# Electricity Markets and the Clean Power Plan

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## Executive Summary

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The Supreme Court found that carbon dioxide emissions are pollutants under the terms of the Clean Air Act (CAA). The Environmental Protection Agency (EPA) determined that carbon dioxide and other greenhouse gases threaten the public health and welfare of current and future generations. With the failure to adopt a national carbon dioxide cap-and-trade program, the responsibility and authority to regulate carbon dioxide falls under the rubric of the CAA.

The regulations divide into those for new and existing affected fossil fuel generating plants. For new plants, the approach is relatively straightforward, and essentially reinforces the market choice to prefer new natural gas plants to new coal plants, at least at the present and expected price of natural gas. For existing fossil generation plants, the situation is more complicated.

The Clean Power Plan (CPP) published by EPA is not strictly a plan. At this stage, it is a final rule defining a set of standards that states would have to meet for emissions from existing fossil generating plants. Under this rule, states are required to develop State Implementation Plans, or accept a default Federal Implementation Plan that would meet the standard.

A well-designed implementation plan that respects and utilizes the special features of organized electricity markets could achieve the benefits of both efficient markets and cost-effective environmental protection. A poorly-designed implementation plan could have the unintended consequence of destroying organized electricity markets and undermining environmental protection.

The legal authority for regulating existing plants falls under a part of the CAA (i.e., Section 111(d)) that raises a number of issues. A narrow interpretation of the authority would limit the regulation to feasible controls "inside the fence" for individual existing generating plants. This would be easy to implement but provide little in the way of carbon dioxide emissions reduction. A more expansive reading would extend the boundary of the fence to encompass the entire energy system, thereby allowing mandates for substitutes for existing fossil plants and a deeper reduction in carbon dioxide emissions.

The logic embedded in the CPP falls in between, described as setting a rate-based standard but extending the definition of the rate to encompass existing fossil fuel plants and new renewable generation. The CPP is controversial and a number of states have already attempted to stop implementation.

A key element of the CPP is the repeated emphasis on flexibility. The authority for EPA to accept different implementation proposals from the states appears to be much broader than the authority to mandate particular approaches. Furthermore, the range of possible implementation tools and policies is broad. This will precipitate extensive analysis and discussion within and among the states, in addition to the consideration of legal challenges.

This flexibility and broad range of implementation options raises a number of issues for Regional Transmission Organizations (RTOs) and organized electricity markets. Some versions of implementation plans for the CPP would be compatible with the operation of electricity markets and be easy to achieve. For example, a national carbon tax would be a preferred policy that would reduce carbon dioxide emissions and produce little or no unwanted distortion in the electricity market. By contrast, other possible polices could undermine the foundations of RTOs and cause electricity markets to collapse. The extreme case would be a mandate for environmental dispatch, but many less intrusive subsidy or procurement mandates would have similar effects.

It is not possible to anticipate every idea that will appear in the discussion of implementation plans, but it is possible to describe many ideas that have already been proposed. The analysis here focusses on the implications for organized electricity markets rather than on the merits of any particular carbon dioxide emission standard. Importantly, the CPP characterizes the operation of electricity markets in ways that are not strictly correct. Attempts by EPA to clarify some of the important points have added to the confusion.

The implementation conversation could be lengthy and litigious. The challenge for the nation is to develop an efficient policy for reducing carbon emissions. The challenge for RTOs and their regulators is to make clear how environmental policies could mesh well with the necessary electricity market design. Environmental policies that put an explicit price on carbon would fit naturally with efficient markets. Absent an explicit price on carbon, RTOs should be alert to avoiding many variants of seemingly innocuous implementation mechanisms that would lead to fundamentally undermining the operation of electricity markets.

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## Introduction

The Environmental Protection Agency issued a final rule that defines a broad and complicated set of standards for controlling carbon dioxide ($CO_2$) emissions from affected electricity generating units. (Environmental Protection Agency, 2015b) The proposed national average reduction by 2030 is 32% from the 2005 level of emissions, about half of which has already occurred. (Environmental Protection Agency, 2015j) The rules for new power plants are relatively straightforward and imply little more than reinforcing the current economic choice of natural gas over coal fired generation, given current projections for the price of natural gas. The Clean Power Plan rules for existing power plants arise under a different section of the Clean Air Act and present a more complicated picture. The result has implications for the nature and degree of future limitations on carbon dioxide emissions from the electricity sector. In addition, some versions of the possible implementation plans could have material implications for the operations of Regional Transmission Organizations under the regulations of the Federal Energy Regulatory Commission. The purpose here is to highlight some of the possible directions for relevant policies of electricity system operators.

## Carbon Pollution Standards

After a long period of debate and litigation, the Supreme Court ruled that carbon dioxide is a pollutant under the meaning of the Clean Air Act (CAA). (U.S. Supreme Court, 2007) The Environmental Protection Agency (EPA) then issued an endangerment finding and precipitated the required regulation of carbon emissions. After a series of appeals, the legal issue was settled as to the jurisdictional question.

With the failed legislative attempt to limit carbon dioxide emissions through a national cap-and-trade program, EPA was left to act according to its authority under the CAA. However, the decision on the legal authority did not resolve the debate on the merits of carbon regulation under the CAA. It is one thing to say that the general term "pollutant" legally encompasses carbon dioxide emissions; it is quite another thing to say that the CAA was designed with carbon dioxide in mind. The design of the CAA and the precedents of court decisions suggest that carbon dioxide is different than other pollutants.

For example, the CAA specifies certain levels of emissions that require regulation. The EPA recognized that these levels were (much) too low to be applied to carbon dioxide and other greenhouse gas (GHG) emissions as discussed in its so-called "Tailoring Rule":

> "The rule establishes a schedule that will initially focus CAA permitting programs on the largest sources with the most CAA permitting experience. … The CAA permitting program emissions thresholds for criteria pollutants such as lead, sulfur dioxide and nitrogen dioxide, are 100 and 250 tons per year (tpy). While these thresholds are appropriate for criteria pollutants, they are not feasible for GHGs because GHGs are emitted in much higher volumes. … Without this tailoring rule, the lower emissions thresholds would take effect automatically for GHGs on January 2, 2011. PSD and title V requirements at these thresholds would lead to dramatic increases in the number of required permits —tens of thousands of PSD permits and millions of title V permits. State, local, and tribal permitting authorities would be overwhelmed and the programs' abilities to manage air quality would be severely impaired." (Environmental Protection Agency, 2010)

Hence, EPA set a schedule that delays regulation of many sources of carbon dioxide emissions until some indefinite time in the future, while focusing immediately on the largest emitters.

Debates continue over the merits of the resulting regulations. Different authorities apply to mobile sources, new stationary sources and existing stationary sources. Some authorities allow for federal implementation, and others require state implementation plans.

> "The Clean Air Act lays out distinct approaches for addressing new and existing sources under Section 111: a federal program for new sources and state programs for existing sources.
>
> - Section 111 (b) is the federal program to address new, modified and reconstructed sources by establishing standards of performance.
>   - EPA is proposing two standards for natural gas-fired stationary combustion units, depending on size. … 1,000 lb $CO_2$/MWh-gross for larger units, 1,100 lb $CO_2$/MWh-gross for smaller units.
>   - New natural gas-fired stationary combustion turbines can meet the proposed standard without the need for add-on control technology.
>   - The proposed limits for fossil fuel-fired utility boilers and IGCC units are based on the performance of a new efficient coal unit implementing partial carbon capture and storage (CCS).
>   - These limits require capture of only a portion of the $CO_2$ from the new unit. … 1,100 lb $CO_2$/MWh-gross over a 12-operating month period, or 1,000-1,050 lb $CO_2$/MWh-gross over an 84-operating month (7-year) period
> - Section 111 (d) is a state-based program for existing sources. EPA establishes guidelines. States then design programs to fit their particular

> mix of sources and policies and get the needed reductions." (Environmental Protection Agency, 2015a)

The rules for new power plants would require expensive carbon capture equipment for new coal power plants. However, with current and anticipated natural gas prices, the economics already argue against construction of new coal-fired power plants in favor of natural gas. Hence, there was relatively little controversy over substance for the standards for new sources under Section 111 (b).

By contrast, the Clean Power Plan under Section 111 (d) for existing sources could be another matter entirely. Many states strongly oppose the plan.

