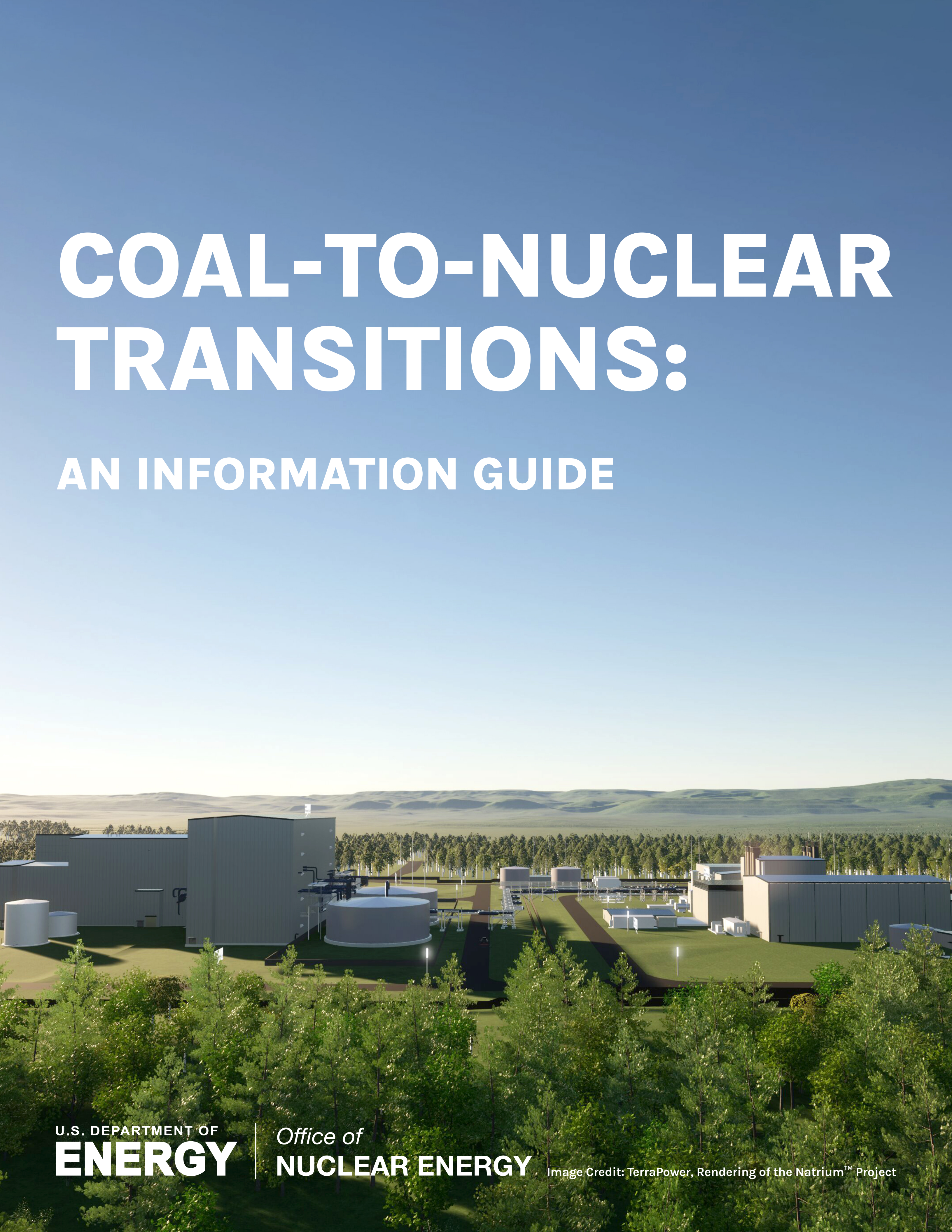
COAL-TO-NUCLEAR TRANSITIONS:

AN INFORMATION GUIDE



U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

Image Credit: TerraPower, Rendering of the Natrium™ Project

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COAL-TO-NUCLEAR TRANSITIONS

The pivot away from carbon-emitting sources, such as unabated coal power plants—while beneficial for reducing carbon emissions—has left many surrounding energy communities with economic uncertainty. Nearly 30% of the nation's coal plants are **projected to retire** by 2035. In some communities, coal plants have already shuttered, resulting in loss of jobs, local tax revenue, and economic activity.

A **2022 U.S. Department of Energy (DOE)** study found that hundreds of coal power plant sites across the country could be converted to nuclear power plant sites. This would dramatically increase the supply of reliable, clean electricity to the grid and deliver huge gains to the nation's goal of net-zero emissions by 2050. The transition would also bring tangible benefits to energy communities with additional jobs, new economic activities, and improved environmental conditions. These benefits are especially important for communities that have been disproportionately impacted by fossil fuel pollution.

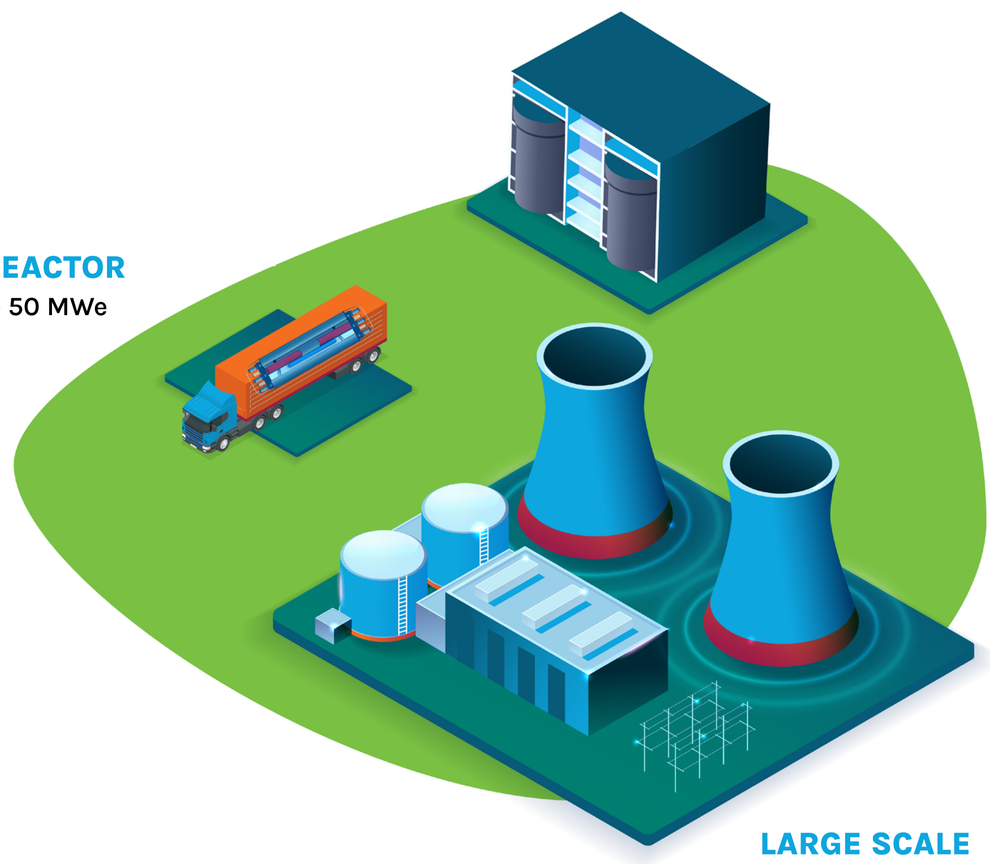
As communities consider coal-to-nuclear transitions, they need access to information to help navigate the decision-making process. DOE prepared a technical report, titled **Stakeholder Guidebook for Coal-to-Nuclear Conversions**, to provide analysis-backed information on topics relevant to coal-to-nuclear transitions. This information guide is a companion piece to help interested energy communities facilitate conversations on the data presented in the guidebook. This information guide offers a high-level look at the economic impacts, workforce transition, and policy and funding considerations associated with coal-to-nuclear transitions. Readers can refer to the full guidebook for in-depth, technical analysis of topics covered in this guide.

