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Issue Paper: Electricity System Adequacy - Challenges Facing the Nuclear Power Industry

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Table of Contents

Exhibits

Acronyms and Abbreviations

AEO 2014	Annual Energy Outlook 2014
CC	Combined cycle
CO_2	Carbon dioxide
COL	Combined Operating License
DOE	Department of Energy
EIA	Energy Information Administration
EISPC	Eastern Interconnection States' Planning Council
EPA	Environmental Protection Agency
ESPA	Energy Sector Planning and Analysis
GW	Gigawatt
kW	Kilowatt
LSE	Load Serving Entity
MW	Megawatt
NARUC	National Association of Regulatory Utility Commissioners
NERC	North American Electric Reliability Corporation
NETL	National Energy Technology Laboratory
NRC	Nuclear Regulatory Commission
O&M	Operating and maintenance
TVA	Tennessee Valley Authority
U.S.	United States

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1 Introduction

The nuclear industry is in a state of flux, because the last several years have seen earlier proclamations of a nuclear renaissance give way to predictions of the industry's ultimate decline, and now, in the face of new carbon emissions regulation, renewed optimism for the future. After coasting steadily through the 1990s, with profitable plant operations, few retirements, and rising capacity through uprates, the nuclear industry began to look forward to a possible revival in plant builds. In 2007, the Nuclear Regulatory Commission (NRC) received the first applications for new nuclear reactors that had been submitted since 1978. (1) Five nuclear reactors are currently under construction[i] and more are in advanced stages of development, which is a significant increase in activity since the last nuclear plants went into operation during the late 1980s and early 1990s.

In the midst of this activity, the nuclear power industry has begun to experience new challenges. As natural gas prices have dropped, bringing down the price of electricity as well, the economics of nuclear plants have begun to look less competitive. Operators of existing nuclear power plants are now experiencing lower cost margins due, in part, to the increased competition from gas-fired generation. (2) Further, estimates of the cost of constructing new nuclear plants have increased from earlier predictions, and new regulations, such as those adopted by the NRC after the 2011 Fukushima accident, are driving up costs for existing reactors. Instead of a nuclear renaissance, some analysts are now predicting a decline for the nuclear industry, arguing that nuclear power is too expensive to compete in energy markets. (3) Seemingly bearing out this prediction, operators of six nuclear reactors, representing nearly 5,000 MW of generating capacity, have either shut down or announced retirement plans since 2012 (4), and still others have cancelled planned uprates. (5)

Those predictions have not taken into account considerations of carbon emissions regulation. In April 2014, the Environmental Protection Agency (EPA) announced its proposed "*Clean Power Plan*" [ii]. This plan, which could change significantly before it becomes a final rule, would reduce carbon emissions from the electric power industry, and it includes nuclear power as an option for meeting state emissions goals. (6) This caused analysts to predict that nuclear power may still have a future. (4) However, there is still a great deal of uncertainty surrounding compliance with the *Clean Power Plan*, which allows states flexibility in choosing how they will comply. In addition, as discussed further in this report, the EPA itself does not appear to expect nuclear power to play a major role in compliance with the *Clean Power Plan*. The EPA's model predicts

[i] Four of the units are V.C. Summer Units 1 and 2 in South Carolina, and Vogtle Units 3 and 4 in Georgia. A fifth unit, Watts Bar Unit 2 in Tennessee, is also under construction and expected to go into service as early as 2015. The Watts Bar Unit 2 was originally granted a construction permit in 1973; due to multiple deficiencies and complications, construction was suspended in 1986. In 2007, Tennessee Valley Authority (TVA) informed the NRC of its intention to resume construction.

[ii] Environmental Protection Agency (EPA) Standards of Performance for Greenhouse Gas Emissions from Existing Sources: Electric Utility Generating Units. *Federal Register* June 18, 2014. Also referred to by industry as the proposed "Existing Source Greenhouse Gas" regulations.

that state goals will be met by decreased use of coal-fired generation paired with increased gas-fired generation, renewables, and efficiency. (7)

This report attempts to provide clarity to the potential outlook for the nuclear industry by examining the factors that influence it. It includes an analysis of recent trends affecting nuclear power generation while focusing on the specific potential impact of the EPA's proposed Clean Power Program on nuclear power.

