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EPA's Proposed Greenhouse Gas Regulations: Implications for the Electric Power Sector

Richard J. Campbell
Specialist in Energy Policy

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Summary

The Environmental Protection Agency (EPA) has proposed regulations to reduce greenhouse gas (GHG) emissions from existing power plants. EPA believes that its proposed Clean Power Plan (CPP) will "protect public health, move the United States towards a cleaner environment, and fight climate change while supplying Americans with reliable and affordable power." Burning fossil fuels to produce electricity results in the release of carbon dioxide, and represents the largest source of GHG emissions in the United States. Under its proposed plan, EPA believes it will be possible to lower the carbon intensity of power generation in the United States by approximately 30% in 2030 from carbon dioxide emissions levels in 2005. To achieve this goal, EPA is giving each state a numerical carbon reduction target, based on the state's existing power generation portfolio.

Under the Clean Air Act (CAA) section 111(d), the EPA must identify the best system of emission reductions (BSER) that is adequately demonstrated and available to reduce pollution. The regulations allow EPA to set goals, and give states the responsibility for creating compliance plans which meet those goals. EPA set the state-specific goals based on (1) measures which improve the efficiency of fossil-fueled power plants, (2) use of lower-emitting generation sources such as natural gas or fuel-switching to natural gas, and use of nuclear power, (3) demand-side efficiency, and (4) renewable electric generation. EPA has suggested these measures as four BSER "building blocks" or options for states to consider when choosing how to meet their specific GHG reduction goals. Under the proposed plan, however, states would have the flexibility to choose the most cost-effective strategies to meet the targets.

EPA's proposal for GHG reduction answers some questions from the electric power sector with regard to the timeframe, timeline, and choices that would be made available for compliance. The CPP proposal sets out a vision for a greater proportion of electricity coming from natural gas and renewable electric generation, and less from coal-fired power plants. However, some issues still remain unresolved with the potential implementation of the CPP.

Some observers say that EPA's CPP essentially proposes an environmental dispatch regime for power plant operation which could potentially result in increased electricity prices to consumers, depending on the generation resource mix employed. But EPA believes adoption of greater energy efficiency measures will actually reduce average retail electricity bills. Compliance may require more natural gas consumption to firm up variable renewable electric generation. Increasing the use of natural gas for power generation has resulted in some concerns, as deliverability and price volatility issues have emerged as recently as this past winter. Power companies, gas suppliers, and regulatory regimes are working on resolving these issues.

The electric utility industry values diversity in fuel choice options since reliance on one fuel or technology can leave electricity producers vulnerable to price and supply volatility. Also, state-specific compliance plans geared to individual state needs may complicate the coordination necessary for reliability purposes. But EPA expects coal to remain a substantial part of the U.S. energy mix through 2030, allowing goals of fuel diversity and generating resource mix to be maintained.

Many fossil-fueled power plants do more than just generate electricity. Some of the power plants scheduled for retirement provide ancillary services to the grid such as voltage support and frequency regulation. Additional retirements of coal-fired capacity resulting from implementing

the proposal could impact reserve margins and even grid reliability during weather-related outages or periods of temperature extremes. Incidents of more extreme weather appear to be occurring, and will need to be planned for when considering the types of future generation which may be needed to assure electric system reliability.

Implementing compliance plans will not come without real costs or hard choices for the states and electric utilities that will have to work together. Potential implications for reliability and the ultimate financial costs of the CPP are not known but will become clearer as state compliance plans are filed, and implementation plans become known.

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Introduction

The Environmental Protection Agency (EPA) has proposed regulations to reduce greenhouse gas[1] (GHG) emissions from existing power plants (also referred to as electric generating units or EGUs by EPA). EPA believes that its proposed Clean Power Plan (CPP)[2] will "protect public health, move the United States towards a cleaner environment, and fight climate change while supplying Americans with reliable and affordable power."[3] Carbon emissions are linked by many to anthropogenic climate change,[4] and the EPA cites the Obama Administration's intent to address climate change[5] concerns in its proposed Clean Power Plan to reduce carbon emissions.

Since carbon dioxide (CO_2) from fossil fuel combustion is the primary GHG, and fossil fuels are used for the majority of electric power generation, the focus of the proposed policies is on reducing carbon emissions from power plants. Under its proposed plan, EPA believes it will be possible to lower the CO_2 emissions from power generation in the United States by approximately 30% by 2030 compared to levels in 2005. To achieve this goal, EPA is giving each state a numerical carbon reduction target, based on the state's existing power generation portfolio, and EPA's estimate of the state's potential to reduce power demand.

EPA's guidelines allow a 120-day comment period on the proposal, and require states to file a compliance plan by June 2016. States that choose to join a regional carbon reduction plan would have until June 2018 to submit the plan. The compliance mechanism would require states to reduce the carbon emissions rate of power plants (i.e., overall tons of carbon dioxide emitted per each MegaWatt-hour (MWh) of electricity produced). Whether working individually or regionally, states would be allowed to choose an appropriate mix of generation using diverse fuels (including renewable electricity[6] and nuclear power), energy efficiency, and demand-side management to meet the goals and their own needs.[7]

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[1] Greenhouse gases, according to EPA, are any gases that absorb infrared radiation in the atmosphere. There are six greenhouse gases addressed by EPA regulatory actions: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases—sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). Carbon dioxide is the most prevalent GHG produced by combustion of fossil fuels. See http://www.epa.gov/climatechange/ghgemissions/gases.html.

[2] See EPA's proposed Clean Power Plan at http://www2.epa.gov/sites/production/files/2014-05/documents/20140602proposal-cleanpowerplan.pdf. (CPP)

[3] Environmental Protection Agency, "EPA Proposes First Guidelines to Cut Carbon Pollution from Existing Power Plants/Clean Power Plan is flexible proposal to ensure a healthier environment, spur innovation and strengthen the economy," press release, June 2, 2014, http://www2.epa.gov/carbon-pollution-standards/clean-power-plan-proposed-rule.

[4] "Humans tap the huge pool of fossil carbon for energy, and affect the global carbon cycle by transferring fossil carbon—which took millions of years to accumulate underground—into the atmosphere over a relatively short time span. As a result, the atmosphere contains approximately 35% more CO_2 today than prior to the beginning of the industrial revolution. As the CO_2 concentration grows it increases the degree to which the atmosphere traps incoming radiation from the sun, which further warms the planet." CRS Report RL34059, *The Carbon Cycle: Implications for Climate Change and Congress*, by Peter Folger.

