

# Coal Repowering

a White Paper Series

## Repowering Coal-Fired Power Plants for Advanced Nuclear Generation



## Abstract

Facing increasing pressure to retire coal-fueled generating assets, U.S. utilities have formally announced the retirement of more 70 gigawatts (GW) of coal plant retirements in the next 15 years [1]. Until recently, newly constructed natural-gas-fired units typically replaced decommissioned coal plants.

In 2021, the U.S. Congress and U.S. Environmental Protection Agency (EPA) began encouraging owners and operators that are closing coal-fired generation plants to redevelop the sites for renewable power generation [2]. Developing clean energy alternatives at coal-fired power plants slated for closure can help achieve corporate decarbonization goals. This is not just a U.S. phenomenon, globally many countries have significant carbon reduction goals and are looking to replace coal-fueled generation with other low carbon energy sources [3,4].

Repowering a fossil-fueled generation facility for clean energy generation offers many advantages, including the potential to reuse existing site infrastructure, operating and environmental permits, equipment, facilities, and water usage for future clean power generation and energy storage facilities. Repowering to clean power generation may also provide social and economic benefits to the surrounding community through retention of jobs and tax base.

For these reasons, many utilities seek strategies to evaluate the potential for repowering of coal-powered facilities and sites planned for decommissioning to low-carbon and carbon-free generation. This document summarizes key issues to consider and understand when evaluating whether a closing coal-fired plant can effectively be repurposed for nuclear power generation.

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## Introduction

Evolving economic, regulatory, and carbon reduction goal conditions continue to change the viability and desirability of operating coal-fueled generating assets. In the United States, more than 90 gigawatts (GW) of older, smaller, and less economically efficient coal units have been retired since 2000 due to environmental and economic changes [1]. Global goals for managing climate change have put intense policy pressure on the coal fleet while driving significant financial change, including an increasing difficulty in financing coal related projects [5]. Pressures to retire and decommission the remaining coal fleet continue to mount as power generators worldwide transition to low-carbon or carbon-free energy sources.

Utilities across the United States have announced over 70 GW of coal plant retirements within the next 15 years [1]. This next round of plant retirements presents several new challenges. The average name-plate capacity for U.S. coal plants being retired in the next 15 years is approximately 420 MW per unit, compared to an average of 152 MW for units retired in the past 15 years. Globally, including the United States, the expected coal retirements over the next 15 years amount to nearly 290 GW [4]. In fact, the World Economic Forum has noted that international coal plant retirements, preferably converted to cleaner energy, must be accelerated to meet International Panel on Climate Change (IPCC) goals by 2050 [3].

The plants slated for retirement now are more complex than the older plants due to the presence of equipment such as air emission controls. Regulatory changes have resulted in more strict environmental limits, new regulated materials, and more public scrutiny on the closure process. These new challenges are adding cost and risk to the decommissioning process for the larger plants.

Utilities have typically addressed replacement of decommissioned baseload generation by constructing natural gas-fired units at existing facilities. However, the transition to low-carbon generation suggests this type of baseload replacement may no longer be feasible or desirable. Rather, companies need to assess the coal-fired facilities to identify the assets, limitations, and options for developing new clean energy generation in place of the existing fleet. The current scenario in converting the existing challenges to opportunities can be addressed by systematically creating an inventory of the existing site infrastructure, characteristics, permits, and other attributes, and correlating it with the needs of the clean energy alternative that will fit both the retiring coal plant and the needs of the local community.

There are several advantages to repowering an existing site for new generation:

- Operating coal plant sites have existing transmission infrastructure and interconnection permits.
  - Many such sites have access to well-developed transportation infrastructure via road, rail, and waterways, as well as existing utility connections for buildings.
  - The existing environmental permits for a coal facility may be modifiable for application to a new generating facility, possibly forestalling lengthy permitting processes that require multiple periods of public input.
  - Many current sites offer the advantage of access to a large daily water withdrawal and water discharge allowance. In the United States, the right to withdraw water is under more scrutiny, and there are reputational and permitting advantages to modifying existing water withdrawal and discharge permits rather than undergoing the permitting process in a new area.
  - Larger facilities that already have a land use permit, certificate of occupancy, and buffer property to provide a visual and physical barrier from nearby neighbors provide siting advantages that may allow new generation to be constructed and commissioned more quickly than siting in a new location.
  - Existing buildings, warehouses, and site equipment such as generators may offer opportunities to lower the cost of construction by repurposing those for the new generation.
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In addition to the benefits of existing land, infrastructure, permits and potentially equipment, repowering a site for new generation may benefit the surrounding community. Local, state, and federal governments, municipalities, non-governmental organizations, development commissions, and environmental justice advocates increasingly call for fossil-fuel-based power generation facilities planning for, or undergoing, decommissioning to transition via site redevelopment to a new use for the property. The goal is to replace the taxes, jobs, and community support that are lost when plants retire, and potentially providing retraining and continued employment for some or all of the workforce.