2 Current Trends in Nuclear Generation

There are currently 100 nuclear reactor units operating in the United States (U.S.), totaling over 100,000 MW of operating capacity. Nearly all of these reactors were built prior to 1990. Aside from a few retirements, and even fewer units coming online, the number of operating units remained fairly static throughout the 1990s. During this period, additional operating capacity was mainly achieved through uprates, which increase the power output of an existing unit through an equipment upgrade. (8) Since then, however, there has been increased interest in constructing new nuclear reactors. From 2007 to 2009, the NRC has received applications to construct new nuclear facilities, called Combined Operating Licenses (COL), for 28 new units. (9) Of those applications, the NRC has approved 4 new units, 12 units are still under review, and applications for the remaining 12 units have been either postponed or withdrawn by the applicants. Additionally, the Tennessee Valley Authority (TVA) resumed construction of the Watts Bar Unit 2 reactor in 2007, which had been suspended for two decades and is now expected to go into service in 2015.

Exhibit 2-1 Nuclear power reactors in the U.S. (9) (10)

Status	Number of Units	MW Operating Capacity
Operating	100	100,715
Under Construction	5	5,538
COL Under Review	12	15,587
Postponed/Withdrawn COL Application	12	14,495
Retired/Planned Retirement 2013-2019	6	4,836

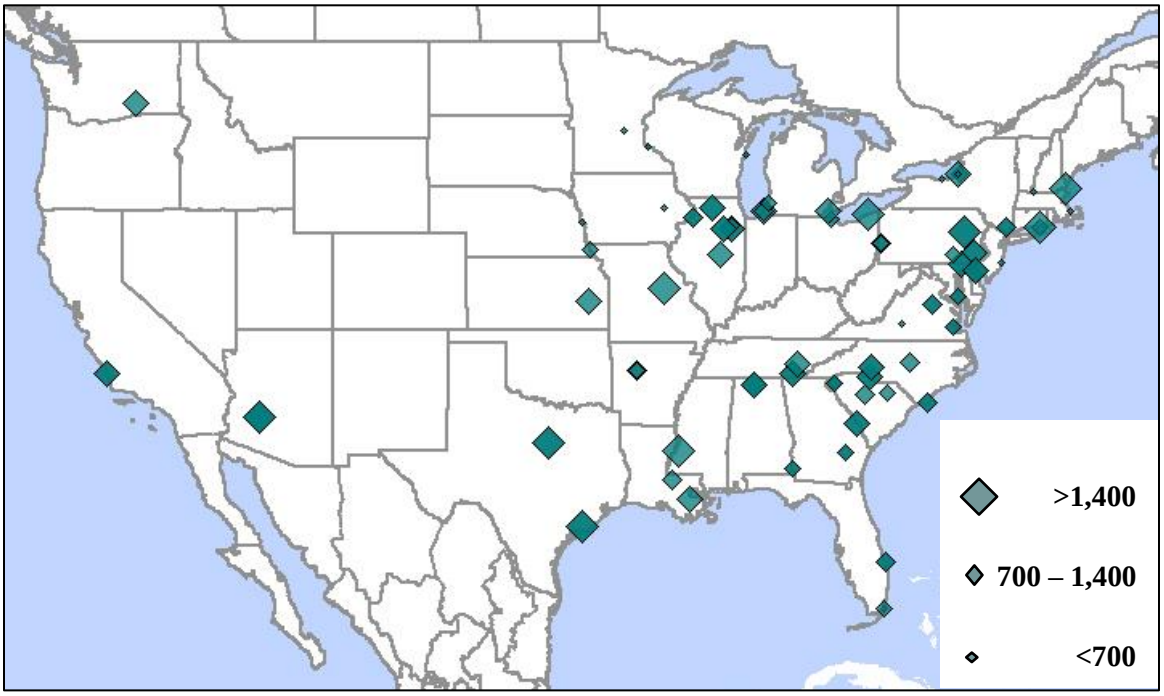
The NRC's process for reviewing units was stalled for two years, following a June 8, 2012 ruling by the U.S. Court of Appeals for the DC Circuit that found that the NRC's Waste Confidence Rule did not satisfy its obligations per the National Environmental Protection Act (NEPA). The court found that in assessing the environmental impacts of a potential nuclear plant, the NRC should consider the impact of failing to secure permanent disposal for spent nuclear fuel, as well as the impact of potential spent fuel pool leaks and fires. In response to the ruling, the NRC chose to suspend licensing decisions that rely on the Waste Confidence Rule until a revised rule could be developed. (11) During this time, the NRC continued to work on licensing activities, but did not issue any licenses for new nuclear facilities or for relicensing of existing plants. On August 26, 2014, the NRC voted to approve a new rule on waste analysis and to resume making decisions on licenses. (12) (13)

