



# 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 1, 2016

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## ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Term
2016 Scenario Report	2016 20-Year Scenario Analysis Report
Black Hills	Black Hills/Colorado Electric Utility Company, L.P.
CAISO	California Independent System Operator
CCPG	Colorado Coordinated Planning Group
Commission or CPUC	Colorado Public Utilities Commission
Companies	Black Hills, Tri-State and Public Service
Company	Black Hills, Tri-State or Public Service
CPCN	Certificate of Public Convenience and Necessity
CPP	Clean Power Plan
CPWG	Conceptual Planning Work Group
DG	Distributed Generation
EIM	Energy Imbalance Market
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
HVDC	High Voltage Direct Current
IOU	Investor Owned Utility
ISO	Independent System Operator
kV	Kilovolt
L&R	Load and Resource
MOU	Memorandum of Understanding
MW	Megawatts
MWTG	Mountain West Transmission Group
NECO	Northeast Colorado
Public Service or PSCo	Public Service Company of Colorado
PV	Photovoltaic
RES	Renewable Energy Standard
RFI	Request for Information
RTO	Regional Transmission Operator
SPP	Southwest Power Pool
SB07-100	Colorado Senate Bill 07-100

<b>Acronym or Abbreviation</b>	<b>Term</b>
SCADA	Supervisory Control and Data Acquisition
SPSG	Scenario Planning Steering Group
SWEP	Southwest Weld Expansion Project
TEPPC	Transmission Expansion Planning Policy Committee (of the WECC)
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. In 2012, the Companies were not required to submit a 20-year conceptual plan. The first 20-Year Conceptual Scenario report was filed in 2014. This 2016 20-Year Conceptual Scenario Report (“2016 Scenario 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. 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 provided by Black Hills, three from Tri-State, and four from Public Service. The Companies’ scenarios generally address what the future state of the transmission system 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.

In addition to the Companies’ scenarios, the Colorado Coordinated Planning Group (“CCPG”) evaluated a scenario through the Conceptual Planning Work Group (“CPWG”). As with all CCPG activities, the CPWG was open to all interested stakeholders. In the

2014 20-year Conceptual Scenario Report, the Companies included scenarios developed by the Western Electricity Coordinating Council (“WECC”). However, since the time of filing the 2014 20-year Conceptual Scenario Report, WECC has not updated the scenarios.

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

On March 23, 2011, the 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.

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 2016 Scenario 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<sup>1</sup>
- studies of any scenarios requested by the Commission in the previous biennial review process
- changes in market conditions

With respect to reasonably foreseeable future policy initiatives, in addition to the public policy requirements of Colorado Senate Bill 07-100 (“SB07-100”), all three Companies are subject to the requirements of the Environmental Protection Agency’s (“EPA”) Clean Power Plan (“CPP”) and Colorado’s CPP compliance plan which is being developed. The final rules related to CPP were published in the Federal Register on October 23, 2015. The Companies are engaged with each other and relevant state agencies in the development of Colorado’s CPP compliance plan which is due in September, 2016. While the Companies anticipate that aspects of the Colorado CPP compliance plan may impact the 20-year Conceptual Scenario Report, those impacts are not yet known and it is premature to include in the 2016 Scenario Report specific scenarios or the impacts on

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<sup>1</sup> The CCPG 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.”

current scenarios related to CPP. The Companies will continue to coordinate with each other and stakeholders with respect to the transmission planning implications of CPP and expect to address this issue in the next 20-year Conceptual Scenario Report.

### **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. When considering the large number of potential future scenarios for this report, Black Hills also had the opportunity to explore and draw on the implications of various driving factors experienced by its sister utilities in Wyoming and South Dakota.

It is Black Hills' view that much of the planning work that has been previously performed within the various utilities and regional planning groups and reported in the 2014 Rule 3627 20-Year Scenario report 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).



For the purposes of this filing, Black Hills considered scenarios that resemble those included in the 2014 filing as well as new scenarios unique to this filing. The scenarios described below were selected by contemplating scenarios that provided dissimilar yet significant impacts to the transmission system while remaining plausible. There are no specific transmission plans associated with the scenarios described herein, but rather a general discussion of potential impacts and considerations.

### **Black Hills Scenarios**

Included below is a brief summary of each of the scenarios explored by Black Hills. Full descriptions, including rationale, drivers and assumptions behind each scenario, can be found in Appendix A.

#### ***BHCE Scenario #1: Transition to an Organized Regional Energy Market***

This scenario foreshadows a continuation of the gradual transition to an organized market similar to that of RTO. A paradigm shift in the approach to generating, transmitting, and delivering energy across the west would lead to efficiency gains and optimal utilization of assets throughout the electric utility industry.

#### ***BHCE Scenario #2: Significant Spot Load Growth***

The scenario explores the impacts of substantial demand growth in localized areas due to sudden and pronounced changes in drivers such as commodity prices. This spot load growth is often in remote areas and industrial in nature, creating challenges in reliably delivering energy to meet the demand but also managing potentially problematic power quality or stability issues. Growth in areas of probable load development should be considered in transmission planning assessments and incorporated into transmission expansion plans as appropriate.

