Colorado Coordinated Planning Group
Colorado Energy Plan Task Force

Public Service Company of Colorado

October 18, 2018

Agenda

- Introductions
- Antitrust Reminder
- CEP/ERP Update
- 2018 Study Scope
- Schedule
- Next Steps

Antitrust Reminder

It should be the policy and practice (Policy) of the parties participating in the Colorado Coordinated Planning Group to obey the antitrust laws and avoid all conduct that unreasonably restrains competition. Under this Policy, participants should avoid any conduct or behavior that violates, or that might appear to violate, the antitrust laws. Among other things, the antitrust laws forbid any agreement between or among competitors regarding prices, availability of service, product design, terms of sale, division of markets, allocation of customers or any other activity that unreasonably restrains competition.

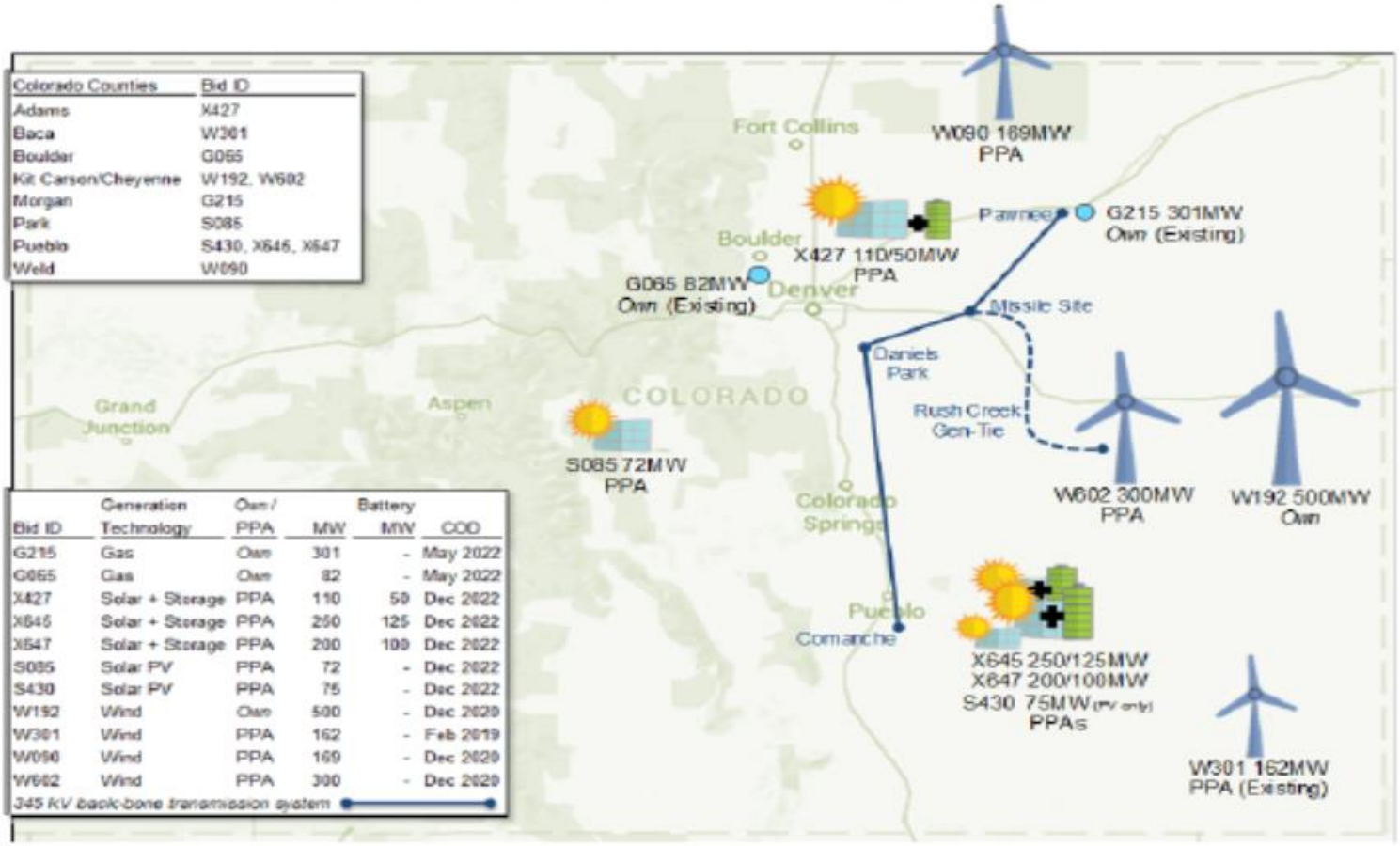
ERP/CEP Update

Background

- **PSCo 2016 Electric Resource Plan (ERP)**
  - Filed May 2016, 450 MW by 2023
- **PSCo Colorado Energy Plan (CEP)**
  - Filed August 2017
  - Retire Comanche 1 (335 MW) by end of 2022
  - Retire Comanche 2 (325 MW) by end of 2025
