PUBLIC SERVICE COMPANY OF COLORADO

Economic Impacts of Wind Energy Investments in Colorado

A consulting research study conducted for Xcel Energy by the:

Business Research Division
Leeds School of Business
University of Colorado Boulder

Final Report

May 23, 2016

Colorado PUC E-Filings System

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DEFINITIONS

Employment: Includes the number of full-time and part-time jobs (headcount) by business physical location.

Deflators: Measure of price changes within an industry.

Gross Domestic Product: Total value of final goods and services produced each year within a country or region.

Leakage: Economic activity that occurs outside the area of study but is driven by activity within the study area.

Metropolitan Statistical Area: Geographic areas with 50,000 or more population.[1]

Multiplier: Change in total economic activity driven by a change in direct economic activity.

Output: Total production value of goods and services, including intermediate goods purchased and value added.

Personal Income: Includes all sources of income, including employee compensation, proprietors' income, rental income, capital income, and transfer payments.

[1]For more information, visit: http://www.whitehouse.gov/sites/default/files/omb/assets/fedreg_2010/06282010_metro_standards-Complete.pdf, retrieved July 13, 2014.

EXECUTIVE SUMMARY

This document presents the results of an analysis prepared by the Leeds School of Business to quantify the economic impacts on the state of Colorado of a proposed wind project by Public Service Company of Colorado (PSCo). The proposal includes reducing future generation of electricity using gas-fired and coal-fired resources and deferring future gas generation, replaced with 600 megawatts of wind energy generation. The purpose of an economic impact study is to identify the impacts on employment, gross domestic product, disposable personal income, and other economic metrics for those locations impacted by a change in operating expenditures, capital expenditures, and electricity rates.

The study area was the state of Colorado. Impacts on the four counties with planned wind installations were not included in the scope of economic analysis, nor were impacts on any other sub-state regions. The study period included the 25 years from 2016 through 2040. This period was selected to capture the near-term economic activity increased capital investments, as well as the long-term effects of a change in operating expenses and electricity rates.

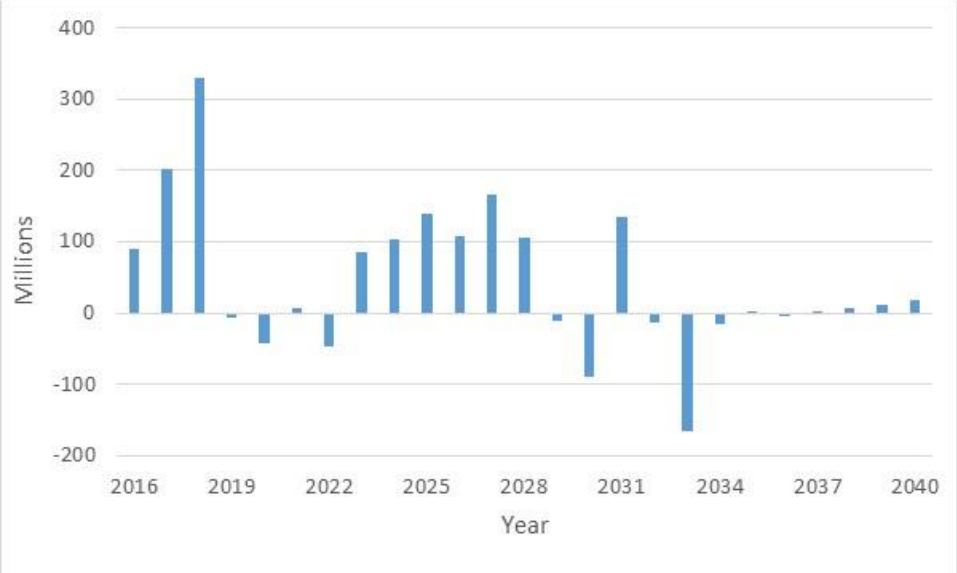
The study examined the Rush Creek Wind Project compared to the baseline scenario. The baseline scenario included generating electricity using coal-fired and gas-fired resources and the addition of new gas-fired generation. The alternative wind scenario included 600 MW of capacity, produced by 300 wind turbines manufactured locally (in Colorado) by Vestas. In addition to purchasing and erecting the wind turbines, the project will include the creation of access roads, pouring of foundations, installation of transmission lines, and construction of substations. The wind installation project is planned in the rural Eastern Colorado counties of Elbert, Lincoln, Cheyenne, and Kit Carson.

The research team used the REMI model for the analysis. The model used by Leeds was provided by REMI specifically for the state of Colorado using national and Colorado economic and demographic data. The REMI model used for this analysis is a single region, PI+ model 1.7.2 for the state of Colorado. The 1.7.2 model includes historical data through 2013. PSCo provided data that included capital expenditures, operating expenditures, revenue requirements, and taxes for each scenario. The research team worked under the assumption that the company provided good-faith estimates for each scenario.

To frame the analysis of this report, an increase in capital expenditures in Colorado increases economic activity in Colorado while a decrease in operating expenditures reduces economic activity in Colorado. Finally, a decrease in revenue requirements is a reduction in costs for utility customers, thus resulting in additional spending in other industries. These three data points are analyzed collectively to consider if the project provides a net economic benefit to Colorado. The study findings show that the increased wind project will have a greater economic impact on the Colorado economy compared to the base case resource plan. The Rush Creek Wind Project results in capital expenditures of $909.4 million above the baseline scenario from 2016-2040; 78% directly impacts the Colorado economy through local purchases. Related operating expenditures decrease by $2 billion compared to the baseline scenario from 2016-2040; 55% directly impacts Colorado, largely due to abundant indigenous fuels. Revenue requirements decrease by $846 million, spread across Colorado's residential, commercial, and industrial customers.