### ***BHCE Scenario #3: Increased Renewable Energy Penetration***

This scenario may complement Scenario #1 and is driven largely by public policy initiatives. As the penetration of renewables increases, transmission expansion is needed to ensure delivery of that energy to load centers. Additional dispatchable generation may be needed to balance the intermittent resources unless a high degree of geographic diversity is achieved, presumably through the development of a robust transmission network. Technological breakthroughs in energy storage may also help drive this scenario closer to reality. This scenario may be addressed in part through the efforts of the biennial Senate Bill 07-100 filings.

### ***BHCE Scenario #4: Widespread Transmission Infrastructure Damage***

Scenario #4 contemplates the unexpected replacement of major transmission infrastructure due to a natural disaster. The urgency of such a replacement may preclude the 'right-sizing' of those facilities for long-term system adequacy. Various options for pre-emptively planning and preparing for key transmission facility replacements in an expedited manner should be explored. The primary purpose of this scenario is to initiate a dialog for further consideration.

## **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 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, which includes Arizona as well as the four states where its Member Systems are located, also results in a different perspective for Tri-State.

All of these considerations influence Tri-State’s conclusions with respect to what may constitute “credible alternatives” for purposes of 20-year conceptual scenarios. Notwithstanding these differences, Tri-State’s identified conceptual scenarios have much in common with the scenarios identified by Black Hills and Public Service. All three utilities recognize that regional market considerations and a changing resource mix driven by public policy developments and the growth of distributed generation are possible scenarios during the next 20 years.

Tri-State’s 2016 conceptual scenarios are summarized below. Full descriptions, including rationale, drivers and assumptions behind each scenario, can be found in Appendix B.

### **Tri-State Scenarios**

In developing its scenarios for inclusion in the 2016 Rule 3627 filing, Tri-State considered key public policy, industry, and technology drivers that are likely to influence – possibly to a significant degree – the operation and evolution of Colorado’s transmission system over the course of the next 20 years. Drivers identified in 2016 are generally consistent with those discussed in Tri-State’s 2014 20-Year Conceptual Scenarios. Inclusion of Colorado in an organized electricity market (2016 Scenario #1) is consistent with the regional interconnections discussed in Tri-State’s 2014 Scenario #3, Increased Connectivity Between Western and Eastern Interconnections. The evolving role of distributed generation resources is recognized in Scenario #2 in both the

2014 and 2016 reports. And the role of low carbon-emitting generation resources associated with Clean Power Plan compliance (2016 Scenario #3) is consistent with the discussion of advanced carbon capture and sequestration technologies included as Scenario #3 in the 2014 Report.

Where the 2014 scenarios were highly conceptual, the passage of time has shown the relevance of these scenarios. While the 2016 scenarios are still conceptual, it is now somewhat easier to identify how the various drivers discussed in these scenarios correspond to policy, industry, and technology developments.

### **TSGT Scenario #1: Inclusion of Colorado in Organized Electricity Market**

This scenario assumes that organized electricity markets – in the forms of energy imbalance markets (“EIM”), regional transmission operators (“RTO”), and independent system operators (“ISO”) – will continue to grow in the western United States. With this continued growth, it is assumed that there will be increasing pressure or interest in Colorado joining an existing electricity market or becoming part of a new regional market focused on the Rocky Mountain region. This scenario considers impacts on the Colorado transmission system as a result of such organized market developments.

### **TSGT Scenario #2: Growth of Distributed Energy Resources**

This scenario assumes continued and significant advancement in wholesale and retail distributed energy resources coupled with low load growth and higher efficiency. This scenario focuses on the growth of distributed energy technologies such as solar Photovoltaic (“PV”) generation, advancements in energy storage, and increased interest in and deployment of other distributed resources such as community wind, geothermal, biomass, small and micro hydropower, coal mine methane, synthetic gas produced by pyrolysis of municipal solid waste, and recycled energy, as well as associated public policy developments. This scenario considers the potential impact on the transmission system as a result of increasing distributed resources at the grid level and behind the meter.

### **TSGT Scenario #3: Changing Generation Resource Portfolio in Response to Clean Power Plan**

This scenario assumes that Colorado will develop and implement a state plan that complies with the Environmental Protection Agency's Clean Power Plan ("CPP") as promulgated in October, 2015. It is further assumed that Colorado's CPP compliance plan will include decreased use of higher carbon-emitting resources and increased use of lower carbon-emitting resources. Given the location of existing fossil-fueled electric generating units and the locations of Colorado's renewable resource generation development areas, such a change in Colorado's generation resource portfolio may require improvements and additions to Colorado's transmission system to ensure its continued reliability and to deliver resources to load centers.

#### **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 2015 peak customer demand of 6,332 Megawatts ("MW"). The entire Public Service transmission network is located within the State of Colorado and consists of approximately 4,500 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 CCPG, WestConnect, and 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 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.