[5] Executive Office of the President, *The President's Climate Action Plan*, June 2013, http://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf.

[6] Renewable electricity includes power generation from wind, solar, geothermal, and biomass sources. However, while hydropower is generally considered as renewable, some would argue that hydropower from large dams with impoundments have potentially harmful environmental impacts both upstream and downstream from the dam.

[7] EPA says that to date, 47 states have demand-side efficiency programs, 38 have renewable portfolio standards or goals, and 10 states have market-based greenhouse gas emissions programs.

This report presents an analysis of EPA's proposed plan. Electric utilities and other stakeholders will be analyzing the CPP to understand its provisions, and have until the close of the comment period[8] to provide input. It is possible that the CPP will be modified in response to relevant comments received. The implications of implementing a final CPP are thus unlikely to be known until after the states file their compliance plans which are due by June 2016.

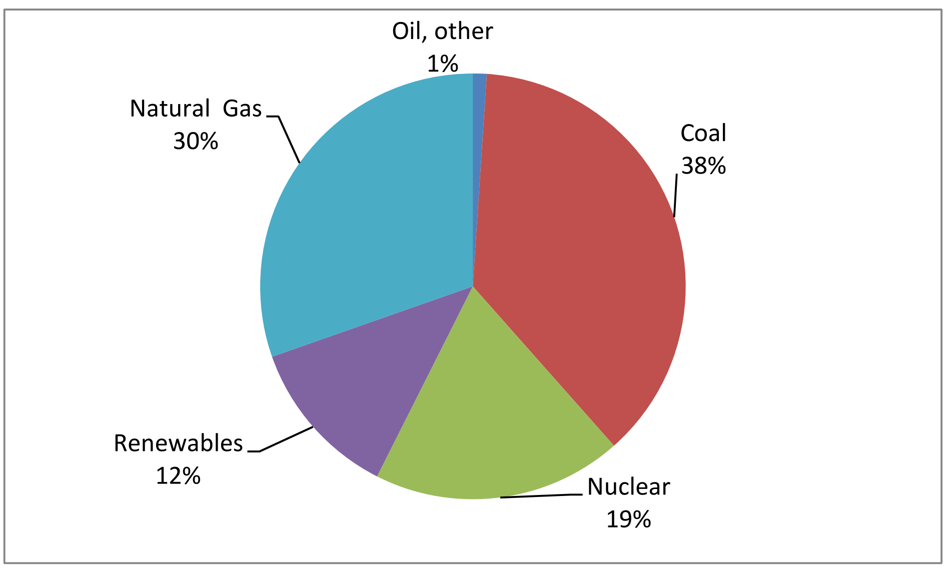
The issues for Congress will be focused on the implications of the CPP on electric power system reliability, the costs of electric power to customers, and the future structure of the electric utility industry which could result from implementation of compliance plans.

Background

Burning fossil fuels to produce electricity results in the release of carbon dioxide, and represents the largest source of GHG emissions in the United States. As shown in **Figure 1**, fossil fuel combustion was responsible for approximately 68% of electric power generation as of 2012.Coal was the fuel most used. Coal is also the fossil fuel which emits the most carbon dioxide per unit of electric power produced, averaging 216 pounds of carbon dioxide per million British thermal units (mmBTUs) of energy produced. By comparison, natural gas combustion releases about half the carbon emissions at 117 pounds of carbon dioxide per mmBTU of energy produced.[9]

Figure 1. U.S. Electricity Generation by Fuel, 2012

Trillion kiloWatt-hours per Year



Source: DOE, Annual Energy Outlook, 2014 Early Release, December 16, 2013, http://www.eia.gov/forecasts/aeo/er/early_elecgen.cfm.

Notes: Renewable electricity includes hydropower, wind, solar, and biomass power generation. "Other" includes other liquid fuels.

[8] Comments on the proposed rule must be received on or before October 16, 2014.

[9] Energy Information Administration, "How Much Carbon Dioxide Is Produced When Different Fuels Are Burned?," June 4, 2014, http://www.eia.gov/tools/faqs/faq.cfm?id=73&t=11.

In a 2007 decision, the Supreme Court found in *Massachusetts vs. EPA*[10] that GHG emissions were air pollutants which could be regulated under the Clean Air Act (CAA).[11] EPA then moved in 2009 to declare that GHGs were a threat to public health in its "endangerment" finding, which served as a basis for its subsequent actions.[12] With regard to stationary sources of GHGs, EPA proposed standards in September 2013 for the control of carbon dioxide emissions from new electric power plants burning fossil fuels, under CAA section 111(b) regulations.

EPA has now released a proposal for reducing carbon dioxide emissions from existing power plants which burn fossil fuels. Under CAA 111(d), the EPA must establish a procedure under which states will submit plans establishing standards of performance for existing fossil fuel-fired power plants. The standards of performance are to reflect the degree of emissions limitation achievable through the application of the best system of emission reductions (BSER) that is adequately demonstrated and available to reduce pollution. The regulation under CAA 111(d) allows EPA to set goals, and gives states the responsibility for creating compliance plans which meet EPA's guidelines.

EPA's Proposed Plan for Existing Coal Plants[13]

Under the provisions of EPA's proposed Clean Power Plan, all existing fossil fuel-fired electric power generation plants must comply with new state-specific targets to reduce carbon emissions.[14] The combined state targets are expected to result in reducing carbon emissions from U.S. power generation approximately 30% by 2030 compared to carbon emissions levels in 2005.

EPA has designated four "building blocks" that it used to develop the state-specific GHG reduction goals:

1. **Improve the heat rate[15] of fossil-fueled power plants.** EPA suggests increasing power plant efficiency by equipment upgrades and improvements. Using less fossil fuel to create the same amount of electricity reduces carbon emissions. An average heat rate improvement of 6% is targeted for coal-fired power plants.[16]
2. **Increase use of low-emitting power sources.** EPA suggests more frequent use of power plants with lower carbon emissions resulting in less carbon pollution. Dispatching (i.e., scheduling the operation) of higher efficiency natural gas combined cycle units more often is suggested.

[10] 549 U.S. 497, 529 (2007).

[11] 42 U.S.C. 7401 et seq. (as amended).

[12] U.S. Environmental Protection Agency, *Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act,* November 22, 2013, http://www.epa.gov/climatechange/endangerment/.

