenberger "Independent Transmission Companies: Business Models, Opportunities, and Challenges," *American Antitrust Institute's 13th Annual Energy Roundtable*, April 23, 2013.
- Pfeifenberger, Chang, Hou "Bridging the Seams: Interregional planning under FERC Order 1000," *Public Utilities Fortnightly*, November 2012.
- Pfeifenberger "Transmission Investment Trends and Planning Challenges," *EEI Transmission and Wholesale Markets School*, August 8, 2012
- Pfeifenberger and Hou, "Seams Cost Allocation: A Flexible Framework to Support Interregional Transmission Planning," April 2012.
- Pfeifenberger and Hou, *Transmission's True Value: Adding up the Benefits of Infrastructure Investments*, Public Utilities Fortnightly, February 2012.
- Pfeifenberger and Hou, *Employment and Economic Benefits of Transmission Infrastructure Investment in the U.S. and Canada*, on behalf of WIRES, May 2011.
- Pfeifenberger, *Easier Said Than Done: The Continuing Saga of Transmission Cost Allocation*, Harvard Electricity Policy Group meeting, Los Angeles, February 24, 2011.
- Pfeifenberger and Newell, *Direct testimony on behalf of The AWC Companies re: the Public Policy, Reliability, Congestion Relief, and Economic Benefits of the Atlantic Wind Connection Project*, filed December 20, 2010 in FERC Docket No. EL11-13.
- Pfeifenberger, Chang, Hou, Madjarov, "Job and Economic Benefits of Transmission and Wind Generation Investments in the SPP Region," *The Brattle Group, Inc.*, March 2010.
- "Comments of Peter Fox-Penner, Johannes Pfeifenberger, and Delphine Hou," in response to FERC's Notice of Request for Comments on Transmission Planning and Cost Allocation (Docket AD09-8).
- Pfeifenberger, "Assessing the Benefits of Transmission Investments," presented at the Working Group for Investment in Reliable and Economic Electric Systems (WIRES) meeting, Washington, DC, February 14, 2008.
- Pfeifenberger, Direct Testimony on behalf of American Transmission Company re: Transmission Cost-Benefit Analysis Before the Public Service Commission of Wisconsin, Docket 137-CE-149, January 17, 2008.
- Pfeifenberger, Testimony on behalf of Southern California Edison Company re: economic impacts of the proposed Devers-Palo Verde No. 2 transmission line, before the Arizona Power Plant and Transmission Line Siting Committee, Docket No. L-00000A-06-0295-00130, Case No. 130, September and October, 2006.

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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:

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
Rate Design, Cost Allocation, & Rate Structure
Regulatory Compliance & Enforcement
Regulatory Strategy & Litigation Support
Renewables
Resource Planning
Retail Access & Restructuring
Strategic Planning
Transmission

Appendix

Details on Benefit Metrics in “Checklist”

1. Additional Production Cost Savings

Transmission Benefit	Benefit Description	Approach to Estimating Benefit	Examples
1a. Reduced impact of generation outages and A/S designations	Consideration of generation outages (and A/S unit designations) will increase impact	Consider both planning and (at least one draw of) forced outages in market simulations. Set aside resources to provide A/S in non-optimized markets.	Outages considered in most RTO's
1b. Reduced transmission energy losses	Reduced energy losses incurred in transmittal of power from generation to loads reduces production costs	Either (1) simulate losses in production cost models; (2) estimate changes in losses with power flow models for range of hours; or (3) estimate how cost of supplying losses will likely change with marginal loss charges	CAISO (PVD2) ATC Paddock-Rockdale SPP (RCAR)
1c. Reduced congestion due to transmission outages	Reduced production costs during transmission outages that significantly increase transmission congestion	Introduce data set of normalized outage schedule (not including extreme events) into simulations or reduce limits of constraints that make constraints bind more frequently	SPP (RCAR) RITELine
1d. Mitigation of extreme events and system contingencies	Reduced production costs during extreme events, such as unusual weather conditions, fuel shortages, or multiple outages.	Calculate the probability-weighted production cost benefits through production cost simulation for a set of extreme historical market conditions	CAISO (PVD2) ATC Paddock-Rockdale
1e. Mitigation of weather and load uncertainty	Reduced production costs during higher than normal load conditions or significant shifts in regional weather patterns	Use SPP suggested modeling of 90/10 and 10/90 load conditions as well as scenarios reflecting common regional weather patterns	SPP (RCAR)
1f. Reduced costs due to imperfect foresight of real-time conditions	Reduced production costs during deviations from forecasted load conditions, intermittent resource generation, or plant outages	Simulate one set of anticipated load and generation conditions for commitment (e.g., day ahead) and another set of load and generation conditions during real-time based on historical data	
1g. Reduced cost of cycling power plants	Reduced production costs due to reduction in costly cycling of power plants	Further develop and test production cost simulation to fully quantify this potential benefit ; include long-term impact on maintenance costs	WECC study