In contrast to the spike in COL applications to the NRC, 6 units have either retired or announced their near-term retirement since 2013. Two of the units, San Onofre Units 2 and 3 in San Diego, California, were retired early once it was determined that it was not economic to restart them. (14) The units had been shut down after a leak was discovered in one steam generator, and the cost to repair the leak and ensure the reliability of the plant's other steam generators was too high to justify keeping San Onofre in operation. (15) Similarly, the Crystal River reactor in Citrus County, Florida, was retired in 2013 rather than repaired, after it experienced problems with a steam generator replacement. (16) The Kewaunee plant in Wisconsin also retired in 2013, although it was operating well and had just extended its operating license for another 20 years. Driven by cheap natural gas and an influx of available wind energy, power prices in the Midwest had declined to the point where the Kewaunee plant was operating at a loss and unable to compete in the energy markets. (17)

The Vermont Yankee and Oyster Creek nuclear reactors have announced their retirements, for 2014 and 2019, respectively, both citing high operating costs and low energy prices as driving factors in the decision to retire. In both cases, the economic issues facing the plants were made more difficult because of state level opposition. In the case of Oyster Creek, the New Jersey Department of Environmental Protection would have required the plant to install cooling towers, estimated to cost $700 million, if Oyster Creek had not chosen to retire early. (18) The state legislature in Vermont passed legislation that would have forced Vermont Yankee to shut down in 2012. Although Entergy Corporation, Vermont Yankee's owner, successfully sued to keep the plant open, the legal battles contributed to the difficulties it faced in continuing operations. (19) (20) As discussed further below, more units may be at-risk of retirement if certain economic trends continue.

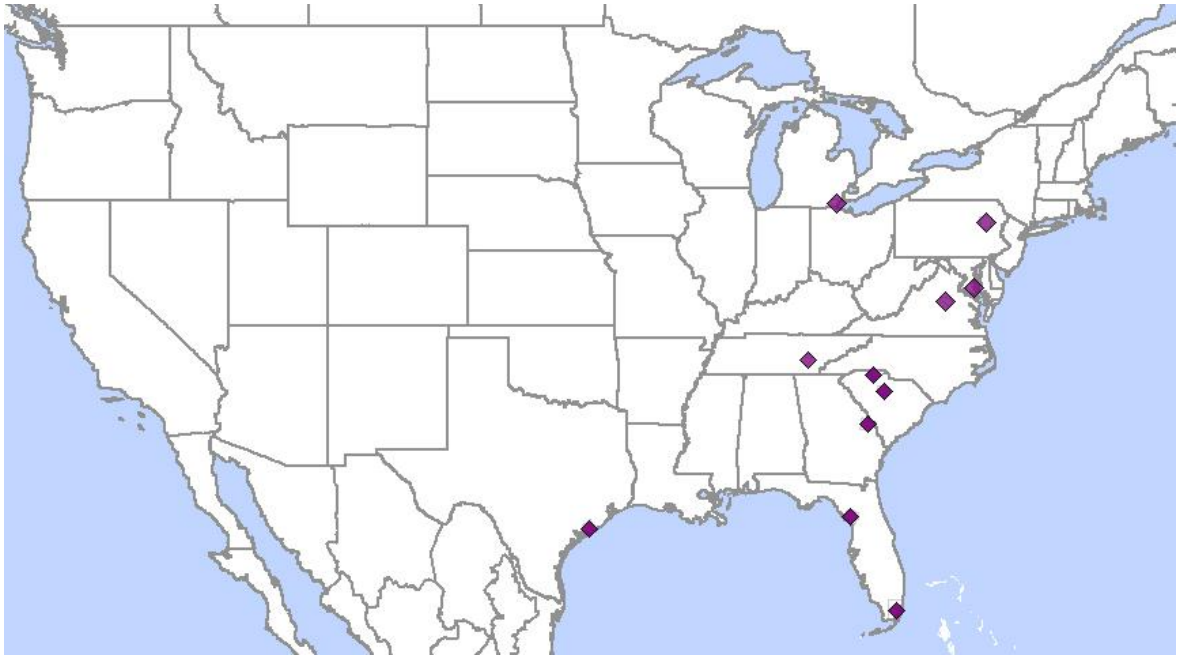
As shown in Exhibit 2-2, existing nuclear plants are scattered across the Eastern Interconnection, with only a few plants located in the West. Much of the recent activity in nuclear development has been concentrated in the southeastern U.S., as seen in Exhibit 2-3. The five nuclear reactor units currently being constructed are located in Georgia (Vogtle Units 3 and 4), South Carolina (V.C. Summer Units 1 and 2), and Tennessee (Watts Bar Unit 2). Among the COL applications under review by the NRC, which have not been suspended, most are located in East Coast states.