[13] EPA, *Clean Power Plan Proposed Rule*, June 2, 2014, http://www2.epa.gov/carbon-pollution-standards/clean-power-plan-proposed-rule.

[14] U.S. Environmental Protection Agency, "Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units," 79 Federal Register 34829, June 18, 2014. (EMEGU)

[15] Heat rate is the efficiency of conversion from fuel energy input to electrical energy output often expressed in terms of BTU per kiloWatt-hour.

[16] A discussion of potential improvements at coal-fired power plants is presented in CRS Report R43343, *Increasing the Efficiency of Existing Coal-Fired Power Plants*, by Richard J. Campbell.

3. **Use of more zero -emitting power sources.** EPA suggests expanding renewable electricity generation (such as zero-carbon emission wind and solar facilities), and nuclear power plants as a way to lower carbon emissions.
4. **Using electricity more efficiently.** EPA suggests energy efficiency as a way to reduce power demand, with a targeted increase in demand-side energy efficiency of 1.5% annually.

EPA recognizes that such options are already being used by some states to promote clean energy and efficiency goals. EPA considers a BSER to include measures which improve the efficiency of fossil-fueled power plants, use lower emitting generation sources such as natural gas or fuel-switching to natural gas, and use nuclear power and renewable electric generation. Under the proposed plan, EPA believes the states have the flexibility to choose the most cost-effective strategies to meet the targets.

States must file a plan by 2016 to comply with EPA's state-specific goals, unless they choose to join a multi-state regional plan. Each state has been given a unique carbon emissions reduction goal,[17] which EPA maintains offers broad flexibility in which to plan and achieve reductions in carbon emissions. **Option 1** would involve a higher level of deployment of the four building blocks over a longer timeframe (i.e., over 15 years to 2030). EPA also suggested an alternative path on which it is asking for comment in **Option 2**, which would allow a lower level of deployment of the four building blocks but over a shorter timeframe (i.e., over ten years to 2025). EPA has set interim and final goals for the state-specific goals under both compliance scenarios. They can meet the goals as individual states, or join together for regional solutions.

The state goals are given as an overall rate of carbon dioxide emissions intensity, that is, the amount of carbon dioxide emissions in pounds (lbs.) from fossil-fueled power plants *divided* by the amount of electricity generated in the state (from fossil-fired generation and low- or zero-carbon emitting power sources) in MWh. EPA estimates that the state-specific carbon reduction goals will result in the elimination of approximately 730 million metric tonnes[18] of carbon by 2030, resulting in a reduction of approximately 30% of carbon levels compared to 2005.[19]

Discussion of EPA's Proposal

Electric power generation in the United States differs regionally, and largely reflects local resources, fuel costs, and availability of fuel supplies.[20] EPA recognizes that it will take time to implement compliance solutions to meet its proposed carbon pollution reduction plan. EPA has attempted to provide flexibility for state compliance with its plan for reducing carbon emissions from existing fossil-fueled power plants.

> The EPA is also proposing to give states considerable flexibility with respect to the timeframes for plan development and implementation, with up to two or three years

[17] EMEGU, Table 8, Proposed State Goals.

[18] One tonne (also known as a metric ton) is a unit of mass equaling 1,000 kilograms.

[19] EPA, *EPA Fact Sheet—Cutting Carbon Pollution from Power Plants*, June 2, 2014, http://www2.epa.gov/sites/production/files/2014-06/documents/20140602fs-important-numbers-clean-power-plan.pdf.

[20] Edison Electric Institute, *Different Regions of the Country Use Different Fuel Mixes to Generate Electricity*, 2014, http://www.eei.org/issuesandpolicy/generation/fueldiversity/Documents/map_fuel_diversity.pdf.

> permitted for final plans to be submitted after the proposed GHG emission guidelines are finalized, and up to fifteen years for all emission reduction measures to be fully implemented.[21]

While 2005 has been mentioned in broader U.S. policy terms for reductions in GHG emissions to 2030, it is not the year that EPA has used in its emissions reduction calculation. EPA chose 2012 as the year from which to establish a baseline for emissions reduction since that was the year for which it has the most complete state emissions, net generation, and capacity data for all affected EGUs.

> For purposes of establishing state goals, historical (2012) electric generation data are used to apply each building block and develop each state's goal (expressed as an adjusted CO_2 emission rate in lbs per MWh).[22]

Many regard this as beneficial for many states since U.S. GHG emissions overall have dropped 15% between 2005 and 2012.[23]

Existing State Clean Energy Programs

EPA also considers expanding state renewable electric programs and portfolio standards as tools to reduce GHG emissions. However, for purposes of establishing a baseline, existing hydropower is not included.

> Hydropower generation is excluded from this existing 2012 generation for purposes of quantifying BSER-related [renewable electricity] generation potential because building the methodology from a baseline that includes large amounts of existing hydropower generation could distort regional targets that are later applied to states lacking that existing hydropower capacity. The exclusion of pre-existing hydropower generation from the baseline of this target-setting framework does not prevent states from considering incremental hydropower generation from existing facilities (or later-built facilities) as an option for compliance with state goals.[24]

However, states will not receive credit for "early action" taken to reduce GHGs in the period prior to the timeframe of the proposal. Therefore, GHG reductions resulting from state renewable portfolio standards (and other similar measures) in the period from 2005 to 2012 will not count towards GHG reductions in the 2020 to 2030 timeframe. But since they are programs already in place, EPA considers these programs as helpful to meeting state-specific goals in the compliance timeframe.

> The EPA is also proposing that measures a state takes after the date of this proposal, or programs already in place, which result in CO_2 emissions reduction during the 2020-2030 period, would apply toward achievement of the state's 2030 CO_2 emissions goal. Thus, states

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[21] EMEGU, p. 34940.

[22] EMEGU, p. 34863.

[23] Matthew Philips, "EPA Did the Power Industry a Big Favor by Using 2005 Levels," *Bloomberg BusinessWeek*, June 2, 2014, http://www.businessweek.com/articles/2014-06-02/epa-did-the-power-industry-a-big-favor-by-using-2005-levels.

[24] EMEGU, p. 34867.

> with currently existing programs and policies, and states that put in new programs and policies early, will be better positioned to achieve the goals.[25]

While states must begin compliance with the proposed plan by 2020, full compliance is not required until 2030. EPA points out that its four building blocks are suggested as a framework for implementation; the states themselves will decide how to meet their goals. EPA also suggests that regional compliance strategies would be acceptable under its proposal.