  - New Badger Hills Substation
- **Formed CEPTF under CCPG**
- **120 Day Report - Filed June 2018**
- **PUC Decision- Aug/Sep 2018**
  - **Approved:**
    - Retirement of Comanche 1 and 2
    - Resource Selection in CEPP
  - **Set Requirements for:**
    - CPCN Applications
    - Next ERP

CEPP Map

Figure 5 - Preferred CEPP Generation Locations



Preferred CEPP

Table 9 - Preferred CEPP Projects

Bid ID	Project Name	Technology	MW	Ownership	In-Service
X645	[redacted]	Solar w/ Storage	250/125	IPP	2023
X647		Solar w/ Storage	200/100	IPP	2023
X427		Solar w/ Storage	110/50	IPP	2023
S430		Solar	75	IPP	2023
S085		Solar	72	IPP	2023
W192		Wind	500	Own	2021
W602		Wind	300	IPP	2021
W090		Wind	169	IPP	2021
W301		Wind (repower)	162	IPP	2019
G215		Gas (existing)	301	Own	2022
G065		Gas (existing)	82	Own	2022

Note: In-Service refers to the first summer the unit is available.

Study Update

Zinn Photography/Courtesy of SunEdison

Scope Shift

I. **Preliminary Analysis**
   1. **Reliability (Comanche Retirement)**
      - **Steady State, Dynamic, Short Circuit, Flicker**
   2. **Capacity**
      - **Three Regions (Northeast, South, Central)**
      - **Stand-Alone**

