The Brattle Group

Assessing the Benefits of Transmission Investments

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Agenda

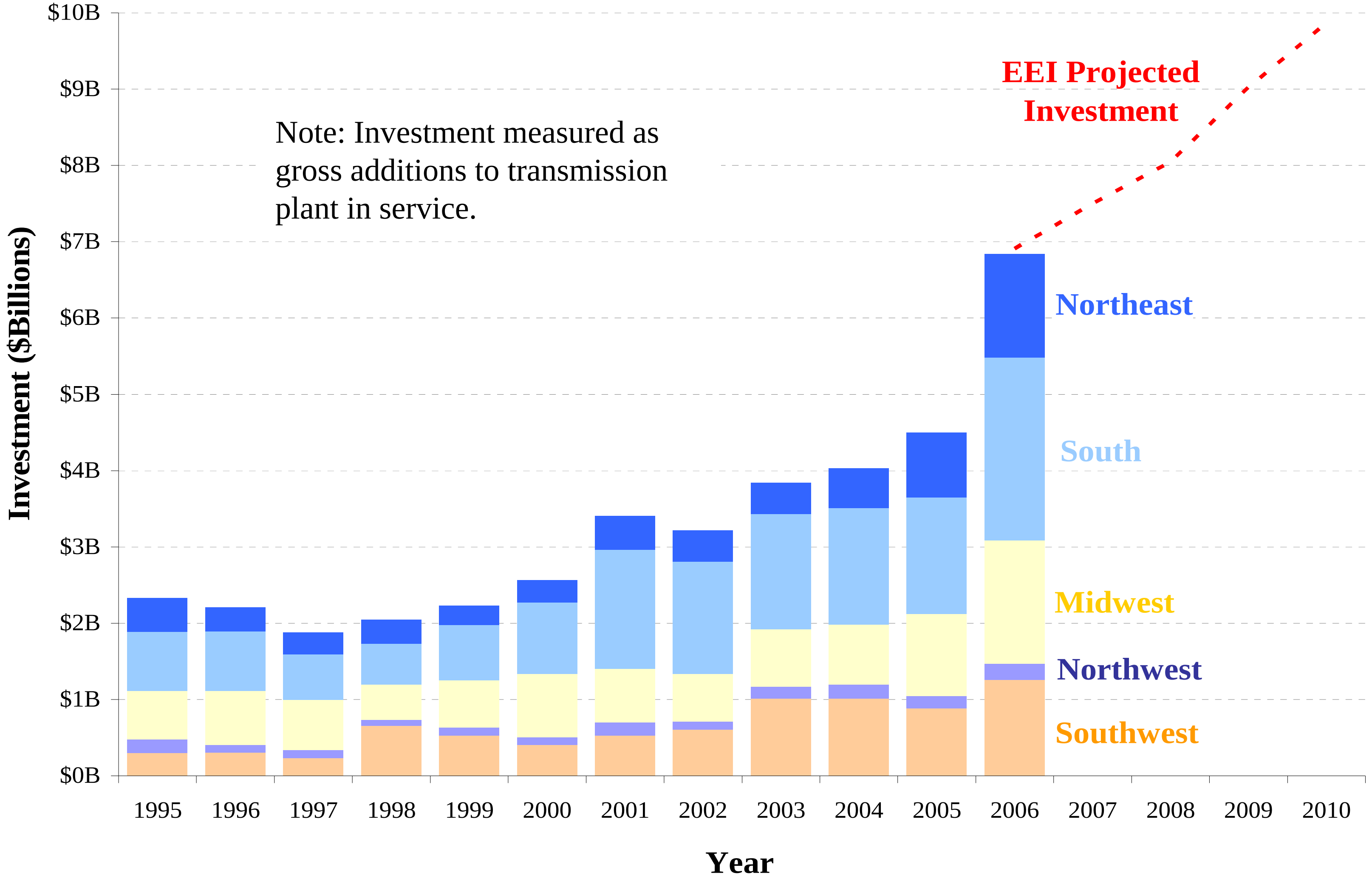
I. Background on Transmission Investments

