

Transmission Policy: Frameworks for Efficient Investments and Interprovincial, International Expansion

PRESENTED BY

Johannes Pfeifenberger

PRESENTED AT

Ivey Energy Policy and Management Centre

8th Annual Workshop on the Economics of Electricity Policy and Markets

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Topics discussed today

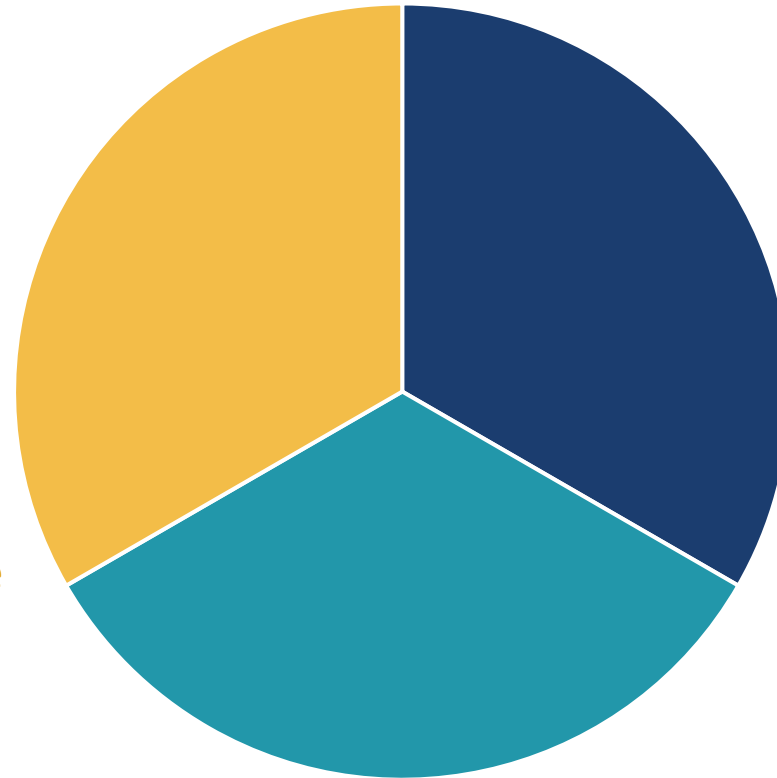
1. The need for more proactive, scenario-based economic transmission planning
2. The challenge of planning interregional or international transmission
3. Transmission policies to support a more cost-effective and affordable clean-energy transition

Need: to double or triple transmission capability in North America!

Question: How can we do so quickly and cost-effectively?

1. Advanced, grid enhancing technologies

- Dynamic line ratings
- Flow control devices
- Topology optimization
- Grid-optimized DER/storage
- Remedial action schemes
- Grid-forming inverters



2. Upgrades of existing lines

- Advanced conductors
- Rebuild aging lines at higher voltage
- Conversions to HVDC

3. New transmission

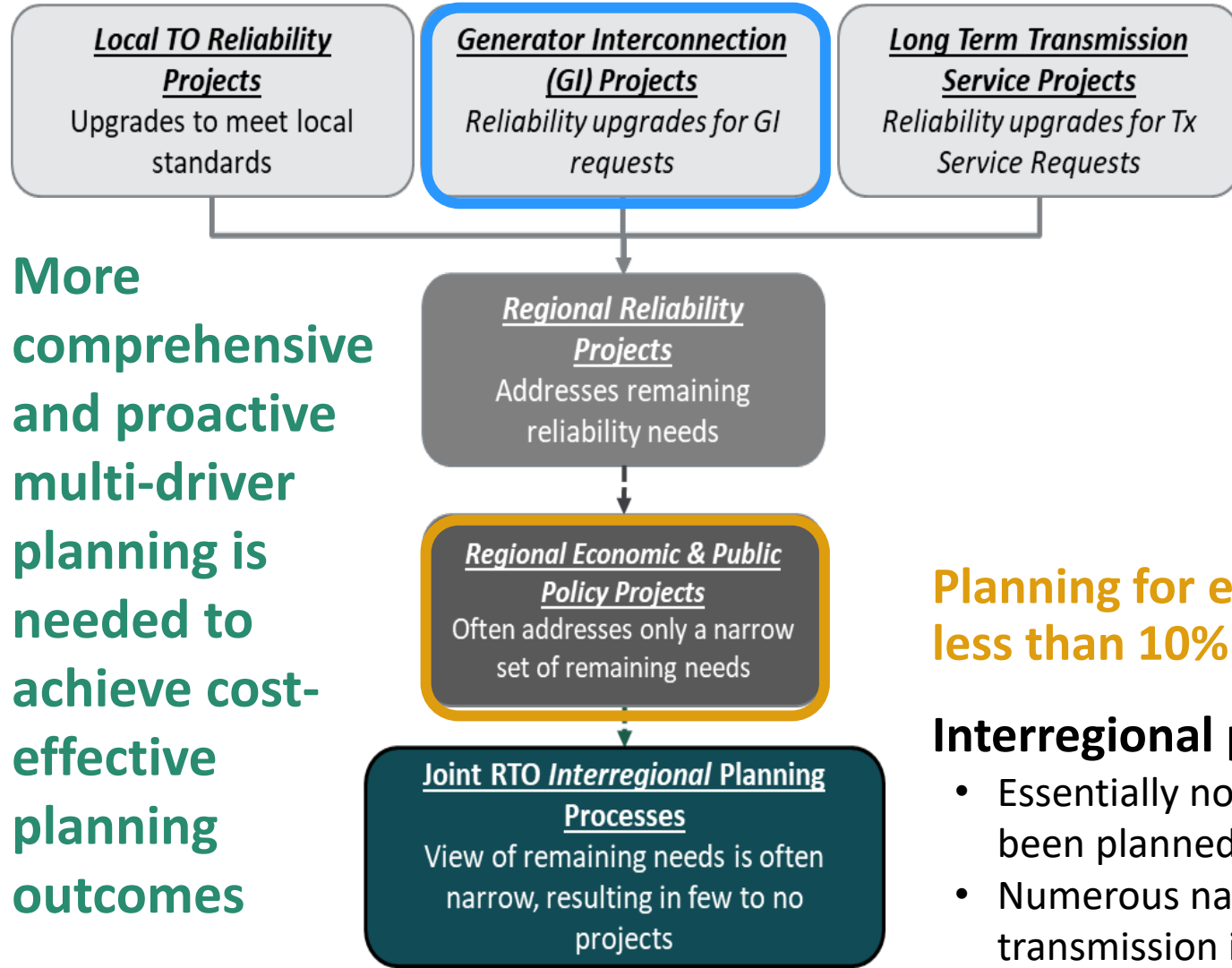
- Highway/railroad corridors
- ROW-efficient AC designs
- HVDC transmission
- Submarine/underground
- New greenfield overhead

Examples:

[Priority order](#) required by the German “[NOVA Principle](#)”

MA [CETWG Report](#): Loading Order and ATT/GETs recommendations

Today's reliability-focused transmission planning is too siloed to identify cost-effective or interregional solutions



More comprehensive and proactive multi-driver planning is needed to achieve cost-effective planning outcomes

These solely reliability-driven processes account for > 90% of all U.S. transmission investments

- None involve any assessments of economic benefits (i.e., cost savings offered by the new transmission)

Incremental generation interconnection has become the primary tool (and efficiency barrier) to support public policy goals

Planning for economic & public-policy needs results in less than 10% of all U.S. transmission investments

Interregional planning processes are large ineffective

- Essentially no major interregional transmission projects have been planned and built in the last decade
- Numerous national studies show that more interregional transmission is needed to reduce total system costs

Proactive, holistic, scenario-based, long-term planning is needed!

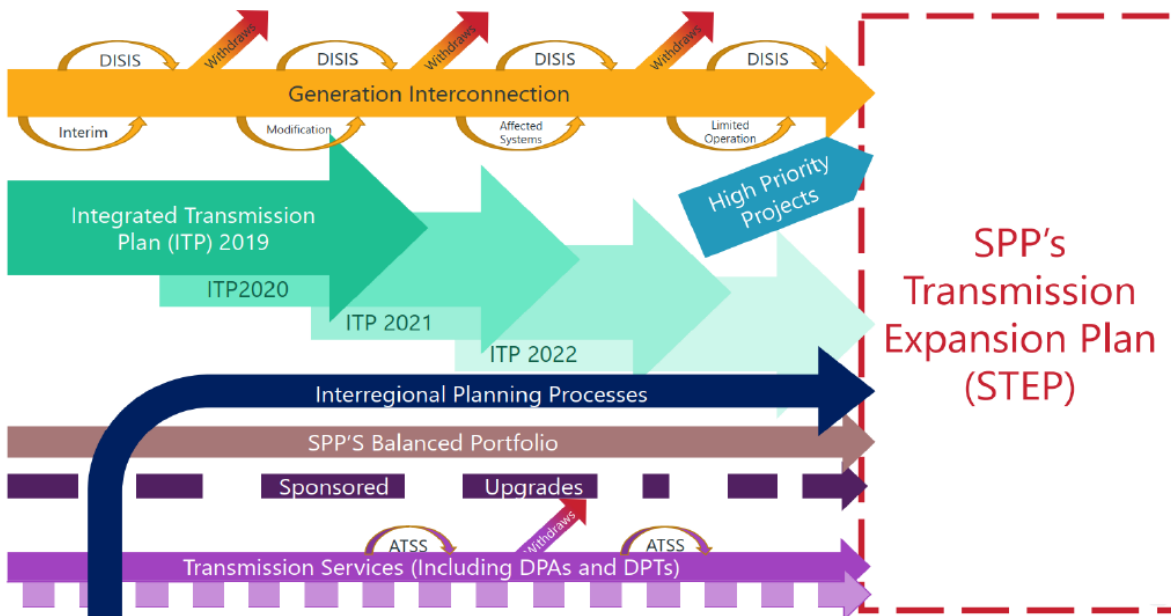
The benefits (overall cost savings) of proactive planning increase for transmission planning processes that:

1. Holistically consider all transmission needs over longer time frames (i.e., consolidate two decades of already-known or likely needs for generator interconnection, local and regional reliability, economic benefits, and public policies, as opposed to need at a time)
2. Use proactive, multi-value planning processes to address both urgent near-term needs and long-term needs, utilizing scenario-based planning to address long-term uncertainties
3. Reduce the scope of network upgrades triggered by generator interconnection through the proactive, holistic planning process (and improve generator interconnection study criteria)
4. Look beyond regional seams to identify more cost-effective interregional solutions to the range of identified transmission needs
5. Rely on advanced transmission technologies and flexible solutions to address identified needs and enhance the grid
6. Utilize pragmatic cost allocations that are roughly commensurate with (but not formulaically based on) benefits received

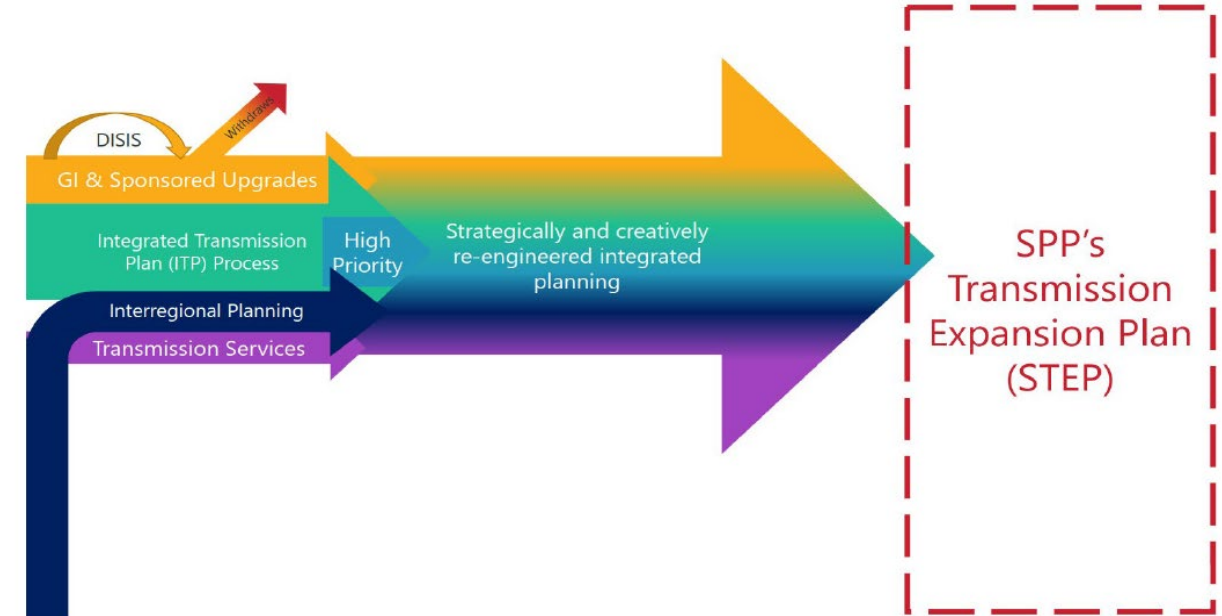
Example: SPP's proposed Consolidated Planning Process (CPP)

The Southwest Power Pool (SPP) is working on consolidating its several siloed planning processes (e.g., for generator interconnection, integrated regional transmission, transmission service requests, and interregional planning) into a single holistic process:

Current Planning Process



Proposed Consolidated Planning Process



What is proactive, scenario-based, long-term planning?

Scenario-based planning is a process first developed in the 1940s and 1950s as a tool for integrating uncertainties into long-term strategic planning:

- Used by Shell with great success since the 1970s for long-term planning under large uncertainties
- **Allows planners to think, in advance, about the many ways the future may unfold and how to respond effectively and flexibly as uncertain future outcomes become reality**
- Ranks among the top-ten management tools in the world today
- Scenario = one fully-defined, plausible view of what the future may look like

Scenario-based planning is a multi-step process:

1. Define scenarios of plausible futures by scanning the current reality, trends and forecasts, uncertainties, and important internal and external drivers
2. Develop a series of plans (initiatives, projects, policies, tactics) that work well across multiple scenarios (e.g., by developing **solutions that are flexible and robust across all plausible futures**)
3. Implement preferred plan and define indicators to alert planners that a certain future is likely to occur, so they can take action (e.g., exercise options to address the new developments)

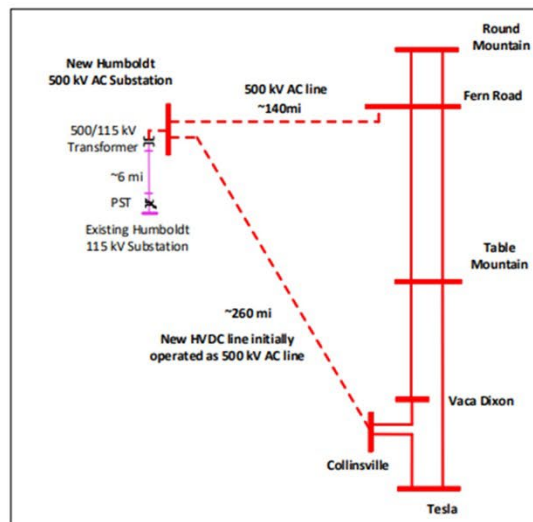
See [Living in the Futures \(hbr.org\)](https://hbr.org) and [Scenario Planning-A Review of the Literature.PDF \(mit.edu\)](https://mit.edu)

Create value and mitigate risk through more flexible solutions

Planning processes need to develop flexible transmission solutions that create valuable options, given high long-term uncertainties:

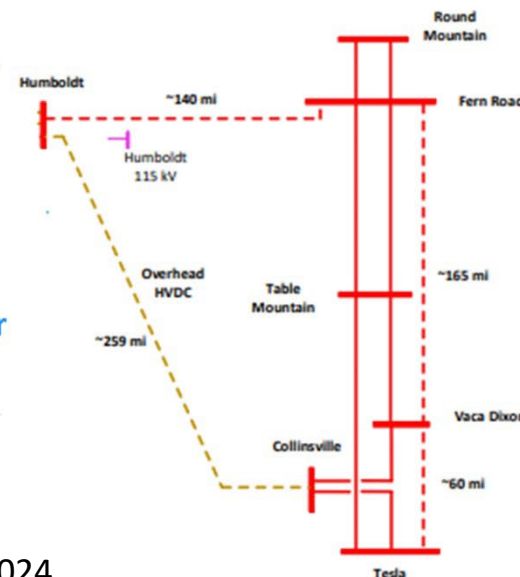
- Example 1 – rebuild single-circuit 230kV line as 345kV-ready with double-circuit towers to create option to: (1) initially operate circuit at 230kV, (2) later add 1 GW of transfer capability by stepping it up to 345kV (with transformation), and (3) ultimately expand the capacity by adding a second circuit
- Example 2 – CAISO’s expandable offshore-wind integration solution with HVDC-ready 500kV line:

Phase 1: Base Case Plan
(1,607 MW)



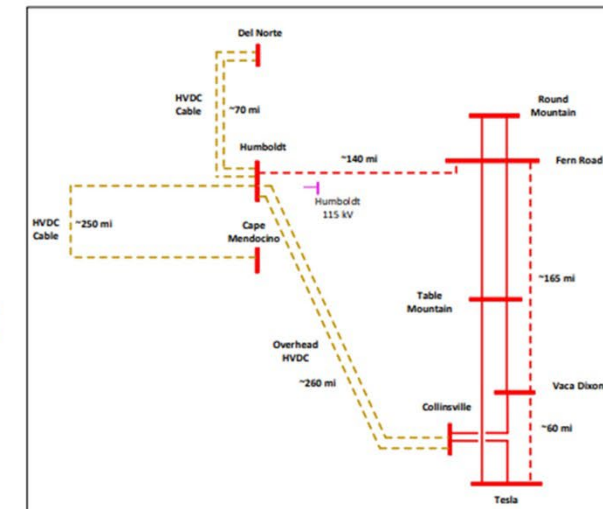
Source: [CAISO-2023-2024-transmission-plan](#), May 23, 2024.

Phase 2: DC Conversion
(3,100 – 3,300 MW?)



Add DC converter stations to each end of the line

Phase 3: Expanded Plan (Option B)
(8,045 MW)



Add a second HVDC line

Two new 500kV lines, of which one is “HVDC-ready”

