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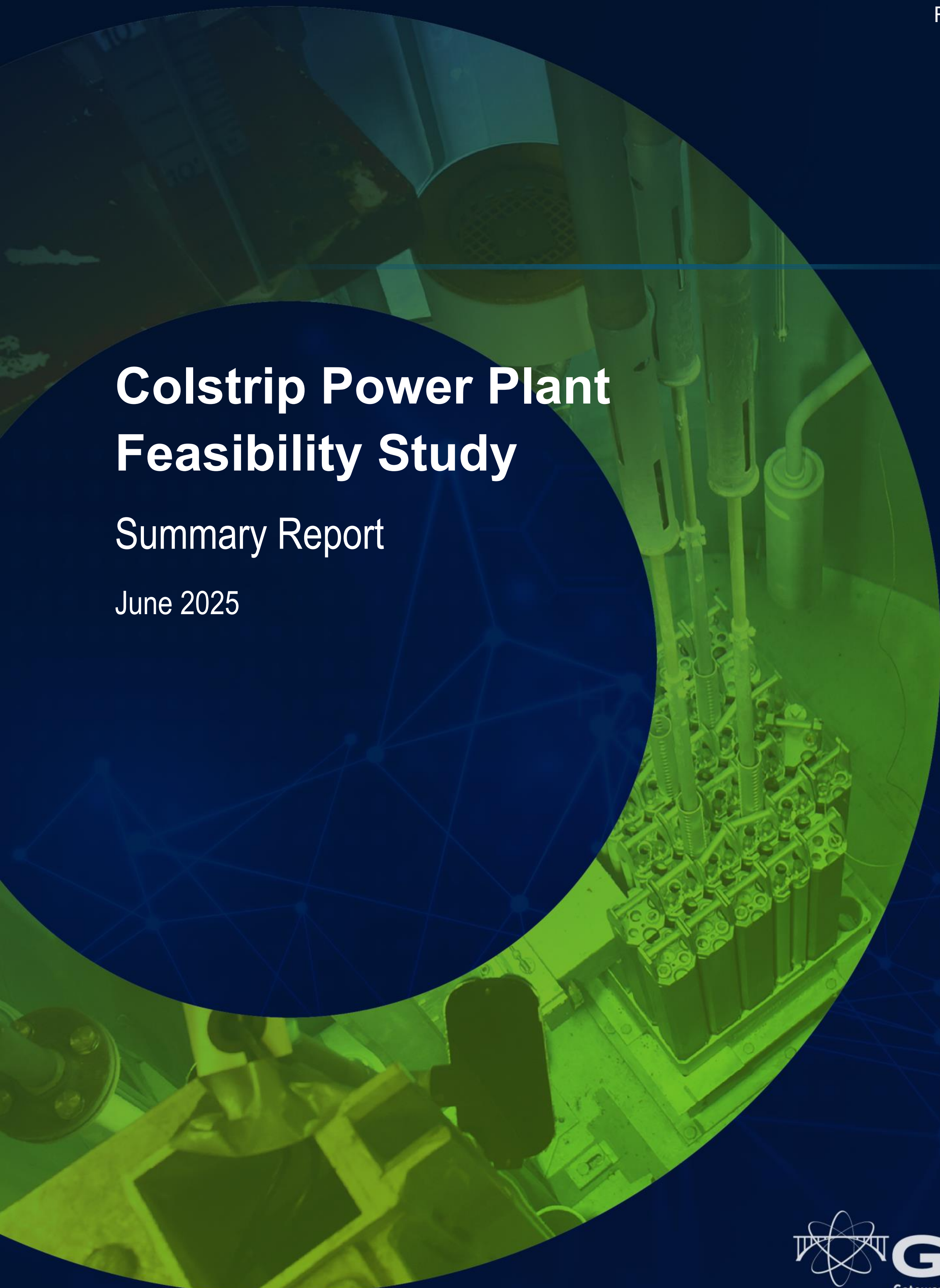

Colstrip Power Plant Feasibility Study

Summary Report

June 2025

GAIN
Gateway for Accelerated Innovation in Nuclear

COLSTRIP POWER PLANT FEASIBILITY STUDY

Summary Report

Revision 0

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EXECUTIVE SUMMARY

As the power industry moves to meet growing electricity demands while maintaining a resilient and reliable energy economy, utilities are considering various pathways that balance grid reliability, and ratepayer affordability.

Evaluating, planning, and successfully deploying a large power generation project is a major task. These projects require the right partnerships and consortiums to ensure that the execution strategy and project deployment team will deliver a successful project, while also meeting business and community goals. Community engagement is an important part of the evaluation and planning process and helps to ensure successful deployment. All these considerations are especially true for potential nuclear power projects.

The Gateway for Accelerated Innovation in Nuclear (GAIN) is working to connect diverse groups of participants with access to the technical, regulatory, and financial support necessary to move innovative nuclear energy technologies toward commercialization. NorthWestern Energy (NWE) is one of several utilities GAIN has partnered with to evaluate the potential of adding nuclear energy, in addition to other power generation technologies, to their energy portfolio.

Colstrip Power Plant (CPP) is an example of a critical power generating asset that is important to its owners due to its proximity to a high-voltage grid interconnection and the energy community in Colstrip, Montana. CPP is a four-unit coal power plant located in Colstrip, Montana. Units 3 and 4 are operational and have net capacities of 740 MW_e each. Units 1 and 2 are retired and are no longer operational.

NWE, a partial owner of CPP, is considering additional power generation options, including nuclear, in Colstrip and assessing their respective economic impacts to the region. NWE requested that GAIN investigate potential deployment scenarios to inform planning for investment decisions and identify key risks/opportunities by:

- Assessing the suitability of locations of interest within NWE's service territory, including Colstrip, for nuclear generation
- Identifying the benefits, risks, and opportunities associated with different technologies at CPP, while considering potential deployment windows
- Evaluating the regional economic impact induced by different deployment options

The siting assessment determined the suitability of various potential locations within NWE's service territory in South Dakota and Montana for nuclear generation. While the formal siting process for a nuclear reactor requires a significant amount of time (i.e., multi-year), effort, and detail, the siting assessment evaluated high level feasibility of siting a nuclear power plant in the region. Locations in South Dakota and near CPP were evaluated against industry guidance to determine if locations of interest had characteristics that could preclude nuclear development (i.e., exclusionary factors) or characteristics that could present challenges leading to increased deployment cost and project risk (i.e., avoidance factors). Based on review of publicly available information and data provided by NWE, siting a nuclear reactor is feasible near Colstrip and in some locations in South Dakota.

The deployment scenario comparison effort assessed the feasibility of different technologies near CPP. NWE identified technologies of interest including coal with carbon capture and sequestration (CCS), natural gas (NG) with and without CCS, nuclear, wind with battery storage, and solar with battery storage. This assessment identified potential deployment windows and primary risks and opportunities for each technology of interest. Based on the results of the deployment scenario comparison study, several technologies could be feasibly deployed at Colstrip.

The economic impact assessment, completed by researchers at the Idaho National Laboratory (INL), evaluated socio-economic data and estimated the impacts on the region surrounding CPP for technologies similar to those evaluated in the deployment scenarios described above. Results of the economic impact modeling effort show the existing coal power plants and coal mine in Colstrip provide a significant contribution to the local economy. The coal power industry, including mining, is responsible for more than 2,000 jobs in the local economy. Those jobs are roughly evenly split between CPP and the Rosebud Coal Mine. The addition of a 500 MW_e nuclear power plant, for example, in the Colstrip region would be responsible for supporting an additional 680 jobs to the region. If additional nuclear power capacity were added, the total number of jobs would approximately scale proportionally. The impact would also grow over time as the region develops a supportive supply chain to meet the operations and maintenance needs of a new nuclear facility.

While the assessments performed for Colstrip are informed by NWE’s specific mission and business objectives, many of the key takeaways are applicable to other communities and developers considering similar deployment scenarios. Other utilities and energy communities may be interested in factors that influence the nuclear site selection process; factors that influence deployment risk of a new power generating asset; or the economic impacts their community could experience when replacing or supplementing existing infrastructure.

CONTENTS

ACRONYMS / ABBREVIATIONS

ANR-GEIS	Advanced Nuclear Reactor Generic Environmental Impact Statement
APS	Arizona Public Service
CCS	Carbon Capture and Sequestration
C-LEAP	Communities Local Energy Action Program
CO_2	Carbon Dioxide
CPP	Colstrip Power Plant
DOD	Department of Defense
DOE	Department of Energy
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
ER	Environmental Report
ESP	Early Site Permit
FAA	Federal Aviation Administration
GAIN	Gateway for Accelerated Innovation in Nuclear
GW	Gigawatt
HB	House Bill
INL	Idaho National Laboratory
ISFSIs	Independent Spent Fuel Storage Installations
MDEQ	Montana Department of Environmental Quality
LOIs	Locations of Interest
MT	Montana
MW_e	Megawatt Electric
MWh	Megawatt Hour
NASEO	National Association of State Energy Officials
NG	Natural Gas
NOx	Nitrogen Oxides
NRC	Nuclear Regulatory Commission
NWE	NorthWestern Energy
PPE	Plant Parameter Envelope
SME	Subject Matter Expert
SRP	Salt River Project
TEP	Tucson Electric Power

INTRODUCTION AND PURPOSE

The Gateway for Accelerated Innovation in Nuclear (GAIN) is working to connect diverse groups of participants with access to the technical, regulatory, and financial support necessary to move innovative nuclear energy technologies toward commercialization. NorthWestern Energy (NWE), partial owner of the Colstrip Power Plant (CPP) located in Colstrip, Montana, is one of several utilities GAIN has partnered with to evaluate the potential of adding nuclear energy, in addition to other power generation alternatives, to their energy portfolio.

The purpose of this report is to summarize the approach taken and results obtained in the CPP feasibility study. GAIN's approach to the research project is intended to be applied and repeatable for other utilities and communities considering deploying nuclear, in addition to other power generating assets.

The three-part feasibility study includes (1) a siting assessment, (2) a deployment scenario comparison effort and (3) an economic impact assessment. The objective of this research project is to inform NWE's decision-making process regarding future power generation options and reduce uncertainty associated with the potential deployment of technologies of interest, including nuclear. GAIN's efforts relied on industry-recognized guidance, publicly available information, input from NWE and Colstrip, and nuclear domain expertise within GAIN, MPR Associates, Inc. (MPR), and the Idaho National Laboratory (INL).

BACKGROUND AND MOTIVATION

The electric power industry is undergoing a significant amount of change driven by technology innovation, customer demands, reliability challenges, and economic factors. Between 2015 and 2020, the United States (U.S.) retired an average of 11 gigawatts (GW) of coal capacity each year (Reference 1). Coal retirements are expected to continue as existing coal plants age. Across the U.S., communities, state and local governments, utilities, and researchers are seeking options to maintain or increase generating capacity to meet growing electricity demand. Adding nuclear power to the energy mix is one pathway to ensure the resiliency of the electric grid through the distribution of firm, dispatchable electricity.

Evaluating, planning for, and successfully completing the deployment of a power generation project is a complex task for any utility. These projects require the right partnerships and consortiums to ensure that technology options and licensing pathways are available, while also meeting business and community goals. Community engagement is an important part of the evaluation and planning process and helps to ensure successful deployment.

NWE, partial owner of CPP, is considering potential technologies for CPP and the associated impacts on the surrounding energy community. NWE requested that GAIN: (1) conduct a regional siting assessment to evaluate the feasibility of nuclear deployment within their service territory; (2) investigate various deployment scenario options in Colstrip to compare technologies on a like-for-like basis, inform planning for investment opportunities, and identify risks and opportunities; and (3) conduct an economic impact assessment for the technologies of interest.

NORTHWESTERN ENERGY

NWE is an investor-owned energy company that provides electricity and natural gas (NG) to more than 775,000 customers across Montana, South Dakota, Nebraska, and Yellowstone National Park (Reference 2). NWE has a diversified portfolio of electricity generation assets (Figure 1), with coal plants supplying 433 megawatts electric (MW_e) of NWE's total electric generation in 2023 (Reference 3). NWE owns shares in the coal plants listed in Table 1 and currently (as of 2024) has 30% ownership of Colstrip Unit 4 (Reference 3). Beginning in January 2026, NWE will acquire Avista's ownership of Colstrip Units 3 and 4, as well as Puget Sound Energy's ownership of Units 3 and 4 (Reference 2). These acquisitions will result in a 40% ownership of Unit 3 and a 70% ownership of Unit 4 (References 2 and 5).

To continue to meet the growing electricity needs of their customers, NWE is investigating alternative next-generation power sources to supplement current coal-generating assets and is considering nuclear power as one such alternative. NWE's current electricity generation portfolio includes 58% carbon-free generation, with a corporate goal to reach net-zero for Scope 1 and 2[1] emissions by 2050 (Reference 6).

[1] The Environmental Protection Agency (EPA) defines Scope 1 greenhouse gas emissions as those from activities in a company's control. The EPA defines Scope 2 greenhouse gas emissions as indirect emission from purchased power used at facilities (Reference 6).

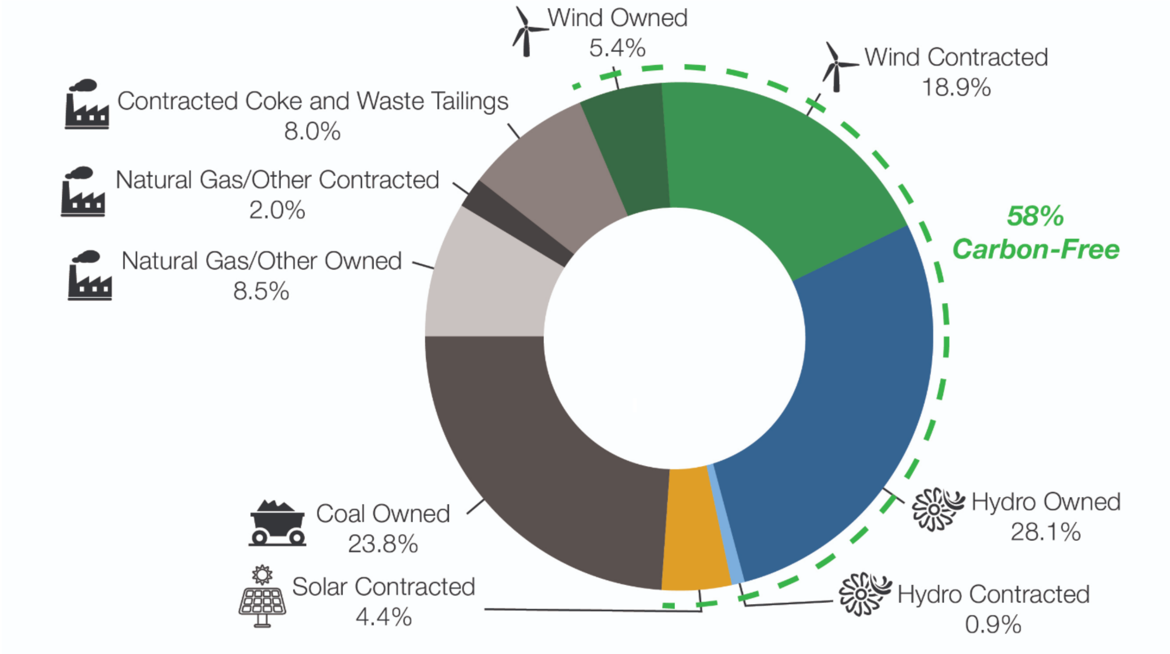

Figure 1. *Northwestern Energy 2024 Electric Generation Portfolio (Reference 4)*

Table 1. *NWE Owned or Partially Owned Coal Generating Plants in 2023 (References 3 and 5)*

Station Name (Number of Units)	Location	Approximate Total Capacity [MW_e] (1)	NWE Ownership Interest
Colstrip Power Plant (2 Operational Units)	Colstrip, Montana	1480	30% of Unit 4(2)
Big Stone Plant (Single Unit)	Big Stone City, South Dakota	475	23.4%
George Neal Energy Center (4 Units)	Sioux City, Iowa	655	8.7% of Unit 4
Coyote Electric Generating Station (Single Unit)	Beulah, North Dakota	430	10%

Notes:

1. Total capacity is the net generating capacity for the units mentioned. NWE receives a share of the total capacity based on percentage of units owned.
2. NWE plans to increase its ownership share to 40% of Unit 3 and 70% of Unit 4 by January 2026 through the acquisition of shares from Avista and Puget Sound Energy (References 2 and 5).

