Transmission Cost Allocation:
Principles, Methodologies, and Recommendations

PRESENTED BY

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PREPARED FOR

OMS Cost Allocation Principles Committee Meeting

Organization of MISO States
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THE Brattle GROUP

Presenting Today

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Hannes has analyzed transmission needs, transmission benefits and costs, transmission cost allocations, and transmission-related renewable generation challenges for independent system operators, transmission companies, generation developers, public power companies, and regulatory agencies across North America. He has worked with SPP and its RSC on regional transmission cost allocation reviews and with MISO and OMS on the evaluating cost-allocation alternatives for multi-value transmission projects.

Hannes received an M.A. in Economics and Finance from Brandeis University's International Business School and an M.S. and B.S. ("Diplom Ingenieur") in Power Engineering and Energy Economics from the University of Technology in Vienna, Austria.

Content

Introduction and background

The importance of separating two distinct tasks:

- Benefit-cost analysis for approving individual (or synergistic groups of) projects
- Cost allocation for approved portfolios of transmission projects

Experience with quantifying transmission-related benefits

Considerations for cost allocation

Summary and recommendations

Additional reading

Transmission Planning Processes Need Urgent Improvements to be "Future Ready"

Efforts to improve planning processes are urgently needed to fully realize the potential future savings for at least three reasons:

- Transmission projects require at least 5–10 years to plan, develop, and construct; as a result, **planning has to start early to more cost-effectively meet the challenges** of changing market fundamentals and the nation's public policy goals in the 2020–2030 timeframe
- A continued reliance on traditional transmission planning that is primarily focused on **reliability and local needs leads to piecemeal solutions** instead of developing integrated and flexible transmission solutions that enable the system to meet public policy goals will be more costly in the long run
- U.S. is in the midst of an investment cycle to replace **aging existing transmission** infrastructure, mostly constructed in the 1960s and 70s; this provides unique **opportunities** to create a more modern and robust electricity grid at lower incremental costs and with more **efficient use of existing rights-of-way** for transmission

Substantial recent transmission investments focused too narrowly on reliability and local needs have resulted in missed opportunities

Disagreements over cost allocation have derailed many planning efforts and created barriers to the development of valuable transmission projects

Key Challenges in U.S. Transmission Planning

Current planning processes do not yield the most valuable transmission infrastructure. Key barriers to doing so are:

1. Most projects are build solely to address **reliability and local needs**; the substantial recent investments in these types of projects now make it more difficult to justify valuable new transmission that could cost-effectively address economic and public policy needs
2. Planners and policy makers **do not consider the full range of benefits** that transmission investments can provide, understating the expected value of such projects and how these **values change over time**
3. Planners and policy makers do not sufficiently account for the **risk-mitigation and option value of transmission** infrastructure that can avoid the potentially high future costs of an insufficiently-robust and insufficiently-flexible transmission grid
4. Regional **cost allocation** is overly divisive, particularly when applied on a project-by-project (rather than portfolio- or grid-wide) basis
5. Ineffective **interregional planning processes** are generally unable to identify valuable transmission investments that would benefit two or more regions

Basic Cost Allocation and Recovery Mechanisms

1) **License plate:** each utility recovers the costs of its own transmission investments (usually located within its footprint).
2) **Beneficiary pays:** various formulas that allocate costs of transmission investments to individual Transmission Owners (TOs) that benefit from a project, even if the project is not owned by the beneficiaries. TOs then recover allocated costs in their License Plate tariffs from own customers.
3) **Postage stamp:** transmission costs are recovered uniformly from all loads in a defined market area (e.g., RTO-wide in ERCOT and CAISO).
   In some cases (e.g., SPP, MISO, PJM) cost of certain project types are allocated uniformly to TOs, who then recover these allocated costs in their License Plate tariffs.
4) **Direct assignment:** transmission costs associated with generation interconnection or other transmission service requests are fully or partially assigned to requesting entity.
   Innovative variance: Tehachapi LCRI (up-front shared funding, later charged back to generators)
5) **Merchant cost recovery:** the project sponsors recover the cost of the investment outside regulated tariffs (e.g., via negotiated rates with specific customers); largely applies to DC lines where transmission use can be controlled.
6) **Co-ownership:** benefitting transmission owners co-own the facility (each recovering costs through rate base treatment); one operator; shared transmission rights (often used in WECC)

Disagreements on Cost-Allocation Creates Challenges Even for Clearly-Beneficial Projects

Easiest: develop "needed" local and regional transmission projects that do not involve cost allocation (now majority in many regions)

Harder: share costs of reliability-driven transmission projects "needed" to meet regional reliability standards

- Most TOs strongly prefer recovering costs associated with their own ratebase
- Policy makers reluctant to pay for transmission that benefit other states

Hardest: allocate costs of economic and public policy projects that provide broad regional or interregional benefits (but are "optional" as they are not needed to maintain reliability)

- Fundamentally different future views of the world
  - Planners and policy makers may disagree on the outlook of natural gas costs but they agree the cost exists; not so with carbon or other policy-related benefits, which are often ignored
- Large regional and inter-regional projects for environmental policies pit states that have the policies (often major population centers) against states that don't (often more remote areas)
- Reluctance to pay for transmission that facilitates out-of-state generation investments with few direct local jobs