## Clean Power Plan

Strictly speaking, the Clean Power Plan (CPP) published by EPA in August of 2015 is not a plan. The content of the CPP could have major implications for the development of the electricity system, but the structure of the CPP is to define rules and a methodology for setting limits on future emissions of carbon, with an interim goal for 2022 and a final goal for 2030. The limits are described as limits for existing plants, but the final rule covers something different. The initial proposal for the standard setting methodology was subject to over four million filed comments. (Environmental Protection Agency, 2014a) As it promised, EPA reviewed these comments and produced a final rule. (Environmental Protection Agency, 2015b)

Under the final rule a state will have one year to submit an initial State Implementation Plan (SIP) that would meet the limits on carbon emissions. States may apply for up to a two-year extension, through September 2018, to submit their final SIP. The SIPs are subject to approval by EPA, and EPA can step in to adopt its own Federal Implementation Plan (FIP) for any state that does not comply. Along with the final rule setting emission standards, EPA published a proposed FIP, requesting comments on different designs. (Environmental Protection Agency, 2015g)

There likely will be litigation over many aspects of the CPP. For example, there was an initial suit by 15 states to block the proposed CPP; this suit was rejected in June 2015 on procedural grounds that the court could not intervene until a final rule was issued. A similar suit in August 2015 to delay implementation of the published final rule was also rejected in September 2015. Legal challenges to the final rule cannot be filed until the published plan appears in the Federal Register, which EPA expected within two months.

### *Rate-Based Targets for Existing Fossil Plants*

The existing authority and precedents under the CAA appear to substantially constrain design of the CPP. This is part and parcel of the underlying problem that the CAA was not written with carbon emission controls in mind. As discussed below, while there may be substantial flexibility in what EPA can approve—given cooperation from a state or group of states—there may be much less flexibility in what EPA can require absent cooperation of the states.

While much of this issue of the authority and context of the CAA will be matters of dispute and litigation, and while the purpose of this paper is not to offer legal advice, understanding the rule requires some articulation of at least one view of what the law allows and requires. This framing of the problem provides at least a possible "ex post" justification of the organizing principles.

Given the decisions about EPA's jurisdiction under the CAA, the least controversial part of the authority would be in setting state-by-state requirements regulating the rate of emissions from existing individual power plants. The limits for the rate-based standard would be set by application of the "Best System of Emissions Reductions" (BSER) as determined by EPA to have been adequately demonstrated. For example, a feasible and relatively inexpensive heat-rate improvement on an existing coal plant could be an element of a BSER. Whereas converting an existing coal plant to natural gas might not be considered as required under a BSER standard.

This narrow view creates two problems. First, unlike many other pollutants, the principal impacts of a state's carbon emissions do not fall only on the state, or even only on its region. As EPA makes clear in its regulatory impact analysis, the global impacts of carbon dioxide are recognized as part of the benefits of emissions controls. This would argue for extending the boundaries to the limits of EPA's jurisdiction. Second, the limitation to actions "inside the fence" at individual plants would not give much latitude to constrain emissions. In fact, a frequent comment heard is that any responsible owner has already implemented all cost-effective means of improving heat rates at individual plants.

The distinction between what is or is not inside the fence appears to turn on the definition of "system" in the BSER. Does system define the fence as around the plant and technologies applied at or on the plant; or does system extend the fence to incorporate a broader definition that extends across fuels and among plants? The approach of EPA in looking "outside the fence" introduces novel features of the CPP that are difficult to understand without recognizing that the design might not be legally secure and the perspective that this reach to extend the fence may prove to be a reach too far.

If there were no "fence" and EPA could consider actions anywhere that affected the total emissions, not just the rate of emissions from existing power plants, then we could build an edifice something like the following: (i) Assume that all existing power plants implement incremental improvements in heat rates and corresponding reduction in emissions; (ii) Assume all increases in the utilization of existing natural gas units result in reduced utilization of existing coal plants and correspondingly reduced emissions; (iii) Assume that all incremental renewables substitute for use of existing coal plants. These are the three "building blocks" (BB) adopted by EPA. Take the resulting predicted level of carbon from emissions from existing fossil plants and predicted levels of generation for existing fossil plants and new renewables, and compute a ratio to get a number. This number would be a type of rate-based target in lbs-$CO_2$/MWh. (Environmental Protection Agency, 2015j)

In the earlier proposal for the Clean Power Plan there were additional building block elements, including increased energy efficiency. These were dropped from the final rule. However, energy efficiency would play a major role as a tool for meeting the standards even if it was not part of setting the standard. "The Clean Power Plan puts energy efficiency front and center because it is an important, proven strategy widely used by states that can substantially and cost-effectively lower carbon dioxide emissions from the power sector. And while the final state goals don't include energy efficiency as a building block, this does not limit the ability of states to use energy efficiency to meet their clean power goals. … The Clean Power Plan encourages states to select energy efficiency as a compliance path to meet the goals of the Plan." (Environmental Protection Agency, 2015f)

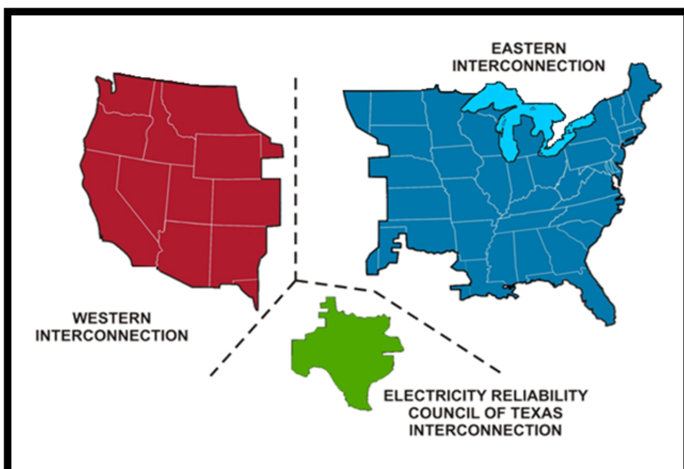
An illustration of the use of the "building block" components that enter into the determination of the rate-based standard appears in the CPP description for fossil steam plants in the Eastern Interconnection. (see box) (Environmental Protection Agency, 2015d, p. 17)

$$\text{Regional Fossil Steam Rate} = \frac{\left[\begin{array}{l}(\text{PostBB3\&2 fossil steam gen x Post BB1 fossil steam emission rate})+\\(\text{Incremental NGCC Generation x baseline NGCC rate})\end{array}\right]}{\left[\begin{array}{l}(\text{Post BB3\&2 fossil steam gen })+\\(\text{BB3 generation replacing fossil steam}+\text{Incremental BB2 generation})\end{array}\right]}$$

$$\text{2030 Eastern Fossil Steam Rate} = \frac{\left[\begin{array}{l}(612{,}922\text{ GWh} * 2{,}071\text{ lbs/MWh})\ +\\(253{,}322\text{ GWh} * 894\text{lbs/MWh})\end{array}\right]}{\left[\begin{array}{l}612{,}922\text{ GWh}+\\253{,}322\text{ GWh}+280{,}515\text{ GWh}\end{array}\right]} = 1{,}305\text{ lb/MWh}$$

This compares with the 2012 CPP baseline rate of 2,160 lb/MWh.

Whether or not this satisfies the legal definition of a rate depends in part on the meaning of "rate," or on the definition of "system" in the BSER. Perhaps the combination of existing fossil generation in 2012, incremental natural gas generation (BB2), and new renewables (BB3) could be a 'deemed cleaner power plant' (DCPP). Then we could say that we have a rate-based standard for the DCPP. But given any common usage for the word "rate," this is not a rate-based standard for existing power plants. It appears to be an artful construction to satisfy the form of setting a rate while reaching well beyond actions with individual plants to encompass a broader policy that expands across the electricity system.



