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Assessing the Final Clean Power Plan

Emissions Outcomes

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Introduction

The U.S. Environmental Protection Agency's (EPA) Clean Power Plan (CPP) is the most significant greenhouse gas (GHG) policy ever undertaken in the United States, and is expected to achieve significant emission reductions by the time it is fully implemented in 2030. However, calculating the ultimate emissions-abatement potential is more difficult than simply adding up the state reduction targets. While the EPA has set a floor on cumulative emissions from existing fossil-fuel-fired power plants, it has not set a ceiling, and projecting the actual emissions outcome on a national level is not straightforward due to the flexibility states have in implementation.

In this note, we seek to deepen the understanding of the potential emissions outcomes of the CPP and what factors could influence that outcome. We start by explaining the primary factor that has the potential to undermine EPA's emissions floor—leakage—and how EPA is attempting to address this issue. We then turn to a quantitative analysis of two potential pathways for state implementation plans (SIPs) under optimal implementation conditions. Bearing in mind that optimal implementation is unlikely, we also explore key drivers and decisions that could result in emissions that are higher or lower than our initial projections.

Key messages from our work include:

- Both rate-based and mass-based implementation achieve similar levels of cumulative abatement under optimal scenarios.
- Mitigating leakage—defined as the migration of emissions from covered to non-covered sources—is rightly recognized by EPA as an important issue to be addressed in CPP implementation. The environmental integrity of the rule could hinge on the effectiveness of leakage-mitigation measures expected in the final model rule and federal implementation plan (FIP).
- In addition to leakage, other non-optimal implementation conditions such as significant implementation delay, mismatched and complex state plan choices, and nuclear retirements could all impact overall emissions abatement achieved by the CPP.

EPA's Goal: Ensuring Environmental Integrity of Rule while Providing Flexibility

In crafting the CPP, EPA had two overriding goals: first, ensuring that the rule achieves ambitious but feasible carbon dioxide emission reductions; and second, giving states maximum flexibility to achieve these goals. Encouraging ambitious reduction goals while maintaining state flexibility are laudable objectives but the complexity of implementation and resulting regulatory permutations across power markets makes determining the overall emissions outcome of the rule in advance more challenging. Moreover, providing states flexibility also has the potential to erode the rule's environmental integrity—a fact that EPA recognizes and has taken proactive steps to address.

The CPP applies only to existing sources because of the way that the Clean Air Act is written, requiring separate regulation of new and existing sources (EPA regulated new fossil-fuel-fired power plants under its New Source Performance Standard emission rate regulations finalized in August 2015). Under the final CPP, EPA's relied on a rate-based plan on existing power plants when calculating emission reductions required of states. Under the CPP rate-based plan, states have to demonstrate that their existing fossil-steam and natural gas combined-cycle (NGCC) plants meet EPA's emission targets, expressed in terms of pounds of CO₂ per megawatt hour. The rate-based standards are also in-line with four decades of regulatory precedent and statutory requirements under the Clean Air Act where performance standards are expressed as emission rates that each pollution source must meet or exceed.¹

Under the draft rule, EPA offered states the option to convert their rate-based goals into a mass-based goal (an absolute limit on greenhouse gas emissions from covered generation). However, many states asked for more clarity on the mass-based option and pushed EPA to streamline the pathway for incorporating a mass-based standard into their CPP state implementation plans (SIPs). States have decades of prior experience with mass-based standards for conventional air pollutants (and Regional Greenhouse Gas Initiative states have a decade of experience with a mass-based program regulating CO₂), while they have only limited experience with tradable rate-based standards on existing sources.²

In order to provide states with a diverse set of robust SIP pathways, the final CPP provides states with the option of either implementing the CPP under a rate-based standard or a mass-based standard on existing plants. EPA claims that both pathways are an equivalent application of the emissions goal. While the emissions goal may be equivalent between the two options and achieve comparable emission reductions, the economic incentives for generators is different in the two systems and leads to different outcomes for them.