The Rush Creek Wind Project will result in net economic benefits in Colorado due to the net effects of an increase in capital expenditures and lower revenue requirements more than offsetting a reduction in operating expenditures. Over 25 years, the wind project resulted in 7,136 more job years compared to the baseline resource plan scenario, or 285 jobs per year on average. Real GDP increases by an average of $44.6 million during the study period, and an increase of $16.6 million in disposable personal income. The pattern for the impact on employment and on GDP are similar; the spikes and dips in economic activity are largely due to timing—specifically the change in activity (capital, operating, and revenue requirements) compared to the baseline scenario.

FIGURE 1: RUSH CREEK WIND PROJECT IMPACT ON COLORADO GDP



The following is a net analysis, examining the benefits as well as the costs. The following table reports the impacts in fixed (2015) dollars.

TABLE 1: ECONOMIC CONTRIBUTION OF RUSH CREEK WIND PROJECT ON COLORADO, 2016–2040

Category	Units	Average					
		Year 1-5	Year 6-10	Year 11-15	Year 16-20	Year 21-25	2016-2040
Total Employment	Jobs	1,012	466	338	-258	-132	285
	Percentage Change	0.03%	0.01%	0.01%	-0.01%	0.00%	0.01%
Private Non-Farm Employment	Jobs	964	384	219	-318	-170	216
	Percentage Change	0.03%	0.01%	0.01%	-0.01%	0.00%	0.01%
Gross Domestic Product	Dollars (Real 2015, Thousands)	114,246	57,815	55,837	-11,489	6,440	44,570
	Percentage Change	0.03%	0.01%	0.01%	0.00%	0.00%	0.01%
Disposable Personal Income	Dollars (Real 2015, Thousands)	63,997	28,034	32,659	-20,344	-21,193	16,631
	Percentage Change	0.02%	0.01%	0.01%	-0.01%	-0.01%	0.00%

STUDY METHODOLOGY

The Business Research Division at the University of Colorado Boulder was hired by Public Service Company of Colorado (PSCo) to conduct economic impact analyses on a wind installation project in the rural Eastern Colorado counties of Elbert, Lincoln, Cheyenne, and Kit Carson.[2] The project includes 600 megawatts (MW) of capacity, produced by 300 wind turbines manufactured locally (in Colorado) by Vestas. In addition to purchasing and erecting the wind turbines, the project will include the creation of access roads, pouring of foundations, installation of transmission lines, and construction of substations.

Analysis of the wind project compares project expenditures to a baseline scenario that includes coal-fired and gas-fired generation. This project adds capacity to the PSCo system, and replaces the future usage of coal and natural gas fuels and defers natural gas plant expansions. This is a statewide analysis of the net economic impacts of the wind scenario versus the resource plan baseline. Sub-state impacts will vary, with benefits generally accruing to the four counties of resource installations, transmissions, and turbine manufacturing, in addition to lower revenue requirements to residential, commercial, industrial, and governmental customers. Economic costs may accrue to producers of the foregone natural resources (i.e., natural gas and coal). There is little overlap between the counties that will directly benefit and that may be adversely impacted by the resource plan.

Economic impact studies detail the direct spending that a company or activity has on the area of study, as well as the indirect impact, which is the ripple effect that direct spending has on other businesses in the community. This term is also referred to as the *multiplier effect*, wherein companies utilize the local supply chain. A multiplier is a numeric way of describing the full effects of money changing hands within an economy. For instance, when PSCo purchases natural gas, this affects the mining and transportation industries. This is the indirect impact. Additionally, spending by employees has an inherent effect on local communities as they purchase groceries, clothes, and gas; pay rent or a mortgage; get haircuts, etc. This is understood as the induced impact.

The research team used the REMI model version 1.7.2, build 3877 for the analysis.[3] Appendix 1 provides an overview of the REMI model. The REMI model is a dynamic forecasting and policy analysis model that incorporates econometric, input-output, and computable general equilibrium techniques. The model

[2] Elbert County is included in the Denver Metropolitan Statistical Area.
[3] Contracted by the University of Colorado from REMI, Inc. in April 2016.

was created by REMI specifically for the state of Colorado using national and Colorado economic and demographic data. The REMI model used for this analysis is the PI+ model 1.7.2 for the state of Colorado, with 2013 data as the last historical year within the model.

PSCo defined the scenario to be examined in this study. This is described in detail in the Scenario Data and Assumptions section. A baseline scenario was provided by PSCo from their 2011 Electric Resource Plan showing the addition of gas fired generation. The research team developed economic scenarios that included spending and rate changes brought about by two different scenarios (baseline and wind). The result is a simulated forecast of the economy under scenarios where utility rates and spending on operating and capital expenditures change. Last, the report compares the simulations to the baseline scenario to quantify the economic impacts on the Colorado economy, statewide.

The research team collected data on PSCo estimates related to ongoing operating and maintenance expenditures, capital expenditures, and revenue requirements. PSCo provided estimates of the percentage of expenditures directly in Colorado compared to activity that occurs in other states (i.e., leakage). The combined impacts exclude potential economic benefits or costs associated with State enterprise zone tax incentives, which may be awarded to both gas-fired and wind projects depending on asset ownership. The timing of operating and capital expenditures is specific to each scenario (baseline and wind). The research team worked under the assumption that the company provided good-faith estimates for each scenario.

