WestTEC
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WEST-WIDE TRANSMISSION STUDY

10-YEAR HORIZON REPORT

Western Transmission Expansion Coalition

February 2026

ACKNOWLEDGEMENTS

We would like to acknowledge all of the regional partners and team members whose expertise, dedication, and professionalism contributed to the successful development of this report. *WestTEC is a voluntary, informational effort, and that inclusion of projects in this report does not imply endorsement by participants of any specific project, sponsor, or routing.*

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Energy Strategies

GDS Associates, Inc.

REC (REGIONAL ENGAGEMENT COMMITTEE)

Consumer-Owned Utilities

Whatcom County PUD

Northwest Requirements Utilities

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The Public Generating Pool

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Salt River Project

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Renewable Northwest

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NV Energy

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Tacoma Power

Clean Energy Buyers Association

Grant County PUD

Pacific Northwest Utilities Conference Committee

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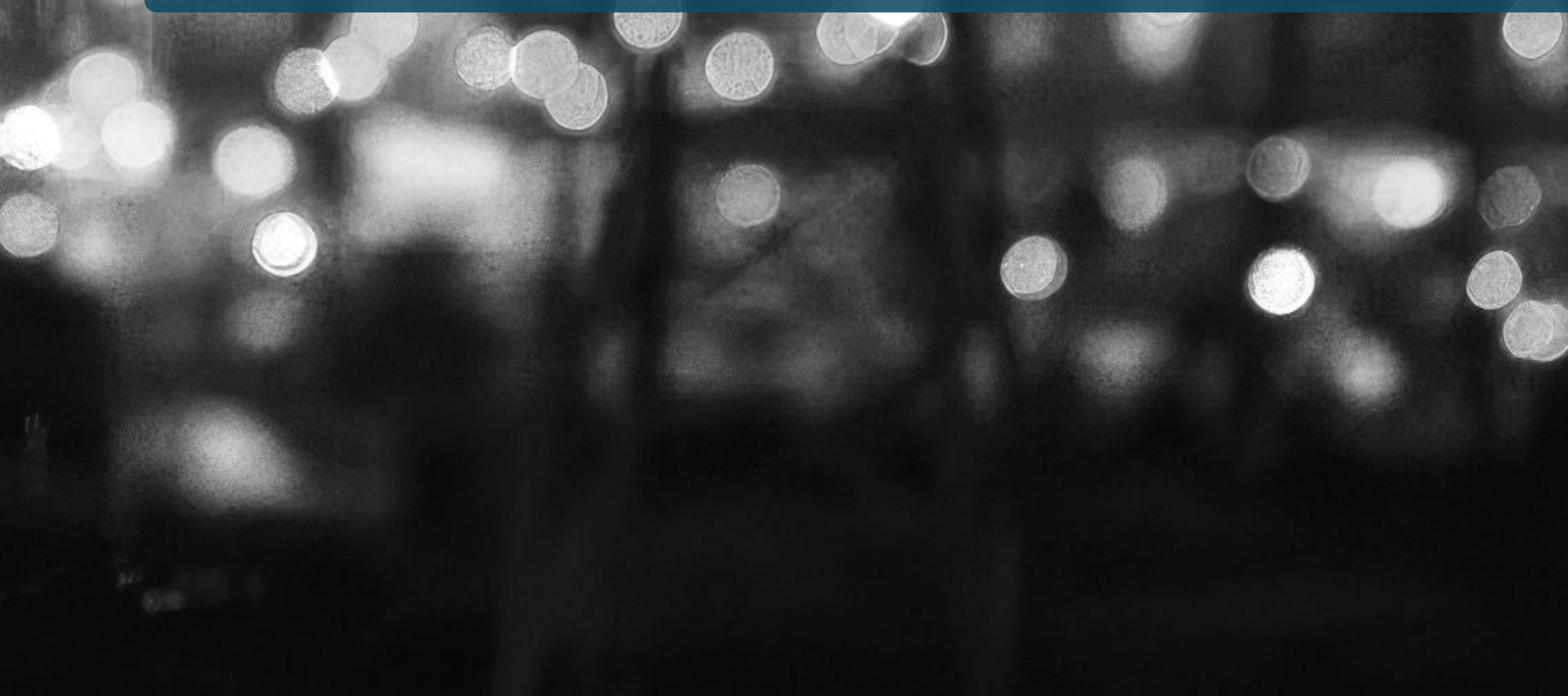

EXECUTIVE SUMMARY

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10-YEAR HORIZON REPORT: EXECUTIVE SUMMARY

The Western power system faces escalating challenges including capacity shortfalls, the need to deliver new generation to rapidly growing loads, greater resilience required to guard against extreme events, and mounting pressure to support strong economic growth with affordable electricity. A common thread running through these challenges is transmission – the mission-critical network of lines and electrical equipment that enables the day-to-day operation of the West's interconnected energy grid. While Western transmission companies have processes to expand transmission *within* planning jurisdictions (e.g., States, individual balancing authority areas, or FERC Order 1000 Planning Regions), many entities across the Western interconnection recognize that current planning frameworks do not produce sufficient transmission *between* these entities which harness the considerable power of an integrated Western grid.

The Western Transmission Expansion Coalition (WestTEC) is an unprecedented partnership between diverse sectors of the energy industry, States, and Tribes focused on closing this **interregional planning gap.** WestTEC's work identifies *actionable* transmission projects that enhance reliability, improve economic efficiency, and support state goals. Its scope includes planning analysis across the Western Interconnection to develop two studies: this **10-year Horizon Study** focused on identifying near-term transmission upgrades needed by 2035, and a **20-year Horizon Study** (to be issued later in 2026) exploring long-term planning scenarios and transmission roadmaps supporting the region through 2045. WestTEC aims to produce well-defined, broadly supported transmission upgrades with clear technical descriptions, and preliminary analyses of alternatives, costs, benefits, and potential corridors. Given the cost, complexity, and long timelines of major transmission development, large-scale interregional planning is critical to meeting multiple regional needs, avoiding duplicative investment, and ensuring a reliable, adaptable system.

WestTEC launched from a Concept Paper released for public comment in October 2023, and work formally began in 2024 to establish the governance structure and develop a Study Plan[1]. What sets WestTEC apart from other Western transmission planning efforts is its committee-based governance, which includes representatives from a broad array of regional interests and from across the entire West—utilities, planning bodies, States, Tribes, public interest organizations, and independent power producers, among others. The governance structure consists of three main committees: the Steering Committee, the WestTEC Assessment Technical Taskforce (WATT), and the Regional Engagement Committee (REC). The desired outcome of this effort is to identify transmission solutions that reflect broad regional consensus, balance diverse interests, and create a repeatable framework for future planning.

[1] https://www.westernpowerpool.org/private-media/documents/WestTEC_Study_Plan_-_V5_Final.pdf

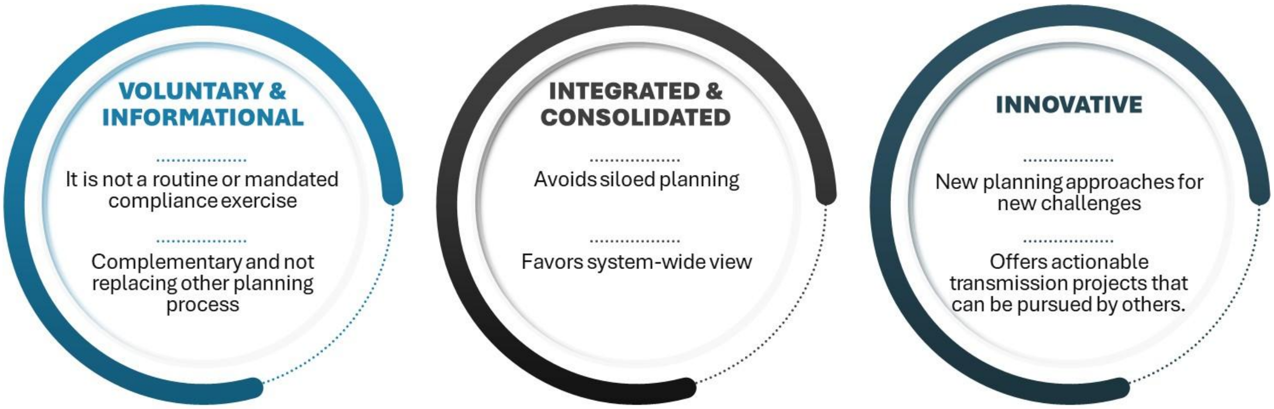


FIGURE E-1. KEY ATTRIBUTES OF WESTTEC

TRANSMISSION DRIVERS

The *10-year Horizon Study* offers a holistic, integrated evaluation of Western interregional transmission needs, with a focus on identifying transmission gaps and filling them with actionable projects. In performing the assessment, drivers of the growing need for transmission over the approaching 10 years became clear:

- **Unprecedented Load Growth.** WestTEC's forecasts show Western peak electric demand increasing by 30% in the next decade. This increase is more than three times greater than what the West experienced over the last decade.
- **Resource Additions to Meet Demand and State Goals.** Nameplate generation capacity is anticipated to increase by 76% in the next decade, more than twice the historical rate. Plans to procure intermittent resources by several Western entities will increase reliance on transmission to manage supply variability.
- **High Interregional Transfers During Time of Need.** By 2035 the Western grid will increasingly depend on the geographic diversity of load and generation to maintain reliability, which drives high-volume power flows across and between regions. Extreme events requiring transfers between entities occur during summer and winter peaks, cold snaps, and periods of high generation output. This highlights how diversity strengthens the system but requires transmission capacity to do so.

The bottom line is that the pace of interregional transmission expansion has not kept up with these drivers: load is growing faster than ever, the region must add more resources to keep up with resource adequacy and state policy needs, and the diverse Western system demands the transfer of large amounts of power over long distances to maintain reliability. WestTEC's ***10-year Horizon Study*** offers a portfolio of actionable projects that help meet these interregional needs.

STUDY RESULTS: TRANSMISSION PORTFOLIO AND FINDINGS

Through its committee structure and independent consultant support, WestTEC has identified a portfolio of transmission expansion projects that meets the region's forecasted needs through 2035. The total portfolio is estimated to add or upgrade **12,600 miles of high-voltage transmission** and will cost an estimated **$60 billion**.[2] The map below details the portfolio, which consists of planned projects and new project concepts identified by WestTEC. "Planned" projects are those transmission facilities that have already been identified by transmission owners, developers, or regional planning bodies and that exhibit a credible path to implementation — for example, inclusion in utility/regional planning documents, permitting or funding progress, or construction underway. These planned projects, together with WestTEC-identified upgrades, form the 10-year portfolio. Importantly, this portfolio includes some projects that have line routings and technical scopes that are conceptual in nature and may change as projects are developed.

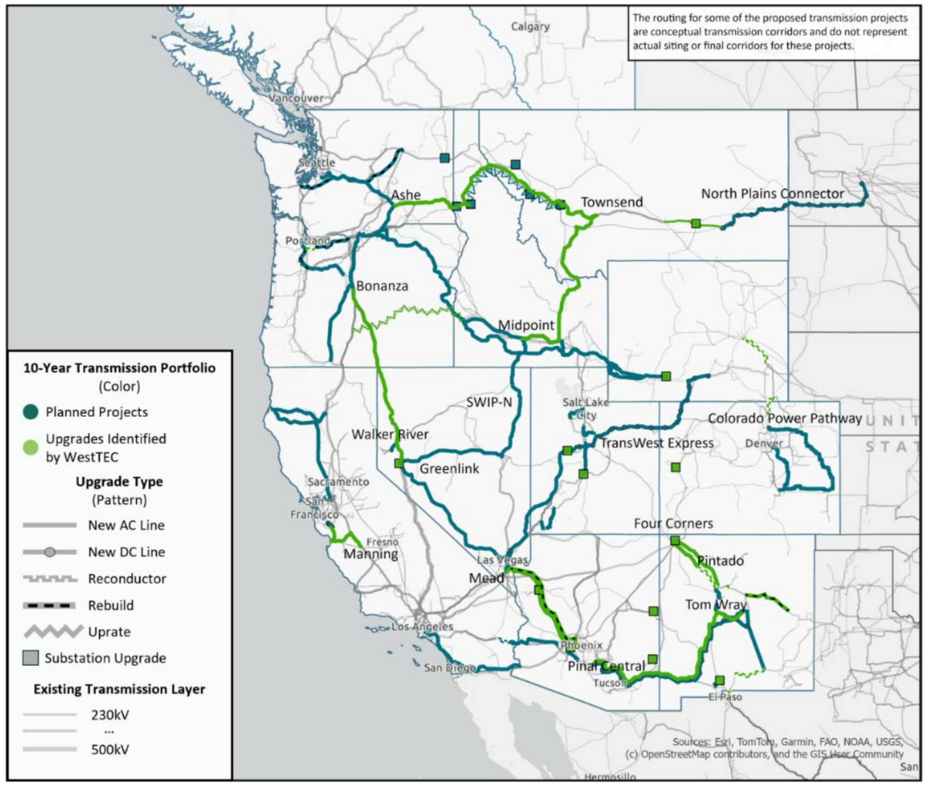


FIGURE E-2. WESTTEC 10-YEAR HORIZON TRANSMISSION PORTFOLIO

This 10-year horizon transmission portfolio includes **9,400 miles of major planned projects** representing approximately **$47 billion** in investment. Roughly 20% of these projects are under or nearing construction today with the rest at varying stages of development. Reconductoring and rebuild projects represent about 10% of planned transmission in terms of both line miles and costs. If these sponsors do not complete these in-flight projects, the total transmission gap will grow and needs identified in this study will not be met.

In addition to these planned projects, the portfolio identified approximately **3,300 miles of further upgrades needed to address interregional reliability, deliverability, and efficiency concerns**. These projects, totaling approximately **$14 billion**, include both new transmission concepts and lines currently in development. Approximately 1 in every 4 line-miles of WestTEC-identified upgrades represent reconductors or rebuilds along existing corridors.

[2] All dollar values in this report are expressed in 2025 real dollars unless otherwise noted.

TABLE E-1. SUMMARY METRICS OF WESTTEC 10-YEAR TRANSMISSION PORTFOLIO

Transmission Project Category		Project Count	Total Line Miles	Total Estimated Cost ($M)
Planned upgrades in Portfolio		73	9,358	$46,648
Upgrades identified by WestTEC in Portfolio	Reliability-driven	21	1,156	$6,050
	Deliverability-driven	8	1,742	$7,239
	Economic-driven	3	394	$391
	10-Year Horizon Portfolio Total	**105**	**12,650**	**$60,328**

Together, this portfolio of planned and newly identified projects offers the Western region:

- The ability to accommodate over **30% growth in electricity demand** with a portfolio of resources consistent with Western Utility resource plans, ensuring that the Western grid can support 10-years of sustained economic growth.
- Reduced threat of reliability-driven power supply disruptions through the **mitigation of over 75 steady-state power flow violations** on the high-voltage system that would occur but for the construction of upgrades identified by WestTEC.
- Significant operational improvements relative to planned lines alone, including a **$500 million per year decrease** in power production costs, with grid congestion costs and generation curtailment falling by 20% and 17%, respectively, as contributors to these savings. These metrics are inherently conservative and do not reflect the full extent of savings and efficiencies that could occur.
- The ability to reliably transfer an additional **~10 GW** of power across key interregional interfaces during times of system need, which can reduce the risk of power shortages and enable lower planning reserve margins.

In lieu of a net-benefit assessment exploring the wide-ranging savings the portfolio will provide—which would offer the most comprehensive framework for evaluating the 10-year horizon portfolio but was not included in the study scope—WestTEC believes that the considerations outlined above offer a compelling picture of what the Western region receives in return for this transmission buildout. Based on typical financing and cost recovery models used to evaluate transmission investments (*see* Appendices Section 5.4), the annualized cost of the entire 10-year horizon portfolio – including both planned and newly identified projects – is approximately at $5.3 billion per year. This value represents an annualized cost typically recovered over the useful life of the asset, which can exceed 40 years for transmission. While transmission requires significant up-front capital investment, it is paid back over decades, with benefits often increasing throughout the asset's life.

Importantly, this $5.3 billion annual cost is quite small relative to total electric-sector spending and other investments. For example, the annualized fixed cost of the generation resources the West is expected to add over the same 10-year period is projected to be roughly **eight times larger** than the transmission cost of the WestTEC 10-year horizon portfolio. Electric customers of all types in the West spent roughly $117 billion on electricity in 2024, a figure more than 20 times greater than the cost of the WestTEC 10-year transmission portfolio.

These benchmarks and others presented in Table E-2 below demonstrate that WestTEC's 10-year horizon transmission portfolio, while substantial, has a cost that is not unprecedented and is comparable to other large public works, remaining a feasible investment for the region.

TABLE E-2. TRANSMISSION PORTFOLIO COST CONTEXT

WestTEC 10-year Horizon Transmission Portfolio Cost Metrics	Cost Benchmarks	WestTEC Transmission Cost vs Benchmark
Capital cost = $60 billion	Comparable to other megaprojects, such as California's high-speed rail system[3] and three Portland-area bridge replacements[4]	~60% of California high-speed rail cost ~5x the Portland bridge program cost
Levelized cost = $5.3 billion per year	Western U.S. customers spend roughly $117 billion annually GDP of Western States exceeds $7.4 trillion.[5] The annualized fixed cost of new generation deployment in the WestTEC 2035 Reference Case is ~$44 billion per year	~4.5% of today's annual electricity spending 0.1% of regional GDP 17% of the annualized fixed cost of new generation
Cost per kWh of electric demand in 2035 = $0.004/kWh	The load-weighted average retail price in the West is ~$0.16/kWh.	~2.5% of today's average retail electricity price

Despite the study's technically robust and transparent approach, it has limitations. For example, the transmission analyses evaluated only high-voltage transmission infrastructure greater than 200 kV, did not account for contract path considerations, modeled the West as a single optimized day-ahead market footprint, and did not explore dynamic stability issues or contingency events in production cost simulations (which could cause additional congestion beyond what was captured). There are also limitations to what the study found in terms of transmission needs and solutions. For example, while best attempts were made to consider all viable and technically feasible transmission solutions for a given need – relying on both independent analysis by consultants and operational expertise – future planning assessments may reveal superior or alternative project configurations. In addition, while the study sought to resolve in-scope transmission deficiencies with upgrades, in some cases doing so may exacerbate or create new transmission issues on lower voltage (<200-kV) infrastructure. Thus, as upgrades in the WestTEC 10-year horizon portfolio are implemented, thorough assessments will be required to identify and mitigate any local issues that were not considered in this study. Finally, the costs presented here are planning-level estimates only with illustrative routes – ***the illustrative routes identified by this report do not constitute siting recommendations***. It is expected and should be understood that project configurations and design details will evolve as they are implemented and as entities

[3] https://hsr.ca.gov/about/high-speed-rail-business-plans/2024-business-plan/
[4] Public cost estimates from I-5, Burnside, and Abernethy bridge projects, combined. Available at: https://www.columbian.com/news/2025/sep/22/i-5-bridge-replacement-slogs-through-permitting-as-costs-rise/
[5] U.S. Bureau of Economic Analysis (BEA). Gross Domestic Product by State, 2024. U.S. Department of Commerce. Available at: https://www.bea.gov/data/gdp/gdp-state

work with impacted communities. These limitations, while notable, were necessary and reflect the study's intentional focus on broad interregional transmission needs.

WHAT'S NEXT FOR WESTTEC

At the end of this report, WestTEC offers recommendations designed to support the implementation of this 10-year horizon transmission portfolio. WestTEC recognizes that many hurdles must be overcome to successfully implement these projects, and that many of the projects are likely to evolve over time. These recommendations include:

- **Prioritize execution** of planned transmission projects in the 10-year horizon portfolio, ensuring their timely, coordinated, and cost-effective delivery by utilities, regulators, and regional stakeholders.
- **Encourage project sponsors** to advance the remaining mission-critical upgrades, with expedited development timelines to ensure they are in-service by 2035.
- **Frame the costs** of the 10-year horizon portfolio in proper context, emphasizing that, while substantial, these investments are both necessary and manageable given the benefits they unlock.
- **Employ all available tools** to address development challenges, including early procurement of long-lead equipment, regulatory incentives for early-stage development activities, streamlined permitting coordinated among States and permitting agencies, proactive outreach to communities impacted by potential routing, continued refinement of cost allocation frameworks, and the increased use of innovative business models advanced by transmission planning entities, individual developers, through partnerships, or by organizations like The Western Transmission Consortium.

WestTEC now turns its attention to its *20-year Horizon Study*, using these 10-year results as a starting point. This longer-term view of the Western system will offer solutions to address the daunting amount of uncertainty facing planners. To address this uncertainty, WestTEC has designed three long-range planning scenarios that will help it understand what additional long-lead transmission investments are "least regrets", and how our transmission needs change in response to wide-ranging planning variables. These scenarios and needs identified in the 20-year horizon will also afford WestTEC the opportunity to reevaluate and potentially right-size upgrades identified in the 10-year portfolio. In addition, this 20-year horizon will provide a more robust analytical foundation to forecast benefits of least regrets transmission portfolios, addressing a gap from the 10-year horizon study. Even though WestTEC is not a compliance-driven process, aspects of this effort can be a model for future FERC Order No. 1920 compliance, and our study aligns with many of these future requirements.