In the United States, redevelopment of decommissioning coal plants became a federal priority in 2021, with the U.S. Congress and the U.S. Environmental Protection Agency (EPA) encouraging the transition of closed or closing coal power plants and the industries that support coal-fired electricity generation to adopt clean energy technologies. For example, in a 2021 report, the U.S. *Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization* identifies the need to promote job-creating investments in communities, provide funding for local infrastructure, economic development, and training, by aligning twelve separate agencies to focus on the issues [2].

Repowering a site with new generation can support both owner and stakeholder goals, while allowing the utility to maintain ownership of sites that may have legacy environmental impacts.

By developing a corporate strategy to thoroughly examine the assets, liabilities, obligations, and limitations of coal-powered facilities slated for decommissioning, utilities can develop long-term plans to support their corporate objectives for transitioning to low-carbon or carbon-free generation. Options include repowering the site to a(n):

- Advanced nuclear generating station
  - Photovoltaic (PV) power generation facility that directly converts sunlight to electricity, perhaps coupled with battery energy storage to improve dispatchability
  - Concentrating solar power (CSP) facility that would create energy from solar thermal heat, potentially using the existing steam power island at the site to create power
  - Bulk energy-storage facility (battery, thermal, compressed air, etc.) that would store energy from the grid (when electricity prices are low) or onsite generation sources and discharge power to the grid when demand is high
  - Low-carbon power generator, in which the existing plant is modified to use low-carbon fuel, such as biomass, ammonia, or hydrogen, for power generation
  - Hybrid plant using two or more low-carbon or carbon-free technologies
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EPRI is exploring low- or zero-carbon repowering options for coal plants through a screening-level evaluation of the available infrastructure, permits, site characteristics, water access and equipment typical of coal-fired generation that may be beneficial for repowering applications. A series of documents will provide information on primary siting and redevelopment criteria for nuclear, PV, CSP, bulk energy storage, and other low-carbon fuels to support decarbonization efforts.

This paper provides a high-level overview of the process of determining whether a coal-fired power plant slated for decommissioning is suitable for repowering to advanced nuclear generation and covers the key issues and general process to consider when performing this evaluation, as shown in Figure 1.

