

# Transmission Competition Under FERC Order No. 1000: What we Know About Cost Savings to Date

Discussion Paper

PRESENTED TO



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# Executive Summary

Competitive transmission planning processes in ISOs/RTOs, the most controversial aspect of FERC Order 1000, have shown **potential for significant customer savings**:

- While the scope of competition has been limited to only 2% of total U.S. transmission investments over the last 5 years, competitive processes led to innovations in proposed solutions, low bids, cost caps, cost control measures, and innovative financial structuring
- **Winning bids average 40% below initial cost estimates while non-competitive projects are completed at 34% above initial estimates**, offering 55% of potential cost savings
- Long-term savings likely less than the currently-observed 55% cost differences, but real prospect of significant customer benefits and innovation nevertheless
- Even if long-term savings were only half the 55% difference, if the scope of competition could be expanded from 2% to 33% of total transmission investments, estimated **customer benefits would be approximately \$8 billion over just five years**
- Lower costs will also make transmission more cost-effective to address market efficiency and public policy needs (e.g., relative to more local and distributed generation)

## Recommendations:

- **Reduce qualification thresholds for competitive process** and develop consistent criteria, drawing from best practices from least-restrictive RTOs **to expand scope of competition**
- Establish and implement consistent **minimum reporting requirements** to facilitate better tracking of project costs across all regions

# Agenda

## Background

- Focus & Scope
- Competition for Regulated Transmission

## Historical Transmission Investments in the U.S.

- Historical and Projected Transmission Investments
- Scope of ISO/RTO Oversight

## The Current State of Competition

- Competition Models
- Experience with Competition
- Limits to Competition in U.S. ISO/RTO Planning
- Competitive Projects Summary

## Benefits of Competition

- Level of Competitive Bids Compared to Initial Project Cost Estimates
- Cost Escalations of Non-Competitive Projects
- Overall Potential for Customer Savings

*This presentation, prepared for LSP Transmission Holdings and GridLiance, is based on the authors' analyses of publicly-available transmission data reported to FERC and ISO/RTO transmission project tracking reports, as assembled for prior client engagements and conference presentations*

# Background

**Focus of this presentation:** An examination of transmission investment trends and current experience with competitive transmission planning in ISO/RTO regions as mandated under FERC Order 1000

- U.S. transmission investments by FERC-jurisdictional transmission providers increased from \$2 billion/year in the 1990s to \$20 billion/year in last 5 years
- We project \$120-160 billion of investments over the next decade (for reliability, to integrate new resources, upgrade/replace aging existing facilities built in 1950-70s)

**Why competition?** In 2011, FERC Order 1000 mandated competition in transmission planning to promote “more efficient or cost-effective transmission development”

- We explore competition in ISO/RTO transmission planning to date and the criteria that currently limit the scope of competitive processes
- We assess the extent to which the experience to date points to potential customer savings and how these savings would increase if the scope of competitive processes can be expanded

# Competition Mostly for “Regulated” Transmission

**Transmission investment remain largely regulated**, based on state or regional planning with cost recovery at regulated rates

Transmission is a public good:

- Benefits broad in scope, wide-spread geographically, diverse in impacts on market participants, and occurring over many decades
- Owners generally unable to capture sufficient portion of benefits
- Will tend to lead to under-investment and over-use without regulated cost recovery

**Competition is mostly for transmission projects with regulated cost recovery**

- Out-of-footprint investments by established transmission owners and independent developers
- Elimination of “Right of First Refusal” (ROFR) of incumbent transmission owners for new builds approved in regional transmission plans as required by Order 1000

**Some competitive “merchant” transmission projects** (but not the scope of this presentation)

- Mostly HVDC lines between regions with sustained price differentials, resource needs, and ineffective interregional planning of regulated transmission
- HVDC is more likely to allow owner capture the benefits of the merchant lines

# Competition Mostly for “Regulated” Transmission (Cont’d)

U.S. competitively-planned, regulated transmission opportunities for non-incumbents are limited to:

- Some regionally-planned projects in FERC-jurisdictional RTO/ISO regions  
U.S. ISO/RTOs are at different stages of using various frameworks for competitive planning processes, largely as a result of FERC Order 1000
- ERCOT’s transmission for competitive renewable energy zones (CREZ)

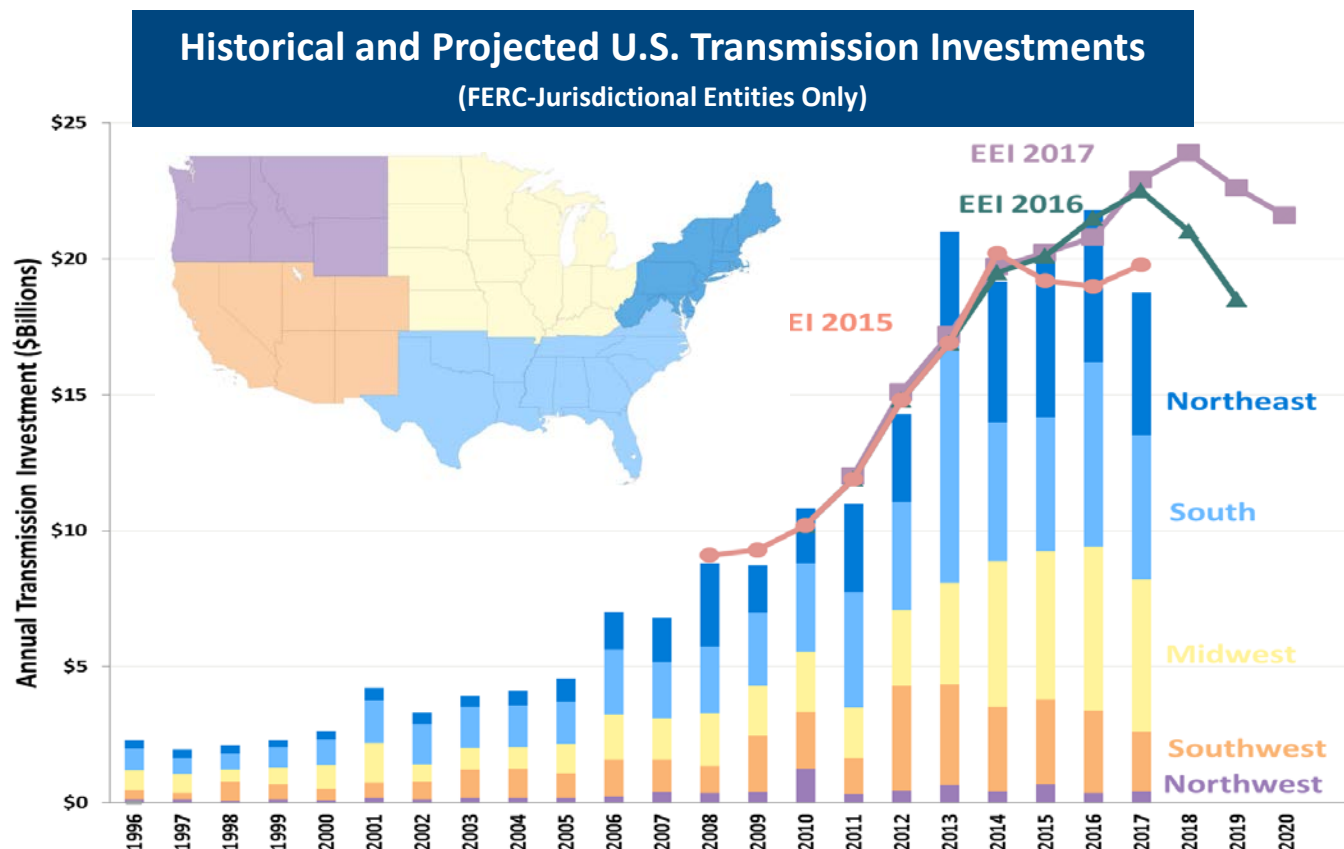
**Important international experience** with competition for regulated projects

