20-YEAR CONCEPTUAL SCENARIO REPORT

For the State of Colorado

To comply with

Rule 3627
of the
Colorado Public Utilities Commission
Rules Regulating Electric Utilities

February 3, 2014

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ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Term
2014 Plan	2014 Ten-Year Transmission Plan
2014 Scenarios Report	2014 20-Year Scenario Analysis for the State of Colorado
Black Hills	Black Hills/Colorado Electric Utility Company, L.P.
CACJA	Clean Air Clean Jobs Act
CAGR	Compound Annual Growth Rate
CCPG	Colorado Coordinated Planning Group
CCS	Carbon Capture and Sequestration
Commission	Colorado Public Utilities Commission (also CPUC)
Companies	Black Hills, Tri-State and Public Service
Company	Black Hills, Tri-State or Public Service
CPUC	Colorado Public Utilities Commission (also Commission)
CWG	Conceptual Work Group (of the CCPG)
DG	Distributed Generation
EIM	Energy Imbalance Market
EPA	Environmental Protection Agency
EPE	El Paso Electric
FERC	Federal Energy Regulatory Commission
HVDC	High Voltage Direct Current
IOU	Investor Owned Utility
L&R	Load and Resource
LTPT	Long Term Planning Tool
PNM	Public Service Company of New Mexico
PSCo	Public Service Company of Colorado (also Public Service)
Public Service	Public Service Company of Colorado (also PSCo)
PV	Photovoltaic
RES	Renewable Energy Standard
RPS	Renewable Portfolio Standard
SCR	Selected Catalytic Reduction
SCPC	Scenario Planning Steering Group (of the TEPPC)
SPP	Southwest Power Pool

Acronym or Abbreviation	Term
TEPPC	Transmission Expansion Planning Policy Committee (of the WECC)
TNP	Texas – New Mexico Power
TP	Transmission Provider
Tri-State or TSGT	Tri-State Generation and Transmission Association, Inc.
WECC	Western Electricity Coordinating Council

I. Executive Summary

Rule 3627, which was adopted by the Colorado Public Utilities Commission ("CPUC" or "Commission") in 2011, requires the preparation and biennial submission of 10-year transmission plans and conceptual long-range scenarios that consider a 20-year transmission planning horizon. The first 10-Year Transmission Plan was submitted jointly by Black Hills/Colorado Electric Utility Company, L.P., d/b/a Black Hills Energy ("Black Hills"), Public Service Company of Colorado ("Public Service" or "PSCo"), and Tri-State Generation and Transmission Association, Inc. ("Tri-State" or "TSGT") (each referred to individually as a "Company" and collectively as the "Companies") on February 1, 2012. On December 13, 2012, Hearing Commissioner James K. Tarpey issued his Recommended Decision (Docket No. 12M-102E, Decision No. R12-1431) wherein he found that the Companies' joint 10-Year Transmission Plan was adequate for purposes of meeting the requirements of Rule 3627. The Recommended Decision became the final decision of the Commission by operation of law on January 2, 2013. The Companies in that first report, however, were not required to submit a 20-year conceptual plan. This present report addressing conceptual long-range scenarios over a 20-year transmission planning horizon is the first the Companies are submitting under Rule 3627.

Scenario-based analysis is a technique for considering uncertainties that may impact decision-making in today's world based on potential future conditions. It may be useful when evaluating long-term investments despite the inability to accurately predict future conditions. While it is impossible to predict the future with complete accuracy, scenario development can assist with the identification of strategic choices that utility planners, project developers, regulators, and advocates may reasonably need to consider over a 20-year time period.

The scenarios offered in this filing include four that were studied by the Colorado Coordinated Planning Group ("CCPG") and five from the Western Electricity Coordinating Council ("WECC"). All alternatives were vetted through open stakeholder processes. Two of the CCPG scenarios resulted in brief reports of potential transmission impacts. However, the other scenarios were evaluated extensively on a technical basis using transmission reliability modeling tools, and explored a wide range of future conditions,

including different levels of renewable energy resource requirements, and several different load forecasts for the 20-year period. The WECC scenario analyses were performed by a committee that is dedicated to the evaluation of scenarios in the Western Interconnection. The Transmission Expansion Planning Policy Committee ("TEPPC") used a one-of-a-kind cost optimization tool for the 20-year analysis, referred to as the Long Term Planning Tool ("LTPT"), that cost optimizes based on generation and transmission assumptions within the scenarios.

In addition to the CCPG and WECC scenarios, Tri-State has provided three additional scenarios and Public Service has provided four additional scenarios. The Companies' scenarios generally address what the future state of the power supply market might look like in Colorado based on the occurrence of different factors or events, including changes in generation mix, load growth, load demand, social economics, generation technology, transmission assumptions, and changing public policy requirements.

II. Overview of the Colorado 20-Year Conceptual Scenarios Analysis

On March 23, 2011, the Colorado Public Utilities Commission ("Commission") issued its Order on Exceptions (Decision No. C11-0318) in Docket No. 10R-526E, "In the Matter of the Proposed Rules Related to Electric Transmission Facilities Planning, 4 Code of Colorado Regulations 723-3." Pursuant to that Order, the Commission adopted Rules 3625 through 3627 pertaining to the coordinated planning for additional electrical transmission facilities in Colorado.

Rule 3627 requires the preparation and biennial submission of 10-year transmission plans and conceptual long-range scenarios that consider a 20-year transmission planning horizon. The first 10-Year Transmission Plan was submitted jointly by the Companies on February 1, 2012. On December 13, 2012, Hearing Commissioner James K. Tarpey issued his Recommended Decision (Docket No. 12M-102E, Decision No. R12-1431) wherein he found that the Companies' joint 10-Year Transmission Plan was adequate for purposes of meeting the requirements of Rule 3627. The Recommended Decision became the final decision of the Commission by operation of law on January 2, 2013. However, the 10-Year transmission plan did not address long-range scenarios that

consider a 20-year planning horizon. When the Commission adopted Rule 3627, it was decided that the first report should only include the 10-year transmission plan.

In this 2014 report the Companies are complying with Rule 3627 by filing both the 2014 20-Year Conceptual Scenarios Report for the State of Colorado ("2014 Scenarios Report") and an updated 2014 10-Year Transmission Plan ("2014 Plan"). This Report has been jointly prepared and is being submitted by the Companies.

Scenario-based analysis is a technique for considering uncertainties that may impact decision-making in today's world based on potential future conditions. It may be useful when evaluating long-term investments despite the inability to accurately predict future conditions. Although it is not possible to predict the future with complete accuracy, scenario development can assist with the identification of strategic choices that utility planners, project developers, regulators, and advocates may reasonably need to consider over a 20-year time period.

The 2014 Conceptual Scenarios Report is not a "plan" as are the 10-year transmission plans required by Rule 3627. Instead, this Report identifies and assesses various credible future alternatives and provides information that can be used individually or in conjunction with utilities, coordinated planning organizations, lawmakers, and other industry stakeholders for further evaluation of ongoing transmission needs in the state of Colorado. These scenarios describe a set of economic, social, technological, and societal circumstances that the Companies believe could conceivably come to pass.

Consistent with the requirements of Rule 3627(e), the Companies' conceptual scenarios discussed herein include, at a minimum:

- reasonably foreseeable future public policy initiatives
- possible retirement of existing generation due to age, environmental regulations, or economic considerations
- emerging generation, transmission, and demand limiting technologies

- various load growth projections[1]
- studies of any scenarios requested by the Commission in the previous biennial review process
- changes in market conditions

[1] The CCPC scenarios address Commission Decision R12-1431 in Docket No. 12M-102E to "Include potential impacts to the transmission system if the assumptions concerning load growth in the 10-year plan are incorrect."

III. Company Perspectives on Conceptual Scenarios Analysis

A. Black Hills

Black Hills recognizes the potential for 20-year conceptual planning to contribute to the development of 10-year transmission plans. While not all utilities and planning organizations will always agree about whether a particular future scenario is probable or realistic, simple consideration of the impacts of any and all given scenarios can only add value to each Company's planning process. One distinction that sets Black Hills apart from some other entities in Colorado is that, as an electric utility under the jurisdiction of both the Federal Energy Regulatory Commission ("FERC") and the Colorado Commission, we must consider potential future federal and/or public policy initiatives that may not directly impact other entities.

It is Black Hills' view that much of the planning work that has been performed within the various utilities and regional planning groups generally suggests transmission development to connect potential resources located along the entire eastern part of Colorado to the Denver area load center. Also included in this trend is transmission development in Wyoming across the TOT3 boundary into NE Colorado. There are identified transmission projects that align with this trend, such as the Lamar-Front Range project. The magnitude and timing of that overall transmission expansion, as well as the degree of participation from utilities and other entities, could be driven by any combination of drivers mentioned in Rule 3627(e).

Black Hills has provided insight into how the three CCPG scenarios and the four WECC scenarios listed within this report may impact the Company. These comments can be found throughout Appendices A-D where shown. However, due to the limited variability of the impacts to the Company in the various scenarios, Black Hills has opted to refrain from discussing additional, company-specific scenarios at this time.

B. Tri-State

Tri-State brings a unique perspective to the 20-year conceptual scenario planning process under Commission Rule 3627(e). While Black Hills and Public Service are investor-owned, vertically integrated electric utilities providing retail electric service in Colorado, Tri-State is a not-for-profit, generation and transmission cooperative providing wholesale electric power to its 44 Member Systems located in four states: Colorado, Nebraska, New Mexico, and Wyoming. As a regional power provider, Tri-State's transmission system is designed and operated without specific regard to individual state boundaries. Rather, Tri-State operates an integrated, interconnected, interstate transmission system to deliver reliable, affordable, and economic power to its Member Systems throughout its four-state footprint. As such, Tri-State's view of the long-range conceptual future is not limited to possible developments in Colorado and must consider the load-serving, reliability, economic, social, and technological needs of all of its Member Systems and the states in which they are located.

In addition to these fundamental differences in transmission system considerations, there are also generation resource differences that influence Tri-State's long-range conceptual transmission scenario perspectives, as compared to other utilities. For example, as a cooperative, Tri-State is subject to slightly different public policy initiatives than those that apply to Black Hills and Public Service under Colorado's Renewable Energy Standard(s) ("RES"). Furthermore, the unique nature and interstate locations of Tri-State's generation resources and power supplies also result in a different perspective for Tri-State.

All of these considerations led Tri-State to different conclusions with respect to what may constitute "credible alternatives" for purposes of 20-year conceptual scenarios. Differences between Tri-State's view of what is credible and the views of Black Hills or Public Service are not intended to reflect negatively on the scenarios of the other Colorado utilities, but rather are simply a result of the three utilities' differing business models and purposes. To the extent that Tri-State has any specific comments with regard to any scenario presented by Black Hills, Public Service, or any other entity discussed herein, Tri-State's view is included in the discussion of that scenario.

