Translating Emission Rate Goals to Mass Goals Under the Clean Power Plan

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Executive Summary

In the June 2014 Clean Power Plan (CPP) proposal, the EPA put forward emission rate goals for each state and also suggested that states have the option to satisfy their emission rate obligations by meeting equivalent mass goals instead of the proposed rate goals. While the EPA did not issue a methodology for translating emission rate goals into mass goals or offer numerical mass goals in the June proposal, it has more recently issued two illustrative methodologies and numerical mass goals for comment by stakeholders. Because of the many policy advantages of mass goals over rate goals, this whitepaper offers several ideas for how the EPA might further facilitate states to choose the mass goal option.

This whitepaper first reviews several analytic approaches for translating rate goals into mass goals, with a focus on mass goals covering emissions from both existing and new sources. This focus on mass goals for existing and new sources is because the alternative version of this policy, which would be to restrict mass goals to existing sources, is likely to create market, emission and policy problems; these unintended consequences are reviewed later in this paper.

Second, this whitepaper describes an alternative "first principles" methodology for translating rate goals into mass goals. The translation methodology discussed here uses data from two EPA analyses: the EPA's Goal Data Computation (GDC) calculations (through which it determined the proposed emission rate goals) and the EPA's June 2014 Regulatory Impact Analysis (specifically, the load growth factors included in that analysis.) Based on this information, the methodology estimates state-specific business-as-usual (BAU) electric loads in 2030. It then determines the fuel-technology mix and energy efficiency resources needed to meet that load based on the data and the computational process in the GDC. Finally, it determines the carbon emissions associated with the fossil generating facilities covered under the rule using emission rates from the GDC. A spreadsheet implementing this methodology and presenting the resulting mass goals for each state is available with this whitepaper.

This first principles approach to setting mass goals is simple, intuitive, and fully transparent. Because it relies on the same emission reduction measures and assumptions used by the EPA to determine rate goals, the resulting mass goals are consistent with the EPA's definition of Best System of Emission Reduction (BSER) and equivalent to the proposed rate goals. Since the sum of the state-specific mass goals is within 1 to 3 percent of the emissions estimated in the Regulatory Impact Analysis and November TSD, the methodology also preserves the carbon emission benefits of the proposed rule as estimated by the EPA.

Finally, this whitepaper illustrates how a small number of state-specific assumptions, primarily the size of each BSER building block and the rate of load growth, drives the mass goals. It also highlights the value of focusing policy discussions on these few assumptions as a primary means to address concerns regarding the level of state-specific goals and any disparity of goals across states; more complex translation methodologies may obscure these fundamental factors. Further, any changes to the EPA's proposed building block assumptions or GDC calculation process made in the final rule could be readily incorporated into this rate to mass translation methodology.

Translating Emission Rate Goals to Mass Goals Under EPA's Clean Power Plan

Bruce Phillips[1]
Iain Kaplan[2]

I. Introduction

In June of 2012, the Environmental Protection Agency (EPA) issued a proposed rule under Section 111(d) of the Clean Air Act, known as the Clean Power Plan (CPP) rule, to control carbon emissions from existing power plants.[3] Under the proposal, states would be required to meet emission rate goals (expressed in pounds of carbon emissions per MWh of electricity) during an interim 2020 – 2029 period and a final compliance period starting in 2030. Alternatively, states could choose to satisfy their emission rate performance obligation through a mass goal (expressed in tons).

While the EPA issued a Technical Support Document (TSD) providing guidance for translating rate goals to mass goals in the June proposal, that guidance is primarily a discussion of concepts, considerations and methods.[4] The June TSD does not propose a specific methodology or provide numerical mass goals for states. Since the CPP and June TSD were both issued, numerous states and other stakeholders have requested further guidance and provisional mass goals from EPA. That interest stems in part from a desire by states with existing mass programs[5] to understand how they might meet the proposed CPP goals and from states without existing mass programs to understand the implications of choosing a mass goal or a rate goal.