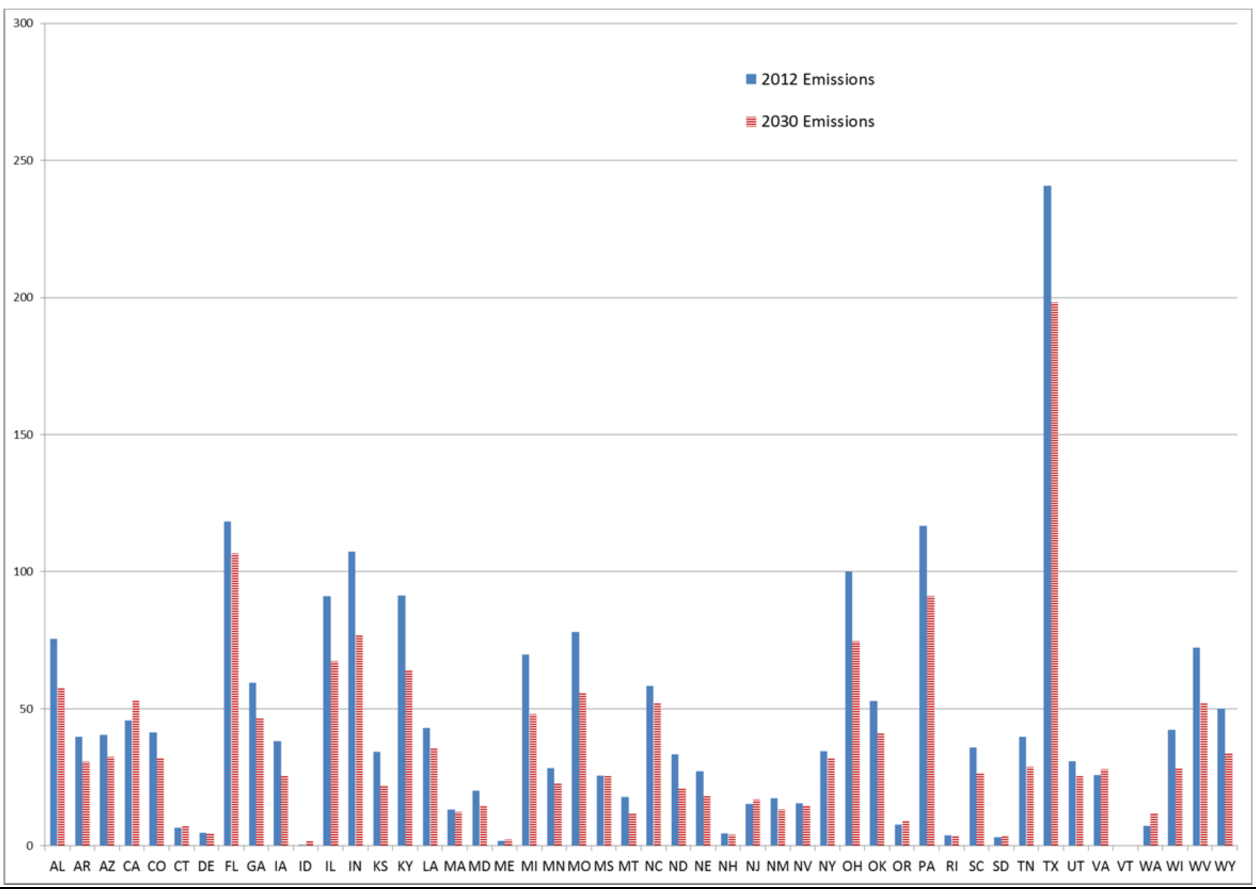

The CPP applies its building block approach to source specific estimates for existing steam fossil (coal and oil) plants and existing natural gas combined cycle (NGCC) plants. The regional aggregation of the analysis is for each of the three interconnected grids (Eastern, Western, and Texas). From these EPA determined a national BSER for each source type, taking the maximum rate across the interconnections, and then applied these two standards to the source mix in each state to obtain each state's aggregate rate-based standard for existing fossil plants. The required 2030 rate reductions range from 7% in Connecticut to 47% in Montana.

The language of the CPP reflects a degree of uncertainty created by this building block approach. For example, some parts of the rule treat the Electric Generating Unit (EGU) affected by the rule as the individual fossil fuel plant (Environmental Protection Agency, 2015b, p. 696), and then treat the rate-based standard as something that can be achieved by an entity that owns or contracts for the output of multiple plants (p. 698).

The legal issue will be settled in the courts. But the substantive confusion and problems going forward will follow from the constraints imposed by the confines of the CAA. There is and probably will be a difference of opinion about whether or not this is good environmental policy. An argument can be made that something is better than nothing. But for a problem as long-lived as the challenge of climate change, a better and more transparent approach may have a greater chance of being effective.

The CPP presents the total emissions that EPA anticipates for the compliance years. This includes reductions in the performance rate but increases in the utilization of existing and new generation plants. This can be compared with the actual emissions. The resulting total state emission levels are in the accompanying graphic.

**EPA Estimated Clean Power Plan $CO_2$ Emissions (Millions of Short Tons)[1]**




Given the focus on reducing emissions from the most carbon intensive sources, the pattern of emission changes is directionally the same as would be found with a common price on carbon dioxide. Because of increased utilization, the reduction in the average performance rate translates into a 21% reduction from 2012 to 2030 total emissions.

[1] Actual emissions from (Environmental Protection Agency, 2015e) (Appendix 3) . Anticipated 2030 emissions from (Environmental Protection Agency, 2015b, pp. 1178–1179).

Application of this DCPP standard will confront a number of implementation challenges. For instance, the assumption that renewables substitute only for existing high carbon fossil units and not nuclear or other sources cannot be correct. Likewise, the assumption that incremental energy efficiency replaces only high carbon fossil plants and not other sources cannot be correct. For example, in another context outside the application of the building blocks, EPA noted that incremental renewables and efficiency would reduce the level of new NGCC generation and associated emissions, partly breaking the connection to existing fossil generation. (Environmental Protection Agency, 2015i) Similarly, while some of the elements such as fossil generation or total renewables energy can be observed and measured directly, other components such as incremental energy efficiency can only be obtained through counterfactual estimation. The inherent uncertainty in such estimates has already raised concerns that the EPA has made flawed assumptions that might miss an opportunity to impose tougher standards. (Wara, Cullenward, & Teitelbaum, 2015) Any plan with a large role for energy efficiency will confront the substantial gap between optimistic engineering predictions and disappointing empirical results. (Fowlie, Greenstone, & Wolfram, 2015) Demonstrating ex post compliance with a DCPP rate-based standard could be a contentious process.

In addition to the uncertainty in measurement, a rate-based standard creates inherent inefficiencies. For example, a rate-based standard provides an incentive not only to shift the mix from more carbon intensive to less carbon intensive generation, but to increase total generation with lower than average emissions in order to reduce the average across the mix. In principle, a rate-based standard could result in an increase in total emissions. (Fowlie et al., 2014)

### *Mass-Based Standards*

As an alternative to a rate-based standard, EPA describes how states might choose a mass-based equivalent standard. The basic idea is to take the EPA projections as given and then compute the total emissions that would apply if the rate-based emission level is just met. This would set an ex ante level of total emissions that would define the emission cap for existing plants.

In principle, a mass-based standard would eliminate the inefficient incentives inherent in a rate-based standard. And as an ex ante rule, it would simplify some of the complicated measurement problems in 2030 when testing for compliance. A feature of the mass-based standard is avoiding any need for estimating or doing counterfactual calculation in determining compliance. Simple measurement of the actual emissions from the affected fossil fuel generating units would suffice to compare against the total emission limit.

As an example of the limitations of the CAA framework, the CPP recognizes that a mass-based standard applied only to existing fossil fuel plants could create incentives to shift generation to new fossil units that would not be covered under the rate-based standard. The solution adopted in the CPP to prevent this "leakage" is to condition approval of any mass-based SIP by requiring certain state authorized modifications of the mass-based rule.

One approach would be to set aside incremental emission allowance allocations for existing plants or new renewable sources. (Environmental Protection Agency, 2015b, p. 1182) The effect would be to provide a subsidy for these plants relative to new NGCC sources and thus reduce or eliminate any leakage through the dispatch. By design, this attempts to lower the implicit price on carbon emissions from existing plants, which will correspondingly reduce the price signal facing load and other supply sources, as an unintended consequence.

An alternative approach suggested by EPA is for a SIP to include new generation under a slightly higher cap that is set by EPA to reflect the anticipated "New Source Complement" emissions from new natural gas plants. (Environmental Protection Agency, 2015i) The idea is to create a cap on all carbon dioxide emissions, for both existing and new plants, and achieve the corresponding efficiency benefits. This would provide the implicit price on carbon that would go with a simple emissions cap, and send the corresponding signal to reduce electricity demand and support efficiency investments.