Figure 1: Infographic with major findings of 2022 C2N Report

Advanced Nuclear Reactors

Advanced nuclear energy systems will provide important options to communities working to meet their energy needs. New reactor concepts are more flexible and versatile than today's light water reactors. They come in a range of sizes, from a few megawatts electric (MWe) to more than 1,000 MWe. Many advanced nuclear reactors are designed to adjust their electricity output making them far more compatible to work alongside variable renewable technologies. Some advanced reactors can also provide process heat to help decarbonize the industrial and transportation sectors and assist in producing clean hydrogen. These applications may be a good match for a coal community looking to replace a coal power plant while also diversifying their economy.

Importantly, many advanced nuclear reactors will be the right size to replace aging and retiring coal plants. Advanced small modular reactors, or SMRs, are particularly well suited to replace coal plants. These reactors are simpler, smaller-scale, manufactured versions of larger-scale reactors. SMRs offer many advantages, such as relatively small physical footprints, reduced construction costs, and enhanced safety features. In some cases, modules can also be added incrementally as demand for energy increases, which can reduce upfront capital costs.



ADVANCED NUCLEAR REACTORS FEATURES:

- Range of sizes
- Smaller footprint
- Advanced manufacturing
- Flexible operation
- Electricity generation and process heat production
- Ability to pair with renewables
- Passive safety features

Figure 2: Sizes of Advanced Nuclear Reactors

ECONOMIC INFORMATION

Key Findings

- A nuclear power plant replacing a coal power plant would employ more people and create additional long-term jobs in host communities.
- A nuclear power plant replacing a coal power plant would increase total income in host communities.
- A nuclear power plant replacing a coal power plant would increase revenue for host communities, power plant operators, and local suppliers.

Power plants provide important economic benefits to their host communities. They employ many people in the local communities and often pay wages and salaries that are above average for the region, resulting in higher standards of living and improved quality of life.

As power plant operators pay employees, those employees boost the local economy through household spending. That increased spending benefits local businesses and some local businesses may also benefit as suppliers of goods and services in support of plant operations.

Our study found that transitioning from a coal plant to a nuclear plant with similar electricity production capacity would create hundreds of additional jobs in the local community and spur millions of dollars in increased revenues and economic activity.

Increased employment opportunities and higher incomes could also lead to increased population size as people move to the area for jobs. Increased populations could stimulate additional economic activities, such as improving or expanding education and healthcare systems, investing in local infrastructure such as housing and transportation, building new recreational parks, or investing in new businesses. These types of add-on economic activities from increased population are not included in the analysis but could be important factors for communities to consider.

The local county could also expect to see an increase in tax revenue from a nuclear plant when compared to the tax revenue from the coal plant prior to its closure. Section 5.3.1.5 of the **2022 DOE coal-to-nuclear study** includes a detailed analysis and discussion of this tax impact.

It’s important to note that benefits will differ based on the size of the reactor, as well as size of the community. For example, a larger reactor requires more employees to support its operation, and thus provides more jobs, revenues, and economic activity within the community. The effects of the size of the community are less obvious, but in a smaller community, the power plant is likely to employ a larger percentage of the population, and thus provide a greater share of the economic activity in that community. The growth in local supply chain availability creates a ripple effect in the economy. As the local population and its supporting economy grows, money spent to support the plant increasingly stays local as there are more goods and services available in the community.

Economic Impacts

To illustrate the impacts of a coal-to-nuclear transition in a community, we compared economic impacts of five sizes of coal plants to the impacts of five sizes of nuclear plants across a set of five population ranges. The figures below show impacts on jobs, income, and revenue within the different community sizes. The impacts shown in each figure are the “total impacts,” which represent the combination of plant operations, supply chain activity, and any additional community impacts from plant employee household spending.

The figures are broken down by plant capacity in MWe. This provides a clear comparison of the net gains in benefits for a community if a coal plant is replaced by a nuclear plant of the same size. If a coal plant is replaced with a nuclear plant of higher capacity, the net change is also greater, meaning even more jobs, added income, and revenue in the community.

Added Jobs

A replacement nuclear power plant of the same size (or larger) would employ more people and create additional long-term jobs in host communities.

Our study evaluated the number of long-term jobs created or sustained by plant operations. These include jobs at the power plant, jobs supporting the supply chain, and jobs in the community supported by additional plant employee spending. We did not include temporary jobs created during construction or coal power plant remediation phases.

LOCAL JOB GAINS BASED ON POPULATION SIZE AND POWER PLANT CAPACITY

	Population Range	< 20,000	20,000-39,999	40,000-89,999	90,000-199,999	200,000+
100 MWe	Jobs with Coal Plant	56	64	68	69	80
	Jobs with Nuclear Plant	121	139	144	150	178
	Added Jobs	65	75	76	81	98
300 MWe	Jobs with Coal Plant	108	128	134	143	171
	Jobs with Nuclear Plant	207	253	266	283	352
	Added Jobs	99	125	132	140	181
500 MWe	Jobs with Coal Plant	166	198	220	223	270
	Jobs with Nuclear Plant	313	387	408	436	548
	Added Jobs	147	189	188	213	278
700 MWe	Jobs with Coal Plant	236	281	312	316	382
	Jobs with Nuclear Plant	443	547	576	616	773
	Added Jobs	207	266	264	300	391
900 MWe	Jobs with Coal Plant	312	370	410	415	501
	Jobs with Nuclear Plant	573	707	744	795	998
	Added Jobs	261	337	334	380	497

Figure 3: Jobs

* Employment during the plant construction is not included in the calculations.
** Calculation of these values may be affected by rounding.

Added Income

A replacement nuclear power plant of the same size (or larger) would increase total income in host communities. All values in this figure are presented in millions of dollars.

