Western Transmission Expansion Coalition

Study Plan

August 27, 2024

1. Introduction

The Western Transmission Expansion Coalition (WestTEC) West-Wide Transmission Study (or "the Study") is an industry-led effort that seeks to address long-term interregional and interstate transmission needs spanning the Western Interconnection. WestTEC is being jointly facilitated by the Northwest Power Pool d/b/a Western Power Pool ("Western Power Pool" or "WPP") in partnership with the Western Electricity Coordinating Council ("WECC")[2] and is and an industry-led effort which is supported by a thoughtful committee-based governance consisting of a broad array of Western regional partner representatives including, but not limited to, Tribes, State regulators and representatives, policy makers, and other interested parties. A detailed description of WestTEC governance, including a complete list of committee representatives and charters as well as a plan for engagement with regional partners[1] is included in the WestTEC Project Charter and Regional Partners Engagement Plan to which this study is appended.

WestTEC will produce an **actionable transmission study** based on transmission portfolios that enhance Western reliability while also considering economic efficiencies and state policy goals. The objective of the work is to conduct integrated planning analysis across the Western Interconnection to produce near-term (10-year) and long-term (20-year) transmission portfolios. The effort is unique in that it is a voluntary planning effort that focuses on identifying interregional and interstate transmission expansion solutions that are based on an assessment of the consolidated and coordinated needs of Western utilities. In doing so, WestTEC responds to a widely recognized concern that current transmission planning frameworks in the West do not result in the identification of sufficient transmission solutions to support the needs of the future grid and that interregional transmission planning can be strengthened. WestTEC is informational and voluntary and is not meant to replace existing transmission processes, such as local, regional, or interregional transmission planning required by orders of the Federal Energy Regulatory Commission (FERC), although it is hoped that WestTEC could complement those efforts. On May 13, 2024, FERC released Order 1920, a landmark rulemaking requiring each of the transmission planning regions in the United States to undergo long-term transmission planning. The rulemaking also contains important reforms to local transmission oversight and interregional coordination. While Order 1920 contains many planning requirements and elements that are similar to the planning approach for WestTEC, the order does not alter this Study Plan or the timeline for project execution. The WestTEC effort will continue as outlined in this Study Plan but will coordinate with participants of WestTEC who are jurisdictional transmission providers as they evaluate the revisions they are contemplating to satisfy Order 1920. WestTEC will share more information on this matter with regional partners as more information becomes known.

Additional features of the actionable transmission study include:

- ✓ Study footprint spanning the Western states that make up the Western Interconnection as well as interties connecting two Canadian provinces to the Western Interconnection.

[1] Regional partners refer to an individual or organization with an interest related to WestTEC. This term replaces the term "stakeholder" which has origins that may be offensive to community members.

- ✓ Load growth forecasts capture the increasing demand for electricity due to electrification and emerging loads such as data centers and hydrogen production.
- ✓ Resource forecast result in a generation mix that meets state policy requirements, reflects clean energy goals, and accounts for voluntary procurement of clean energy.
- ✓ Consideration of multiple planning scenarios to reflect the inherent uncertainties of long-range planning.
- ✓ An integrated approach to identifying transmission portfolios, with an emphasis on identifying transmission needs not addressed by other planning efforts.
- ✓ Robust regional partner engagement and governance.
- ✓ Credible and objective study execution through an independent consultant team.

This Study Plan document is the workplan that will be executed over the approaching ~24 months. The document was developed by the WestTEC Assessment Technical Team (WATT), approved by the WestTEC Steering Committee, and benefited from input provided by both the WestTEC Regional Engagement Committee ("REC"), the Committee on Regional Electric Power Cooperation Transmission Collaborative ("CREPC TC"), Tribes and the public. The document details the goals, methods, tools, data sources, and deliverables for the effort, which will begin upon approval of this Study Plan.

Key Terms

To facilitate a clear and consistent understanding of the concepts and methodologies discussed in this Study Plan, this section provides definitions for key terms used throughout the document. These terms are essential for understanding the scope, purpose, and technical aspects of the Study.

- **Region** – Unless otherwise stated, the term is in reference to one or more of the Western FERC Order 1000 planning regions: CAISO, WestConnect, and NorthernGrid.
- **Interregional** – Refers to a transmission planning approach or infrastructure between multiple regions.
- **Intraregional** - Refers to a transmission planning approach or infrastructure that is within a single region.
- **Interstate** – Pertains to transmission lines and infrastructure that cross state boundaries, facilitating energy transfer and reliability between states. Interstate transmission issues may be interregional or intraregional in nature.
- **Reference Case** – A baseline scenario reflecting a "reasonably anticipated" future with current trends, policies, and projections used to identify transmission needs and solutions over a 10-year and 20-year horizon.
- **Planning Scenario** – Tool used to explore different future states of the grid, considering variations in technology, policy, market conditions, and environmental factors.
- **Transmission Portfolio -** A collection of proposed transmission projects and upgrades designed to address identified needs and enhance the grid's reliability, efficiency, and capacity.
- **Areas or Zones –** Unless otherwise noted, is in reference to Western balancing area authorities (BAA) charged with managing supply and demand balance for a geographic area that is smaller than a region. In most cases areas align with utility and transmission owner footprints.

2. Study Goals

The need for the WestTEC effort arose out of the following observations recognized by many regional partners:

- **Insufficient transmission solutions:** Regional partners have concerns that current transmission planning frameworks in the West are not producing sufficient transmission solutions to effectively meet the expected future needs of the grid. This is seen as a barrier for ensuring reliable, cost-effective energy delivery across regions.
- **Need for enhanced interregional planning:** Regional partners believe that interregional transmission planning needs to be strengthened. The existing planning processes were deemed inadequate for addressing the complexities of an evolving energy landscape that includes significant growth in renewable energy sources and inter-regional dependencies.
- **Policy and economic drivers for coordination:** The shift towards renewable energy sources, integrated energy markets, and the goals set by various state policies demand a more coordinated and strategic approach to transmission planning. Economic factors, including the cost of energy and the need for efficient investment in infrastructure, also play a crucial role.

In response to these drivers, the WestTEC Study will produce information that can be used to resolve grid capability, reliability, and resiliency challenges by meeting the following goals and objectives:

- An Actionable Transmission Study: Development of transmission portfolios that address interregional and interstate needs over a 10-year and 20-year timeframe will be of use to many Western regional partners, including planning processes, transmission development activity by 3rd parties, engagement with communities, and to those needing top-down benefit perspectives to support grid investment. The development of the study is intended to be a repeatable process and serves these needs, as well as others that will become clearer as the work is completed.
- Reliability: Ensure the footprint has sufficient transmission capacity identified and a plan developed that complies with NERC Reliability Standards, enables operational flexibility, and is implementable with a high degree of confidence.
- Commercial/Economic Efficiency: Ensure the footprint has sufficient transmission capacity to meet future energy needs, while also reducing congestion and considering planning reserve margins required to maintain reliable operations.
- Improve Affordability and Reliability: Enable investment savings by unlocking benefits associated with a coordinated transmission portfolio, which provides for diversity in demand and supply across the footprint, and better utilization of transmission infrastructure using a robust and dependable analytical approach.
- Improved Visibility and Coordination: The plan will establish visibility into the combined capabilities and requirements of the study footprint. This will enable stakeholders to make informed transmission planning and engineering solution decisions using collaboratively established best practice approaches, so that transmission needs are met in the most reliable,

efficient, and economical way. This will also include analysis on a portfolio basis of the interplay between and aggregate value of various potential transmission solutions.

- Supports Future Cost Allocation Decisions: The plan would include regional-level information about transmission benefits that could be used as a starting point to support cost allocation discussions for projects or portfolios of projects that might be built. However, development of cost allocation is out of scope for this effort.
- Fair and Unbiased: A plan that is fair and unbiased across resource types, business models, and to all participants and stakeholders, and which includes recommendations that are acceptable within current and evolving regulations and requirements of each applicable federal, state, and local jurisdiction.

The process is designed to be collaborative and forward-looking to help ensure a reliable and sustainable energy future in the West. As a follow-on benefit, it is expected that the effort will lead to the development, application, and publication of common approaches to identifying interregional transmission projects in the West.

