INL/RPT-23-73380
Revision 0

Estimating Economic Impacts of Repurposing the Coronado Generating Station with Nuclear Technology

Summary Report

GAIN
Gateway for Accelerated Innovation in Nuclear

GAIN
Gateway for Accelerated Innovation in Nuclear

Estimating Economic Impacts of Repurposing the Coronado Generating Station with Nuclear Technology

Summary Report

Prepared by:

William Jenson, Nahuel Guaita, Levi Larsen, and Jason Hansen
Department of Integrated Energy and Market Analysis
Idaho National Laboratory

DISCLAIMER

This information was prepared as an account of work sponsored by an agency of the U.S. Government. Neither the U.S. Government nor any agency thereof, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness, of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. References herein to any specific commercial product, process, or service by trade name, trade mark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the U.S. Government or any agency thereof.

EXECUTIVE SUMMARY

As owners of coal-fired power plants decide to retire coal-powered generation capacity, a natural, follow-up question is: what will happen with the coal plant? Or more specifically, what will happen to the people and community where the plant is located? This report focusses on answering that question with respect to the community surrounding the Coronado Generating Station (CGS) in St Johns, Arizona where the Salt River Project (SRP) has announced the plant's retirement.

The report relies on an input-output model to evaluate regional economic impacts in the counties within the labor shed (i.e., commuting distance) of CGS. They are Apache and Navajo Counties ("Region"). These counties are comprised of tribal and non-tribal lands. For the purposes of this report the employment, education and income data is an aggregate of all residents and does not differentiate between tribal and non-tribal populations. The report describes the socioeconomic characteristics of these counties and then provides the results of a comparison between two states of the world: one where CGS runs as a coal power plant and one where it runs as a nuclear power plant. In the case of the nuclear power plant, the analysis evaluates four scenarios based on possible options for nuclear generating capacity in terms of MW. The analysis measures economic impacts to jobs, labor income in the Region, value added (i.e., new economic activity) and economic output. These metrics are assessed at the level of the power plant (direct impacts), at the supply chain supporting the power plant (indirect impacts), and in the community surrounding the power plant (induced impacts). Table 1 shows the combined results of the analysis at the level of the three categories (direct, indirect, and induced) at CGS and the four replacement nuclear scenarios.

Table 1. Summary of Annual Economic Impacts

	CGS	Scenario A	Scenario B	Scenario C	Scenario D
Nameplate Capacity (MWe)	822	320	462	616	924
Employment (jobs)	448	353	576	705	989
% of Total Employment	0.6%	0.5%	0.8%	1.0%	1.4%
Labor Income	$39.7	$31.3	$53.4	$63.3	$86.4
% of Total Labor Income	1.2%	1.0%	1.7%	2.0%	2.7%
Value Added	$129.9	$92.3	$142.4	$181.1	$262.3
% of Regional GDP	2.2%	1.5%	2.4%	3.0%	4.4%
Economic Output	$304.2	$233.4	$339.8	$450.3	$672.6
% of Total Economic Output	3.2%	2.4%	3.5%	4.7%	7.0%
Note: All dollar values in millions.					

A few key points can be attained from this table. First, the column labeled 'CGS' shows an estimate of the losses the Region will experience if the coal power plant is not replaced. Second, Scenarios B – D show the expected economic gain should one of the capacity sizes shown here be selected to replace the coal power plant at CGS. Each of the columns for Scenario B – D exceed the economic impacts listed for CGS. The measurements for Scenario A show less than for CGS, which means that a nuclear reactor of size 320 MW will not likely generate economic impacts on par with the CGS today.

These scenarios have social and environmental justice implications that the report discusses. They also have impacts for workforce transition issues and broader labor shed implications. Additional coal generation capacity in the Four Corners region is projected to retire, so many of the net gain in jobs created under Scenarios B – D could be populated by displaced coal power plant workers outside of the immediate region of analysis.

CONTENTS

FIGURES

TABLES

ACRONYMS

BLS	Bureau of Labor Statistics
CGS	Coronado Generating Station
DOE	Department of Energy
EIA	Energy Information Administration
EPA	Environmental Protection Agency
LEAD	Low-Income Energy Affordability Data
MW	Megawatt electric
MWh	Megawatt hours
NPC	North Pioneer College
NREL	National Renewable Energy Laboratory
SMR	Small modular reactors
SRP	Salt River Project

Estimating Economic Impacts of Repurposing the Coronado Generating Station with Nuclear Technology

INTRODUCTION

As owners of coal-fired power plants decide to retire coal-powered generation capacity, a natural, follow-up question is: what will happen with the coal plant? This question is asked from various perspectives, many of which are discussed in (Hansen et al. 2022). Poignant among them is the perspective of local communities where coal power plants represent a large fraction of the economic base. This report focuses on one coal community, St. Johns, Arizona, where plans for the local coal power plant, the Coronado Generating Station (CGS), include retirement at the end of 2032.

The purpose of this report is to detail what community planners and other interested stakeholders might expect in terms of regional, economic impacts from both the CGS plant retirement as well as what might happen if the owner of CGS, Salt River Project (SRP), chose to install a nuclear power plant for replacement generation. Today, CGS employs about 150 people, and when secondary effects of that employment are factored in, one can reach the conclusion that CGS is responsible for almost 450 jobs in the region. In this study, the region consists of the Apache and Navajo Counties. The analysis considers discrete levels of replacement power generation capacity based on design technologies that exist today. Then an economic model is constructed to estimate regional impacts that compares two states of the world, one with CGS operating as a coal power plant and one with CGS operating as a nuclear power plant. Because of this approach, the transition phase, which includes construction and associated economic impacts, are not part of the results. However, others have estimated that nuclear construction could create up to 1,600 jobs during the transition (NuScale 2021).

The report begins with an overview of the region, including a summary of coal power plants in the region where plans for retirement have been announced. Although the focus of this report is on the CGS, one can consider the sizes of the generating stations in neighboring regions, and the employees located there, when looking at the economic impact results described in this report. The scenarios analyzed change the number of employees working at the replacement nuclear plants. For scenarios where the employee count exceeds that of the CGS, employees from the neighboring stations would be likely contenders to fill the jobs created.

This report is not intended for use as a financial forecast or to replace accounting practices but should be used for comparing socioeconomic impacts of various nuclear power replacement options. These replacement options are sized in a way to facilitate sensitivity analysis in case energy production needs evolve.

A summary of economic multipliers for CGS are as follows:

- **Output Multiplier:** CGS's output multiplier was **1.43**, which means that for every $100 of direct impact added by CGS operations, an additional $43 dollars will be generated throughout the regional economy.
- **Employment Multiplier:** CGS's employment multiplier is **3.01**, which means that adding 100 employees to CGS's payroll will result in an additional 201 jobs created throughout the regional economy.
- **Labor Income Multiplier:** CGS's labor income multiplier is **1.82**, which means that for every $100 in employee compensation (including salaries, payroll taxes, and benefits), paid by CGS to its employees, an additional $82 in employee compensation would be added to the regional economy.
- **Value-Added Multiplier:** CGS's value-added multiplier is **1.45**, which means that if the value added by CGS to the production of final goods and services was to increase by $100 then an additional $45 in value would be added to the regional economy.

The economic results show that, depending on the scenario, almost 550 new (incremental) jobs could be created in the region. These are jobs that net out the effect of coal power plant workers finding employment at the nuclear facility—550 new jobs in the region. Such a scenario could generate as much as $350 million in new economic activity because of the increase in wage and population growth in the region that would likely accompany such a scenario. The report sheds more light on this and other scenarios and the associated impacts. Then the report discusses issues related to workforce transition. The local community college is a strong resource to support such a transition. Lessons learned from the community college in Wyoming, where a coal-to-nuclear transition is already underway, are considered in the context of St. Johns.

The possibility of a coal-to-nuclear transition is not a panacea for energy communities like St. Johns. But it is an option to consider when planning for the retirement of the local coal power plant.

REGION OF ANALYSIS

The region of analysis for this study is composed of two counties in northeastern Arizona, the Apache and Navajo Counties. This section provides a statistical overview of the region, including a discussion of the coal communities therein.

Apache and Navajo Counties

Apache County is in the northeastern corner of Arizona, where the states of Arizona, New Mexico, Utah, and Colorado meet, with nearly three-quarters of the population residing in rural areas. The county seat is St. Johns. Most of the county encompasses the Navajo Nation and the Fort Apache Indian Reservation. In a previously published report completed by Arizona State University, some of the economic data for the Indian reservations was reported separately from the county data. In this report the county economic data is sourced directly from the U.S. Bureau of Labor Statistics and does not separate out tribal data from the county totals.

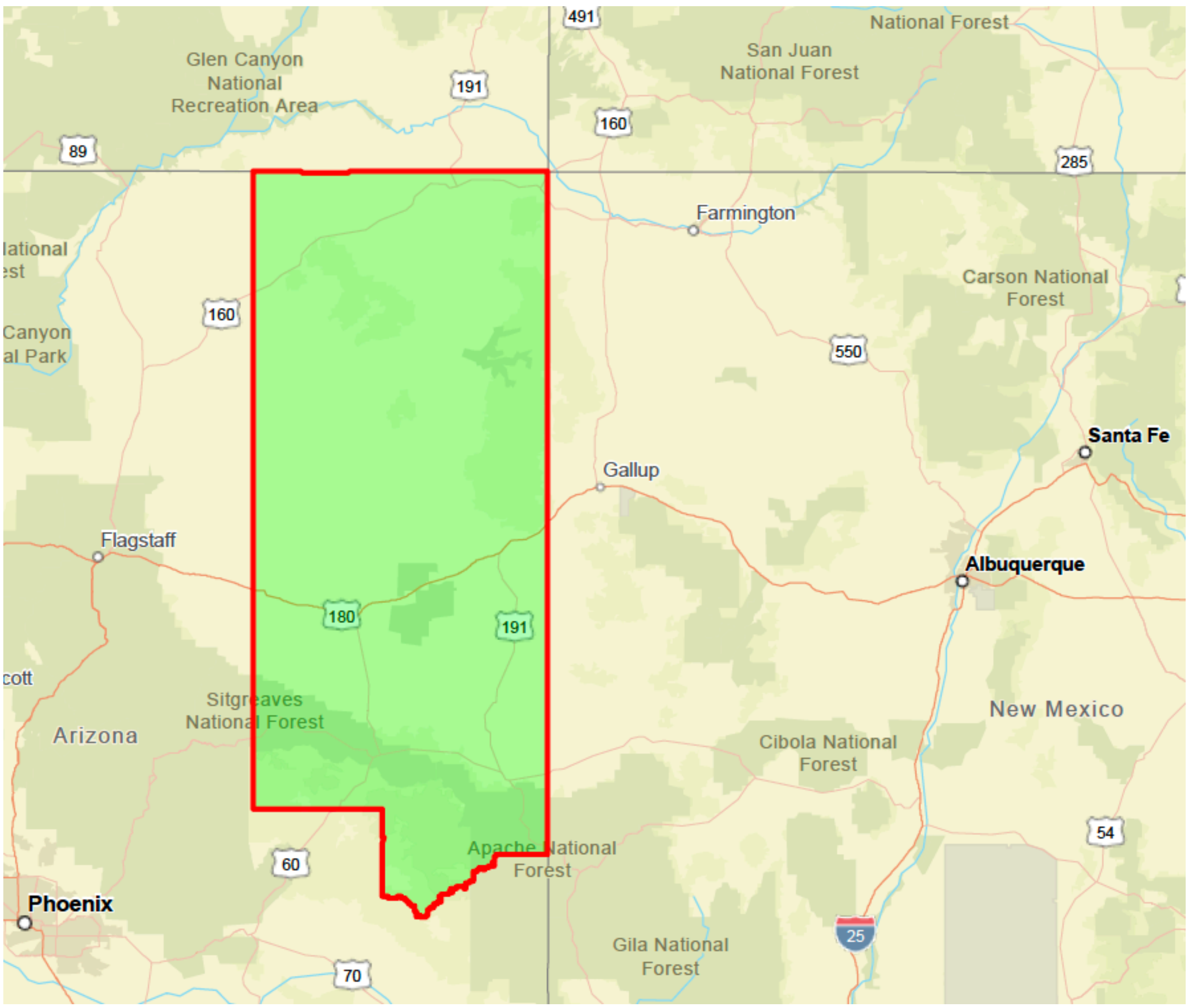

Figure 1. Region of Analysis: Apache and Navajo Counties (U.S. EPA 2022a).

Navajo County contains parts of the Hopi Indian reservation, the Navajo Nation, and Fort Apache Indian Reservation, and it is located adjacent to Apache County. The highlighted area on the map in Figure 1 shows the region of analysis. Navajo County has the third largest area in the

United States of federally designated Indian reservation within its borders, neighboring with Apache County and Coconino County which are the first and second. The sociodemographic characteristics of both the Apache and Navajo Counties are complemented with economic attributes that are described below.

