

National Transmission Planning Study

March 15, 2022

1:00 PM - 3:00 PM ET

Jennifer M. Granholm

Secretary of Energy



Patricia Hoffman

Acting Director,
Grid Deployment Office



Agenda

- **Welcome and housekeeping**
- **Introductory remarks**
 - Jennifer Granholm, United States Secretary of Energy
 - Pat Hoffman, Office of Electricity at the U.S. Department of Energy
- **Plenary panel**
 - Brett Carter, Xcel Energy
 - Debbie Lew, Energy Systems Integration Group (ESIG)
 - Lauren Azar, Azar Law LLC
 - Johannes Pfeifenberger, Brattle
 - Q&A
- **Study overview**
 - Objectives
 - Modeling
 - Public engagement
 - Q&A
- **Next steps**

Welcome and Housekeeping

- **Thank you** for joining and for participating!
- Webinar is being recorded and slides will be made available on the National Transmission Planning (NTP) Study website
- All participants are in listen-only mode
- We welcome your comments and questions
 - Questions for speakers and panelists can be entered into the Q&A box
 - Where applicable in your questions, please reference the speaker or topic
- It is not the object of this session to obtain any group position or consensus



Plenary Panel



Brett Carter

Xcel Energy



Debbie Lew

Energy Systems
Integration Group
(ESIG)



Lauren Azar

Azar Law LLC



**Johannes
Pfeifenberger**

Brattle

Brett Carter

Executive Vice President and Chief
Customer and Innovation Officer

Xcel Energy





Unlock the value for customers

Brett C. Carter | EVP, Group President Utilities, and Chief Customer Officer

March 15, 2022

Our customer expectations



Residential

Reliable Energy
Affordability and Support
Comfort and Easy
Choice and Control
Sustainability
Responsive



Small
Business

Reliable Energy
Affordability and Support
Choice and Control
Comfort and Easy
Sustainability
Business Support Partner



C&I

Cost Reduction
Improve Sustainability
Excellent Power Quality
Resiliency
Simplify Operation
Collaborative Partner

Empower customers to take carbon off the grid

Principles



Keep customers (all classes of customers) at the center of the work



Address congestion to unlock full value



Identify and focus on opportunities for unique impact of federal investment





Debbie Lew

Associate Director

Energy Systems Integration
Group (ESIG)



The need for national transmission planning



Debra Lew

*DOE National Transmission
Planning Study webinar*

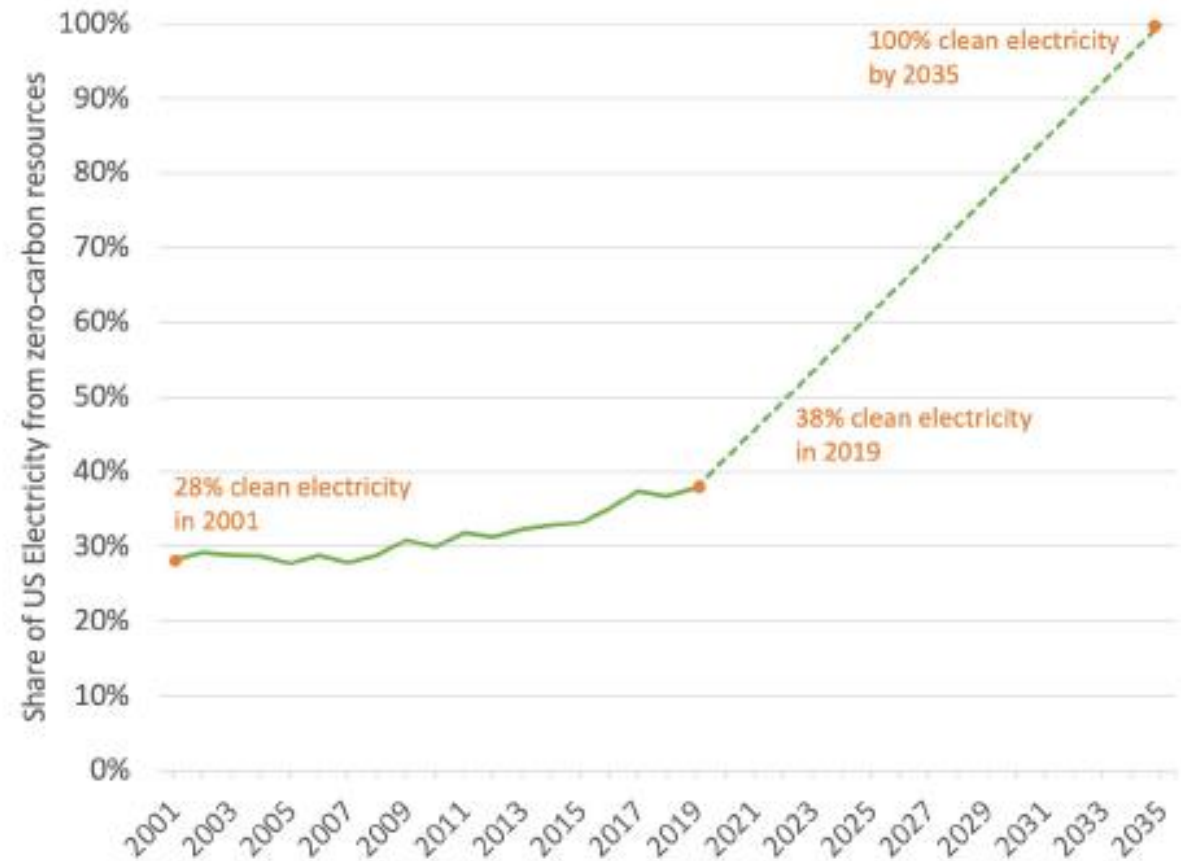
March 15, 2022

The background of the slide features a photograph of several high-voltage electrical transmission towers (pylons) with multiple cross-arms and insulators. The towers are silhouetted against a clear, light blue sky. In the foreground, there is a field of tall, dry grass or reeds. The overall scene is captured from a low angle, looking up at the towers.

If we want reliable, affordable
and clean energy...

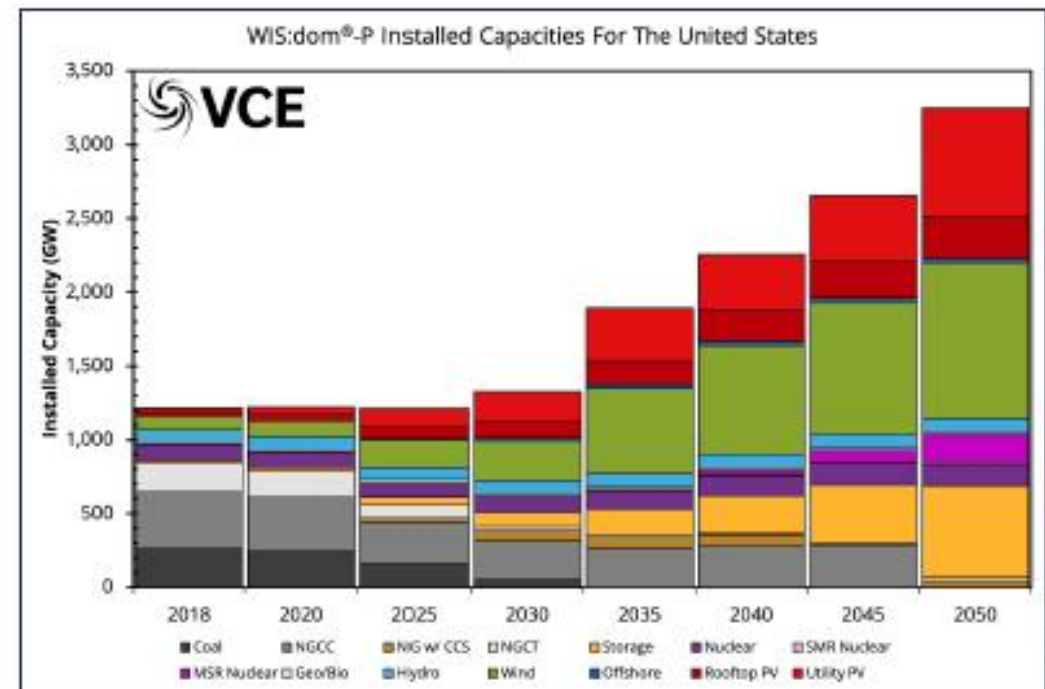
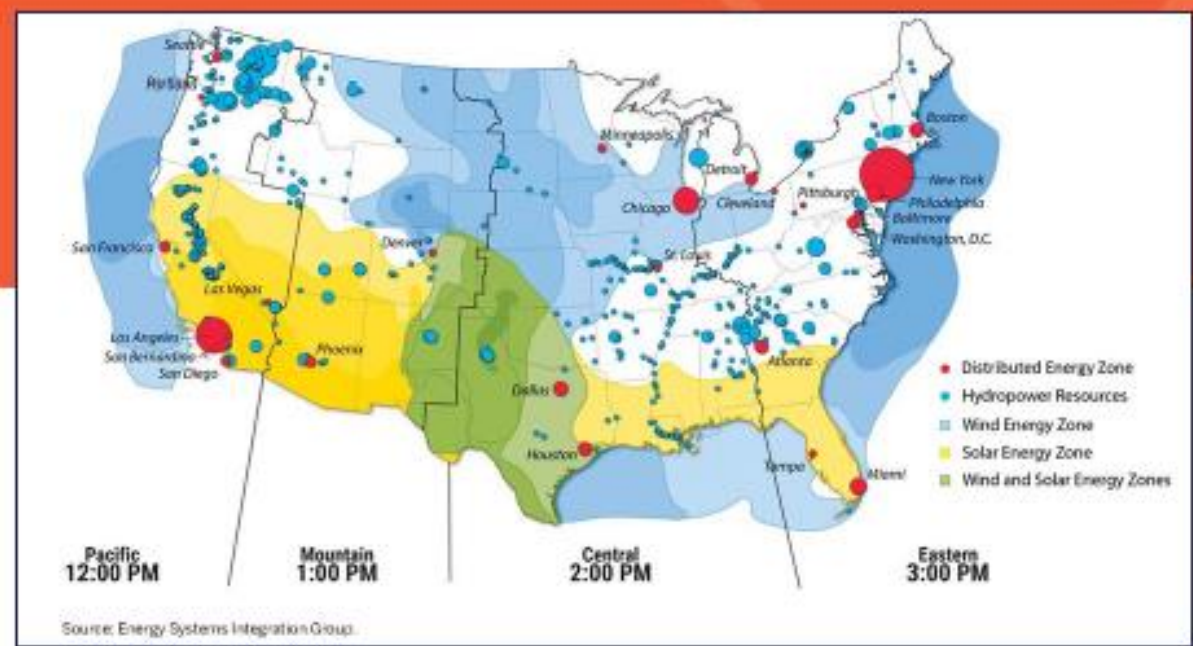
we need significant, national
transmission expansion

Decarbonization requires action on a transformative scale

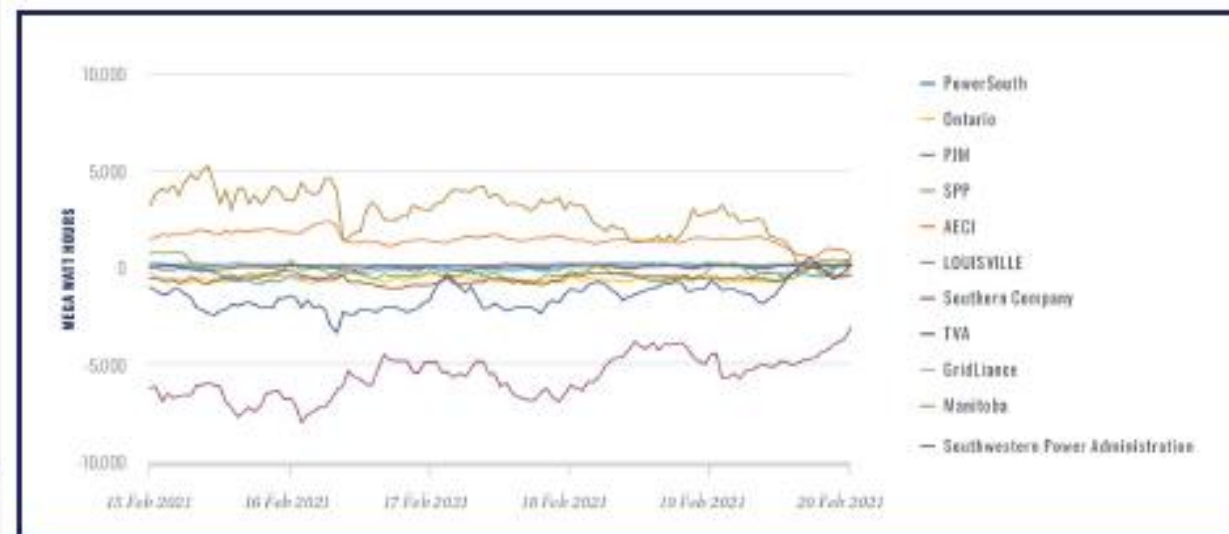
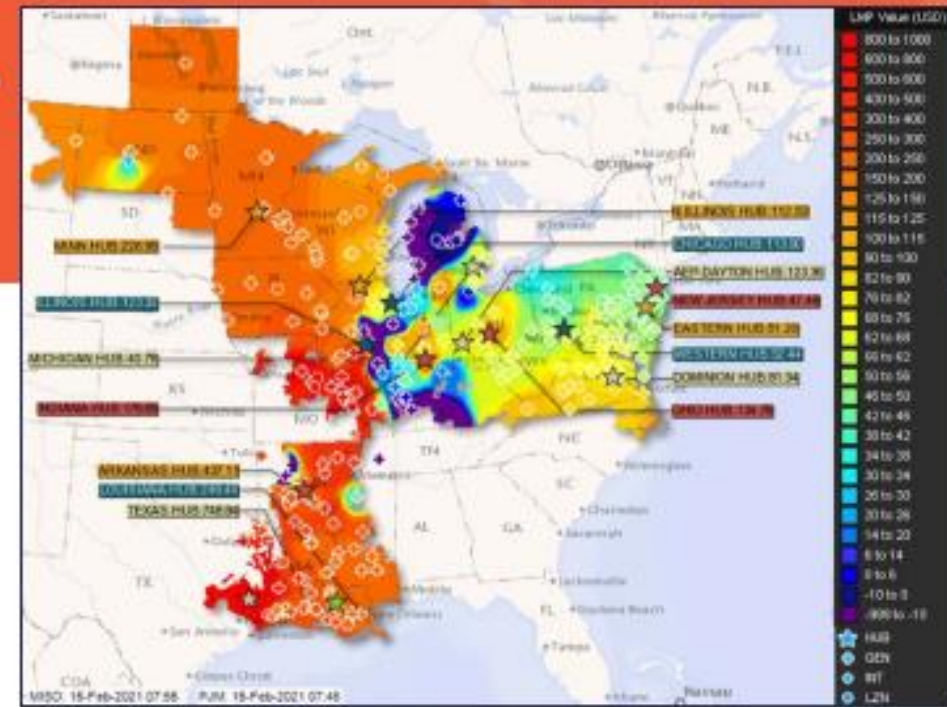
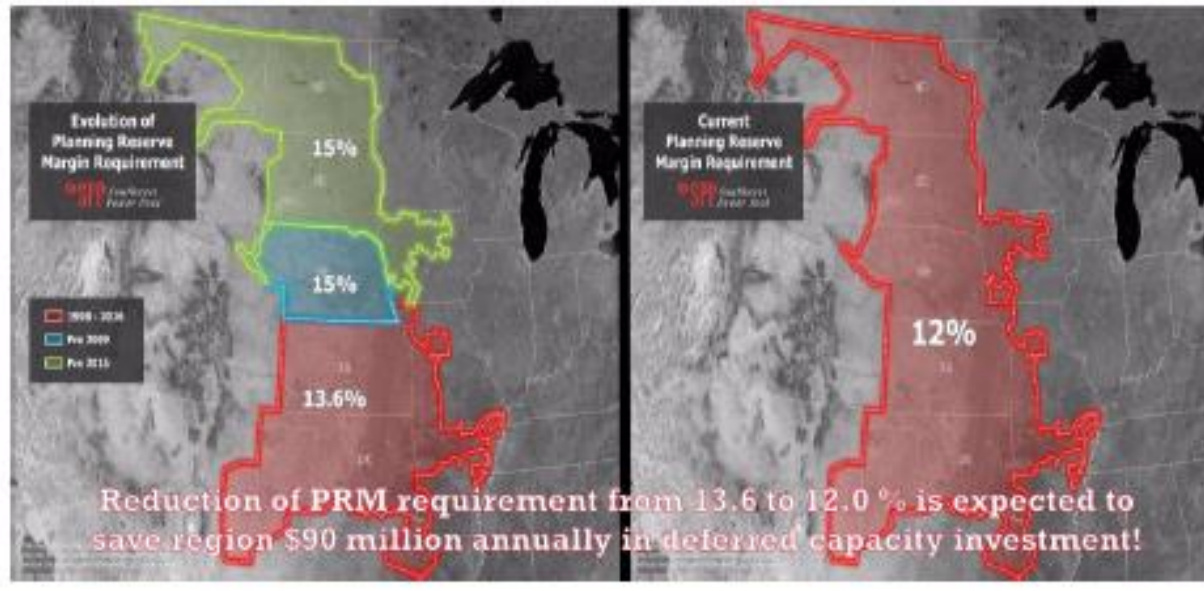