Risk mitigation through proactive “least-regrets” planning

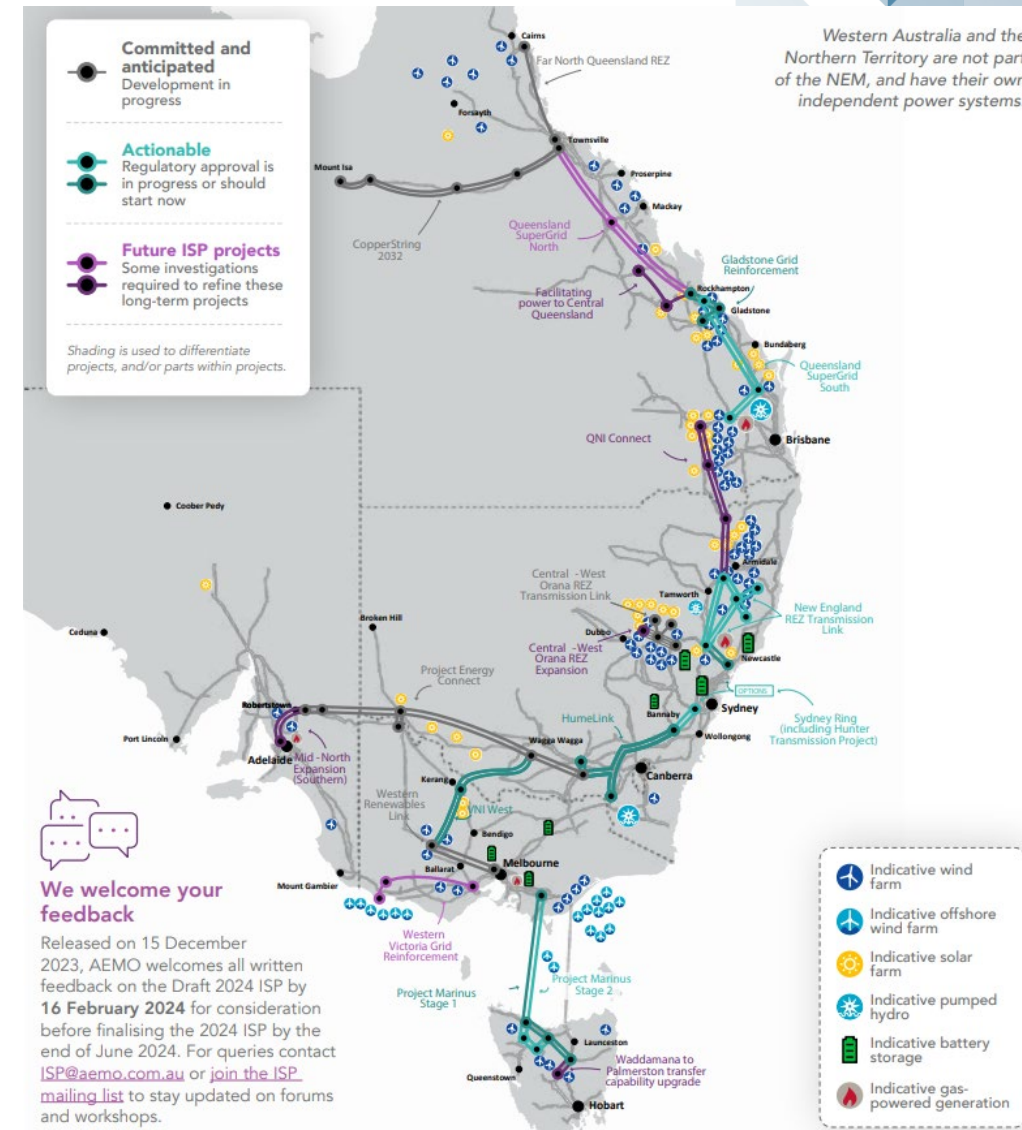
Proactive planning needs to consider both (1) the high risk of delaying infrastructure investment and (2) the risk-mitigation offered by alternative transmission solutions:

- Given that it can take a decade to develop new transmission, **delaying investment can** easily **limit future options** and result in a **higher-cost, higher-risk** overall outcomes
 - “Wait and see” approaches can limit options, so can be more costly in the long term
 - The industry needs to plan for both short- and long-term uncertainties more proactively – and develop solutions that comprehensively and flexibly address uncertain future needs
- **“Least regrets” planning** to minimize the risk of both under - and overinvesting
Use full set of scenarios in planning to identify solutions that minimize both sources of possible regrets:
 1. Avoid oversized projects that “regrettably” end up too costly and under-utilized; and also
 2. Avoid many “regrettable” high-cost outcomes caused by undersized transmission solutions
- Focusing on just one scenario cannot distinguish solutions with higher/lower costs and risk
- Taking probability-weighted averages across scenarios is insufficient as it (a) assumes risk neutrality and (b) does not quantify the value of flexibility and risk mitigation

Example: Australian Integrated System Plan (ISP)

The Australian Energy Market Operator (AEMO) integrated planning process is “best in class” for proactive, scenario-based planning:

- Clearly-specified methodology ([link](#)) produces updated plans every two years with extensive stakeholder consultations (see [Draft 2024 ISP](#))
 - Scenario-based analysis explicitly considers long-term uncertainties and risk mitigation over next 30 years ([link](#))
 - Plans distinguish: (1) actionable projects for which the need is certain enough now to move forward; and (2) future projects that are likely needed at some point
 - Least regrets planning values optionality that can be exercised if/when needed (e.g., projects that can be built/expanded in stages; or undertaking “early works” to develop shovel-ready projects that can be constructed quickly in the future)
- Guidelines for cost-benefit framework, forecasting, and “investment tests” from the Australian Energy Regulator (AER) make AEMO plans actionable ([link](#))



Need: Expand and more efficiently utilize interregional transmission

Significant seams-related inefficiencies exist between RTO markets, which make it difficult to capture the full value of both existing and new interregional transmission:

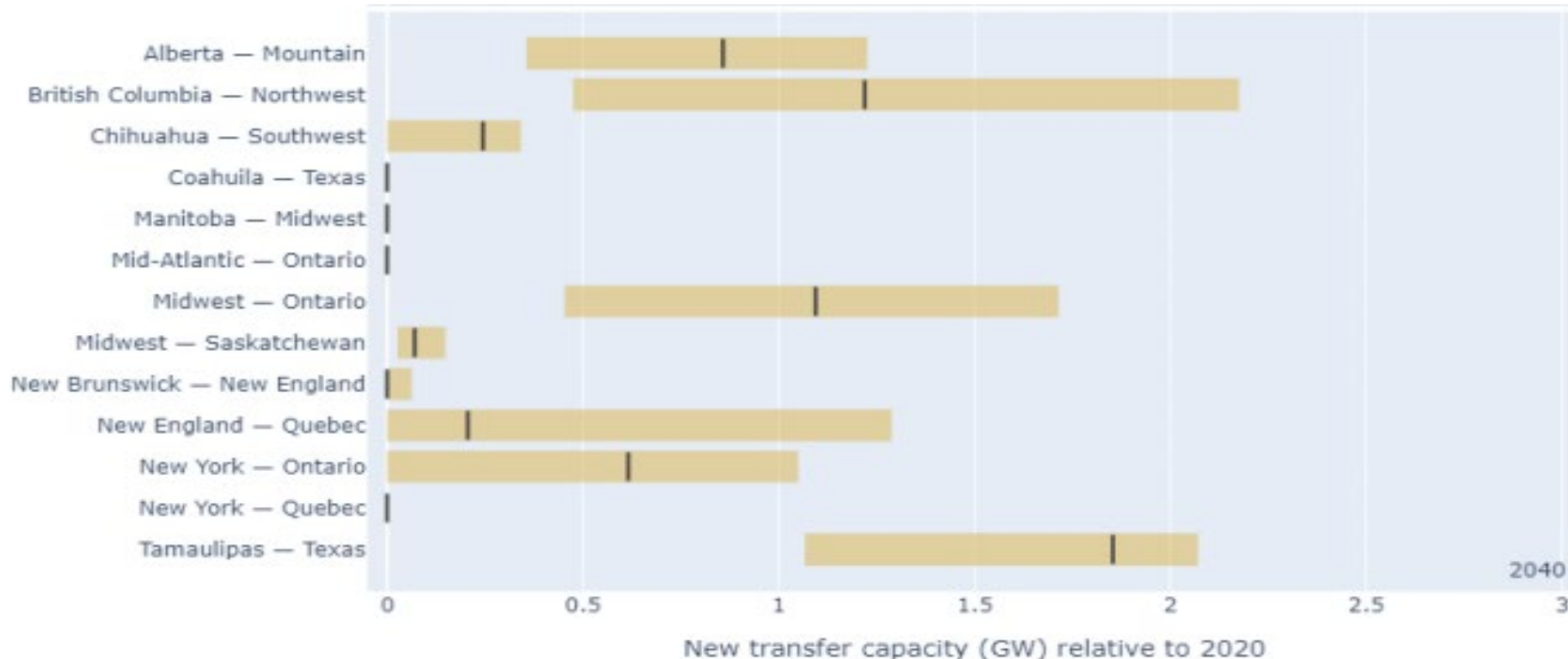
1. **Interregional transmission planning** is mostly not existing or ineffective (beyond merchant T)
2. **Generator interconnection** delays and cost uncertainty created by affected system impact studies (and effectiveness coordination through means such as the SPP-MISO JTIQ, reducing costs by 50%)
3. **Resource adequacy** value of interties (often not considered in RTO's resource adequacy evaluations) and barriers to capacity trades (often created by RTOs' restrictive capacity import requirements and incompatible resource accreditations)
4. **Loop flow management** through market-to-market coordinated flowgates (with shares of firm flow entitlements) under the existing JOAs
5. **Inefficient trading** across contract-path market seams and the need for intertie optimization (see [link](#))

Additional transmission between the US and Canada would reduce costs and maintain reliability

As more weather-dependent renewable resources are added to the grid, the geographic scope of the grid needs to expand beyond the size of large weather systems!

This will make expanding inter-provincial and international transmission increasingly beneficial!

Example: Cost-effective US-Canadian Transmission Expansion for moderate renewable generation and load growth scenarios (2040)



Source: US DOE, [National Transmission Needs Study \(Draft\)](#), Feb 2023, Table 8, Figure VI-7.

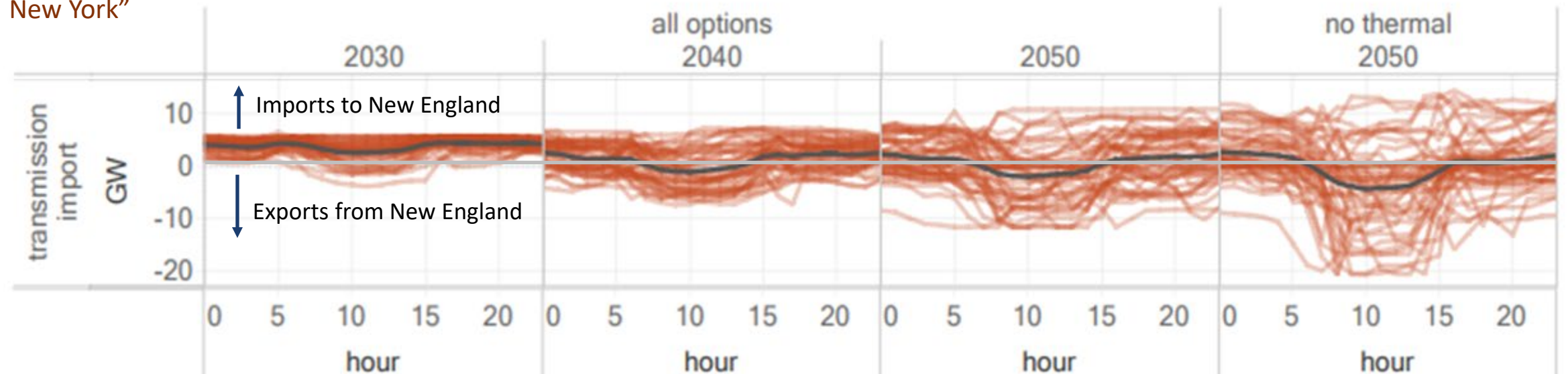
Additional transmission between the US and Canada will be beneficial ... and increasingly be used bi-directionally