- Alberta: Developed a competitive process for major new projects; assigned first \$1.4 billion project (significantly below AESO estimates)
- Ontario: Two competitive solicitations for transmission to date
- Brazil: Since 1999 all transmission projects have been auctioned off (similar processes in other Latin American countries, such as Chile)
- UK: Tenders for offshore grid projects

# Historical Transmission Investment in the U.S.

## Historical and Projected U.S. Transmission Investment by FERC-Jurisdictional Entities

U.S. transmission investments have stabilized at approx. \$20 billion/year in the last five years, after rising steadily from \$2 billion/year in 1990s



### Sources and Notes:

The Brattle Group, © 2018. Regional Investment based on FERC Form 1 investment compiled in Ventyx's Velocity Suite, except for ERCOT for years 2010 - 2017, which are based on ERCOT TPIT reports. Based on EIA data available through 2003, FERC-jurisdictional transmission owners estimated to account for 80% of transmission assets in the Eastern interconnection and 60% in WECC. Facilities >300kV estimated to account for 60-80% of shown investments. EEI annual transmission expenditures updated December 2017 shown (2011 - 2020) based on prior year's actual investment through 2016 and planned investments thereafter.

## Historical Transmission Investment in the U.S.

# Majority of U.S. Transmission Investments are made within ISO/RTO-Operated Regions

Transmission investments in markets operated by FERC-jurisdictional **ISO/RTOs** and **ERCOT** account for **85%** of current transmission investments

Transmission **investments in ISO/RTO regions also have grown by more** (10-16% annually) than investments in the non-ISO/RTO regions (6-10% annually)

### U.S. Annual Transmission Investments (2010–2017) and Growth Since 1999

	1999	2010	2011	2012	2013	2014	2015	2016	2017	2013-2017 Total	1999-2017 CAGR
CAISO	\$0.33	\$1.7	\$0.9	\$3.5	\$3.2	\$2.6	\$2.5	\$2.4	\$1.8	\$12.6	10%
ISO-NE	\$0.09	\$0.7	\$0.6	\$1.4	\$1.8	\$1.4	\$1.7	\$1.4	\$1.2	\$7.5	15%
MISO	\$0.34	\$1.4	\$1.0	\$1.3	\$2.5	\$2.7	\$3.0	\$4.0	\$3.3	\$15.5	14%
NYISO	\$0.08	\$0.5	\$0.7	\$0.3	\$0.4	\$0.5	\$0.5	\$0.5	\$0.6	\$2.6	12%
PJM	\$0.46	\$1.9	\$3.4	\$2.9	\$4.1	\$6.6	\$7.3	\$7.1	\$6.4	\$31.5	16%
SPP	\$0.11	\$0.8	\$0.6	\$1.2	\$1.0	\$2.1	\$0.9	\$1.4	\$0.9	\$6.2	12%
Subtotal FERC-jurisdictional ISO/RTOs	\$1.43	\$7.0	\$7.3	\$10.6	\$12.9	\$15.9	\$15.8	\$16.9	\$14.4	\$75.9	14%
ERCOT	\$0.14	\$0.8	\$1.2	\$1.0	\$5.3	\$0.9	\$0.9	\$2.0	\$1.1	\$10.2	12%
Subtotal U.S. ISO/RTOs	\$1.56	\$7.8	\$8.4	\$11.7	\$18.2	\$16.8	\$16.8	\$18.9	\$15.5	\$86.1	14%
Other WECC	\$0.32	\$1.7	\$0.7	\$0.8	\$1.2	\$0.8	\$1.3	\$1.0	\$0.9	\$5.2	6%
Southeast & Other	\$0.43	\$1.3	\$1.8	\$1.8	\$1.6	\$1.6	\$1.9	\$1.9	\$2.3	\$9.4	10%
Total US Reported to FERC and in ERCOT	\$2.31	\$10.8	\$11.0	\$14.3	\$21.0	\$19.1	\$19.9	\$21.8	\$18.8	\$100.7	12%



