

Transmission Planning in the West: Who is Doing What?

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WTEC (now “WestTEC”) Concept Paper

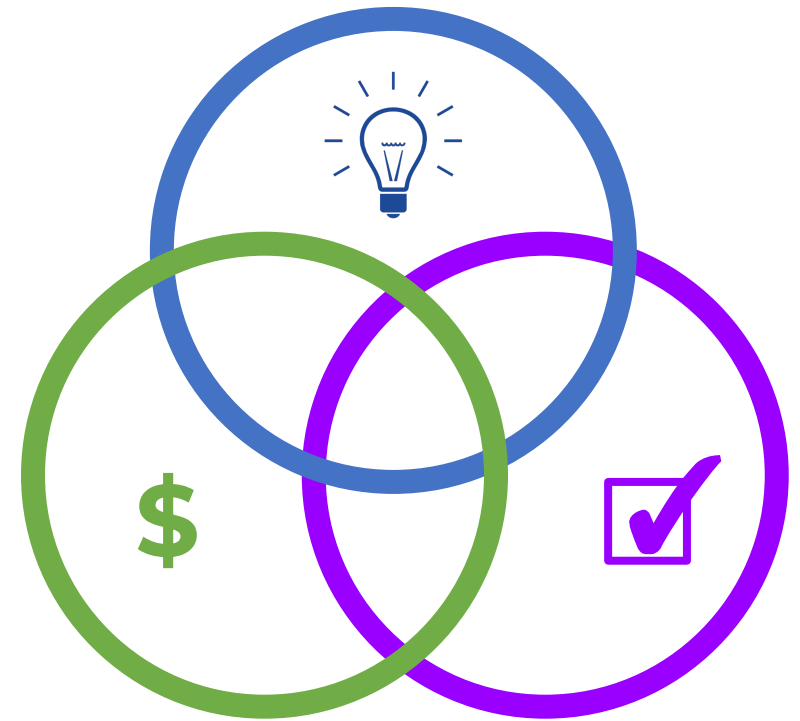
For purposes of this Concept Paper, an **“actionable” transmission plan** is defined as development of a transmission plan that can enhance regional and inter-regional **reliability needs**, address **economic efficiency**, and help states achieve their **respective goals**. The term “regional” is meant to indicate NorthernGrid, the regional planning organization where the WTEC discussion originated, while “inter-regional” is meant to indicate the collective footprint of the three regional planning organizations in the Western Interconnection: NorthernGrid, the California Independent System Operator (CAISO), and WestConnect, as well as BC Hydro & AESO (Canadian Provinces).

What is already being done in the west?

WestTEC Current Scope

The **objective** of the work:

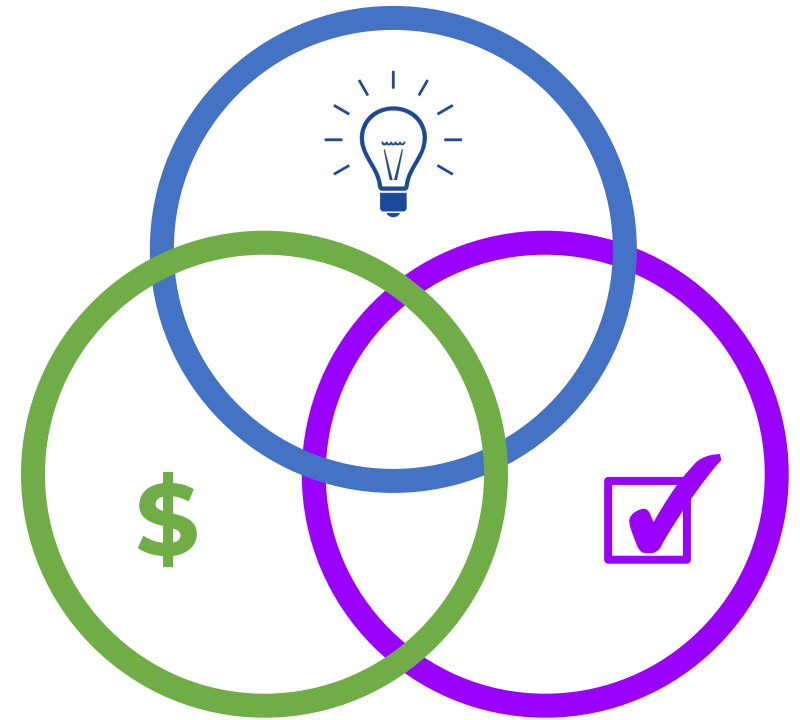
- Conduct planning analysis across the Western Interconnection
- Produce a 10-year and 20-year actionable transmission plan that identifies benefits including:
 - enhanced **reliability** needs
 - improved **economic efficiency**
 - helping western States and Tribes achieve their respective **clean energy goals**
 - improved interregional transmission planning and project identification for the West.

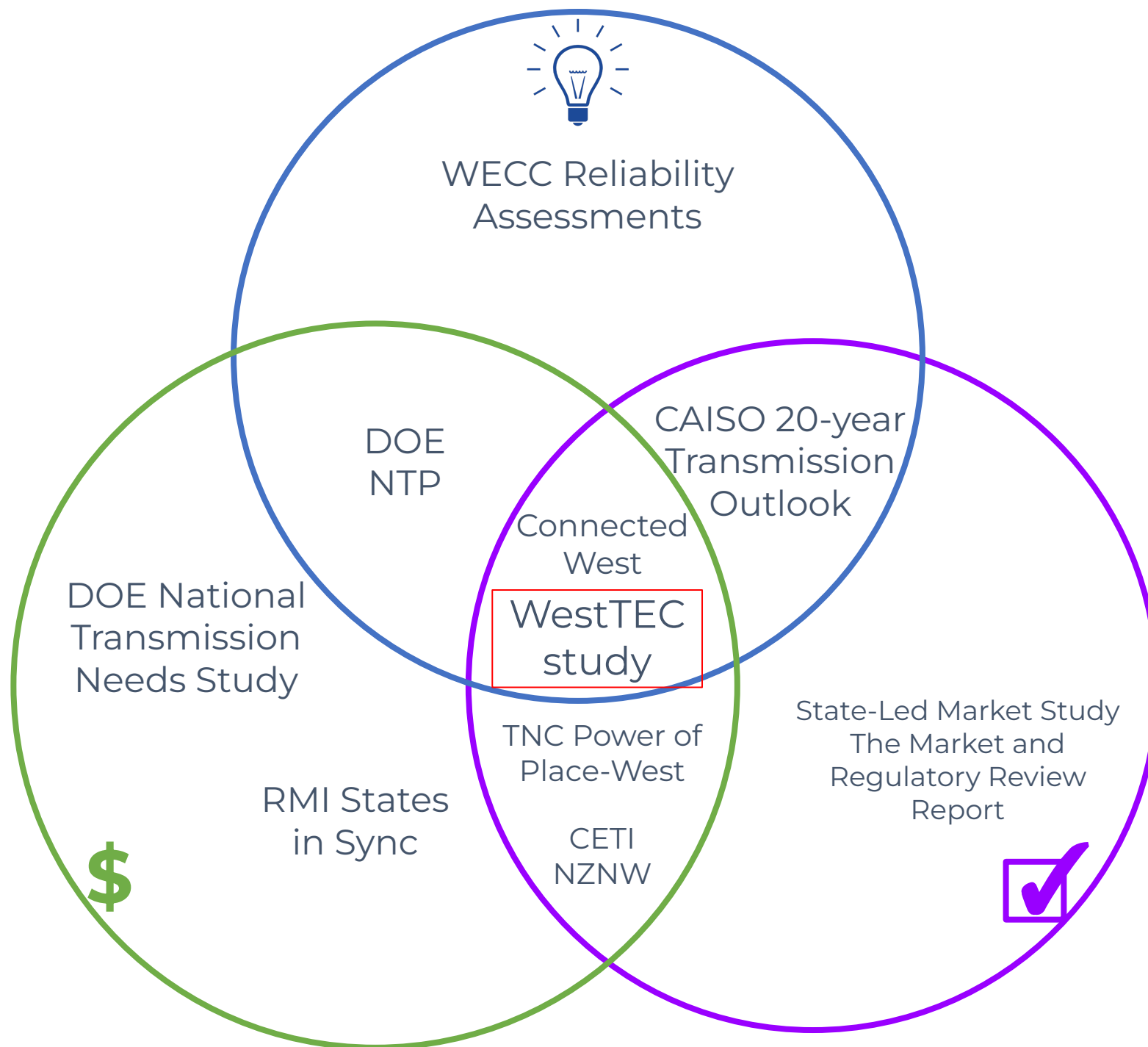


WestTEC Current Scope

The **goals** associated with the stated objective include:

- Reliability
- Resiliency
- Commercial economic efficiency
- Affordability
- Visibility and coordination
- Provide information about a range of potential transmission **benefits**
- Ensure that the execution of the project is fair, unbiased and transparent