3. Actionable Transmission Study

A primary goal of WestTEC is that the transmission portfolios coming out of the process be “actionable”. By defining "actionable", WestTEC sets expectations regarding the findings and data that will come out of the WestTEC study. Equally important to the definition is how WestTEC anticipates the information will be used. It is anticipated that the actionable transmission study may:

- **Serve as an input** into local or regional planning processes where coordinated transmission solutions are needed. Participants in those processes could agree to jointly or solely propose one or more of the WestTEC transmission projects for further evaluation within those processes, some of which have cost allocation and recovery structures that could help critical transmission get built.
- **Initiate bilateral negotiations and development activity** by transmission developers or utilities seeking to propose new transmission projects or refine existing transmission development plans. The actionable nature of the WestTEC transmission plan will improve the development feasibility and help demonstrate demand for such projects.
- **Facilitate proactive engagement** with local communities, tribal nations and regulators such as state commissions and federal agencies.
- **Provide data that assists with evaluating total benefits and their distribution** for certain portfolios of transmission solutions.
- **Offer context** for near-term planning and investment decisions made in other planning processes.
- **Be a resource to developers and utilities** for the identification of potential transmission paths for optimizing resource siting.
- **Be a resource for state regulators** for use in prudency evaluations of utility transmission when utilities request a Certificate of Public Convenience and Necessity and cost recovery.

If WestTEC can generate information surrounding the identified transmission portfolios to support the use cases listed above, and transmission projects resulting from the study have broad regional and community support and are constructed, the effort will have been a success.

Defining "Actionable"

To best position WestTEC for success, it will produce transmission portfolios and associated information that will:

1. Be based on long-term transmission needs that arise out of a transparent study process with methodology and assumptions that are credible, prudent, and broadly **supported by** regional partners.
2. Include a **technical description** of the solution(s), including where infrastructure needs to be located (e.g., substation connections), and what types of technologies or upgrades are required (e.g., conductor and minimum capabilities).
3. Clearly state the **underlying driver(s) and dependencies** for each transmission solution or portfolio of solutions.[2] This information will provide a basis for a transmission solution on its own or those that are a part of a portfolio, and will reflect the conditions under which the transmission solution or portfolio of solutions would be justified.[3]
4. Provide sufficient detail about the estimated **project costs and benefits** to support future discussions regarding feasibility, project partnerships, and cost allocation decisions. This does not mean that each solution will include an area-by-area benefit breakdown. However, it will qualitatively indicate the likely beneficiaries of each project and will, when applicable, provide quantitative benefit estimates for the broader Western region. Estimates of project costs will be based on planning per-unit estimates developed by the WATT during the study. In addition, the work will provide sufficient geospatial detail to support the advancement of transmission permitting, siting and construction feasibility studies, although such activities are outside the scope of WestTEC. To accomplish this, a **preliminary routing option** will be provided for each solution. When possible, WestTEC will provide technical evidence that efficient or low-impact routing alternatives have been identified.
5. Identify **transmission alternatives considered** in arriving at the preferred solution and describe tradeoffs and why the preferred solution(s) was superior. Reasons may be related to technical performance, development feasibility, economics, or a combination of these or other factors.

Study Limitations

While WestTEC anticipates that the Study will fill many planning gaps currently present in the West, there will be limitations. Important study limitations identified to date are:

[2] For example, if a project designed to facilitate cross-state transfers requires a large resource buildout and transmission buildout in a neighboring state, such dependencies will be identified when possible.
[3] For example, "this portfolio supports development of XXX GW of resources in the XXX Zone and is needed to mitigate XXX violations occurring on the XXX-kV system in the area".

- The Study will not be a comprehensive list of all needed transmission infrastructure over the planning horizons. It will not capture all the infrastructure needed to maintain economic and reliable operations. For example, the Study is not focused on identifying substation network upgrades associated with new generator interconnects.
- This will be WestTEC's first iteration of the Study. Approaches, methods, and results will improve over time, adding granularity, insight, and additional details not included in this first iteration.
- The Study will be a "point in time" vision of transmission needs. Transmission at the scale explored by WestTEC will ultimately be implemented in response to evolving needs in the region, which will become clearer over time. For example, resource mixes in one region could evolve at a different pace than another, which would suggest that certain projects explored by WestTEC in one region may need to materialize urgently while projects identified in another region could be delayed or no longer needed.
- The Study will not result in a singular transmission solution for the West. In some cases, a given transmission need may result in the identification of multiple preferred solutions, or there could be solutions that WestTEC does not consider. For example, WATT may not be able to objectively decide between reconductoring options and greenfield options for a given need, so both may be presented, and further diligence can be performed as the concept matures.
- The Study is not focused on identifying infrastructure related to certain pre-existing reliability issues within a single transmission-owner area (such as voltage instability), nor is it focused on identifying and resolving lower-voltage thermal issues (<200-kV) reasonably expected to be addressed through existing interconnection, local, or regional planning process, even if such issues are present on transmission infrastructure that would otherwise be in scope of the assessment. For both exceptions above, we hope transmission owners can provide modeling solutions when requested and the Study will make note when such issues are filtered out.
- Information not currently available during the drafting of this Study Plan, such as announcements regarding new projects, the construction of new transmission projects, or new or revised state policies, may become available in the future. *Material* new information that becomes available after the publication of this Study Plan, and its potential impact on the study approach, will be considered by the Steering Committee on a case-by-case basis. The WATT and the REC will be charged with identifying such new information during the course of the study.

4. Planning Horizons

WestTEC will feature 10-year and 20-year study horizons focused on evaluating transmission requirements in the years 2035 and 2045. To maximize the value of the WestTEC effort in the context of other transmission planning processes in the West, the two study horizons will each have a unique focus and purpose, as outlined in the table below.

Study Horizon	Study Focus
10-year (2035)	• Study focuses on identifying near-term gaps in **interregional** transmission infrastructure (e.g., transmission between regions). In addition, the study may identify transmission expansion opportunities **not otherwise addressed** in regional or local planning processes that may be needed to accommodate resource mixes represented in the Reference Case (including intraregional needs). • Transmission solutioning in response to needs will consider only those options that could be realistically developed in the study horizon (e.g., greenfield unlikely to be feasible, but study will focus on grid enhancing technologies). Transmission solutions will not be sought for commercially unproven generation technologies in the 10-year horizon. In-flight transmission proposals with meaningful development activity (e.g., permitting, ROW acquisition) will also be considered in transmission solutioning. • Expected that the study horizon will be less focused on large portfolios of upgrades and will seek to identify targeted and discrete transmission upgrades. • Assessment will be limited to a Reference Case scenario.
20-year (2045)	• Identifying transmission portfolios that reliably and efficiently enable the transfer of power from where it is generated to where it is consumed, with a focus on upgrades that address major **interregional**, **intraregional**, and **interstate** transmission needs. • Transmission solutioning will consider all commercially and technically viable technologies and project concepts. Advanced transmission solutions under research and development may be considered. • Expected that transmission portfolios will be more expansive and comprehensive relative to what is identified in 10-year horizon. • Scenario planning is the core component of the assessment, in addition to a Reference Case.

Linkage between Horizons

WestTEC will logically connect findings from the two planning horizons. A key principle adopted to ensure proper linkage between the planning horizons will be to consider needs and solutions of the 10-year horizon in the context of evolving needs and solutions in the 20-year horizon. This will help transmission proposals in this study and others prioritize flexible and scalable transmission solutions for nearer term needs to help better position the system for efficient long-run expansion. WestTEC will seek to draw coherent conclusions from both the 10-year and 20-year assessments, but will explore how the needs and solutions identified in each horizon feed into one another.

5. Study Tools & Software

WestTEC will use a series of software tools to conduct expansion modeling, powerflow modeling, and nodal production cost modeling to accomplish the goals of the Study. In addition to these models, WestTEC will feature detailed geospatial analyses to realistically site new generation and evaluate the feasibility of transmission corridors.

Details on each of the primary software tools used by WestTEC is outlined below:

PowerWorld is an AC powerflow software used to evaluate transmission performance under a range of operating conditions. In WestTEC, PowerWorld will be used to evaluate system reliability, the deliverability of resources to loads, and potentially the impact of outages during extreme weather conditions. PowerWorld will also serve as the primary tool to define, evaluate, and iterate on transmission solutions. Those solutions will make up a transmission portfolio and the software will be used to evaluate the ability of that portfolio to meet the reliability requirements.