Together, the WestTEC partnership is advancing a shared vision: *a resilient, efficient, and future-ready grid where interregional transmission enables all Western communities to access reliable and affordable electricity.*

Together, the WestTEC partnership is advancing a shared vision:

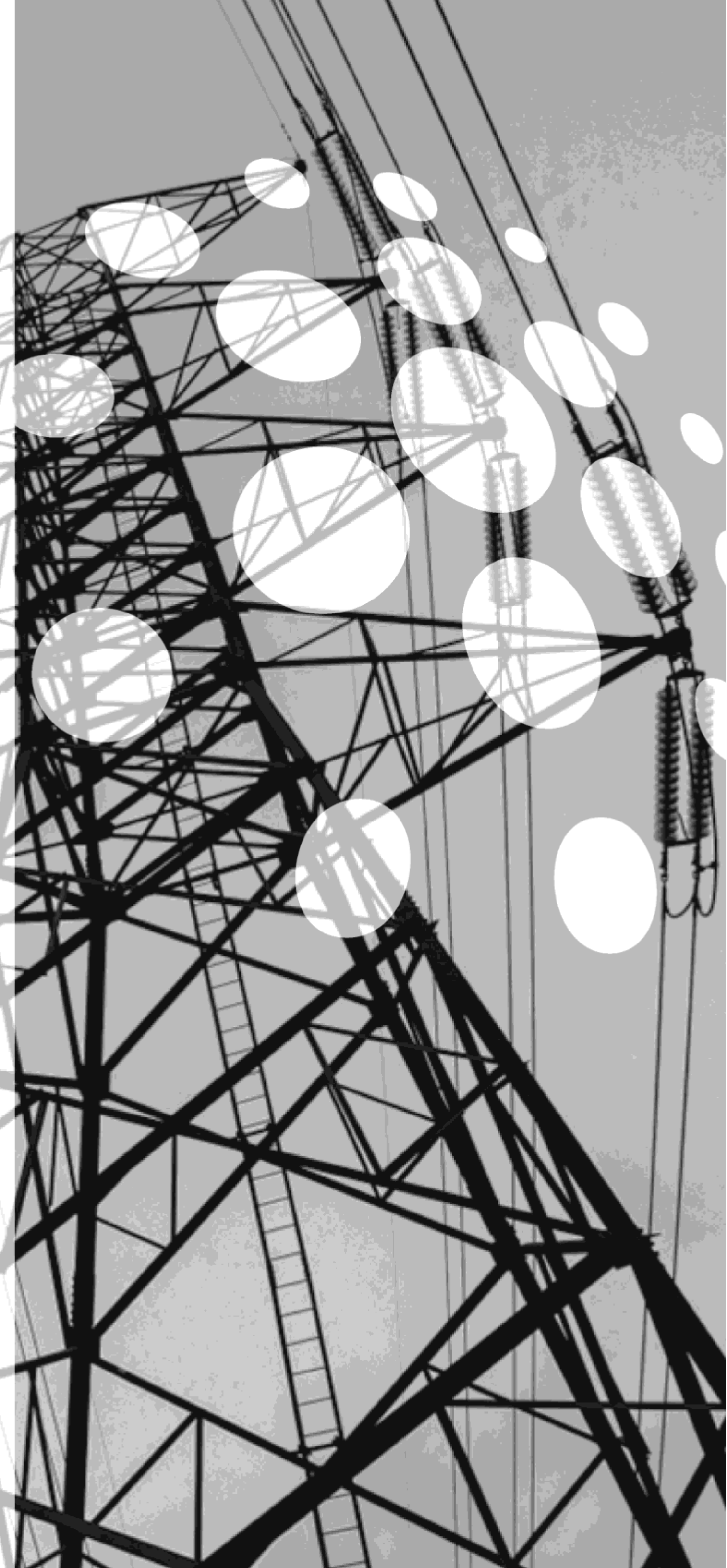
A resilient, efficient, and future-ready grid where interregional transmission enables all Western communities to access reliable and affordable electricity.

The remaining pages of this report are presented in landscape orientation to best support the presentation and display of detailed tables, charts, maps, or graphics. This approach is intentional and used only when portrait orientation would compromise clarity or readability.

TABLE OF CONTENTS

SECTION 1.0

INTRODUCTION & STUDY OBJECTIVES



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1.0 INTRODUCTION & STUDY OBJECTIVES

1.1 OVERVIEW OF WESTTEC & THIS REPORT

The Western Transmission Expansion Coalition (WestTEC) is an unprecedented partnership between diverse sectors of the energy industry, States, and Tribes that is focused on addressing interregional transmission needs across the Western Interconnection.[6] Facilitated by the Western Power Pool (WPP) and supported by independent industry consultants, WestTEC was launched in recognition of the growing need for coordinated, data-driven analysis of Western transmission needs. The effort brings together representatives from a broad array of regional partner interests from the entire West, including among others, utilities, planning bodies, States and Tribes, public interest organizations, and independent power producers to collaboratively assess interregional transmission needs not adequately explored in other processes.

The scope includes planning analysis across the Western Interconnection to develop two major studies: this ***10-Year Horizon Study*** focused on identifying near-term, actionable transmission upgrades needed by 2035, and a subsequent ***20-Year Horizon Study*** that evaluates longer-term planning scenarios and corresponding transmission roadmaps through the year 2045. The 10-Year Horizon Study focuses on immediate transmission needs that lie ahead, while the 20-year Horizon Study will place greater emphasis on addressing planning uncertainties and quantifying the long-term value of a range of transmission portfolios.

Together, these efforts aim to identify gaps in interregional transfer capability, improve economic efficiency of our grid, support the achievement of state energy goals, and ultimately offer portfolios of transmission projects that are ready for development and consideration in other planning processes. *For more information regarding WestTEC's governance, funding, and stakeholder engagement approach, including a complete list of participants, please see Appendix Section 5.3.*

[6] WestTEC's definition of "interregional" includes high-voltage (>200-kV) interstate lines, high-voltage lines connecting FERC Order 1000 planning regions, or high-voltage lines connecting balancing areas. See *Section 2.2* for more details on the transmission scope of this study.

1.2 MOTIVATION FOR THE STUDY

WestTEC was launched to address structural and analytical gaps in Western transmission planning. Current frameworks are widely recognized as insufficient for producing interregional transmission lines that connect the West's regions and States. As the Western Interconnection experiences rapid load growth from electrification, the expansion of data-center and industrial demand, and accelerated resource additions to support resource adequacy and policy goals, the limitations of current processes have become more pronounced.

WestTEC bridges these gaps by enhancing interregional coordination, recognizing that while the Western grid is highly interconnected, its planning remains fragmented. Industry-led and guided by four commitments—different, inclusive, expedient, and transparent—WestTEC provides a voluntary, credible platform for harmonizing methods, data, and planning assumptions across the region.

> Complementing recent federal policy developments such as FERC Order 1920, WestTEC's framework offers a non-jurisdictional, informational approach that integrates insights across entities and regions.

1.3 STUDY OBJECTIVES

The WestTEC *10-Year Horizon Study* is designed to identify actionable, near-term interregional transmission solutions and to establish a transparent, data-driven foundation for long-term planning in the Western Interconnection. The study pursues four key objectives:

1. **Establish and Apply a Coordinated, Repeatable, and Transparent Planning Framework.** Develop and implement a consistent, stakeholder-informed process for identifying interregional transmission needs across jurisdictions. The framework harmonizes modeling inputs across transmission planning tools calibrated to meet Western planning standards, with review by the WestTEC Assessment Technical Taskforce (WATT) and Regional Engagement Committee (REC) to ensure transparency and technical rigor.
2. **Identify and Characterize Transmission Needs by 2035.** Evaluate interregional reliability, deliverability, and congestion constraints across the Western Interconnection using a unified 2035 Reference Case that reflects best-available load, resource, and transmission forecasts.
3. **Define a Portfolio of Actionable Transmission Projects.** Identify technically feasible, stakeholder-vetted upgrades that have the potential to be planned, permitted, and constructed within the 10-year horizon. These findings are intended to inform regional planning processes and support near-term investment decisions by developers and utilities.
4. **Inform the 20-Year Horizon Study and Broader Western Planning Processes.** Provide analytical foundations, vetted data, and insights to guide the forthcoming 20-Year Horizon Study as well as ongoing FERC-mandated transmission-planning efforts.

Together, these objectives enable WestTEC to produce findings that address emerging interregional transmission needs while establishing a credible, stakeholder-vetted foundation for longer-term transmission planning in the Western Interconnection.

SECTION 2.0

STUDY APPROACH & METHODOLOGY

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2.0 STUDY APPROACH & METHODOLOGY

The WestTEC 10-Year Horizon Study applies a stakeholder-informed planning process to identify near-term interregional transmission needs and solutions. The methodology centers on the development of a 2035 Reference Case – a "current trends" trajectory of the Western Interconnection based on best-available forecasts sourced from WECC, public databases, Western utilities, and input from WestTEC partners. Below is a comparison of today's Western system versus the 2035 Reference Case. This comparison shows the magnitude of load and generation growth the West faces, and the degree to which transmission expansion lags in this forecast.

TABLE 2-1. WESTTEC 2035 REFERENCE CASE VS. TODAY'S WECC SYSTEM

Metric	2024[7]	WestTEC 2035 Reference Case	Change (%)
Coincident Peak Demand (GW)	168	219	+30% (2.4% per year)
Annual Energy (TWh)	926	1,246	+35% (2.7% per year)
Generation Capacity (GW)	322	551	+71% (5.0% per year)
Transmission 230 kV+ (Miles)	~98,000	~111,400[8]	+14% (1.2% per year)

This unified view of the West provides the analytical foundation for three complementary assessments – System Reliability (SRA), Interarea Deliverability (IDA), and Congestion Analysis – each designed to identify distinct but related categories of transmission need. Findings from these assessments were synthesized through a transparent, iterative process with the WATT, the REC, the Steering Committee, as well as the public, to develop a portfolio of actionable transmission upgrades that address the identified interregional needs.

In addition to the following summary and further details in *Appendix Section 5.3* a video series summarizing the study methodology is available on the WPP website.[9]

[7] 2024 values sourced or derived from the WECC State of the Interconnection 2025 Report

[8] This number is a lower-bound reflecting only regionally significant, high-voltage transmission additions.

[9] See WestTEC website for study method summary videos.

2.1 BUILDING THE 2035 REFERENCE CASE

The 2035 Reference Case offers a harmonized view of the Western system across all modeling platforms. Its load, generation, and transmission forecasts are summarized below.

2.1.1 Load Forecast

Load projections were sourced primarily from the WECC 2034 Anchor Data Set (ADS) with refinement based on benchmarking with NREL's Electrification Futures scenarios, review by WATT, and data updates from utility participants.[10] In doing so, the 2035 Reference Case incorporated assumptions to reflect:

- Forecasted electrification of transportation and buildings;
- Conservative levels of growth in large industrial and data center loads; and
- Impacts of distributed resources and demand-side programs.

The resulting load trajectory reflects forecasted hourly demand levels for each of the West's balancing areas in 2035.[11] The forecast, summarized in Figure 2-1, shows that WestTEC is forecasting peak demand to grow at roughly 2.4% per year over the approaching 10 years, which is more than double the growth rate over the last 10 years.

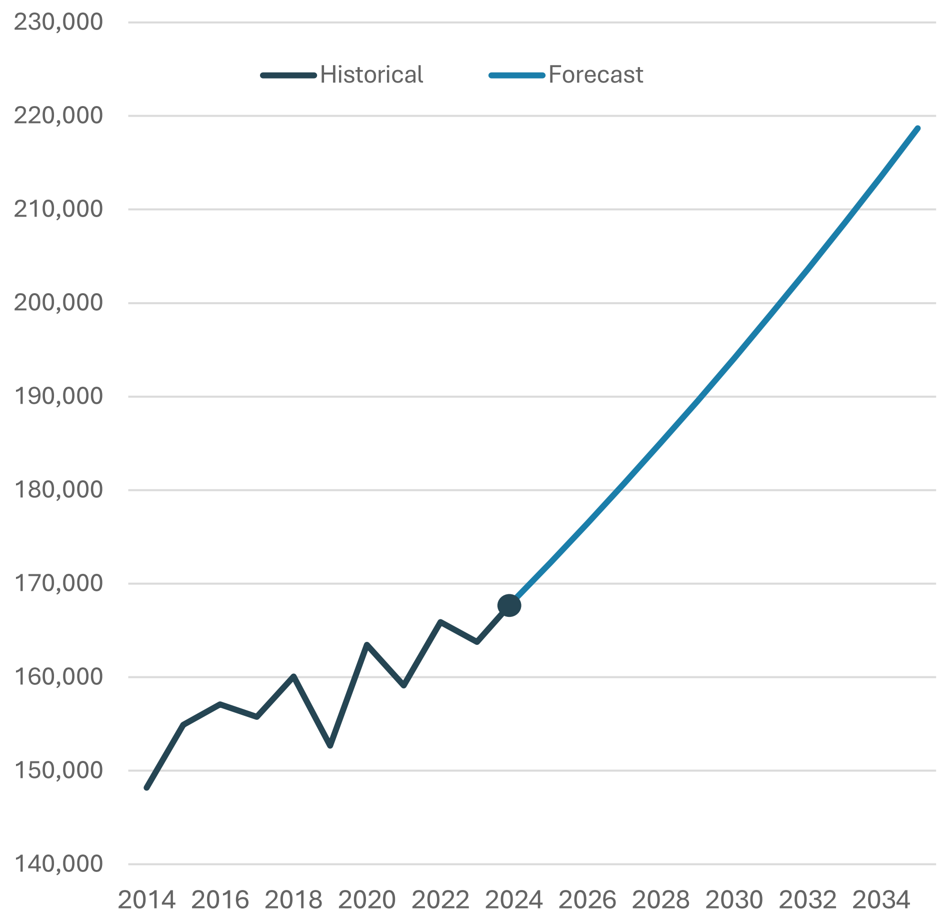

FIGURE 2-1. GROWTH IN WESTERN INTERCONNECT ANNUAL PEAK DEMAND (MW)

[10] The WECC ADS is a comprehensive compilation of load, resource, and transmission topology data for the Western Interconnection used by WECC, regional planners, utilities, developers, and consultants for a variety of planning and analytical purposes. It is built in collaboration between WECC, regional planning groups, WECC stakeholders, and utilities. Core inputs are sourced from data submitters that included balancing authorities and transmission planners/coordinators.

[11] For nodal study purposes, these area-level forecasts are then projected to specific busses and substations represented in power system models.

Through a benchmarking analysis and aggregation of datasets provided by utilities, the 2035 Reference Case load forecast includes **roughly 8 GW of new data center demand**. Should the realized data center load exceed this benchmark, WestTEC expects the transmission needs covered in this report to increase as well.

Additional details on the methods used to develop the load forecast and translate it amongst the models and conditions studied are covered in *Appendix Section 5.4*.

2.1.2 Generation Mix and Resource Siting

WestTEC developed a west-wide resource trajectory for 2035 based on utility resource plan forecasts. Therefore, the WestTEC resource mix is both consistent with utility procurement plans and is consistent with state policy objectives. WestTEC used existing and planned resources from the WECC 2034 ADS as a starting point. WestTEC sourced conceptual resources trajectories from Integrated Resource Plans (IRPs).[12]

Table 2-2 shows how the WestTEC 2035 Reference Case resource mix compares to today's mix, with notable increases in wind, battery storage and solar PV capacity.

TABLE 2-2. WESTTEC RESOURCE MIX FOR 2035 REFERENCE CASE (GW OF CAPACITY)[13]

Resource Type	2024	2035 WestTEC Reference Case
Natural Gas	109	97
Hydro	75	70
Solar PV	44	115
Wind	39	87
Coal	22	9
Battery Storage	16	70
Nuclear	7	6
Other[14]	5	35
Geothermal	4	7
Total	**322**	**495**

[12] Planned resources consistent with NERC Tier 1 and 2 resources. See NERC Long-Term Reliability Assessment reports for definition of NERC Resource Tiers. In general, Tier 1 resources represent in the final stages for interconnection, while Tier 2 resources are further from completion.

[13] Table does not include behind-the-meter solar or demand response since estimates for these are not reported directly in the WECC 2025 State of the Interconnection

[14] The "Other" category includes pumped storage, solar thermal, biomass, and alternative-fuel thermal generators.

Resource forecasts used by WestTEC identify generation types, quantities, and general locations but do not identify specific locations on the grid. WestTEC fills that gap with busbar mapping. Busbar mapping is a critical step in translating the utility- or balancing area-level resource plans into a realistic representation of specific locations where new generation connects to the transmission grid and thus, impacts the transmission network. To address this, WestTEC developed a busbar mapping framework to allocate roughly 87 GW of un-sited conceptual resources from utility IRPs to substations across the region. The resources were assigned to buses based first on a composite siting score that reflected commercial-interest/queue data, land-use, resource quality, community constraints, and transmission connectivity metrics.[15] Then the WATT broke into subregional teams made up of local experts to review the physical siting. Feedback from these subregional teams was incorporated to refine bus-level assignments and regional allocations, ensuring that the mapped resources were both electrically plausible and consistent with current trends and preferences. Although alternative busbar mapping configurations were not evaluated in this study, WestTEC expects that transmission outcomes would show some sensitivity to different resource portfolios & siting assumptions. The final dataset provides a vetted foundation for the reliability, deliverability, and congestion assessments that follow.

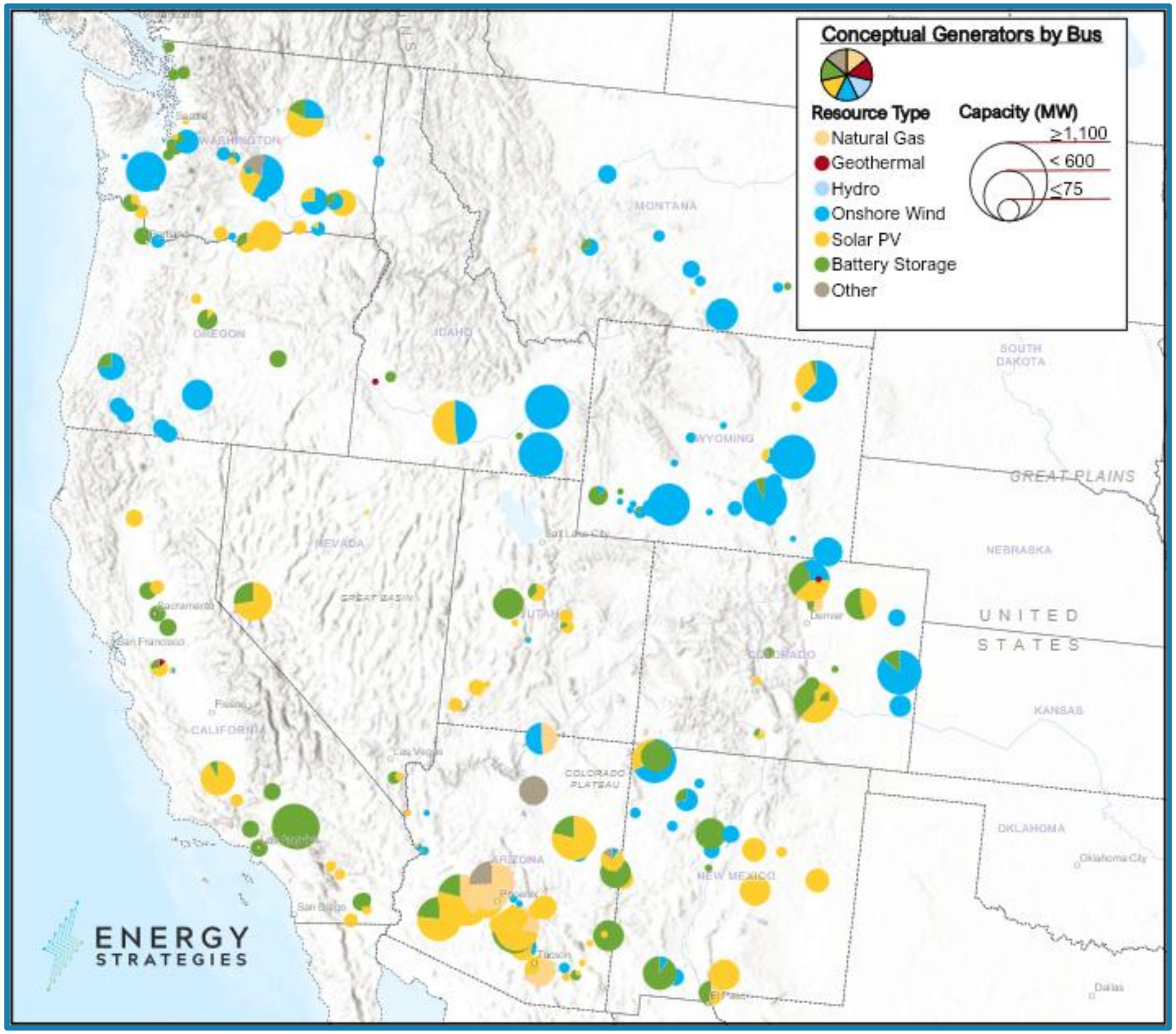

FIGURE 2-2. WECC-US BUSBAR MAPPING OF CONCEPTUAL RESOURCES

[15] Hybrid resources were mapped proportionally with their paired generators, and out-of-region projects were tracked using a “committed region/physical region” designation to preserve interregional relationships.