Exhibit 2-2 Nuclear power reactors currently operating in the U.S. (sized by MW operating capacity)



Source: NETL

Exhibit 2-3 Planned nuclear units under construction and/or NRC review (9)



Source: NETL

In its Annual Energy Outlook 2014 (AEO 2014), the Energy Information Administration (EIA) models several different possible outlooks for nuclear power. Under the Reference case scenario projected in the AEO 2014, EIA assumes that known economical, technological, and demographical trends will continue. (21) For nuclear power, it assumes that the units currently under construction will come online on schedule, and that the existing units that have announced their retirements will retire as planned. The total overnight costs for constructing a new advanced nuclear reactor are assumed to be $5,501/kW, which is in line with the estimates for the four new units currently under construction. (21) The Vogtle reactors are expected to cost $6,800/kW, and the VC Summer units are expected to cost $4,772/kW. (22) In comparison, EIA estimates that the overnight cost for constructing an advanced gas-fired combined cycle (CC) plant is $1,021/kW, while a scrubbed coal plant is $2,925/kW. (21)

EIA estimates that the fixed operating and maintenance (O&M) costs for an advanced nuclear reactor are $93.28/kW/year. (21) These estimated costs are considerably higher than EIA's estimates for other new generating units. For example, an advanced CC plant's estimated fixed O&M costs are $15.37/kW/year and a scrubbed coal plant's costs are $31.18/kW/year. Even the estimated costs for an integrated coal-gasification CC plant with carbon sequestration are lower than for a nuclear plant, at $72.84/kW/year.[iii] (21) The estimated variable O&M costs for an advanced nuclear reactor, however, are only $2.14/kW/year. This is lower than the cost for fossil fuel generation, which EIA estimates is $4.47/kW for scrubbed coal and $3.26/kW for

[iii] See Table 8.2 of "Assumptions to the Annual Energy Outlook 2014" for a complete listing of estimated costs.

advanced CC. However, it exceeds the $0/kW variable O&M costs for wind, solar, and geothermal renewables.

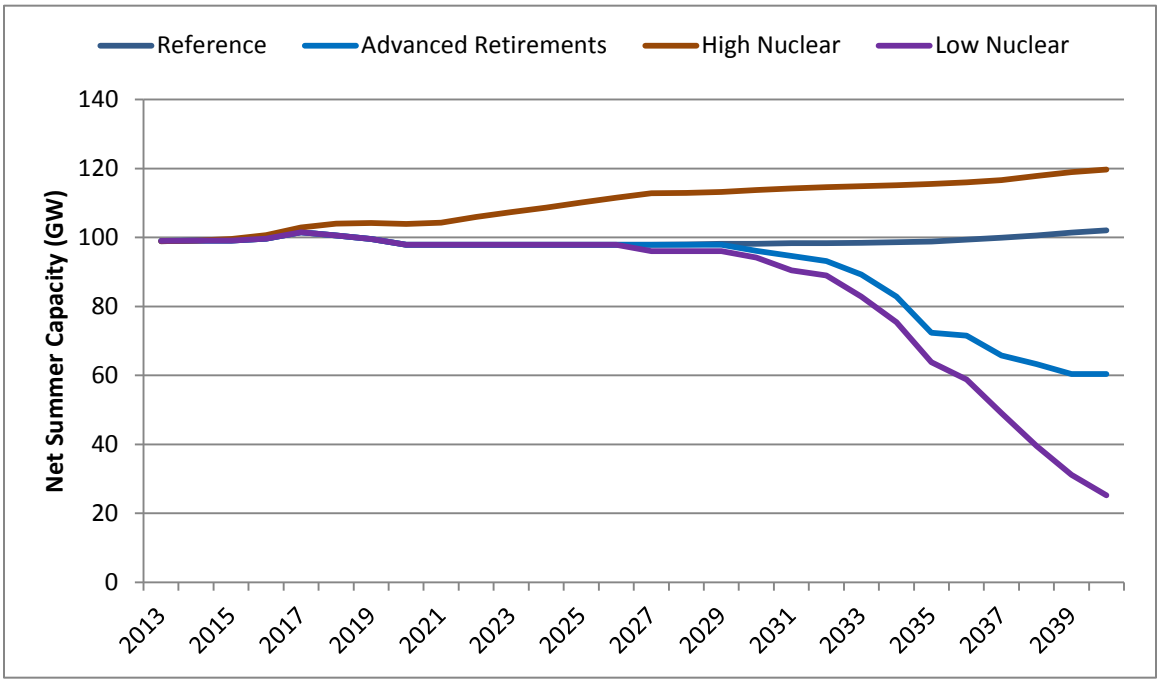
The AEO includes projections for three possible variations for nuclear power, apart from the Reference case – Accelerated Nuclear Retirements, Low Nuclear, and High Nuclear.