Tri-State Scenarios

Tri-State considered the 20-year scenarios developed through CCPG, and also developed three additional scenarios summarized below. Many drivers and assumptions were considered, including potential impacts from high and low load changes (forecasts), changes to renewable resource requirements, and new carbon regulations. Due to the breadth of drivers and assumptions, each scenario resulted in different long-term visions of the evolution of the transmission system in Colorado.

Following is a brief summary of each of the three Tri-State scenarios. Full descriptions, including rationale, drivers and assumptions behind each scenario, can be found in Appendix A.

1. ***TSGT Scenario #1: Advanced Carbon Capture and Sequestration***
   This scenario assumes that, in addition to advances in other clean energy technologies, coal and other fossil fuels will continue to play a strong role in energy production for many decades to come. Globally, there is a continued expansion of coal and other fossil fuel uses for both the energy and industrial sectors. This scenario assumes that this expansion, coupled with increasing concerns for global CO_2 levels, will encourage innovations and cost reductions for Carbon Capture and Sequestration ("CCS") technologies. This scenario considers one potential impact on the design of the transmission system if new carbon regulations were adopted either federally or by the state.

2. ***TSGT Scenario #2: Distributed Generation***
   This scenario assumes significant advancement in wholesale and retail distributed generation ("DG") technology coupled with low load growth rate and higher end-use efficiency. This scenario is predicated on the growth of distributed solar PV generation, advancements in energy storage technologies and associated public policies, as well as increased interest in a variety of other small-scale distributed generation resources such as biomass, coal mine methane, syngas from municipal solid waste, and community wind. Assumptions made are similar to WECC Scenario 2 with what Tri-State believes is a more

realistic valuation of input parameters such as carbon cost, load growth, economic viability, and RES requirements. This scenario considers the potential impact on the design of the transmission system if new renewable regulations were adopted.

3. ***TSGT Scenario #3: Increased Connectivity Between Western and Eastern Interconnections***

   This Scenario assumes that sufficient future resource cost imbalances exist between the WECC and Southwest Power Pool ("SPP") regions to justify additional direct current tie(s) between them. Tri-State examined the impacts and benefits of a new asynchronous interconnection between the Burlington area of eastern Colorado and the Colby area of western Kansas. This scenario considers the potential impact on the design of the transmission system if significant load and generation forecast changes occur.

C. Public Service

Public Service, one of four utility-operating company subsidiaries of Xcel Energy Inc., is an investor-owned utility ("IOU") serving approximately 1.4 million electric customers in the state of Colorado. Public Service serves approximately 75% of the state's population. Its electric system peaks in the summer with a 2013 peak customer demand of 6,646 MW. The entire Public Service transmission network is located within the State of Colorado and consists of approximately 4,183 circuit-miles of transmission lines. Colorado is on the eastern edge of the WECC region, also referred to as the Western Interconnection, which operates asynchronously from the Eastern Interconnection. The Public Service transmission system has been interconnected with the transmission system of another Xcel Energy operating company, Southwestern Public Service Company, since December 31, 2004 via a jointly-owned tie line with a 210 MW High Voltage Direct Current ("HVDC") back-to-back converter station. The Public Service retail service territory includes the Denver-Boulder metro area, as well as the I-70 corridor to Grand Junction, the San Luis Valley, Greeley, Sterling, and Brush.

Public Service participates in both the CCPG and the WECC planning forums, including the subcommittees and working groups that perform transmission scenario analyses. Scenario outlooks differ from 10-year transmission analyses because the number of unknown factors to consider increases significantly with each year into the future. While 10-year plans tend to identify specific or conceptual transmission projects, the longer-term scenario analysis generally results in narrative descriptions of what major drivers to the power supply market might look like from a transmission perspective in the future. These drivers include generation mix, load growth, load demand, transmission assumptions, and pending public policy requirements. Potential impacts to the transmission system are not described in terms of specific projects, but by conceptual descriptions of different drivers and scenarios that may impact transmission.

Scenario investigation can be informative to decision makers, especially during times of high uncertainty and risk as a result of factors such as pending environmental legislation, changes in penetration of renewable energy mix, and changes in efficiency standards. In the utilities industry, 10-year transmission planning analysis is sometimes referred to as “just-in-time planning” because the average time to analyze, site, permit, and construct transmission facilities to meet a known need is approximately 7-10 years. Longer-term scenario analyses can help provide indicators and drivers that could prompt changes in the transmission solutions. This allows decision makers to make better-informed decisions for long-term based assets.

Public Service believes that conceptual scenario analysis also has the ability to help transmission planning and generation planning to become better integrated. One possibility would be to encourage the generation resource planning process to establish an identified resource need including possible resource costs and locations, and available transmission capacity for a period of 15 to 20 years into the future. In addition, resource plans that utilize the results of a competitive bidding process may help identify the general differences in cost between generation plans and their associated transmission expansion plans and cost. Likewise, transmission planners would be informed by the projected generation in the resource plans as a means to

develop transmission expansion alternatives that could provide transmission access for various generation options.

Currently parallel schedules for joint transmission and generation projects within the 10-year planning horizon help protect capital investments worth hundreds of millions of dollars, since one of the most significant drivers of these projects is cost. However, for an integrated transmission and generation process to succeed in planning alternatives and projecting resource costs and locations out 20 years, price sensitivities may not be able to drive all studies to the extent they do in the shorter term.

Public Service continues to be involved in regional energy market development in the Western Interconnection as a means to improve management of conventional and variable energy resources. Some studies have been conducted to identify the benefits of regional markets through stakeholder proceedings by WECC, evaluations of an Energy Imbalance Market ("EIM") by the Western Interstate Energy Board, as well as sub-regional studies including those of the Northwest Power Pool. Public Service's stance on regional markets is based on the following factors: 1) pooled balancing obligations create a diversity benefit and reduced ramping requirements; 2) improved transmission asset utilization can be attained through security-constrained economic dispatch; and, 3) potential reduction in required capacity margin assures resource adequacy. The issues around consolidated tariff administration for transmission access associated with the regional market remain unresolved at this time.

All WECC TEPPC scenarios, which Public Service helped to develop, are based on dispatch modeling that assumes a least-cost interconnection-wide dispatch with transmission solutions. In this sense, the TEPPC scenarios implicitly include an energy market across the interconnection that dispatches the least-cost generation across the least-cost transmission expansion needed to serve load. Regional market operations, including the production-optimized cases used by TEPPC as a proxy, provide congestion price signals that indicate areas where transmission expansion could reduce societal costs for energy supply.

Public Service Long-Term View

Because potential future scenarios are numerous, and due to the uncertainties mentioned above, the long-term view of the build-out of the state's transmission system is uncertain. However, when looking at the results of the CCPG and WECC scenario analyses, some common themes emerge. One is the potential for a transmission network that connects eastern Colorado to the Front Range load centers. Both the CCPG and WECC scenarios indicate such a system may be necessary, if drivers emerge such as an increased requirement for renewable resources, or if there arises a compelling reason to export power to other regions. The Lamar-Front Range Transmission Plan could play a role in facilitating those needs. However, Public Service also sees a potential for cost-effective resource development in northeast Colorado as compared to southeast parts of the state. Because of that, the Company is interested in exploring how a transmission expansion to the northeast part of the state would compare to what has been proposed in the Lamar-Front Range plan. One of our scenarios is intended to explore that comparison.

Public Service Scenarios

Public Service has analyzed four possible scenarios, in addition to those presented by CCPG and WECC, which could affect transmission planning in the future. A summary of each Public Service scenario is provided below. Full descriptions and additional details can be found in Appendix B.

1. ***PSCo Scenario #1: Regional Market Dispatch***

   This scenario contemplates the development of a large-scale regional market within the Western Interconnection that assumes a least-cost interconnection-wide dispatch with transmission solutions. This scenario has assumptions similar to the scenarios developed by TEPPC, which implicitly include an energy market across the interconnection that dispatches the least-cost generation across the least-cost transmission expansion needed to serve load. Public Service is currently involved in joint network tariff discussions with other Colorado utilities to determine if such

an imbalance market can be developed and/or a regional tariff can be developed and implemented.

2. ***PSCo Scenario #2: Significant Load Growth Associated with Oil & Gas Development***

   This scenario is similar to some of the CCPG scenarios, which modeled a 3% annual growth projection. However, this scenario assumes that there are additional pocket areas of load growth within the state that are specifically associated with oil and gas exploration and development, for example, oil and gas development in northeast Colorado in what is referred to as the Niobrara Shale Region.

3. ***PSCo Scenario #3: High Penetration of Distributed Generation***

   This scenario addresses a situation that results in DG serving a significant portion of utility load, which could result in a reduced need for transmission expansion. Although this scenario could potentially slow the investment of new transmission development, transmission may be necessary to address other drivers and changes in energy delivery.

4. ***PSCo Scenario #4: Economic Assessment for North/Central Colorado Generation Additions***

   It is reasonable to analyze a scenario that develops new generation resources, such as natural gas, in the north and central regions of Colorado as compared to other regions of the state. Presently, limited natural gas resources are available in southeastern Colorado, and Public Service expects that will continue to be the case going forward. Additional wind and solar resources could serve a portion of the Company's future demand, and those resources may or may not be located in north and central Colorado. Generation and transmission alternatives would need to be developed in order to perform any study of the cost effectiveness of various scenarios that resulted in need for significant additional generation resources regionally.

IV. Colorado Coordinated Planning Group Scenarios

The CCPG is a sub-regional group of WestConnect that includes transmission providers within the Rocky Mountain region and is open to stakeholder participation. Formed in 1991, the CCPG cooperates with state and regional agencies to assure a high degree of reliability in joint planning, development, and operation of the high voltage transmission system.

The CCPG established the Conceptual Planning Work Group ("CPWG") in the summer of 2010 to evaluate longer-term transmission studies, considering a 20-year planning horizon. This committee is co-chaired by Public Service and Commission staff.

The CPWG met bi-monthly in 2010 and in 2011 with the stakeholders to discuss a variety of scenarios for the CCPG work group to evaluate. The CPWG, after much discussion with stakeholders, developed three scenarios for a 2030 time period, supported by load and resource ("L&R") data supplied by transmission providers ("TPs") in the CCPG. The group spent considerable time gathering future L&R data from the Colorado TPs for the 2030 time period. These details were essential in creating scenario analyses for the group.

CCPG Scenarios

A summary of each CCPG scenario is provided below. Full descriptions and additional details can be found in Appendix C.