COLSTRIP POWER PLANT

CPP is a four-unit coal plant, with two operational and two retired units, located in Rosebud County in Colstrip, Montana (see Figure 2). Units 3 and 4, both of which are still operational, have net capacities of 740 MW_e each (Reference 5).

CPP receives its coal supply through the Rosebud Coal Mine, a 25,000-acre surface coal mine owned and operated by Western Energy Company (Reference 7). Figure 3 shows the layout of CPP in relation to the city of Colstrip, MT, along with the system for transporting coal from the mines to the plant via a conveyor system. Units 3 and 4 began operation in the 1980's and are equipped with several emission controls. These controls include a combustion system with over-fire air injection to limit nitrogen oxides (NOx), as well as a SmartBurn system that helps decrease NOx production during the combustion process (Reference 5). Additionally, activated carbon helps reduce mercury content, and the scrubbers remove sulfur dioxide and other particulate from the gases exiting the plant.

Figure 2. *Map of Montana Counties*

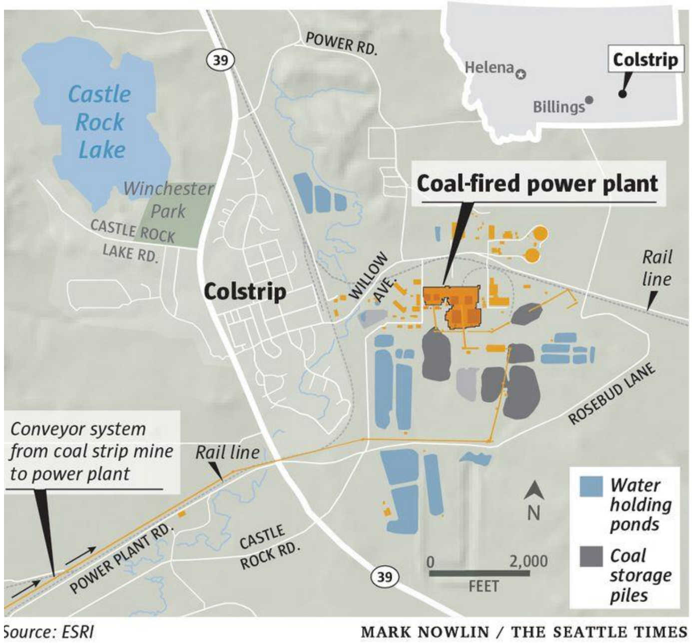

Figure 3. *Colstrip Map (Reference 8)*

INTERMOUNTAIN WEST NEWS

As interest in nuclear energy grows, there are many efforts to study, evaluate, and enable deployment of the technology in various regions throughout the country. Staying informed about relevant news related to nuclear development is important to understanding the current state of the industry. Below are some recent updates in the Intermountain West Region (i.e., Montana, Wyoming, Idaho, Colorado, Arizona, Nevada, and Utah) related to nuclear development:

- **The National Association of State Energy Officials' (NASEO) Advanced Nuclear First Movers Initiative:** This initiative is exploring opportunities to reduce financial and technology risks, devise supportive market adoption policies, define supply chain needs, streamline federal permitting, develop coordinated procurement options, explore state-federal-private financing structures, and create public-private partnerships. Several states in the Intermountain West Region, including Wyoming and Utah, are members of the initiative (Reference 16).
- **Communities Local Energy Action Program (C-LEAP) Project Cohort 2:** GAIN is partnering with several communities under the C-LEAP program. The organization is working with communities in Montana, Utah, and Colorado to assess the feasibility of leveraging data centers to support nuclear innovation in these regions. The objective is to inform the path forward by providing the necessary information to guide decisions on next steps and facilitate conversations with potential partners.

- **Salt River Project, Tucson Electric Power, and the Arizona Public Service Explore New Nuclear Sites:** The Salt River Project (SRP), Tucson Electric Power (TEP), and the Arizona Public Service (APS) are collaborating to assess potential locations for new nuclear capacity, including the retirement of coal plants. The utilities have applied for a Department of Energy (DOE) grant to begin preliminary assessments. This effort is a continuation of previous work GAIN conducted for SRP regarding the Coronado Generating Station (References 17 and 18).

STATE OF MONTANA

As of the time of writing, Montana has no operational or publicly announced plans for nuclear power plants. However, recent legislative efforts signal a shift toward exploring nuclear energy as a potential energy source. In 2021, House Bill (HB) 273 repealed a long-standing requirement for voter approval of nuclear projects, transferring authority to the state legislature (Reference 30). In 2025, HB 623 and HB 696 were proposed to further facilitate nuclear development, with HB 623 allowing nuclear waste facilities and HB 696 permitting uranium enrichment plants (Reference 31).

NORTHWESTERN ENERGY REGIONAL SITING ASSESSMENT

To assist in NWE’s planning efforts, GAIN conducted an initial siting assessment to identify locations in NWE’s service territory that are suitable to host a nuclear power plant. This assessment examined several Locations of Interest (LOIs) within NWE’s South Dakota territory and several parcels of land near CPP.

The siting assessment leverages publicly available information, input from NWE, industry leading siting assessment guidance, and insights from various industry experts at GAIN, INL, and MPR.

NUCLEAR SITING PROCESS

The formal siting process for a nuclear reactor is a multi-year process requiring a great level of time, effort, and detail. Nuclear siting assessments typically consider several locations, with the end goal of identifying one (or multiple) areas to license a nuclear generating station with the Nuclear Regulatory Commission (NRC). Licensing with the NRC is a resource-intensive process, and it can take years to prepare an application and receive formal approval. Therefore, to best manage resources and project licensing risk, a graded approach should be leveraged to efficiently identify sites suitable to host a nuclear generating station.

Siting criteria identified in available industry guidance can be grouped into three distinct stages of assessment: the exclusionary/avoidance factor screen, decision planning phase, and the licensing phase (Reference 9). Below is an explanation of the general requirements of each phase:

1. **Exclusionary/Avoidance Factors (Scope of this Assessment):** During this stage, potential applicants determine if the identified sites that have any exclusionary or avoidance factors that could hinder the construction or operation of a nuclear reactor. Exclusionary factors are characteristics that may preclude nuclear construction due to legal reasons or significant project risk. Avoidance factors are criteria that are not exclusionary but may present challenges during either licensing or construction/operation that could lead to undesirable costs and/or risks. Example criteria that were used in this evaluation is provided in the section below. Sites that do not have any exclusionary nuclear siting factors should be studied further in the subsequent stages. Typically, Exclusionary/Avoidance Factor Assessments can rely on publicly available data or limited applicant information (e.g., water usage rights, insights on community support, etc.).
2. **Decision Planning:** During this stage, a more detailed investigation is required to assess siting considerations and develop a deployment schedule to plan and coordinate information-gathering and siting activities. At this point in the process, applicants have confirmed that the sites do not have any exclusionary factors and have plans to assess risks associated with any avoidance factors identified during the Exclusionary/Avoidance Factor Assessment. While the criteria addressed in this stage are not exclusionary factors, the assessed criteria will help the applicant down-select the "best" site and preferred site layout from both regulatory and business perspectives. Additionally, if an applicant is assessing multiple sites, a definitive site or set of sites should be identified and reevaluated for exclusionary and avoidance using more detailed siting and reactor technology information (e.g., "on the ground" assessments, a Plant Parameter Envelope (PPE), etc.).
3. **Licensing:** During this stage, an applicant has selected a site for hosting a nuclear generating station, developed a deployment schedule, and is applying for either an early site permit (ESP)[2] or a construction permit from the NRC. Activities during this stage often involve site-specific work, such as geotechnical assessments, meteorological and environmental monitoring, and stakeholder engagement.

[2] An Early Site Permit (ESP) is a siting permit granted by the NRC and can be technology agnostic. Once approved, an ESP is valid for 10-20 years and can be renewed for an additional 10-20 years. Current industry estimates for the cost to an applicant for an ESP can range from $50 to $100 million U.S. dollars (2022 Dollars) and it may take up to 5 years from initiation to receiving approval from the NRC (Reference 10).

APPROACH

NWE is early in the process of assessing the feasibility of several potential LOIs in South Dakota and Montana. The primary intent of this assessment is to help NWE in the process of down-selecting LOIs that do not have exclusionary/avoidance factors. Additionally, GAIN has identified site characteristics not considered exclusionary or avoidance factors but require more investigation in the Detailed Planning phase. To better characterize the evaluated LOIs, the GAIN team completed the study in a two-step approach:

- **Step 1 – Exclusionary/Avoidance Factor Assessment:** LOIs are screened for exclusionary and avoidance factors identified in the EPRI Siting Guide (Reference 9). If a location has an exclusionary or avoidance factor present, it will not be included in the second step of GAIN's two-part screening process. This is because NWE is early in the siting process and can readily identify an alternate region with less risk. Below are some general descriptions of the types of criteria that were evaluated during this phase:
    - Geology Seismology: Evaluate seismic activity in the area and exclude regions that have an elevated risk of earthquakes. Avoiding these areas will minimize the risk of extensive safety reviews during the licensing phase.
    - Population: Evaluate the population densities of the region to ensure that the reactor can be sited at a safe distance from population centers.
    - Effects on Surrounding Ecology: Identify and exclude locations that are ecologically sensitive and/or contain endangered/threatened species (i.e., high-quality wetlands, critical habitats, etc.).
    - Socio-economic Considerations: Exclude areas that are cultural and/or have socio-economic significance to the region. Such areas can include national parks, wilderness areas, Native American lands, and wildlife refuges.
    - Nearby Hazardous Land Use: Hazardous land uses are existing facilities that pose a potential risk to a nuclear power plant. Examples include military bases, commercial airports, or chemical plants. This study excluded areas near major airports and Department of Defense (DoD) reserved lands.
    - Cooling Water Supply: A critical aspect of siting a nuclear power plant is ensuring there is sufficient water supply to provide cooling to the station. This criterion is not inherently exclusionary; however, siting away from a viable source of cooling water may increase cost and risk for the project.
    - Engineering and Cost-related Considerations: Costs related to preparing a location for a nuclear development are important to consider during the siting phase.

Consideration such as available transmission infrastructure and site preparation costs can pose an increased risk to a project. Sites that would require significant development may be excluded to avoid this risk.

- **Step 2 – Advanced Nuclear Reactor Generic Environmental Impact Statement (ANR GEIS) Assessment[3, 4]:** Locations that pass the Exclusionary/Avoidance Factor Assessment are screened for potential items that will require more investigation in future stages of the siting process, should NWE decide to pursue next steps. This screening is intended to identify areas that the NRC may focus on during licensing activities and that should be investigated more closely by NWE in the Detailed Planning stage.

Figure 4 illustrates GAIN's approach for this assessment. NWE should use the results of this assessment to complement ongoing NWE siting efforts. Nuclear siting is a process done sequentially and iteratively. This assessment should be considered an initial, complimentary step that NWE can use to inform decision-making going forward.

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[3] This portion of the evaluation is not explicitly required by the EPRI Siting Guide and is simply meant to provide NWE with more information to help inform their future decision-making.
[4] The NRC recently released an updated draft version (September 2024) of the ANR GEIS titled the "New Nuclear Reactor Generic Environmental Impact Statement (NR GEIS)" (Reference 34). The new revision does not have any significant changes that impact the methodology or results of this assessment. As such, the guidance and resulting criteria from the ANR GEIS (Reference 21) are still applicable and were used in this report. NWE should continue to monitor for future updates to the NR GEIS and for additional rulings from the NRC regarding this topic.

Figure 4. *Overview of Regional Siting Assessment Approach*

RESULTS

Conclusions

Based on the results of this siting assessment, NWE may want to continue to consider nuclear as a viable technology to deploy in their service territory. Several of the locations evaluated within this assessment did not have any exclusionary or avoidance factors. Of the locations free of exclusionary or avoidance factors, most had site characteristics that require more investigation by NWE in later planning stages. General characteristics of the results were:

- Several of the locations in South Dakota are suitable for hosting a nuclear power plant; however, common risks present at many of the sites include infringement on wetlands, farmland use, and cooling water supply.
- The land surrounding Colstrip is suitable for hosting a nuclear power plant and does not have any exclusionary or avoidance factors. Some favorable aspects of the region surrounding Colstrip include access to existing transmission infrastructure, water pumping infrastructure, and a workforce familiar with power generation.

Next Steps

If NWE decides to pursue next steps and continue the nuclear siting process, NWE will need to invest additional time and resources to quantify potential siting risks associated with the LOIs, as well as risks associated with the broader context of a nuclear deployment strategy.

Based on the results of this siting assessment, NWE could consider further site development activities for the LOIs that passed the Exclusionary/Avoidance Factor Assessment. Some specific activities could include:

- Align on and document NWE's mission and business objectives to ensure the selected site(s) meet NWE's needs.
- Start to identify specific land parcels within the LOIs and engage with reactor vendors to evaluate site-specific criteria against specific reactor technology features (or multiple reactor technologies) via a PPE.
- Perform more detailed engineering analyses to quantify the site development costs (e.g., cost for transmission and infrastructure upgrades, land acquisitions, etc.) to support nuclear deployment. The total estimated cost required to develop each site will provide a quantitative metric to compare sites. This will also require pulling in additional criteria that could not be evaluated during this assessment. Some areas for future investigation to quantify development costs could include, but are not limited to, the following:
    - Develop cooling strategies based on the needs of the potential plant and availability of resources (e.g., proximity to cooling water sources, permit availability, etc.).
    - Assess transmission infrastructure upgrade costs based on the size of the potential plant.
    - Assess the presence of protected species and their potential impact to nuclear construction and operation.
    - Engage with local and state stakeholders to assess their support of the project and identify potential mutual benefits.

NWE can leverage these next steps to further inform site selection and mature their deployment strategy before investing significant capital and resources in licensing activities. NWE should use the site-specific development costs and information gathered from maturing other workstreams related to nuclear deployment planning (e.g., preliminary licensing, financing, execution, stakeholder engagement, etc.) to select a site (or sites) that best align with their long-term business objectives.

APPLICABILITY TO OTHER ENERGY COMMUNITIES

Many elements of the Colstrip and South Dakota siting assessment could apply to other energy communities around the country. While the detailed results of the study are specific to the regions evaluated, the approach methodology is fully transferrable. Utilities and other stakeholders can leverage industry resources such as the EPRI Siting Guide and the NRC's GEIS to evaluate possible locations for new nuclear development.

Beyond the specifics of the Colstrip siting assessment, there are other aspects that the local community and utility should consider when deciding where to deploy a nuclear reactor. Topics that were of specific interest to the Colstrip community are discussed below.

Spent Nuclear Fuel Management

An important aspect that utilities and communities should understand when siting a nuclear power plant is the long-term management of the facility's spent fuel.