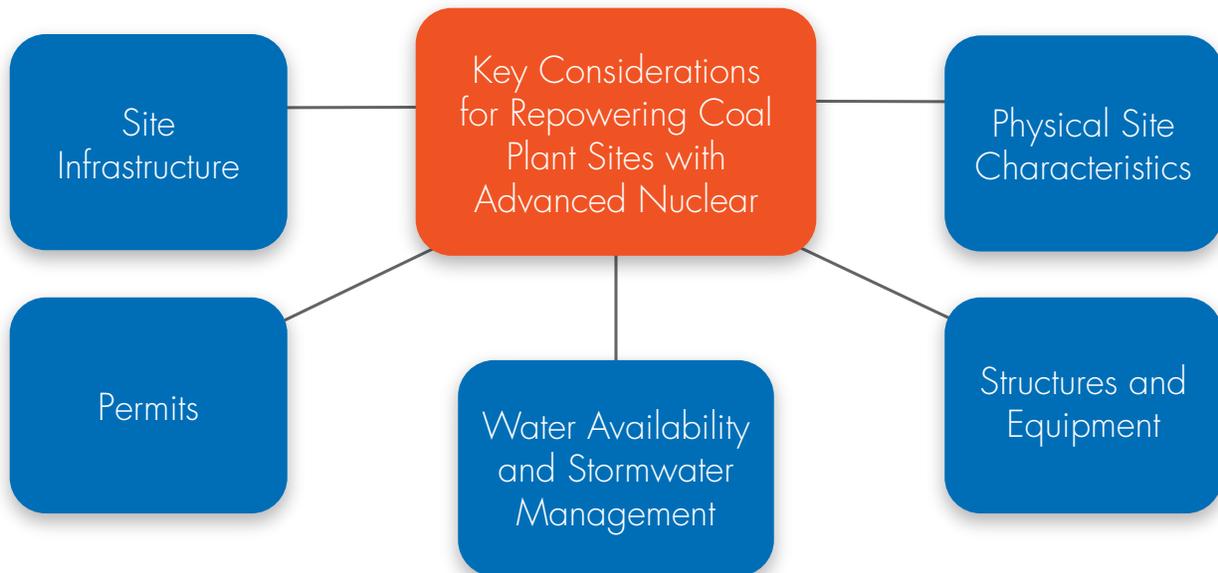


Figure 1. Key issues when evaluating coal plant sites for repowering

## Why Nuclear

The decision to deploy a nuclear plant on a retired coal site is one that must be made based on the owner-operators business objectives in consideration of all other potential uses for the site, including repowering with other technologies or redevelopment. For the purposes of this white paper, it is assumed that a decision to at least evaluate nuclear has been made, and that strict impediments, such as a locale-based moratorium on nuclear, do not prevent deployment. Reasons to include nuclear as a potential deployment option include, but are not limited to:

- **Clean** – While country, state and local regulations may value it differently, nuclear power generation is non-carbon-emitting during its operating lifetime and emits less carbon over its entire lifecycle than any other generation source other than hydropower [6]
- **Reliable** – Nuclear plants have proven to have the highest capacity factors of any generation assets on the grid, routinely operating above 90% [7]

- **Dispatchable** – Modern nuclear plants, as with the operating fleet, will have the ability to operate flexibly on grids that include significant intermittent generation, such as solar and wind [8]
- **Scalable** – Nuclear plants can be sized to have generation parity with the original coal site, providing a similar electrical supply in the same location and efficiently utilizing existing transmission capacity [9]
- **Economical** – Although the cost of nuclear deployment can be higher than other generation, their long life and low fuel cost can make them economically attractive over the long term [10]

As with any other generation option, there are also considerations that may preclude nuclear repowering. The most prominent issues center around community sentiment regarding operational safety and nuclear waste management. From a technical perspective, these issues can be overcome and many forthcoming advanced reactor designs purposely address these concerns, however this must be evaluated when making the business decision to deploy nuclear.

## New Options for Nuclear Technology and Design

The chosen nuclear plant technology and design to be deployed must be compatible with the business objectives of the owner-operator, local regulations, and the site itself. Today, nearly all operating nuclear plants are water-based designs, with the majority being Pressurized Water Reactors (PWRs) or Boiling Water Reactors (BWRs). These plants are predominantly sized on the order of about 1 GW and are often referred to as Large Light Water Reactors (LLWRs). More recent LLWR designs, often referred to as Advanced Light Water Reactors (ALWRs) are now available for deployment. The ALWR designs have the potential to be deployed on a retired coal site, though as noted above the average size for a soon to retire coal plant in the United States is 420 MWe per unit, which may limit options for ALWR deployment based on available acreage, cooling water supply, and transmission interconnection.

There are many new technologies under development from several plant designers (or OEMs). These technologies include novel light water designs as well as other technologies, such as gas cooled reactors or molten salt reactors. From a technology perspective, these options are generally defined by a combination of their fuel form and primary coolant, and each has unique traits that should be considered. These reactors are generally referred to as Advanced Reactors (ARs). Key features of these designs generally include:

- A smaller MWe output (often referred to as Small Modular Reactors, or SMRs)
- The ability to deploy multiple units to target a specific output
- In some cases, higher temperatures, increasing efficiency and enabling other product options
- Increased flexibility options
- Smaller land requirements
- Lower cooling water requirements, including the potential for air cooling
- The ability to deploy closer to populations
- Reduced emergency planning zone sizes

EPRI has a forthcoming report entitled *Owner-Operator Technology Assessment Guide* [11] that can be used to help an owner-operator select a technology and design that fits their mission and business objectives and the constraints the site, once the site has been determined to meet criteria for nuclear technology.

## Physical Site Characteristics and Technology Selection

The deployment of nuclear is more tightly coupled to the physical site characteristics and technology selection than with other repowering options. This is because the regulatory and licensing processes for a nuclear plant are based on the plant’s ability to operate safely and in an environmentally conscious manner on a specific site.<sup>1</sup> The physical characteristics of the site must support the chosen nuclear plant’s design and vice versa, often requiring an iterative process to identify the best site that supports a design that meets the owner-operators business objectives. In the case of repowering a coal site, since a desired site location is known, the site must be well characterized to identify available technologies that will be a good fit. This process will still involve some iteration because the process of characterizing a site is normally completed in multiple stages, with the evolving information and data informing and evolving the technology and design selection process.