Responding to this interest, the EPA in November 2014 issued an additional TSD that described two illustrative methodologies, presented numerical mass goals for each state and requested stakeholder comment on a number of related issues.[6]

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[3] 40 CFR Part 60. Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units; Proposed Rule; Federal Register, Vol. 79, No. 117, June 18, 2014
[4] Projecting EGU CO2 Emission Performance in State Plans, Technical Support Document, Docket ID No. EPA-HQ-OAR-2013-0602
[5] Specifically, California and the states participating in RGGI.
[6] Translation of the Clean Power Plan Emission Rate-Based CO2 Goals to Mass-Based Equivalents. Technical Support Document (TSD) for Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units. Docket ID No. EPA-HQ-OAR-2013-0602

As context for the discussion of mass goals in this whitepaper, it is important to recognize that there are a number of important policy reasons to prefer mass goals to rate goals. These include avoiding seams conflicts across neighboring states that can raise the cost of electric system operations, administrative complexity and risks of accurately reflecting energy efficiency savings in emission rate standards, and the challenge of transitioning to longer term federal carbon policies that would likely measure emission reductions in tons rather than emission rates. All of these concerns could be resolved by having states comply with the CPP emission goals through mass-based programs.[7]

Consequently, this whitepaper offers several ideas for how the EPA might further help states understand the choice between rate and mass goals and facilitate states choosing the mass goal option.

It first reviews several analytic approaches for translating rate goals into mass goals that cover emissions from both existing and new sources, and explains why mass goals covering both existing and new sources should be preferred to mass goals covering only existing sources.

The whitepaper then describes an alternative "first principles" methodology for translating rate goals into mass goals: one that is simple, intuitive, and fully transparent, consistent with the proposed emission rate goals and the EPA's definition of Best System of Emission Reduction (BSER), and preserves the emission reduction benefits of the proposed rule.

Finally, it illustrates how a small number of state-specific building block and load growth assumptions drive the mass goals and highlights the value of focusing policy discussions on these as the primary means to address concerns regarding the level of state goals and any disparity across states.

II. Focus of this Whitepaper

The rate to mass translation methodology discussed in this whitepaper, as described earlier, builds on the data and analytical process used by the EPA in the Goal Data Computation (GDC) to derive the proposed emission rate goals.

However, as discussed by the EPA in its June 2014 TSD, there are a number of analytic approaches and tools that might be used by the EPA or states to determine mass goals. In addition to spreadsheet-based methods such as those put forward by the EPA in its November TSD or the methodology described in this whitepaper, there are at least two others. These include using the emission results from an Integrated Planning Model (IPM) run provided by the EPA in its June 2014 Regulatory Impact Analysis (as updated in the final rule). Another approach would be to use what the EPA has referred to as a "growth tool". Growth tools are relatively simplified modeling systems forecasting future emissions

[7] See Alternate Approaches for Regulating Greenhouse Gas Emissions from Existing Power Plants under the Clean Air Act: Practical Pathways to Meaningful Reductions, Bruce Phillips, the NorthBridge Group, February 27, 2014

based on historic data and trends, but are not fundamental economic or electric system operation models.

Each of these approaches has its own advantages and limitations. Spreadsheet-based approaches are relatively simple and transparent, and can be tied directly to the EPA's calculation of emission rate goals. They can also be used to quickly determine the impact of alternative assumptions on mass goals and so do not create a large administrative burden for states, the EPA and stakeholders discussing the appropriate level of emission goals. For those reasons, this whitepaper focuses on a spreadsheet-based methodology.

Specifically, this whitepaper focusses on a methodology to estimate mass goals covering emissions from both existing and new fossil generating facilities, rather than just existing sources alone. While there are likely to be a number of policy considerations at play on this design issue, it is important to understand that a mass goal that only covers existing sources is seriously problematic from several perspectives. These include the potential for several types of unintended consequences:

- Electric Market Operations: Bifurcating emission sources by placing a mass goal on existing sources but not new sources, in combination with a compliance system that establishes a price on the carbon emissions from existing sources, would result in a situation where there is a carbon price on emissions from existing sources but not from new sources.[8] This would have the practical effect of raising the dispatch price of generation from existing natural gas fired combined (NGCC) units, but not new NGCC units. For instance, with a $25/ton carbon price and an NGCC emission rate of 800 lbs/MWh, the dispatch cost disparity would be $10/MWh. Given typical NGCC fuel costs of approximately $30 to 45/MWh, the $10/MWh disparity is equivalent to about 20 to 35% of NGCC fuel costs – a very large disparity for NGCC units that are otherwise very similar. Further, this disparity would allow new but less efficient gas plants to dispatch before existing but more efficient gas plants, leading to inefficient system operations.
- New Entry and Net System Emissions: The disparate treatment of existing and new NGCC units would also create incentives for new NGCCs to enter the market when that would not otherwise occur. To the extent that this causes new NGCC generation to enter and displace existing generation, whether coal or gas, emissions from existing sources would decline, helping that state or region meet its mass goal for existing sources. However, if new gas primarily displaces existing gas[9], there would be little if any emission reductions on a total net system basis since NGCC generation would be replacing NGCC generation, and both are likely to have similar heat rates and emission rates. Further, excessive new entry of this sort could depress the carbon

[8] The emission standard set under 111(b) for new natural gas fired combined cycle units is not expected to be binding or establish a carbon price on the emissions from those units.
[9] This could occur, for instance, in states or regions with limited coal generation or a relatively large spread between delivered coal and gas commodity prices.

prices that apply to existing sources, reducing the value and amount of other types of abatement such as re-dispatch undertaken by covered entities. This could cause overall emissions to rebound.

- Long Term Policy: Most long-term policy structures, such as carbon taxes or cap and trade mechanisms, are intended to cover both existing and new sources on a mass basis. Regulating some sources on a mass basis and other sources on a rate basis would be inconsistent with that and could hinder the transition to a long-term policy.

For these reasons, the rest of this whitepaper focuses on estimating mass goals for both existing and new emission sources.

III. Alternative Mass Translation Methodology

In brief, this methodology first determines the total demand for generation resources in each state in a future year absent the CPP policy. It then calculates the mix of energy efficiency and generation sources required to satisfy this demand under the CPP policy. Finally, the resulting mix of fossil generation and carbon emissions from the fossil sources covered under the rule determine the mass goal for each state.

These calculations are performed individually for each state in a spreadsheet being made available with this whitepaper. Specifically, the spreadsheet makes the following calculations illustrated in Figure 1.[10]

Initially, 2012 retail sales, grossed up to account for line losses and reflect total 2012 generation, are escalated by a business-as-usual (BAU) load growth rate. This produces an estimate of total state generation needs for 2030 of approximately 4,587 TWh. This amount is represented in Figure 1 by the third bar from the left. The 2012 retail sales assumptions in these calculations are taken from the EPA's GDC and the load growth data are taken from the EPA's Integrated Planning Model cases issued as part of its June 2014 Regulatory Impact Analysis. This approach to incorporating load growth factors in the goal development process is analogous to the EPA's approach taken in the NOx SIP call.

Next, demand and supply resources are deployed sequentially to meet total state generation needs. All four building blocks, along with generating resources not covered under the CPP rule, are represented in this analytical process; in this way, total resources are balanced with total energy demands.

