WESTERN RESOURCE ADVOCATES

Protecting the West's land, air, and water

CARBON REDUCTION CREDIT PROGRAM

A State Compliance Tool for
EPA's Clean Power Plan Proposal

By Steven Michel and John Nielsen[1]

November 12, 2014 (revised)

<u>Working Paper</u>

This paper is distributed for comment and discussion.
Comments can be provided to:

Steven Michel
Chief Counsel, Energy Program
smichel@westernresources.org

John Nielsen
Director, Energy Program
john.nielsen@westernresources.org

CARBON REDUCTION CREDIT PROGRAM

A State Compliance Tool for
EPA's Clean Power Plan Proposal

Abstract: A credit-based carbon dioxide (CO_2) emission rate reduction program for existing power plants is presented. This program provides an easy-to-administer system for state policymakers and regulators to comply with federal guidelines under Section 111 of the Clean Air Act (CAA), currently being developed by the Environmental Protection Agency (EPA). The proposal awards carbon reduction credits (CRCs) to generators and others based upon their output and CO_2 emission rate relative to EPA-approved standards. Owners or operators of regulated facilities then retire CRCs in sufficient amounts to demonstrate emission rate compliance. The standard is flexible, technology neutral and market based. CRCs are tradable, and the program is designed so that policymakers can begin implementation at the state level and later merge into multi-state or regional efforts, if desired. An appendix provides model regulatory language.

1.0   Introduction

On June 25, 2013 President Obama spoke at Georgetown University and laid out his Administration's plan to address climate change. Among the items identified by the President were carbon pollution standards established by the Environmental Protection Agency for new and existing power plants. Section 111 of the Clean Air Act is the statute EPA is using to develop its proposals, with subsection (b) applying to new sources and subsection (d) applying to existing sources. On September 20, 2013 EPA issued its new-source proposal and on June 2, 2014 the existing-source proposal was released. The standards for new sources are to be finalized in January 2015, with final existing-source standards to follow in June 2015. State compliance plans are to be submitted in 2016, with some opportunities to extend that date. Both the President and EPA have emphasized the prominent role states will play to develop specific regulatory programs that work best for them in implementing EPA's standards.

2.0   Overview of EPA's Proposals

EPA's proposals for new and existing power plants limit the rate of emissions, in pounds of CO_2 per megawatt-hour of electricity produced, rather than the total mass (e.g. pounds or tons) of emissions. This type of policy is often referred to as an emission performance standard.

For new sources, which are facilities that meet a threshold size and for which construction commenced after the September 20, 2013 proposed rule release date, the proposed standard is between 1000 and 1100 pounds of CO_2 per megawatt-hour (lbs/MWh), depending on the resource type and measurement period. These rates are comparable to those of a gas-fired power plant. In other words, as long as a new source emits at a rate no greater than approximately 1000-1100 lbs/MWh, it would be permitted.

EPA's existing-source proposal identified the specific fossil-fueled power plants in each state – referred to as electric generating units or EGUs – which would be subject to the regulation. The agency then established emission rate standards for the years 2020 to 2030 and thereafter, to be achieved across all of each state's affected EGUs.

EPA's emission rate standard is based upon the "best system of emission reduction" (BSER) available in each state during the 2020 to 2030 period. BSER includes four "building blocks." Building block 1 is heat rate

improvements at EGUs. Building block 2 is re-dispatch from coal-fired to gas-fired facilities. Building block 3 is the deployment of zero-emission resources such as renewable or nuclear energy. Building block 4 is reducing demand for generation through energy efficiency. In developing its proposed standards EPA determined each state's 2012 emission rate and then calculated what rate could be achieved in that state over time using the BSER available in that state. As an example, EPA determined that Colorado's EGUs could achieve an overall emission rate of 1159 pounds of CO_2 per megawatt-hour between 2020 and 2029, and 1108 lbs/MWh in 2030 and beyond.

An important part of EPA's proposal is to allow states to count savings from energy efficiency, and production from renewable energy and some hydro and nuclear power,[2] toward meeting their standards. To do so, EPA allows the energy associated with these zero-emission resources to be included in calculating, and lowering, a state's overall EGU emission rate.

This paper describes a state regulatory framework which relies on a system of tradable carbon reduction credits to implement EPA's existing-source emission rate standard.[3] The program would be overseen by state air regulators, in cooperation with state utility commissions.

3.0   Why Develop a Carbon Reduction Credit Program?

Before describing the Carbon Reduction Credit Program, it is important to understand why such a program would be helpful to a state crafting a compliance strategy.

EPA's proposal establishes *statewide* standards. It is left to states to translate those statewide requirements into specific, enforceable requirements for regulated facilities. Concerns have been expressed that EPA's proposal would be complicated and expensive to implement, difficult to enforce, and could place state or federal environmental regulators in a role typically reserved for state public utility commissions – overseeing and enforcing specific state renewable energy and energy efficiency requirements, and power plant development and operation. A well-designed state program would overcome these concerns and would also be fair, so that facilities assume responsibility for their impact on state compliance. The program described in this paper satisfies these objectives. In particular, the program's advantages include:

1. **Simplicity:** Uses a straightforward emission accounting mechanism to assure compliance with the statewide emission rate standard.

2. **Clarity:** Preserves the traditional roles of utility regulators and air regulators and identifies for each EGU what its compliance obligation is, and how to comply.

3. **Enforceability:** Contains specific state enforcement provisions to assure that state control of renewable energy and energy efficiency programs, as well as power plant development and operation, is preserved.

4. **Fairness:** Assigns credit and responsibility to facilities based upon their impact on state compliance.

5. **Low cost:** Creates a statewide trading platform to assure the most economic CO_2 reduction opportunities can be deployed. The program is designed so that it can be expanded over time into a multi-state or regional effort that can further reduce cost.