Socioeconomics and Environment

EJScreen serves as the U.S. Environmental Protection Agency's (EPA's) mapping and screening tool for environmental justice and energy burdens (U.S. EPA 2022b). Environmental justice is defined as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (U.S. EPA 2022a). Energy burden is the percentage of gross household income spent on energy costs (U.S. DOE 2019). The tool offers a standardized data set and methodology so that users of the data can find information on environmental factors and socioeconomic indicators.

Table 2 shows descriptive statistics of the Apache and Navajo Counties with corresponding socioeconomic, employment, and population data. These data shed light on the social justice implications for the region and serve as quantitative measures enabling the evaluation and comparison of demographic and socioeconomic characteristics across different areas. By incorporating multiple indicators, these indexes provide a more comprehensive understanding of the social and economic dynamics within specific geographic regions.

Table 2. Social and Environmental Justice Indicators Part 1.

Index	Apache County	Navajo County	State Avg.	USA Avg.
Demographic Index	71%	54%	38%	35%
Supplemental Demographic Index	26%	21%	15%	15%
People of Color	82%	58%	46%	40%
Low Income	60%	49%	33%	30%
Unemployment Rate	9%	11%	6%	5%
Limited English Speaking	17%	5%	4%	5%
Population with Less Than High School Education	19%	16%	12%	12%
Housing Energy Burden (A)	4.01%	4.61%	N/A	N/A
Transportation Burden (B)	4.89%	4.42%	N/A	N/A
Energy Burden (A)+(B)	8.9%	9.03%	2%	2.46%
Source: U.S. EPA 2022b				

The EPA screening tool incorporates two indices derived from socioeconomic indicators (U.S. EPA 2022b). The Demographic Index is computed as the average of two key socioeconomic indicators, the proportion of individuals classified as low income and people of color. This metric represents the percentage of individuals residing in a block group who self-identify as a racial category other than solely white, in addition to individuals who identify their ethnicity as Hispanic or Latino. The Supplemental Demographic Index is calculated as the average of five socioeconomic indicators. These indicators encompass (i) the proportion of individuals classified as low income, (ii) the unemployment rate, (iii) the percentage of individuals with limited English proficiency, (iv) the percentage of individuals with less than a high school education, and (v) data on low life expectancy derived from a health data set.

Total energy burden is the sum of household energy and transportation burden data. Housing energy burden data comes from the Low-Income Energy Affordability Data (LEAD) Tool, developed by the U.S. Department of Energy (DOE) and National Renewable Energy Laboratory (NREL) (NREL 2023). The NREL analysis shows that when energy bills consume more than 6% of a single household's income that the household is then categorized as having a high energy burden. Note that the energy burden data for the Apache and Navajo Counties are greater than the state and national data on energy burden.

The Apache and Navajo Counties show a demographic index above the state and national averages. For instance, low-income people represent more than 50% of the total population in Apache County, and it reaches 49% in Navajo County. This low income also is affected by high unemployment with a 9% and 10% unemployment rate in the Apache and Navajo Counties, respectively. In addition, education attainment for bachelor's degrees or higher falls well below the state average. Table 3 shows that poverty in both regions is above average compared to the rest of the state, as more than one-fourth of the population is under the poverty line. In summary, the Apache and Navajo Counties present indicators showing socioeconomic disadvantages.

Table 3. Social and Environmental Justice Indicators Part 2 (U.S. Census 2021).

Index	Apache County	Navajo County	Arizona
Total Population	66,021	108,650	7,359,197
Median Household Income	$40,628	$49,449	$69,056
Poverty	28.50%	25.60%	12.8%
Bachelor's Degree or Higher	16.20%	18.20%	32.4%
Source: U.S. Census 2021			

Employment

Table 4 shows employment data in the region. Employment in Apache County is mostly dependent on the government, service related, and non-service related. Farm and health care and social assistance have a big share of the total employment as it shows in the following table. For Navajo County, the service-related sector is critical to the county's total employment, followed by government and non-service related. Retail trade, health care, and social assistance are also important, each with an 11% share of total employment.

Table 4. Regional Job Categories by Sector and Total.

	Apache		Navajo	
Sector	Jobs	(%)	Jobs	(%)
Total Employment	27,051	100	42,408	100%
Government	9,964	37	9,808	23
Services related	9,701	36	24,698	58
Non-services related	7,150	26	7,902	19
Farm	5,224	19	3,879	9
Health care and social assistance	2,934	11	4,528	11
Retail trade	1,430	5	4,795	11
Construction	1,208	4	2,589	6
Accommodation and food services	1,048	4	3,831	9
Other services, except public admin.	656	2	1,974	5
Transportation and warehousing	600	2	1,418	3
Real estate and rental and leasing	585	2	1,807	4
Administrative and waste services	492	2	1,525	4
Educational services	463	2	784	2
Professional and technical services	446	2	1181	3
Manufacturing	323	1	549	1
Utilities	262	1	719	2
Arts, entertainment, and recreation	262	1	641	2
Forestry, fishing, and agricultural services	250	1	719	2
Finance and insurance	228	1	1069	3
Wholesale trade	156	1	568	1
Mining (including fossil fuels)	145	1	166	0
Information	107	0	318	1
Management of companies	32	0	150	0
Source: U.S. Census 2021				

Coal Power Plants in the Region

Table 5 shows the coal-fired power plants and their scheduled retirement in the areas surrounding the region of analysis. Most of the units have been active for decades, but it is expected that between 2025 and 2032 most of the units will be closed. This closure will create a socioeconomic and environmental transformation as workers migrate to other industries, state, local, and household income is affected, and the environmental effects of the coal plants change.

Table 5. Coal-Fired Generating Stations in the Region of Analysis and Surrounding Area.

Name	County	Capacity (MWe)	Year Opened	Scheduled Retirement
Coronado Generating Station	Apache, AZ	822	1979 (Unit 1- 411 MW) 1980 (Unit 2- 411 MW)	2032 (Unit 1) 2032 (Unit 2)
Springerville Generating Station	Apache, AZ	1,766	1985 (Unit 1- 425 MW) 1990 (Unit 2- 425 MW) 2006 (Unit 3- 458 MW) 2009 (Unit 4- 458 MW)	2027 (Unit 1) 2032 (Unit 2) TBD (Unit 3) TBD (Unit 4)
Cholla Power Plant	Navajo, AZ	426	1962 (Unit 1- 114 MW) 1978 (Unit 2- 289 MW) 1980 (Unit 3- 312 MW) 1981 (Unit 4- 414 MW)	2025 (Unit 1) 2015 (Unit 2- closed) 2025 (Unit 3) 2020 (Unit 4- closed)
Four Corners Generating Station	Fruitland, NM	1,636	1963 (Unit 1) 1963 (Unit 2) 1964 (Unit 3) 1969 (Unit 4) 1970 (Unit 5)	2013 (Unit 1,2, 3) 2031 (Unit 4 and 5)

As some coal-fired power plants have closed or converted to natural gas, state coal production was also affected. Arizona has no current coal production to supply the four coal-fired power plants. Currently, the coal is imported into the state by rail from New Mexico, Wyoming, and Montana. In 2022, coal fueled 12% of the state's total net generation. Though, areas in the northeastern part of the state on the Navajo and Hopi reservations and in east-central Arizona have some coal, the state's last coal mine (Kayenta mine) ceased operations in 2019 because its only consumer was the coal-fired Navajo Generating Station, which closed (U.S. EIA 2023a, WMI 2021).

Coronado Generating Station

The CGS employed 211 workers at the end of 2019 with the goal to reduce the total employment to 128 by the end of 2025 (WMI 2021). Most workers reside in the Region, and due to the commuting patterns of employees driving to work, the input-output model region is defined by those two counties. Considerations about the local economy and potential for businesses to supply goods and services to the power plant will determine the level of economic impact for the Region. A more developed economy provides an enhanced opportunity for the region to capture economic benefits from Coronado's presence. Dually beneficial economic activity between Coronado and supporting businesses becomes increasingly possible.

Background

CGS is a nameplate capacity 822-megawatt electric (MW) coal-fired power station that was constructed in 1979 near St. Johns, Arizona. Net summer generation for both units at CGS is 762 MW. CGS is owned and operated by SRP, a not-for-profit community based public power utility, which is a political subdivision of the State of Arizona. SRP is the largest electricity provider in the greater Phoenix metropolitan area, serving approximately 1.1 million customers, providing generation, transmission, and distribution services to about 920,000 homes and businesses in central Arizona (SRP 2023). The SRP energy mix comes from a combination of fossil, nuclear, and renewable sources like solar, geothermal, biomass, wind, and hydropower as it can be seen in Figure 2.

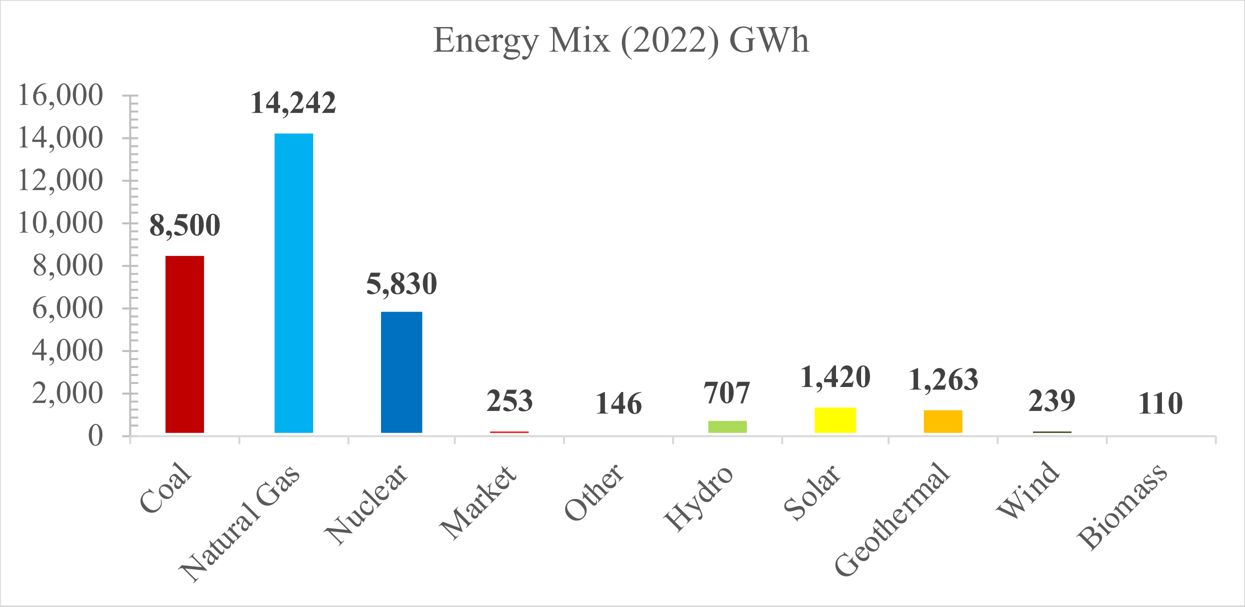

Figure 2. SRP Energy Portfolio in 2022. *Source:* SRP 2022

SRP's 2035 Sustainability Goals 5-year Action Plan outlines a schedule to reduce existing coal generating resources over the next 15 years as part of the effort to reduce emissions (SRP 2022). Currently, the coal for the CGS is transported by rail from the Antelope Mine in Wyoming and the Spring Creek Mine in Montana.

The city of St. Johns has shown an interest in studying the feasibility of transitioning CGS from coal to an advanced nuclear reactor. In 2021, SRP released an updated timeline for reducing the workforce at the CGS, over the next 4 years in preparation for the plant's accelerated retirement no later than 2032 as part of the company's goal to reduce carbon dioxide emissions (Seidman and Carey 2022). The White Mountain Independent reported that when SRP shuts down the CGS, it could cost the region another 200 jobs because of the accelerating shift away from coal (WMI 2020). Before the closures began, the coal industry and its spinoffs provided up to 4% of the jobs in Navajo County and 8% of the jobs in Apache County (WMI 2020). In other words, this industry has provided the counties and state with high-paying jobs and tax revenue for decades.

ECONOMIC IMPACT EVALUATION

The goal of this economic impact evaluation is to compare a baseline scenario of normal operations at the existing CGS facility with nuclear replacement alternatives. An input-output model was used to quantify the impacts of each scenario. Input-output models are created by combining regional economic data with industry-level transaction data for a specific time period, usually 1 year. Using mathematical formulas, the impact of new economic activity observed in a specific industry can be traced as it is absorbed by other industries throughout the region. These industry-to-industry transactions create opportunities for increased revenue, job creation, and income growth. These models can be calculated manually or can be processed using advanced applications that are available from multiple software developers. The model used in this report was produced using the IMPLAN input-output modeling application (IMPLAN 2022).