¹ Under the Clean Air Act, EPA and states share authority to regulate existing sources. EPA has sole authority to permit new sources under the Clean Air Act. In regulating new sources, EPA typically employs rate-based plans.

² States have experience with mass-based trading programs, but EPA sets rate-based standards for new sources and there has not historically been trading on new sources.

Rate- versus Mass-based Standards

The choice between a rate- or mass-based standard presents a series of tradeoffs for states. A rate-based standard is an intensity standard and can therefore dynamically adjust to increases (or decreases) in electricity demand, whereas a mass-based standard establishes a finite limit on total CO₂ emissions, regardless of demand growth. A mass-based cap could be viewed by some stakeholders as a hard limit on electric power demand growth, though there are an array of low- and zero-emitting generation technologies (as well as demand-side measures) that could help to address any potential increases in demand.

Beyond the potential for growth, the other major difference between the two options is what entities can capture the economic rents from reducing carbon dioxide. States face tradeoffs on the control of compliance credits. Under a mass-based standard, states can control how emission allowances are distributed. They can opt to sell (generally by auction) some or all allowances and use the revenue for policy goals such as softening the impact of the CPP on ratepayers, and can distribute some or all allowances to adversely affected entities in their state, among other options. In a rate-based standard, however, states forgo control over credits—and therefore potential credit revenues—as all credits are created, bought, and sold among covered generators. Finally, the other major consideration for states in opting for a rate- or mass-based standard is how this choice will constrain or augment interstate trading opportunities, potentially lowering or raising the cost of compliance for regulated entities and consumers in their state. Under the CPP, EPA allows trading only between states of similar plan types, such that states that choose a rate-based standard can trade compliance credits only with other rate-based states (and the same goes for mass-based states).

Several factors may impact state decisions about which type of plan they will implement. These include:

Power exporters. Regulators in states that export significant amounts of power will likely take what their importing neighbors are doing into consideration, because harmonizing—or not—with the importing state impacts the value of the state's exports. Power exporters are therefore more likely to be open to the idea of interstate credit trading.

Critical mass. States that decide to pursue trading in order to lower compliance costs (or sell abatement) will want the most liquid market. Mass-based states that wish to engage in trading are allowed to trade only with other mass-based states, and rate-based states are allowed to trade only with other rate-based states. If a critical mass of states (not just how many but total size of covered generation) choose one option or the other, the available trading options in that system should be far broader and lower in cost than in the other system. Still, states will need to weigh compliance market opportunities against the relative stringency of their CPP requirements and available in-state abatement options. States still on the fence about trading may opt for the larger compliance system with an aim to lower compliance costs.

Utility footprint. In states where the dominant electric generators are investor-owned utilities with multistate footprints, these utilities may make a compelling case to regulators in both their states and adjacent states that compliance will be less burdensome and costly if the type of plan they implement is consistent across their entire footprint.

Power pool decisions. States that are part of organized wholesale power markets such as PJM and MISO joined these markets in order to reap the benefits of consistent market rules across a broad and diverse section of the power grid. Efficient operation of these markets is essential to maximize the benefits of participation. If states implement different types of plans that lead to inconsistent CO₂ compliance incentives across a power market, some amount of market efficiency will be compromised. States are likely to consult with other states in their power markets, and could agree to implement the same type of plan to maximize the efficiency of their power market (although this does not bias which type of plan the states could concurrently choose to implement).

Current regulatory infrastructure. Ten states already have mass-based CO₂ trading programs in place. Given the familiarity of these programs in these states (and the dozens of states that participate in mass-based conventional pollutant emission trading programs), it may be unlikely that they will opt for a rate-based SIP. There is also a group of states that have very few renewables and energy-efficiency deployment policies in place. A rate-based SIP pathway in these states will require substantial investment in evaluation, monitoring, and verification (EM&V) regulations and infrastructure before their plan would be approvable by EPA. Under a mass-based approach for existing sources only, EPA also requires EM&V rules as part of its broader allowance distribution framework to address leakage. A mass-based approach on existing and new sources is simpler and would require the least amount of up-front administrative investment.