Challenges and Solutions: Addressed in Reports on Transmission Planning, Benefit-Cost Analyses, and Cost Allocations

Well-Planned Electric Transmission Saves Customer Costs:

Improved Transmission Planning is Key to the Transition to a Carbon-Constrained Future

Link: https://bit.ly/3dnKrxe

PREPARED FOR

WIRES

PREPARED BY

Judy W. Chang

Johannes P. Pfeifenberger

May 2016

THE Brattle GROUP

Toward More Effective Transmission Planning:

Addressing the Costs and Risks of an Insufficiently Flexible Electricity Grid

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April 2015

Link: https://bit.ly/2GU4h7w

The Brattle Group

Link: https://bit.ly/3jS0PsB

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

July 2013

Judy W. Chang

Johannes P. Pfeifenberger

J. Michael Hagerty

Benefits for the 2013 Regional Cost Allocation Review

September, 13 2012

Approved by:

Metrics Task Force

Economic Studies Working Group

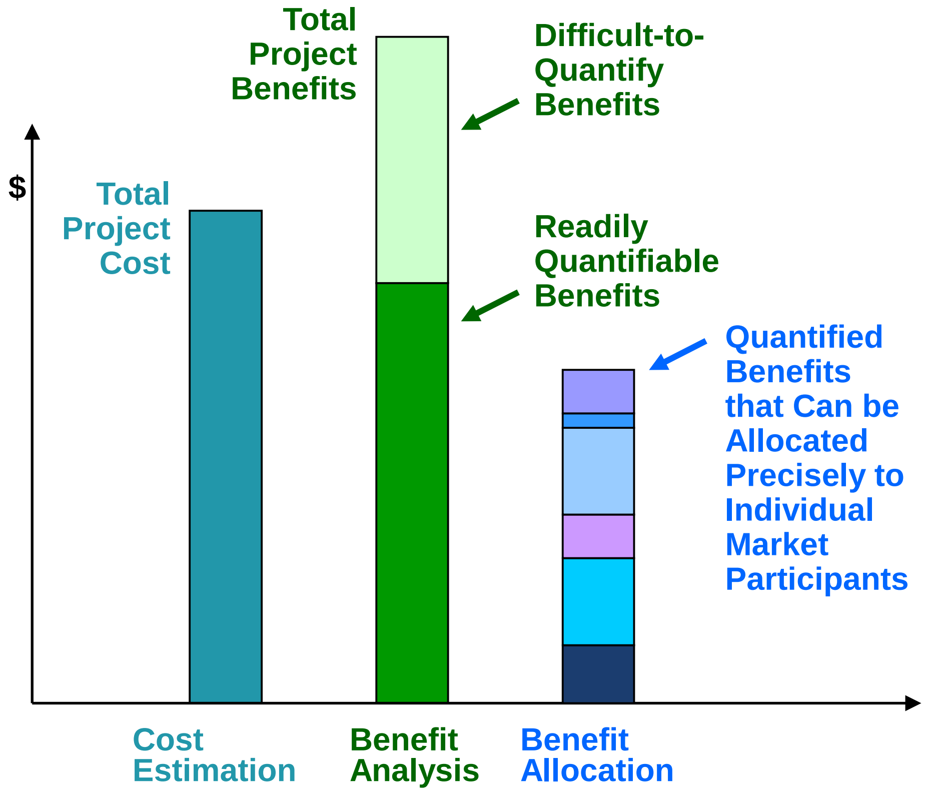
Link: https://bit.ly/3eYBAD6

SPP Southwest Power Pool

Recommendation: Clearly Separate Benefit-Cost Analysis of Projects from Cost-Allocation of Approved Portfolios

Recommend 2-step approach:

1. Determine whether projects are beneficial overall, quantifying a broad set of benefits
   - Without quantifying most benefits, many desirable projects will be rejected
   - Benefits that can be allocated precisely may only be a subset of total benefits
   - Avoid temptation to understate benefits in effort to reduce cost allocation to individual study participants
2. Evaluate how the cost of a portfolio of beneficial projects should be allocated based on distribution of benefits
   - Reduces conflict: a broad set of benefits quantified for a portfolio of projects tends to be more stable over time and be distributed more uniformly



Step 1: Quantify Transmission-Related Benefits for individual Projects (or Synergistic Groups of Projects)

The wide-spread nature of transmission benefits creates challenges in estimating benefits and how they accrue to different users

▪ **Broad in scope, providing many different types of benefits**	• Increased reliability and operational flexibility • Reduced congestion, dispatch costs, and losses • Lower capacity needs and generation costs • Increased competition and market liquidity • Renewables integration and environmental benefits • Insurance and risk mitigation benefits • Diversification benefits (e.g., reduced uncertainty and variability) • Economic development from G&T investments
▪ **Wide-spread geographically**	• Multiple transmissions service areas • **Multiple states** or regions
▪ **Diverse in their effects on market participants**	• **Customers**, **generators**, **transmission owners** in regulated and/or deregulated markets • Individual market participants may capture one set of benefits but not others
▪ **Occur and change over long periods of time**	• Several decades (50+ years), typically increasing over time • Changing with system conditions and future generation and transmission additions • Individual market participants may capture different types of benefits at different times

Production Cost Savings, the Most Common Metric, Misses Many Important Transmission-related Benefits