### **Public Service Long-Term View**

Public Service continues to be interested in the future scenarios that were described in the 2014 Scenario Report. 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 past 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 past WECC scenarios indicate such a system may be necessary, if drivers emerge such as an increased requirement for renewable resources, or if a compelling reason arises 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**

In the planning cycle leading to the 2014 20-Year Conceptual Scenario Report, Public Service analyzed four possible scenarios. Those included:

1. Regional Market Dispatch
2. Significant Load Growth Associated with Oil & Gas Development
3. High Penetration of Distributed Generation
4. Economic Assessment for North/Central Colorado Generation Additions

These are scenarios that remain of interest to Public Service; as a result, Public Service is providing updates on how each of these have actually started to impact the Company.

#### ***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 assumes the development of an energy market across the interconnection that dispatches the least-cost generation across the least-cost transmission expansion needed to serve load. In the last two years, Public Service has been an active member of the Mountain West Transmission Group (“MWTG”), which is also comprised of

- Western Area Power Administration (LAP and CRSP)
- Tri-State Generation and Transmission Association
- Basin Electric (West, Common Use System)
- Black Hills Corp (Common Use System, Cheyenne, Colorado Electric)
- Platte River Power Authority
- Colorado Springs Utilities



The MWTG has been working on developing a single transmission tariff that would apply to all generation, transmission and load and transmission within its footprint. A single tariff would provide a number of benefits to the MWTG parties and their customers, including but not limited to: the potential increase in available transfer capability; elimination of pancaked transmission charges that reduce the opportunities for beneficial energy transfers; avoidance of the future duplication of transmission facilities; increased future resource siting opportunities; and, a single transmission planning process. Under a single tariff, each MWTG transmission owner would receive its revenue requirements from the network loads located in its zone, and as a result short-term energy transactions would be able to occur among the parties with no additional transmission service fees. While each owner's revenue requirements will be recovered, the elimination of pancaked transmission charges results in rate increases to some members, something commonly called a "cost shift."

The MWTG has concluded an extensive rate design analysis and developed a rate plan that mitigates the cost shifts that occur to several of the members. The MWTG parties are currently negotiating a Memorandum of Understanding ("MOU") to memorialize these understandings and develop a framework for the future progression of MWTG into a single tariff. The parties expect to conclude the MOU, and a corresponding request for information ("RFI") in the March 2016 timeframe.

Note that this scenario is similar to Black Hills Scenario #1 and Tri-State Scenario #1.

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

This scenario contemplated pockets of the Company's service territory that have the potential for high customer load growth associated with oil and gas exploration and development. The Niobrara Shale region of northeastern Colorado was mentioned specifically.

As it turns out, in the last few years, companies have been drawn to Northeast Colorado in search of oil and natural gas from the Niobrara Shale Formation. Load-serving entities such as Public Service and Tri-State have recognized the potential for increased demand

for electricity due to oil and gas development. Public Service is also interested in ensuring reliability for its customers in the region, including the City of Greeley. Greeley is served by aging 115 kilovolt (“kV”) and 44 kV transmission networks, and needs to ensure that the transmission system is planned and upgraded to accommodate reliability and load growth needs into the future. Therefore, the Public Service has focused a significant portion of its planning on the development of a coordinated transmission plan for northeast Colorado. Public Service is working towards participating in the Tri-State Southwest Weld Expansion Project (“SWEPP”), which will initiate the transmission development in the region for serving oil and gas loads. The SWEPP consists of 230 kV and 115 kV transmission that begins near Ft. Lupton, Colorado, travels east towards Hudson, and then heads north and ultimately connects to existing transmission a few miles south of Kersey. Tri-State received a Certificate of Public Convenience and Necessity (“CPCN”) for the project from the Commission in 2014. Much of the SWEPP transmission is planned to be constructed as double-circuit with 230 kV capability, with one circuit initially energized at 115 kV.

The Weld – Rosedale and Rosedale – Milton 230 kV transmission projects are extensions of the SWEPP transmission that will allow Public Service to serve its own requests for oil and gas load service in the region, allow reliability improvements to the southern Greeley transmission system, and facilitate longer-term transmission plans in northeastern Colorado. The Weld County Expansion planning effort includes the projects mentioned above, and may also include additional high-voltage transmission plans for the northeast Colorado region which could facilitate load growth, improve reliability in and around Greeley, provide access to potential resources in the region, and complement longer-term transmission projects in northeast Colorado. Public Service is working through the CCPG to develop these coordinated transmission plans.

Note that this scenario is similar to Black Hills Scenario #2.

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

This scenario contemplated a future where distributed generation (“DG”) would serve 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. This scenario continues to be of interest to Public Service. It is important to note that in the last few years, Public Service has implemented over 200 MW of DG on its system through community solar programs such as Solar Rewards and Solar Gardens and expects to continue to add DG in the coming years.

Note that this scenario is similar to Tri-State Scenario #2.

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

This scenario contemplated the development of 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. Public Service still sees this as a reasonable scenario and in the last two years, received approval from the PUC for the Pawnee – Daniels Park 345 kV Transmission Project, which will enable access to new generation resources in northeast and central Colorado.

#### **IV. Colorado Coordinated Planning Group Scenarios**

The CCPG is a sub-regional group of WestConnect that includes transmission providers ("TPs") 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 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 2014 Scenario Report documented three scenarios that were evaluated by the CPWG:

- Scenario #1 contemplated 1000 MW of import/export into the state of Colorado.
- Scenario #2 contemplated a reduction of coal-fired generation in Colorado.
- Scenario #3 evaluated various levels of RES for Colorado.