### Preliminary Site Characterization

The EPRI report, *Site Selection and Evaluation Criteria for New Nuclear Energy Generation Facilities (Siting Guide)* [12,13], provides a regulatory neutral process for characterizing a potential nuclear site. The process and requirements are detailed and can take considerable time and effort; however, the process can be completed in stages, with the early work targeted at identifying the viability of the site to support a potential nuclear plant and the potential technologies and designs that could be deployed.

A primary factor that must be addressed first is the sites available land area. The EPRI Siting Guide identifies general land area requirements as noted in Table 1 below.

Table 1: Typical nuclear plant land area requirements

Size <sup>2</sup>	Operating (MWt)	Output (MWe)	Typical Land Area Needed [acres (hectare)] <sup>3</sup>		
			Plant Footprint	Overall Site	Additional Construction
Micro	<= 150	<= 50	0.1 to 4 (0.04 to 1.6)	1 to 8 (0.4 to 3.2)	2 to 10 (0.8 to 4)
Small (SMR)	150 >= 900	50 >= 300	25 to 200 (10 to 80)	50 to 500 (20 to 200)	50 to 100 (20 to 40)
Medium	900 >= 1800	300 >= 600	60 to 250 (25 to 100)	250 to 800 (100 to 325)	75 to 200 (30 to 80)
Large	> 1800	> 600	100 to 400 (40 to 160)	500 to 2000 (200 to 800)	100 to 500 (40 to 200)

1. The specific regulatory and licensing requirements for nuclear deployment vary globally, however the technical considerations are generally the same. U.S. NRC requirements are used as examples in this document.
2. See the ‘Reactor Size and Type Designations’ in the EPRI Siting Guide [13] for more detail.
3. The EPRI Siting Guide notes several caveats regarding this table, but the most important are that the sizes represent a single nuclear unit, if a cooling reservoir is needed as much as 4000 more acres may be required, and in the end, consultation with an OEM or AE is highly recommended to obtain the most accurate values.

The size of any existing coal site will be dependent on several factors, often driven by the density of local development. Some sites may be large enough that a portion of the site may be cleaved off separately so nuclear development can start prior to shut down and decommissioning, others may have sufficient acreage only following coal plant demolition. Some sites may require acquisition of additional acreage to be viable for nuclear development. This allows use of the grid connection and water supply (see Site infrastructure below) and may allow for some nuclear development prior to shut down with little to no remediation.

The EPRI Siting Guide provides 42 technical criteria generally needed to characterize the site supporting these licensing purposes. However, a limited set of 11 criteria can be evaluated to identify the potential for a coal site to support a nuclear plant (see Table 2).

Table 2: Initial criteria for evaluation of a coal site for nuclear

#	Criteria	Description
1	Geology/Seismology	Areas where regional hazard mapping shows that the Peak Ground Acceleration (PGA) are high may result in certain reactor technologies being screened out for exceeding the reactor specific design requirement for a Safe Shutdown Earthquake.
2	Cooling Water Supply	Water sources that can supply the identified cooling water demand (either singly or in combination).
3	Flooding	Flood-prone areas should be avoided to the extent practical.
4	Nearby Hazardous Land Uses	Avoid military installations, land within 10 mi (16 km) of major airports, evaluate airport takeoff and landing patterns, and maximize distance to other major industrial areas or potential hazards (such as active oil and gas well fields, chemical facilities, refineries, dams, etc.)
5	Population	Regulations vary by country and can be somewhat complicated. Current U.S. NRC guidance requires a population density of 500 people per square mile or less over a 20-mile (32-km) radius.
6	Atmospheric Dispersion	Areas where short-term atmospheric dispersion would be limited should be avoided to the extent practical.
7	Groundwater Radionuclide Pathway	Regions with U.S. EPA Class I groundwater resources and/or sole source aquifers should be excluded from further siting consideration.
8	Disruption of Important Species/Habitats – Plant Site	Exclude areas designated a ‘critical habitat.’ Other protected ecological areas (national wildlife refuges, national marine sanctuaries, and so on) are also routinely excluded as part of the land use criterion evaluation. Effort should be made to avoid sites where threatened and endangered species (flora and fauna) are known to be present.
9	Disruption of Wetlands	Wetlands should be avoided.
10	Land Use	Established public amenity areas—those dedicated by federal, state, or local governments to scenic, recreational, or cultural purposes.
11	Pumping Distance	This is primarily a cost related issue and may not have any impact if reusing pumping infrastructure.

The criteria above are intended to provide an early evaluation of the site technical capability to support a nuclear plant. A site that meets these criteria will still need additional characterization for a final determination of adequacy.

