ECONOMIC TRANSITION IN NORTHWEST COLORADO:

THE ECONOMIC CONTRIBUTION OF COAL POWER AND COAL MINING, AND THE ECONOMIC IMPACT OF SOLAR POWER AND NATURAL GAS POWER

COLORADO MESA UNIVERSITY

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Executive Summary Part 1: The Economic Contribution of Coal Power

- This report estimates the economic contribution of coal mining and coal power generation in Moffat, Rio Blanco, and Routt Counties. The study also estimates the economic impact of a potential solar plant (PV) as well as a potential natural gas-fired power plant to replace coal power.
- The economic contribution of coal includes employment and wages, severance and Federal Mineral Lease royalties, and ad valorem taxes.
- This economic contribution and impact report uses multipliers to estimate the supply-chain and household spending effects associated with an industry, while adjusting for leakages to imports, taxes, profits, and savings.
- The total economic contribution of the coal industry including both coal mining and coal power in Northwest Colorado is 2,862 jobs, with $228,392,532 in labor income, and $621,433,561 in regional GDP. For scale purposes this is 21.7% of the three-county regional GDP, and 8.2% of the three county region jobs. The effects are stronger in Moffat County, where coal contributes 47% of regional GDP and 19.8% of jobs. In each of the scenarios put forth in this study, Moffat County incurs significantly larger losses than neighboring Routt County, which has a larger, more diverse economy. All scenarios assume the coal fired power plants are decommissioned.
- Assuming only three coal mines are decommissioned (Trapper Mine, Colowyo Mine, and Foidel Creek Mine), and one stays open (Deserado Mine), the economic contribution is $551,584,064 in regional GDP, or 19.28% of total regional GDP, and 2,553 jobs, or 7.29% of employment.
- Assuming two coal mines are decommissioned (Trapper Mine and Colowyo Mine), and two stay open (Deserado and Foidel Creek mines), the economic contribution of coal is $409,928,068, or 14.33% of regional GDP, with 1,900 jobs, or 5.43% of jobs.

Executive Summary Part 2: The Economic Impact of Solar Power

- Three different outputs of solar power (PV) were analyzed using construction and operation and maintenance cost estimates from JEDI, and input into an IMPLAN model.
- The economic impact of a 145 MW solar power plant for the 2-year construction timeline is 527 jobs (264 per year), with $57,840,888 in total regional GDP ($28,920,444 per year). The operations and maintenance phase of a 145 MW solar plant is 12 jobs annually, with an impact of $1,910,437 to regional GDP.
- The economic impact of a 600 MW solar power plant for the 2-year construction timeline is 2,184 jobs (1,092 per year), with $239,398,020 in total regional GDP ($110,699,010 per year). The operations and maintenance phase of a 600 MW solar plant is 48 jobs annually, with an impact of $7,912,314 to regional GDP.
- The economic impact of a 1200 MW solar power plant for the 2-year construction timeline is 4,369 jobs (2,184 per year), with $478,822,873 in total regional GDP ($239,411,436 per year). The operations and maintenance phase of a 1200 MW solar plant is 96 jobs annually, with an impact of $15,826,767 to regional GDP.

Executive Summary Part 3: The Economic Impact of Natural Gas Power

- A 400 MW Natural Gas fired power plant construction phase creates 2,447 jobs over three years, or 815 average annual jobs. The regional GDP impact is $318,444,861, or $106,144,508 yearly for three years. The operations and maintenance phase creates 282 jobs annually, with many created due to local natural gas extraction supply chain effects. The yearly regional GDP impact of the O&M phase is $49,353,073.

BACKGROUND AND CONTEXT

The goal of this report is to provide economic estimates on the changing economic landscape of Northwest Colorado, specifically in Moffat, Rio Blanco, and Routt counties, three counties where coal mining and coal power will be decommissioned in the coming years.

This study provides the employment, wage, and GDP impacts of the decommissioning of coal power plants and coal mines in order to provide accurate information to the public, policy makers, and government officials to inform the scope and scale of this economic transition. This information can be used to inform the next steps for these economies.

In addition to this, Northwest Colorado is currently investigating the potential for solar power. This study also calculates the economic impact of a potential solar farm in Northwest Colorado. The study examines the potential economic impact of a natural gas power plant as backup generation to potential solar due to the intermittency of solar power.

This study presents the first of a series of steps meant to help alleviate potential economic problems caused by a transition away from coal power. This study is not a political document written in support of any particular industry, but is intended to provide accurate information to communities, policy makers, and other interested parties to help solve the issue of economic transition away from coal.

A full analysis should include the following, of which this study provides information for step 1:

1) Scope of the employment problem
2) Feasibility study of potential solutions
3) A direct plan for local governments to implement these solutions

SCOPE OF STUDY

What this study is:
This study is an assessment of the employment, wage, and GDP effects of eliminating coal power and coal mines in Northwest Colorado. In addition to this, the study provides information on the potential gains in employment, wages, and GDP estimates for replacing 1600 MW coal fired power plants with a combination of solar energy (1200 MW) and natural gas (400 MW).

What this study is not:
This is not a comprehensive study of the policy of coal, solar, or natural gas. This study does not look at the cost of power to the consumer, externality effects (pollution, carbon emissions, health impacts, etc.), or an assortment of other factors that may play into a broader County-, State-, or National-level energy policy.

ACKNOWLEDGEMENTS

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INTRODUCTION

As the cost of renewable energy falls, and as the public's appetite for renewable energy increases, communities where coal is the primary economic driver face economic decline. The State of Colorado's goal is to operate on 100% renewable energy by 2040. Xcel Energy wants to reach this same goal by 2050.[1] Xcel Energy plans to have 80% of its energy coming from renewables by 2030.[2] As governments and power companies move away from energy sources like coal and towards renewable resources, there will be an inevitable impact on both the economies losing coal and the economies gaining renewable power generation.

COAL STUDY FOCUS

In Northwest Colorado, two coal-fired power plants—the Craig Generating Station and the Hayden Generating Station—use coal from the nearby Trapper, Colowyo, and Foidel Creek mines. Table 1 lists the two power plants and the four total coal mines in the study area, their planned retirement dates, the approximate number of employees, megawatts per station, and the county location. These power plants produce a total of 1668 megawatts (MW) of power.

Table 1:
Power Station and Mines

Name	County	Estimated Retirement Date	Megawatts	Workers
Power Stations				
Craig Station 1	Moffat	2025	427	253 for units 1, 2, and 3
Craig Station 2	Moffat	End of 2029	410	
Craig Station 3	Moffat	End of 2029	448	
Hayden Station1	Routt	2030	220	100 for units 1 and 2
Hayden Station 2	Routt	2036	221	
Coal Mines[3]				
Deserado Mine	Rio Blanco	None		150
Foidel Creek Mine (20 mile Mine)	Routt	None		266
Trapper Strip	Moffat	End of 2029		172
Colowyo Coal Mine	Moffat	End of 2029		187

The concept for studying the impacts of the loss of 1600 MW of coal and replacing it with 1200 MW of solar and 400 MW of natural gas power originates with what happened in Pueblo, CO, in regards to Comanche stations 1 and 2. The Comanche Generating Station consists of 3 units, with unit 1 producing 325 MW, unit 2 producing 335 MW, and unit 3 producing 750 MW. There is no plan to retire Comanche 3, but Comanche stations 1 and 2 will be retired (660 MW total). Note that this information was gather in late 2019, as this may change as time moves forward. The Comanche power from units 1 and 2 will be replaced with 1100 MW of wind, 700 MW of solar PV, 383 MW of natural gas generation, and 275 MW of battery storage, much of which will end up in Pueblo, CO.[4] Since wind is not currently under consideration in Northwest Colorado, a similar plan, albeit hypothetical, was instituted in the report as a baseline. What if 1600 MW of coal power was replaced with 1200 MW of solar and 400 MW of natural gas production, and all of this power generation stayed in Northwest Colorado? The solar and natural gas sections of this report analyze this, along with smaller potential nameplate sizes for solar power in the region.

[1] https://coloradosun.com/2019/01/22/colorado-power-companies-net-zero-emissions-vs-100-percent-renewable/
[2] https://coloradosun.com/2019/05/29/guzman-tri-state-coal-plant-offer/
[3] Data for coal mine workers is from Colorado Division of Reclamation, Mining, and Safety, as of December 2019.
[4] https://www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates%20&%20Regulations/Resource%20Plans/CO-Energy-Plan-Fact-Sheet.pdf

THE ECONOMIC SITUATION IN NORTHWEST COLORADO

Table 2 illustrates the total employment, gross regional product, total output, and population of the three-county study area. Data is from 2018, which is the study area year. Moffat County has 7,052 jobs, with Rio Blanco at 4,291. Routt County has 23,666 jobs and is a more geographically and economically diverse County, with Western Routt County (Hayden) being closer to the coal economic base than Eastern Routt (Steamboat Springs). Eastern Routt County and Steamboat Springs derive a lot of employment from the tourism economy which makes it very different from Hayden. The difference can be seen in median household income per county, with Routt having a significantly higher number.

Table 2:

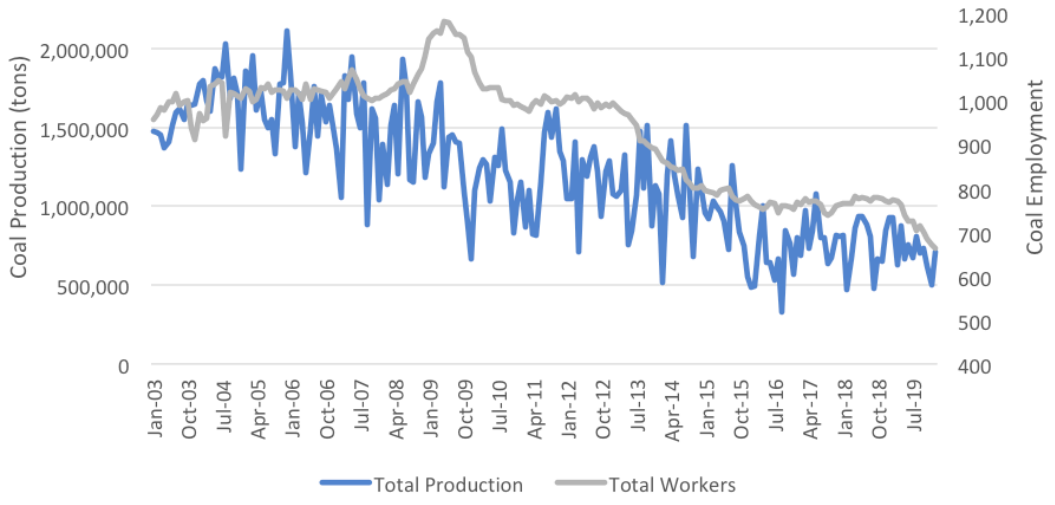
Study Area Data, 2018[5]

	Employment	Regional GDP	Output	Population	Median Household Income
Moffat	7,052	$683,507,487	$1,442,463,601	13,188	$59,500
Rio Blanco	4,291	$384,907,130	$700,598,100	6,336	$63,411
Routt	23,666	$1,791,894,669	$3,348,916,662	25,733	$81,033
Total	35,008	$2,860,309,286	$5,491,978,362	45,257	

Coal is an important driver in Moffat and Rio Blanco, while in Routt County the percentage of coal wages of total wages is significantly smaller, and Western Routt and the town of Hayden derive a higher percentage of wages from the coal industry. Figure 1 illustrates coal production and coal mine workers over time. Both have fallen over the last 10 years with workers dropping quickly since early 2019.[6]

Figure 1:

Coal Production and Coal Miners, 2003-2019



[5]Employment, regional GDP, and Output are from IMPLAN. Population and Median Household Income are from the Census Department.
[6]Coal data is from the Colorado Division of Mining, Reclamation, and Safety.