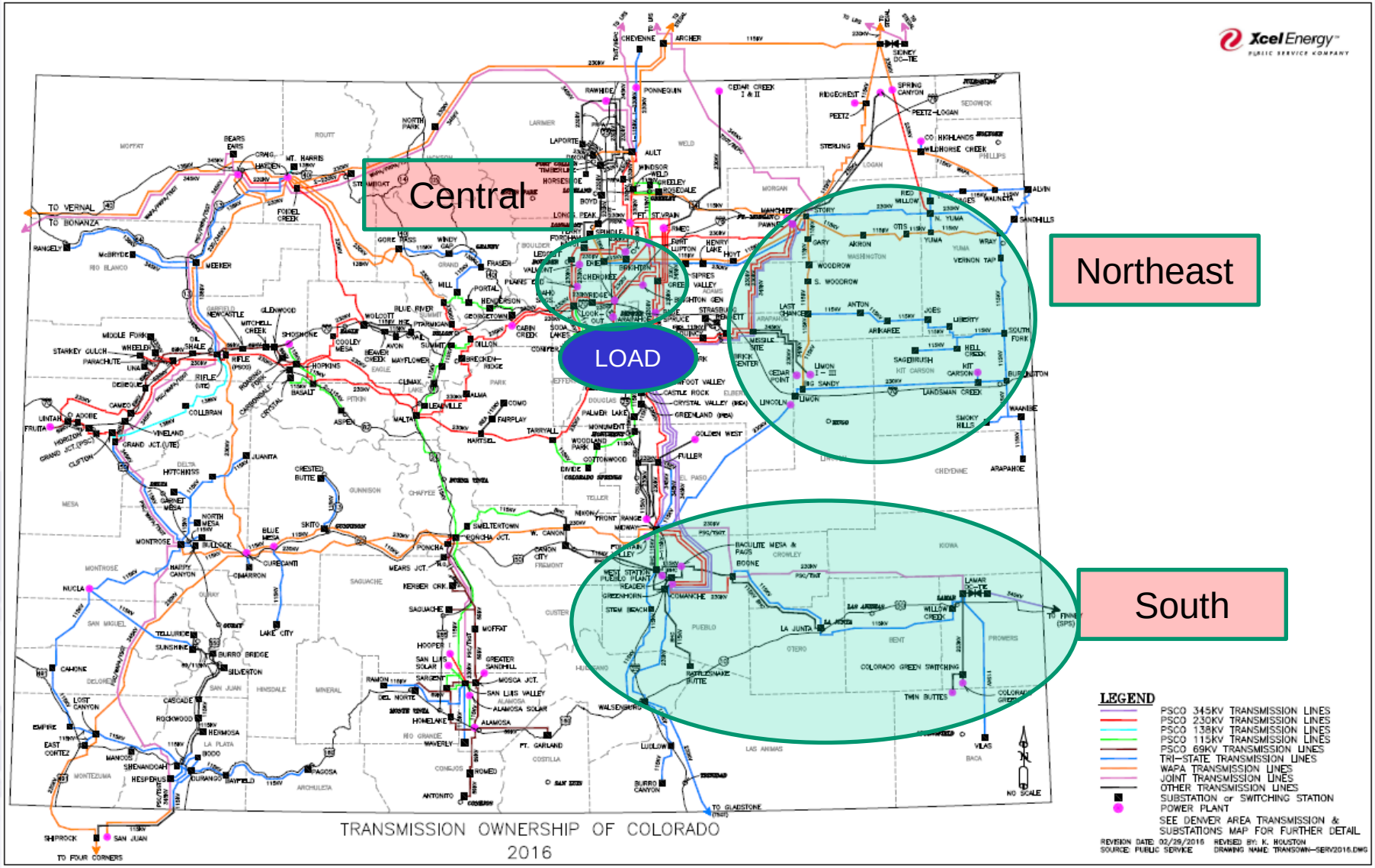
II. **Bid Analysis**
   - **System-Wide Study**
   - **Rush Creek Gen-tie**
   - **Flicker Mitigation**

III. **Portfolio Analysis**
   - **Rush Creek Gen-tie Performance**
   - **Network Upgrades**

Preliminary Study Results

- **Reliability**
  - No Performance Issues (Pflow: Voltage/Loading, System Stable
- **Capacity**
  - Northeast (Based on RCTF Studies):
    - 550 MW – No Upgrades; Limit: Denver-Metro
    - 850 MW – Metro Upgrades
  - South:
    - 250 MW – No Upgrades (PSCo/CSU Operating Procedure)
    - Limit: CSU
  - Central (Gas):
    - 400 MW (2 x 200) @ Ft. St. Vrain, Spruce, Cherokee 230
    - 250 MW @ Spindle, Cherokee 115
    - 100 MW @ RMEC
    - All with No Upgrades
  - Each Area Studied "Stand-Alone"

Injection Areas



Badger Hills Substation

- **Concept:**
  - **Electrically Equivalent to Comanche**
  - **Allow Additional Generation Interconnections**
  - **Similar Concept as Missile Site Substation**
  - **Flexibility for Future Expansion**
- **Planned Configuration (CEP)**
  - **Bisect one 345 kV, one 230 kV Com-DP**
  - **One 345/230 kV transformer**
- **CPCN Required**

Bid Analysis Studies (2018)

- **Preliminary Portfolio Analysis**
  - **Revised Assumptions for Wind and Gas**
    - **Coal at or Near Max**
    - **Fountain Valley & Manchief at 50%**
    - **Wind at 80%, 60%, 40%**
    - **“Central” Gas Used for Balance**
    - **CSU Limitation Fixed by Phase Shifter**
  - **Assume New Generation in Each Injection Area**
  - **Results:**
    - **Upgrades Depend on Portfolio and Wind Level**