Data were provided in nominal dollars, quantified in the year of expected impact. The impacts are presented in fixed, 2015 dollars, and discounted by the model using industry price deflators.

Costs were entered into the REMI model based on total activity expenditures. The direct spending was entered as industry sales/exogenous production. The researchers deferred to the model for the industry intermediate inputs, local purchasing coefficients for intermediate inputs, and for the proportion of spending devoted to capital and labor. The local purchasing coefficients within REMI change over time based on changing demand.

ECONOMIC MODEL AND THE COLORADO ECONOMY

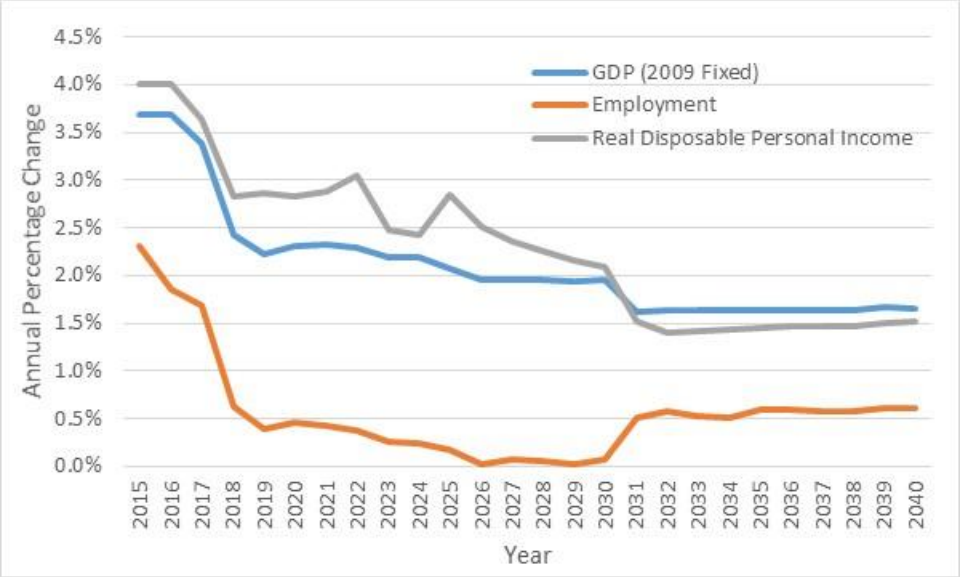
The REMI model used for this analysis is the single region, PI+ model 1.7.2 for the state of Colorado. The model used for this study excludes the government spending response to changes in GDP. The REMI model includes an input-output table, industry spending patterns, and local purchasing coefficients, in addition to the underlying economic and demographic data for the study region.

Data from the Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW) show the state recorded 2.4 million total nonfarm covered employees in 2014; the combined region for the wind installment (Cheyenne, Elbert, Kit Carson, and Lincoln counties) represented 0.4%, or 9,179 of the total.[4] Employment in the area peaked in June 2007 at 9,992 jobs (not seasonally adjusted); employment in 2014 was more than 8% below peak. Data from the Bureau of Economic Analysis shows Colorado GDP of $306 billion in 2014 (current dollars). Real GDP in the state grew at a rate of 5% year-over-year. Per capita personal income for the state in 2014 was $48,869. Per capita personal income was $50,823 in Cheyenne County, $47,361 in Elbert County, $36,626 in Kit Carson County, and $33,434 in Lincoln County. These four counties had that 14th highest, 18th highest, 19th lowest, and 11th lowest per capita personal incomes in the state.

The REMI standard regional control places Colorado on a growth trajectory throughout the analysis horizon, with faster rates of growth in the short term and slowing growth over the entire study period (Figure 3).

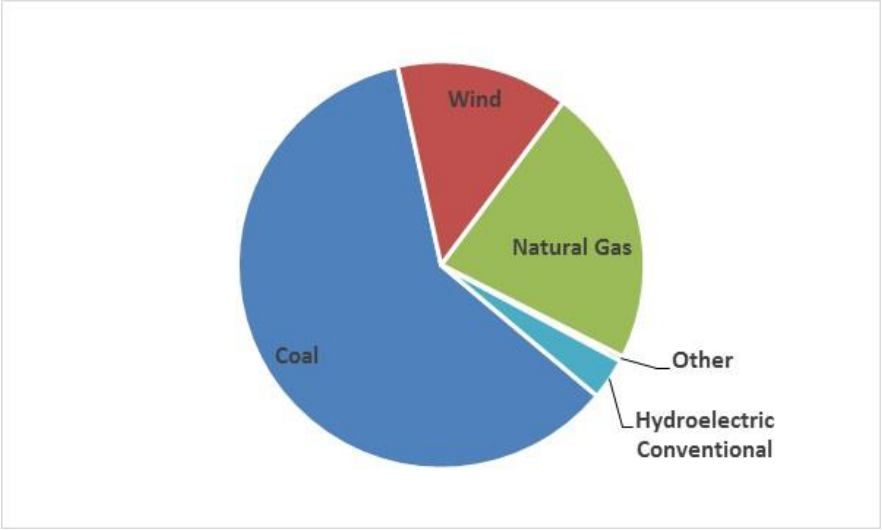
[4] At time of publication, 2014 data was the most current full-year Quarterly Census of Employment and Wages data published by the Bureau of Labor Statistics and the Colorado Department of Labor and Employment.