# Historical Transmission Investment in the U.S.

## Scope of ISO/RTO Oversight in U.S. Transmission Investments

Of \$70 billion in transmission investments by FERC-jurisdictional TOs in ISO/RTO regions over the last 4-5 years, almost **half was made without full ISO/RTO and stakeholder engagement** in the planning process

- Investments based on local planning processes of incumbent TOs are only subject to limited ISO/RTO review
- FERC's August 31 Order (Docket No. EL17-45, still subject to rehearing): only transmission “expansion” activities are subject to full regional planning requirements

### Transmission Investments Subject to Full or Limited Review in ISO/RTO Regional Planning Processes

	Years Reviewed	FERC Jurisdictional Additions by Transmission Owners (nominal \$million, based on FERC Form 1 Filings)	Investments Approved Through <u>Full</u> ISO/RTO Planning Process (nominal \$million)	% of Total FERC Jurisdictional Investments Approved Through <u>Full</u> ISO/RTO Planning Process	% of Total FERC Jurisdictional Investments with <u>Limited</u> ISO/RTO Review
CAISO	2014 - 2016	\$7,528	\$4,043	54%	46%
ISO-NE	2013 - 2017	\$7,488	\$5,300	71%	29%
MISO	2013 - 2017	\$15,530	\$8,068	52%	48%
NYISO	2013 - 2017	\$2,592	n/a	n/a	n/a
PJM	2013 - 2017	\$31,469	\$14,458	46%	54%
SPP	2013 - 2017	\$6,202	\$4,226	68%	32%
<b>Total</b>	-	<b>\$70,810</b>	<b>\$36,095</b>	<b>53%</b>	<b>47%</b>

**Sources & Notes:** Data based on FERC Form 1 and ISO/RTO Tracking Reports. CAISO data reflects only select transmission additions/approved investments of PG&E, SCE, and SDG&E for 2014 -2016, based on available data. Aggregate Investment for each ISO/RTO reflects total FERC Form 1 transmission additions over indicated time periods. Investments approved by ISO/RTO reflects total value of transmission additions placed in-service over indicated time periods, approved through ISO/RTO processes.

# Competition Models in Transmission Planning

### Sponsor-Based Competitive Processes



Developers compete to provide and build innovative solutions 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**

### Bid-Based Competitive Processes

Project Development

Developers only compete to finance, build, own, and operate specified projects

- Planning entities identify need and specify solutions (i.e., specific projects)
- Competition to finance, own, and construct the specified project based on a number of factors, including costs
- **Examples: CAISO, MISO, SPP, ERCOT, Brazil, Alberta, Ontario,**

# Experience with Competition in U.S. ISO/RTO Transmission Planning Processes

Since implementation of FERC Order 1000 (around 2013), FERC-jurisdictional ISO/RTOs have completed **29 competitive transmission project solicitations**

- Of the 29 ISO/RTO competitive processes, 10 were by CAISO, 16 by PJM, and one each in NYISO, MISO, and SPP. These processes have resulted in 15 competitive projects to date.

**Since 2013, only 2% of all FERC-jurisdictional transmission investments have been subject to competitive processes**

Total Costs of Competitively-Bid Projects by ISO/RTO and Project-Selection Year (\$million)							
	CAISO	ISO-NE	MISO	NYISO	PJM	SPP	All Six FERC Jurisdictional ISO/RTOs
2013	\$144	\$0	\$0	\$0	\$0	\$0	\$144
2014	\$148	\$0	\$0	\$0	\$0	\$0	\$148
2015	\$425	\$0	\$0	\$0	\$283	\$0	\$425
2016	\$133	\$0	\$50	\$0	\$320	\$8	\$794
2017	\$0	\$0	\$0	\$181	\$0	\$0	\$181
Total Estimated Competitive Project Costs 2013 – 2017 (\$million)	<b>\$851</b>	<b>\$0</b>	<b>\$50</b>	<b>\$181</b>	<b>\$603</b>	<b>\$8</b>	<b>\$1,693m</b>
Total Reported Investment in Each RTO 2013-2017 (\$billion)	\$12.6	\$7.5	\$15.5	\$2.6	\$31.5	\$6.2	\$75.9b
Estimated Total Competitive Project Costs as a % of Total RTO Spend	<b>6.8%</b>	<b>0.0%</b>	<b>0.3%</b>	<b>7.0%</b>	<b>1.9%</b>	<b>0.1%</b>	<b>2.2%</b>