System-Wide Generation Assumptions

Type	Level	Units
Coal	Max	Comanche, Pawnee
Gas Backbone	50%	Manchief, Fountain Valley
Gas Metro	Variable: Used to Balance Renewable Dispatch	St. Vrain, Spindle, Cherokee, Plains End
Wind	80%	All Wind Generation Also Studied 70%, 60%, 40%
(Wind Penetration Level May Be Most Significant Assumption)		
Solar	85%	All Solar Generation
New	100%	Assume Gen in North & South Modeled @ Rush Creek & Badger

Basis for 80% Wind Penetration Level

1. **Variable Energy Resource Guidelines**
   - **Used by Transmission Planning for LGIP Studies**
   - **However, No Precedent for System-wide Level**
2. **Conservative Maximum**
   - **Could Use 60-70%**
3. **Historical Analysis**
   - **Company Data:**

Top Load Hours	2017	2016	2015	2014	2013		Average
1	42%	20%	66%	66%	33%		45%
10	45%	52%	66%	37%	38%		48%
25	54%	71%	71%	32%	48%		55%
100	76%	77%	71%	26%	78%		66%

Revised Northern Dispatch

Type	Generation Name	Nameplate MW	2017 Levels	% NP1	2018 Levels	% NP2
Wind	Peetz Logan	575	230	40%	345	60%
	Limon	600	480	80%	360	60%
	Cedar Point	250	200	80%	150	60%
	Rush Creek	600	600	100%	360	60%
Total Wind		2025	1510	75%	1215	60%
Coal	Pawnee	530	530	100%	505	95%
Gas	Manchief	280	280	100%	140	50%
Total		2835	2320	82%	1860	66%

