Transmission Planning: The Challenges Ahead

PRESENTED TO

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THE Brattle GROUP

Content

A. Proposed Transmission Planning Framework

Identify and describe future scenarios to be considered in transmission planning

Identify likely valuable transmission projects under most scenarios and develop a comprehensive list of likely benefits

Estimate the value of the identified benefits without regard to distribution of benefits

Compare estimated economy-wide ("societal") benefits with project costs

Address cost allocation last to reduce incentives to minimize benefits and avoid premature rejection of valuable projects

B. Evolving RTO and non-RTO Experience

- Despite the differences among regions in how transmission benefits are considered in planning, **the same set of potential transmission benefits applies to all.**
- **Expanding both the horizon of uncertainties and time** will allow planners to look beyond immediate reliability and load serving needs.
- Some RTOs—SPP, MISO and CAISO— have expanded transmission planning to incorporate 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

B. Benefits Identified in RTO Regional Planning

RTO Planning Process	Estimated Benefits	Other Benefits Considered (without necessarily estimating values)
California CAISO TEAM (as applied to PVD2)	• Production cost savings and reduced energy prices from both a societal and customer perspective • Mitigation of market power • Insurance value for high-impact low-prob events • Capacity benefits due to reduced generation investment costs • Operational benefits (RMR) • Reduced transmission losses • Emissions benefits	• Facilitation of the retirement of aging power plants • Encouraging fuel diversity • Improved reserve sharing • Increased voltage support
Southwest Power Pool ITP Analysis	• Production cost savings • Reduced transmission losses • Wind revenue impacts • Natural gas market benefits • Reliability benefits • Economic stimulus benefits of transmission and wind generation construction	• 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	• 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	• Mitigation of weather uncertainty • Mitigation of renewable generation uncertainty • Reduced cycling of baseload plants • Increased ability to hedge congestion costs • Increased competition and liquidity