A. ***CCPG Scenario #1: 1000 MW import/export into Colorado***

This scenario was based on a 2010 NREL study and considered transmission between Colorado, Wyoming, Utah, and New Mexico. No technical studies were completed, but engineering judgment and empirical knowledge were used to develop potential substation sites to connect 345kV lines. The group determined that the export/import of 1000 MW over 200 miles would require two 345kV lines from Colorado to adjoining states.

A document for 1000 MW import/export into the state of Colorado was posted on the Westconnect site in July 2012 after discussions and comments from the stakeholders. Please refer to Appendix C for more information.

B. *CCPG Scenario #2: Reduction of coal-fired generation in Colorado*

The narrative report on this scenario used a pragmatic approach concerning reduction of coal-fired generation in Colorado and considered the existing transmission infrastructure assets associated with coal units. One recommendation was to utilize the current transmission assets and replace coal-fired generation with other types of generation such as natural gas generation or renewables.

C. *CCPG Scenario #3a: 30% RES for Colorado*

This scenario studied a 30% RES for all utilities in the state of Colorado, with a normal load forecast from the individual transmission providers and a high probability load forecast of 3% per year L&R data was collected from the CCPG TPs; which resulted in a summer peak load of approximately 1.5% growth along with high load scenario using a 3% annual growth rate. Renewable and conventional generation amounts and locations were contributed by TPs and stakeholders. Transmission was added as needed to serve customer load in a reliable fashion from the generation to the load centers. Transmission plans were added as a tabletop exercise based on experience of the stakeholder group. The group spent the majority of the time working on Scenario 3a and a detailed report has been produced, communicated to the stakeholders, and posted on the WestConnect website. Please refer to Appendix C for more information.

D. *CCPG Scenario #3b: State Statute RES Levels*

For 2035 time period RES based on the state statute with a peak load period and an off peak load period 2012 through 2013, the CPWG developed a modification to Scenario 3. Scenario 3b updated all the load

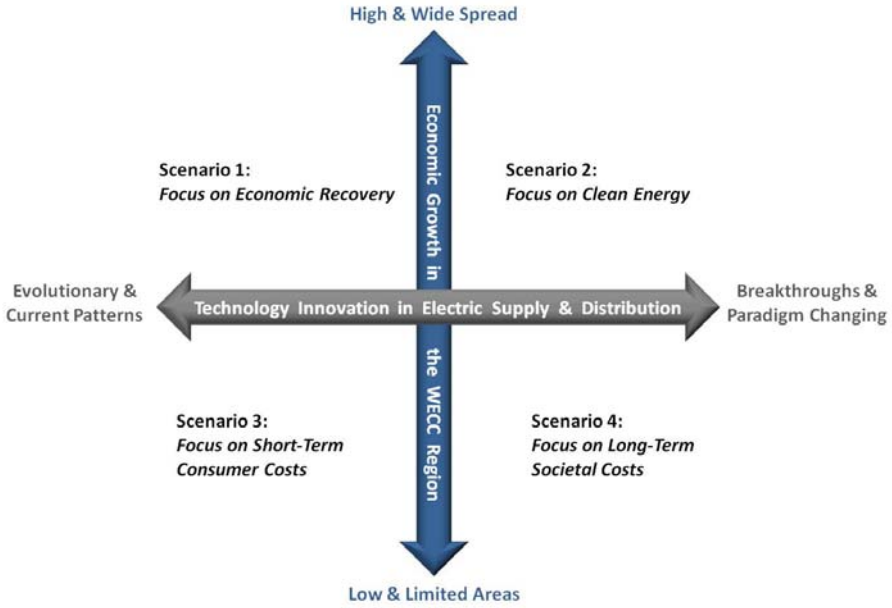
data, resources, and locations as well as a RES per state statute versus the 30% that was used in Scenario 3a for a 2035 time period. In Scenario 3B, the group also placed the loads, resources and transmission into a power flow to conduct a brief technical analysis. Scenario 3b looked at two situations: a summer peak case, and an off peak case, which simulated light load and high wind output. In this analysis the group was able to study limited wind resources for the summer load and much higher wind resources being available during the off peak conditions, which were normally night time loading conditions during the spring or winter.

V. Western Electricity Coordinating Council Scenarios

The WECC's Transmission Expansion Planning includes both 10-year and 20-year studies as part of its interconnection-wide planning process. These studies and the resulting Interconnection-Wide Plan are directed by the Transmission Expansion Planning Policy Committee ("TEPPC"). The WECC's plan evaluated several 20-year scenarios, of which five are provided here. These include a Reference Case and four scenarios developed by the TEPPC Scenario Planning Steering Group ("SPSG"). The Reference Scenario shows a 20-year representation of the future based on "business as usual" policies. The other four WECC scenarios represent four contrasting futures based on economic, technological, social, environmental, and other factors.

As stated in the Introduction, a key advantage of scenario planning is that each of the scenarios described by the WECC plan is a "plausible" future that considers a broad range of realistic circumstances, as opposed to a purely hypothetical situation. In the WECC study, two key drivers—technology innovation and economic growth—help shape and define the scenarios described below.

Figure 1. Key Drivers in WECC 2014 Scenario Planning



It is important to realize that in the models designed by the TEPPC, the system is represented as a single balancing authority, where any load can be served by any resource based on economics and transmission capability. In reality, the current system is comprised of multiple balancing authorities and system operators. For instance, Public Service resources are used solely for Public Service loads; the system is not designed to import/export energy across the various TP systems in Colorado.

In addition, the transmission models described below are simplified in comparison to models used in nearer-term technical planning studies. Loads and resources are located in "hubs", where load hubs represent population centers, conventional generation hubs represent the current location of existing conventional generation, and renewable hubs represent designated geographic pockets where high potential for wind and solar development exist.

WECC Scenarios

A summary of each WECC scenario is provided below. Full descriptions and additional details can be found in Appendix D and/or at:

http://www.wecc.biz/committees/BOD/TEPPC/Pages/2013Plan_20-Year.aspx

A. WECC Reference Scenario: Business As Usual

The Reference Scenario is described in WECC documentation as the "business as usual" case. It starts from what is referred to as the 2022 Common Case and extrapolates out to year 2032, applying informed assumptions on myriad factors such as load growth, generation requirements (e.g., Renewable Portfolio Standards ("RPS"), fuel costs, etc.) The Reference Case provides the basis for developing modeling and structure for the other scenarios, as well as providing the baseline frame of reference against which the most important results of other study cases can be identified and assessed.

B. *WECC Scenario #1: Focus on Economic Recovery*

Scenario 1 describes a world in which an initially slow rise out of recession is followed by rising economic growth in the WECC region. Along with a steady pace of incremental, rather than breakthrough, technology improvements in the power sector, this growth supports the emergence of the next-generation power system for the region—one which is more efficient, flexible, responsive to customers, and takes full advantage of a spreading smart grid.

C. *WECC Scenario #2: Focus on Clean Energy*

Scenario 2 describes a world in which the economic gloom from the 2008 to 2010 recession turns around as a result of effective economic policies and a technological rebound that shows the power of innovation to restructure markets and industries.

D. *WECC Scenario #3: Focus on Short-Term Consumer Costs*

Scenario 3 is defined as a future in which economic growth in the United States, including the Western region, is restrained for two decades. Technologies that are low-risk, proven and assured of cost-recovery proceed at a steady pace out of regard for short-term capital cost expenditures.

E. *WECC Scenario #4: Focus on Long-Term Societal Costs*

In Scenario 4, the world has experienced a fundamental shift in the usage and generation of electricity. Economic growth is slowed by constraints on government spending and persistent problems in the capital markets. Consumers are willing to pay for cleaner and more environmentally sustainable products because they see the benefits in improved health and lifestyles, which do not require exceptionally higher spending as many new technologies are very cost-competitive and highly efficient. In this future, consumers recognize the short- and long-term societal costs associated with climate change.

2014 Scenario Analysis Appendices

Appendix A

Tri-State Scenarios

TSGT Scenario #1: Advanced Carbon Capture and Sequestration

1. Description

This scenario assumes that, in addition to advances in other clean energy technologies, coal and other fossil fuels will continue to play a strong role in energy production for many decades to come. Globally, there is a continued expansion of coal and other fossil fuel uses for both the energy and industrial sectors. This scenario assumes that this expansion, coupled with increasing concerns for global CO_2 levels, will encourage innovations and cost reductions for Carbon Capture and Sequestration ("CCS") technologies. This scenario considers one potential impact on the design of the transmission system if new carbon regulations were adopted either federally or by the state.

2. Rule 3627 (e) Application

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	**X**
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	
(III)	Emerging generation, transmission and demand limiting	**X**
(IV)	Various load growth projections	
(V)	Requested by Commission	

3. Assumptions and Drivers

- Fossil fuels continue to be a large incremental source of global primary energy.
- Improved, less costly CCS technology
- 25% net reduction in energy production caused by CCS demands
- CCS technology is not economically feasible on smaller (< ~600 MW) coal plants
- Environmental regulations require or incentivize use of CCS technology at new or possibly existing fossil fuel fired generation facilities

4. Indicators

- Carbon tax policy stimulates CCS research and development.
- CCS research and development results in CCS developing into a viable technology, making coal-based energy environmentally and economically equivalent to other fuel choices.
- Explicit recognition of CCS in CO2 emission reduction strategies.
- Consistent government policies giving private sector confidence to invest in CCS projects.
- Regulatory framework allowing geologic CO2 storage has been established.

5. Potential Benefits and Transmission Impacts to Colorado

This scenario envisions the continued but reduced utilization of existing infrastructure. Large base-load coal plants would continue providing non-intermittent energy over an established transmission network. While they would stay on-line, the net output of these large plants would decrease by 25% due to the energy demands of CCS technologies. Further, smaller coal-based generation would be retired rather than install CCS due to marginal cost considerations. The combined energy displacement would be made up with a mix of intermittent renewable and dispatchable simple-cycle gas generation. The generation resources necessary to make up for this displaced generation may or may not require additional transmission build-out depending on the location of the replacement resources

There are numerous benefits to this alternative. First, past infrastructure investments would continue to be leveraged to serve the state's energy needs, but would not preclude other investments in alternative generation. Second, CCS installation involves major modifications to plant emissions facilities. This would result in at least a temporary increase in design and construction jobs. Last and most important, large, base-load generation would continue to be connected to the grid, providing a stable source of energy, continuous dynamic voltage support, and good frequency support due to their large rotating mass.

The potential broader transmission impacts for this alternative could be minimal. Since the net output of the base load plants would go down, their impact on the stress of the surrounding transmission network would go down. This would free up capacity for higher regional transfers and increased loads. The build-out of the transmission network to accommodate intermittent generation would still occur, but would be on a smaller scale than any of the "no-coal" scenarios, reducing the visual and environmental impact of this expansion.