4.0   The Carbon Reduction Credit (CRC) Program

The Carbon Reduction Credit Program uses a tradable credit system[4] to implement EPA's proposed existing-source performance standards. The program awards carbon reduction credits, or CRCs, based on the CO_2 emission rate and output of generators over time, and requires credits to be periodically retired to demonstrate compliance with EPA's standard. Under this program, for each MWh of electricity produced (or saved with

energy efficiency), one credit is awarded for each pound of emissions less than that permitted by EPA's proposal. To the extent that a source emits at a rate greater than the EPA-approved standard, a credit deficit is established. The program accommodates trading, either intrastate or interstate, to enable excess reductions from one facility to be used for compliance at a deficient facility. One of the attractive features of this program is that it can be developed incrementally – starting with individual state programs that, over time, could link together into multi-state and regional efforts.

4.1   The Mechanics of the Program

There are three steps in administering the program. The first is to provide credits, or establish credit deficits, each year for each affected electric generating unit in a state based upon its output and emission rate relative to the EPA-approved state standard for that year. The second task is to award credits to eligible zero-emission resources (e.g. renewable energy, nuclear energy and energy efficiency) based upon their output or savings each year. The final task is to require EGUs to annually retire enough credits to offset any credit deficit they have at the end of the relevant compliance period.

4.1.1   Provide Credits or Establish a Credit Deficiency for Electric Generating Units

The first step is to provide credits, or establish a credit deficiency, for each affected EGU in the state each year. To do so, state air regulators would determine, each year, the emissions for each of the EGUs that EPA has identified as affected facilities in the state. EPA prescribes acceptable procedures for measuring emissions in its proposed rule. Additionally, owners or operators of affected EGUs would measure and report the megawatt-hours produced by their facility during that same annual period.

To determine the number of credits each EGU receives, regulators would compare the emission rate of the EGU in a compliance year to the required standard for that same year. Each generator would receive one carbon reduction credit for each pound of CO_2 per megawatt-hour that its emission rate was less than the standard in that year, multiplied by the output in that year. So, if the standard was 1200 lbs/MWh in a particular year, and a generator produced 1000 MWh with an emission rate of 1000 lbs/MWh, that generator would receive 200,000 credits for that year.

$$\left(1200\frac{lbs}{MWh} - 1000\frac{lbs}{MWh}\right) * 1000\ MWh * 1\frac{CRC}{lbs} = 200{,}000\ CRCs$$

Mathematically, the number of CRCs provided to a facility each year can be shown as:

$$CRCs = (R_{STATE} - R) * E * C$$

R_{STATE} is the state's CO_2 emission rate (lbs/MWh) standard for that year
R is the CO_2 emission rate (lbs/MWh) of the facility in that year
E is the output, i.e. net[5] energy (MWh), produced by the generator during the year
C is the conversion factor of 1 CRC per pound

Facilities that emit CO_2 at a rate greater than the standard for that year would have a credit deficiency (negative credits), using the same formula as above. This is important because EGUs with credit deficits will have a compliance obligation to the extent of that negative balance, which they would meet by acquiring or earning CRCs. At the end of a compliance period, an EGU will be in compliance with the standard if it does not have a credit deficit.[6] Provided that none of the state's EGUs have a credit shortfall, the state will be able to demonstrate compliance with EPA's performance standard.

4.1.2 Provide Credits to Eligible Zero-Emission Resources

The second step is to provide credits to zero-emission resources. EPA has identified zero-emission (renewable and some nuclear and hydroelectric) energy production and energy efficiency programs as emission reduction systems that states can use to reduce the emission rates of their generation portfolios. Because these measures produce or avoid megawatt-hours and have zero emissions, EPA has authorized the energy associated with either measure to reduce the average emission rate for all generators in a state. To receive credit for either zero-emission energy or energy efficiency,[7] a state would determine the energy production or, in the case of energy efficiency, the savings.

Those financially responsible for the development of these resources, e.g. the utility or renewable energy certificate (REC) holder, would be entitled to receive CRCs. The program described here would allow any renewable or efficiency resource, regardless of where it produced or saved energy, to receive CRCs in a state so long as safeguards were in place to prevent duplicative CRC awards. Allowing out-of-state providers to receive CRCs is consistent with the "system" of emission reduction EPA has identified. If state law defines RECs to include *all* environmental attributes, CRCs would be awarded to a REC holder only if that person or entity committed to retire the RECs in the same state where the CRCs are used for compliance, or to hold the RECs until they expire.

The award of credits to renewable energy, eligible nuclear and hydroelectric energy, and energy efficiency is straightforward, and uses the same formula as for EGU's above except that the resource emission rate is zero. Put another way, for every megawatt-hour produced or saved in a year, these measures receive credits equal to the state's emission rate standard for that year. EPA has prescribed specific metering requirements to measure renewable energy production, and intends to develop evaluation, measurement and verification (EM&V) protocols for energy efficiency as part of its final rule. The CRC program would also allow aggregated renewable distributed generation, such as rooftop solar, to receive credits for its metered production. Using the scenario above with a 1200 lbs/MWh standard, if a renewable resource produced 1000 MWh, or an efficiency measure reduced consumption by 1000 MWh, 1,200,000 CRCs would be awarded.

$$\left(1200\,\frac{lbs}{MWh} - 0\,\frac{lbs}{MWh}\right) * 1000\,MWh * 1\,\frac{CRC}{lbs} = \ 1,200,000\,CRCs$$

4.1.3 Retire Carbon Reduction Credits for Compliance

The final task of this regulatory mechanism is to annually require the retirement of credits to ensure compliance with the standard. This obligation is on each affected EGU. The number of credits to retire equals the credit deficit, if any, that an EGU accumulated during the compliance year. So, if a generator had a credit deficit of 100,000 at the end of a compliance year the EGU would need to retire 100,000 credits. Any person, entity or generator that was awarded credits at any time would have those credits available to provide or sell to deficient EGUs. Put another way, an EGU whose emissions exceed the state standard emission rate in a year would offset its excess emissions through the retirement of CRCs. Those CRCs represent emission reductions beyond the standard at another EGU, or created by an emission reduction measure. Under this program, until retired for compliance, credits can be banked, sold or traded, and do not expire.