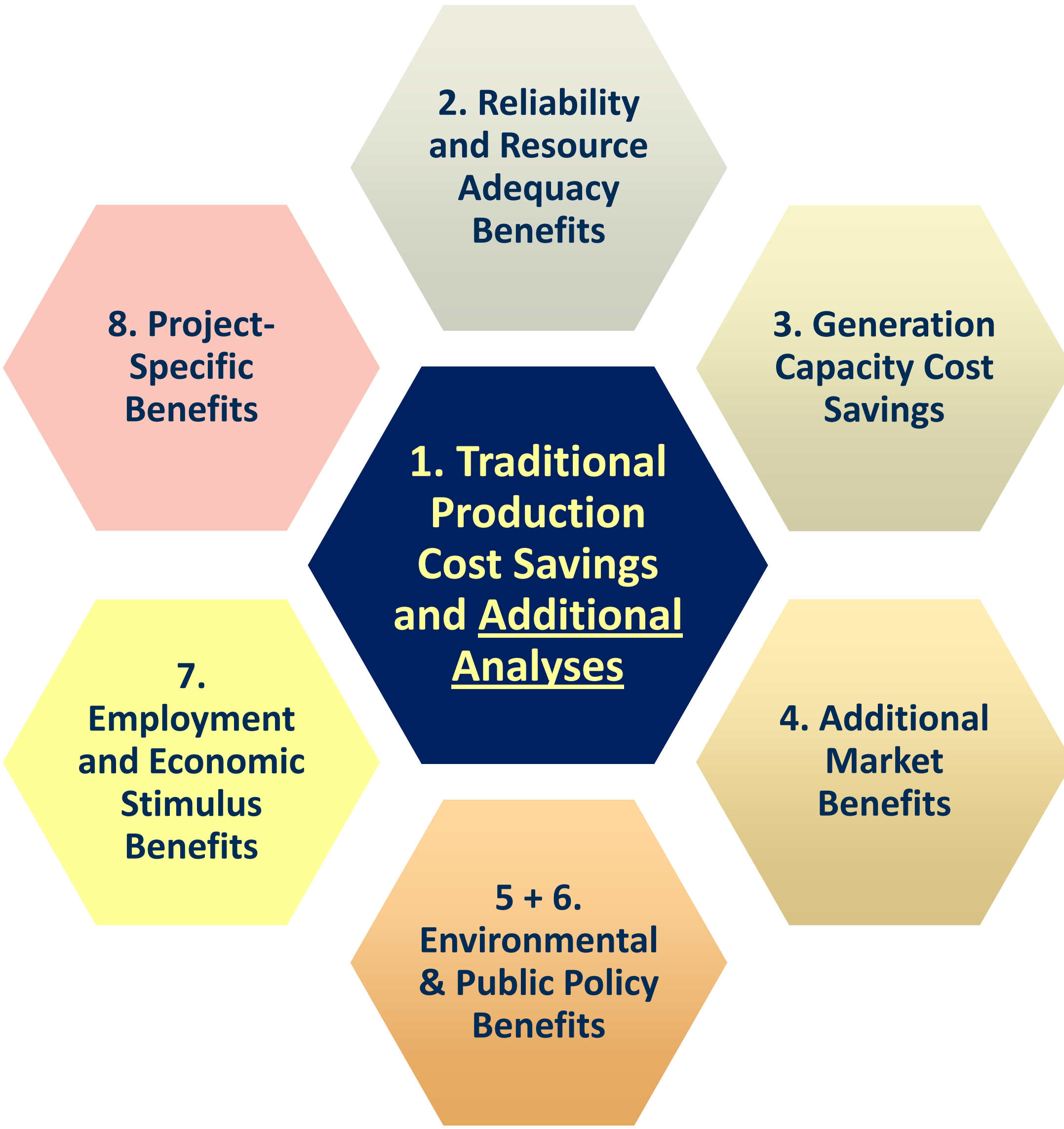
B. Benefits in RTO Regional Planning

RTO Planning Process	Estimated Benefits	Other Benefits Considered (without necessarily estimating their value)
MISO 2012 Multi-Value Project Analysis	• Production cost savings • Reduced operating reserves • Reduced planning reserves • Reduced transmission losses • Reduced renewable generation investment costs • Reduced future transmission investment costs	• Enhanced generation policy flexibility • Increased system robustness • Decreased natural gas price risk • Decreased CO_2 emissions output • Decreased wind generation volatility • Increased local investment and job creation
NYISO Congestion Assessment and Resource Integration Study	• Reliability benefits • Production cost savings	• Emissions costs • Load and generator payments • Installed capacity costs • Transmission Congestion Contract value
PJM Regional Transmission Expansion Plan	• Reliability benefits • Production cost savings	• Public policy benefits
ERCOT Long Term Study	• Reliability benefits • Production cost savings • Avoided transmission project costs	• Public policy benefits
ISO-NE Regional System Plan	• Reliability benefits • Net reduction in total production costs	• Public policy benefits