ECONOMIC IMPACT VS. ECONOMIC CONTRIBUTION

Economic contribution and economic impact are two different concepts. Economic impact only counts new money that an event or an industry brings to the study area. This type of study is suitable for festivals or events or new businesses, for example. Economic contribution looks at the total economic activity of an existing event or industry, and its contribution to regional Gross Domestic Product (GDP).[7] Since the coal section of this report is hypothetically removing the coal industry to get an understanding of its contribution, the coal section is an economic contribution report, and measures the total contribution to regional GDP that the coal industry contributes to Northwestern Colorado.[8,9] The solar and natural gas sections would be new industries' impacts on the area, hence the solar and natural gas sections of this report are economic impact analyses.

For the coal section, the study calculates the economic contribution of coal for Moffat, Routt, and Rio Blanco counties. This includes not just the direct employment contribution of coal mining, electric power generation, and coal support services, but the severance tax, federal mineral lease, and ad valorem contributions that are a result of coal mining and coal power in the area. The model takes these inputs and calculates direct, indirect, and induced economic impacts resulting from the coal industry. Table 3 lists the IMPLAN and corresponding NAICS codes.

Table 3:
IMPLAN and NAICS Codes

Category	IMPLAN9	NAICS
Coal Mining	21	212111
Other nonmetallic minerals services	38	213113, 213115
Electric Power Generation: Fossil Fuel	40	221112

INPUT-OUTPUT MODELING[10,11]

This report uses a data and software program called IMPLAN to conduct the economic contribution and impact analysis. IMPLAN is an Input-Output model that accounts for all flows of economic activity between different sectors in an economy, including government and households. The model uses a Social Accounting Matrix (SAM) which, along with accounting for the relationships between different industries, also accounts for the relationships between industries, households, and government, as well as other elements like savings, commuting, and trade.

The direct effect from wages, taxes, and royalties is only the beginning of the economic contribution story. After the direct industry contribution is added, these raw tax and royalty numbers need to be adjusted for leakages from the economy, supply chain effects, and multiplier effects, all of which IMPLAN estimates.

Leakages are important to consider because not every dollar spent in the three-county region stays in the region. Leakages include taxes, commuting (a leakage of employee compensation), savings, and imports from other areas (as imported goods do not drive further local effects). In addition to this, there is a difference between proprietor-owned businesses and corporate businesses, as corporate-owned businesses send profits to a corporate office and are not spent locally. Leakages are calculated by IMPLAN for each economic activity.

[7] For a detailed discussion of the difference between economic impact and economic contribution, please refer to the following reference: Watson, P., Wilson, J., Thilmany, D., & Winter, S. (2007). Determining economic contributions and impacts: What is the difference and why do we care? Pedogogy in Regional Studies, JRAP 37(2): 140-146.

[8] Throughout this report, descriptions of IMPLAN, economic impact/contribution, and other generic descriptions are taken from previous work from Nathan Perry, specifically Perry (2019).

[9] It is important to note that this report is an economic contribution report which focuses on the contribution of employment, wages, and GDP to the area. It is not a comprehensive assessment of whether coal should be mined or used for power. A comprehensive assessment may include the costs of power to the consumer, environmental impacts, health impacts, and a host of other issues which are outside of the scope of this report. Other economic measures which try to include some of these assessments within the GDP framework include the genuine progress indicator (GPI), which would take the GDP calculation in this study and then add/subtract for the costs/benefits of some of these other considerations. This work would not contradict a GPI measure; rather, it would be its starting point.

[10] IMPLAN Group LLC. IMPLAN 2020. Huntersville, NC. IMPLAN.com.

[11] This explanation of input-output modeling is taken from Perry (2019).

IMPLAN also calculates supply chain effects for each spending category and industry. Supply chain effects, or indirect effects, are the effects of local spending on suppliers. For instance, repairing a truck used to transport recently mined coal would be a supply chain effect. The truck repair company in turn spends money on other local suppliers, buying tires, truck parts, etc., which also affect the supply chain. However, there may be instances where there is not a local truck repair company, and repairs are purchased outside of the region. Both the coal company and the truck repair company are affected by the direct spending, and IMPLAN estimates how much of this supply chain effect is spent locally.

Induced effects are also calculated by IMPLAN and are vital to any economic impact report. Every dollar spent by both coal workers and employees of coal supply chain businesses in the area becomes income to someone else, such as a local business, hotel employee, gas station attendee, or waiter/waitress. Each of these businesses or employees spends this new income, creating income for someone else. The cumulative impact of these rounds of spending are known as the multiplier effect. The multiplier effect is the total economic effect divided by the direct effect.

The model used in this report is known as a multi-regional model, or MRIO, which has the advantage over a single-region model because the MRIO "offers the advantage of providing a more robust and accurate picture of a local economy, because most economies are not isolated to a single region."[12] The MRIO analysis allows each region (county in this analysis) to keep its multiplier identity (as opposed to a single-region model, which would average the multipliers over the three counties), and allows the researcher to capture feedback linkages to another region from purchases in the study region. All models are performed using 2020 dollars.

Economic Contribution of Coal

All coal power is scheduled to be retired by 2036 in Northwest Colorado including the Trapper and Colowyo mines, which both supply coal to power stations. What is unknown is the fate of Deserado (Blue Mountain) and Foidel Creek (20 Mile) mines. Deserado has a coal market that is not dependent on the coal fired power plants to the north. Foidel Creek supplies coal to both the power plants in addition to selling coal to other markets. There is currently no retirement plan for either of these mines, however, conventional wisdom regarding Foidel Creek is that without the Craig/Hayden stations, the mine will be shut down.

Because of the uncertainty regarding Deserado, and especially Foidel Creek, a variety of scenarios are put forth. In all these scenarios, it is assumed that coal power is eliminated:

Scenario 1: All coal mining and coal power are eliminated from Northwest Colorado

Scenario 2: Deserado mine stays open

Scenario 3: Deserado and Foidel Creek both stay open

Scenario 4: Timeline scenario (based on scenario 2)

SCENARIO 1: TOTAL ECONOMIC CONTRIBUTION OF COAL

a) Direct Industry Contribution

Scenario 1 assumes both power plants are decommissioned, as well as all four coal mines. As this section progresses, the economic contribution of each input (employment and wages, severance and federal mineral lease (FML), and ad valorem property taxes) will be calculated individually, with the final result showing the total economic contribution. The total economic contribution is what matters most, but seeing the individual contribution of each category is important to understand the full economic contribution of coal to the area.

[12]Clouse, Candi. "MRIO: Multi-Regional Input-Output Analysis FAQ." IMPLAN Support Site, IMPLAN Group LLC, February 14, 2020.

Table 4 illustrates employment, labor income (wages), gross regional product (regional GDP), and total output estimates for the entire coal industry in Northwest Colorado.[13] The direct effect is the initial value that the industry contributes to the study region. Indirect effects are supply chain effects, and induced effects represent the employee spending from those working in the direct and indirect industries. The three combined are the total economic contribution. The direct employment for this industry is 1,182, and after indirect and induced effects, the total contribution to regional employment is 2,548. The direct industry contribution portion of the oil and gas industry contributes $601,711,712 to gross regional product. This equates to 21% of the total GDP for the three counties.

The contribution to regional GDP, or value added, is the difference between and industry's output and the cost of intermediate inputs. Value Added is defined as the total market value of all final goods and services produced within a region in each period of time. Output includes value added (regional GDP) plus the cost of intermediate goods.[14]

The total output value of $1,121,168,302 represents the gross total value of all sales and production due to coal mines and coal power. This is a broader measure than the standard gross domestic product (GDP). Output is the value of an industry's production. It counts the regional GDP and the intermediate inputs that are associated with it. This total output measure is the gross measure of local economic activity, and is more in line with how a business would account for the sales transaction from one firm to another. Value Added is a subset of Output and is a useful measure of wealth created by an economy. Therefore, value added (contribution to GDP) is considered a more accurate representation of economic contribution and is the emphasis of this report.

Table 4:
Economic Contribution of Employment

	Employment	Labor Income	Regional GDP	Output
Direct	1,183	$148,092,315	$471,803,499	$833,925,300
Indirect	818	$45,310,615	$88,799,447	$213,844,770
Induced	548	$19,576,214	$41,108,766	$73,398,232
TOTAL	2,549	$212,979,143	$601,711,713	$1,121,168,302

b) Severance and Federal Mineral Lease

Severance and federal mineral lease taxes are collected as a result of the extraction of coal. This money is collected and sent to the state, which is then redistributed back to the counties through a variety of different programs. This study only counts money that comes back to the counties as a result of these programs, that which is directly associated with coal. The approach used is the same as in Perry (2019). The severance and FML data is from the year 2018.

Direct distribution is money from both severance and FML that is distributed to the county, municipalities, and school districts based on three sets of formulas (see Appendix A). These revenues come from the State severance tax receipts and the FML non-bonus payments.

There are three types of direct distribution. The first is direct distribution that goes directly to local government budgets and is from severance taxes. The second goes to counties and municipalities from federal mineral lease taxes. The third comes from federal mineral lease taxes and is distributed to school districts. Table 5 illustrates these three separately, although they are all part of the direct distribution program. A visual representation severance and FML flow of funds can be seen in Figure 4 in Appendix A and Figure 5 in Appendix B.

It is important to note that severance and FML are taxes and royalties collected from not just coal extraction but also from oil/gas extraction and other mining. Only the impact of coal is calculated in this study. To adjust for this, the proportion of coal to oil/gas/

[13] Northwest Colorado is defined as Moffat, Rio Blanco, and Routt Counties.

[14] A good example illustrating the relationship between total output and regional GDP is car production: Regional GDP only counts the final value of the car, but total output adds the intermediate goods of steel, rubber, and other parts, plus the total value of the car. This is known as double counting in GDP calculations.

other mining for both severance and FML was calculated and the numbers adjusted for each input into the model. The proportion for severance and FML was estimated using data from the Office of Natural Resource Revenue, and is a weighted share based on each county's proportion of coal to other extraction. The proportion of severance/FML that is a result of coal is 69% for Moffat County, 25% for Rio Blanco County, and 70% for Routt County.

Table 5 illustrates the total numbers for the three types of direct distribution as well as their adjusted numbers to reflect the proportion of coal to oil/gas/other mining. Note that all numbers in Table 5 are adjusted for this proportion.