> Each state will have the flexibility to design a program to meet its goal in a manner that reflects its particular circumstances and energy and environmental policy objectives. Each state can do so alone or can collaborate with other states on multi-state plans that may provide additional opportunities for cost savings and flexibility.[26]

In establishing the state-specific goals for GHG reduction, EPA believes it has taken into consideration the regional differences that exist in power generation types and resources. Each state's goal reflects the fact that a state's CO_2 emissions are a result of how efficiently its fossil-fueled power plants operate, and how much they operate. Under the state-specific goals, the highest allowed rate of GHG emissions is 1,783 lbs. of CO_2 per MWh of electricity produced for North Dakota, while the lowest emissions rate is 215 lbs. of CO_2 per MWh in Washington state,[27] with the apparent disparity in state goals reflecting the existing underlying generation mix in the states.

Best System of Emissions Reduction

EPA has modeled the opportunities for heat rate improvement, dispatch of more gas and less coal, increased renewable and nuclear generation, and end-use energy efficiency. The agency considers these actions representing the "Best System of Emissions Reductions" which is adequately demonstrated.[28]

> Overall, the BSER proposed here is based on a range of measures that fall into four main categories, or "building blocks," which comprise improved operations at EGUs, dispatching lower-emitting EGUs, and zero-emitting energy sources, and end-use energy efficiency. All of these measures have been amply demonstrated via their current widespread use by utilities and states.
>
> The proposed guidelines are structured so that states would not be required to use each and every one of the measures that the EPA determines constitute the BSER or to apply any one of those measures to the same extent that the EPA determines is achievable at reasonable cost. Instead, in developing its plan, each state will have the flexibility to select the measure or combination of measures it prefers in order to achieve its CO_2 emission reduction goal.[29]

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[25] EMEGU, p. 34839.

[26] EMEGU, p. 34833.

[27] EMEGU, Table 8.

[28] EPA, Office of Air and Radiation, *Goal Computation Technical Support Document*, Technical Support Document for the CAA Section 111(d) Emission Guidelines for Existing Power Plants, June 2014, http://www2.epa.gov/sites/production/files/2014-05/documents/20140602tsd-goal-computation.pdf.

[29] EMEGU, p. 34835.

> As part of the BSER determination, the EPA considered the impacts that implementation of the emission reductions [based on the combination of the blocks] would have on the cost of electricity and electricity system reliability.... Importantly, the proposed BSER, expressed as a numeric goal for each state, provides states with the flexibility to determine how to achieve the reductions (i.e., greater reductions from one building block and less from another) and to adjust the timing in which reductions are achieved, in order to address key issues such as cost to consumers, electricity system reliability and the remaining useful life of existing generation assets.[30]
>
> The EPA is proposing to evaluate and approve state plans based on four general criteria: 1) enforceable measures that reduce EGU CO_2 emissions; 2) projected achievement of emission performance equivalent to the goals established by the EPA, on a timeline equivalent to that in the emission guidelines; 3) quantifiable and verifiable emission reductions; and 4) a process for biennial reporting on plan implementation, progress toward achieving CO_2 goals, and implementation of corrective actions, if necessary.[31]

In devising a compliance strategy, EPA proposes to allow each state to design a GHG reduction program using strategies or technologies the state selects.

> To meet its goal, each state will be able to design programs that use the measures it selects, and these may include the combination of building blocks most relevant to its specific circumstances and policy preferences. States may also identify technologies or strategies that are not explicitly mentioned in any of the four building blocks and may use those technologies or strategies as part of their overall plans (e.g., market-based trading programs or construction of new natural combined cycle units or nuclear plants).[32]

EPA believes that shifting electric power production from coal-fired power plants to natural gas combined-cycle generation (NGCC) represents a major opportunity to reduce GHG emissions due to the greater overall efficiency of the newer NGCC generation fleet especially as compared to older coal-fired power plants, and the current underutilization of NGCC generation capacity.

> Our analysis indicated that the potential CO_2 reductions available through re-dispatch from steam EGUs to NGCC units are substantial. As of 2012, there was approximately 245 GW of NGCC capacity in the United States, 196 GW of which was placed in service between 2000 and 2012. In 2012, the average utilization rate of U.S. NGCC capacity was 46 percent, well below the utilization rates the units are capable of achieving. In 2012, approximately 10 percent of NGCC plants operated at annual utilization rates of 70 percent or higher, and 19 percent of NGCC units operated at utilization rates of at least 70 percent over the summer season. Average reported availability generally exceeds 85 percent. We recognize that the ability to increase NGCC utilization rates may also be affected by infrastructure and system considerations, such as limits on the ability of the natural gas industry to produce and deliver the increased quantities of natural gas, the ability of steam EGUs to reduce generation while remaining ready to supply electricity when needed in peak demand hours, and the ability of the electric transmission system to accommodate the changed geographic pattern of generation.[33]

[30] EMEGU, p. 34836.

[31] EMEGU, p. 34838.

[32] EMEGU, p. 34837.

[33] EMEGU, p. 34857.

> The amount of re-dispatch from coal-fired EGUs to NGCC units that takes place as a result of this competition is highly relevant to overall power sector GHG emissions, because a typical NGCC unit produces less than half as much CO_2 per MWh of electricity generated as a typical coal-fired EGU.[34]

Under its proposal, EPA has suggested a range of equipment upgrades and improvement options to increase heat rates (specifically at existing coal-fired power plants), which it believes represents cost-effective opportunities to reduce GHG emissions.

> Our assessment of heat rate improvements showed that these measures would achieve CO_2 emission reductions at low costs, although compared to other measures, the available reductions were relatively limited in quantity. Specifically, our analysis indicated that average CO_2 emission reductions of 1.3 to 6.7 percent could be achieved by coal-fired steam EGUs through adoption of best practices, and that additional average reductions of up to four percent could be achieved through equipment upgrades. Heat rate improvements pay for themselves at least in part through reductions in fuel costs, generally making this a relatively inexpensive approach for reducing CO_2 emissions. We estimated that CO_2 reductions of between four and six percent from overall heat rate improvements could be achieved on average across the nation's fleet of coal-fired steam EGUs for net costs in a range of $6 to $12 per metric ton.[35]
>
> Although heat rate improvements have the potential to reduce CO_2 emissions from all types of affected EGUs, the EPA's analysis indicates the potential is significantly greater for coal-fired steam EGUs than for other EGUs, and for purposes of determining the best system of emission reduction at this time EPA is conservatively proposing to base its estimate of CO_2 emission reductions from heat rate improvements on coal-fired steam EGUs only.[36]

Fuel Switching

EPA sees the opportunity for coal to natural gas conversions at existing power plants (rather than co-firing coal and natural gas together) as having a great potential to reduce GHGs. While converting a coal-fired power plant to natural gas would be considered a higher cost option compared to other heat rate improvements, EPA believes the incremental difference in the cost of fuel would be the most significant cost component.