Input-output model results are based on three main drivers: employment, revenue, and labor income. As input data into the input-output model, plant revenue was calculated using annual megawatt hours (MWh) multiplied by the price of electricity which is an approach that more closely reflects the value added by the generating station. Retail prices were not used for revenue estimation to properly account for the value created by the plant itself. Using retail electricity prices would overstate the value of the generating station since there is additional value added by activities during the transmission and distribution process performed at the utility level. Employment and labor income figures for CGS were provided by SRP.

The nuclear replacement options were selected based on the availability of data required to operationalize the input-output model. Various public reports from reactor vendors have identified employment estimates for small modular reactors (SMRs). So far, those reactor vendors include NuScale Power, X-Energy, and TerraPower (NuScale 2021; TerraPower 2022; Tan 2022; X-Energy 2023). These reactor vendors published or announced employment estimates that help increase the accuracy of model results. Accurate employment and wage information are major components necessary for input-output modeling.

Economic impacts are separated into the following four categories:

- **Direct Impact:** Values based on coal or nuclear plant operations which include employment, labor costs, and wholesale revenue from electricity produced by the generating facilities. These can be thought of as “plant-level” impacts.

- **Indirect Impact:** The result of supply chain activity between the generating stations and suppliers of goods and services within the region.
- **Induced Impact:** New economic activity caused by households spending income earned directly or indirectly from generating station operations. These can be thought of as "community-level" impacts.
- **Total Impact:** The combination of all three impact categories.

Pre-closure Impact Analysis

Pre-closure economic impacts of CGS were modeled to enable a baseline comparison of current operating conditions with potential nuclear replacements. The data obtained by performing the pre-closure analysis was critical for running the input-output model. This baseline analysis of CGS operations is based on average plant business volumes over multiple years to smooth fluctuations that typically occur. In recent years, electricity prices fluctuated throughout the United States and Arizona. For this analysis, SRP provided a long run wholesale electricity price that represented what is typically observed during normal operational years. Employment and labor costs in the pre-closure analysis were based on the most recent annual values. CGS operated with 149 employees that had a combined labor cost of $21.9 million once taxes and benefits were included.

Since SRP does not track revenue at the plant level, direct economic output, which is equivalent to revenue from plant operations, was calculated by multiplying MWh of electricity produced by the wholesale price of electricity. This resulted in an estimated direct output of $212.7 million. After electricity is produced by the power plant, additional value is added through transmission, distribution, and administrative support to utility customers. The value added by utility operations is roughly equal to the difference between the retail price of electricity and the wholesale price that was provided by SRP. Retail prices were not used in this analysis to avoid overstating the impact specifically tied to electricity generation. Using retail prices would overstate the impact on the CGS two-county region since much of the utility related activities take place in other locations. This allows the results to be representative of the target region of analysis and not other regions where the additional value is created and captured in retail prices.

Besides measuring economic output, the input-output model also estimates employment, which is a count of jobs that are created or sustained by the economic activity. The labor income impact includes salaries, wages, benefits, and employment taxes. Finally, the model estimates a value-added impact that is equivalent to gross regional product. Labor income is often a large component of value-added impacts. Value-added impacts increase within the region as raw materials are transformed into final goods. The price difference between the raw materials and the final goods is equal to the value-added impact.

Combining plant operations with additional indirect and induced impacts, in the region, CGS added $304 million to total economic output and more than 448 jobs. The generating facility is estimated to contribute nearly $130 million to the two counties' gross regional product through value-added impacts. These impacts are tied specifically to the Apache and Navajo Counties. Impacts are based on simulated industry interactions that could result from employee spending and potential transactions with local suppliers. Supply chain transactions are based on the availability of local businesses that could support CGS operations. Dollars spent on items like coal are allowed to "leak" from the local economy if no coal mines are available. In the case of CGS, coal is sourced from locations outside of the region. Table 6 summarizes the anticipated losses for the region, an impact that will be lost in the case where the CGS closes.

Table 6. Economic Impact Summary – Projected Losses from CGS Plant Closure.

Impact Type	Employment[a]	Labor Income[b]	Value Added[c]	Output[d]
Direct Effect	149	$21.9	$89.9	$212.7
Indirect Effect	208	$14.2	$32.6	$77.7
Induced Effect	91	$3.7	$7.5	$13.8
Total Impact	448	$39.7	$129.9	$304.2
Multiplier	3.01	1.82	1.45	1.43

DOLLAR VALUES IN $MILLIONS

a. Employment: The number of jobs created or sustained

b. Labor Income: The amount of income including employee compensation (wages and benefits) and proprietor income

c. Value Added: The value of a combination of innovation and improvement made as basic resources and intermediate goods are processed into final goods

d. Output: The value of industry production

CGS Output

Coronado operations add $304 million to the region's gross economic output. This results from the direct effects of Coronado operations multiplied through the economy. Coronado supports the purchase of more than $77 million worth of goods and services from region businesses.

Coronado employee spending creates an additional induced effect of $13.8 million to the regional economy. For every $100 in direct economic activity at Coronado, an additional $43 of activity is created or sustained throughout the state's economy. This results in an output multiplier of 1.43. See Figure 3 for an illustration of Coronado's impact on total output.

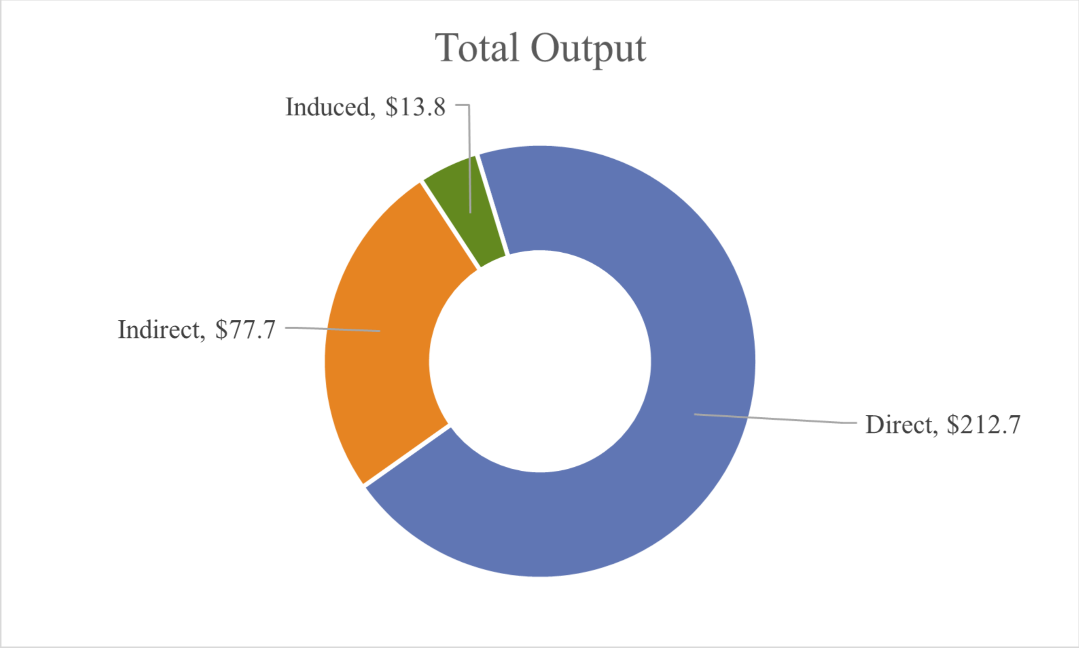

Figure 3. CGS Total Output Impacts (Million USD).

CGS Employment

On average, CGS employs around 149 workers. An additional 208 jobs are created or sustained by industries that support Coronado operations. Coronado employee spending creates or sustains an additional 91 jobs throughout the region. The combined employment impact accounts for 448 jobs. For every 100 Coronado jobs created, an additional 201 jobs are created or sustained throughout the region. See Figure 4 for an illustration on CGS's impact on employment.

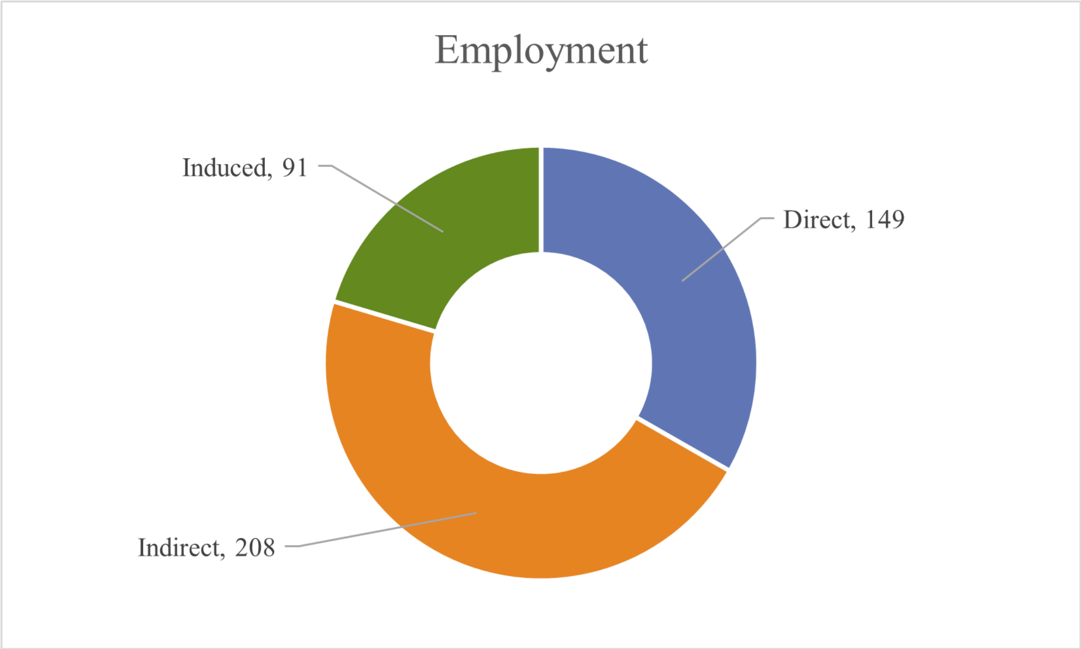

Figure 4. CGS Employment Impacts (jobs).

CGS Labor Income

Coronado's impact on the region's total labor income was nearly $40 million. Total labor income includes wages and salaries, employee benefits, and payroll taxes. The total income for employees of industries that support CGS operations was $14.2 million. Coronado employee's household spending patterns generated nearly $4 million in employee compensation for individuals employed by the region in businesses. The CGS facility itself produced $21.9 million in direct labor income. See Figure 5 for an illustration of Coronado's impact on labor income.

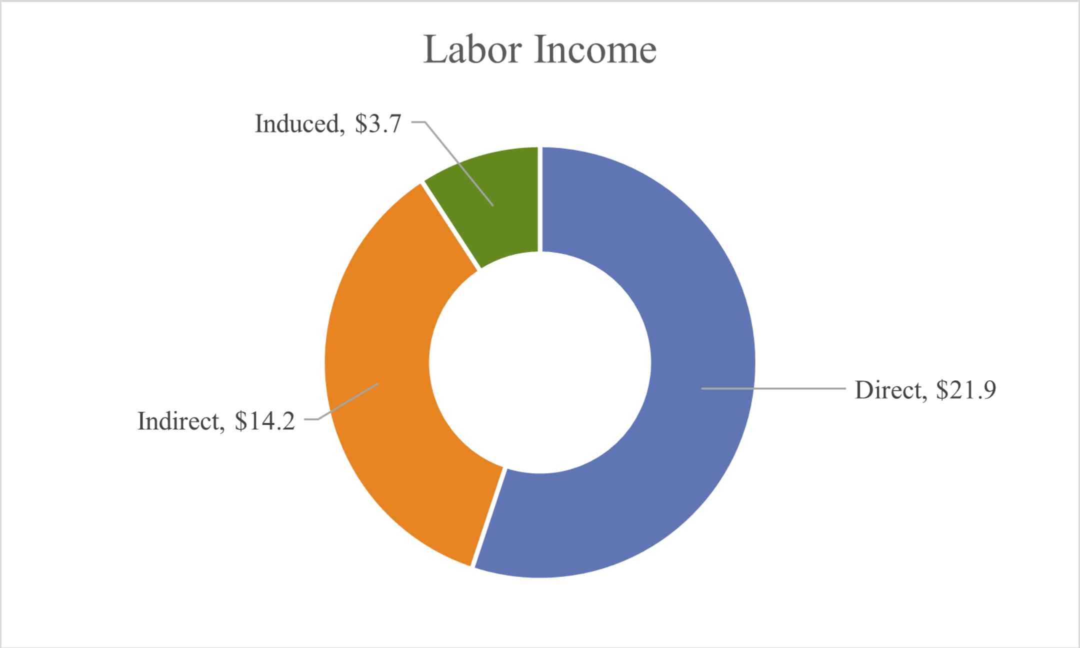

Figure 5. CGS Labor Income Impacts (Million USD).