GridView is a nodal security constrained economic dispatch model that will be used to identify transmission congestion and to evaluate the efficacy of transmission solutions designed to mitigate congestion and improve operations of the system. GridView will also be used to estimate reductions in production costs (e.g., economic benefits) associated with transmission portfolios. In addition, the tool can be used to evaluate system operations under extreme weather conditions.

PLEXOS is a capacity expansion model and production simulation model that combines least-cost optimization and production cost modeling capabilities. The primary role of PLEXOS in the WestTEC study is to establish a credible long-term generation resource and transmission capacity expansion plan for the West. PLEXOS has both zonal and nodal modeling capabilities, but for the purpose of developing the capacity expansion in the WestTEC study, this analysis will utilize the zonal model topology. E3 will determine zones together with the study team, but will include BAAs level with aggregation where feasible for improving runtime without reducing relevant granularity. Outside of PLEXOS, the expansion plan will then be mapped to substations and will heavily impact identified transmission needs, especially in the 20-year planning horizon. The results of the capacity expansion analysis will also help to quantify certain types of transmission benefits, such as generation investment savings, and support development of a ranking of the considered transmission projects.

In addition to the software above, WestTEC will use a GIS-based substation mapping process to develop reasonable assumptions about where and in what amounts new generation resources are likely to be developed and interconnected to the grid. Commercial interest in substations sourced from interconnection queues as well as generation resource quality data and land use constraints will be key inputs into the geospatial analysis that will inform generation resource siting. A similar geospatial analysis will also be used to assess the feasibility of existing and new transmission corridors that may be used to help address identified transmission needs.

Finally, WestTEC will need to either develop or adopt tools and assumptions appropriate for estimating the costs of transmission solution. The WATT will be charged with formulating this framework and will, at a minimum, consider prior work such as the TEPPC Capital Cost Calculator and other cost guides such as those published by the CAISO and MISO. Ideally, the tool will be based on updated per-unit transmission cost estimates, will specify a planning-level estimate error range (e.g., +/- 30%), and will make cost adjustments based on terrain, geographic region, and land use type.

6. Reference Case: Assumptions and Data Sources

A Reference Case representation of the Western grid 10 years and 20 years into the future will assume the system evolves based on current trends, existing policies, and generation projections and load forecasts. The Reference Case will serve as a "reasonably anticipated" future and will be used to help identify transmission needs and solutions under a single future, while also serving as a clear and quantifiable baseline that scenarios can be compared against. Scenarios will be characterized through changes made to the Reference Case. For more information on how WestTEC will consider scenarios, see *Section 8 Scenario Planning & Sensitivities*.

The sections below outline methods and sources for developing Reference Case assumptions, including resources, loads, and transmission topology. While the study plan does not describe the detailed methods that will be used to translate data and assumptions between models, assumptions will be consistent whenever practical and applicable amongst the models. Modeling details addressing these nuances will be provided to regional partners throughout the WestTEC study process.

Load Forecast

This section outlines the methodologies and sources that will be used for creating the load forecast assumptions for the study. Primary data sources will include the following:

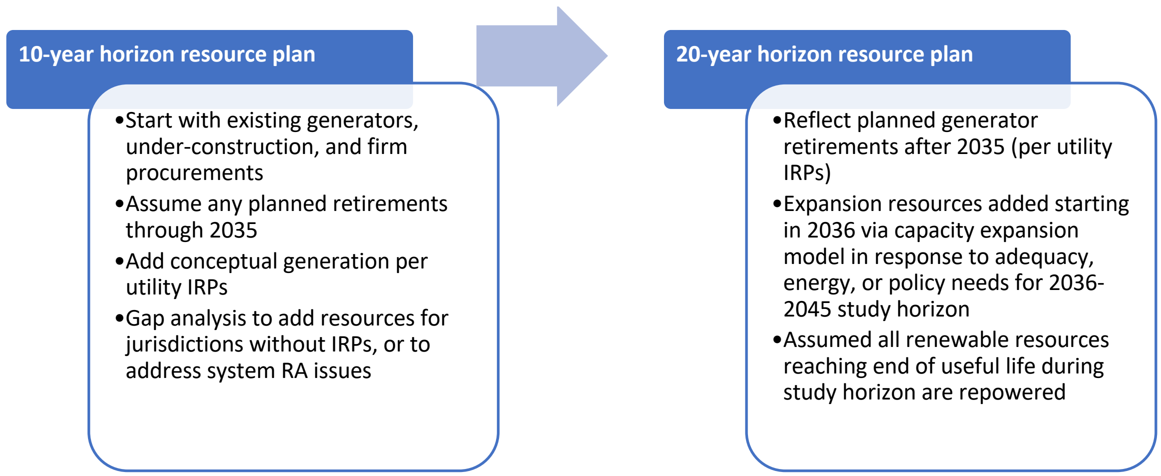
- WECC 2034 Anchor Dataset
- Utility integrated resource plans (IRPs)
- State agency data
- Other non-proprietary data sources

There is substantial uncertainty around the nature of loads in the future, particularly with considerations of the different state and regional policies on deep decarbonization. As such, the load forecasts will reflect multiple scenarios accounting for different potential futures, taking into consideration elements such as differing levels of building and transportation electrification, varying levels of distributed energy resources (DERs) and flexible loads, and increases due to large loads customers such as data centers. The Reference Case forecast will include a baseline level of DERs so that their impacts on transmission need can be considered.

Resources

This section outlines the methodologies and assumptions used to forecast the resource mix for the Western Interconnection for the Study's 10-year and 20-year horizons. The evolution of the generation fleet in the West is foundational to the WestTEC transmission planning effort. With little transmission capacity left on today's grid, where we connect new generation, and in what amounts and time horizons, will be a critical driver of transmission needs. Therefore, gaining stakeholder consensus on the methodology is crucial as it directly influences the identification of transmission needs and the nature of transmission solutions WestTEC will identify.

The sections below focus on methods and assumptions used to develop the Reference Case resource plan for the West. The approach attempts to balance a need, in the near-term, to recognize local generation plans developed by utilities through integrated resource plans (IRPs) as well as the need to consider future transmission expansion under a more integrated planning framework. To address the latter, WestTEC proposes to develop a long-term view of consolidated Western resource needs so that transmission can be planned as efficiently as possible. WestTEC's approach to developing resource plans for the 10-yearand 20-year study horizons is summarized in the figure below.



Not included in this section is a narrative of how scenarios will change this Reference Case resource plan. Such scenarios will be developed during study execution and will be characterized as modifications to this Reference Case resource trajectory, when applicable.

Existing, Planned, and Retiring Resources

Conceptual IRP Generation

Beyond existing and planned generators described above, utility IRPs also typically identify a set of expansion resources that are typically characterized by their technology type (e.g., wind), in-service dates (e.g., 2032), and amount (e.g., 500 MW). The conceptual additions planned through 2035 will be reflected in the modeling, with their location being informed by the bus-bar mapping methodology outlined in *Section 7*.

10-year Horizon Gap Analysis

E3 will compare the conceptual IRP generation plus existing resources to the projected load in the case and, where necessary, identify capacity resource additions needed to fill any gaps in the 10-year horizon to provide sufficient resource adequacy for the region.

Expansion Resources

In the 20-year horizon, the study will allow the capacity expansion model to select from a range of new resources that consist of both established commercially viable clean technologies and emerging technologies. The list of technologies include:

- Solar PV
- Land-based wind

- Offshore wind
- Geothermal
- Biomass
- Battery storage (including a range of technologies)
- Pumped hydro storage
- Natural gas with or without carbon capture and sequestration (CCS)
- Nuclear small modular reactors (SMRs)
- Hydrogen fuel

The more commercially viable technologies will be utilized in the 10-year time horizon, while the emerging technologies will be available in the 20-year time horizon. For the purposes of this study, commercially viable technologies will be limited to those captured utility integrated resource plans with planned in-service dates through 2035.

The primary data sources for resource potential, operating characteristics, and resource costs will be publicly available studies including:

- NREL Annual Technology Baseline
- NREL ReEDS
- State and regional regulator databases and analyses (such as the CPUC IRP Inputs and Assumptions, and CEC land-use screens dataset)
- Other publicly available studies and research data

Using this data, a supply curve of resources in zonal resources will be created with detailed resource characteristics including:

- Resource potential
- Capacity factors
- Capacity contribution
- Generation profiles
- Transmission utilization factors

Energy Policy & Voluntary Procurement Targets

The table below addresses only state energy policies that will be used to inform capacity expansion planning constraints.