- The Accelerated Nuclear Retirements case assumes that all nuclear plants are limited to a 60-year lifespan; uprates have been limited to the 0.7 GW that have been reported to EIA, and there are no new nuclear power units beyond those currently under construction. In addition to the 4.8 GW of announced retirements accounted for in the Reference case, the Accelerated Nuclear Retirements case also includes a decrease of 5.7 GW in capacity to account for plants at risk of early retirement. It assumes that nonfuel operating costs will increase by 3% per year after 2013.
- The Low Nuclear case combines the assumptions of the Accelerated Nuclear Retirements case with those in the High Oil and Gas Resource and the No Sunset cases.[iv] The assumptions from High Oil and Gas Resource case forecast more favorable conditions for natural gas-fired and renewable generation, depressing the economic outlook for nuclear power.
- The High Nuclear case assumes that all nuclear plants, except for the 4.8 GW of announced retirements, are life-extended beyond 60 years. It also assumes a total of 6.0 GW of uprates at existing plants. It includes new plants currently under construction as well as those that have completed COL applications with NRC, for a total of 12.6 GW of planned capacity additions. (21)

In the Reference case, overall energy production from nuclear power remains flat through 2040, as shown in Exhibit 2-4. Under the High Nuclear case, there is a net increase of 20.8 GW of nuclear capacity from 2013 to 2040. The Advanced Nuclear Retirements and Low Nuclear cases see dramatic declines in capacity of 38.5 GW and 73.8 GW, respectively. Under the Low Nuclear case, retirements rapidly accelerate after 2030 so that by 2040, only 25.2 GW of capacity remain. The Low Nuclear Case makes clear the negative impact that abundant natural gas could have on nuclear capacity.

[iv] The High Oil and Gas Resource case assumes that recovery per shale gas, tight gas, and tight oil well is 50 percent higher and well spacing is 50 percent lower than in the Reference case. It also adds new tight oil resources and includes 50 percent higher undiscovered resources than in the Reference case. The No Sunset case assumes the extension of all existing tax credits and policies that contain sunset provisions, except those requiring additional funding or extensive regulatory analysis.

Exhibit 2-4 AEO 2014 projections of nuclear capacity



As the different cases modeled in the AEO 2014 show, the outlook for the nuclear power industry in the U.S. varies dramatically depending on the set of assumptions being used. Although the AEO 2014 offers several different scenarios, it does not provide a full explanation for the drivers behind the different assumptions in each case. To understand which of these outlooks is more accurate, a better context is needed for the economic and regulatory circumstances facing the nuclear industry.

Recent studies on the state of the nuclear power industry in the U.S. have identified several key challenges facing the nuclear industry, naming economic conditions as the biggest of those challenges. In 2013, the Eastern Interconnection States' Planning Council (EISPC) and the National Association of Regulatory Utility Commissioners (NARUC) published the "Assessment of the Nuclear Power Industry" (Nuclear Assessment). (8) In addition to serving as a primer on the history of the nuclear industry and offering an overview of future nuclear technology, the Nuclear Assessment identifies the issues currently faced by the industry. The Vermont Law School has put out two reports on the state of the nuclear industry – one in 2009 and one in 2013. Both Vermont Law reports argue that the nuclear industry is facing an imminent decline. (3) (23)

The Nuclear Assessment finds that the nuclear industry faces a significant timing challenge. Reviewing the outlook for replacing anticipated coal plant retirements, the Nuclear Assessment found that natural gas power compared much more favorably than nuclear power, even when factoring in natural gas infrastructure constraints. According to the Nuclear Assessment, a natural gas plant can be constructed in two-to-three years following the receipt of permits. A new pipeline serving that plant can be sited, approved by regulatory authorities, and constructed within three years. In contrast, the COL application process for a new nuclear reactor takes four to six years, and then subsequent construction is five to six years. (8) Considering that a significant number of coal plant retirements are projected to take place over the next five years,

nuclear plants not already under construction could not be constructed quickly enough to replace a retiring coal plant.

Noting the recent retirements of plants facing economic difficulties, the Nuclear Assessment finds that the significant additions of new nuclear baseload generation envisioned are unlikely to be built. According to the estimates provided in the Nuclear Assessment, the capital costs of building a nuclear reactor would have to be reduced by half in order to be competitive with a CC natural gas plant under the current economic climate. It further claims that the "nuclear renaissance" may be a phenomenon confined to the southeastern U.S. (8) The regulatory environment in the southeastern U.S. is more favorable to nuclear power than many other regions because it does not have deregulated energy markets. Deregulated energy markets place all of the risk for construction delays, project financing, and cost estimates on the plant investor. This is riskier for companies building a nuclear plant than for a regulatory regime, because a regulatory regime allows the investor to place some of the risk on customers. (9) All of the nuclear plants currently under construction are in states with traditional regulatory structures, and most of the plants that have retired or announced retirements were operating in deregulated energy markets.