FIGURE 2: EMPLOYMENT FORECAST, 2015–2040



As a side point, Colorado ranked 7th in the nation in total energy production and 35th for total energy consumption per capita in 2013, according to data from the Energy Information Administration.[5] Colorado ranked 28th in 2013 and 30th in 2014 for total electric power generation.[6] As shown in Figure 4, approximately 60% of energy generated in the state came from coal-fired power plants, and an additional 22% was produced by natural gas plants. Colorado ranked 9th in wind-generated electricity in 2013 and 2014.

FIGURE 3: COLORADO ELECTRICITY GENERATION, SHARE OF MWH GENERATION, 2014



[5] Total Energy Production, 2013 (trillion Btu) and Total Energy Consumer per Capita, 2013 (million Btu).
[6] Net Generation by State by Type of Producer by Energy Source, Megawatt-hours.

SCENARIOS DATA AND ASSUMPTIONS

This study analyzes the impact of investments in a 600 MW wind farm compared to a baseline scenario. The Rush Creek Wind Project will be installed in rural Colorado on the Eastern plains in four Colorado counties—Elbert, Lincoln, Cheyenne, and Kit Carson. Additional impacts will stem from the installation of transmission lines and the construction of system substations, as well as the local (Colorado) purchasing of wind turbines from Vestas. According to PSCo, the project will include the installation of 300 Vestas wind turbines that will collectively generate 600 MW. This report reflects analysis of the statewide impacts, and does not study the sub-state impacts that will vary based on local resources purchases.

PSCo provided the research team with capital expenditures, operating expenditures, and revenue requirements for each scenario. The timing of operating and capital expenditures is specific to each scenario. The research team worked under the assumption that the company provided good-faith estimates for each scenario. For modeling purposes, cost assumptions were provided in nominal dollars.

Nominal costs were entered into the REMI model based on total activity expenditures for Colorado. The researchers deferred to the model for the local purchasing coefficients for intermediate inputs, and for the proportion of direct spending attributable to labor and capital. The local purchasing coefficients within REMI change over time based on changing demand.

Capital and Operating Expenditures

Capital

The Rush Creek Wind Project incurs capital expenditures of $909.4 million above the baseline scenario from 2016-2040. The capital activities include the purchase of wind turbines, balance of plant, extension of transmission lines, and other utility and related construction. Compared to the baseline scenario, most of the increase in spending occurs within the first three years during project installation. Increased investments in transmission account for 13% of the change in capital expenditures compared to the baseline scenario.

Operating Expenditures

The higher capital costs are overcome by lower long-term operating costs. While the change in capital spending is front-loaded in the first three years, the change in operating expenditures begin to be realized post installation, and are spread across the 25-year analysis period. The change in operating

costs include fixed and variable operating and maintenance expenditures for wind installations, transmission, and plant; as well as land leases, insurance, and taxes. Additionally, the change in operating expenditures includes reduced fuel expenditures on coal and natural gas. The change in operating expenditures as a result of the wind project is a decrease of $2 billion, of which nearly $1.1 billion directly impacts Colorado through local spending.

TABLE 2: CAPITAL AND OPERATING EXPENDITURES (NOMINAL DOLLARS), 2016–2040

Wind Investment	Total ($ Millions)	Colorado ($ Millions)	Percentage Change	Percentage Colorado
Capital Expenditures	909.4	705.0	15.0%	78%
Operating Expenditures	-2,001.7	-1,092.4	-5.6%	55%
Total	-1,092.3	-387.3	-2.6%	35%

Revenue Requirements

Based on the level of operation and capital expenditures detailed in this report, PSCo estimated a decrease in revenue requirements included in electricity rates for electric customers for the wind project compared to the baseline scenario. This effectively isolates the revenue requirements and the electricity rate impact for the alternative scenario and holds economic growth and electricity demand constant.[7] Revenue requirements are not equal to the sum of operation and capital expenditures because capital expenditures are recovered over the life of the asset. Therefore, revenue requirements occur over the life of the asset and include both a return of and return on capital. The revenue requirements estimate the change in electric revenues that would be recovered from customers for the wind scenario, despite the location of the supply chain for operating and capital purchases. Changes in revenue requirements, estimated at $846 million, were applied to residential, commercial, and industrial customers in Colorado based on revenues. More than one-third of revenue was attributed to the residential sector.

TABLE 3: CHANGE IN REVENUE REQUIREMENTS FOR COLORADO CUSTOMERS (NOMINAL), 2016–2040

Wind Investment	Change ($ Millions)	Percentage Change
Revenue Requirements	-845.9	-0.7%

[7]Electricity costs were entered as fuel cost variables: “Electricity (Commercial Sectors) Fuel Cost (amount)” for nonresidential sectors, and “Consumer Price (amount) for the residential sector.”

TABLE 4: ELECTRIC REVENUES, 2015

Customers	$ Thousands	Percentage
Residential	$1,060,626	34%
Large C&I	$433,061	14%
Small C&I	$1,220,064	39%
Public Authorities	$52,783	2%
Wholesale	$180,716	6%
Other	$168,007	5%
Total	$3,115,257	100%

Source: PSCo Form 10-K.