Example: MA Decarbonization Pathway Study shows additional transmission to Quebec is needed and bidirectional used starting in 2030:

“the Quebec hydro system in effect acts as a form of seasonal energy storage, with energy exported to Quebec during many hours to serve Quebec loads, and with imports from Quebec in other hours to serve loads in New England and New York”

Cost effective new transmission by 2050:

Zone from	Zone to	no thermal	regional coordination	efficiency limited	100% renewable primary	all options	breakthrough der	pipeline gas	offshore wind constrained
Quebec	Maine	2	1.2	1.1	0.9	0.6	0.6	0.6	0.9
Quebec	Massachusetts	4.3	4.8	3.7	3.3	2.7	2.8	3.1	3.9
Quebec	New Brunswick	0	0	0	0	0	0	0	0
Quebec	New York	6.8	6.8	6.8	4.7	4.4	4.2	5.6	3.8
Quebec	Vermont	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8



Significant barriers to planning new interregional transmission

A. Leadership, Alignment and Understanding	<ol style="list-style-type: none">1. Insufficient leadership from RTOs and federal & state policy makers to prioritize creating effective interregional planning processes2. Limited trust amongst states, RTOs, utilities, & customers3. Limited understanding of transmission issues, benefits & proposed solutions4. Misaligned interests of RTOs, TOs, generators & policymakers5. States prioritize local interests, such as development of in-state renewables
B. Planning Process and Analytics	<ol style="list-style-type: none">6. Benefit analyses are too narrow, and often not consistent between regions7. Lack of proactive planning for a full range of future scenarios8. Sequencing of local, regional, and interregional planning9. Cost allocation (too contentious or overly formulaic)
C. Regulatory Constraints	<ol style="list-style-type: none">10. Overly-prescriptive tariffs and joint operating agreements11. State need certification, permitting, and siting

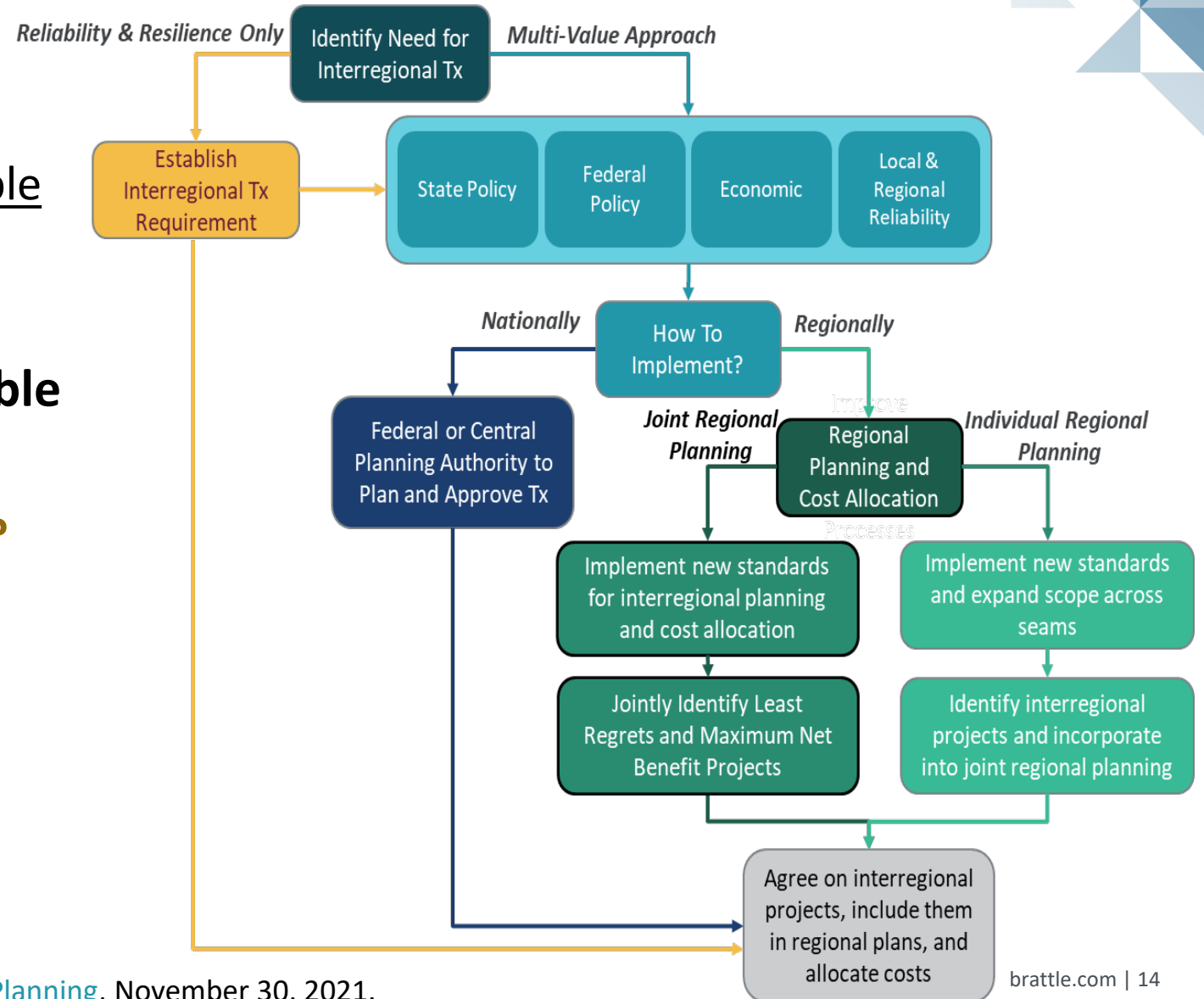
Source: Appendix A of [A Roadmap to Improved Interregional Transmission Planning](#), November 30, 2021. Based on interviews with 18 organizations representing state and federal policy makers, state and federal regulators, transmission planners, transmission developers, industry groups, environmental groups, and large customers.

Four pathways for planning interregional transmission

While national studies show there are benefits of interregional transmission, these studies do not create an actionable “need” for approving projects

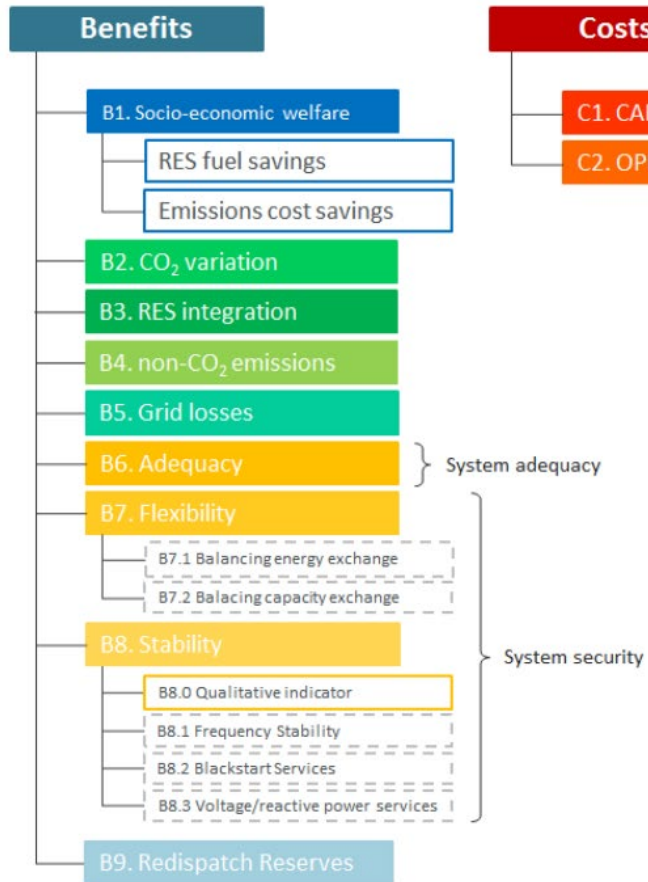
Four paths can be pursued simultaneously, identifying actionable transmission needs through:

1. **New Interregional Tx requirements?**
2. **New Federal planning?**
3. **Improve joint RTO planning**
4. **Expand planning by individual RTOs**



Example: Continent-wide proactive, multi-value planning. The European 10-year Network Development Plan (TYNDP)