Table 5:
Direct Distribution

	TOTAL NUMBERS			ADJUSTED NUMBERS		
	SDD $	**FML Muni/ County $**	**FML School District $**	**SDD $**	**FML Muni/ County $**	**FML School District $**
Moffat	$559,697	$694,754	$59,054	$385,315	$478,293	$40,655
Rio Blanco	$784,917	$3,111,179	$264,450	$194,525	$771,041	$65,538
Routt	$638,027	$70,028	$5,952	$447,035	$49,066	$4,172
Totals	$1,982,640	$3,875,962	$329,457	$1,026,875	$1,298,399	$110,364
Grand Total			$6,188,059			$2,435,638

SDD $: Distribution that goes directly to local government budgets and is from severance taxes.
FML Muni/County $: Distribution to counties and municipalities from federal mineral lease taxes.
FML School District $: Distribution to school districts from federal mineral lease taxes.

ENERGY IMPACT ASSISTANCE FUND

The Energy Impact Assistance Fund is a program that results from both severance taxes and federal mineral lease royalties and can be seen on both the FML flow chart and severance tax flow chart (see appendices A and B). The Department of Local Affairs (DOLA) describes the program as follows:

"The purpose of the EIAF Program is to assist political subdivisions that are socially and/or economically impacted by the development, processing, or energy conversion of minerals and mineral fuels. Funds come from the state severance tax on energy and mineral production and from a portion of the state's share of royalties paid to the federal government for mining and drilling of minerals and mineral fuels on federally-owned land."[15]

The Energy Impact Assistance Fund is rewarded to municipalities, counties, school districts, and other political subdivisions in the form of grants or loans. The exact awards for each of the six counties are listed in Table 6. Each award was coded into IMPLAN to reflect the type of expenditure. In the event that the grant awarded money for a purchase or for equipment that was likely to be purchased from outside of the county, the award was omitted from the IMPLAN model as there would be no local impact.

[15] Source: https://www.colorado.gov/pacific/dola/energymineral-impact-assistance-fund-eiaf

Table 6:

Energy Impact Assistance Fund

County	Project Name	Grant Recipient	FML Award Amount	Severance Award Amount	Adjusted Amount
Moffat	Dinosaur Bio-Solid Removal Planning	Dinosaur, Town of	$20,000		$13,769
Moffat	Dinosaur Waste Water Treatment Plant- Phase IIIA	Dinosaur, Town of	$135,000		$92,939
Moffat	Moffat County Community Park Plan	Moffat County		$10,000	$6,884
Rio Blanco	Rangely Water & Gas Distribution System Improvements	Rangely, Town of	$209,000		$51,796
Rio Blanco	Eastern Rio Blanco County HSD Cheimcal Analyzer Lab Equp.	Eastern Rio Blanco Health Service Dist		$60,000	$14,870
Rio Blanco	Meeker Main Street Scholarship	Meeker, Town of		$2,500	$620
Routt	Town of Hayden Washington Street Lift Station Replacement	Hayden, Town of	$90,000		$63,059
Routt	Routt County Phippsburg WW Treatment Liner Replacement	Routt County	$150,000		$105,099
Routt	Timbers WSD Wastewater System Improvements	Routt County	$305,000		$213,699
Routt	NWCCOG Broadband Strategic Plan Implementation	Northwest Colorado Council of Governments		$103,347	$72,410
Routt	Routt County Priority-based Budgeting Program	Routt County		$50,000	$35,033
Routt	Steamboat Springs/Routt County Law Enforcement Facility	Steamboat Springs, City of		$1,000,000	$700,652
Routt	Steamboat Springs Main Street Scholarship	Steamboat Springs, City of		$2,500	$1,752

State Public School Fund

The FML money that goes into the State Public School Fund is intermingled and indistinguishable from other budget sources. However, we know from Perry (2019) that the total state school budget is $4,121,000,000, and that $64,813,020 of that budget comes from FML. Dividing the FML amount by the total amount provides a proportion of 1.573%. A reasonable estimate for the FML contribution back to the counties in the form of school funds is thus the total money distributed by the state to the school districts multiplied by the proportion of funds that are FML funds for the 2017/2018 fiscal year, or 1.573%, with this number then being adjusted for the proportion that results from coal. The total amount of school spending as a result of FML funds resulting from coal is listed in Table 7. The total amount for the three-county area adjusted for FML and the proportion of coal to oil/gas/other mining is $238,992.

Table 7:

State Public School Fund FML Local Proportion

	Total School Funding	Proportion from FML	Proportion from Coal
Rio Blanco	$3,395,585	$53,404	$13,234
Moffat	$6,391,993	$100,530	$69,250
Routt	$14,203,054	$223,379	$156,510
Total	$23,990,632	$377,313	$238,993

In addition to this, severance and FML from coal flow into a variety of state level programs known as Tier 1 and Tier 2 programs. Perry (2019), with the assistance of the Colorado Department of Natural Resources, estimates the state expenditures that would be spent on the Western Slope as result of severance and FML for oil and gas extraction. However, the amount compared to the overall numbers is relatively small. Since Rio Blanco, Moffat, and Routt are much smaller than the study area in Perry (2019), these tier one and tier two programs—many of which have not received funding due to lack of "overflow" funding—are not included in this report.

ECONOMIC CONTRIBUTION OF SEVERANCE AND FML

Table 8 illustrates the economic contribution of programs related to severance and FML distributions back to the three counties. Severance and FML programs create in 49 jobs in total, $2.8 million in labor income, and $3.6 million in gross regional product.[16]

Table 8:

Economic Contribution of Severance and FML

Impact Type	Employment	Labor Income	Regional GDP	Total Output
Direct Effect	39.40	$2,468,980	$2,875,298	$3,661,739
Indirect Effect	2.73	$127,037	$217,619	$453,096
Induced Effect	7.22	$254,000	$558,651	$990,297
Total Effect	49.36	$2,850,016	$3,651,569	$5,105,132

c) Ad Valorem

The three counties collect ad valorem property taxes from both the coal mines and the coal power stations. The County Assessors Office's provided data for their ad valorem collection. Table 9 illustrates the ad valorem tax received. The taxes reflect 2018 production, which would be the 2019 payroll, collected in 2020. As this report is trying to capture the economic impact of 2018, it makes the most sense to use 2018 production numbers even though the counties actually receive the funds at a later date.

A significant portion of each county's ad valorem taxes go to the school system, including Moffat County (46%), Rio Blanco (23%) and Routt (63%). In IMPLAN, this money was coded based on information from the County Assessor's Office split between general government spending and school spending. Note that Craig Station makes up 37% of all taxes for Moffat County ($9,970,574 out of $27,001,297), while the two coal mines account for $2,154,316, or 7% of all taxes, for a combined 44.9% of all taxes.[17]

[16] For the Energy Impact Assistance Fund, industry output codes were used to match the spending type. For the State Public School Fund, Ad Valorem, and other Severance and FML money, institutional spending patterns for education and local government were used.

[17] It is important to note that if all coal mining and coal power were to be eliminated, there may still be some small ad valorem collection from the properties and land. However, after discussions with the County Assessor's offices, this amount a) is impossible to predict and b) is expected to be very small, hence it is not accounted for in this report.

Table 9:

Ad Valorem Taxes for 2018

Power Plant/Mine	County		
	Moffat	Rio Blanco	Routt
Craig Station	$9,970,574		
Hayden Station			$5,203,532
Colowyo Mine	$1,162,391	$135,717	
Trapper Mine	$991,925		
Blue Mountain Mine		$1,236,572	
Foidel Creek Mine			$984,885
Total	$12,124,890	$1,372,289	$6,188,417

Table 10 illustrates the economic contribution of ad valorem taxes for the three counties. Ad valorem taxes create a significant amount of economic activity, resulting in 264 jobs, $12,584,725 in labor income, and $16,133,543 in GDP.

Table 10:

Economic Contribution of Ad Valorem

Impact Type	Employment	Labor Income	Regional GDP	Total Output
Direct Effect	220.03	$10,894,569.95	$12,783,472	$14,565,262
Indirect Effect	7.59	$359,572.64	$604,049	$1,345,484
Induced Effect	36.97	$1,330,582.99	$2,746,022	$4,921,330
Total Effect	264.59	$12,584,725.57	$16,133,543	$20,832,076

TOTAL ECONOMIC CONTRIBUTION

This section combines all the previous sections (employment, severance and FML, ad valorem) to determine the total economic contribution of the coal industry in Northwest Colorado. It is important to remember that these results take into account leakages from the economy. The total economic contribution resulting from the coal industry is $621,433,561 in gross regional product (Table 11). As a comparison point, total gross regional product for the three-county area is $2,860,309,285, equating to 21.7% of total regional GDP. Total employment resulting from the coal industry in NW Colorado totals 2,862.47. For scale purposes, there are 35,008 total jobs estimated by IMPLAN in the region in 2018, equating to 8.2% of total jobs. The contribution of labor income is $228,392,532, while total output resulting from the industry is $1,146,947,896.

Table 11:

Total Economic Contribution of Coal Related Activities, 2018

Impact Type	Employment	Labor Income	Regional GDP	Total Output
Direct Effect	1,441.94	$161,455,569	$487,461,651	$852,151,142
Indirect Effect	828.42	$45,778,909	$89,566,257	$215,505,299
Induced Effect	592.10	$21,158,054	$44,405,653	$79,291,455
Total Effect	2,862.47	$228,392,533	$621,433,561	$1,146,947,896

Table 12 illustrates the direct, indirect, induced, and total industry level employment effects of removing the coal industry from the model. Outside of the direct impact on coal industry employment, the model predicts 117 job losses in local government school services, 74 for professional services, 66 for management of companies and enterprises, and 63 in real estate. The local government education losses are the result of ad valorem and direct distribution being lost.

Table 12:

Top 20 Employment Effects by Industry for Coal, 2018

Industry	Direct	Indirect	Induced	Total
21 - Coal mining	860.81	0.00	0.00	860.81
40 - Electric power generation - Fossil fuel	187.32	0.00	0.00	187.32
38 - Other nonmetallic minerals services	134.38	0.00	0.00	134.38
542 - * Employment and payroll of local govt, education	117.20	0.00	0.00	117.20
468 - Marketing research and all other miscellaneous professional, scientific, and technical services	0.32	70.27	3.89	74.48
469 - Management of companies and enterprises	0.00	59.59	6.63	66.22
447 - Other real estate	2.16	40.63	20.43	63.22
509 - Full-service restaurants	0.14	21.19	41.48	62.81
541 - * Employment and payroll of state govt, other services	58.97	0.00	0.00	58.97
544 - * Employment and payroll of local govt, other services	54.61	0.00	0.00	54.61
47 - Electric power transmission and distribution	0.02	47.68	0.87	48.57
442 - Other financial investment activities	0.02	34.72	13.60	48.35
456 - Accounting, tax preparation, bookkeeping, and payroll services	0.35	34.79	4.65	39.79
510 - Limited-service restaurants	0.29	3.38	32.72	36.39
60 - Maintenance and repair construction of nonresidential structures	6.49	27.12	1.42	35.04
413 - Retail - Nonstore retailers	0.01	12.21	18.24	30.46
476 - Services to buildings	0.95	22.92	5.02	28.89
20 - Oil and gas extraction	0.10	27.91	0.34	28.35
490 - Hospitals	0.00	0.00	27.68	27.68
445 - Insurance agencies, brokerages, and related activities	0.00	24.25	2.45	26.70

In addition to the total economic contribution for the region, the individual county economic contribution can also be calculated. Table 13 illustrates the individual effects per county. The impact on the individual regions becomes more apparent, as Moffat County is expected to experience a 46.9% reduction in economic activity (regional GDP), Routt—which is more diversified and larger—an 11.1% reduction, and Rio Blanco a 26% reduction as a result of the phasing out of all coal. It is important to note that the IMPLAN dataset codes the Hayden Station in Moffat County and not Routt County, hence Moffat takes the bulk of the economic consequences of the Hayden Station retirement. This is not entirely unrealistic, as Hayden is more geographically and economically intertwined with Craig than Eastern Routt. All severance, FML, and ad valorem collected in Routt resulting from Hayden is coded in the model as Routt County. The 46.9% reduction in economic activity for Moffat needs to be interpreted as Moffat plus the Hayden Stations.