## State of Competition

# List of Projects Selected Through Competitive Solicitations by ISO/RTOs

Despite the limited number of competitive projects, independent TOs have competed successfully across ISO/RTO regions

- 15 projects in the U.S. plus 3 in Canada
- Independent developers won in both NYISO's and MISO's first competitive procurements and in 40% of all of CAISO's
- PJM has awarded projects mostly to incumbents:
  - Out of 16 projects, all but 2 were awarded to the incumbent TOs
  - PJM received 622 proposals between 2013 and 2016, of which 37% to 50% were submitted by non-incumbents

Participation in competitive processes (as documented by FERC staff) indicates strong interest by both incumbent and independent developers, but RTO criteria are limiting competitive opportunities

## Competitive Transmission Project Summary

ISO/RTO	Project	Decision Year	Winner	Incumbent
CAISO	Gates-Gregg	2013	PG&E/MidAmerican Citizen Energy	Yes
CAISO	Imperial Valley	2013	Imperial Irrigation District	No
CAISO	Sycamore-Peñasquitos 230 kV	2014	SDG&E w/ Citizen Energy	Yes
CAISO	Delaney-Colorado River	2015	DCR Transmission	No
CAISO	Estrella Substation	2015	NextEra	No
CAISO	Wheeler Ridge Junction	2015	PG&E	Yes
CAISO	Suncrest Project	2015	NextEra	No
CAISO	Spring Substation	2015	PG&E	Yes
CAISO	Harry Allen-Eldorado	2016	Desert Link	No
CAISO	Miguel Substation	2014	SDG&E	Yes
MISO	Duff-Coleman 345 kV	2016	LS Power w/ Big Rivers	No
NYISO	Western NY Public Policy	2017	NextEra	No
PJM	Artificial Island	2015	LS Power	No
PJM	ApSouth Market Efficiency	2016	Transource, BGE, and Allegheny Power	No
SPP	North Liberal – Walkemeyer 115 kV	2016	Mid Kansas Electric	Yes
AESO	Fort McMurray West 500 kV	2014	Alberta PowerLine	Yes
IESO	East West Tie Line	2013	NextBridge	No
IESO	Wataynikaneyap Power	2015	Fortis Inc.	No

## Limits to Competition in U.S. ISO/RTO Transmission Planning

ISO/RTO qualifications and exclusion criteria greatly reduce the scope of projects eligible for competitive processes. Experience shows scope can be increased.

	CAISO	ISO-NE	MISO	NYISO	PJM	SPP
<b>Types of Projects Eligible for Competition</b>						
	Reliability, Economic, Public Policy	Reliability, Economic, Public Policy	Market Efficiency, MVP	Reliability, Economic, Public Policy	Reliability, Economic, Public Policy	Reliability, Economic, Public Policy
<b>Exclusions</b>						
Exclusions Based on Need Date		✓ (For Reliability)	✓ (For Reliability)	✓ (For Reliability)	✓ (For Reliability)	✓ (For Reliability)
Exclusions for Local Reliability or Local Cost Allocated	✓	✓	✓ (Except for MVP)		✓ (For Reliability)	✓
Excludes Upgrades/Addition to Existing Facilities and on Existing ROW	✓	✓	✓		✓	✓
State Mandated Exclusion			✓		✓	✓
Exclusions Based on Minimum Cost Requirements			✓			
<b>Additional Exclusions Based on Voltage</b>						
Voltage > 300 kV			✓ (For Reliability)			
Voltage 200-300 kV			✓ (For Reliability)			
Voltage 100-200 kV	✓		✓ (Except For MVP)		✓	✓
Voltage < 100 kV	✓	✓	✓		✓	✓

# Competitive Project Experience Indicates Potential for Significant Cost Savings

Experience with 15 projects selected through the ISO/RTO competitive planning processes show potentially large cost advantages of competition