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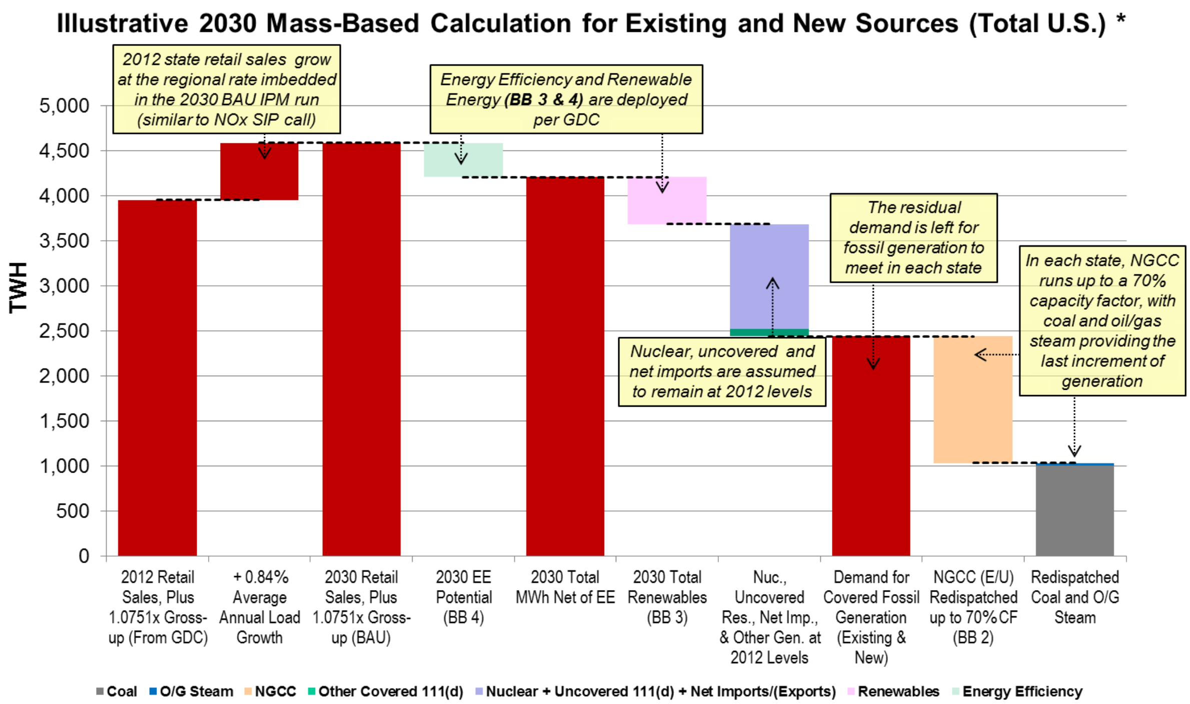
[10] Note that this explanation and the spreadsheet are based on a 2030 compliance year. The analytical process would be replicated for the years 2020 through 2029 to determine the interim emission goals.

- First, the total BAU state generation needs in 2030 are reduced by the state's energy efficiency (EE) resource potential (Building Block 4) as specified in the GDC. This results in an estimate of the total amount of energy demand in each state that is to be met with generating sources. As shown in Figure1, this amount is 4,206 TWh.

Figure 1



* Note: This is an illustration of calculations that are performed on a state-by-state basis.

- Next, total net energy demand is reduced by qualifying renewable energy resources (Building Block 3) as specified in the GDC.
- Following that, a block of energy from generating sources whose emissions are not covered under the rule are deducted. These include nuclear, hydro-electric, uncovered fossil, and net interstate imports or exports.
  - The generation from all of these (except new nuclear) is assumed to remain constant over time. The amount of energy from these fixed resources is calculated from GDC data by deducting 2012 coal, NGCC, oil/gas steam, other covered generation, and existing renewable energy from total 2012 sales.
  - For states with expected new nuclear generation, the amount of generation from these new sources is then added to this block of energy.

- The last remaining block of demand is met by covered fossil generation (coal steam, NGCC, oil/gas steam, and other covered generating units [11]). Generation from NGCC capacity is deployed first up to a maximum capacity factor of 70% consistent with the EPA's GDC methodology. Any remaining energy needs are met from existing coal and oil/gas steam in proportion to the 2012 generation levels from these two sources. This process incorporates Building Block 2 by dispatching NGCC to its maximum potential before coal.
- This analytical process so far has produced estimates of the energy mix required to satisfy electric demand in a future year. The results of this process in comparison to 2012 generation are shown below in Figure 2.
- Finally, to create the state's emission budget, the amount of energy produced by each fossil source covered under the rule is multiplied by the average state emissions rate for that fossil source in 2012. The one exception to this process is the coal emission rate, which is assumed to be 6% lower than 2012 levels consistent with Building Block 1 of the GDC.
- This results in the estimated covered emissions shown in Figure 3 below. The total U.S. covered emission estimate of 1,543 million metric tonnes is a 21 percent reduction relative to 2012 levels.