4.2 Example of a Compliance Strategy

This section provides an example of a system with three types of generation to demonstrate how various aspects of the program work. Appendix A provides three additional examples. It is important to emphasize that EPA does not require use of building blocks, or their use in specific amounts, to achieve compliance. In addition to the building blocks, covered facilities can use power plant retirements, plant ramp-ups and ramp-downs, and

reworked maintenance schedules to assist in achieving compliance. This program also allows EGUs to purchase, sell, trade or bank CRCs as a part of an overall compliance strategy.

In our example we look at a system with three types of generation: coal, gas and wind, emitting 2000, 1000 and 0 pounds of CO_2 per megawatt-hour, respectively. The coal and gas plants are EGUs with a compliance obligation, and the wind facility is an emission reduction measure. Each generator also produces 1000 MWh. If a state's standard in a particular year is 800 lbs/MWh, we have the following CRC awards or deficits:

$$Coal: \left(800\frac{lbs}{MWh} - 2000\frac{lbs}{MWh}\right) * 1000\ MWh * 1\frac{CRC}{lbs} = -1{,}200{,}000\ CRCs$$

$$Gas: \left(800\frac{lbs}{MWh} - 1000\frac{lbs}{MWh}\right) * 1000\ MWh * 1\frac{CRC}{lbs} = -200{,}000\ CRCs$$

$$Wind: \left(800\frac{lbs}{MWh} - 0\frac{lbs}{MWh}\right) * 1000\ MWh * 1\frac{CRC}{lbs} = 800{,}000\ CRCs$$

$$Net = -600{,}000\ CRCs$$

For the state to come into compliance, resources must adjust in a way that offsets the deficit of 600,000 CRCs, and then exchange credits such that each EGU (fossil generator) has a zero or positive balance. There are many ways to adjust the resources to accomplish a zero-balance outcome. One way would be to increase renewable energy generation by 750 MWh, which earns 600,000 CRCs. A second is to ramp down coal generation by 500 MWh, which reduces its CRC deficit to negative 600,000. A third way is to re-dispatch 600 MWh from coal to gas-fired generation, which creates a zero balance across the three resources. In each case the state would be compliant, and it would be left to the EGUs to acquire sufficient credits to establish a zero balance:

1) Increasing renewables or efficiency by 750 MWh adds 600,000 CRCs:

$$\left(800\frac{lbs}{MWh} - 0\frac{lbs}{MWh}\right) * 750\ MWh * 1\frac{CRC}{lbs} = 600{,}000\ CRCs$$

2) Ramping down 500 MWh of coal reduces the coal CRC deficit from 1,200,000 to 600,000:

$$\left(800\frac{lbs}{MWh} - 2000\frac{lbs}{MWh}\right) * 500\ MWh * 1\frac{CRC}{lbs} = -600{,}000\ CRCs$$

3) Re-dispatching 600 MWh of coal to gas balances the CRCs across the three resources:

$$Coal: \left(800\frac{lbs}{MWh} - 2000\frac{lbs}{MWh}\right) * 400\ MWh * 1\frac{CRC}{lbs} = -480{,}000\ CRCs$$

$$Gas: \left(800\frac{lbs}{MWh} - 1000\frac{lbs}{MWh}\right) * 1600\ MWh * 1\frac{CRC}{lbs} = -320{,}000\ CRCs$$

$$Wind: \left(800\frac{lbs}{MWh} - 0\frac{lbs}{MWh}\right) * 1000\ MWh * 1\frac{CRC}{lbs} = 800{,}000\ CRCs$$

Under each of these scenarios the overall state emission rate is compliant at 800 lbs/MWh:

1) Increase renewables or efficiency by 750 MWh: $\dfrac{3{,}000{,}000\ lbs}{3750\ MWh} = 800\ lbs/MWh$

2) Ramp down 500 MWh of coal: $\dfrac{2{,}000{,}000\ lbs}{2500\ MWh} = 800\ lbs/MWh$

3) Re-dispatch 600 MWh coal to gas:
$$\frac{2,400,000 \; lbs}{3000 \; MWh} = 800 \; lbs/MWh$$

5.0   Additional Topics

In this section we discuss two additional topics of importance to regulators and policymakers. The first has to do with exchanging credits between state programs. The second is a discussion of rate impacts to electricity customers under this program.

5.1   Linking State Programs Using a Carbon Reduction Credit Approach

There are many policies that can be used to drive CO_2 emission reductions. Of these, however, market-based systems are often able to deliver the most economic outcomes. This is both because a market-based system makes the lowest cost emission reductions available throughout the participating market, and because competition in markets will drive innovation and new technology.

The effectiveness of market-based systems can be increased by linking with other, perhaps differently designed, market-based programs in order to expand the area of participation. EPA has identified multi-state and regional programs as a possible compliance strategy for Section 111(d). The CRC program described here has this linkage potential. While *intrastate* credit exchange among sources is straightforward under this program, the different state stringency requirements of EPA's proposed regulation make *interstate* linkage more complex.

One way to develop a multi-state or regional program is for participating states to adopt a single, weighted-average stringency requirement for EGUs across the states. Because EPA has assigned each state a different stringency requirement, and those requirements are rate-based rather than mass-based, developing a uniform requirement that achieves the same overall outcome as stand-alone programs could prove challenging. In addition, states with weaker stringencies may be reluctant to accept higher, averaged, requirements for their EGUs.

At the same time, if two linking states do not adopt a uniform stringency, but simply agree to accept each other's credits at face value, there will be an incentive for low or zero emission resources to obtain CRCs in the state with the weaker, i.e. higher, emission standards. This is because those resources will receive a greater number of credits in the state with the higher standard. For example, 1 MWh of renewable energy in a state with a 2000 lbs/MWh standard would receive twice the number of credits as an identical resource in a state with a 1000 lbs/MWh standard. A similar issue exists with natural gas plants that could earn more credits by increasing production in one state over another. This is a "leakage" problem that advantages some states in a multi-state program over others for resource credits and siting, and compromises the overall emission outcome EPA's program would otherwise achieve.