In a rate-based system, fossil generators that don't meet the standard face a cost in the form of credits they must buy to achieve compliance with the program while fossil generators and eligible zero-emitting generators (such as new wind, solar, and nuclear plants) that exceed the standard receive compliance credits that can be sold for revenue. Put another way, any generator with an emission rate higher than the standard has an incentive to generate less (the cost of their generation is now higher, since they must purchase credits), while any generator with an emission rate below the standard has an incentive to generate more (the cost of their generation is now lower, since they receive credits for generation). While the incentives have shifted, on average, the entire fleet meets the rate-based standard. But all generators below the standard see a benefit, and all generators above the standard face a penalty.

In contrast, under a mass-based system, all covered fossil generators face a cost. Under a mass-based system, all generators who emit must hold allowances in an amount equal to their total emissions. The more these generators emit, the more credits they must hold and the higher total cost they face. Zero-emitting generation does not have to hold allowances because they do not have any emissions to cover. But they also do not receive any subsidy because they do not generate any compliance credits. Under a mass-based program, *all* fossil generators have an incentive to run less due to the cost of allowances while zero-emitting generators have an incentive to run more as power prices increase to reflect the cost of allowances. Since new fossil generators such as NGCCs are not covered by the CPP, there is a concern that emissions could “leak” from covered sources to uncovered sources depending on the structure of the emissions standards. In the final CPP, EPA recognizes the potential adverse emissions outcomes that could result and requires states to structure plans in a way that avoids them.

How EPA Addresses Leakage

EPA defines emissions leakage and a shift in emissions within a state from covered fossil generators to uncovered fossil generators. Under a rate-based plan, EPA found that leakage under this definition is unlikely to occur because existing NGCCs receive a subsidy through the creation and sale of compliance credits. This allows them to outcompete new NGCC generators within a state, thereby avoiding emissions leakage. Because this is not the case under a mass-based plan due to the different set of incentives—existing NGCCs face a cost under a mass system that new NGCCs do not, possibly resulting in a shift from existing to new generation (leakage). This shift in generation would undermine the overall environmental integrity of the CPP. Therefore, states implementing a mass-based plan have to go an extra step to demonstrate to EPA that their plan addresses leakage.

In an attempt to realign incentives to more closely match the emissions outcomes of a rate-based standard, EPA requires states to adopt one of three presumptively approvable leakage-mitigation strategies or create their own plan that demonstrates to EPA that they have addressed leakage. States opting for a mass-based standard have two options: 1) cover both new and existing generation under a cap that is slightly higher than the cap for existing sources alone, thereby eliminating the possibility of leakage from existing to new sources because all sources under one overall cap would face the same allowance costs; or 2) cover only existing fossil generators but

also include EPA’s prescribed allowance distribution approach to ensure that generators are compensated in a way that emulates the rate-based standard’s incentive framework. While this latter option meets EPA’s requirements for demonstrating that leakage is adequately addressed, it also constrains states’ options on how to use their allowance value. If states choose a cap on all generation (new plus existing), they are free to use all of their allowance value in any way they want.

While EPA is rightly concerned about emissions leakage between existing and new fossil sources within a state and is focused on solutions, the potential exists for other adverse emissions outcomes not captured under its leakage definition. There are two additional categories of potential adverse emissions outcomes. The first is interstate leakage, in which emissions shift from existing sources in one state to new sources in another state. The second is emissions increases from new fossil generators due to the replacement of generation from existing non-emitting generators such as nuclear and hydroelectric plants. We discuss both of these issues in further detail below.

Modeling Approach

To assess the emissions outcome of the CPP we model a reference scenario and two implementation scenarios in RHG-NEMS, a version of the National Energy Modeling System used by the U.S. Energy Information Administration (EIA). The reference case is keyed to EIA’s Annual Energy Outlook 2015 and includes all major energy and environmental policies except for the CPP.³ Our two CPP scenarios represent uniform, nationwide implementation of 1) a rate-based tradable performance standard covering existing fossil generators (Rate); and 2) a mass-based emissions standard covering both existing and new fossil generators (Mass). Table 1 describes each scenario. Targets for each scenario are derived from EPA’s CPP Final Rule. Specific annual targets are included in the appendix at the end of this note.