This scenario assumes that all coal production will be eliminated, but as of this writing neither Deserado mine nor Foidel Creek mine have a decommissioning date. The scenarios that follow will use the information put forth from Scenario 1 and adjust it to model the possibility that either one or both of Deserado and Foidel Creek mines stay open.

Table 13:

Individual County Economic Contributions of Coal, 2018

Region	Employment	Labor Income	Regional GDP	Total Output	Employment % of Total	Regional GDP % of Total
Moffat	1,398.47	$109,992,178	$321,187,590	$632,428,130	19.83%	46.99%
Routt	1,074.79	$85,801,045	$199,947,246	$355,846,027	4.54%	11.16%
Rio Blanco	389.21	$32,599,310	$100,298,726	$158,673,740	9.07%	26.06%
Total Effect	2,862.47	$228,392,533	$621,433,561	$1,146,947,896	8.18%	21.73%

SCENARIO 2: ECONOMIC CONTRIBUTION OF COAL POWER AND THREE COAL MINES (DESERADO MINE STAYS OPEN)

As discussed earlier, the fates of the Deserado and Foidel Creek mines are unknown. In this scenario (scenario 2), Deserado mine remains open in Rio Blanco, and hence the support activities, ad valorem and potential severance/FML that results from the mine stays in the local economy. An important assumption made in this model is that the coal support industry (IMPLAN Industry 38) in all three counties scales down based on the reduction of coal production. This models the coal support industry as regional instead of county-based. This model adjusts the ad valorem, severance and FML, and employment numbers to provide an accurate estimate of total economic contribution if Deserado mine remains open.

Table 14 illustrates that total job losses resulting from the elimination of three coal mines and both power stations is 2,553, with a regional GDP impact of $51,584,064. For scale purposes this would be 7.29% of total jobs, and 19.28% of total regional GDP for the three-county region. Individual county effects can be seen in Table 15.

Table 14:

Total Economic Contribution of Scenario 2 (Omitting Deserado Mine)

Impact Type	Employment	Labor Income	Regional GDP	Total Output
Direct Effect	1,242.15	$141,861,552	$426,413,968	$755,472,670
Indirect Effect	761.05	$42,721,075	$84,325,707	$202,320,230
Induced Effect	549.89	$19,827,520	$40,844,389	$73,087,260
Total Effect	2,553.09	$204,410,148	$551,584,064	$1,030,880,160

Table 15:

Individual County Economic Contributions (Omitting Deserado Mine)

Region	Employment	Labor Income	Regional GDP	Output	Employment % of Total	Regional GDP % of Total
Moffat	1,392.18	$109,719,054	$320,576,980	$630,143,867	19.74%	46.90%
Rio Blanco	146.09	$12,936,765	$37,265,964	$59,545,591	3.40%	9.68%
Routt	1,014.82	$81,754,328	$193,741,121	$341,190,701	4.29%	10.81%
Total	2,553.09	$204,410,148	$551,584,064	$1,030,880,160	7.29%	19.28%

SCENARIO 3: DESERADO MINE (BLUE MOUNTAIN) AND FOIDEL CREEK (20 MILE) MINE STAY OPEN

In this scenario (scenario 3), both Deserado and Foidel Creek mines remain open, along with the support activities, ad valorem, and severance/FML associated with each. The same assumptions as in Scenario 2 apply. Table 16 illustrates that when keeping Foidel Creek mine and Deserado mine open, job losses resulting from the closures of the rest of the coal industry are 1,900, with a regional GDP loss of $409,928,068. For scale purposes, this would be 5.4% of total jobs, and 14.3% of total regional GDP. Table 17 illustrates the county-level effects. With Deserado and Foidel Creek assumed to stay open, employment losses are significantly smaller in Rio Blanco and Routt, and are mostly concentrated in Moffat County.

Table 16:

Total Economic Contribution of Scenario 3 (Deserado Mine and Foidel Creek Mine Remain Open)

Impact Type	Employment	Labor Income	Regional GDP	Total Output
Direct Effect	935.76	$104,663,784	$311,288,004	$582,738,311
Indirect Effect	561.45	$33,337,328	$69,086,760	$165,342,803
Induced Effect	403.54	$14,201,450	$29,553,305	$53,244,483
Total Effect	1,900.75	$152,202,562	$409,928,069	$801,325,598

Table 17:

Individual County Economic Contributions (Omitting Deserado and Foidel Creek Mines)

Region	Employment	Labor Income	Regional GDP	Output	Employment % of Total	Regional GDP % of Total
Moffat	1,372.14	$108,788,088	$318,357,751	$622,773,045	19.46%	46.58%
Rio Blanco	141.52	$12,296,892	$36,435,606	$58,051,884	3.30%	9.47%
Routt	387.09	$31,117,582	$55,134,712	$120,500,669	1.64%	3.08%
Total	1,900.75	$152,202,562	$409,928,069	$801,325,598	5.43%	14.33%

Table 18 summarizes the results from the three models. Removing all four coal mines and both power stations creates employment losses of 2,862. Removing three mines and keeping the Deserado mine creates employment losses of 2,553, and keeping both Deserado and Foidel Creek mines open creates losses of 1,900 for the region.

Table 18:

Scenario 1, 2, and 3 Comparison

Scenario	Employment	Labor Income	Regional GDP	Total Output
Scenario 1: Total Contribution	2,862.47	$228,392,533	$621,433,561	$1,146,947,896
Scenario 2: Omit Deserado Mine	2,553.09	$204,410,148	$551,584,064	$1,030,880,160
Scenario 3: Omit Deserado Mine and Foidel Creek	1,900.75	$152,202,562	$409,928,069	$801,325,598

SCENARIO 4: REALISTIC TIMELINE SCENARIO

Scenario 4 uses the known retirement dates of the Craig and Hayden stations, along with the Trapper and Colowyo mines, to create a realistic timeline of economic contribution loss through the last retirement date (2036, for Hayden Station 2). Since Trapper mine sells coal only to the Craig stations, Trapper mine employment and economic activity will be proportionally scaled down with the retirement dates of the Craig stations. Colowyo will be scaled down proportionally to all five stations. Severance and FML will be scaled based on mining activity, and ad valorem will be scaled based on information from the County Assessor's Office and the actual tax collected per mine/plant. The numbers presented are in nominal 2020 numbers (not adjusted for inflation). Below are the assumptions for mine/plant closures, as well as the assumptions of the model necessary to construct this timeline scenario model.

Assumptions for closures:

1) Craig Station Unit 1: 2025
2) Craig Station Unit 2: 2028
3) Craig Station Unit 3: 2030
4) Hayden Station Unit 1: 2030
5) Hayden Station Unit 2: 2036
6) Trapper Mine/Colowyo close by 2030
7) Foidel Creek Mine closes in 2036

Assumptions for model:

1) Deserado Mine does not close.
2) Foidel Creek Mine closes at the retirement of Hayden Station.
3) Coal production for Colowyo, Trapper, and Foidel Creek declines based on the proportion of megawatts retired at the Craig and Hayden stations.
4) Severance and FML for Moffat and Routt resulting from coal scales down based on the reduced coal production for the region over the timeline.
5) Severance and FML revenues resulting from coal are the same as in 2018.
6) Coal support services decline scaled by falling coal production for the region. Note that since Deserado Mine remains open in this scenario not all coal support jobs are lost.
7) Ad valorem taxes are scaled down based on percentage reductions per power station megawatts and coal mine production.

Note that if Deserado Mine stays open, severance and FML payments should stay the same for Rio Blanco (as in Scenario 2). Rio Blanco will lose ad valorem taxes for Colowyo Mine (which falls over the border), but will not lose ad valorem taxes for Deserado Mine.

Table 19 illustrates the employment, labor income, regional GDP, and total output losses for each phase of decommission based on the timeline in Table 1. By 2025, the region should lose 716 jobs and $155,343,127 of regional GDP. By 2028 when Craig Station 2 is estimated to be decommissioned, the total job losses will be 1,498, with $315,094,409 in regional GDP. By 2030, Craig Station 2 and Hayden Station 1 are decommissioned, and at this point Colowyo and Trapper mines are also decommissioned. The losses increase to 2,353 job with $503,959,427 in regional GDP. By 2036, Hayden Station 2 is decommissioned and the assumption is made that Foidel Creek will be decommissioned at that point. By 2036 total losses match those of Scenario 2, with 2,553 jobs and $551,584,064 in regional GDP. All results in the timeline scenario are in 2020 dollars.

Table 19:
Realistic Timeline Scenario (Deserado Mine Stays Open)

Year	Employment	Labor Income	Regional GDP	Total Output	% of Total EMP	% of Total Regional GDP
2025	716.78	$57,057,580	$155,343,127	$286,534,264	2.05%	5.43%
2028	1,498.31	$117,572,858	$315,094,409	$578,643,150	4.28%	11.02%
2030	2,353.11	$186,356,321	$503,959,427	$935,187,063	6.72%	17.62%
2036	2,553.09	$204,410,148	$551,584,064	$1,030,880,160	7.29%	19.28%

CONCLUSION: REPLACING JOB LOSSES

This section models employment, wage, and regional GDP losses as Northwest Colorado transitions away from coal. Since there is uncertainty as to the fate of the Deserado and Foidel Creek Mines, several models were developed to provide a variety of scenarios for potential economic impacts. It is important to note that when trying to replace these job losses, new jobs create supply chain and multiplier effects of their own. For instance, in Scenario 3 where 1,900 jobs will phase out, a combination of direct employment effects, supply chain effects, and induced (multiplier) effects will occur. To replace this economic loss, an initial 1,900 jobs would not be necessary, as bringing in (as a hypothetical example) 1,200 jobs in a particular industry would create supply chain and multiplier effects of their own, potentially resulting in as many as the 1,900 jobs lost as these workers start spending, etc. Just as 935 direct coal workers support supply chain and multiplier effects that result in 1,900 total jobs, a new industry would have similar impacts. The exact impacts would depend on the industry and the wages paid. One reason so many jobs are lost in supply chain and multiplier effects is because the coal industry a) has a high average salary and b) has well established supply chains; in other words, many supporting businesses have developed around the coal industry over time to sell necessary inputs, services, etc. To what extent this would happen with new jobs depends on the industry and the pay. For information on the change in average wage in the study area before and after coal is eliminated, see Appendix C.