To examine this issue in more detail, assume that both State A and State B have EGUs producing 2000 MWh with emissions of 1500 lbs/MWh. In a particular year, State A has a stringency requirement of 1000 lbs/MWh and State B has a stringency requirement of 500 lbs/MWh. Acting alone, State A would need to add 1000 MWh of renewables to achieve compliance:

$$\frac{\left(1500 \frac{lbs}{MWh} * 2000 \; MWh\right) + \left(0 \frac{lbs}{MWh} * 1000 \; MWh\right)}{3000 \; MWh} = 1000 \frac{lbs}{MWh}$$

And State B, also acting alone, would need to add 4000 MWh of renewables to achieve compliance:

$$\frac{\left(1500\frac{lbs}{MWh}*2000\ MWh\right)+\left(0\frac{lbs}{MWh}*4000\ MWh\right)}{6000\ MWh} = 500\frac{lbs}{MWh}$$

In total then, acting separately, 5000 MWh of renewables would be needed for compliance in the two states. If the two states linked, but did not adjust imported credits, then compliance could be achieved with only 3000 MWh of additional renewables credited in State A. This is because the CRC deficiency in the two state programs would be:

$$State\ A: \quad \left(1000\frac{lbs}{MWh} - 1500\frac{lbs}{MWh}\right)*2000\ MWh*1\frac{CRC}{lbs} = -1{,}000{,}000\ CRCs$$

$$State\ B: \quad \left(500\frac{lbs}{MWh} - 1500\frac{lbs}{MWh}\right)*2000\ MWh*1\frac{CRC}{lbs} = -2{,}000{,}000\ CRCs$$

And if the two states linked and accepted imported credits at face value, they could comply by simply crediting 3000 MWh of renewables in State A, where they receive 1000 CRCs per MWh. A solution to this leakage issue is for states with different stringencies to link their programs, preserve their respective standards, and adjust the number of out-of-state credits as though they were created in the recipient state.

To accomplish this adjustment and assure there is not a reduction in the MWh of lower emission rate energy caused by a CRC exchange, a state would adjust out-of-state CRCs by the following ratio:

$$\frac{(R_c - R_{crc})}{(R_o - R_{crc})}$$

R_c is the emission rate standard in the compliance state
R_o is the emission rate standard in the origin state
R_{crc} is the emission rate of the entity awarded the CRC[8]

This adjustment requires two notations to be made to CRCs as they are issued. The first is to note the state where the CRC is issued. The second is to note the emission rate of the entity earning the credits. As an example, CRCs earned by a combined-cycle natural gas plant could be noted as originating in Wyoming from an 850 lbs/MWh resource. For renewable energy and energy efficiency, the emission rate is zero.

To illustrate this concept using the example above, State B would reduce State A's CRCs by one-half:

$$\frac{\left(500\frac{lbs}{MWh} - 0\frac{lbs}{MWh}\right)}{\left(1000\frac{lbs}{MWh} - 0\frac{lbs}{MWh}\right)}$$

When that is done, the intended 5000 MWh rather than 3000 MWh of renewable energy must be developed to achieve compliance. More broadly, this adjustment allows 5000 MWh of renewable resources to be developed and credited in either state without a locational preference created by the different stringencies. If all the renewables are credited in State A, 5,000,000 CRCs are awarded,[9] with 4,000,000 used to achieve State B compliance (reduced by one-half) and 1,000,000 used in State A. Conversely, if all 5000 MWh of renewables are credited in State B, 2,500,000 State B CRCs are awarded, with 500,000 used in State A to achieve compliance (increased by a 2 to 1 ratio), and 2,000,000 used in State B. We believe this adjustment avoids the locational incentive to credit resources in State B over State A, and preserves the overall stringency of EPA's proposed program. An example using this same adjustment factor with CRCs from gas-fired generation is provided in Appendix A.

As a final note, while EPA's rate-based stringency proposal lends itself to a ratio mechanism, that may not be the case for other types of compliance programs such as a mass-based approach that EPA might allow, or existing cap & trade programs in the Western and Eastern United States.[10] These cap & trade programs include rigorous protocols with strict carbon accounting to assure specific tonnage outcomes. Linking mass-based programs with rate-based mechanisms that lack a cap on overall emissions could dilute the outcome in the mass-based jurisdictions. To link these mixed types of programs, therefore, the price of credits from the less rigorous program might be further discounted to reflect the uncertainty of the tonnage outcome.

5.2 Electricity Rate Impacts

In developing this program, several provisions have been included to ensure that the rate impact of this regulation on electric utility customers is minimized.

The first involves matching the periodic compliance obligation to the lumpiness of typical utility resource development and retirement. This lumpiness can create short-term credit shortfalls that would be difficult or costly to address. To mitigate this concern, credits do not expire unless retired for compliance, and can be banked, sold or exchanged - providing flexibility for generator compliance.
In addition, to assure that market failures or other dislocations do not create short-term credit scarcities and extraordinary prices, an affected EGU that is unable to comply with the standard in a particular compliance period would be permitted to make up its deficiency within twelve (12) months by retiring 125% of the CRC shortfall. This provision protects against price spikes if the market temporarily fails. Requiring non-compliant EGUs to later retire 125% of their deficit should provide a strong incentive for timely compliance.