Table 1. Scenarios Analyzed in This Research Note

Policy Scenario	Description of Standard	Source Coverage	Trading	Credit Distribution	EPA Leakage-Mitigation Option Utilized
Mass	Single national mass-based standard	New and existing fossil generators subject to 111d	Nationwide, unrestricted trading	100% auction	Cap on new and existing sources
Rate	Single, uniform national emission rate standard	Existing fossil generators subject to 111d	Nationwide, unrestricted trading	To eligible resources (existing NGCCs, incremental zero-emitting generation, and incremental demand-side efficiency) based on generation/savings	No mitigation required

Source: CSIS and Rhodium Group (RHG).

³ The tax extenders for renewable energy that recently passed Congress are not included in our modeling in this note, but we hope to discuss the impacts of this development in our next note.

We chose to focus on these distinct implementation pathways for two reasons. First, the choice between rate- and mass-based standards is one of the first that states need to make, as many subsequent implementation decisions build upon it. The second is that the two pathways we model represent the most streamlined pathways to SIP approval provided by EPA.⁴

For both scenarios we assume optimal implementation of the standards. This means we assume all states submit SIPs on time, all SIPs meet EPA's approvability requirements, and all state standards are applied in 2022 at the start of EPA's mandated compliance period. Both the Rate and Mass targets follow EPA's glide path targets from 2022 through 2030 and then are flat after that. We also assume complete and unrestricted compliance credit trading between all states. Given the broader complexity of SIP design, and the additional constraints regarding allowance distribution imposed by a mass cap on existing units only, states may find it attractive to choose either a rate-based approach or mass-based standard on new and existing sources. We have selected to model these two pathways because neither option contains additional requirements for states to demonstrate leakage mitigation or adopt prescribed allowance distribution approaches.

We did not attempt to model outcomes from the millions of possible implementation permutations that could arise such as a patchwork of mass and rate standards across states, multiple credit-trading groups, and different source coverage between states with mass-based standards. Instead we analyze the best-case scenarios for smooth implementation. Later in this note we explore how emissions outcomes may deviate from our optimal scenarios due to different factors.