ECONOMIC IMPACT OF SOLAR POWER IN NORTHWEST COLORADO

This section of the report models the economic impact of a Solar photovoltaics (PV) power plant in the three-county region. Two approaches for the solar section are used:

1) A statistical analysis that uses previous literature to forecast employment from solar power for NW Colorado.
2) An IMPLAN model using estimated cost inputs from JEDI, the Jobs and Economic Development Impact Models. The emphasis for this section is on the construction and operations of a potential 1200 MW power plant.

As explained earlier, the hypothetical exercise is to replace the 1600 MW of coal fired power and replace with 1200 MW of solar and 400 MW of natural gas power. The current feasibility for solar power is under investigation in Northwest Colorado. These estimates will provide benchmark employment numbers if the feasibility of solar implementation is deemed appropriate.

STATISTICAL MODEL

This section uses previous research to create a predictive model using megawatts to jobs for both the solar construction and the operations and maintenance phases. In the review of literature, three specific qualifications were necessary to be included in the dataset.

1) Nameplate size. Since this study is investigating the impact of replacing coal with solar, a range of 0-2,000 megawatts was chosen as a reasonable scale comparison.
2) Direct jobs. Many studies report job years without the time length of the construction phase, making calculating yearly job numbers difficult. Other studies reported the full impacts, which include direct, indirect, and induced impacts. Only studies that stated the direct impacts were included in this representative sample.
3) County-level study. State-level studies generally have higher levels of employment from solar due to the indirect (supply chain) and induced (household spending) effects from the larger geographic area. The focus of this study is not the employment effects on the state of Colorado but the employment effects on Moffat, Rio Blanco, and Routt, hence only county level results are included.
4) Conducted in the last 10 years. Solar technology has changed rapidly, and the installation costs and scale of employment have changed along with it, hence using more recent studies leads to more accuracy.

There were seven studies that met these criteria. A simple linear regression model was used in order to create a predictive model of megawatts to construction jobs, and megawatts to operation and maintenance jobs. The data is listed in table 20 and is illustrated graphically in Figure 2 and Figure 3. Both regressions are significant at the 95% level and have a clear visual linear relationship. Table 20, Figure 2, and Figure 3 use direct jobs, so these numbers do not take into account indirect (supply chain) and induced (household spending) effects.

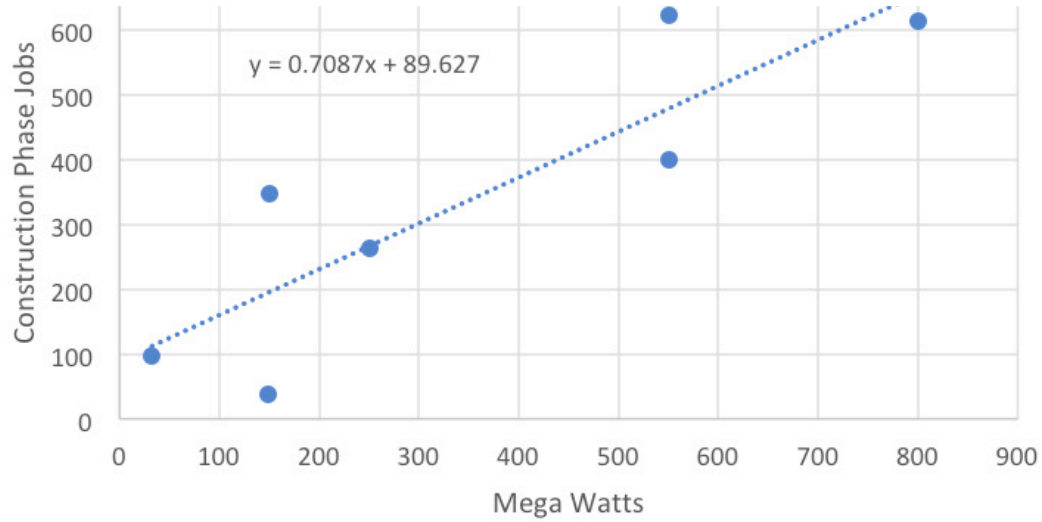
Table 20:

Solar Literature[18]

Author	MW	Direct Construction Jobs Yearly	Direct O&M Jobs
Hamilton, Smith, and Banda*	250	264	12
Hamilton and Berkman*	550	400	15
Aspen Environmental Group*	800	614	26
Berkman, Tran, and Ahlgren*	550	624	15
Origis Energy	32.5	98	3
Stanton 2018 (County)	150	348	10
Loomis 2019 County	149	38	4

Figure 2:

Construction Phase Jobs Regression



[18] Asterisks indicate the literature was taken from Phillips (2013 and 2014), as the original papers could not be found.

Figure 3:

O&M Phase Jobs Regression

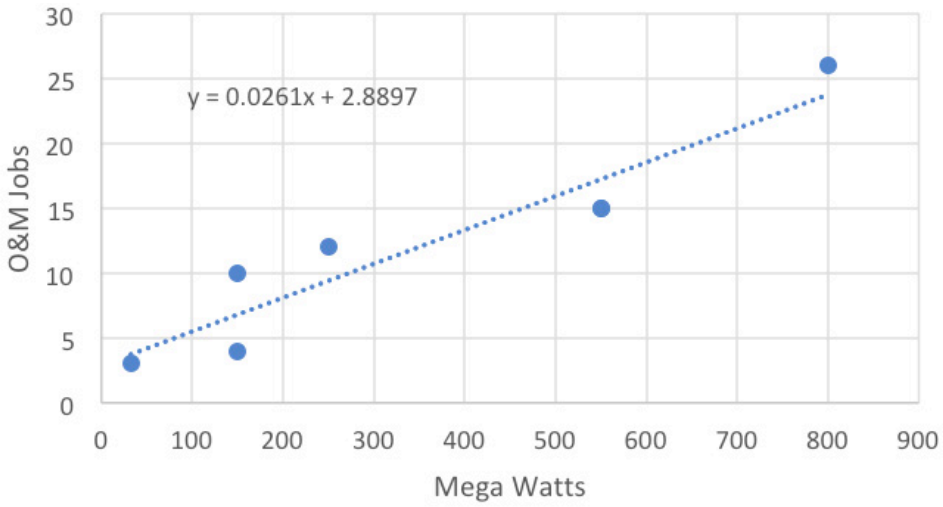


Table 21 shows the predicted direct jobs created during both the construction phase and Operation and Maintenance (O&M) phase. For a 1200 MW solar power plant, 940 jobs are expected to be created per year for the two to three years of construction. For the O&M phase, a 1200 MW solar plant is expected to create 34 direct jobs resulting from the yearly maintenance and operations. O&M jobs are expected to last the life of the solar plant, approximately 25 years. These are direct jobs, and do not include indirect effects (supply chain effects) or induced effects (household spending effects). Indirect and induced effects will be explored in the next section.

Table 21:

Statistical Model Projections for Direct Yearly Employment

	145 MW	600 MW	1200 MW
Construction Phase (Yearly)	192.38	514.83	940.05
O&M Phase (Yearly)	6.67	18.55	34.21

IMPLAN MODEL

This section models the potential impacts of solar power implementation in Northwest Colorado through economic impact modeling using both JEDI and IMPLAN. JEDI is used to predict the expenditure categories and expenditure amounts. These amounts are then plugged into IMPLAN to create an accurate model for regional economic impact.

Jobs and Economic Development Impact Models (JEDI) was created by the National Renewable Energy Laboratory of the U.S. Department of Energy. JEDI default estimates of expenditures for various power sources, including solar and natural gas, are based on interviews with industry experts and project developers.[19] The expenditure estimates assume a construction cost of $1,331 per KW, while operation and maintenance costs are set at $15.19 per KW, each of which are taken from Energy Information Administration (EIA) estimates.[20]

[19] See https://www.nrel.gov/analysis/jedi/about.html

[20] See The Energy Information Administration's "Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2020."

Table 22 illustrates the construction cost expenditures by category derived from the JEDI model using the EIA estimates. These expenditures assume 1200 Megawatts of solar power. The table for construction expenditures contains the total expenditures over the course of the construction period which, in this case, is assumed to be two years.[21] In order to get the expenditures per year, the total was divided in half. Operation and maintenance expenditures are, however, yearly, as the life of the solar plant is expected to be 25 years.

Table 22:

JEDI Total Expenditures for 1200 MW Solar Plant

Construction Costs	
Materials	
Construction (concrete rebar, equip, roads and site prep)	$42,620,383
Materials Subtotal	$42,620,383
Labor	
Sitework and Infrastructure	$12,024,414
Field Erection	$143,727,795
Support Structures	$8,491,515
Piping	$46,890,562
Electrical	$18,708,778
Labor Subtotal	$229,843,064
Construction Subtotal	$272,463,448
Equipment Costs	
Mirrors	$94,509,101
Heat Collection Elements	$299,654,438
Thermal Energy Storage Tanks	$87,013,031
Heat Exchangers	$64,643,434
Heat Transfer System Equipment	$53,030,688
Heat Transfer and Storage Fluids	$187,166,861
Steam Turbines & Generators	$126,477,296
Misc. Electrical and Solar Equipment (pumps, motors, drive, etc.)	$4,258,550
Water Treatment	$3,684,076
Metal Support Structure	$56,744,999
Interconnection Piping	$82,447,475
Electronics & Controls	$28,502,745
Balance of Plant	$32,519,411
Equipment Subtotal	$1,120,652,105
Other Costs	
Freight & Transportation	$0
Engineering & Project Management	$165,502,123
Misc. Costs (permitting, licensing, legal)	$38,582,324
Other Subtotal	$204,084,447
Subtotal	$1,597,200,000
Sales Tax (Materials & Equipment Purchases)	$33,734,902
Total	$1,630,934,902

[21] This is also taken from the Energy Information Administration's "Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2020."

These expenditures were categorized by IMPLAN Industry, and input into a Multi-Regional Input-Output analysis model with Moffat County as the location of the solar plant. The construction costs and labor were coded as direct industry output, while equipment and other costs were coded as commodity outputs. This was done because we know the construction and labor will be in Moffat County, but we do not know the amount of equipment and materials that will come from the three-county area. This forces IMPLAN to predict how much of the equipment and materials will come from the three-county area versus outside the three county area based on IMPLAN's industry level data. Because the three-county study area is small, much of the equipment and other costs come from outside the study region, and hence their economic impacts are felt elsewhere. The results were obtained for a 1200 MW, 600 MW, and 145 MW size power plants for comparison purposes.

Table 23 illustrates the economic impact of a 1200 MW power plant, showing 1,357 direct jobs resulting from the construction phase, 352 indirect (supply chain) effect jobs, and 474 induced (household spending effect) jobs, for a total of 2,184 jobs yearly during the construction phase.

Table 23:

1200 MW Solar Plant Construction Phase: Average Annual Jobs

Impact	Employment	Labor Income	Regional GDP	Output
Direct	1,357.12	$131,069,920	$185,240,454	$196,802,640
Indirect	352.81	$11,896,709	$20,057,728	$48,648,214
Induced	474.58	$16,626,242	$34,113,254	$61,986,226
Total	2,184.51	$159,592,870	$239,411,436	$307,437,080

Table 24:

1200 MW Solar Plant Construction Phase: Total Jobs over 2 Years

Impact	Employment	Labor Income	Regional GDP	Output
Direct	2,713.31	$262,099,308.07	$370,428,132.39	$393,507,306.42
Indirect	672.68	$22,077,924.77	$37,008,462.21	$90,538,521.53
Induced	1,007.34	$35,930,895.25	$73,316,094.73	$134,245,960.06
Total	4,393.33	$320,108,128.09	$480,752,689.33	$618,291,788.01

Table 24 shows that the total impact over the two-year period is 4,393 jobs with $320,108,128 in labor income and $480,752,689 in regional GDP. Table 25 shows the employment impacts of the 1200 MW power plant by industry for the 2 year total. The top industries impacted, aside from the construction of new power and communication structures, are retail trade, architectural, engineering, and related services, real estate, legal services, restaurants, and hospitals.