1. Additional Production Cost Savings (cont'd)

Transmission Benefit	Benefit Description	Approach to Estimating Benefit	Examples
1h. Reduced amounts and costs of ancillary services	Reduced production costs for required level of operating reserves	Analyze quantity and type of ancillary services needed with and without the contemplated transmission investments	NTTG WestConnect MISO MVP
1i. Mitigation RMR conditions	Reduced dispatch of high-cost RMR generators	Changes in RMR determined with external model used as input to production cost simulations	ITC-Entergy CAISO (PVD2)
1j. More realistic “Day 1” market representation	Transmission expansion provide additional benefits in markets where congestion is managed less efficiently	Apply “hurdle rates” between transmission systems and balancing areas (standard approach) plus derate transfer capability for underutilized system during TLR events (e.g., by 5-16%)	DOE and MISO Day-2 market benefit studies

2+3. Resource Adequacy and Generation Capacity Cost Savings

Transmission Benefit	Benefit Description	Approach to Estimating Benefit	Examples
2a. Avoided or deferred reliability projects	Reduced costs on avoided or delayed transmission lines otherwise required to meet future reliability standards	Calculate present value of difference in revenue requirements of future reliability projects with and without transmission line, including trajectory of when lines are likely to be installed	All RTOs and non-RTOs ITC-Entergy analysis MISO MVP, ERCOT
2b. Reduced loss of load probability Or:	Reduced frequency of loss of load events (if planning reserve margin is not changed despite lower LOLEs)	Calculate value of reliability benefit by multiplying the estimated reduction in Expected Unserved Energy (MWh) by the customer-weighted average Value of Lost Load (\$/MWh)	SPP (RCAR)
2c. Reduced planning reserve margin	Reduced investment in capacity to meet resource adequacy requirements (if planning reserve margin is reduced)	Calculate present value of difference in estimated net cost of new entry (Net CONE) with and without transmission line due to reduced resource adequacy requirements	MISO MVP SPP (RCAR)
3a. Capacity cost benefits from reduced peak energy losses	Reduced energy losses during peak load reduces generation capacity investment needs	Calculate present value of difference in estimated net cost of new entry (Net CONE) with and without transmission line due to capacity savings from reduced energy losses	ATC Paddock-Rockdale MISO MVP SPP ITC-Entergy
3b. Deferred generation capacity investments	Reduced costs of generation capacity investments through expanded import capability into resource-constrained areas	Calculate present value of capacity cost savings due to deferred generation investments based on Net CONE or capacity market price data	ITC-Entergy
3c. Access to lower-cost generation	Reduced total cost of generation due to ability to locate units in a more economically efficient location	Calculate reduction in total costs from changes in the location of generation attributed to access provided by new transmission line	CAISO (PVD2) MISO ATC Paddock-Rockdale