CGS Value-Added

Value-added impacts are created by a combination of innovation and improvement made as basic resources and intermediate goods are processed into final goods. Service-related production also added significant value to the economy. Coronado added nearly $130 million of value to the gross regional product, of that $90 million is attributed directly to CGS operations. Industries that supported Coronado indirectly added nearly $33 million of value. Induced value-added impacts resulted in $7.5 million in economic activity. See Figure 6 for an illustration on Coronado's value-added impact.

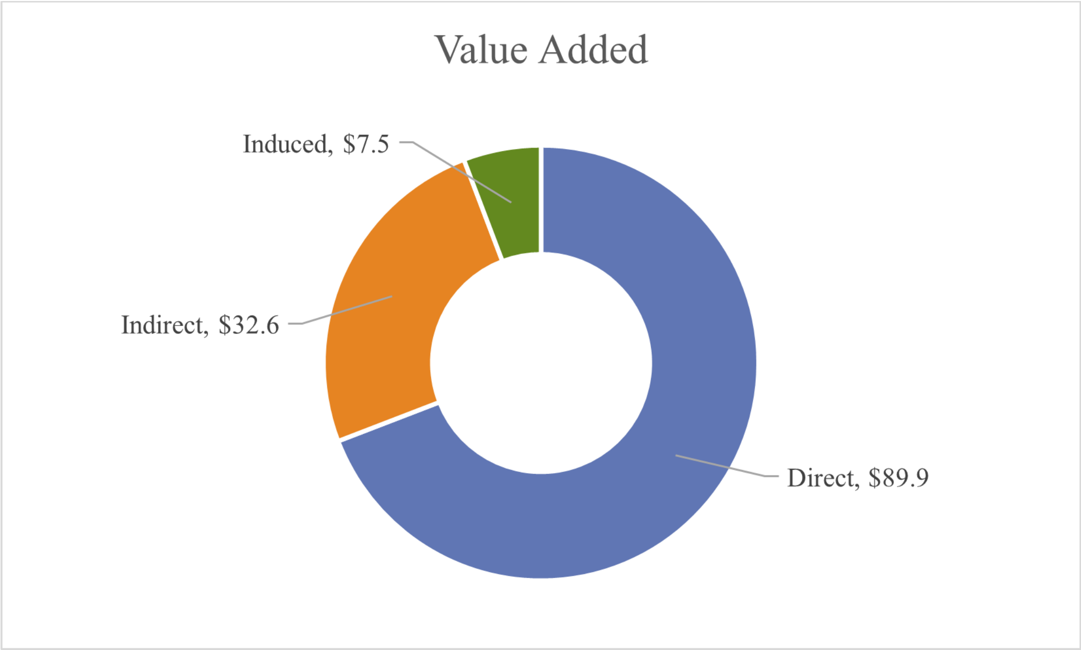

Figure 6. CGS Value-Added Impacts (Million USD).

Analysis of Alternative Nuclear Power Output Levels

Nuclear replacements presented in this report range in size from 300 to more than 900 megawatts (MW). CGS is rated to 811 MW and typically produces around 3.5 million MWh of electricity annually. The nuclear equivalent for this level of electricity production would be similar to the NuScale VOYGR 6 reactor, rated to 462 MW with annual electricity production reaching 3.8 million MWh, assuming a capacity factor of 93%.

Nuclear replacement options are presented without discrimination based on transmission infrastructure capacities for any of the scenarios that were modeled. Infrastructure limitations were not used to filter the range of nuclear replacement options. The model results presented in this report can be applied to other reactor options if values for employment, revenue, and labor income are similar.

A range of nuclear replacement options was established based on publicly available employment information that was critical to building an accurate input-output model. It is important to note that other reactor designs may be viable options but do not have publicly available employment forecasts that could be used in this report. SMRs vary in size from 10s to 100s of MW. At this point, the economic impact results presented in this report could be equally applied to other SMR technologies if employment and annual MWh are comparable. As more information from reactor developers is made available model results could be revised to incorporate additional data.

Labor income and plant revenue values for the nuclear replacement options were both estimated by the research team and were not provided by the reactor vendors. These calculated values, along with employment estimates from reactor vendors, were required for the input-output modeling. Labor income was estimated by using industry wage and benefits data from the U.S. Bureau of Labor Statistics. Total plant output or revenue was calculated by multiplying the wholesale price of electricity by the annual electricity production estimates in MWh. Capacity factors were applied to determine an expected annual MWh value.

Table 7 provides an overview of key characteristics of the SMR replacement options and variables used to develop the input-output model. These calculated values for revenue, employment, and labor income become the "direct" impacts presented in the results of the input-output model.

Table 7. Generating Station Comparison Values.

Plant (Technology)	Plant Capacity in MW	Capacity Factor	Annual MWh (Millions)	[a]Plant Revenue	Employment	Labor Income
Coronado Gen. Station	822	49%	3.5	$212.7	149	$21.9
Scenario A: (Xe-100 4)	320	93%	2.5	$155.5	101	$16.3
Scenario B: (NuScale 6)	462	93%	3.7	$224.5	193	$31.1
Scenario C: (NuScale 8)	616	93%	5.0	$299.4	212[b]	$34.2
Scenario D: (NuScale 12)	924	93%	7.5	$449.1	270	$43.5

Dollar values in $millions

a. Based on electricity price of $59.85 per MWh
b. Estimated employment based on 6 and 12 module versions of the reactor

Nuclear Alternatives Impact Analysis

Economic impacts from the nuclear alternatives are presented and compared with CGS to comprehend how these replacement scenarios would impact the regional economy. In the same fashion as the CGS economic impact results in the previous section of this report for CGS, each nuclear scenario is evaluated based on output, employment, labor income, and value-added. Calculations were also completed to evaluate the net change in economic impact across all four scenarios. The following sections provide a detailed analysis of these findings. Employment estimates were available only through actual vendor data. For this purpose, the results could be applied to other SMR designs if employment and MW are similar. The trend in SMR employment forecasts indicates there will be an increasing labor efficiency, but until actual demonstration reactors are built, there is no way to fully understand the number of jobs required to operate these new reactor facilities.

Nuclear Alternative Output

The annual total output impact of CGS is estimated at $304 million which falls between Scenario A and Scenario B. Scenarios were introduced earlier in Table 7 but the output impact of scenarios is listed in Figure 7. The Scenario B replacement option offered the closest annual electricity production value to what CGS currently generates. Total output of nuclear replacement scenarios diverge depending on the amount of electricity being produced. Although only the largest SMR replacement option is rated to produce more electricity at maximum output, Scenario B (462 MW) and Scenario C (616 MW) replacements will produce more electricity over the year due to higher capacity factors. Only the smallest replacement option fell below CGS' estimated total economic output. The nuclear replacements are expected to have direct impacts of at least $155.5 million. Scenario D would generate nearly $450 million in direct output. Once indirect and induced impacts are accounted for, these impacts are expected to reach $233 million and as much as $672.6 million.

The total output multiplier effects of the current CGS configuration are not significantly different from the nuclear technology. This is likely because of limited local supply chain availability for either plant type. However, the input-output model results do show the nuclear replacements had slightly higher output multipliers. Higher output multipliers are likely the result of higher labor to capital ratios which allow more operating dollars to be spent on wages. One way to think about this is that sourcing coal feedstock out of the region for fuel is an economic leakage. That is, with coal power plants, money leaves the region to pay for coal while with nuclear facilities a smaller percentage of operating costs are spent on fuel.

The output multiplier for CGS was 1.43 while the nuclear replacements averaged 1.5. This means that the nuclear options produced $50 of economic activity among suppliers and other support industries for every $100 of electricity produced. In comparison, CGS produced $43 of economic activity within the region for every $100 of electricity generated. Figure 7 provides a view of total output impacts for each electricity generation scenario.

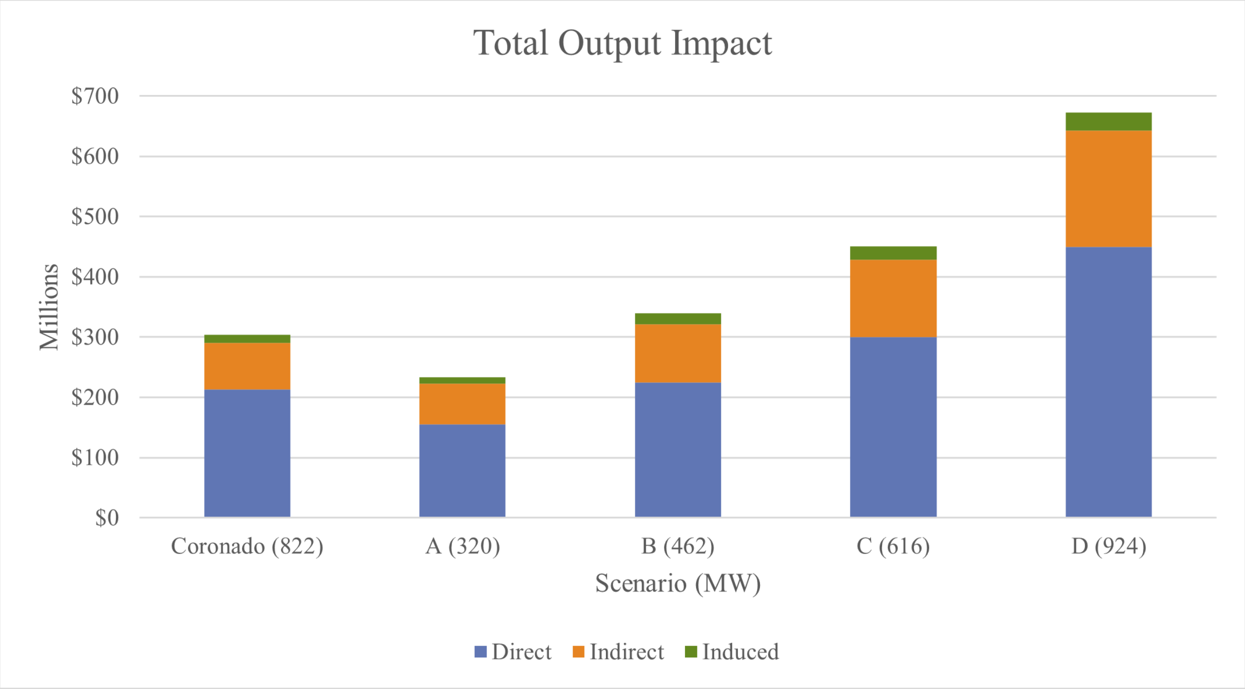

Figure 7. Total Output Impact.

If the smallest nuclear replacement option is selected, identified as Scenario A, the net change in total output, compared to current CGS operations, would decrease by a total of $95 million. This loss consists of declines in all three economic impact categories. The direct impact is expected to decrease by $45 million, while indirect and induced impacts would decrease by $27 million and $19 million, respectively. These declines in economic impact are a result of reduced electricity production. Under Scenario B, electricity production would drop by 27% to 2.6 million MWh compared to 3.5 million in the coal scenario.

Scenario B offers the closest MWh to what CGS currently produces, although attempting to find replacement options that match MWh is beyond the scope of this report. In this scenario, MWh would increase by 5.6% assuming the nuclear plant operates at levels consistent with industry averages. This scenario would result in a proportionally higher increase in total output impact. Total output would increase by 35.7%, a 11.7% net increase over current output. This improvement is the result of a higher labor to capital ratio for nuclear plants when compared to coal-fired plants. Scenario B offers a total output impact of $340 million, a net increase of $35.7 million. Scenario C and D would produce a net change in total output impacts of $146 and $360 million, respectively. See Figure 8 for a detailed view of net changes in total output impacts.