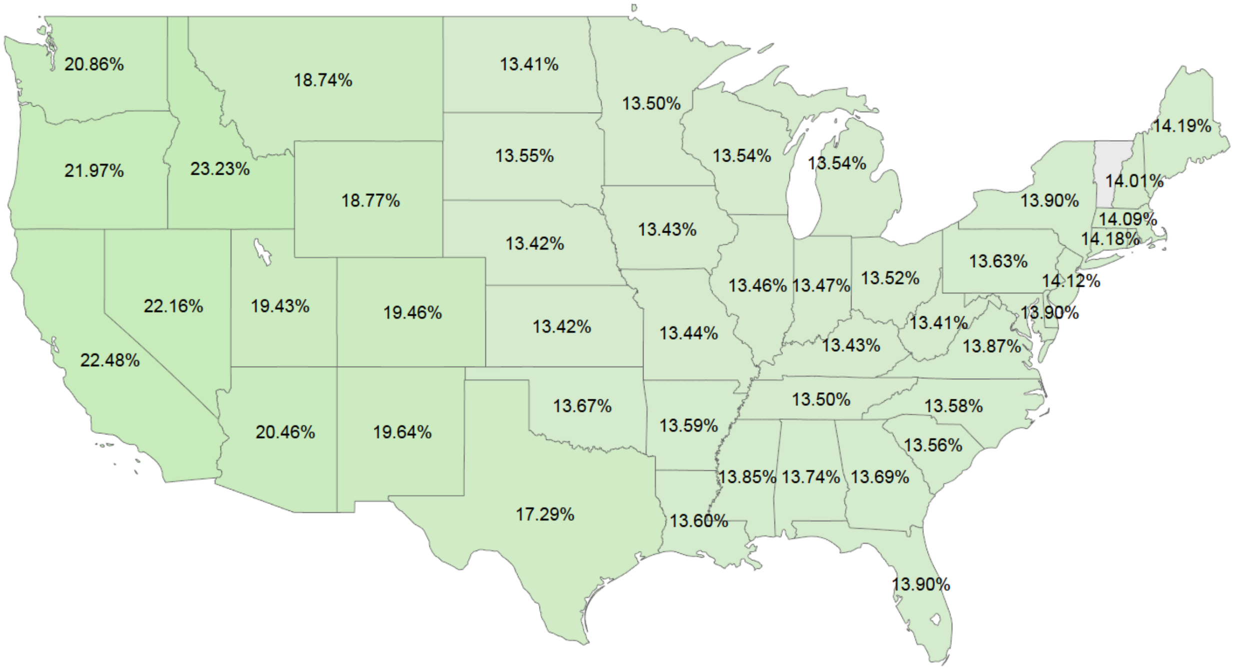
The resulting increments to the state emission caps are smaller than implied by the expected growth in demand. The CPP sets the performance standard based on the maximum across the three interconnections. This was for the Eastern interconnection. When applied to the Western and Texas interconnections, this in effect leaves unused lower emitting resources not needed to meet their rate-based standard. EPA assumes that these resources will be utilized nationally in a type of trading regime to increases the output of existing resources beyond the 2012 base year levels and will go towards meeting incremental demand. (Environmental Protection Agency, 2015b, p. 832) However, the associated emissions are included in the mass-based equivalent standard and a corresponding amount of load and associated emissions are removed from the apparent "New Source Complement" adjustment for new generation. As a result, the resulting "New Source Complement" average percentage of the equivalent allowed emissions for existing fossil generation is a relatively low 2.74%. Converting from a rate-based to a mass-based standard that would be approved by the EPA may raise questions about this low increment and the appearance of increased stringency of the cap on total emissions under a mass-based system.

However, this "New Source Complement" does not represent the full emission allocation that would be available to meet load growth, as shown in the accompanying map. This alternative way to present the information identifies incremental emissions assuming the baseline 2012 generation level produces emissions at the rate-based standard for 2030. Then all emissions above this level would be available to meet load growth under the mass-based standard.

From this perspective, the implied total emissions available to meet load growth are materially higher than the reported "New Source Complement" under the CPP methodology. There is not an unintended increase in stringency relative to the rate-based standard and compared to the assumed load growth of 12.7%, 13.6%, and 17.4% for the Eastern, Western and Texas Interconnections, respectively. (Environmental Protection Agency, 2015i, p. 3)

These emission limit increases for new load would be provided by the allocations from EPA for a state that adopts a mass-based standard. This allocation provides an advantage compared to the rate-based standard where these increased emissions would be allowed only if the state could achieve the optimistic level of success embedded in the assumptions of the EPA analysis.

**EPA Implied Increments for Increased Load with Mass-Based Goals (% of Equivalent Mass-Based Baseline Goal in 2030)**[2]




### *Flexibility*

The CPP repeatedly emphasizes an interest in flexibility in designing implementation plans. Although the CAA appears to substantially limit what EPA can require of the states, there seems to be a much greater range of options that EPA could approve if the states would make the offer to follow a different plan:

> "• In developing its plan, each state will have the flexibility to select the measures it prefers in order to achieve the $CO_2$ emission performance rates for its affected plants, or meet the equivalent statewide rate- or mass-based $CO_2$ goal.
>
> • States will also have the ability to shape their own emissions reduction pathways over the 2022-29 period since their affected sources together must only meet the states' interim goals "on average" over the eight-year span.
>
> • States, through various state plan types, can utilize the reduction methods outlined in the Best System of Emission Reduction (BSER) (i.e., increasing coal plant efficiency, shifting coal generation to natural gas generation, and increasing renewable power generation) or they can choose to rely upon other measures such as demand-side energy efficiency programs or increased nuclear generation.

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2 Mass-based increment for increased load with baseline generation at the 2030 rate-based performance level and total emissions allowed including the "New Sources Complement.". Table 13, (Environmental Protection Agency, 2015b) and Table 9, (Environmental Protection Agency, 2015i).

> • EPA is providing a Clean Energy Incentive Program to reward early investments in certain renewable energy (RE) and demand-side energy efficiency (EE) projects that generate carbon-free MWh or reduce end-use energy demand during 2020 and 2021. …
>
> • The final rule also gives states the option to work with other states on multi-state approaches that allow their power plants to integrate their interconnected operations within their operating systems and their opportunities to address carbon pollution.
>
> • The flexibility of the rule allows states to reduce costs to consumers, minimize stranded assets and spur private investments in renewable energy and energy efficiency technologies and businesses." (Environmental Protection Agency, 2015c)

In addition, in the discussion of its earlier proposal, EPA acknowledged the utility of pricing carbon emissions and using the associated incentives to change both power dispatch and future electricity investments.

> "… [T]here are a number of different ways that states can design programs that achieve required reductions while working within existing market mechanisms used to dispatch power effectively in the short term and to ensure adequate capacity in the long term. These programs and programs for conventional pollutants, such as the Acid Rain Program under Title IV of the CAA, have demonstrated that **compliance with environmental programs can be monetized such that it is factored into power sector economic decision making in ways that reduce the cost of controlling pollution, maintain electricity system reliability and work within the least cost dispatching principles that are key to operation of our electric power grid**. The proposal would also allow states to work together with individual companies on potential specific challenges. These and other flexibilities are discussed further in Section VIII of the preamble." (Environmental Protection Agency, 2014a) (p. 34834, emphasis added)

Notably, the proposed FIP rule offered by EPA presents a rate-based and a mass-based trading program. While it seeks comments on both programs, the "EPA recognizes that the mass-based trading approach would be more straightforward to implement compared to the rate-based trading approach, both for industry and for the implementing agency." (Environmental Protection Agency, 2015g)

The CPP mentions the success of the Regional Greenhouse Gas Initiative (RGGI), a multi-state cap-and-trade program, and implies RGGI is a model for regional cooperation. By their very nature, the impacts of carbon emissions anywhere have a global effect. Hence, a cost-effective approach for controlling emissions would balance the marginal choices everywhere, but not on a "state-by-state" objective. The constraint of the CAA approach is most clearly evident in the exclusion of Vermont and the District of Columbia in all the standards. The stated reason is that Vermont and DC have no "affected" generating units. Hence, by implication of EPA's rate-based building-block methodology, increased renewables and greater energy efficiency in Vermont or DC have no impact on carbon emissions even though both regions are an explicit part of a larger dispatch organized under an RTO. If regional trading is approved, Vermont would do well to create a voluntary SIP and sell its emission credits from the building blocks for its DCPP that will have no emissions.

The principal limitation imposed on trading arrangements restricts trading to like systems under the CPP. Hence, states using a rate-based implementation method may trade various credits with each other. And states using a mass-based system may trade emission credits among themselves. But the credits cannot be traded across rate-based and mass-based systems. Given the extensive trading of electricity across systems, it is clear that any restrictions on trading credits could have important indirect effects in other regions. The ideal approach would be to have a common system with trading across the widest possible market that EPA can allow under its jurisdiction.

Although the details are not yet known about what degree of cooperation is allowed, there are assertions that the incentives of the CPP could work against flexibility and cooperation. (Bushnell et al., 2014) Obviously, without some mechanism for trading across boundaries, there is not much incentive for cooperation from Vermont.

## Clean Power Plan Implementation Options

The Clean Power Plan is only a rule that sets emission standards. In principle, it is not a prescription for how to meet the standards. For rate-based plans, presumably compliance assessment will be based on the building blocks approach. Hence, there will be a tendency to try to design implementation plans to reflect the "building blocks" of the DCPP. But this is not a requirement and the call for flexibility would allow consideration of other implementation options. For mass-based plans, the building block framework is not relevant once the standard is set, at least until the time of revisiting the standard in the future.

There are many potential options for meeting the mandates of the CPP. One study by the National Association of Clean Air Agencies described 26 chapters discussing categories of implementation options, as shown in the accompanying table.