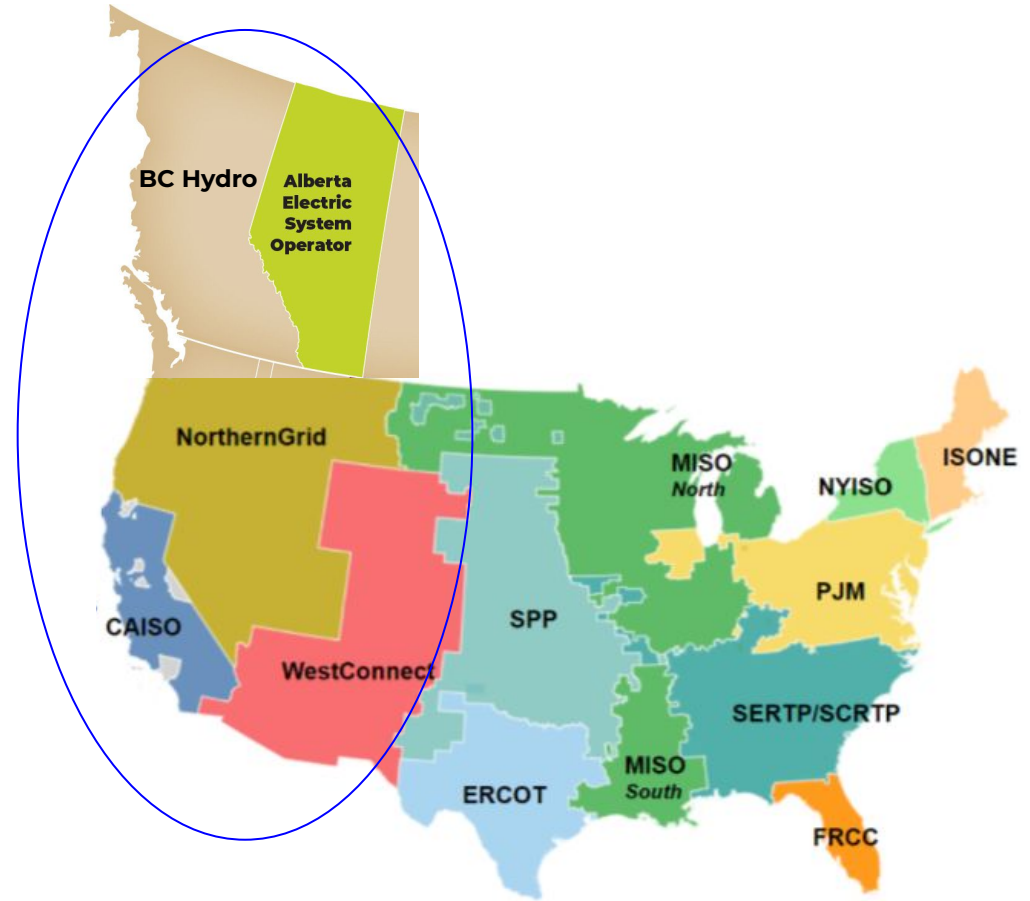


WestTEC and the Western Transmission Consortium

“Inter-regional”

Power transmission between:

- CAISO
- NorthernGrid
- WestConnect
- BC Hydro
- AESO



Study	Description	Release Date	Link
The Nature Conservancy Power of Place-West	An analysis of the land use requirements and conservation impacts of clean energy pathways for the eleven Western Interconnection states in a highly decarbonized and electrified west.	2022 - August (Complete)	https://www.nature.org/content/dam/tnc/nature/en/documents/TNC_Power-of-Place-WEST-Executive_Summary_WEB_LR.pdf
WECC's Reliability Assessments	WECC performs various reliability assessments and the 2023 Study Program Assessments include three "Year 20" Studies: Year 20-Extreme Heat; Extreme hot weather event Year 20-Extreme Cold; Extreme cold weather event Year 20-Compound Load Impacts; Impacts of compound changes in loads/electrification	2024 - January & February	https://www.wecc.org/RAC/Pages/StS.aspx
RMI's States in Sync	(1) an assessment of potential growth in clean energy markets under three load scenarios and the transmission constraints for traditional energy export states (MT, WY, CO, and NM) seeking access to those markets (2) an energy modeling effort to quantify the cost reductions from achieving clean energy goals in the West collaboratively compared to pursuing state goals independently within a single state.	2024 - March	https://rmi.org/our-work/electricity/
CAISO 20-Year Transmission Outlook	CAISO's 20-Year Transmission Outlook will be updated in parallel with the CAISO's 2023-2024 Transmission Planning Process (TPP). The study will use 2045 scenario based on demand and resource forecasts developed by California Energy Commission staff. High level of technical studies to test the feasibility of alternatives and will not be as detailed as the 10-year TPP. Focus will be on the bulk transmission system. Using a zonal approach to resource mapping.	2024 - March (draft) 2024 - May (final)	https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/20-Year-transmission-outlook-2023-2024
WECC Transmission Trends Assessment	In conjunction with the 2023 Study Program, WECC will be developing the first Transmission Trends Assessment to look across the year-20 scenarios to identify areas of common transmission congestion across the Western Interconnection.	2024 - March	https://www.wecc.org/RAC/Pages/StS.aspx#2020-2021StudyProgram
Connected West	Identifying the most valuable transmission corridors in a highly decarbonized 2045 West	2024 - April	https://gridworks.org/publications/
DOE Expanded Markets and Transmission Study	Modeling benefits of increasing market coordination in the Western U.S. and expanding transmission across the Eastern-Western Interconnection Seam.	2024 - April	
DOE National Transmission Planning Study (NTP)	Capacity Expansion (ReEDS), Production Cost (Plexos & Gridview), and AC Power flow modeling to identify interregional transmission needs and corridors for the continental U.S.	2024 - mid year	https://www.energy.gov/gdo/national-transmission-planning-study
NERC Interregional Transfer Capability Study (ITCS)	NERC, in consultation with the regional entities, will perform an Inter-regional Transfer Capability Study (ITCS). The study is to include three elements: 1) an assessment of the current total transfer capability between neighboring regions, 2) a recommendation on total transfer capability increases between regions to strengthen reliability, and 3) recommendations to meet and maintain total transfer capability between regions.	2024 - December (draft)	https://www.nerc.com/news/Pages/Statement-on-Interregional-Transfer-Capability-Study.aspx
DOE West Coast Offshore Wind Study	Investigate pathways for offshore wind generation and transmission development across the West Coast in support of state and federal clean energy goals through 2050. Resolve nodal representations of the Western Electricity Coordinating Council (WECC) in 2035 and 2050 to meet existing adequacy, contingency, steady-state, and transient stability requirements	2025 - January	https://www.pnnl.gov/projects/west-coast-offshore-wind-transmission-study

WECC Reliability Assessments

WECC Reliability Assessment Committee; Studies Subcommittee

Katie Rogers

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Q1, 2024

<https://www.wecc.org/RAC/Pages/StS.aspx>

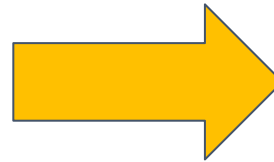
WECC Reliability Assessments

2023 WECC Study Program

Year 20: Extreme hot weather event

Year 20: Extreme cold weather event

Year 20: Impacts of compound changes in loads/electrification



Transmission Trends Assessment

- Identify areas in the Western Interconnection where planners consistently see **transmission congestion**.
- Provide an interconnection-wide, **reliability-based** perspective of areas in the West that may benefit from new transmission.

2032 ADS PCM
2042 Foundational PCM

Nodal dispatch modeling
(GridView™)

States In Sync: The Western Win-Win Transmission Opportunity

RMI

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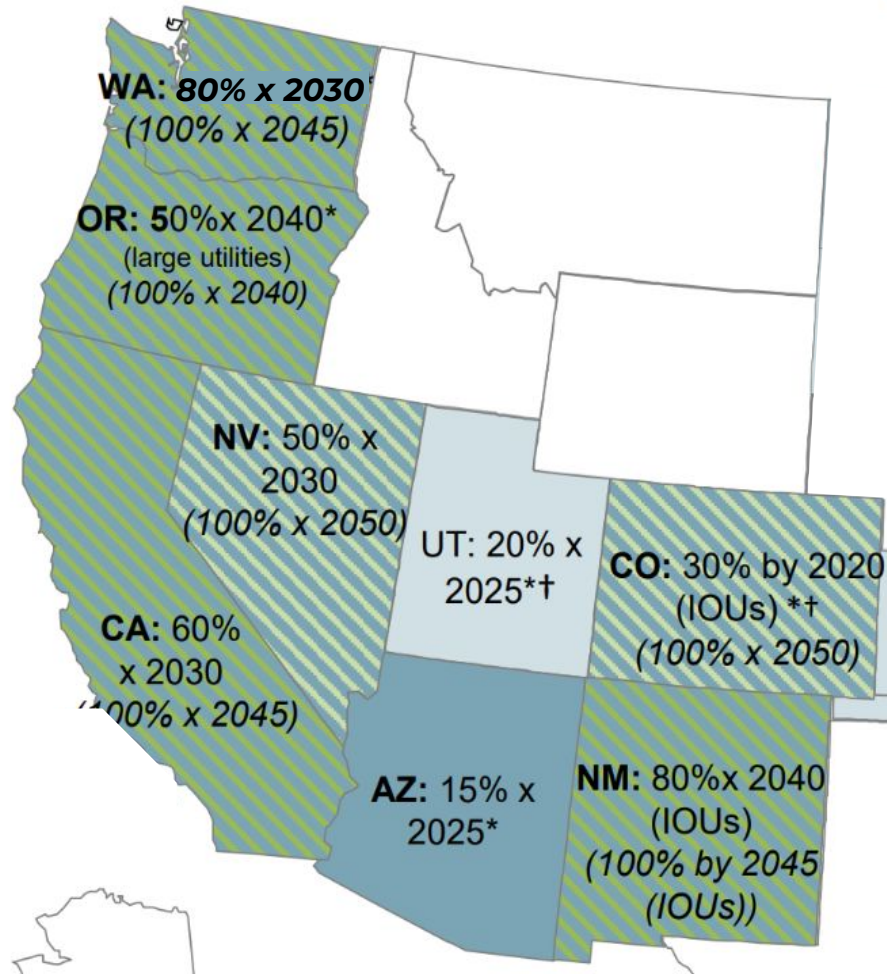
March 2024