Modeling Results

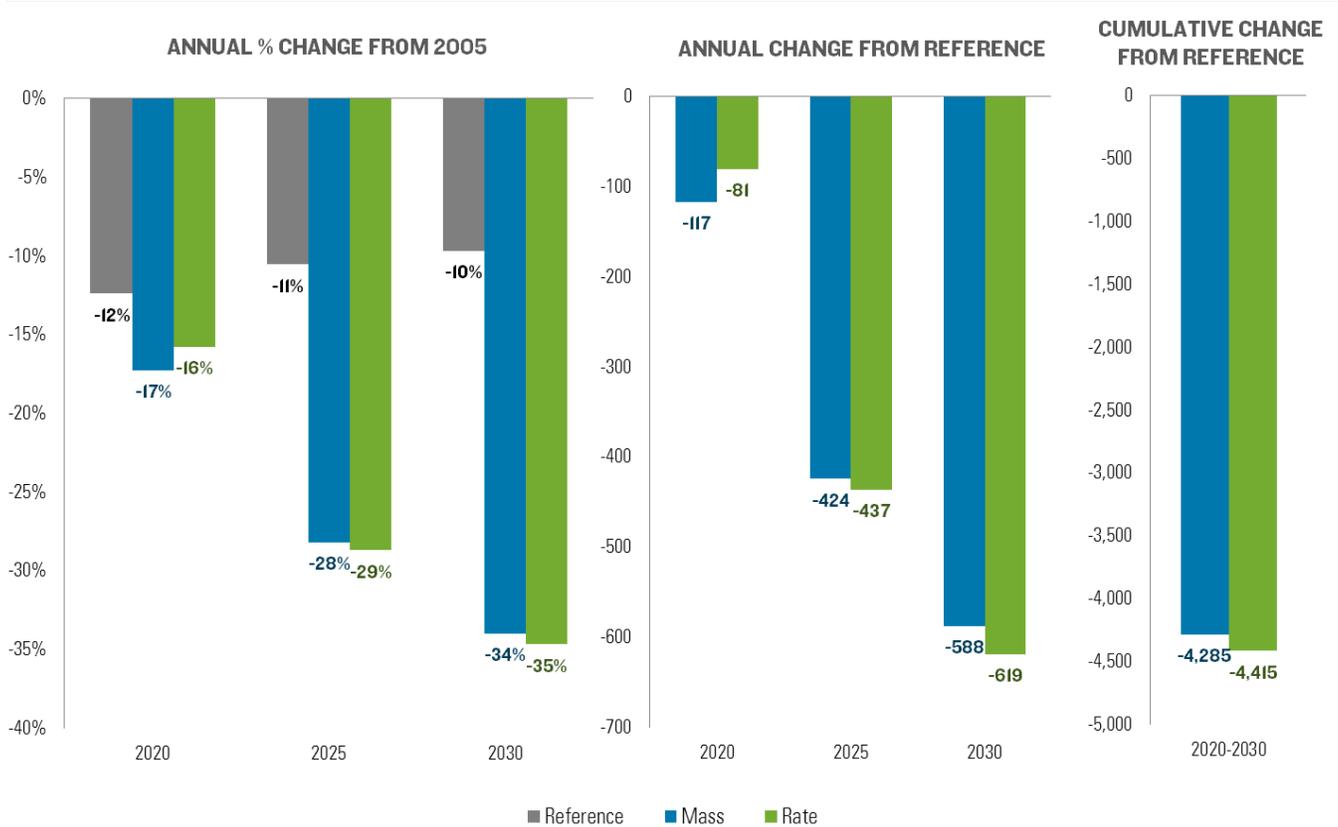
Under our two CPP implementation scenarios we find similar emissions results. Figure 1 shows results for the mass and rate scenarios compared to power-sector emissions in 2005 and compared to the reference case. Both scenarios achieve a little over 4 billion metric tons of cumulative abatement between 2020 and 2030, with practically no cumulative difference in abatement (the cumulative difference in abatement is about 0.1 percent). The general emission reduction pathway under both scenarios is also similar. Both achieve modest reductions of 117 and 81 million metric tons for Mass and Rate, respectively, in 2020 (RHG-NEMS has perfect foresight, and therefore power-sector participants anticipate the 2022 compliance start year and start making investments to address compliance in 2020). These reductions are roughly equal to a 16–17 percent cut in emission relative to 2005. From there, emission reductions gradually

⁴ In our model, the credits are auctioned (as opposed to being freely allocated) and the auction proceeds are not distributed. We chose this method of credit allocation because it is economically rational, according to the economic literature. See, for example, Lawrence H. Goulder, Marc Hafstead, and Michael Dworsky, "Impacts of Alternative Emissions Allowance Allocation Methods under a Federal Cap-and-Trade Program," Working Paper No. 15293, National Bureau of Economic Research, August 2009, <http://www.nber.org/papers/w15293>. In the rate scenario we assume states would credit the broadest available set of compliance options allowed by EPA.

decline, achieving 34–35 percent reductions relative to 2005 levels by 2030, or 588 and 619 million metric tons of abatement for Mass and Rate, respectively.⁵

The lack of any material emissions difference between scenarios is not surprising. EPA has argued that rate- and mass-based goals for states are designed to have equivalent stringency for existing fossil generators, and the modeling results demonstrate that to be the case.

Figure 1. Emissions under Mass and Rate Scenarios, 2020–2030



Source: CSIS, Rhodium Group analysis.