B. Benefits in Non-RTO Regional Planning

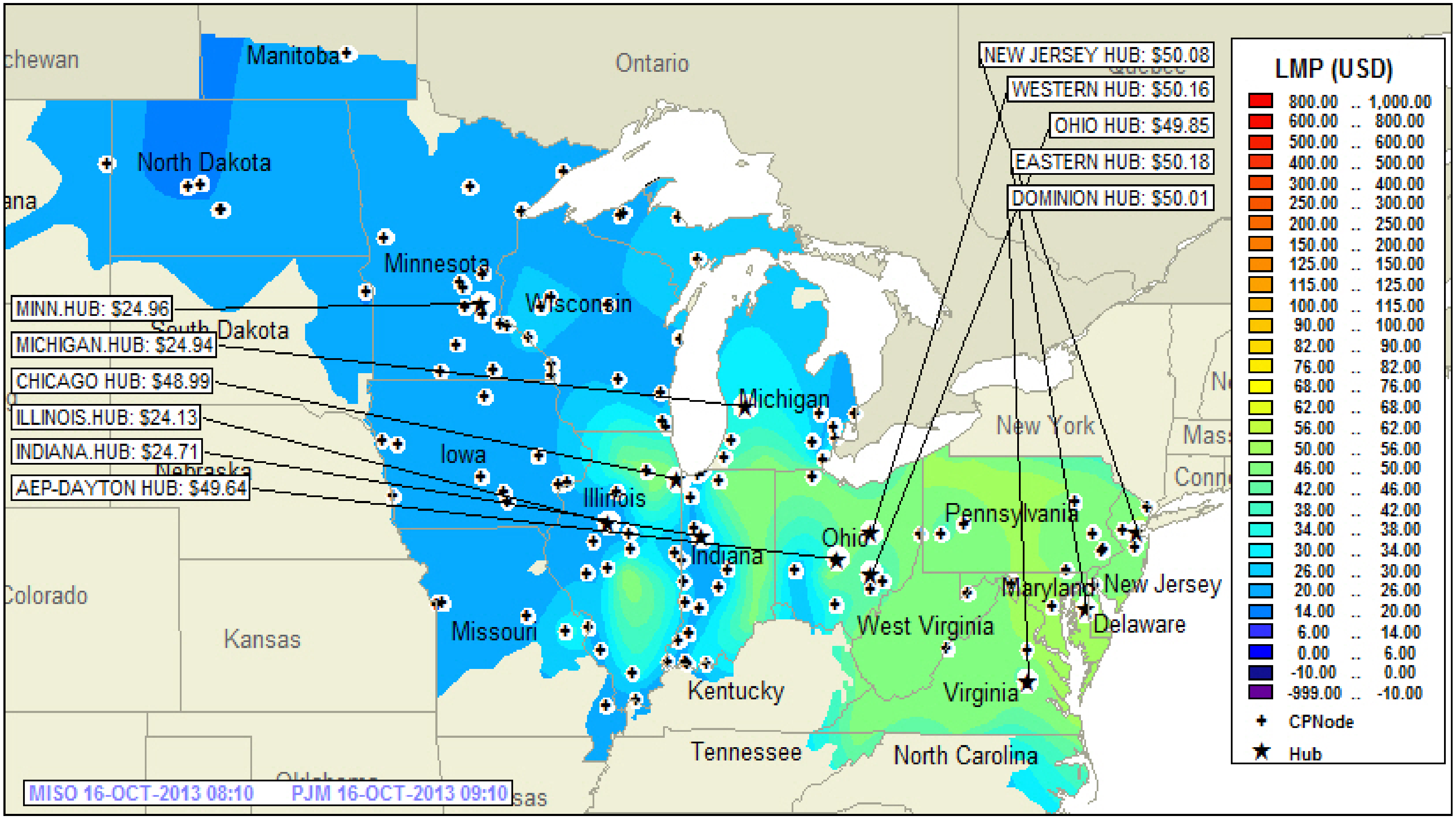
Non-RTO Planning Organization	Benefits Considered in Regional Planning
WECC	• Avoided local transmission project costs • Production cost savings • Reduced generation capital costs
ColumbiaGrid	• Avoided local transmission project costs
Northern Tier Transmission Group	• Avoided local transmission project costs • Reduced energy losses • Reduced reserve costs
WestConnect	• Avoided local transmission project costs • Production cost savings • Reserve sharing benefits
Southeastern Regional Transmission Planning Process	• Avoided local transmission project costs
North Carolina Transmission Planning Collaborative	• Avoided local transmission project costs
Florida Sponsors	• Avoided local transmission project costs

C. Consideration and Evaluation of Transmission Benefits



- **Recommend policy makers and planners use this checklist** to document, evaluate, and communicate a comprehensive "business case" for transmission.
- **Do NOT assign zero value to difficult-to-estimate benefits** because omitting them inherently assumes customers are better off paying for higher cost of delivered power