One probable negative impact of this alternative stems from the decommissioning of smaller coal-based generation facilities. This would have a negative impact on local jobs and also a negative impact on the transmission network close to the affected generators. Small conventional generators positively impact their local transmission network due to their ability to regulate voltage and reduce energy flows over the larger network. As has been seen in the past, the removal of these small generators can result in poor local voltage performance necessitating additional VAR support, and possibly transmission line construction. Transmission network expansions to accommodate increased levels of intermittent generation may naturally mitigate these issues, so this consequence may be insignificant.

TSGT Scenario #2: Distributed Generation

1. Description

This scenario assumes significant advancement in wholesale and retail distributed generation technology coupled with low load growth rate and higher efficiency. This scenario is predicated on the growth of distributed solar PV generation, advancements in energy storage technologies and associated public policies, as well as increased interest in a variety of other small scale distributed generation resources such as biomass, coal mine methane, syngas from municipal solid waste, and community wind. Assumptions made are similar to WECC Scenario 2 with what Tri-State believes is a more realistic valuation of input parameters such as carbon cost, load growth, economic viability, and RES requirements. This scenario considers the potential impact on the design of the transmission system if new renewable regulations were adopted.

2. Rule 3627 (e) Application

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	X
(III)	Emerging generation, transmission and demand limiting	X
(IV)	Various load growth projections	X
(V)	Requested by Commission	

3. Assumptions and Drivers

- Cost of rooftop solar PV continues to fall
- Battery technology improves and cost remains flat or declines
- Continued increased consumer and policy interest in distributed generation and energy storage technologies
- Nationwide RES increases to more than 30%
- EPA restricts use of coal-fired generation
- Annual load growth is less than 2% for the next 20 years

4. Indicators

Two of the primary key scenario indicators are dependent on federal and state policy changes in the regulation of the electric power system in the WECC region. These policies would include:

- EPA carbon policy is implemented with an assumed cost of carbon that approaches $100.00 (2012$/metric ton).
- RES requirements increase to 50% and include a federally implemented component of 15%.

The price of solar rooftop PV is also a primary indicator for this scenario with the assumption that the current cost of installed rooftop solar decreases by 30% from the 2012 referenced cost. This decreased cost may be attributed to either technological advances, federal and state subsidies, or both. In addition, battery technology would need to improve such that battery life would not be degraded below 50% for a typical 4-hour discharge during peak hour operation for low solar radiance. The cost of the improved battery technology would need to remain comparable to current Lithium Ion batteries at $425/kWh for 2012 referenced cost. Finally, sufficient plant capacity utilizing gas turbine technology would be required to replace high carbon coal generation units with an assumed gas price of $6.90/mm BTU for a 2012 referenced cost.

5. Potential Benefits and Transmission Impacts to Colorado

The impact of the distributed generation scenario would result in limited transmission development due to the reduction of native load served by the transmission system as well as limited capital investment available to serve decreasing load. Potential benefits would include increased line capacity and system voltage during historical peak times. Possible negative impacts would include the need for switched reactors during lightly loaded conditions and insufficient return on investment for reliability transmission projects.

TSGT Scenario #3: Increased Connectivity Between Western and Eastern Interconnections

1. Description

This Scenario assumes that sufficient future resource cost imbalances exist between the WECC and SPP Regions to justify additional DC tie(s) between them. Tri-State examined the impacts and benefits of a new asynchronous interconnection between the Burlington area of eastern Colorado and the Colby area of western Kansas. This scenario considers the potential impact on the design of the transmission system if significant load and generation forecast changes occur.

2. Rule 3627 (e) Application

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	X
(III)	Emerging generation, transmission and demand limiting	X
(IV)	Various load growth projections	X
(V)	Requested by Commission	

3. Assumptions and Drivers

- Future resource cost imbalances between WECC and SPP making construction of asynchronous facilities economical.
- Technological advances in asynchronous transmission connection facilities.
- Considerably more favorable conditions for siting and permitting new generation and transmission facilities in western Kansas rather than eastern Colorado.

4. Indicators

- Colorado Front Range loads exceed generation and WECC rated path import transfer capabilities.
- Staged implementation of Lamar-Front Range project.
- Substantial generation developments in Kansas
- Transmission system construction (230 kV or higher) and/or upgrades between Burlington, CO and Colby, KS.

5. Potential Benefits and Transmission Impacts to Colorado

The SPP and WECC regions are interconnected by three DC ties: Blackwater, Eddy, and Lamar. Blackwater and Eddy are in southeastern New Mexico and are owned by utilities with interests in New Mexico and Texas. These utilities include PNM, EPE, and TNP. The Lamar DC tie is located in southeastern Colorado and is owned and operated by Public Service.

The Lamar DC tie is capable of transferring approximately 210 MW between the WECC and SPP interconnections. While this capacity is sufficient to serve Public Service's load and resource obligations in the regions, it would likely be insufficient to serve all of Tri-State's future demands in eastern Colorado. In the event future economics and demands promote importing a substantial amount of energy from Kansas, a second Colorado DC tie would be needed. Adding another SPP interconnection in the Burlington area would leverage the investments made in the Lamar-Front Range project and also provide a more balanced resource injection into the eastern Colorado transmission system.

In addition to transmission infrastructure improvements in western Kansas, the Colorado transmission system would require some level of Lamar-Front Range project implementation to realize the benefits of another DC tie. The scale of implementation would be largely dependent on the size. Some scenarios envisioned a modestly sized unit, in the 100-200 MW range. This case would only require a modest implementation of the Lamar-Front Range project, and possibly only include a 230 kV, single circuit version. For larger transfers, up to 1000 MW, the full Lamar-Front Range project would have to be constructed.

Appendix B

Public Service Scenarios

Public Service Scenario #1 Regional Market Dispatch

1. Description

This scenario contemplates the development of a large-scale regional market that assumes a least-cost interconnection-wide dispatch with transmission solutions. This scenario has assumptions similar to the scenarios developed by TEPPC, which implicitly include an energy market across the interconnection that dispatches the least cost generation across the least cost transmission expansion needed to serve load but on a more regional basis. Public Service is currently involved in joint network tariff discussions with other Colorado utilities to determine if such a regional tariff can be developed and implemented.

2. Rule 3627 (e) Application

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	**X**
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	**X**
(III)	Emerging generation, transmission and demand limiting	**X**
(IV)	Various load growth projections	
(V)	Requested by Commission	

3. Potential Benefits and Transmission Impacts to Colorado

Regional market operations, including the production-optimized cases used by TEPPC as a proxy, provide congestion price signals that indicate areas where transmission expansion could reduce societal costs for energy supply. As mentioned within the WECC scenario section of this report, there is a correlation of the transmission identified within the WECC studies and the Colorado 10-year transmission plan. The difficulty that still remains are the movement to a market based dispatch, regional tariff, and a means to address transmission investment and cost allocation.

Public Service Scenario #2: Significant Load Growth Associated With Oil & Gas Exploration and Development

1. Description

This scenario is similar to some of the CCPG scenarios, which modeled a 3% annual growth projection. However, this scenario assumes that there are additional areas of load growth within the state that are specifically associated with oil and gas exploration and development -- for example, oil and gas development in northeast Colorado in what is referred to as the Niobrara Shale Region.

2. Rule 3627 (e) Application

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	**X**
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	**X**
(III)	Emerging generation, transmission and demand limiting	**X**
(IV)	Various load growth projections	**X**
(V)	Requested by Commission	

3. Potential Benefits and Transmission Impacts to Colorado

If significant fossil fuel development occurred in areas of the state such as this, it could lead to additional transmission requirements, but possibly more local than regional.

Public Service Scenario #3: High Penetration of Distributed Generation

1. Description

This scenario addresses a situation that results in DG serving a significant portion of utility load, which could result in a reduced need for transmission expansion. Although this scenario could potentially slow the investment of new transmission development, transmission may be necessary to address other drivers and changes in energy delivery.

2. Rule 3627 (e) Application

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	X
(III)	Emerging generation, transmission and demand limiting	X
(IV)	Various load growth projections	X
(V)	Requested by Commission	

3. Potential Benefits and Transmission Impacts to Colorado

Although this scenario could potentially slow the investment of new transmission development, transmission may be necessary to address other drivers and changes in energy delivery. A high penetration of DG could require changes in generation cost allocation; evaluations of new distribution reliability issues; increased flexible generation resources which could be different than the current resource mix that could result in the overbuild of capacity to ensure the appropriate resource flexibility; significant impact to reliability protection schemes on the distribution system; and the development of additional distribution reliability management systems that to date are not widely deployed. These management systems would be analogous to SCADA systems for the real-time operation and management of the transmission system. Extensive communication networks would be required as well as data handling.

Public Service Scenario #4: Economic Assessment for North/Central Colorado Generation Additions

1. Description

It is reasonable to consider a scenario where it is more economical to develop new generation resources, such as natural gas, in the north and central regions of Colorado compared to other regions. Presently, there are limited natural gas resources available in southeastern Colorado, and Public Service expects that will continue to be the case. Additional wind and solar resources could serve a portion of the Company's future demand, and those resources may or may not be located in north and central Colorado. These generation and transmission alternatives would need to be developed in order to perform any study of the cost effectiveness of various scenarios that resulted in need for significant additional generation resources.

2. Rule 3627 (e) Application

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	**X**
(III)	Emerging generation, transmission and demand limiting	**X**
(IV)	Various load growth projections	**X**
(V)	Requested by Commission	

3. Potential Benefits and Transmission Impacts to Colorado

The Lamar-Front Range Transmission Plan addresses a scenario where a significant amount of generation resources are developed in southeastern Colorado. However, if economics show that it is more cost-effective to develop resources in northern and central Colorado, additional transmission would likely be required in that region of the state. Generation and transmission alternatives would need to be evaluated to determine the overall cost effectiveness of such a scenario.

This scenario also has consistencies with assumptions made for other scenarios including those that assume additional load growth in northeast Colorado and the CCPG scenarios that contemplate import and export.

Appendix C

CCPG Scenarios

CCPG Scenario #1: Colorado Import/Export

1. Description

This scenario contemplates a future where Colorado needs to develop additional transmission across state borders in order to import economical energy from other states, export its own resources to other states where there is a market, and facilitate the transfer of energy throughout the state. The emphasis is on renewable resources of solar and wind generation.