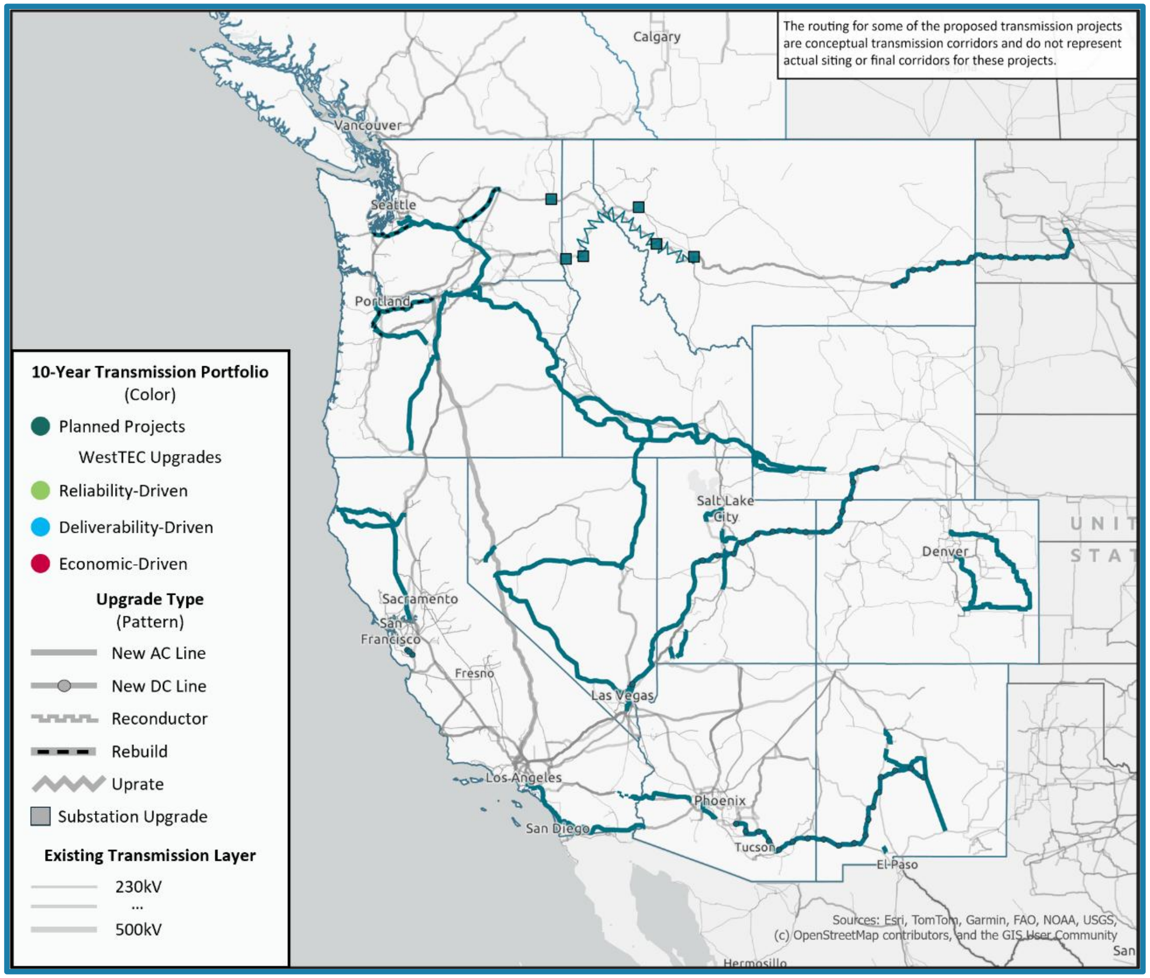

FIGURE 2-3. PLANNED TRANSMISSION IN THE 2035 REFERENCE CASE

Additional details on the resource mix and busbar mapping approach are covered in *Appendix Section 5.4*.

2.1.3 Transmission Topology

WestTEC developed the 2035 Reference Case topology – or grid representation – through a comprehensive audit of the Western Interconnection's transmission system to ensure a consistent foundation for subsequent modeling steps. WestTEC reviewed more than 450 transmission projects drawn from regional and local planning sources, independent developer proposals, and other public sources.

WestTEC consultants, in coordination with WATT, evaluated projects for inclusion in the 2035 Reference Case using the *WestTEC Study Plan* criteria, which limited inclusion to facilities that: (1) have a defined sponsor and are expected to be in service by 2035, (2) operate at 200 kV or higher, and (3) are traceable to regional transmission plans. Through direct engagement with transmission providers, over **70 projects** were confirmed or incorporated into the 2035 network, while lower-voltage or uncommitted facilities were cataloged but not explicitly modeled. The resulting 10-Year Reference Case transmission list represents a regionally vetted and consistent topology aligned with local and regional transmission commitments. It serves as the common transmission foundation for all subsequent assessments in the *10-Year Horizon Study*.

A full list of projects included in the 2035 Reference Case is available in *Appendix Section 5.4*.

2.1.4 Other 2035 Reference Case Assumptions

While the 2035 Reference Case is grounded in harmonized planning inputs for load, resource, and transmission across the Western Interconnection, each modeling tool used in the study requires a set of additional, tool-specific assumptions to support simulations. These assumptions—such as fuel prices, generator heat rates, start-up costs, and dispatch characteristics for the production cost model—are not shared across platforms but are instead tailored to the analytical requirements and data structures of each model. Accordingly, the production cost model (Hitachi GridView®) and power flow model (PowerWorld) incorporate distinct technical parameters to accurately represent system characteristics each are designed to reflect. These can be found in *Appendix Section 5.5*.

2.2 TRANSMISSION ASSESSMENT SCOPE

The transmission portfolios developed by WestTEC are focused on addressing transmission line issues which are:

- Interstate lines 200 kV or greater,
- Interregional lines 200 kV or greater,
- Lines between balancing authority areas (BA) 200 kV or greater,
- Lines that make up WECC paths, so long as the path rating is greater than 1000 MW.

WestTEC considered these lines to be interregional in nature and were the core of the study scope.

The issues include but are not limited to equipment overloads (thermal limits), voltage stability, and economically driven congestion. The WestTEC transmission assessments did not include an evaluation of available transmission rights.

2.3 SYSTEM ASSESSMENT METHODOLOGIES

Following the development of the 2035 Reference Case, the WestTEC study team conducted a series of system assessments to evaluate the adequacy of the West's interregional transmission infrastructure. These assessments were executed in accordance with the planning process outlined in the *WestTEC Study Plan* and reviewed iteratively with the WATT and REC. Each analytical stage is designed to answer a specific planning question, while maintaining consistency of data, assumptions, and model calibration across tools. Each assessment stage builds upon the previous one in an iterative sequence validated by stakeholders:

1. The **System Reliability Assessment (SRA)** evaluates how the power system performs under stressed but realistic operating conditions. It screens for potential issues such as equipment overloads (thermal performance) and unacceptable voltage levels to ensure the grid can operate safely and reliably.
2. The **Interarea Deliverability Assessment (IDA)** evaluates the ability of the system to support high interregional transfers and resource sharing during stressed operations.
3. The **Congestion Assessment** evaluates economic dispatch and transmission utilization, identifying where transmission constraints cause economic inefficiencies.

Together, these assessments form the technical foundation for identifying actionable, near-term transmission needs and solutions.

2.3.1 System Reliability Assessment (SRA)

The SRA evaluates whether the Western Interconnection's high-voltage transmission system can maintain reliable performance under stressed but credible operating conditions in the 2035 study year. Using steady-state AC contingency analysis in Power World software, the SRA tests the grid's ability to meet WECC and NERC reliability criteria while serving projected loads with the resources available during specified conditions. The assessment focuses on power flows exceeding equipment rating and unacceptable voltage levels on major interregional transmission facilities, screening out local issues, to identify constraints that may warrant transmission reinforcement.

WestTEC developed four reliability cases to reflect distinct stressed system conditions expected in 2035. Each case was derived from the 2035 Reference Case hourly production cost model simulations, which capture interactions between load, generation dispatch patterns, and transmission flows. The PCM results were analyzed to identify the top five coincident hours that exhibited:

- Maximum total system load for Heavy Summer and Heavy Winter, or
- Maximum variable renewable generation for High Solar and High Wind conditions.

Operating conditions & dispatch for the SRA were translated from preliminary production cost modeling simulation. This ensured that each stressed case corresponded to realistic, internally consistent dispatch conditions grounded in 2035 operational forecasts. The selection logic—illustrated in the scatterplot of hourly variable generation versus load—captures how the four cases span the operational extremes most likely to test Western transmission system reliability.

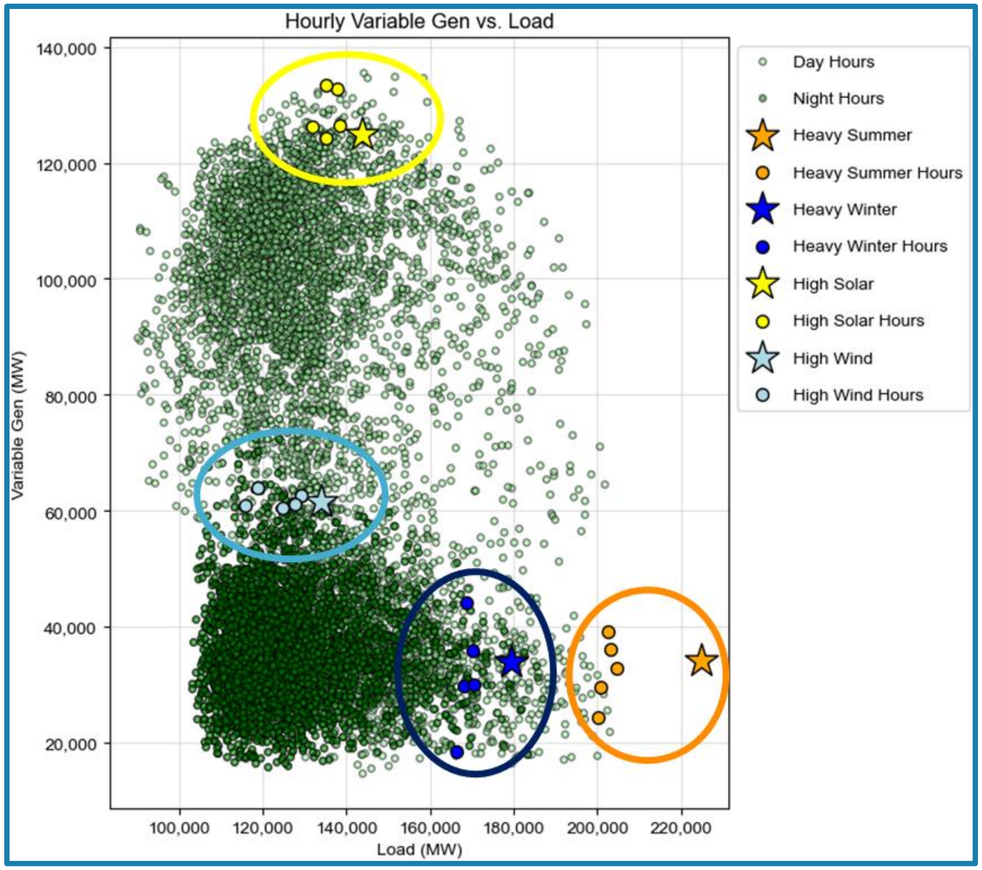

FIGURE 2-4. 2035 WESTTEC REFERENCE CASE LOAD AND VARIABLE GENERATION AND SRA CASES

The selected hours, summarized in Table 2-3, show the range of conditions reflected in the SRA.

TABLE 2-3. DESCRIPTION OF SRA POWER FLOW CASES

Scenario	System Stress Represented	Approx. WECC Coincident Demand (GW)	WECC-wide Variable Renewable Energy Output (% of Nameplate)	Primary Objective
Heavy Summer	Coincident WECC peak demand; low solar output; high thermal dispatch	225	~16%	Test ability to serve WECC coincident summer peak load under contingency conditions
Heavy Winter	High electric heating load with limited solar and variable wind generation	179	~16%	Test ability to serve WECC coincident winter peak load under contingency conditions
High Solar	Midday hours with high solar generation and low net load	144	~60%	Evaluate impacts of high renewable and low to moderate levels of conventional generation
High Wind	Moderate load at nighttime and spring hours with strong wind generation	134	~30%	

SRA findings were reviewed iteratively through the WATT to ensure accuracy of study results and potential transmission needs. During multiple review cycles, participants validated case assumptions, examined power flow results, and provided local insights on modeled system conditions and potential mitigation measures. Through this process, WestTEC identified a focused set of transmission solutions, including reconductoring, rebuilding and greenfield transmission expansion, designed to address power flows exceeding equipment rating and unacceptable voltage levels observed across multiple stressed cases. These proposed reinforcements were tested and refined in follow-up screening runs to verify their effectiveness in resolving identified reliability concerns. Once validated, the candidate upgrades were incorporated into the IDA as starting-point network enhancements, allowing subsequent analyses to consider their contribution to interregional transfer capability and system reliability.

Additional details on the methods and assumptions for the SRA are available in *Appendix Section 5.4*.

2.3.2 Interarea Deliverability Assessment

The IDA evaluates whether interregional transmission capacity in the 2035 WestTEC Reference Case is sufficient to deliver energy to load during times of high regional demand. Building upon the SRA, the IDA examines if resources can be reliably transferred when areas experience significant imports or exports due to shifting generation and demand patterns. The analysis focuses on conditions that represent evolving operational realities in the Western Interconnection—conditions that are not fully captured by the SRA's static peak and renewable cases.

The IDA was not conducted for every balancing area, but rather for select regions identified through WATT consultation. IDA scenarios were selected based on:

- Production cost modeling results, highlighting zones with high renewable curtailment or heavy import reliance.
- Planned resources identified to serve loads in a different region than where they are located; and
- Observed interregional transfers where interfaces have very high flows or limited transfer capacity under stressed operating conditions.

This process led WestTEC to focus on the following two deliverability scenarios, each representing a major transfer dynamic forecasted for the 2035 Western grid.

TABLE 2-4. IDA TRANSFER LEVELS AND ANALYTICAL OBJECTIVES

Scenario	Target Transfer	Analytical Objective
Northwest Import (Scenarios 1a & 1b)	14.1 GW (PNW imports) and 17.3 GW (Cross-Cascades flow)	Test whether the PNW can reliably import power during winter peak conditions and transfer it westward across the Cascades to coastal load centers.
East-to-West Transfer (Scenario 2)	15.1 GW	Evaluate whether transmission from eastern (MT/WY/CO/NM/AZ-E) to western (PNW/CA/UT/NV/AZ-W) Western Interconnection can support high renewable exports during periods of surplus generation. Evaluate whether 7,849 MW out of state WY and NM wind identified in CPUC's resource portfolio can be delivered to CAISO.

Targeted transfers were defined for critical area-to-area flows and incrementally increased in the “Transfer Limit” tool in PowerGem TARA® to identify the limiting elements—both thermally and voltage-constrained—that restrict these transfers under contingency conditions (as detailed in Figure 2-5)..

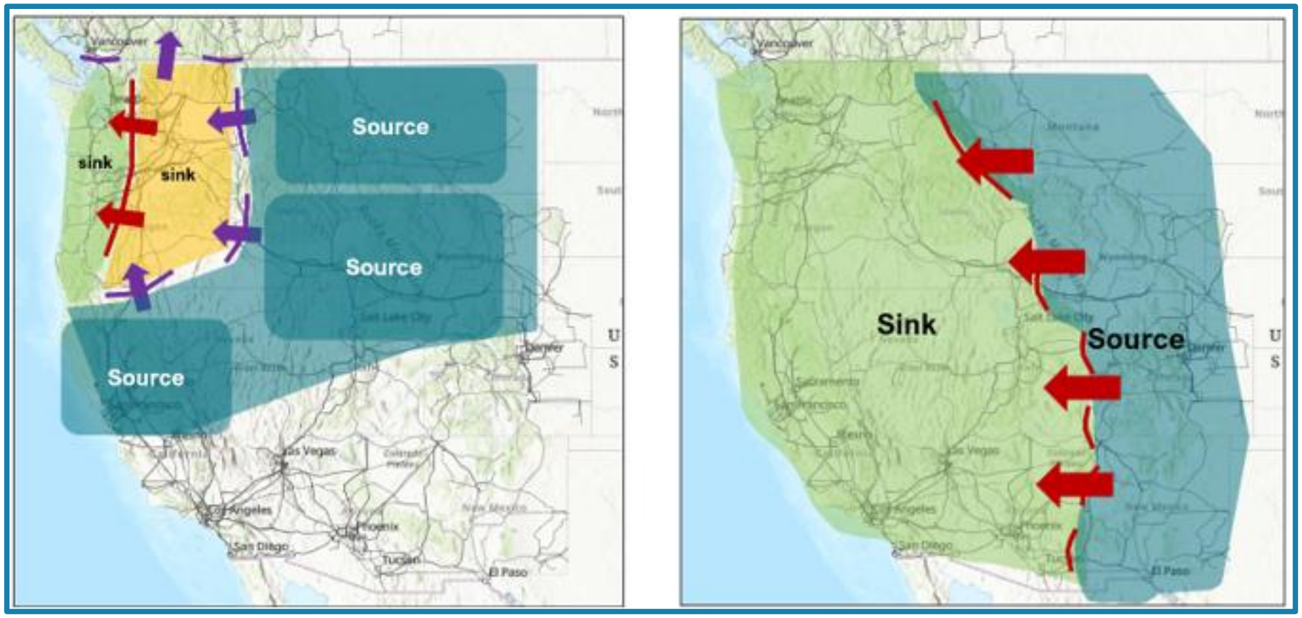

FIGURE 2-5. 2035 WESTTEC REFERENCE CASE LOAD AND VARIABLE GENERATION & SRA CASES

Transmission upgrades were developed for each violation that limited transfers below the defined transfer target and were added incrementally until the target transfer level was achieved.

The IDA results were reviewed iteratively through the WATT to ensure accuracy of study results and potential transmission needs. Like the SRA, members examined and revised the study assumptions, reviewed proposed network upgrades, and provided local insights on modeled system conditions and potential mitigation measures. Once validated, the recommended SRA and IDA transmission solutions were incorporated into the 2035 production cost model to test their impact on economic congestion.

While the IDA was developed to test specific stressed conditions that represent what WestTEC members forecast to be the prevailing flow patterns in 2035, this assessment does not assert that flow patterns will always be from sources in the east to sinks in the west. Nor does this assessment suggest that the transmission portfolio identified in the WestTEC effort only provides benefit to the sink areas. In many cases, especially under extreme weather conditions, the source regions will benefit from increased access to diverse resources.

Additional details on the methods and assumptions for the IDA are available in *Appendix Section 5.3*.

2.3.3 Congestion Assessment

Using the GridView nodal production cost model (PCM), the study simulated hourly economic dispatch across the Western Interconnection under the 2035 Reference Case to identify economic inefficiencies associated with transmission constraints. The PCM is a DC power flow model simulated operations under "normal" system intact conditions, allowing for detailed assessment of system efficiency under typical operating conditions without introducing reliability contingencies, which were the focus of the prior two studies.

This analysis evaluated the following key elements:

- Binding constraints and hours of congestion across monitored transmission lines and flowgates;
- Shadow prices associated with constrained lines and flowgates;
- Renewable curtailments resulting from transmission constraints; and
- Regional price divergence caused by insufficient interregional transfer capacity.

The model assumed a single integrated regional day-ahead energy market and updated with thermal, hydro, renewable, and storage dispatch logic consistent with forecasted 2035 operational practices. The study assumed a single integrated day-ahead energy market despite ongoing development of multiple Western day-ahead markets. Future market structures may involve multiple subregional optimizations, which could reduce coordination efficiency and alter both dispatch patterns and the resulting stress conditions. WestTEC adopted this approach to ensure that findings related to the need for interregional transmission expansion were based on clear market fundamentals and not market seams, which may change over time.

After resolving in-scope reliability and deliverability issues through the SRA and IDA, as described above, the resulting transmission upgrades were integrated into the PCM. The updated model was then used to identify and evaluate "high-value" congestion areas—transmission constraints whose mitigation could yield significant economic and operational benefits not addressed in the prior two studies.

This congestion assessment identified key transmission limitations that, if addressed, could reduce production costs, enhance grid operational efficiency, and improve access to a diverse resource mix across the Western Interconnection.

Key metrics used to identify and quantify congestion included:

- **Shadow Price.** The marginal production cost saving when a constraint is relieved by one MW;
- **Congested Hours.** The duration of time a constraint binds during simulation;
- **Congestion Cost.** The sum-product of shadow price and flow on a constrained element; and
- **Congestion Measure.** The annual average shadow price, when congested, multiplied by total congested hours.

Through an iterative process, the PCM results and key congestion metrics above were reviewed with the WATT. WestTEC performed many sensitivities and iterations, exploring the impact of addressing observed congestion. WestTEC congestion assessment upgrades were limited to those elements which are 230 kV and above, interregional in nature, and had congestion measure greater than 50,000 $/MW. Selection of this threshold resulted in a limited set of highly congested elements, outlined in *Appendix Section 5.5*.

2.4 TRANSMISSION SOLUTIONING

In developing conceptual transmission solutions, WestTEC relied on the approach described in more detail in *Appendix 5.4.* Some key principles include:

- When feasible lines were reconductored using higher-capacity or high-performance conductors (primary mitigation for thermal overloads);
- Where reconductoring was not feasible lines were rebuilt to higher thermal rating;
- New lines were needed to mitigate diverged contingencies or where multiple violations or materially increased transfer capacity were required;
- Series-capacitor overloads were assumed to be mitigated by replacement with higher-capacity units; and
- Transformer overloads were assumed to be mitigated by adding parallel units.

Grid-enhancing technologies and other non-wires alternatives were evaluated based on the severity and nature of the need. Generally, dynamic line ratings did not provide the level of firm interregional capacity required within the 10-year timeframe and therefore were not treated as primary mitigations (although they may be useful for local incremental needs or to complement larger upgrades). Importantly, as the consulting team developed potential transmission solutions to identified needs, they were reviewed by the WATT and refined or substituted based on local planning expertise or consideration of new system needs stemming from iterative analysis.