A recent study by the U.S. Department of Energy [14] performed a preliminary evaluation of many U.S. coal sites, both retired and operating, for their potential viability to support a new nuclear plant. The study made use of manual techniques as well as automated Geographic Information System (GIS) software to perform an analysis similar to that noted above. The study estimates that about 300 retired and operating coals sites *have the basic characteristics needed to be considered amenable to host an advanced nuclear reactor*. The report is extensive and contains several different breakdowns of the data, but two key takeaways are noted in the maps below. Figure 2 identifies the number of currently operating coal sites, by state, likely amenable to nuclear repowering<sup>4</sup> while Figure 3 identifies the number of coal sites retired in last six years, by region, likely amenable to siting an advanced reactor.<sup>5</sup>

Two additional important considerations are identified in the report: The first is that population density is a key discriminator in determining viability for repowering with new nuclear (see Table 2, Population), and the second is that a key *factor favoring backfit of near-term nuclear technology at operating coal-fired utility and IPP generators is the existence of a dedicated cooling source*, a property exhibited by 43% of retired coal sites and 68% of operating coal sites.

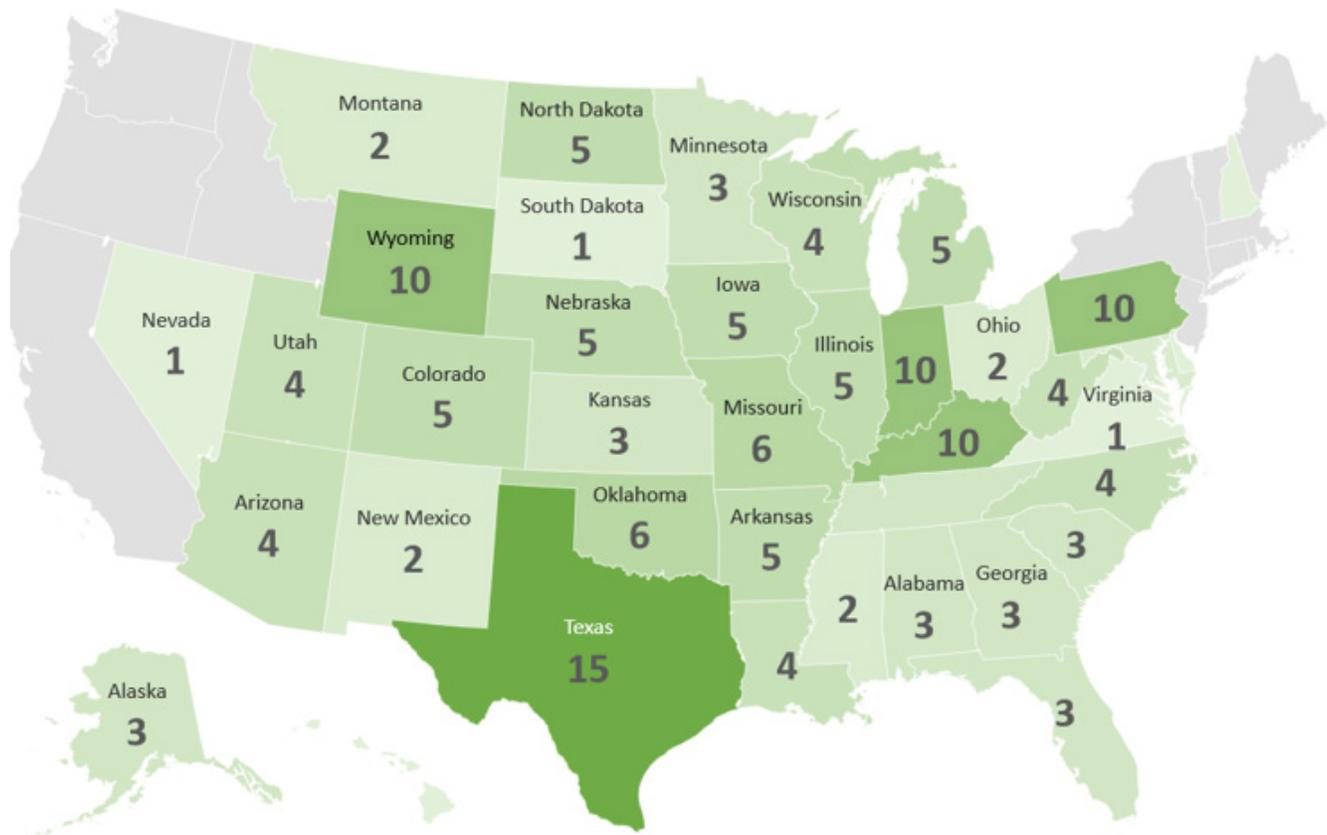


Figure 2: Map of operating U.S. coal sites potentially viable for advanced nuclear

4. The data in Figure 2 is based on operating plant data and analysis found in Tables 3-15 through 3-19 of the DOE report and does not consider retirements dates.  
 5. The data in Figure 3 is based on data and analysis found in Table 3-7 of the DOE report.