While the many details of the options overlap, it is clear that virtually every aspect of electricity system planning and operation is or could be implicated. As Federal Energy Regulatory Commission (FERC) member Moeller said: "Let's face it, we have air regulators planning the electricity grid, like it or not. And there's always going to be a lot of unforeseen consequences to that." (Moeller, 2015)

| Clean Power Plan Implementation Options<br>(National Association of Clean Air Agencies, 2015) | |
|---|---|
| Optimize Power Plant Operations | Implement Combined Heat and Power in the Electric Sector |
| Implement Combined Heat and Power in Other Sectors | Improve Coal Quality |
| Optimize Grid Operations | Increase Generation from Low-Emission Resources |
| Pursue Carbon Capture and Utilization or Sequestration | Retire Aging Power Plants |
| Switch Fuels at Existing Power Plants | Reduce Losses in the Transmission and Distribution System |
| Establish Energy Savings Targets for Utilities | Foster New Markets for Energy Efficiency |
| Pursue Behavioral Efficiency Programs | Boost Appliance Efficiency Standards |
| Boost Building Energy Codes | Increase Clean Energy Procurement Requirements |
| Encourage Clean Distributed Generation | Revise Transmission Pricing and Access Policies |
| Revise Capacity Market Practices and Policies | Improve Integration of Renewables into the Grid |
| Change the Dispatch Order of Power Plants | Improve Utility Resource Planning Practices |
| Improve Demand Response Policies and Programs | Adopt Market-Based Emissions Reduction Programs |
| Tax Carbon Dioxide Emissions | Consider Emerging Technologies and Other Important Policies |

Some of these options could be effective and benign from the perspective of an RTO. The easiest case would be to simply tax carbon dioxide emissions. Other options could be quite intrusive, such as changing the order of dispatch without taxing carbon dioxide, as discussed below.

A fundamental issue embedded in these many different options is the different degree of cost effectiveness. Although the BSER standard can accommodate cost considerations, the default CPP proposal for state-based standards is not cost effective.

The criterion employed by EPA in setting the BSER is a "reasonableness" test. "EPA may not adopt a standard the cost of which would be 'exorbitant,' 'greater than the industry could bear and survive,' 'excessive,' or 'unreasonable.' These formulations appear to be synonymous, and for convenience, in this rulemaking, we will use reasonableness as the standard, so that a control technology may be considered the 'best system of emission reduction ... adequately demonstrated' if its costs are reasonable, but cannot be considered the best system if its costs are unreasonable." (Environmental Protection Agency, 2015b, pp. 298–299) (footnotes omitted)

This expansive definition of what is reasonable would include actions which are expensive but not so expensive as to mean the end of the electricity industry. The issue turns on the cost of renewable technologies. The principal justification of the reasonableness of expanded renewable generation is that installations have been growing and costs have been falling. (Environmental Protection Agency, 2015b, p. 736) But this argument for further deployment of renewables is circular. The expansion has been driven by mandates and subsidies, and the cost of renewable technologies remains high.

## Alternative Energy System Costs

The background for considering the cost effectiveness and efficiency of different electricity system options confronts a fundamental problem when comparing alternatives. A starting point is an assessment of the current costs of competing energy supply technologies. Although not invoked in the CPP, a good way to frame the problem starts with the original Google initiative to develop renewable energy that cost less than coal, "known as RE<C." (Google, 2007)

The costs of clean technologies are high, but declining. Success stimulating the development of less expensive energy sources will be crucial in achieving the climate goals.

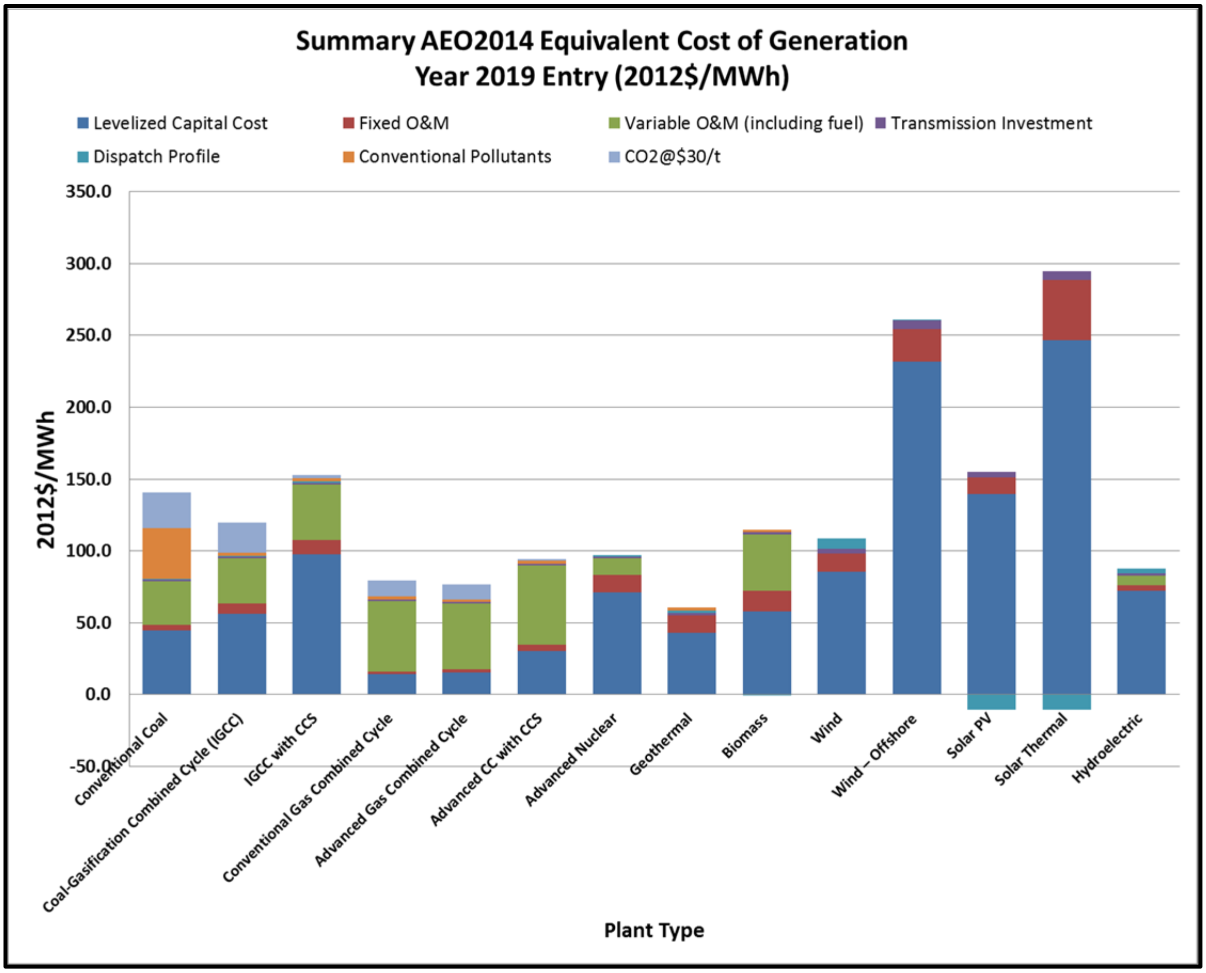
- **RE<C.** The earlier mantra from Google, where renewable energy (RE) is cheaper than coal (C). This would make adoption of renewables an easy choice even without considering the environmental benefits.
- **RE<C+Carbon Price.** The economic welfare outcome that internalizes the carbon externality. Renewable energy is expensive, but it is worth it. Climate policy includes a mix of mitigation and adaptation.
- **RE>C+Carbon Price.** Renewable energy is too expensive, and climate policy leans heavily towards adaptation.

More generally, the benchmark would include the lesser of the cost of coal or natural gas.

The policy prescription should depend on the diagnosis. How and how much should we be supporting the development and deployment of clean energy technologies?

The levelized cost of energy (LCOE) for supply technologies provides one benchmark. The CPP refers to the "National Renewable Energy Laboratory's (NREL's) 2015 Annual Technology Baseline." (Environmental Protection Agency, 2015b, p. 754) The NREL baseline report (Sullivan et al., 2015) is built from the supporting analysis of the Energy Information Administration used in the 2014 Annual Energy Outlook. The NREL report provides internally consistent scenarios that are not projections. However, the EIA's own analysis for its baseline outlook allows a consistent comparison of its underlying cost projections. This includes adjustments to put the supply technologies on an equivalent basis.