Adjusted Production Costs (APC) is the most widely-used benefit metric for production-cost simulations (e.g., with PROMOD). Standard model output, meant to capture the cost of generating power within an area net of purchases and sales (imports and exports):

Adjusted Production Costs (APC) =

- **+ Production costs** (fuel, variable O&M, startup, emission costs of generation within area)
- **+ Cost of hourly net purchases** (valued at the area-internal load LMP)
- **– Revenues from hourly net sales** (valued at the area-internal generation LMP)

Limitations:

- ♦ Assumes no losses, no unhedged congestion costs for delivering generation to load within each area
- ♦ Does not capture "gains of trade" – the extent that a utility can buy or sell at a better "outside" price
  - Assumes import-related congestion cannot at all be hedged with allocated FTRs
  - Assumes there here are no marginal loss refunds with imports or exports
- ♦ For simplicity, APC are typically only quantified for "normal" base-case conditions with perfect foresight
  - No transmission outages (every transmission element is assumed 100% available all the time)
  - Only "normal" conditions (weather-normalized loads, only "normal" generation outages)
  - No consideration of renewable generation uncertainty, change in A/S needs, reduction in transmission losses, fixed O&M cost of increased generation cycling, etc.
- ♦ Does not capture any investment-related (capacity cost) and risk-mitigation (insurance value) benefits

Good News: We have a Decade of Experience with Identifying and Quantifying a Broad Range of Transmission-related Benefits

SPP 2016 RCAR, 2013 MTF

Quantified

1. **production cost savings***
   - value of reduced emissions
   - reduced ancillary service costs
2. avoided transmission project costs
3. reduced transmission losses*
   - capacity benefit
   - energy cost benefit
4. lower transmission outage costs
5. value of reliability projects
6. value of mtg public policy goals
7. Increased wheeling revenues

Not quantified

8. reduced cost of extreme events
9. reduced reserve margin
10. reduced loss of load probability
11. increased competition/liquidity
12. improved congestion hedging
13. mitigation of uncertainty
14. reduced plant cycling costs
15. societal economic benefits

(SPP Regional Cost Allocation Review Report for RCAR II, July 11, 2016. SPP Metrics Task Force, *Benefits for the 2013 Regional Cost Allocation Review*, July, 5 2012.)

MISO MVP Analysis

Quantified

1. **production cost savings** *
2. reduced operating reserves
3. reduced planning reserves
4. reduced transmission losses*
5. reduced renewable generation investment costs
6. reduced future transmission investment costs

Not quantified

7. enhanced generation policy flexibility
8. increased system robustness
9. decreased natural gas price risk
10. decreased CO_2 emissions output
11. decreased wind generation volatility
12. increased local investment and job creation

(Proposed Multi Value Project Portfolio, Technical Study Task Force and Business Case Workshop August 22, 2011)

CAISO TEAM Analysis

(DPV2 example)

Quantified

1. **production cost savings*** and reduced energy prices from both a societal and customer perspective
2. mitigation of market power
3. insurance value for high-impact low-probability events
4. capacity benefits due to reduced generation investment costs
5. operational benefits (RMR)
6. reduced transmission losses*
7. emissions benefit

Not quantified

8. facilitation of the retirement of aging power plants
9. encouraging fuel diversity
10. improved reserve sharing
11. increased voltage support

(CPUC Decision 07-01-040, January 25, 2007, Opinion Granting a Certificate of Public Convenience and Necessity)

NYISO PPTN Analysis

(AC Upgrades)

Quantified

1. **production cost savings*** (includes savings not captured by normalized simulations)
2. capacity resource cost savings
3. reduced refurbishment costs for aging transmission
4. reduced costs of achieving renewable and climate policy goals

Not quantified

5. protection against extreme market conditions
6. increased competition and liquidity
7. storm hardening and resilience
8. expandability benefits

(Newell, et al., Benefit-Cost Analysis of Proposed New York AC Transmission Upgrades, September 15, 2015)