Table 25:

Top 20 Employment Effects by Industry for 1200 MW Solar Plant Construction Phase 2 Year Total

Industry	Direct	Indirect	Induced	Total
52 - Construction of new power and communication structures	1,095.95	0.00	0.00	1,095.95
412 - Retail - Miscellaneous store retailers	649.39	2.28	26.43	678.11
457 - Architectural, engineering, and related services	569.97	43.57	2.00	615.54
405 - Retail - Building material and garden equipment and supplies stores	275.34	38.34	8.66	322.34
447 - Other real estate	0.00	108.92	41.96	150.88
455 - Legal services	93.00	8.51	7.04	108.54
509 - Full-service restaurants	0.00	28.56	64.91	93.47
490 - Hospitals	0.00	0.00	77.34	77.34
510 - Limited-service restaurants	0.00	5.12	59.68	64.80
468 - Marketing research and all other miscellaneous professional, scientific, and technical services	0.00	55.91	7.94	63.85
396 - Wholesale - Other durable goods merchant wholesalers	12.34	23.36	5.10	40.81
411 - Retail - General merchandise stores	0.00	3.38	37.12	40.49
406 - Retail - Food and beverage stores	0.00	0.45	39.38	39.83
476 - Services to buildings	4.78	24.20	9.85	38.82
512 - Automotive repair and maintenance, except car washes	0.00	10.11	28.68	38.79
413 - Retail - Nonstore retailers	0.00	3.13	32.10	35.23
463 - Environmental and other technical consulting services	3.21	25.38	4.40	32.99
470 - Office administrative services	0.00	27.16	4.90	32.06
456 - Accounting, tax preparation, bookkeeping, and payroll services	0.00	22.58	9.08	31.66
525 - Private households	0.00	0.00	30.91	30.91

Table 26:

600 MW Solar Plant Construction Phase: Average Annual Jobs

Impact	Employment	Labor Income	Regional GDP	Output
Direct	678.56	$65,534,960	$92,620,227	$98,401,320
Indirect	176.32	$5,944,241	$10,022,478	$24,311,526
Induced	237.29	$8,312,965	$17,056,306	$30,992,543
Total	1,092.16	$79,792,165	$119,699,011	$153,705,389

Table 27:

145 MW Solar Plant Construction Phase: Average Annual Jobs

Impact	Employment	Labor Income	Regional GDP	Output
Direct	163.98	$15,837,615	$22,383,221	$23,780,318
Indirect	42.52	$1,432,044	$2,415,583	$5,862,576
Induced	57.34	$2,008,823	$4,121,640	$7,489,332
Total	263.84	$19,278,482	$28,920,444	$37,132,226

OPERATIONS AND MAINTENANCE PHASE

To model the operations and maintenance phase, the same methodology was used here as for the construction phase: JEDI default expenditures using the assumptions listed in the previous section were input into IMPLAN (see Table 28). Instead of categorizing individual expenditures, the full expenditure amount was put into IMPLAN Industry 42, electric power generation for solar. Since there is no solar plant in Moffat County currently, assumptions for Industry 42 from the State of Colorado were taken and input into Moffat County so an economic impact analysis could be performed.[22]

Table 28:

JEDI Expenditure Estimates for O&M 1200 MW

Expenditures	Cost
Personnel	
Operations	$5,840,291
Administrative	$789,600
Power Plant Maintenance	$2,485,298
Field Maintenance	$7,459,709
Personnel Subtotal	$16,574,898
Materials and Services	
Water	$175,049
Water Treatment (Chemicals)	$45,451
Misc. Services	$205,313
Utilities	$109,597
Fuel (motor vehicle gasoline)	$0
Field Parts and Materials and Plant Equip	$1,117,692
Misc. Supplies & Equipment	$0
Materials and Services Subtotal	$1,653,102
Total	$18,228,000

[22] These assumptions include output per worker, employment compensation per worker, proprietary income per worker, other property income per worker, and taxes on production and imports per worker.

Table 29 illustrates the economic impact of a 1200 MW solar power plant operations and maintenance (O&M) phase. The model predicts 55.61 people directly employed, with 21.53 resulting from supply chain effects and 18.47 from household spending effects, for a total employment impact of 95.61. Total labor income created per year is $6,639,610, and total gross regional product is $15,826,767 per year, with the expected lifespan of the plant at 25 years. Table 30 illustrates which industries benefit from the employment impact of the O&M phase.

Table 29:

1200 MW Solar Plant O&M Phase

Impact	Employment	Labor Income	Regional GDP	Output
Direct	55.61	$4,556,725	$10,580,073	$18,228,000
Indirect	21.53	$1,434,664	$3,915,165	$10,029,367
Induced	18.47	$648,221	$1,331,530	$2,416,156
Total	95.61	$6,639,610	$15,826,768	$30,673,523

Table 30:

Top 20 Employment Effects 1200 MW O&M Employment Effects by Industry

Industry	Direct	Indirect	Induced	Total
Industry	Direct	Indirect	Induced	Total
42 - Electric power generation - Solar	55.61	0.01	0.00	55.62
468 - Marketing research and all other miscellaneous professional, scientific, and technical services	0.00	4.50	0.14	4.64
47 - Electric power transmission and distribution	0.00	3.34	0.01	3.35
509 - Full-service restaurants	0.00	1.11	1.18	2.29
447 - Other real estate	0.00	1.40	0.62	2.02
40 - Electric power generation - Fossil fuel	0.00	1.87	0.01	1.88
490 - Hospitals	0.00	0.00	1.46	1.46
510 - Limited-service restaurants	0.00	0.08	1.12	1.20
472 - Employment services	0.00	1.00	0.08	1.09
406 - Retail - Food and beverage stores	0.00	0.03	0.75	0.78
411 - Retail - General merchandise stores	0.00	0.05	0.70	0.75
413 - Retail – Non-store retailers	0.00	0.10	0.61	0.71
456 - Accounting, tax preparation, bookkeeping, and payroll services	0.00	0.47	0.17	0.63
512 - Automotive repair and maintenance, except car washes	0.00	0.08	0.54	0.62
420 - Scenic and sightseeing transportation and support activities for transportation	0.00	0.58	0.04	0.61
525 - Private households	0.00	0.00	0.59	0.59
476 - Services to buildings	0.00	0.40	0.17	0.57
408 - Retail - Gasoline stores	0.00	0.36	0.19	0.55
455 - Legal services	0.00	0.40	0.13	0.53
412 - Retail - Miscellaneous store retailers	0.00	0.01	0.50	0.51

Table 31 and 32 illustrate the economic impact of the O&M phase of a 600MW solar power plant and a 145 MW solar plant. The 600 MW plant creates 47.79 jobs per year during the operations phase, expected to last 25 years. This contributes $3.3 million in wages and $7.9 million on regional GDP. The 145 MW plan creates 11.53 jobs, creates $800,926 of labor income, and $1.9 million in regional GDP.

Table 31:

600 MW Solar Plant O&M Phase

Impact	Employment	Labor Income	Regional GDP	Output
Direct	27.81	$2,278,362	$5,290,037	$9,114,000
Indirect	10.75	$716,716	$1,956,583	$5,012,687
Induced	9.23	$324,076	$665,695	$1,207,953
Total	47.79	$3,319,154	$7,912,314	$15,334,640

Table 32:

145 MW Solar Plant O&M Phase

Impact	Employment	Labor Income	Regional GDP	Output
Direct	6.72	$550,604	$1,278,426	$2,202,550
Indirect	2.58	$172,037	$471,205	$1,208,294
Induced	2.23	$78,286	$160,807	$291,800
Total	11.53	$800,927	$1,910,438	$3,702,644

Table 33 summarizes the three nameplate sizes into one table for comparison purposes. Table 34 compares the statistical model to the IMPLAN models developed, compared by megawatt. The table shows that the statistical model anticipates fewer job impacts than the IMPLAN model (940 compared to 1,357), however the statistical model in the 145 MW case shows more jobs created (29 job difference). The comparison for the O&M results show that, for the 145 MW case, the jobs are the same but that, for the 600 and 1200 MW cases, the IMPLAN model predicts more jobs than the statistical model.

It is important to note that these employment impacts focus on Moffat, Rio Blanco, and Routt counties. There is very little supply chain impact from solar compared to if this study were for the entire State of Colorado. For instance, the Front Range/Denver area has solar manufacturers and all the supply chain industries that support it. If this same study was conducted at the State level, and not the 3-county level, the employment impacts would likely be higher because of the deeper supply chain impacts and the induced spending that comes with it. This is important to note, but the Colorado impacts are outside of the scope of this study, as this study is addressing the impacts in the three-county area only.

Table 33:

Nameplate Size Comparison, Average Annual Jobs for 145 MW, 600 MW, and 1200 MW Outputs

	Nameplate Size	Employment	Labor Income	Regional GDP	Output
Construction	145 MW	263.84	$19,278,482	$28,920,444	$37,132,226
	600 MW	1,092.16	$79,792,165	$119,699,011	$153,705,389
	1200 MW	2,184.51	$159,592,870	$239,411,436	$307,437,080
O&M	145 MW	11.53	$800,927	$1,910,438	$3,702,644
	600 MW	47.79	$3,319,154	$7,912,314	$15,334,640
	1200 MW	95.61	$6,639,610	$15,826,768	$30,673,523

Table 34:

Statistical Models Compared to IMPLAN Models (Direct Jobs Comparison)

Model	Direct Employment	145 MW	600 MW	1200 MW
Statistical model	Construction Phase (Yearly)	192.38	514.83	940.05
	O&M Phase (Yearly)	6.67	18.55	34.21
IMPLAN model	Construction Phase (Yearly)	163.98	678.56	1,357.12
	O&M Phase (Yearly)	6.72	27.81	55.61

ECONOMIC IMPACT OF NATURAL GAS

LITERATURE REVIEW NATURAL GAS POWER

The same assumptions used for solar were applied to natural gas power plant economic impact studies, (i.e. only studies of 0-2000 MW, county level, etc.). There were not enough studies that met the criterion to have statistical significance. There were two studies that did meet the criterion, and they are listed in Table 35. Due to lack of data points that fit the criterion set in the solar section, conducting a statistical analysis of direct impacts was not performed for the natural gas power plant section of this report.