II. Limitations of Standard Economic Modeling Tools

III. Quantification of "Other Benefits"

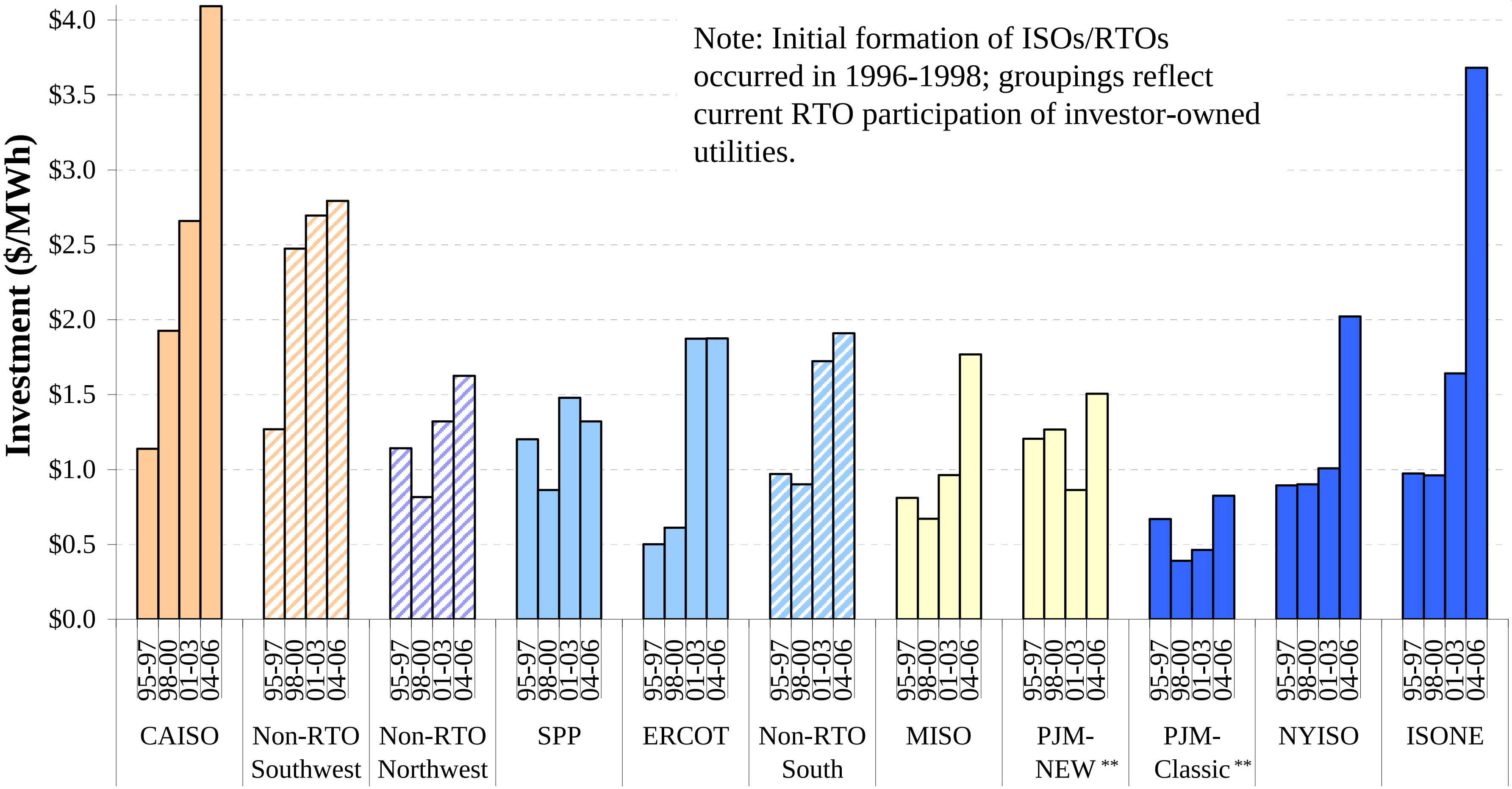
IV. Conclusions

Background: Increasing Transmission Investments



Source: The Brattle Group based on EEI survey and FERC Form 1 data compiled by Global Energy Decisions, Inc., The Velocity Suite.

Transmission Investment Activity Varies by Region



Source: The Brattle Group based on FERC Form 1 and EIA Form 861 data compiled by Global Energy Decisions, Inc., The Velocity Suite.