The evaluation of Scenarios #1 and #2 resulted in brief summary reports that spoke in general terms about how the transmission system might be impacted by those scenarios. However, for Scenario #3, a technical analysis was undertaken by the CPWG to study how various levels of RES and load forecasts might impact the transmission system. Each of these reports can be found on the WestConnect web site under:

[http://www.westconnect.com/planning\\_ccpg\\_conceptual\\_planning.php](http://www.westconnect.com/planning_ccpg_conceptual_planning.php)

In the CPUC Decision regarding the 2014 Scenario Report, the Commission stated that future conceptual long range scenario reports should contain at least one scenario that utilizes an updated 20-year base case power flow model.<sup>2</sup>

As a result, the CPWG developed power flow models to reflect the 2036 time period, supported by load and resource (“L&R”) data supplied by TPs in the CCPG. The group spent considerable time gathering future L&R data from the Colorado TPs for the 2030 time period. Throughout 2014 and 2015, the CPWG focused on re-evaluating Scenario #3.

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<sup>2</sup> Decision No. R14-0845, Proceeding Nos. 14m-0110e, 13m-1167e, & 13m-1183e, Recommended Decision Of Hearing Commissioner Pamela J. Patton Addressing The 2014 Ten-Year Transmission Plan And The 2014 Twenty-Year Conceptual Scenario Report

## **CCPG Scenario**

A summary of the CCPG scenario analysis is provided below. Additional details can be found in Appendix D.

### ***CCPG Scenario #3: State Statute RES Levels***

The CCPG scenario might be referred to as a “current trend” scenario. The CPWG created powerflow models based on currently enacted RES of 30% for Public Service and Black Hills, 20% for Tri-State and 10% for all other utilities. Each utility provided load data for their expected forecast. Three powerflow models were created. One modeled peak summer conditions, one modeled an off-peak condition (50% of summer peak loads), and the last modeled high load growth ( 2% per year) in the Greeley area. The transmission studies utilized the peak and off peak cases. The off-peak case was used to study. Higher wind resources being available during the off peak conditions, which could represent night time loading conditions that would occur during the spring or winter. The results of the studies are documented in a draft report, titled “A Conceptual Transmission Plan for the Year 2036 for the State of Colorado”. The report can be found at:

[http://www.westconnect.com/planning\\_ccpg\\_conceptual\\_planning.php](http://www.westconnect.com/planning_ccpg_conceptual_planning.php)<sup>3</sup>

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<sup>3</sup> The report represents the opinions of the author, who was a member of the staff of the CPUC. It does not necessarily represent the opinion of the CPUC or other utilities, nor does it bind the CPUC in any way.

## **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 TEPPC is organized to include the Scenario Planning Steering Group ("SPSG"). One of the responsibilities of the SPSG is to provide strategic guidance to the TEPPC on emerging policy, regulatory, environmental, industry and social trends that may have significant impacts on electric transmission expansion planning, and on future scenarios of the Western Interconnection to be modeled in transmission planning studies. Information about the WECC TEPPC scenarios and processes can be found at [www.wecc.biz/teppc](http://www.wecc.biz/teppc) .

# 2016 Scenario Analysis Appendices

# **Appendix A**

## **Black Hills Scenarios**



# Black Hills Scenario #1 Transition to an Organized Regional Energy

## Market

### 1. Description

This scenario envisions the near-term utilization of least-cost generation resource dispatch within an extensive regional energy market comprised of utilities serving loads in the Front Range region. Future public policy initiatives may cause a shift to a hybrid carbon/economic dispatch of resources. This scenario does not implicate certain load growth or public policy assumptions but would align well with any reasonably foreseeable future economic or policy environment. The regional energy market would include a transmission planning process to ensure the best cost transmission expansion needed to serve load. Black Hills, PSCo, Tri-State and other Front Range utilities are actively exploring whether a regional joint tariff can be 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. Assumptions and Drivers

- Public policy initiatives mandate higher penetration of renewable energy resources, leading to the need for geographic diversity and efficient generation dispatch to maintain reliability while meeting emissions mandates.
- Regional transmission planning under FERC Order 1000 coupled with a migration of neighboring entities into organized markets indicates a natural progression for entities within the Rocky Mountain Region to adopt a more consolidated approach to generation, transmission and delivery of energy to customers.

#### **4. Indicators**

- There is growing interest in joining a regional market within areas surrounding the Rocky Mountain Region, with organized market adoption occurring to the east and west of the region.
- There is growing interest in the concept of a regional market within the Rocky Mountain Region as shown by the progress of the Mountain West Transmission Group toward adoption of a regional transmission tariff.

#### **5. Potential Benefits and Transmission Impacts to Colorado**

Benefits provided by an organized energy market include the potential to reduce the required balancing reserves in the region, enable a more geographically and fuel-diverse resource mix, improve transmission system reliability and reduce congestion. These factors may delay or eliminate the need for certain transmission infrastructure investments. If transmission expansion is required, the risk of project duplication is reduced.