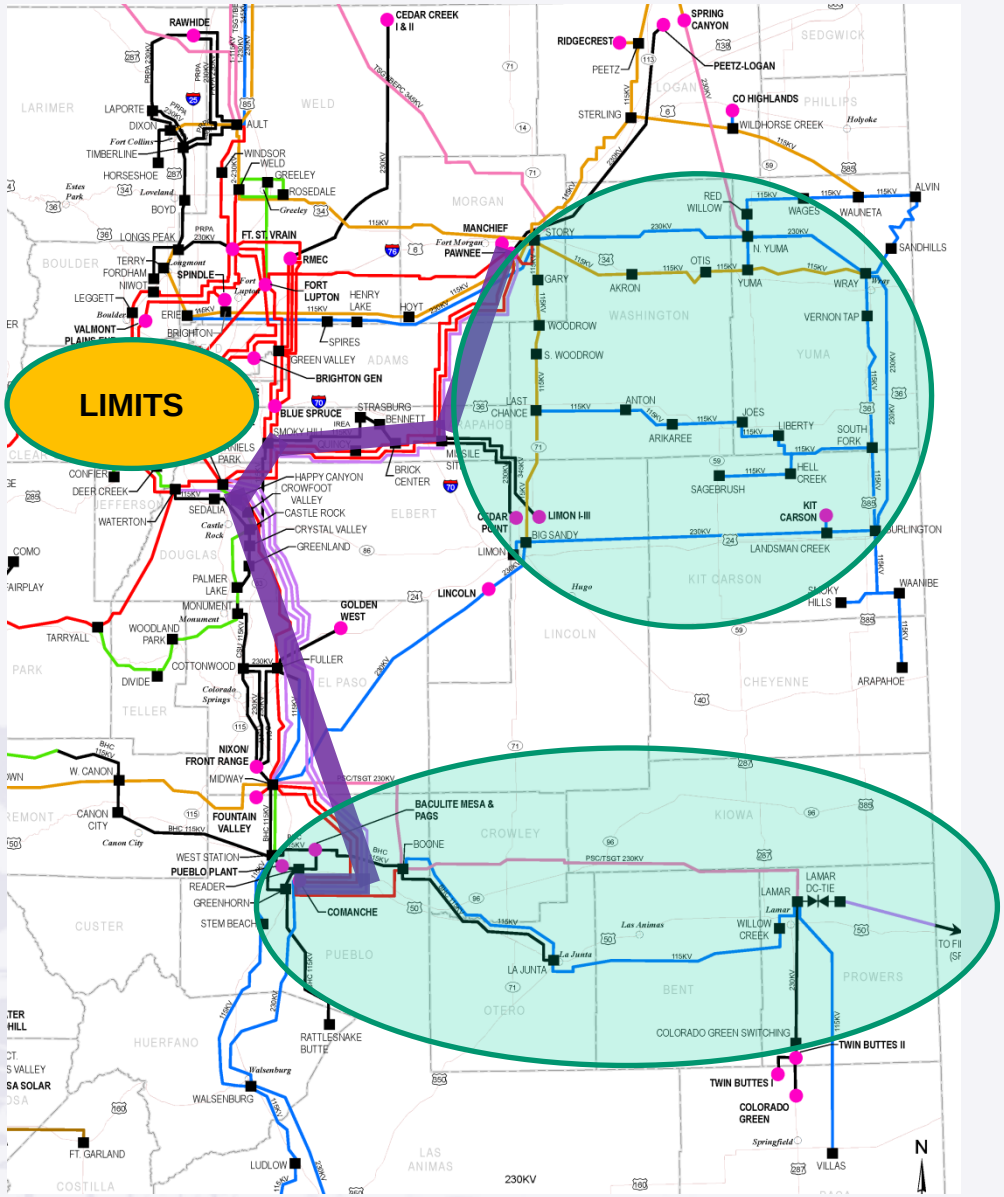
Revised Southern Dispatch

Type	Generation Name	Nameplate MW	2017	% NP1	2018 New	% NP2
DC Tie	Lamar	210	101	48%	0	0%
Wind	Colorado Green	162	130	80%	98	60%
	Twin Buttes	75	60	80%	45	60%
	Golden West	250	200	80%	150	60%
Total Wind		487	390	80%	293	60%
Solar	Comanche	120	102	85%	102	85%
Coal	Comanche 1&2	725	703	97%	703	97%
	Comanche 3	805	805	100%	805	100%
Total Coal		1530	1508	99%	1508	99%
Gas	Fountain Valley	240	0	0%	120	50%
Total		2587	2101	81%	2023	78%
North					1860	
Total N+S					3883	

Study Results (Network Upgrades)

- **Upgrades Depend on Portfolio Generation and Wind Level**
- **345 kV Backbone Allows Flexibility for New Gen**
  - **"Backbone" Gen Can Accommodate about 4300-4400 MW**
- **Level of Wind Penetration Drives Upgrades**
  - **80% System-wide Wind →Upgrades Required for Any New Gen**
  - **60% Wind, 500-600 MW Capability w/o Upgrades**
- **Limitations → Denver-metro System**