Table 35:

Literature on Natural Gas

		Construction		O&M	
Author	Nameplate Size	Direct	Total	Direct	Total
AKRF, Inc.	1200	2,146	3,484	33	139
Peabody	1500	1,350	5,970	78	868

IMPLAN MODEL

For the IMPLAN model, the same approach was used in the solar section: Input assumptions into the JEDI model, and use the expenditure output to input into the regional IMPLAN model. Table 36 illustrates the assumptions for the JEDI model. Sources for these assumptions primarily come from the Energy Information Agency and are in the footnotes for each category. The nameplate size estimated is 400 MW, which would provide backup generation for the 1200 MW of solar power being estimated in the previous section. 1200 MW of solar and 400 MW of natural gas power would replace the 1600 MW of coal power in the region.

Table 36:

Assumptions for JEDI model

Assumption	#
Project Size - Nameplate Capacity (MW)	400
Capacity Factor (Percentage)[23]	57%
Heat Rate (Btu per kWh)[24]	7,627
Construction Period (Months)[25]	36
Plant Construction Cost ($/KW)[26]	$1,079
Cost of Fuel ($/mmbtu)	$2.50
Fixed Operations and Maintenance Cost ($/kW)	$14.04
Variable Operations and Maintenance Cost ($/MWh)	$2.54

[23] Capacity factor is from https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_a

[24] Heat rate is from https://www.eia.gov/electricity/annual/html/epa_08_02.html.

[25] Construction period and $/KW are from The Energy Information Administration's "Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2020."

[26] $2.50 of natural gas was used as the assumption for natural gas prices, which affects variable costs in the O&M phase of the model.

Table 37 lists the JEDI estimated construction costs that are used to input into IMPLAN. The total project cost is $439,183,466, with an estimated three-year construction period. To get the yearly costs in Table 37 you must divide by three. Similar to the solar plant O&M phase, the O&M expenditures were put into IMPLAN Industry 40, Electric power generation for fossil fuels. Since there is no natural gas power plant in Moffat County currently, assumptions for Industry 40 from Garfield County were taken and input into Moffat County so an economic impact analysis could be performed to accurately model natural gas power.[27]

Table 37:

JEDI Total Expenditures

Construction Costs	Cost
Facility and Equipment	
Power Generation	$152,329,412
General facilities	$38,082,353
Plant Equipment	$68,548,235
Subtotal	$258,960,000
Labor and Management	
Construction Labor	$73,625,882
Project management (construction and owner's)	$40,621,176
Construction Utilities	$2,538,824
Subtotal	$116,785,882
Construction Subtotal	$375,745,882
Other Costs	
Engineering/Design	$10,155,294
Construction insurance	$2,538,824
Land	$20,310,588
Permitting Fees	$10,155,294
Grid intertie	$10,155,294
Spare Parts	$2,538,824
Other Subtotal	$55,854,118
Subtotal All Costs (without sales tax)	$431,600,000
Sales Tax (Materials & Equipment Purchases)	$7,583,466
Total Project Cost	$439,183,466
Interconnection Piping	$82,447,475
Electronics & Controls	$28,502,745
Balance of Plant	$32,519,411
Equipment Subtotal	$1,120,652,105
Other Costs	
Freight & Transportation	$0
Engineering & Project Management	$165,502,123
Misc. Costs (permitting, licensing, legal)	$38,582,324
Other Subtotal	$204,084,447
Subtotal	$1,597,200,000
Sales Tax (Materials & Equipment Purchases)	$33,734,902
Total	$1,630,934,902

[27] These assumptions include output per worker, employment compensation per worker, proprietary income per worker, other property income per worker, and taxes on production and imports per worker.

Table 38 illustrates the yearly impact, which shows that the construction of a natural gas power plant creates 815 in employment, $53,765,627 in labor income, and $106,144,508 in regional GDP. Table 39 illustrates the total impact for the full three years of the construction phase for the natural gas power plant. The total impact of the three-year construction period is 2,447 jobs, including 1,552 direct jobs and $318,444,861 in regional GDP. Table 38 illustrates the yearly impact, which shows that the construction of a natural gas power plant creates 815 in employment, $53,765,627 in labor income, and $106,144,508 in regional GDP. Table 39 illustrates the total impact for the full three years of the construction phase for the natural gas power plant. The total impact of the three-year construction period is 2,447 jobs, including 1,552 direct jobs and $318,444,861 in regional GDP.

Table 38:

400 MW Natural Gas Plant Construction Phase: Average Annual Jobs

Impact	Employment	Labor Income	Regional GDP	Output
Direct	517.44	$42,545,570.13	$84,524,979.98	$127,039,922.36
Indirect	121.79	$4,906,157.68	$8,717,674.32	$20,427,029.75
Induced	176.58	$6,313,899.50	$12,901,854.58	$23,585,145.36
Total	815.81	$53,765,627.31	$106,144,508.88	$171,052,097.46

Table 39:

400 MW Natural Gas Construction Phase: Total Jobs over 3 Years

Impact	Employment	Labor Income	Regional GDP	Output
Direct	1,552.33	$127,635,811.73	$253,574,041.72	$381,119,769.07
Indirect	365.47	$14,721,343.97	$26,158,130.29	$61,294,316.46
Induced	529.82	$18,946,012.08	$38,712,689.76	$70,769,876.90
Total	2,447.62	$161,303,167.78	$318,444,861.77	$513,183,962.42

The construction phase employment impacts by industry and type are listed in Table 40. The direct employment utilized in construction is 1,552 total over three years, with architectural, engineering, and other related services second with 132 jobs. Hospitals, real estate, restaurants, and retail are the next biggest beneficiaries from the construction phase.

Table 40:

Top 20 Employment Effects by Industry for 400 MW Natural Gas Plant Construction Phase (3 Year Total Numbers)

Industry	Direct	Indirect	Induced	Total
52 - Construction of new power and communication structures	1,511.39	0.00	0.00	1,511.39
457 - Architectural, engineering, and related services	29.23	37.55	1.05	67.83
405 - Retail - Building material and garden equipment and supplies stores	0.00	51.38	4.52	55.90
447 - Other real estate	0.00	32.93	21.94	54.87
509 - Full-service restaurants	0.00	5.50	34.36	39.87
490 - Hospitals	0.00	0.00	38.99	38.99
510 - Limited-service restaurants	0.00	1.02	31.12	32.14
396 - Wholesale - Other durable goods merchant wholesalers	0.00	28.59	2.67	31.27
445 - Insurance agencies, brokerages, and related activities	10.97	12.11	1.60	24.68
512 - Automotive repair and maintenance, except car washes	0.00	8.69	14.91	23.61
411 - Retail - General merchandise stores	0.00	4.06	18.98	23.04
406 - Retail - Food and beverage stores	0.00	0.45	20.63	21.08
413 - Retail - Nonstore retailers	0.00	2.99	16.75	19.74
468 - Marketing research and all other miscellaneous professional, scientific, and technical services	0.00	14.27	4.11	18.39
476 - Services to buildings	0.24	13.00	5.14	18.39
412 - Retail - Miscellaneous store retailers	0.00	2.54	13.70	16.24
525 - Private households	0.00	0.00	15.93	15.93
456 - Accounting, tax preparation, bookkeeping, and payroll services	0.00	10.00	4.72	14.71
488 - Home health care services	0.00	0.00	12.86	12.86
482 - Other educational services	0.00	0.36	11.81	12.17

OPERATIONS AND MAINTENANCE PHASE

The operations and maintenance phase was modeled assuming that 100% of natural gas production for the power plant would come from the region.[28] The results show that 40 direct jobs would be created per year resulting from the power plant, with 197 indirect (supply chain) jobs and 45 induced jobs being created, for a total of 282 per year (Table 41). The labor income impact is $24,823,646, while the regional GDP impact is $49,353,073.

Table 41:

400 MW Natural Gas Plant O&M Phase

Impact	Employment	Labor Income	Regional GDP	Output
Direct	40.06	$3,370,350	$13,973,442	$48,656,347
Indirect	197.13	$20,177,244	$31,458,148	$63,576,083
Induced	44.58	$1,276,053	$3,921,483	$6,789,810
Total	281.77	$24,823,646	$49,353,074	$119,022,240

[28] In order to accurately model this, an Analysis-by-Parts approached was used. Analysis-by-Parts is a technique by which you can analyze the impact of an Industry's production/spending in separate components using multiple Events instead of using a single Industry Event.

Table 42 illustrates the employment impacts of the O&M phase. Aside from 40 direct jobs created from the power plant, 47 jobs are created in the oil and gas extraction industry, while professional services, employment services, real estate, and electric power transmission all benefit from the O&M phase.

Table 42:

Top 20 Employment Effects by Industry for 400 MW Natural Gas Plant O&M Phase

Industry	Direct	Indirect	Induced	Total
40 - Electric power generation - Fossil fuel	40.06	0.00	0.00	40.06
20 - Oil and gas extraction	0.00	46.81	0.07	46.87
468 - Marketing research and all other miscellaneous professional, scientific, and technical services	0.00	25.94	0.31	26.25
472 - Employment services	0.00	16.59	0.44	17.03
447 - Other real estate	0.00	14.26	1.61	15.87
47 - Electric power transmission and distribution	0.00	13.21	0.19	13.40
509 - Full-service restaurants	0.00	5.85	5.25	11.09
441 - Monetary authorities and depository credit intermediation	0.00	5.46	1.09	6.54
420 - Scenic and sightseeing transportation and support activities for transportation	0.00	4.87	0.19	5.07
417 - Truck transportation	0.00	4.31	0.68	4.98
499 - Independent artists, writers, and performers	0.00	4.00	0.55	4.55
419 - Pipeline transportation	0.00	4.21	0.00	4.21
396 - Wholesale - Other durable goods merchant wholesalers	0.00	2.98	0.54	3.51
406 - Retail - Food and beverage stores	0.00	0.20	3.22	3.42
476 - Services to buildings	0.00	3.14	0.24	3.37
445 - Insurance agencies, brokerages, and related activities	0.00	3.17	0.18	3.34
473 - Business support services	0.00	2.96	0.28	3.24
512 - Automotive repair and maintenance, except car washes	0.00	1.41	1.75	3.16
475 - Investigation and security services	0.00	2.42	0.24	2.66
511 - All other food and drinking places	0.00	1.09	1.55	2.64

CONCLUSION: COMPARING LOSSES FROM COAL TO THE GAINS FROM SOLAR AND NATURAL GAS

The economic contribution of coal takes into account severance, FML, and ad valorem taxes. The economic impact of solar and natural gas does not, simply because the estimated amount of these revenues is difficult to predict. When comparing the two, this can have the effect of underestimating solar and natural gas. As a reference, severance, FML, and ad valorem taxes make up 10.9% of employment losses in coal. However, it is unlikely that solar will be able to replace the severance, FML, and ad valorem taxes as solar does not fall under severance or FML requirements, and potential ad valorem taxes on solar are beyond the scope of this report. Table 43 illustrates a simple comparison, assuming that Scenario 2 employment losses happen in time period one, and solar and natural gas construction happen in period one. The table extends to six time periods, but would continue as such for the life of the power plants. The results show that solar and natural gas cannot replace all of the employment of labor intensive coal. The employment levels for

solar and natural gas are higher during the construction phase, which could help workers transitioning from the coal industry, but during the O&M phase employment gains from 1600 MW of solar and natural gas replace 14.8% of jobs lost from coal. When framing the problem solely from an employment perspective, solar and natural gas can be part of the solution, but the solution to job replacement must be much bigger to replace employment losses.