We need transmission to deliver significant resources

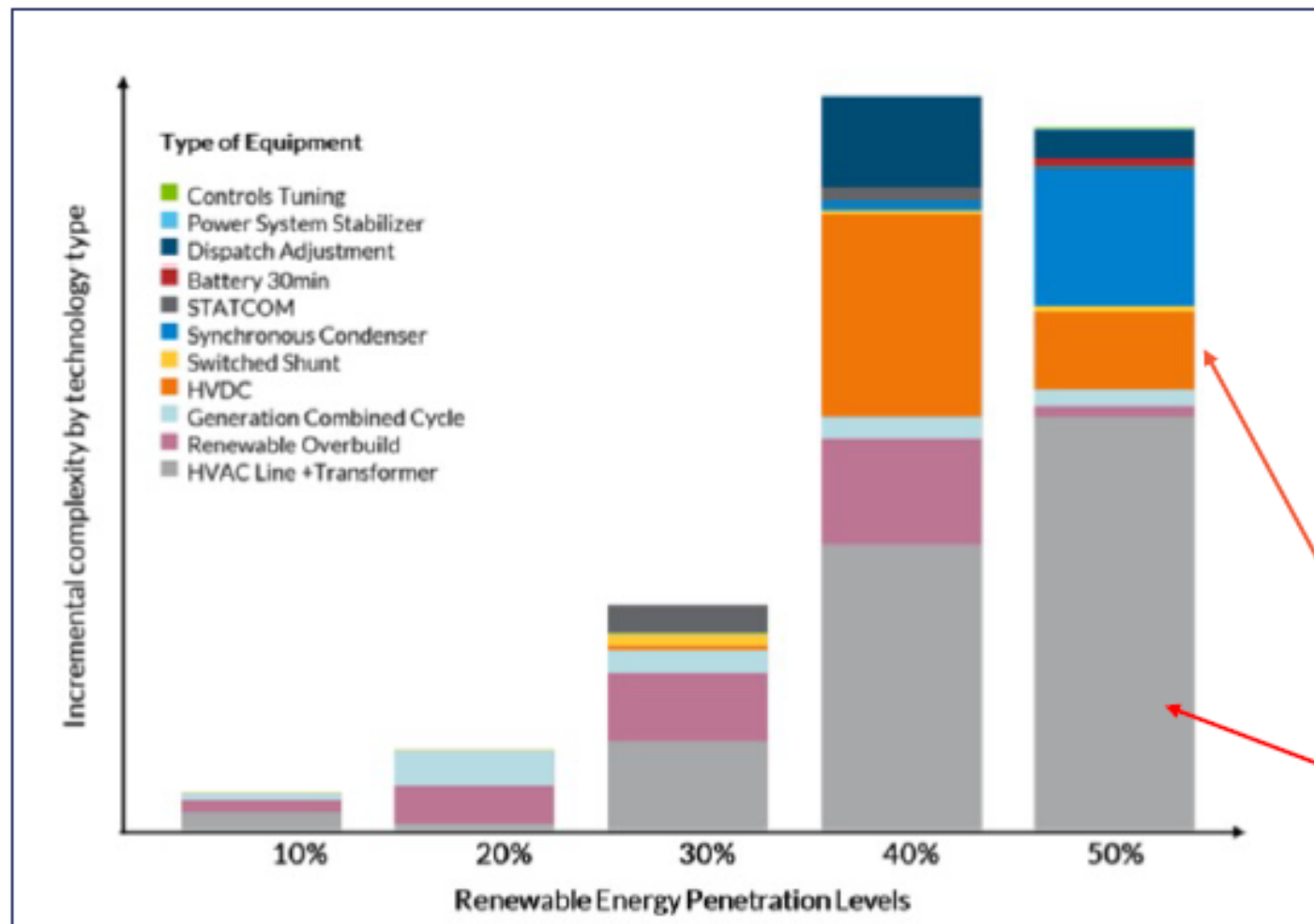
- We may need 1000 GW+ of new wind and solar to meet 100% clean electricity goals
- Electrification will lead to significantly increased demand
- Distributed energy resources will contribute but are not sufficient on their own
- We have 700 GW of zero carbon resources in interconnection queues across the US



We need transmission for resource adequacy and resilience



We need transmission for a host of other reliability benefits



MISO's RIIA study found that transmission was the key enabler to meet reliability standards at 50% wind/solar

DC TRANSMISSION

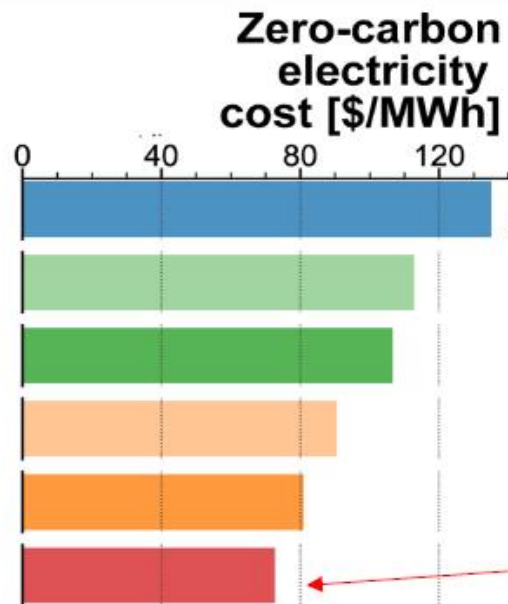
AC TRANSMISSION

National transmission planning is needed

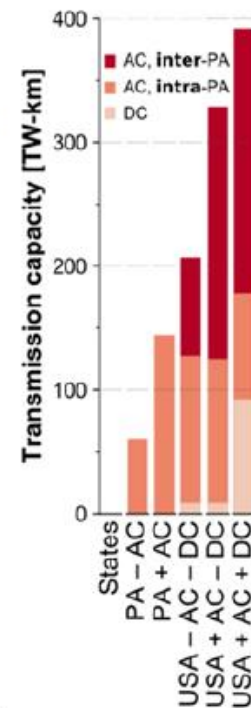
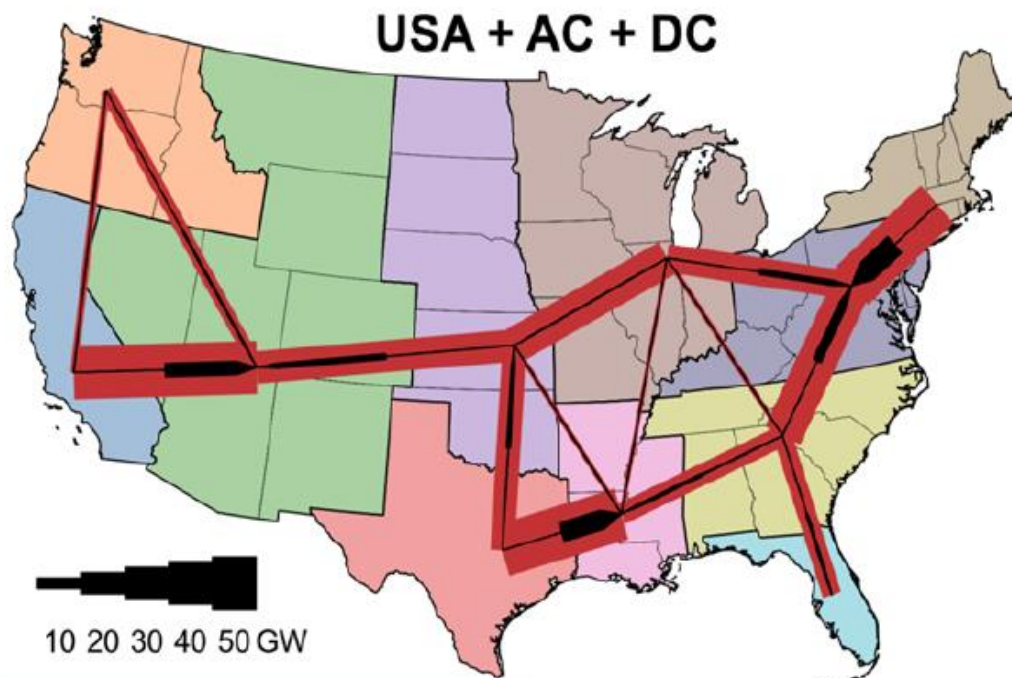
This study examines 100% clean electricity in the US under scenarios with increasing geographic levels of transmission expansion and operations

Inter-state transmission

- None
- + Existing regional
- + New regional
- + Existing inter-regional
- + New inter-regional within interconnects
- + New inter-regional across interconnects



"Every state for itself" costs twice as much (\$135/MWh) as the nationally optimized and coordinated approach (\$73/MWh)

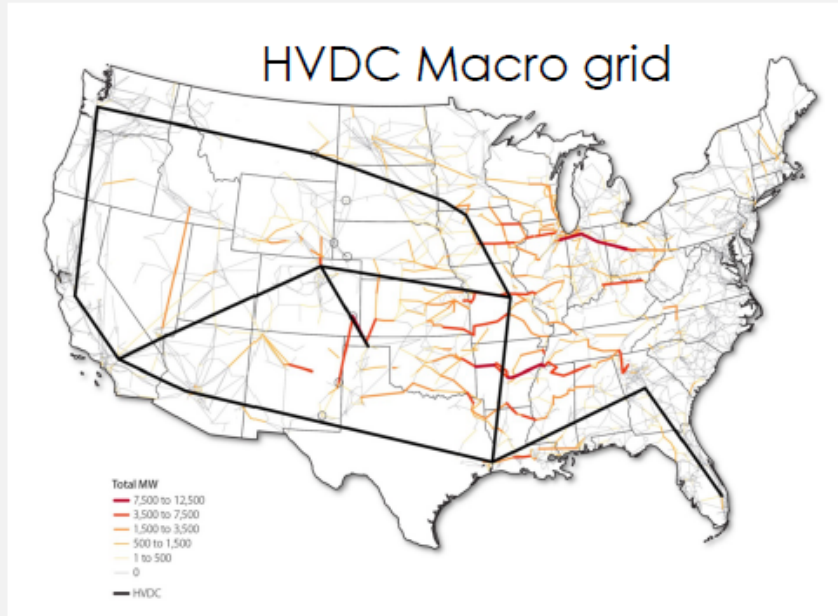


Brown and Botterud, "The Value of Inter-Regional Coordination and Transmission in Decarbonizing the US Electricity System," Joule 5, 1-20, Jan 20, 2021

Stronger interconnection across the country saves money – especially with decarbonization

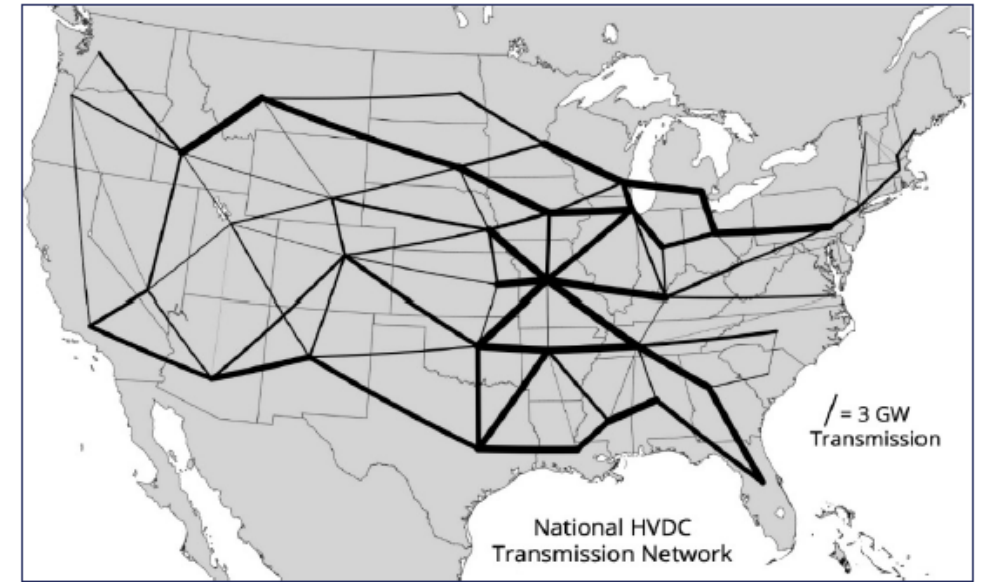


NREL Interconnection Seams Study



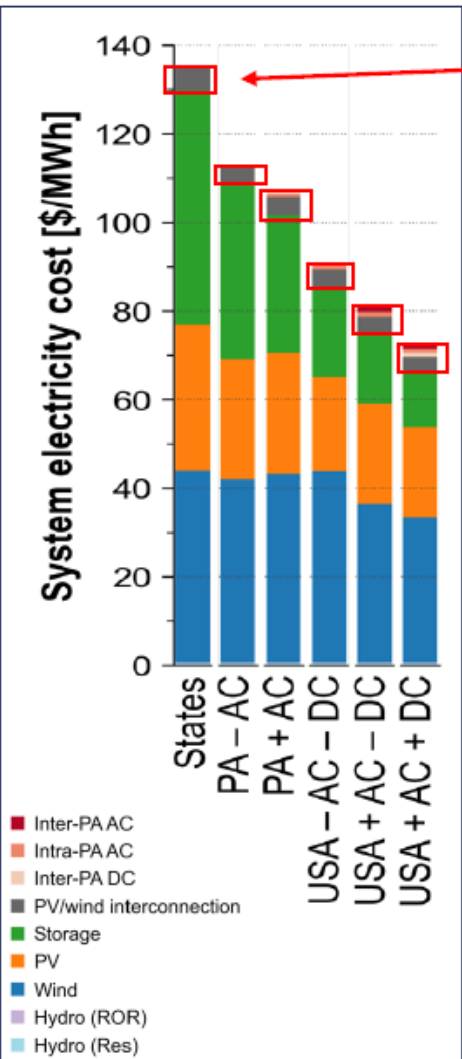
- With a 50% renewables goal, this HVDC macro grid has a benefit-to-cost ratio of 2.5
- With a 85% renewables goal, this HVDC macro grid has a benefit-to-cost ratio of 2.9

Vibrant Clean Energy ZeroByFifty

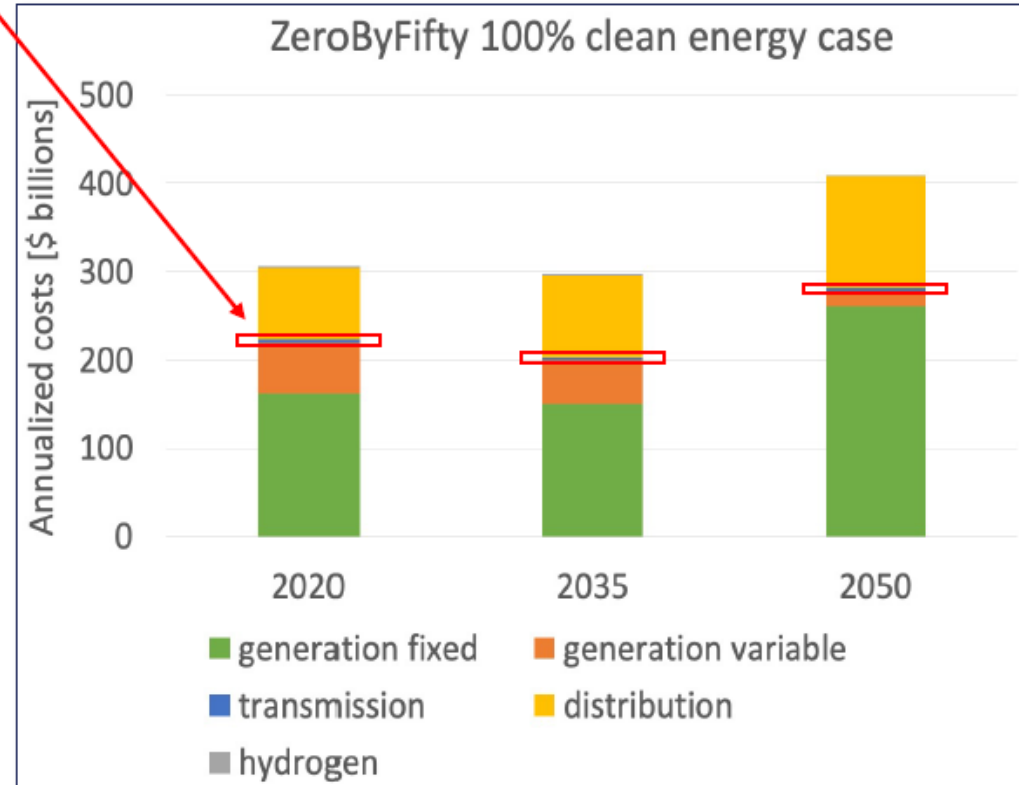
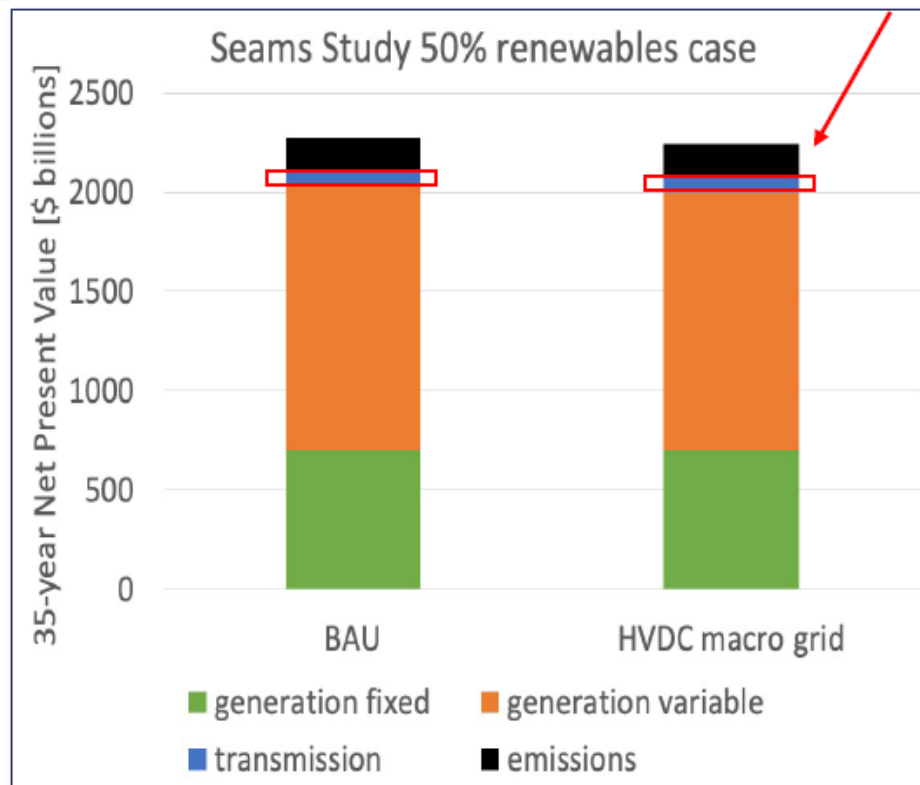


- Transmission expansion costs are \$200B and \$350B for 100% clean electricity and 100% clean energy, respectively
- If a macrogrid is not built, it costs \$1T more to get to 100% clean energy by 2050