SECTION 3.0

SOLUTIONS TO WESTERN TRANSMISSION NEEDS

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3.0 SOLUTIONS TO WESTERN TRANSMISSION NEEDS

The 10-year transmission portfolio was developed by identifying transmission solutions from the three transmission needs assessments (SRA, IDA, and Congestion Assessment). These solutions, along with the portfolio of existing and planned lines already included in the 2035 Reference Case, make up a west-wide transmission portfolio that meets forecast needs identified in this study. The portfolio is shown below. ***The routes for proposed transmission solutions shown on the map (Figure 3-1) are representative of many possible routes and should not be interpreted as WestTEC's recommended routes***.

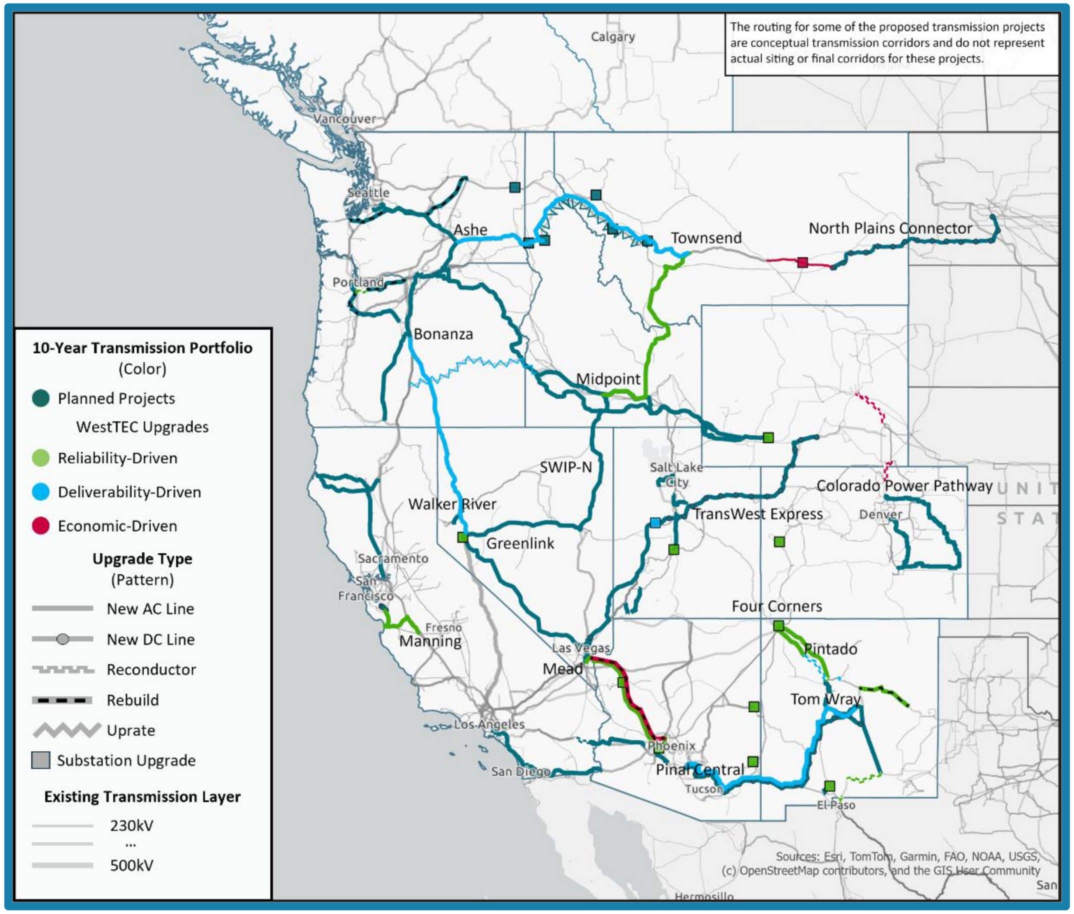

FIGURE 3-1. 2035 WESTTEC 10-YEAR HORIZON TRANSMISSION PORTFOLIO[16]

3.1 TRANSMISSION PORTFOLIO

Projects in the 10-year horizon portfolio are classified as SRA, IDA or Congestion transmission solutions based on which assessment identified the need for the upgrade. Detailed description of the project, the driver of the upgrade and estimated costs are provided below, and a summary with aggregate costs and line miles is provided in the Appendix. Estimated costs are based on per unit costs from the 2025 MISO Transmission Expansion Plan (MTEP) cost estimation[16] methodology, unless otherwise specified. ***All financial values in this report are adjusted to 2025 dollars.***

[16] Transmission Cost Estimation Guide for MTEP25

[17] The North Plains Connector (NPC) was included in the WestTEC 2035 Reference Case and is shown on the maps for context. For the 10-year study the NPC was represented as a 3,000 MW import at the Colstrip substation (modeled as a generation injection) and therefore is not listed among the Planned Projects in the 2035 Reference Case inventory. See *Appendix 0* for modeling conventions and further documentation on this issue.

3.1.1 SRA Transmission Solutions

These transmission projects help meet WECC and NERC reliability criteria under credible but stressed system conditions.

TABLE 3-1. SRA TRANSMISSION SOLUTIONS

Project Name	Upgrade Type	Upgrade Rating	Line Miles	Estimated Cost ($M)	Connecting Area(s)
Reconductor Keeler - Pearl 500kV #1 Line	Reconductor	3029 MVA	18	$40	BPA
New Manning - Metcalf 500kV Line[18]	New Line	3291 MVA	100	$700	CAISO
Reconductor Amrad - Chavez 345kV Line	Reconductor	1415 MVA	65	$49	El Paso Electric
Reconductor Otero - Picante 345kV Line	Reconductor	1415 MVA	15	$11	El Paso Electric
Arroyo phase shifter #2	New phase-shifter (advanced power flow controller)	400 MVA	NA	$31	El Paso Electric, PNM
New 500/345kV Transformer at Walker River	New Transformer	998 MVA	NA	$19	NVE
Southern Nevada MVAR Support	New Shunt	150 MVAR	NA	$5	NVE
New Townsend - Midpoint 500kV Line	New Line	2773 MVA	429	$2,112	NWMT, IPCO, PACE
New 345/230kV Transformers at Bridger and Sigurd	New Transformer	450 MVA / 500 MVA	NA	$26	PACE
New Rio Puerco - San Juan 345kV Circuit 2	New Line	1200 MVA	41	$163	PNM
Rebuild Clines Corner - Guadalupe - Taiban Mesa to Double Circuit	Rebuild	2160 MVA	110	$940	PNM

[18] Approved in CAISO's 2024-25 TPP. Project cost estimate obtained from the TPP report.

Project Name	Upgrade Type	Upgrade Rating	Line Miles	Estimated Cost ($M)	Connecting Area(s)
New Four Corners - San Juan 345kV Circuit 2	New Line	1200 MVA	10	$49	WAPA R.M.
New Four Corners - Pintado 345kV Circuit 2	New Line	1099 MVA	81	$312	PNM, APS
New 345/230kV Transformer at Grand Junction	New Transformer	270 MVA	NA	$10	PSCo
New 345/230kV Transformer at Copper Verde	New Transformer	224 MVA	NA	$10	TEP
New 500/345kV Transformer at Coronado	New Transformer	826 MVA	NA	$20	TEP, SRP
New Mead - Liberty - West Wing 500kV Line	New Line	2051 MVA	273	$1,418	WAPA LC
New 345/230kV Transformers at Liberty and Peacock	New Transformer	720 MVA / 650 MVA	NA	$29	WAPA LC
Second Mead - Market Place 500kV Line	New Line	2598 MVA	14	$79	WAPA LC, LADWP
San Juan Phase Shifter #3	New phase-shifter (advanced power flow controller)	300 MVA	NA	$26	WAPA R.M.
Western Colorado MVAR Support at Mill Creek, Montrose and Hesperus 345 kV substations	New Shunts	100 MVAR each	NA	$21	WAPA R.M.

3.1.2 IDA Transmission Solution

The solutions seen in Table 3-2 support interregional power flow which may occur during times of high regional demand and decreased local supply, allowing the West to realize its vast amounts of load and resource diversity.

TABLE 3-2. IDA TRANSMISSION SOLUTIONS

Project Name	Upgrade Type	Upgrade Rating	Line Miles	Estimated Cost ($M)	Connecting Area(s)
New Pinal Central - Saguaro – Winchester – Macho Springs – Tom Wray 500kV Line (projects such as RioSol)[19]	New Line	1600 MVA	550	$2,400	CAISO, PNM, APS, SRP, TEP, Rio Sol
Uprate Hemingway - Summer Lake Circuit 1 via Substation Upgrades	Uprate	4625 MVA	NA	$55	IPCo, PACE
New Townsend - Ashe 500kV Line	New Line	3845 MVA	500	$2,618	NWMT, BPA
Reconductor Sams Valley - Whitestone 230kV line[20]	Reconductor with advanced conductors	1000 MVA	2	$2	PACW
Reconductor Diamond Tail – B-A 345 kV Circuit 1 and 2 line	Reconductor using advanced conductors	2160 MVA	10	$15	PNM
Reconductor Rio Puerco - Pintado 345 kV Circuit 1 line	Reconductor	2160 MVA	63	$74	PNM
New Walker - Bonanza 500kV Line	New Line	3500 MVA	375	$2,034	SIERRA, BPA
Additional TWE Phase Shifter	New phase-shifter (advanced power flow controller)	580 MVA	NA	$41	TWE, CAISO, PACE

[19] Estimated cost of this project is based on cost of the Rio Sol project.
[20] This upgrade is already included in the scope of PacifiCorp's initial construction of Sams Valley substation but was missing from the data provided to WestTEC for 2035 Reference Case model development.

3.1.3 Congestion Assessment Solutions

This set of transmission projects detailed in Table 3-3, address remaining and severe economic congestion on the grid after accounting for IDA and SRA upgrades above.

TABLE 3-3. CONGESTION TRANSMISSION SOLUTIONS

Project Name	Upgrade Type	Upgrade Rating	Line Miles	Estimated Cost ($M)	Connecting Area(s)
Colstrip - Broadview 500kV Series Capacitor Upgrade	Series Capacitor	2771 MVA	NA	$67	NWMT
Reconductor Mead - Perkins 500 kV Line	Reconductor	2800 MVA	242	$252	WAPA LC
Reconductor Laramie River - Dave Johnston 230kV Line	Reconductor	986 MVA	77	$37	WAPA R.M.
Path 36 TOT 3 Upgrade	Reconductor	800 MVA	75	$36	WAPA R.M.

SECTION 4.0

STUDY FINDINGS & CONCLUSIONS

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4.0 STUDY FINDINGS AND CONCLUSIONS

The scope and scale of transmission needs in the 10-Year Horizon Study confirms that a coordinated, interregional approach to transmission expansion is essential for meeting the West's rapidly growing electricity needs. The resulting portfolio—approximately 12,600 miles of planned, new and upgraded transmission representing an estimated $60 billion in investment—positions the Western Interconnection to integrate new load, connect needed generation, and support reliability and affordability through 2035.

4.1 STUDY FINDINGS

FINDING 1.
The 10-Year Horizon Portfolio Positions the West to Meet Growing Demand, Integrate New Resources, and Strengthen Reliability

The portfolio reflects a coordinated response to three interrelated challenges confronting the Western power system: rising electricity demand, large-scale resource additions, and the need for a more reliable and resilient grid.

- **Integrating Rapidly Growing Load.** The current Western Interconnection load growth forecasts are projected to rise by nearly 30% by 2035, more than triple the growth rate observed over the previous decade. This growth is driven by electrification of transportation and buildings, new data -center and industrial loads, and continued regional economic growth. The WestTEC portfolio adds new transfer capacity along major interregional corridors and alleviates historic bottlenecks, enabling the system to reliably meet this once-in-a-generation surge in demand. Increasing interregional transfer capability by nearly 10 GWs allows regions to share resources efficiently during extreme conditions, reducing both reliability and cost risks for consumers.
- **Accommodating Large-Scale Generation Additions.** More than 200 GW of new generation will be needed over the next decade to meet state policy and resource adequacy needs. The 10-Year horizon portfolio connects these resources to load centers through new and reinforced high-voltage corridors. Collectively, these upgrades reduce congestion, minimize curtailment, and lower production costs by roughly $500 million per year while supporting a diverse and flexible resource mix.
- **Strengthening Reliability and Resilience.** The study's technical analyses confirm that without additional high-voltage transmission, the Western system would face voltage and thermal violations under credible stress conditions. These issues, if not mitigated, could lead to widescale power outages and an inability to serve new large energy customers. The portfolio directly mitigates over 75 of these issues by reinforcing key 230- and 500-kilovolt corridors, adding reactive-power support, and expanding interregional transfer capability. Beyond compliance, the upgrades improve resilience by providing alternate power paths and redundancy that reduces vulnerability to outages caused by extreme weather or wildfires.

FINDING 2.
Timely Completion of Planned Projects is Essential

The planned projects included in the 10-Year horizon portfolio represent critical near-term steps supportive of the West-wide needs identified in this study. The coordinated and cost-effective delivery of these 9,300 miles of transmission should be prioritized by utilities, developers, regulators, and regional stakeholders. While roughly one-fifth of these projects are already under construction, ensuring completion of the balance of the projects on schedule is fundamental to achieving the planning objectives of this study.

FINDING 3.
Uncommitted Projects Require Sponsorship and Support

Several high-value projects identified in this study are unsponsored or are at conceptual planning states. Examples of such include:

- Projects that increase connectivity between Montana and the rest of the Pacific Northwest region
- Projects deepening electrical ties between the Pacific Northwest market and the Desert Southwest region.
- Projects that increase connectivity between CAISO and the Desert Southwest, enabling integration of out-of-state resources.

These conceptual or unsponsored upgrades address critical interregional needs and require active development on an ambitious timeline. WestTEC and its partners encourage utilities, merchant developers, and public-power entities to take on such sponsorship roles and advance these facilities with additional planning analyses, design, permitting, and stakeholder engagement.

FINDING 4
Transmission Costs Are Manageable in Context

Although the 10-year horizon portfolio represents an estimated $60 billion in capital investment, its annualized cost of ~$5.3 billion is modest relative to the overall scale of generation and distribution investment needed across the interconnection by 2035. For example, this annual cost is eight times less than the cost of generation that must be added over the same time horizon and represents only 2.5% of today's average retail electric price in the West. Historically, transmission expansion accounts for only a small share of total system spending, yet it delivers region-wide benefits in reliability, flexibility, and long-term cost reduction. This trend continues with the WestTEC 10-year horizon portfolio.

Critically, transmission investments operate for many decades, providing benefits with minimal continued operating costs. This trend as transmission as a relatively low-cost "enabler" of other benefits is apparent in the results of this *10-year Horizon Report*. Properly framed, the 10-year horizon portfolio can be considered a **cost-containment measure against future cost increases**, ensuring access to the lowest cost generation while avoiding inefficient dispatch and system congestion. Transmission expansion on this scale is necessary to ensure continued economic growth in the Western region.

FINDING 5.
Coordinated Action Can Overcome Development Challenges

Significant development, regulatory, and financing challenges face the projects identified in the 10-year horizon portfolio. Coordinated action among Western States, utilities, developers, and regional partners can materially improve outcomes. Potential enablers include:

- **Explore reasonable and prudent sharing or allocation of costs to support transmission project business case development.** States, planning regions, developers, and utilities should pursue continued refinement of formal and informal cost allocation (or cost sharing) frameworks that align funding responsibilities with benefits and each project's unique need and business case. Once established, these business cases should be used at the relevant regulatory forums to justify early development activities.
- **Long-lead equipment procurement.** Utilities could support implementation efforts by collaborating on pooled procurement of critical components—such as high-voltage transformers—to mitigate cost and supply-chain risks.
- **Regulatory support for early-stage development activities.** Given how broadly the transmission needs in this report have been vetted, utility commissions could consider opportunities for their regulated utilities to pursue limited recovery of preliminary siting and design expenses.
- **Voluntary agreement mechanisms.** Stakeholders could leverage voluntary agreements to support collaborative approaches to transmission development. The framework enables States and transmission providers to share costs and benefits more flexibly, improving feasibility for multi-jurisdictional projects.
- **Innovative business models.** Entities should leverage vehicles such as the Western Transmission Consortium (TWTC) to advance shared-investment and financing structures that accelerate interregional development.[21] The CAISO's Subscriber Participating Transmission Owner (PTO) model is another example of a collaborative approach to building transmission that has a proven track record as a tool that enables sharing of transmission costs and capacity, ultimately accelerating the delivery of interregional projects.
- **Streamlined permitting.** Federal, state, and local agencies should coordinate environmental reviews and right-of-way approvals to shorten project timelines while maintaining robust community and Tribal engagement.

4.2 CONCLUSION

The 10-Year horizon portfolio represents an interregional transmission blueprint for how the West can sustain reliability and affordability while progressing on state policy goals. Its implementation will demand leadership, risk taking, and collaboration across industry sectors and jurisdictions, but the benefits are enduring: a more resilient, efficient, and interconnected grid that supports the West's growing economy and communities. With this study, WestTEC and its partners have established the foundation for a new era of coordinated transmission planning in the Western Interconnection.

The scope and scale of transmission needs identified in the WestTEC *10-Year Horizon Study* demonstrates that a coordinated, interregional approach to transmission expansion is essential for meeting the West's rapidly growing electricity needs. The study

[21] See https://www.westerntransco.com/.

shows that a reliable, efficient, and policy-compliant grid can indeed be realized by 2035, but deliberate near-term action is needed on a substantial portfolio of regionally significant transmission upgrades. This portfolio consists of approximately 12,600 miles of new and upgraded transmission and requires an investment of approximately $60 billion, but in return leaves the Western Interconnection positioned to accommodate unprecedented levels of load growth, integrate and delivery generation resources at twice the historical rate, all while enhancing interregional transfer potential and maintaining compliance with reliability standards in 2035.

4.3 FURTHER CONSIDERATIONS

The WestTEC *10-Year Horizon Study* was conducted using data and analytical approaches vetted by engineers and planners representing transmission owners from across the West. However, several methodological and practical limitations should be considered when interpreting the results. These caveats apply to the individual assessments and to the overall development of the transmission portfolio.

4.3.1 10-Year Reference Case

- Balancing Authority Area-level resource and load trajectories represent reasonably anticipated trends developed by referencing resource plans and other public documentation. WestTEC performed a multi-month stakeholder review process from approximately Q4 2024 through Q2 2025 to finalize resource and busbar mapping assumptions. Resource outcomes therefore reflect this vintage of planning documents and forecasting. Study results are sensitive to these assumptions; adjustments made to transmission constraints and transmission capacity additions in future resource plans could result in significant changes to resource portfolios. Future study iterations may result in an increase or decrease in transmission capacity need between areas due to new resource trajectories.

4.3.2 System Reliability Assessment (SRA)

- The SRA monitored transmission elements rated 230 kV and above. Lower-voltage facilities were evaluated only if they formed part of a WECC Interface Path. Evaluation of 115 kV transmission elements in other parts of the system that are not part of the WECC Paths, but that can substantively affect congestion on those Paths, was out of scope for this study. As specific routes are explored, the underlying 115 kV system and associated upgrade costs should be assessed.
- Violations identified on 230-kV elements located within a single balancing area were classified as *local issues*. These were documented, but no network upgrades were developed to mitigate them. Such local constraints are typically known to facility owners and will be addressed through their individual transmission planning processes.
- The SRA did not include transient stability analysis. Dynamic performance and stability impacts may be considered in future WestTEC study cycles.

4.3.3 Interarea Deliverability Assessment

- The IDA evaluations did not incorporate contractual transmission service requests or reserved flows. Modeling these contractual transfers could affect the resulting upgrade portfolio or alter the magnitude of interregional transfer limits.

4.3.4 Congestion Assessment

- The production cost model monitored only transmission elements rated 230 kV and above. Lower-voltage facilities were evaluated only if they were part of a WECC Interface Path.

- Contingencies were not modeled in this economic assessment to provide a conservative estimate of the congestion benefits of the portfolio. In real world operations with regular line outages and service disruptions, the economic benefits of the portfolio expected to be higher. Instead, WECC line and flowgate limits were applied to maintain flows below defined limits.
- WECC Path 3 East (PNW–BC Hydro) was congested in the 2035 Reference Case, with congestion increasing after inclusion of SRA and IDA upgrades. Because mitigation of this constraint is considered a longer-term need, a corresponding project will be evaluated in the forthcoming 20-Year Horizon Study rather than in this 10-year analysis.

4.3.5 Transmission Solutioning

- Cost estimates for baseline transmission projects were sourced from public data wherever available. When public information was lacking, costs were estimated using per-unit values from the 2025 MISO Transmission Expansion Plan (MTEP) which assumes 2025 dollars.
- Some WestTEC transmission solutions align with actual planned projects; however, inclusion in this study does not imply endorsement of any specific project, sponsor, or routing.
- The transmission routes shown in portfolio maps are conceptual and represent one of many potential configurations. They should not be interpreted as WestTEC's recommendation for siting or alignment, but rather as an aid to visualize approximate project locations and interregional connections.