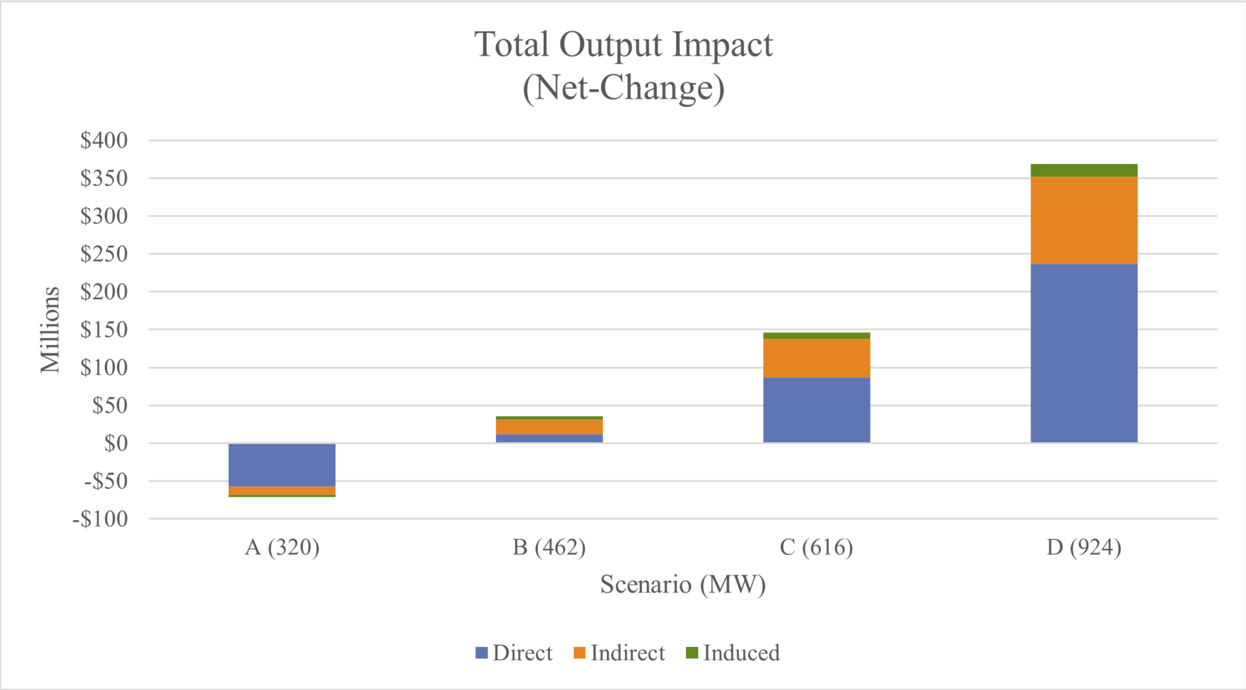

Figure 8. Total Output Impact Net-Change.

Nuclear Alternative Employment

According to reports provided by SRP, the Coronado plant employed an average of 149 workers in 2022. Several employment estimates for SMRs were available from public documents released by NuScale Power and X-Energy (NuScale 2021). The most recent reports from reactor designers indicate employment for SMR facilities could range between 100 and 270. On average, SMR facility employment estimates fluctuate between 1.4 and 4.5 MW per employee.

As discussed in the

CGS Employment section, indirect and induced effects of CGS operations support nearly 300 additional jobs in the two-county region for a combined total of 448 jobs. Of the evaluated alternatives for nuclear designs, total employment impacts range from around 350 to nearly 1,000. The average employment multiplier for the nuclear plants was 3.37 compared to 3.01 for CGS. On average, the nuclear plants are expected to sustain 237 jobs in the surrounding economy for every 100 jobs at the plant while CGS sustains around 200 community jobs. Figure 9 displays employment impacts for each generating station scenario.

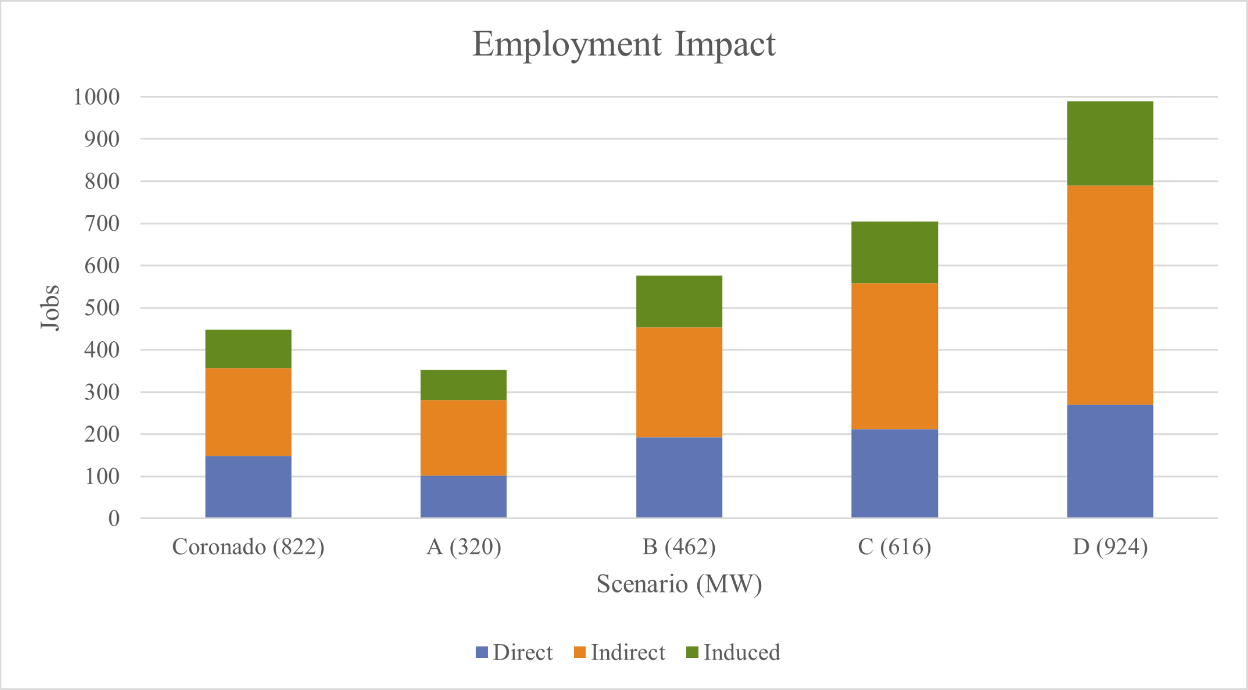

Figure 9. Employment Impact.

According to EIA (U.S. EIA 2023b), fuel costs make up 28% of total operating expenses for nuclear plants compared to 69% at fossil-based plants. The CGS facility has a nameplate generating capacity of 822 MW or 5.2 MW per employee while the closest comparison plant in the nuclear scenarios has a capacity of 924 MW or 3.4 MW per employee. The local impact of this change results in spending operating funds on employee salaries rather than on fuel, which in the case of CGS is purchased from outside the region. See Table 8 for detailed production values associated with various plant configurations.

Table 8. Plant Employment Efficiency Comparison.

Plant Configuration	Coronado	Xe-100 4 (A)	Natrium	NuScale 6 (B)	NuScale 8 (C)	NuScale 12 (D)	Xe-100 3, 4-Packs
Plant Jobs	159	96	250	193	212[a]	270	212

Plant Nameplate Capacity (MW)	822	320	345–500[b]	462	616	924	960
MW/Emp	5.2	3.3	1.4-2.0	2.4	2.9	3.4	4.5
MWh/Emp	22,400	27,100	11,200	19,400	23,600	27,800	36,800

[a] Estimated employment.

[b] Capacity including thermal energy storage.

Fuel for the CGS is sourced from coal mines in Montana and Wyoming. It should be noted that any nuclear fuel used by a SMR would also be sourced outside the counties, but because fuel expense is relatively small for nuclear plants, it becomes a smaller source of economic leakage in the input-output model. This is an important factor when considering the local economic impact of selecting electricity generating technology. Under current operating conditions, nuclear facilities produce more jobs per MW of electricity than coal power plants which brings more benefits to the local economy. Plant worker salaries have a greater chance of impacting the local economy than fuel purchases that take place out of state. Even though nuclear Scenario A has a 61% lower plant capacity, it would produce only 27% less electricity. The net change in employment impact for the smallest replacement scenario would only decrease by 95 jobs compared to the coal plant scenario. Scenarios B, C, and D would result in employment impacts increasing between 128 and 541 jobs. Detailed net changes in employment impacts are available in Figure 10.

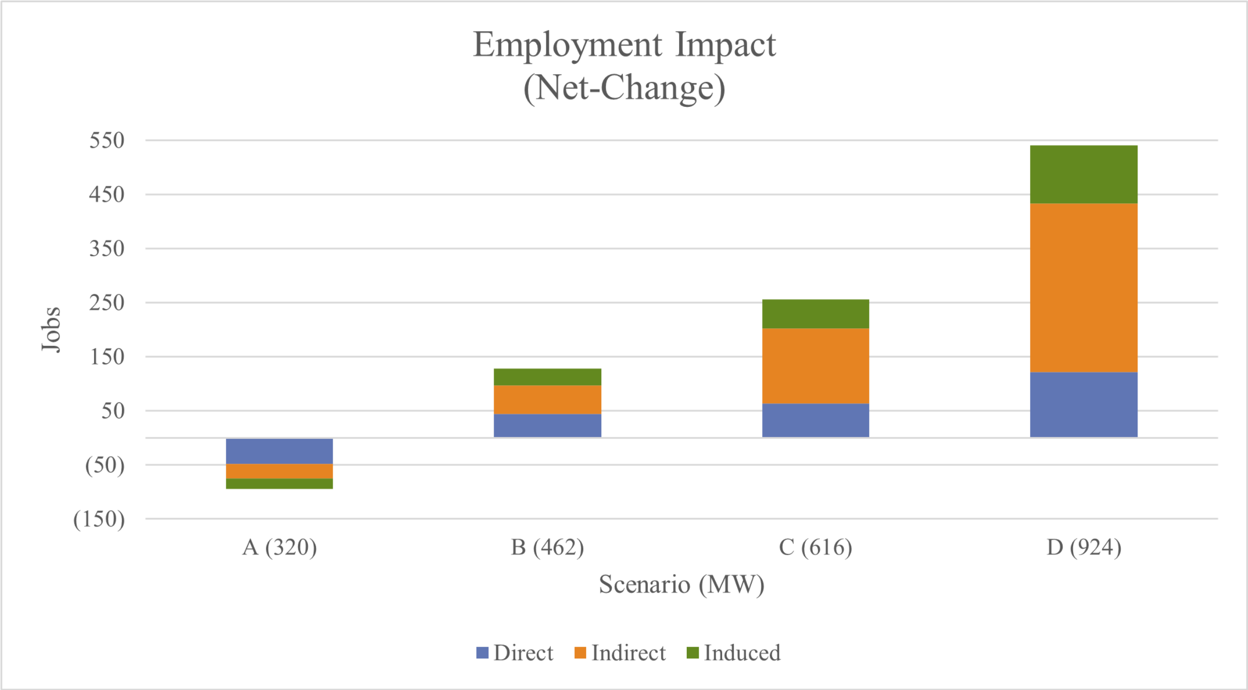

Figure 10. Employment Impact Net-Change.

Nuclear Alternative Labor Income

Labor income includes employee compensation, which includes the total payroll cost of salaries, benefits, and payroll taxes, and any applicable proprietor income. SRP provided information showing CGS had a fully loaded payroll expense of nearly $22 million which is considered the direct labor income impact of the facility. As stated earlier, the indirect and induced impacts accounted for $14.2 and $3.7 million respectively for a combined total impact of nearly $40 million annually for labor income impacts of CGS to the region today. Comparing this to impacts of the nuclear replacement options, only the smallest nuclear option fell short of the current CGS labor income impact. Like the employment impacts, labor income is also very important to the local economy. Wages earned by power plant workers support local businesses and create a positive impact on the local population size. The increase in employment and wages can further stimulate the economy and provide a higher tax base to support infrastructure. If plant workers bring families to the area, additional population growth would be expected. According to the U.S. Census Bureau (2022), the average household consisted of 2.5 people in 2022.

The smallest nuclear replacement option is expected to produce $16.3 million in direct impacts to the region with a total impact of over $31 million. The largest nuclear option is anticipated to have a direct impact of $43.5 million and a total impact of $86.4 million. See Figure 11 for detailed information on expected labor income impacts.

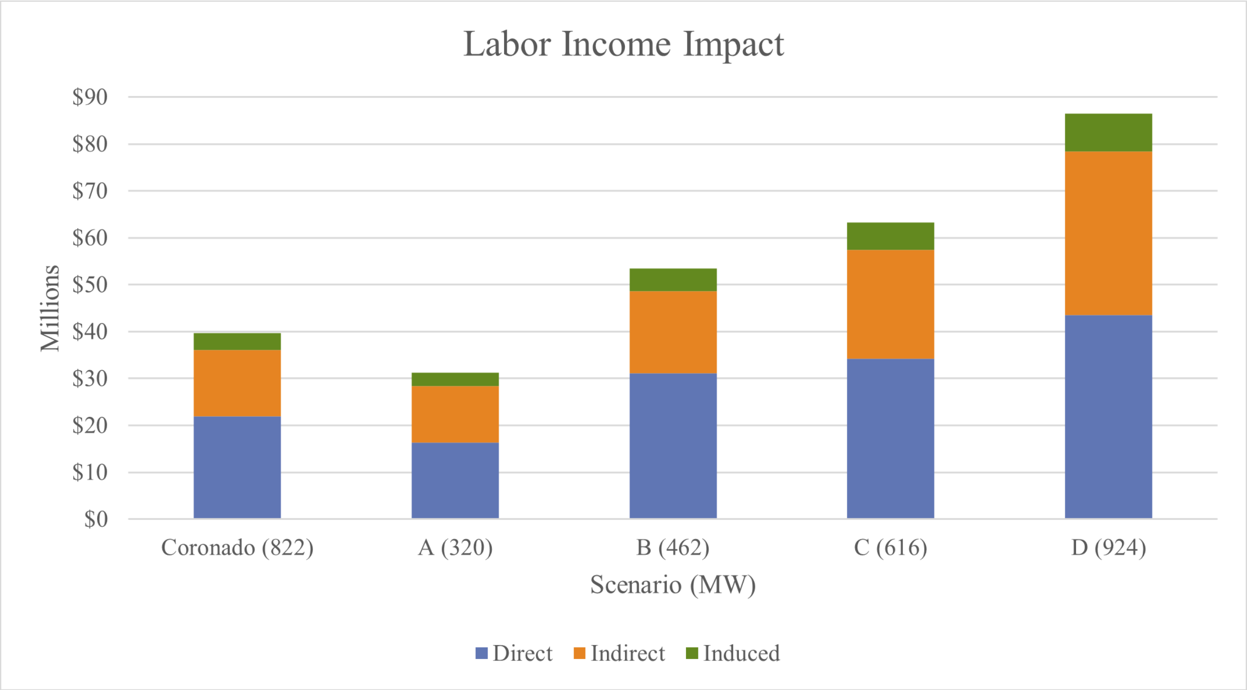

Figure 11. Labor Income Impacts.