Figure 2

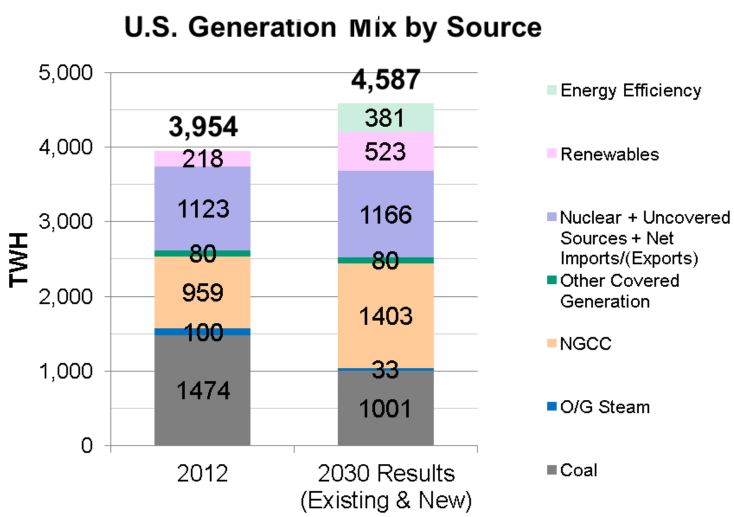
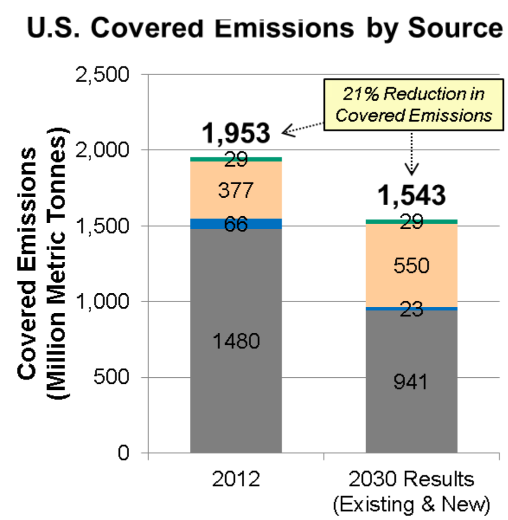


Figure 3



This methodology is a "first principles" approach to mass translation in that it starts with the fundamental demand, resource data and building block assumptions used by the EPA in the GDC process to determine the EPA's proposed emission rate goals. Structured on complete and balanced estimates of electric demand, energy efficiency and generation in future policy years, it is simple, intuitive, and

[11] Generation from other covered sources (high utilization simple cycle turbines, IGCC, and cogeneration units with useful thermal output) is assumed to remain at 2012 levels.

fully transparent. Because it relies on the same assumptions and calculation process used by the EPA, the resulting mass goals are consistent with the EPA's definition of Best System of Emission Reduction (BSER) and equivalent to the proposed rate goals.

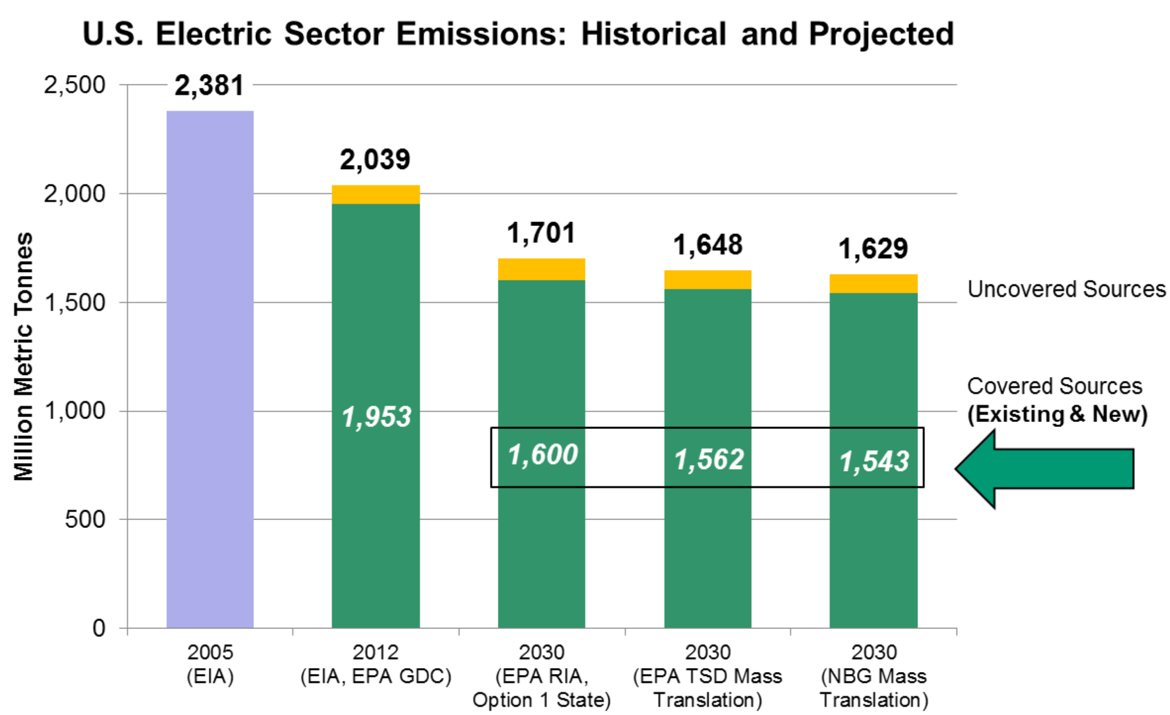
IV. National and State Results and Mass Goals