SECTION 5.0

APPENDICES

WestTEC
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5.0 APPENDICES

5.1 ACRONYMS

AC	Alternating Current	**NVE**	Nevada Energy
ACCC	Aluminum Conductor Composite Core	**NWMT**	Northwestern Energy in Montana
ADS	Anchor Dataset (WECC)	**REC**	WestTEC Regional Engagement Committee
APS	Arizona Public Service Company	**PACE**	PacifiCorp East
BPA	Bonneville Power Administration	**PACW**	PacifiCorp West
BTM	Behind-the-Meter	**PCM**	Production Cost Model
CAGR	Compound Annual Growth Rate	**PDCI**	Pacific DC Intertie
CAISO	California Independent System Operator	**PG&E**	Pacific Gas & Electric
Cap	Capacitor	**PNM**	Public Service Company of New Mexico
CEC	California Energy Commission	**PNW**	Pacific Northwest
DC	Direct Current	**PV**	Photovoltaic
DG	Distributed Generation	**PSCO**	Public Service Company of Colorado
DR	Demand Response	**SIERRA**	Sierra Pacific Power Company
FERC	Federal Energy Regulatory Commission	**SRA**	System Reliability Assessment

FCRPS	Federal Columbia River Power System	**SRP**	Salt River Project
GW	Gigawatt (1,000,000 kW)	**TARA**	Transmission Adequacy & Reliability Assessment software by PowerGEM
IDA	Interarea Deliverability Assessment	**TEP**	Tucson Electric Power
IEPR	Integrated Energy Policy Report (CEC)	**TPP**	Transmission Planning Process (CAISO)
IPCO	Idaho Power Company	**TSR**	Transmission Service Request
IPP	Intermountain Power Project	**TWE**	TransWest Express
IRP	Integrated Resource Plan	**TWh**	Terawatt-Hour (1,000,000 MWh)
kW	kilowatt	**TWTC**	The Western Transmission Consortium
LADWP	Los Angeles Department of Water and Power	**VRE**	Variable Renewable Energy
LBNL	Lawrence Berkeley National Laboratory	**WAPA**	Western Area Power Administration
L&R	Loads and Resources (WECC Data Submittal Process)	**WAPA RM**	Rocky Mountain region of WAPA
MMBTU	Millions of British Thermal Units	**WAPA LC**	Lower Colorado region of WAPA
MVA	Megavolt-Ampere	**WAPA DSW**	Desert Southwest
MW	Megawatt (1,000 kW)	**WATT**	WestTEC Assessment Techncial Taskforce
MWh	Megawatt-hour	**WECC**	Western Electricity Coordinating Council
NERC	National Electricity Regulatory Commission	**WestTEC**	Western Transmission Expansion Coalition
NREL	National Renewable Energy Laboratory	**WPP**	Western Power Pool

Other abbreviations used throughout the report include state abbreviations (e.g., CA for California) and GridView Areas & Regions (e.g., BS_PACE for PacifiCorp East).

5.2 GOVERNANCE, FUNDING AND STAKEHOLDER ENGAGEMENT

WestTEC is organized under a transparent, collaborative governance model designed to ensure regional balance, technical credibility, and stakeholder accountability. The initiative is administered by the WPP and overseen by a cross-functional Steering Committee composed of representatives from multiple sectors across industry with a vested interest in transmission infrastructure, including, but not limited to, participating transmission providers, federal power marketing administrations, investor and publicly-owned load-serving entities, States, Tribes, consumer advocates, large commercial consumer, independent power producers, independent transmission developers, energy trade organizations, and environmental organizations. The Steering Committee provides strategic direction, approves key milestones, and ensures alignment with the priorities of Western stakeholders.

TABLE 5-1. WESTTEC PARTICIPANTS

Western Interstate Energy Board	Clean Energy Transition Institute
GridWorks	NW Energy Coalition
Western Electricity Coordinating Council	From the Light Consulting
Connected Grid Initiative	Navajo Transitional Energy Company
Wyoming Office of Consumer Advocate	Warm Springs Power & Water Enterprises
Public Advocates Office at the California Public Utilities Commission	Avangrid Renewables
Bonneville Power Administration	EDF Renewables
Grid United	Aypa Power
Clean Energy Buyers Association	Renewable Northwest/Grid Strategies
Amazon	Pacific Gas & Electric
PacifiCorp	Southern California Edison
Puget Sound Energy	Seattle City Light
Portland General Electric	Black Hills Energy
Renewable Northwest	Los Angeles Department of Water and Power
Snohomish PUD	GridLab
Tucson Electric Power Company	California ISO
Grant County PUD	Southwest Power Pool
Interwest Energy Alliance	Washington Department of Commerce
Invenergy	Avista

Idaho Power Company	Xcel Energy
NorthWestern Energy	Powerex
NV Energy	BC Hydro
Salt River Project	GridLiance
Arizona Public Service	Pacific Northwest Utilities Conference Committee
Public Service Company of New Mexico	Pattern Energy
Western Area Power Administration	Cascade Renewable Transmission
WestConnect	Chelan County PUD
NRDC	Pacific Northwest National Laboratory
Northwest & Intermountain Power Producers Coalition	Northwest Power and Conservation Council
Public Power Council	Whatcom County PUD
Colorado River Energy Distributors Association	Savion
LS Power	Western Power Pool
Tacoma Power	E3
Northwest Requirements Utilities	GDS Associates, Inc.
PNGC Power	Energy Strategies
Western Resource Advocates	

Technical oversight of the study is provided by the **WestTEC Assessment Technical Taskforce (WATT)**, a group of subject matter experts from across the Western Interconnection with modeling, system planning, and forecasting expertise. WATT members are responsible for guiding model development, validating assumptions, and interpreting study results. Their contributions are foundational to ensuring that the study reflects regionally appropriate inputs and produces results with practical value for planners and policy makers.

Stakeholder input is central to the WestTEC process. Throughout the study period, a **Regional Engagement Committee (REC)** has facilitated structured input from a diverse array of sector-based participants, including public power entities, utilities, regulators, clean energy developers, advocacy groups, and academic institutions. REC meetings and broader public webinars serve as venues for sharing study updates, interim results, reviewing methodological decisions, and gathering feedback that is incorporated into study iterations. This tiered engagement approach strengthens the legitimacy and relevance of the study's findings while supporting broader regional planning harmonization efforts.

5.2.1 Committee Member Leadership

WestTEC Assessment Technical Taskforce (WATT) Members

Co-Chairs: Jennifer Galaway, Portland General Electric, Ben Fitch-Fleischmann, InterWest, Jeff Billinton, California ISO

WestTEC Steering Committee Members

Co-Chairs: Kelsey Martinez, Public Service Company of New Mexico and John Martinsen, Public Utility District No. 1 of Snohomish County

Regional Engagement Committee (REC) Sectors & Members

Co-Chairs: Robb Davis, GridLiance, Vijay Satyal, Western Resource Advocates

5.2.1.1 Stakeholder Engagement Opportunities & Committee Meetings

The WestTEC 10-Year study was supported by a robust stakeholder engagement process that included presentation, discussion, and solicitation of feedback via the following engagements:

- **Regional Engagement Committee (REC):** 20 monthly meetings
- **WestTEC Assessment Technical Taskforce (WATT):** 39 bi-weekly meetings
- **Steering Committee:** 39 bi-weekly meetings
- **All Committees Meetings:** 6 quarterly meetings
- **Public:** 7 quarterly webinars

Consultants often met with WATT or REC stakeholders on an ad-hoc basis when additional review or discussion of study methodology or assumptions was needed. The public was invited and encouraged to attend all REC meetings and there will be public comment opportunities at each meeting. Interested participants can stay up to date on any future REC meeting by registering on WPP website. Recordings of the REC meeting are always available to view after the event on the WPP site.[22]

[22] https://www.westernpowerpool.org/events/

5.3 WESTTEC TRIBAL ENGAGEMENT

A desired outcome of the WestTEC effort is the identification of electricity transmission solutions that reflect broader regional consensus and balance diverse interests, which is why the partners in this coalition recognize the importance and significance of including Tribes at every stage of the consideration of the transmission solutions. Although the WestTEC 10-year horizon study is not a construction plan and does not trigger immediate siting or permitting actions, the study aims to encourage companies to pursue bilateral negotiations and development agreements for potential interregional lines. To ensure the study is actionable, WestTEC has prioritized early and proactive engagement with Tribes, recognizing both the complexities of siting transmission on or near Tribal lands and the importance of respecting Tribal sovereignty and protecting cultural and environmental resources.

WestTEC representatives actively pursued opportunities to work with Tribal representatives and proposed several engagement pathways to ensure outreach with Tribes would be as robust as possible, including establishing a dedicated Tribal Committee comprised of any representatives identified by the Tribes. One thing WestTEC considered was meeting quarterly to inform Tribal representatives of the work and receive feedback, but we remained open to any suggestions on meaningful engagement. Given limited Tribal capacity and the number of energy related efforts already underway, WestTEC determined that the most effective early approach was to invite Tribal representatives to participate in existing committees and to meet Tribes where they are. This approach resulted in active engagement from several Tribal representatives, supplemented by outreach by WestTEC representatives at numerous Tribal conferences and organizational work groups. We recognize there is still much more work to do to strengthen Tribal engagement across the West. We understand ongoing, active engagement is essential, and we remain open to suggestions on how best to share information and seek feedback.

Over the last year, these engagement efforts have provided essential insights for WestTEC and its partners. The themes below summarize what we heard from Tribal representatives and should guide future evaluation and development of WestTEC transmission solutions.

- Tribal concerns about environmental and cultural impacts must be prioritized: the physical footprint of the transmission lines can disrupt ancestral lands, sacred sites, and sensitive ecosystems. Tribes also experience frustration when consultation is inadequate, untimely or when regulatory processes diminish Tribal authority.
- Current maps and GIS data used by transmission planners do not fully or accurately reflect Tribal ancestral lands and sacred sites due to both the need to protect data sovereignty and fundamental differences between Tribal and Western concepts of land boundaries. For this reason, WestTEC intentionally chose not to try to depict Tribal ancestral lands and sacred sites boundaries on the WestTEC transmission solution maps while simultaneously expressing the shared understanding that these lands warrant respectful treatment in any siting procedure.
- Tribal perspectives on transmission development vary. While some Tribes may be opposed to transmission solutions crossing their lands, others may want to participate in development and potential interconnection of Tribal generating projects. This may be because of an interest in potential revenue from land use and ownership opportunities by Tribes, job creation, increased energy independence, infrastructure upgrades, or alignment with climate and stewardship goals, and many other reasons.

Even though Tribal ancestral lands and sacred site boundaries are not shown on WestTEC transmission solution maps, it is of critical importance that regional partners and stakeholders using WestTEC's transmission analysis understand the potential sensitivities and priorities of individual Tribes that could be affected as projects move toward development.

Based on Tribal engagement to date, WestTEC recommends as best practices the following principles and approaches:

- Engage early and consistently. Engagement should be community-led, flexible, and aligned with Tribal priorities. Focusing on shared outcomes—rather than predetermined solutions—supports Tribal sovereignty, cultural revitalization, and long-term community well-being. Tribes may have very different needs and priorities for energy development on their lands.
- Build partnerships that advance Tribal economic and energy sovereignty.
- Approach regulatory processes collaboratively and transparently, navigating complex federal and local regulations in ways that ensure compliance and fairness.
- Remain flexible. No two communities or processes are the same. Engagement should respond to specific community priorities rather than preconceived assumptions.

Together, these insights underscore the importance of centering Tribal sovereignty, capacity, and priorities in all future transmission-related efforts. By engaging early, listening deeply and developing solutions collaboratively with Tribal Nations, WestTEC and its regional partners can support more durable, equitable, and successful outcomes.

5.4 KEY ASSUMPTIONS AND DETAILED STUDY METHODS

5.4.1 2035 Reference Case Data

5.4.1.1 Load Forecast

The base weather for load profiles is 2018 sourced from the WECC ADS build process. There were two different data sources for monthly peak and energy, unless otherwise provided by the balancing authority. The monthly peak and energy were then used to grow the 2018 load shape to 2035 hourly loads.

The two main data sources were either:

- 2024 WECC Loads and Resources (L&R), or
  - Hourly profile was used directly from the 2034 WECC ADS
- 2023 NREL Cambium 2023 Mid-case scenario

If the NREL Cambium 2035 peak and energy was higher than the L&R data, it was used instead of the L&R data. WestTEC requested review of this data by WATT stakeholders. If they saw a discrepancy or had more up to date data, it was provided and used.

The exceptions to the two data sources listed above are the loads for California ISO (CAISO), Nevada Energy (NVE), and BC Hydro (BCHA). CAISO load profiles were sourced from the 2024-2025 TPP PCM case. NVE monthly peak and energy was provided by NVE from their 2024 IRP. Although the base assumption for BCHA was the 2034 ADS profile, Powerex staff provided data for the model to adjust imports and exports to the US on Path 3 based on dispatch and loads from the PCM. The approach is detailed below.

5.4.1.2 Resource Additions

The WestTEC resource planning effort aimed to align as closely as possible with Western utility Integrated Resource Plans (IRPs). WECC's 2023 ADS 2034 nodal representation served as the foundation for WestTEC's representation of resources, loads, and transmission for all power flow and production cost modeling.

5.4.1.2.1 Existing & Planned Resources

Generators in the ADS dataset were first categorized using the NERC Resource Tiers or the "Development Status" field into one of three buckets: Existing, Planned, and Conceptual resources. Existing and Planned resources represented resources that were 1) associated to a known bus or generation facility, 2) had an in-service date on or before 1/1/2024, 3) a resource with NERC's "Tier 1-Under Construction" or "Tier 2-Planned" development status in the ADS, or 4) a resource provided to Energy Strategies as part of stakeholder input. So, for example:

- A solar facility built with an in-service date in 2023 would be considered "existing"
- An existing natural gas power plant that is slated to retire by 2032 would be considered "existing", and would remain included in the dataset for visibility, but would not be in operation in the model
- A solar facility with an in-service date after 1/1/2024 would be considered "planned"
- A utility building a new power plant before 2035 would generally be considered "planned" if the point of interconnection was stated in the IRP
- A utility converting an existing plant to a different fuel source was generally considered "planned"

Existing and Planned resources were cross-referenced against IRPs, updated where necessary, and incorporated in the 10-year WestTEC Resource dataset.

5.4.1.2.2 Conceptual Resources

The dividing line between Planned and Conceptual resources was that conceptual resources, in general: 1) were "generic" resources included in an IRP, 2) were not duplicative with any planned resource, 3) were not already under construction, 4) was not a technology/fuel change associated with an existing plant, and 5) NERC Tier 3 Conceptual resources assigned to high-voltage monitored buses. So, for example:

- A utility IRP showing a total of 100 MW of Solar PV in its footprint by 2035 has 50 MW that met our "planned" criteria. The remaining 50 MW of solar would be labelled as conceptual.

Conceptual resources were aggregated by region and resource type to determine additional capacity, on top of existing and planned resources, should be mapped to specific buses and integrated into the 10-year Resource dataset.

5.4.1.2.3 CAISO Resources from 2024-25 TPP

All CAISO resources from the 2024–25 TPP 2034 GridView case were incorporated without modification.

5.4.1.2.4 Out-of-Region Conceptual Resources

IRPs often included stated plans to procure resources outside of their service territories or might not have enough viable or reasonable locations to build new resources in their footprints. These instances were documented and represented with committed region/physical region designations consistent with utility preferences stated in IRPs. For resources physically located in a different region, naming conventions were structured to clearly indicate this distinction. This ensured that interregional relationships with remote resources were preserved in all models.

Table 5-3 below showcases the committed region/physical region designation and resource capacities.

TABLE 5-3. REMOTE RESOURCES IN 2035 REFERENCE CASE

Committed Region	Remote Region	Solar PV	Wind	Battery Storage
BANC (California)	California	895	0	0
	Northwest	0	425	0
LDWP (California)	Basin	0	548	0
	California	1,388	0	522
	Northwest	0	183	0
	Southwest	1,388	1,096	522
AVA (Northwest)	Northwest	0	643	0
PGE (Northwest)	Northwest	0	1,001	0
	Rocky Mountain	0	334	0
PSEI (Northwest)	Basin	0	600	0
	British Columbia	307	95	32
	Northwest	0	750	125
SCL (Northwest)	Northwest	175	245	0

5.4.1.2.5 Distributed Solar and Demand Response

Special consideration was given to representing future capacities for distributed generation- solar (DG) and demand response (DR). For demand response, the less of the winter and summer reported IRP values were adopted due to PCM model differentiating between the two capacities. For solar DG, each region's 2034 ADS forecast was retained or scaled up if the region's IRP reported a higher value.

Both solar DG and demand response were distributed, by default, to nodes across entire region load areas consistent with 2034 ADS.

5.4.1.2.6 Un-Sited IRP Committed Resource Table

The preceding steps resulted in a comprehensive table of existing and planned resources sited to specific buses as well as 87 GW of un-sited conceptual resources that required busbar mapping to be properly connected to the transmission grid.

Conceptual ("generic") resources were compiled from IRPs but were not mapped to specific buses (points of interconnection). The preceding steps resulted in an internal "Unmapped IRP Committed" table. This table included the MWs of each resource type that were expected within each GridView region (balancing authority) by 1/1/2035. The IRP review identified approximately 87 GW of unsited conceptual resources which were mapped to nodal buses.

5.4.1.3 Busbar Mapping

5.4.1.3.1 Bus Table & Siting Criteria

The conceptual busbar mapping effort aimed to fully allocate the 87 GW of unmapped conceptual resources to reasonable locations on the system. All conceptual resources identified in the IRP review were mapped to buses 230kV or higher, which helped the study team better track interregional transmission solutions for the WestTEC study. Several different kinds of siting criteria were associated with each bus, including:

- Commercial interest score (from the 2022 LBNL Queued Up study; split out for solar, wind, and battery)
- Land use score
- Disadvantaged community score
- Transmission interconnectedness score (Number of edges (230kV+ lines) connecting to the bus)

Using the above criteria, a set of siting weights were developed to calculate a bus siting score for each region and rank ordered in to prioritize the "best" buses, see weights Table 5-4 below. In general, the scores prioritized commercial interest, land use, and disadvantage communities score, but more connected buses were also used to inject power centrally within each region.

TABLE 5-4. BUSBAR MAPPING SCORE WEIGHTS

Resource Category	Included Resource Types	Transmission Network Score	Commercial Interest	Land Use	Societal
Solar	Solar PV, Hybrid PV	25%	25%	25%	25%
Wind	Onshore Wind, Hybrid Wind	25%	25%	25%	25%
Battery	Stand-alone Batteries	25%	75%		
Firm		Natural Gas Geothermal, ICE		Sited in consultation with WATT Members	

Note that hybrid resources, such as paired PV and battery, had to be represented by two generators in the 10-yr resource dataset. In these cases, the battery was always mapped in the same proportion as the paired generator (e.g., 40% of capacity to bus A, 20% to bus B, etc.).

5.4.1.3.2 Injection Limits

No injection studies were performed for this process. Instead, max injection potentials were estimated for each bus in the system given 1) its voltage, and 2) the “edge count” or number of 230kV lines that go in or out of a given bus. These numbers were developed and vetted by Energy Strategies staff and help to get future resources located more centrally in the grid, rather than on isolated or radial areas.

TABLE 5-5. MAX INJECTION POTENTIAL (MW) BY EDGE COUNT AND VOLTAGE

Base kV	1	2	3	4	5+
230	37.5	93.75	187.5	281.25	375
345	75	187.5	375	562.5	750
500	150	375	750	1125	1500

5.4.1.3.3 Watt Review

Resources were initially assigned to specific buses using a composite siting score that incorporated the above-mentioned commercial interest/queue data, land use, resource quality, community constraints, and transmission connectivity. WATT then formed subregional teams of local utility experts to review the physical siting. The major areas of feedback Energy Strategies received from WATT members were:

- Refined bus-level assignments for existing, planned, and conceptual generators, especially firm generators, based on input from local utility experts
- Updated inaccurate generator nameplate capacities due to data source discrepancies
- Relocated large renewable facilities outside of urban centers
- Corrected generator operating details, including commissioning and retirement dates
- Identified additional generator units missing from the 2034 ADS or not captured in recent IRPs

All of the feedback was incorporated into the final 10-year WestTEC Reference Case dataset, and further review was done by Energy Strategy’s power flow and PCM teams to ensure proper representation.

Values in Table 5-6 on the following page represent the in-service nameplate capacity of resources in the final 2035 models by point of interconnection, even though some of these resources may be contractually committed to offtakers in other balancing authorities.