All commercial nuclear reactors in the U.S. use a once-through fuel cycle. There are many reasons for this, both political and economic, but the total amount of spent fuel generated by all commercial nuclear reactors in the U.S. is relatively small compared to other generation sources. Some countries, such as France and others, use a closed fuel cycle, where used fuel is reprocessed and reused. This significantly reduces the amount of spent fuel generated by their nuclear power plants (Reference 11).

In the U.S., while efforts to construct a long-term geological repository are suspended, evaluation activities continue. As a result, the majority of used nuclear fuel is in dry storage on-site at nuclear power plants. Specifically, until a long-term repository is established in the U.S., reactor operators are storing used fuel on-site in Independent Spent Fuel Storage Installations (ISFSIs) (Reference 36). ISFSIs are a part of standard plant design and are built to hold dry casks containing the used nuclear fuel. To date, all used nuclear fuel in the U.S. has been stored without incident (Reference 13).

The DOE identified the need to construct a federal consolidated storage facility (CSF) for the nation's commercial spent nuclear fuel. The DOE is currently engaging in a collaborative siting process with communities interested in learning more about potentially hosting a federal CSF. The federal CSF project covers removal of commercial spent nuclear fuel from where it is currently stored at nuclear power plant sites or a shutdown site, transportation of the fuel, and temporary storage of the fuel at a centralized location(s) (Reference 12).

Passive Safety Systems

As nuclear technology development progresses, the criteria for the siting of these new reactors will change accordingly. An important feature of these new technologies that may influence the siting criteria is the implementation of passive safety features in the reactor design.

Passive safety systems and inherent safety features in nuclear generating stations refer to systems and features which safeguard reactor operations without the need for operator intervention (References 14 and 15). The National Academy of Sciences distinguishes between passive and inherent safety systems on the basis that passive features are those which are developed to only require natural forces, properties of materials, or internally stored energy to complete a safety function, while inherent safety features rely on fundamental properties (materials or design choices that cannot be changed by internal or external conditions) to complete a safety function. While older generations of nuclear reactors heavily rely on operator action/intervention, next generation reactor designs incorporate passive and inherent safety features to reduce operator action/intervention. Passive and inherent safety features simplify nuclear power plant operations and design, reduce the regulatory overhead required, and improve overall plant safety.

The reduced risk profile of next-generation nuclear reactors is anticipated to allow for smaller exclusion zones compared to traditional reactors, enabling new reactors to be built in a wider variety of areas and on less land, should vendors pursue reduced exclusion zone sizes from the NRC. For example, NuScale Power received NRC approval of their methodology that justifies a reduced emergency planning zone of the company's VOYGR™ reactor (Reference 35). Passive and inherent safety features also help build public support of next-generation projects when potential owners communicate their merits effectively. Theoretically, new safety systems and features are likely to make newly built nuclear generating stations more reliable, cheaper to operate, and safer.

COLSTRIP DEPLOYMENT SCENARIO COMPARISON

To assist in NWE's planning efforts, the project conducted an evaluation of benefits, risks, and opportunities associated with different potential technologies at CPP. The deployment scenario comparison study specifically identifies activities and associated risks and opportunities for each technology of interest.

DEPLOYMENT PLANNING

Deployment of a power generation asset is a significant undertaking that requires due diligence before investment decisions are made. Project development is managed through multiple phases and decisions points. Several inputs are required to make investment decisions; some of the key factors that can contribute to an investment decision include:

- Project cost and the associated impact to rate payers
- Project deployment timeline
- Lifetime of the generating asset
- Site compatibility
- The fit of the resource in the overall generation portfolio and integrated resource plans
- Alignment between the communities and states (e.g., emissions, economic impact)
- Confidence in project deployment and overall risk tolerance (e.g., technology readiness, supply chain maturity)

This research project provides independent data to help inform NWE decision making regarding the deployment of potential technologies.

APPROACH

NWE is interested in investigating different power generating technology options in the Colstrip region in the event CPP is eventually retired. The purpose of investigating these different technology options and deployment scenarios is to:

- Compare technologies on a like-for-like basis.
- Contribute to planning for investment opportunities.
- Provide awareness of key risks, benefits, and drawbacks for each technology and scenario.

NWE requested the following technologies based on internal discussion with the executive team and resource planning teams: carbon capture and sequestration (CCS), NG with and without CCS, nuclear, wind with battery storage, and solar with battery storage. Each technology was studied independently, and in some scenarios in combination with one another (e.g., coal to gas to nuclear, etc.) to capture the key activities, risks, and opportunities associated with each.

The deployment scenario options shown in Figure 5 indicate a transition from coal, at a time decided by NWE and other owners, to a new power generating asset. It should be noted these scenarios are also applicable if these generation sources are integrated into NWE's portfolio (in addition to power already provided by CPP). Other uses of this assessment could inform deployment of these new technologies to their portfolio while continuing to operate the CPP to meet increasing demand.

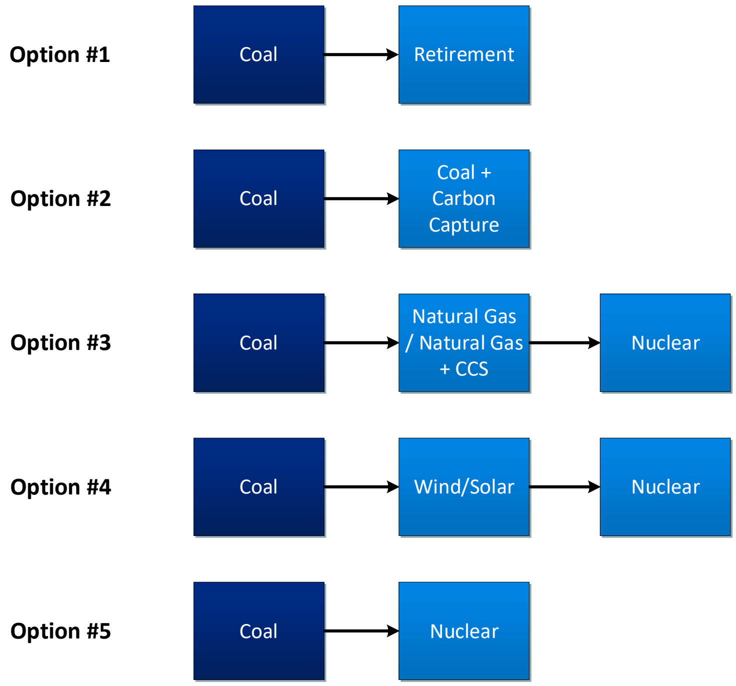

Figure 5. *Colstrip Deployment Options*

To assess the above deployment scenarios, the project leveraged workstreams for each technology to organize key activities. Major activities were grouped into the following workstreams: feasibility considerations, technology maturity, supply chain maturity, interconnection scope, licensing, infrastructure requirements, procurement and lead time, and deployment duration. Scenario risks (i.e., events that could increase cost and/or extend the schedule) and opportunities (i.e., events that could reduce cost and/or shorten the schedule) were then assessed through the lens of these workstreams, enabling a like-for-like comparison. Insights captured here were determined through engagement with subject matter experts (SMEs) and research of publicly available, independent sources provided by agencies such as the NRC, DOE, Environmental Protection Agency (EPA), Lawrence Berkeley National Laboratory, Montana Department of Environmental Quality (MDEQ), and experience from similar NWE projects.

RESULTS

The results of this study highlight the complexity of factors that influence the selection of a particular technology for development in power generation resource planning. This project investigated and summarized major activities that drive development, along with the associated risks and opportunities.

Table 2 provides an overview of the key takeaways associated with each technology of interest. These insights provide context for understanding the driving factors and risks that impact the development of power generation assets and the overall durations of the timelines.

Based on the results of the deployment scenario comparison study, several technologies could be successful at Colstrip. This report serves as a good foundation for NWE as they proceed with portfolio planning. Next steps could include:

- Conduct more detailed feasibility studies, leveraging the information provided by the project to guide areas of focus.
- Assess the fit of each technology within NWE's broader resource plans and mission/ business objectives.
- Refine schedules and risk registers with project- and technology-specific information by engaging with vendors and/or construction contractors.

Table 2. *Technology Takeaways*

<table>
<tr><th>Workstream</th><th>Coal with CCS</th><th>Natural Gas with CCS</th><th>Natural Gas without CCS</th><th>Wind with Battery Storage</th><th>Solar with Battery Storage</th><th>Nuclear</th></tr>
<tr><td>Key Feasibility Considerations</td><td colspan="2">CCS has a high associated hotel load, which decreases net power exported to grid.
There is a risk that geologic sequestration or the pipeline transport of CO_2 to other locations may not be feasible.
Remaining life of the coal plant must be considered to ensure investment in CCS infrastructure is being maximized.</td><td>Carbon capture may be required to comply with EPA.
There is opportunity to leverage coal plant infrastructure (e.g., interconnection and substation).</td><td colspan="2">The amount of land available for wind or solar development will directly impact the capacity, and the desired capacity may differ from what is achievable.</td><td>Overall risk status and appetite.
Desire to be the first, early, or later mover in the pursuit of a project.</td></tr>
<tr><td>Technology Maturity</td><td colspan="2">CCS is a maturing technology.
Technology economic viability not yet demonstrated.</td><td>Mature, commercially available technology.</td><td colspan="2">Mature, commercially available technology.
Grid scale and long-duration battery storage technologies are maturing. Assumed lithium-ion batteries, a mature technology, for this investigation.</td><td>Maturing, only a few advanced nuclear technologies are commercially available.</td></tr>
<tr><td>Supply Chain Maturity</td><td colspan="2">New supply chain with high demand, but raw materials and manufacturing methods are standardized.</td><td>Developed supply chain.</td><td colspan="2">Developed supply chain for solar and wind.
Battery supply chain has high demand, and longer procurement durations are expected.</td><td>Advanced nuclear supply chain is not mature.
Advanced reactor components and fuel supply chains must be established.</td></tr>
<tr><td>Interconnection Scope</td><td>Modification to existing interconnection agreement.</td><td colspan="2">Modification to existing interconnection agreement (pending timing of coal plant retirement and proximity of natural gas plant to existing infrastructure).</td><td colspan="2">Interconnection studies required for use of existing agreement. Grid upgrades and interconnection queue could impact cost/schedule.</td><td>Interconnection studies required. Grid upgrades and interconnection queue could impact cost/schedule. Interconnection queue time expected to be longer for new generation sources.</td></tr>
</table>

__Table 2.__ Technology Takeaways

Workstream	Coal with CCS	Natural Gas with CCS	Natural Gas without CCS	Wind with Battery Storage	Solar with Battery Storage	Nuclear
Licensing and Permitting Risk Considerations (State and Federal)	High - CO_2 sequestration permit development and EPA review are lengthy. Few permits have been granted.		Low - Right-of-way permits for natural gas pipeline could extend schedule.	Low – Federal Aviation Administration Environmental permits, Land permits, and Flood/National Pollutant Discharge Elimination System permits required.	Low - Land permits, Flood/National Pollutant Discharge Elimination System permits, Zoning permits, and Building/Electrical permits required.	High -NRC construction and operation license application develop ment and review durations are dependent on the nuclear technology selected.
Potential to Leverage Existing CPP Infrastructure	High - Carbon capture infrastructure connected to back-end of coal plant.	Medium/High - Potential to leverage existing interconnection and transmission infrastructure. Potential to leverage available land on site.		Medium – Some existing land could be leveraged but more would be needed for sufficient capacity. Interconnection studies required, but existing interconnection and transmission infrastructure could be leveraged.		Low – Likely nuclear plant would be developed near CPP rather than on the existing footprint. Still, existing transmission infrastructure could be leveraged.
Major Infrastructure Gaps	CO_2 pipeline and geological storage infrastructure required (none currently exist in MT).		Local natural gas transmission line abandoned in place. Status unknown.	Additional substations/switchyards and network upgrades may be required.		Level of site work dependent on location selected.
Procurement	Procurement of long lead items (e.g., transformers) should begin as early as the end of preliminary design to reduce risk of schedule delays. Procurement timing will depend on risk tolerance.					
Deployment Duration Range Based on the Timing of Decisions to Proceed [(1)]	6 – 10 Years			Less than 6 Years		10+ Years

Note:

1. Durations could be impacted by project- and technology-specific risks (e.g., interconnection queue delays) and opportunities.

APPLICABILITY TO OTHER ENERGY COMMUNITIES

This research project serves as an example of one of the first steps required to make resource planning decisions. CPP is among many important aging power generation assets in the U.S. that may be impacted by change driven by technological innovation, evolving customer demands, reliability issues, and economic factors in the coming years. The overall approach used in the deployment scenario comparison effort can be adapted by other utilities and energy communities as they begin to explore different power generation sources.

The first step in completing a deployment scenario comparison is to identify the appropriate and possible scenarios for a given energy community based on all stakeholder needs and objectives. From there, further investigation into the relevant regulations and permitting for each scenario can begin. Additionally, utilities and/or energy communities can continue to explore interconnection agreement pathways, long-lead materials, and other critical technology items. Beyond the general applicability of the deployment scenario comparison approach, the key technology takeaways may also be relevant to other utilities and energy communities. Key feasibility considerations, technology and supply chain maturation, and procurement offer useful insights that are non-site specific may be leveraged.

Many of the risks and opportunities identified for the development of various power generation technologies apply not only to CPP but also to other sites. They can help in understanding the key schedule drivers for deployment of each technology and in identifying which items will likely require additional effort during later stages of development.

ECONOMIC IMPACT ASSESSMENT

The purpose of the CPP economic impact assessment report, performed by energy economists from INL, is to evaluate regional economic impacts associated with existing coal mining and coal plant operations in Colstrip and compare them to potential regional economic impacts associated with other technologies of interest, including nuclear, in Colstrip. This was done by analyzing the economic impact of the coal plant and associated coal mine assuming continued operation and separately analyzing impacts to the economy should a new power generating asset be deployed.

Regional economic impacts (e.g., jobs and income) associated with deployment and operation of power generating assets depend on several factors, including the population of the local community, and the capacity and technology associated of the asset(s) of interest. This assessment is particularly focused on the economic activity within Rosebud, Yellowstone, and Big Horn Counties. The results of this assessment are not intended to be used for financial forecasting or to replace accounting practices but should be used to compare socio-economic impacts of various generation options. The full CPP economic impact assessment is available in Appendix A.

APPROACH

An input-output model was used to quantify the impacts associated with potential deployment scenarios (i.e. nuclear, NG, wind, and solar). These models are created by combining regional economic data with industry-level transaction data for a specific period, usually one year. The impact of new economic activity 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. Such models can be calculated manually or processed using advanced applications from multiple software developers. The model used in this report was produced using the IMPLAN input-output modeling application.

Input-output model results are based on three main drivers: employment, revenue, and labor income. For the model's input data, revenue from electricity generation was calculated by multiplying annual megawatt hours (MWh) by the wholesale price of electricity, an approach that more closely reflects the value added by the generating station. Retail electricity prices were not used for revenue estimation to better account for the value created solely by the plant. Using retail electricity prices would overstate the generating station's value, as additional value is added during the transmission and distribution processes performed by the utility.

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- and medium-sized reactors. To date, these reactor vendors include NuScale Power, X-Energy, and TerraPower. They have published or announced employment estimates that help improve the accuracy of the model results. Accurate employment and wage information is a major component necessary for input-output modeling. The analysis of wind, solar, and NG incorporated data from publicly available resources and industry trends.