*Transmission investment expressed as total investment dollars per MWh of retail sales.

**PJM-New includes Commonwealth Edison, AEP, Dayton, Duquesne, and Dominion. PJM-Classic includes all other PJM members.

Reliability vs. Economic Transmission Investments

- **Most transmission investments are justified as "Reliability Projects"**
  - Fairly clear-cut determination of "need" without much second guessing
  - Potentially leaves out economically-sound investments in new transmission facilities and technologies
  - Missed opportunities to select reliability project alternatives based on economic value?
- **Relatively few "Economic Projects"**
  - Despite headlines and some large projects, relatively few economically-justified projects are underway
  - **Requires assessment of complex and often controversial interaction between transmission and power markets**
  - **Economic evaluation procedures are not sufficiently developed**

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Limits in Modeling Economic Benefits

- **Security-constrained dispatch simulation models are the primary tool used to assess economic benefits**
  - Measures changes in production costs, power flows, LMP, and congestion
  - Allows for different definitions of "benefits", but provides incomplete picture of total transmission-related value
- **Limits of simulation models are easily overlooked**
  - Results remain assumptions-driven
  - Focused on dispatch costs and short-term effects
  - Different metrics used to interpret results
  - Many "other benefits" of transmission not captured in modeling efforts

Interpretation and Processing of Model Results

- **Application of simulation models can vary widely**
  - Benefits to whom (customer, generators, region, states)?
  - Types of benefits (production costs, market prices, congestion, losses, total resource costs)?
  - At what point in time and under what market conditions?
- **Applied benefit metrics vary similarly:**
  - Broad scope of CAISO TEAM approach
  - Narrow scope of MISO metrics (production costs and LMP)
  - Broad impact on utility cost-of-service (ATC in Wisconsin)
- **Post processing of model results often fails to address:**
  - Hedged congestion and FTRs
  - Losses and loss refunds
  - Actual degree of market vs. cost-based generation

Important "Other Benefits" Often Are Not Addressed

- **Simulation models do not typically capture a wide range of transmission-related benefits**
- **Potentially large but hard-to-quantify "<u>other benefits</u>" are too often dismissed as "qualitative," "indirect" or "intangible"**
- **Narrow scope of models gets "baked" into formulaic cost-benefit frameworks**
  - Can lead to formulaic rejection of desirable projects
  - Can create exaggerated perception of winners and losers

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"Other Benefits" of Transmission Investments