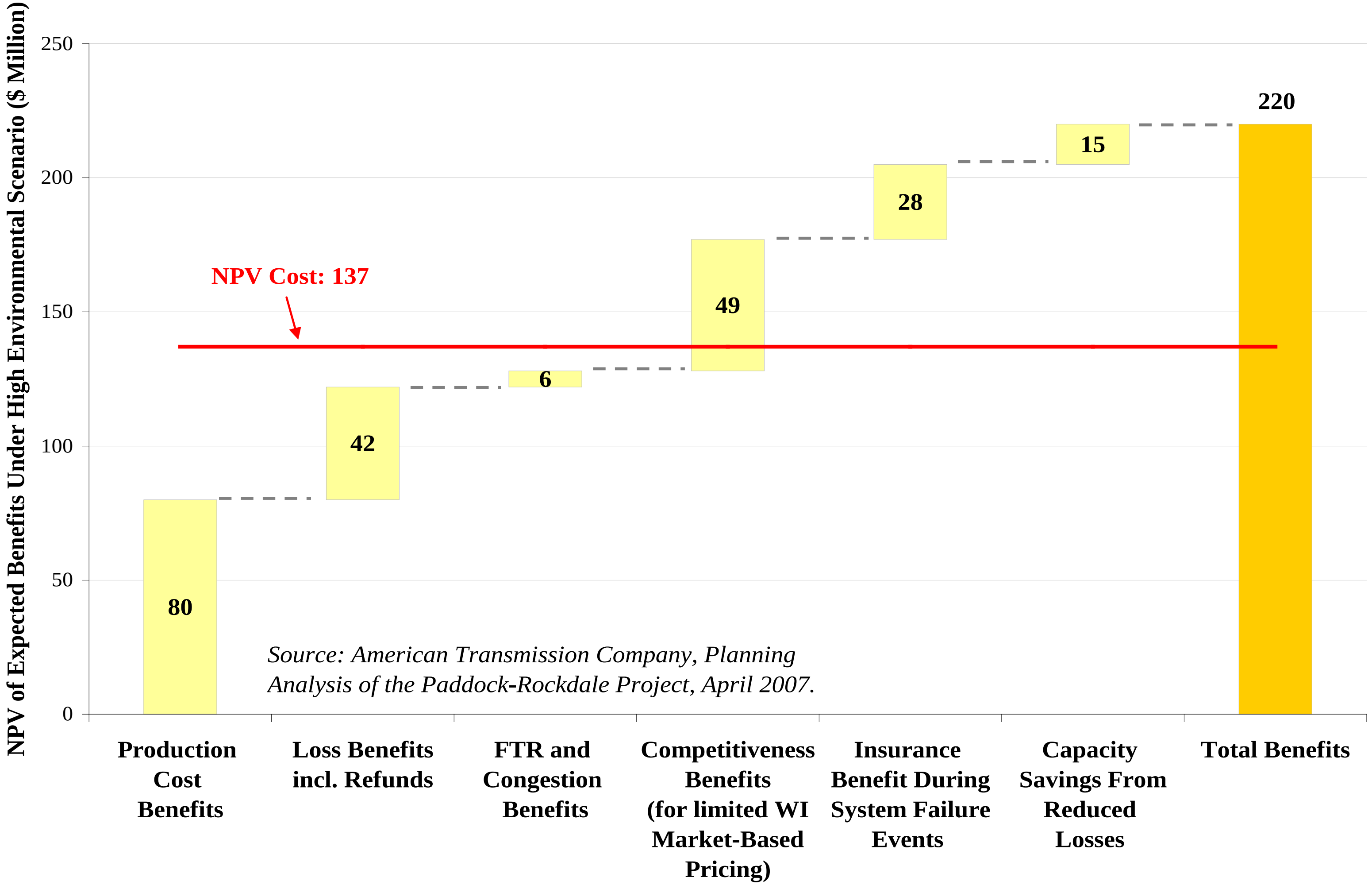
* Fairly consistent across RTOs

2013 WIRES Study: "Checklist" of Transmission Benefits and Best Practices for Quantifying Them

Benefit Category	Transmission Benefit
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

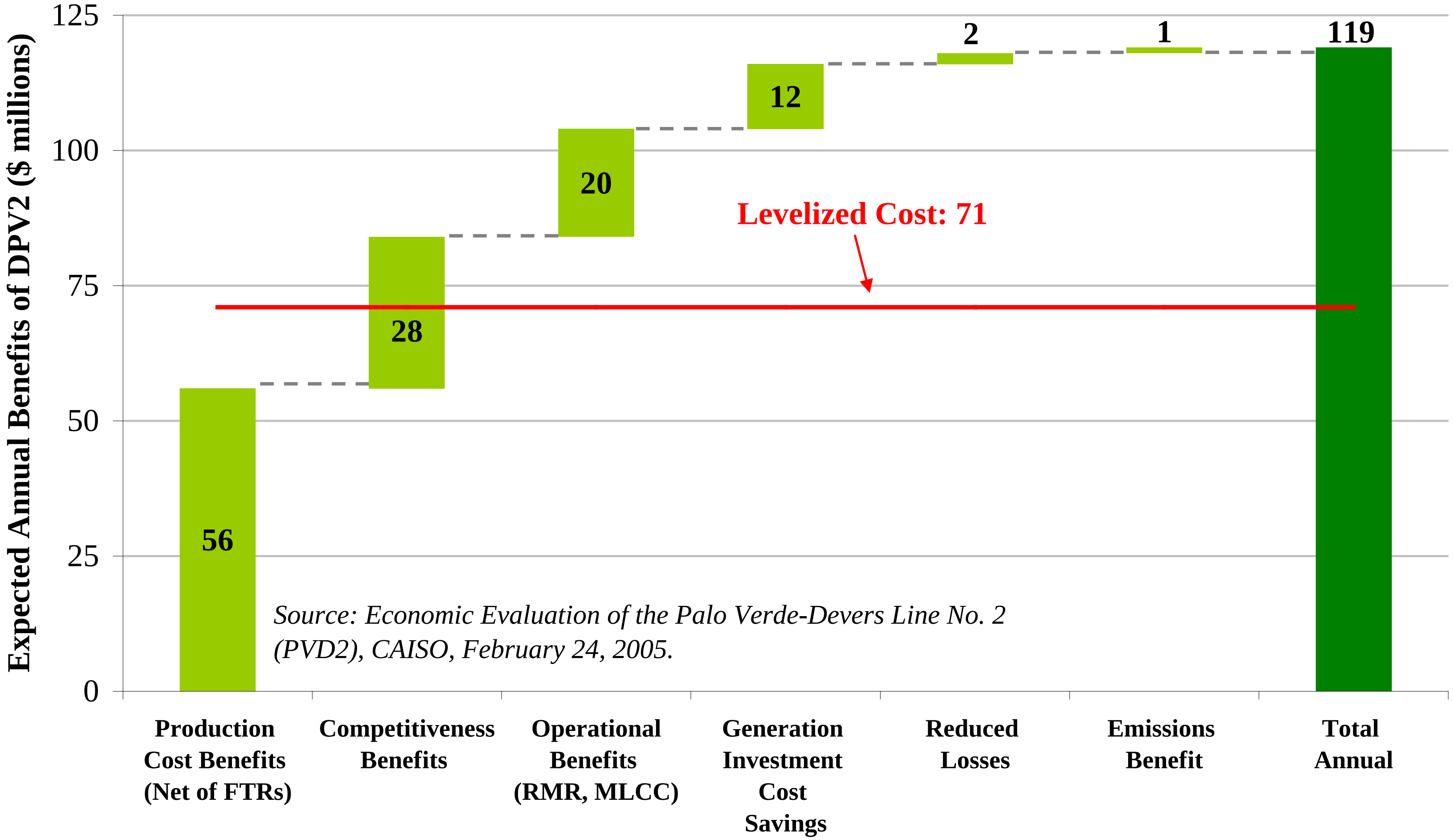
Example: Transmission Benefits and Costs in Wisconsin