The 2009 Vermont Law report finds that, compared to preliminary industry estimates of the costs to build a new nuclear plant that were issued in the early 2000s, more recent estimates can be as much as four times higher. (3) The cost overruns that are experienced at the reactors currently under construction confirms that the real cost of new nuclear reactors tends to be higher than early estimates predicted. For example, the costs to complete the Watts Bar Unit 2 reactor were estimated at $2.5 billion; the budget for completion is now $4 billion and has been delayed by three years. (22) The 2009 Vermont Law report concluded that nuclear power is not competitive with other forms of electric generation. According to the report, even under carbon emission reduction policies, there are multiple other generation options, particularly wind and natural gas, which are lower cost than new nuclear reactors. (3)

The 2013 Vermont Law report focuses on the economics of existing nuclear units, identifying nuclear reactors that are at risk of early retirement. Most of the nuclear generation fleet has been operating for decades. As the AEO 2014's Low Nuclear case illustrates, the majority of the nuclear fleet will reach the end of their 60-year lifespans between 2030 and 2040. (21) Aging plants are often more costly to maintain, and thus, they are at greater risk of retiring earlier due to maintenance problems. As discussed above, three of the units that retired in 2013 did so because repairs were too expensive.

According to the 2013 Vermont Law report, 38 nuclear power plants are at risk of early retirement. (3) Two of those plants – Oyster Creek and Vermont Yankee – have already announced that they will retire soon. The 2013 Vermont Law report evaluated the plants based on a number of risk factors, including costs, age, and size of the facility, whether or not it is operating in a deregulated market, its history of reliability and long-term outages, and whether it would require a retrofit to comply with new Fukushima-related regulations. The report finds that risk factors related to costs, reliability, and repairs increase with a plant's age.

Regulation also has a significant effect on nuclear plants, particularly as post-Fukushima regulations go into effect at the same time nuclear plants are experiencing financial difficulties. Since the accident at the Japanese Fukushima Dai-ichi plant in 2011, the NRC has reviewed the circumstances of the event to evaluate the need for additional regulation to prevent or mitigate

such an accident at U.S. nuclear facilities. As a result of this review, the NRC is enacting several new requirements, including the construction of containment venting systems at plants with designs similar to the Fukushima plant, the addition of spent fuel pool instrumentation, and the implementation of other mitigation strategies. A number of other possible regulations are still under consideration. (24)

The industry has recently begun to push back against the regulatory burdens that they feel the NRC has placed on them, and the NRC has implemented a pilot program in six nuclear plants aimed at addressing some of these concerns. Specifically, the pilot program attempts to prioritize the regulations that the nuclear operators must comply with, and allows operators some flexibility in how and when they reach compliance. (25) In another example of industry pushback, the Department of Energy (DOE) has suspended its collection of the nuclear waste disposal fee after the industry successfully challenged it in court. (26) This does not, however, solve the spent fuel storage problem. The Nuclear Assessment points out that long-term storage of spent fuel may be the most complex problem faced by the nuclear industry, which is a problem that cannot be solved under the current regulatory structure. The nuclear industry is dependent on a political solution to the problem of long-term storage, something that has been debated without resolution since the first nuclear power reactors began operation in 1956.

3 Potential Impact of Greenhouse Gas Regulation

The EPA's *Clean Power Plan* could potentially improve the outlook for the nuclear power industry. Nuclear power generation is specifically included in the *Clean Power Plan* as a possible way to reduce carbon emissions. The proposed *Clean Power Plan* designates four building blocks for how states can reduce their electric power sector carbon emissions. They are:

1) Increase efficiency of existing coal-fired plants
2) Increase utilization of natural gas
3) Increase utilization of renewables and nuclear
4) Increase the amount of energy efficiency (6)

States do not need to use all of these building blocks to comply with the *Clean Power Plan*. Instead, these four building blocks can be mixed and matched in different ways – giving states maximum flexibility in deciding how best to comply with the rule. According to the EPA, policies that encourage development of new nuclear capacity and discourage premature retirement of nuclear capacity could be useful elements of a carbon reduction strategy. (6)

3.1 Clean Power Plan

The *Clean Power Plan*, as proposed, requires each state to design a plan to meet state-specific rate-based goals for lowering carbon emissions from the power sector. These state-specific goals must be met by 2030. The state goals established by the *Clean Power Plan* were not developed from a uniform baseline (i.e., requiring states to reduce their carbon emissions by a certain percentage based on emissions from a specific year), but rather from the EPA's assessment of the amount of emissions that can be reduced at existing fossil-fired electric generating units, at a reasonable cost, through application of the four building blocks. (6) The EPA developed a base case that modeled each state's expected emissions for the year 2030 (absent any new

regulations), which it used in developing its assessment of the amount of emissions each state could achieve. Thus, the emissions goals vary by state.