State / Province	State-level Policy (modeled as planning constraint)	Notes
Alberta	• RPS of 30% by 2030	
Arizona	• RPS of 15% by 2025	
British Columbia	100% carbon-free electricity by 2030	
California	• 100% carbon-free electricity by 2045 (SB 100) • 60% RPS by 2030	
Colorado	• 100% clean energy by 2050 and 80% emission reduction by 2030 (from 2005) for large retail utilities [SB19-236]	

State / Province	State-level Policy (modeled as planning constraint)	Notes
	• 30% RPS for large utilities (exempts municipalities with less than 40,000 customers), with 10% RPS for coops with less than 100,000 meters and 20% for those with >100,000 meters	
Idaho	N/A	N/A
Montana	N/A	
Nevada	• 100% carbon-free electricity by 2050 and 50% RPS by 2030 (SB 358)	
New Mexico	• 100% carbon-free electricity by 2045, with 80% from renewables in 2040 (SB 489)	Rural electric coops have a 2050 target date
Oregon	• Greenhouse gas emissions reduced 100 percent below baseline emissions by 2040 (HB 2021) • RPS of 50% by 2040 (SB 1547), with reduced goal for smaller utilities	Requires investor-owned utilities to reduce greenhouse gas emissions associated with the electricity they sell to 80 percent below baseline emissions levels by 2030, 90 percent below baseline emissions levels by 2035, and 100 percent below baseline emissions levels by 2040.
Utah	• 20% by 2025 RPS, if cost effective (SB 202)	
Washington	• Greenhouse gas emissions to be 80% from renewable and non-emitting resources by 2030 and 100% by 2045 (SB 5116) • 15% RPS by 2020	
Wyoming	N/A	N/A
Voluntary Market (WECC-wide)	N/A	N/A

Not included in the table is consideration that will be given to utility voluntary goals, utility emission reduction trajectories, corporate voluntary goals, and incremental procurement forecasted to occur in the voluntary markets via green tariffs and other mechanisms. Representation of planning constraints associated with these resource drivers will be developed with WATT and regional partners in the course of the study.[4]

Transmission Topology

Representation of the Western transmission grid is one of the most critical study inputs and will impact the location and nature of transmission needs identified by WestTEC. This study assumes a modest and reasonable trajectory regarding the amount of transmission that is likely to be in-service for purposes of assessing transmission need within each study horizon.

Transmission Project Category	10-year Horizon	20-year Horizon
Existing system & under construction projects	Assumed to be in-service.	Same as 10-year horizon.

[4] Examples include Idaho where Idaho Power and Avista are pursuing 100% clean energy by 2045; and PacifiCorp which is on trajectory to reduce GHG emissions by 73% by 2043 (per 2023 IRP Update). In addition, WATT will engage with entities such as CEBA to develop reasonable forecasts of corporate procurement of resources, facilitating a benchmark between these forecasts and IRP forecasts.

Local transmission plans	All “planned” transmission projects in transmission provider 10-year plans will be included in the study. Planned projects are those that are not “conceptual” and WATT may use its discretion in removing any projects it determines to be conceptual in nature. WATT may request that Western transmission providers submit any differences between WECC seed case selected for the study and 10-year transmission plans.	Same planned projects as 10-year horizon.
Regional transmission plans	All transmission projects identified in regional transmission plans with in-service dates forecasted for 2035 or sooner will be assumed in the study. The applicable regional transmission plans include those listed below and earlier versions of the same: 1. **CAISO 2023-2024 TPP** (Draft Plan) 2. **NorthernGrid 2022-2023 Regional Transmission Plan** 3. **WestConnect 2022-2023 Regional Transmission Plan** 4. **BC Hydro Regional Transmission Plan**	All regional projects including those with forecasted in-service dates after 2035 will be assumed in the study. To the extent intra-regional transmission needs are identified in WestTEC, WATT may request that relevant planning regions provide solutions so that WestTEC can focus efforts on inter-regional or inter-state planning needs. For example, WATT may request that CAISO provide transmission solutions needed to integrate forecasted levels of offshore wind along the California coast.
Merchant business model projects (e.g., independently developed)	All transmission projects that are under construction or have been identified in the regional transmission plans listed above will be included. Projects under construction as of drafting of this study plan include: • SunZia (HVDC, CAISO subscriber PTO) • TransWest Express (HVDC and HVAC, CAISO subscriber PTO) SWIP North, while not under construction, was conditionally approved by the CAISO in 2023 and will be assumed to be in-service.	No additional projects beyond those in the 10-year horizon.
WestTEC 10-year additions	N/A	Transmission upgrades identified as needed in the WestTEC 10-year assessment will either be included in the 20-year models, or transmission constraints monitored closely in the 20-year assessment to enable re-sizing or optimizing of 10-year WestTEC transmission solutions.

Conceptual or proposed transmission projects not included in either the 10-year or 20-year horizon Reference Case will be collected and used to inform the hypothesis maps outlined in *Section 7 Planning Assessment & Methodology - Step 4*.

Energy Markets

Consistent with the study theme of planning the system on an integrated and holistic basis, WestTEC will evaluate future transmission needs assuming a future in which the West operates under a single day-ahead energy market. This will allow the study to focus less on near-term market seams and more on long-term fundamentals that are likely to drive transmission infrastructure. WestTEC is agnostic to future day-ahead market operators and does not seek to identify transmission upgrades that are based on market seams, which in the current Western environment would be unreliable and subject to a great deal of risk as market footprints may materially change or shift in the near-term. By focusing on system fundamentals, the 20-year analysis core to the WestTEC effort will be more informative and actionable to regional partners. WestTEC understands that this is an area of great interest to regional partners and, as such, observes the possibility that future iterations of WestTEC (should there be future iterations) or other long-term planning efforts could undertake analysis of this matter as more certainty on market footprints materialize.

7. Planning Assessment & Methodologies

WestTEC was initiated to explore a new approach to West-wide transmission planning. Such an approach is undoubtedly required to accomplish the many goals outlined in this Study Plan. Within this section we summarize the WestTEC study methodology and approach to identifying interregional and inter-state transmission infrastructure. While the approach is described in order of execution below, there will be some iteration and unmentioned coordination between study steps.

Overview of Methodology

WestTEC features a 10-step study process to develop Western transmission portfolios that reliably and economically transmit energy to loads in the 20-year horizon. The 10-year horizon will feature many of the same analytical steps as the 20-year horizon, although some will be condensed and expedited to limit the 10-year assessment as outlined in Section 4.

The first three steps of the study assessment involve developing a West-wide trajectory of resource deployment and load growth that is appropriate for determining transmission needs. In response to this forecast of changes to the grid, a transmission "hypothesis map" will be developed.

Next, in steps 5-7, the hypothesis map will be subject to refinement based on analysis of power system reliability and congestion. The initial hypothesis map will be refined until it is representative of a transmission portfolio that is sufficient to accommodate the resource portfolio in a reliable and efficient manner.

The hypothesis map will then evolve into a more detailed transmission portfolio in Step 8 where a transmission solutioning exercise will ensure that the portfolio consists of solutions that most efficiently address the needs of the system. Potential transmission solutions that will be considered include: reconductor or rebuilds (including HVDC conversion), co-located new build, greenfield new build, advanced conductor rebuild / greenfield, storage as a transmission solution, advanced powerflow controllers, dynamic line ratings and other proven transmission technologies suggested by stakeholders.

Consistent with the purpose of the study, the transmission portfolios developed by WestTEC will be focused on addressing issues on:

- Inter-state transmission lines that are 200-kV or greater
- Interregional transmission lines that are 200-kV or greater[5]
- Lines between transmission provider areas (or balancing areas) that are 200-kV or greater (even within a given region)
- Lines that makeup WECC paths, so long as the path rating is greater than 1000 MW

After the transmission portfolio is finalized, a value proposition study (Step 9) will commence to estimate the benefits offered by the transmission portfolio. A cost estimate of the transmission upgrades will also be developed.

This process will be followed for both a Reference Case and two Planning Scenarios, as described in Section 8. Once all portfolios are compiled, a synthesis of the resulting transmission portfolio (Step 10) will be used to identify common or "persistent" upgrades that are likely to provide the region with significant value.