<https://rmi.org/our-work/electricity/>

RMI - States in Sync: The Western Win-Win Transmission Opportunity

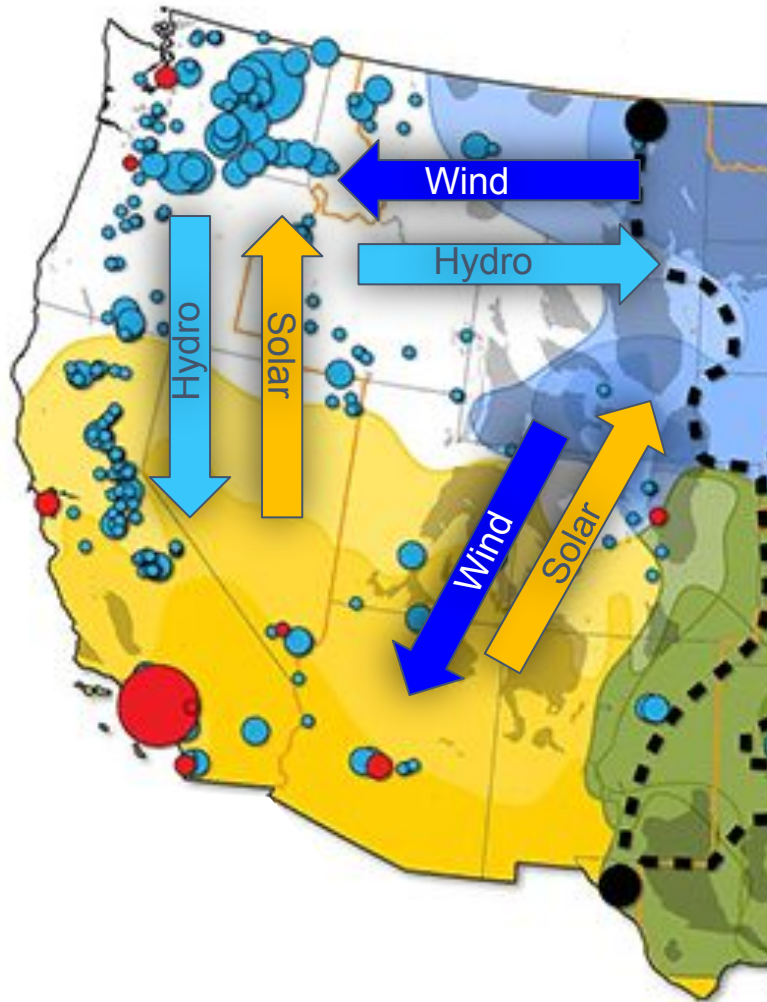
How much can MT, WY, CO, NM
deliver to this market...

Using only this?

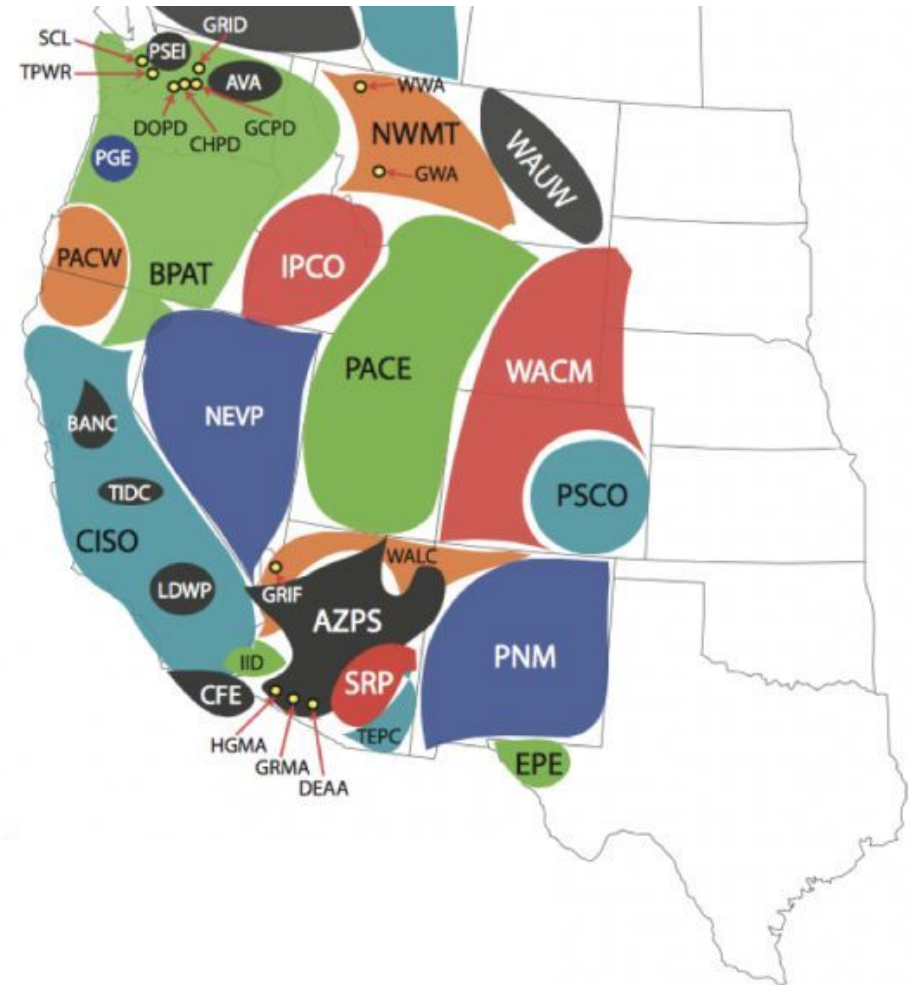


RMI - States in Sync: The Western Win-Win Transmission Opportunity

How much can each state
save doing this...



Instead of this?