LOCAL INCOME GAINS BASED ON POPULATION SIZE AND POWER PLANT CAPACITY

	Population Range	< 20,000	20,000-39,999	40,000-89,999	90,000-199,999	200,000+
100 MWe	Income with Coal Plant	$6.0 M	$6.5 M	$6.9 M	$6.8 M	$8.4 M
	Income with Nuclear Plant	$14.6 M	$15.5 M	$16.2 M	$16.4 M	$20.0 M
	Added Income	$8.6 M	$9.0 M	$9.3 M	$9.6 M	$11.6 M
300 MWe	Income with Coal Plant	$10.9 M	$12.0 M	$12.8 M	$13.0 M	$17.1 M
	Income with Nuclear Plant	$22.4 M	$24.9 M	$26.8 M	$27.3 M	$36.5 M
	Added Income	$11.5 M	$12.9 M	$14.0 M	$14.3 M	$19.4 M
500 MWe	Income with Coal Plant	$16.4 M	$18.3 M	$20.3 M	$20.0 M	$26.7 M
	Income with Nuclear Plant	$32.8 M	$36.9 M	$40.0 M	$40.9 M	$55.9 M
	Added Income	$16.4 M	$18.6 M	$19.7 M	$20.9 M	$29.2 M
700 MWe	Income with Coal Plant	$23.5 M	$26.1 M	$28.9 M	$28.4 M	$37.9 M
	Income with Nuclear Plant	$46.6 M	$52.4 M	$56.7 M	$58.0 M	$79.1 M
	Added Income	$23.1 M	$26.3 M	$27.8 M	$29.6 M	$41.2 M
900 MWe	Income with Coal Plant	$31.2 M	$34.6 M	$38.2 M	$37.6 M	$49.9 M
	Income with Nuclear Plant	$60.5 M	$67.8 M	$73.5 M	$75.0 M	$102.2 M
	Added Income	$29.3 M	$33.2 M	$35.3 M	$37.4 M	$52.3 M

Figure 4: Income

* Income generated during the construction phase is not included in the calculations. The data includes income generated by jobs at the plant and associated activities.

** Calculation of these values may be affected by rounding.

Added Revenue

A replacement nuclear power plant of the same size (or larger) would increase revenue for host communities, power plant operators, and local suppliers.

The impacts analyzed here include industry revenues from electricity production, supply chain activity, and employee spending. All values in this figure are presented in millions of dollars.

LOCAL REVENUE GAINS BASED ON POPULATION SIZE AND POWER PLANT CAPACITY

	Population Range	< 20,000	20,000-39,999	40,000-89,999	90,000-199,999	200,000+
100 MWe	Revenue with Coal Plant	$29.3 M	$30.7 M	$33.2 M	$32.7 M	$36.3 M
	Revenue with Nuclear Plant	$57.4 M	$61.0 M	$64.4 M	$64.7 M	$74.1 M
	Added Revenue	$28.1 M	$30.3 M	$31.2 M	$32.0 M	$37.8 M
300 MWe	Revenue with Coal Plant	$86.3 M	$90.2 M	$95.0 M	$96.0 M	$105.6 M
	Revenue with Nuclear Plant	$167.5 M	$177.2 M	$187.1 M	$187.6 M	$212.5 M
	Added Revenue	$81.2 M	$87.0 M	$92.1 M	$91.6 M	$106.9 M
500 MWe	Revenue with Coal Plant	$143.5 M	$149.9 M	$162.1 M	$159.5 M	$175.3 M
	Revenue with Nuclear Plant	$278.3 M	$294.2 M	$310.6 M	$311.3 M	$352.0 M
	Added Revenue	$134.8 M	$144.3 M	$148.5 M	$151.8 M	$176.7 M
700 MWe	Revenue with Coal Plant	$201.0 M	$210.0 M	$227.1 M	$223.4 M	$245.6 M
	Revenue with Nuclear Plant	$389.7 M	$412.0 M	$435.1 M	$436.0 M	$493.1 M
	Added Revenue	$188.7 M	$202.0 M	$208.0 M	$212.6 M	$247.5 M
900 MWe	Revenue with Coal Plant	$258.6 M	$270.3 M	$292.3 M	$287.6 M	$316.3 M
	Revenue with Nuclear Plant	$501.1 M	$529.9 M	$559.5 M	$560.7 M	$634.3 M
	Added Revenue	$242.5 M	$259.6 M	$267.2 M	$273.1 M	$318.0 M

Figure 5: Revenue

* Revenue generated during the construction phase is not included in the calculations
** Calculation of these values may be affected by rounding.

WORKFORCE INFORMATION

Key Findings

- A comparably sized nuclear plant provides more jobs than a coal plant.
- With planning and support for training and reskilling, most workers at the existing coal plant should be able to transition to work at a replacement nuclear plant.
- Nuclear plants require more workers in almost every educational category, except for jobs that require a high school diploma or less. Nuclear plants employ a similar number of people with a high school diploma or less.
- Training or reskilling a coal plant workforce to support a nuclear plant involves the collaboration of multiple groups, including the utility or utilities involved in the transition, labor unions, local communities impacted by the loss or gain of jobs, and local colleges or other educational institutions.

As communities consider coal-to-nuclear transitions, effective transitioning of the existing workforce is vitally important. Establishing strong workforce transition practices will help communities navigate these changes and mitigate negative impacts to local workers. This section highlights how workforces might be impacted.

Overall, our study found there will be more jobs at a comparably sized replacement nuclear plant.