- On average, the winning bids of these 15 competitive transmission projects have been priced **40% below** the ISO/RTOs' or incumbent TO's initial project cost estimates
- Similar bid cost advantages observed in Alberta
- However, all 15 projects are still under development (in-service dates post-2019), so final costs are not yet known
- In addition to low bid prices, winning bids generally offer **cost caps or cost-control** measures, reducing the risk and magnitude of significant cost increases as they are developed and constructed

Cost advantage calculated as:

- Bid-based processes (MISO, SPP, CAISO): cost difference = between costs of winning bids and ISO/RTO's or TO's initial reference cost estimate for the project
- Sponsorship-based processes (PJM and NYISO): cost difference = between winning bid and lowest-bid of incumbent TOs

**Differences in Competitive Bids and Initial Cost Estimates**  
for Competitive Processes of FERC-Jurisdictional ISO/RTOs

RTO	Number of Competitive Projects	ISO/RTO or Incumbent Estimate of Project Cost (\$million)	Winning Bid of Competitive Projects (\$million)	Average <u>Cost Advantage</u> of Competitive Bids
CAISO*	10	\$1,180	\$833	29%
ISO-NE	0	n/a	n/a	n/a
MISO	1	\$59	\$50	15%
NYISO	1	\$232	\$181	22%
PJM*	2	\$692	\$280	60%
SPP	1	\$17	\$8	50%
<b>Total</b>	<b>15</b>	<b>\$1,948</b>	<b>\$1,171</b>	<b>40%</b>

\* Note: The only competitively selected project in NYISO project is not reflected in the average cost advantage. Additionally, just 1 of 2 competitively selected projects in PJM projects are reflected in the average cost advantage.

## Benefits of Competition

# Cost Escalations of Non-Competitive ISO/RTO Transmission Projects

Transmission investments outside competitive processes (98% of total since Order 1000 was implemented) often experience cost escalations:

- Comparing initial estimates and final project costs of transmission projects not subject to competitive processes shows [cost escalations average 34%](#)
- Average cost escalations range from 18% (for projects in MISO and SPP) to 33%–70% (for projects in CAISO and ISO-NE)
- A portion of these observed cost escalations reflects inflation, routing changes, etc.
- The absence of cost-tracking mechanisms in some ISO/RTOs (CAISO and NYISO) makes it difficult to document project cost increases (CAISO data from FERC Complaint, EL17-45)
- More consistent and transparent project cost tracking and reporting standards are needed

### Historical Cost Escalations of Non-Competitive Projects In FERC-Jurisdictional ISO/RTOs

RTO	Years Reviewed	Transmission Cost Data Analyzed	Average <u>Cost Escalation</u> of Non-Competitive Projects
CAISO	2014-16	2014-2016 PG&E and SDG&E projects for which data is available (from FERC Complaint)	41%
ISO-NE	2013 -17	Reflects eleven major 345 kV/115 kV projects approved by ISO-NE between 2002 and 2016	70%
MISO	2013 -17	2014-2017 In-Service or Under-Construction Baseline & Network Upgrade projects.	18%
NYISO	2013 -17	n/a	n/a
PJM	2013 -17	2015-2017 In-Service, and 2018 In-Service or Under-Construction projects	22%
SPP	2013 -17	Selected 2012-2016 ITP Portfolio Projects, and completed Balanced Portfolio and Priority projects, as reported in SPP's 2017 Quarterly Project Tracking Reports	18%
Weighted Average of Cost Escalation*			34%

\* Weighted average based on *competitively selected transmission investments* in each ISO/RTO. ISO-NE has yet to select any transmission project through its competitive planning processes. Therefore, the weighted average of historical cost escalation in *non-competitive projects* shown above excludes ISO-NE projects' observed historical cost-escalation.