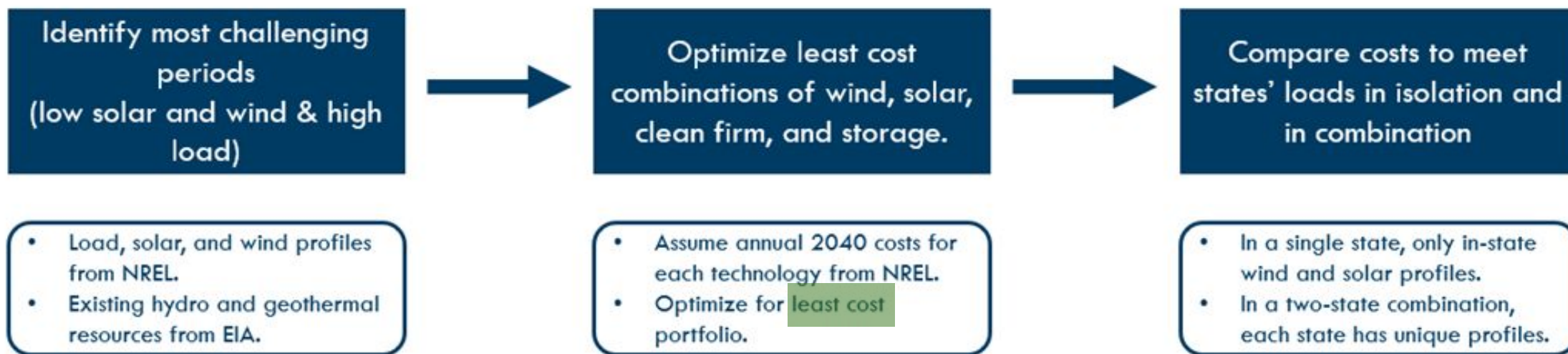


Source: Western Electricity Coordinating Council

RMI - States in Sync: The Western Win-Win Transmission Opportunity

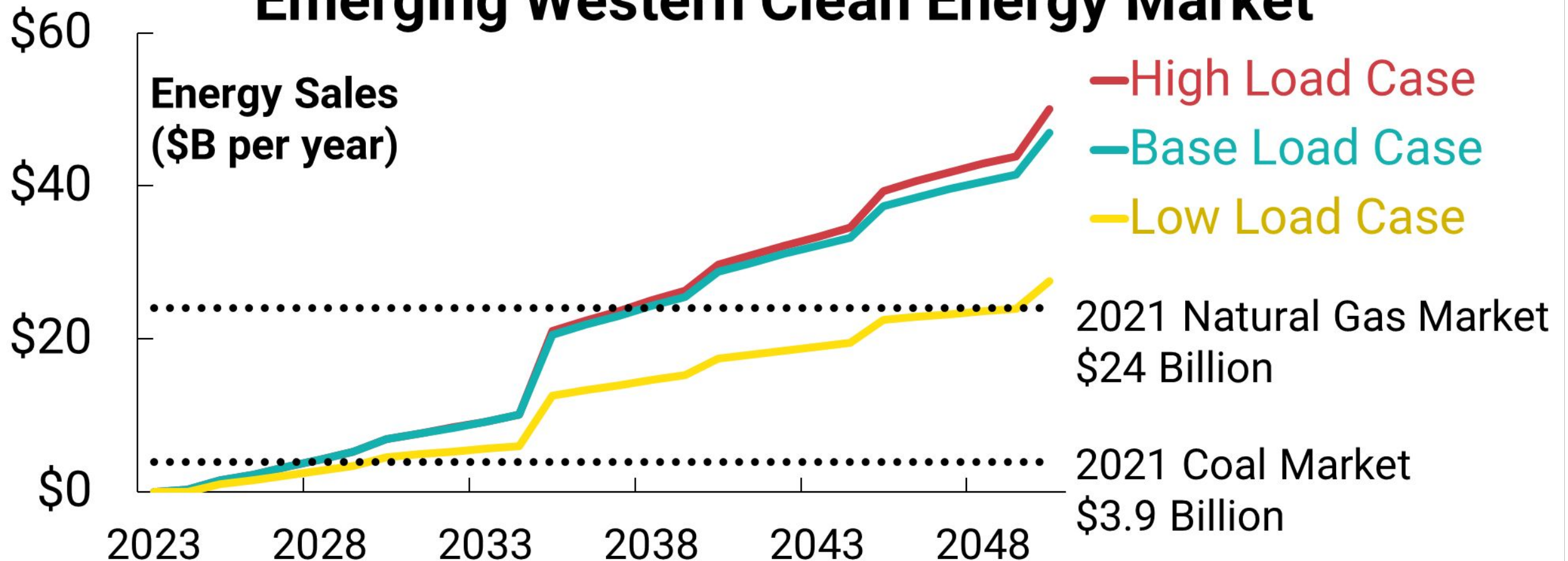
Key Assumptions:

- Load Model: NREL's 2050 Cambium 8,760 hour
- Generation **Cost** Model: NREL's Annual Technology Baseline moderate cost scenario in 2040
- Variable Generation Profile: NREL's standard scenario model (2014 weather year)



RMI - States in Sync: The Western Win-Win Transmission Opportunity

Emerging Western Clean Energy Market



RMI - States in Sync: The Western Win-Win Transmission Opportunity

Regional transmission allows the West to

1. Leverage regional diversity in load and generation;
2. Leverage existing clean firm resources such as hydro, nuclear, and geothermal;
3. Decrease reliance on expensive new clean firm technologies.

Planning with neighboring states could lead to savings upward of 30% compared to only instate generation build out

California 20-Year Transmission Outlook

CAISO

Jeff Billinton

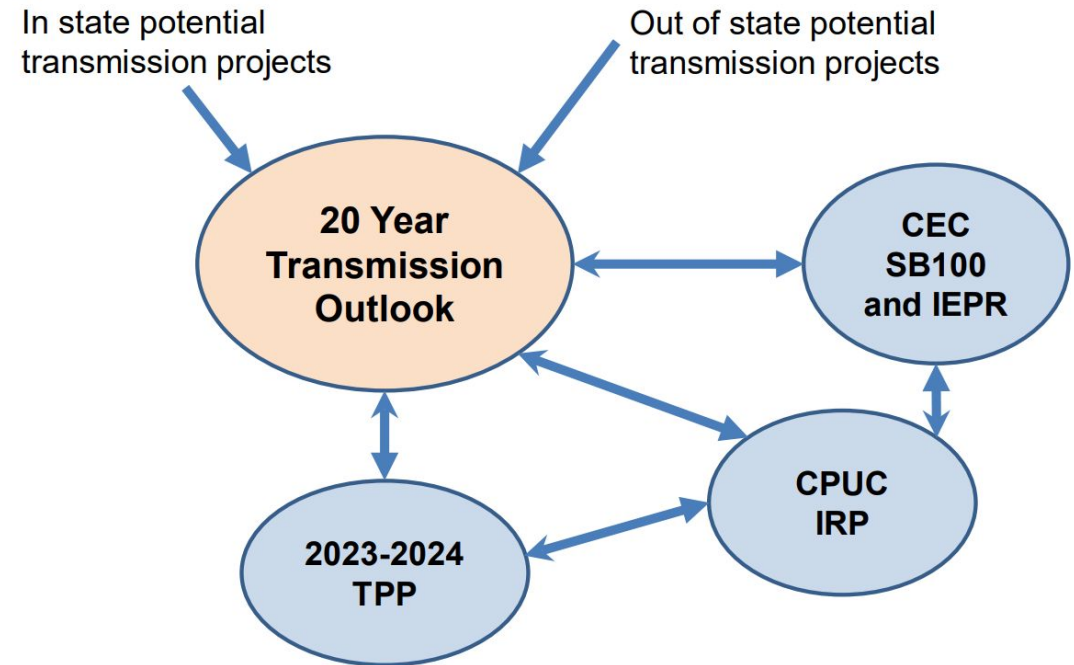
jbillinton@caiso.com

2024 - March (draft), 2024 - May (final)

<https://stakeholdercenter.caiso.com/RecurringStakeholderProcesses/20-Year-transmission-outlook-2023-2024>

CAISO 20-Year Transmission Outlook

- “SB100” (2045 100% RPS) outlook that considers:
 - Diverse resources known to require transmission development such as offshore wind energy, out-of-state resources, and geothermal resources; and,
 - Gas power plant retirements that may require transmission development to reduce local area constraints.
- Start with the 2035 TPP case and extend to a 2045 scenario developed through the California Energy Commission (updated load and resource forecast)
- Developed conceptual transmission system additions and conducted high-level technical studies to test feasibility of these alternatives, focusing on the bulk transmission system.



CAISO 20-Year Transmission Outlook

- **Contingency Analysis** to identify the potential transmission enhancement requirements:
 - Net Peak (HSN)
 - based on the HSN in deliverability studies and reflects the system in early evening summer conditions
 - Peak consumption (SSN)
 - based on the SSN in deliverability studies and reflects the system in early afternoon summer conditions
 - Off Peak
 - reflects the system in the middle of the day in spring when electricity consumption is low while the solar and BTM PV generation is high

CAISO 20-Year Transmission Outlook

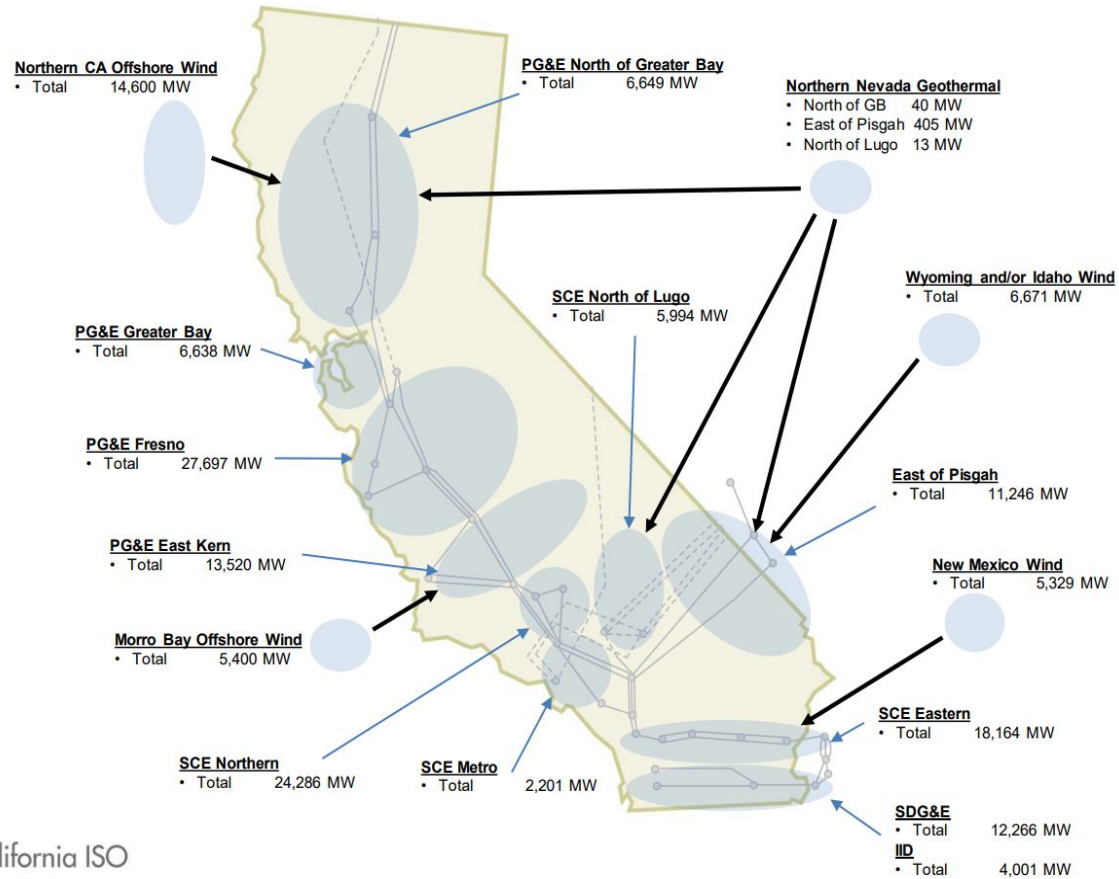
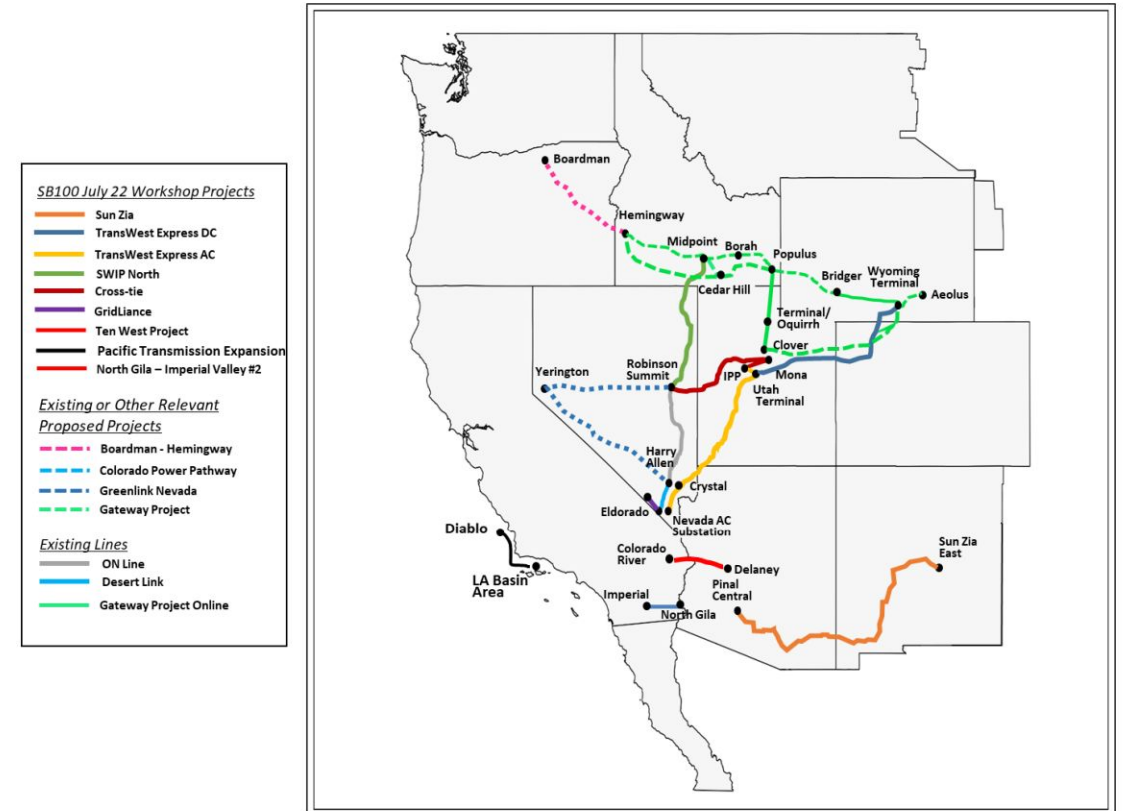