Table 43:

Coal Losses Compared to Solar and Natural Gas Gains

Year	1200 MW Solar Employment Gains	400 MW Natural Gas Employment Gains	Coal Employment Losses	Net Gain/Loss
1	2,184 (Construction)	815 (Construction)	2,553	446
2	2,184 (Construction)	815 (Construction)	2,553	446
3	95.61 (O&M)	815 (Construction)	2,553	-1,642
4	95.61 (O&M)	282 (O&M)	2,553	-2,175
5	95.61 (O&M)	282 (O&M)	2,553	-2,175
6	95.61 (O&M)	282 (O&M)	2,553	-2,175

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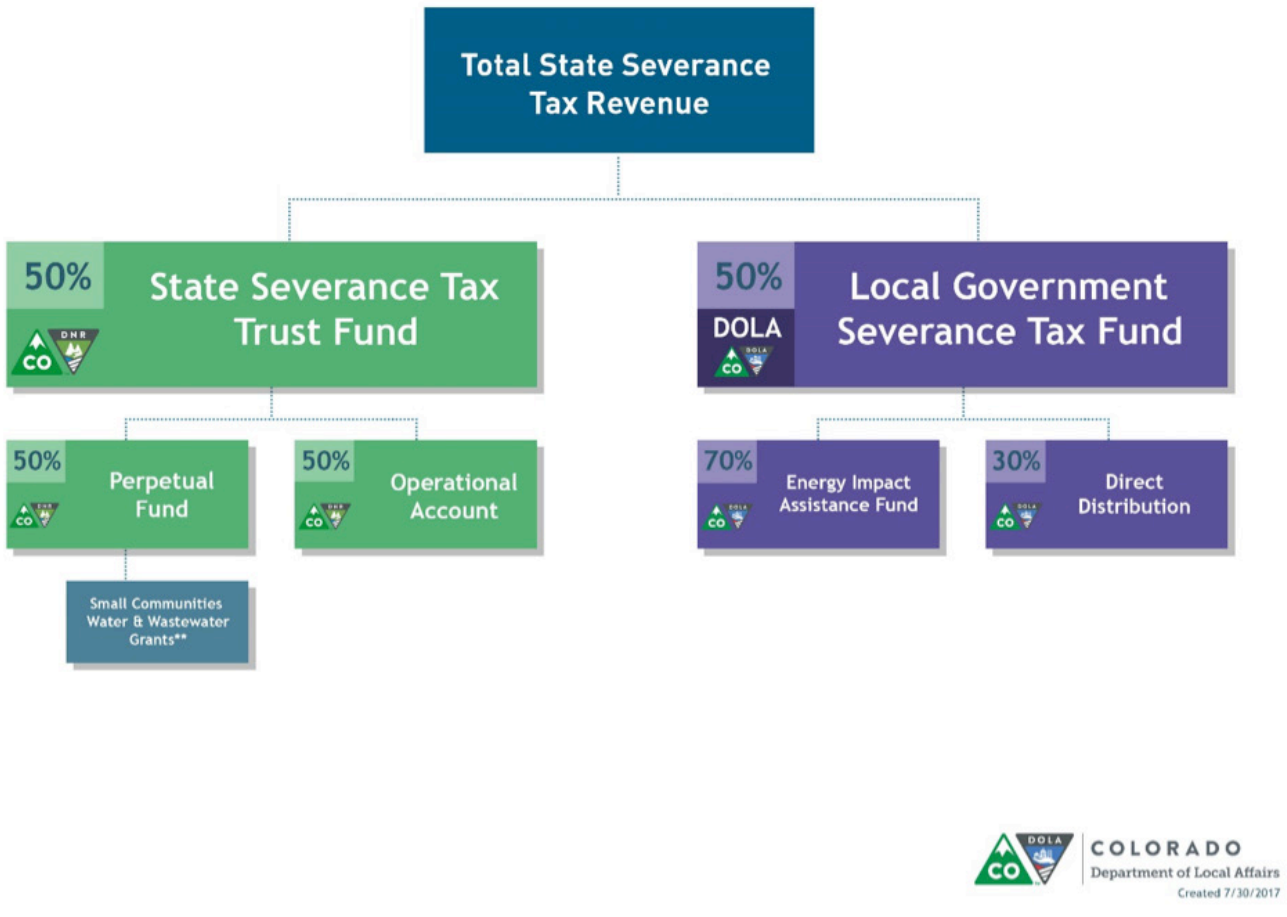
[29] Note that information from Hamilton, Smith, and Banda (2010), Hamilton, Berkman, and Tran (2011), Aspen Group (2011), and Berkman and Ahlgren (2011) are all taken from Phillips (2013) and (2014) and are cited the same.

APPENDIX A: SEVERANCE TAXES

A severance tax is a tax on the removal of a non-renewable energy source. Figure 4 illustrates the flow chart of state severance tax revenue. For information on the formula that DOLA uses to distribute income via direct distribution from severance and FML, visit https://www.colorado.gov/pacific/dola/direct-distribution-severance-tax-federal-mineral-lease.

Figure 4:

Department of Local Affairs Severance Tax Flow Chart

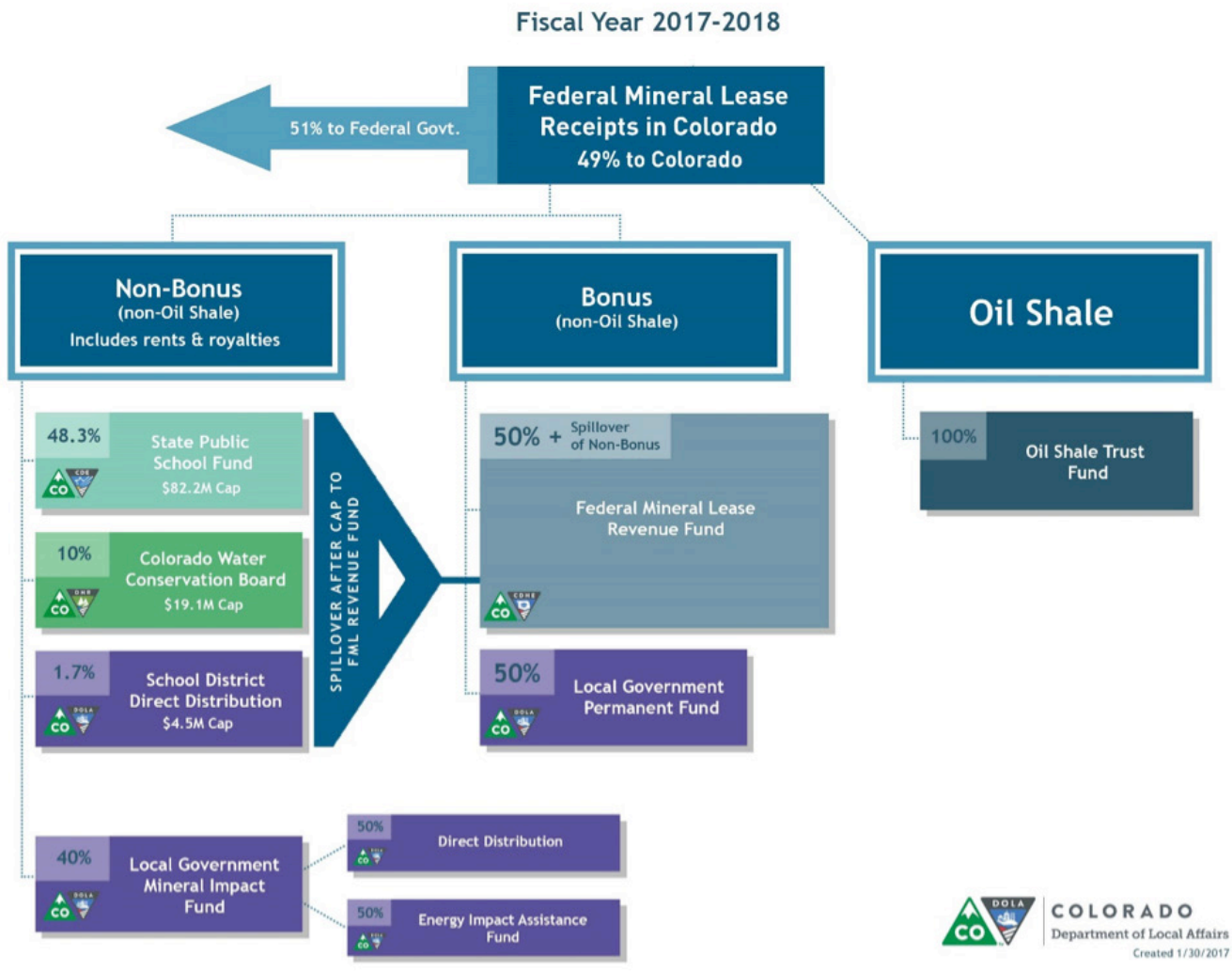


APPENDIX B: FEDERAL MINERAL LEASE

Federal mineral lease (FML) money is collected from the lease of federal land to companies that extract natural resources. Figure 5 illustrates how FML is distributed.

Figure 5:

Department of Local Affairs FML Flowchart



APPENDIX C: AVERAGE WAGE CHANGE CALCULATION

The following tables illustrate estimates of the average wage change. IMPLAN provides data on employee compensation and proprietor income. The combination of the two is labor income. In the economic contribution/impact models, labor income is reported by IMPLAN, and not employee compensation and proprietor income individually. Because of this, labor income changes will be used to estimate the average wage change. Table 44 summarizes the total employee compensation, proprietor income, labor income, employment, and average wage (calculated using this data) for all three counties. Table 45 uses the data from table 44 and the estimates of losses derived earlier in the report to estimate average wage changes per county per scenario. The average wage in table 44 is the average wage before coal losses, whereas the average wage in table 45 is after the coal losses.

Table 44:

IMPLAN Labor Income Data

County	Employee Compensation	Proprietor Income	Labor Income	Employment	Average Wage
Moffat	$280,937,931	$38,924,143	$319,862,075	7,052	$45,357
Rio Blanco	$181,374,622	$31,499,489	$212,874,112	4,291	$49,609
Routt	$834,033,829	$230,710,962	$1,064,744,791	23,666	$44,990
Total	$1,296,346,383	$301,134,595	$1,597,480,979	35,008	$45,631

Table 45:

Estimates of Average Wage Losses

3 Counties Combined	Labor Income Lost	Employment Lost	New Average Wage	% Drop in Average Wages
Scenario 1	$228,392,533	2,862	$42,590	7.14%
Scenario 2	$204,410,148	2,553	$42,923	6.31%
Scenario 3	$152,202,562	1,901	$43,655	4.53%
Moffat				
Scenario 1	$109,992,178	1,398	$37,122	22.19%
Scenario 2	$109,719,054	1,392	$37,129	22.16%
Scenario 3	$108,778,088	1,372	$37,164	22.05%
Rio Blanco				
Scenario 1	$32,599,310	389	$46,203	7.37%
Scenario 2	$12,936,765	146	$48,237	2.85%
Scenario 3	$12,296,892	142	$48,338	2.63%
Routt				
Scenario 1	$85,801,045	1,075	$43,333	3.83%
Scenario 2	$81,754,328	1,015	$43,397	3.67%
Scenario 3	$31,117,582	387	$44,402	1.33%