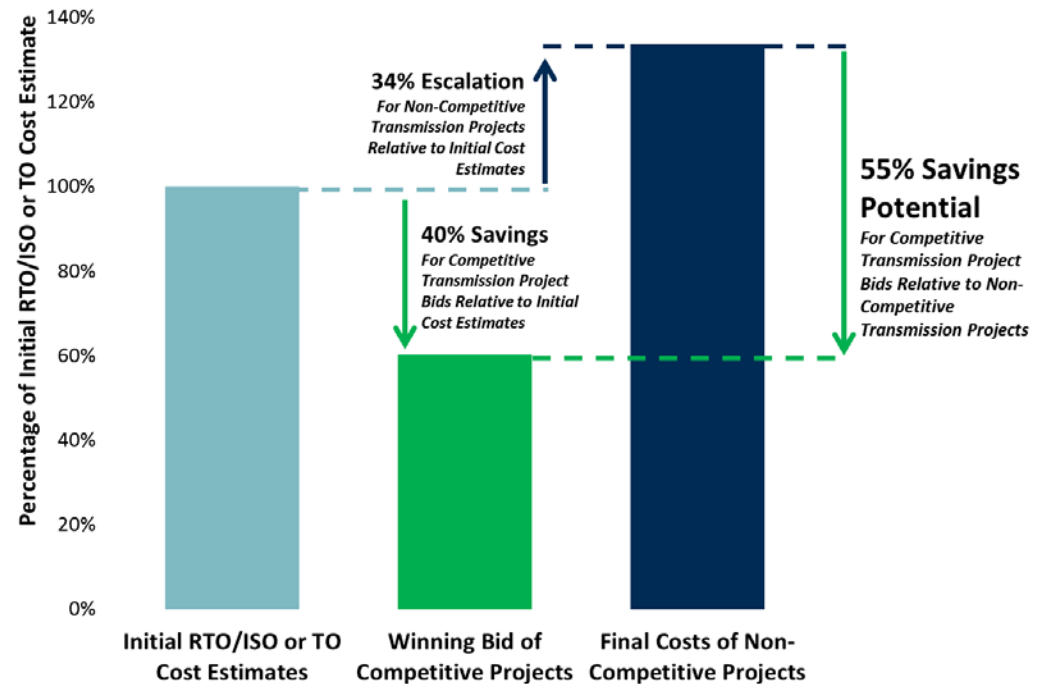
## Benefits of Competition

# Potential Customer Savings from Competitive Transmission Planning Processes

The experience with ISO/RTO competitive transmission planning processes to date indicates a significant potential for customer savings

- Winning bids of FERC-jurisdictional competitive projects selected by ISO/RTOs on average were **priced 40% below** the ISO/RTOs' initial project cost estimates or the lowest-cost incumbent bids
  - Bids generally include cost caps or cost controls, reducing the risk and magnitude of cost escalations
- In contrast, historical cost escalations of non-competitive ISO/RTO projects averaged **34% above** initial cost estimates (including inflation)
- As a result, **if** competitive projects can be developed as bid (without further cost escalations), **savings would be 55%** relative to the escalated costs of non-competitive projects

Illustration of Potential Cost Savings from Competition





# Implications for Customers and Transmission Owners

As documented in many studies, transmission investments have been providing significant overall cost savings through a wide range of benefits. Increasing the scope of competition will further improve the value proposition of transmission investments to the benefit of both customers and transmission owners.

- **Customer Benefits**: Even if long-term savings were only half the 55% difference documented to date, if the scope of competition could be expanded from 2% to 33% of total transmission investments, estimated customer benefits would be approximately \$8 billion over just five years
- **Transmission-Owner Benefits**: More cost-effective transmission would...
  - Reduce “rate pressure” which is already causing significant opposition by customers and policy makers to all types of transmission investments
  - Increase the attractiveness of transmission as the preferred solution to enhance wholesale power market efficiencies and to integrate and balance increasing amounts of renewable generation
    - Cost reductions needed to maintain attractiveness of transmission in an environment of low natural gas prices and declining costs for wind, solar, storage, and distributed resources
    - Lower costs mean more transmission projects can exceed benefit-to-cost thresholds