> Natural gas co-firing or conversion at coal-fired steam EGUs offers greater potential CO_2 emission reductions than heat rate improvements, but at a higher cost (although less than the cost of applying CCS [Carbon Capture and Storage] technology). Because natural gas contains less carbon than an energy-equivalent quantity of coal, converting a coal-fired steam EGU to burn only natural gas would reduce the unit's CO_2 emissions by approximately 40 percent. The CO_2 reductions are generally proportional to the amount of gas substituted for coal, so if an EGU continued to burn mostly coal while co-firing natural gas as, for example, 10 percent of the EGU's total heat input, the CO_2 emission reductions would be approximately four percent. The EPA determined that the most significant cost associated with natural gas conversion or co-firing is likely to be the incremental cost of natural gas relative to the cost of coal. [37]

[34] EMEGU, p. 34862.

[35] EMEGU, p. 34856.

[36] EMEGU, p. 34859.

[37] EMEGU, p. 34857.

Nuclear Power

Another higher cost option would be the construction of new nuclear power plants. However, EPA views the completion of nuclear units currently under construction, and avoiding the "premature" retirement of an estimated 6% of existing nuclear capacity, to be important to GHG reduction goals in some states.[38]

> Policies that encourage development of renewable energy capacity and discourage premature retirement of nuclear capacity could be useful elements of CO_2 reduction strategies and are consistent with current industry behavior. Costs of CO_2 reductions achievable through these policies have been estimated in a range from $10 to $40 per metric ton.[39]
>
> Nuclear generating capacity facilitates CO_2 emission reductions at fossil fuel-fired EGUs by providing carbon-free generation that can replace generation at those EGUs. Because of their relatively low variable operating costs, nuclear EGUs that are available to operate typically are dispatched before fossil fuel-fired EGUs. Increasing the amount of nuclear capacity relative to the amount that would otherwise be available to operate is therefore a technically viable approach to support reducing CO_2 emissions from affected fossil fuel-fired EGUs.[40]
>
> We have determined that, based on available information regarding the cost and performance of the nuclear fleet, preserving the operation of at-risk nuclear capacity would likely be capable of achieving CO_2 reductions from affected EGUs at a reasonable cost.[41]
>
> In addition to the nuclear generation taken into account in the state goals analysis, any additional new nuclear generating units or uprating of existing nuclear units, relative to a baseline of capacity as of the date of proposal of the emission guidelines, could be a component of state plans.[42]

Demand-Side Energy Efficiency

The fourth building block of the BSER identified by EPA is "cost-effective" demand-side energy efficiency programs.

> The purposes of demand-side energy efficiency programs vary; goals include to reduce GHG emissions by reducing fossil-fired generation, help states achieve energy savings goals, save energy and money for consumers and improve electricity reliability. They are typically funded through a small fee or surcharge on customer electricity bills, but can also be funded by other sources, such as from CO_2 [allowance auction program] proceeds. [43]
>
> California has been advancing energy efficiency through utility-run demand-side energy efficiency programs for decades and considers energy efficiency "the bedrock upon which climate policies are built." It requires its investor-owned utilities to meet electricity load

[38] "EIA in its most recent Annual Energy Outlook has projected an additional 5.7 GW of capacity reductions to the nuclear fleet.... [EPA views] this 5.7 GW, which comprises an approximately six percent share of nuclear capacity, as a reasonable proxy for the amount of nuclear capacity at risk of retirement." EMEGU, p. 34871.

[39] EMEGU, p. 34858.

[40] EMEGU, p. 34870.

[41] EMEGU, p. 34871.

[42] EMEGU, p. 34923.

[43] EMEGU, p. 34849.

> "through all available energy efficiency and demand reduction resources that are cost-effective, reliable and feasible."[44]
>
> Demand-side energy efficiency programs produce electricity-dependent services with less electricity, and thereby support reduced generation from existing fossil fuel-fired EGUs by reducing the demand for that generation. Reduced generation results in lower CO_2 emissions. More than 40 states already have established some form of demand-side energy efficiency polices, and individual states have avoided up to 13 percent of their electricity demand.[45]

New Source Review

The New Source Review[46] (NSR) program was designed to prevent the degradation of air quality from the construction of new facilities or modification of existing facilities which have potentially harmful emissions. Efficiency improvements to power plants that reduce regulated pollutants should not theoretically trigger NSR requirements, unless the improvements result in an increase in emissions (e.g., because the modified plant operates for more hours). EPA has proposed that states be given a primary role with regard to NSR determinations.

> As part of its CAA section 111(d) plan, a state may impose requirements that require an affected EGU to undertake a physical or operational change to improve the unit's efficiency that results in an increase in the unit's dispatch and an increase in the unit's annual emissions. If the emissions increase associated with the unit's changes exceeds the thresholds in the NSR regulations discussed above for one or more regulated NSR pollutants, including the netting analysis, the changes would trigger NSR.
>
> While there may be instances in which an NSR permit would be required, we expect those situations to be few. As previously discussed in this preamble, states have considerable flexibility in selecting varied measures as they develop their plans to meet the goals of the emissions guidelines. One of these flexibilities is the ability of the state to establish the standards of performance in their CAA section 111(d) plans in such a way so that their affected sources, in complying with those standards, in fact would not have emissions increases that trigger NSR. To achieve this, the state would need to conduct an analysis consistent with the NSR regulatory requirements that supports its determination that as long as affected sources comply with the standards of performance in their CAA section 111(d) plan, the source's emissions would not increase in a way that trigger NSR requirements. [47]
>
> The EPA is aware of the potential for "rebound effects" from improvements in heat rates at individual EGUs. In this context, a rebound effect would occur where, because of an improvement in its heat rate, an EGU experiences a reduction in variable operating costs that makes the EGU more competitive relative to other EGUs and consequently raises the EGU's generation output. The increase in the EGU's CO_2 emissions associated with the increase in generation output would offset the reduction in the EGU's CO_2 emissions caused by the decrease in its heat rate and rate of CO_2 emissions per unit of generation output. The extent of the offset would depend on the extent to which the EGU's generation output increased (as well as the CO_2 emission rates of the EGUs whose generation was displaced). The EPA

[44] EMEGU, p. 34850.