2. Rule 3627 (e)

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	X
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	
(III)	Emerging generation, transmission and demand limiting	
(IV)	Various load growth projections	
(V)	Requested by Commission	

3. Assumptions and Drivers

- 1.5% annual load growth and a high forecast of 3% annual growth
- 30% RES for entire Colorado load
- Wind generation costs will continue to fall
- Need to develop an interstate transmission system that is capable of at least 1000 MW from Wyoming to New Mexico
- Wind generation in Wyoming and New Mexico are attractive for Colorado utilities
- Larger balancing authority in the western U.S

4. Indicators

- Economics justify consideration of resources outside the state of Colorado
- Regulatory policies are developed that promote other states to accept Colorado generation

5. Potential Transmission Impacts to Colorado

- Interstate transmission would be at least 200 miles long
- 1000 MW shipped 200 miles could require transmission development on the order of three 345kV circuits
- Potential transmission could include the following:

a) 1000 MW Export/Import Case Colorado to Wyoming, need 3-345kV circuits

Termination points for Colorado could be Ault, St. Vrain, Pawnee/Story, and Sidney/Wray. Termination points in Wyoming could be Archer, Laramie River Station, and Dave Johnson. Here are the three potential circuits:

1. Dave Johnson-Archer-Ault 345kV circuit
2. Laramie River Station-Pawnee 345kV circuit
3. Laramie River Station-Sidney-Wray 345kV circuit

b) Export/Import Case Utah to New Mexico, need 2-345kV circuits

Termination points for Utah could be Sigurd and Emery/Hunter. Termination points in New Mexico could be 4 corners and Shiprock. Here are the two potential Utah-New Mexico circuits.

1. Four Corners-Emery 345kV circuit
2. Shiprock - Sigurd 345kV circuit

c) Export/Import Case Utah to Colorado

1. Transmission circuits of A and B above, plus
2. Waterton-Malta-Rifle-Grand Junction 345kV circuit in Colorado. Grand Junction-Emery 345kV circuit in Utah.

d) Export/Import Case Wyoming to New Mexico through Utah

Transmission circuits of A, B, and C plus:
Ben Lamond-Terminal-Emery-Sigurd 345kV circuit in Utah.

Detailed results are provided at the WestConnect/CCPG under Conceptual Planning Work Group → Reports:

http://www.westconnect.com/planning_ccpg_conceptual_planning.php

6. Company Comments

a) Black Hills

The CWG explored this scenario to determine the additional transmission infrastructure required to transfer large amounts of power across Colorado state lines, and found significant transmission expansion would be required to accommodate those transfers. As a participant in the CWG, Black Hills agrees that the identified upgrades would meet the technical requirements for Scenario #1, but feels that the economics would be challenging unless approached on a large, collaborative scale. The magnitude of the necessary projects, in comparison to Black Hills' load requirements, combined with their geographic distance from Black Hills' service territory, would likely prevent the Company's involvement as a sole sponsor, as the direct benefit and/or system impact to the Company and its customers would be relatively minor. Black Hills strives to provide cost-effective service by supporting its load with resources located near its system within the state of Colorado.

Statewide, it is conceivable that light demand levels combined with high renewable generation output could result in bulk exports to neighboring states. Reinforcements to the existing network transmission system to support the additional import/export lines identified would be addressed on a case-by-case basis.

b) Tri-State

Tri-State's mission is to provide our member systems a reliable, cost-based supply of electricity in accordance with cooperative principles. To that end, Tri-State utilizes Network Resources across its four state service territory to most economically serve Network Customer loads. This routinely involves the transmission of energy across state boundaries. To the extent the transmission projects described in CCPG Scenario #1 support a more economical dispatch of Network Resources, Tri-State sees promise in their implementation. Tri-State's mission does not include speculation on and construction of transmission facilities based solely on their potential to buy and sell energy in other markets. Projects as these are best accomplished through multi-participant collaborative efforts. The High Plains Express Initiative is an example.

c) Public Service

This scenario presents numerous challenges in that it assumes that economics will justify the construction of long high-voltage transmission in and out of the state of Colorado. Presently, it is more economical to locate renewable generation within the state using existing transmission, and since both Wyoming and New Mexico have good wind generation potential, it is uncertain if it would be economical to export wind generation from Colorado. Further, Public Service is confident it can meet current RES requirements (30%) by interconnecting renewable generation within the state. Participating in intrastate transmission that is capable of at least 1000 MW implies that either the RES requirement is increased well beyond 30% (though operating experience indicates that 30% may be a reasonable limit for wind generation), or that other states can justify wheeling Colorado renewables to their load centers. If such a scenario were to come to pass, then the above conceptual transmission projects could help to meet such requirements. Also, strengthening the transmission between Colorado and other states could provide additional reliability benefits, especially if an increase in RES requirements significantly increased the amount of wind generation on the system. Higher RES could lead to more generation on the system that does not provide inertial stability, and additional transmission could help alleviate transient stability concerns. It would also provide dispatch flexibility by taking advantage of diversities in wind generation patterns across the state boundary.

CCPG Scenario #2: Reduction of Coal-Fired Generation in Colorado

1. Description

This scenario contemplates a significant retirement of coal-fired generation in the state of Colorado. This could be driven by regulatory or economic changes.

The EPA or other entity could impose national regulations requiring significant reductions in emissions such that it would be more economical to pursue other sources of energy, rather than modify existing coal plants to meet emission requirements. Taxes on emissions could eliminate the economic viability of coal-fired plants compared to cleaner alternatives.

2. Rule 3627 (e)

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	**X**
(III)	Emerging generation, transmission and demand limiting	**X**
(IV)	Various load growth projections	
(V)	Requested by Commission	

3. Assumptions and Drivers

- Additional required conventional generation to meet the summer peak will be gas-fired generation.
- Coal-fired generation will be replaced with gas-fired generation at existing locations.

4. Indicators

- Existing plants are approaching limits of usefulness.
- Taxes are increased on carbon emissions.
- Legislation requires lower emissions.
- Pressure from influential environmental groups is on the rise.

5. Potential Transmission Impacts to Colorado

One potential outcome is that coal-fired generation would be replaced at existing or nearby sites by gas-fired generation with similar output capabilities. Since the transmission infrastructure is already in place, then no new transmission lines would have to be built from these existing plant locations to export the power to the load-serving network. This scenario can be viewed as a highly probable result, as Public Service already has plans to retire its coal-fired units at Arapahoe, Valmont, and

Cherokee 1,2 and 3. In addition Public Service will add gas-fired units #5, #6, and #7 at the Cherokee plant site as a result of the Clean Air Clean Jobs Act ("CACJA"). This scenario assumes that natural gas can be supplied to existing locations at economical costs. *Detailed results are provided at the WestConnect/CCPG under Conceptual Planning Work Group → Reports:*

http://www.westconnect.com/planning_ccpg_conceptual_planning.php

6. Company Comments

a) Black Hills

Black Hills considers this scenario to be in progress. The CACJA has already resulted in the retirement of the W.N. Clark coal-fired generation plant at Cañon City, which represented 100% of the utility's coal-fired fleet in Colorado. As a result, Black Hills has applied to replace that capacity with gas-fired generation within its service territory, but at an alternate location served by existing infrastructure. This relocation of resources was a primary driver for an additional 115 kV circuit into the Cañon City load center to meet reliability criteria and maintain the existing level of reliability in lieu of the retired generation.

b) Tri-State

Tri-State agrees that, given the current trajectory of EPA regulations and renewable energy subsidies, there will continue to be downward pressure on the amount of coal-based generation in Colorado. Given that the bulk of new generation is in the form of intermittent resources, the demand for fast cycling generation (gas combustion turbines) will increase. New transmission infrastructure is costly, difficult to permit, and challenging to construct timely. Thus, it would be logical to leverage the transmission systems at existing coal-based sites. This entire concept, however, is predicated on an assumed availability of natural gas, which is not necessarily the case.

c) Public Service

Based on the outcome of the CACJA, Public Service believes that if retirement of coal-fired generation were imminent, the first consideration would be to replace retired generation with gas-fired generation at existing sites for maximum utilization of existing transmission and water infrastructure. However, if certain plant locations do not have access to natural gas resources, they may not be as attractive for replacement generation. Under CACJA, Public Service plans to retire coal units at Arapahoe, Valmont, and Cherokee. Cherokee unit #2 was converted to a synchronous condenser for voltage control in the metro area, while Cherokee 4 will be run on natural gas. Public Service also plans to install Selected Catalytic Reduction ("SCR") systems at both the Pawnee and Hayden units to reduce nitrous oxide. A new 2-by-1 combine cycle will be constructed on the Cherokee plant site in 2015; Cherokee 5, 6, and 7 will consist of 569 MW of

gas-fired generation. These projects will require minor transmission upgrades in the metro area.

CCPG Scenario #3a: 30% RES for Colorado

1. Description

This scenario contemplates that the requirements for utilities to serve demand with renewable energy will increase to 30% for all utilities. Several sensitivities of this scenario were evaluated by the CCPG.

2. Rule 3627 (e)

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	**X**
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	
(III)	Emerging generation, transmission and demand limiting	
(IV)	Various load growth projections	**X**
(V)	Requested by Commission	

3. Assumptions and Drivers

- 30% RES statewide; 1.41% load growth
- A high load growth scenario of a 3% load increase each year
- Renewable and conventional generation amounts and locations were contributed by the TPs and stakeholders
- Transmission plans were added as a tabletop exercise based on experience of the stakeholder group

4. Indicators

- Transmission plans include the Public Service SB-07-100 facilities and additional transmission lines to accommodate the RES assumptions.
- Transmission lines added from the resources to load center based on engineering judgment and empirical knowledge.

5. Potential Impacts to Colorado

The CWG spent considerable effort in evaluating the potential transmission impacts to Colorado for this scenario and developed potential transmission plans and system models by using transmission planning methods. L&R modeling was performed for both 2030 and 2035 timeframes.

Detailed results are provided at the WestConnect/CCPG under Conceptual Planning Work Group → Reports:

http://www.westconnect.com/planning_ccpg_conceptual_planning.php

6. Company Comments

a) *Black Hills*

Scenario 3a and 3b sensitivities result in a similar RES requirement for Black Hills. Scenario 3a, and especially the 3% load growth sensitivity, results in considerable resource addition requirements. Black Hills expects that by 2030 and beyond the renewable generation requirements will continue to favor economies of scale. As the demand for additional renewable generation grows inversely to the amount of land available in close proximity to load centers, the development of large-scale transmission projects to remote areas becomes more likely. The importance of wind resource capacity factors is also expected to grow, potentially helping to justify longer transmission projects to distant wind development areas. Joint participation in large transmission projects may become more common to facilitate the significant capital outlay required to complete the projects.

b) *Tri-State*

As with Scenario 2, the current trajectory of EPA regulations and renewable energy subsidies will continue to put downward pressure on the amount of base-load generation in Colorado. Given the intermittent nature of renewable generation, the demand for dependable and fast cycling generation (gas combustion turbines) will increase. New transmission will have to be constructed to accommodate both types of generation.

c) *Public Service*

Scenario 3a and 3b represent “business as usual” conditions for Public Service, where nothing significant changes from today’s operations in terms of RES standards, growth rates, etc.