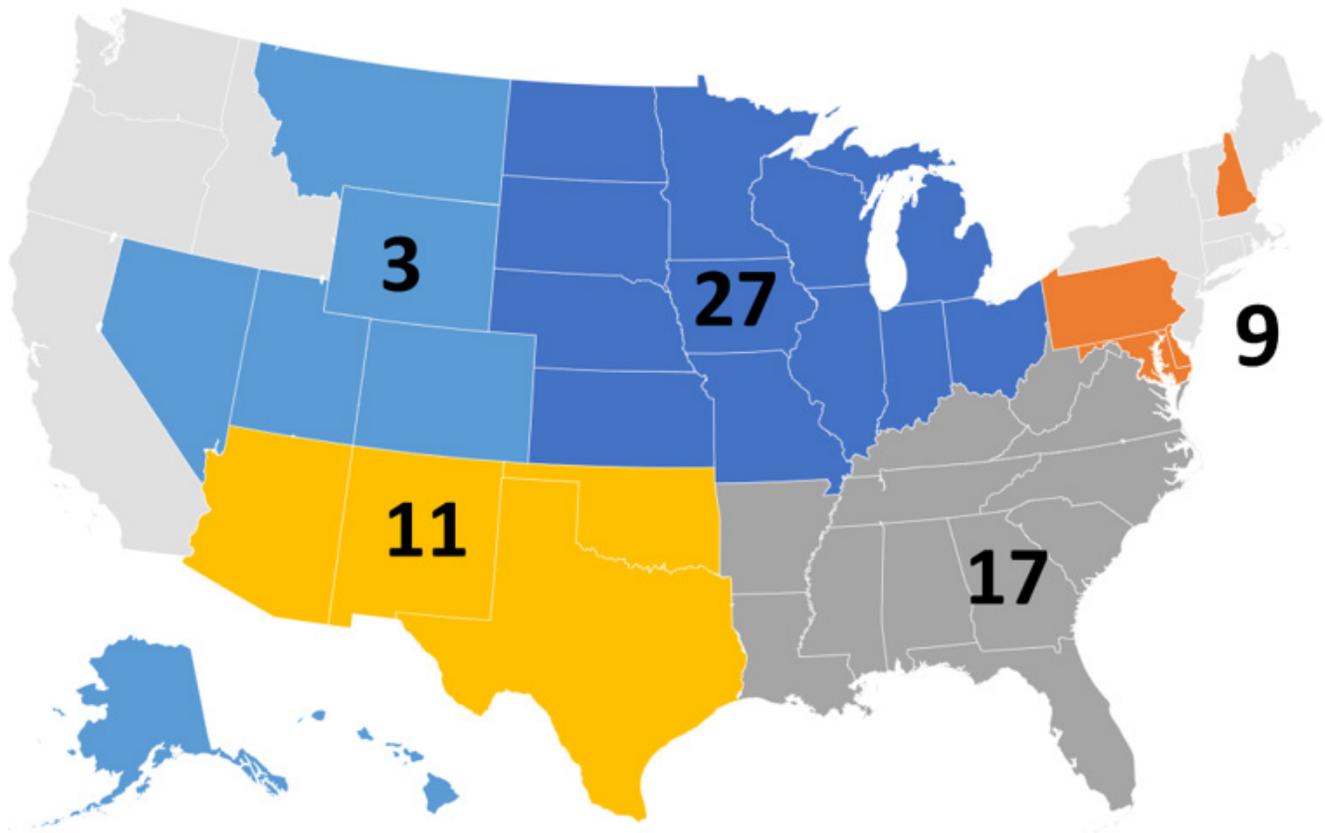


Figure 3: Number of U.S. coal sites retired in last 6 years likely amenable to siting an advanced reactor