Step 1: Area-to-area Transfer Constraints and Upgrade Tranches

To help improve coordination between the resource planning and transmission planning assessments core to WestTEC, Step 1 will generate information and data that will populate the capacity expansion model (PLEXOS) with inter-area transfer constraints and inter-area upgrades. These inputs are critical to capacity expansion modeling performed for WestTEC as it is likely the model, left unconstrained, that will select generation additions from high-value resource areas with no consideration of (1) constraints on the existing system that may limit the delivery of those resources between areas; and (2) the cost of incremental transmission infrastructure required to deliver resources between areas. While WestTEC does not endeavor to generate an "optimal" transmission and generation plan for the West, it does seek to generate a transmission portfolio that is based on better coordination between resource planning and the need to expand the transmission system.

The development of area-to-area transfer constraints will be supported by WATT with input from regional partners Sources for such data include transfer capability studies, WECC path ratings, historical scheduling or operational/flow data, and information about how planned upgrades included in the Reference Case will impact area-to-area transfers.

The development of transmission expansion candidates in the capacity expansion model will also be developed by WATT with input from stakeholders. WATT will seek to leverage existing planning studies and per-unit cost guidance as well as engineer judgement/local expertise to develop a supply curve of

[5] In certain cases, to facilitate the integration of resources, WATT may explore single transmission owner transmission solutions that will be a part of a broader transmission portfolio. Since it is expected that these lines will be a part of a broader inter-state or interregional network solution, such evaluations focused on a single system are appropriate.

transmission expansion options appropriate for modeling increased capacity between capacity expansion model areas.

Step 2: Develop Resource Plan

In this step the capacity expansion model will be used to generate an expansion plan that will be a "hybrid" of utility IRP plans and a new resource plan for the West selected as the least cost resource adequate generation portfolio. Key inputs include existing and planned resources, IRP conceptual additions, load forecasts, generation costs, generation characteristics, and policy constraints. Key outputs include:

- Resource plan specifying MWs of generation capacity type added over time by area
- Any information about transmission additions provided by model (e.g., area to area expansions)

The goal of this step of study is to forecast generation and transmission additions for the WECC region in a manner that will facilitate further evaluation of transmission needs. Load forecasting will also be performed as a part of the resource plan development.

Step 3: Busbar Mapping

Generation expansion plans developed via the capacity expansion modeling will be geographically coarse. To perform network modeling in both the powerflow and production cost modeling environments, an analysis is required to "map" the projected resource additions to specific points on the transmission system. To this end, the study will feature a busbar mapping analysis that defines where resources are to be located on the grid, which is an assumption that will feed into subsequent nodal transmission models.

The busbar mapping analysis focuses on the siting of generic future utility-scale generation and storage resources that are not already represented in the WECC seed cases adopted for the study. The busbar mapping methodology can be refined in response to regional partner input. The general approach will take capacity expansion modeling results, by zone, and will map them to substations within that zone considering a screening and analysis method that considers:

- Commercial interest (e.g., activity in interconnection queues)
- Transmission voltage and proximity of substation to resource potential
- Technical resource potential
- Land use and environmental constraints
- Development feasibility
- IRA energy communities
- Engineering judgement regarding transmission capability
- Input from transmission providers regarding transmission constraints
- Alignment with utility transmission plans
- Generation retirements

These factors are weighted and analyzed in a logical work flow that allows the generation identified in the capacity expansion modeling to be mapped to specific substations. Given the material impact this step is likely to have on certain transmission needs, the process seeks an outcome that is data driven, repeatable, and highly transparent.

For more information about prior busbar mapping analyses that will help inform the detailed methodology adopted by WestTEC, see prior work by the CEC, CPUC, and CAISO in support of the **2023-2024 CAISO Transmission Planning Process**,[6] as well as work by Energy Strategies and Montara Mountain Energy for the **Colorado Electric Transmission Authority**[7].

Step 4: Hypothesis Map Development

Step 4 in the study process will produce a series of hypothesis maps, based on WestTEC's understanding of what resource and demand changes the future grid will need to accommodate.

Such maps have been a useful tool for MISO's Long-Range Transmission Planning (LRTP) process. The hypothesis maps serve as an initial set of potential transmission solutions which can then be modified to fit many different study scenarios by adjusting, adding, removing and improving the networking of conceptual transmission lines – the maps are only a starting point. The maps do not represent final projects or a portfolio and are created simply as a "hypothesis" to be tested via detailed study. Qualitative factors that WestTEC may consider in developing the hypothesis maps includes:

1. Resource fleet change (e.g., capacity expansion results, bus bar mapping, IRPs)
2. Operational considerations (e.g., operational dynamics present in capacity expansion modeling)
3. Demand side requirements (e.g., load growth and location of load growth)
4. Transmission project proposals not included in the Reference Case
5. Transmission development corridors (e.g., National Interest Electric Transmission Corridor)

Prior study work and experience will support the creation of the maps, as will direct input from regional partners. Once study work begins, the maps will evolve as WestTEC performs analyses, identifies or confirms system issues, and considers substitutes or alternative configurations. Ultimately, the maps should be a useful conversation starter based on previously gained knowledge and qualitative considerations available at Step 4 of the study process.[8]

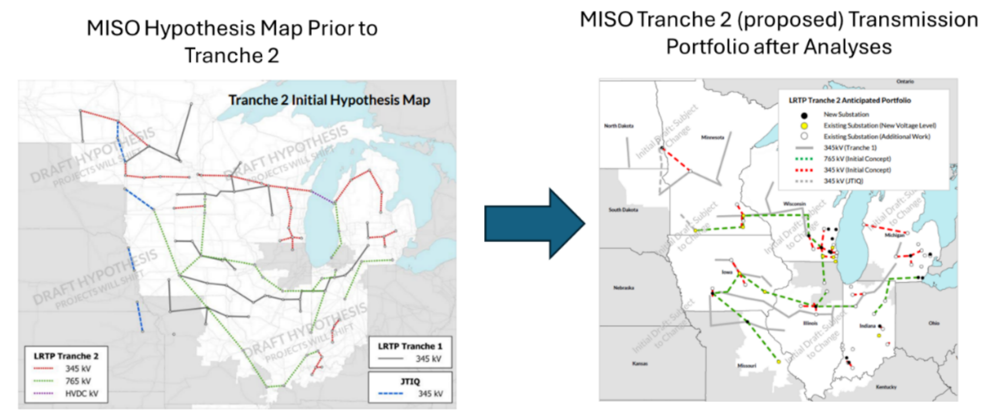
Below is an example of MISO's application of the hypothesis map approach where a conceptual transmission portfolio overlay was developed prior to detailed analysis based on public input, study

[6] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2022-irp-cycle-events-and-materials/2023-2024-tpp-portfolios-and-modeling-assumptions/23-24tpp_portfolios_workshopslides.pdf

[7] https://static1.squarespace.com/static/6390da3a799a023d4be2c27e/t/6604963fd91b6001393c1892/1711576642942/CETA+Stakeholder+Meeting+2+-+FINAL+-+3-22-24.pdf

[8] Another more technical reason to adopt a hypothesis map is that transmission planners often have difficulty getting AC powerflow solutions to converge of "solve" when faced with very drastic changes in resource deployment, such as those expected to occur between now and 2045. By starting with even a "hypothetical" transmission network, planners can more quickly get models to solve and can quickly iterate transmission configurations from a feasible starting point (versus an infeasible one).

work, and engineering judgement. That portfolio was refined during the LRTP planning process to arrive at the currently proposed Tranche 2 transmission portfolio.



Source: MISO.org

Step 5: Powerflow Assessment

The study region encompasses all of the high-voltage transmission in the WECC region, which has relatively long transmission lines and a diverse resource mix. These physical factors, plus an increasing dependence on system diversity and weather patterns, make planning an efficient and reliable grid both critically important and technically challenging. The powerflow assessment is how many transmission needs and solutions will be identified. The goal of the assessment is to refine the hypothesis map such that it results in a set of transmission expansion solutions that can reliably move electricity across the WECC region from where it is generated to where it is consumed as efficiently as possible. WestTEC will need to identify issues, draft solutions, and refine solutions in the course of this work. The goal of the study step is to arrive at a set of potential transmission projects that represent the most efficient solution to the issues identified on the Western system.