Figure 2.1-1: Illustration of potential transmission projects identified at CEC SB100 workshop



Connected West

Gridworks, Gridlab, & Energy Strategies

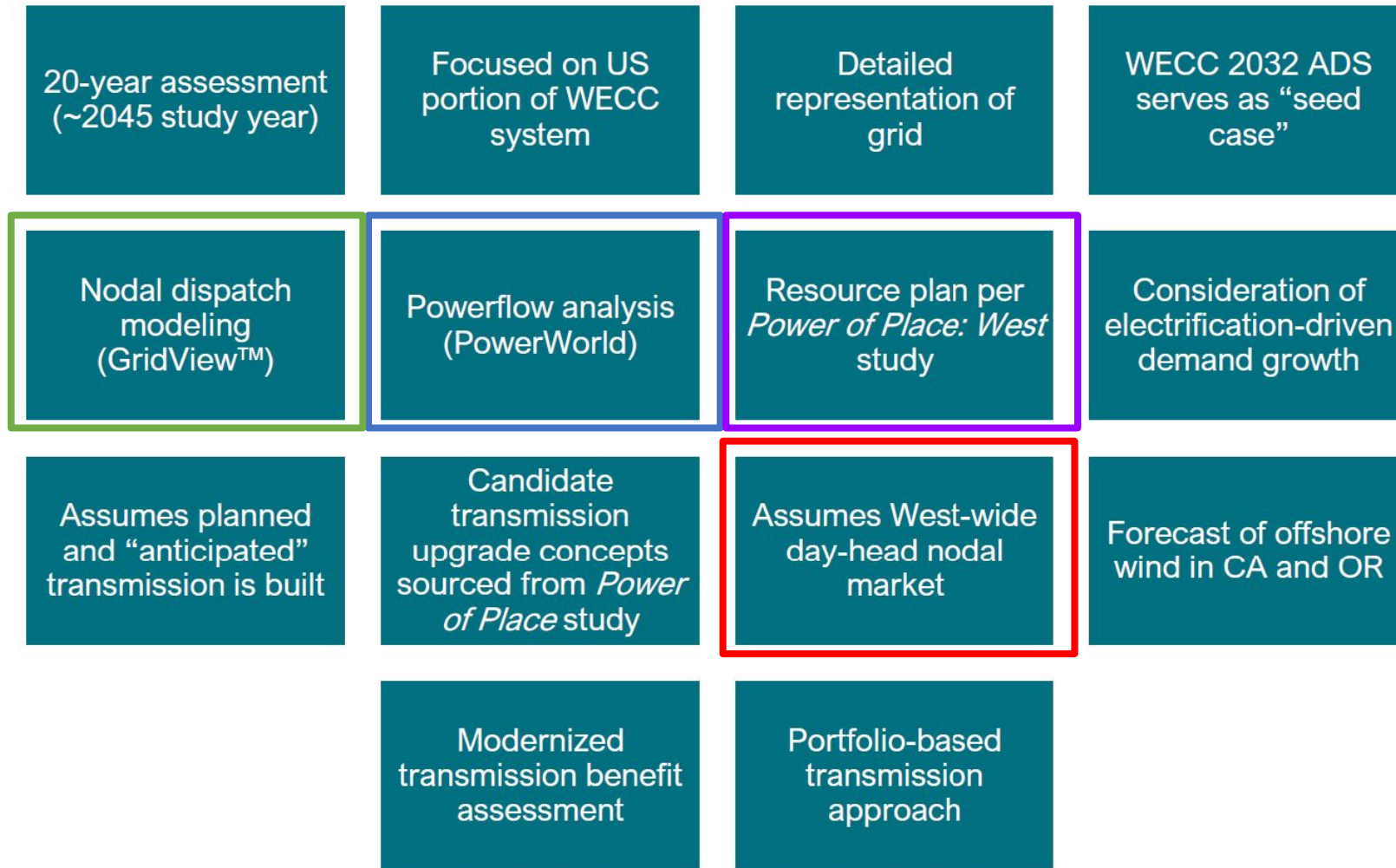
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Q1, 2024

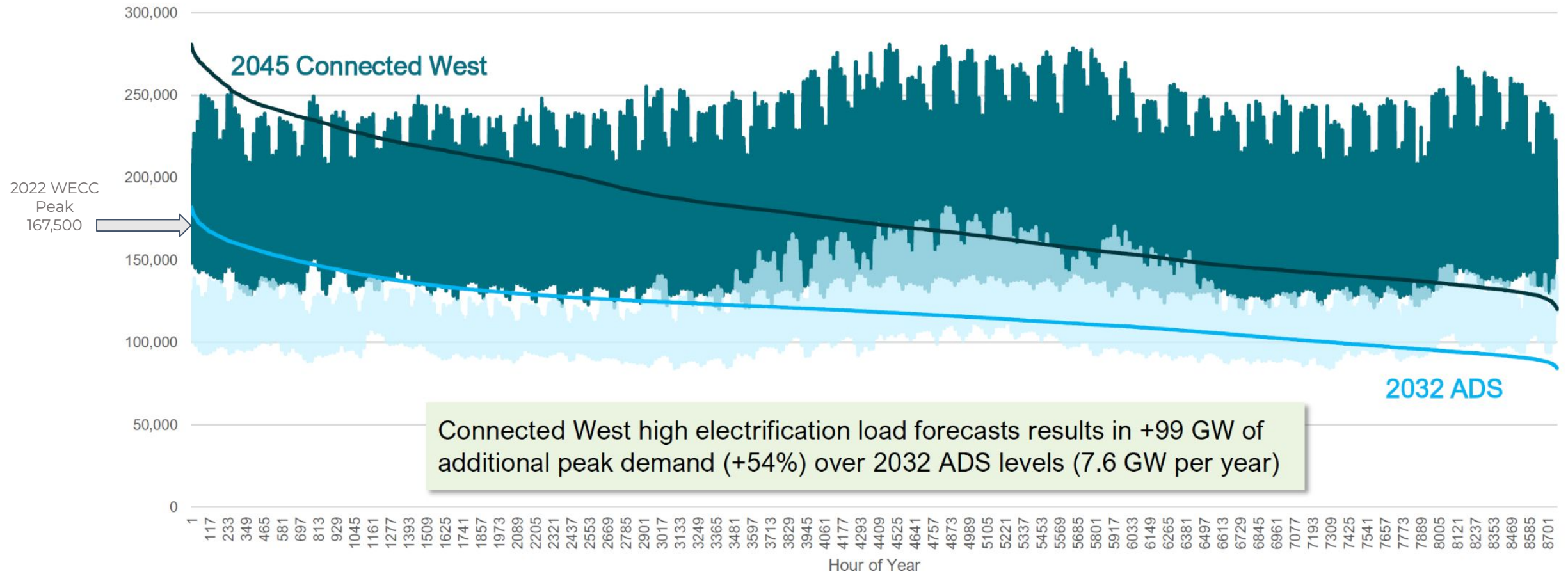
<https://gridworks.org/publications/>

Connected West



Connected West 2045 load profile versus 2032 WECC ADS

Hourly WECC Loads: 2045 Connected West vs. 2032 WECC ADS (MW)