## Site Infrastructure

The EPRI *Site Selection and Evaluation Criteria for New Nuclear Energy Generation Facilities (Siting Guide)* contains special guidance on the reuse of existing sites, be they retired coal plants, other generation or industrial facilities, or previous nuclear sites. As noted in the Siting Guide, as well as in [9,15,16] existing facilities can offer several valuable existing infrastructure elements that can make a site more attractive, particularly from economic and timeframe perspectives. The infrastructure elements of most value for repowering with nuclear technology include:

- Grid Interconnection** – Coal plants have existing high-voltage power connection infrastructure, interconnection studies, and a site permitting evaluation, land-use rights, and off-taker agreements in place (especially electrical) to facilitate grid interconnection of future nuclear generation. Utilizing the existing structures and connection avoids the cost of new ones and saves time to secure the necessary authorizations from the authorities having jurisdiction. The available carrying capacity of transmission and distribution (T&D) lines near the site can impact overall costs. For example, if the capacity of the nuclear plant is greater than the coal plant, existing substation equipment or utility lines may need to be upgraded to accommodate the change in generation capacity. Depending on the nuclear plant size, a feasibility study may be required to determine any changes needed to the existing interconnection and the cost and timeline for upgrades.

- **Cooling Water Supply** – While some new nuclear designs are expected to be able to use air cooling, it is likely that designs with output like that of the coal plant it is replacing will make use of cooling water. Coal and nuclear plants require the ability to remove the heat generated and typically use large amounts of water. This can be in the form of once-through cooling or via the use of cooling towers. In the United States, the ability to use once-through cooling, even if it was the method previous used by the coal plant, is unlikely due to environmental protection rules [17]. The ability to use the existing plant’s cooling systems is dependent on many factors, but of key value is the proximity to a significant amount of water, and possibly more important, the availability of water use rights (see below).
- **Transportation Access** – Transportation access is a key need for nuclear, both during construction and over the life of the plant. Access for workers, heavy equipment, and components is needed for construction. Many OEMs are incorporating modular construction in their new designs that is intended to reduce the need for heavy haul and barge access, sizing their modules to be easily delivered via highways and rail. Once construction is complete, there will still be a need for transportation access during operations for workers, nuclear fuel delivery, and equipment for maintenance and potential replacement.
- **Utilities** – Existing utilities and easements, such as water, gas, and sewer, may be useful during plant construction and operation.

Other infrastructure elements that may be of value for nuclear deployment include:

- Light cooling water and fire water systems
- High voltage power, emergency power, and off-site power
- Switchyard
- Meteorological tower data collection
- Site emergency services
- Balance of Plant Systems (see Reuse of Balance of Plant Systems below)
- Existing environmental permits (see Securing Land, Transmission, and Water Rights and Other Permits below)

The ability to make use of any of these elements for a new nuclear plant is dependent on several factors including the selected nuclear technology, specific location and layout of the new plant, the planned output (ex: MWe), and the required amount of cooling water. The age and physical condition of the elements are also an issue that must be addressed. Ultimately, the most valuable aspects of the coal site will be the land availability, an existing transmission corridor, and cooling water supply (including water rights, see below). The reuse of other infrastructure elements would typically be considered almost entirely on a cost basis.

A key concern with reusing a coal site for a nuclear plant involves the level of decommissioning and remediation that will need to be completed prior to the start of nuclear deployment. The EPRI Siting Guide goes into some discussion on the decisions that will need to be made, but it must be understood that:

*[t]he requirements and responsibilities for contamination cleanup at such sites are established as matters of law and regulatory requirements; they may also be affected by legal agreements reached in real estate transactions. The post-remediation cleanup goals depend on the nature and extent of contamination, regulations, and legal documents. Thus, even if legacy contamination exists, use of the site for [a new] industrial purpose may obviate or mitigate the need for some cleanup actions.*

Depending on the overall size of the site, the amount of open space already available, and the extent any existing environmental hazards, it may be possible to decommission and prepare a portion of the site for nuclear without addressing the whole site. However, the nuclear plant's environmental analysis will need to be based not only on its specific site, but also nearby hazards, which could include portions of the coal site, for example, an ash pond.

## Reuse of Balance of Plant Systems

There have been previous cases where the boiler of a coal plant was replaced by a combined cycle gas plant and connected to the existing balance of plant (BOP) systems, including the turbine and generator [18]. A few studies have been completed on the potential reuse of the balance of plant systems for nuclear [9, 15, 19], and there are historical examples of this being done in the early days of nuclear [20]. One study estimated that the potential overnight capital cost (OCC) savings for new construction could be as much as 28–35% versus greenfield construction [9] and the recent DOE report [14] identifies potential savings of 15–35%.