CCPG Scenario #3b: State Statute RES Levels

1. Description

This scenario contemplates that the requirements for utilities to serve demand with renewable energy will be modeled at 30% for PSCo and Black Hills, and 10% for all other utilities. Several sensitivities of this scenario were evaluated by the CCPG including a normal 2035 summer peak load and an off peak load scenario.

2. Rule 3627 (e)

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	**X**
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	
(III)	Emerging generation, transmission and demand limiting	
(IV)	Various load growth projections	**X**
(V)	Requested by Commission	

3. Assumptions and Drivers

- 30% RES for Public Service and Black Hills and 10% for other utilities
- 1.41% load growth
- Off-peak case with light loads and high wind outputs
- Renewable and conventional generation amounts and locations were contributed by the TPs and stakeholders.
- Transmission plans were added to a power flow analysis
- Detailed one line diagrams were created from the power flow analysis for the summer peak case and the off peak case

4. Indicators

- Transmission plans include the Public Service SB07-100 facilities and additional transmission lines to accommodate the RES assumptions
- Transmission lines added from the resources to load center based on engineering judgment and empirical knowledge

5. Potential Impacts to Colorado

Like Scenario 3a, the Conceptual Planning Work Group spent considerable effort in evaluating the potential transmission impacts to Colorado for this scenario and developed potential transmission plans and system models by using transmission

planning methods. L&R modeling was performed for both 2030 and 2035 timeframes.

Detailed results are provided at the WestConnect/CCPG under Conceptual Planning Work Group → Reports:

http://www.westconnect.com/planning_ccpg_conceptual_planning.php

6. Company Comments

a) *Black Hills*

Scenario 3a and 3b sensitivities result in a similar RES requirement for Black Hills. In Scenario 3b, the reduced RES requirements for utilities other than Black Hills and Public Service, along with the reduced forecasted Black Hills demand compared to Scenario 3a would result in less resource and associated transmission development. Black Hills expects that by 2030 and beyond the renewable generation requirements will continue to favor economies of scale. As the demand for additional renewable generation grows inversely to the amount of land available in close proximity to load centers, the development of large-scale transmission projects to remote areas becomes more likely. The importance of wind resource capacity factors is also expected to grow, potentially helping to justify longer transmission projects to distant wind development areas. Joint participation in large transmission projects may become more common to facilitate the significant capital outlay required to complete the projects.

b) *Tri-State*

As with Scenario 2, the current trajectory of EPA regulations and renewable energy subsidies will continue to put downward pressure on the amount of base-load generation in Colorado. Given the intermittent nature of renewable generation, the demand for dependable and fast cycling generation (gas combustion turbines) will increase. New transmission will have to be constructed to accommodate both types of generation.

c) *Public Service*

Scenario 3a and 3b represent “business as usual” conditions for Public Service, where nothing significant changes from today’s operations in terms of RES standards, growth rates, etc.

Appendix D

WECC Scenarios

WECC Reference Scenario: Business As Usual

1. Description

The Reference Scenario is described in WECC documentation as the "business as usual" case. It starts from what is referred to as the 2022 Common Case and extrapolates out to year 2032, applying informed assumptions on myriad factors such as load growth, generation requirements (e.g., RES), fuel costs, etc.

The Reference Scenario provides the basis for developing modeling and structure for the other scenarios, as well as providing the baseline frame of reference against which the most important results of other study cases can be identified and assessed.

2. Rule 3627 (e)

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives.	**X**
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations.	
(III)	Emerging generation, transmission, and demand limiting.	
(IV)	Various load growth projections.	
(V)	Requested by Commission.	

3. Assumptions and Drivers

- Gas price = $6.90 (2012$/mmBTU)
- Cost of carbon = $37.11 (2012$/metric ton)
- Peak demand compound annual growth rate (CAGR) = 1.5% (1.3% growth from 2022)
- Peak energy CAGR = 1.54% (1.4% growth from 2022)
- State-specific RPS requirements as they exist in 2013; no national RPS policy
- Four expansion cases: Heavy Summer, Light Spring, Light Fall, and Heavy Winter

4. Indicators

- Expansion values for 2032 factors are extrapolated from 2022 values
- Policies remain the same as year-end 2022

5. Summary of Findings

- Interconnection-wide results showed sufficient gas resources to meet energy needs and sufficient conventional generation to meet peak demand.
- Significant renewable resources were selected based on their energy value only

- New coal-fired generation was not selected, as the CO2 price of $37.11/ton made it uneconomical
- Levelized costs of new wind resources are very close to the levelized cost of gas resources
- Transmission needs are being driven primarily by renewable generation additions and modeling assumptions made in the long term planning too
- Transmission constraints and generator operational flexibility limitations might limit ability to serve some load locations in some hours, using only gas resources.
- Expected capital costs = $120B ($30B for transmission).
- LCOE = $47/MWh

Figures 2 and 3 below are from the 2013 WECC TEPPC Plan and show potential transmission development in the WECC region. Figure 2 is a graphical depiction of the expansion for both generation and transmission build-outs for the 2032 study year.

Figure 2. Anticipated generation and transmission build-outs in 2032

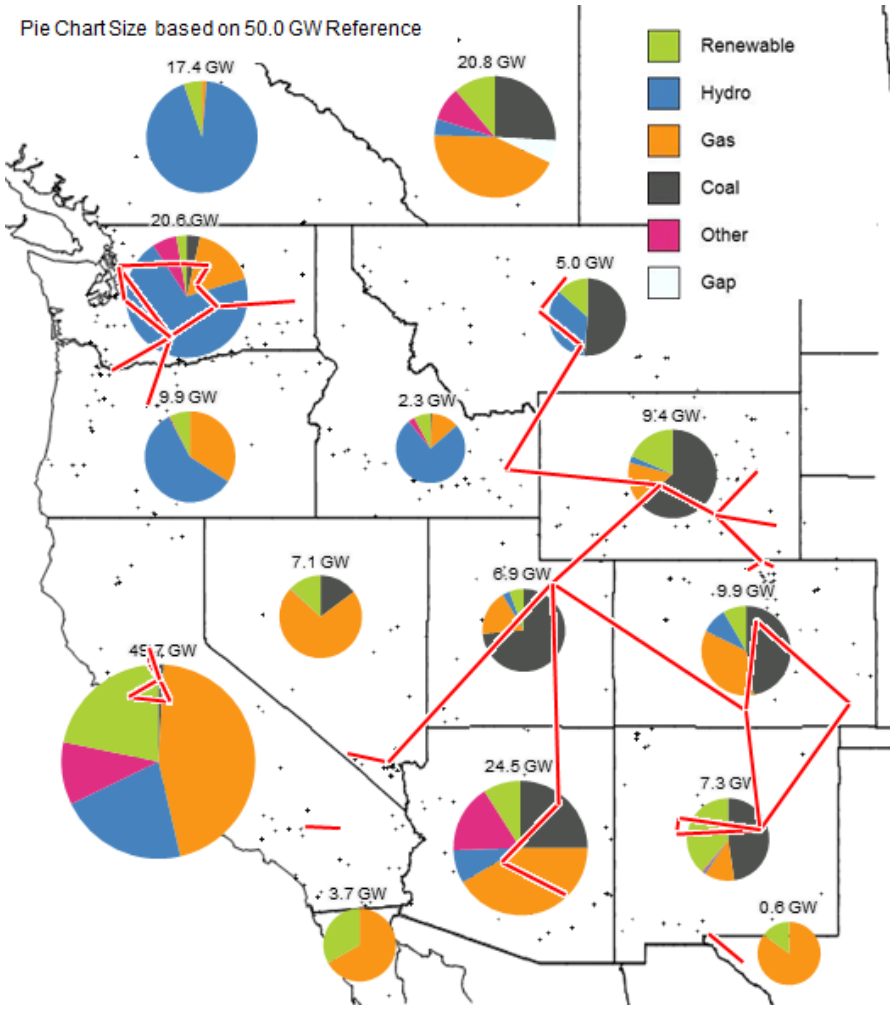
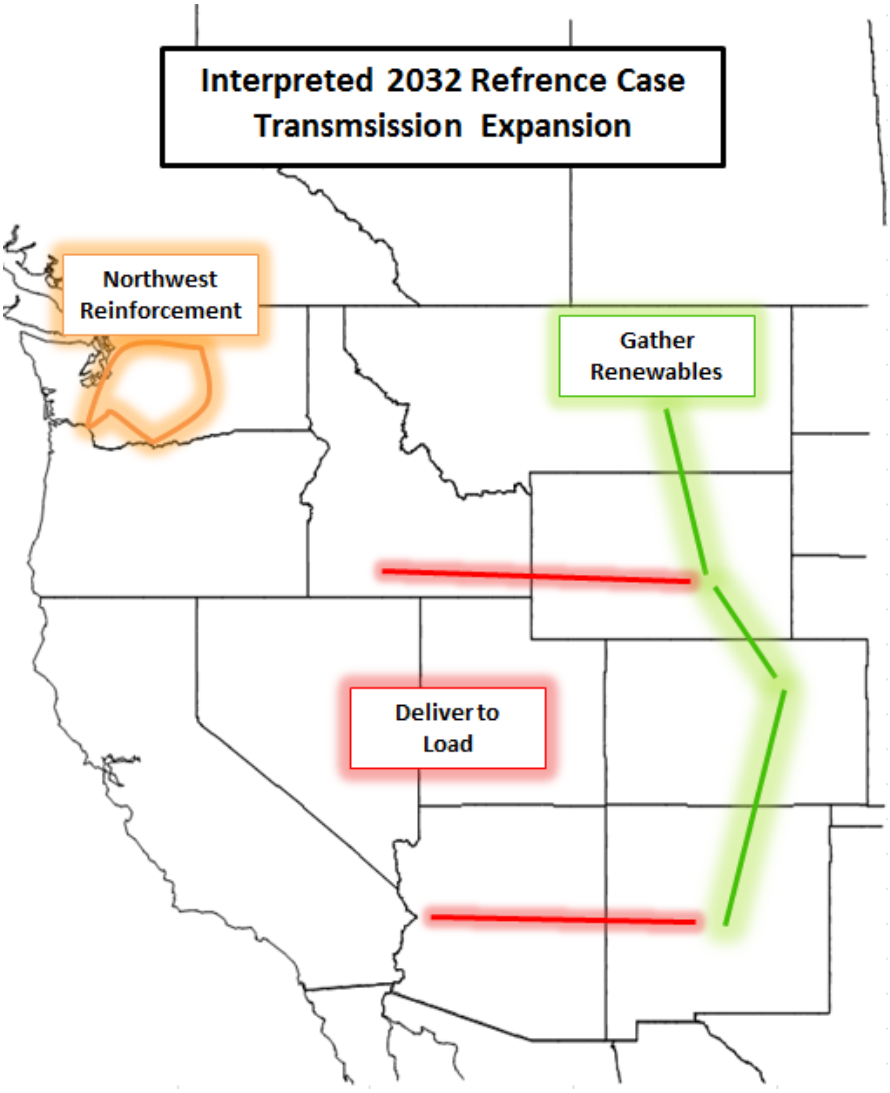


Figure 3 shows what the TEPPC report refers to as an "interpreted" compilation of the discrete transmission segments shown on the left. The interpreted case shows a renewable "collection" system in green, and "load serving" system in red.