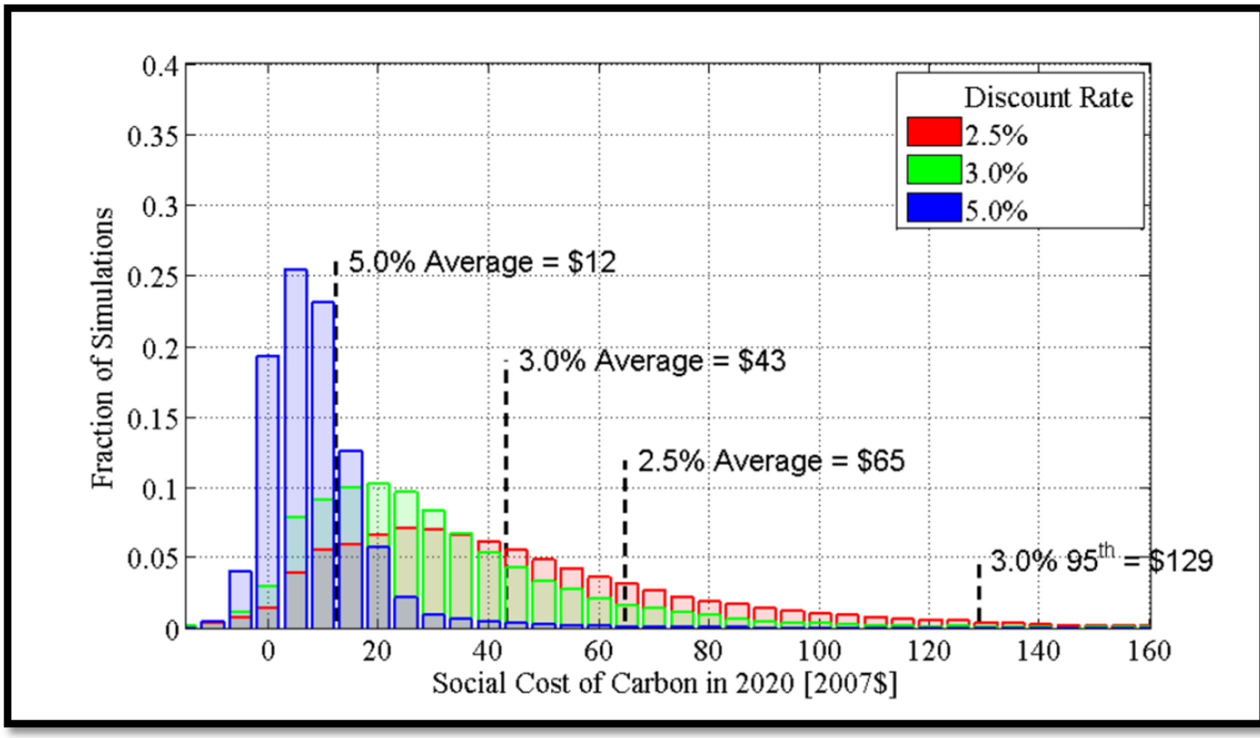
The estimates summarized in the accompanying graphic use the same tax and depreciation schedules for plants of similar life, adjust for dispatch and transmission impacts of solar and wind, and incorporate the externality effects of plant emissions. This is an apples-to-apples comparison based on the assumptions and input data for the United States as developed by the Energy Information Administration. (Energy Information Administration, 2014)




The implication of the EIA data is that on average it is not cost effective to deploy clean renewables, either as new additional generation sources or to replace existing fossil fuels plants. Often this unfortunate conclusion is obscured by the many subsidies for renewables, or anecdotes about exceptional deals with distressed suppliers. However, the presentation of the EIA data projected for entry on 2019 is on an apples-to-apples basis that puts all technologies on the same footing.

Faced with this reality, in 2011 Google abandoned its "RE<C" initiative. More recently, the same challenge was revived in the so-called "Global Apollo Programme" with a target "that new-build base-load energy from renewable sources becomes cheaper than new-build coal in sunny parts of the world by 2020, and worldwide from 2025." (King et al., 2015) This is a target; the test has not yet been met.

Nonetheless, estimates from the U.S. government imply a substantial social cost of carbon dioxide ($/ton-$CO_2$) that is not internalized in the market. (U. S. Government Interagency Working Group on Social Cost of Carbon, 2013) (p. 14.)




Although there is considerable uncertainty about estimation of the social cost of carbon, a reasonable number from this figure would be in the neighborhood of \$30/ton-$CO_2$. This is the figure included in the illustrative LCOE estimates above based on the EIA data.

Apparently, at present, and for most of the future envisioned under the CPP, the prevailing condition will be "RE>C+Carbon Price." The implication is that research and development to discover new and cheaper sources of renewable energy should be a high priority. But wide scale deployment of existing renewable technologies is not supported.

An accompanying implication for the CPP is the challenge that will arise in trying to compel large scale deployment of technologies that are too expensive relative to the estimated marginal social cost.

## Electricity Market Design

Electricity markets operated by RTOs cover approximately 70% of electricity load in the United States. These organized electricity markets are expanding, especially in the West through the growth of the Energy Imbalance Market (EIM). The recent expansion is being driven in large part because of the pressures created by the growth in variable energy resources such as wind and solar. "Competitive markets are critical to the integration of renewable resources, demand response, and distributed generation. The markets provide the geographic scope to integrate large amounts of renewable resources and the market signals to attract and integrate new technologies in an efficient manner." (Moot, 2014)

The centerpiece of the organized markets is the framework of bid-based-security-constrained-economic-dispatch-with-locational-prices. (Hogan, 2010) The history of development of this market design is long and complicated. (Hogan, 2002) This market design is now found in all the organized markets, but only after many failures along the way in the misguided attempts to embrace some alternative approach.

The fundamental principles of organized electricity markets in the United States include open access and non-discrimination in the terms and conditions for use of the high voltage grid. (Federal Energy Regulatory Commission, 1996) Since access to the grid is necessary to participate in the market, the principles undergird everything else in market design. Furthermore, since the flow of power on the grid and the dispatch of generation and load are inherently interconnected, the rules for access to the grid drive everything related to short-term system operations.

The economic dispatch approach provides efficiency of operation. The security constraints assure that this efficient dispatch respects the constraints of operational reliability and transmission limits. The marginal cost of meeting demand determines the location price. The locational prices assure that the resulting incentives are consistent with the dispatch and avoid artificial arbitrage opportunities that have been problematical with other market models. And the locational differences in these same prices provide the essential ingredient for financial transmission rights that meet the economic purposes of the otherwise unavailable physical transmission rights.

In the end, this model embraced in all the RTOs has a special status. In particular, this economic dispatch market model is the *only* way to organize electricity markets under the principles of open access and non-discrimination. It follows, therefore, that a key responsibility for RTOs and their regulators is to maintain the integrity of this market model.

Although there are ways to implement carbon emission control policies that are consistent with this necessary electricity market design, the CPP includes very mixed messages about the degree to which EPA understands or respects the importance of market design fundamentals.

The CPP analysis utilizes EPA's "Integrated Planning Model (IPM) … a multi-regional, dynamic, deterministic linear programming model of the U.S. electric power sector. It provides forecasts of least cost capacity expansion, electricity dispatch, and emission control strategies while meeting energy demand and environmental, transmission, dispatch, and reliability constraints." (Environmental Protection Agency, 2014b) However, whatever its merits for planning and analysis, IPM is a zonal model built on load duration curves and inter-zonal transmission limits. Hence, IPM cannot replicate the impact of transmission constraints in actual dispatch operations. (Environmental Protection Agency, 2013)

This distinction between the actual details of "dispatch" and EPAs discussion in the CPP of changing the dispatch apparently raised a number of questions. Subsequent to publication of the CPP proposal, when EPA addressed the determination of a mass-based standard, the associated technical report included a lengthy footnote which revealed some confusion:

> "EPA recognizes that the word "dispatch" can be used to describe how balancing authorities conduct real-time selection of specific generation (supply) to meet load (demand), on an hourly or even 15-minute basis. In the context of the proposed CPP and in this [Technical Support Document], the word "dispatch" is intended to refer to broader patterns of generation across different generating technologies over longer periods of time, in keeping with the compliance flexibilities afforded

> under this rule (e.g., where emission performance can be averaged over multiple years)." (Environmental Protection Agency, 2014c) (footnote 6)

This footnote confuses rather than clarifies, and raises a concern that EPA does not understand the nature of the economic dispatch model or its central importance in maintaining the possibility of open access and non-discrimination in electricity markets.

## Policies for Regional Transmission Operators

The national policy on carbon standards that stand behind the CPP presents a complicated pattern and many challenges to developing an efficient outcome. The large array of options for reducing carbon emissions means that there will be extensive debate over the content of State Implementation Plans. The full scope of the tradeoffs has already filled millions of public comments, and the process is only beginning. The next round following the EPA final rule will expand the conversation rather than resolve the most contentious issues.

The first responsibility of RTOs is to operate the electricity system to maintain reliability. Within that mandate is the objective to operate an efficient and open market under the principles of open access and non-discrimination. The challenges for this policy are well known, even without the overlay of the CPP. The CPP final rule includes an added discussion of the means to meet reliability requirements and the possibility of a "safety valves" to avoid unintended reliability consequences. (Environmental Protection Agency, 2015b) (p. 50)

An important agenda for RTOs is to improve operation and pricing in the real-time market. (Hogan, 2014) This is already a priority for RTOs and could reinforce capabilities that would be helpful under certain implementations of the CPP. However, the CPP could raise a number of new challenges for RTOs that should be anticipated and should guide discussion on the development of SIPs.

From the perspective of RTOs and their regulators, there are some observations that can guide policy development during this process. Here the perspective reflects "the predominant view held by the FERC's leadership across multiple administrations, both Democratic and Republican, is that the FERC is a fuel-neutral agency and, therefore, does not pick winners and losers by choosing sides in the climate change debate." (Moot, 2014) This perspective extends by implication to the RTOs, where the focus should be on avoiding unintended consequences in the implementation of carbon emission standards.