System Reliability Assessment (SRA)

With increasing penetration of renewable energy sources and storage technologies, the Western region faces new challenges in transmission planning that extend beyond traditional reliability assessments. The dynamic nature of renewable energy production and evolving load profiles will create a range of potential dispatch scenarios that are complex to model. The WestTEC system reliability assessment (SRA) will help ensure that the Western transmission system has interregional and inter-state transmission sufficient to ensure the grid is robust and flexible enough to manage these operational scenarios. This requires focusing on the most severe and credible conditions that could impact the WECC region, while acknowledging that local conditions may differ significantly (and are outside of this study scope).

To assess the impact of variable renewable and hybrid generation, along with other system conditions, WestTEC will develop a series of base case models to perform the SRA. These models are designed to capture multiple uncertainties including variations in renewable energy output, load levels, and seasonal factors that impact hydro operations and other system dynamics. This approach provides a versatile platform for conducting extensive reliability studies.

The SRA will concentrate on **three base cases** designed to address unique load conditions or renewable output scenarios in both 10-year and 20-year studies. These base cases are summarized in the table below.

Base Case	Load Description	Renewable, Storage, and Hydro Dispatch Approach	Justification
Case 1: Summer Peak Load	Summer peak demand condition for study horizon	• TBD renewable dispatch based on analysis of coincident output during summer peak hours • Storage idle - assuming some will be depleted, and some will be saving charge for evening • Hydro method TBD	Tests transmission systems ability to reliably service summer peak load with available renewable generation and dispatchable resources
Case 2: Winter Peak Load	Winter peak demand condition for study horizon	• TBD renewable dispatch based on analysis of coincident output during winter peak hours • Storage discharging • Hydro method TBD	Tests transmission systems ability to reliably service winter peak load with available renewable generation and dispatchable resources
Case 3: Max Renewable	Off-peak demand condition for study horizon	• Represent very high coincident renewable output • Storage charging • Hydro method TBD	Assess system ability to move power and reliably serve load during the annual maximum coincident wind/solar

In developing the base cases outlined above, WestTEC will leverage hourly wind, solar, and load data to explore coincidence of a given load and generation dispatch, adopting a data driven approach to developing operational patterns. Historical data as well as data sourced from modeling tools used in the course of the study will be used to inform this analysis.

In evaluating system performance under these conditions, the SRA will focus on steady-state contingency analysis with monitoring for thermal violations and voltage stability performance of the Western system. Dynamic modeling or transient stability analysis will not be pursued for this initial iteration of the WestTEC Study Plan but may be included in future iterations of the planning effort. Additional details regarding the SRA study methodology are outlined below.

Assumption	Approach

Scope	All powerflow areas in the WestTEC planning footprint will be included in the analysis, subject to limitations in scope as outlined below in Line Monitoring.
Contingencies	NERC TPL Category P0 (system intact or “normal”, N-0) and NERC Category P1 (single contingency, N-1) will be the primary focus of the study. In addition, WATT will engage with transmission providers to develop and refine a list of multiple contingency outages (P4, P5, and P7) that are appropriate for inclusion in the SRA, with a priority on always credible multiple contingency outages. WATT may explore the development of severe multiple contingency events (P3 and P6) expected to have a severe impact on system operations. As a guideline, the study will limit contingencies to those >200-kV. In select circumstances, the WATT may recommend that contingencies include <200-kV transmission, particularly when such outages are likely to cause violations on high-voltage transmission infrastructure. Any unique extreme event contingencies will be developed by WATT consistent with scope of extreme event assessment listed in *Section* 8. These events may be outside of NERC TPL-001-5.
Line Monitoring	The following Bulk Electric System (BES) elements (e.g., busses, lines, and transformers) within the US portion of the WECC region (including CAN-US interties) will be monitored: • Interstate transmission lines that are 200-kV or greater • Interregional transmission lines that are 200-kV or greater • Lines between transmission owners (or balancing areas) that are 200-kV or greater (within a given region) • WECC paths/interfaces will be monitored in the 10-year assessment but not the 20-year assessment Transformers with low-side voltages >200-kV will be included in monitoring, and bus voltage will be considered for >200-kV facilities. Monitoring above will be adjusted per the scope of each study horizon. In select cases, the WATT may choose to monitor <200-kV transmission facilities, especially when violations on these lower-voltage lines may impact the scope and nature of the transmission expansion options under consideration. WATT may identify scenarios where the monitoring of the high voltage system within a transmission provider area is warranted if it is anticipated that load or generation changes assumed in the study will require material backbone upgrades to the system.
Performance Criteria	Evaluated under system intact and contingency conditions consistent with NERC and WECC reliability standards, specifically:

	• NERC TPL-001-5.1 Transmission System Planning Performance Requirements • WECC TPL-001-WECC-CRT-4 Transmission System Planning Performance
RAS	WECC Powerflow RAS are included in WECC operational Base Cases. WATT will request WECC to seek adjustments or RAS modification appropriate for planning case and will implement existing RAS accordingly. The Study will seek to minimize modification or new single contingency RAS when developing transmission portfolios. Modifications or expansions to multiple contingency RAS will be made as needed at the discretion of WATT.
System adjustments	Will be considered as appropriate based on the nature of multiple contingency outages developed by WATT. System adjustments will not include load shed and will be limited to minor redispatch of generation (captured only to reflect uncertainty of study assumptions, limited to a 10% adjustment).

Interarea Deliverability Assessment (IDA)

The IDA is necessary to identify transmission needed to ensure resources can be reliably transferred – or are "deliverable" – to load in expected quantities during times of system need. Generally, resources that are designated in planning processes as having "deliverability status" can be counted on for resource adequacy purposes. Since growing demand and capacity need in the West is likely to be a major driver of resource deployment over the approaching 20-years, it follows that transmission capacity may become a limiting factor to ensuring reliability when resources are mostly remote from load (in high quality resource areas). This analysis is designed to help bridge this gap, ensuring that resources that are needed to support adequacy have the transmission to do so.

The IDA assessment will not be performed for every area. WATT will review study results and will decide which areas may benefit from IDA. The study will not focus on intra-area transmission constraints, such as those found within the CAISO system (which already has a robust deliverability analysis approach). WestTEC's IDA will focus primarily on transmission constraints associated with (1) zones that are critical exporters of energy, such as Wyoming, Montana, and New Mexico; and (2) zones that experience large deployments of generation that may not have sufficient transmission capacity to deliver power to other zones during times of system need.

The IDA assessment will present an opportunity to further refine and revise the hypothesis map in response to study results and planner observations of system need. The IDA assessment also represents a useful opportunity to refine upgrades identified as needed in the SRA to advance both general system reliability and deliverability goals.

The IDA will require WATT to develop dispatch methodologies that allow it to achieve these objectives. We anticipate that dispatch levels will be determined on a zone-by-zone basis and will be informed by data generated in the capacity expansion or production cost models that will indicate how much power must be exported from a given zone under a critical system condition (E.g., system peak). Line monitoring, contingency lists, and performance criteria are likely to mirror the SRA, although will be adjusted to focus on inter-area deliverability constraints.

Assumption	Approach
Scope	Based on resource plan and results from the SRA, WATT will identify areas home to resources that are likely needed for resource adequacy purposes across the broader system. Such areas are likely to be heavy exporters of energy.
Contingencies	NERC TPL Category P0 (system intact or “normal”, N-0) and NERC Category P1 (single contingency, N-1) will be the primary focus of the study. In addition, WATT will engage with transmission providers to develop and refine a list of multiple contingency outages (P4, P5, and P7) that are appropriate for inclusion in the IDA, with a priority on always credible multiple contingency outages. As a guideline, the study will limit contingencies to those >200-kV.
Line Monitoring	The following Bulk Electric System (BES) elements (e.g., busses, lines, and transformers) within the US portion of the WECC region (including CAN-US interties) will be monitored: • Interstate transmission lines that are 200-kV or greater • Interregional transmission lines that are 200-kV or greater • Lines between transmission owners (or balancing areas) that are 200-kV or greater (within a given region) • WECC paths/interfaces will be monitored in the 10-year assessment but not the 20-year assessment Transformers with low-side voltages >200-kV will be included in monitoring, and bus voltage will be considered for >200-kV facilities. Monitoring above will be adjusted per the scope of each study horizon. For the IDA, WATT will set a monitoring criteria that focuses on the transferability of resources between areas and regions. WATT may identify scenarios where the monitoring of the high voltage system within a transmission provider area is warranted if it is anticipated that load or generation changes assumed in the study will require material backbone upgrades to the system.
Performance Criteria	Evaluated under system intact and contingency conditions consistent with NERC and WECC reliability standards, specifically:

	• NERC TPL-001-5.1 Transmission System Planning Performance Requirements • WECC TPL-001-WECC-CRT-4 Transmission System Planning Performance
RAS	Significant reductions in generation to accommodate transmission outages contradict the premise of the study, which is that resources need to be available to service loads in times of need. Therefore, RAS will only be used in select circumstances where the lost generation I minimal. Otherwise, the study will not consider RAS.
System Adjustments	Will be considered as appropriate based on the nature of multiple contingency outages developed by WATT.