There are some potential negative impacts of this scenario. There is a risk of having a portion of transmission expansion costs allocated to a utility or utilities within a region with limited benefits received locally from that project. There is a general push within an organized market structure to unify operational policies and practices. Modification of existing policies has the potential to result in a degradation of transmission system capacity on certain paths, leading to congestion.

It is unlikely that all of the impacts of a shift to an organized market can be identified for all participating entities in advance of that shift. It is generally accepted that an organized market offers savings and efficiencies in excess of the consequences. Ultimately the strategy for transmission expansion planning would not be significantly altered in the short term, and most shifts would be gradual rather than immediate and disruptive.

## Black Hills Scenario #2 Significant Spot Load Growth

### 1. Description

This scenario considers the development of significant (>20 MW) localized customer loads within a single industry sector driven by a relatively abrupt change in commodity prices, legislation, or regulatory initiatives. Sudden changes in these drivers can impact an entire industry, leading to aggressive load growth at several points within a region. Potentially impacted industries include but are not limited to mining, oil and gas exploration, and data centers. Significant commercial and/or industrial demand growth often occurs in remote areas where transmission infrastructure is absent or insufficient to accommodate the energy delivery or reliability requirements.

### 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	
(IV)	Various load growth projections	X
(V)	Requested by Commission	

### 3. Assumptions and Drivers

- Changes in the economic climate lead to financial uncertainty and rapidly climbing gold and silver prices. This, coupled with emerging technologies in the industry triggers a resurgence in mining activity.
- Technological advancements and state tax incentives drive a major expansion of large centralized data centers in areas where adequate fiber optic communication infrastructure exists.
- Initiatives like the Clean Power Plan and the need to balance renewable resources lead to rapid expansion of renewable energy sources and natural gas fired generation. That additional generation drives expansion of inter and intrastate gas pipelines and associated pumping stations.
- Global unrest drives a spike in oil prices. That spike, coupled with developments in carbon capture technology, lead to widespread adoption of CO2 injection into existing oil wells for enhanced oil recovery.

#### **4. Indicators**

New pipeline routes or existing pipelines with latent capacity are candidates for significant potential growth, as are undeveloped or underdeveloped mining or oil extraction properties. Areas with substantial fiber optic communication networks are likely locations for large data centers.

#### **5. Potential Benefits and Transmission Impacts to Colorado**

Significant localized demand growth can have an impact on a local transmission system. When several large growth customers materialize in a given area, it can materially alter transmission plans of any size. As transmission plans are developed, there should be close coordination with representatives from industries with large demand potential to optimize planned infrastructure.

Increased intermittent energy resource penetration coupled with significant industrial type loads (pumps, motors, arc furnaces) may create large power quality fluctuations and problems on the electrical system, mainly harmonics, inter-harmonics, flicker and voltage imbalances. Transmission development should consider existing and potential locations for steel mills and similar facilities near rail access but away from populated load centers to minimize these detrimental impacts.

## Black Hills Scenario #3 Increased Renewable Energy Penetration

### 1. Description

This scenario considers a significant increase in the penetration of renewable generation projects beyond current renewable mandates due to various drivers such as the Clean Power Plan, extension of Investment Tax Credits and Production Tax Credits, and implementation of a national renewable energy standard.

### 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. Assumptions and Drivers

- Court challenges to the Clean Power Plan are unsuccessful and states move forward with implementation plans
- Further interest in green energy development results in an increase in requirements established in the Clean Power Plan; a 40 or 50% national renewable energy standard

### 4. Indicators

A future regional energy market could concentrate certain renewable resources in areas where the capacity factor is greatest; Colorado contains areas of very desirable solar resource as well as very desirable wind resource.

### 5. Potential Benefits and Transmission Impacts to Colorado

Addition of significant new renewable resources in Colorado would necessitate development of new transmission to access currently constrained areas with significant renewable energy resources. Eastern and southeastern Colorado as well as the San Luis Valley all have strong renewable resources which could see generation development interest in this scenario.

## Black Hills Scenario #4 Widespread Transmission Infrastructure

### Damage

#### 1. Description

This scenario considers an unexpected need to repair or replace large portions of the Bulk Electric System in CO due to damage from a widespread natural disaster. If critical electric transmission infrastructure were to become damaged, necessitating expedited replacement, a comprehensive, forward-looking strategy is needed to determine if those facilities should be replaced in kind or upgraded to a higher operating voltage, different structure type, different conductor, etc. Consideration should be given to potential transmission needs over the extended planning horizon to determine the best long-term solution.

#### 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. Assumptions and Drivers

- The impact of mountain pine beetle infestations, for example, has led to the death of large portions of national forest across several western states. As portions of the forest die off, the risk of forest fires and subsequent damage to transmission through mountainous areas can increase dramatically.

#### 4. Indicators

- Diminishing capacity margin on critical transmission facilities in the long term planning horizon
- Transmission facilities through areas prone to natural disasters such as flooding, fires, tornadoes, etc.