ATC's Paddock-Rockdale Project study: Total benefits significantly exceed production cost savings



Example: CAISO Transmission Project Benefits vs. Costs

Total benefits of CAISO's DPV2 project exceeded project costs by more than 50%, but only if multiple benefits are quantified

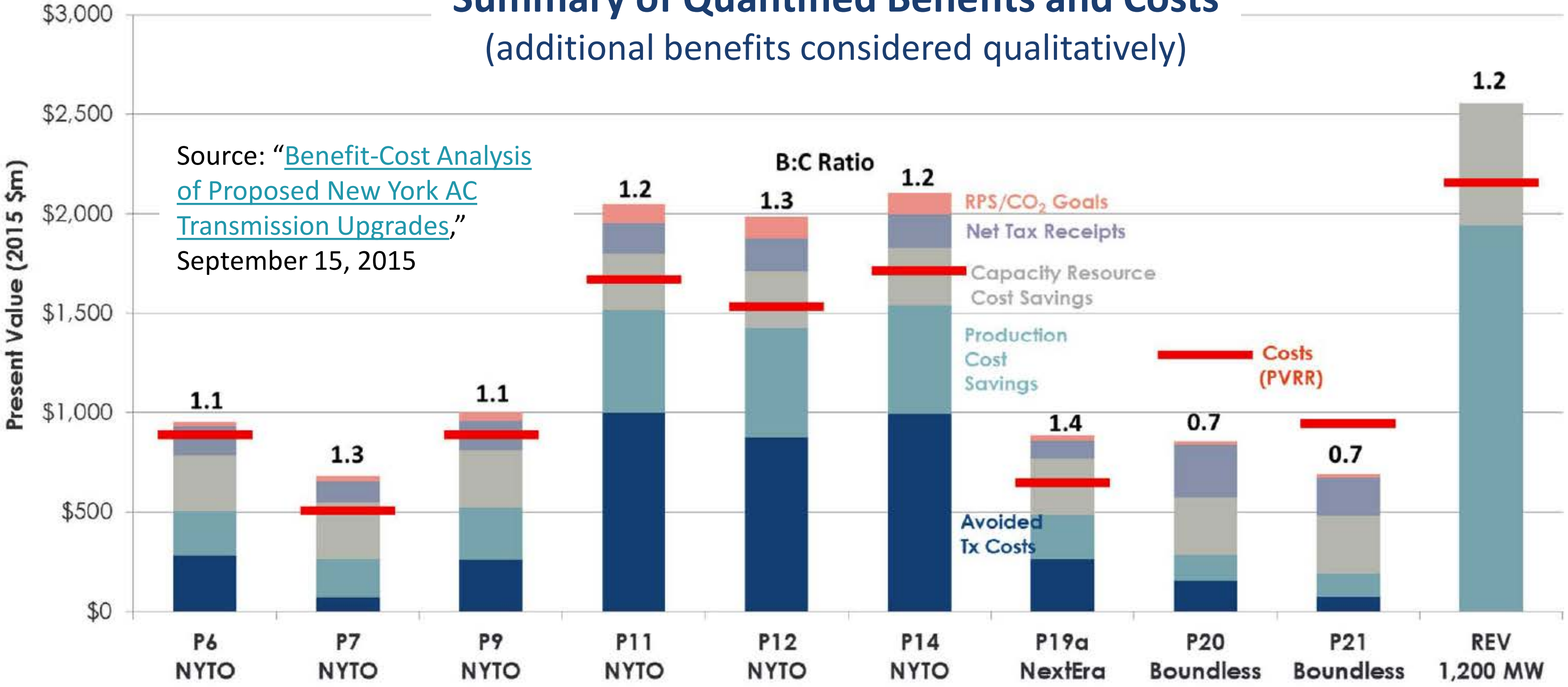


Source: Economic Evaluation of the Palo Verde-Devers Line No. 2 (PVD2), CAISO, February 24, 2005.