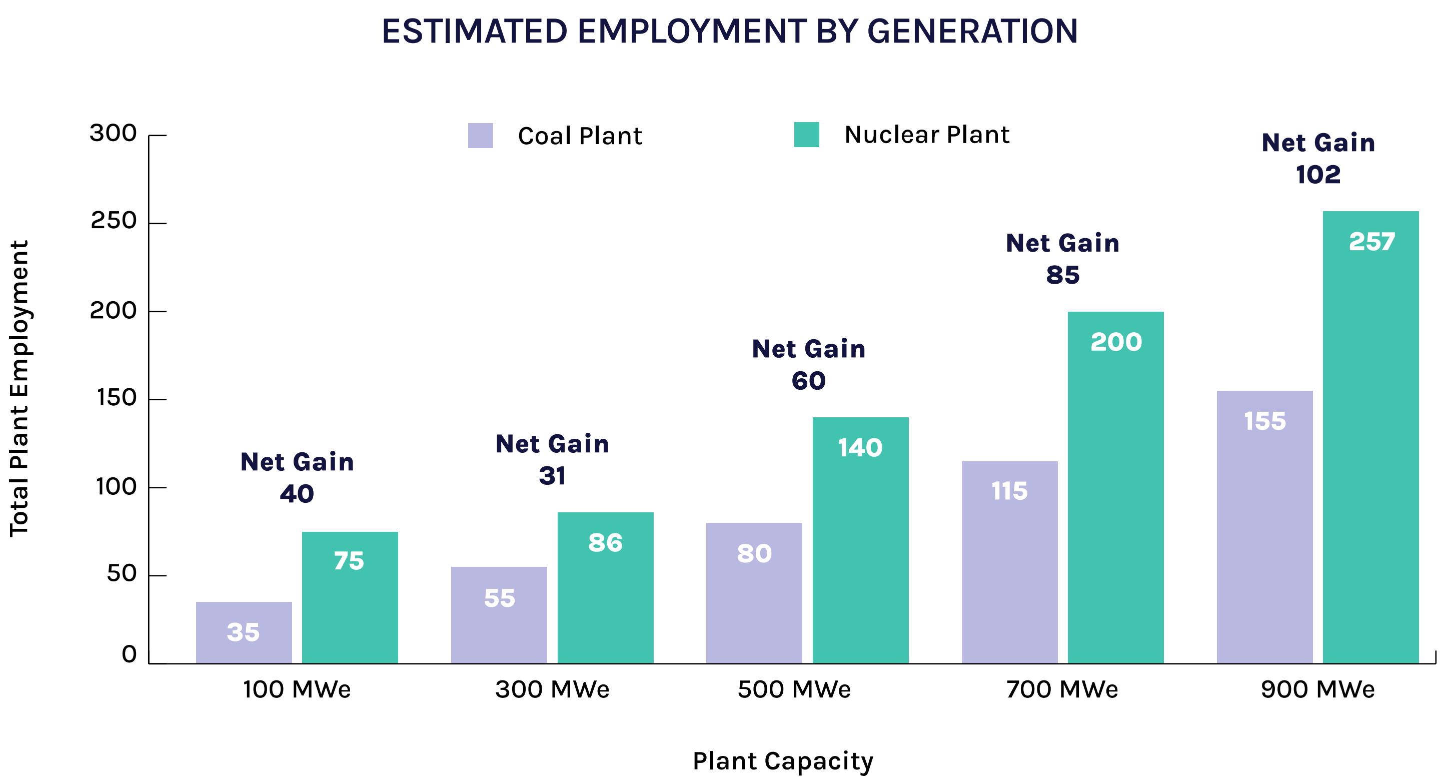


Figure 6: Number of jobs to support operations at typical coal plant and typical nuclear plant of comparable generation size

Overlap in Jobs

The workforce at an existing coal plant is highly skilled and constitutes a key asset in a coal-to-nuclear transition. Our analysis shows significant overlap in the types of jobs at a coal plant with those at a nuclear plant. However, depending on an individual worker's experience and educational background, additional training may be required to fill similar positions at the nuclear plant.

Many of the jobs at existing nuclear plants share identical or similar occupation codes to jobs at coal plants. It is expected that some training or reskilling will be needed for jobs with identical and similar occupation codes across the two types of power plants, although this training or reskilling could be minimal.

For example, industrial mechanics (occupation code 49-9041) have identical occupation codes in both coal and nuclear plants. If a coal power plant is replaced with a nuclear power plant of the same electric output capacity, the industrial mechanics from the existing workforce could transition to work in the same position at a nuclear power plant.

While comparing occupation codes is not always exact, it is likely that many of the skills needed to work on these same areas of the plants are similar. In most cases, training or reskilling for the same type of jobs can occur on site, and as a part of the onboarding process. The amount of training needed could vary depending on the position, and more work needs to be done to evaluate specific roles between the two types of plants.

Further examination of the overlap and differences between workforces at specific sites will be essential to determine the impact on workers at the existing plant. With planning and support for training and reskilling, most workers at the existing coal plant should be able to transition to work at the replacement nuclear plant.

Figure 7 breaks down eight occupation groups and highlights common jobs within each at a coal and nuclear power plant. The figure shows how many of these jobs are typically needed at a 500 MWe coal plant and a nuclear power plant of a similar size, as well as how many jobs might be gained or lost during a transition. These jobs have been extracted to show an overall representation of the net change of jobs in the transition. The jobs and categories listed do not represent all of the occupation groups or all the jobs present at a coal or nuclear plant.

What are occupation codes?

Occupation codes can be found at the **Bureau of Labor Statistics**' Website. The codes are used to classify workers into occupational categories for the purpose of collecting, calculating, or disseminating data.

The code is a six-digit number with the first two digits identifying a major group, third digit a minor group, and last three digits identifying a specific occupation.

For example, the code 17-0000 denotes architecture and engineering occupations, 17-2000 denotes engineering occupations, and 17-2161 identifies the role as a nuclear engineer.

In our study, we considered identical occupation codes to be those where all six digits match and similar occupation codes to be those where up to five digits match.

In some cases, a specific occupation may appear to be eliminated in the transition from a coal plant to a nuclear plant. It is important to remember that workers in those positions may retrain or reskill to fill a similar role in the replacement nuclear plant—likely one of the roles within that same broader job category, but with a different occupation code.

An example of this is seen with power plant operators. Both occupations are responsible for the main operating procedures at their respective plants. Both occupations require a similar amount of education and training. However, some of that training is unique to the safety and procedural requirements that are specific to coal or nuclear fuel sources. As a result, the occupation titles are changed.

BASED ON 500 MWe PLANT	Occupation Code	Occupation Title	Coal Jobs	Nuclear Jobs	Jobs Gained or Lost
Management, Business, and Financial Operations Occupations	11-1021	General and operations managers	1	1	0
	11-3010	Administrative services and facilities managers	1	0	-1
	11-3051	Industrial production managers	1	2	+1
	11-9041	Architectural and engineering managers	1	3	+2
	13-1020	Buyers and purchasing agents	1	1	0
	13-1111	Management analysts	1	1	0
	13-1151	Training and development specialists	0	4	+4
	13-1198	Project management specialists and business operations specialists, all other	1	0	-1
	13-2011	Accountants and auditors	1	0	-1
	13-2098	Financial and investment analysts, financial risk specialists, and financial specialists, all other	1	0	-1
Computer and Mathematical Occupations	15-1211	Computer systems analysts	1	0	-1
Engineering Occupations	17-2071	Electrical engineers	4	4	0
	17-2112	Industrial engineers	0	2	+2
	17-2161	Nuclear engineers	0	20	+20
	17-3023	Electrical and electronic engineering technologists and technicians	1	1	0
Life and Physical Science Occupations	19-2031	Chemists	0	1	+1
	19-4031	Chemical technicians	0	1	+1
	19-4051	Nuclear technicians	0	14	+14
Technical and Protective Service Occupations	29-9011	Occupational health and safety specialists	0	1	+1
	33-1099	First-line supervisors of protective service workers, all other	0	2	+2
	33-9032	Security guards	0	14	+14

BASED ON 500 MWe PLANT	Occupation Code	Occupation Title	Coal Jobs	Nuclear Jobs	Jobs Gained or Lost
Office and Administrative Support Occupations	**43-1011**	First-line supervisors of office and administrative support workers	1	0	-1
	43-4051	Customer service representatives	3	0	-3
	43-5061	Production, planning, and expediting clerks	1	1	0
	43-6011	Executive secretaries and executive administrative assistants	0	1	+1
	43-6014	Secretaries and administrative assistants, except legal, medical, and executive	1	1	0
	43-9061	Office clerks, general	1	1	0
Construction and Extraction, and Installation, Maintenance, and Repair Occupations	**47-2073**	Operating engineers and other construction equipment operators	1	0	-1
	47-2111	Electricians	2	3	+1
	49-1011	First-line supervisors of mechanics, installers, and repairers	2	4	+2
	49-2095	Electrical and electronics repairers, powerhouse, substation, and relay	4	4	0
	49-9012	Control and valve installers and repairers, except mechanical door	2	0	-2
	49-9041	Industrial machinery mechanics	2	4	+2
	49-9051	Electrical power-line installers and repairers	5	1	-4
	49-9071	Maintenance and repair workers, general	1	1	0
Production Occupations	**51-1011**	First-line supervisors of production and operating workers	3	7	+4
	51-8011	Nuclear power reactor operators	0	14	+14
	51-4121	Welders, cutters, solderers, and brazers	1	0	-1
	51-8012	Power distributors and dispatchers	2	0	-2
	51-8013	Power plant operators	14	2	-12
	51-8031	Water and wastewater treatment plant and system operators	1	0	-1
		Total	**62**	**116**	**+54**

Figure 7. A sample of occupations and how they change during a coal-to-nuclear transition, based on a 500 MWe plant

* Does not include all jobs at either plant type, thus the total number of 54 jobs gained is less than the estimate presented in Figure 6
**All employment estimates are based on 500 MWe plant capacity
***Data source: Occupational Employment and Wage Statistics & Employment Projections Program, U.S. Bureau of Labor Statistics

The occupation totals in the figure above were calculated using industry staffing patterns available through the Bureau of Labor Statistics (BLS). Staffing patterns show the percentage of total industry employment for each occupation. These percentages are then used to estimate the actual number of jobs for both types of power plants. The figures are reflective of typical employment at a 500 MWe coal plant and at a similarly sized nuclear plant, based on currently operating plants. The number of workers needed will increase and decrease depending on the size of either plant, as well as the specific designs and operations of those plants. These results are based on BLS industry surveys. Therefore, the actual number of employees may differ from plant to plant.