[45] EMEGU, p. 34858.

[46] NSR was established by Congress as part of the 1977 Clean Air Act Amendments (P.L. 95-95), and is codified in sections 165-169 of the act. NSR requires pre-construction permits and the application of Best Available Control Technology at new major sources of air pollution, and at major modifications of existing major sources.

[47] EMEGU, p. 34928.

> considers the rebound effect to be a potential concern if heat rate improvements were the only approaches being considered for the BSER, but believes that the effect can be addressed by establishing the BSER as a combination of approaches that includes not only heat rate improvements but also approaches that will encourage reductions in electricity demand or increases in generation from lower- or zero-emitting EGUs.[48]

Issues Related to Compliance Strategies

The EPA's proposal for GHG reduction answers questions from the electric power sector with regard to the timeframe, timeline, and choices that would be made available for compliance. The CPP proposal sets out a vision for a greater proportion of electricity coming from natural gas and renewable electric generation, and less from coal-fired power plants, with state-specific goals for carbon emissions reductions proposed for 2030. However, there are still some unresolved issues remaining with potential implementation of the CPP.

Potential Impacts on Retail Electricity Prices

Under the Energy Policy Act of 2005 (P.L. 109-58), security constrained economic dispatch is defined in section 1234 as follows:

> ... the operation of generation facilities to produce energy at the lowest cost to reliably serve consumers, recognizing any operational limits of generation and transmission facilities.

EPA's CPP recognizes that security constrained economic dispatch "assures reliable and affordable electricity."[49] However, some observers say that EPA's CPP essentially proposes an environmental dispatch regime for power plant operation.[50] Under environmental dispatch, the goal is to use "cleaner" power generating units (i.e., which emit the least pollutants) by scheduling these plants to operate first and as much as possible to serve load demands.

Power plants today are generally scheduled to operate (i.e., dispatched) under an economic dispatch regime whereby power generation units are dispatched using generating units with the lowest costs. Thus, under these economic dispatch regimes, the cost of power generation is characterized by a power plant's efficiency or heat rate, its variable costs of generation, its variable costs of environmental compliance, and its start-up costs.[51]

The increased availability of natural gas has resulted in lower prices for wholesale electricity, with a general expectation that wholesale prices will remain relatively low for the next few years.[52] EPA has conceded that this increased demand could push natural gas prices higher.[53]

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[48] EMEGU, p. 34859.

[49] EMEGU, p. 34862.

[50] "Scheduling of power plant operation or intertie access in the order of increasing damage to the environment, with the least environmentally damaging first." See http://www.bpa.gov/news/pubs/Pages/Definitions---E.aspx.

[51] FERC Staff, *Economic Dispatch: Concepts, Practices and Issues*, Federal Energy Regulatory Commission, November 13, 2005, http://www.ferc.gov/eventcalendar/Files/20051110172953-FERC%20Staff%20Presentation.pdf.

[52] See EIA, Natural Gas Section, at http://www.eia.gov/forecasts/archive/aeo13/source_natural_gas_all.cfm#netexporter.

[53] "Under both approaches, the shifting in generation from higher-emitting steam EGUs to lower-emitting NGCC units results in an increase in natural gas production and price. The two-block approach results in a production increase of (continued...)

There is a concern that shifting to an environmental dispatch regime could potentially result in increased electricity prices to consumers, depending on the generation resource mix employed. However, EPA expects only a "modest impact" on retail prices will result.

> As described below in Section X, the results indicate that the proposed state goals (discussed in Section VII) are readily achievable with no adverse impacts on electricity system reliability, and that impacts on retail electricity prices are modest and fall within the range of price variability seen historically in response to changes in factors such as weather and fuel supply.[54]
>
> Retail electricity prices are projected to increase 6 to 7 percent under Option 1 and increase by roughly 4 percent under Option 2, both in 2020 and on an average basis across the contiguous U.S. By 2030 under Option 1, electricity prices are projected to increase by about 3 percent.[55]

Moreover, EPA expects that energy efficiency measures may lead to an actual reduction in the average retail bill for electricity of 9% by 2030.

> Average monthly electricity bills are anticipated to increase by roughly 3 percent in 2020, but decline by approximately 9 percent by 2030. This is a result of the increasing penetration of demand-side programs that more than offset increased prices to end users by their expected savings from reduced electricity use.[56]

Implications for Fuel Diversity

EPA's CPP proposal ostensibly involves natural gas consumption under two of the four legs of the BSER stool. EPA has suggested shifting the dispatch of power generators to lower-emitting sources by increased scheduling of higher efficiency natural gas combined cycle units. Scheduling these plants will result in higher natural gas consumption.[57] EPA has also suggested using more zero-emitting sources by deploying more renewable generation, which in many parts of the United States will require more natural gas consumption to make variable renewable electric generation more firm (i.e., provide power as renewable electric generation ebbs).

(...continued)

19-22 percent and a price increase of 10-11 percent. The four-block approach results in a production increase of 12-14 percent and a price increase of 9-12 percent." EMEGU, p. 34933.

[54] EMEGU, p. 34885.

[55] EMEGU, p. 34935.

[56] EMEGU, p. 34934.

[57] "Given that significant underutilized NGCC exists in various U.S. regions, the possibility of further shifting from coal base load plants to natural gas intermediate capacity exists. A recent study by the Massachusetts Institute of Technology in 2011 noted that the existing U.S. NGCC generation fleet had an average capacity factor of approximately 41%, while its design capacity allowed such plants to operate at 85%. The MIT study looked at a scenario across selected regions of the United States which mimicked the 'full dispatch' of existing natural gas combined cycle plants. The study concluded that under such a scenario (while noting that transmission constraints exist), there is 'sufficient surplus NGCC capacity to displace roughly one-third of U.S. coal generation, reducing CO_2 emissions from the power sector by 20%.'" See CRS Report R42950, *Prospects for Coal in Electric Power and Industry*, by Richard J. Campbell, Peter Folger, and Phillip Brown. (CoalProspects)