The short version of the story is to support initiatives that put an explicit price on carbon and avoid activities that undermine the basic purposes of RTOs and put them on a slippery slope towards unravelling the market design.

### *Carbon Tax*

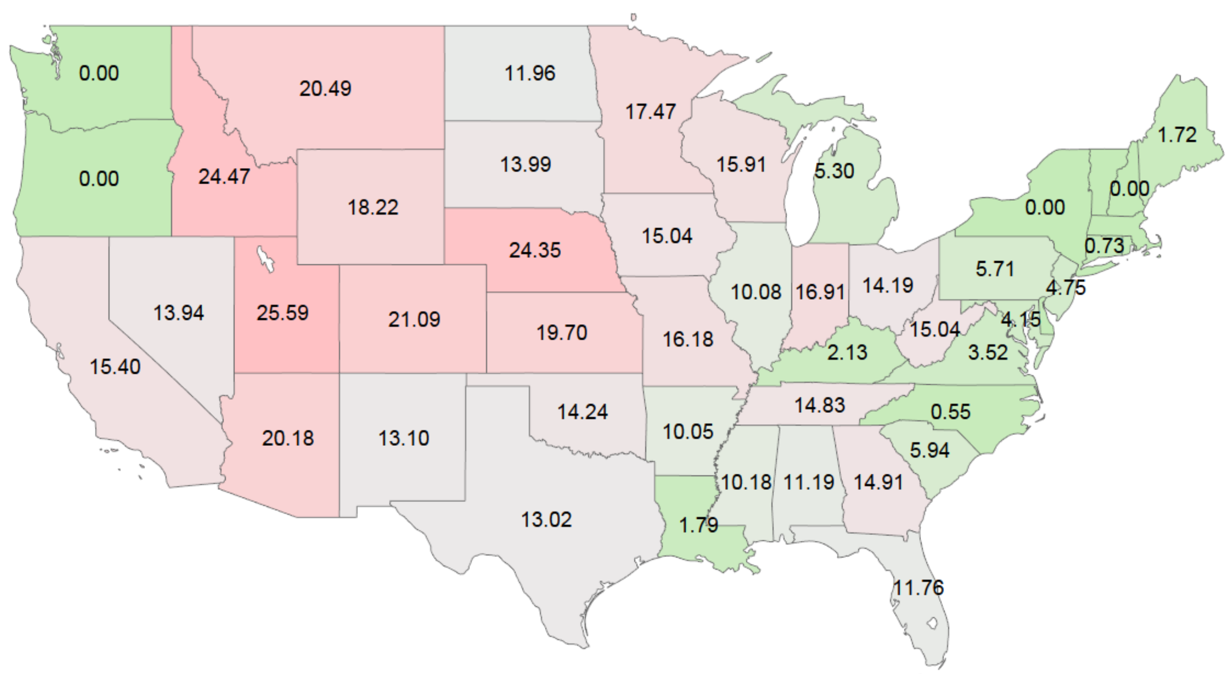
The best single instrument policy for the country would be to adopt a national carbon tax that reflected the social cost of carbon. A common price for carbon would reflect the global impact of carbon emissions and be consistent with an efficient and cost-effective approach to carbon controls.

A carbon tax would add to the marginal cost of generation in proportion to the carbon emissions of a plant, and change the tradeoff in economic dispatch. This carbon price would be incorporated automatically in the generation offers. The result would be a different pattern of generation, locational prices and incentives for investment. The price incentives would affect both supply and demand. From the perspective of the RTOs and organized markets, however, everything would be quite simple. There would be no material impact on the basic design of economic dispatch. A price on carbon is completely compatible with the necessary market design.

A common concern with a carbon tax is that it does not give certainty about the quantity of carbon emissions. However, it is not the quantity of emissions per se that is the issue, but rather the damage the emissions could cause. The purpose of the social cost of carbon estimate is to capture this damage as best we can, and let the quantity be determined that is consistent with that estimate. From this perspective, the quantity uncertainty is a feature but not a problem.

While it is imaginable (with a lot of imagination) that the states would get together with a proposal equivalent to a national carbon tax, and nothing else, and EPA could approve this as the ultimate in multi-state cooperation, we are very far away from this good outcome.

**EPA Estimated Marginal Abatement Cost in 2030 under the Clean Power Plan (2011\$/ton-$CO_2$)**[3]




One measure of how far the CPP deviates from this best-practices approach is to consider the EPAs own estimates of the implied price of carbon under the default approach of state-by-state implementation of its mass-based standard. The results in the accompanying map come from EPAs extensive documentation of its analysis for the state-by-state implementation.

The good news is that there is a great deal of analysis documented; the bad news is that it is not particularly transparent. For example, the EPA Regulatory Impact Analysis does not discuss the

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[3] The data field is the "Constraint Shadow Price" for the "#NSPS State $CO_2$ Constraint" by state in "US\$2011/ton" for the period "2028-2033(RY 2030)" in spreadsheet "Mass-Based SSR.xlsx" in sheet "All Constraints," (Environmental Protection Agency, 2015h). This follows the graphic by Michael Wara (Wara, 2015).

implications of these critical results for the implied carbon price. (Environmental Protection Agency, 2015k) These reported prices raise many questions. For example, presumably the \$0/ton-$CO_2$ for several states reflects policies that EPA deems as exceeding the BSER and the required mass-based standard, implying that the price is for the incremental effect of the EPA standard as a zero-cost option. Without going into the details of the underlying modeling, it is hard to know exactly why there are such great differences from a common carbon price or how this relates to EPA's own cost analysis. However, this is prima facie evidence that the default CPP proposal is far removed from being a cost-effective climate policy with a common price on carbon dioxide, with estimated marginal costs ranging from \$0-\$26/ton-$CO_2$ across states.

These prices differences present significant opportunities for unintended consequences in the likely attempts to exploit the implicit regulatory arbitrage benefits. They also point to the national advantages of trading.

### *Cap-and-Trade*

Setting a cap on national or regional carbon emissions, and then allowing trading of the associated emission permits, will induce a price on carbon. Absent material transaction costs, this price on carbon should settle at the equivalent carbon tax. As with a tax, the price on carbon would be observable in the trading market and would affect the variable cost of generation in essentially the same way as a tax.

The resulting price on carbon would be incorporated in the bids and offers in the electricity market. The process would be transparent and would not have any material effects on the electricity market design. Incorporating a price on carbon would be simple.

A principal problem with a cap-and-trade approach is the result can be an uncertain implied price of carbon. This has been an issue for the European Union, and the California cap has been designed with so many safety values producing a floor and a ceiling on price that it could be argued it is closer to a carbon tax. (Borenstein, Bushnell, Wolak, & Zaragoza-Watkins, 2014) Given uncertainty about benefits and costs, the optimal design would be a hybrid that is close to but not quite a carbon tax. (Pizer, 2002)

Under its trading rules, the CPP envisions banking but not borrowing of credits, which should further help smooth the price over time. Variation in price may be a problem for public policy, and will certainly be a problem for investors, but it should have little impact on the RTO market design or the integrity of the economic dispatch framework. As demonstrated with RGGI or the California counterpart, the RTO market model can adapt readily to a cap-and-trade approach.

### *Restricted Offers*

Absent an explicit price on carbon emissions, there could be an interest in presenting the RTO with multipart bids that amount to restricted offers. For example, a generating plant might be limited to operate for only a select number of hours in a day. Or the plant might be withheld except in emergency conditions. In principle, the multi-part daily offers could be consistent with the RTO market design and incorporated for individual plants.

Although the modeling and dispatch could accommodate some such restricted offers on a daily basis, at least two problems would confront the market. First, the restricted offers would produce higher total prices that could be similar to the prices that would accrue with a carbon cap. But the treatment and attribution of the price increases would be quite different and could complicate market acceptance.

Second, without an explicit carbon price, the "Restricted Offers" would involve the same actions found in the exercise of market power. In effect, a "Restricted Offer" would be the same as physical withholding. The RTO would lose the advantage of offer-mitigation as a simple and efficient means for constraining market power. This would put the RTO and the associated market monitors in a more difficult position in identifying and tracking the application of market manipulation through the exercise of market power.

Although the complications would not be insurmountable, reliance on restricted offers would reduce the efficiency of the dispatch and create complicated new oversight problems for RTOs.

### *Self-Scheduling*

Self-scheduling would be the extreme form of using restricted offers in a daily dispatch. The burden would be on each plant operator to make a judgement every day about the generation profile, rather than rely on economic dispatch.

This approach would raise the same problems in pricing and market monitoring as with restricted offers. However, the scale would be different and the difficulties would be more serious. In addition, substantial reliance on self-scheduling to meet environmental constraints would raise again the question of operational feasibility that produced the need for a coordinated dispatch.