map


LIMITS
RAWHIDE
CEDAR CREEK I & II
RIDGECREST
SPRING CANYON
PEETZ
PEETZ-LOGAN
CO HIGHLANDS
WILDHORSE CREEK
STERLING
LARIMER
WELD
LOGAN
PHILLIPS
SEDGWICK
LAPORTE
DIXON
AULT
TIMBERLINE
HORSESHOE
WINDSOR
WELD
GREELEY
ROSEDALE
BOYD
LONGS PEAK
FT. ST. VRAIN
RMEC
MANCHIEF
PAWNEE
MORGAN
STORY
RED WILLOW
WAGES
WAUNETA
ALVIN
SANDHILLS
N. YUMA
OTIS
YUMA
WRAY
AKRON
GARY
WOODROW
S. WOODROW
VERNON TAP
WASHINGTON
YUMA
BOULDER
TERRY
FORDHAM
NIWOT
SPINDLE
LEGGETT
ERIE
VALMONT
BRIGHTON
FORT LUPTON
HENRY LAKE
HOYT
SPIRES
GREEN VALLEY
ADAMS
BRIGHTON GEN
BLUE SPRUCE
STRASBURG
BENNETT
IREA
LAST CHANCE
ANTON
JOES
LIBERTY
SOUTH FORK
ARIKAREE
HELL CREEK
SAGEBRUSH
KIT CARSON
LIMON I-III
BIG SANDY
CEDAR POINT
LIMON
LANDSMAN CREEK
BURLINGTON
WAANIBE
SMOKY HILLS
ARAPAHOE
CHEYENNE
KIT CARSON
LINCOLN
ELBERT
CONIFER
DEER CREEK
WATERTON
HAPPY CANYON
CROWFOOT VALLEY
CASTLE ROCK
CRYSTAL VALLEY
GREENLAND
BRICK CENTER
SEDALIA
PALMER LAKE
MONUMENT
WOODLAND PARK
TARRYALL
COTTONWOOD
DIVIDE
GOLDEN WEST
FULLER
LINCOLN
COMO
DOUGLAS
TELLER
PARK
EL PASO
NIXON
FRONT RANGE
MIDWAY
W. CANON
CANON CITY
FOUNTAIN VALLEY
WEST STATION
PUEBLO PLANT
READER
GREENHORN
STEM BEACH
COMANCHE
BACULITE MESA & PAGS
BOONE
CROWLEY
KIOWA
LAMAR
LAMAR DC-TIE
WILLOW CREEK
LA JUNTA
PUEBLO
BENT
OTERO
PROWERS
CUSTER
HUERFANO
LAS ANIMAS
COLORADO GREEN SWITCHING
TWIN BUTTES II
TWIN BUTTES I
COLORADO GREEN
RATTLESNAKE BUTTE
WALSENBURG
LUDLOW
FT. GARLAND
VILLAS
COSTILLA
230KV
N

Sample
Network Upgrades for Bid Evaluation

Incremental Gen on 345 kV Backbone (MW)	Total MW	Incremental Upgrade Cost ($Million)	Total Upgrade Cost ($Million)	Upgrade
0	0	$0	$0	Greenwood - Monaco 230 kV "Minor Upgrades"
200	200	$1	$1	Monaco - Leetsdale 230 kV OH Replacement
200	400	$25	$25	Leetsdale - Monroe 230 kV UG Replacement
100	500	$22	$59	Greenwood - Monaco - Leetsdale Upgrade
200	700	$50	$98	Monroe - Elati 230 kV UG Upgrade Smoky - Tollgate 230 kV Upgrade
100	800	$35	$133	Leetsdale - Harrison 115 kV UG Upgrade

CEPP Generation

Generation Interconnection Projects

This list consists of generation interconnection projects that must be pursued once the Company has approval of the CEP.

	Generation Interconnection Project	Voltage (kV)	Interconnection Point	MW	ISD- BF	Cost $Million	CPCN	3206	3627
	Rush 2 Wind Interconnection	345	Rush 2 (Rush Creek Gen-tie)			$12.0	Yes	No	No
1	*Bronco			300	2020				
	* Cheyenne Ridge			500	2020				
2	[redacted]	230	Comanche - Midway 230 kV line Badger Hills	200/100	2022	$12.0	Yes	Yes	Yes
3	[redacted]	345	Comanche - Daniels Park 345 kV line	250/125	2022	$12.0	Yes	No	No
4	[redacted]	230	Comanche - Midway 230 kV line (3) North of Arkansas River	75	2022	$12.0	Yes	No	No
5	[redacted]	230	Hartsel - Taryall 230 kV line	72	2022	$12.0	Yes	No	No
6	[redacted] Solar+Storage 110+50	230	Barr Lake (Existing Substation)	110/50	2022	$5.0	No	No	No
7	[redacted]	230	Keenesburg (Existing Substation)	169	2020	$5.0	No	No	No