Finally, it is worth noting that the rate impacts associated with this program will be small. To understand the magnitude of the rate impact, consider a typical utility with an average electricity rate of $100/MWh and an overall emission rate of 1400 lbs/MWh. If the utility has a 30% reduction requirement by 2030 and can reduce emissions at a cost of $0.015 per pound ($33 per metric ton),[11] the *total* increase to electricity rates, from today's levels, in 2030 would be 6.3%, or 0.4% per year on average.

$$1400\,\frac{lbs}{MWh} * 30\% * \$0.015/lbs = \$6.30/MWh \text{ (i.e. 6.3\% of \$100)}$$

6.0 Conclusions

The Environmental Protection Agency has issued proposed emission rate standards to be achieved between now and 2030. Once those standards are final, states will be tasked with developing state programs to effectuate them. We believe the Carbon Reduction Credit Program described in this paper fits well with state interests and provides a flexible, low-cost, market-based and technology-neutral approach that states can use to comply with EPA's proposal. The program also allows states to develop stand-alone programs that can later merge into broader multi-state or regional efforts.

Appendix A provides examples of how the program works, and Appendix B provides model regulatory language that states could use as a starting point to effectuate the concepts described in this paper (using Colorado as an example).

APPENDIX A

In this Appendix, we provide three examples of compliance strategies and how they would work in the CRC Program, and one example showing how the exchange ratio works with gas-fired generation using CRCs across state lines. The first compliance strategy involves a re-dispatch of generation from coal to gas. The second involves adding renewable energy. The third utilizes each of the four building blocks identified by EPA.

1)   Re-dispatch generators

First, we look at the example of a re-dispatch program that moves 1000 MWh of production from coal to gas. Prior to re-dispatch, a coal plant produces 2000 MWh and emits 2000 lbs/MWh. At the same time, an available gas plant would emit 1000 lbs/MWh. If the emission rate standard is 1500 lbs/MWh, before re-dispatch the coal plant would have a 1,000,000 credit deficit:

$$\left(1500\frac{lbs}{MWh} - 2000\frac{lbs}{MWh}\right) * 2000\ MWh * 1\frac{CRC}{lbs} = -1,000,000\ CRCs$$

After re-dispatch, the gas and coal plants will be in compliance when considered together, with the gas plant receiving 500,000 CRCs to offset the coal plant's 500,000 CRC deficit:

$$Coal:\ \left(1500\frac{lbs}{MWh} - 2000\frac{lbs}{MWh}\right) * 1000\ MWh * 1\frac{CRC}{lbs} = -500,000\ CRCs$$

$$Gas:\ \left(1500\frac{lbs}{MWh} - 1000\frac{lbs}{MWh}\right) * 1000\ MWh * 1\frac{CRC}{lbs} =\ 500,000\ CRCs$$

At the same time, the two facilities in combination achieve the emission rate standard of 1500 lbs/MWh:

$$\frac{\left(2000\frac{lbs}{MWh}*1000\ MWh\right)+\left(1000\frac{lbs}{MWh}*1000\ MWh\right)}{2000\ MWh} = 1500\frac{lbs}{MWh}$$

Renewable energy could work the same way as re-dispatch, except that more credits would be awarded because renewables have zero emissions rather than 1000 lbs/MWh. Providing 1000 MWh of energy efficiency savings would have the same result as re-dispatching to renewables.

2)   Add renewable energy

Under EPA's proposal and this program, even if a specific high-emission generator in a state is not curtailed, it is still possible to achieve compliance by providing additional low-emission resources or energy efficiency to the system. Because of the nature of electricity and the overall inability to store power, supply will equal demand. This means that when renewables are producing energy, or efficiency is providing savings, even if not associated with ramping down a particular generator in a particular state, there will be less generation than otherwise, somewhere on the system. In the example below, we show that adding 1000 MWh of renewables to 3000 MWh of coal generation can achieve compliance with a 1500 lbs/MWh standard, without ramping down the coal plant:

$$Coal:\ \left(1500\frac{lbs}{MWh} - 2000\frac{lbs}{MWh}\right) * 3000\ MWh * 1\frac{CRC}{lbs} =\ -1,500,000\ CRCs$$

$$Renewables:\ \left(1500\frac{lbs}{MWh} - 0\frac{lbs}{MWh}\right) * 1000\ MWh * 1\frac{CRC}{lbs} = 1,500,000\ CRCs$$

In this scenario, one sees that the emission rate achieved is the state standard of 1500 lbs/MWh:

$$\frac{\left(2000\frac{lbs}{MWh}*3000\ MWh\right)+\left(0\frac{lbs}{MWh}*1000\ MWh\right)}{4000\ MWh} = 1500\frac{lbs}{MWh}$$

3) Four building blocks

In our final compliance strategy example we look at a combination that includes coal plant heat rate improvement, re-dispatch, renewable energy development and energy efficiency, i.e. all four building blocks.

To start, assume that a state has a coal plant and a gas plant, each producing 2000 MWh with emission rates of 2000 lbs/MWh and 1000 lbs/MWh, respectively. This means the starting average emission rate is 1500 lbs/MWh. Also, assume the emission rate standard for a compliance year is 1250 lbs/MWh.

A compliance strategy that uses all four building blocks would improve the coal plant's emission rate by 5% (from 2000 lbs/MWh to 1900 lbs/MWh), re-dispatch 300 MWh of coal to natural gas, and add 300 MWh of renewable energy and 124 MWh of efficiency. When this is done, we have the following zero-credit balance outcome:

$$Coal: \left(1250\frac{lbs}{MWh} - 1900\frac{lbs}{MWh}\right) * 1700\ MWh * 1\frac{CRC}{lbs} = -1,105,000\ CRCs$$

$$Gas: \left(1250\frac{lbs}{MWh} - 1000\frac{lbs}{MWh}\right) * 2300\ MWh * 1\frac{CRC}{lbs} = 575,000\ CRCs$$

$$Renewables: \left(1250\frac{lbs}{MWh} - 0\frac{lbs}{MWh}\right) * 300\ MWh * 1\frac{CRC}{lbs} = 375,000\ CRCs$$

$$Efficiency: \left(1250\frac{lbs}{MWh} - 0\frac{lbs}{MWh}\right) * 124\ MWh * 1\frac{CRC}{lbs} = 155,000\ CRCs$$

And the overall emission rate is compliant:

$$\frac{\left(1900\frac{lbs}{MWh}*1700\ MWh\right)+\left(1000\frac{lbs}{MWh}*2300\ MWh\right)+\left(0\frac{lbs}{MWh}*300\ MWh\right)+\left(0\frac{lbs}{MWh}*124\ MWh\right)}{4424\ MWh} = 1250\frac{lbs}{MWh}$$

At the end of the compliance period, the coal plant in this scenario would need to acquire and retire the CRCs of the other facilities, in order to zero out its negative credit balance and show that it is individually meeting its obligations.