Additionally, since these percentage totals come from BLS surveys, we don't have clear insights into how the surveys were carried out or who answered the questions. This could lead to inconsistencies in the data, such as zero security guards for coal plants in Figure 7, despite the apparent need for some level of security.

New Job Roles

There are several occupation codes included under the jobs listed for a nuclear plant that are not included at a coal plant. These represent new jobs needed to operate a nuclear plant. Workers from the coal plant would likely need additional education, training, or reskilling to fill those roles. People from outside the community may also relocate to the area for these new jobs.

Figure 8 highlights the top 10 jobs that would be gained if a 500 MWe coal plant was replaced with a 500 MWe nuclear plant. If the plant size were to change, the values in the figure would change accordingly.

Occupation Code	Occupation Title	Jobs Gained
17-2161	Nuclear engineers	20
33-9032	Security guards	14
51-8011	Nuclear power reactor operators	14
19-4051	Nuclear technicians	14
51-1011	First-line supervisors of production and operating workers	7
49-2095	Electrical and electronics repairers, powerhouse, substation, and relay	4
49-1011	First-line supervisors of mechanics, installers, and repairers	4
49-9041	Industrial machinery mechanics	4
13-1151	Training and development specialists	4
17-2071	Electrical engineers	4

Figure 8. Estimated 500 MWe nuclear power plant staffing patterns

Overlap in Educational Levels Required

Both coal plants and nuclear plants require employees with a variety of educational backgrounds. Understanding the differences between the number of jobs requiring different levels of education in each type of plant helps show how much additional education might be needed. This helps determine what resources should be offered to the existing workforce at the coal plant.

To understand differences in educational levels between the coal and nuclear power generation industries, we collected educational data from the **Bureau of Labor Statistics** across occupations.

Nuclear plants require more workers in almost every educational category, except for jobs that require a high school diploma or less. However, nuclear plants employ a similar number of people with a high school diploma or less – so most existing coal plant employees with these levels of education could still find employment at a nuclear plant.

Figure 9 shows the total jobs required at 500 MWe coal and nuclear power plants by educational type.

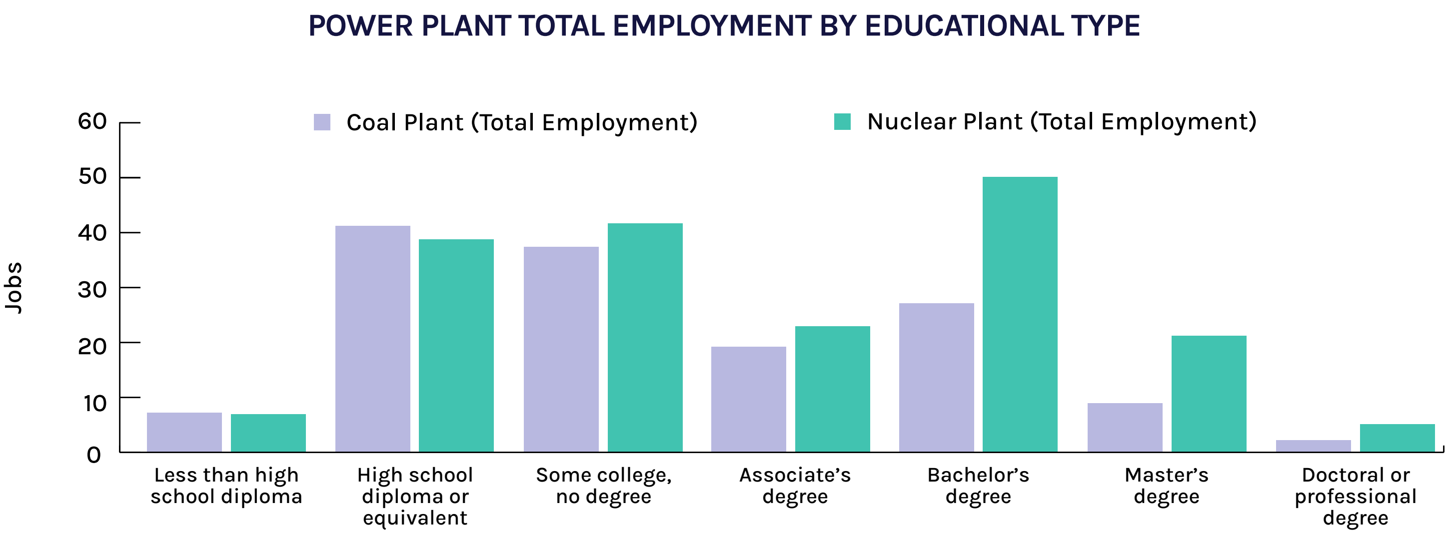


Figure 9. Total jobs by educational requirement across all coal and nuclear plant jobs in the United States for 500 MWe power plants

To minimize losses from the existing workforce, some coal workers will need additional education or training. The amount of additional education required will vary by each job position. In some cases, this may mean simply taking a few additional classes; in others, an individual may want to pursue a bachelor's or advanced degree.

In some cases, workers may not have access to education locally and may have to move out of the community to find and attend educational programs, pursue online educational programs, or find jobs that do not require additional education. For those with families and established roots in the community, such a move may be even more difficult. Additionally, the costs associated with obtaining education might create added financial hardship for aspiring workers.

Community leaders, unions, and utilities should work together to determine how they can support the existing workforce by providing access to educational classes and training programs. Workers and their representatives should be proactively and regularly consulted throughout the process of a coal-to-nuclear transition.

Avenues of Training and Reskilling Workforces

Training or reskilling a coal plant workforce to support a nuclear plant involves the collaboration of multiple groups, including the utility or utilities involved in the transition, labor unions, local communities impacted by the loss or gain of jobs, and local colleges or other educational institutions.

Communities undergoing coal-to-nuclear transitions will want to minimize job losses and shorten the transition period during which workers may be unemployed. Nuclear utilities often have training strategies and workforce acquisition tactics. To minimize negative impacts on the workforce, communities should consider early and ongoing conversations with utilities to ensure training and reskilling programs are implemented as early as possible.

In locations where educational institutions (e.g., universities, community colleges, and trade schools) exist, there are often job pipelines from training programs into the coal power plant. These educational institutions will likely have developed programs in coordination with the utility that include the necessary curriculum and training facilities. These programs could be leveraged to help develop the training resources needed to reskill employees from the coal plant for the nuclear plant. Workers may also be able to use online educational programs to take additional classes or pursue a new degree.