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# Additional Reading

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, at

[http://wiresgroup.com/docs/reports/WIRES%20Brattle%20Report\\_TransmissionPlanning\\_June2016.pdf](http://wiresgroup.com/docs/reports/WIRES%20Brattle%20Report_TransmissionPlanning_June2016.pdf)

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, at

[http://wiresgroup.com/docs/reports/WIRES%20Brattle%20Rpt\\_TransPlanning\\_042315.pdf](http://wiresgroup.com/docs/reports/WIRES%20Brattle%20Rpt_TransPlanning_042315.pdf)

Chang, Pfeifenberger, and Hagerty, "The Benefits of Electric Transmission: Identifying and Analyzing the Value of Investments," WIRES and The Brattle Group, July 2013, online at:

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

Pfeifenberger, Chang, and Tsoukalis, "Dynamics and Opportunities in Transmission Development, presented at TransForum East, December 2, 2014, at

[http://www.brattle.com/system/publications/pdfs/000/005/089/original/Dynamics\\_and\\_Opportunities\\_in\\_Transmission\\_Development.pdf?1417535596](http://www.brattle.com/system/publications/pdfs/000/005/089/original/Dynamics_and_Opportunities_in_Transmission_Development.pdf?1417535596)

Chang, Pfeifenberger, Newell, Tsuchida, Hagerty, "Recommendations for Enhancing ERCOT's Long-Term Transmission Planning Process," October 2013, at <http://www.brattle.com/news-and-knowledge/news/brattle-consultants-assist-ercot-in-scenario-planning-and-improving-its-long-term-transmission-planning-process>

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 and Hou, "Seams Cost Allocation: A Flexible Framework to Support Interregional Transmission Planning," April 2012, online at:

[http://www.brattle.com/system/publications/pdfs/000/004/814/original/Seams\\_Cost\\_Allocation\\_Report\\_Pfeifenberger\\_Hou\\_Apr\\_2012.pdf?1378772132](http://www.brattle.com/system/publications/pdfs/000/004/814/original/Seams_Cost_Allocation_Report_Pfeifenberger_Hou_Apr_2012.pdf?1378772132)

Pfeifenberger, Johannes, "Transmission Investment Trends and Planning Challenges," presented at the EEI Transmission and Wholesale Markets School, Madison, WI, August 8, 2012, online at:

[http://www.brattle.com/system/publications/pdfs/000/004/432/original/Transmission\\_Investment\\_Trends\\_and\\_Planning\\_Challenges\\_Pfeifenberger\\_Aug\\_8\\_2012\\_EEI.pdf?1378772105](http://www.brattle.com/system/publications/pdfs/000/004/432/original/Transmission_Investment_Trends_and_Planning_Challenges_Pfeifenberger_Aug_8_2012_EEI.pdf?1378772105)

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

[http://www.brattle.com/system/publications/pdfs/000/004/501/original/Employment\\_and\\_Economic\\_Benefits\\_of\\_Transmission\\_Infrastructure\\_Investment\\_Pfeifenberger\\_Hou\\_May\\_2011\\_WIRES.pdf?1378772110](http://www.brattle.com/system/publications/pdfs/000/004/501/original/Employment_and_Economic_Benefits_of_Transmission_Infrastructure_Investment_Pfeifenberger_Hou_May_2011_WIRES.pdf?1378772110)

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- Risk Management
- Market-Based Rates
- Market Design and Competitive Analysis
- Mergers and Acquisitions
- Transmission

# Our Practices and Industries

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Electrification & Growth Opportunities  
Energy Litigation  
Energy Storage  
Environmental Policy, Planning and Compliance  
Finance and Ratemaking  
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Big Data & Document Analytics  
Commercial Damages  
Environmental Litigation & Regulation  
Intellectual Property  
International Arbitration  
International Trade  
Labor & Employment  
Mergers & Acquisitions Litigation  
Product Liability  
Securities & Finance  
Tax Controversy & Transfer Pricing  
Valuation  
White Collar Investigations & Litigation

## INDUSTRIES

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Financial Institutions  
Infrastructure  
Natural Gas & Petroleum  
Pharmaceuticals & Medical Devices  
Telecommunications, Internet, and Media  
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