4. Exchange Ratio

This final example demonstrates that the exchange ratio provides the same amount of lower-emission energy as would be achieved in stand-alone programs, when CRCs from gas-fired generation are exchanged.

We assume that two states, A and B, each produce 10 MWh of coal-fired generation emitting 2200 lbs/MWh, have idle gas capacity that emits 1000 lbs/MWh, and have emission rate stringency requirements of 1600 lbs/MWh and 1300 lbs/MWh respectively. This means that A has a CRC deficiency of -6000 CRCs ((1600 lbs/MWh – 2200 lbs/MWh) x 10 MWh)), and B has a CRC deficiency of -9000 CRCs ((1300 lbs/MWh - 2200 lbs/MWh)) x 10 MWh).

To offset their deficiencies by acting separately, A could increase gas-fired generation by 10 MWh to achieve compliance ((1600 lbs/MWh – 1000 lbs/MWh) x 10 MWh = 6000 CRCs), and B could add 30 MWh of gas-fired generation to be compliant ((1300 lbs/MWh – 1000 lbs/MWh) x 30 MWh = 9000 CRCs). This means that, on a stand-alone basis, 40 MWh of gas is required across the 2 states.

To demonstrate that the ratio adjustment provides an identical generation outcome, we can assume all the increased gas generation was either in State A or State B. In both cases, 40 MWh would still be required, because of the exchange ratio of 2 to 1 ((1600-1000) ÷ (1300-1000)) for CRCs going from B to A, and 1 to 2 for CRCs going the other way: 40 MWh of gas-fired generation in B provides 12,000 CRCs, with 9000 CRCs used to comply in B, and 3000 (x 2), used to comply in A. Going the other direction (A to B), 40 MWh in A provides 24,000 CRCs, with 6000 used to comply in A, and 18,000 (x ½) to comply in B.

APPENDIX B

CARBON REDUCTION CREDIT RULE
FOR ELECTRIC GENERATING UNITS

Section A: Objective. The objective of this Rule is to establish a State of <u>Colorado</u>[12] program for emission rate reductions from electric generating units that complies with the Clean Air Act and EPA regulations pursuant thereto, and to address and mitigate global warming and climate change.

Section B: Definitions. As used in this Rule the following definitions shall apply, provided however that in the event of a conflict the definition provided in this Section shall prevail for purposes of this Rule.

(1) **compliance year emission rate** means <u>1244 lbs/MWh in 2020, 1220 lbs/MWh in 2021, 1197 lbs/MWh in 2022, 1175 lbs/MWh in 2023, 1155 lbs/MWh in 2024, 1135 lbs/MWh in 2025, 1123 lbs/MWh in 2026, 1117 lbs/MWh in 2027, 1112 lbs/MWh in 2028, and 1108 lbs/MWh in 2029 and thereafter;</u>[13]

(2) **CDPHE** means the <u>Colorado Department of Public Health and Environment</u>;

(3) **carbon reduction credit**, **CRC** or **credit** means an instrument, in a format approved and issued by <u>CDPHE</u>, which represents one pound of carbon dioxide emissions by an EGU less than would have been emitted had it operated at the compliance year emission rate, which amount can be negative and, if so, represents a compliance obligation. For Emission Reduction Measures, it equals the number of MWh produced or saved multiplied by the compliance year emission rate. Mathematically, the number of CRCs provided to a facility each year is:

$$CRCs = (R_{CY} - R) * E * C$$

R_{CY} is the compliance year emission rate (lbs/MWh)
R is the CO_2 emission rate (lbs/MWh) of the facility in that year
E is the net energy (MWh) produced or saved during the year
C is the conversion factor of 1 CRC per pound;

(4) **CO_2** means carbon dioxide;

(5) **Division** means the <u>Air Pollution Control Division</u> of the <u>CDPHE</u>;

(6) **electric generation unit** or **EGU** means the following electricity producing facilities: <u>Arapahoe (units 3 and 4), Arapahoe Combustion Turbine Project (units 5,6 and 7), Brush Generation Facility (ST1, ST2, ST4,GT1,GT2 and GT3), Cherokee (units 1,3 and 4), Comanche (units 1,2 and 3), Craig (units 1,2 and 3), Fort St. Vrain (units 1,2,3 and 4), Front Range Power Plant (units 1,2 and 3), Hayden (units 1 and 2), J.M. Shafer Generating Station (STA, STB, LMA, LMB, LMC, LMD and LME), Lamar Plant (unit 4), Martin Drake (units 5,6 and 7), Nucla (ST4), Pawnee (unit 1), Pueblo Airport Generating Station (units 4,5,6,7,43 and 53), Rawhide (unit 1), Ray D. Nixon (unit 1), Rifle Generating Station (ST1 and GT4), Rocky Mountain Energy Center (STG1, CTG1 and CTG2), Thermo Power & Electric (GEN1, GEN2, GEN3), Valmont (unit 5), W. N. Clark (unit 2) and Zuni (unit 2);</u>[14]

(7) **emission(s)** means carbon dioxide emitted into the atmosphere by an EGU;

(8) **emission rate** means pounds of emissions from a facility in a calendar year divided by net megawatt-hours of production in that same calendar year;

(9) **emission rate factor** means $\dfrac{(R_c - R_{crc})}{(R_o - R_{crc})}$ where

R_c is the emission rate standard in <u>Colorado</u> in the compliance year,
R_o is the emission rate standard in the origin state in the compliance year, and
R_{crc} is the emission rate of the entity awarded the CRC;