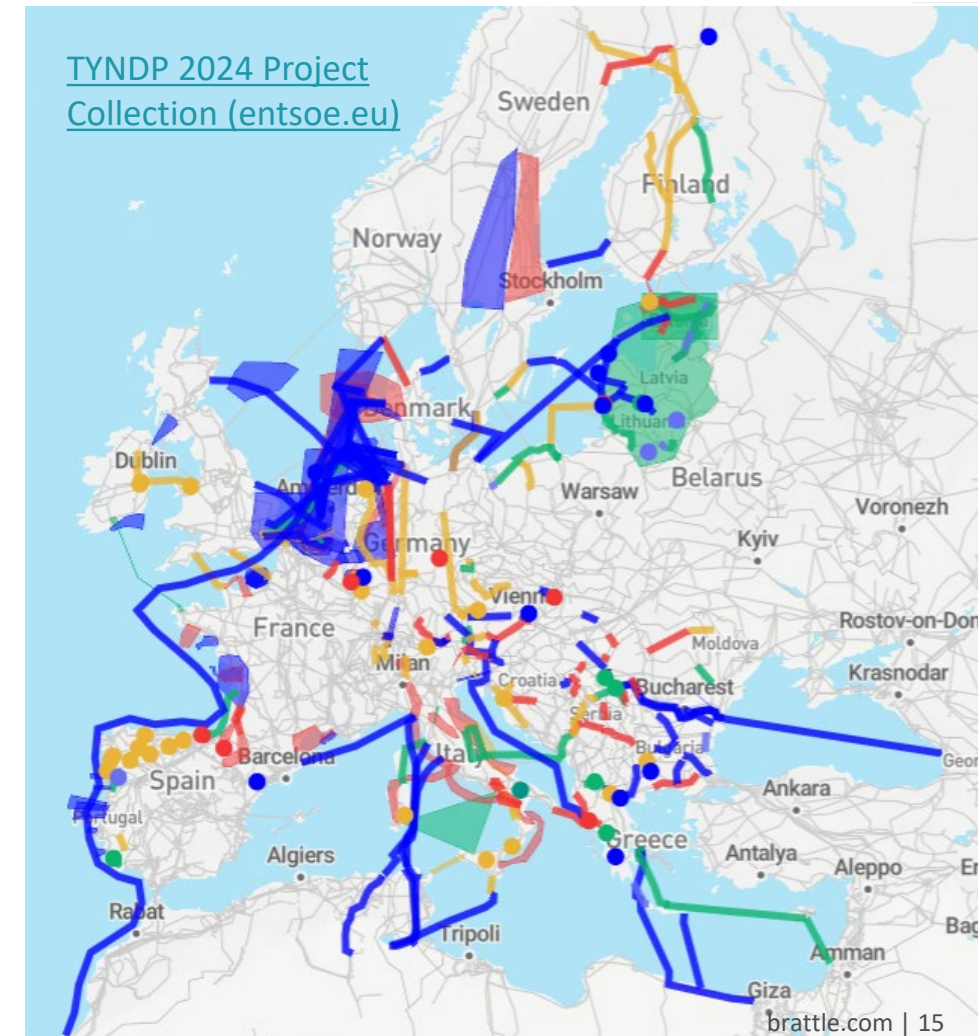
ENTSO-E: Standardized Multi-value Benefit-Cost Analysis Framework for EU-wide Transmission Planning (incl. HVDC)



Entso-E Planning and CBA framework

- Association of European Grid Operators
- 10 year investment plan
- Scenario-based looking out 10-30 years
- Standardized benefit-cost analysis
- Specifically addresses HVDC benefits: Cost savings achievable from optimized dispatch of HVDC lines; transient, voltage, and frequency stability benefits of HVDC lines; blackstart services; voltage and reactive power support

10-Year Network Development Plan (TYNDP) to Evaluate 176 Transmission, 33 Storage Projects



Source: ENTSO-e, [4th ENTSO-e Guideline for Cost Benefit Analysis of Grid Development Projects](#), Oct 18, 2023, Figure 8; [TYNDP 2024 Implementation Guidelines](#), Mar 4, 2024. For a summary of the ENSTO-e framework, incl. HVDC, see pp. 77-80 [here](#).

The Challenge: How to keep the energy transition affordable



The challenge to achieving an affordable clean-energy transition is formidable:

1. Much of the (aging) existing generating resources will need to be replaced over the next two decades
2. Electrification and data center load growth will double the amount of generation supply needed (even with EE)
3. Local, regional, and interregional transmission capacity will need to double or triple to achieve a cost-effective outcome (as numerous studies have already shown)

More investment will be needed than can easily be provided and recovered

Unless done efficiently and cost-effectively, the size of investments and customer rate impacts will quickly exceed feasible and acceptable levels!

Nobody will be “happy” if rates start to exceed certain levels

- Unaffordable rates will undermine or delay policy goals
- High fixed costs will create uneconomic bypass of existing facilities, which will further increase total costs
- Unhappy customers and regulators create risk and challenges for regulated companies and their investors
- Utility credit ratings will deteriorate and limit the amount of investments that can be financed

Options for achieving a more affordable energy transition



Achieving cost-effective transmission-related outcomes requires a multi-faceted approach:

1. More **proactive and holistic transmission planning**
 - Multi-driver/value planning (incl. for generator interconnection) to find lowest-total-cost solutions
 - Least regrets planning to mitigate risk and costs of both overbuilding and undersizing
2. “**Loading order**” for transmission planning that prioritizes lower cost/impact options
 - Optimize existing grid → upsize existing lines → add new lines
3. **Cost control incentives**
 - Soft/hard cost caps, broad-based PBR, or targeted incentives (such as shared savings/overruns)
4. **Competitive solicitations**
 - Where possible and practical; with added cost-control incentives
5. **End-use efficiency and demand flexibility**
 - To reduce transmission, distribution, generation, and resource-adequacy costs

Competitive procurements: innovation and reduced costs

In the U.S., FERC's Order No. 1000 was intended to promote "more efficient or cost-effective transmission development" through competitive procurements



Developers compete to provide, finance, build, own, and operate innovative solutions to meet specified needs

- Planning entities identify needs and solicit innovative solutions
- Planning entities select preferred solution; selected developers finance, build, own, and operate projects
- **Examples: PJM, NYISO, UK**

Developers compete to finance, build, own, and operate pre-specified projects

- Planning entities identify need and specify solution; solicit bids for the specified project
- Planning entities select developer to finance, construct, and own the projects based on factors including bid prices
- **Examples: CAISO, MISO, SPP, Brazil, Alberta, Ontario**

Several [studies](#) of competitive procurements in the U.S., Canada, U.K., and Brazil show that competitive solicitations yield **more innovative solutions** and **cost savings of 20-30%**, yet less than 5% of projects are subject to competitive procurements

The Bottom Line: Necessary Improvements

Holistic and proactive transmission planning

- More cost-effective solutions (that integrate generator interconnection, asset refurbishment, and all other transmission needs) can be identified
- The costs and time required to address future transmission needs (and interconnect the large number of resources necessary to meet clean-energy goals) can be reduced dramatically
- More flexible plans can be developed to address the wide range of uncertain long-term needs

The benefits of holistic, proactive planning increase for processes that:

1. Consider both near- and long-term transmission needs (i.e., at least a decade of already known resource needs, as opposed to addressing only near-term needs without considering long-term needs)
2. Simultaneously considers multiple needs (generator interconnection, local and regional reliability, economic benefits, and public policy needs)
3. Reduce the scope of network upgrades triggered by generator interconnection proactive and holistic planning
4. Look beyond regional seams to identify more cost-effective interregional solutions to the range of identified transmission needs
5. Rely on advanced transmission technologies and upsizing of existing lines to address some of the identified needs
6. Utilize pragmatic cost allocations that are roughly commensurate with (not formulaically based on) benefits received



Thank You!

(Additional Slides)

About the Speakers



Johannes P. Pfeifenberger

**PRINCIPAL
THE BRATTLE GROUP, BOSTON**

Hannes.pfeifenberger@brattle.com

+1.617.234.5624

[\(webbio and publications\)](#)

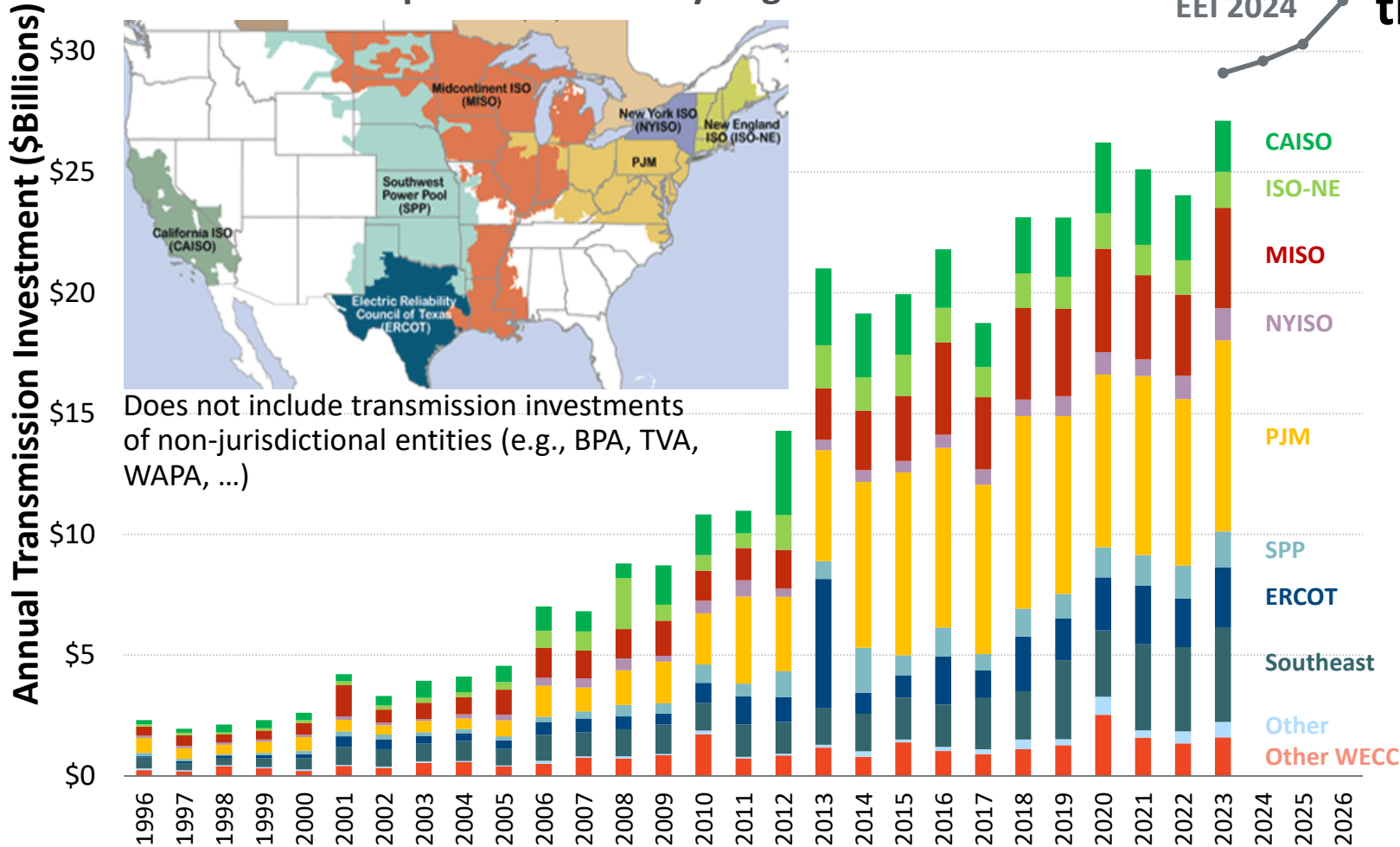
Johannes (Hannes) Pfeifenberger, a Principal at The Brattle Group, is an economist with a background in electrical engineering and over twenty-five years of experience in wholesale power market design, renewable energy, electricity storage, and transmission. He also is a Visiting Scholar at MIT’s Center for Energy and Environmental Policy Research (CEEPR), a former Senior Fellow at Boston University’s Institute of Sustainable Energy (BU-ISE), a IEEE Senior Member, and currently serves as an advisor to research initiatives by the U.S. Department of Energy, the National Labs, and the Energy Systems Integration Group (ESIG).