Connected West: Transmission Benefit Methodology

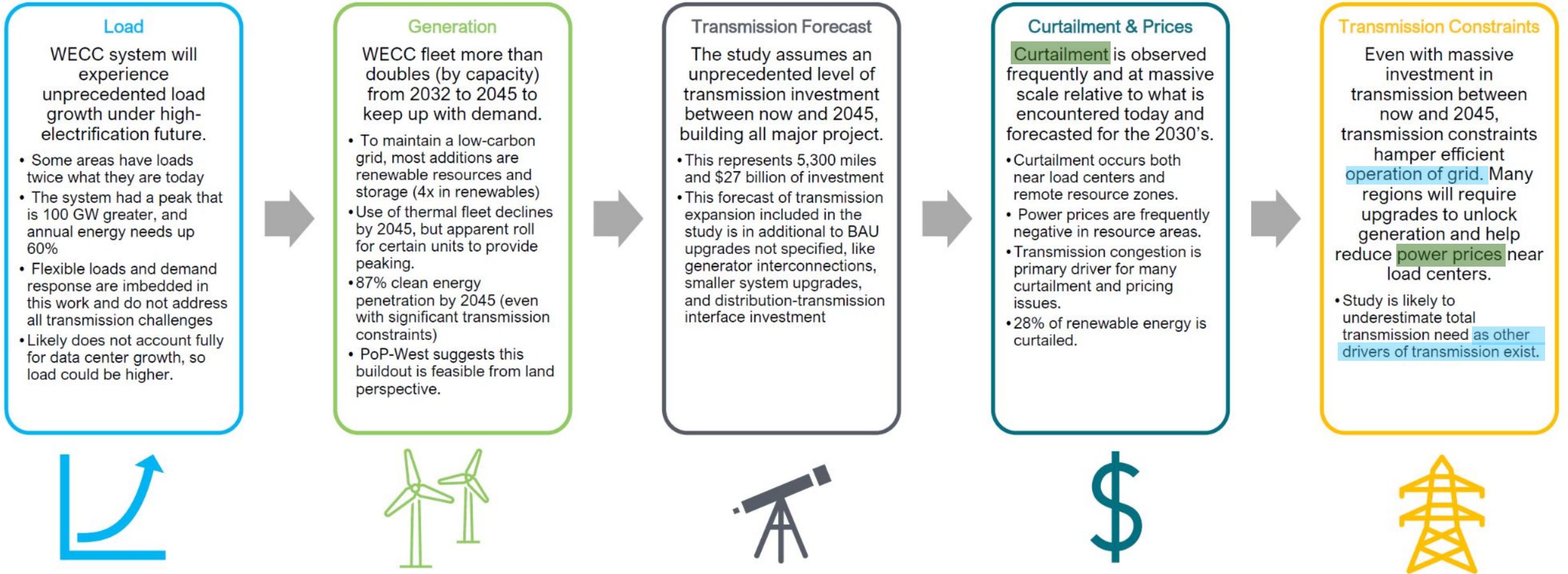
- The study will focus on evaluating the efficiency of transmission expansion within a series of corridors considered simultaneously, as a part of a portfolio, and in some cases, individually (to help judge relative corridor performance)
 - To facilitate this evaluation and to drive towards a ranking of corridors, the cost of the corridor upgrade or new build (or portfolio thereof) will be compared to the benefits calculated for that corridor (or the portfolio thereof)

Portfolio Examples

	A	B	C	D	E	F	Benefits	Cost	Net Benefits
Portfolio 1	X	X	X	X			TBD	TBD	TBD
Portfolio 2		X	X		X	X	TBD	TBD	TBD
Portfolio 3	X		X	X	X		TBD	TBD	TBD
Portfolio 4	X	X	X			X	TBD	TBD	TBD
....									

Benefit	Metric
Operational & congestion relief savings	Change in WECC-wide production cost.
Capacity benefit	MWs of resource and load diversity enabled via transmission upgrade * value of avoided capacity.
Extreme event mitigation (resilience benefits)	Use historical weather and grid condition data to simulate short-term operational conditions with and without project to determine change in load payments & potentially benefit of avoiding cost of unserved load (loss-of-load = \$20,000/MWh).
Generation access (public policy benefits)	Not considered as we are assumed capital expansion model from Power of Place study already considered tradeoffs of accessing different resources with transmission.
Environmental benefits	Avoided emissions = Reduction emissions * carbon price
Transmission reliability	Quantify savings from avoiding upgrades otherwise needed to maintain transmission reliability. A powerflow study will be conducted with and without the upgrade and we will quantify the avoided overloads and the cost avoided that would otherwise be required to mitigate those overloads.
Environmental feasibility	Environmental data from Power of Place will inform this “scoring” result. It is TBD if this score will be quantified as a dollar benefit.
Portfolio performance	Corridors/project that appear to be required to meet needs in many portfolios will be prioritized and ranked higher than those included in portfolios that don’t perform as well or are needed in only certain portfolios.

Connected West Interim Findings



National Transmission Planning Study (NTP)

Department of Energy

Jeff Dagle

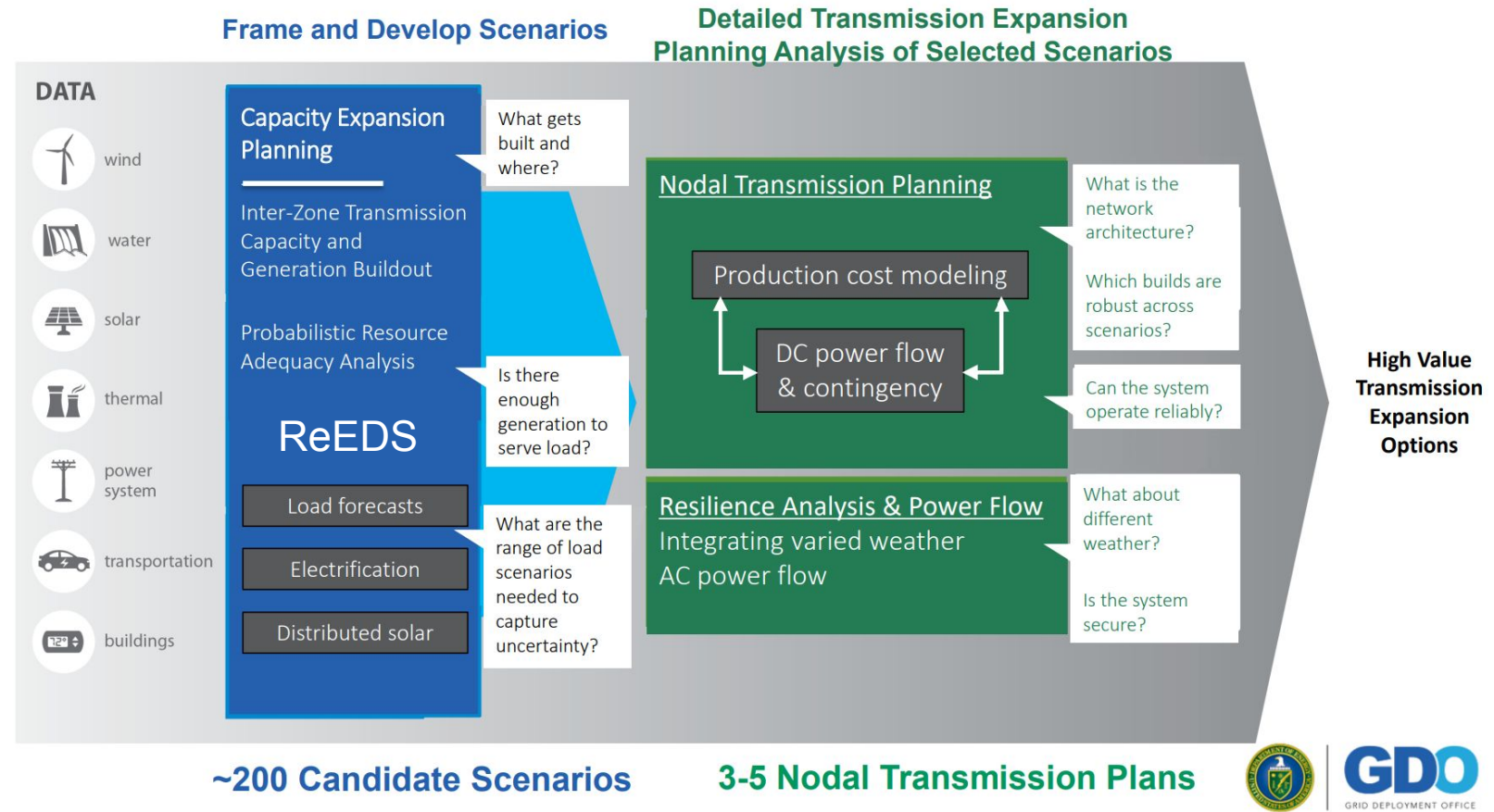
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Mid-Year 2024