Economic impacts are separated into the following four categories:

- **Facility Operations Impact:** Also known as the "Direct Impact." These values are based on facility operations, including employment, labor costs, and wholesale revenue from electricity produced by the generating facilities or the sale of coal. These can be considered "plant-level" impacts.
- **Supply Chain Impacts:** Also known as "Indirect Impacts." This refers to the supply chain activity created through interactions between the power generating assets and suppliers of goods and services within the region.
- **Induced (Community) Impact:** New economic activity created by households spending income earned directly or indirectly from generating station operations. These can be considered "community-level" impacts.
- **Total Impact:** The combination of all three impact categories.

RESULTS

The results of the economic impact modeling show that the existing coal power plants and the coal mine in Colstrip provide a significant contribution to the local economy. Through operations, as well as associated supply chain and community impacts, the coal power industry, including mining, is responsible for supporting more than 2,000 jobs in the local economy. This impact is split almost evenly between coal power plant operations and coal mining.

The addition of a 500 MW_e nuclear power plant in the Colstrip region would support more than 680 jobs. This impact would grow in an almost linear fashion with increases in the power generation size of the power plant. Additionally, the impact would increase over time as the region develops a supportive supply chain to meet the operations and maintenance needs of a new nuclear facility.

Table 3 provides a detailed estimate of employment impacts by technology type. Previous studies have shown that approximately 74% of the jobs at a nuclear power facility are also found at coal power plants (Reference 19). A 500 MW_e natural gas power plant would also provide a boost to the local economy, with an estimated employment impact of around 225 jobs, about one-third the impact of a nuclear facility. Of those jobs, nearly 200 would result from supply chain activity and community spending by employees. The total employment impact of a 200 MW_e wind farm and a 150 MW_e solar farm would be approximately 75 and 30 jobs, respectively. Figure 6 shows the employment impact for each technology on a per MW_e basis. More detailed information related to education and income is available in Appendix A.

Table 3. *Employment Impact Comparison of Colstrip Energy Options (# of Jobs)*

Impact Area	Colstrip Power Plant (1480 MW_e)(1)	Nuclear (500 MW_e)(2)	Natural Gas (500 MW_e)(2)	Rosebud Power Plant (41 MW_e)	Wind (200 MW_e)(2)	Solar (150 MW_e)(2)
Facility Operations	250	199	25	31	18	4
Supply Chain	433	188	134	15	33	18
Community	353	294	66	31	24	8
Total	1,036	681	225	77	75	30

Notes:

1. Job numbers for Colstrip Power Plant do not include jobs and associated impacts of the Rosebud Coal Mine
2. The total installed capacities are based off typical capacity sizes for these technologies in the proposed region.

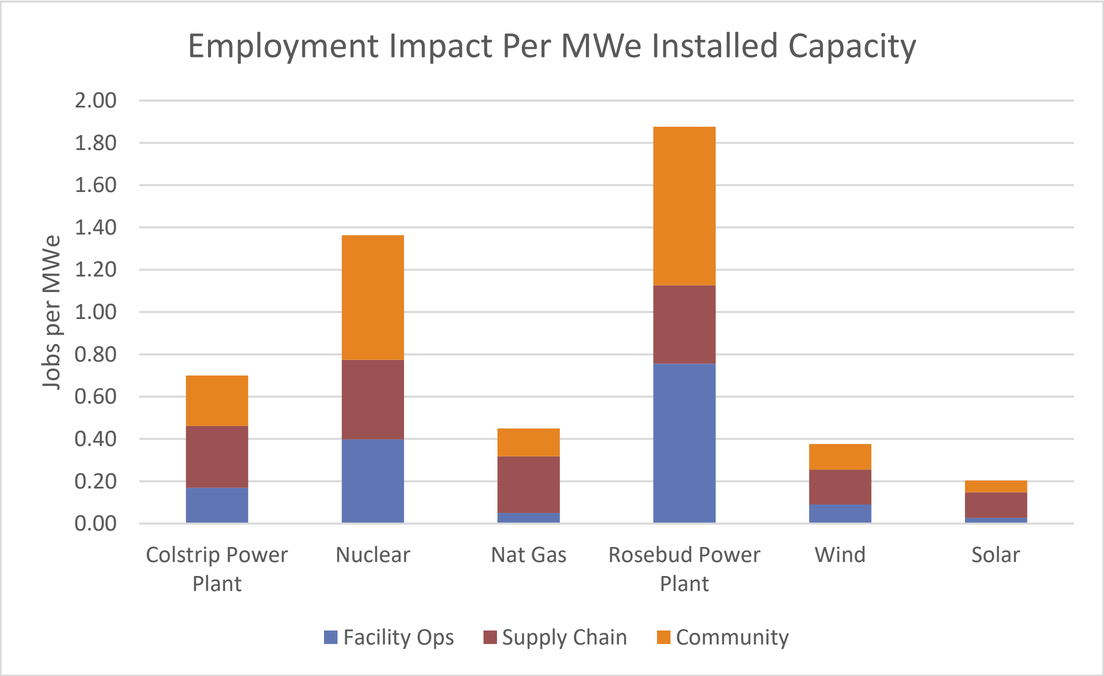

Figure 6. *Employment Impact per MW_e Installed Capacity*

During peak construction, a 500 MW_e nuclear facility would support more than 1,500 plant construction workers. Additional construction supply chain activity related to construction would support nearly 1,000 jobs, and community spending by construction workers and suppliers would support over 2,200 jobs. Altogether, the three-year peak construction period could support more than 4,700 jobs. Initial construction activity during site preparation and demobilization would support between 675 and 1,350 jobs.

Table 4 provides the total output impact (i.e., dollar value of industry production) associated with each technology type. The total output impact also provides insight into current and potential economic impacts. The facility operations impact is based on estimated revenue from electricity sales, calculated by multiplying the wholesale price of electricity for the region by estimated electricity production. Actual electricity sales figures may vary slightly from the estimates shown in Table 4. Coal sales for the Rosebud mine are based on the historical price of coal for electricity production, as reported by the Energy Information Administration (EIA) (Reference 20).

The total output impact for the nuclear and natural gas scenarios is estimated at $310 million and $183 million, respectively. CPP has an estimated output impact of $617 million. As mentioned previously, CPP has a generating capacity of more than 1,400 MW_e, significantly larger than the comparison technologies. The 150 MW_e solar facility is expected to produce a total output similar to that of the Rosebud power plant, which is rated to 41 MW_e. The 200 MW_e wind facility would produce roughly double that of the solar facility.

Table 4. *Total Output Impact Comparison of Colstrip Energy Options ($ millions)*

Impact Area	Colstrip Power Plant (1480 MW_e)	Nuclear (500 MW_e)[1]	Natural Gas (500 MW_e) [1]	Rosebud Power Plant (41 MW_e)	Wind (200 MW_e)[1]	Solar (150 MW_e)[1]
Facility Operations	$382	$186	$118	$13	$27	$14
Supply Chain	$175	$74	$54	$6	$13	$7
Community	$60	$50	$11	$5	$4	$1
Total	$617	$310	$183	$24	$44	$22

Note:

1. The total installed capacities are based off typical capacity sizes for these technologies in the proposed region.

Appendix A of this report includes economic impact estimates for labor income and contributions to the local gross domestic product. Additional details are also provided on the Colstrip region's economy, as well as information on education and training.

USEFUL RESOURCES

SITING ASSESSMENT RESOURCES

As industry interest in nuclear generating stations grows, numerous siting guidance documents are being made available to assist utilities and communities in evaluating site suitability. These guidance documents are best used early in the siting process, as they provide high-level overviews of exclusionary and avoidance criteria, along with guidance on more detailed nuclear siting considerations.

The report leveraged the following siting guidance documents to assess the suitability of the Colstrip Region and South Dakota.

- **"Advanced Nuclear Technology: Site Selection and Evaluation Criteria for New Nuclear Energy Generation Facilities (Siting Guide)" (Reference 9):** This guide, published by EPRI, provides siting guidance to prospective utilities throughout the lifecycle of the siting process. It combines both regulatory guidance and business-related considerations, serving as a comprehensive reference and a good starting point for any siting activities.
- **NRC NUREG – 2249: Advanced Nuclear Reactor (ANR) Generic Environmental Impact Statement (GEIS) (Reference 21):** The NRC is in the process of amending its rules and regulations to adopt a set of plant and site features that, if met, will expedite the NRC's review of ERs. This will allow the NRC to conduct a targeted review of specific environmental topics in the Environmental Report (ER) that may have a larger impact, rather than reviewing all aspects of the ER.
- **Previous GAIN Siting Studies (References 22 and 23):** GAIN has completed and released two publicly available siting assessments for the Coronado Generating Station (CGS) in St. Johns, Arizona and the Ghent Generating Station (GGS) in Ghent, Kentucky. These reports use and apply industry guidance to assess feasibility of hosting a nuclear generating station at two separate coal plants. These reports provide a practical application and overview of how siting criteria are applied to these sites to reach a conclusion on each site's ability to host a nuclear reactor.
- **From Coal to Nuclear: A Practical Guide for Developing Nuclear Energy Facilities in Coal Plant Communities (Reference 24):** This guide published by EPRI provides owner-operators and other stakeholders with guidance for deployment of a nuclear generating station on, or near, an existing coal plant site.

- **DOE's "Investigating Benefits and Challenges of Converting Retiring Coal Plants into Nuclear Plants" (Reference 32):** This report specifically considers the transition of coal-fired power stations to nuclear generating stations and addresses some of the key pros and cons associated with converting. This report also highlights some of the economic aspects to consider when converting coal-fired power stations into a nuclear generating station.

DEPLOYMENT SCENARIO COMPARISON RESOURCES

The report leveraged the following documents to understand risks and opportunities associated with deploying technologies at Colstrip.

- **"Pathways to Commercial Liftoff: Advanced Nuclear" (Reference 25):** This guide was published by the Department of Energy and provides guidance on the possible pathways to commercial operation of advanced nuclear power given current legislation and NRC guidance.
- **DOE's "Land-Based Wind Energy Siting: A Foundational and Technical Resource" (Reference 26):** This report serves as a resource for land-based, utility-scale wind energy, considering the implementation of wind energy from a community perspective. This includes discussion on wind energy technology, important considerations, and a general examination of siting requirements.
- **Decommissioning Handbook for Coal-Fired Power Plants (Reference 27):** This guide, published by EPRI, provides guidance for decommissioning of a coal-fired power station based on previous efforts at three other sites.
- **"Queued Up: Status and Drivers of Generator Interconnection Backlogs," (Reference 28):** This presentation illustrates the current state of interconnection in the U.S. and the key drivers behind the current interconnection backlog as utilities work to connect more assets to the grid.
- **DOE's "Energy Transitions Initiative: Energy Transitions Playbook: Execute and Manage" (Reference 29):** This report focuses on the energy and infrastructure challenges associated with transitioning energy sources, including key risks and insights from ongoing efforts of other communities and utilities.

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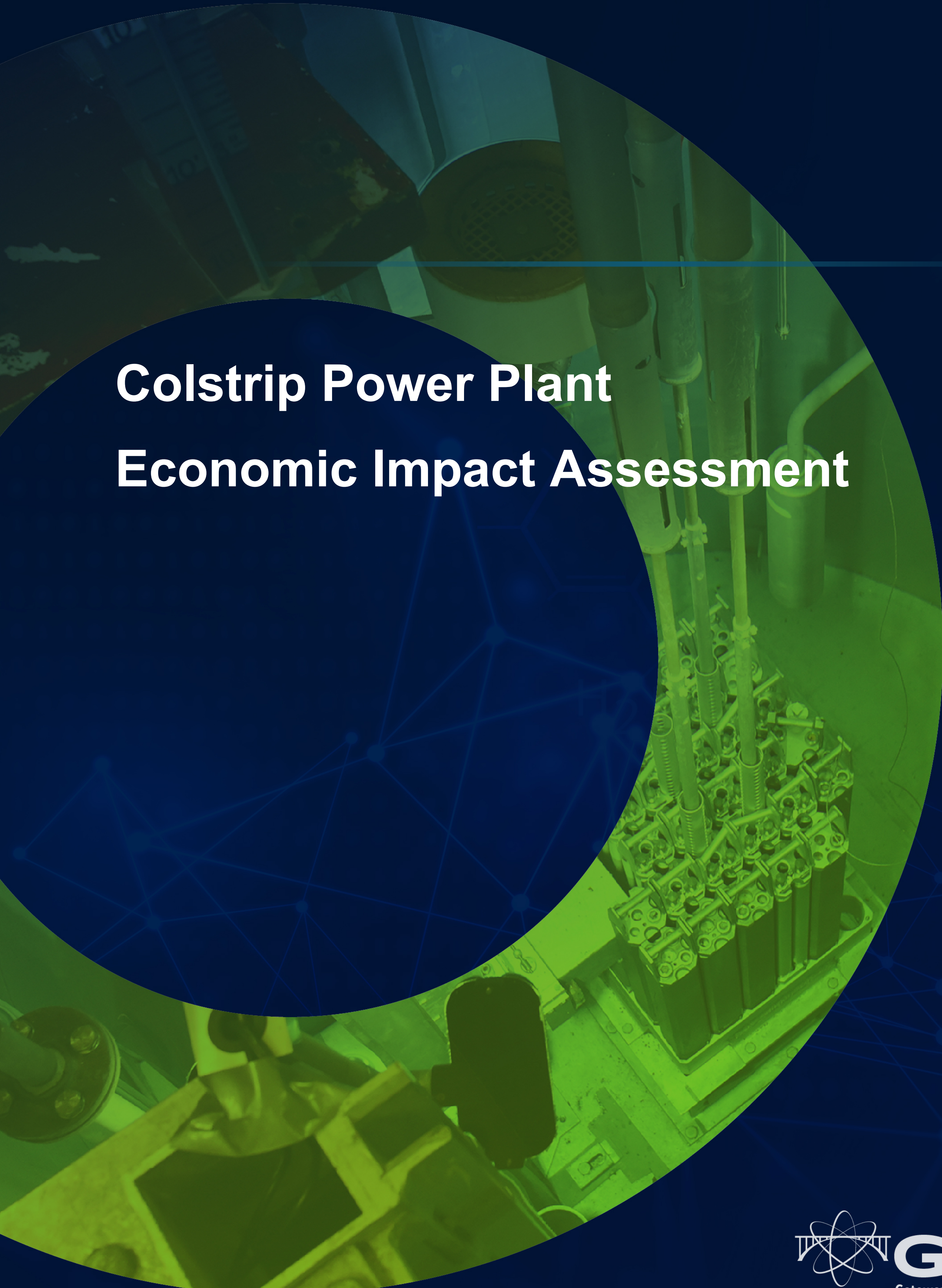
APPENDIX A

Below is the Colstrip economic impact report prepared and reviewed by economists at INL. The report expands on content provided in the summary report above and provides more detail into the methodology and results of the evaluation.

Colstrip Power Plant

Economic Impact Assessment



GAIN
Gateway for Accelerated Innovation in Nuclear

EXECUTIVE SUMMARY

An economic impact model was used to analyze the potential economic impacts associated with multiple grid scale electricity-generating technologies and how they differ from the existing economic impact of coal mining and coal power plant operations. The generating technology production capacity scenarios used in this analysis are based on recent energy industry trends and input from stakeholders. This effort also includes an analysis of the economic impact associated with constructing a 500-megawatt electric (MWe) nuclear power plant. Further analysis was completed to provide information on workforce needs that would arise with the addition of a nuclear power facility. In an energy community like Colstrip, there is already a skilled workforce supporting coal power and mining operations. Some resources outside the region would be required to support nuclear-specific education and training needs that do not currently exist locally.