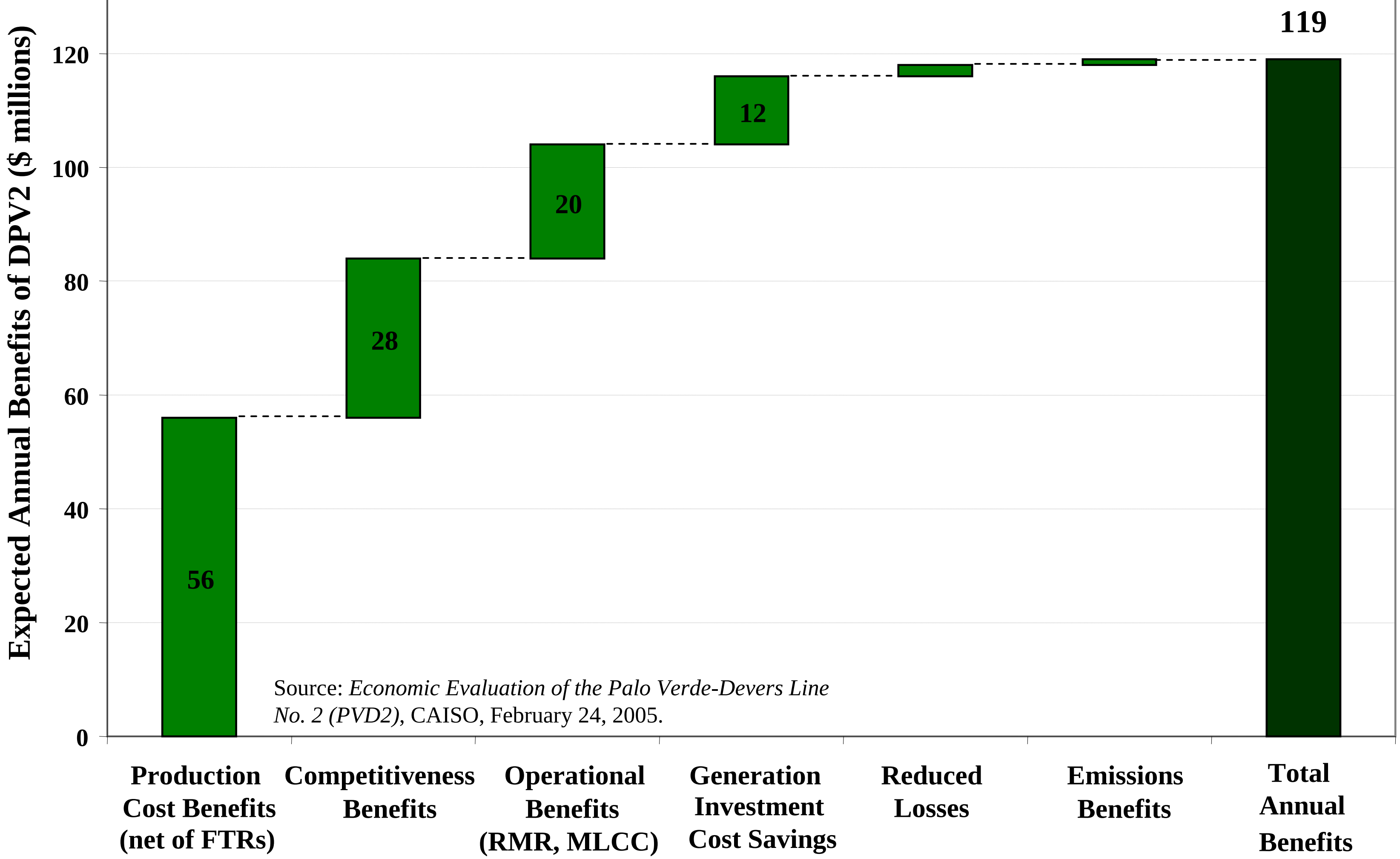
<u>Other benefits</u> applicable to specific transmission projects can vary but generally include:

• Enhanced market competitiveness • Enhanced market liquidity	Additional market benefits
• Reliability benefits • Added operational and A/S benefits • Insurance and risk mitigation benefits	Reliability/operational benefits
• Capacity benefits • Long-term resource cost advantage • Synergies with other transmission projects	Investment and resource cost benefits
• Impacts on fuel markets • Environmental and renewable access benefits • Fiscal benefits from construction and taxes	External benefits