Example: New York's (Multi-Value) "Public Policy" Transmission Planning Process

New York DPS recently modified its "public policy" transmission planning process by mandating that a full set of benefits be considered. Resulted in approval and competitive solicitation of two major upgrades to the New York transmission infrastructure

Summary of Quantified Benefits and Costs
(additional benefits considered qualitatively)



Source: "Benefit-Cost Analysis of Proposed New York AC Transmission Upgrades," September 15, 2015

Step 2: Portfolio-Based Cost Allocations offer Substantial Advantages over Project-by-Project Allocations

Order 1000 does not require that the cost of each project is allocated based on its benefits … as long as the cost allocation for a portfolio of projects is roughly commensurate with overall benefits.

Even postage stamp (load-ratio share) allocation is appropriate and acceptable if:

- All customers tend to benefit from class or group of facilities
- Distribution of benefits likely to vary over long life of facilities

Portfolio-based cost allocations are less controversial and easier to implement

- **Portfolio-wide benefits tend to be more even distributed and more stable over time**
- **One cost allocation analysis for portfolio vs. many analyses for many projects**

Examples of portfolio-based cost allocations:

- SPP Highway-Byway (designed by RSC): Periodic review if benefits of all approved projects is roughly commensurate with costs of all projects
- MISO MVPs (with OMS input): Benefits of entire portfolio compared with allocated costs

SPP's "RCAR" Experience: More Uniform Total Benefits for Large Portfolio Evaluated with Multiple Benefits Metrics

SPP's Regional Cost Allocation Reviews show (1) B-C Ratios of SPP's ITP Portfolio has grown over time and (2) provides members with total benefits that exceeds their allocated costs in most cases

- Done every few years for all ITP projects approved to date
- Evaluation of entire ITP portfolio makes quantification of multiple benefits metrics possible

Metric	RCAR I (2013$m)	RCAR II (2016$m)
APC Savings	$3,020	$8,974
Assumed Benefit of Mandated Reliability Projects	$2,475	$5,759
Mitigation of Transmission Outage Costs	$340	$1,014
Capacity Savings from Reduced On-Peak Losses	$155	$743
Increased Wheeling Through and Out Revenues	Not Monetized	$641
Marginal Energy Losses Benefits	Not Monetized	$427
Avoided or Delayed Reliability Projects	$97	$41
Benefit from Meeting Public Policy Goals	$296	$0
Reduced Cost of Extreme Events	Not Monetized	Not Monetized
Reduced Loss of Load Probability	Not Monetized	Not Monetized
Capital Savings from Reduced Minimum Required Margin	Not Monetized	Not Monetized
Total Benefits (PV of 40-yr Benefits for 2015-2054)	$6,383	$17,599
Total Portfolio Cost (PV of 40-yr ATRR)	$4,581	$7,180

Estimated 40-year Present Value of Benefit Metrics and Costs (2016 $million)