The net change in labor income impacts, shown in Figure 12, range from a loss of $8.5 million for Scenario A to a net gain of nearly $47 million for Scenario D. As mentioned above, nuclear facilities tend to have higher employment per MW than coal power plants. As a result, labor income impacts correlate with employment impacts. The average annual labor cost per employee at CGS was $147,000 compared to $161,000 for a nuclear plant worker. Wages paid to workers are used locally based on typical household spending patterns which have a higher likelihood of impacting businesses within the region. This local spending creates income and employment opportunities for other workers in the region. Detailed net changes in labor income impacts are available in Figure 12.

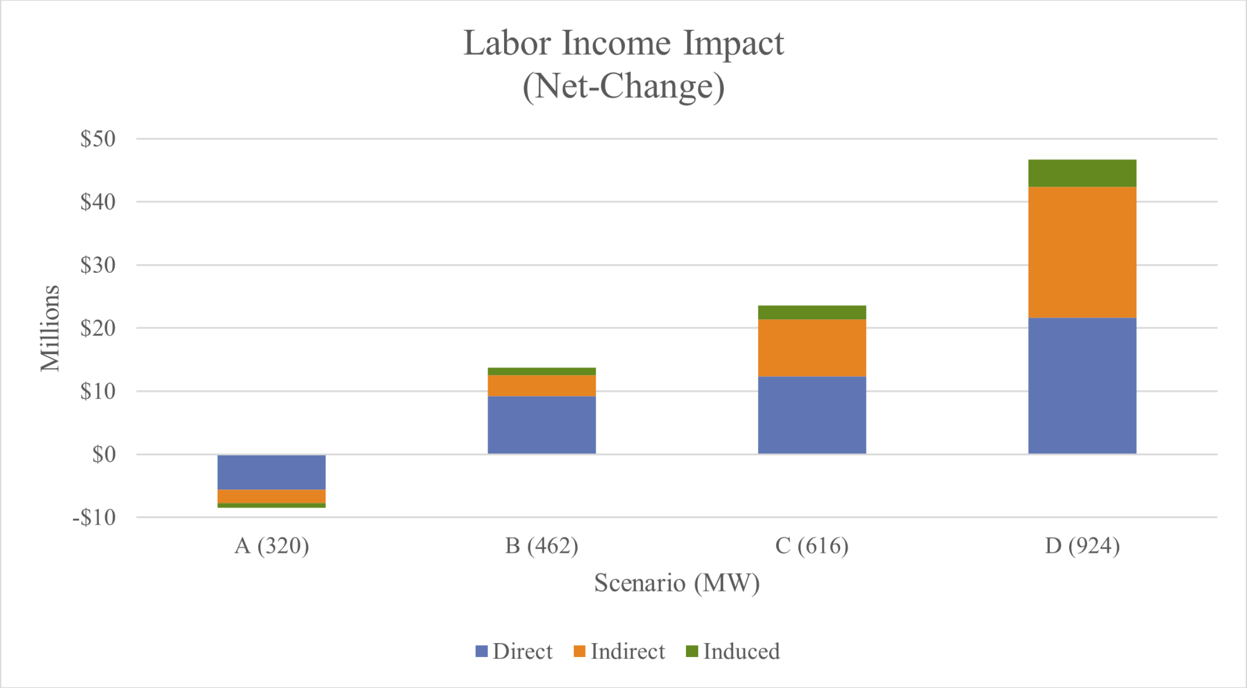

Figure 12. Labor Income Impact Net-Change.

Nuclear Alternative Value-Added

Value-added impacts are the equivalent of gross regional product, or the market value of new production within the two-county area. Like gross domestic product at a national level, this value-added impact is an important measure of economic health and prosperity. It measures local production and is the combination of productivity, innovation, and improvement as intermediate goods are transformed into final goods. Value-added impacts only measure the value of local production unlike total output that measures the market value of local final demand regardless of where the good or service was produced.

As mentioned in the

CGS Value-Added section, CGS is estimated to directly contribute nearly $90 million to the local economy on an annual basis. An additional $33 million is contributed by businesses indirectly impacted by CGS operations. Employee spending is linked to more than $7 million in value-added impacts. These three impact categories combine to $130 million in total value added. The nuclear replacement scenario’s total value-added impacts range from $92 million to $262 million. Figure 13 provides detailed estimates for value-added impacts.

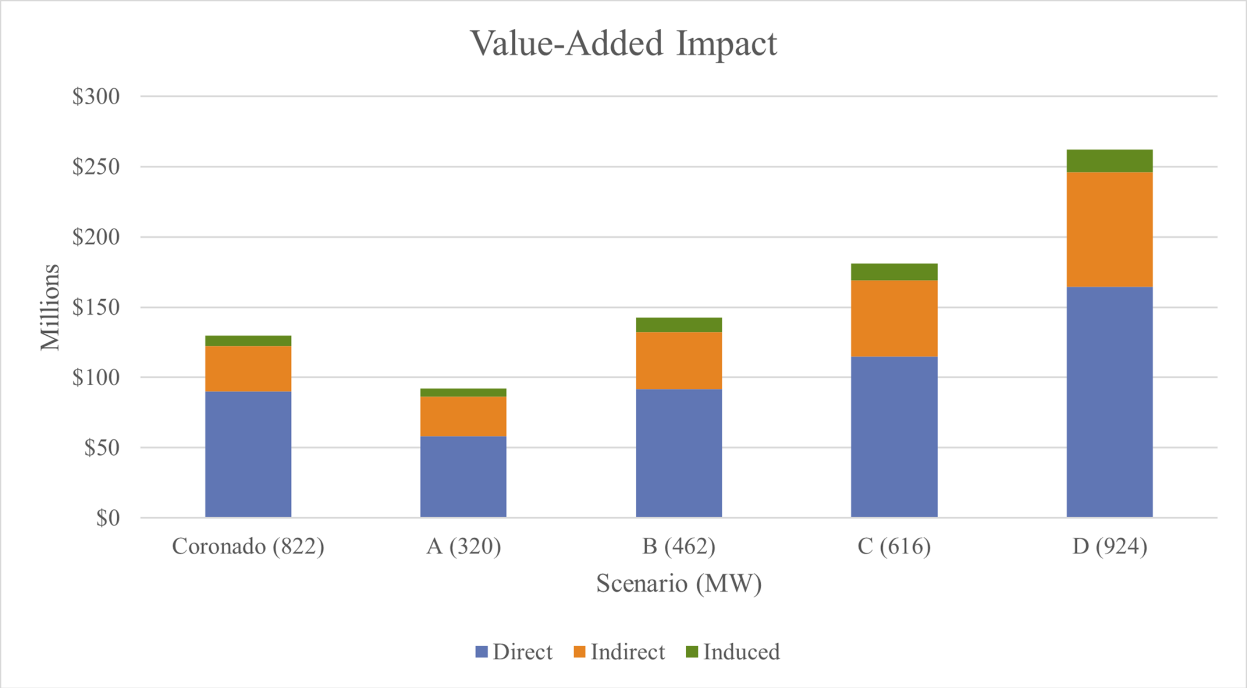

Figure 13. Value-Added Impact.

If the smallest nuclear replacement option was selected, value-added impacts would decrease by $38 million. Under Scenario B, the most comparable scenario based on MWh, value-added impacts would increase by $12.5 million. Scenarios C and D would increase value-added impacts by $146 and $368 million, respectively. See Figure 14 for detailed value-added net-change impact estimates.

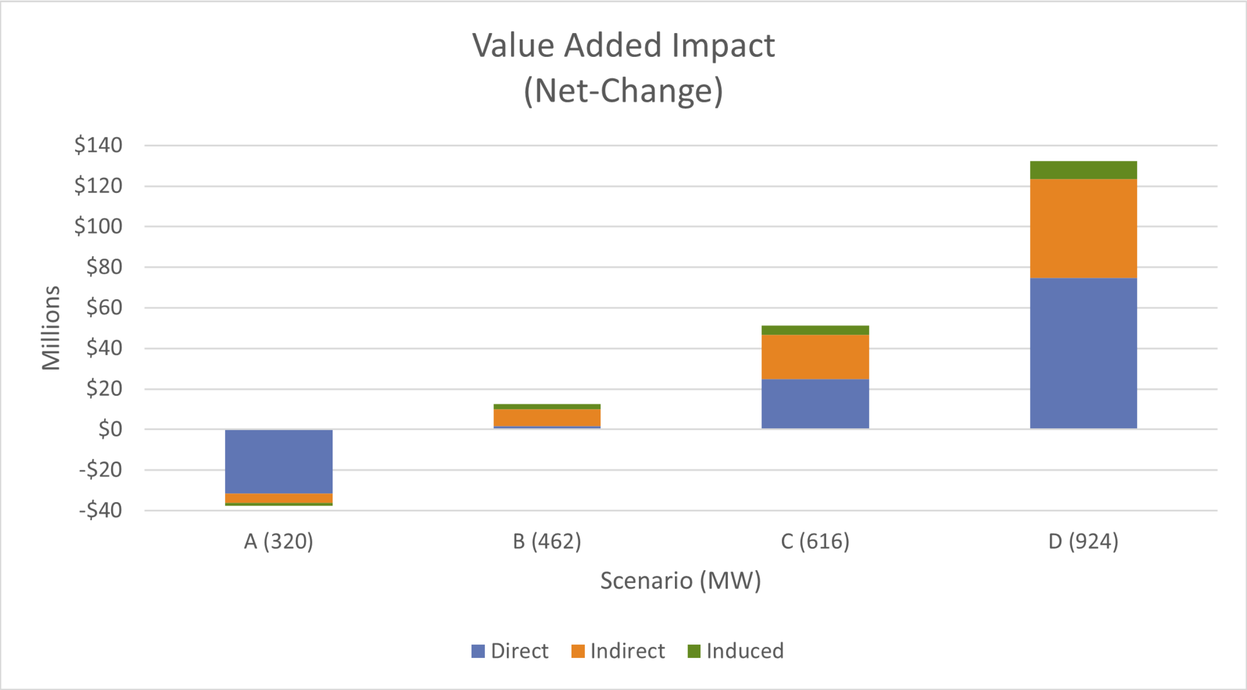

Figure 14. Value-Added Impacts Net-Change.

Previous Report Comparison

The Arizona State University Seidman Research Institute (Seidman and Carey 2022) completed a previous economic impact report that used an alternative economic impact modeling application making a direct comparison with this report difficult. The two applications estimate CGS' contributions to gross regional product, referred to as value-added impacts in this report. The Seidman report projects losses related to a CGS closure for each year between 2022 and 2040 while this report focuses on a single year scenario of plant operations. The findings in this report could be applied to multiple years if desired.

The plant operations values for employment and labor costs used in the Seidman report differ from the most recent figures provided by SRP. Updated employment for CGS in the two-county region was 149 workers compared to 160 in the Seidman report. The total cost of labor decreased from $29.9 million in the Seidman report to $21.9 in this study. Despite the differences in these CGS operating values, the total value-added impacts are similar. The Seidman report projects a loss of $178.3 million in gross regional product by year 2040 while this report estimates the loss at $130 million but without a specific timeline. The difference between the two estimates is correlated with the difference in labor costs; 28% higher labor costs in the previous study resulted in 37% higher value-added impacts. Actual CGS employment was only 7% higher in the Seidman report.

Social and Environmental Justice Considerations

An unintended consequence of plant closures is the loss in property tax income, which has cascading effects on the communities that depend on these revenue streams. In Apache County, this issue is currently playing out in the cities of Springerville and Eagar. The planned closure of Units 1 and 2 at Springerville Generation Station, which are set to begin in 2027 (see Table 5), could substantially reduce tax revenues in the area. An example of which would be impacts to the school district funding.