Results of the economic impact modeling effort show that the existing coal power plants in Colstrip provide a significant contribution to the local economy. Through operations and additional supply chain and community impacts, the coal power industry, including mining, is responsible for more than 2,000 jobs in the local economy. That impact is split almost evenly between coal power plant operations and coal mining. The addition of a 500 MWe nuclear power plant in the Colstrip region would be responsible for supporting more than 680 jobs. This impact would grow in an almost linear way if the size of the power plant increases. The impact would also grow over time as Rosebud County, and the other counties surrounding Colstrip, develop a supportive supply chain to meet the operations and maintenance needs of a new nuclear facility.

Previous studies have shown that around 74% of jobs found at a nuclear power facility are also found at coal power plants (Jenson, et al. 2023). A 500-MWe natural gas power plant would also provide a boost to the local economy. The employment impact would likely support around 225 jobs, one-third of the employment impact of a nuclear facility. Nearly 160 of those jobs would be the result of supply chain activity and community spending by employees. The total employment impacts of a 200-MWe wind farm and a 150-MWe solar farm would result in 70 and 31 jobs, respectively. Table 1 provides a detailed estimate of employment impact by technology type. More detailed education and income-related information is available in the appendix of this report.

Table 1. Colstrip energy options employment impact comparison.

Colstrip Energy Options Employment Impact Comparison							
Impact Area	**Colstrip Power Plant (1,480 MWe)**	**Rosebud Mine**	**Nuclear (500 MWe)**	**Natural Gas (500 MWe)**	**Rosebud Power Plant (41 MWe)**	**Wind (200 MWe)**	**Solar (150 MWe)**
Facility Ops	250	321	199	25	31	18	4
Supply Chain	433	248	188	134	15	33	18
Community	353	364	294	66	31	24	8
Total	1,036	933	681	225	77	75	30
*Mine included to show impact of mining operations that support the Colstrip and Rosebud power plants.							

During the peak construction, the related impacts of a 500-MWe nuclear facility would support more than 1,500 plant construction workers. Additional construction related supply chain activity would support close to 1,000 jobs. The community spending by construction workers and suppliers would support more than 2,200 jobs. All combined, the 3-year construction impact could support more than 4,700 jobs at the peak. Initial construction activity during site preparations and demobilization would support between 675 and 1,350 jobs.

The total output impact, or dollar value of industry production, can also provide insight regarding current and potential economic impact. The facility operations impact is the estimated revenue from sales of electricity based on the wholesale price of electricity for the region multiplied by the estimated electricity production. Actual electricity sales figures may differ somewhat from what is presented in Table 2 because these are only estimates. Coal sales for the Rosebud mine are based on the historical price of coal for electricity production originating from EIA (EIA 2025).

The total output impact for the nuclear and natural gas scenarios accounts for $310 million and $183 million, respectively. The Colstrip power plant has an estimated output impact of $617 million. As mentioned previously, the Colstrip power plant has a generating capacity of more than 1,400 MWe, much larger than the comparison generating technology. The 150-MWe solar facility would be expected to produce a similar total output to the Rosebud Power Plant, which is rated to 41 MWe.

Table 2. Colstrip energy options total output impact comparison.

Colstrip Energy Options Total Output Impact Comparison ($Millions)							
Impact Area	Colstrip Power Plant (1,480 MWe)	Rosebud Mine*	Nuclear (500 MWe)	Natural Gas (500 MWe)	Rosebud Power Plant (41 MWe)	Wind (200 MWe)	Solar (150 MWe)
Facility Ops	$382	$275	$186	$118	$13	$27	$14
Supply Chain	$175	$83	$74	$54	$6	$13	$7
Community	$60	$61	$50	$11	$5	$4	$1
Total	$617	$419	$310	$183	$24	$44	$22
*Mine included to show impact of mining operations that support the Colstrip and Rosebud power plants.							

The appendix of this report includes economic impact estimates for labor income and contributions to local gross domestic product. Additional details are also provided on the Colstrip region economy along with education and training information details.

Economic Impact Analysis Introduction

Colstrip has an economy that is primarily centered around energy production, particularly coal. The town is home to the Colstrip Power Plant, one of the largest coal-fired power plants in the western United States. This power plant has been a significant source of employment and economic activity in the area for several decades.

The Colstrip Power Plant, with its multiple units, is a major employer and economic driver. This plant generates electricity for several states and has historically been a cornerstone of Colstrip's economy. The nearby Rosebud Mine, which employes around 350 workers, supplies coal to the Colstrip Power Plant. The mining operations provide jobs and stimulate local businesses through the demand for services and supplies. It is typical for various businesses in the surrounding area to provide support services to the power plant and mining operations, including maintenance, transportation, and other logistical needs.

The community has faced economic challenges due to the broader shift toward renewable energy and the decline in coal's share of the energy market. There have been discussions and efforts around economic diversification and planning to mitigate the impact of potential plant closures or reductions in coal production. Local and state government initiatives have been put in place to support economic diversification and workforce retraining programs. These efforts aim to prepare the community for a future with potentially less reliance on coal-based industries.

Overall, Colstrip's economy is heavily influenced by the energy sector, especially coal, but is also facing the need to adapt to changing energy trends and economic diversification initiatives.

Regional Economy

Socioeconomics

Rosebud County has a diverse socioeconomic profile shaped by its rural character, agricultural activities, and the presence of the coal industry, particularly in Colstrip. Rosebud County has a relatively small population, with around 9,000 residents. The population density is low, characteristic of many rural areas in Montana. The county includes towns such as Forsyth (the county seat), Colstrip, and Lame Deer. Employment in Rosebud County is varied, with significant contributions from agriculture, energy production, and public services. Key employers include the Colstrip Power Plant and the Rosebud Mine, as well as local government, schools, and healthcare facilities. The Northern Cheyenne Indian Reservation, located in part within the county, also provides employment opportunities.

Median household income of $57,656 in Rosebud County is lower than the national average of $75,149 but could vary significantly depending on the community and employment sector (U.S. Census Bureau 2024a). Areas with strong ties to the energy industry, like Colstrip, tend to have higher incomes compared to more agriculturally based or reservation communities. Educational attainment in Rosebud County is mixed. While some areas, particularly those with ties to the energy sector, have higher levels of high school and some college education, other parts of the county, including the Northern Cheyenne Reservation, face challenges with lower educational attainment and school completion rates.

Rosebud County faces several socioeconomic challenges, including economic diversification, educational attainment, and healthcare access. The decline in the coal industry poses economic risks, while the Northern Cheyenne Indian Reservation faces issues related to poverty and unemployment. However, there are opportunities for growth in areas such as renewable energy, tourism, and agricultural innovation. Access to healthcare and social services varies within the county. Forsyth and Colstrip provide some healthcare facilities, but more specialized care often requires travel to larger cities like Billings. Social services are available but can be limited in more remote areas.

Overall, Rosebud County's socioeconomic makeup reflects its rural character, economic reliance on agriculture and energy, and the diverse needs of its communities. Efforts to address economic and social challenges are ongoing, with a focus on leveraging local strengths and opportunities for sustainable development.

Employment

People working in Colstrip primarily commute from within Rosebud County, where Colstrip is located, as well as from surrounding counties. Based on information from the U.S. Census Bureau, roughly 75% of commuters to Colstrip are coming from Rosebud, Yellowstone, and Big Horn Counties (U.S. Census Bureau 2024b). Colstrip itself is situated in Rosebud County. Many workers live within the county, including in Colstrip and other towns like Forsyth. Although it is further away, Yellowstone County, which includes the city of Billings, is another potential source of commuters and suppliers. Billings is the largest city in the region and offers more amenities, making it an attractive residential area for some workers despite the longer commute. It is more likely that workers residing in Yellowstone County could be located toward the eastern edge of the county. Located to the south and southwest of Rosebud County, Big Horn County includes towns like Hardin and Lame Deer.

These counties form the primary labor and supply chain shed area for the workforce at the Colstrip Power Plant and the Rosebud Mine. Workers from these counties contribute to the economic activity in Colstrip and help sustain its key industries.

Existing Power Plants

Colstrip Generating Plant

The Colstrip Power Plant in Montana is a symbol of both industrial might and the evolving energy landscape of the United States. This power plant has been a critical player in the region's economy and energy production since its inception. Constructed in the 1970s and 1980s, the Colstrip Power Plant was built to meet the growing demand for electricity in the western United States. The plant originally operated four units, each powered by coal from the nearby Rosebud Mine. At its peak, Colstrip could generate over 2,000 megawatts of electricity (MWe), providing power to homes and businesses across multiple states.

For decades, the plant and mine have been the lifeblood of Colstrip, offering high-paying jobs and supporting local businesses. The plant's towering stacks and sprawling infrastructure became a defining feature of the town. The economic benefits extended beyond the town itself, contributing significantly to the state’s economy through jobs, taxes, and secondary industries. However, the Colstrip Power Plant also became a focal point in the broader national conversation about energy and the environment including popular podcasts and national news articles.

In recent years, the plant has faced significant challenges. Units 1 and 2 were shut down in 2020 due to economic pressures and regulatory requirements, marking a significant reduction in the plant's capacity and a blow to the local economy. When all four units were operating, the Power Plant employed about 320 people (PowerMag 2019). The remaining units, 3 and 4, continue to operate with a workforce of around 250, but face an uncertain future as energy markets continue to evolve.

The community of Colstrip has been actively working on plans to diversify its economy and reduce its reliance on coal. State and local governments, along with various stakeholders, have initiated workforce retraining programs and economic diversification efforts to help the town. Renewable energy projects, technology initiatives, and other industries are being explored as potential new pillars of the local economy.

Rosebud Power Plant

Although it is much smaller than the neighboring power plant, the Rosebud Power Plant is a source of employment for more than 30 workers. The 41-megawatt plant operates on waste coal and has been in operation since 1990 (Global Energy Monitor 2025). The Rosebud plant has a capacity factor of 82%, much higher than the national average for coal power plants.

Assumptions for Proposed Energy Options

An analysis of four energy options was completed to understand the economic implications of various energy choices and how they compare to existing coal power generation in Colstrip. These energy options, which include electricity generation technology from natural gas, wind, solar, and nuclear fuel sources, formed scenarios that were later used in economic models. The results of this effort are independent of any specific manufacturers of electricity-generating technology. The installed electricity-generating capacity of each scenario is based on energy industry trends and stakeholder preferences. Each energy scenario was developed using publicly available information that was collected to help estimate employment levels, labor costs, electricity production, and revenue from electricity sales.

The scenario for nuclear energy is based on the use of a 500-MWe small modular reactor (SMR) configuration. Multiple reactor developers offer configurations that are in this size range. Based on industry reports, the average employment for an SMR of this size will require around 200 workers. Once SMR reactors are in operation, actual employment levels may differ from initial projections. Reports from TerraPower indicate peak construction employment for their Natrium facility in Wyoming could reach 1,600 workers. The estimated economic impact of constructing and operating a 500-MWe nuclear facility will be discussed in the Nuclear Reactor Construction Impact section. Nuclear power facilities are known to operate at or near their capacity most of the time. According to the Energy Information Administration (EIA), the capacity factor of nuclear electricity-generating facilities is 93% on average (EIA 2024). It is possible that new reactor designs could have even higher capacity factors.

Statistics from EIA suggest recently built and proposed wind energy projects are commonly sized at around 200 MWe. For this purpose, a 200-MWe wind-based electricity scenario was used in this report. Based on industry averages, wind projects of this size would typically need around 18 workers for operations and maintenance. The combined capacity factor of the turbines is typically around 34%.

The solar energy scenario is also based on trends for recent and future projects that have been completed or are under construction. EIA statistics suggest these solar projects have an installed capacity of around 150 MWe. Industry statistics suggest the average capacity factor for solar energy is 23%. Once installed, this size of solar facility would likely require around four employees for operations and maintenance.

It was requested to include a 500-MWe natural gas combustion power plant as a scenario in the economic impact study. Employment estimates for this size of natural gas facility were not readily available since most facilities in the dataset were larger. There was some indication that staffing below 25 workers is unlikely. The Nemadji Trail Energy Center in Wisconsin reported a staff of 25 with a nameplate capacity of 625 MWe (WPR 2024). Many other facilities that were investigated were larger in size and had similar employment levels if the installed capacity was below 1,000 MWe. The addition of carbon capture capabilities may be a contributing factor for increased staffing, but there is a lack of data on how many additional employees would be needed. A Sargent & Lundy report published through EIA suggested the addition of a carbon capture capability would make up $518.9 million of the total $1.161 billion to construct a 543-MWe combined-cycle gas power plant (Sargent & Lundy 2024). The addition of carbon capture technology would certainly increase the economic impact during the construction phase due to the added cost and duration of construction efforts.

Adding grid-scale battery storage would also create short-term economic impacts during the installation process. Reports have suggested that there would not be a measurable economic impact on the community while the batteries are in use (Jenson, et al. 2024).

Economic Impact Evaluation

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 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[1] input-output modeling application.

Input-output model results are based on three main drivers: employment, revenue, and labor income. As input data for the input-output model, revenue from electricity generation was calculated using annual megawatt hours (MWh) multiplied by the wholesale price of electricity, which is an approach that more closely reflects the value added by the generating station. Retail electricity prices were not used for revenue estimation to more properly account for the value created by the plant only. 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.

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 SMRs. So far, those reactor vendors include NuScale

[1] IMPLAN® model, 2023 Data, using inputs provided by the user and IMPLAN Group LLC, IMPLAN System (data and software), 16905 Northcross Dr., Suite 120, Huntersville, NC 28078 www.IMPLAN.com

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:

- **Facility Operations Impact:** Otherwise known as the direct impact. These values are based on facility operations, which include employment, labor costs, and wholesale revenue from electricity produced by the generating facilities or the sale of coal. These can be thought of as *plant-level* impacts.
- **Supply Chain Impacts:** Otherwise known as indirect impacts. These are 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.

Existing Facility Impact

Existing facility economic impacts of power plants located in Colstrip were modeled to enable a baseline comparison of current operating conditions with other forms of electricity generating technology. The data obtained by performing the existing facility analysis were critical for running the input-output model. This baseline analysis of local power plant 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 Montana. For this analysis, a regional wholesale electricity price was used.

Employment and labor costs in the existing facility analysis were based on the most recent annual figures from the Colstrip and Rosebud Power Plants. These two plants operated with around 250 and 30 employees, respectively, and had a combined labor cost of more than $66 million including taxes and benefits.

The Rosebud coal mine also makes a significant contribution to the Colstrip economy. The mine provides jobs for more than 320 employees with an estimated total labor cost of nearly $53 million annually including taxes and benefits.

Employment Impact

Results of the economic impact model show the Colstrip Power Plant had a combined employment impact of 1,036 jobs. More than 430 of those jobs are created from the supply chain activity that supports plant operations. The economic impact model does allow some mining-related jobs to be included as part of the supply chain employment impact. In this case the model predicted less than 15 local coal mining jobs would be created as part of power plant supply chain. This highlights the importance of modeling local mining activity in addition to the power plant operations to accurately display the mining impact on the economy. More than 350 other jobs are created by the plant's operations as plant employees spend their paychecks based on typical spending patterns throughout the community. As mentioned previously, the power plant itself requires around 250 workers to operate the currently functioning generating units.

The Rosebud Mine operates with around 320 employees but has a slightly lower combined employment impact of 933 jobs. Nearly 250 of those jobs are attributed to supply chain activity, and 364 jobs are associated with employee spending within the local economy.

As seen in Figure 1, the much smaller Rosebud Power Plant is responsible for a total employment impact of 77 jobs. The plant requires around 30 jobs to operate. An additional 15 jobs are created through supply chain activity and more than 30 jobs from community spending by employees.