## **5. Potential Benefits and Transmission Impacts to Colorado**

This scenario bridges the gap between long term transmission expansion planning and short-term operational needs. If a line that is critical to reliability becomes unavailable, the effort to return that facility to service becomes a priority. Careful consideration of the future needs of that facility may go unaddressed. Additionally, upgrades to a transmission line to meet those future needs may not be possible without additional easements, permits, etc. A short term solution may be implemented to increase reliability at the expense of long term system adequacy. Given the potentially destructive nature of natural disasters, this scenario has the possibility to expand beyond a single-facility concern into a regional problem for the Colorado BES. The value of a long term transmission plan is evident for this scenario. To take it one step further, a long-term transmission plan could be used, in conjunction with a list of relatively critical transmission facilities, to develop plans for expanded right-of-way or obtaining equipment with a long lead time. Furthermore, opportunities could be explored to expedite the processes for regulatory approvals and permitting for expansion or upgrades when responding to emergency situations.

# **Appendix B**

## **Tri-State Scenarios**



## TSGT Scenario #1: Inclusion of Colorado in Organized Electricity Market

### 1. Description

This scenario assumes that organized electricity markets – in the forms of energy imbalance markets (“EIM”), regional transmission operators (“RTO”), and independent system operators (“ISO”) – will continue to grow in the western United States. With this continued growth, it is assumed that there will be increasing pressure or interest in Colorado joining an existing electricity market or becoming part of a new regional market focused on the Rocky Mountain region. This scenario considers impacts on the Colorado transmission system as a result of such organized market developments.

### 2. Rule 3627(e) Application

Rule	Credible Alternatives	Apply
(I)	Reasonably foreseeable future public policy initiatives	X
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	
(III)	Emerging generation, transmission and demand limiting technologies	X
(IV)	Various load growth projections	X
(V)	Scenarios requested by the Commission in 2014 biennial review process	

### 3. Assumptions and Drivers

- Federal regulatory requirements such as FERC Order No. 1000 and the Environmental Protection Agency’s Clean Power Plan may create incentives for regional approaches to transmission challenges to facilitate compliance with these requirements.
- External developments related to expansion of existing organized markets such as the California Independent System Operator (“CAISO”) and the Southwest Power Pool (“SPP”) may create operational and practical pressures on Colorado electric utilities to join an existing market or form a new one.

- Apart from such external developments, changes in electric utility industry planning and economics may incentivize utilities to explore the benefits of organized market mechanisms such as joint tariffs and imbalance markets.

#### **4. Indicators**

- To the west of Colorado, CAISO has experienced significant interest and growth in its membership with utilities in Arizona, Nevada, and Oregon formally joining CAISO's EIM and various other western states' utilities exploring possible participation.
- To the east of Colorado, SPP has seen similar interest and growth with Western Area Power Administration's Upper Great Plains Region, Basin Electric Power Cooperative, and Heartland Consumers Power District becoming RTO members in October, 2015. Tri-State will transfer to SPP functional control of its Eastern Interconnection transmission facilities on January 1, 2016.
- Tri-State, Public Service Company of Colorado and other Colorado transmission providers continue to explore development of a joint regional transmission tariff through the Mountain West Transmission Group.

#### **5. Potential Benefits and Transmission Impacts to Colorado**

There are currently seven organized electricity markets in the US including California ISO, Southwest Power Pool, ERCOT, Midcontinent ISO, PJM, New York ISO, and New England ISO. A potential benefit of any organized electricity market is that transmission planning, operations, expansion, and resource dispatching are centralized, which can potentially result in a more efficient utilization of the transmission grid and generation fleet. This has the potential to reduce costs, reduce congestion, and reduce incentives for duplication. These processes would also be more consistent with other regions in the US.

Alternately, joining an organized market will fundamentally shift existing transmission business processes, which will come with associated costs. Also, there is a risk that Colorado utilities would be required to financially participate in projects that are considered regional, but not necessarily beneficial to Colorado customers. Ultimately, there would be some loss of autonomy and self-determination for all Colorado transmission system stakeholders. Still, it is possible that the benefits would outweigh the consequences.

## TSGT Scenario #2: Growth of Distributed Energy Resources

### 1. Description

This scenario assumes continued and significant advancement in wholesale and retail distributed energy resources coupled with low load growth and higher efficiency. This scenario focuses on the growth of distributed energy technologies such as solar PV generation, advancements in energy storage, and increased interest in and deployment of other distributed resources such as community wind, geothermal, biomass, small and micro hydropower, coal mine methane, synthetic gas produced by pyrolysis of municipal solid waste, and recycled energy, as well as associated public policy developments. This scenario considers the potential impact on the transmission system as a result of increasing distributed resources at the grid level and behind the meter.

### 2. Rule 3627(e) Application

Rule	Credible Alternatives	Apply
(I)	Reasonably foreseeable future public policy initiatives	X
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	
(III)	Emerging generation, transmission and demand limiting technologies	X
(IV)	Various load growth projections	X
(V)	Scenarios requested by the Commission in 2014 biennial review process	

### 3. Assumptions and Drivers

- The price of solar PV continues to fall.
- There is continued interest in community-based and behind the meter business models which make solar PV available to more consumers.
- The price of energy storage technologies, particularly batteries, continues to fall.