(10) **emission reduction measure** or **ERM** means a non-nuclear zero-emission electricity production facility, six percent of the capacity of a nuclear facility in service on June 2, 2014, one hundred percent of a nuclear-powered facility in construction or for which construction commenced or any life extension or capacity addition occurred after June 2, 2014,[15] additional or new hydroelectric facilities[16] developed after June 2, 2014, or any evaluated, measured and verified electric energy efficiency savings provided through a program overseen by a state agency. Such measures include, but are not limited to, wind, solar, nuclear and hydro electricity production, as well as aggregated and metered distributed renewable generation. ERMs that are not nuclear or hydro-electric may be from outside Colorado;

(11) **EPA** means the Environmental Protection Agency of the United States of America;

(12) **ERM provider** means the owner, operator, provider or other person or entity financially responsible for the ERM. For energy efficiency, it is the person or entity that administers or directs the state overseen program. For renewable energy production which is an ERM and for which renewable energy certificates or credits (RECs) have been created and are compliant with EPA standards for Clean Air Act §111d compliance, it is the person or entity holding the RECs associated with the production, provided that person or entity commits to extinguish the associated RECs or retire the associated RECs in the same state that the CRC is retired;

(13) **Evaluated, measured and verified (EM&V)**, or **metered** means that the MWh of production or savings are determined in a manner that meets EPA established protocols for energy efficiency and renewable energy;[17]

(14) **megawatt-hour** or **MWh** means one thousand kilowatt-hours;

(15) **net MWh** means generation output of an EGU measured at the point of delivery to the transmission grid;[18] and

(16) **origin state** means the state in which an EGU or ERM applies for and receives CRCs.

Section C: Electric Generating Units (EGUs) and ERMs.

(1) On or before March 31, 2020, and each year thereafter, each EGU shall accurately report its emissions and net MWh during the prior calendar year to the Division. The report shall include a detailed description of how the emissions and net MWh were measured or estimated. Emissions monitoring and calculation methods provided in 40 CFR Part 98, or other methods chosen by the EGU, may be used to meet this requirement, provided those methods comply with protocols established by the EPA.

(2) In order to receive credits for its contribution toward lower emission rates, on or before March 31, 2021, and each year thereafter, each ERM provider shall accurately report the MWh produced, or saved in the case of energy efficiency measures, during the prior calendar year to the Division. The report shall include a detailed description of how the MWh were evaluated, measured and verified or metered, and shall be certified by the Colorado Public Utilities Commission (CPUC) or the Colorado Energy Office. In the event that the CPUC or Energy Office has not certified the results by March 31, the ERM may seek an extension of time to submit its report.

(3) The Division shall approve or disapprove each EGU's annual emissions and net MWh report, and each ERM provider's report, along with any adjustments thereto, by April 15 of the year of report submission. In the event of disapproval, the EGU or ERM provider may correct the report or appeal the Division's decision to the Colorado Air Quality Control Commission.

Section D: Carbon Reduction Credits (CRCs).

(1) The Division shall provide an EGU one CRC each calendar year commencing in 2020 for each pound of CO_2 that it emits in that year less than the compliance year emission rate would allow, for all net

MWh produced. An EGU that emits an amount greater than the compliance year emission rate would allow in a calendar year shall have a credit deficit to the extent of its excess emissions for that year. A credit deficit represents a compliance obligation for that EGU.

(2)   The Division shall provide to each ERM one CRC each calendar year commencing in 2020 equal to the compliance year emission rate multiplied by the net MWh produced by that ERM, or saved if from an energy efficiency program, in accordance with Section C(2), *supra*.

(3)   Each CRC provided by the Division shall be designated as having been issued by the State of Colorado, along with the CO_2 emission rate of the resource qualifying for the CRC and the year of issuance. For example, a combined-cycle natural gas plant could be designated as "*Colorado-2022-840 lbs/MWh.*"

(4)   CRCs may be sold, traded or otherwise transferred, do not expire, and may be used at any time unless and until they are retired for compliance with this rule or a similar emission reduction program in another jurisdiction.

(5)   The Division shall allow credits or allowances created in another state(s), with a rule approved to comply with federal Clean Air Act Section 111(d) stringency requirements for CO_2, to be used for compliance in Colorado, provided the other state(s) accepts credits from Colorado for compliance with its own program, and provided that the number of credits or allowances tendered for compliance in Colorado shall be increased or reduced by multiplying it times the emission rate factor for that compliance year. As an example, if the emission rate factor for non-Colorado CRCs in 2020 is 1.25, then those CRCs shall be valued at 1.25 times their face value if tendered for compliance in Colorado. If the stringency in the origin state is of a different nature than that of Colorado (for example, not expressed in pounds per MWh), the Division may establish an appropriate multiplier, subject to EPA approval, for application to that origin state's credits or allowances that does not compromise the effectiveness of this rule in reducing CO_2 emissions.

Section E: Compliance.

(1)   Each EGU shall demonstrate compliance by the certified retirement, in a manner prescribed by the Division, of CRCs every year. The number of CRCs to be retired for compliance shall equal the credit deficit, if any, accumulated by that EGU during the prior one-year period.

(2)   An EGU shall first present and retire CRCs on or before June 30, 2021 for compliance in 2020, and shall retire CRCs on June 30 every year thereafter for compliance during the preceding calendar year. The Division shall certify the retirement of CRCs and otherwise assure compliance with this rule.

Section F: Record Retention.

All filings, submittals, work papers, records, data and any other documentation of the administration of this rule shall be preserved by the Division for at least ten (10) years from the date of its preparation.[19]

Section G: Non-compliance.

Any EGU that fails to comply with the CRC credit balance requirements established by this Rule shall be required to make up the shortfall by retiring one hundred twenty-five percent (125%) of the deficient CRCs within the following twelve (12) months. Each day that a deficiency exists after this twelve (12) month extension shall be considered a separate violation of this Rule.