Hannes specializes in wholesale power markets and transmission. He has analyzed transmission needs, transmission benefits and costs, transmission cost allocations, and renewable generation interconnection challenges for independent system operators, transmission companies, generation developers, public power companies, industry groups, and regulatory agencies across North America. He has worked on transmission matters in SPP, MISO, PJM, New York, New England, ERCOT, CAISO, WECC, and Canada and has analyzed offshore-wind transmission challenges in New York, New England, and New Jersey.

He 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.

Annual U.S. Transmission Investments 1996-2023

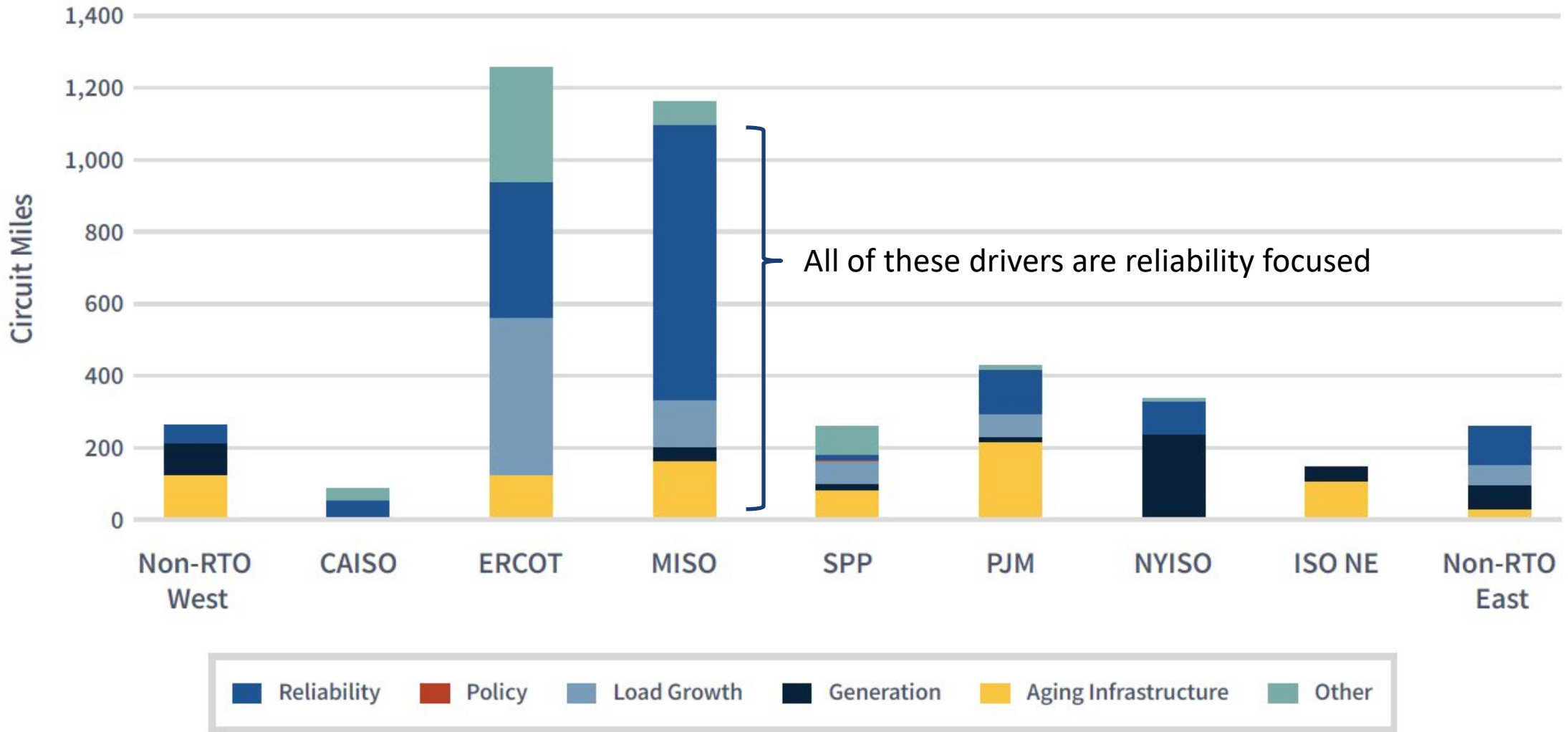
Annual Transmission Investment as Reported to FERC by Region



\$25+ billion in annual U.S. transmission investments, but:

- More than 90% of it justified solely based on reliability needs without benefit-cost analysis
 - About 50% solely based on “local” utility criteria (without going through regional planning processes)
 - The rest justified by regional reliability and generation interconnection needs
- While significant experience with transmission benefit-cost analyses exists, very few projects are justified based on economics to yield overall cost savings
- FERC Order 1920 may change that

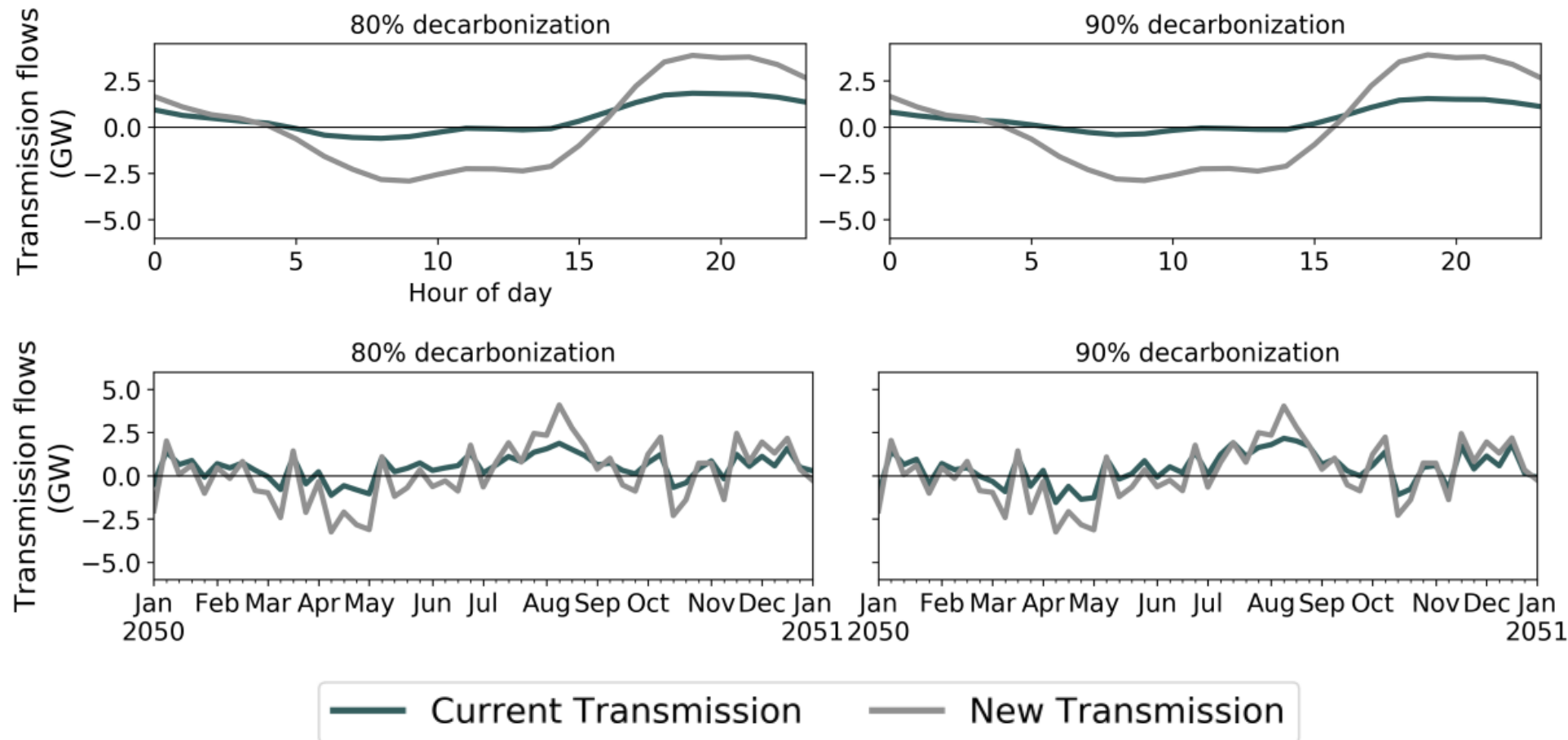
2023 Transmission Investments by Driver



Source: [FERC Staff Report: 2023 State of the Markets \(March 21, 2024\)](#), Figure 15 (based on C3 Group data)

MIT Study: Additional transmission between the Northeastern US and Canada will be cost effective and used bi-directionally

MIT similarly found that decarbonization of the electric grid in the Northeastern US will increase the need for transmission capacity and bidirectional power flows.