⁵ In its Regulatory Impact Analysis (RIA) of the final CPP, the EPA projected that the CPP will achieve a 32 percent reduction in power-sector CO₂ emissions relative to 2005. This is slightly less, though directionally the same, as what we find in our analysis. This relatively small difference can be explained by two factors: differences in historical data sources and different modeling frameworks. We rely on EIA data for historical CO₂ emissions data because of its consistency with NEMS output. EPA uses its own emissions data. The two sources may be different enough to explain some of the gap. EPA’s used a different model (the Integrated Planning Model) and different input and policy implementation than what we used in RHG-NEMS. These differences may explain the remaining gap.

Potential Departures from Optimal Implementation

While our modeling results capture the emissions impacts under optimal and nationally uniform rate- and mass-based SIP scenarios, we recognize that actual implementation is likely to look different from this perfect-world construct. Many factors could impact state decisionmaking, such as concerns about reliability, environmental impacts, infrastructure considerations, the cost to ratepayers, and the distributional impact within a state. The ultimate emission impacts of the rule will depend on the cumulative impact of thousands of major and minor state decisions encapsulated by 47 SIPs.

Below we outline several actions and issues that could cause actual emissions to deviate from our optimal scenarios. We also review several considerations and circumstances that may influence state decisions on how they implement the CPP.

Factors that could impact cumulative national emission reductions:

- Treatment of hot air credits.* We refer to hot air credits as surplus allowances or compliance credits that result from CPP requirements less stringent than what states will achieve under business as usual. States already on track to beat their abatement targets will likely have extra credits to sell into the market. Whether they choose to do so will impact the ultimate abatement impact of the rule. States holding these “hot air” credits must weigh the advantages and disadvantages of allowing some or all of their extra credits to be sold. The advantage of selling the extra credits is that they would provide a revenue stream for in-state entities. However, they are also a source of “non-additional” emission reductions. Stakeholders in states that wish to be more aggressive about national emission reductions may put pressure on state officials to retire (not sell) hot air credits, because in doing so, they will increase the overall abatement impact of the CPP. If hot air credits are retired rather than distributed into the trading market, emission reductions could be greater than what we present in this note. States that retire hot air credits also forgo any revenue or other use of the value of those credits.
- Patchwork implementation.* If all states choose rate-based plans or all states choose mass-based plans, the emissions impact, as detailed above, will be virtually the same. It is less clear what would happen under a system where some states opt for mass systems and other states opt for rate systems. Such a mixed or patchwork rate and mass system would provide different incentives for generators in different states. It is difficult to predict what would happen to emissions, but a mixed system could result in greater or fewer cumulative emissions. Patchwork implementation probably increases the chances of interstate leakage, but it is challenging to estimate a range of outcomes without further information about state SIP decisions. In the final CPP, EPA acknowledged these potential issues but chose not to attempt to quantify potential impacts for the same reasons we discuss here. As states begin to make SIP choices, the range of potential outcomes will be less speculative and easier to quantify.