Transmission costs are *tiny* compared to other resource/infrastructure costs

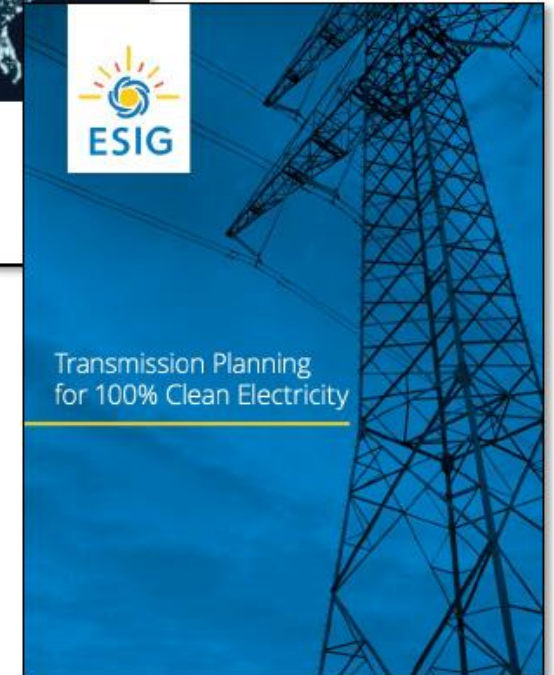
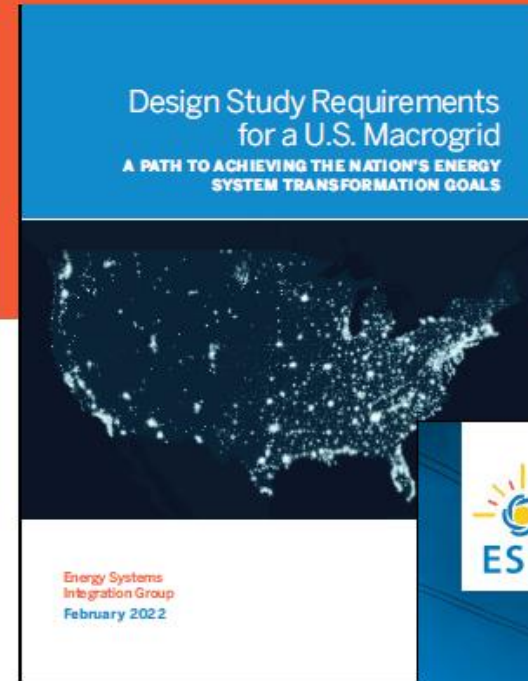


TRANSMISSION COSTS



ESIG recommendations

- **We need ongoing national transmission planning, not just a one-off study**
- **We need to proactively plan and build transmission to high quality clean energy zones**
- **We need to design and evaluate performance of a national macro grid for reliability, resilience, operations and economics**





THANK YOU

Debra Lew

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(303) 819-3470

Lauren Azar

Owner, Advisor

Azar Law LLC



STATES WORKING TOGETHER SAVE CUSTOMERS MONEY

How states, working together, can cost-effectively address the nation's changing generation portfolio

LAUREN AZAR

DOE'S NATIONAL TRANSMISSION PLANNING STUDY WEBINAR

MARCH 15, 2022





1. MISO's Multi-Value Projects (MVPs) of 2011

2. MISO's Long-Range Transmission Planning (LRTP) of 2021/2022

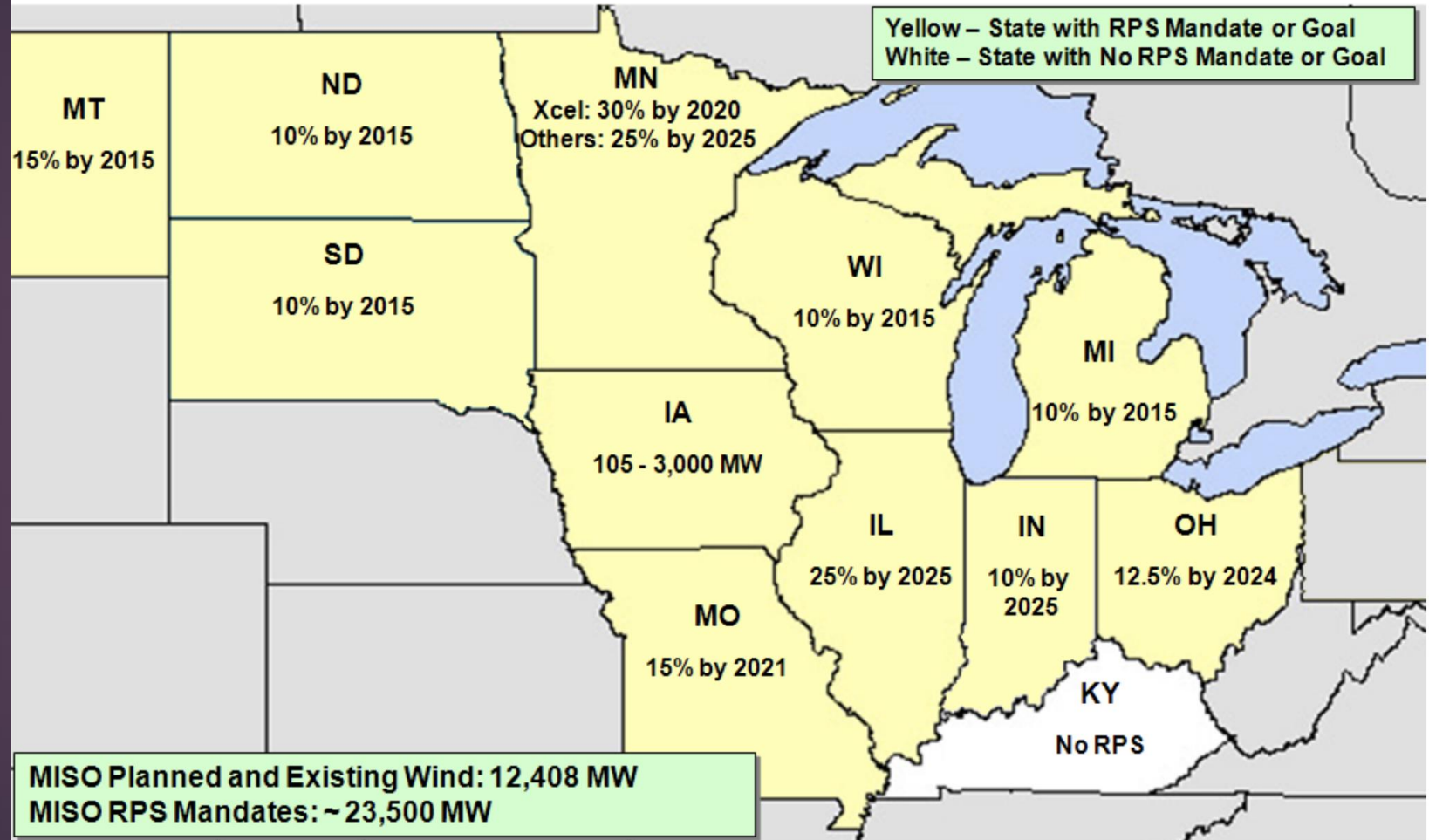
3. MISO and SPP's Joint Targeted Interconnection Queue Study (JTIQ) of 2021/2022

MVPs:

States asked
MISO to
enable RPS
compliance

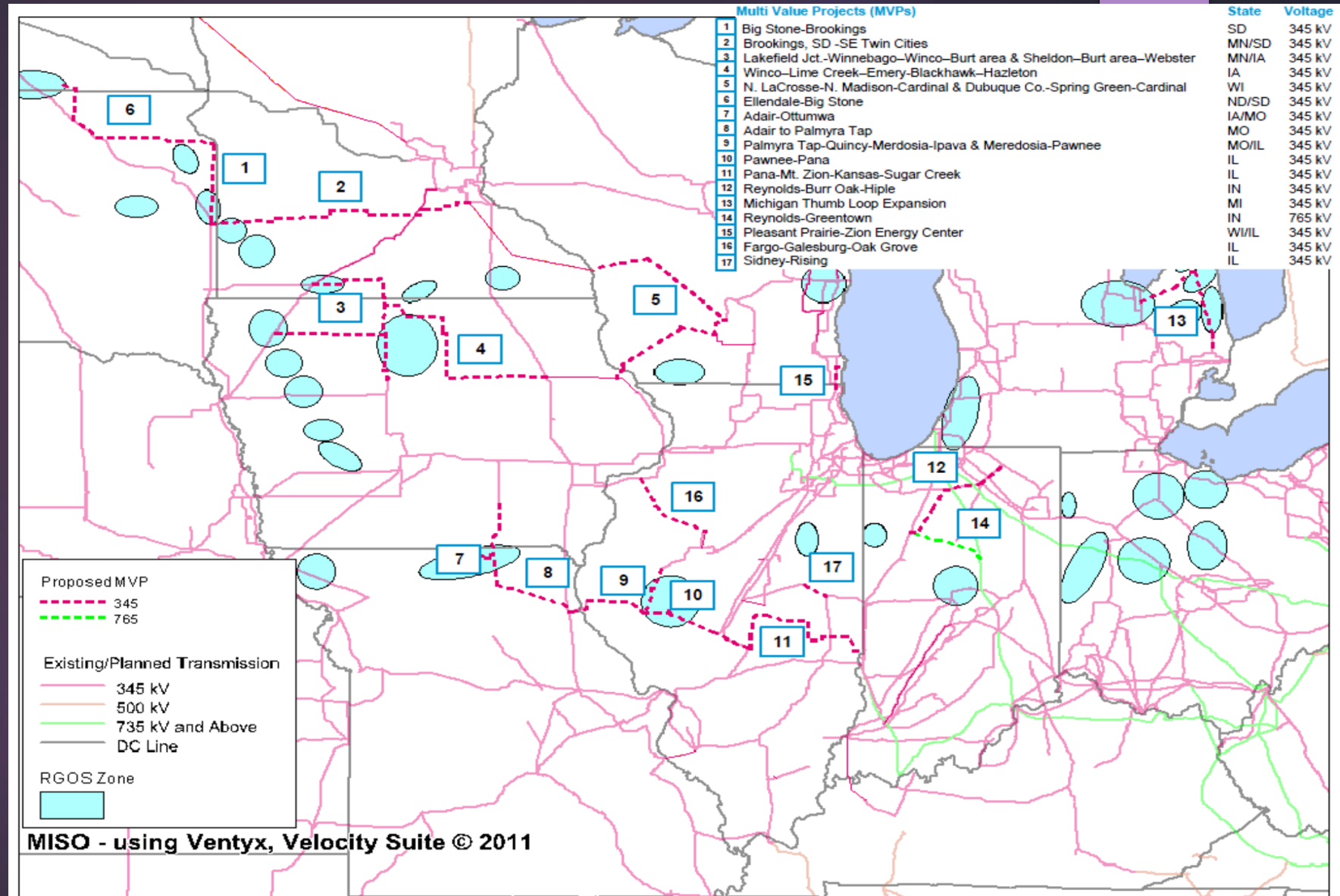
Current State Renewable Portfolio Standards

As of 07/27/2011



Planned and Existing Wind as of 3/28/2011

MVPs: MISO's 2011 Renewable Energy Zones and 17 Lines

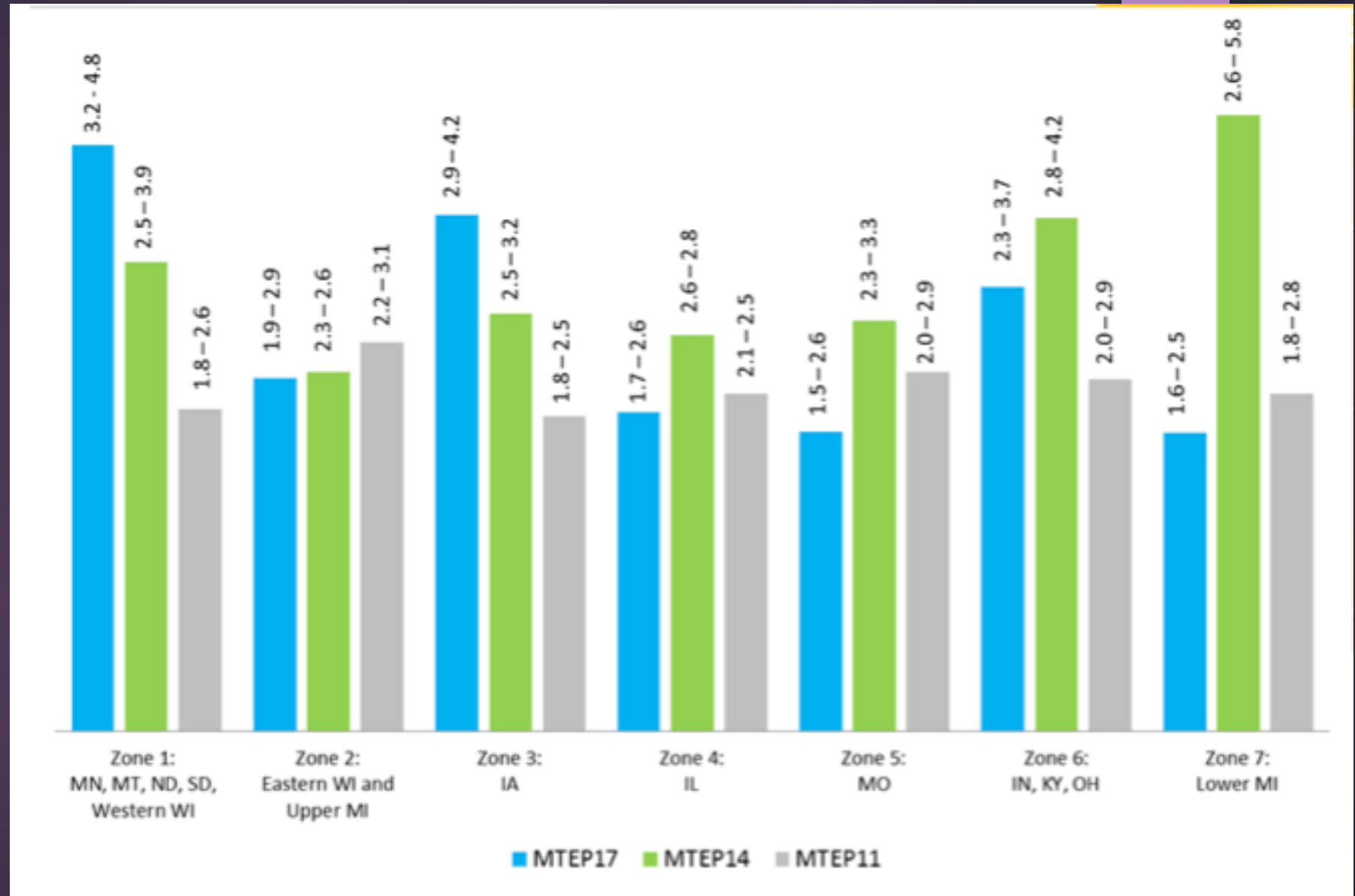


Multi Value Project (MVP) Portfolio

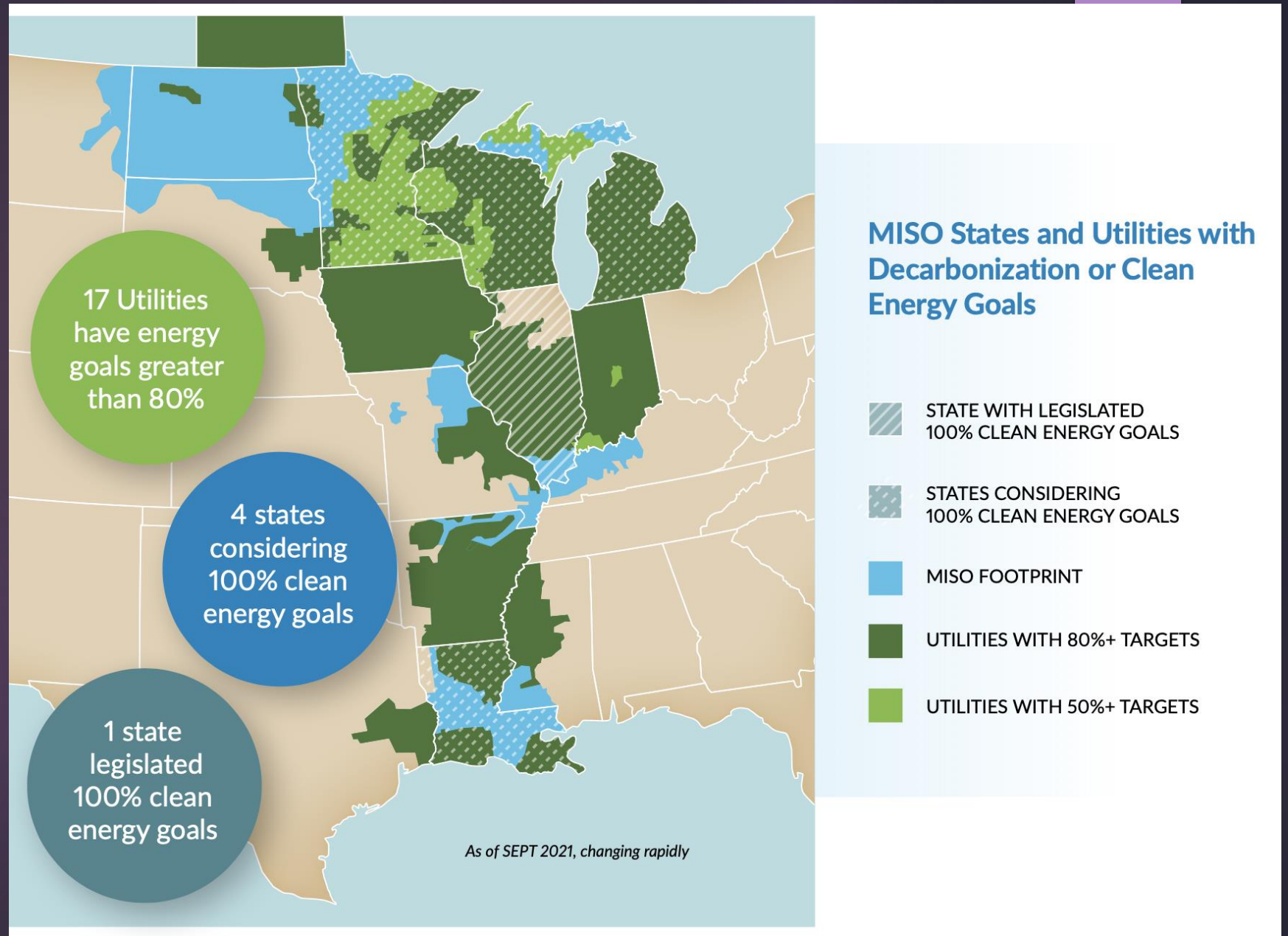
Source: MISO MVP Portfolio Results and Analysis 1/10/2012, Figure 1.1

MVPs:

Benefits Change Over Time but Outweigh Costs

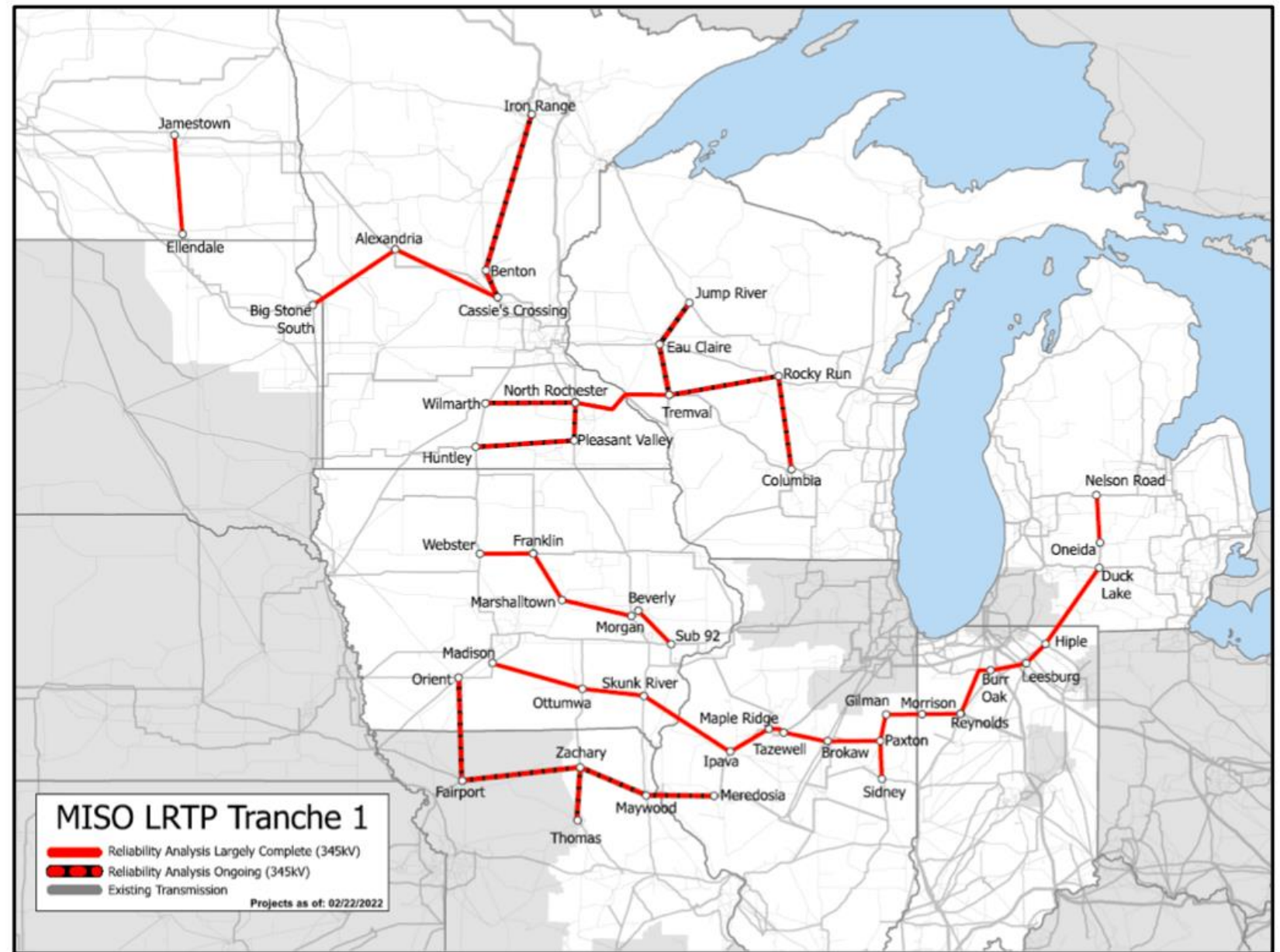


LRTP: State and Utility Goals in 2021



LRTP:

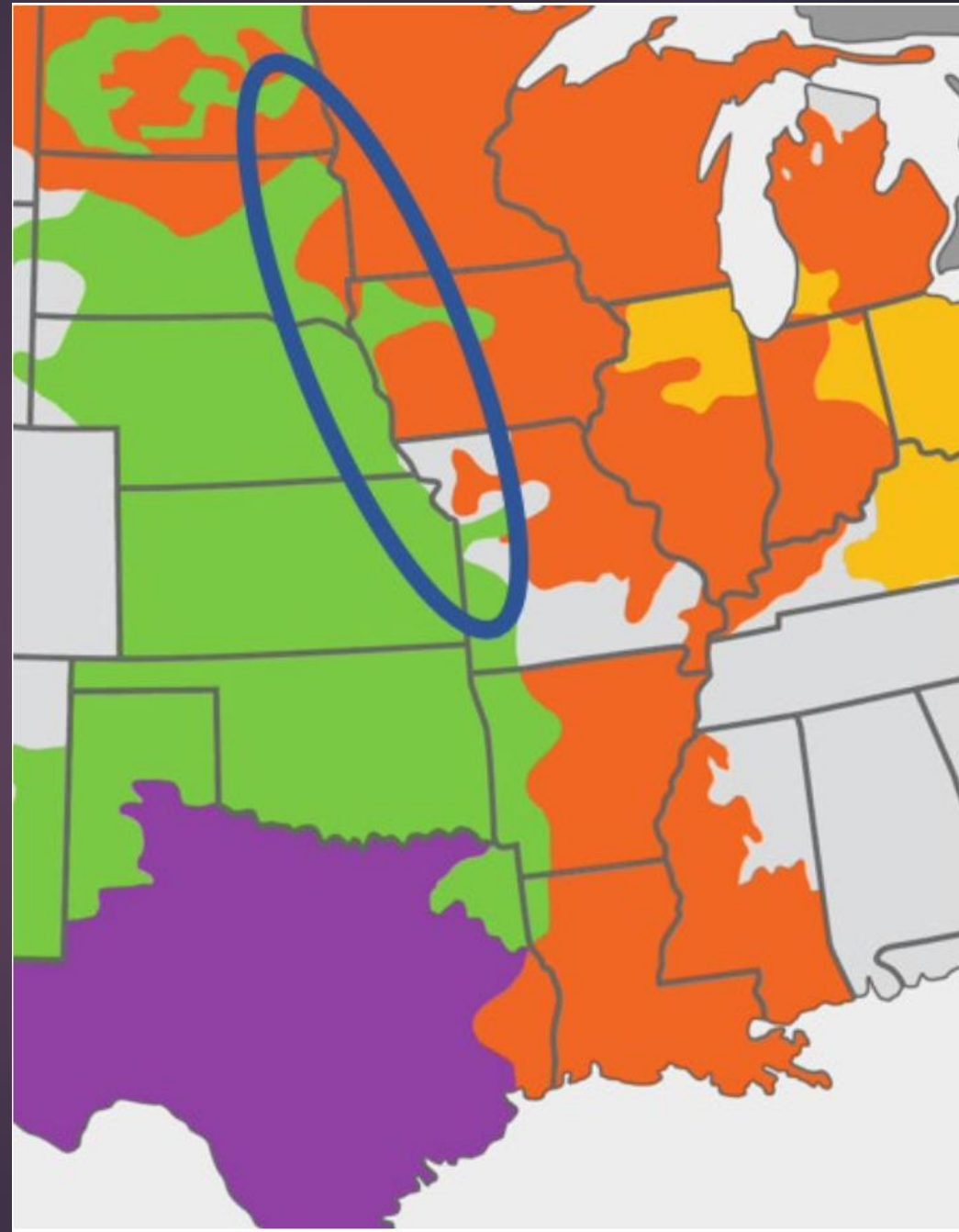
Tranche 1 – as of 2/22/22



Source: LRTP Workshop, slide 2, retrieved at <https://cdn.misoenergy.org/20220225%20LRTP%20Workshop%20Item%2002%20Tranche%201%20Reliability%20Analysis%20Presentation623078.pdf>

JTIQ:

The MISO-SPP Seam is Preventing New Interconnections



Source: JTIQ Final Report March 2022 retrieved at <https://cdn.misoenergy.org/JTIQ%20Report623262.pdf>

JTIQ:

Report identified potential solutions

Source: JTIQ Final Report March 2022
retrieved at
<https://cdn.misoenergy.org/JTIQ%20Report623262.pdf>



JTIQ Portfolio Map

-  345 kV
-  Existing Transmission
-  MISO Region
-  SPP Region



Figure 2: JTIQ Portfolio Map

CONCLUSIONS

1. Regional and interregional lines will:
 - ▶ enable the most cost-effective transformation of the generation portfolio, AND
 - ▶ bolster regional reliability and resilience.
2. These regional and interregional solutions can only be realized if states work together.
3. States taking a parochial approach--refusing to work with their neighbors--will unnecessarily force consumers to pay more for their electricity resulting in unjust and unreasonable rates.



Johannes Pfeifenberger

Principal
Brattle



The Benefits of Interregional Transmission: Grid Planning for the 21st Century

PRESENTED BY

Johannes Pfeifenberger

PREPARED FOR

Building a Better Grid Initiative
DOE Office of Electricity

March 15, 2022



Contents

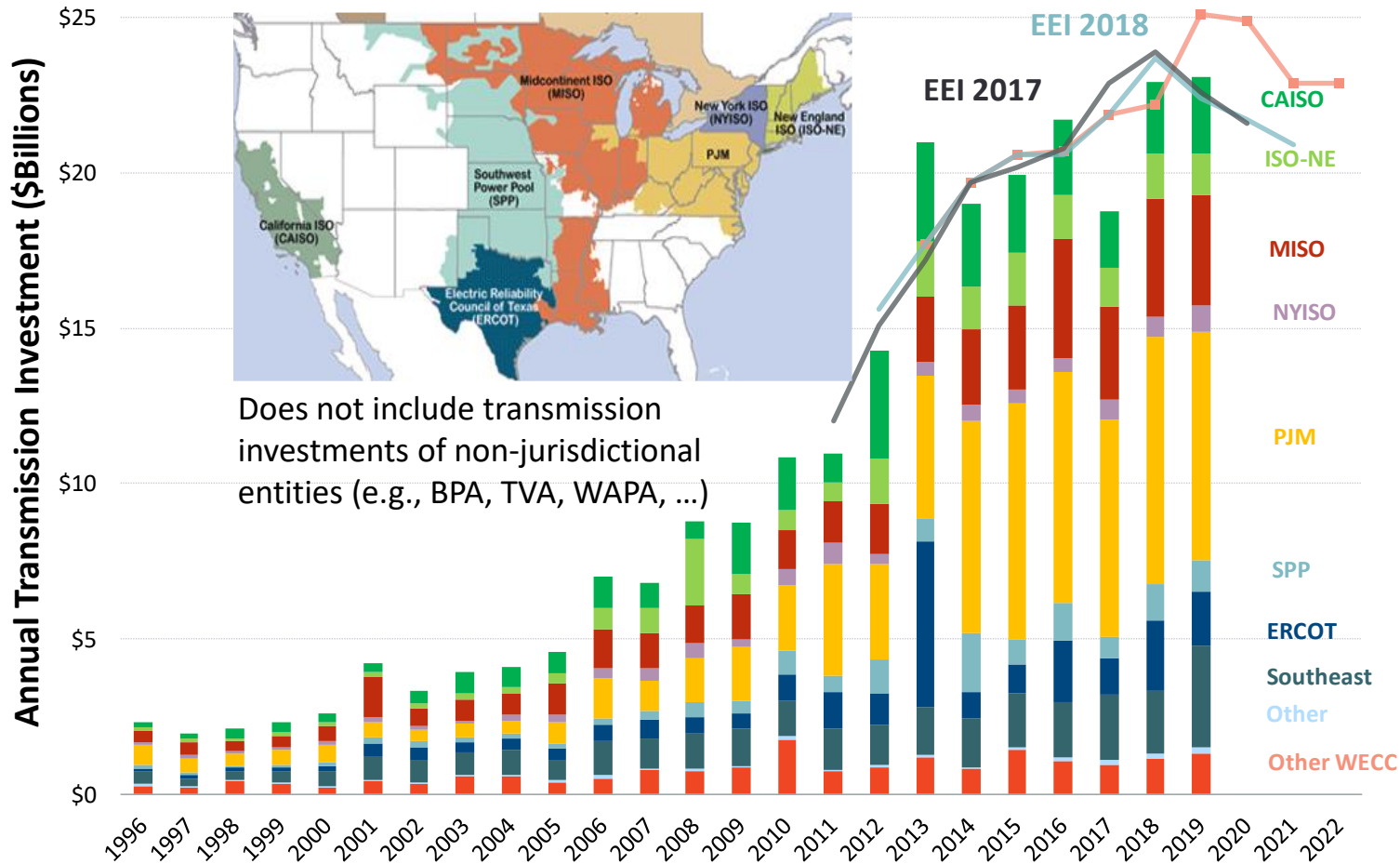
1. The Need for Improved Transmission Planning
2. Quantifying Transmission Benefits
3. Interregional Transmission Planning
4. Proposal for a Better Planning Process

Additional Reading



Transmission Investment is at Historically High Levels

Annual Transmission Investment
As reported to FERC by Region (1996 – 2019)

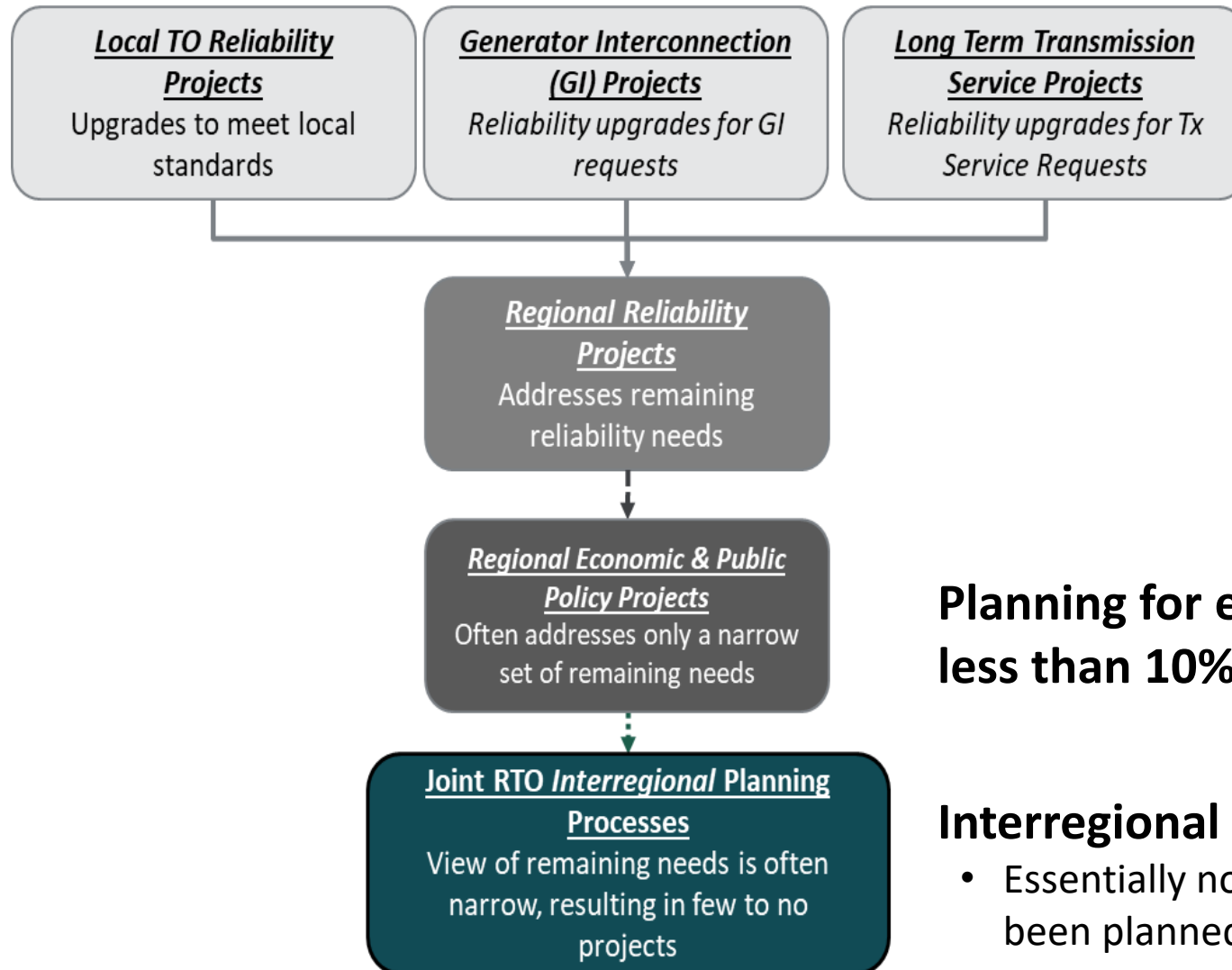


\$20-25 billion in annual U.S. transmission investment, but:

- 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 and overall cost savings

Source: FERC Form 1 Data, EEI "Historical and Projected Transmission Investment" most recent accessed here: <https://www.eei.org/resourcesandmedia/Documents/Historical%20and%20Projected%20Transmission%20Investment.pdf>

Current U.S. Grid Planning Processes are Siloed



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

- None involve any assessments of economic benefits (i.e., cost savings offered by the new transmission)
- Which also means these investments are not made with the objective to find the most cost-effective solutions
- Will yield higher system-wide costs and electricity rates

Planning for economic and public-policy projects: less than 10% of all transmission investments

Interregional planning processes are large ineffective

- Essentially no major interregional transmission projects have been planned and built in the last decade

Barriers to Regional and Interregional Transmission Planning

A. Leadership, Alignment and Understanding

1. Insufficient leadership from RTOs and federal & state policy makers to prioritize interregional planning
2. Limited trust amongst states, RTOs, utilities, & customers
3. Limited understanding of transmission issues, benefits & proposed solutions
4. Misaligned interests of RTOs, TOs, generators & policymakers
5. States prioritize local interests, such as development of in-state renewables

B. Planning Process and Analytics

6. **Benefit analyses are too narrow, and often not consistent between regions**
7. Lack of proactive planning for a full range of future scenarios
8. **Sequencing of local, regional, and interregional planning**
9. Cost allocation (too contentious or overly formulaic)