The EPA's methodology for developing the state goals relies on its assessment of emissions from all existing electric generating units within each state. With respect to nuclear power, the EPA considered all currently operating nuclear plants as existing plants, except Vermont Yankee, which has announced plans to retire in 2014. "At-risk" plants (those that might be shut down) were also included in the analysis as were the five units currently under construction as existing units. (27) This means that when the Vogtle, V.C. Summer, and Watts Bar reactors come online, they will be considered part of their respective state's base case generation mix, and will not count toward meeting emissions goals. If they were to fail to come online, or if any "at-risk" plants were to retire, their state's emissions would fall further from the emissions goals set by the EPA. A state that experiences the shutdown of a large nuclear plant would be faced with having to make up the loss of non-carbon emitting generation in addition to the actions it would already need to take in order to meet its emission reduction goals. This will likely place pressure on states to ensure that nuclear plants within their boundaries remain in operation.

In its regulatory impact analysis of the *Clean Power Plan*, the EPA modeled the impact of compliance on the generation mix. Compared to the base case, the EPA predicts that nuclear capacity will remain unchanged under the *Clean Power Plan*. In both the base case and the compliance case, EPA predicted that nuclear power generation will fall from 103 GW in 2020 to 101 GWh in 2030. (7) Notwithstanding the inclusion of nuclear power as one of the building blocks for compliance, the EPA itself does not appear to expect nuclear power to play a major role in compliance with the *Clean Power Plan*. The EPA's model instead predicts that state goals will be met by increased retirements of coal-fired generation paired with increased gas-fired generation, renewables, and efficiency.

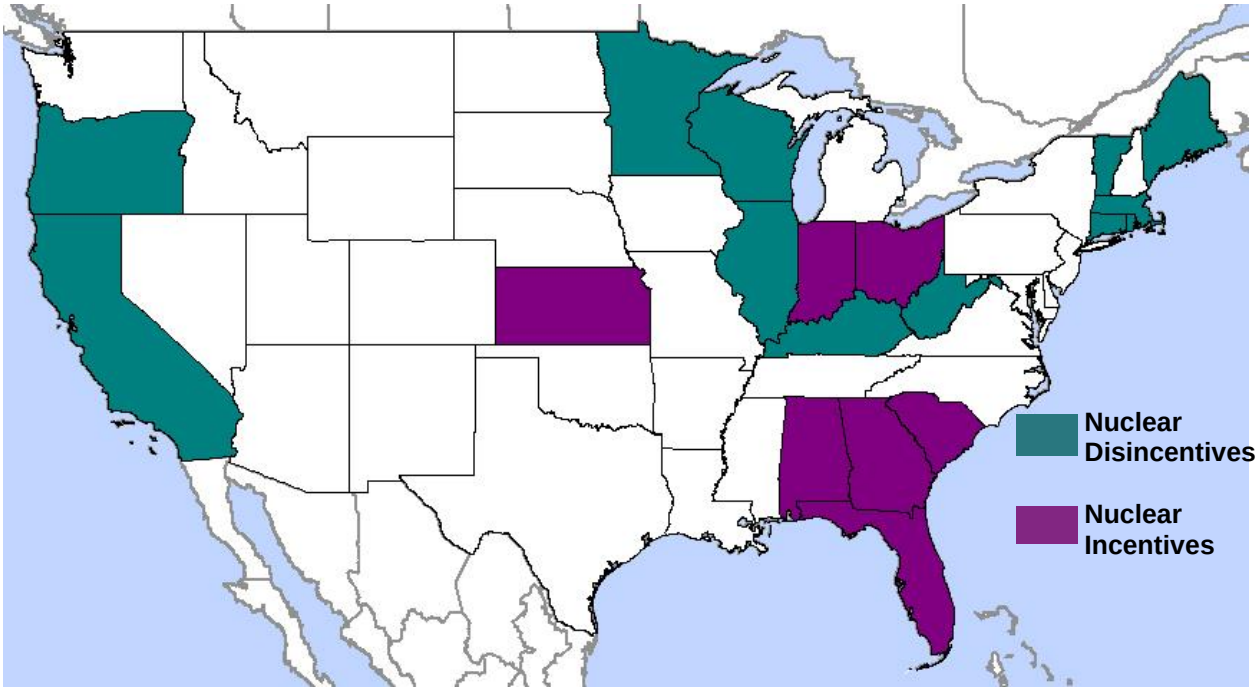
In its discussion of nuclear power's emissions reduction potential in the proposed rule, the EPA stated that it will accept comments on whether it is appropriate to include the five nuclear units under construction in a state's goals. The EPA acknowledged that reflecting completion of these units in developing a state's goals has a significant impact on the calculated goals for the states in which these units are located. It thus appears that this portion of the *Clean Power Plan* is still an open question. The EPA also stated that it is seeking comments on how it should factor at-risk nuclear capacity and planned nuclear construction into the calculation of state goals. (6)