RESULTS

The Rush Creek Wind Project will result in net economic benefits in Colorado. The net economic benefits is the result of the increase in capital expenditures and the increase in lower revenue requirements exceeding the reduction in operating expenditures. Over 25 years, the wind project resulted in 7,136 more job years compared to the baseline resource plan scenario, or 285 jobs per year on average. Real GDP increases by an average of $44.6 million during the study period, and an increase of $16.6 million in disposable personal income.

The following is a net analysis, examining the benefits as well as the costs. The growing demand for energy and plant energy output is controlled by comparing the economic impacts of the wind scenarios to the baseline scenario. This section reports the impacts in fixed (2015) dollars and the following paragraphs summarize the economic impacts by scenario.

TABLE 5: ECONOMIC CONTRIBUTION OF RUSH CREEK WIND PROJECT ON COLORADO, 2016–2040

Category	Units	Average					
		Year 1-5	Year 6-10	Year 11-15	Year 16-20	Year 21-25	2016-2040
Total Employment	Jobs	1,012	466	338	-258	-132	285
	Percentage Change	0.03%	0.01%	0.01%	-0.01%	0.00%	0.01%
Private Non-Farm Employment	Jobs	964	384	219	-318	-170	216
	Percentage Change	0.03%	0.01%	0.01%	-0.01%	0.00%	0.01%
Gross Domestic Product	Dollars (Real 2015, Thousands)	114,246	57,815	55,837	-11,489	6,440	44,570
	Percentage Change	0.03%	0.01%	0.01%	0.00%	0.00%	0.01%
Disposable Personal Income	Dollars (Real 2015, Thousands)	63,997	28,034	32,659	-20,344	-21,193	16,631
	Percentage Change	0.02%	0.01%	0.01%	-0.01%	-0.01%	0.00%