When electricity restructuring was first considered, the so-called "Bilateral" model embraced self-scheduling as the natural way to organize any market. It took many years and expensive failed experiments to demonstrate finally that the special conditions created by interaction across the transmission grid made large scale reliance on self-scheduling both highly inefficient and a threat to operational reliability. (Hogan, 2002)

Any proposals for SIPs that essentially rely on self-scheduling will be a threat to the future reliability of the electricity system and would fundamentally undermine the hard-won progress in establishing the only workable framework for open access and non-discrimination in operation of the electricity grid.

### *Cumulative Constrained Dispatch*

The need for flexibility and the limits of restricted offers or self-scheduling will interact with the carbon emission standards that are almost certainly to be based on a time frame longer than a day. The CPP default calculations envision compliance based on averages over multiple years. Absent an explicit price on carbon and given the uncertainty associated with dispatch over the year, there might be a call to have cumulative carbon emissions as a constraint to be managed by the system operator. The state would specify the emissions to be counted, and the RTO would be left to ensure that the emissions did not exceed the limit at the end of the compliance period.

To be sure, with a cumulative compliance measure, someone must make the decision as to when and how much to emit from each source. However, when plant operators make these decisions and face both the upside benefits and downside risks, they will be in a position to make the commercial decisions about how to change the offer price for their plants. For the RTO however, there would be no commercial upside to balance the downside of failing to meet the restrictions. The result is likely to be a major problem for RTOs, lead to inferior dispatch over time, and produce conservative operation of the system that will create vocal losers and silent winners.

The problem of balancing across time is already an issue with energy limited facilities such as pondage hydro or isolated fossil plants with limited fuel storage. Converting all fossil fuel facilities into explicitly energy limited plants would materially complicate operation of RTO markets. This could produce increased cost and reliability problems when there are unusual operating conditions or weather conditions.

### *Deemed Cost Adders*

Absent an explicit price of carbon, a common idea borrowed from planning models is to impose a deemed cost adder to be included to alter the economic dispatch but not to be included in the direct compensation in the dispatch settlement system. In other words, the system operator would impose a carbon price for purposes of the dispatch but exclude that carbon price when determining market prices for the settlement system.

Although this may have surface appeal to some who want to avoid price signals, it would create a number of problems. For example, it would not leave prices unaffected. Depending on the particular rules, this approach would necessarily change the dispatch and therefore change the underlying total and marginal costs of operation. Somehow these changes in costs would have to be reflected in prices. Just how this would occur would depend on the particular rule for pricing.

However, a more serious problem would arise that would not depend on the particular rule for pricing. Since the locational prices based on marginal costs for the dispatch represent the only system for pricing that is consistent with the dispatch, any change must produce a set of prices that are inconsistent with the dispatch. It is these inconsistencies which create the false arbitrage opportunities that lead to market manipulation, and in the extreme case of the California crisis of 2000-2001 the complete breakdown of the electricity market.

We already know of the problems of dealing with out-of-market transactions, and the general trend is or should be to eliminate or minimize reliance on such transactions. The use of deemed cost adders would in effect make all carbon emission transactions out-of-market and compromise the effectiveness of market design. The RTOs are familiar with these problems and should be alert that the SIPs do not drive down this particular slippery slope.

### *Proliferating Subsidies*

Absent an explicit price on carbon, a more indirect approach for deemed cost adders would be to create extensive subsidy programs for the various CPP building blocks. For example, the introduction of renewables has depended on special production tax credits, investment tax credits, renewable portfolio standards and the like. So far these policies have been implemented through government programs or regulatory mandates on utilities. For the most part, the RTOs have been responsible only for dealing with the results as reflected in the bids and offers in the market, but there has been no significant need to change the market design to administer the subsidies.

A principal exception has been the ill-fated implementation of demand response pricing and the market benefit test required by FERC under its Order 745. (Federal Energy Regulatory Commission, 2011) The unhappy outcome was major litigation now under review by the Supreme Court.[4] That demand-response subsidy regime may fall away, but it is indicative of the

[4] "Federal Energy Regulatory Commission v. Electric Power Supply Association," Supreme Court Docket No. 14-840, 14-841.

problems that would confront market design and system operations when the purpose is to introduce expensive alternatives that are otherwise out-of-market.

Putting a price on carbon is not the same as providing a subsidy to carbon substitutes. As we have seen with the production tax credit (PTC) for wind, subsidies can have material effects on market prices. For example, the negative prices sometimes induced by the PTC can create other problems that require further intervention to counteract the unintended consequences.

The cost of renewable alternatives suggests that there will be even greater pressure to avoid the logical implications of carbon pricing and find subsidies that lower the apparent prices while increasing overall costs. This too is a slippery slope that RTOs should anticipate and avoid. A public policy reason for supporting subsidies as a second-(or third)-best approach does not translate into a good policy for requiring RTOs to administer and enforce the subsidy regime.

### *Capacity Market Tranches*

Although improvements are in the pipeline, operation of real-time energy markets has produced the familiar "missing money" problem where the profits in the electricity market are deemed not sufficient to support investment. Better pricing in real-time has not always been the highest priority, and the result has been development of capacity markets of various designs to make up the missing money in some of the RTOs. The problems with capacity markets are well known. (FERC-ISONE, 2014)

The fundamental purpose of capacity markets is to provide additional payments for capacity needed to meet the planning reliability requirements. The existence of a mechanism for procurement of capacity that is otherwise uneconomic could create a call to broaden the purpose and create special refinements of the capacity markets to meet the goals of the CPP by supporting otherwise uneconomic capacity that helps meet the CPP targets. Existing capacity markets already make distinctions about the amount of capacity that can be credited to a particular resource. The idea would be to create new tranches to give separate quotas for various renewable generation or energy efficiency programs. This may seem like a small step.

However, this seemingly small step would be a big leap for the RTOs. When capacity markets were first proposed, the idea seemed relatively simple and the duration of the commitment was modest. The problems that surfaced were serious enough. By contrast, the CPP building blocks for new generation or programs would add another cost on top of the missing money that these investments could earn in the capacity market. The scale and duration of the commitments likely would both be greater than for the capacity requirements to meet reliability standards. In effect, the RTO would see its full transformation from the operator of markets to the procurement agency for all long-term power contracts.

This would likely unravel the structure that depends on independence and efficient markets. It would be one matter to have tradeable permit or renewable energy credits systems administered by the states, with independent RTOs operating efficient real-time electricity markets across large regions. It would be quite another matter to have the RTOs take on the responsibility of deciding on the many competing investments and objectives for long-term procurement, and also try to be an unbiased operator of the plants they deemed worthy of investment. The costs and conflicts of just such a central, regulated procurement model were a key part of the problem that led to electricity structuring in the first place. (Hogan, 2002) The cost allocation issues for all but single state RTOs might be enough to cause the defection of states from the organized markets. All that has been achieved in organized markets could be undone as part of the collateral damage.

### *Environmental Dispatch*

Absent an explicit price on carbon, a version of modifying the dispatch is to change the objective function of the dispatch model.

> "Environmental dispatch is a policy in which the system operator explicitly considers environmental criteria (primarily air pollution emissions) when making dispatch decisions, even if the environmental impacts do not lead to an actual regulatory compliance cost." (National Association of Clean Air Agencies, 2015) (p. ES-7)

The extreme version of this would simply replace the objective function with emissions rather than the bid-based costs. In effect, only carbon would have a price and all other costs would be treated as zero.

While this could be done mechanically, there would be no prices in the settlement system to correspond to the actual costs of operation. Perhaps the RTO could work around this with a two-stage dispatch and pricing mechanism where the first stage minimizes carbon emissions and the second stage imposes the resulting emissions as the cap for the dispatch and minimizes total costs. Of course, this would then determine an implicit carbon price that would be included in the settlements system. But now the revenues would accrue to the RTO and not carbon emission permit holders. It is difficult to imagine where this leads, but it is hard to see the electricity market design surviving in this environment. This approach is consistent with one possible reading of the CPP, and EPA offers no discussion of why this would be a problem. Although it may seem far-fetched, RTOs should be alert to this alternative direction down a slippery slope.

## Conclusion

The Clean Power Plan sets a specific methodology for setting a rate-based limit on carbon emissions from existing affected generating units and provides flexibility to states regarding how they achieve these limits. The actual state implementation plans for meeting such standards will be the focus of potentially complicated policy discussions. The conversation could be lengthy and litigious. The challenge for the nation is to develop an efficient policy for reducing carbon emissions. The challenge for RTOs and their regulators is to make clear how environmental policies could mesh well with the necessary electricity market design. Environmental policies that put an explicit price on carbon would fit naturally with efficient markets. Absent an explicit price on carbon, RTOs should be alert to avoiding many variants of implementation mechanisms that lead to fundamentally undermining the operation of electricity markets.

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