In an interview with the president of the local Northland Pioneer College (NPC), Dr. Chato Hazelbaker, the gravity of such a loss of funding was contextualized. Dr. Hazelbaker explained that maintenance for the local high school dome stadium, outside of the study area but near to it, depended greatly on taxes collected from the region's generation stations. Dr. Hazelbaker expressed concern that the facility would no longer be able to be maintained should this funding dry up (Hazelbaker 2023). Although this percentage may have changed some since then, the reality is a loss of funding anywhere close to such an amount would dramatically change the landscape of the many programs depending on this money. The loss of a stadium would likely be only one of many impacts felt by Springerville and Edgar. The socioeconomic statistics discussed earlier show that this region is economically challenged. Unemployment in the region exceeds the state average, the unemployment rate is 7.7% in Apache County and 5.2% in Navajo County, while the state unemployment rate is 3.8% (BLS 2022). And the median income for the region is 36% lower than that of the state. These statistics play into the strong energy burden facing the region. Relative to the state average, the regional energy burden is more than four times greater than the state. The region faces economic challenges that, when coupled with the prospects of CGS shutting down, will grow.

The pre-closure impact analysis shows that jobs will be lost, and tax revenues will decrease when the CGS shuts down. Nearly 450 jobs in the region are attributed to activity at CGS. As discussed, these include jobs at the power plant as well as the supply chain that supports it and the community that surrounds it. With an economic impact measured to exceed $300 million (see Table 6), the region will face increasing economic stress if replacement generation capacity for CGS is not found.

The economic impact analysis of the nuclear alternatives shows that the potential for improving the social justice conditions of the region is strong. The analysis shows that economic conditions could improve substantially. Scenarios C and D show a potential $150 million to $350 million in new economic activity, spurred on with 250 to 550 new jobs. Although not factored in here, people who work in these jobs are members of households and/or families. So, for every new job created, multiplied by the average household size of 2.5, one can see that the scenarios considered here would likely lead to substantial population growth. Growth like this means upward pressure on housing values and wages. For instance, the analysis projects that wage growth could reach somewhere between $10 million to $45 million in new wages.

WORKFORCE TRANSITION

Understanding workforce transitions is an important prerequisite for converting coal power plants to nuclear power plants because workforce transitions address a vital question of how the community will be impacted by the change. Here the goal is to minimize the overall impact on the community workforce. This section aims to provide guidance on workforce transition by addressing the following areas:

1. Educational differences required between power plants
2. What job types will be most impacted by the transition
3. Training or retraining of workforce

To address the first two areas, a quantitative approach was taken that leveraged data from the Bureau of Labor Statistics (BLS) employment matrices (U.S. BLS 2022). The third area was addressed using a qualitative approach that involved interviewing key leaders of community colleges in Arizona and Wyoming (where current coal-to-nuclear transitions are underway).

BLS employment matrices give a national-level view of staffing patterns in each industry. Each industry is separated into employment matrices by occupation, and key statistics are provided such as total employment per industry, what percent of an industry is employed in each occupation, and educational attainment in each occupation, among others. It should be noted that this data provides insights on a national level; it is not broken down into regional or plant specific staffing patterns. Additionally, the data are grouped as coal and fossil fuel generation plants together. Because site specific data are not available, it was determined that comparing national average staffing pattern for nuclear and fossil fuel facilities was the best alternative. The approach for this study mirrored the approach used in the original a recent report by Hansen et al. (2022). The method involved making assumptions, informed by BLS matrix staffing data, around the amount of employment, education, and similarity of employment for the current Coronado Generation Plant and different sized potential nuclear plants. The following sections will highlight the results of this study in more detail.

Educational Differences

The distribution of educational attainment by power plant type is shown in Figure 15. When comparing the two overlayed histograms, it becomes apparent that the educational attainment of coal power plants is more left skewed. This suggests that on average jobs at coal power plants tend to be filled by individuals with less education relative to nuclear power plants. In the context of a coal-to-nuclear conversion, this suggests that additional training and education may be necessary for a workforce to transition optimally.

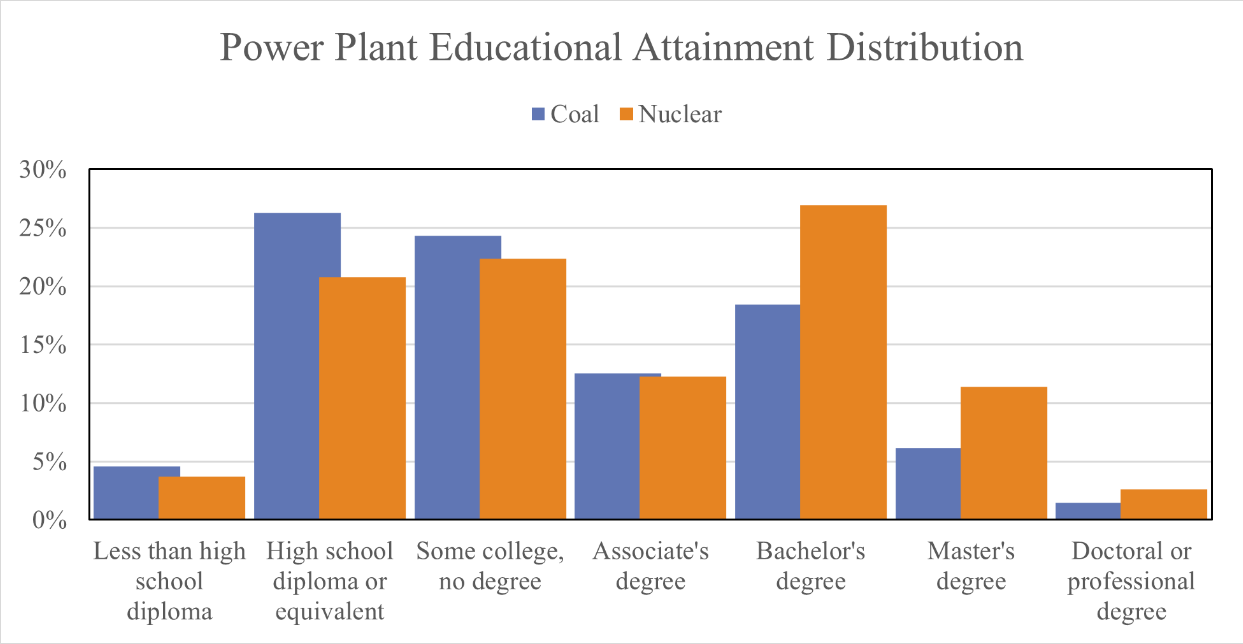

Figure 15. Distribution of Education Attainment across all Coal and Nuclear Plant Jobs in the United States.

Impacts to Employment

Although the technology behind the power generation stations is changing, there is still overlap in the skills and expertise needed to operate each plant. The transition could therefore be visualized as a type of Venn diagram shown in Figure 16. The figure helps to illustrate that there is some amount of job type overlap where less retraining is needed for employees and then some amount of job type overlap where significant retraining will be required. It should be noted that this illustration is purely qualitative in nature, and the amount of overlap is not meant to be interpreted quantitatively.

To compare jobs between plant-type BLS occupation codes were compared. Occupation codes, also known as SOC codes, are used to create a universal occupational classification for data collection and comparison. Codes are made up of six digits[1] with the first two digits representing major group, the third digit minor group, fourth- and fifth-digits broad occupation, and the sixth digit detailed occupation—subsequently, the more numerically different the code, the more different the role. See (U.S. BLS 2018) for additional information on occupational codes.

1 Codes appear in tables with a dash after the first two number as follows, XX-XXXX.

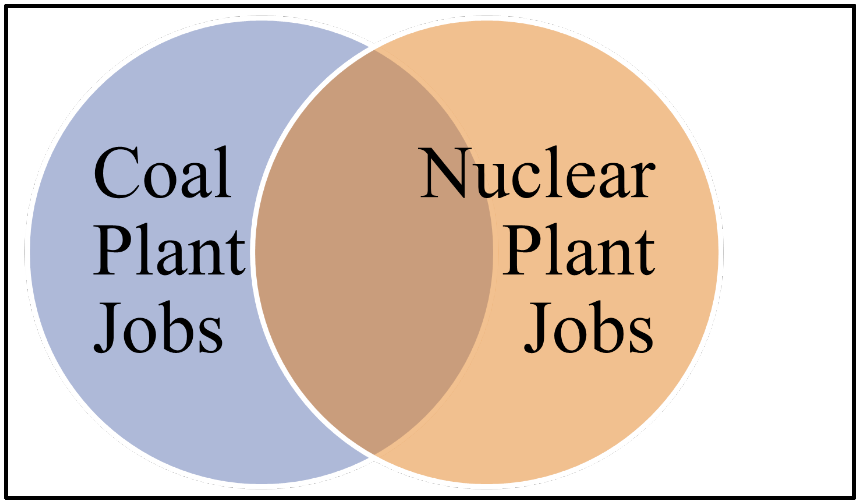

Figure 16. Graphical Illustration of Job Overall between Coal and Nuclear Power Plants.

A good example of two highly similar roles between power plants is industrial machinery mechanics (occupation code 49-9041 in Table 9 and Table 10). These jobs would land within the overlapping section of the Venn diagram. Both have the same job code which suggests they have highly similar, if not identical, job requirements. The nuclear plant requires seven industrial machinery mechanics while the coal plant only required five. In this instance, the transition could allow all the current persons in this job to transition, with demand for more. In total, 48% of the added jobs in the nuclear plant shared identical six-digit occupation codes with coal plant.

Other roles may share similarities but require more training for workers to transition to the new plant. For example, in Table 9, it shows the nuclear power plant creating 26 nuclear power reactor operator jobs (occupation code 51-8011), and Table 10 shows the coal plant losing 25 power plant operator jobs (occupation code 51-8013). It is important to note that these job codes are not identical but share the same occupation code up to five digits. This suggests that the roles are similar but would have some differences in training or skill set. In this instance, a coal power plant operator may have much of the basic training needed to qualify as a nuclear power reactor operator, but some amount of retraining is needed to fully qualify them for the role. Overall, of all the jobs added in the nuclear plant, roughly 74% had identical occupation codes up to the fifth digit. That number grows larger when only looking at the first four digits, but job similarities can begin to widen substantially at this level. (An example of a match up to four digits is nuclear engineers, mechanical engineers, and industrial engineers).

It is worth noting at this point that the exercise of comparing occupation codes is not an exact science. In application, identical codes between nuclear and coal plant jobs may still need training, and the amount of training needed could vary depending on the position. The utility of this exercise is it provides a numerical approximation of job similarities and therefore helps to better understand roughly how technology transition could look.

Nuclear power plants will also create jobs where there is almost no overlap in training. Nuclear engineers (occupation code 17-2161 in Table 9) is an example of such a role. Coal power plants do not have a comparable role, and the workers to fill said roles must either be hired from outside the existing job pool or existing workers must undergo significant retraining. Differences in generation technology is not the only driver of jobs. Due to the nature of nuclear power reactors, security becomes a more significant factor relative to coal plants. The significance of this added security requirement drives the addition of 27 security guard jobs (occupation code 33-9032) in Table 9. Total jobs with no match up to five digits comprised 26% of all occupations.

Table 9. Bureau of Labor Statistics Nuclear Power Plant Staffing Patterns (Abbreviated).

Largest Gains in Nuclear Jobs (Top 10)					
Occupation Code	Occupation Title	Scenario D: (NuScale 12)	Scenario C: (NuScale 8)	Scenario B: (NuScale 6)	Scenario A: (Xe-100 4)
17-2161	Nuclear engineers	38	30	27	13
33-9032	Security guards	27	21	19	10
51-8011	Nuclear power reactor operators	27	21	19	10
19-4051	Nuclear technicians	26	21	19	10
51-1011	First-line supervisors of production and operating workers	14	11	10	5
49-2095	Electrical and electronics repairers, powerhouse, substation, and relay	9	7	6	3
49-1011	First-line supervisors of mechanics, installers, and repairers	8	6	6	3
49-9041	Industrial machinery mechanics	7	6	5	3
13-1151	Training and development specialists	7	5	5	2
17-2071	Electrical engineers	7	5	5	2

Table 10. Bureau of Labor Statistics Coal Power Plant Staffing Patterns (Abbreviated).