National Results

As shown above, this methodology yields an estimate of total U.S. covered emissions when all state budgets are summed across the country of 1,543 million metric tonnes.

This aggregate estimate is quite close to the EPA estimates of 2030 covered emissions in its June 2014 Regulatory Impact Analysis and November 2014 mass translation TSD. As shown in Figure 4 below, this methodology produces an estimate that is 1.2 percent below the EPA's TSD estimate and 3.6 percent below the EPA's Regulatory Impact Analysis estimate.

Figure 4



Note:
- *EPA data from Regulatory Impact Analysis (R.I.A.). Covered sources are approximated by emissions totals from all fossil units >25 MW excluding Indian Country units.*
- *Uncovered emissions for 2030 EPA TSD and NBG Mass Translation are approximated from historical emissions data*

The small difference in results between this and the EPA's national estimate from the TSD is caused by several factors, most of them quite small. The largest is that this methodology reduces the amount of fossil generation that may be re-dispatched when incremental building block resources (energy efficiency, renewables and new nuclear) exceed load growth.[12] Technical modifications to this methodology could potentially further reconcile this estimate with the EPA's TSD and Regulatory Impact Analysis estimates.

State Results – Comparison to Emission Rate Reductions

The state results flowing from this methodology and the EPA's assumptions are shown below in Figure 5, which compares the percentage change in emissions and emission rates to 2012 levels. While the state-specific mass goal results will be of interest to many, there are several broader patterns which are worth understanding.

First, as a general matter, the percentage reduction in tons tends to be less than the percentage reduction in emission rates. Some states that have been focused on the magnitude of the emission rate reduction implied by the EPA's proposed rate goals issued in June 2014 may find this of some interest.

Second, the states tend to cluster themselves into three groups that provide some insight into the underlying assumptions. Most states, shown in the central group in the middle of the chart, have tonnage reductions that are lower in percentage terms than the emission rate reductions, as previously noted. However, two groups of other states stand out.