Figure 3. Interpreted transmission system for study year 2032



1. Potential Transmission Impacts to Colorado

The Reference Scenario shows some potential for transmission expansion in Colorado as seen in Figures 2 and 3. In the Reference Scenario, the transmission is driven by the need to collect renewable energy and transport it to loads throughout WECC. The collection system shown in green in Figure 3 is similar to the High Plains Express conceptual plan. The TOT7 Expansion Project and the Lamar-Front Range Project have synergies with the High Plains Express concept and are in various stages of planning in Colorado. Therefore, there is some consistency with

the present plans for transmission in Colorado and the results of the TEPPC Reference Scenario.

2. Company Comments

a) Black Hills

The TEPPC Reference Scenario, and the assumptions made within that case, do not represent Black Hills' expectations for the future. One example of this is the assumed carbon tax. In Black Hills' most recent ERP in Docket 13A-0445E, the carbon tax was assumed in the "Environmental Scenario" only, not in the base case.

b) Public Service

The "business as usual" concept for the Reference Case, as defined by the TEPPC, does not translate to business as usual for Public Service. As stated previously, the TEPPC premise for this case is a socialized system where there are no contractual or policy boundaries for delivery of generation to load. Public Service does not foresee the development of a single or larger scale balancing area in the 20-year future. Therefore, it is not likely that transmission will be developed to export Colorado renewables to other parts of the country.

However, Public Service has developed transmission plans, such as Lamar-Front Range and the TOT7 Expansion that could deliver potential renewable resources to the Denver-metro and Front Range load centers. Even though the TEPPC studies represent a socialized paradigm in which there are no contractual or policy boundaries for load service, both of these projects, which are meant to serve Colorado load, could be part of a larger transmission network as envisioned by the Reference Scenario.

WECC Scenario #1: Focus on Economic Recovery

1. Description

TEPPC describes Scenario 1 as a world in which an initially slow rise out of recession is followed by rising economic growth in the WECC region. Along with a steady pace of incremental, rather than breakthrough, technology improvements in the power sector, this growth supports the emergence of the next generation power system for the region—one which is more efficient, flexible, responsive to customers, and takes full advantage of a spreading smart grid. Scenario 1 imagines a future that has:

- Wide-spread economic growth in WECC region with increasing standards of living
- Evolutionary, rather than breakthrough, changes in supply and transmission technology
- No overriding policy theme as a result of its focus on economic recovery

2. Rule 3627 (e)

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	
(III)	Emerging generation, transmission and demand limiting	X
(IV)	Various load growth projections	
(V)	Requested by Commission	

3. Assumptions and Drivers

- Gas price = $10.48 (2012$/mmBTU)
- Cost of carbon = $37.11 (2012$/metric ton)
- Higher energy and peak-demand growth than Reference Scenario:
  - Peak demand CAGR = 1.66% (1.7% growth from 2022)
  - Peak energy CAGR = 1.93% (1.8% growth from 2022)
- State-specific RPS requirements as they exist in 2013; no national RPS policy
- Four expansion cases: Heavy Summer, Light Spring, Light Fall, and Heavy Winter

4. Indicators

- Energy efficiency policies lag, presenting low technology innovation/development, low penetration of smart grid applications and minimal use of demand-response programs.

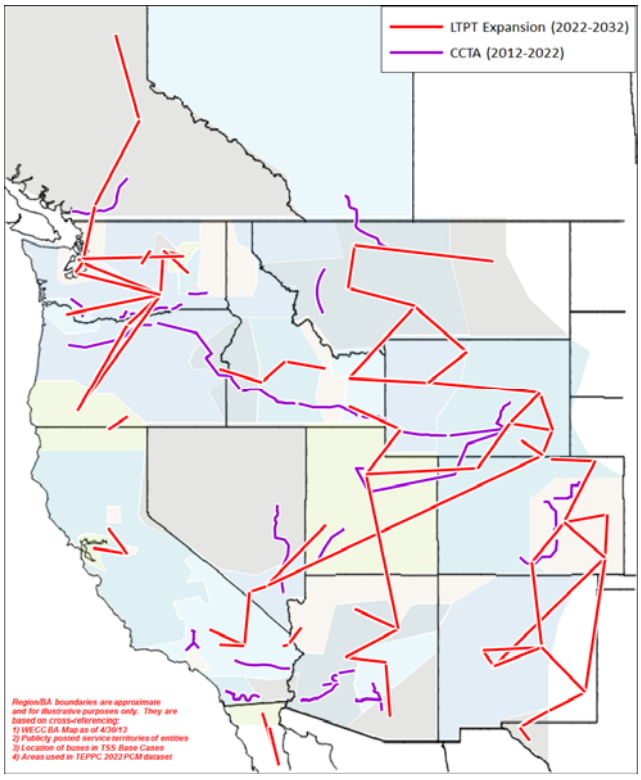
- Region is experiencing high economic growth with an increase in load demand

5. ***Summary of Findings***

- Added wind resources result in extensive transmission expansion, compared to the Reference Scenario
- Wind resources were added in excess of state RPS requirements, due to the economic viability of wind generation
- Resource flexibility issues may exist, possibly due to the nature of TEPPC modeling. The level of renewable generation required to meet load may also face other issues in terms of reliability and reserve margins
- Expected capital costs are 50% higher than in Reference Scenario = $180B ($35B for transmission)
- LCOE is 20% higher than in Reference Scenario = $57/MWh

Figure 4 is from the 2013 WECC TEPPC Plan and shows what this committee refers to as “significant” potential transmission development in the WECC region.

Figure 4. Potential Major Transmission Initiatives within WECC (Focus on Economic Recovery)



6. Potential Impacts to Colorado

From the figure above, this scenario identified the potential for transmission development in Colorado. The results show some transmission segments in addition to what was identified in the Reference Scenario needed to deliver renewable energy to loads both inside and outside of the state. The segments appear to show consistency with existing CCPG transmission plans such as the TOT7 Expansion, Pawnee-Daniels Park, Lamar-Front Range, Transwest Express, Zephyr Wyoming-Colorado Intertie, and the Valley Corridor Project.

7. Company Comments

a) Black Hills

Black Hills views this scenario as it would view a combination of CCPG Scenarios 1-3 identified above. The integration of a high level of renewables correlates with 1000 MW of import/export capability and possibly RPS requirements in excess of 30%. Similar to CCPG Scenario 3, Black Hills would anticipate increased joint participation in large transmission projects as they become more prevalent. As with any major backbone transmission projects, it is fair to assume the underlying system would need to be reinforced as local constraints deem necessary.

b) Public Service

As with the Reference Scenario, the Scenario 1 transmission needs shows similarities to statewide conceptual plans already in place (and already undergoing Public Service's planning process) such as the TOT7 Expansion and portions of the Lamar-Front Range Project, including Lamar-Burlington-Missile Site, and Lamar-Vilas.

WECC Scenario #2: Focus on Clean Energy

1. Description

TEPPC describes Scenario 2 as a world in which the economic gloom from the 2008 to 2010 recession turns around as a result of effective economic policies and a technological rebound that shows the power of innovation to restructure markets and industries. Scenario 2 imagines a future that has:

- Wide-spread economic growth in WECC region with increasing standards of living
- Paradigm-changing innovation in electricity supply and transmission technologies
- Aggressive policies that reduce greenhouse gas emissions and develop new technologies

Simply put, Scenario 2 features significant technology innovation (generation and distribution) and high economic growth as compared to the Reference Scenario.

2. Rule 3627 (e)

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	**X**
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	**X**
(III)	Emerging generation, transmission and demand limiting	**X**
(IV)	Various load growth projections	**X**
(V)	Requested by Commission	

3. Assumptions and Drivers

- Gas price = $6.90 (2012$/mmBTU)
- Cost of carbon = $100.00 (2012$/metric ton)
- Lower energy and peak demand growth than Reference Scenario:
  - Peak demand CAGR = 0.75% (1.4% growth from 2022)
  - Peak Energy CAGR = 1.15% (1.5% growth from 2022)
- Fifty percent increase in state RPS requirements with a 15 percent floor
- Significant reductions in capital costs for renewable and carbon capture and sequestration technologies
- Four expansion cases: Heavy Summer, Light Spring, Light Fall, and Heavy Winter

4. Indicators

- A national carbon policy is implemented, increasing the cost of carbon to more than 250% of its cost in the Reference Scenario
- Coal plants are required to be decommissioned or retrofitted with additional emission controls
- A national RPS policy is implemented in addition to state RPS requirements.
- There is aggressive use of energy efficiency, demand-response and smart grid applications
- There is high penetration of distributed generation including rooftop solar.
- High economic growth allows investment in technology solutions to offset load increases
- Renewable energy resources are the fuel of choice, and are supplemented by gas turbines for reliability

5. Summary of Findings

- Large wind and solar additions causes extensive transmission expansion compared to the Reference Scenario
- $100 carbon price drives resource selection
- Resource flexibility issues may exist, possibly due to the nature of TEPPC modeling. The level of renewable generation required to meet load may also face other issues in terms of reliability and reserve margins
- Expected capital costs are more than three times those in the Reference Scenario = $380B ($60B for transmission)
- LCOE is 10% higher than in the Reference Scenario = $52/MWh

Figure 5 shows the extensive and aggressive transmission needed in the Western Interconnection to keep pace with a scenario that focuses on, and legislates toward, a focus on clean energy.

6. Potential Transmission Impacts to Colorado

As shown in Figure 5, Scenario 2 would add a significant number of transmission segments over those needed for Scenario 1. Notable additions include a transmission link between the Denver-metro and Salt Lake City load hubs to enhance the delivery of Colorado renewable generation to load centers outside of the state. There also appears to be some transmission development in the western half of the state that may enable energy transfers into the Four Corners region.