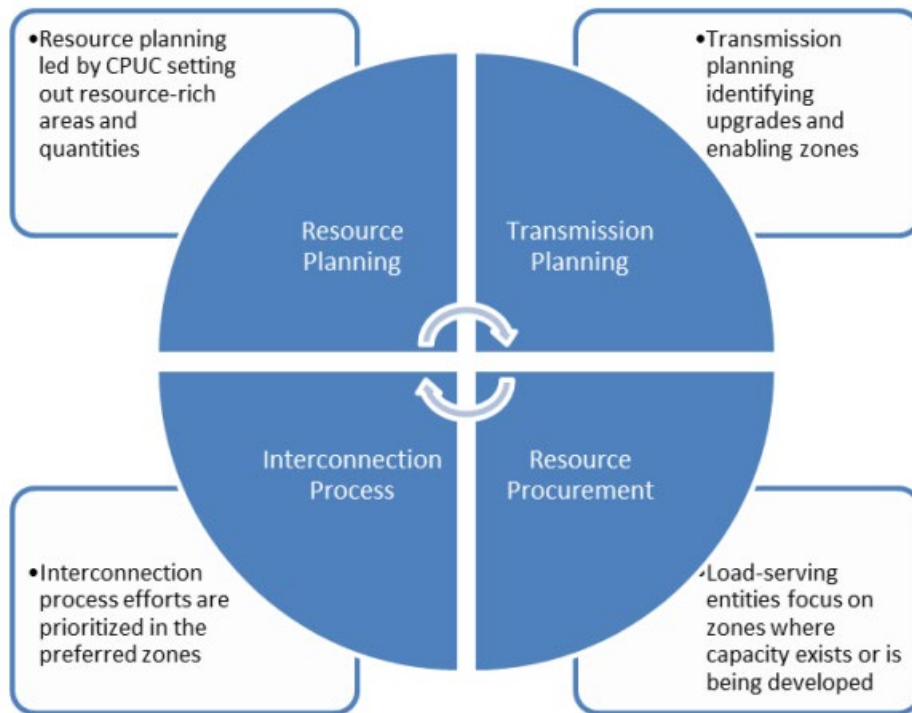


Source: [Two-Way Trade in Green Electrons: Deep Decarbonization of the Northeastern U.S. and the Role of Canadian Hydropower](#), MIT, Feb 2020.

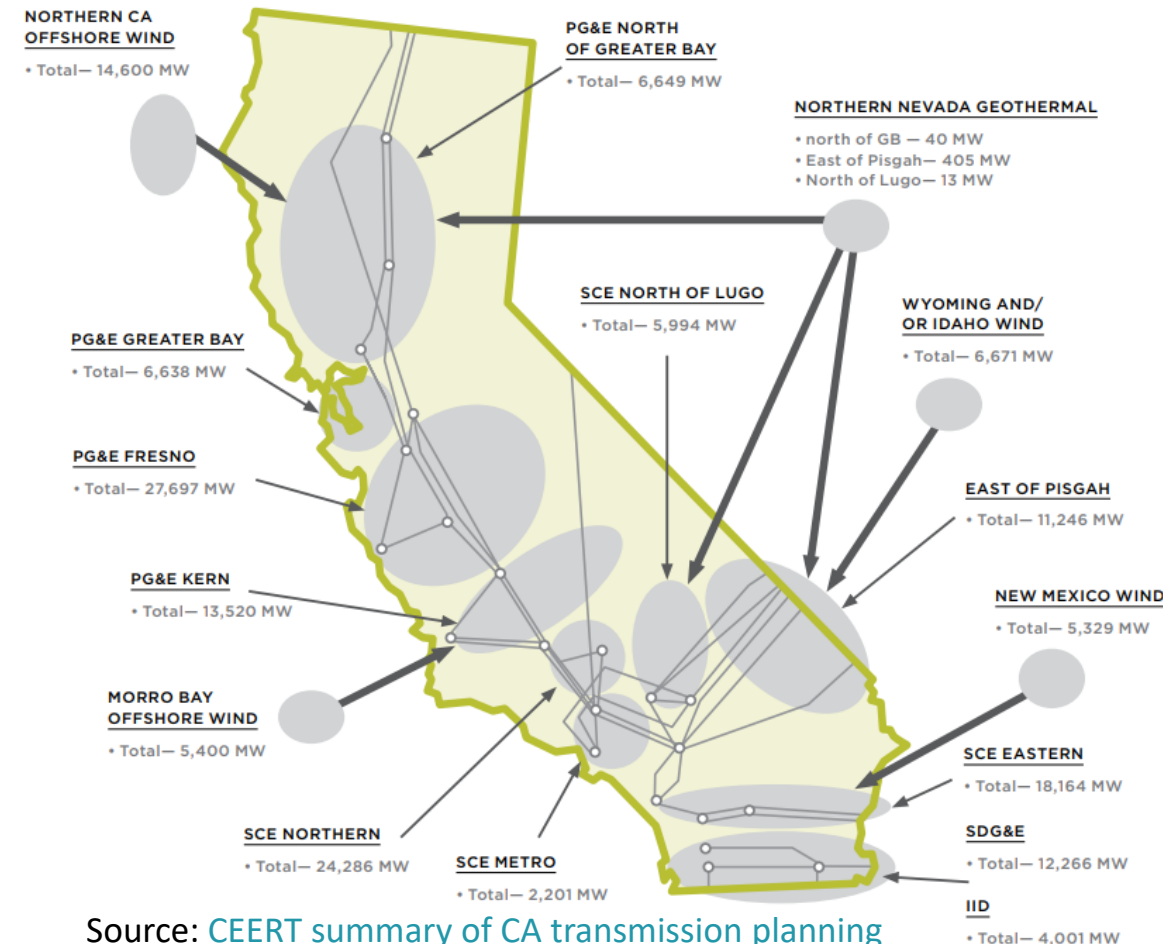
Example 4: California's Transmission Planning Process (TPP)

California's TPP combines (1) scenario-based, zonal resource development outlooks prepared by state agencies with (2) the planning and procurement of transmission solutions by the California ISO

- See [overview](#) and board-approved [2022-2023 Plan](#)
- Improved generator interconnection process ([link](#)) offers substantial [headroom](#)



2045 SCENARIO PORTFOLIO BY INTERCONNECTION AREA



Source: [CEERT summary of CA transmission planning](#)

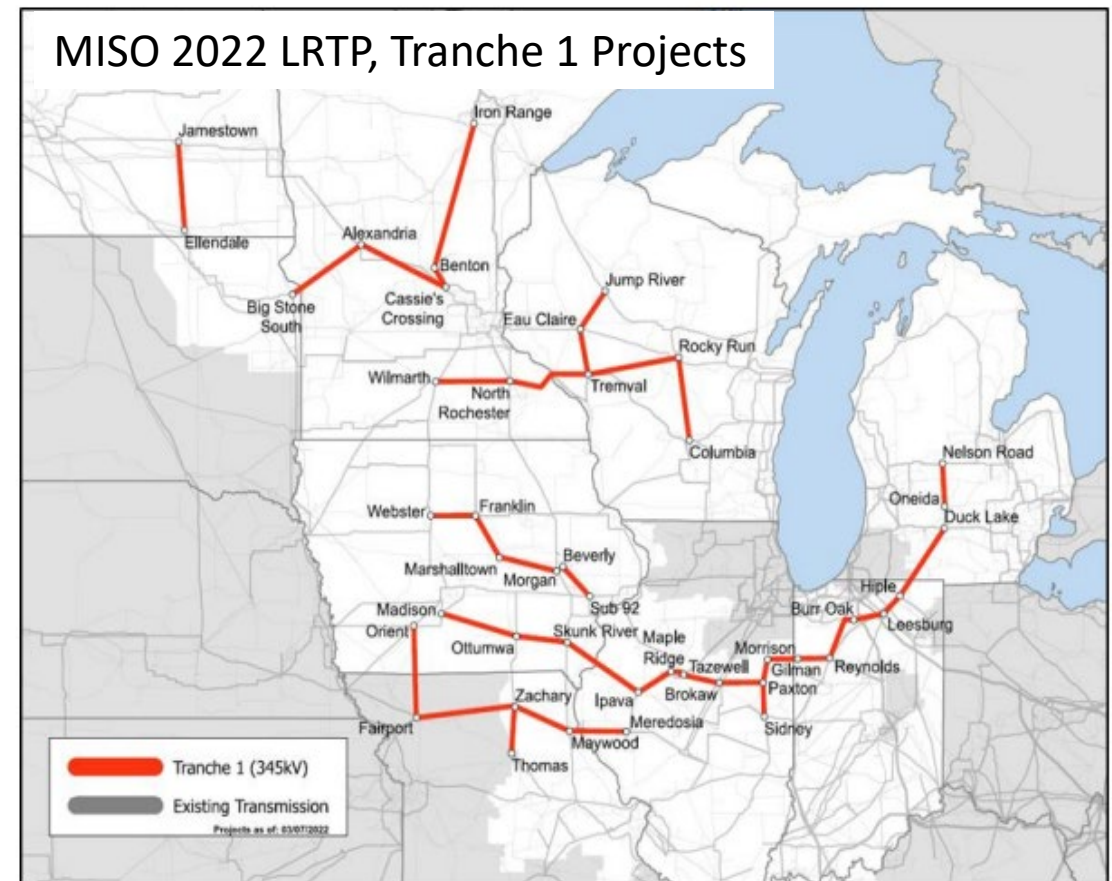
Example: MISO Long-Term Transmission Planning (LRTP)

Scenario-based LRTP → Several tranches of “least regrets” portfolios of multi-value transmission projects (MVPs)

MISO 2022 LRTP results

- Tranche 1: \$10 billion portfolio of proposed new 345 kV projects for its Midwestern footprint
- **Supports interconnection of 53,000 MW of renewable resources**
- **Reduces other costs by \$37-70 billion**
- Portfolio of beneficial projects designed to benefit each zone within MISO’s Midwest Subregion
- Postage-stamp cost allocation within MISO’s Midwest Subregion

MISO is currently in the process of finalizing \$23 billion of Tranche 2 projects ([link](#))