C. Regulatory Constraints

10. Overly-prescriptive tariffs and joint operating agreements
11. State need certification, permitting, and siting

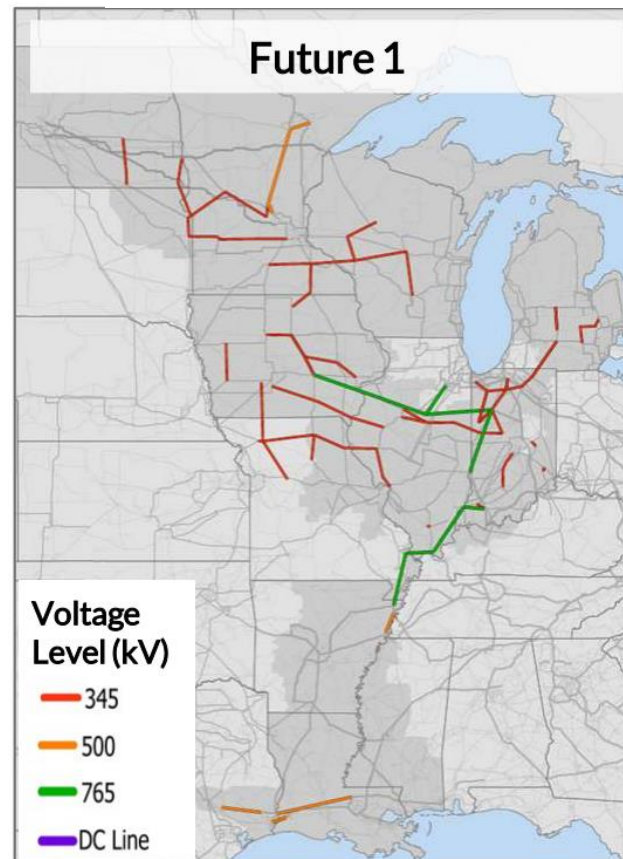
Source: Appendix A of [A Roadmap to Improved Interregional Transmission Planning](#), November 30, 2021. Based on interviews with 18 organizations representing state and federal policy makers, state and federal regulators, transmission planners, transmission developers, industry groups, environmental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

Example (B8): Prioritizing Regional over Interregional Solutions

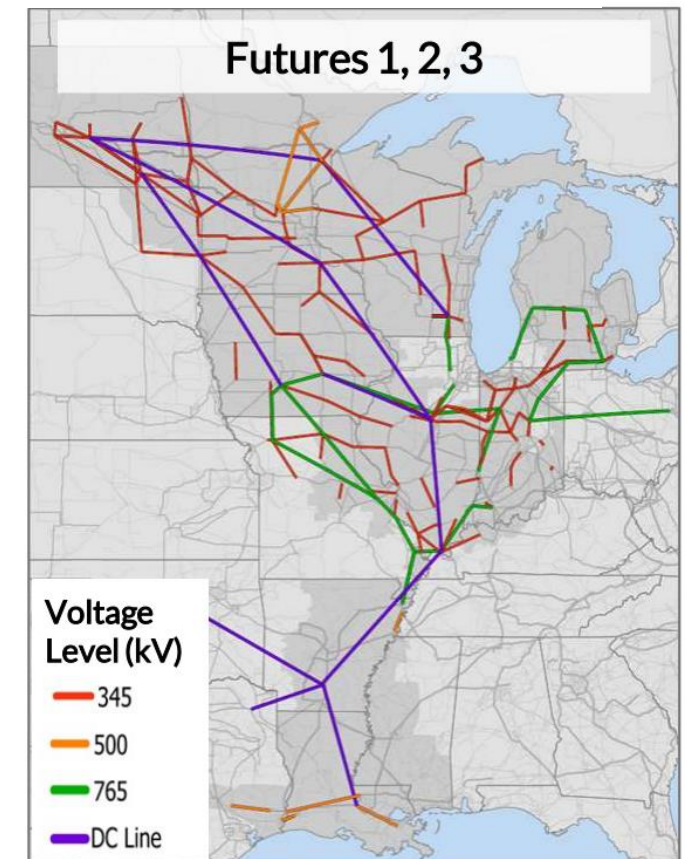
How would SPP-MISO-PJM wide planning results differ?

MISO's projected scope of transmission expansion needs

- MISO's new Renewable Integration Impact Assessment (RIIA) improves on many other planning studies by:
 - Establishing the need to study both policy goals and reliability goals simultaneously
 - Considering diverse future scenarios
 - Recommends a “least-regret” transmission plan (but one that does not address possibility of regret from inadequate T)
- By design, **the scope of study does not address any interregional opportunities:**
 - Despite modeling five regions in addition to MISO, the study mostly did not consider interregional transmission (see figures)
 - Even if “optimal” for MISO, it likely preempts more cost-effective interregional solutions



Source: [MISO LRTP Roadmap March 2021](#)



Understanding Transmission-Related Benefits

Wide-spread nature of benefits creates challenges in estimating them and how they accrue to different users, which also complicates cost allocation

<ul style="list-style-type: none"> ▪ Broad in scope, providing many <u>different types</u> of benefits 	<ul style="list-style-type: none"> • 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
<ul style="list-style-type: none"> ▪ <u>Wide-spread</u> geographically 	<ul style="list-style-type: none"> • Multiple transmissions service areas • <u>Multiple states</u> or regions
<ul style="list-style-type: none"> ▪ <u>Diverse</u> in their effects on market participants 	<ul style="list-style-type: none"> • <u>Customers, generators, transmission owners</u> in regulated and/or deregulated markets • Individual market participants may capture one set of benefits but not others
<ul style="list-style-type: none"> ▪ Occur and <u>change</u> over long periods of time 	<ul style="list-style-type: none"> • 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

Economic benefit of transmission =

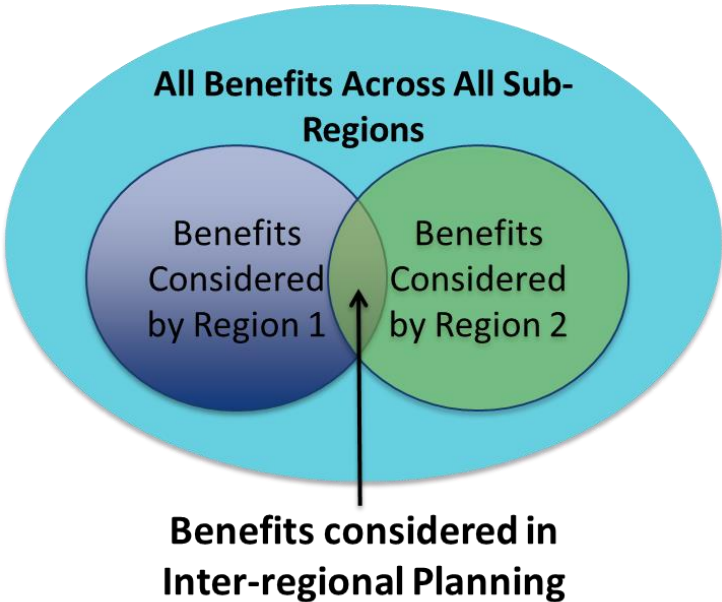
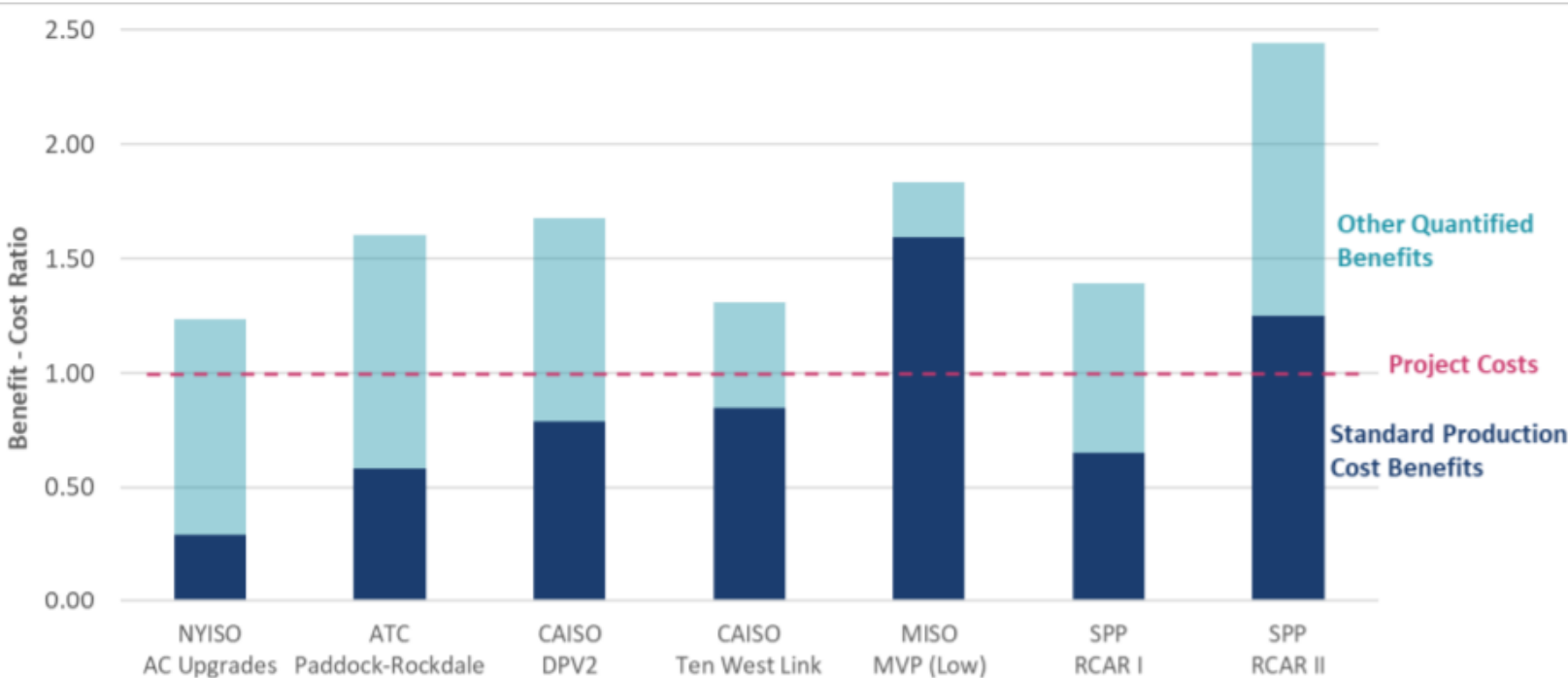
+ Cost savings that reduce overall system-wide costs faced by customers

+ Economic value of added reliability

Quantifying Benefits Beyond “Production Cost” Savings

Relying solely on traditionally-quantified Adjusted Production Cost (APC) Savings results in the rejection of beneficial transmission projects – particularly for interregional planning efforts that consider an even smaller subset of benefits:

FIGURE 5. BENEFIT-COST RATIOS OF TRANSMISSION PROJECTS WITH AND WITHOUT A BROAD SCOPE OF BENEFITS



Source: [Transmission Planning for the 21st Century: Proven Practices that Increase Value and Reduce Costs](#)
[A Roadmap to Improved Interregional Transmission Planning.](#)

We have a Decade of Experience with Identifying and Quantifying a Broad Range of Transmission 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**

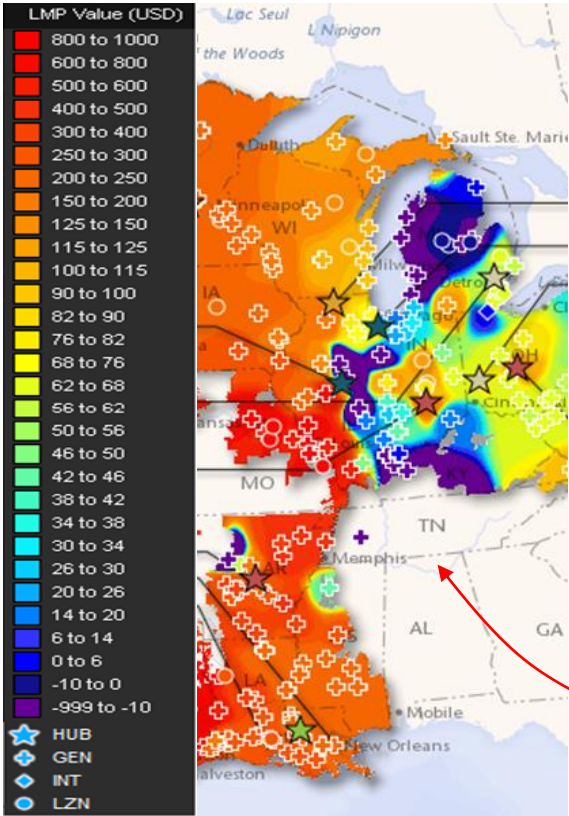
(Newell, et al., [Benefit-Cost Analysis of Proposed New York AC Transmission Upgrades](#), September 15, 2015)

* Fairly consistent across RTOs

Interregional Reliability Benefits: Winter Storm Uri

Transmission constraints led to substantial price separations. An additional GW of transmission into Texas would have fully paid for itself over the course of the four-day event ([Goggin, 2021](#)).

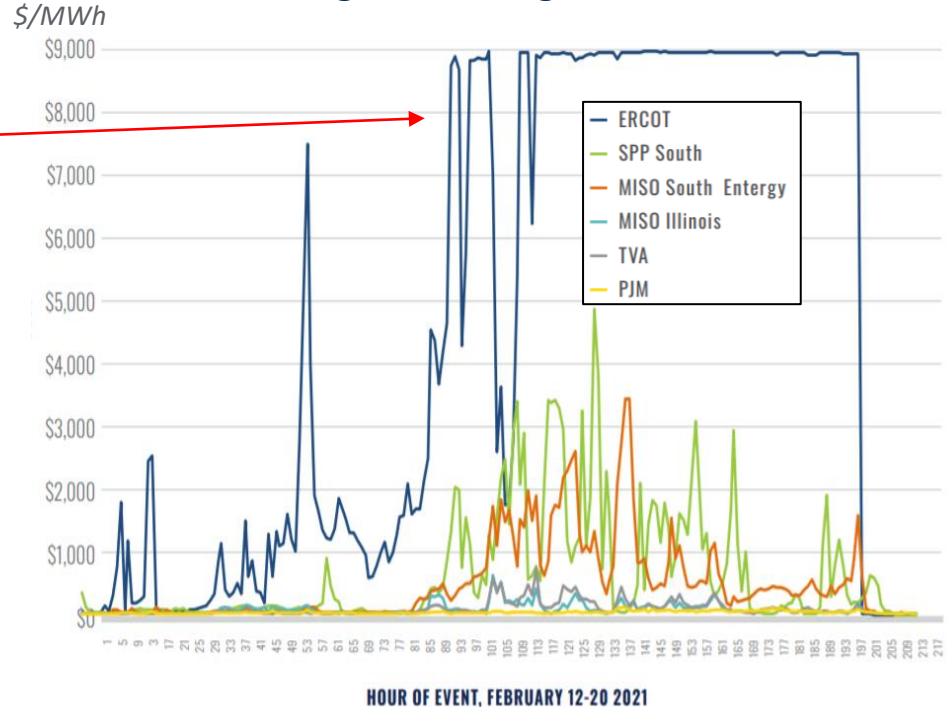
MISO LMPs on Feb 15th, 2021 at 7:45-7:55



Savings per 1000 MW of Additional Interregional Transmission Capability (\$ millions)

ERCOT - TVA	\$993
SPP South - PJM	\$129
SPP South - MISO IL	\$122
SPP South - TVA	\$120
SPP S - MISO S (Entergy Texas)	\$110
MISO S-N (Entergy Texas - IL)	\$85
MISO S (Entergy Texas) - TVA	\$82

Electricity Price Differences Between Regions During Uri



Brattle Reports on Transmission Benefit-Cost Analyses and Interregional Planning Summarize the Available Experience

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
Akarsh 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

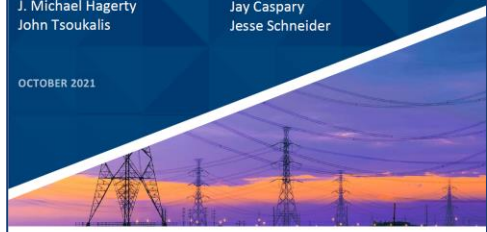
Link: [Brattle Grid Strategies](#)



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OCTOBER 2021



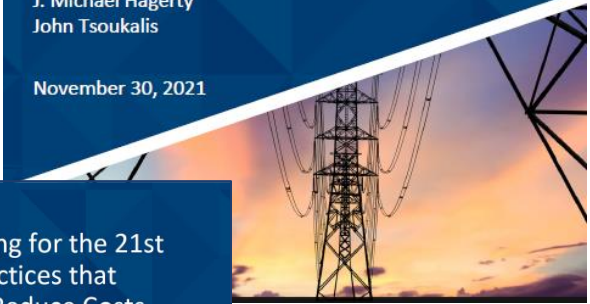
 

A Roadmap to Improved Interregional Transmission Planning

Link: [Interregional Roadmap](#)