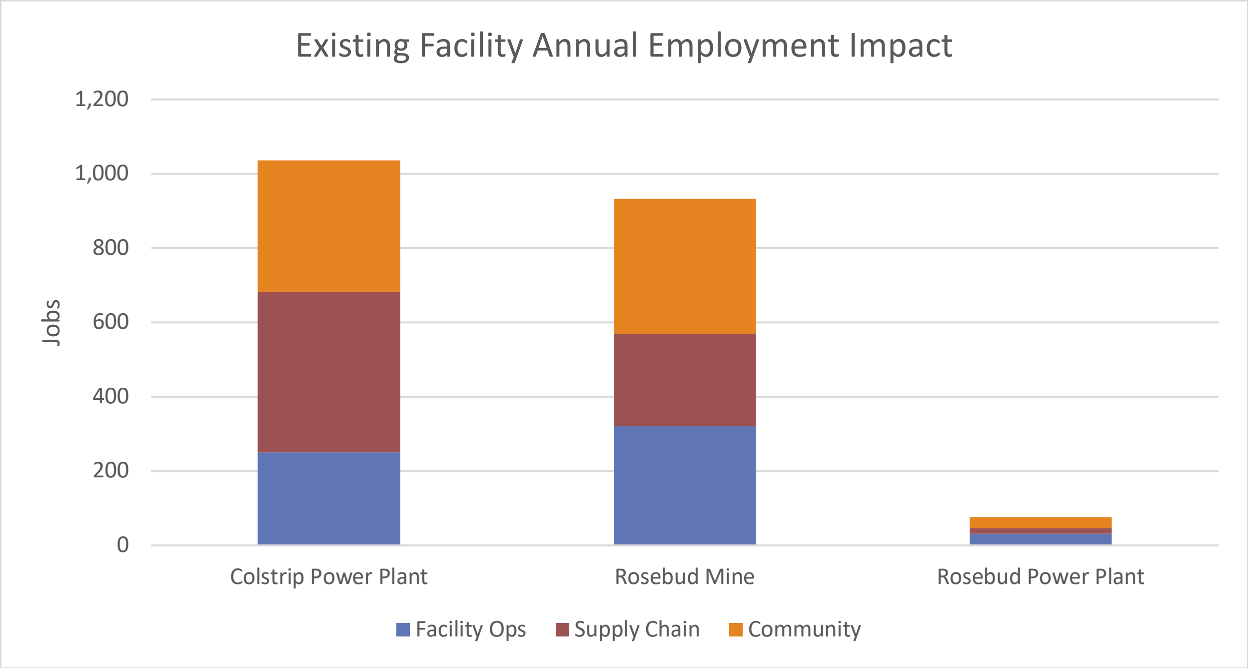


Figure 1. Existing facility annual employment impact.

Labor Income Impact

The total annual labor income impact of the existing coal mine and power plants in Colstrip makes significant contributions to local incomes. The Rosebud Power Plant has a total estimated labor income impact of more than $9 million annually. Nearly 70% of the labor income impact is tied to plant operations while the remaining 30% is tied to supply chain and community spending.

The Rosebud coal mine is responsible for a total labor income impact of more than $107 million. Around 64% of this labor income impact is the result of mine operations, and the remaining 36% is associated with supply chain and community spending. When combined, these two areas of labor income account for nearly $40 million.

The Colstrip Power Plant contributes a total labor income impact of more than $104 million. The power plant supply chain and employee spending are responsible for 52% of the labor income impact. Compared to the coal mine labor, the total labor income impact of the power plant itself is slightly less concentrated on operations because of access to the local coal mine. This allows for higher levels of labor income to be paid out locally rather than being sent to coal mines outside the region. Figure 2 provides additional details on annual labor income impacts for existing facilities.

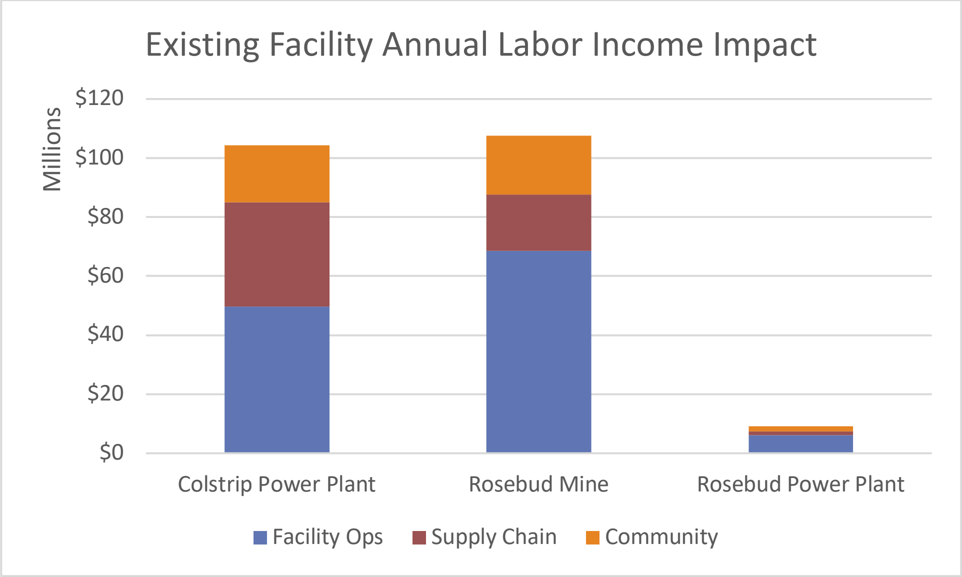


Figure 2. Existing facility annual labor income impact.

Output Impact

Economic output is defined as the dollar value of industry production; in this case, economic output stems from coal and electricity sales. In Colstrip's case, the total output impact from power plant operations ranged from nearly $24.8 million for the Rosebud Power Plant to nearly $617 million for the much larger Colstrip Power Plant. Operations at the Colstrip Power Plant were responsible for 62% of the total impact. A slightly lower percentage (i.e., 54%) of the total impact at the Rosebud Power Plant was due to facility operations. The remaining balance of the total impact was the result of industry production among suppliers and businesses where employees spend paychecks throughout the community. The Rosebud Mine had an estimated total output impact of nearly $420 million annually with 66% of the impact coming from mining operations. More details regarding existing facility output impacts are available in Figure 3.

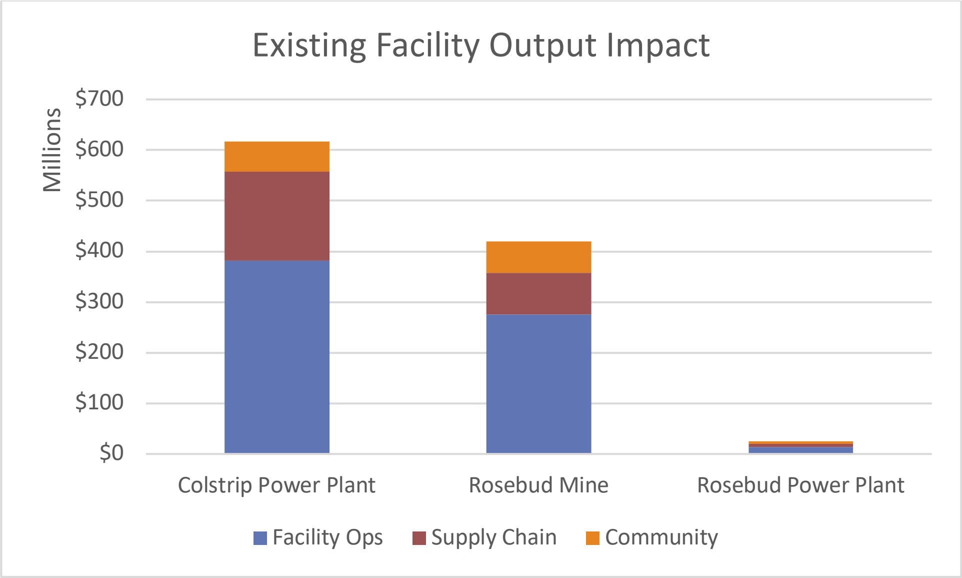


Figure 3. Existing facility output impacts.

Value Added Impacts

Value added impacts can be interpreted as the dollar value of new production less the cost of imports and intermediate goods. It is a measure of production that is equivalent to what is typically reported as gross domestic product for a region.

As seen in Figure 4, the Rosebud Power Plant produced nearly $14.8 million in total value added impacts. The much larger Colstrip Power Plant produced nearly $246 million in value added impacts compared to $228 million at the Rosebud coal mine.

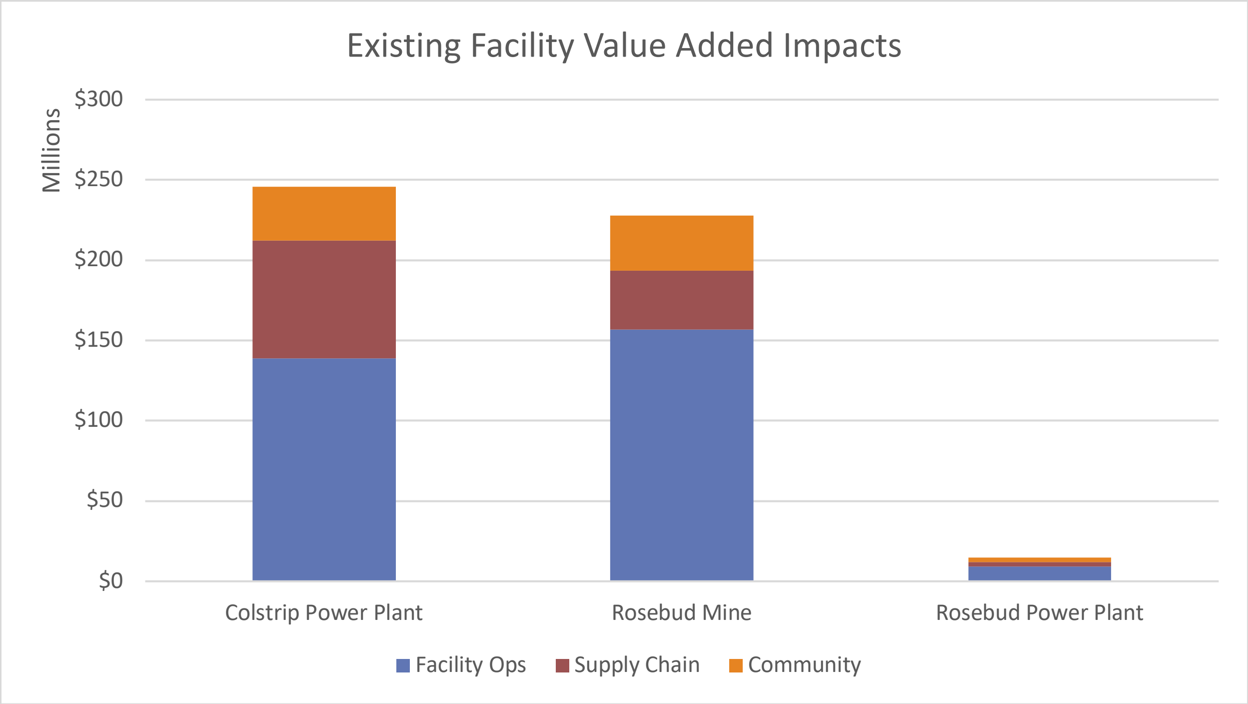


Figure 4. Existing facility value added impacts.

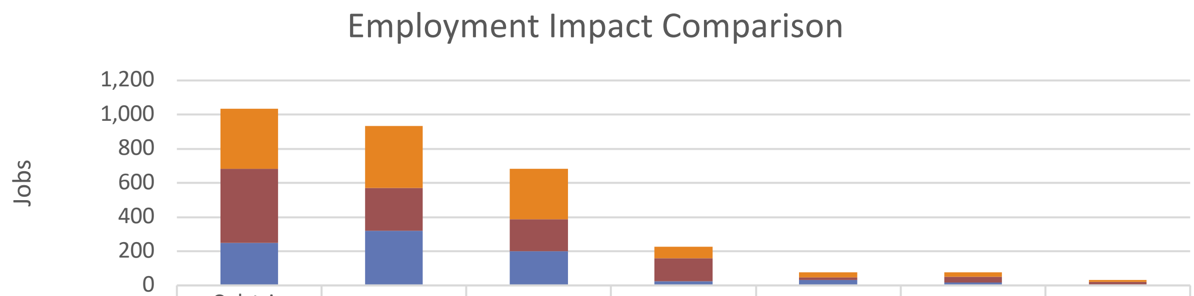
Energy Options Economic Impact Comparison

According to the U.S. Bureau of Labor Statistics (BLS), there were 3,448 people employed in Rosebud County in 2023. Based on the results of the economic impact model, it is possible that more than 2,000 of those jobs are closely tied to the operations, supply chains, and community spending of the power plants and coal mine. As additional grid-scale energy options are considered, understanding how these options will impact the local economy can add to the evaluation process.

This section of the report compares the impacts of multiple electricity-generating technologies that were discussed in detail in the Assumptions for Proposed Energy Options section. In addition to the existing coal power plants facilities in Colstrip, impact comparisons were also analyzed for nuclear, natural gas, wind, and solar-powered electricity-generating technologies. For reference purposes, the impacts associated with the coal power plant are also included in the comparison. As mentioned previously, the installed capacity of each energy option was based on recent market trends for operating generating stations and additional stations that are under construction according to the EIA.

Employment Impact Comparison

Results of the economic analysis show that 500-MW nuclear power generating facilities would have significantly more employment impact than a similar sized natural gas plant. As seen in Figure 5, the nuclear facility would likely support over 680 jobs compared to 225 at a natural gas plant. Coal-fired power plants do support a significant number of supply chain jobs, especially in a scenario like Colstrip where the power plant is in proximity to the coal source. The Rosebud Mine employment impacts were included because of the close economic relationship between the power plants and mining activities. Essentially all of the coal produced from the Rosebud mine is used by the local power plants.



	Colstrip Power Plant (1,480 MWe)	Rosebud Mine	Nuclear (500 MWe)	Natural Gas (500 MWe)	Rosebud Power Plant (41 MWe)	Wind (200 MWe)	Solar (150 MWe)
Community	353	364	294	66	31	24	8
Supply Chain	433	248	188	134	15	33	18
Facility Ops	250	321	199	25	31	18	4

Figure 5. Energy options employment impact comparison.

The wind and solar options produce an even smaller number of jobs when compared on a per-megawatt basis, as seen in Figure 6. Although larger solar or wind projects could be built than what was analyzed in this report, solar and wind projects tracked by the EIA that were recently completed or are currently under construction were typically sized with a 150 and 200 MW capacity, respectively. The per-megawatt employment impact of the Rosebud Power Plant was very high compared to the other scenarios presented. This is due to the small size of the power plant relative to the minimum staffing needed to operate the plant, creating an extremely high number of jobs per megawatt of installed capacity.