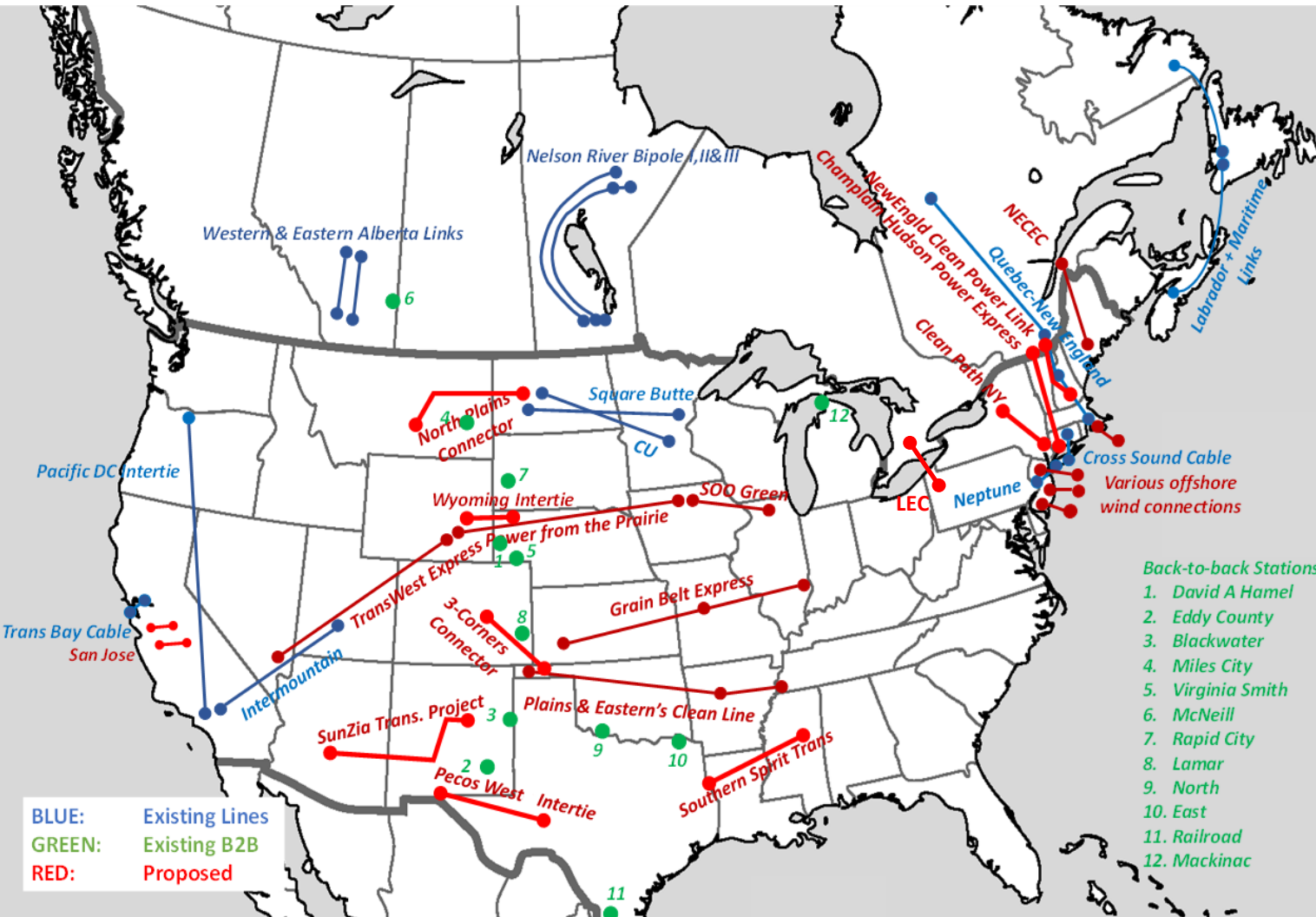
Options for interconnecting resources more quickly and efficiently

With FERC Order 2023 guidance and emerging best practices from other regions, the following measures can add resources more quickly and cost-effectively:

1. Implement fast-track process for sharing and transfers of existing POIs
2. Identify existing “headroom” at possible POIs
3. Fast-track new POIs for “first-ready” projects
4. Allow for GETs and (simple) RAS/SPS to address interconnection needs
5. Simplify ERIS (energy-only) interconnections with option to upgrade to NRIS (capacity) later
6. Proactively and holistically plan for long-term transmission needs
7. Speed up state & local permitting for projects with signed interconnection service agreements ([PJM blog](#): 44+ GW with ISAs yet only 2 GW brought online in 2022)

Interregional Transmission Needs Are Addressed Mostly Through Proposed Merchant HVDC Lines

North American HVDC Projects (Existing and Planned/Proposed)



Most U.S. interregional transmission projects are HVDC lines proposed by merchant and OSW developers (i.e., not planned by system operators)

Main HVDC advantages:

- High capacity (1-5 GW), long-distance
- Efficient right of way (including underground and submarine)
- Controllable power flows (for transmission access, economic dispatch and during contingencies)
- Synchronous and asynchronous applications
- Grid-forming capability / weak AC grids
- Grid services (to support AC network)

Examples of Brattle Reports on Regional and Interregional Transmission Planning and Benefit-Cost Analyses

Well-Planned Electric Transmission Saves Customer Costs:
Improved Transmission Planning is Key to the Transition to a Carbon-Constrained Future


PREPARED FOR
 **Link: [Well-Planned Transmission](#)**

PREPARED BY
Judy W. Chang
Johannes P. Pfeifenberger

May 2014

THE **Brattle** GROUP

Toward More Effective Transmission Planning:
Addressing the Costs and Risks of an Insufficiently Flexible Electricity Grid

PREPARED FOR
 **Link: [Effective Transmission Planning](#)**

PREPARED BY
Johannes P. Pfeifenberger
Judy W. Chang
Akash Shellenbranath

April 2015

The Brattle Group


Link: [Transmission Benefits](#)

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

July 2013


Judy W. Chang
Johannes P. Pfeifenberger
J. Michael Hagerty

Link: [Diversity Value](#)

 Boston University Institute for Sustainable Energy

The Value of Diversifying Uncertain Renewable Generation through the Transmission System

September • 2020



Transmission Planning for the 21st Century: Proven Practices that Increase Value and Reduce Costs

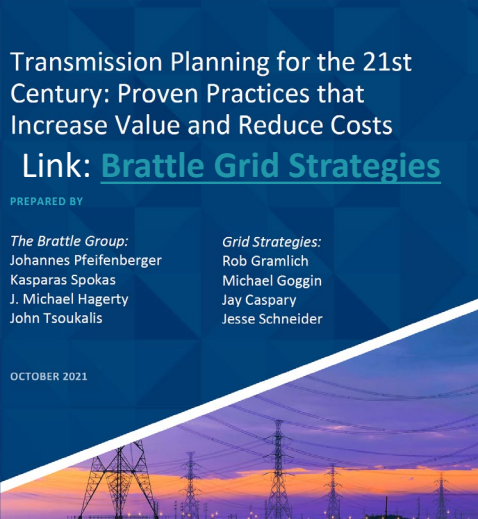
Link: [Brattle Grid Strategies](#)



PREPARED BY

The Brattle Group:
Johannes Pfeifenberger
Kasparas Spokas
J. Michael Hagerty
John Tsoukalis

Grid Strategies:
Rob Gramlich
Michael Goggin
Jay Caspary
Jesse Schneider

OCTOBER 2021




 

A Roadmap to Improved Interregional Transmission Planning

Link: [Interregional Roadmap](#)

PREPARED BY
Johannes P. Pfeifenberger
Kasparas Spokas
J. Michael Hagerty
John Tsoukalis

November 30, 2021



Summarizes proven approaches to quantifying various benefits

“Checklist” of Transmission Benefits With Proven Practices for Quantifying Them

We documented in our [report](#) proven practices, which were largely adopted in FERC Order 1920:

1. Consider for each project (or synergistic portfolio of projects) the full set of benefits that transmission can provide (see table)
2. Identify the benefits that plausibly exist and may be significant for that particular project or portfolio; then
3. Focus on quantifying those benefits

(See our [report](#) with Grid Strategies for a summary of quantification practices)

Benefit Category	Transmission Benefit
1. Traditional Production Cost Savings	Adjusted Production Cost (APC) savings as currently estimated in most planning processes
2. Additional Production Cost Savings	i. Impact of generation outages and A/S unit designations
	ii. Reduced transmission energy losses
	iii. Reduced congestion due to transmission outages
	iv. Reduced production cost during extreme events and system contingencies
	v. Mitigation of typical weather and load uncertainty, including the geographic diversification of uncertain renewable generation variability
	vi. Reduced cost due to imperfect foresight of real-time system conditions, including renewable forecasting errors and intra-hour variability
	vii. Reduced cost of cycling power plants
	viii. Reduced amounts and costs of operating reserves and other ancillary services
	ix. Mitigation of reliability-must-run (RMR) conditions
	x. More realistic “Day 1” market representation
3. Reliability and Resource Adequacy Benefits	i. Avoided/deferred cost of reliability projects (including aging infrastructure replacements) otherwise necessary
	ii. (a) Reduced loss of load probability or (b) reduced planning reserve margin
4. Generation Capacity Cost Savings	i. Capacity cost benefits from reduced peak energy losses
	ii. Deferred generation capacity investments
	iii. Access to lower-cost generation resources
5. Market Facilitation Benefits	i. Increased competition
	ii. Increased market liquidity
6. Environmental Benefits	i. Reduced expected cost of potential future emissions regulations
	ii. Improved utilization of transmission corridors
7. Public Policy Benefits	Reduced cost of meeting public policy goals
8. Other Project-Specific Benefits	Examples: increased storm hardening and wild-fire resilience, increased fuel diversity and system flexibility, reduced cost of future transmission needs, increased wheeling revenues, HVDC operational benefits

Examples of Significant U.S. 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 CO₂ 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

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Brattle Group Practices and Industries

ENERGY & UTILITIES

Competition & Market
Manipulation
Distributed Energy
Resources
Electric Transmission
Electricity Market Modeling
& Resource Planning
Electrification & Growth
Opportunities
Energy Litigation
Energy Storage
Environmental Policy, Planning
and Compliance
Finance and Ratemaking
Gas/Electric Coordination
Market Design
Natural Gas & Petroleum
Nuclear
Renewable & Alternative
Energy

LITIGATION

Accounting
Analysis of Market
Manipulation
Antitrust/Competition
Bankruptcy & Restructuring
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

Electric Power
Financial Institutions
Infrastructure
Natural Gas & Petroleum
Pharmaceuticals
& Medical Devices
Telecommunications,
Internet, and Media
Transportation
Water

Our Offices