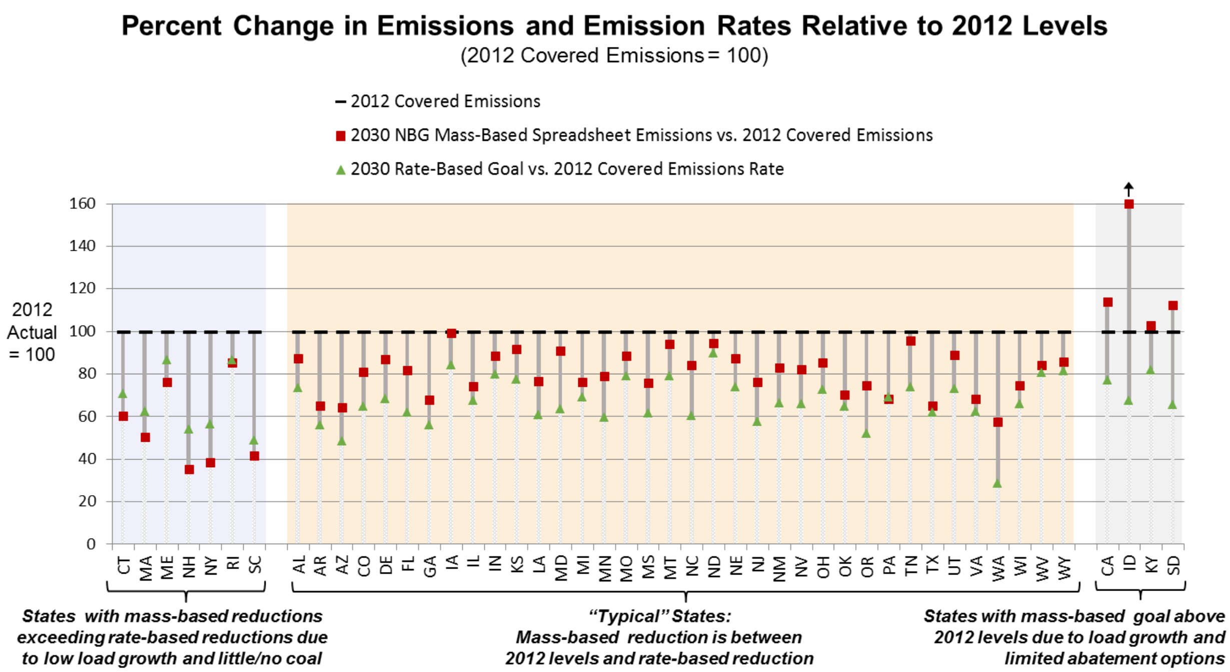
1. The group of states shown on the left hand side of the figure are states where the reverse is true – the percentage reduction in tons in greater than the percentage reduction in rates. The states in this group include Connecticut, Massachusetts, Maine, New Hampshire, New York, Rhode Island and South Carolina. Importantly, this is due to the assumptions underlying the calculations, specifically a low rate of load growth, limited coal generation, relatively ambitious building block assumptions or a large contribution from new nuclear generation. The large share of gas in the BAU energy mix limits the rate reduction, while load growth and relatively large abatement assumptions still result in large tonnage reductions.

[12] In contrast to this methodology, the TSD methodology determines mass goals by multiplying state emission rate goals by a number of TWh. That approach effectively fixes a blended mix of fossil and non-fossil resources determined by the June emission rate formula. In states where incremental building block resources exceed load growth, it implicitly assumes all resources, fossil and non-fossil, are "backed down" on a pro-rated basis to balance load and resources. In contrast, under these circumstances, the methodology outlined in this whitepaper would only back down fossil generation, causing fossil emissions in this approach to be modestly lower than that estimated in the TSD.

2. The group of states on the right hand side of the chart – California, Idaho, Kentucky and South Dakota – also stands out, but for somewhat different reasons. These states all have mass goals that are higher than 2012 emission levels. The reasons for this are also tied to the underlying load growth and building block assumptions. These states share a combination of relatively high load growth assumptions and/or relatively limited building block assumptions (and so relatively limited emission abatement assumptions.)

The importance of the underlying assumptions for determining mass goals will be discussed further later.