See Appendix for discussion and quantification of individual benefits

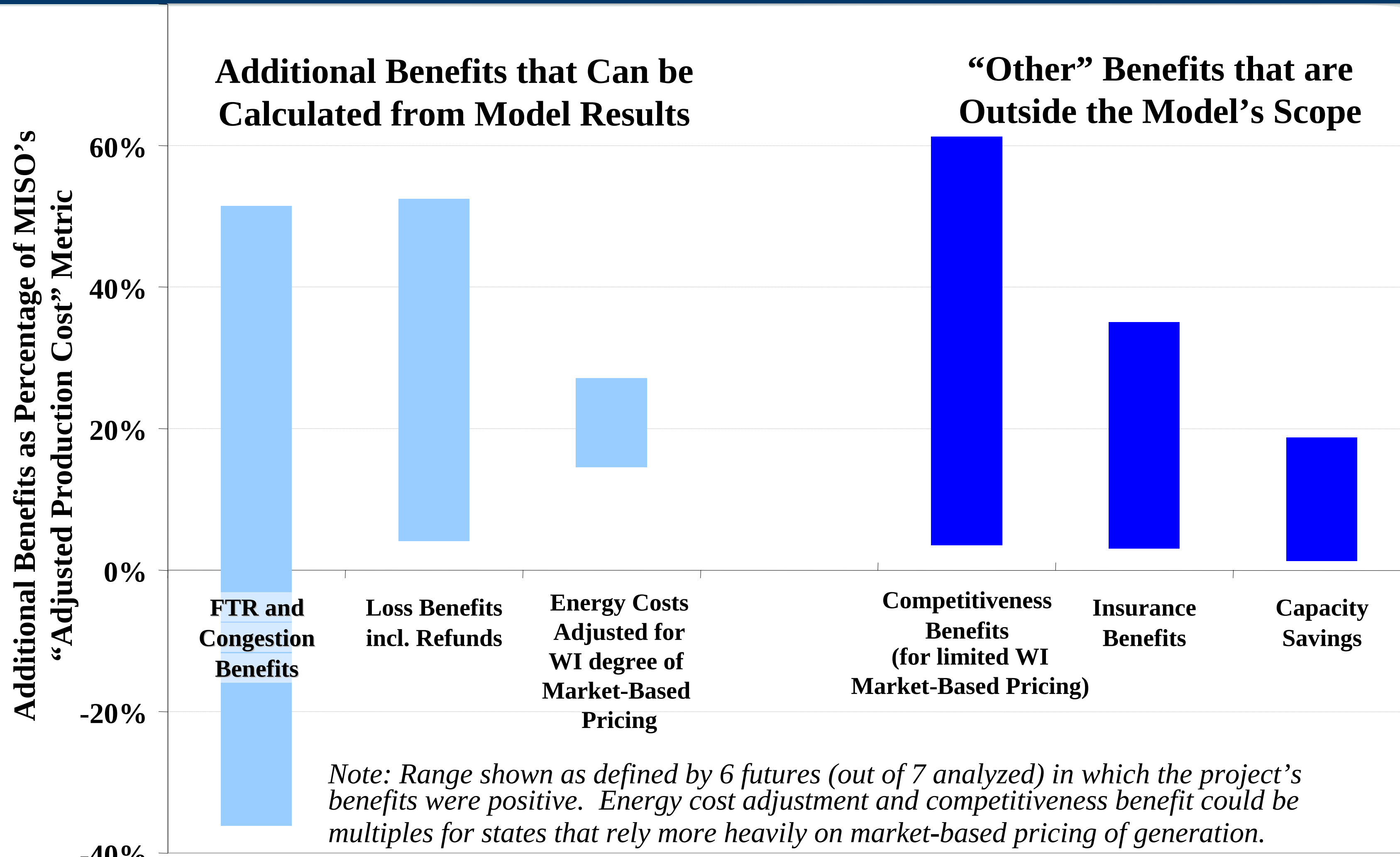
Potential overlaps create risk of omissions as well as double counting

Example: CAISO Found Total Benefits of DPV2 are More than Double its Production Cost Benefits



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

Example: Adders to Production Cost Savings in Transmission Cost-Benefit Study by Brattle and ATC