Two key considerations for reuse of the BOP are that the nuclear steam supply system (NSSS) must provide a steam supply that meets the steam temperature, pressure, throughput, and quality, for which the BOP systems were originally designed, and that under typical nuclear designs the BOP can have systems, structures, and components (SSCs) that are considered *safety significant*, meaning that their design, materials, and construction must be considered in the overall safety of the nuclear plant. Due to the regulatory process in most locales, a nuclear plant is typically designed and licensed to very particular specifications, which may or may not be in line with the BOP's current state, potentially requiring significant modification.

A study by TerraPraxis [19] and a design proposed by TerraPower [21] consider the concept of including an intermediate heat storage system which offers the opportunity to decouple the steam supply from the balance of plant, which could alleviate these concerns. While these studies and potential designs indicate that reuse of the BOP is a technical possibility and could provide cost savings, this is currently an untested scenario.

## Securing Land, Transmission, and Water Rights and Other Permits

A key value proposition for repurposing a coal plant with a new nuclear plant is that there are existing and available infrastructure elements already in place. Three of the key elements are:

- The site property, including any additional adjacent land owned by the utility
- Access to a transmission corridor and system
- Access to water

However, each of these infrastructure elements are usually accompanied by the need to have sufficient rights to access them. While these rights are in place for the operating coal plant, it is possible they could be lost and difficult to recover when the coal plant retires. The owner-operator should evaluate each of these rights and understand their ability to maintain them for new nuclear development. The rules, requirements, and regulations vary by locale, often nationally, and by state and county in the United States. Several regulatory and permitting agencies may need to be involved. It is important to keep the land, transmission, and water rights active during the phases of decommissioning, new nuclear construction, and new plant operation. Other permit categories that should be reviewed include, but are not limited to:

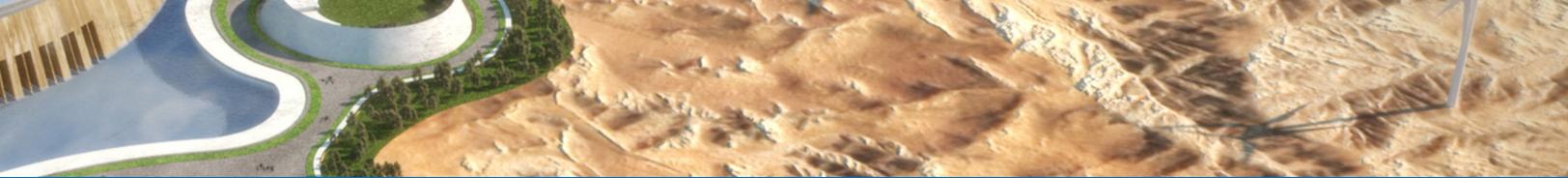
- Air and water discharge
- Building codes and occupancy
- Fire protection systems
- Waste disposal
- Utility right-of-way
- Well water

A determination must be made if these permits can be extended, or if not, their likelihood of being reissued. Care should be taken to investigate issues for which regulatory changes have been made but the coal site was not required to backfit. The new nuclear plant may need to comply with the new requirements, even if on the same site.

## Obtaining an Early Site Permit (Optional)

Completing the actions above will put the owner-operator into a great situation if there is a decision to develop a nuclear plant at the retired coal site. However, in the United States, there is one more item that should be considered by the owner-operator; development of an Early Site Permit (ESP). The process of obtaining an ESP is essentially the same as described in the activities above, where the collected data and information is packaged into an ESP licensing application with the U.S. NRC. The development of an application and resulting review with the NRC can be time and resource intensive, but the resultant ESP from the regulator is a significant asset that lasts for twenty-years. The An ESP can leverage flexibility for the site because it does not require that a specific reactor technology be decided upon, and due to its twenty-year validity, an ESP provides the owner-operator with a valuable asset, one that could even be sold to another organization, perhaps another utility with a greater nuclear operating background that has more interest in developing a nuclear plant.

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## Conclusion

This is the second paper in a planned EPRI white paper series on considerations for repowering a decommissioning coal plant with an alternative type of low- or zero-carbon power generation or energy storage technology. While repowering is complex and requires careful planning, nuclear development supports the transition to clean energy and presents several opportunities to leverage existing coal plant land use, transmission corridor, cooling water availability, various elements of site infrastructure, and key rights and permits. This may translate to reduced nuclear development costs through shorter construction timelines, reduced environmental impacts, and increased community support. Reuse of a coal site for nuclear can be an available option, but the transition can be complex and use of well-developed processes to support the transition is key.

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