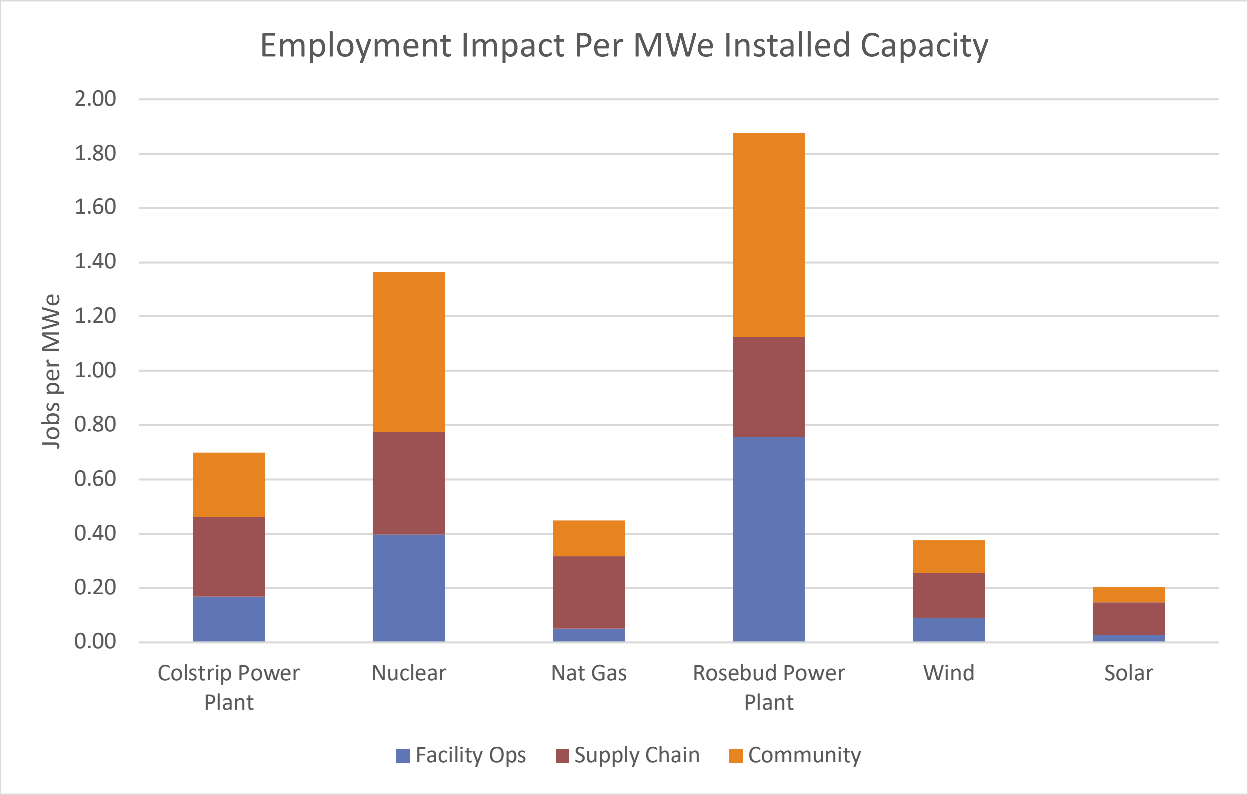
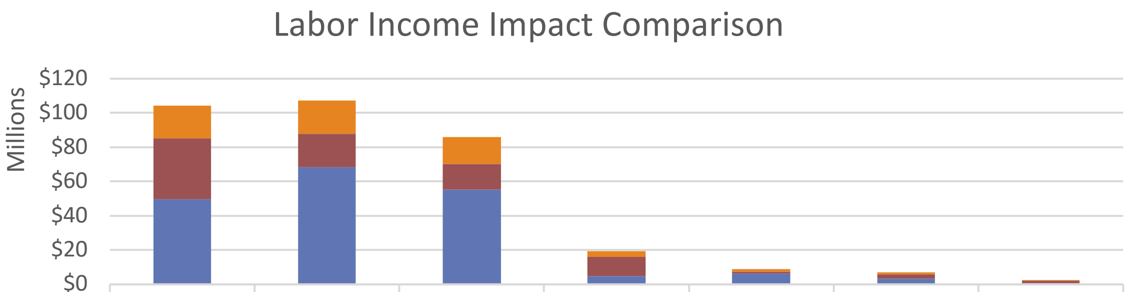


Figure 6. Employment impact per MWe installed capacity.

Labor Income Impact Comparison

The facility operations portion of the labor income impacts, which includes the cost of benefits and employment taxes, was highest for the nuclear power option. This is due to higher wages typically paid to nuclear workers. On average, the nuclear power workers earn more than any other type of electricity generation industry workers. A more detailed comparison of energy worker income is available in the Nuclear Power Workforce Income Comparison section.

Once supply chain and community-related income is accounted for, the Colstrip Power Plant and Rosebud Mine are responsible for the largest amount of labor income in the region. It should be noted that some of the supply chain labor income impact observed for the Colstrip and Rosebud Power Plants is also included as facility operations labor income impacts for the Rosebud Mine. For this reason, the facility operations labor income impacts for the coal power plants and mining activities should not be combined. This will help avoid double counting impacts. A detailed comparison of labor income impacts is available in Figure 7.

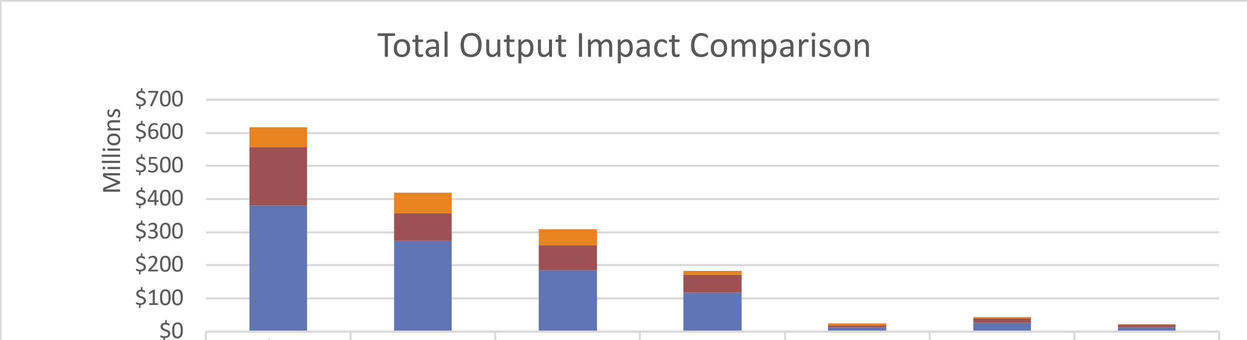


	Colstrip Power Plant (1,480 MWe)	Rosebud Mine	Nuclear (500 MWe)	Natural Gas (500 MWe)	Rosebud Power Plant (41 MWe)	Wind (200 MWe)	Solar (150 MWe)
Community	$19,205,825	$19,746,756	$15,995,349	$3,588,841	$1,671,950	$1,315,558	$457,990
Supply Chain	$35,373,716	$19,235,897	$14,751,605	$10,931,651	$1,241,280	$2,590,246	$1,422,003
Facility Ops	$49,691,546	$68,498,290	$55,373,438	$4,965,175	$6,163,444	$3,234,439	$605,495

Figure 7. Energy options labor income impact comparison.

Total Output Impact Comparison

When comparing the dollar value of industry output, the Colstrip Power Plant was estimated to produce more than $600 million in economic output. More than $235 million of that impact is the result of local supply chain activity and employee spending at businesses within the community. Although the nuclear and natural gas generating facilities are equal in installed capacity, the nuclear facility would likely produce a larger output impact due to higher capacity factors. The capacity factor for nuclear facilities is 93%, suggesting the 500-MWe nuclear facility would produce over 4 million megawatt hours (MWh) of electricity annually. Natural gas facilities typically operate with a capacity factor of 59%. This would result in nearly 2.6 million MWh of electricity produced annually. Additional generating technology output impact details are available in Figure 8.

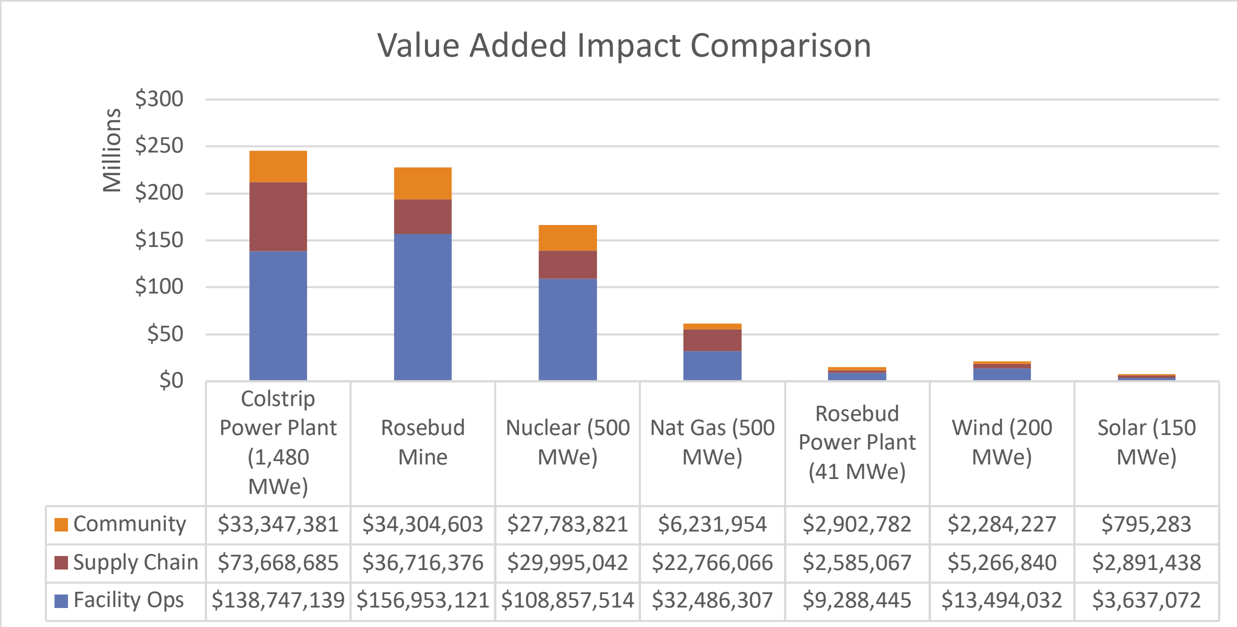


	Colstrip Power Plant (1,480 MWe)	Rosebud Mine	Nuclear (500 MWe)	Nat Gas (500 MWe)	Rosebud Power Plant (41 MWe)	Wind (200 MWe)	Solar (150 MWe)
Community	$59,773,608	$61,490,294	$49,801,737	$11,170,513	$5,203,087	$4,094,369	$1,425,511
Supply Chain	$175,337,463	$83,030,237	$74,374,442	$54,185,090	$6,152,671	$13,059,423	$7,169,503
Facility Ops	$381,734,862	$275,226,000	$185,980,710	$117,968,730	$13,395,249	$27,192,792	$13,976,295

Figure 8. Energy options output impact comparison.

Value Added Impact Comparison

Value added impacts provide a good measure of contributions to the local gross domestic product. These values represent new production without counting intermediate goods or services that are sourced outside the region. It is typical for a significant share of the value added impact to come from workforce activities. That is especially the case in electricity generation. Even though the Colstrip Power Plant is nearly three times the size of the nuclear power plant in the study, the facility operations portion of the value added impact is similar in size. Nuclear facilities require more employees to operate on a per-megawatt basis. This dependency on labor results in capturing more economic impact locally, as wages for employees at the generating facility are kept within the local economy. The fuel source for a nuclear facility is typically not found locally, but it is a relatively small portion of the operating budget compared to coal or natural gas power plants. Any fuel sourced outside the region would result in economic leakage, as well as money and jobs leaving the area. That would particularly be the case with natural gas. The total value added impact of a 500-MWe nuclear facility is estimated at more than $166 million compared to $61 million at a natural gas facility. By comparison, the value added impact of the Colstrip Power Plant and Rosebud Mine is nearly $246 million and $228 million, respectively. Additional value added impact details are available in Figure 9.



	Colstrip Power Plant (1,480 MWe)	Rosebud Mine	Nuclear (500 MWe)	Nat Gas (500 MWe)	Rosebud Power Plant (41 MWe)	Wind (200 MWe)	Solar (150 MWe)
Community	$33,347,381	$34,304,603	$27,783,821	$6,231,954	$2,902,782	$2,284,227	$795,283
Supply Chain	$73,668,685	$36,716,376	$29,995,042	$22,766,066	$2,585,067	$5,266,840	$2,891,438
Facility Ops	$138,747,139	$156,953,121	$108,857,514	$32,486,307	$9,288,445	$13,494,032	$3,637,072

Figure 9. Energy options value added impact comparison.

Alternative Nuclear Reactor Impact Scenarios

A previously released guidebook does provide alternative economic impact results for various nuclear reactor deployment scenarios based on average employment estimates that have been publicized by reactor developers (Hansen, et al. 2024). The nuclear plant employment estimates from the guidebook are slightly lower than what is used in this Colstrip energy options report. Actual employment at future-built SMR facilities has yet to be established. The estimates used in this Colstrip report are like what has been reported by NuScale for their six module VOYGR™ configuration that has been announced in Romania (World Nuclear News 2023).

Table 3 provides an overview of the expected employment impact for various sizes of nuclear reactors based on the combined three county Colstrip region. Economic impact results for output, labor income, and value added are available by referencing the previously mentioned guidebook.

Table 3. Employment impact by size of nuclear reactor in MWe.

Employment Impact by Size of Nuclear Reactor in MWe					
Impact Type	**100 MWe**	**300 MWe**	**500 MWe**	**700 MWe**	**900 MWe**
Facility Ops	75	100	140	200	260
Supply Chain	43	129	215	301	386
Community	32	54	81	115	149
Total	150	283	436	616	795

Nuclear Reactor Construction Impact

The most recent nuclear reactor construction activities in the United States occurred between 2009 and 2023 as the Plant Vogtle unit 3 and 4 project was being completed. This project was reported to have a peak employment of 9,000 construction jobs (Georga Power n.d.). It should be noted that these were large-scale Westinghouse AP1000 reactors that require a significant amount of onsite construction work.

SMR construction projects have yet to be completed in the United States. TerraPower has provided some information about what could be expected during the construction of their Natrium reactor in Wyoming. According to the company website, peak construction employment is expected to reach around 1,600 workers (TerraPower 2024) and last up to 5 years. Figure 10 provides a possible scenario for constructing a generic 500-MWe SMR. As construction activity occurs, local supply chains are expected to perform some of the required tasks. During peak construction, this new supply chain activity could create or sustain almost 1,000 jobs. As the plant construction and supply chain workers begin spending their paychecks, additional job creation is expected within the local community. This activity could create or sustain more than 2,200 employees on an annual basis. These jobs would be spread across businesses and services that correlate with typical household spending patterns. Figure 10 shows the change in the expected nuclear construction labor impacts over time.

A large construction project in a small community like Colstrip would require significant planning to accommodate the influx of workers. This would include provision of temporary housing solutions and increasing the availability of goods and services. The construction effort would bring significant temporary economic benefits to the community but not without burden.