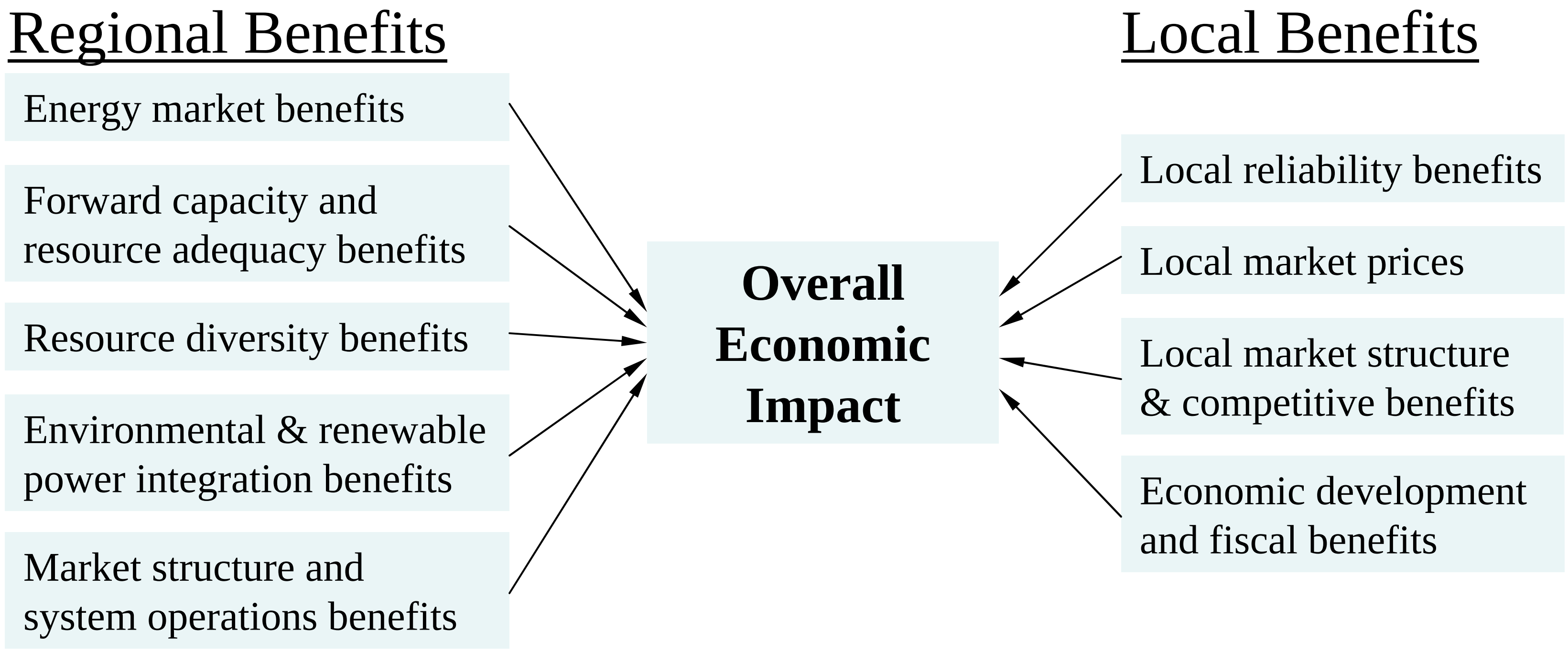
Note: Range shown as defined by 6 futures (out of 7 analyzed) in which the project's benefits were positive. Energy cost adjustment and competitiveness benefit could be multiples for states that rely more heavily on market-based pricing of generation.

Source: Preliminary results from analysis of the Paddock-Rockdale project, ATC, 3/07.

Regional vs. Local Economic Benefits

Consideration of regional and local benefits can be critical if approval is needed in multiple states.

Example: recent qualitative evaluation of an regional transmission project in early proposal stages



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The Challenge of "Economic" Transmission Projects

- **Significant opportunities to improve transmission grid and power markets through "economic" transmission projects**
  - Most projects justified based on "reliability" or regulatory mandates
  - Economic projects face extra hurdle in demonstrating "need"
  - Some reliability projects now also require demonstration of economic benefits
- **Simulation models have emerged as the standard tool to quantify economic benefits**
  - Excellent tools, but results are no better than modeling assumptions
  - Benefits dependent on geographic scope and choice of metric
  - Models do not address important "other benefits" that are too often dismissed as "qualitative", "indirect" or "intangible"
  - Narrow scope gets baked into RTOs' cost-benefit frameworks

Importance of Addressing "Other Benefits"

- **Benefits quantified with dispatch models may be sufficient to justify a transmission investment**
- **Still, addressing "other benefits" can be critical:**
  - Necessary if easy-to-quantify benefits are less than project costs
  - Needed to show benefits to regions for which dispatch models suggest adverse impacts
    - By not considering all benefits, simulation models tend to create <u>exaggerated perception of winners and losers</u>
- **Other benefits <u>can easily double</u> simulated production cost savings**
  - Shouldn't assume these "other benefits" are zero just because they are more difficult to quantify

Bio and Contact Information

Hannes Pfeifenberger is a Principal of The Brattle Group, where he manages the firm's utility practice. He is an economist with a background in electrical engineering and twenty years of experience in the areas of regulatory economics and finance. He advises companies and governmental agencies on subject areas such as industry restructuring, transmission access and cost-benefit analyses, ratemaking and incentive regulation, competitive analyses, financial valuation, and litigation support. He has published widely, assisted clients in the formulation of business and regulatory strategy, submitted expert testimony to the U.S. Congress, courts, arbitration panels, and regulatory agencies, and provided analytical support in mediation, arbitration, settlement, and stakeholder processes.