3.2 Implications for Nuclear Power

To date, nuclear power has not been included by most states in their attempts to reduce carbon emissions. Of the 37 states that have adopted some form of renewable portfolio standard or goal, only Indiana and Ohio include nuclear power as part of their clean energy policies. (28) (29) Additionally, several states have policies expressly meant to restrict the development of nuclear reactors. (8) Exhibit 3-1 shows which states have adopted policies to either encourage or discourage the development of nuclear power generation. Policies that are considered a disincentive include, but are not limited to, restrictions on nuclear waste, requiring voter or legislature approval before a nuclear plant can be constructed, and Minnesota's ban on any

development of new nuclear reactors.[v] Policies that are considered incentives include, among others, Kansas and Alabama's tax incentives for nuclear reactors and Indiana and Ohio's categorization of nuclear power as clean energy for the purpose of meeting clean energy policies. As demonstrated by the number of states with disincentives for nuclear development, as well as the lack of consideration of nuclear power as a source of clean energy, using nuclear power as a means to meet the *Clean Power Plan's* goals would constitute a shift in policy for many states.

Exhibit 3-1 State policies on nuclear power generation (8)



Source: NETL

The *Clean Power Plan* requires an average of about 30 percent in carbon emission reductions compared to the EPA's estimated 2030 base case for each state, although some state goals require as little as 10 or 12 percent and some require as much as 62 percent in reductions. For most states, constructing a new nuclear reactor alone would not be sufficient to meet their emissions goals. This does not mean, however, that states will not choose to use nuclear power as one of the building blocks in their state plans. There are several states with pro-nuclear policies that would be more likely to embrace nuclear expansion in their plans for compliance. For those states where plans for new nuclear reactors are already underway, continuing with their development could prove to be a cost-effective option. Those states with limited renewable resources may also need to turn to nuclear power generation in order to meet their goals.

The analysis in this report indicates that the states most likely to include nuclear power are located in the southeastern U.S. As shown in Exhibit 3-2, these states already have policies and

[v] Minnesota does have three existing nuclear reactors still operating within the state – Monticello and Prairie Island Units 1 and 2.

regulatory regimes in place that support nuclear development as well as nuclear projects that are either under construction or being developed.

Exhibit 3-2 Factors encouraging nuclear development in southeast

State	Traditional regulatory structure	Pro-nuclear policies	Nuclear projects under construction or development
Alabama	Yes	Yes	Yes
Florida	Yes	Yes	Yes
Georgia	Yes	Yes	Yes
South Carolina	Yes	Yes	Yes
Tennessee	Yes	No	Yes

4 Conclusions

Despite earlier predictions of a nuclear renaissance, the economics facing both new and existing nuclear power reactors remain challenging. Nuclear reactors in deregulated markets are experiencing declining cost margins as low gas prices and increasing amounts of renewables push energy prices lower. Existing reactors are also experiencing rising costs as maintenance costs at aging plants rise and new regulations impose additional burdens on the nuclear industry. The outlook for nuclear power in states with a traditional regulatory structure remains more positive. Most of the nuclear reactors under construction or development are located in these regulated states.

It appears that even under the proposed *Clean Power Plan*, large amounts of nuclear plants are unlikely to be built. Most states will be able to more cost-effectively reach their emissions goals by relying on other means, such as replacing coal plants with natural gas-fired generation and providing greater incentives for renewable sources of electricity. The most significant impact of the *Clean Power Plan* may be in providing states with the incentive to prevent aging nuclear plants from retiring in order to prevent the loss of a major non-carbon-emitting source of power. Rather than a nuclear renaissance characterized by the construction of new nuclear reactors and the continued relicensing of older ones, the outlook for the nuclear industry is likely to be more modest. The *Clean Power Plan* may slow the number of retirements that would otherwise have occurred, but it does not provide states with significant incentives to add more nuclear capacity.

As the proposed rule is finalized, however, the *Clean Power Plan* could change significantly. As such, continued monitoring of its potential impacts on the nuclear power industry is important. Additionally, the expected shift from baseload coal and nuclear sources of electricity to increasing amounts of gas-fired and renewable generation could have significant impacts on the reliability of the bulk power system. The *Clean Power Plan's* potential impact on grid reliability could cause cost increases that have not been accounted for in this report and which could change the economic calculus for some nuclear reactors on the margin.

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