Largest Losses in Fossil Fuel Jobs (Top 10)		
Occupation Code	Occupation Title	Jobs Lost
51-8013	Power plant operators	-25
49-9051	Electrical power-line installers and repairers	-10
49-2095	Electrical and electronics repairers, powerhouse, substation, and relay	-8
17-2071	Electrical engineers	-7
51-1011	First-line supervisors of production and operating workers	-6
43-4051	Customer service representatives	-5
49-9041	Industrial machinery mechanics	-5
49-1011	First-line supervisors of mechanics, installers, and repairers	-4
49-9012	Control and valve installers and repairers, except mechanical door	-3
47-2111	Electricians	-3

It should be noted that the specific example highlighted previously in this section is drawn from Scenario D in Table 7, where the CGS is replaced with a NuScale 12 module station. In this scenario, the existing power generation capacity is surpassed by 102 MW (822 MW originally compared to a new 924 MW station), which results in a net gain of 121 jobs. Table 7 also shows the other possible scenarios where the nuclear plant would be smaller. Intuitively, as the size of the potential nuclear power station changes, so too do the employment numbers in Table 7. Figure 17 illustrates this point graphically by showing the relationship between plant capacity and total plant employment. From it, one can conclude that total plant employment increases with the transition in all instances except Scenario A. However, this scenario would also result in significantly less plant capacity (320 MW for Scenario A versus the 822 MW produced in the existing power station).

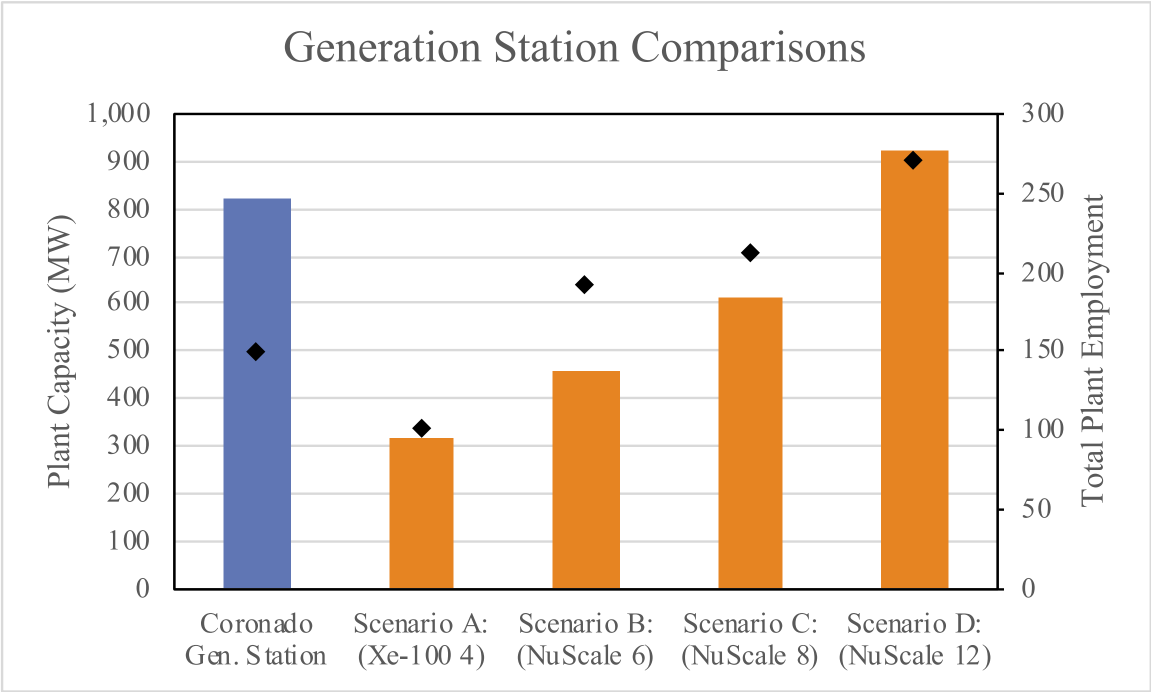

Figure 17. Generation Station Comparisons of Power Generation (Bars, Left Axis) and Total Employment (Points, Right Axis).

Avenues of Retraining Workforces

The process of retraining workers will require the involvement of multiple parties. This could include the cities impacted by the transition of the plant (the most notable being St. Johns), colleges in the area (such as NPC), and the utility that will operate the new plant, among others. An important goal for the community will be to minimize job losses due to the transition and limit the time crossover workers will be unemployed between the closure of the coal plant and the opening of the nuclear plant. A useful example to reference when discussing this topic is the coal-to-nuclear transition taking place in Kemmerer, Wyoming where the well know Natrium Power Plant is being built (Natrium 2023).

It is common for areas where an existing coal power plant operates to have training programs in place that create an employment pipeline to the facility. Often these courses are hosted at local colleges and technical schools. In the case of the Kemmerer, Wyoming coal plant, Western Wyoming Community College (Western) offers multiple programs for a variety of positions at the coal plant. To better understand how Western is playing a role in the ongoing transition, the dean of outreach and workforce development and the vice president of student learning were interviewed to discuss changes to existing programs.

Amy Murphy, dean of outreach and workforce development, explained that many of the existing programs could be augmented to meet the additional requirements for a comparable role at a nuclear facility. A specific example that Dean Murphy gave was the conversion of an industrial safety course for coal plant workers. The course was augmented in several ways, but one change was to include three-way communication training, something the coal plant industrial safety course did not require (Murphy 2023). In this sense, the training programs were not being reinvented, but gaps were filled to accommodate the change in the technology and regulation.

To better understand the potential for reeducation via college-driven programs in the St. Johns area, the president of NPC, Dr. Chato Hazelbaker, was interviewed. Dr. Hazelbaker explained that NPC has an existing program to train workers for coal plants in the area. At its peak, the program had between 150–200 students enrolled each year, but since the announcement of upcoming coal plant closures, enrollment has decreased drastically. So much so, that the program in 2023 only had three students. However, the college is well positioned to pivot this program for nuclear training/retraining. According to Dr. Hazelbaker, the college has two 10,000 square foot buildings, one near CGS, built with technical training programs in mind (Hazelbaker 2023). If a coal-to-nuclear transition were to take place in St. Johns, there would be abundant resources and educational infrastructure to enable retraining though a NPC-led program. The college could also glean advice on how to execute on such a transition by connecting with Western. The ability to learn from Western's experience because it is further along in the transition process could be invaluable.

Training programs can also be offered by the incoming power plant operator. Some employers may partner with out-of-state colleges or institutes where a relationship already exists or provide company training at other locations. The incoming plant operator may even have persons who coordinate the training and workforce transition to assure readiness for plant startup. This will vary from utility to utility and therefore is not easily quantifiable.

Ultimately, transitioning CGS from coal to nuclear while trying to match energy output is likely to result in more jobs for the community. Of these jobs, 74% will be relatively similar and potentially require minimal retraining. The remaining 26% could require more extensive retraining or require talent to move to the community. The community can achieve this by partnering with local colleges, the new utility, regulators, and other non-governmental agencies. Given the plant is not a first-of-its-kind transition, it can also reference the experience of other places where such a transition is taking place.

REFERENCES

Bravo, A. 1991. “Small Arizona High School to be First With Own Dome.” Seattle, WA: *The Seattle Times*. https://archive.seattletimes.com/archive/?date=19910922&slug=1306882.

Hansen, J. K., et al. 2022. “Investigating Benefits and Challenges of Converting Retiring Coal Plants into Nuclear Plants.” INL/RPT-22-67964-Rev000, Idaho National Lab., Idaho Falls, ID, United States. https://doi.org/10.2172/1886660.

Hazelbaker, D. C. 2023. “Northland Pioneer College’s Current and Future Role in Power Plant Training.” Personal Communication, June 6, 2023.

IMPLAN. 2022. “IMPLAN Economic input output modeling application, data, and solutions.” IMPLAN. https://implan.com/data/.

Murphy, A. 2023. “Western Wyoming Community College’s Role in the Kemmerer Coal to Nuclear Transition.” Personal Communication, May 18, 2023.

Natrium. 2023. “The Demonstration Project.” Natrium Power. https://natriumpower.com/wyoming/.

NREL. 2023. “SLOPE: State and Local Planning for Energy.” Golden, CO: National Renewable Energy Laboratory.

NuScale. 2021. “NuScale SMR Technology: An Ideal Solution for Repurposing U.S. Coal Plant Infrastructure and Revitalizing Communities.” NuScale. https://maps.nrel.gov/slope.

Seidman, L. W. and Carey, W. P. 2022. “Estimating the impacts of reduced operations at, and the closures of, Springerville and Coronado generating stations.” Seidman Research Institute. Arizona State University. Tempe, Arizona, United States. https://www.srpnet.com/assets/srpnet/pdf/grid-water-management/grid-management/improvement-projects/coal-communities-transition/ASU-Economic-Impact-Study.pdf.

SRP. 2022. “An Energy Mix to Power Tomorrow.” *Salt River Project*. https://www.srpnet.com/grid-water-management/grid-management/power-generation-stations.

SRP. 2023. “SRP Board Selects Jim Pratt as new General Manager and CEO of SRP, the Nation’s 3rd-Largest Not-for-Profit, Community-Based Public Power Utility.” *Salt River Project.* https://media.srpnet.com/srp-board-selects-jim-pratt-as-new-general-manager-and-ceo-of-srp-the-nations-3rd-largest-not-for-profit-community-based-public-power-utility/.

Storrow, B. 2019. “The Navajo Nation’s shift away from coal toward renewables is a test case for a wider U.S. transition.” *Scientific American*: E&E News. https://www.scientificamerican.com/article/coals-days-in-navajo-country-are-numbered/.

Tan, C. 2022. “Kemmerer nuclear project secures millions in funding.” *Natural Resours & Energy*, Online: Wyoming Public Media. https://www.wyomingpublicmedia.org/natural-resources-energy/2022-08-24/kemmerer-nuclear-project-secures-millions-in-funding.

TerraPower. 2022. “Project Will Bring a Fully Functioning Natrium Power Plant to Retiring Coal Generation Site.” TerraPower, A Nuclear Innovation Company, accessed 5/18/2022. https://www.terrapower.com/natrium-demo-kemmerer-wyoming/.

U.S. BLS. 2018. *Standard Occupational Classification Manual.* Washington, D.C.: United States Department of Labor, Bureau of Labor Statistics. https://www.bls.gov/soc/2018/home.htm.

U.S. BLS. 2022. “Employment Projections, Industry-occupation matrix data, by industry.” Edited by U.S. Bureau of Labor Statistics. https://www.bls.gov/emp/tables/industry-occupation-matrix-industry.htm.

U.S. Census. 2021. Census Bureau, *American Community Survey.* Washington, D.C.: United States Department of Commerce. https://www.census.gov/programs-surveys/acs.

U.S. Census Bureau. 2022. *American Community Survey.* Washington, D.C.: United States Department of Commerce, Census Bureau.

U.S. DOE. 2019. “Low-Income Household Energy Burden Varies Among States — Efficiency Can Help In All of Them.” Washington, D.C.: United States Department of Energy.

U.S. EIA. 2023a. “Arizona State Energy Profile.” Washington, D.C.” United States Energy Information Administration. https://www.eia.gov/state/print.php?sid=AZ.

U.S. EIA. 2023b. “Average Power Plant Operating Expenses for Major U.S. Investor-Owned Electric Utilities, 2011 through 2021 (Mills per Kilowatthour).” United States Energy Information Administration. https://www.eia.gov/electricity/annual/html/epa_08_04.html.

U.S. EPA. 2022a. “EJScreen Map Descriptions.” United States Environmental Protection Agency, accessed 5/26/2022. https://www.epa.gov/ejscreen/ejscreen-map-descriptions#category-demographics.

U.S. EPA. 2022b. “EPA’s Environmental Justice Screening and Mapping Tool.” United States Environmental Protection Agency, accessed 5/26/22. https://ejscreen.epa.gov/mapper/.

WMI. 2020. “Coronado Generating Station could shut down between 2024 and 2035.” *White Mountain Independent*. https://www.wmicentral.com/news/latest_news/coronado-generating-station-could-shut-down-between-2024-and-2035/article_a3e965d9-02c1-5e9e-a446-f38797d4495f.html.

WMI. 2021. “SRP announces timeline for planned workforce reduction at Coronado Generating Station.” *White Mountain Independent*. https://www.wmicentral.com/news/latest_news/srp-announces-timeline-for-planned-workforce-reduction-at-coronado-generating-station/article_56d9c719-ac8a-55ca-bba0-ec5700d0c6a3.html.

X-Energy. 2023. “X-Energy Investor Presentation.” X-Energy Reactor Company, LLC. https://drive.google.com/file/d/15Z5evynFiyMRG_Wst8QxqyI0hlsouXEQ/view.

GAIN MANAGEMENT TEAM

Christine King, GAIN Director
Lori Braase, GAIN Program Manager
Chris Lohse, GAIN Innovation and Technology Manager
Andrew Worrall, GAIN Deputy Director
Hussein Khalil, GAIN Senior Advisor
John Jackson, Former GAIN Technical Interface
Holly Powell, GAIN Coordinator
Alison Conner, GAIN Business Manager

Prepared for the
U.S. Department of Energy
Office of Nuclear Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

INL/RPT-23-73380
June 2023