Mr. Pfeifenberger holds an M.A. in economics and finance from Brandeis University and an M.S. in power engineering and energy economics from the University of Technology, Vienna, Austria.

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Appendix

Discussion of “Other Benefits” Listed on Slide 10

Market Competitiveness Benefits

- **New transmission enhances competition (especially in load pockets) by broadening set of suppliers**
  - Impacts structural measures of market concentration (HHI, PSI)
  - Various approaches are available to translate improvements in these structural measures into potential changes in market prices
  - Size of impact differs in restructured and non-restructured markets
- **Can substantially reduce market prices during tight market conditions**
  - We found competitiveness benefits can range from very small to multiples of the production cost savings, depending on
    1. fraction of load served by cost-of-service generation
    2. the generation mix and load obligations of market-based suppliers
  - CAISO estimated competitiveness benefits can average 50% to 100% of energy cost benefits (for DPV2 and Path 26 Upgrade), with very wide range (5% to 500%) depending on future market conditions

Market Liquidity Benefits

- **Limited power market liquidity is costly to participants in both restructured and non-restructured markets**
- **Added transmission can increase liquidity of trading hubs or allow access to more liquid trading hubs**
  - Lower bid-ask spreads
  - Increased pricing transparency, reduced risk of overpaying
  - Improved risk management
  - Improved long-term planning, contracting, and investment decisions
- **Quantification is challenging but benefit can be sizeable**
  - Bid-ask spreads for bilateral contracts at less liquid hubs are 50 cents to $1.50 per MWh higher than at more liquid hubs
  - At transaction volumes of 10 to 100 million MWh per quarter at each of 30+ trading hubs, even a 10 cent reduction of bid-ask spreads saves $4 to $40 million per year and trading hub

Reliability Benefits

- **Reliability has economic value**
  - Average value of lost load easily exceed $5,000 to $10,000 per MWh

  Reliability cost = (expected unserved energy) x (value of lost load)

  - About 24 outages per year with curtailments in 100-1,000 MW range, 5 in 1,000-10,000 MW range, and 0.25 in 10,000+ MW range
- **Even "economic" projects tend to improve reliability**
  - Increases options for recovering from supply disruptions and transmission outages
  - For example, DPV2 would reduce load drop requirements of certain extreme contingencies by 2300 MW (i.e., $10-$100 million benefit for each avoided event)
- **Models tend to understate unserved energy**
  - EUE/LOLP models often consider only generation reliability, not probability of transmission outages
  - Dispatch models do not cover full range of possible outcomes; generally also ignore transmission outages and voltage constraints

Added Operational Benefits

- **New transmission projects can reduce certain reliability-related operating costs**
  - Examples are out-of-merit dispatch costs, reliability-must-run costs, unit commitment costs (RMR, MLCC, RSG, etc.), which can be a multiple of total congestion charges
  - Added transmission can also reduce costs by increasing flexibility for maintenance outages, switching, and protection arrangements
  - Ancillary service benefits
- **Dispatch models do not generally capture these costs**
  - RMR costs not explicitly considered
  - Ancillary services modeled only incompletely
  - Transmission outages (planned or forced) not generally modeled
- **CAISO estimated operational benefit of DPV2 would <u>add 35%</u> to energy cost savings**

Insurance and Risk Mitigation Benefits

- **Even if a range of "scenarios" is simulated in economic analysis, new transmission can offer additional "insurance" benefits**
  - Helps avoid high cost of infrequent but extreme contingencies (generation or transmission) not considered in scenarios
  - Incur premium to diversify resource mix to address risk aversion of customers and regulators
- **Insurance and risk mitigation value can be quantified:**
  - Calculate probability-weighed market price and production cost benefits through dispatch simulation of extreme events
  - Additional reliability value (EUE x VOLL)
  - Potential additional risk mitigation value if project diversifies resource mix and reduces the cost variances across scenarios

In recent case, value of insurance against high energy costs during extreme events (even ignoring reliability and risk premium) added as much as 25% to production cost savings

Capacity Benefits

- **New transmission can reduce installed capacity and reserve requirements**

    1. ***Reduced system losses during peak load*** reduces installed capacity requirement
        - On a recently-evaluated transmission project, loss related capacity benefits on average added 5% to 10% to production cost savings.