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

DOE - NREL/PNNL National Transmission Planning Study (NTP)

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. Results help inform future **DOE funding** for transmission infrastructure support

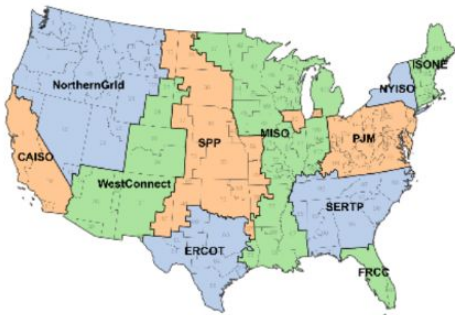


Source: <http://www.energy.gov/gdo/national-transmission-planning-study>

DOE - NREL/PNNL National Transmission Planning Study (NTP) Transmission Paradigms

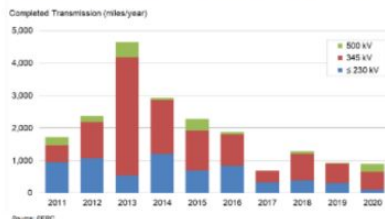
Regional

Limited



- **Intra-regional** transmission expansion within planning regions only
- Annual transmission additions <1.1 TW-miles per year based on recent (since 2009) development of ≥ 345 kV lines

New transmission build has been relatively modest in recent years



Interregional

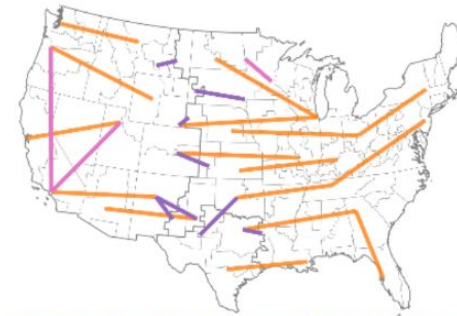
AC



- **Intra-interconnection** transmission expansion between 134 zones (no new back-back DC ties across seams)
- Transmission cost and losses based on AC transmission (500 kV).

HVDC-P2P

HVDC "point-to-point"



Illustrative of one potential scenario. Scenarios will vary.

- **Inter-interconnection** transmission expansion
- Expansion of back-to-back interties, existing HVDC, and select new connections allowed
- ~200 candidate interregional connections (≤ 1000 miles) between high-wind resource and high-demand regions; capacities optimized by the model
- Costs of HVDC are based on line-commutated-converter technologies

National

HVDC-MT

HVDC "multi-terminal"



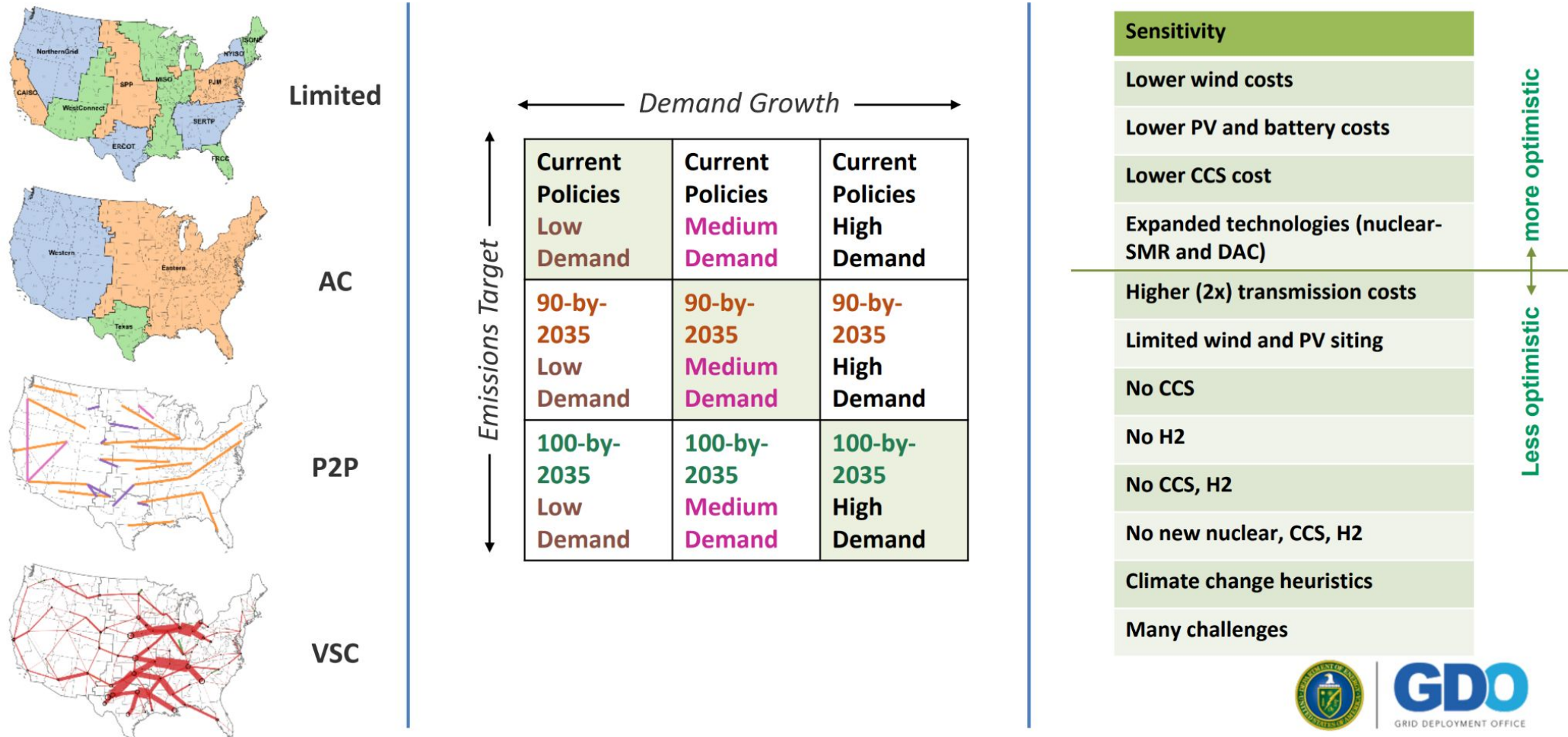
Illustrative of one potential scenario. Scenarios will vary.

- **Multiterminal HVDC** network designed by the model and specific to the scenario
- Costs and characteristics are based on voltage-source-converter technologies
- Transmission lines converter capacities are decided separately
- MT expansion is not allowed until after 2030

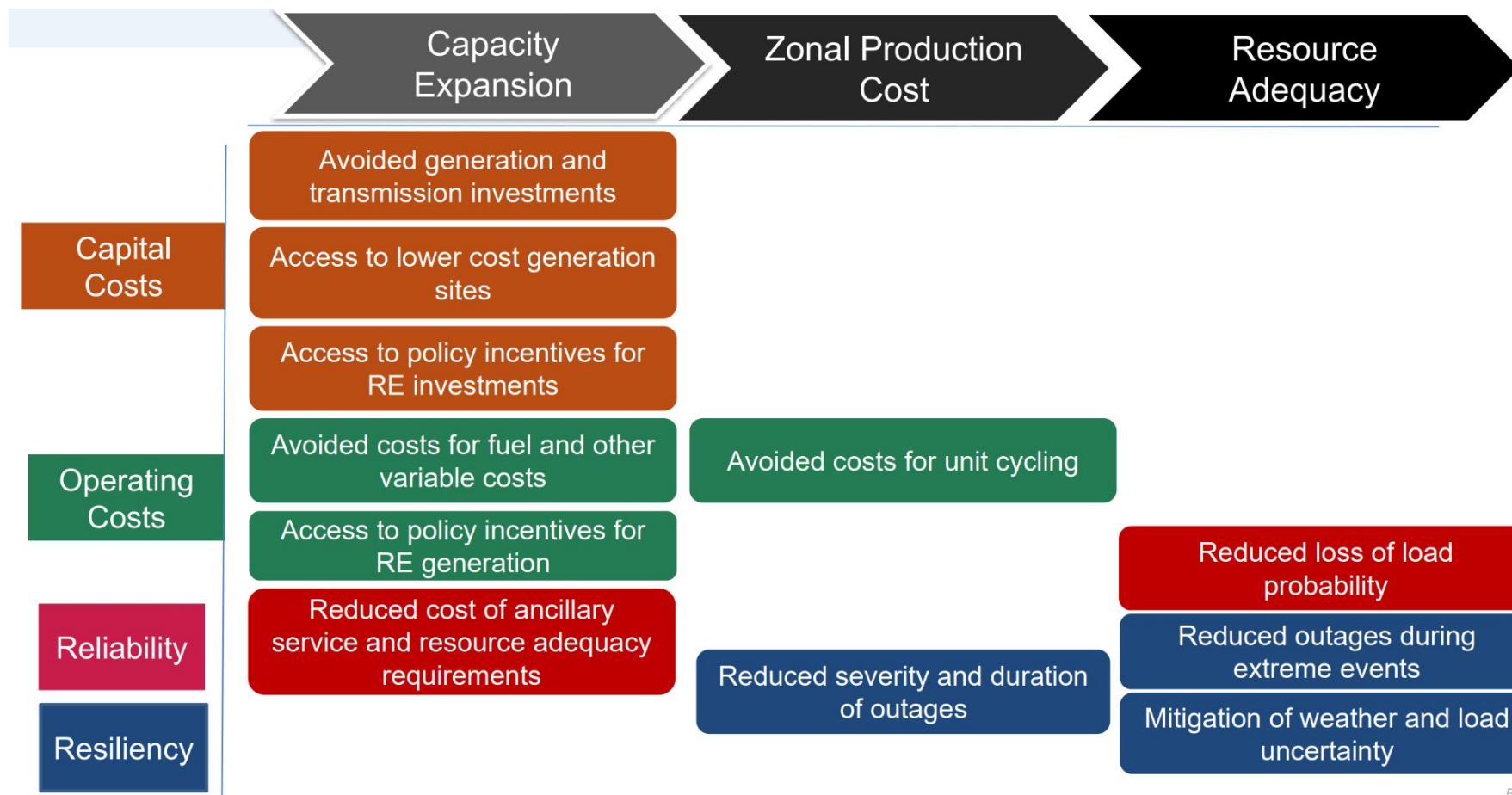


DOE - NREL/PNNL National Transmission Planning Study (NTP)