Step 6: Transmission Portfolio Refinement & Iteration

While not identified within Step 5, the hypothesis maps identified in Step 4 will be refined and iterated upon in Step 5. For example, planners may conclude that a conceptual transmission line in the hypothesis map between node A and B is undersized, oversized, or needs to be relocated or modified to address system needs more efficiently. Generally, this process involves planners reviewing powerflow analyses results (from the Step 5 assessments) and iterating on studies, applying engineering judgment when necessary, and refining solutions. Given the collaborative nature of WestTEC, WATT will seek to have local planning experts (e.g., utility planners) advise consultants in developing efficient transmission expansion plans during this refinement and iteration task. Results from the SRA and IDA will be used to help refine the hypothesis map to arrive at a set of potential transmission projects that represent the most efficient solution to the identified issues.

Step 7: Congestion Assessment

After several iterations between Step 6 and Step 7 have occurred, WestTEC will have identified a revised transmission hypothesis map that addresses in-scope reliability issues identified via the SRA and IDA. To develop a transmission portfolio that ensures the reliable and economic delivery of energy resources to loads, WestTEC will then conduct a congestion assessment. The purpose of the congestion assessment is to identify transmission constraints that cause congestion on the system that, if addressed, could help reduce production costs, improve the operational efficiency of the grid, and enhance access to a diverse resource mix.

To identify transmission congestion WATT will review nodal production cost model results for specific constraints and data associated with those constraints such as:

- Shadow prices
- Frequency of binding (e.g., congested) hours
- Binding flow levels
- Historical incidence of congestion (if applicable)

Once congestion data and issues are identified, they will be reviewed and shared with regional partners for feedback. Note that since the economic models are based primarily on public data, WestTEC (like other planning efforts) will have to consider the potential for “noise” in the observed congestion results.

As a result, WATT should prioritize severe congestion on major transmission elements or paths within the scope of the study.[9]

WestTEC will then further augment the hypothesis map to address the identified congestion. Material changes to the hypothesis map topology may cause a need for some iteration with Task 5 to ensure that changes to the hypothesis map do not generate new in-scope reliability issues.

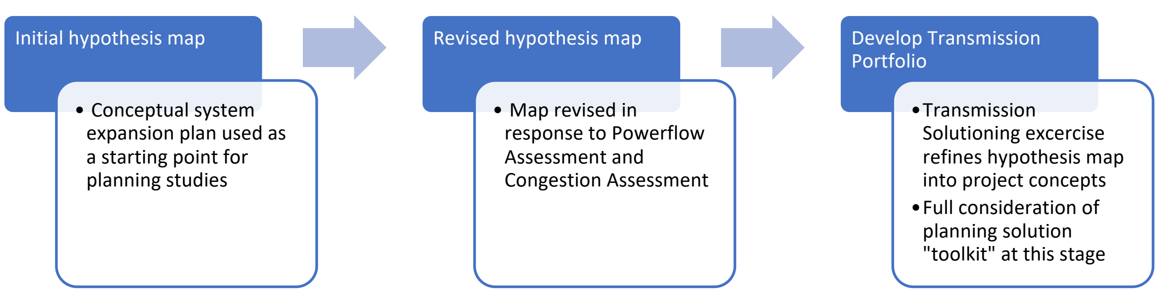
Step 8: Transmission Solutioning

Once the six-step planning process outlined above is complete, the initial hypothesis map will have been refined and optimized and will be representative of a transmission portfolio that is sufficient to accommodate the resource portfolio in a reliable and efficient manner. Within this transmission solutioning task, the hypothesis map established at the conclusion of Step 7 will be "converted" into a transmission portfolio. This process, which is effectively an alternative assessment, will ensure that the transmission portfolio identifies the most efficient and appropriate upgrades.

For modeling simplicity during Steps 1-8, the hypothesis map will consist of primarily new build and upgrade projects (e.g., reconductors). During the transmission solutioning phase (Step 8) WestTEC will determine if upgrades can be replaced with different transmission alternatives that meet the needs of the system at a lower cost, considering options from the list below:

- Reconductor or rebuilds (including HVDC conversion)
- Co-located new build or greenfield new build
- Advanced conductor technology rebuild or greenfield
- Non-wires options, such as storage as a transmission solution, advanced powerflow controllers, dynamic line ratings and other proven transmission technologies suggested by regional partners

The criteria to introduce a transmission alternative into the portfolio will be based on technical performance, cost comparisons, development feasibility, project complexity, and the nature of the underlying reliability or congestion need. A flow chart demonstrating how WestTEC will develop a transmission portfolio based on the revised hypothesis map is outlined below.



[9] During the course of the study WATT can choose to explore metrics that may serve as a threshold to filter through transmission congestion with the goal of identifying transmission constraints within the scope of WestTEC.

Through this exercise, WestTEC will identify a transmission portfolio that meets the goal of being the most efficient solution to the planning issues identified in the assessment. The transmission solutioning work (Step 8) will result in documentation regarding the alternatives considered as well as the need for projects in the transmission portfolio.

Step 9: Value Proposition (Benefits & Costs)

Once a transmission portfolio is established for the Reference Case (or a given Planning Scenario) WestTEC will perform a benefits assessment. The purpose of the benefits assessment is to provide an estimate of the value proposition for a given transmission portfolio by quantifying the following transmission benefits:

Operational & Congestion Efficiencies – Measured as change in annual adjusted production cost (APC), capturing reductions in short-run generation production costs to service loads due to reduced congestion and/or curtailment. GridView will be used to estimate this benefit. This benefit captures savings associated with reduced transmission energy losses. It can also be enhanced to capture the reduction in production costs due to transmission outages to the extent contingencies are modeled in the production cost model study.

Improved Resource Adequacy (reduced loss of load probability) – Estimated through an analysis of load diversity savings achieved due to greater inter-area transfer capability. The additional capacity created by the transmission portfolio will help balancing areas share resources that could otherwise be constrained, which has the potential to avoid the construction of capacity resources.

Capacity Savings from Reduced Peak Energy Losses – Benefit will be quantified as the savings in capacity costs resulting from reduced peak energy losses, which lower the total generation capacity required to meet peak demand.

Extreme Event Mitigation (resilience benefits) – Estimated as a change in cost of unserved load and/or production through a nodal production cost model simulation whereby the system is stressed to reflect a tail event grid condition, such as a winter or summer extreme event condition that combines high loads, generation unavailability, transmission outages, changing weather patterns, and other compromising factors (like wildfires and ice storms) that have historically contributed to lost load. Value of lost load (VOLL) will be used to quantity the value of any avoided load curtailments. The study will use the extreme event assessment described in *Section 8 Scenario Planning* and will be designed to capture the value of the transmission portfolio's ability to reduce risk of load shedding during severe events.

Increased resource Access – Estimated as the savings associated with accessing higher value resources due to transmission expansion. PLEXOS counter-factual scenarios (e.g., no transmission expansion resource portfolios) will be used to help estimate these savings, which are reductions in capital costs associated with the resource portfolio.

Avoided Emissions – Benefits of reducing GHG emissions due to transmission expansion and resources enabled via transmission portfolio. GHG emission reduction is quantified based on carbon cost and discount rate analysis.

Avoided or Deferred Reliability Upgrades – Captures avoided cost of reliability upgrades that would need to be built but for the transmission portfolio. Identification of avoided upgrades are based on an analysis of powerflow modeling results where loading on facilities near (or above) thermal limits is evaluated with and without the transmission portfolio. By estimating the costs to upgrade or replace overloaded facilities we will estimate savings that will accrue due to the transmission portfolio.