TABLE 5-6. WESTTEC 10-YR REFERENCE CASE NAMEPLATE CAPACITY (MW)

Region Name	Coal	Natural Gas	Nuclear	Geothermal	Hydro	Solar PV	Wind	Battery Storage	Other	Demand Response	Solar DG	Total
AB_AESO	0	14,369	0	0	896	3,486	5,893	270	375	0	583	**25,871**
BC_BCHA	0	141	0	0	17,052	451	1,180	32	879	0	0	**19,734**
BS_IPCO	0	795	0	79	2,293	2,401	3,398	1,007	16	120	106	**10,215**
BS_PACE	5,252	4,301	345	155	276	5,213	11,429	1,510	13	521	2,080	**31,094**
CA_BANC	0	1,377	0	0	2,294	1,055	0	1,200	636	0	1,360	**7,921**
CA_CFE	0	4,399	0	570	0	950	40	0	706	0	0	**6,665**
CA_CISO	19	25,312	0	1,975	7,235	40,469	20,066	31,216	23,054	1,825	30,434	**181,603**
CA_IID	0	739	0	1,777	64	1,479	0	711	106	0	109	**4,986**
CA_LDWP	0	321	0	885	324	2,466	425	5,661	3,655	579	850	**15,166**
CA_TIDC	0	1,021	0	50	222	264	40	100	114	0	113	**1,924**
NW_AVA	0	856	0	0	1,248	19	509	0	209	14	56	**2,911**
NW_BPAT	0	3,247	1,169	4	22,211	2,405	9,269	1,377	611	267	141	**40,700**
NW_CHPD	0	0	0	0	1,984	0	0	0	0	0	0	**1,984**
NW_DOPD	0	0	0	0	840	0	0	0	0	0	1	**841**
NW_GCPD	0	0	0	0	2,192	277	100	121	270	0	1	**2,961**
NW_NWMT	1,659	332	0	0	751	418	7,161	347	509	69	173	**11,418**
NW_PACW	0	1,144	0	0	967	1,483	3,019	943	56	187	945	**8,743**
NW_PGE	0	1,686	0	0	706	1,507	717	637	236	95	145	**5,728**
NW_PSEI	0	1,772	0	0	342	647	966	1,300	759	374	1,054	**7,213**

Region Name	Coal	Natural Gas	Nuclear	Geothermal	Hydro	Solar PV	Wind	Battery Storage	Other	Demand Response	Solar DG	Total
NW_SCL	0	0	0	0	1,945	0	0	0	0	96	43	**2,084**
NW_TH_Malin	0	0	0	0	0	7	0	0	180	0	0	**187**
NW_TPWR	0	0	0	0	787	0	0	0	0	10	0	**797**
NW_WAUW	0	0	0	0	226	0	0	0	0	0	3	**228**
RM_PSCO	0	5,498	0	0	17	4,553	6,010	2,659	374	786	2,768	**22,665**
RM_WACM	1,946	1,921	0	20	1,363	1,932	2,049	662	257	128	164	**10,444**
SW_AZPS	0	4,593	0	0	0	7,539	2,907	4,082	715	600	3,764	**24,201**
SW_EPE	0	1,129	0	0	0	1,892	203	1,142	0	81	159	**4,606**
SW_NVE	242	6,061	0	1,361	1	10,725	0	4,818	33	15	1,817	**25,072**
SW_PNM	0	1,322	0	11	51	4,351	9,173	2,855	0	280	527	**18,571**
SW_SRP	0	7,503	0	0	80	11,706	882	4,631	1,159	300	1,273	**27,533**
SW_TEPC	0	1,495	0	0	0	2,409	1,001	1,960	188	242	479	**7,774**
SW_TH_Mead	0	293	0	0	2,079	0	0	0	0	0	0	**2,372**
SW_TH_PV	0	4,054	4,210	0	0	406	0	0	0	0	0	**8,669**
SW_WALC	0	1,330	0	0	1,706	4,003	685	270	0	0	78	**8,073**
Total	**9,118**	**97,008**	**5,724**	**6,886**	**70,151**	**114,513**	**87,123**	**69,510**	**35,109**	**6,587**	**49,226**	**550,955**

5.4.1.3.4 10-Year Horizon Gap

E3 and Energy Strategies compared these 10-year resource levels with results from the 20-year Reference Case capacity expansion model and determined that no additional resources were needed to fill resource adequacy gaps in the 10-year timeframe. Accordingly, no expansion resources were included in the 10-year study.

5.4.1.4 Transmission Topology

Energy Strategies developed a transmission topology consistent among WestTEC power flow and PCM models, with documentation listing projects included based on criteria in the WestTEC Study Plan. The transmission network was based on the WECC 2034 ADS case, modified to incorporate updates and region-specific projects. This included the following topology enhancements:

- Adjustments to line ratings, transformer configurations, and series compensation;
- Reconfigurations of topology to align with expected system evolution by 2035.

The resulting topology represents a feasible, near-term network aligned with ongoing planning trajectories, but explicitly excludes speculative, long-lead infrastructure more suitable for evaluation in the 20-year study. Ten-Year Planned Upgrades included in the 2035 Reference Case are shown in Table 5-7.

TABLE 5-7. 10-YEAR PLANNED TRANSMISSION LINES

Project Name	Upgrade Type	Line Miles	Estimated Cost ($M)	Project Sponsor(s)	Cost Source
New Jojoba to Rudd 500kV Line	New Line	31	$146	AZPS	MTEP
Montana to Washington (M2W)	Uprate	90	$545[23]	BPA	Developer
Six Mile Canyon Substation	Substation	NA	$250[23]	BPA	Developer
Bonanza to Lower Columbia 500kV Reinforcement Project - Longhorn to Bonanza Line	New Line	274	$1,300[23]	BPA	Developer
Bonanza Substation	Substation	NA	$300[23]	BPA	Developer
Rebuild Big Eddy - Ostrander-Pearl 500kV Line	Rebuild	91	$670[23]	BPA	Developer
Rebuild Pearl - Chemawa 230kV Line	Rebuild	25	$50[23]	BPA	MTEP
New Bonanza - Lapine 230kV Line	New Line	53	$150[23]	BPA	Developer
Cross Cascades North Upgrade TSEP 2022	Reconductor	77	$400[23]	BPA	Developer

[23] BPA cost estimates include direct costs only and do not include overheads.

Project Name	Upgrade Type	Line Miles	Estimated Cost ($M)	Project Sponsor(s)	Cost Source
Rebuild Grand Coulee - Columbia - Schultz 500kV Line	Rebuild	98	$1,079[23]	BPA	MTEP
North of Marion: Rebuild Marion-Chemawa-Pearl 500kV Line	Rebuild	47	$225[23]	BPA	MTEP
North of Pearl 500kV Upgrade (incl. Pearl-Keeler #2 500kV)	New Line	19	$88[23]	BPA	MTEP
Reconductor Ostrander - Pearl #1 500kV Line	Reconductor	20	$21[23]	BPA	MTEP
Raver -Paul: Chehalis - Cowlitz Tap 230kV	Reconductor	35	$95[23]	BPA	Developer
Rebuild Schultz - Olympia 500kV Line	Rebuild	131	$508[23]	BPA	MTEP
South of Allston: Rebuild Ross-Rivergate 230kV Line	Rebuild	8	$50[23]	BPA	Developer
South of Knight: Reconductor Rock Creek-John Day 500kV Line	Reconductor	14	$37[23]	BPA	Developer
Reconductor Colorado River-Red Bluff 500kV #1 Line	Reconductor	32	$50	CAISO	Developer
Humboldt to Fern Road 500 kV line	New Line	140	$1,400	CAISO	Developer
Humboldt to Collinsville 500 kV line	New Line	260	$2,740	CAISO	Developer
New San Jose Area HVDC 230kV Line (Newark - NRS)[24]	New Line	12	$726	CAISO, LS Power Grid California LLC	Developer
Ten West Link	New Line	125	$555	CAISO, DCR Transmission	Developer
New Imperial Valley–North of SONGS 500kV Line and Substation	New Line	145	$2,280	CAISO, Horizon West Transmission (NextERA)	Developer
New North Gila - Imperial Valley #2 500kV Line	New Line	85	$340	CAISO, Horizon West Transmission (NextERA)	Developer
TransWest Express	New Line	732	$3,000	CAISO, LADWP, TWE	Developer
SWIP-North	New Line	285	$1,230	CAISO, LS Power, NVE, IPCo	Developer

[24] This project was modified such that the Newark – NRS HVDC became an AC project and the Metcalf – San Jose B HVDC was modified to 1,000 MW from 500 MW in addition to some other changes (including the 230 kV project, approved in the 2024-2025 TPP, between NRS and San Jose B) in the 2024-2025 CAISO TPP.

Project Name	Upgrade Type	Line Miles	Estimated Cost ($M)	Project Sponsor(s)	Cost Source
SunZia	New Line	552	$1,800	CAISO, Pattern	Developer
New Serrano–Del Amo–Mesa 500kV Line[25]	New Line	41	$1,125	CAISO, SCE	Developer
New North of SONGS – Serrano 500kV line	New Line	31	$503	CAISO, SCE, Lotus Infrastructure	Developer
Ready WY: Sweetgrass - Bluffs 230 kV Line, West Cheyenne - Sweetgrass 230 kV Line, West Cheyenne - Windstar 230 kV Line	New Line	260	$260	Cheyenne, BHE	Developer
New Afton North-Airport 345kV Line	New Line	12	$2	El Paso Ele	Developer
New Afton-Afton North 345kV Double Bundled Line	New Line	1	$2	El Paso Ele	Developer
New Hemingway - Bowmont #2 230kV line	New Line	13	$29	ID Power	Developer
New Hubbard - Bowmont 230kV Line	New Line	16	$36	ID Power	Developer
New Mayfield 230kV Substation and Transmission Lines	New Line	8	$32	ID Power	MTEP
New Mayfield Substation to Boise Bench Substation 230kV Line	New Line	20	$50	ID Power	Developer
New Mayfield Substation to Chip Substation 230kV Line	New Line	16	$41	ID Power	Developer
New Mayfield Substation to South Boise Substation 230kV Line	New Line	21	$45	ID Power	Developer
Longhorn to Hemingway (B2H)	New Line	290	$1,200	IPCo/PAC	Developer
Greenlink North	New Line	235	$1,380	NVE	Developer
Greenlink West	New Line	350	$2,820	NVE	Developer
New Lantern – Comstock Meadows 345kV line	New Line	33	$124	NVE, Sierra Pacific	MTEP
New Corral - Grassland Annex 500kV Line	New Line	159	$659	PacifiCorp	MTEP

[25] Under review by the CAISO as of the writing of this report

Project Name	Upgrade Type	Line Miles	Estimated Cost ($M)	Project Sponsor(s)	Cost Source
New Corral - Snow Goose 500kV Line	New Line	161	$763	PacifiCorp	MTEP
Energize the existing Red Butte – St. George line at 345 kV	New Line	20	$75	PacifiCorp	MTEP
New Grassland Annex - B2H Tap Substation 500kV Line	New Line	16	$76	PacifiCorp	MTEP
New Oquirrh-Terminal 345 kV #3 and #4 Double Circuit Line	New Line	14	$52	PacifiCorp	MTEP
New Sigurd - Clover 345kV Line	New Line	69	$125	PacifiCorp	Developer
New Spanish Fork - Mercer 345kV Line	New Line	45	$106	PacifiCorp	Developer
New Three Peaks - Purgatory Flat 345kV Line	New Line	55	$205	PacifiCorp	MTEP
Energy Gateway	New Line	2300	$8,200	PacifiCorp, IPCo	Developer
New Harborton - Trojan #3 & #4 230kV Line	New Line	33	$135	PGE	Developer
New Bethel-Round Butte 500kV Line (Warm Springs Power Pathway)	New Line	100	$857	PGE, Confederated Tribes of Warm Springs	Developer
Bolo Tie	New Line	35	$168	PNM	MTEP
New Western Spirit - Chavez County 345kV Line	New Line	136	$525	PNM	Developer
New Western Spirit - Hidden Mountain 345kV #2 Line	New Line	104	$480	PNM	Developer
New Rio Puerco - Prosperity 345kV Line	New Line	36	$195	PNM	Developer
Colorado's Power Pathway	New Line	550	$1,700	PSCo	Developer
Cross-Cascades Project	New Line	235	$3,700	PSE	MTEP
New Hassayampa - Pinal West 500kV #2 Line	New Line	51	$244	Salt River	MTEP
Southeast Power Link	New Line	7	$71	Salt River	Developer
New Badger Creek - Big Sandy 230kV Line	New Line	80	$86	Tri-State	Developer

Project Name	Upgrade Type	Line Miles	Estimated Cost ($M)	Project Sponsor(s)	Cost Source
Big Sandy - Burlington 230kV Uprate	Rebuild	81	$8	Tri-State	Developer
New Boone - Huckleberry 230kV Line	New Line	30	$40	Tri-State	Developer
New Burlington - Lamar 230kV Line	New Line	107	$107	Tri-State	Developer
Rebuild DMP - Vail 230kV Line	Rebuild	12	$24	Tuscon Ele	MTEP
Rebuild Tortolita - DMP 230kV Line	Rebuild	52	$104	Tuscon Ele	MTEP
New Golden Valley 230kV Line	New Line	17	$64	Tuscon Ele, UniSource Energy Services	MTEP
Bouse Upgrade	New Line	20	$47	WAPA	MTEP
New Pinal Central - ED5 230kV Line	New Line	19	$44	WAPA	MTEP
Pinnacle Peak - Rogers 230kV Restoration Project	Rebuild	3	$14	WAPA	Developer
Ault-Husky 230KV Line Upgrade	Rebuild	5	$9	WAPA	MTEP

The North Plains Connector (NPC) is shown on the study maps but is not included in this list of Planned Projects. Steering approved inclusion of the NPC for modeling, however, the NPC was represented in the 10-year analyses as an import at Colstrip (i.e., modeled as an injection rather than as a network facility) and therefore was excluded from the Planned Projects listing.

5.4.1.5 Production Cost Model Data

The GridView production cost model (PCM) was developed using inputs from the 2034 WECC Anchor Data Set (ADS) and the 2024–2025 CAISO Transmission Planning Process (TPP) and was subsequently updated to reflect 2035 projected conditions.

5.4.1.5.1 Fuel Prices

Fuel prices were updated with 2035 projections from several sources. They were initially provided in 2022$ and were updated using the latest US government Consumer Price Index data to adjust the prices to 2024$.

- Natural gas prices were sourced from the CEC's 2023 IEPR (Integrated Energy Policy Report) burner tip price forecast. There are 31 hubs which each have their own monthly prices. Each NG hub is assigned to the NG generators in the area. (i.e. Montana hub NG prices apply to all NG generators in Montana.

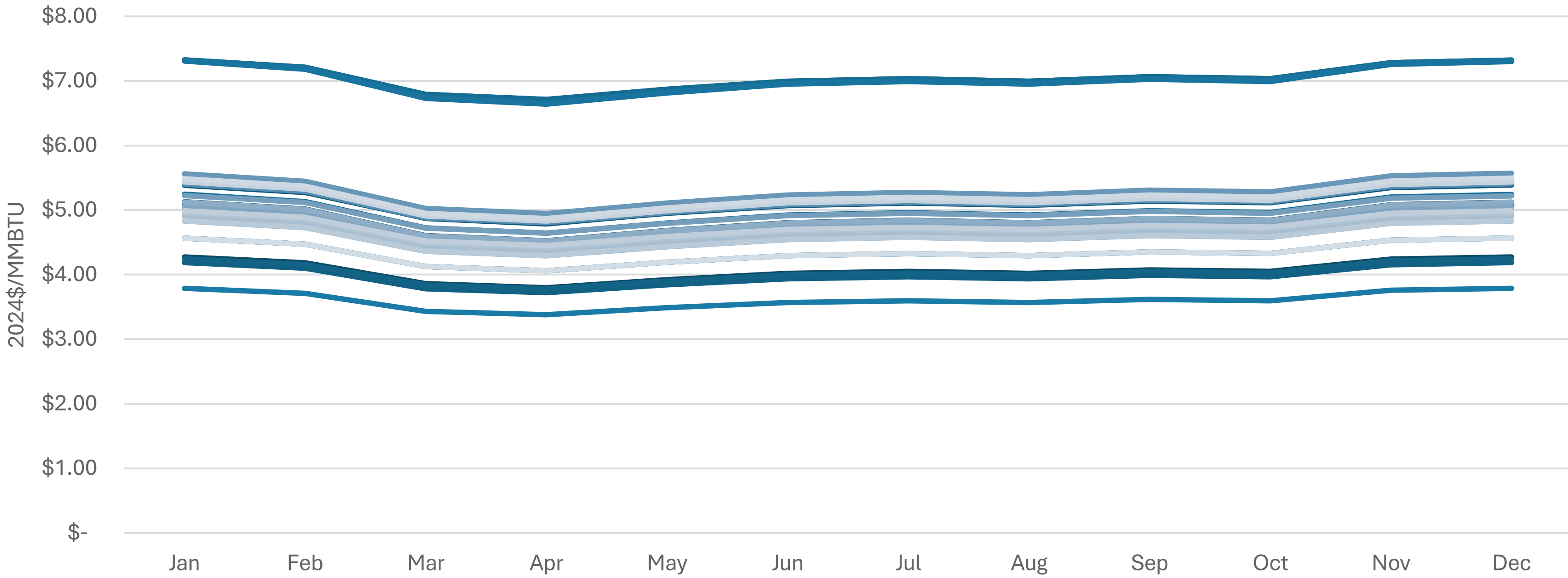

FIGURE 5-1. 2035 MONTHLY NG BURNER TIP PRICES FOR WECC PRICING HUBS ($2024/MMBTU)

Oil and Uranium fuel prices were sourced from the 2023 EIA Annual Energy Outlook 2023. Coal prices come from stock 2034 ADS assumptions. Prices range from as low as 0.518 $/MMBTU for a Wyoming generating station to as high as 2.456 $/MMBTU. The average price is 1.24 $/MMBTU.

TABLE 5-8. OIL AND URANIUM FUEL PRICES IN 2035 REFERENCE CASE

Fuel Type	Price ($2024/MMBTU)
Distillate Fuel Oil	$24.42
Residual Fuel Oil	$17.58
Uranium	$0.71

5.4.1.6 Market Model

WestTEC evaluated future transmission needs assuming a future in which the West operates under a single day-ahead energy market (or a future in which multiple day-ahead markets have no inter-market friction with highly efficient seams). The WestTEC approach was to be agnostic to future day-ahead market footprints and does not seek to identify transmission upgrades that are based on market seams. Thus, this approach allows the study to focus less on near-term market seams and more on long-term fundamentals that are likely to drive transmission infrastructure. In the event that the WestTEC analysis is refreshed or iterated upon, there is opportunity to reconsider the impact of market footprints.

It was assumed that up to 90% of the capacity between balancing authorities is available in the day- ahead market and that 100% of transfer capability is available for real-time optimization. Tarriff rates from the Open Access Transmission Tariffs apply to any transfers above the 90th percentile in the day-ahead timeframe. Since the modeling approach assumed an integrated day-ahead market, the study did not attempt a detailed representation of contract paths or transmission service reservations.

5.4.1.7 Carbon Model

By 2035, the study assumes that California, Oregon, and Washington will participate in a linked carbon market, allowing for coordinated carbon pricing across the West Coast. For the WestTEC 2035 Reference Case, the carbon price trajectory, representing allowance costs, was derived directly from the CEC’s 2023 IEPR using this framework:

1. Emitting generators within these states are charged a $38.90 per short ton penalty that mirrors the cost of purchasing a carbon allowance, with this cost reflected in their energy bid prices.
2. Imports into these states (but not transactions between them) are subject to a $18.35 per MWh carbon adder, similar to the existing AB-32 program in California, which helps prevent emissions leakage.

British Columbia and Alberta use the ADS assumptions of $69.92 per short ton.

5.4.2 System Reliability Assessment

5.4.2.1 Model Development

The System Reliability Assessment is a holistic system evaluation that focusses on the following four stressed, but credible system conditions; all developed using actual system characteristics derived from production cost modeling and vetted through WATT discussions:

- Heavy Summer Peak Load
- Heavy Winter Peak Load
- High Solar Generation
- High Wind Generation

Power flow cases representing these scenarios were developed from the WECC 2034 Heavy Summer and 2033 Heavy Winter planning cases. Loads, resources, and transmission topology in the WECC seed cases were updated to reflect the WestTEC 2035 reference case assumptions.

Each dispatch case was constructed from the modified WECC seed cases using a set of core modeling assumptions, summarized below:

- **Load Assumptions:** Load dispatch levels were calculated as the average of the hourly load data from the 2035 reference case for the top five hours corresponding to each SRA scenario. Since hourly load data is based on a "1 in 2" load forecast, an adjustment was applied to increase the loads to reflect "1 in 10" year planning conditions to study more critical system load conditions. The summer and winter peak load levels are based on WECC-wide coincident peaks and may not reflect the seasonal peaks for each balancing area.
- **Renewable Dispatch:** Renewable generation levels were derived from resource outputs for hours corresponding to each SRA scenario in the production cost model. The dispatch was calculated as average capacity factors and reflected geographic variability at the balancing authority level. These values were used directly in setting solar and wind outputs in the SRA cases.
- **Storage Dispatch:** The Study Plan originally assumed storage resources would be idle (0 MW output). However, SRA cases considered alternate behavior—some storage units were modeled as partially depleted while others held reserve to dispatch during evening ramp periods. Observations from the production cost model were used to refine dispatch values.
- **Hydro Dispatch:** Hydro generation was calibrated using a combination of dispatch profiles from the production cost model and input from WATT members on dispatch of FCRPS hydro facilities based on seasonal water availability and regional constraints.
- **Thermal Dispatch:** Base-loaded thermal resources, including coal and nuclear, were generally dispatched near their maximum capacity as reflected in the WECC seed cases. Gas-fired and peaking units were committed and dispatched as needed to balance load and support interchange targets. Colstrip units 3 and 4 were modeled at 518 MW each based on expected changes to unit ownership, as approved by WATT.
- **DC Line Flows:** DC Line flows were established using average hourly flows observed in the production cost model during representative hours for each SRA scenario, with some adjustments to prevent unintended loop flows - such as ensuring PDCI and COI flows are in the same direction.
- **Interchange Targets:** Area-level interchanges were established using average hourly flow data from the production cost model, representing economic dispatch patterns across balancing areas during high-stress conditions. Adjustments to reflect contractual or operational expectations were incorporated based on WATT feedback. North–South and East–West interties between Canada and the U.S. were preserved at WECC seed case levels.

5.4.2.2 Analytical Approach

Steady State AC contingency analysis was performed using Power World version 23. 5,978 contingencies were simulated for each SRA case, which included:

- Single line outage of all elements at 230 kV and above in the US Western Interconnection footprint.
- Relevant common tower, breaker failure and extreme event contingencies provided by WATT members.

Energy Strategies monitored elements in the US Western Interconnection footprint at 230 kV and above, using thermal ratings and voltage limits provided with WATT members.

5.4.2.3 Findings

The assessment identified thermal overloads on monitored transmission lines and transformers; voltage violations resulting from system stress or reactive power deficiencies; and impacts on major WECC paths and interties. Violations on elements with rated voltage under 300 kV and within a single area were classified as local violations. While those on elements 300 kV and above or between two areas were classified as inter-regional issues. This study only mitigated inter-regional violations, since WATT agreed that local issues will be addressed through member's transmission planning process.

Energy Strategies developed transmission solutions to mitigate identified reliability issues, with inputs from WATT members. The SRA transmission portfolio includes a combination of greenfield projects, rebuild and reconductoring of existing lines and substation upgrades which help improve system reliability in the 10-year period.