Labor unions can also play a role in training or reskilling the transitioning workforce. Unions have experience organizing workers, connecting them to resources, and interfacing with employers, politicians, and local governments on their behalf.

As communities consider the impact of a coal-to-nuclear transition on their workforce, they may also benefit from the experience of other communities currently undergoing energy transitions. For example, TerraPower plans to build its Natrium reactor near a retiring coal plant in Kemmerer, WY. Other communities may want to learn from community members there as they evaluate the impacts on their workforce.

POLICY AND FUNDING INFORMATION

Key Findings

- Significant new nuclear capacity will be crucial in achieving net-zero policy targets by 2050.
- The *Inflation Reduction Act* includes billions of dollars in financial support to spur the deployment of clean energy projects with a focus on deploying clean energy in disadvantaged communities, energy communities, and other communities in need.
- There are several funding mechanisms that may be leveraged to support advanced nuclear energy projects that communities and utilities can explore as they consider coal-to-nuclear transitions. These include significant tax credits through the *Inflation Reduction Act*, as well as loans and loan guarantees offered by DOE.

Significant new nuclear capacity will be crucial in achieving net-zero policy targets by 2050. DOE's **Pathways to Commercial Liftoff: Advanced Nuclear** report released in 2023 found that the U.S. will need between 550-770 gigawatts (GW) of additional clean, firm power to complement the deployment of variable renewables in order to reach net-zero by 2050. Based on various models, the report estimates that advanced nuclear technology could provide about 200 GW of additional capacity by 2050.

Coal-to-nuclear transition projects can reduce the capital costs required to implement new nuclear capacity, making coal-to-nuclear projects a viable way to accelerate reaching decarbonization goals.

The *Inflation Reduction Act of 2022* made the single largest investment in climate and energy in American history. Billions of dollars in financial

The Pathways to Commercial Liftoff: Advanced Nuclear Report Key Findings

Nuclear Power is a Key Asset

- Advanced nuclear energy offers a unique value proposition as it generates clean electricity, provides firm power to complement variable renewable energy sources, uses land efficiently, and does not need a lot of transmission buildout.

Advanced Nuclear Provides Economic Benefits and High-Quality Jobs

- Small modular reactors are estimated to provide nearly 240 permanent jobs per gigawatt.
- Nuclear energy jobs tend to have higher industry wages compared to other generation sources.

support will be used to spur the deployment of clean energy projects with a focus on deploying clean energy in disadvantaged communities, energy communities, and other communities in need.

Momentum is building for nuclear energy in the United States. The investments and tax incentives included in The *Inflation Reduction Act* guarantee a commitment to nuclear energy that will continue throughout the nation's journey to net-zero.

Funding Mechanisms

The *Inflation Reduction Act* includes grants, loans, rebates, incentives, and other investments to support efforts to expand deployment of new clean energy projects. There are various mechanisms that may be leveraged to support advanced nuclear energy projects that communities and utilities can explore as they consider coal-to-nuclear transitions. These include significant tax credits through the *Inflation Reduction Act*, as well as loan guarantees offered by DOE.

Tax Credits

Many of the clean energy tax provisions in the *Inflation Reduction Act* offer additional credits to clean energy projects located in disadvantaged communities or energy communities. These investments help ensure that these communities see the expansion of clean energy projects and benefit from new economic development, good-paying jobs, and less pollution.

A summary of the tax provisions potentially applicable to coal-to-nuclear projects are highlighted in the figure below. Please review the **Inflation Reduction Act Guidebook** for more details on each provision and for a full list of tax incentives and investment programs in the *Inflation Reduction Act*.

Visit **CleanEnergy.gov** for the most recent information on the *Inflation Reduction Act*. This website will update as new funding announcements and program details become available.

New Nuclear Deployment Is Needed Now

- Waiting until the mid-2030s to deploy advanced reactors at scale could threaten U.S. decarbonization goals and/or lead to significant overbuild of the supply chain.
- If new nuclear deployment starts by 2030 and annual deployment increases to 13 GW by 2040, the U.S. could deploy an additional 200 GW by 2050.

New Projects Will Be Different from Recent Over-Budget Builds

- Repeat deployments, or "Nth-of-a-kind" deployments, could reduce overnight capital costs by 40%.
- Those cost reductions are primarily due to improvements to project planning, standardization, build time reduction, modularization, and supply chain development.

The Path to Commercial Scale Deployment

- Full-scale advanced nuclear deployment will occur in three overlapping phases: (1) committed order books of 5-10 deployments of at least one reactor design, (2) project delivery that is on-time and on-budget, and (3) industrialization of advanced nuclear power and scaling up of the workforce, supply chain, and licensing.

Tax Provision	Funding Mechanism	Description
Clean Energy Production Tax Credit (PTC)	Tax Credit	Provision to incentivize investment in communities most in need of new economic development. The PTC, as extended, and the new Clean Electricity PTC offer a 10 percent credit increase for facilities located in an energy community.
Clean Energy Investment Tax Credit (ITC)	Tax Credit	The ITC, as extended, and the new Clean Electricity ITC offer up to a 10-percentage point bonus credit for projects located in an energy community. The ITCs also offer another 10-percentage point bonus allocated investment credit for qualified solar and wind facilities located in a low-income community or on Tribal land and a 20-percentage point bonus for projects that are part of a qualified low-income residential building project or a qualified low-income economic benefit project.
Advanced Energy Project Credit	Allocated Investment Credit	Provides a tax credit for investments in advanced energy projects, as defined in 26 USC § 48C(c)(1).
Zero-Emission Nuclear Power Production Credit	Production tax credit	Tax credit for electricity produced at a qualified nuclear power facility.

Figure 10. Summary of tax provisions potentially applicable to coal-to-nuclear projects
Source: Inflation Reduction Act Guidebook

Loans and Loan Guarantees

Under the Title 17 Clean Energy Financing Program, DOE's Loan Programs Office can finance projects in the United States that support clean energy deployment and energy infrastructure reinvestment to reduce greenhouse gas emissions and air pollution.

In 2022, Title 17 was updated by the *Inflation Reduction Act*. This expanded the scope of Title 17 to include certain state-supported projects and projects that reinvest in legacy energy infrastructure. It also leverages additional loan authority and funding for projects involving innovative energy technologies.

As part of this update, the **Program Guidance** organizes Title 17 into four broad project categories through which eligible projects can receive financing: (1) Innovative Energy (Section 1703), (2) Innovative Supply Chain (Section 1703), (3) State Energy Financing Institution-Supported Projects (Section 1703), and (4) the Energy Infrastructure Reinvestment Program (Section 1706).

The different categories under Sections 1703 and 1706 cover projects across a range of sectors. For example, through the **Energy Infrastructure Reinvestment (EIR) Program**, the Loan Programs Office has up to $250 billion in additional loan authority. This authority can be used to retool, repower, repurpose, or replace energy infrastructure that has ceased operations or to enable operating energy infrastructure to avoid, reduce, utilize, or sequester air pollutants or anthropogenic emissions of greenhouse gases. This could include projects like the conversion of retiring coal assets into nuclear power plants. Additional EIR project examples and possible project areas are available on pages 28-30 of the **Program Guidance**.

Communities and utilities should work with the DOE's Loan Programs Office to learn more about the Title 17 Clean Energy Financing Program and to understand what financial assistance their coal-to-nuclear transition project may qualify for.