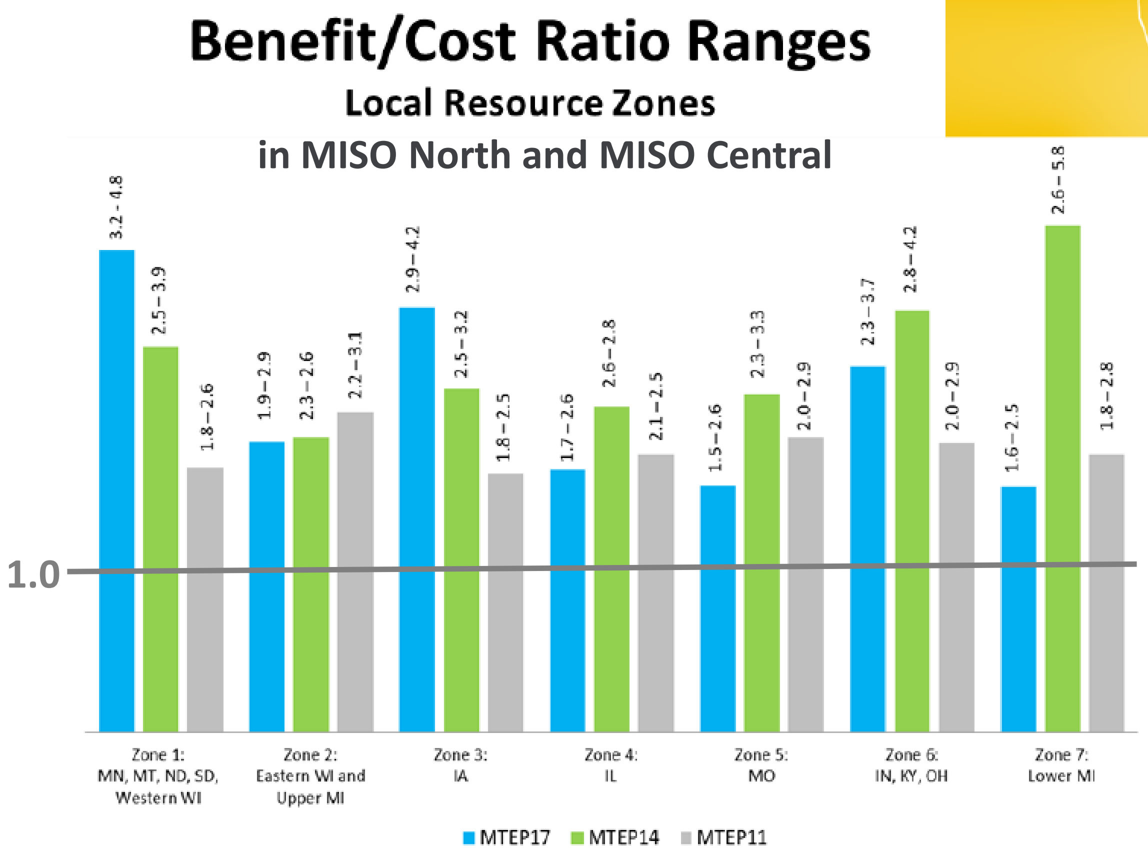
	Present Value of 40-yr Benefits for the 2015-2054 Period (2016 $million)												PV of 40-yr ATRRs (2016 $million)			
	APC Savings	Avoided or Delayed Reliability Projects	Capacity Savings from Reduced On-Peak Losses	Mitigation of Trans-mission Outage Costs	Assumed Benefit of Mandated Reliability Projects	Benefit from Meeting Public Policy Goals	Increased Wheeling Through and Out Revenues	Marginal Energy Losses Benefits	Reduced Cost of Extreme Events	Reduced Loss of Load Probability	Capital Savings from Reduced Minimum Required Margin	Total Benefits	Before PtP and MISO Revenue Offset	PtP and MISO Revenue Offset	After PtP and MISO Revenue Offset	Benefit/ Cost Ratio
AEP	$1,216	$20	$87	$207	$965	$0	$133	$59				$2,686	$1,654	$121	$1,533	1.75
CUS	-$33	$0	$0	$14	$53	$0	$5	$2				$42	$76	$5	$71	0.59
EDE	-$25	$0	$0	$24	$83	$0	$12	$0				$95	$126	$9	$117	0.81
GMO	$174	$1	$3	$38	$180	$0	$19	-$2				$412	$207	$15	$192	2.15
GRDA	$82	$0	$1	$19	$70	$0	$13	-$6				$179	$114	$8	$106	1.68
KCPL	$642	$1	$6	$76	$308	$0	$37	$51				$1,122	$407	$29	$378	2.97
LES	$115	$0	$1	$19	$64	$0	$8	$15				$223	$106	$8	$98	2.27
MIDW	$76	$0	$11	$8	$93	$0	$5	-$3				$190	$71	$5	$66	2.89
MKEC	$60	$0	$17	$13	$171	$0	$14	$30		Not Monetized		$306	$259	$20	$239	1.28
NPPD	$158	$1	$53	$58	$275	$0	$38	-$9				$574	$404	$29	$375	1.53
OGE	$1,428	$2	$65	$131	$635	$0	$66	-$64				$2,262	$838	$60	$777	2.91
OPPD	$24	$1	$3	$48	$150	$0	$23	$9				$257	$320	$23	$297	0.87
SEPC	$83	$0	$12	$9	$159	$0	$8	$11				$283	$82	$6	$76	3.73
SPS	$3,537	$12	$357	$115	$1,024	$0	$90	-$13				$5,122	$1,402	$102	$1,301	3.94
UMZ	$281	$1	$47	$96	$595	$0	$55	$191				$1,266	$397	$45	$352	3.60
WFEC	$159	$0	$77	$34	$222	$0	$20	$56				$568	$295	$21	$274	2.08
WR	$996	$1	$5	$105	$710	$0	$94	$100				$2,011	$1,002	$73	$930	2.16
TOTAL	$8,974	$41	$743	$1,014	$5,759	$0	$641	$427				$17,599	$7,760	$579	$7,180	2.45

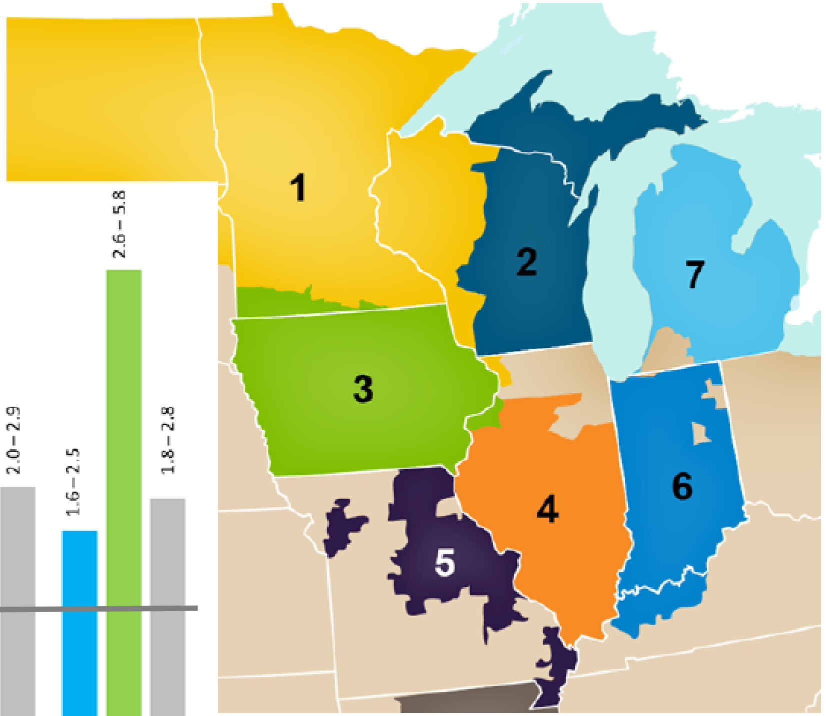
Source: https://www.spp.org/documents/46235/rcar%202%20report%20final.pdf