5.4.3 Interarea Deliverability Assessment

Interarea Deliverability Assessment is a targeted transfer analysis that identifies transmission needed to ensure resources from outside a given region can be reliably transferred to loads during times of high regional demand. It ensures generation that is needed to support resource adequacy has the transmission to do so. The analysis primarily focused on constraints associated with:

- Regions that are critical exporters of energy;
- Regions that do not have sufficient transmission to support the 10-year planned resource build out;
- Regions that are dependent on imports during system stress events.

This led WestTEC to focus on two deliverability scenarios:

- **SCENARIO 1.** Northwest Imports
- **SCENARIO 2.** WECC East-to-West Transfers

The analysis evaluated the power transfer capacity between two regions or subsystems and identified violations that limit the transfer below desired levels for system intact and contingency conditions. Transfer analysis is primarily a DC analysis with AC verification and focuses on thermal overloads. We developed conceptual solutions for thermal overloads and then ran AC contingency analysis to identify any remaining voltage violations that were not mitigated.

This analysis was performed using Transfer Limit Analysis tool in Power Gem TARA. A **"Source"** subsystem, a **"Sink"** subsystem and a **"Study Interface"** were defined for each IDA scenario in TARA. A Source subsystem is the region from where power is exported to meet demand in the Sink subsystem. The total power transfer between the Source and Sink is measured across the Study Interface. TARA incrementally increases transfers under system intact and contingency conditions until a violation occurs, or the target transfer level is reached. Transmission solutions developed for each violation were tested iteratively until the desired transfer level was reached.

Detailed assumptions for each IDA scenario are described below.

5.4.3.1 Scenario 1 – Pacific Northwest Imports Study Assumptions

This scenario tested whether the PNW can reliably import power during winter peak conditions and transfer it westward across the Cascades. To be able to capture impacts of both transfers, Energy Strategies developed two sub-scenarios:

- **SCENARIO 1A.** Import 14.1 GW into the Pacific Northwest
- **SCENARIO 1B.** Transfer 17.3 GW from east of the Cascades to the west.

The IDA target transfer levels are derived as average of 10 highest levels of PNW imports and cross-cascades flows observed in the 2035 Reference Case production cost model.

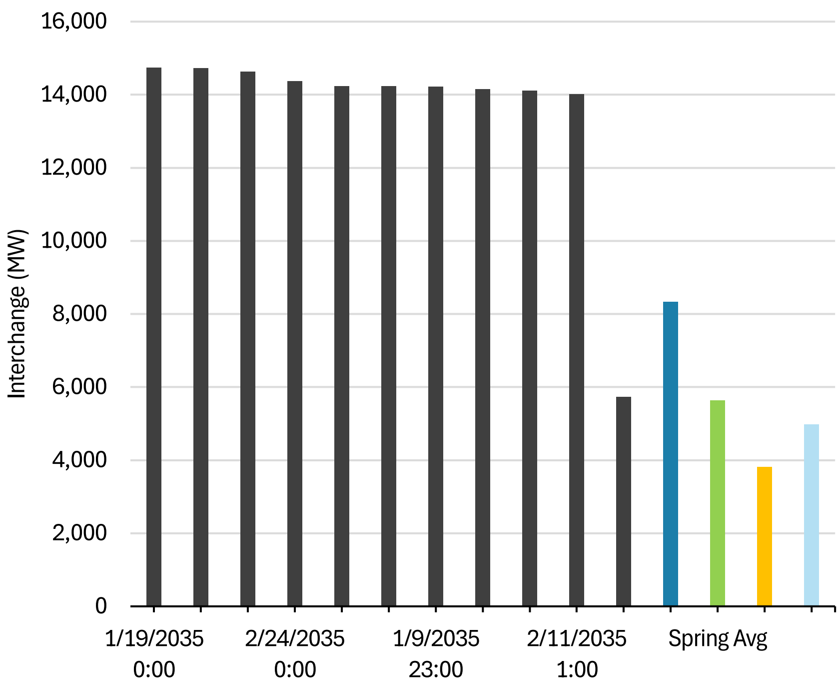

FIGURE 5-2. MAXIMUM PACIFIC NORTHWEST IMPORTS IN THE 2035 REFERENCE CASE

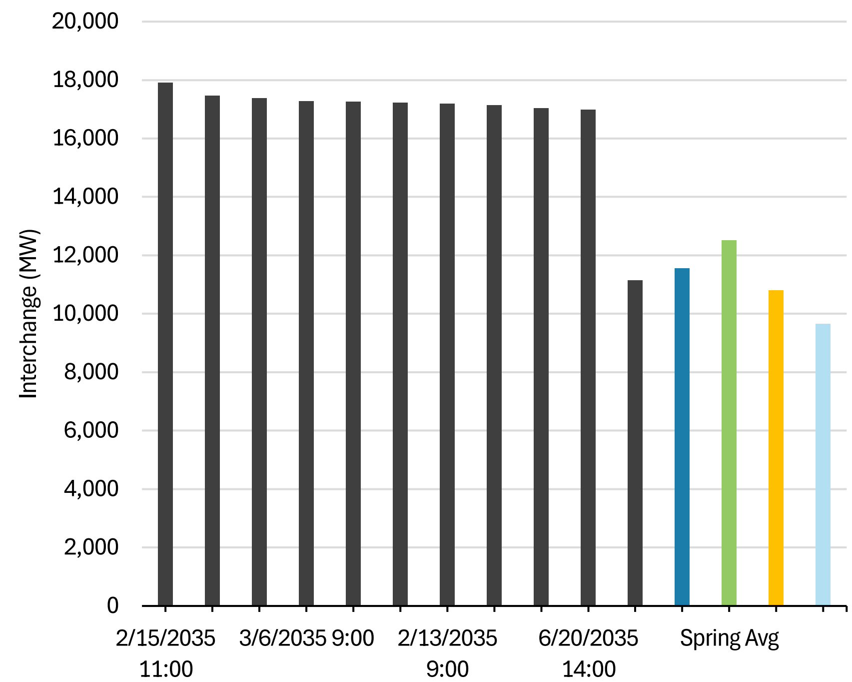

FIGURE 5-3. MAXIMUM E->W CROSS-CASCADES FLOWS IN THE 2035 REFERENCE CASE

The 2035 Heavy Winter SRA case was used as the seed case. Other assumptions are detailed below.

TABLE 5-9. IDA SCENARIO 1A STUDY ASSUMPTIONS

Assumption	Description
Case Updates	Set Path 3 flow to 1500 MW, flowing from PNW to BC Hydro.
Study Interface	Lines in P08 Montana to Northwest, P14 Idaho to Northwest, P65 Pacific DC Intertie, P66 COI, P75 Hemingway-Summer Lake, P76 Alturas Project
Source Subsystem	PG&E (Area 30), Idaho (Area 60), Montana (Area 62), PacifiCorp East (Area 65), NVE (Area 64)
Sink Subsystem	Pacific Northwest (Area 40)
Contingency	WestTEC contingencies in Areas 30, 40, 60 and 62; any PDCI outages
Line monitoring	Following elements were monitored: 1. All the WECC Paths that form the study interface and lines that make up these paths 3. All Interfaces in the Pacific Northwest 2. Elements in and ties to the Pacific Northwest that are at 230 kV and above 3. Elements at 345 kV and above in the Source subsystem

TABLE 5-10. IDA SCENARIO 1B STUDY ASSUMPTIONS

Assumption	Description
Case Updates	Set Path 3 flow to 1500 MW, flowing from PNW to BC Hydro.
Study Interface	P04 West of Cascades-North P05 West of Cascades-South Klamath Falls - Meridian 500 kV line Klamath Falls - Boyle 230 kV line
Source Subsystem	Montana (Area 62) and zones in the Pacific Northwest that are east of the Cascades
Sink Subsystem	Zones in the Pacific Northwest that are west of the Cascades
Contingency	WestTEC contingencies in Area 40 as well as any PDCI outages
Line monitoring	We will monitor all the following elements: 1. All the WECC Paths in the Pacific Northwest 2. Elements in the Pacific Northwest that are at 230 kV and above

5.4.3.2 Findings

Scenario 1a evaluation identified the need for a new 500 kV lines from MT to WA and a new line from Northern NV to Oregon, as well upgrades on two existing transmission lines to be able to import 14.1 GW into the PNW. No additional transmission upgrades are required to achieve target transfers east of the Cascades to the west. The planned projects BPA, PSE and PGE have in place to expand capacity across the Cross-Cascades interfaces provide sufficient transmission capacity. Some of these larger Cross-Cascades capacity expansion projects are still in the planning phase and have energization dates in 2035. Timely completion of planned projects is essential to these IDA findings.

5.4.3.3 Scenario 2 – WECC East – West Transfers Study Assumptions

This scenario evaluated whether transmission from eastern WECC (MT/WY/CO/NM/AZ-E) to western WECC (PNW/CA/UT/NV/AZ-W) can support high renewable transfers during periods of surplus generation. The target transfer level for this scenario is the average of 10 highest WECC East to West flows observed in the 2035 Reference Case production cost model.

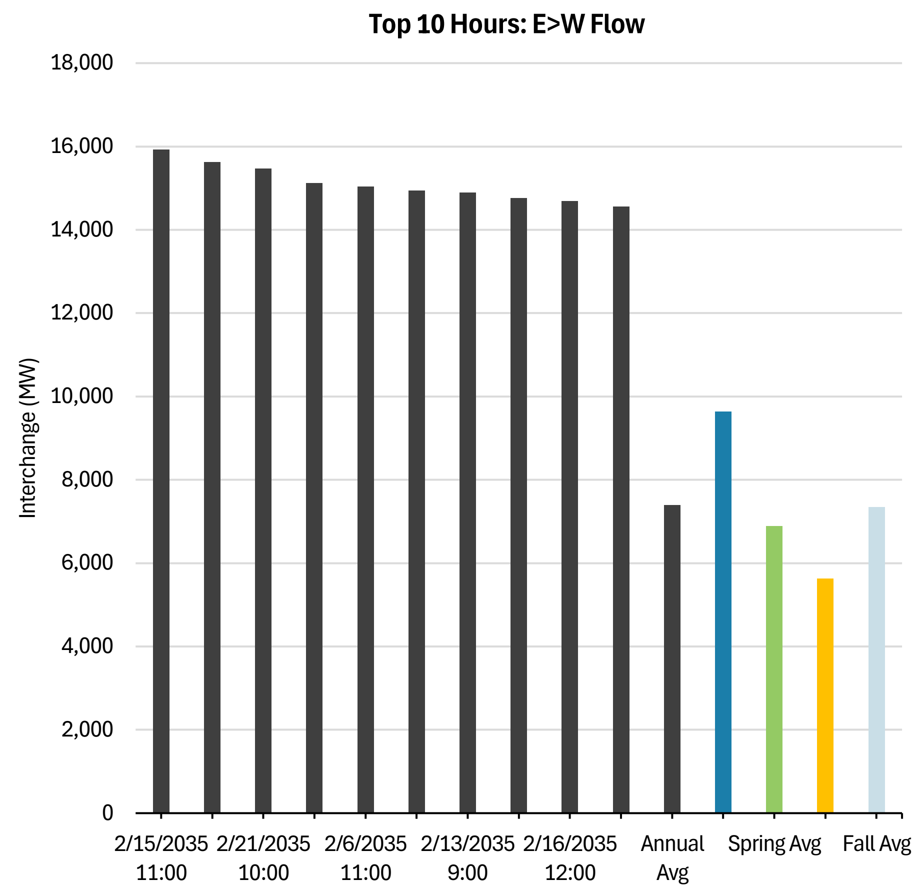

FIGURE 5-4. MAXIMUM WECC EAST – WEST TRANSFER IN THE 2035 REFERENCE CASE

We also performed a sensitivity analysis to evaluate whether the following out of state wind identified in CPUC's resource portfolio that could be delivered to CAISO:

- 3,000 MW of Wyoming wind delivered to El Dorado, 1500 MW of which will be delivered on Transwest Express AC line.
- 3,099 MW of New Mexico wind delivered to Palo Verde through the Sun Zia transmission project.
- 1,750 MW of New Mexico wind delivered to Lugo.

The 2035 High Wind SRA case was used as the seed case. Other assumptions are detailed in Table 5-11.

TABLE 5-11. IDA SCENARIO 2 STUDY ASSUMPTIONS

Assumption	Description
Case Updates	Flow on Transwest Express and Intermountain DC lines set to maximum
Study Interface	P08 Montana to Northwest, P18 Montana-Idaho, P19 Bridger West - Post Gateway West, Gateway South Transmission Project, Naughton - Ben Lomond 230 kV, Naughton - Treasureton 230 kV and Birch Creek - Ben Lomond 230 kV, P30 TOT 1A, P78 TOT 2B1, P31 TOT 2A Cholla - Pinnacle Peak 345 kV #1 and #2 Line, Springerville - Greenlee 345 kV Line, Four Corners - Moenkopi 500 kV Line, Ship Rock - Kayenta 230 kV Line, Sun Zia HVDC Line, Cholla - Saguaro 500 kV Line, Transwest Express HVDC, Hidalgo - Greenlee 345 kV line, Coronado - Silver King 500 kV Line, Cholla-Leupp 230 kV Line, Sugarloaf 500/69 kV Transformer
Source Subsystem	Montana (Area 62), WAPA R.M. (Area 73), PSCo (Area 70), New Mexico (Area 10), El Paso Electric (Area 11), PacifiCorp Zones in WY, Zones in Eastern AZ
Sink Subsystem	Pacific Northwest (Area 40), Idaho (Area 60), PacifiCorp Zones in ID and UT, APS (Area 14), SRP (Area 15), TEP (Area 16), AEPCO (Area 17), NVE (Area 18), WALC (Area 19)
Contingency	Single Line outage at 345 kV and above, in all areas included in the Source and Sink subsystems
Line monitoring	1. Elements at 345 kV and above in the Source and Sink subsystems 2. All WECC Paths.

5.4.3.4 Findings

Scenario 2 identified a new AC line and upgrades on some of the exiting 345 kV lines to enable exports out of New Mexico, as well as upgrades to the Transwest Express phase shifting transformers. These upgrades enabled 15.1 GW of transfers from East to West in the WECC system.

5.4.4 Congestion Assessment

Following the completion of the System Reliability Assessment (SRA) and Inter-Area Deliverability Assessment (IDA), a congestion assessment was conducted to evaluate remaining transmission constraints within the interconnection. While the SRA and IDA incorporated a range of conceptual transmission upgrades to address reliability and deliverability needs, this subsequent analysis focused on identifying economically driven and interregional transmission improvements that could further enhance system transfers and resource access.

5.4.4.1 Analytical Approach

Transmission upgrades from the SRA and IDA were incorporated into the 10-Year Reference Case model to establish a representative baseline system configuration. Using this enhanced model, the team conducted a detailed review of congestion patterns across major transmission interfaces and interties, focusing on the metrics presented in Section 2.3.2.

The congestion metrics were evaluated to determine where residual constraints continued to limit interregional transfer capability. These metrics informed the identification of transmission paths that may benefit from additional economically driven upgrades.

5.4.4.2 Findings and Adjustments

The results of the analysis indicated that, while the SRA and IDA upgrades alleviated a substantial portion of existing congestion, residual congestion remained or worsened on several key interregional interfaces. To address these remaining limitations, Energy Strategies identified and incorporated targeted transmission upgrades aimed at relieving high-impact constraints and facilitating more efficient regional energy transfers.

These additional upgrades help to ensure that the 10-Year reliability and economic cases reflect a cost-effective, regionally optimized transmission system, providing both reliability and economic efficiency under the studied future.

5.4.5 Transmission Solutioning

While Energy Strategies broadly used the following criteria to develop transmission solutioning, the mitigation for specific violations deviated based on experience and WATT member feedback:

- Wherever feasible, transmission lines were reconductored using higher-capacity or high-performance conductors. This approach served as the primary mitigation strategy for addressing thermal overloads. If reconductoring is not feasible, rebuilding the line to higher thermal rating would also be a possible solution in these corridors.
- New lines were considered to mitigate diverged contingencies. They were also assumed when there was a need to mitigate multiple violations or increase overall transfer capacity.
- Overloads on series capacitors were assumed to be mitigated by replacing existing equipment with higher capacity ones.
- Transformer overloads were mitigated by adding an additional one in parallel.

While some Grid Enhancing Technologies (GETs) and non-wires alternatives, such as power flow controllers and advanced conductors were considered; others, such as dynamic line ratings were not well suited for the types of interregional violations observed. This technology does not provide the level of firm transmission capacity required within the 10-year timeframe. However, it may be more appropriate for addressing incremental issues identified through local, near-term planning studies and could serve to complement the broader WestTEC transmission solutions portfolio including use during construction of larger grid upgrades. Final SRA Power Flow cases and Production Cost Model which includes the WestTEC transmission portfolio will be posted to the WECC Website. Access to base cases is subject to a non-disclosure agreement and other WECC requirements.

5.4.6 Transmission Monitoring

Transmission monitoring determines which lines and flowgates are limited to ratings included in the model. Monitoring was determined based on the scope in the Study Plan. Transformers, except phase shifting transformers were excluded from monitoring. The powerflow and production cost model cases monitored:

- All lines 345 kV and above,
- Interstate, Interregional, inter-BA lines 200 kV and above,
- All lines that make up a WECC path,
- All WECC paths listed in the 2025 WECC Path Rating Catalog.

5.5 TRANSMISSION PORTFOLIO DETAILS & MAPS

5.5.1 SRA Needs & Solutions

The recommended Network Upgrades for each violation identified in the SRA are listed in Table 5-12 below:

TABLE 5-12. SRA UPGRADE DETAILS

SRA Upgrade	Upgrade Rating	Connecting Areas	Limiting Element	Worst Contingency	Limiting Scenario
Second Mead - Market Place 500 kV line	2,598 MVA	WAPA LC, LADWP	Mead - Marketplace 500kV Line CKT 1	Crystal-McCullough 500kV Line CKT 1	Heavy Winter
New Townsend - Midpoint 500 kV transmission line with 25% series compensation	2773 MVA	NWMT, BPA, IPCO, PACE	Path 8 Montana - Northwest	Aeolus - Ferris 500kV CKT 1	Heavy Winter
2024-25 TPP CAISO approved upgrades: - **Metcalf 500/230kV Transformer addition,** - **New Manning - Metcalf 500 kV line**	Multiple	CAISO	Tesla - Los Banos 500kV Line CKT 1 Los Banos - Manning 500kV Line CKT 1 & 2 Gates - Midway 500kV Line CKT 1	Los Banos 500KV - Middle Breaker Bay 3 Manning – Midway 500 kV CKT 1 Manning – Midway 500 kV C2	Heavy Summer Heavy Winter High Solar
BPA GERP 2.0 Project: - **Reconductor Keeler – Pearl 500 kV #1**	3029.4 MVA	PGE, BPA	North of Pearl (NOPE)	P5: Trojan 230kV Bus Fault (No Substation Battery)	Heavy Winter
Western Colorado MVAR Support: Adding reactive support at - **Milk Creek 345kV** - **Montrose 345kV** - **Hesperus 345kV**	100 MVAR each	WAPA RMR	Low Voltage at following buses: - Meeker 345kV - McBryde 345kV - UTE Grand Junction 345kV - Rifle 345kV - Montrose 345kV - Hesperus 345kV - Milk Creek 345kV	Craig - Bonanza 345kV line CKT 1	High Solar

SRA Upgrade	Upgrade Rating	Connecting Areas	Limiting Element	Worst Contingency	Limiting Scenario
Southern Nevada MVAR Support: shunt at Northwest 138kV substation	150 MVAR	NEVADA	Northwest 138kV Substation voltage	System Intact conditions	Heavy Summer Heavy Winter High Wind
Rebuild and upgrade Clines Corner - Guadalupe - Taiban Mesa to Double circuit	2160 MVA	PNM	Case Divergence	Clines Corner - Guadalupe 345kV CKT 1 Guadalupe - Taiban Mesa 345kV CKT 1	High Wind
Second Four Corners - Pintado 345 kV transmission line	1099 MVA	PNM, WAPA RMR, PSCO	Four Corners - Pintado 345kV Line CKT 1	Cabezon - Rio Puerco 345kV line CKT 1	High Wind
Third San Juan 345kV Phase shifter	300 MVA	PNM, WAPA RMR, PSCO	San Juan Phase Shifter #1 & #2 Shiprock - San Juan 345kV Line CKT 1	Lost Canyon - Shiprock 230kV Line CKT 1 Four Corners - San Juan 345kV line CKT 1	Heavy Summer Heavy Winter High Solar
New single circuit Mead - Liberty - West Wing 500 kV line with 75% compensation	2051 MVA	WAPA LC	Liberty - Peacock 345kV line CKT 1	Liberty - Liberty Phase Shifter Station 230kV line CKT 1	High Solar
Reconductor Amrad - Chavez 345 kV line	1415 MVA	El Paso Electric, PNM	Amrad - Chavez 345 kV line CKT 1	Arroyo 345kV Phase Shifter #1 Cabezon - Rio Puerco 345kV line CKT 1	Heavy Winter High Solar
Reconductor Otero - Picante 345 kV line	1415 MVA	El Paso Electric, PNM	Otero - Picante 345 kV line CKT 1	Arroyo 345kV Phase Shifter #1	High Solar
Second Arroyo 345kV Phase Shifter	400 MVA	El Paso Electric, PNM	Arroyo 345kV Phase Shifter #1	Amrad - Chavez 345 kV line CKT 1	High Solar
Second Four Corners - San Juan 345 kV transmission line	1200 MVA	APS, PNM	Four Corners - San Juan 345kV Line CKT 1	Shiprock - Four Corners 345kV line CKT 1	High Solar