    2. ***Added import capability*** may improve LOLE and, as a consequence, allow to reduce local reserve margin requirements or satisfy requirement by improving deliverability of resources
        - Reduced reserve margin or resource adequacy requirements often difficult to attribute to individual transmission projects
        - Still, benefits can be large if a project were to trigger such a reduction (e.g., $8 million annually if Wisconsin reserve margin requirements could be reduced from 18% to 17%)

Long-term Resource Cost Advantage

- **Impact of transmission on total resource costs (capital and operating) may not be captured in simulation**
  - Simulations with and without the transmission project, but generally for fixed generation system
  - Dispatch models do not generally capture capital costs of resources nor the facilitation of unique low-cost generating options
- **New transmission can <u>lower total resource costs</u>**
  - Make feasible physical delivery from generation in remote locations that may offer a variety of cost advantages:
    - lower fuel costs (e.g., mine mouth coal plants)
    - better capacity factors (e.g., renewables from wind-rich areas)
    - lower land, construction, and labor costs
    - access to valuable unique resources (e.g., pumped storage)
    - lower environmental costs (e.g., carbon sequestration options)

  Risk: double counting of capacity and congestion cost benefits

  Advantage of lower-cost remote resource can exceed higher transmission-related costs (incl. congestion and losses)

Synergies with other Transmission Projects

- **Individual transmission projects can provide significant benefits through synergies with other transmission investments**
  - For example, construction of DPV2 improves the economics and feasibility of TransWest Express and Project Zia
    - If failure to site DPV2 delays TransWest Express, each year of delay may forego $200-300 million in low-cost imports to AZ
    - Transmission to access renewables in New Mexico (Project Zia) also may be uneconomic if California markets cannot be reached
  - Construction of the Tehachapi transmission project (to access 4,500 MW of wind resources) allows low-cost upgrade of Path 26 and provides additional options for future transmission expansions
- **Economically justified transmission projects may avoid or delay the need for (or reduce the cost of) future reliability projects**

Impacts on Fuel Markets

- **Transmission can reduce fuel demand and prices**
  - Through dispatch of more efficient plants
  - Through integration of resources that don't use the particular fuel.

    For example, Western transmission projects (Tehachapi, Frontier, TransWest Express) each have the potential to reduce Southwestern natural gas demand by several percent through additional renewable or clean coal generation
- **As a substitute to transporting fuel, transmission projects can benefit fuel transportation markets**
  - "Coal by wire" can help reduce railroad rates (e.g., in the West)
  - Accessing generation on the unconstrained side of pipelines
- **These fuel market benefits can be wide-spread**
  - Additional reductions in generation costs and power prices if fuel is on the margin (e.g., natural gas in the Southwest and East Coast)
  - All fuel users outside the electric power industry benefit as well

Environmental and Renewable Access Benefits

- **New transmission can reduce emissions by avoiding dispatch of high-cost, inefficient generation**
  - Can reduce SO2, NOx, particles, mercury, and CO2 emissions by allowing dispatch of more efficient or renewable generation
    - DPV2 estimated to reduce WECC-wide NOx emissions from power plants by 390 tons and natural gas use by 6 million MMBtu or 360,000 tons CO2 per year (worth $1-10 million/yr)
    - Tehachapi transmission project to access 4,500 MW of renewable (wind) generation
  - Can also be environmentally neutral or even result in displacement of cleaner but more expensive generation (e.g., gas-fired)
- **Local-only or regional/national benefits?**
  - Reduction in local emissions may be valuable (e.g., reduced ozone and particles in heavily populated areas) irrespective of regional/national impact
  - May not reduce regional/national emissions due to cap and trade but may reduce the cost of allowances and renewable eneryg credits

Fiscal Benefits from Construction and Taxes

- **Approval of some transmission projects often is dependent on support by “other” states and local governmental entities**
- **May warrant quantification of fiscal benefits (jobs and taxes) to these entities**
  - Economic value of construction activities
  - Increased property taxes for counties
  - State taxes on generator profits and natural gas use

  Can amount to tens of millions of dollars

- **These benefits can be important if entities along transmission path do not receive certain other economic benefits of transmission expansion**