4 transmission paradigms X 3 emissions-demand combinations X 12 sensitivities



DOE - NREL/PNNL National Transmission Planning Study (NTP) **Cost/Benefit** Analysis of Transmission Corridors



50

DOE - NREL/PNNL National Transmission Planning Study (NTP)

What the study will do

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

What the study will not do

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

Putting it all together



WECC-Wide Peak Demand

“The 2022 interconnection-wide annual peak demand, and new all-time peak, was 167,530 MW, which occurred on September 6, 2022, during the August-September heat event.”

-WECC State of the Interconnection March, 2023

“Demand is expected to increase by 16.8% over the next 10 years, almost double the 9.6% growth reported in WECC’s 2022 assessment”

-WECC Western Assessment of Resource Adequacy Report November 2023

Integrated Resource Plans

RMI's States in Sync

Economics

The Nature Conservancy Power of Place West

DOE Expanded Markets and Transmission Study

Net-Zero Northwest (NZNW) Transmission

Connected West

WestTEC Study

DOE National Transmission Planning Study (NTP)

Regional

Interregional

National

CAISO 20-Year Transmission Outlook

NERC Interregional Transfer Capability Study

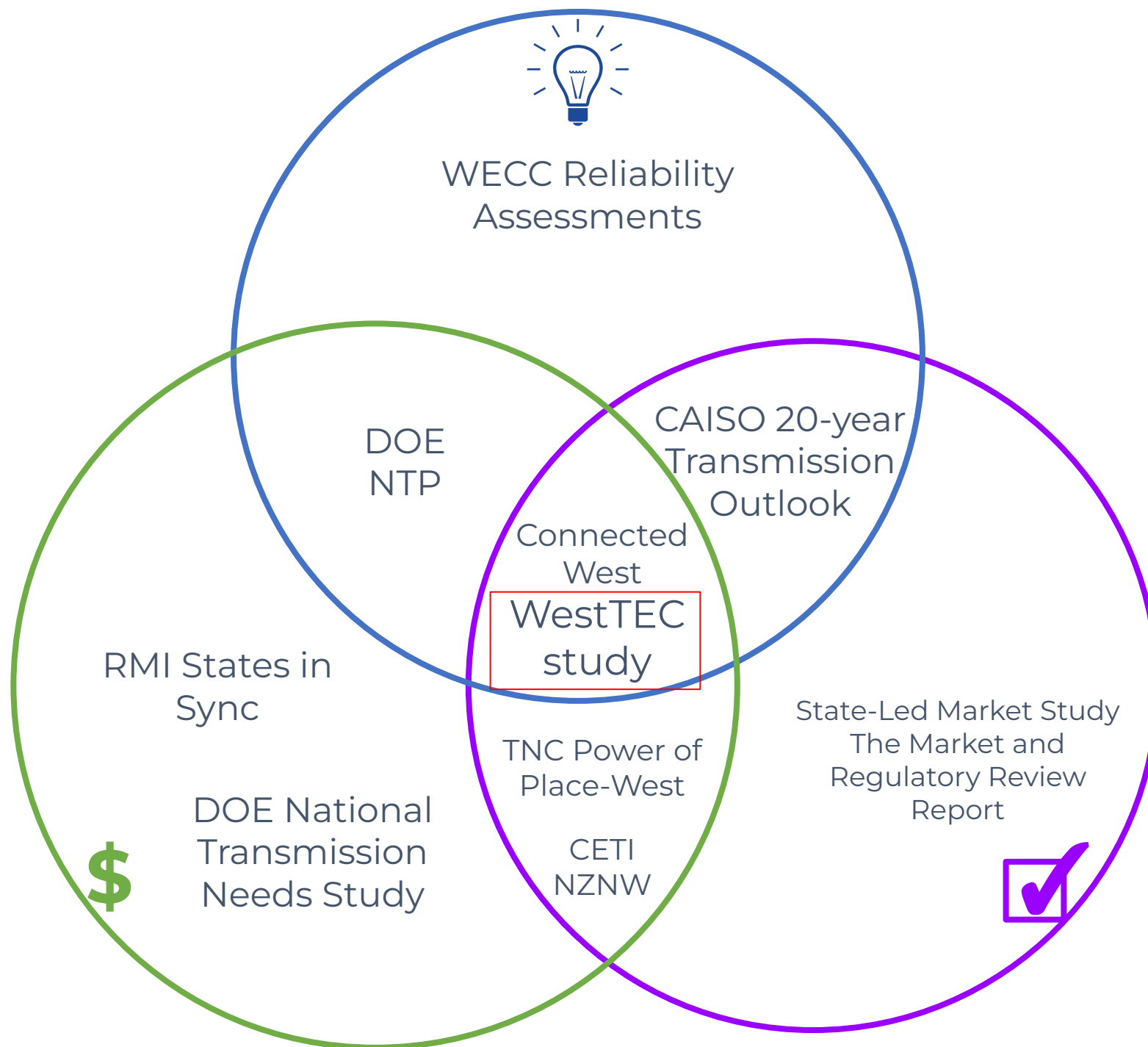
DOE West Coast Offshore Wind Study

WECC Transmission Trends Assessment

WECC 20-year Reliability Assessments

NERC Studies

Reliability



Topics under investigation:

Reliability	Economics	Policy Goals/Laws
<ul style="list-style-type: none"> Reliability at the bulk level with <u>some</u> contingency analysis Processes to link Resource Adequacy and Deliverability (i.e. Transmission Reliability) Extreme heat and cold weather scenarios Large load forecast increases due to electrification and data center development East-West Seam development 	<ul style="list-style-type: none"> System-level and state-by-state benefits of increased resource sharing Cost-benefit analysis of new transmission corridors at WECC and National levels Cost-benefit analysis of augmenting existing transmission corridors (reconductoring, HVDC Conversion) especially through the CAISO TPP 	<ul style="list-style-type: none"> Identification of transmission corridors under “highly decarbonized” or zero-carbon scenarios by 2045/2050 Zonal analysis of reaching state RPS goals California 100% by 2045 Environmental impact minimization (PoP-West)

Remaining Gaps:

Reliability	Economics	Policy Goals/Laws
<ul style="list-style-type: none"> Local reliability constraints are left to respective planning entities Wind and solar “droughts” Load forecast uncertainty analysis Reliability benefits of new transmission corridors broken out by utilities, states, and stakeholders Electric-Gas coordination/interface Westwide “Zonal Approach” to interconnection similar to CAISO 	<ul style="list-style-type: none"> State-by-state or utility-by-utility benefits for new transmission build Resource Adequacy costs/savings impacts under a variety of transmission portfolios (broken out by entity) Western Market(s) development impacts on transmission planning 	<ul style="list-style-type: none"> Federal and state funding sensitivities (are there corridors that are particularly sensitive to public finance) Sensitivities of transmission corridors to new technology development (OSW, SMRs, CCS, Hydrogen, LDES)

Parallel Processes and Additional Studies

Clean Energy Transition Institute (CETI) Net-Zero Northwest: Technical and Economic Pathways to 2050

[Transmission Study](#)

DOE Transmission Needs Study and NEITC Process

[DOE_GDO_Needs_Study_Fact_Sheet_United_States.pdf \(energy.gov\)](#)

[Public Submission Window for National Interest Electric Transmission Corridor \(NIETC\)](#)

[Designations Closes February 2 | Department of Energy](#)

BLM Section 368 Energy Corridor Revisions

[West-wide Energy Corridor Information Center](#)

FERC Regional Planning NOPR

West-East Seams Development

[Projects | Grid United](#)

NERC [Statement on Interregional Transfer Capability Study](#)

WECC Regional Market(s) development

Audubon Society Birds and Transmission

[BIRDS AND TRANSMISSION](#)

General Q&A



Discussion Questions

1. How is load forecast variability being incorporated?
2. At what granularity will the economics or reliability costs and benefits be estimated (WECC, Region, State, Utility)?
3. How is Offshore Wind being integrated?
4. What is driving the renewable buildout (WECC-wide Zero-Carbon, State RPS, Carbon Price, etc)?
5. Are extreme weather scenarios being modeled, and if so how are they being developed?
6. What is/was the stakeholder engagement process and are there any lessons learned?
7. How could any of these studies be used in the DOE's NIETC Designation process?
8. How could a FERC Regional Planning Rule impact results?