7. Company Comments

a) Black Hills

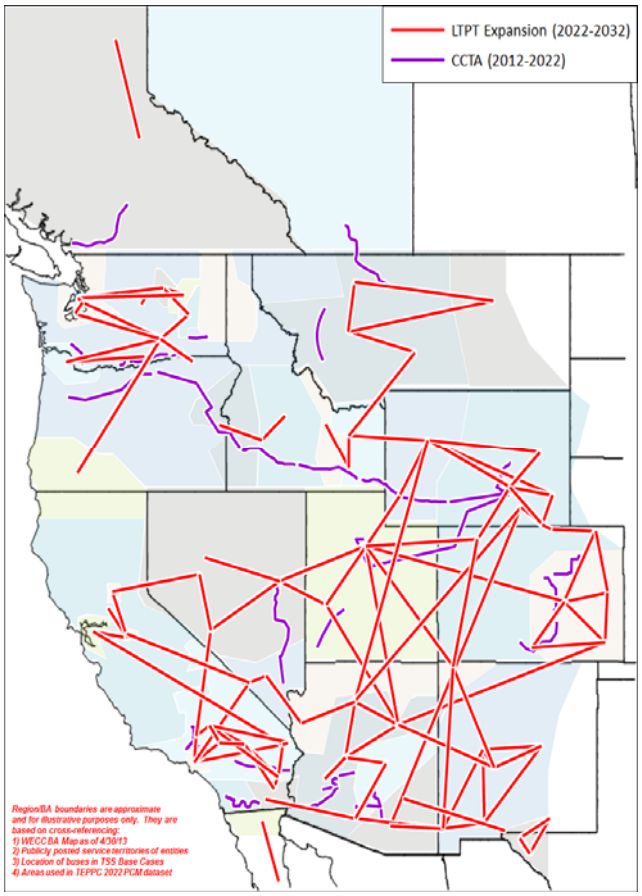
From Black Hills' perspective, this scenario is not unlike the previous one in that the identified transmission infrastructure is very capital-intensive, and the utility's

participation would favor joint-sponsorship. The large expansion of the transmission system may provide increased opportunities for competition in the energy markets by relieving transmission constraints. As with the previous scenario, upgrades to the existing transmission system would be addressed on a case-by-case basis.

b) Public Service

As with the Reference Scenario and Scenario 1, Scenario 2 transmission continues to show similarities to existing transmission plans such as the TOT7 Expansion and the Lamar-Front Range. This scenario aligns with a more complete build out of the Lamar-Front Range Project.

Figure 5 Scenario 2. Potential Transmission Segments for Clean Energy Development (Focus on Clean Energy)



WECC Scenario #3: Focus on Short-Term Consumer Costs

1. Description

Scenario 3 is defined as a future in which economic growth in the United States, including the Western region, is restrained for two decades. Technologies that are low-risk, proven and assured of cost-recovery proceed at a steady pace out of regard for short-term capital cost expenditures. Scenario 3 imagines a future that has:

- Slow and narrow economic growth resulting in a standards of living plateau;
- Evolutionary technology development that follows current patterns; and
- A policy theme of slow growth that leads to tough choices and focuses on keeping rates low.

2. Rule 3627 (e)

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	**X**
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	**X**
(III)	Emerging generation, transmission and demand limiting	**X**
(IV)	Various load growth projections	**X**
(V)	Requested by Commission	

3. Assumptions and Drivers

- Gas price = $6.90 (2012$/mmBTU)
- Decrease in cost of carbon from $37 to $0 per ton
- Lower energy and peak demand growth than Reference Scenario:
  - Peak demand CAGR = 0.85% (0.9% growth from 2022)
  - Peak energy CAGR = 1.14% (1.0% growth from 2022)
- Fifty percent decrease in state RPS requirements

4. Scenario Indicators

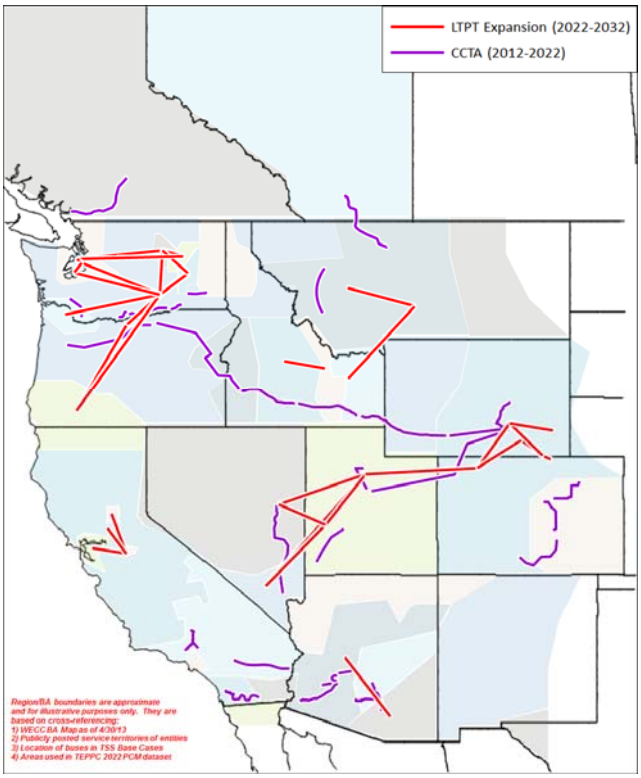
- Generation technology innovation/development is slower than expected
- Low economic growth leads to low load growth and limited financial ability to implement demand-side solutions
- National RPS or carbon policies have been eliminated; state requirements have been decreased by 50 to 100%
- Gas is the preferred fuel for new generation resources

5. ***Summary of Findings***

- A relatively small transmission expansion is required
- Gas is the predominant conventional resource, even without a carbon cost
- Expected capital costs are 40% lower than in the Reference Scenario = $75B ($15B for transmission)
- LCOE is comparable to the Reference Scenario = $45/MWh

Figure 6 shows the few expansion projects needed to meet transmission requirements in Scenario 3.

Figure 6. Potential Transmission Initiatives for Minimal Capital Investment (Focus on Customer Costs)



6. ***Potential Transmission Impacts to Colorado***

As shown in Figure 6, Scenario 3 does not provide any drivers for major transmission expansion in Colorado.

7. Company Comments

a) Black Hills

This scenario reflects a load growth rate similar to Black Hills' current projected growth rate. The incremental generation additions and associated transmission expansion align with the utility's current strategy and are viewed as being business as usual. This may be the closest to a 'do nothing' WECC scenario for Black Hills under the context of transmission system development in Colorado and the West.

WECC Scenario #4: Focus on Long-Term Societal Costs

1. Description

In Scenario 4, the world has experienced a fundamental shift in the usage and generation of electricity. Economic growth is slowed by constraints on government spending and persistent problems in the capital markets. Consumers are willing to pay for cleaner and more environmentally sustainable products because they see the benefits in improved health and lifestyles, which do not require exceptionally higher spending as many new technologies are very cost-competitive and highly efficient. In this future, consumers recognize the short- and long-term societal costs associated with climate change. Scenario 4 attempts to depict a future that focuses on long-term societal costs:

- Narrow and slow economic growth in the region resulting in a standards of living plateau
- Paradigm changes in electric supply and distribution technology
- An overall focus on long-term societal costs

2. Rule 3627 (e)

Rule	Credible alternatives	Apply
(I)	Reasonable foreseeable future policy initiatives	**X**
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	**X**
(III)	Emerging generation, transmission and demand limiting	**X**
(IV)	Various load growth projections	**X**
(V)	Requested by Commission	

3. Assumptions and Drivers

- Gas price = $5.00 (2012$/mmBTU)
- Cost of carbon = $75.00 (2012$/metric ton)
- Decrease in the cost of wind
- Much lower energy and peak demand growth than Reference Scenario:
    - Peak demand CAGR = 0.18% (0.6% growth from 2022) (Adjusted for DSM/DR/EE)
    - Peak energy CAGR = 0.43% (0.7% growth from 2022) (Adjusted for DSM/DR/EE)
- Aggressive EE and DR coupled with transportation electrification
- Fifty percent increase in state RPS requirements with a 15 percent floor

4. Indicators

- Narrow and slow economic growth in the region and stagnating standards of living leads to low growth in demand

- There have been paradigm changes in electric supply and distribution technology, as well as paradigm-changing technological developments entering the marketplace
- Energy efficiency, demand response, and smart grid applications contribute to a lower-than-normal growth in demand
- Environmental policies, such as a Federal carbon policy, increase costs of coal plants
- Gas remains the fuel of choice

5. Summary of Findings

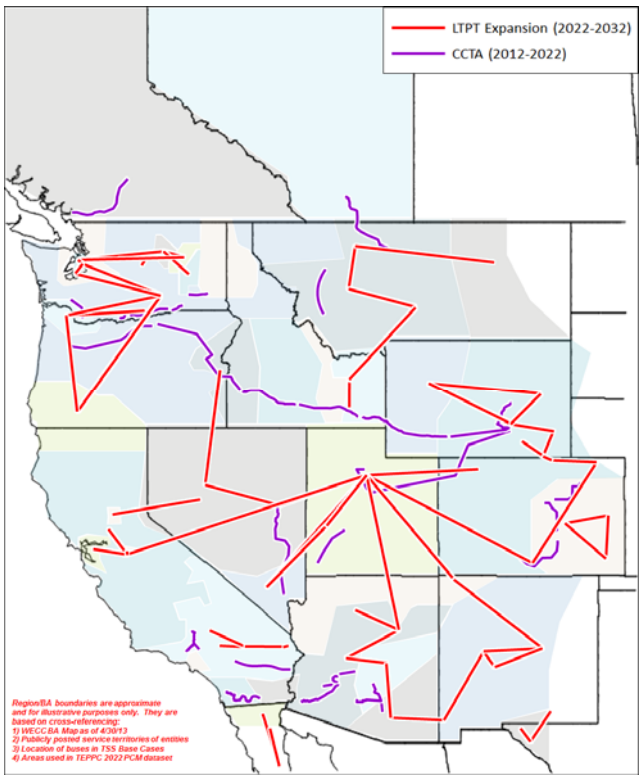
- A “large” WECC-wide transmission expansion is necessary
- Large financial impacts are felt from coal resources not being selected based on the high carbon price
- Expected capital costs are 50% higher than in Reference Scenario = $180B ($30B for transmission)
- LCOE is slightly lower than in Reference Scenario = $43/MWh

Figure 7 shows transmission infrastructure needed to import a high volume of renewable energy from generation sources to load centers and make up for the decommissioning or under-utilization of existing coal-fired generation.

6. Potential Impacts to Colorado

As shown in Figure 7, there are fewer transmission segments needed in this scenario than in the Reference Scenario.

Figure 7. Potential Transmission Initiatives for Low Demand and High RPS (Focus on Long Term Societal Costs)



1. Company Comments

a) Black Hills

This scenario exhibits the most limited growth in demand of all the WECC scenarios. Investment would be in technology to manage load wisely as well as adding significant renewable generation. Based on the characteristics of the utility's transmission system, Black Hills would not likely be a major driver for the identified transmission expansion, but would explore joint participation in transmission projects to accommodate the significant renewable resource growth. Upgrades to address impacts to the local system due to the larger projects would be reviewed on a case-by-case basis.