FIGURE 4: RUSH CREEK WIND PROJECT IMPACT ON COLORADO EMPLOYMENT

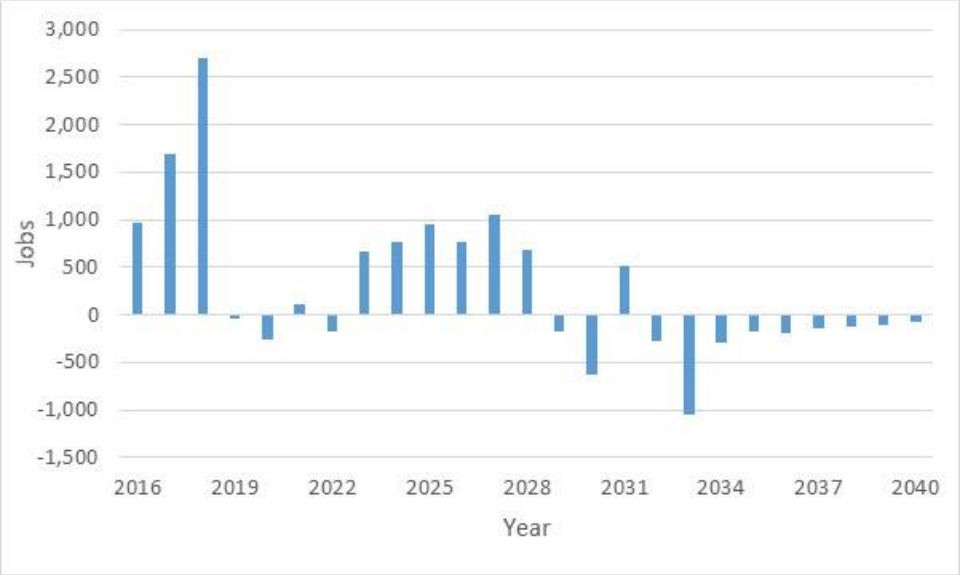


FIGURE 5: RUSH CREEK WIND PROJECT IMPACT ON COLORADO EMPLOYMENT, BY SOURCE

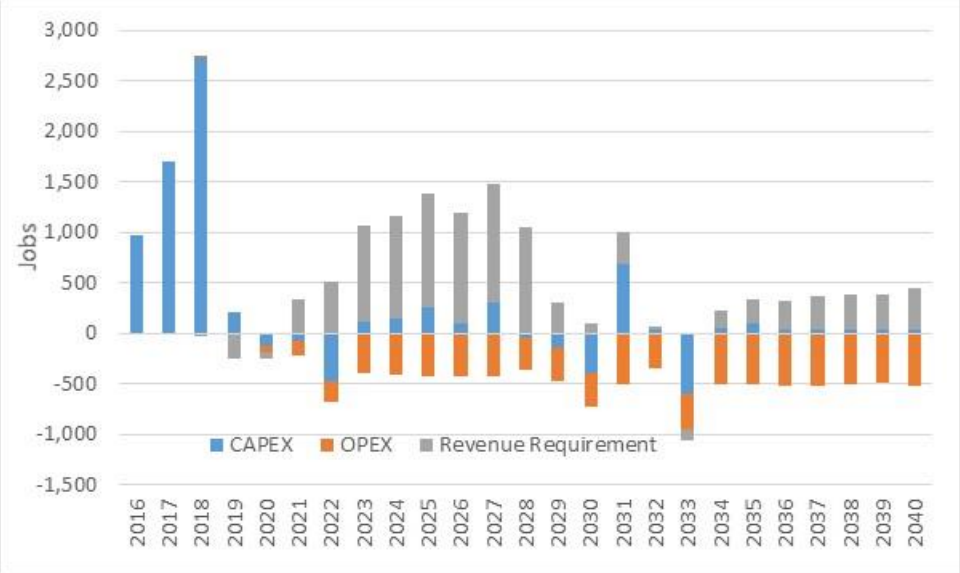


FIGURE 6: RUSH CREEK WIND PROJECT IMPACT ON COLORADO GDP

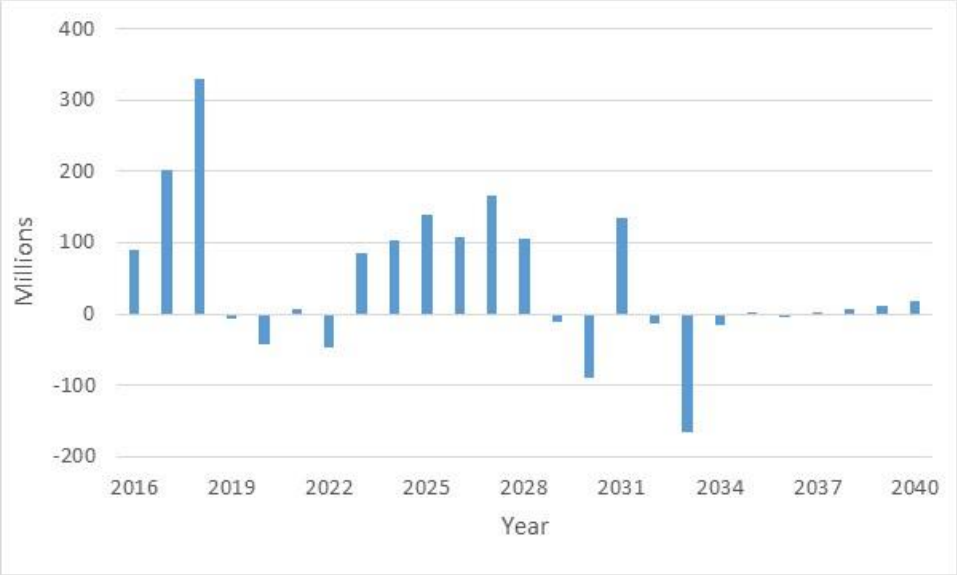
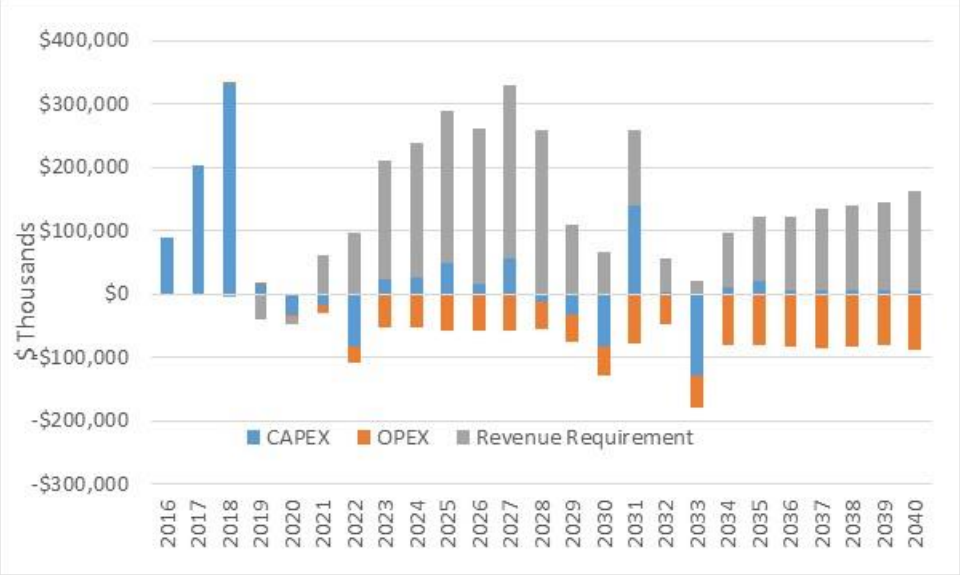


FIGURE 7: RUSH CREEK WIND PROJECT IMPACT ON COLORADO GDP, BY SOURCE



The greatest increase in economic benefits occur early in the project—the first three years. This is the period of intensive capital investment—capital spending exceeds the baseline scenario spending in excess of $1.03 billion during this period. Nearly 70% of this 3-year capital investment is expected to directly impact the Colorado economy through the local sourcing of wind turbines, and the local portion of plant, transmission, and other capital activities. Of the remaining 22 years within the analysis period, 13 years have increased planned investments compared to the baseline scenario, and 9 years have

decreased planned investments. Decreases in the investments are attributed to the foregone investments in natural gas combustion or combined cycle turbines.

Operating and maintenance costs were lower under the wind scenario than under the baseline scenario for the entire forecast horizon when including fuel costs (i.e., natural gas and coal and related transportation). Colorado had abundant indigenous fossil fuel resources, and while PSCo does not source all of these fuels from within Colorado, a majority of PSCo's purchases are native to the state. However, when excluding fuel costs, operating and maintenance costs increased each year of the forecast horizon. Overall, 55% of the change in operating and maintenance expenditures compared to the baseline scenario were estimated to directly impact the Colorado economy through local resource fulfillment and construction. Compared to the front-loaded capital expenditure impacts, the impacts from the change in operating and maintenance expenditures are delayed by two years while facilities are being constructed, and the change in operating expenditures grows larger over time.