As of 2012, electric power generation used 8.5 trillion cubic feet (TCF) of natural gas.[58] EPA's CPP proposal essentially favors a switch to natural gas as the primary fuel used for power generation, and estimates an increase of 1.2 TCF over 2012 consumption in 2020.[59] However, increasing the use of natural gas for power generation raises some concerns, as deliverability and price volatility issues have emerged as recently as this past winter with the demand spikes associated with the Polar Vortex cold weather events.[60] Recovery of costs from the Polar Vortex have proved to be an issue for some utilities,[61] and the performance of demand response programs in periods of extreme weather (e.g., in the winter especially) have come under question.[62]

FERC is working to improve coordination between the electricity and natural gas industries.[63] Electricity generators get their natural gas from major pipelines or local distribution companies, and these deliveries are usually scheduled during nomination cycles.[64] More cost-effective, natural gas storage facilities may be required for electric power production purposes, if greater natural gas use for power generation is expected. However, the regulatory regime (i.e., Regional Transmission Organization markets or traditional regulation) in place will likely have a bearing on what choices are available to natural gas generators with regard to gas storage options or contracting for firm capacity vs. the "just-in-time" manner of natural gas deliveries traditionally available to power generators.

The electric utility industry values diversity in fuel choice options since reliance on one fuel or technology can leave electricity producers vulnerable to price and supply volatility. EPA's proposal expects additional retirements of coal-fired power plants, with some new NGCC capacity likely built to replace retiring coal capacity. Nuclear power plants are also aging, and some plants expected to be in operation in the 2020 to 2030 timeframe could face premature

[58] EIA Annual Energy Outlook 2014.

[59] EMEGU, p. 34934.

[60] FERC, *2014Winter 2013-2014 Operations and Market Performance in RTOs and ISOs*, AD14-8-000, April 1, 2014, http://www.ferc.gov/legal/staff-reports/2014/04-01-14.pdf.

[61] Veronique Bugnion, *The Polar Vortex Wreaks Havoc On Utility Bills*, Energy Collective, January 31, 2014, http://theenergycollective.com/vbugnion/334481/polar-vortex-wreaks-havoc-utility-bills.

[62] "Not all events requiring commitment of demand resources will occur during the spring, summer, and early fall, when the Limited and Extended Summer Demand products apply. As the Commission's gas-electric coordination investigation has shown, reliability problems can occur during the winter when gas-fired generators may have difficulty with obtaining natural gas or transportation of natural gas. See Communication of Operational Information Between Natural Gas Pipelines and Electric Transmission Operators, Order No. 787, FERC Stats. & Regs. ¶ 31,350 (cross-referenced at 145 FERC ¶ 61,134, at P 8 (2013)) ("short term swings in demand by gas-fired electric generators resulting from redispatch by electric transmission operators may be difficult to manage, particularly during times of coincident peak loads on interstate natural gas pipelines and electric transmission systems, such as during unusual cold weather events when end-use customers may rely on both natural gas and electricity"). See also PJM supplemental answer at 7 (discussing PJM's need for demand response during the polar vortex on January 7 and 8, 2014, and indicating that all of its demand response was Limited Demand Response and therefore could not be required to run)." See 146 FERC ¶ 61,052, footnote 48.

[63] FERC, *Natural Gas—Electric Coordination*, June 2014, http://www.ferc.gov/industries/electric/indus-act/electric-coord.asp.

[64] "The natural gas industry generally follows the scheduling cycles adopted by the [North American Energy Standards Board (NAESB)], which FERC regulations incorporate by reference. The NAESB standards set a nationwide natural gas operating day (Gas Day), beginning at 9:00 a.m. CCT [Central Clock Time] and ending at 9:00 a.m. CCT the following day. Current regulations provide for a minimum of four standard nomination cycles over that 24-hour period with a 'Timely Cycle' and 'Evening Cycle' for nominations closing in the prior day and two 'Intra-Day' nominations during the Gas Day." See http://www.vnf.com/2311.

retirement for a variety of reasons ranging from plant age to electricity market or other conditions.

Unless electricity storage capacity is increased or other concepts develop, natural gas will likely be used to smooth the variable output of some renewable electricity technologies. The developing potential for a heavier reliance on natural gas for power generation is a concern for many in the power sector. EPA, for its part, believes that its BSER proposal can help preserve fuel diversity goals.

> Large vertically integrated utilities generally have options within all four building blocks. They tend to have large and, as a general matter, at least somewhat diverse generation fleets. For their higher-emitting units, they have opportunities to use measures that reduce the units' CO_2 emission rates, such as heat rate improvements, co-firing, or fuel switching. While this proposal preserves fuel diversity, with over 30 percent of projected 2030 generation coming from coal and over 30 percent from natural gas, even companies that have traditionally depended upon coal to supply the majority of their generation are diversifying their fleets, increasing their opportunities for re-dispatch.[65]

Conversion of Coal to Natural Gas Firing

Switching a coal burning plant to natural gas can be a major undertaking as the boiler, fuel handling, and fuel storage areas would have to be modified or replaced. A major engineering study would have to be undertaken to determine the cost and extent of work to be performed for a specific power plant unit. Coal power plants can have multiple units (i.e., with separate steam boilers), some of varying ages and designs. A power plant location near a major natural gas pipeline would make supplying natural gas to the facility easier, although a local natural gas distribution company could also supply the fuel.

Adding a gas turbine to an existing steam turbine would be one option, but not without challenges or significant modifications based on the age of the existing steam turbine and balance of plant. Moderate increases in plant efficiency are possible from such a modification. A conversion to a combined-cycle configuration could be a major modification, both in terms of work performed and cost. But a considerable increase in power output and efficiency could result from such an upgrade.[66]

Regulatory, Policy, and Reliability Concerns

State-specific compliance plans geared to individual state needs may complicate the coordination necessary for reliability purposes. The individual state compliance plans required by EPA's CPP may have to be submitted to multiple jurisdictions (i.e., state public utility commissions, Regional Transmission Organizations, the North American Electric Reliability Corporation, and FERC) at a number of deliberative levels before a compliance plan can be finalized.[67]

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[65] EMEGU, p. 34886.

[66] See Table 1, "Summary of Emission Reduction Scenarios," Congressional Distribution Memorandum CD145, *Summary of Studies on Achieving Increased Coal Power Plant Efficiency and Lower Carbon Dioxide Emissions*, January 15, 2014, http://rsinquery.loc.gov/crsx/products-nd/14.5.doc.pdf.

[67] See CoalProspects, "Electricity Reliability—State and Market Inputs."