Energy Communities

The Interagency Working Group on Coal & Power Plant Communities & Economic Revitalization has identified communities across the United States that qualify as energy communities and are eligible for additional tax credits to support and revitalize the economies of coal and power plant communities.

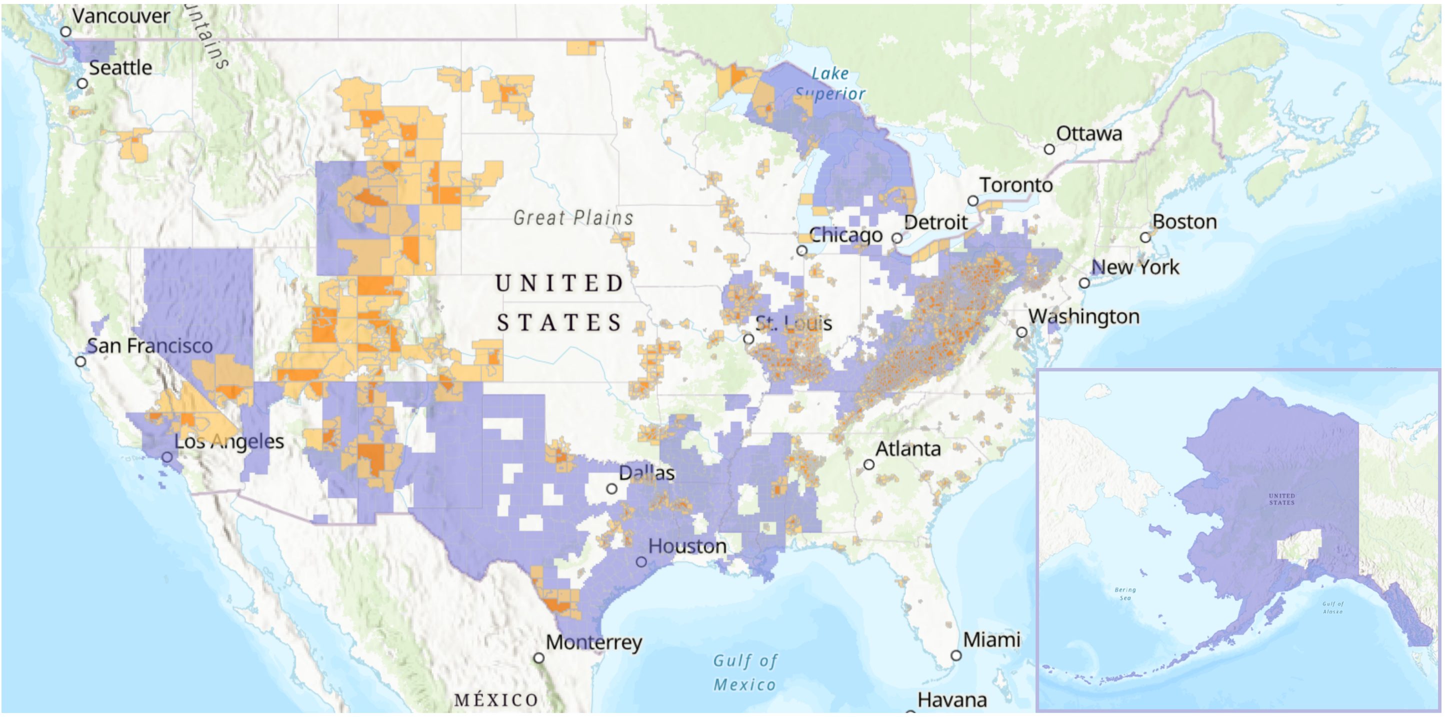
As defined in the *Inflation Reduction Act*, the Energy Community Tax Credit Bonus applies up to 10% (for production tax credits) or 10% (for investment tax credits) for projects, facilities, and technologies located in energy communities.

The *Inflation Reduction Act* defines energy communities as:

1. A "brownfield site" (as defined in certain subparagraphs of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 [CERCLA])
2. A "metropolitan statistical area" or "non-metropolitan statistical area" that has (or had at any time after 2009)
    a. 0.17% or greater direct employment or 25% or greater local tax revenues related to the extraction, processing, transport, or storage of coal, oil, or natural gas; and
    b. has an unemployment rate at or above the national average unemployment rate for the previous year
3. A census tract (or directly adjoining census tract)
    a. in which a coal mine has closed after 1999; or
    b. in which a coal-fired electric generating unit has been retired after 2009

The map in Figure 11 highlights communities the Working Group has identified. For more information and an interactive map, visit [Energy Community Tax Credit Bonus – Energy Communities](#).

Visit [Funding – Energy Communities](#) to learn more about additional funding opportunities specifically for energy communities.



Coal Closure Energy Communities

Tract Status

- Census tract directly adjoining a census tract with a coal closure
- Census tract with a coal closure

MSA/Non-MSAs that are Energy Communities

Status

- MSAs/non-MSAs that meet both the Fossil Fuel Employment (FEE) threshold and the unemployment rate requirement

Figure 11. Energy communities eligible for energy community tax bonus
Source: [Energy Community Tax Credit Bonus – Energy Communities](#)

Disadvantaged Communities

In 2021, Executive Order 14008, Tackling the Climate Crisis at Home and Abroad established the [Justice40 Initiative](#). Justice40 directs 40% of the overall benefits of certain Federal investments – including investments in clean energy and energy efficiency; clean transit; affordable and sustainable housing; training and workforce development; the remediation and reduction of legacy pollution; and the development of clean water infrastructure – to flow to disadvantaged communities.

Nationwide, the Climate and Economic Justice Screening Tool (CEJST) identifies approximately 27,251 census tracts as disadvantaged. Generally, a census tract that meets the threshold for: 1) environmental, climate, or other burdens, and 2) an associated socio-economic burden will be marked as disadvantaged.

CEJST considers the following eight categories of burden:

1. climate change
2. energy,
3. health,
4. housing,
5. legacy pollution,
6. transportation,
7. water and wastewater,
8. workforce development.

In addition, a census tract that is completely surrounded by disadvantaged communities and is at or above the 50% percentile for low income is also considered disadvantaged.

Census tracts that are overburdened and underserved are highlighted as being disadvantaged on the CEJST map. Federally Recognized Tribes, including Alaska Native Villages, are also considered disadvantaged communities.

Explore the map – **Climate & Economic Justice Screening Tool (geoplatform.gov)**

INFORMATION FOR UTILITIES

As utilities look to meet energy demands, build diverse energy portfolios, and reduce carbon emissions, they may want to explore repowering their closing or retired coal power plants with nuclear power plants.

Coal-to-nuclear transitions are complex projects. Utilities will need to weigh competing priorities and make decisions on timeline, project scope, technical requirements, infrastructure reuse, and costs.

To help ensure the success of a coal-to-nuclear project, utilities must also be strong partners with the host community and engage with stakeholders at the state and local levels.

Factors to Consider for a Coal-to-Nuclear Transition

When starting to think about a coal-to-nuclear transition, a utility could consider the following four questions to help define the coal-to-nuclear transition based on the compatible nuclear power plant concept and existing coal power plant infrastructure:

- How much power should the new nuclear plant provide?
- Would the replacement nuclear plant be built on the site of the original coal plant or nearby?
- What existing coal plant infrastructure can be reused for a nuclear plant?
- Can the project support a gap in operations between the two plants?