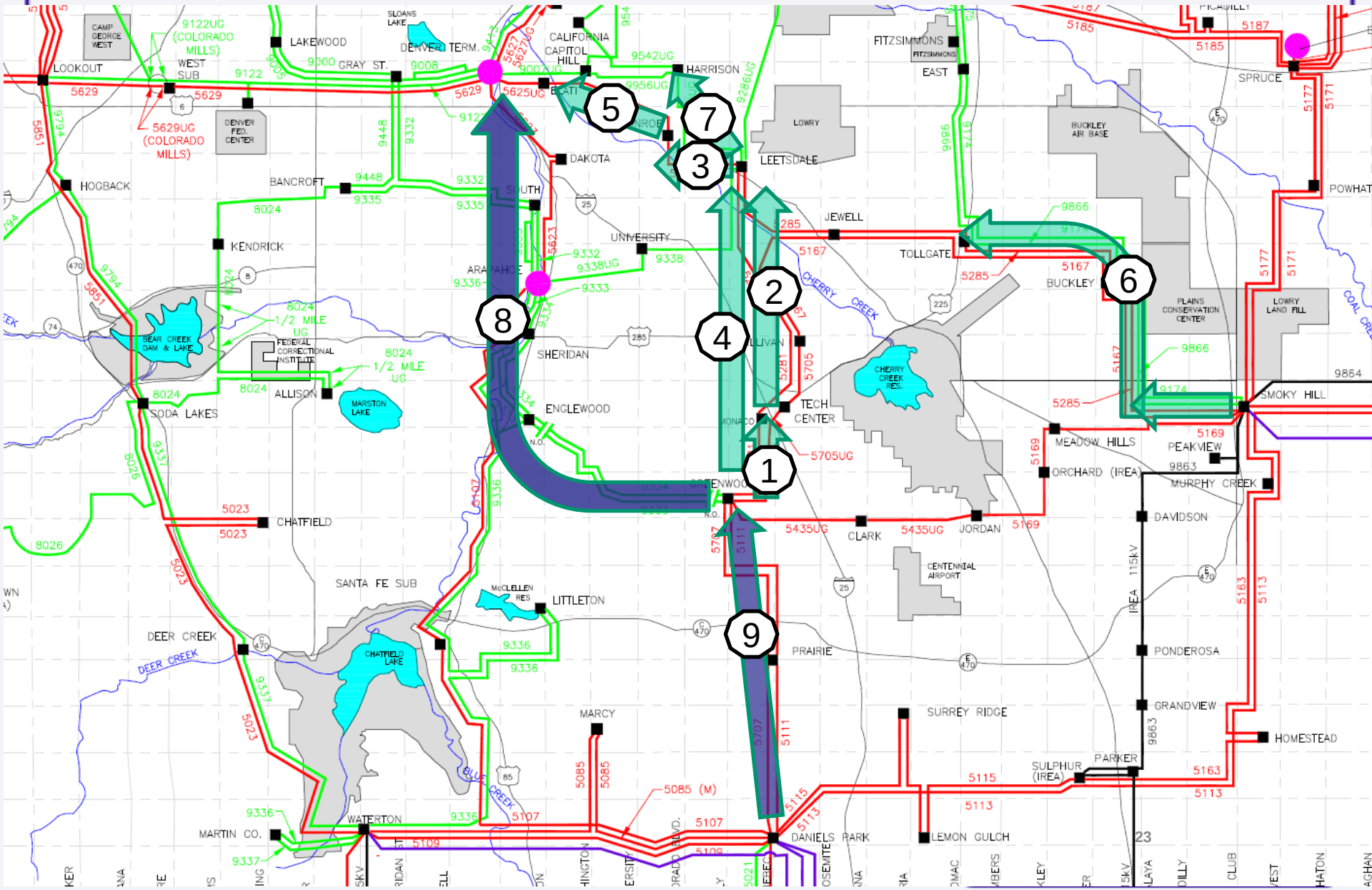
CEPP Transmission

Potential Transmission Projects

This list consists of projects that might be pursued once the Company has approval of the CEP. Additional studies are needed to determine recommendations for specific projects and the in-service dates.

	Project	Voltage (kV)	Description	ISD	Cost $Million	CPCN	3206	3627
	ALTERNATIVE 1							
1	Greenwood - Monaco 230 kV	230	Minor substation upgrade	2020	$0.0	No	No	No
2	Monaco - Leetsdale 230 kV	230	Overhead line replacement	2020	$0.6	No	Yes	No
3	Leetsdale - Monroe 230 kV	230	Underground line replacement	TBD	$25.0	Yes	Yes	No
4	Greenwood - Monaco 230 kV	230	UG/OH line replacement	TBD	$22.0	Yes	Yes	No
5	Monroe - Elati 230 kV	230	UG line replacement	TBD	$45.6	Yes	Yes	No
6	Smoky Hill - Tolgate 230 kV	230	OH line replacement	TBD	$3.6	Yes	Yes	No
7	Leetsdale - Harrison 115 kV	115	Underground line replacement	TBD	$34.6	Yes	Yes	No
	ALTERNATIVE 2							
8	Greenwood - Arapahoe - Denver Terminal 230 kV	230	New Transmission Line	TBD	$41.5	Yes	No	No
9	Daniels Park - Prairie	230	Upgrade Line Rating	TBD	$20	No	No	No