- Technological advances and regulatory policies are prompting utilities to explore the various applications of energy storage such as demand response, peak shaving, integration of renewables, and ancillary services.
- Existing and potentially increased state renewable energy standards will continue to drive the need for renewable resources at both the utility and consumer levels.
- EPA's Clean Power Plan will incentivize the development of additional low carbon emitting generation resources.
- Siting and permitting of large fossil-fueled generation resources will become increasingly difficult.

#### **4. Indicators**

Key indicators for this scenario include:

- changes to renewable energy standard requirements
- Colorado's CPP compliance plan
- regulatory policies related to net metering and distributed generation
- evolving business models and public interest in community-based and behind-the-meter distributed renewable resources
- continuing decline in distributed resource costs, particularly solar PV and energy storage
- development of a state, regional, or national carbon cost policy or carbon credit trading frameworks

#### **5. Potential Benefits and Transmission Impacts to Colorado**

An increase in distributed generation has the potential to delay or eliminate the need for significant transmission expansion, particularly if the distributed generation can be counted on during periods of peak demand. Distributed generation also has the potential to provide back-up power, provide process steam from waste heat, and reduce utility costs to the end user.

A potential consequence of high penetrations of distributed generation is that it can pose challenges to entities responsible for grid reliability. Since typical distributed generators are relatively small, they do not employ power system stabilizer controllers, nor do their owners typically maintain precise computer models of the generator's governor or excitation systems. At high concentrations, distributed generation will impact the frequency and voltage performance of the local grid, especially following disturbances. The magnitude of their impact can be analyzed and incorporated into grid modeling, but only if the responsible entities participate in the analysis process.

## **TSGT Scenario #3: Changing Generation Resource Portfolio in Response to Clean Power Plan**

### **1. Description**

This scenario assumes that Colorado will develop and implement a state plan that complies with the Environmental Protection Agency’s Clean Power Plan (CPP) as promulgated in October, 2015. It is further assumed that Colorado’s CPP compliance plan will include decreased use of higher carbon-emitting resources and increased use of lower carbon-emitting resources. Given the location of existing fossil-fueled electric generating units and the locations of Colorado’s renewable resource generation development areas, such a change in Colorado’s generation resource portfolio may require improvements and additions to Colorado’s transmission system to ensure its continued reliability and to deliver resources to load centers.

### **2. Rule 3627(e) Application**

<b>Rule</b>	<b>Credible Alternatives</b>	<b>Apply</b>
(I)	Reasonably foreseeable future public policy initiatives	<b>X</b>
(II)	Possible retirement of existing generation due to age, environmental regulations or economic considerations	<b>X</b>
(III)	Emerging generation, transmission and demand limiting technologies	<b>X</b>
(IV)	Various load growth projections	<b>X</b>
(V)	Scenarios requested by the Commission in 2014 biennial review process	

### **3. Assumptions and Drivers**

- Colorado required to develop and implement a CPP compliance plan that will achieve a 38% reduction in the rate of CO2 emissions or a 31% reduction in the mass of CO2 emissions by 2030.
- Initial Colorado CPP compliance plan to be submitted by September 6, 2016.
- Final Colorado CPP compliance plan to be submitted by September 6, 2018.

- It is assumed that the Colorado CPP compliance plan will result in CO2 emission reduction requirements for all Colorado electric utilities that own and operate fossil-fuel fired electric generating units.
- Among the options available to the state and Colorado's electric utilities, utilities may choose to decrease the use of higher carbon emitting generation resources and increase the use of lower carbon emitting resources. This may necessitate a change in Tri-State's and other utilities' generation resource portfolio (e.g., retirement or decreased utilization of certain plants, increased utilization of other plants, construction of new plants, etc.). Such changes may impact the reliability and capacity of the Colorado transmission system

#### **4. Indicators**

- Colorado's initial CPP compliance plan will not be due until after the 2016 Ten-Year Transmission Plan is filed with the Commission pursuant to Rule 3627. Accordingly, the initial CPP compliance plan is not available to inform the 2016 Ten-Year Plan. Similarly, Colorado's final CPP compliance plan is not scheduled to be submitted to the EPA until after the 2018 Ten-Year Transmission Plan is submitted. Assuming no extensions of this schedule and assuming the EPA approves Colorado's final CPP compliance plan, that plan will begin to inform Colorado's ten year transmission plans to be submitted in 2020.
- It is assumed that all Colorado electric utilities with affected EGUs will participate in discussions related to development of Colorado's CPP compliance plan; however, until such plan is developed, submitted, and approved, no specific transmission plans can be identified let alone implemented.
- At a high level, some scenarios can be considered with regard to decreased utilization or retirement of existing fossil-fueled generating resources, increased utilization of existing renewable resources or development of new renewable resources generally located within Colorado's identified Renewable Resource Generation Development Areas, and increased development of grid-level, community-scale, and behind-the-meter distributed generation resources. These various possible scenarios may indicate potential impacts on the Colorado electric transmission system and the transmission system improvements or additions needed to mitigate or accommodate those impacts.