Change in expenditures are effectively passed along to rate payers either through increases or decreases in revenue requirements. Revenue requirements increased for 8 of the 25 years analyzed; and decreased for 17 of the 25 years. The sum of the decrease in revenue requirements totals $845.9 million. These savings were assigned to residential, commercial, and industrial customers.

Electric generation investments in Colorado may be eligible for either the enterprise zone investment tax credit or the renewable energy enterprise zone investment tax credits. According to the Colorado Department of Revenue publication on the Investment Tax Credit, 3% of investments may qualify for tax credits if the plant is in a Colorado enterprise zone. According to PSCo, tax credits are available if the company has not reached the maximum amount of credits per company. Enterprise zone and renewable energy enterprise zone tax credits are each limited to a maximum of $750,000 per year per company. The renewable energy enterprise zone investment tax credit is refundable whereas the enterprise zone investment tax credit is not. Both can be carried forward. The economic impact study did not account for these credits because the combination of enterprise zone and renewable energy enterprise zone investment tax credits in the Rush Creek scenario could be more or less than those in the base case resource plan. Several natural gas units are planned to be added through 2040 under both the base case and Rush Creek scenarios. The Rush Creek project should be eligible for renewable energy enterprise zone investment tax credits of $750,000 per year over the study period beginning in 2018 or

$17,250,000 over the study period from 2016-2025.[8] If the full $750,000 annual tax credit is applied, then the impact of decreased government spending on the Colorado economy is a reduction of 17 jobs and $1.5 million in GDP on average over the 23-year horizon (from 2018-2040). However, outside of the wind project itself, PSCo does not currently know who would develop the natural gas units in the base line or Rush Creek scenarios or where the units will be located. As such, the renewable energy enterprise zone investment tax credits for the Rush Creek project may or may not result in a reduction in public revenue compared to the baseline scenario.

TABLE 6: ECONOMIC COST OF DECREASED GOVERNMENT SPENDING, 2018–2040

Category	Units	Average					
		Year 3-5	Year 6-10	Year 11-15	Year 16-20	Year 21-25	2018-2040
Total Employment	Jobs	-21	-20	-17	-15	-14	-17
Private Non-Farm Employment	Jobs	-11	-10	-8	-7	-6	-8
Gross Domestic Product	Dollars (Real 2015, Thousands)	-1,710	-1,698	-1,514	-1,404	-1,322	-1,514
Disposable Personal Income	Dollars (Real 2015, Thousands)	-1,156	-1,362	-1,364	-1,318	-1,260	-1,304

Note: The tax incentive would not take effect until 2018 under the proposed plan.

[8] The tax credit would not take effect until 2018.

CONCLUSION

This paper provides an analysis of the economic impact of the Rush Creek Wind Project in comparison to PSCo's baseline resource plan. This report finds the costs associated with an increase in capital investments for wind installations are more than offset by the benefits of lower operating costs and lower revenue requirements.

This analysis uses data on operations, maintenance, capital expenditures, and revenue requirements provided by PSCo on the current base case resource plan; and on the alternative resource plan, the Rush Creek Wind Project.

Overall, the study found the following:

- Compared to the baseline scenario, the Rush Creek Wind Project will result in comparatively greater growth within the Colorado economy from 2016-2040 in terms of:
    - Employment (285 jobs on average)
    - GDP ($45 million on average), and
    - Real disposable personal income ($17 million).
    - These changes represent a relatively small percentage of the overall Colorado economy.
- The Rush Creek Wind Project will result in lower revenue requirements of $845.9 million as a result of lower operating expenditures—notably, fuel costs.
- The Rush Creek Wind Project will require additional investments in transmission totaling about 13% of total capital expenditures compared to the baseline scenario.
- The impact of changes in capital and operating costs are not isolated to Colorado due to leakage as some goods and services are sourced from places outside of the state; however, revenue requirements are applied only to Colorado customers (residential, commercial, and industrial).
- The abundant indigenous fossil resources in Colorado increases the potential economic losses to some industries.

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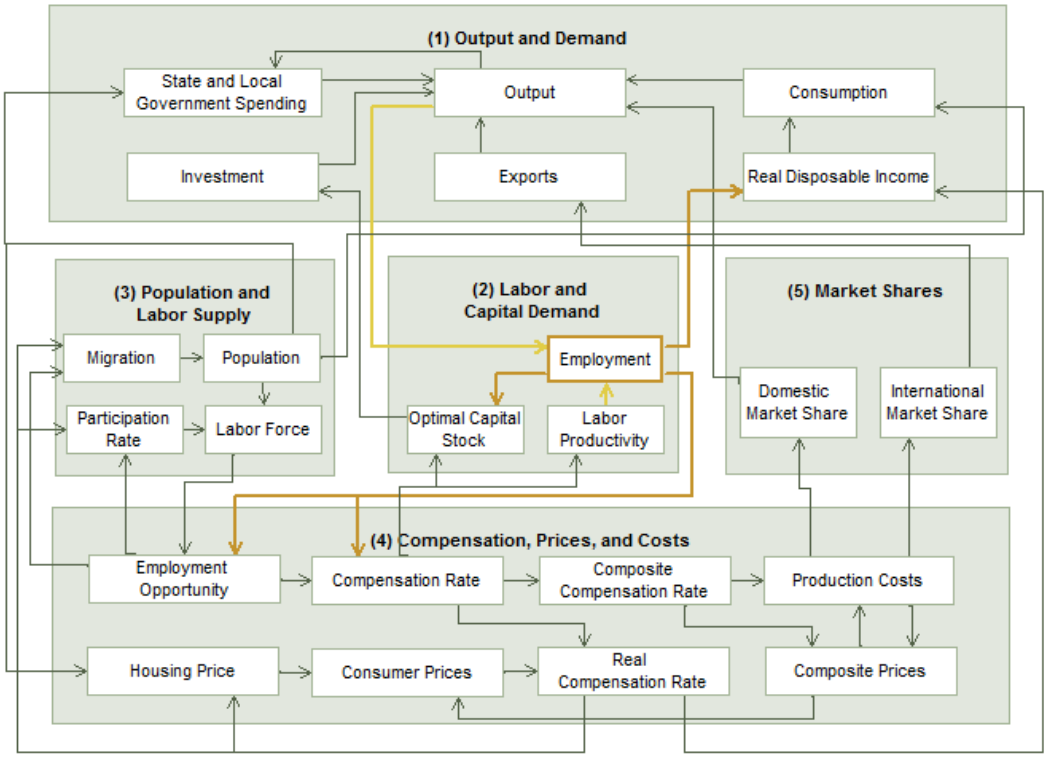
APPENDIX 1: OVERVIEW OF REMI POLICY INSIGHT