How much power should the new nuclear plant provide?

The replacement nuclear plant can deliver roughly the same, more, or less power than the original coal plant depending on the type and number of reactors deployed. Utilities will need to consider the target nameplate capacity for the replacement nuclear plant.

Would the replacement nuclear plant be built on the site of the original coal plant or nearby?

Utilities will need to evaluate whether the direct site of the coal plant will support the replacement nuclear plant or whether it makes more sense to build the replacement plant away from the original coal plant, but nearby. In cases where the nuclear plant will be built on the original site, the plant may be able to use existing infrastructure from the coal plant.

What existing coal plant infrastructure can be reused for a nuclear plant?

As mentioned above, the infrastructure that can be reused for the nuclear power plant depends on siting of the replacement plant: either directly on site or away from the site, but nearby. While there are certainly differences between these two, the distinction is not absolute. If a nuclear power plant is built near the boundary of the coal power plant, it could potentially reuse more on-site coal power infrastructure, such as permits, grid connection, and office buildings, while potentially removing some requirements for coal power decommissioning and demolition.

The utility could save money building the nuclear plant by reusing assets including the existing land; the coal plant's electrical equipment (transmission connection, switchyard, etc.); environmental permits such as water and transmission rights; and civil infrastructure, such as roads and buildings.

Can the project support a gap in operations between the two plants?

The site of the replacement nuclear plant—either directly on the original coal plant site or away from the site, but nearby—affects the downtime in operations between the two plants. During some coal-to-nuclear transitions, there may be a gap between the coal plant shutdown and nuclear power plant startup during which the utility receives no operating income from either plant. The duration of the gap is determined by how early the coal power plant needs to be retired to perform refurbishment and regulatory activities before construction of the nuclear power plant.

In cases where the nuclear plant will be built directly on site to reuse additional infrastructure such as electrical, heat-sink, and steam-cycle components, the coal plant must be shut down prior to the start of the nuclear project. Some of the existing plant will need to be dismantled, and the equipment being reused in situ will need to be tested, refurbished, and possibly licensed by the Nuclear Regulatory Commission (NRC) or other regulatory bodies.

To avoid a gap in operations, building the replacement nuclear plant away from the original coal plant site is an option, as the schedule of the nuclear plant construction does not depend on the schedule of coal plant demolition. In this case, the coal power plant shutdown can be planned to coincide with the nuclear power plant's start of operations. Utilities who have the choice between an on-site or away-from-site transition, will need to weigh the tradeoff in revenue from continued operating income from the coal plant versus the cost savings from reusing additional coal plant infrastructure directly on the site.

Time gaps between coal power plant retirement and nuclear power plant operation may also entail loss of access rights to water or transmission or reduce the potential for coal power plant employee retention. These risks should be carefully assessed and mitigated as much as possible.

Coal plant workers and the unions who represent them should also be consulted in advance of temporary and permanent site closure. Pathways to retirement, opportunities for employment in coal plant decommissioning and refurbishment, commitments to hiring of displaced workers, and any upskilling or reskilling necessary for construction, operations, and maintenance positions in nuclear should be developed in coordination with the existing workforce.

Please see the **Stakeholder Guidebook for Coal-to-Nuclear Conversions** for an in-depth discussion and data on the economics, potential cost savings, and technology matching between a coal plant and nuclear technology designs.

Utilities may also find the following two Electric Power Research Institute (EPRI) reports helpful as they consider repowering their coal power plants:

- **Repowering Coal-Fired Power Plants for Advanced Nuclear Generation** (2022)
- **Repowering Coal-Fired Power Plants for Bulk Energy Storage** (2022)

ADDITIONAL RESOURCES

Coal-to-nuclear transitions offer energy communities an option to replace retiring coal power plants, preserving hundreds of jobs that would otherwise be lost, adding additional new jobs, spurring new economic activities, and improving environmental conditions.

This guidebook offers a high-level look at the economic impacts, workforce transition, and policy and funding information that communities interested in a coal-to-nuclear transition might consider. It also provides a brief overview of considerations that utilities should be aware of before undergoing a coal-to-nuclear transition.

DOE's Gateway for Accelerated Innovation in Nuclear

The Department's **Gateway for Accelerated Innovation in Nuclear (GAIN)** is leading an expansive effort to respond to community leaders' interest in coal-to-nuclear transitions. Some of these efforts have resulted in **direct engagement** with communities and studies to support community interest. GAIN also coordinates a research group for information sharing and opportunities related to coal-to-nuclear transitions.

GAIN is conducting three feasibility studies to assess different aspects of repurposing coal power plant sites with nuclear power. These studies are specific to the community and utility in each study. However, they provide insight and could serve as a jumping off point for other coal sites exploring energy transitions.

The GAIN team can also provide assistance to communities around the country as they consider advanced nuclear in their energy transitions. This assistance can include providing information about nuclear energy plants, transition opportunities, and connecting communities to potential **funding opportunities** through the interagency working group.

If you are interested in working with our GAIN team, please email **GAINTechAssist@inl.gov**.

Other Resources

In addition to the full Stakeholder Guidebook for Coal-to-Nuclear Conversions and resources from GAIN, other coal-to-nuclear resources include:

The Electric Power Research Institute (EPRI) published four white papers that provide a high-level overview of factors on decommissioning a coal power plant and reusing parts of its infrastructure for a nuclear power plant.

- A Comprehensive Approach to Repurposing Retired Coal Power Plant Sites (2019)
- Repowering Coal-Fired Power Plants for Advanced Nuclear Generation (2022)
- Repowering Coal-Fired Power Plants for Bulk Energy Storage (2022)
- From Coal to Nuclear: A Practical Guide for Developing Nuclear Energy Facilities in Coal Plant Communities (2023)

EPRI is also working to develop a stakeholder guidebook that aims to provide power plant owner-operators with regulatory guidance on repurposing an existing coal power plant.

The **Net Zero World** initiative recently published a report that summarizes case studies of the decision-making process for energy and economic development pathways of fossil fuel communities.

The Bipartisan Policy Center published a white paper that addresses the viability of advanced nuclear power replacing the coal capacity in the United States (Jacobs and Jantarasami 2023). It largely leverages analysis from DOE's 2022 report, but places the DOE findings in the context of policy discussion oriented towards coal-to-nuclear transitions.

The Nuclear Innovation Alliance (NIA) recently published a thought-piece on coal-to-nuclear transition issues. It provides useful insights on topics ranging from the increasing frequency of coal power plant retirements, to siting and screening issues, and to timelines for bridging the gaps in employment for the coal power plant workforce. NIA's thought piece also adds useful insights to the DOE findings.

The Gateway for Accelerated Innovation in Nuclear (GAIN) is leading an expansive effort to respond to community leaders' interest in coal-to-nuclear transitions. Some of these efforts have led to direct engagement with communities and studies to support community interest. GAIN coordinates a research group for information sharing and opportunities related to coal-to-nuclear transitions.

Good Energy Collective recently published a policy report that explored where small modular reactor (SMR) technology could support environmental justice communities that relied on coal.

Note: Some of the data presented in this report use the IMPLAN's economic modeling platform: IMPLAN® model, 2022 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