SRA Upgrade	Upgrade Rating	Connecting Areas	Limiting Element	Worst Contingency	Limiting Scenario
Second Rio Puerco - San Juan 345kV transmission line	1200 MVA	PNM	San Juan - Cabezon 345kV line CKT 1 Cabezon - Rio Puerco 345kV Line CKT 1	Four Corners - Pintado 345kV CKT 1	High Wind
Fourth 345/230 kV transformer at Bridger	450 MVA	PACE	Bridger 345/230kV TXR #1, #2, and #3	Bridger 345/230kV TXR #1, #2, and #3	High Solar
Third 345/230 kV transformer at Sigurd	500 MVA	PACE	Sigurd 345/230kV TXR #1and #2	Sigurd 345/230kV TXR #1and #2	High Solar
Second 345/230kV Transformer at Grand Junction	270 MVA	PSCO	Grand Junction TXR 345/230kV #1	Grand Junction TXR 345/230kV #1	High Solar
Third 500/345 kV transformer at Walker River	998 MVA	SIERRA	Walker River 500/345kV TXR #1 & #2	Walker River 500/345kV TXR #1 & #2	High Wind
Third 345/230 kV transformer at Coronado	826 MVA	SRP, TEP	Coronado 500/345kV TXR #1 & #2	Coronado 500/345kV TXR #1 & #2	High Solar
Third 345/230 kV transformer at Copper Verde	224 MVA	TEP	Copper Verde 345/230kV TXR #1 & #2	Copper Verde 345/230kV TXR #1 & #2	Heavy Summer Heavy Winter High Solar High Wind
Second 345/230 kV transformers at Liberty	720 MVA	WAPA LC	Liberty 345/230kV TXR #1	Whitehills - Mead 345kV line CKT 1	High Solar
Second 345/230 kV transformers at Peacock	650 MVA	WAPA LC	Peacock 345/230kV TXR #1	McConico - Davis 230kV Line CKT 1	Heavy Summer Heavy Winter

5.5.1 IDA Needs & Solutions

Limiting Elements mitigated by each IDA transmission solution and the corresponding transfer interface limit from the source to the sink that is enabled by the upgrade are described below:

TABLE 5-13. PNW IMPORT IDA SCENARIO RESULTS (SCENARIO 1A)

IDA Upgrade	Upgrade Rating	Limiting Element Mitigated	Transfer Interface Limit
New Walker River - Bonanza 500kV Line	3,500	- Overloads on following elements: - Path 75 (Hemingway – Summer Lake) - Hemingway – Maverick 500kV line - Burns Series Capacitor 1 & 2 - Midline – Maverick 500kV line overload (B2H Segment) - Sand Springs 500kV Series Capacitor - Taft – Dworshak 500kV line - Hemingway – Midpoint 500kV line	8,600 MW
New Townsend-Ashe 500kV Line	3,845	Overloads on following elements: - Dworshak 500kV Series Capacitor - Summer Lake – Burns 500kV line - Path 8 (Montana – Northwest)	9,990 MW
Reconductor Sams Valley - Whitestone 230kV with ACCC[26]	1,000	Overloads on following elements: - Whitestone – Sams Valley 230kV line overload	11,939 MW
Upgrade Wave Trap and Series capacitor on Hemingway - Summer Lake 500 kV Line	4,625	Overloads on following elements: - Hemingway – Burns 500kV line - Path 14 Idaho – Northwest	14,126 MW

[26] This upgrade is already included in the scope of PacifiCorp's initial construction of Sams Valley substation, but was missing from the data provided to WestTEC for 2035 Reference Case model development

TABLE 5-14. WECC EAST – WEST TRANSFER IDA SCENARIO RESULTS

IDA Upgrade	Upgrade Rating	Limiting Element Mitigated	Transfer Interface Limit
Additional TWE Phase Shifter	580	Overloads on following elements: - TWE IPP Phase shifter 1, 2, & 3 overloads	12,583 MW
Rio Puerco – Pintado 345kV Series Cap upgrade	2,160	Overloads on following elements: - Rio Puerco – Pintado 345kV series capacitor overload	15,205 MW
Rio Puerco – Pintado 345kV Reconductor	2,160	Overloads on following elements: - Rio Puerco – Pintado 345kV line overload	15,278 MW

TABLE 5-15. CAISO OUT OF STATE WIND DELIVERABILITY RESULTS

IDA Upgrade	Upgrade Rating	Limiting Element Mitigated	Transfer Interface Limit
TWE Phase Shifter Enable or Additional	580	Overloads on following elements: - TWE IPP Phase shifter 1, 2, & 3 overloads	200 MW
Pinal Central – Saguaro – Winchester – Macho Springs – Tom Wray 500kV Transmission Line	1,600	Overloads on following elements: - Rio Puerco - Pintado 345kV Line CKT 1 - Pintado - Four Corners 345kV Line CKT 1 - Rio Puerco - Cabezon 345kV Line CKT 1 - Cabezon - San Juan 345kV Line CKT 1	500 MW
Reconductor Diamond Tail – B-A 345kV Ckt 1&2	2,160	Overloads on following elements: - Diamond Tail – B-A 345kV Ckt 1&2	1425 MW

5.5.2 Congestion Needs & Solutions

Economic constraints driving the need for each Congestion transmission solution is described below:

TABLE 5-16. CONGESTION ASSESSMENT DETAILS & DRIVERS

Network Upgrade	Description	Ratings (MVA)	Connecting Area(s)	Driver
Colstrip – Broadview 500 kV Series Capacitor Upgrades	Rating increase of series capacitors (A & B) at Broadview to match the line ratings	Pre: 1,731 Post: 2,771	NWMT	Series capacitors limiting element causing high congestion, increasing after Townsend – Ashe IDA upgrade
Mead – Perkins 500 kV Line rebuilt	Increase rating and impedance to balance flow between parallel SRA Network Upgrades	Pre: 1,905 Post: 2,800	AZPS, SRP, WALC	Highly congested with the addition of the SRA NU, Mead - Liberty - West Wing 500 kV line
Dave Johnston – Laramie River 230 kV Line Reconductor	Reconductor the 230 kV line between Dave Johnston and Laramie River	Pre: 478 Post: 986	PACW, WACM	Highly congested N-S
Path 36 TOT 3	Reconductor Ault – Terry Ranch 230 kV Reconductor Ault – Archer 230 kV	Pre: 470 Post: 800 Pre: 462 Post: 800	WACM	TOT 3 congested with high congestion measure, increasing once including the Dave Johnston – Laramie River upgrade

TABLE 5-17. PRODUCTION COST SAVINGS RESULTS

2035 Study Case	Annual West-wide Production Costs ($M, $2024)	Production Cost Reduction from Original Reference Case
Reference Case with Planned Projects	$17,287	N/A
Reference Case with Planned Project and SRA + IDA Upgrades	$16,995	$292 million (2% reduction)
Reference Case with 10-year Horizon Portfolio (Planned, SRA, IDA, and Congestion Upgrades)	$16,753	$534 million (3% reduction)

5.5.3 Additional Tables and Figures

TABLE 5-18. BREAKOUT OF LINE MILES AND COST OF THE 10-YEAR PORTFOLIO

Upgrade Type	Count	Total Line Miles	Total Estimated Cost ($M)
10-Year Planned	**73**	**9,358**	**$46,648**
New Line	53	8,457	$42,125
Rebuild	11	553	$2,741
Reconductor	7	348	$687
Substation	2	-	$550
Uprate	1	90	$545
Congestion	**3**	**394**	**$391**
Reconductor	3	394	$324
Series Capacitor	2	-	$67
IDA	**8**	**1,742**	**$7,239**
New Line	3	1,425	$7,052
New Transformer	1	-	$41
Reconductor	3	75	$92
Uprate	1	242	$55
SRA	**21**	**1,156**	**$6,050**
New Line	7	947	$4,834
New Shunt	2	-	$26
New Transformer	8	0	$171
Rebuild	1	110	$940
Reconductor	3	98	$79
Grand Total	**105**	**12,650**	**$60,328**

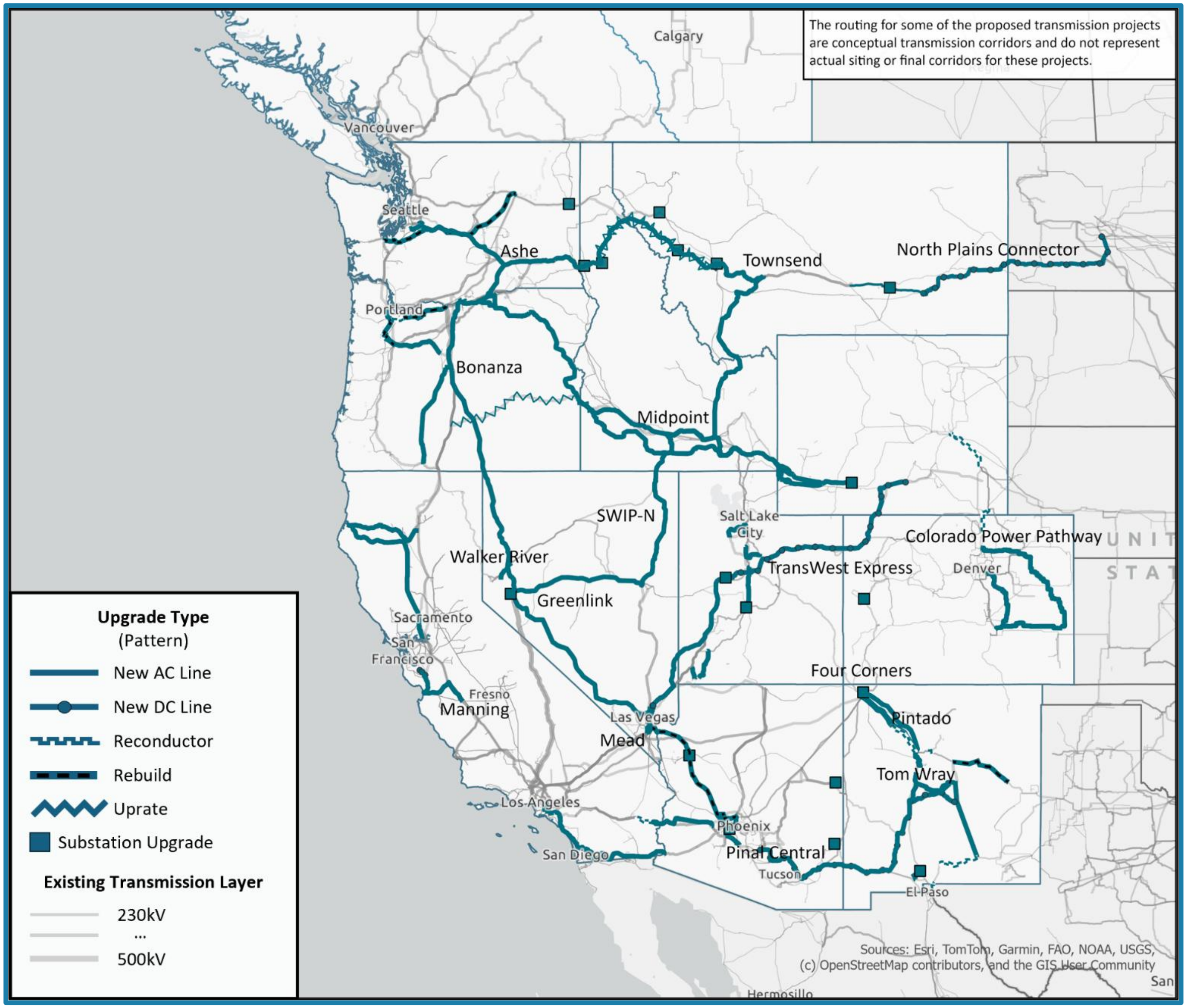

FIGURE 5-5. ALL IDENTIFIED UPGRADES IN THE 2035 STUDY

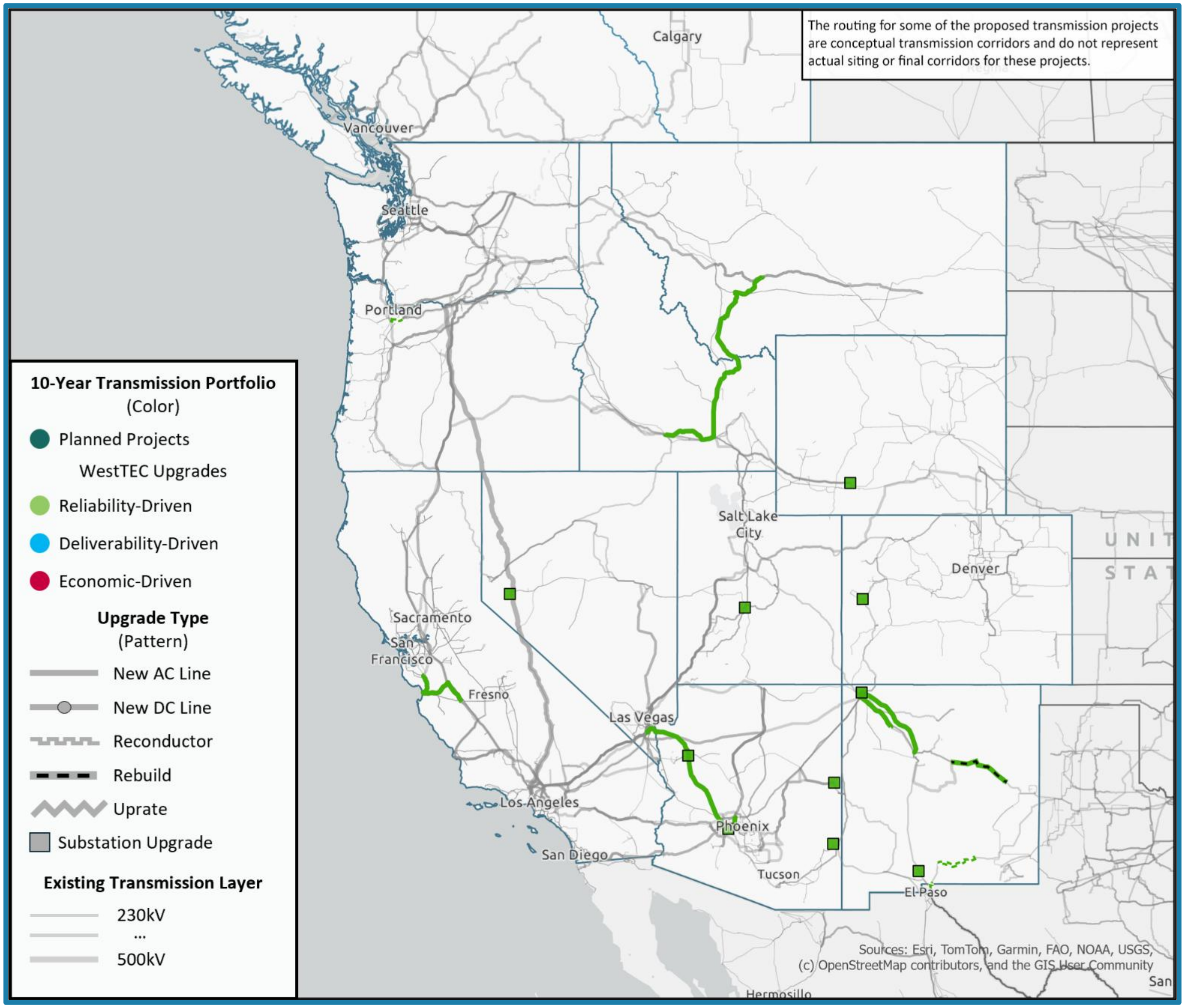

FIGURE 5-6. UPGRADES IDENTIFIED IN THE SYSTEM RELIABILITY ASSESSMENT (SRA)

FIGURE 5-7. UPGRADES IDENTIFIED IN THE INTERAREA DELIVERABILITY ASSESSMENT

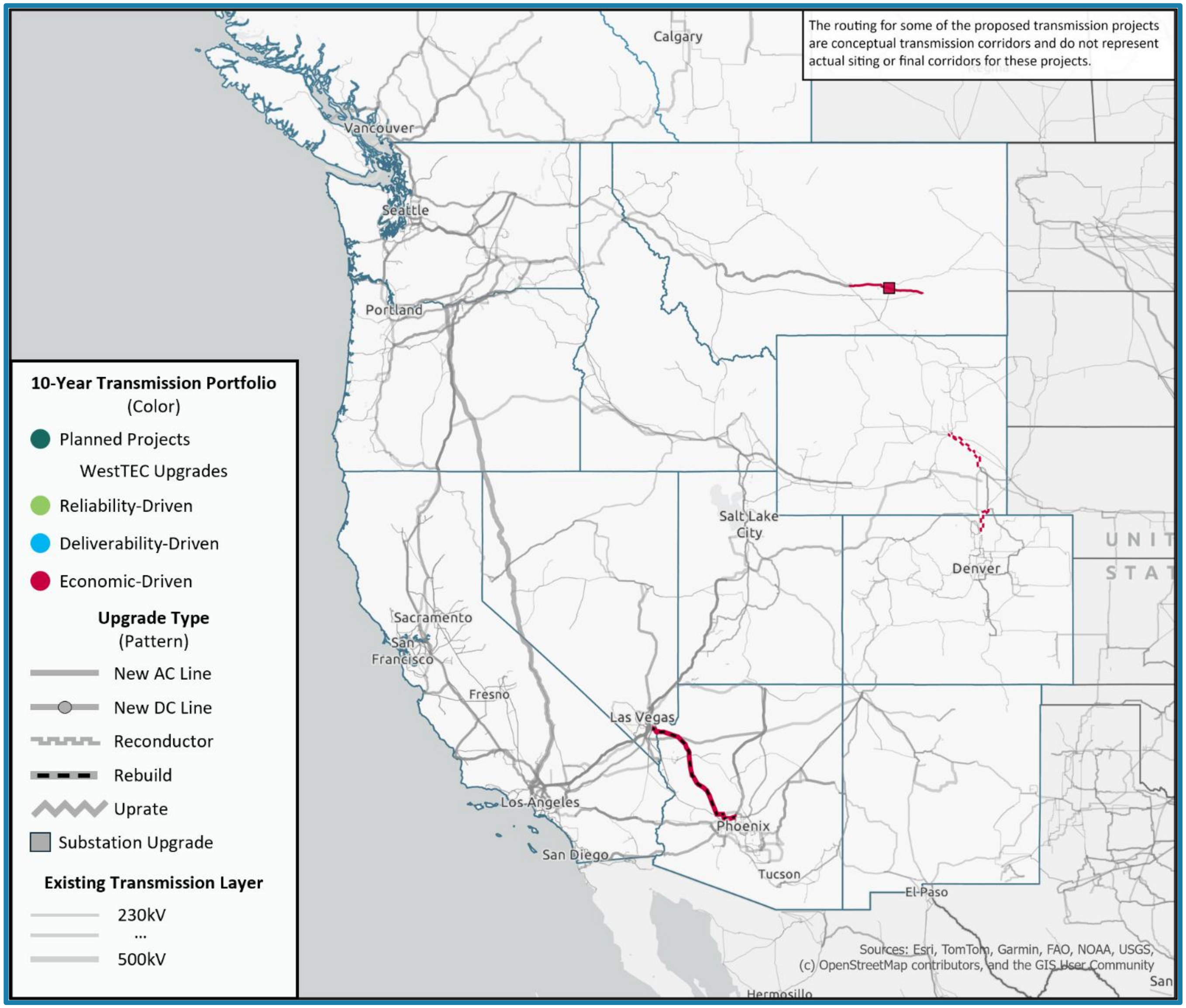

FIGURE 5-8. UPGRADES IDENTIFIED IN THE CONGESTION ASSESSMENT

5.5.1 Affordability Analysis

WestTEC consultants performed a study exploring how the costs of the transmission portfolios identified in the study compared to other investments and costs likely to be incurred across the Western region during the approaching 10-years. The purpose of the assessment was to add context to the capital cost estimates provided in this report. Results of this assessment are presented in the body of the report and in the Executive Summary. Notably, this report lacks a comprehensive benefit-cost assessment of the transmission portfolio. This analysis does not replace such an assessment, which would be the best and most thorough means of justifying the transmission investments. However, due to the complexity of transmission drivers and needs identified in this study, WestTEC could not include a benefit-cost assessment in its scope.

TABLE 5-19. KEY ASSUMPTIONS IN AFFORDABILITY ANALYSIS

Category	Assumptions
10-year transmission portfolio capital cost	- $60.33 billion in 2025 real dollars
Transmission financing assumptions for calculating annualized cost of portfolio	- 40-year asset life - 7% WACC (nominal) for purposes of determining annual revenue requirement of transmission investment - Assumed that lines are build out linearly between 2026 and 2035, with estimated spend per year of $4.7 billion (2025 real dollars) - 3% O&M with 1% per year escalation - Additional expense factor of 2.5% applied to net plant in-service - 2.5% inflation rate
Generation cost analysis	- Analysis designed to estimate the cost of incremental resources assumed in the 10-year Reference Case - Levelized costs based on LAZARD's 2025 LCOE+ Report available at: https://www.lazard.com/research-insights/levelized-cost-of-energyplus-lcoeplus/ - Levelized costs based on LAZARD's 2025 LCOE+ Report available at: https://www.lazard.com/research-insights/levelized-cost-of-energyplus-lcoeplus/ - No consideration of learning curves or technology cost declines - Analysis does not capture variable costs – only levelized capital and fixed O&M are considered in deriving estimate for annualized generation cost
Western state electric rates	- Based on analysis of EIA data for 11 Western States available: https://www.eia.gov/electricity/sales_revenue_price/

5.6 LIST OF FIGURES

5.7 LIST OF TABLES

5.8 IMAGE CREDITS

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