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John Tsoukalis

November 30, 2021

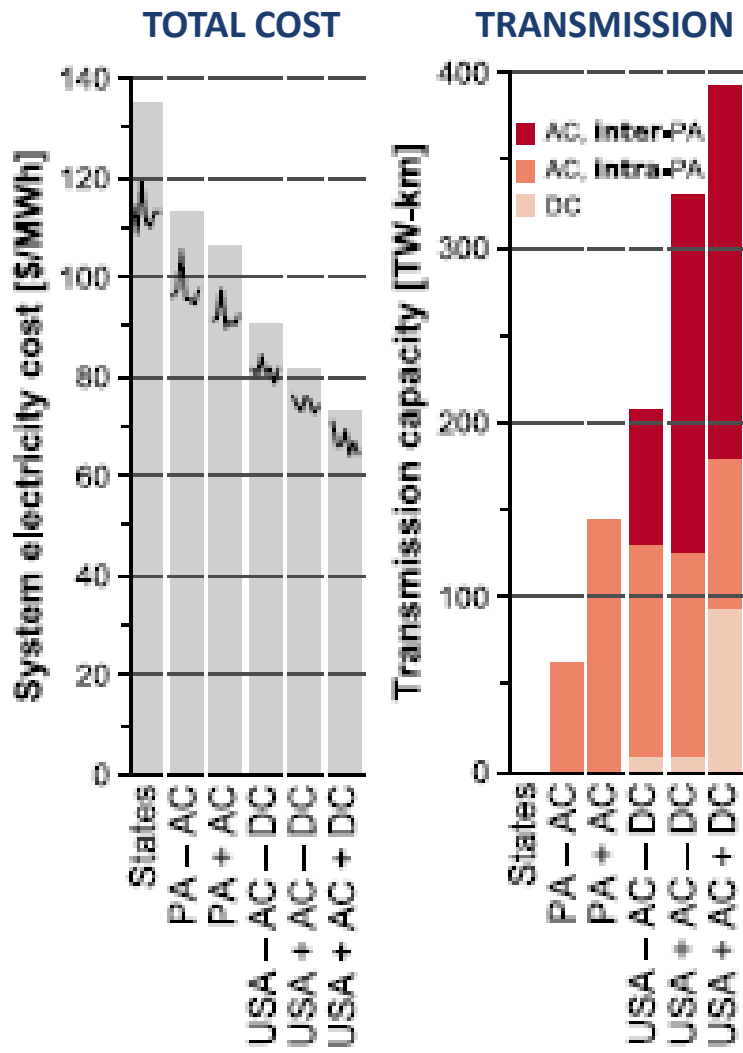


Summarizes proven approaches to quantifying various benefits

National Studies Show Large Benefit of Interregional Transmission

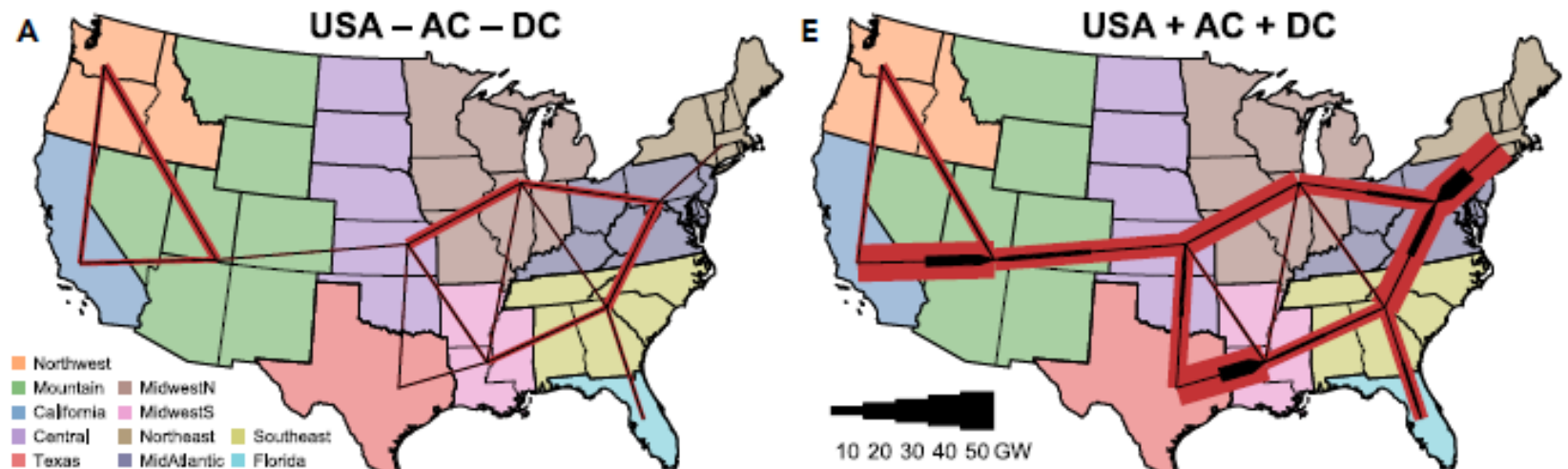
Study	Region	Findings
NREL North American Renewable Integration Study (2021)	U.S., Canada, Mexico	<ul style="list-style-type: none"> Increasing trade between countries can provide \$10-30 billion in net benefits Interregional transmission expansion achieves up to \$180 billion in net benefits
MIT Value of Interregional Coordination (2021)	Nation-Wide	<ul style="list-style-type: none"> National coordination of reduces the cost of decarbonizing by almost 50% compared to no coordination between states The lowest-cost scenario builds almost 400 TW-km of transmission; including roughly 100 TW-km of DC capacity between the interconnections and over 200 TW-km of interregional AC capacity No individual state is better off implementing decarbonization alone compared to national coordination of generation and transmission investment Low storage and solar costs still result in significant cost effective interregional transmission
Princeton Net Zero America Study (2021)	Nation-Wide	<ul style="list-style-type: none"> Achieving net-zero emissions by 2050 requires 700-1,400 TW-km of new transmission Investment in transmission needed ranges \$2-4 trillion dollars by 2050
U.C. Berkeley 90% by 2035 (2020)	Nation-Wide	<ul style="list-style-type: none"> The only national study that suggest relatively little interregional transmission would be needed to achieve 90% clean electricity. However, the study's simulation approach does not utilize more granular and well-established methods to properly value interregional transmission.
Vibrant Clean Energy Interconnection Study (2020)	Eastern Interconnect	<ul style="list-style-type: none"> 40 to 90 TW-km of transmission is built by 2050 to meet climate goals Transmission development can create 1-2 million jobs in the coming decades, more than wind, storage, or distributed solar development Transmission reduces electricity bills by \$60-90 per MWh
Wind Energy Foundation Study (2018)	ERCOT, MISO, PJM, and SPP	<ul style="list-style-type: none"> Transmission planners are not incorporating this rising tide of voluntary corporate renewable energy demand into plans to build new transmission
NREL Seams Study (2017)	Eastern and Western Interconnects	<ul style="list-style-type: none"> Major new ties between interconnections saves \$4.5-\$29 billion over a 35 year period

Example: MIT Value of Interregional Coordination (2021)



Key Result: A more robust national grid would reduce the total cost of decarbonizing the grid ... but (higher-cost) regional and more local solutions may also be feasible

Optimal Transmission Build:
With and Without National Transmission Coordination



Limitations of National Studies

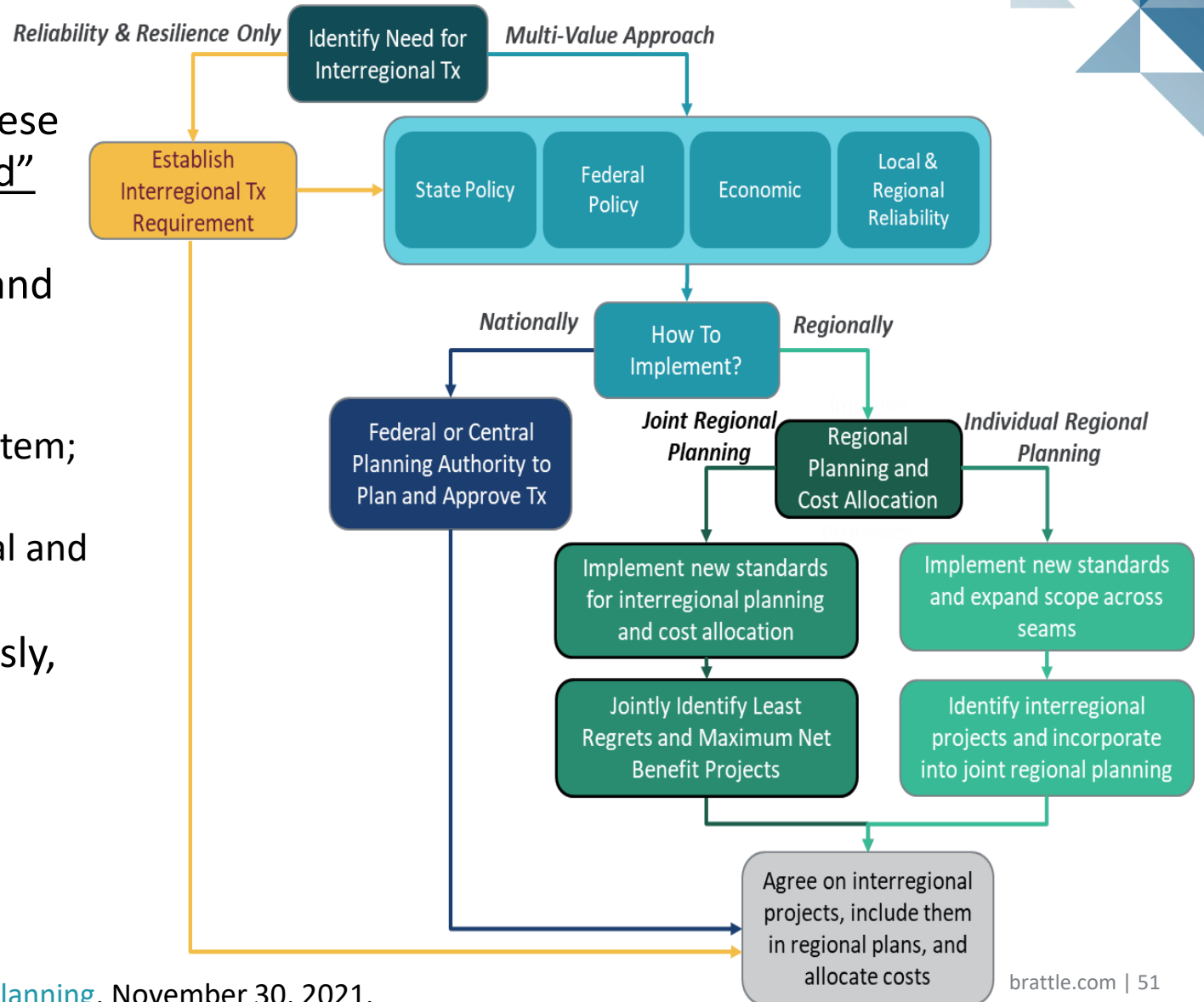
Although existing studies demonstrate the benefits of interregional transmission, they have not been successful in motivating improved interregional planning or actual transmission project developments.

The reasons include some or all of the following:

- Many studies **tend to analyze aspirational clean energy targets (e.g., 90% by 2035 or 100% by 2050)** not the actual policies and mandates applicable for the next 10-15 years
 - By not modeling actual state or federal policies, clean-energy mandates, and renewable technology preferences, the studies cannot demonstrate a compelling “need” to policy makers, regulators, and permitting agencies
- The studies are **not transmission planning studies** that produce specific transmission projects that can be developed to deliver the identified benefits and they **do not support an actionable need for specific projects**
 - The results of these studies do not connect with RTO planning processes and needs identification
- Studies **do not to identify how benefits and costs are distributed** across utility service areas, states, or RTO/ISO under different scenarios, as would be necessary to gain support and develop feasible cost recovery options
 - The studies typically do not consider or propose how to recover (“allocate”) transmission costs
- There has not been **an analysis of the state-by-state economic impact and job creation** from interregional transmission development, reduced electricity prices, and shifts in the locations of clean-energy investment
- Most studies do not **propose actionable solutions** to address the many barriers to planning processes and to the development of new interregional transmission projects

Options for Improving Interregional Planning Processes

- While national studies show there are benefits of interregional transmission, these studies do not create an actionable “need” for approving projects
- Multiple paths to establish the need for and planning of interregional transmission projects based on:
 - the value they provide to the electricity system; and
 - planning process implementation by federal and regional planning authorities
- These paths can be pursued simultaneously, identifying transmission needs through:
 - **New Interregional Tx requirements?**
 - **New Federal planning?**
 - **Improved joint RTO planning**
 - **Expanded planning by individual RTOs**



Proposal: Transmission Planning for the 21st Century*



Available experience points to proven planning practices that reduce total system costs and risks:

1. Proactively plan for future generation and load by incorporating realistic projections of the anticipated generation mix, public policy mandates, load levels, and load profiles over the lifespan of the transmission investment
2. Account for the full range of transmission projects' benefits and use multi-value planning to comprehensively identify investments that cost-effectively address all categories of needs and benefits
3. Address uncertainties and high-stress grid conditions explicitly through scenario-based planning that takes into account a broad range of plausible long-term futures as well as real-world system conditions, including challenging and extreme events
4. Use comprehensive transmission network portfolios to address system needs and cost allocation more efficiently and less contentiously than a project-by-project approach
5. Jointly plan inter-regionally across neighboring systems to recognize regional interdependence, increase system resilience, and take full advantage of interregional scale economics and geographic diversification benefits

Presented By



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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 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 transmission-related renewable generation 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, resource adequacy, and wholesale power market design matters in SPP, MISO, PJM, New York, New England, ERCOT, CAISO, WECC, Alberta and Ontario.

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.

The views expressed in this presentation are strictly those of the presenter(s) and do not necessarily state or reflect the views of The Brattle Group or its clients.

Additional Reading on Transmission

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- Pfeifenberger, Spokas, Hagerty, Tsoukalis, [A Roadmap to Improved Interregional Transmission Planning](#), November 30, 2021.**
- Pfeifenberger, [Transmission—The Great Enabler: Recognizing Multiple Benefits in Transmission Planning](#), ESIG, October 28, 2021.
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- Pfeifenberger, [“Transmission Cost Allocation: Principles, Methodologies, and Recommendations,”](#) prepared for OMS, Nov 16, 2020.
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- Tsuchida and Ruiz, [“Innovation in Transmission Operation with Advanced Technologies,”](#) T&D World, December 19, 2019.
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- 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.
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- 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.

Questions and Discussion

Study Overview



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National Transmission Planning Study

March 15, 2022



Agenda

Introduction

- Project team
- Objectives
- Desired outcomes

Project Scope

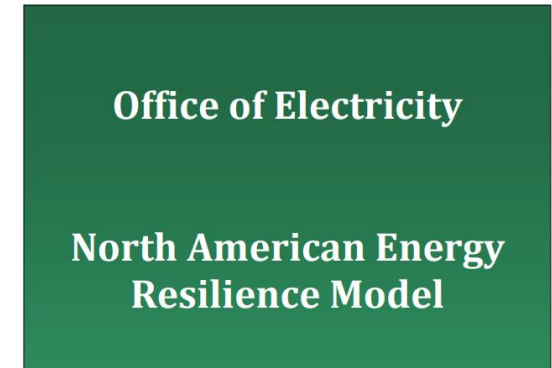
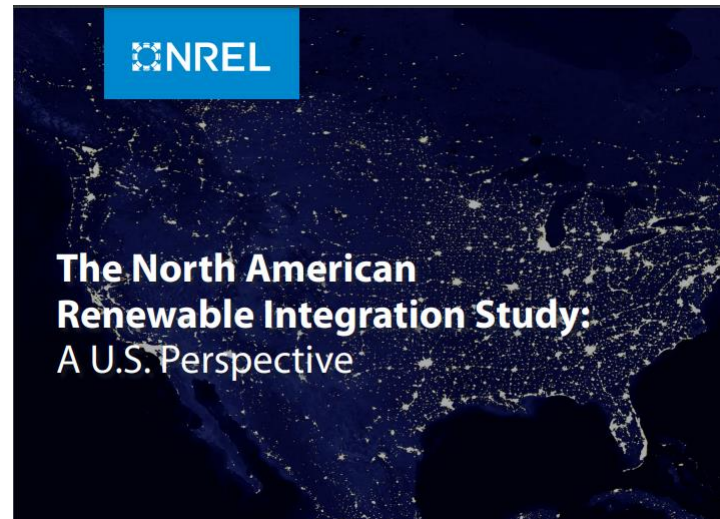
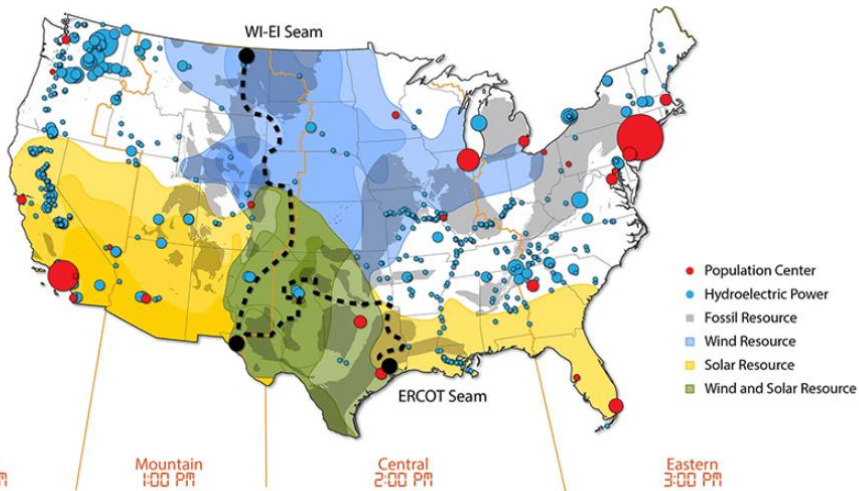
- Baseline analysis
- Scenario analysis
- Public engagement



Project team

This study is being conducted by a joint **National Renewable Energy Laboratory (NREL)** and **Pacific Northwest National Laboratory (PNNL)** project team

This study builds on past projects and expertise at NREL and PNNL with the support and direction of DOE's Office of Electricity



Objectives of the study

- 1 Identify **interregional and national strategies** to accelerate cost-effective **decarbonization** while maintaining system reliability
- 2 Inform regional and interregional transmission planning processes, particularly by **engaging stakeholders** in dialogue
- 3 Identify **viable and efficient** transmission options that will provide broad-scale benefits to electric customers