This summary was provided by REMI, Inc.

Policy Insight is a structural economic forecasting and policy analysis model. It integrates input-output, computable general equilibrium, econometric, and economic geography methodologies. The model is dynamic, with forecasts and simulations generated on an annual basis and behavioral responses to wage, price, and other economic factors.

The REMI model consists of thousands of simultaneous equations with a structure that is relatively straightforward. The exact number of equations used varies depending on the extent of industry, demographic, demand, and other detail in the model. The overall structure of the model can be summarized in five major blocks: (1) Output and Demand, (2) Labor and Capital Demand, (3) Population and Labor Supply, (4) Wages, Prices and Costs, and (5) Market Shares.



Block 1. Output and Demand

This block includes output, demand, consumption, investment, government spending, import, product access, and export concepts. For each industry, demand is determined by the amount of output, consumption, investment and capital demand on that industry. Consumption depends on real disposable income per capita, relative prices, differential income elasticities and population. Input productivity depends on access to inputs because the larger the choice set of inputs, the more likely that

the input with the specific characteristics required for the job will be formed. In the capital stock adjustment process, investment occurs to fill the difference between optimal and actual capital stock for residential, non-residential, and equipment investment. Government spending changes are determined by changes in the population.

Block 2. Labor and Capital Demand

The Labor and Capital Demand block includes the determination of labor productivity, labor intensity and the optimal capital stocks. Industry-specific labor productivity depends on the availability of workers with differentiated skills for the occupations used in each industry. The occupational labor supply and commuting costs determine firms' access to a specialized labor force.

Labor intensity is determined by the cost of labor relative to the other factor inputs, capital and fuel. Demand for capital is driven by the optimal capital stock equation for both non-residential capital and equipment. Optimal capital stock for each industry depends on the relative cost of labor and capital, and the employment weighted by capital use for each industry. Employment in private industries is determined by the value added and employment per unit of value added in each industry.

Block 3. Population and Labor Supply

The Population and Labor Supply block includes detailed demographic information about the region. Population data is given for age and gender, with birth and survival rates for each group. The size and labor force participation rate of each group determines the labor supply. These participation rates respond to changes in employment relative to the potential labor force and to changes in the real after tax compensation rate. Migration includes retirement, military, international and economic migration. Economic migration is determined by the relative real after tax compensation rate, relative employment opportunity and consumer access to variety.

Block 4. Wages, Prices, and Costs

This block includes delivered prices, production costs, equipment cost, the consumption deflator, consumer prices, the price of housing, and the wage equation. Economic geography concepts account for the productivity and price effects of access to specialized labor, goods and services.

These prices measure the price of the industry output, taking into account the access to production locations. This access is important due to the specialization of production that takes place within each industry, and because transportation and transaction costs of distance are significant. Composite prices for each industry are then calculated based on the production costs of supplying regions, the effective

distance to these regions, and the index of access to the variety of output in the industry relative to the access by other uses of the product.

The cost of production for each industry is determined by cost of labor, capital, fuel and intermediate inputs. Labor costs reflect a productivity adjustment to account for access to specialized labor, as well as underlying compensation rates. Capital costs include costs of non- residential structures and equipment, while fuel costs incorporate electricity, natural gas and residual fuels.

The consumption deflator converts industry prices to prices for consumption commodities. For potential migrants, the consumer price is additionally calculated to include housing prices. Housing price changes from their initial level depend on changes in income and population density.

Compensation changes are due to changes in labor demand and supply conditions and changes in the national compensation rate. Changes in employment opportunities relative to the labor force and occupational demand change determine compensation rates by industry.

Block 5. Market Shares

The Market Shares equations measure the proportion of local and export markets that are captured by each industry. These depend on relative production costs, the estimated price elasticity of demand, and effective distance between the home region and each of the other regions. The change in share of a specific area in any region depends on changes in its delivered price and the quantity it produces compared with the same factors for competitors in that market. The share of local and external markets then drives the exports from and imports to the home economy.

The Labor and Capital Demand block includes labor intensity and productivity as well as demand for labor and capital. Labor force participation rate and migration equations are in the Population and Labor Supply block. The Wages, Prices, and Costs block includes composite prices, determinants of production costs, the consumption price deflator, housing prices, and the wage equations. The proportion of local, inter-regional and export markets captured by each region is included in the Market Shares block.