Many fossil-fueled power plants do more than just generate electricity. Many power plants provide ancillary services such as voltage support and frequency regulation to the grid. Additional retirements of coal-fired capacity can impact reserve margins, potentially impacting reliability when needed during weather-related outages or periods of temperature extremes.

Incidents of more extreme weather appear to be occurring, and will need to be planned for when considering the types of future generation which may need to be built to assure electric system reliability.[68] EIA currently expects that a total of 60 GigaWatts of coal capacity will retire by 2020, with 90% of these retirements taking place by 2016 "coinciding with the first year of enforcement for the Mercury and Air Toxics Standards."[69] Much of this capacity scheduled for retirement was dispatched during the recent Polar Vortex, adding concern to how the grid will meet power demands in future weather extremes.[70]

EPA's CPP proposal relies on state-implemented renewable portfolio standards (RPSs) and energy efficiency resource standards going forward. However, many state renewable portfolio standards and goals are scheduled to expire in the 2015 to 2020 timeframe, with more by 2025.[71] And many state RPS policies with mandatory requirements have cost caps to ensure that the targets can be met cost-effectively. Similarly, many state energy efficiency resource standards are expiring by 2020.[72]

The transmission system itself is aging and in need of modernization.[73] The grid is stressed in many regions because the system is being used in a manner for which it was not designed. More transmission capacity will likely be needed to handle potentially more transmission transactions under the EPA proposal. Much of the transmission system was built by individual electric utilities to serve their own power plants. New power plants or increased use of existing NGCC capacity may require upgraded transmission facilities, and potentially new natural gas infrastructure to provide fuel. Increased dependence on renewable generation will likely require new transmission lines, and many of today's transmission projects awaiting regulatory approvals are intended to serve renewable electricity projects.

FERC identified public policy requirements (such as state renewable portfolio standards) as drivers which should be elevated to the level of reliability when it comes to approving new transmission projects in its Order No. 1000, *Transmission Planning and Cost Allocation*.[74] Actual implementation of regional compliance plans will demonstrate whether the regime for transmission planning and cost sharing will achieve FERC's goals.

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[68] See CRS Report R42696, *Weather-Related Power Outages and Electric System Resiliency*, by Richard J. Campbell.

[69] Energy Information Administration, "AEO2014 Projects More Coal-Fired Power Plant Retirements by 2016 Than Have Been Scheduled," February 14, 2014, http://www.eia.gov/todayinenergy/detail.cfm?id=15031.

[70] Matthew L. Wald, "Coal to the Rescue, but Maybe Not Next Winter," *The New York Times*, March 10, 2014, http://www.nytimes.com/2014/03/11/business/energy-environment/coal-to-the-rescue-this-time.html?_r=0.

[71] Database of State Incentives for Renewables and Efficiency, *Renewable Portfolio Standard Policies*, March 2013, http://www.dsireusa.org/documents/summarymaps/RPS_map.pdf.

[72] American Council for an Energy-Efficient Economy, *State Energy Efficiency Resource Standards*, April 2014, http://www.aceee.org/files/pdf/policy-brief/eers-04-2014.pdf.

[73] Dwayne Stradford, *The Revitalization, Modernization of the Aging Transmission System*, Electric Light & Power, January 1, 2012, http://www.elp.com/articles/2012/01/the-revitalization-modernization-of-the-aging-transmission-system.html.

[74] See discussion of Order No. 1000 in CRS Report R41193, *Electricity Transmission Cost Allocation*, by Richard J. Campbell and Adam Vann.

The focus of the EPA's CPP proposal will arguably fall on coal-fired power plants, with at least two of the four building blocks centering on coal plant efficiency, dispatch, and emissions. The age and condition of coal-fired power plants are key considerations in a decision to upgrade or modify plants. Power plants in Regional Transmission Organization (RTO) regions operate in competitive environments where a power plant's operating and maintenance costs are not guaranteed recovery. The additional costs of plant upgrades may not be cost-effective under RTO electricity market regimes or prices. State implementation plans for EPA's CPP may also result in differing requirements within RTO regions for competitive generators. Capacity markets designed to incentivize the construction of new generation in regions with competitive markets have had mixed results. New power plants will most likely be built in regions of the country with traditional regulation using tools like integrated resource planning, and rules allowing cost recovery from ratepayers for approved investments.[75]

Potential for Varying State Impacts

EPA's state-specific GHG emissions goals vary considerably in magnitude, leading to concerns that some states may have much more to do than others and thus compliance with the CPP could result in "winners and losers." The approach to compliance taken by each state will certainly have a unique cost and economic impact, and these could vary considerably between states. However, EPA asserts the benefits of GHG reduction will far outweigh these costs. The agency says that the state-specific goals reflect each state's unique emissions profile and generation resource mix, and maintains that the flexibility offered by its "building blocks" approach will allow states the opportunity to choose a strategy capable of minimizing compliance costs and economic impacts.

> Similarly, we recognize and appreciate that states operate with differing circumstances and policy preferences. For example, states have differing access to specific fuel types, and the variety of types of EGUs operating in different states is broad and significant. States are part of assorted EGU dispatch systems and vary in the amounts of electricity that they import and export. For these reasons, we also recognize and appreciate the value in allowing and promoting multi-state reduction strategies.[76]

Conclusion

Moving forward, EPA GHG regulations can provide a basis for the evolution of the U.S. Electric Power Sector. EPA recognizes that the grid and many of its fossil-fueled power plants are aging, and provides input via the CPP as to how a future national system providing cleaner energy choices could be powered. EPA believes the benefits of a cleaner environment from its plan are without question. However, meeting the goals of EPA's proposed plan will effectively require less power generation from coal-fired power plants, or even outright retirements of coal-fired generation. Considering the average age of the coal-fired power plant fleet, more retirements are likely when the costs of efficiency improvements or upgrades are weighed in compliance plans.

EPA is not proposing the adoption of any new technologies, but suggests a framework for transition. Implementing compliance plans will not come without real costs or making hard

[75] Generally, an Integrated Resource Plan is a 10- to 20-year look forward at options for meeting future energy demand which is revisited typically every three to five years to help ensure the continued validity of the planning process.

[76] EMEGU, p. 34855.

choices for the states and electric utilities who will have to work together to find an acceptable compromise. The potential implications for reliability, and the ultimate financial costs of the CPP will become clearer as state compliance plans are filed, and implementation plans become known.

Author Contact Information

Richard J. Campbell
Specialist in Energy Policy
rcampbell@crs.loc.gov, 7-7905