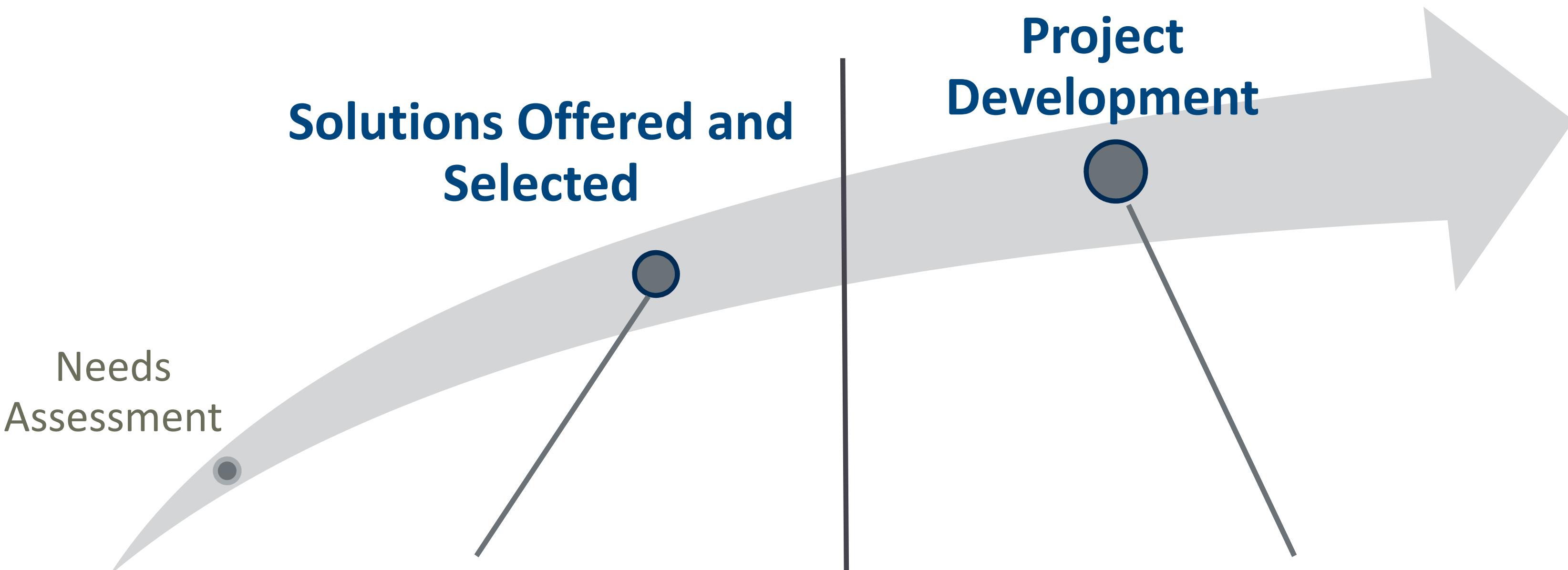
D. Planning Across Seams



D. Planning Across Seams

- **Divergent criteria create barriers** for transmission between RTOs
  - For example, the MISO-PJM cross border tariff for market efficiency projects (CBMEP) is limited to narrowly defined economic drivers in both RTOs.
  - Projects must simultaneously pass three tests to be included in the plan:
    1. MISO's MTEP process and criteria: production cost savings > 1.5 cost
    2. PJM's RTEP process and criteria: production cost savings and savings to load (different calculations as MISO's)
    3. Joint cross border interregional process and criteria: also different from individual RTO test
- **Need to consider the combined benefits** to find transmission projects that benefit across regions
- **Need to avoid this "least common denominator" outcome** by evaluating interregional projects based on benefits.

E. Scope of Competition in Transmission Business



Developers compete to provide and build <u>innovative solutions</u> to meet needs

- Planning entities identify needs and solicit competitive proposals/solutions
- Planning entities select preferred solution; winner has rights to finance, build, own, and operate projects
- **Examples: PJM, ISO-NE, NYISO**

Developers only compete to <u>finance, build, own, and operate specified projects</u>

- Planning entities identify need and specify solutions
- Competition to finance, own, and construct based on a number of factors including costs
- **Examples: Brazil, Alberta, Ontario, CAISO, ERCOT, MISO, SPP**

E. Transmission Projects Subject to Competition

- What would be "Competitive" is defined by physical and locational attributes.
- Competition can be introduced to projects that are:
  - Subject to regional cost sharing
  - New facilities (Used by every U.S. planning region per FERC Order No. 1000), with other details (including regional vs. inter-regional) to be sorted out
  - High Voltage
    - CAISO (>200 kV), SPP (>300 kV), Brazil (≥230kV)
  - Needed in the long-term (because could be too time-consuming)
    - PJM: only for projects needed beyond 3-5 years
    - ISO-NE, SPP: competitive for high voltage projects or those needed beyond 3 years
  - Needed to support special requirements:
    - CREZ, Offshore Wind in U.K.
- Some state instated state-level ROFRs that limit competition:
  - For example: Indiana, Minnesota, Nebraska, North & South Dakota, Oklahoma

E. Selection Criteria for Competitive Proposals

✓ - Key Qualification Criteria ✓✓ - Selection Criteria	PJM	NYISO	MISO	SPP	ISO-NE	CAISO	ERCOT /CREZ	ON	AB	UK	Brazil
Pre-Qualification	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Planning Process	✓	✓	✓✓	✓	✓	✓					
Experience/Resources	✓	✓	✓✓	✓✓	✓	✓✓	✓✓	✓✓	✓	✓	✓
Design/Technical	✓✓	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓	✓	
Schedule				✓✓	✓✓	✓✓		✓✓	✓	for build option	✓
Public Consultation								✓✓	✓		
ROW	✓	✓			✓✓	✓✓			✓		
Cost Containment						✓✓					
Cost / Cost-Effectiveness	✓✓	✓✓	✓✓	✓✓	✓✓		✓✓	✓✓	✓✓	✓✓	✓✓
Scoring System				✓✓				✓✓	✓	✓✓	