Desired outcomes of the study

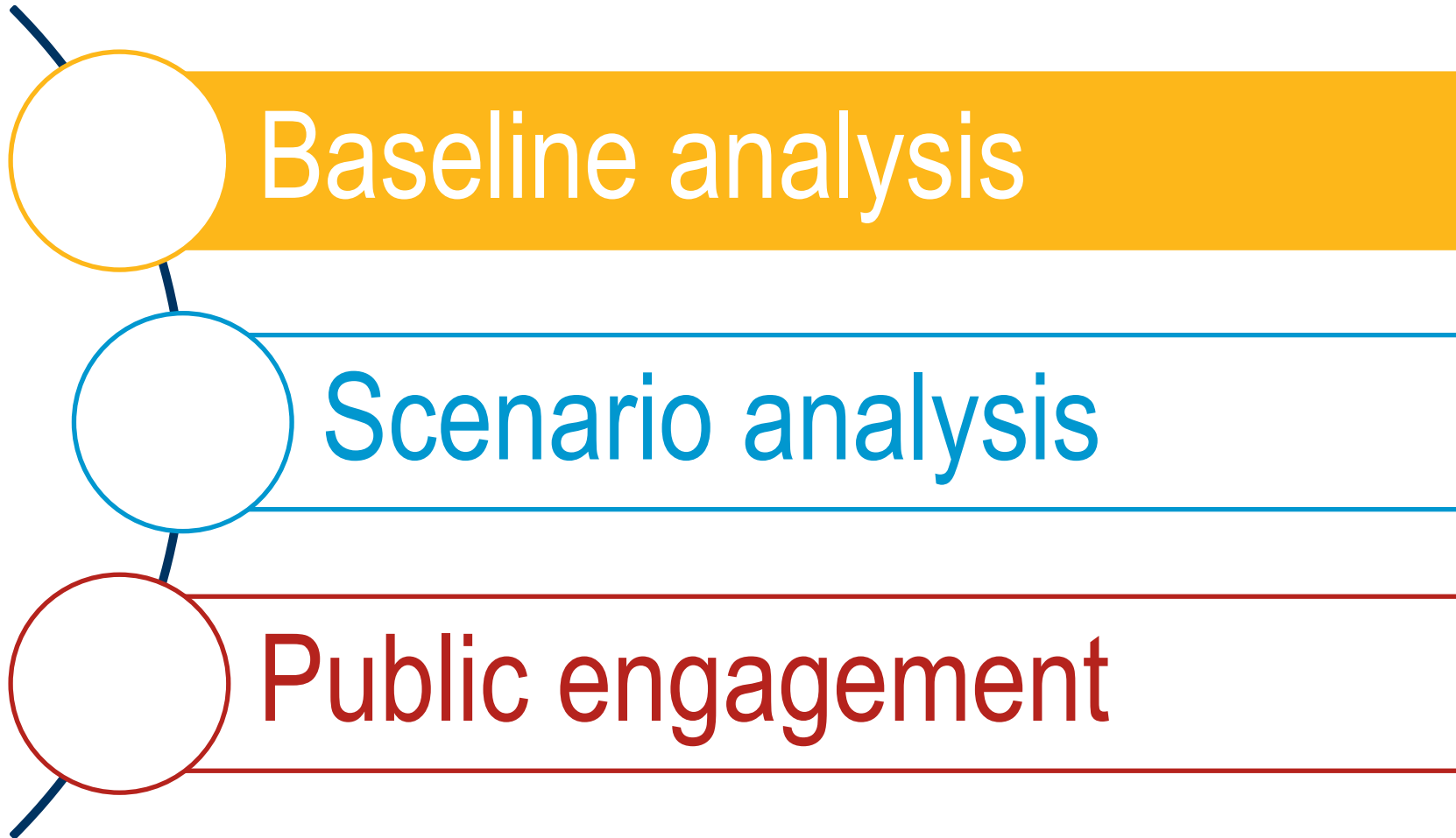
 Results help **prioritize future DOE funding** for transmission infrastructure support

 Results help **fill existing gaps** within interregional transmission planning

 Study provides a framework for stakeholders to discuss **desired grid outcomes** and **address barriers** to achieving them

National Transmission Planning Study Scope





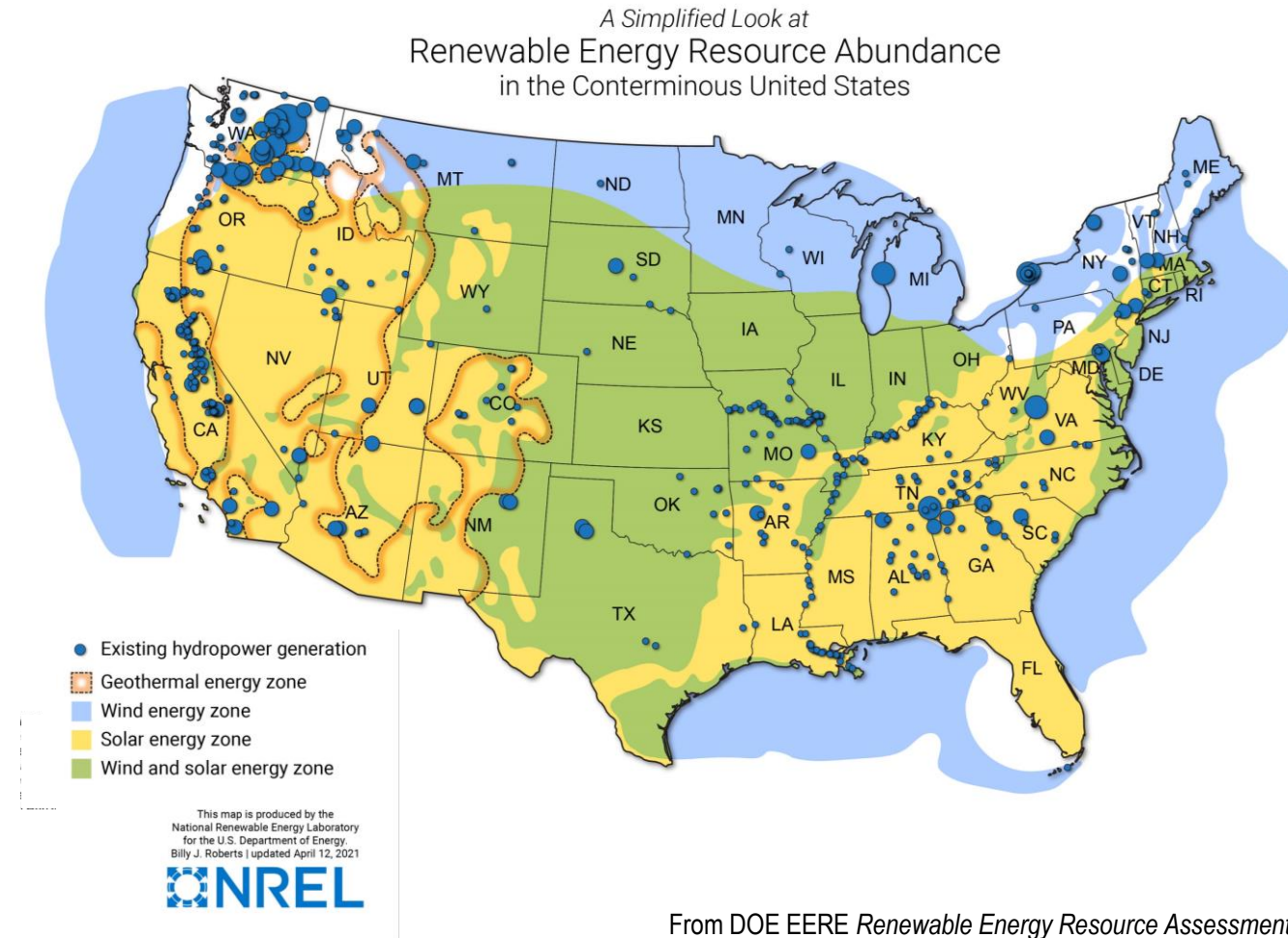
Baseline Analysis: Key Tasks

- Develop database of large, high-probability **transmission projects** likely to be in place by 2030
- Develop a database of power **generation projects** likely to be in operation in 2030
- From the above develop a transmission and power generation **nodal base case**
- Use the nodal base case to **conduct power flow and production cost modeling** for the grid in 2030
- **Answer the question:** How close does the currently-planned 2030 system get to meeting the Administration's 2035 decarbonization goal?

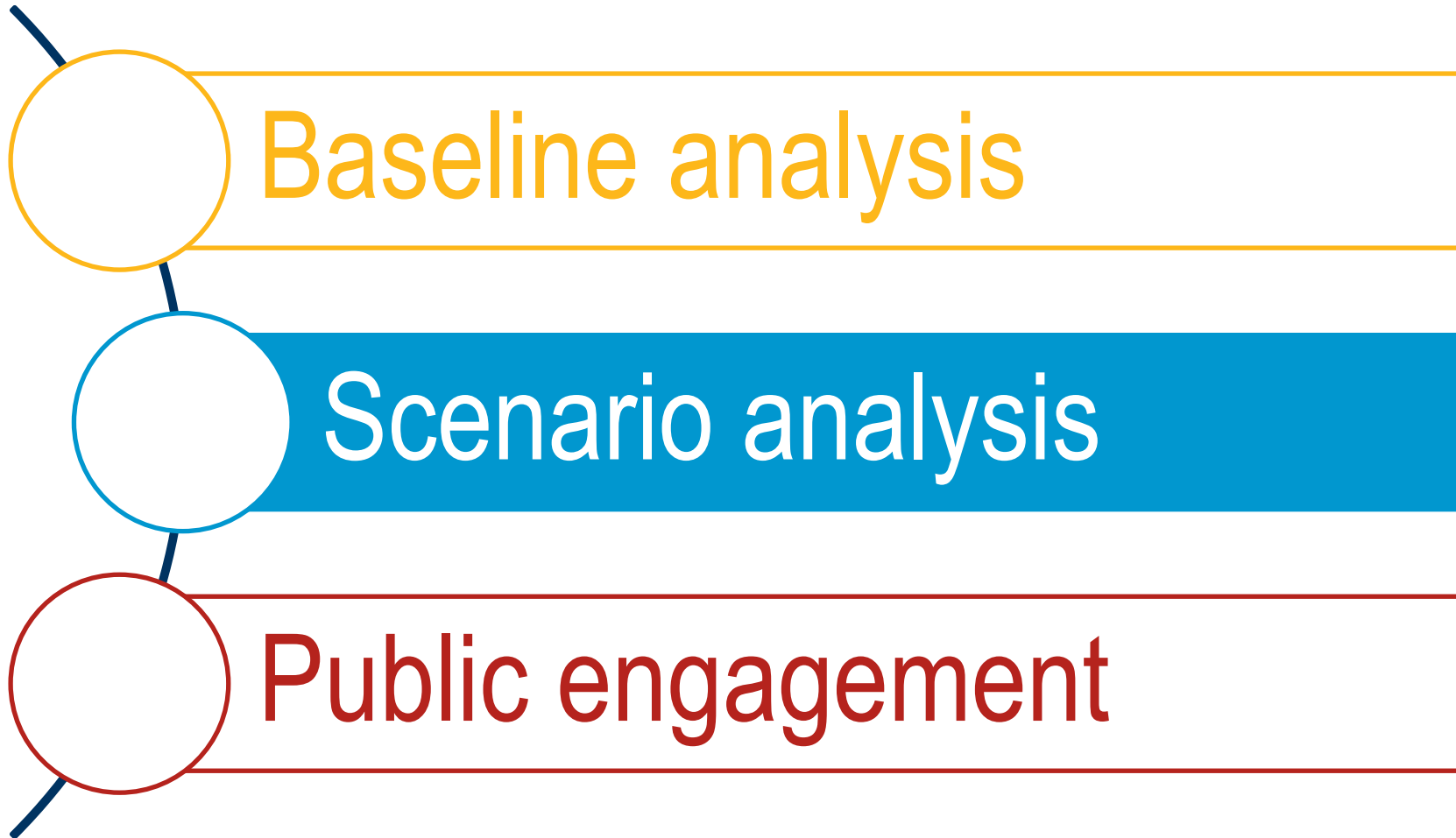


Baseline Analysis: Incorporating High Renewables

- Start from Baseline 2030 system
- Interconnect additional renewable generation to fully utilize planned 2030 transmission
- **Answer the question:** How close does the currently-planned 2030 system + high renewables get to meeting the country's 2035 decarbonization goal?



From DOE EERE *Renewable Energy Resource Assessment Information for the United States* (March 2022)



Scenario Analysis: Key Tasks

- Define different **scenarios or storylines** to explore in capacity expansion modeling to identify potential future generation resources and transmission expansion options (more details on next slide)
- Conduct **capacity expansion modeling**
- Independently, identify potential **interregional renewable energy zones**
- Conduct **production cost modeling**
- Conduct **AC power flow** and **dynamic reliability** analysis
- Conduct **economic analysis**
- Conduct **stress case** and **resource adequacy** analysis
- Identify a **portfolio of potential transmission options**

Scenario Analysis: Drivers and Characteristics



Transmission Drivers

Topology

- Intra-Balancing Area
- Interconnection-Wide Expansion
- Macrogrid Overlay

Technology & Cost

- Existing Technology & Costs
- High Costs
- Voltage Source Converters
- Non-wires Alternatives (e.g., FACTS, DLR, etc.)



Demand Drivers

Electrification

- High
- Medium
- Low

Distributed energy resources

- High
- Medium
- Low



Generation Drivers

Renewable siting

- Open
- Reference
- Constrained

RE & Storage Costs

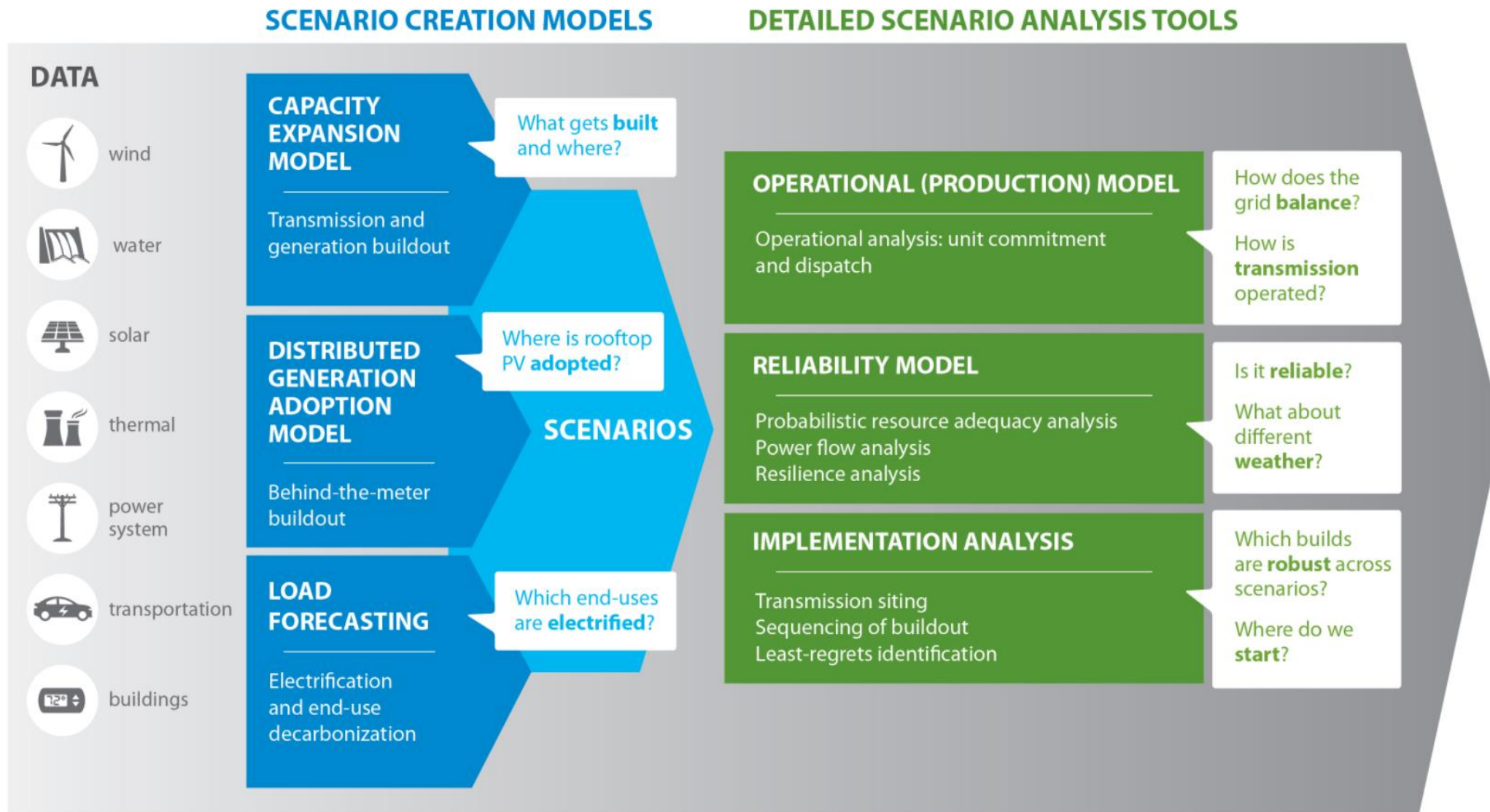
- High
- Medium
- Low

Thermal fleet

- Nuclear fleet extension
- Clean firm capacity
- Carbon capture and sequestration

We welcome feedback on which of these are the most important to consider.

Scenario Analysis: Study Plan

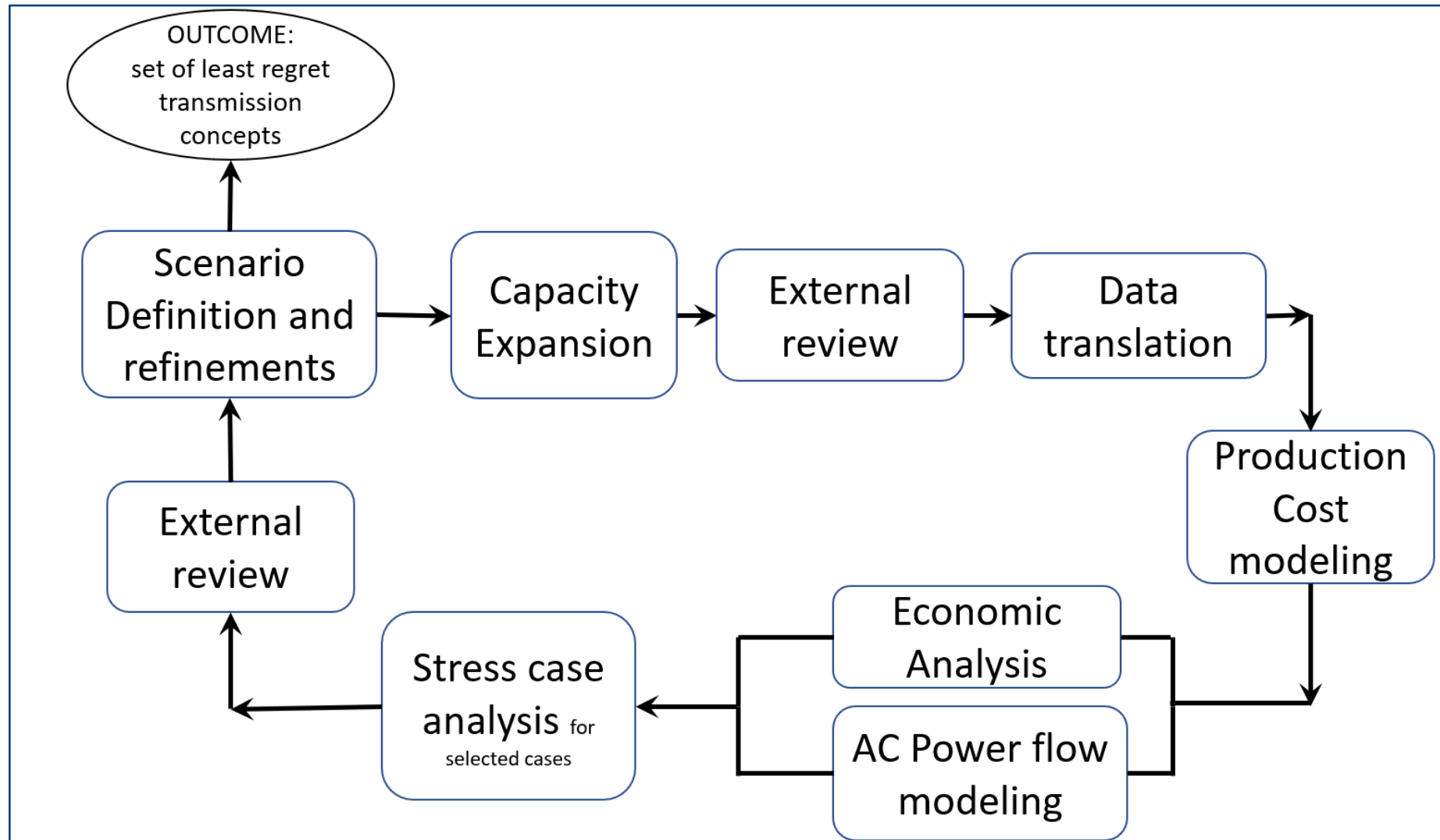


Scenario Analysis: Iterative Modeling and Review

Scenarios will be down-selected throughout modeling process.