- *Intrastate leakage.* As discussed above, EPA has tried to minimize leakage from existing fossil generating units to new NGCC units by requiring states to demonstrate that they will address this issue. EPA solicited comment on its preferred mitigation measures and will finalize requirements under a final model rule and federal implementation plan. If these provisions are not effective and there is a shifting of generation to new NGCCs not covered by a state plan, emissions could be higher than we present in our scenarios.
- *Interstate leakage.* Putting aside the question of whether or not EPA's intrastate leakage provisions will be effective, EPA's leakage definition pertains to shifts in emissions from existing sources to new sources within a single state, not between states. Interstate leakage is not explicitly prevented in the CPP, due to requirements under the CAA that EPA must set performance standards within a state (not across states or nationally). Interstate leakage is most likely to occur where there are many different types of plans (not just rate versus mass, but states choose different pathways to address intrastate leakage). For example, consider two states with mass-based programs, where the first has a cap on existing sources only, and the other has a cap on new sources and existing sources. In this example, the state with a cap only on existing generation could see a surge in new NGCC generation and associated emissions even if there is no corresponding decline in generation from existing sources. Instead, emissions are leaking from the state with a cap on new and existing source via interstate trade in electricity. Any instance of interstate leakage could result in higher emissions than we present in this note.
- *Loss of existing zero-emitting baseload generation.* Rate and mass plans have different implications for existing zero-emitting generators such as nuclear and hydroelectric plants. If it is a policy goal of the state to maintain the existing zero-emitting generation fleet in its state, then the choice of implementation plan (rate versus mass, and mass with a cap on only existing or on new plus existing) matters. For example, under most plan options, holding all else equal, if an existing nuclear plant retires, economics dictates that new NGCCs are likely to provide the replacement generation, leading to an increase in emissions compared to our results. Under a rate-based system, this is allowed because both existing nuclear generators and new NGCCs are not covered by the rate plan and, therefore, as the lowest-cost baseload option, NGCCs will be built to make up the generation shortfall. Under a mass-based plan with a cap on existing generation only, NGCCs could also make up the difference. EPA requires that states prove that generation does not shift from existing covered generation (e.g., fossil-fuel plants) to new generation. In the case of nuclear retirements, however, generation is not technically shifting between covered existing sources and new sources, since nuclear is not a covered existing source. Therefore, if a nuclear plant retires, new NGCC generation could fill the gap without being considered "leakage," leading to higher emissions than what we report in this analysis. States can circumvent this issue by implementing a mass-based plan on existing and new sources. However, while they will avoid the possibility of higher emissions in the event of

nuclear retirement, the cost of meeting the generation shortfall were a nuclear plant to retire would be higher than under a plan with no cap.⁶

- *Implementation delays.* States that are resistant to the rule may attempt to drag out implementation through legal challenges or other means, ultimately affecting the timing of abatement. This is especially true if the courts issue a stay on the rule. Even without a stay, however, states may find ways to delay implementation. States and EPA may differ, for example, about whether they have demonstrated reasonable progress in submitting an interim SIP, and may have extended discussions once a SIP is submitted and prior to its approval. Moreover, were EPA to reject a state's SIP, the state could petition the court to review it, possibly further delaying implementation. If several states with large emission-reduction requirements delay implementation by a year or if a stay is issued and implementation is delayed, EPA has the regulatory authority to tighten the cap before the end of the implementation period. If implementation is delayed and EPA does not revise the cap, however, then national emission reductions will be less than what we present in this note. Cumulative abatement between 2020 and 2030 could also be lower.
- *Clean Energy Incentive Program (CEIP) implementation.* The CEIP is an optional, proposed crediting system that would provide participating states with credits for any qualifying renewable energy projects or energy efficiency projects in low-income areas in 2020 and/or 2021 (before the 2022 initial compliance year). State decisions about whether to pursue CEIP credits will not necessarily impact the cumulative emission impact of the rule, but would pull abatement to 2020 and 2021 just before the beginning of the first compliance period.

Conclusion

Under an optimal implementation scenario, both the rate-based and mass-based approaches modeled here achieve similar levels of cumulative abatement. The two cases are not necessarily representative of how CPP implementation will occur since states have a variety of factors to consider when choosing a plan to pursue in their state and non-optimal implementation conditions like significant implementation delay, mismatched and complex patchworks, and the possibility of nuclear or other zero-generation retirements. Each of these factors could impact overall emissions abatement. We will be exploring the energy market impacts of these two scenarios, including fuel prices, generation and installed capacity, and ratepayer impact, in the final note in our CPP series due out later this winter.

⁶ For a deeper discussion of this issue and the potential emission implications, see John Larsen, "Nukes in the Crosshairs: Can the Clean Power Plan Save the Day?," Rhodium Group, November 12, 2015, <http://rhg.com/notes/nukes-in-the-crosshairs-can-the-clean-power-plan-save-the-day>.

Appendix: National Goals Used in Modeling Scenarios

Scenario	Standard units	2022	2023	2024	2025	2026	2027	2028	2029	2030 and beyond
Rate	lbs./MWh	1,405	1,360	1,298	1,263	1,228	1,192	1,159	1,125	1,092
Mass	Million metric tons	1,858	1,804	1,739	1,710	1,678	1,643	1,615	1,585	1,551

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