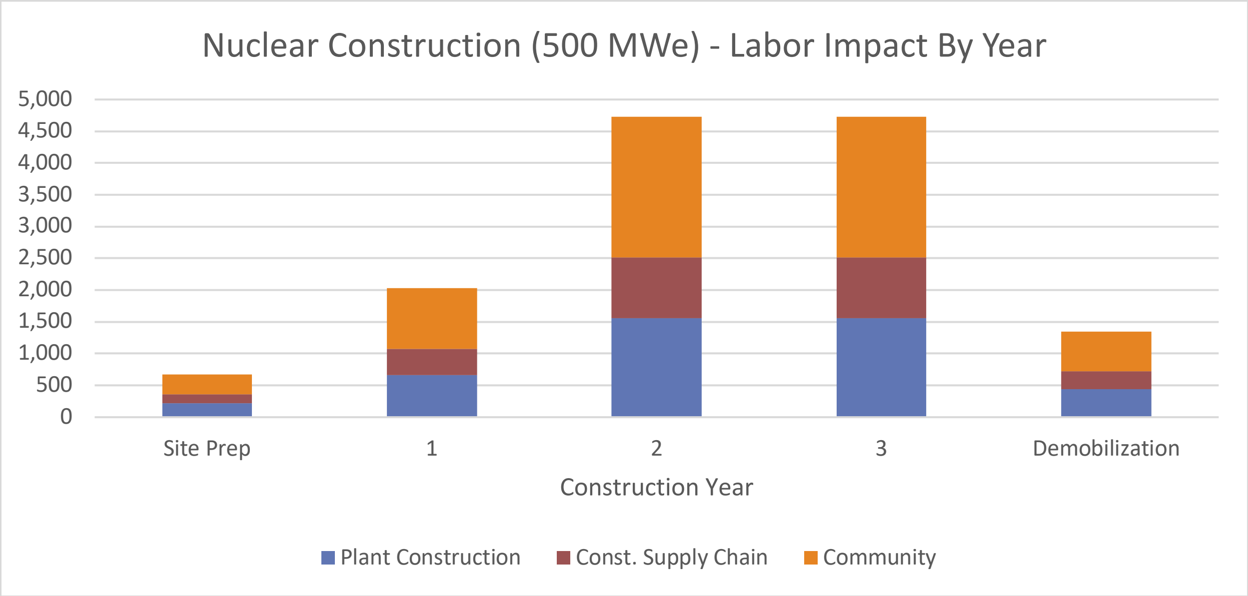


Figure 10. Estimated nuclear facility construction impact.

Workforce Comparison

Previous reports indicate around 74% of jobs at coal power plants are also needed at nuclear power plants (Jenson, et al. 2023). This suggests that much of the training and education that is already supporting the Colstrip Power Plant could also support a nuclear power plant. The remaining nuclear-specific training needs could be developed locally over time or may require out-of-area assistance.

Education Requirements

Figure 11 shows the most common education levels for workers entering various energy-related industries and compares these to the education levels that make up the largest share of the total workforce for each occupation within the industry. According to the Bureau of Labor Statistics (BLS) data, almost 90% of all coal mining workers had a high school diploma compared to 64% of all entry-level workers (BLS 2023). In contrast, 46% of entry-level workers at nuclear-based electricity-generating facilities had a high school diploma. As nuclear facility workers transition to long-term employment, only 33% of workers held a high school diploma. Almost 50% of all workers at a nuclear power plant hold a bachelor’s degree, compared to 32% at coal power plants. With advanced planning and coordination through educational institutions, preparing workers to fill new nuclear deployment positions will be more achievable.

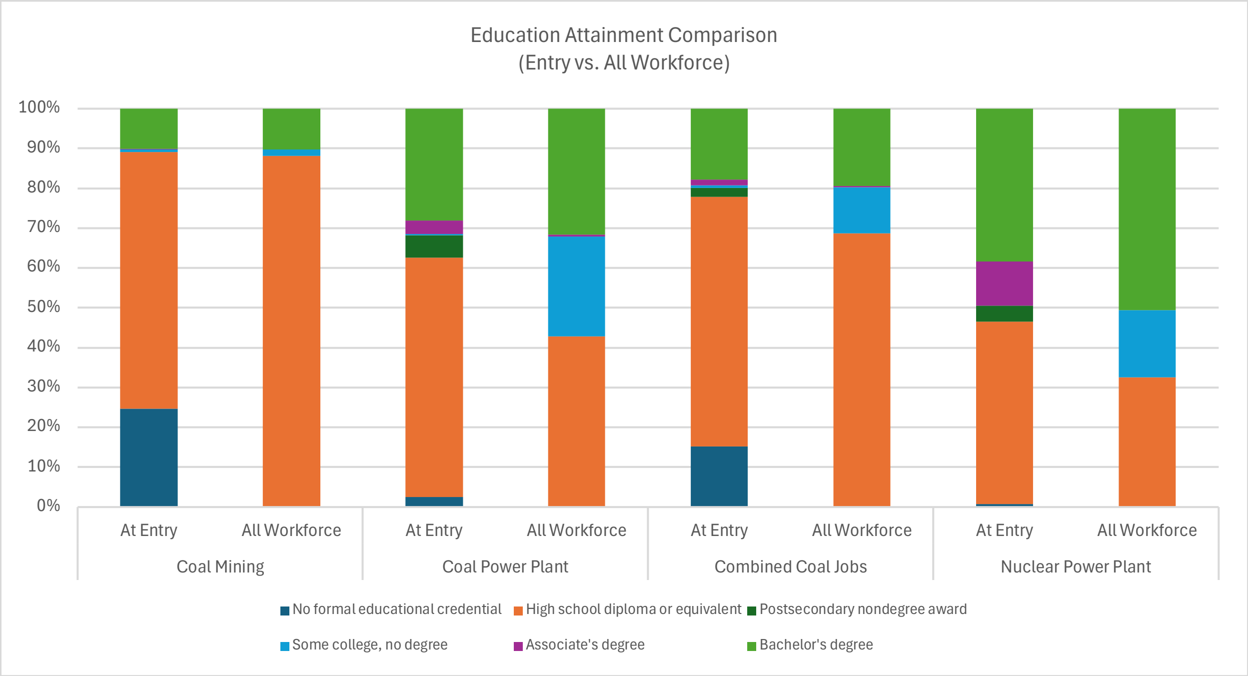


Figure 11. Education attainment comparison.

The current education attainment levels for specific nuclear industry occupations show there are multiple training pathways to successful long-term employment. *Table 4* provides a detailed look at three nuclear-industry-specific occupations. It is very common for nuclear engineers to hold at least a bachelor's degree. The latest BLS data indicate that 84% of those working as nuclear engineers hold a bachelor's degree or higher. In contrast, only 46% of nuclear technicians hold a bachelor's degree or higher. The highest percentage of nuclear power reactor operators has some college experience but no degree. In fact, 57% of nuclear power reactor operators have some college or less education. Those who pursue training to become a nuclear power reactor operator must pass a comprehensive written and performance examination administered by the Nuclear Regulatory Commission. Training programs typically last 18 to 24 months.

Table 4. Detailed nuclear workforce education attainment.

Nuclear Workforce Education Attainment Example								
Occupation title	SOC code	Less than high school diploma	High school diploma or equivalent	Some college, no degree	Associate's degree	Bachelor's degree	Master's degree	Doctoral or professional degree
Nuclear engineers	17-2161	1%	4%	7%	6%	49%	27%	8%
Nuclear technicians	19-4051	3%	17%	24%	11%	36%	8%	2%
Nuclear power reactor operators	51-8011	2%	24%	31%	20%	19%	4%	0%

Although nuclear engineers are very prevalent at reactor facilities, other engineering degrees are also in high demand. According to BLS, nuclear engineers make up 61% of engineering disciplines, and the remaining 39% comes from other engineering fields that are vital to operations. Figure 12 provides a detailed overview of other engineering fields that are utilized at nuclear reactor facilities.

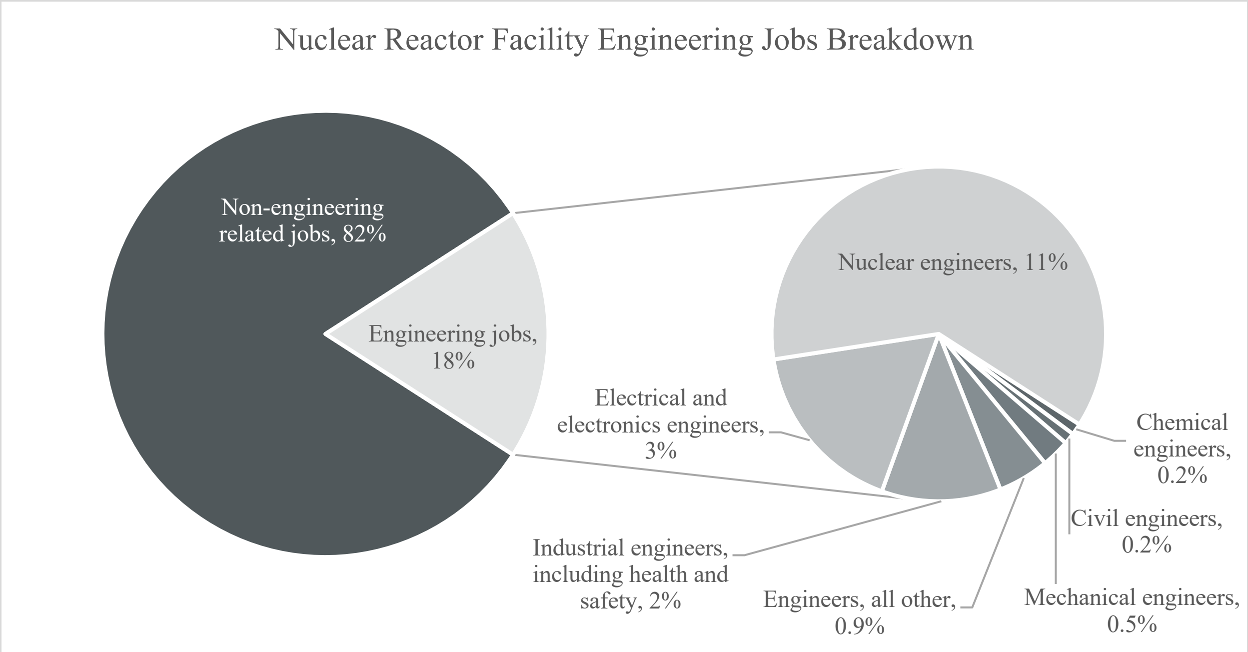


Figure 12. Engineering disciplines utilized by nuclear reactor facilities.

The interest in nuclear industry workforce education and training is national, and there are multiple organizations that are engaged in the effort. This report will not have a comprehensive list of organizations, but it is worth highlighting a few, such as the Regional Center for Nuclear Education & Training, which is headquartered at Indian River State College in Florida. This center was established by the National Science Foundation as a resource to help maintain a nuclear-fields-workforce pipeline across the United States (RCNET 2024). Other industry associations like the Nuclear Energy Institute are also very involved in assisting efforts related to nuclear workforce development. In September 2024, the U.S. Department of Energy announced a $100 million Nuclear Safety Training and Workforce Development Program (DOE 2024). This program was specifically created to help ensure there is an adequate workforce in place as the U.S. nuclear energy industry grows.

Nuclear Power Workforce Income Comparison

The local economy benefits from increased employee income opportunities that come from nuclear power plants. According to BLS, the average coal mine worker earned $105,459 based on 2023 data. Coal- and natural-gas-based electricity-generating workers made an average annual salary of $139,985, which was close to the median among the other forms of electricity-generating technology. Nuclear power plant workers earned the highest annual salary at $160,980.

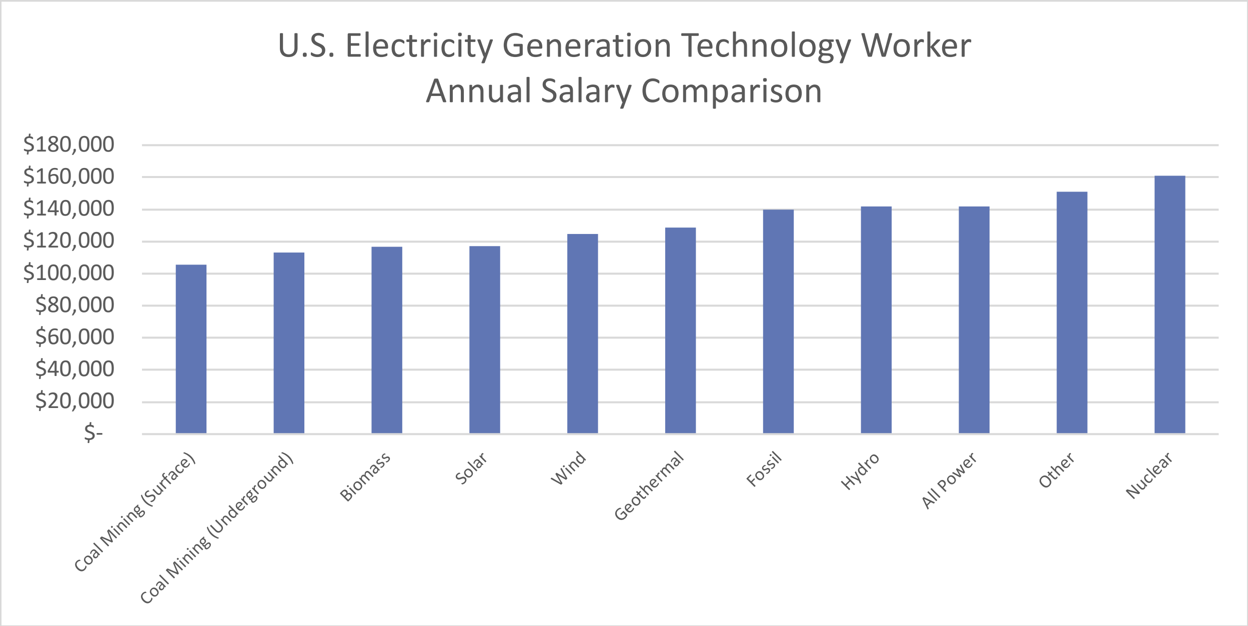


Figure 13 identifies other annual salaries for electricity generation technology workers.

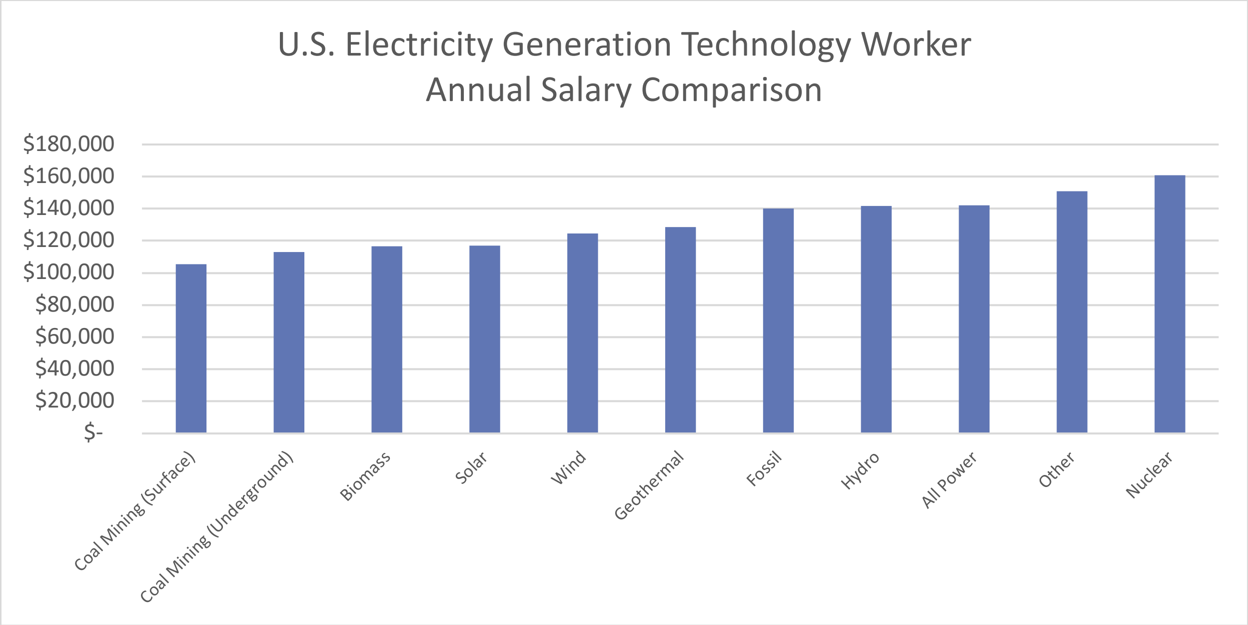


Figure 13. Annual salary comparison.

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