Will start with several dozen scenarios and end with only a few.

Top-down and bottom-up approach throughout



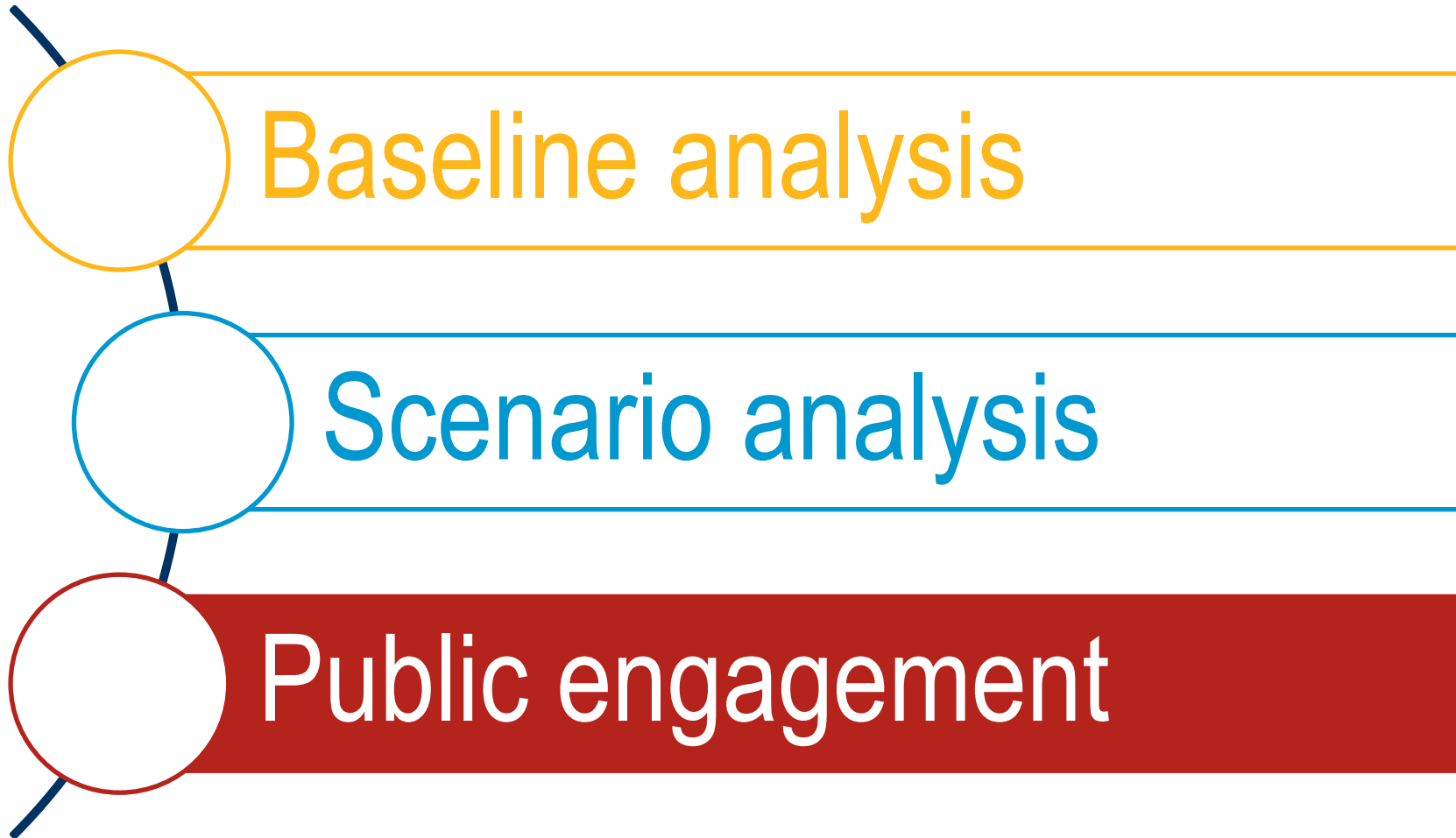
Scenario Analysis: What it is doing and is not

What the study will do

- Link several long-term and short-term power system models to test a number of transmission buildout scenarios
- Inform existing planning processes
- Test transmission options that lie outside current planning
- Provide a wide range of economic, reliability, and resilience indicators for each transmission scenario

What the study will not do

- Replace existing regional and utility planning processes
- Site individual transmission line routes
- Address the detailed environmental impacts of potential future transmission lines
- Provide results that are as granular as planning done by utilities
- Develop detailed plans of service



Public Engagement: Four Aspects

Public Workshops and Input

- Introduce project and provide updates
- Share interim and final results
- Provide opportunities for public feedback via website

Existing Convenor Groups

- Validate data and input assumptions
- Discuss consistency with groups' existing efforts
- Share project updates and interim results

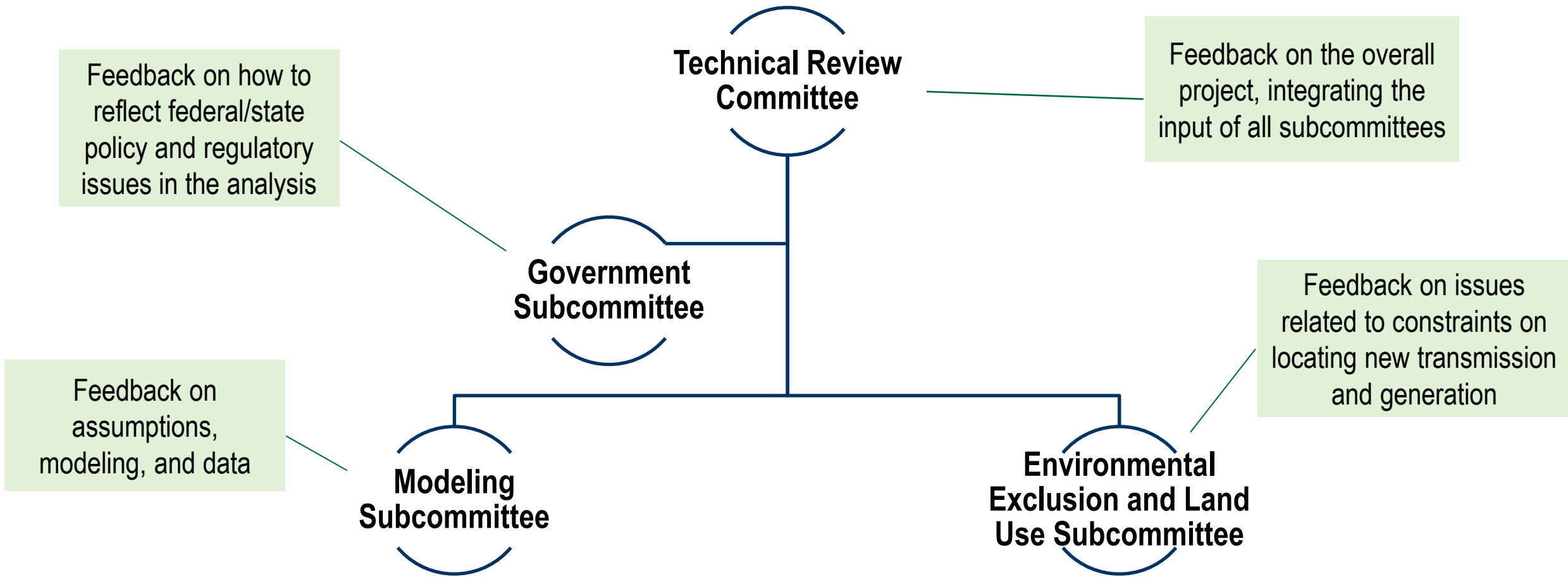
Technical Review Committee

- Provide project input
- Suggest project course corrections
- Review interim results

Tribal Outreach

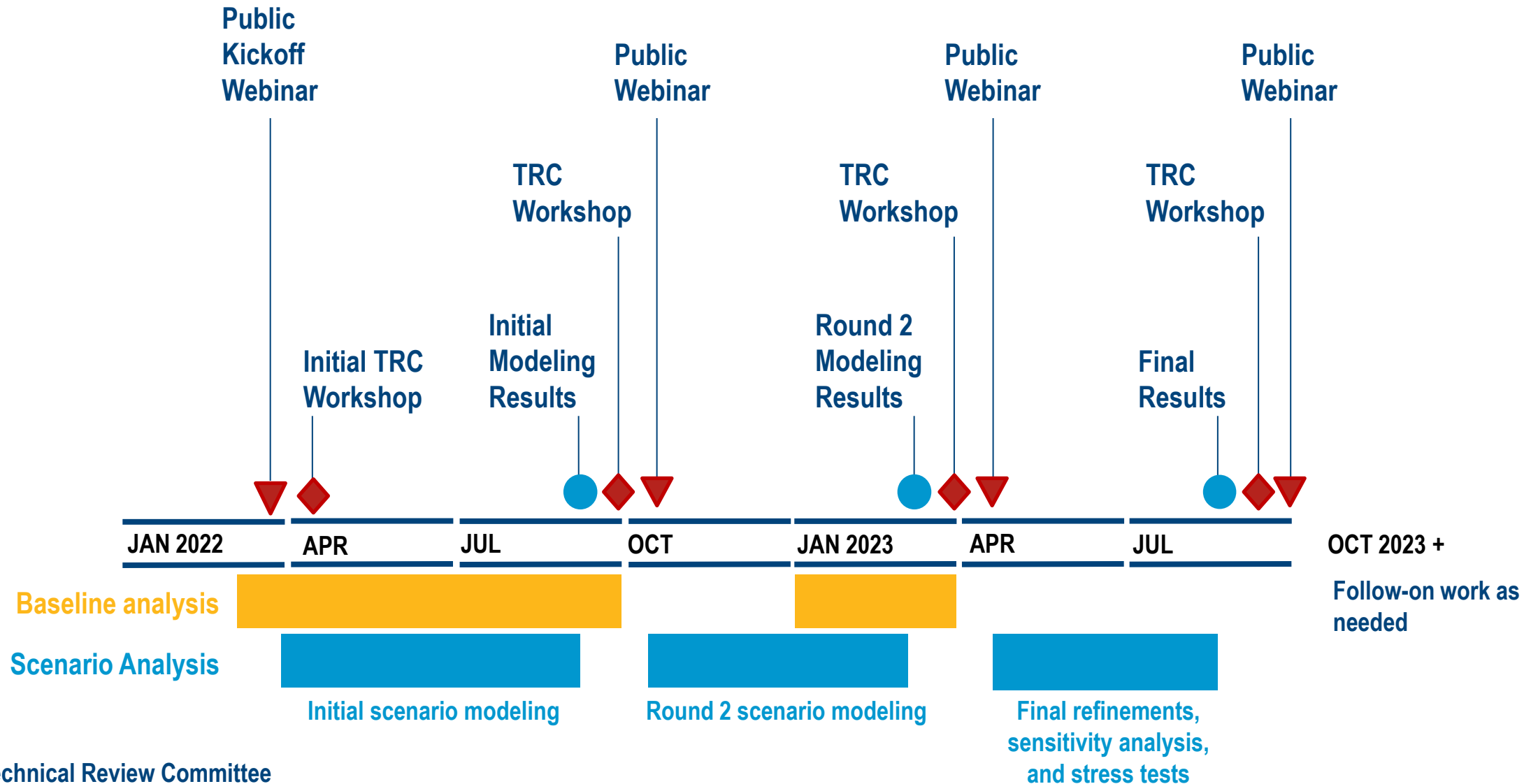
- Initiate broad outreach to all Tribes
- Invite statements of interest
- Incorporate Tribal input into analysis

Public Engagement: Technical Review Committee



Members will be invited based on knowledge and expertise, interest, sectoral and geographic diversity, participation in previous planning efforts, and other criteria

Public Engagement: Preliminary Timeline

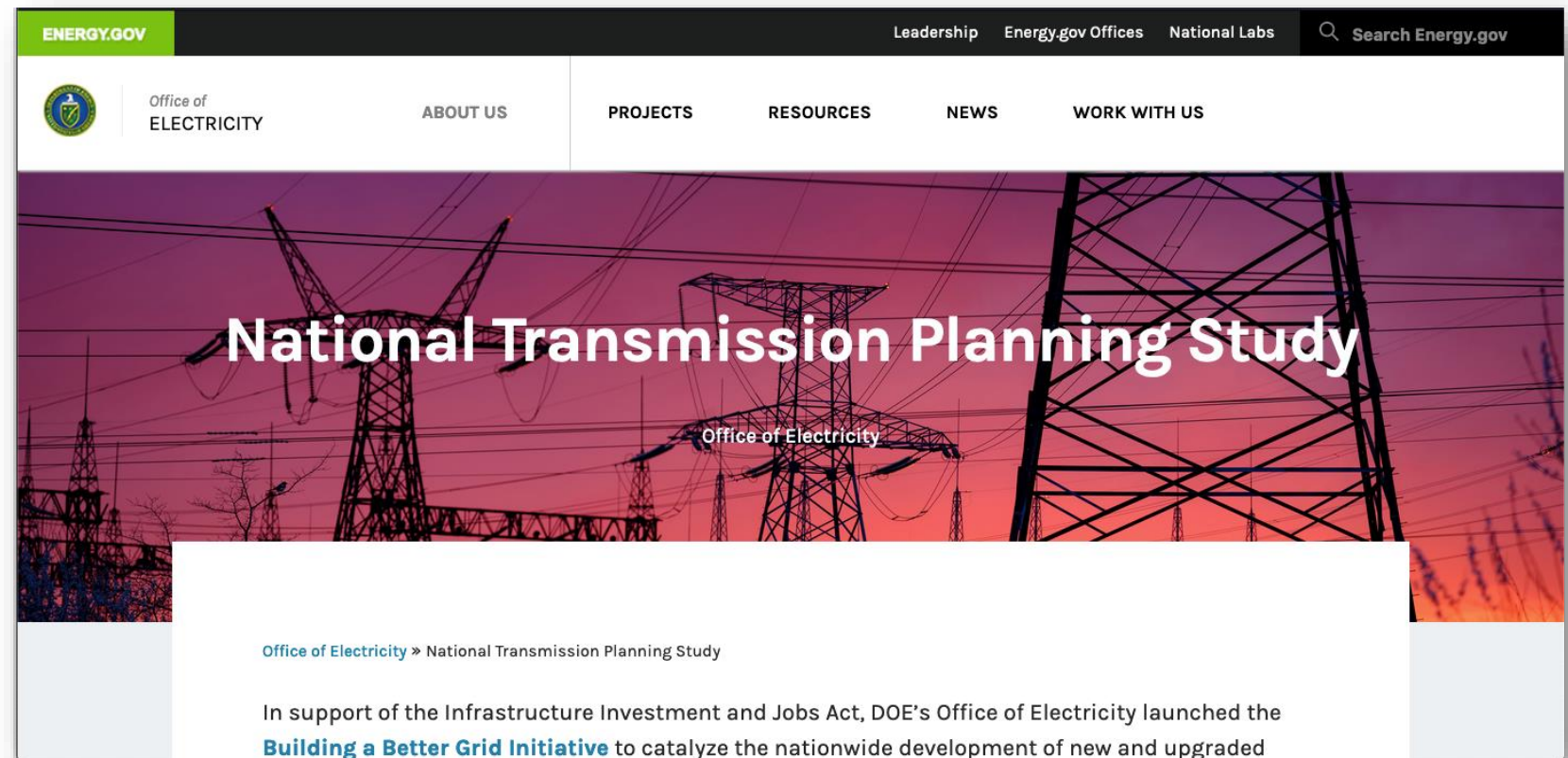


TRC = Technical Review Committee

How to get updates and provide comments

<https://www.energy.gov/oe/national-transmission-planning-study>

- Overview of NTP Study goals and objectives
- Project news and milestone results
- Webinar presentations (including this one)
- NTP Study mailing list
- TRC meeting schedules and presentation materials
- **Public comment form**



The screenshot shows the top portion of the National Transmission Planning Study webpage. At the top left is the ENERGY.GOV logo. To its right is the Office of Electricity logo and name. Further right is a navigation menu with links for ABOUT US, PROJECTS, RESOURCES, NEWS, and WORK WITH US. On the far right of the top navigation bar are links for Leadership, Energy.gov Offices, National Labs, and a search bar labeled Search Energy.gov. The main content area features a large background image of power transmission towers against a sunset sky. Overlaid on this image is the title "National Transmission Planning Study" in large white text, with "Office of Electricity" in smaller white text below it. Below the image, there is a breadcrumb trail: "Office of Electricity » National Transmission Planning Study". The main text block begins with "In support of the Infrastructure Investment and Jobs Act, DOE's Office of Electricity launched the Building a Better Grid Initiative to catalyze the nationwide development of new and upgraded".



Q&A and Discussion

Next steps

- **Participants provide comments** through the comment form on the website
- Interested parties **sign up for email** updates through the NTP Study website
- Lab team will continue conducting the **baseline and scenario analysis**
- Lab team will select **Technical Review Committee (TRC) members**
- **Initial TRC meeting** - April
 - Emails will be sent to the distribution list about this and all TRC meetings
- **Next public webinar** will be in Fall 2022 to share interim results

Thank You!

Office of Electricity

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