End Notes

[1] Mr. Michel holds a B.A. in economics and history from Northwestern University and M.B.A. and J.D. degrees from Vanderbilt University. Mr. Nielsen holds a B.A. in economics and mathematics from the University of Colorado and a Master of Philosophy degree in economics from Yale University. Both Mr. Michel and Mr. Nielsen are with the Energy Program of Western Resource Advocates, an environmental law and policy center. The authors wish to acknowledge the contribution and assistance of Stacy Tellinghuisen, Erin Overturf, Douglas Howe, David Berry, David Farnsworth and Brad Musick to the development of this paper.

[2] EPA's proposal would allow the emissions from new nuclear facilities to contribute to a state's emission rate compliance. For currently operating nuclear plants, EPA's proposal would allow 6% of the nuclear capacity in each state to contribute to that state's emission rate calculation (EPA proposed rule at pp. 114 and pp. 214-217).

[3] EPA's proposed existing-source standard includes an option for states to develop mass-based standards instead of EPA's rate-based proposal. A mass-based standard would have states achieve an actual tonnage reduction from power plant emissions, as opposed to a reduction in the rate of emissions. EPA provides guidelines for how states might establish a mass-based alternative.

[4] Using a credit system to drive emission reductions was introduced by the authors in *The Electricity Journal* in May 2008 as a way to approach a mass-based regional greenhouse gas regulation with incomplete market participation. The concept was updated to address different regulatory scenarios in three subsequent articles of that same journal. See *The Electricity Journal*: Vol. 21, Issue 4, May 2008, p. 31; Vol. 22, Issue 8, October 2009, p. 45; Vol. 24, Issue 3, April 2011, p. 45; Vol. 26, Issue 93, November 2013. Former Senator Jeff Bingaman proposed a credit system as part of a rate-based emission program in his Clean Energy Standards Act of 2012, and the Department of Interior has committed, as part of a proposed resolution for Navajo Generating Station regional haze issues, to use a mass-based, credit-based system to reduce the CO_2 emissions associated with some of its usage. In 2012, Resources for the Future released a discussion paper with an emission rate credit concept similar to the one presented here: "Tradable Standards for Clean Air Act Carbon Policy," Burtraw, Fraas and Richardson, Resources for the Future (2012).

[5] EPA proposes that the MWh to be used for compliance purposes must be "net," meaning that they are measured at the point of interconnection with the transmission grid and exclude energy consumed at the plant site.

[6] To show that that an affected source will be in compliance with the EPA standard if and only if its CRC holdings at the end of the compliance period are non-negative, simply rearrange the equation as: $R \leq R_{EPA} - \frac{CRC}{G*C}$ For R to be less than or equal to $R_{EPA,}$ $\frac{CRC}{G*C}$ must be non-negative. Given that C and G are positive, this can only be the case if CRC holdings are greater than or equal to zero.

[7] Energy efficiency is widely regarded as the lowest cost, least environmentally impacting resource available to meet the energy needs of customers. See "Reducing Greenhouse Gas Emissions: How Much at What Cost?" U.S. Greenhouse Gas Abatement Mapping Initiative, Executive Report, December 2007, McKinsey & Company: http://www.mckinsey.com/clientservice/ccsi/pdf/US_ghg_final_report.pdf. When a new zero-emission generator such as a renewable resource is dispatched to meet load, it produces energy with zero emissions. Similarly, when energy efficiency is deployed and reduces load by the same amount, the environmental outcome is identical. Therefore it makes sense to provide equivalent credit for renewable energy and energy efficiency, which is included in EPA's proposal and captured by this credit system.

[8] To demonstrate why this formula is correct, we can assume a situation with 2 states, A and B, with State A being the CRC recipient state. Our goal is to determine what adjustment to CRCs from B should be made to create CRCs in A. Put another way, we want to solve for "X" in the equation $CRC_A = X * CRC_B$, with X being the exchange rate.

When R_A and R_B are the rate standards in A and B, and R is the emission rate of the resource that would earn CRCs, our CRC awards in the two states would be: 1) $CRC_A = (R_A - R) \times MWh_{A,}$ and 2) $CRC_B = (R_B - R) \times MWH_{B.}$ Because the goal is to assure the MWh of lower emission energy are not compromised by the exchange, we assume the MWh in A and B to be equal, and we solve for the exchange rate ("X") as:

$$X = CRC_A / CRC_B = (R_A - R) \; \cancel{\times MWh_A} \, / (R_B - R) \; \cancel{\times MWH_B} = (R_A - R) \, / \, (R_B - R)$$

[9] 5000 MWh x 1000 lbs/MWh x 1 CRC/lbs = 5,000,000 CRCs.

[10] The Western Climate Initiative (WCI) and the Regional Greenhouse Gas Initiative (RGGI).

[11] $33 per tonne is likely a conservative estimate given that most carbon markets are trading in the $10/tonne range, and given EPA's estimated costs for the 4 building blocks: $6-$12/tonne for heat rate improvements, $30/tonne for re-dispatch, $10-$40/tonne for zero-emission resources and $16-$24/tonne for efficiency – EPA proposed rule at pp. 143-152.

[12] Underlined items are placeholders specific to Colorado.

[13] The compliance year emission rates included in this model rule are those that were included for Colorado in EPA's Clean Power Plan proposal, see EPA proposed rule: 20140602tsd-state-goal-data-computation.xlsx. EPA's proposal appears to allow states flexibility to set different compliance path so long as there are annual requirements that achieve the interim 2020-2029 average in a way that shows regular progress over time. See, e.g. EPA proposed rule at pp. 620-635.

[14] EPA proposed rule: 20140602tsd-plant-level-data-unit-level-inventory.xlsx.

[15] EPA proposed rule at e.g. p.503.

[16] EPA proposed rule at p.200.

[17] EPA proposed rule at p.485.

[18] EPA proposed rule at p.343.

[19] EPA proposed rule at p.453.