- U.S. proposed competitive processes are still subject to revisions and FERC approval
- U.S. RTOs also require non-incumbents to participate in regional planning process to qualify
- Selection of solutions offered may vary based on projects

E. Varying Experiences – Sample Examples

- **Brazil:**
  - Auctioned off $28 billion transmission investments over last 15 years
  - Bidders have a price to beat (Maximum reference annual revenue allowed) with the lowest cost bidder win
  - Concession granted for 30 years, with allowed revenue reduced by 50% after 15 years
- **ERCOT:**
  - ERCOT identified four plans to integrate 18,000 MW of wind in pre-specified CREZ
  - Public Utility Commission selected one plan and allocated to 14 companies
  - Scope and cost expanded (As of October 2013, estimated cost of $6.81B for 3,588 miles of new lines compared to initial estimate of $4.97B for 2,963 miles of new 345kV lines)
- **Ontario:**
  - Selection process scored 9 categories on equal weighting, cost being one
  - OEB judged costs based on ranking of project development costs and completeness of cost estimate (not necessarily lowest cost)
- **Alberta:**
  - Identified "critical transmission infrastructure" for competition
  - Shortlisted five bidders – results to be determined

E. Evolving Transmission Business Models

While focusing primarily on regulated investments, non-incumbent transmission developers have become increasingly active.

Below are 10 distinct business models:

	Strategy	Examples
1	Transmission partnerships with incumbents	ITC and AEP JVs in SPP
2	Public-private partnerships	MATL, Transbay Cable, Path15
3	Independent transmission company (new build)	Anbaric, TransElect, AWC
4	Merchant transmission	Zephyr, SunZia, Neptune
5	Renewable developers participating as ITC	NextEra, RES Americas
6	Transmission subsidiaries	AEP, Transource, DATC
7	Spin-off of transmission into quasi-ITC	ATC
8	Independent incumbent transmission (acquisitions)	ITC
9	Passive investment	Private Equity
10	Buy/invest in developer	Cleanline, Path 15

E. Impressions About Evolving Experiences in Competitive Transmission

- Experience with established competitive transmission processes (Brazil, UK) suggests **competition at the engineering and construction stage can offer some cost savings**
- But true savings probably are **greater when competition occurs at the idea/solution stage**, not just in the build stage
  - Benefits from innovation, ideas and problem solving are likely to be great. Thus procedures should allow competitions at these stages.
- Emerging Canadian and US experience shows **importance of local expertise and incumbent participation**
  - Having local experience/partner will often be critical to successful bids
  - Local system knowledge and relationship with RTO planning groups
  - Lower-cost opportunities to upgrade existing facilities or sharing of existing ROW

E. Going Back to Our Framework….

Identify and describe future scenarios to be considered in transmission planning
Include stakeholders and those that know the system

Identify likely valuable transmission projects under most scenarios
Think about likely benefits upfront

Estimate the value of the identified benefits without regard to distribution of benefits
Conduct the analysis

Compare estimated economy-wide ("societal") benefits with project costs
Include all benefits

Address cost allocation
Avoid creating barriers to valuable projects

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Note:

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Ms. Judy Chang is an energy economist and policy expert with a background in electrical engineering and over 16 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 Master's 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.

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
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Appendix

Additional Reading

Chang, Pfeifenberger, Newell, Tsuchida, Hagerty, “Recommendations for Enhancing ERCOT’s Long-Term Transmission Planning Process,” October 2013.

Chang, Pfeifenberger, Hagerty, "The Benefits of Electric Transmission: Identifying and Analyzing the Value of Investments,“ prepared for WIRES, July 2013.

Chang, “Implications of the Increase in Wind Generation for Alberta’s Market: Challenges of Renewable Integration,” presented at 13th Annual Alberta Power Summit, Calgary, Alberta, November 28, 2012.

Chang, “Challenges of Renewable Integration: Comparison of Experiences,” presented at Transmission Executive Forum West 2012, Meeting Public Policy Objectives through Transmission Investment, October 22, 2012.

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, Chang, Hou, Madjarov, *“Job and Economic Benefits of Transmission and Wind Generation Investments in the SPP Region,” The Brattle Group, Inc.*, March 2010.

D. "Checklist" of Economic Transmission Benefits

Benefit Category	Transmission Benefit (see Appendix for descriptions and detail)
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 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

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-weighed 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

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