## **5. Potential Benefits and Transmission Impacts to Colorado**

In general, the Clean Power Plan (CPP) represents a policy decision to shift the nation's power generation from higher carbon dioxide emitting resources to lower emitting resources. Conceptually, this can be accomplished through the elimination of or reduction in operations by fossil-fueled power plants, greater utilization of lower-emitting and non-emitting resources, and other measures such as increased energy efficiency. How Colorado will comply with the CPP is yet to be determined; however, it is possible to speculate about the potential benefits and impacts to the Colorado transmission system as a result of the types of measures generally described above.

The structure of Colorado's existing transmission system is concentrated around large, central-station generation plants. The operation of these plants is integral not only to the production of power to meet the needs of Colorado consumers, but also to the continued reliable operation of the transmission system. The power generated by these plants as well as the location of each plant affects power flows on the Colorado transmission system and in the region, the reliability and quality of the power delivered throughout the state, and the capacity to add new generation resources to meet the state's energy needs and the requirements of CPP. As a result, any CPP-driven changes to Colorado's power generation portfolio will have consequences for the operation and planning of the present and future Colorado transmission system.

For example, if it is determined that a fossil-fueled power plant must cease operations, this will impact both the amount of power available for consumption as well as power flows on and the reliability of the interconnected transmission system. It is possible that a coal-fired power plant may switch fuel and become a natural gas-fired power plant; however, even such a change could impact the transmission system during the conversion process as well as afterwards due to power output and operational differences from the previous plant on which the surrounding transmission system was developed.

If new lower-emitting resources must be constructed to replace higher-emitting resources, it is possible if not likely that such resources will be constructed in a different location than the original resources they are intended to replace. If so, new and/or upgraded transmission elements will be needed to interconnect those new resources. It is common knowledge that the siting, permitting, and construction of transmission lines – especially larger and/or longer lines – is becoming increasingly challenging. As a result, it may be difficult to timely place into service new or upgraded transmission lines needed to deliver power from new, lower-emitting resources contemplated by a CPP compliance plan. This is especially true in Colorado where large portions of the state include federal lands, which entail lengthy federal permitting processes for new or significant rebuild transmission projects.

In addition to developing new or upgraded transmission lines to accommodate the location of and delivery from new generation resources, it is possible that various transmission system improvements may be needed to ensure that the "hole" created by existing fossil-fueled power plants that are closed or that have reduced operations does

not result in unreliable transmission system operations. This will especially be true in cases where grid resiliency to system disturbances is affected.

These challenges demonstrate that Colorado's CPP compliance plan cannot be developed solely by focusing on power generation resources, but must also consider the relationship between existing and new generation resources and the transmission system on which they depend.

Notwithstanding these challenges, that are potential benefits to the Colorado transmission system as a result of CPP-driven changes to Colorado's generation portfolio. For example, the development of new transmission lines needed to interconnect new lower-emitting resources may provide additional capacity and opportunities to interconnect additional resources in the future. New transmission infrastructure could have the added benefit of delaying or eliminating the need for improvements to or reconstruction of older transmission lines. Similarly, new transmission elements generally result in a more robust transmission system that may be better able to accommodate maintenance of transmission lines and ensure reliable power deliver during storms and other unforeseen events. Finally, since CPP is a nationwide obligation, it may lead to regional responses and an expanded need to move power between lower-emitting resources and the states in which they are located. This could result in the construction of increased transmission ties between Colorado and other states, the combined effect of which could be opportunities for more diverse energy production in Colorado.



# **Appendix C**

## **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 WECC, 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 2016 20-year Conceptual Scenario 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.

Also, refer to the Black Hills Scenario #1 and the Tri-State Scenario #1, which are similar scenarios.

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

### 1. Description

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 continues to be engaged with the Northeast Colorado Subcommittee (NECO) of CCPG, which has been developing transmission plans for northeast Colorado, particularly in Weld County. In addition, Public Service has several planned and conceptual transmission projects for the Western Slope of Colorado that could be implemented depending on actual and forecasted load growth in the area.

## 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 Supervisory Control and Data Acquisition (“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, economic trends appear to indicate that it is more cost-effective to develop resources in northern and central Colorado. As a result, Public Service is planning to construct the Pawnee – Daniels Park 345 kV transmission project, which will provide transmission to accommodate generation in the northeast quadrant of the state. Public Service continues to evaluate how some or all of the components of Lamar – Front Range plan may be beneficial for the future.

# **Appendix D**

## **CCPG Scenario**

## CCPG Scenario #3: 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, 20% for Tri-State, and 10% for all other utilities. Several sensitivities of this scenario were evaluated by the CCPG including a normal 2036 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, 20% for Tri-State, and 10% for other utilities
- 1.34% 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

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 2036 timeframes.

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

[http://www.westconnect.com/planning\\_ccpg\\_conceptual\\_planning.php](http://www.westconnect.com/planning_ccpg_conceptual_planning.php)

## 6. Company Comments

### a) **Black Hills**

Scenario 3 sensitivity results in a similar RES requirement for Black Hills. In Scenario 3, the reduced RES requirements for utilities other than Black Hills and Public Service, along with the reduced forecasted Black Hills demand 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**

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 3 represents “business as usual” or “current trend” conditions for Public Service, where nothing significant changes from today’s operations in terms of RES standards, growth rates, etc.