Network Upgrade Map



Portfolio Studies

Zinn Photography/Courtesy of SunEdison

Portfolio Study Scope

- **Gen-tie Reliability**
- **Transmission Plan**
  - **(Network Upgrades)**
- **CPCNs**

Rush Creek Gen-tie Issues

Long Gen-tie Presents Issues

- Planning Concerns:
  - High Gen → High VAR Consumption→ Potential Voltage Issues
  - Wind Power Factor Requirements May Be Insufficient
  - Loss of Gen-tie
- Operations Concerns:
  - VAR Flow
  - Ability to Control Network Voltages
  - Resource Balance & Reserves
  - Most Severe Single Contingency
- Third Party Consultant to Evaluate Mitigation

Rush Creek Gen-tie Preliminary Results

- **Loss of Gen-tie**
  - High & Low Load Conditions Studied
  - Loading Up to 1600 MW on Gen-tie
  - Studies Show No Transient Stability Issues
  - Ultra High Penetration (UHP) Studies
- **Reactive Power Study:**
  - Approx. 300-400 MVARs Needed
  - Locate @ Missile Site, Pronghorn, Harvest Mile
  - Shunt Caps or STATCOM
- **Comprehensive Studies**
  - Consultant to Determine Mitigation

Network Upgrade Studies

Network Upgrade Studies

- Objective:
  - Develop Plan for Denver-metro System
- Methodology
  - Use System-wide Dispatch:
    - Remove Comanche 1 & 2
    - Model CEPP Generation at 100% Nameplate
    - Model Existing / Planned Wind at 80% Nameplate
    - Model Existing / Planned Solar at 85% Nameplate
    - Balance by Reducing Gas Fleet
- Preliminary Results:
  - Similar to Bid Evaluation

EVRAZ
Flicker Mitigation

Xcel Energy® 30

Zinn Photography/Courtesy of SunEdison

EVRAZ Power Quality Issue

- **Arc Furnace Operation Impacts Local System**
  - **Voltage Fluctuation**
  - **Comanche Retirement →Lower Short Circuit Ratio (SCR)**
  - **Lower SCR and Inertia →Higher Flicker Problem**
- **Mitigation Options:**
  1. **Synchronous Condenser**
  2. **Static VAR Compensation (SVC)**
  3. **STATCOM**
- **Study**
  - **GE Performed Study**
  - **Evaluated Synchronous Condenser, SVC, STATCOM**
- **Recommendation**
  - **STATCOM – Best Performance, Best Value**
  - **Cost: $15-$20 Million**

Next Steps

- **Determine Gen-tie Reliability Facilities**
- **Determine Transmission Plan for Network Upgrades**
- **CPCN Applications**
- **Coordinate with CCPG, CEPTF, DEEP**

CPCN Activity

- **Generation**
  - Needed for Company-owned Projects
  - First Up: Cheyenne Ridge (File 2018)
- **Interconnection Stations**
  - For All New Generation Interconnections
- **Network Upgrades**
  - Transmission Needed to Accommodate Portfolio

Resources

- **Links:**
  - **CCPG**
    - http://regplanning.westconnect.com/ccpg.htm
  - **CEPTF**
    - http://regplanning.westconnect.com/ccpg_ceptf.htm
  - **ERP / CEP Information**
    - https://www.xcelenergy.com/company/rates_and_regulations/resource_plans
- **Email:**
  - **Tom Green:**
    - thomas.green@xcelenergy.com

Xcel Energy®

RESPONSIBLE BY NATURE™

QUESTIONS