4+5+6+7. Market, Environmental, Public Policy, and Economic Stimulus Benefits

	Transmission Benefit	Benefit Description	Approach to Estimating Benefit	Examples
4. Market Benefits	4a. Increased competition	Reduced bid prices in wholesale market due to increased competition amongst generators	Calculate reduction in bids due to increased competition by modeling supplier bid behavior based on market structure and prevalence of “pivotal suppliers”	ATC Paddock-Rockdale CAISO (PVD2, Path 26 Upgrade)
	4b. Increased market liquidity	Reduced transaction costs and price uncertainty	Estimate differences in bid-ask spreads for more and less liquid markets; estimate impact on transmission upgrades on market liquidity	SCE (PVD2)
5. Environmental Benefits	5a. Reduced emissions of air pollutants	Reduced output from generation resources with high emissions	Additional calculations to determine net benefit emission reductions not already reflected in production cost savings	NYISO CAISO
	5b. Improved utilization of transmission corridors	Preserve option to build transmission upgrade on an existing corridor or reduce the cost of foreclosing that option	Compare cost and benefits of upsizing transmission project (e.g., single circuit line on double-circuit towers; 765kV line operated at 345kV)	
6. Public Policy Benefits	Reduced cost of meeting public policy goals	Reduced cost of meeting policy goals, such as RPS	Calculate avoided cost of most cost effective solution to provide compliance to policy goal	ERCOT CREZ ISO-NE, CAISO MISO MVP SPP (RCAR)
7. Employment and Economic Stimulus Benefits	Increased employment, economic activity, and tax revenues	Increased full-time equivalent (FTE) years of employment and economic activity related to new transmission line	A separate analysis required for quantification of employment and economic activity benefits that are not additive to other benefits.	SPP MISO MVP

8. Other Project-Specific Benefits

Transmission Benefit	Benefit Description	Approach to Estimating Benefit	Examples
8a. Storm hardening	Increased storm resilience of existing grid transmission system	Estimate VOLL of reduced storm-related outages. Or estimate acceptable avoided costs of upgrades to existing system	ITC-Entergy
8b. Increased load serving capability	Increase future load-serving capability ahead of specific load interconnection requests	Avoided cost of incremental future upgrades; economic development benefit of infrastructure that can	ITC-Entergy
8c. Synergies with future transmission projects	Provide option for a lower-cost upgrade of other transmission lines than would otherwise be possible, as well as additional options for future transmission expansions	Value can be identified through studies evaluating a range of futures that would allow for evaluation of “no regrets” projects that are valuable on a stand-alone basis and can be used as an element of a larger potential regional transmission build out	CAISO (Tehachapi) MISO MVP
8d. Increased fuel diversity and resource planning flexibility	Interconnecting areas with different resource mixes or allow for resource planning flexibility		
8e. Increased wheeling revenues	Increased wheeling revenues result from transmission lines increasing export capabilities.	Estimate based on transmission service requests or interchanges between areas as estimated in market simulations	SPP (RCAR) ITC-Entergy
8f. Increased transmission rights and customer congestion-hedging value	Additional physical transmission rights that allow for increased hedging of congestion charges.		ATC Paddock-Rockdale
8g. Operational benefits of HVDC transmission	Enhanced reliability and reduced system operations costs		PJM PATH, AWC analyses

What is Not Addressed in our Report?

- ◆ Permitting and siting of new transmission facilities
- ◆ Processes and options for cost allocation
- ◆ Differences between regulated and merchant transmission
- ◆ Differences between the transmission planning and utility IRP processes
- ◆ Detailed discussion of iterative transmission planning process itself, including evaluation of transmission and non-transmission alternatives
- ◆ Development of decision-analysis tools or frameworks that may be able to streamline the planning process
- ◆ Institutional and organizational barriers to creating a credible, unbiased, and comprehensive planning process
- ◆ Implications of setting different allowed rates of return on transmission investments and regulatory incentives for such investments
- ◆ Broader political economy associated with building transmission, cost allocation, permitting, and regulation