MISO's MVP Analyses: Benefits of the Portfolio (as a Whole) Significantly Exceed Postage-Stamp-Allocated Costs in all Regions

MISO's MVP Portfolio provides benefits across the MISO footprint that are roughly equivalent to (postage-stamp) allocated costs

- MISO quantified 6 types of economic benefits (plus reliability and public policy benefits)





- MTEP17 analysis shows $22 to $75 billion in total benefits to MISO North and Central
- Total costs increased from $5.6 to $6.7 billion, but benefits grew even more
- B-C ratios exceed 1.5 to 2.6 in every zone

Source: https://cdn.misoenergy.org/MTEP17%20MVP%20Triennial%20Review%20Report117065.pdf

Cost Allocation Alternatives Developed in 2010 by MISO and OMS for $29 billion RGOS Transmission Overlay

Brattle supported MISO and OMS in analyzing various cost allocation proposals for the $29 billion RGOS portfolio. Final proposal used injection-withdrawal approach:

- Costs allocated to injections and withdrawals based on local and regional usage
- Ultimately replaced with MVP postage stamp (due to TO and generator preference)

Layer	Local	Regional
Central below 345 kV	55%	45%
Central 345 kV	48%	52%
Eastern below 345 kV	64%	36%
Eastern 345 kV	59%	41%
Western below 345 kV	43%	57%
Western 345 kV	27%	73%
MISO-wide above 345 kV*	6%	94%

*For facilities above 345 kV, usage percentages determined for overall footprint.

- MISO engineering study determined how much of the grid is used for local (within zone) and regional (MISO-wide) transmission
- **Local charges** on $/MW shared between loads and generators within pricing zone
- **Regional charges** on $/MWh basis to all loads and exports
- Generation Interconnection Projects pay the higher of (a) the local portion of network upgrade costs and (b) the local access rate

Source: Regional Expansion Criteria and Benefits (RECB) Task Force Meeting, March 11, 2010.

Summary and Recommendations

Benefit-cost analyses and cost allocations can be improved to offer more cost-effective and less controversial outcomes:

- More fully consider broad range of reliability, economic, and public-policy benefits, including experience gained though:
  - SPP value of transmission and RCAR benefits metrics
  - NYISO broad set of benefits quantified for public policy projects
  - MISO MVP benefits; CAISO economic and public policy projects
- Reduce divisiveness of cost allocation through broad set of portfolio-based benefits
  - Recognize broad range of benefits → more likely to be evenly distributed and exceed costs
  - Focus on larger portfolios of transmission projects → more uniform distribution of benefits
  - Broad range of benefits for a portfolio will also be more stable over time

In addition: Focus less on addressing near-term reliability and local needs, but more on infrastructure that provides greater flexibility and higher long-term value at lower system-wide cost

- Recognize that every transmission project offers multiple values
- Lowest-cost transmission is not "least cost" from an overall customer-cost perspective

Additional Reading

Pfeifenberger, Ruiz, Van Horn, "The Value of Diversifying Uncertain Renewable Generation through the Transmission System," BU-ISE, October 14, 2020.

Pfeifenberger, Newell, Graf and Spokas, "Offshore Wind Transmission: An Analysis of Options for New York", prepared for Anbaric, August 2020.

Pfeifenberger, Newell, and Graf, "Offshore Transmission in New England: The Benefits of a Better-Planned Grid," prepared for Anbaric, May 2020.

Tsuchida and Ruiz, "Innovation in Transmission Operation with Advanced Technologies," T&D World, December 19, 2019.

Pfeifenberger, "Cost Savings Offered by Competition in Electric Transmission," Power Markets Today Webinar, December 11, 2019.

Pfeifenberger, "Improving Transmission Planning: Benefits, Risks, and Cost Allocation," MGA-OMS Ninth Annual Transmission Summit, November 6, 2019.

Chang, Pfeifenberger, Sheilendranath, Hagerty, Levin, and Jiang, "Cost Savings Offered by Competition in Electric Transmission: Experience to Date and the Potential for Additional Customer Value," April 2019. "Response to Concentric Energy Advisors' Report on Competitive Transmission," August 2019.

Ruiz, "Transmission Topology Optimization: Application in Operations, Markets, and Planning Decision Making," May 2019.

Chang and Pfeifenberger, "Well-Planned Electric Transmission Saves Customer Costs: Improved Transmission Planning is Key to the Transition to a Carbon-Constrained Future," WIRES and The Brattle Group, June 2016.

Newell et al. "Benefit-Cost Analysis of Proposed New York AC Transmission Upgrades," on behalf of NYISO and DPS Staff, September 15, 2015.

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 2015.

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

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

Pfeifenberger and Hou, "Seams Cost Allocation: A Flexible Framework to Support Interregional Transmission Planning," on behalf of SPP, April 2012.

Pfeifenberger, Hou, "Employment and Economic Benefits of Transmission Infrastructure Investment in the U.S. and Canada," on behalf of WIRES, May 2011.

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- Energy Litigation
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