Portfolio benefits that are quantifiable in dollar terms identified above will be on a present value basis for a range of years and discount rates. It is anticipated that the benefit estimates may be used to support future discussions regarding development opportunities around the portfolio. Importantly, this analysis will not generate benefits at a level sufficient to be used for the purposes of cost allocation, or the equitable distribution of benefits which will require a detailed tracking of benefits with transmission areas. WATT will perform the analysis prioritizing quantification of total portfolio benefits as estimated for the aggregate study footprint. Then, WATT will prioritize the disaggregation of total portfolio benefits to Western regions. Once those tasks are complete, WATT will contemplate re-calculating portfolio benefits for sub-portfolios (e.g., smaller groups of projects) for individual regions or areas. However, this is not required as a task in this Study Plan and given the ambitious nature of WestTEC and this effort, such work will be pursued at the discretion of WATT.

Transmission Portfolio Cost

Another goal of the value proposition study is to demonstrate the potential for cost savings in a future with the transmission upgrades in the portfolio as compared to a future in which those upgrades are not built. Therefore, in addition to this benefits assessment, WATT will estimate the incremental cost to construct and operate the transmission portfolios identified in the study. As outlined in *Section 5 Study Tools & Software,* WATT will develop and apply a capital cost calculator using per-unit cost guides that will be used to generate planning-level cost estimates for the transmission portfolios. A range of discount rates will be used to estimate a present value investment cost and total revenue requirement. These results may be used to inform a cost-benefit ratio calculation for each transmission portfolio if deemed appropriate by WATT. WATT will also develop high- and low-end cost estimates for each transmission portfolio to capture uncertainty regarding future transmission development and operation costs.

Step 10: Synthesis of Transmission Portfolios

A priority of the study is identifying risk-minimizing solutions, which are transmission solutions likely to be needed under multiple future scenarios. Once the Reference Case and a number of Planning Scenarios are complete, WestTEC will look across the identified transmission portfolios for “persistent projects”, which will represent a set of upgrades that are needed under many or all futures. It is anticipated that the Western region will benefit greatly from having identified projects that, if prioritized, may provide a great deal of low-risk benefit to the region.

8. Scenario Planning & Sensitivities

Scenario assessments will be performed to explore alternative but plausible grid conditions that differ than those captured in the Reference Case study outlined above. While the 10-year assessment will focus heavily on the Reference Case, the 20-year assessment will include ample scenario analysis. WestTEC will seek regional partner input and guidance on what scenarios it will pursue and it will collect and organize proposed scenarios during the study. Currently, WestTEC envisions three categories of scenarios and sensitivities: planning scenarios, an extreme event assessment, and powerflow assessment sensitivities.

Planning Scenarios

The inaugural WestTEC Study will feature the development of **two regional partner-driven planning scenarios**, which will represent a collection of material and coordinated changes to the 20-year Reference Case.[10] These planning scenarios will be designed to explore a range of possible future states of the Western grid, considering variations in technology advancement, load growth, policy changes, market dynamics, or environmental factors. The involvement of regional partners in shaping these scenarios is essential to ensure that they reflect a comprehensive understanding of regional priorities and potential future developments.

WestTEC regional partners will be actively engaged through **facilitated public workshops and feedback sessions** to help identify key drivers and trends that could impact the energy landscape. This collaborative process is crucial as it allows WestTEC to capture diverse perspectives and expertise, ensuring that the planning scenarios are robust and capture various viewpoints. Regional partners contribute by providing insights into potential regulatory changes, technological advancements, market trends, and environmental considerations that should be included in the scenario planning process.

These planning scenarios will be developed based on the Reference Case, which assumes the continuation of current trends and policies. This baseline serves as the foundation from which diverse future pathways are constructed, reflecting changes such as aggressive renewable energy adoption, shifts in consumer behavior, electrification, or new policies. Each scenario will provide a platform to assess how different futures could affect grid reliability and the need for transmission expansion.

By analyzing the transmission needs and solutions that persist regardless of the scenario, WestTEC will seek to identify transmission investments that are most likely to yield benefits under a range of future conditions. These common investments could represent foundational upgrades or enhancements that improve grid reliability, economics, or connectivity regardless of future developments in the region. This

[10] The two planning scenarios plus the Reference Case (baseline) will result in three futures that will inform the initial WestTEC planning process. In order to complete the process in a timely manner and to explore all components of the study scope, WestTEC seeks to limit the number of scenarios and makeup for the quantity by thoughtfully crafting the futures with guidance from stakeholders.

will help WestTEC prioritize deeper analysis and insight into investments that provide the greatest value and risk mitigation across different scenarios.

Extreme Event Assessment

WestTEC has received interest in the modeling of extreme events. This scenario will be a powerflow study designed to test the performance of the transmission portfolio under extreme weather events and/or a limited set of contingencies representing outages consistent with high impact low probability events (such as transmission outages due to wildfires). Examples of such events include a heat dome, polar vortex, or similar condition that reflects high/low temperatures and impact on demand, changes in hydroelectric output, low wind or solar production, restrictions on imports, transmission outages, and impacts to generation availability through unplanned outages. WestTEC will develop a detailed scope for this assessment during the scenario development process that will initiate upon completion of this study plan.

Powerflow Assessment Sensitivities

In addition to the base cases outlined in the SRA (Step 5 within Section 7), WestTEC will consider developing base case scenarios that will be used to assess the transmission portfolio's ability to maintain system reliability under alternative dispatch and/or load conditions. Potential base case scenarios identified in drafting of this study plan include:

- **Winter low renewable condition** to test the transmission portfolio's ability to deliver energy to load when solar and wind production is low but loads may be high in some regions.
- **Twilight summer condition** to test the transmission portfolio's ability to deliver energy to load when solar resource output is decreasing, wind output may be low, and energy storage resource have limited availability.

As with the other scenarios, the base case scenarios will be developed with stakeholders during the WestTEC effort.

9. Seed Cases & Source Data

It will be necessary to adopt several "seed cases" to perform the WestTEC study. Seed cases are modeling datasets that will serve as a starting point for the study and will be updated in accordance with this work plan. The following are a list of the seed cases WestTEC is likely to pursue (pending release of better of enhanced models by WECC at a future date):

- WECC 2034 & 2032 Anchor Data Set
- WECC 10-year base cases, including:
  - 2034-35 Heavy Winter (or 2033-34 Heavy Winter as an alternate)
  - 2035 Heavy Summer (or 2034 Heavy Summer as an alternate)

In addition, WestTEC may seek the following databases to support compilation of models needed to perform the assessment outlined in this Study Plan:

- Various WECC powerflow cases as adapted by Western Order 1000 Planning Regions
- Various WECC powerflow cases as adapted by transmission providers, such as those models used to perform local planning assessments and interconnection studies

10. Study Schedule & Milestones

The schedule for the 10-year horizon and 20-year horizon workstreams are presented below. **Not included in this schedule is a detailed cadence for regional partner and WestTEC committee input or review.** The schedule is limited to the key technical milestones that will be accomplished during the study. A timeline that includes public engagement in the Study Plan is included in the WestTEC Project Charter and Regional Partner Engagement Plan to which this study is appended to.

10-year Horizon Study (Reference Case)	
Milestone	**Completion Date**
Data collection for Reference Case	September-24
Model development, calibration, and testing	October-24
Establish resource plan (10-year gap analysis) and busbar mapping	November-24
Hypothesis map development (as needed)	December-24
Powerflow assessment & hypothesis map refinement	March-25
Congestion assessment (as needed)	April-25
Transmission solutioning for revised hypothesis map (establish Reference Case transmission portfolio)	May-25
WestTEC 10-year Horizon Report (draft)	June-25
WestTEC 10-year Horizon Report (final)	August-25
20-year Horizon Study	
Milestone	**Completion Date**
Data collection for Reference Case	January-25
Model development, calibration, and testing	March-25
Scenario development with stakeholders	March-25
Establish resource plan & busbar mapping	April-25
Hypothesis map development	May-25
Powerflow assessment & hypothesis map refinement	September-25
Congestion assessment	November-25
Transmission solutioning for revised hypothesis map (establish Reference Case transmission portfolio)	January-25
Value proposition study	May-26
Portfolio synthesis	June-26
Planning scenarios complete	July-26
Power Flow sensitivities complete	July-26
Extreme event scenarios complete	July-26
WestTEC 20-year Horizon Report (draft)	September-26
WestTEC 20-year Horizon Report (final)	October-26