Figure 5

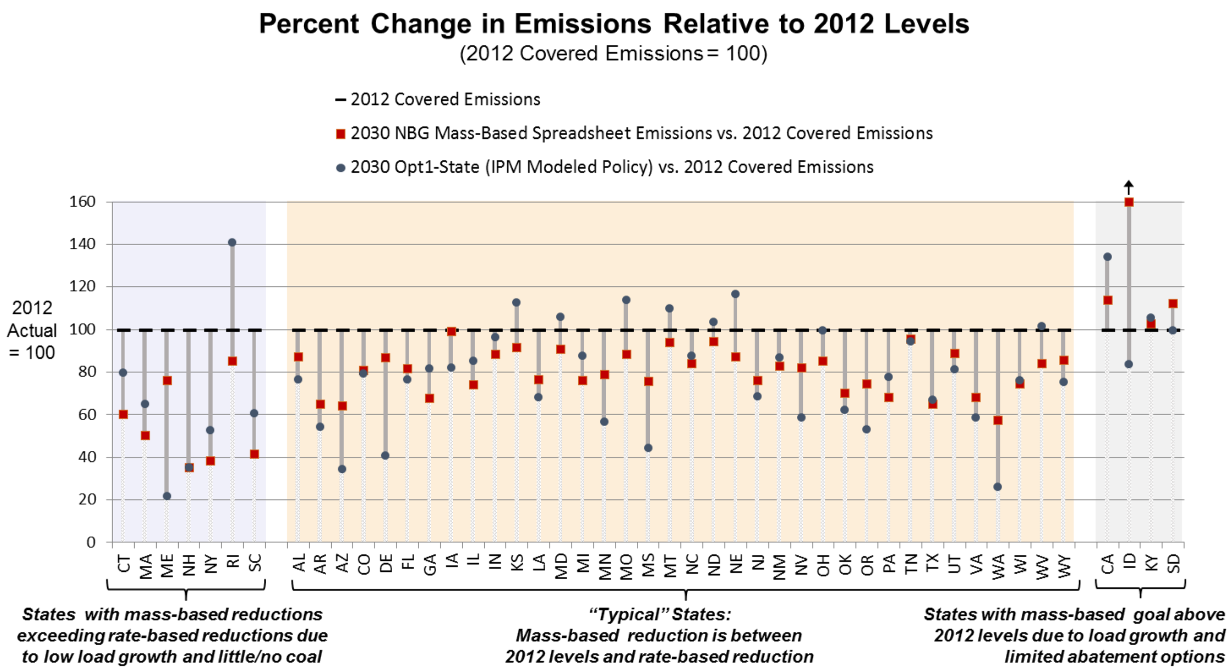


Note: Mass-based goal data is a comparison to 2012 on a tonnage basis, while the rate-based goal is a comparison to 2012 on a rate basis.

State Results – Comparison to IPM Modeling Results

Another comparison of interest to some stakeholders may be how these mass goals compare to the results of IPM modeling.[13] This is shown below in Figure 6. A general pattern emerging from this comparison is the notably greater variability in tonnage results from the IPM modeling than the mass goals, which can be seen by simply scanning across the figure and comparing the IPM results (shown in blue) to the mass goals (shown in red). This is likely due, at least in part, to the changes in interstate power flows and in-state generation expected to occur over time both without the CPP and also due to the CPP, and the impact of those changes in state emissions. These changes are reflected in the IPM modeling results but not the spreadsheet based mass translation methodology. One consequence of this is that any disparity in mass goals across states will tend to be lower under this type of spreadsheet-based mass translation method than one based on fundamental market modeling that captures the impact of interstate power flows on unit dispatch and state emissions.

Figure 6



[13] Specifically, the "Option 1 – State Compliance" model run is used in this whitepaper as the representative compliance scenario among the many variations modeled by EPA.

This comparison also illustrates the trade-off between the emissions reductions expected from the rule and the flexibility given to states in setting their own mass goals. Both options depicted in Figure 6 may have merits, yet in a given state there is sometimes a material discrepancy between the goals produced by the two methodologies. With the flexibility to choose a translation methodology, each state would have an incentive to choose the methodology that permits the greatest level of emissions and the smallest emission reductions. As an example, Table 1 on the following page shows that if all states are permitted to choose a mass goal based on either IPM results or this spreadsheet methodology, the mass goal for the Lower 48 states would effectively be 1,677 million metric tonnes. This result is higher than if either of the two options were used for all states and would achieve a 13 percent reduction from 2012 levels rather than 17 or 20 percent under a single approach.

Table 1

Lower 48 Covered Emissions Budget			
	Million Metric Tonnes	Reduction from 2005[14]	Reduction from 2012
GDC with Load Growth	1,536[15]	32%	20%
IPM Results	1,600	29%	17%
Higher of the Two	1,677	26%	13%

<u>State Results – Comparison to November TSD Goals</u>

The figures on the following page, numbered 7 and 8, compare the percent changes in emission goals for this methodology and the goals presented by the EPA in its November TSD (Figure 7 at the top) and the corresponding results on a tonnage basis (Figure 8 at the bottom). Consistent with the fact that the total national results were quite similar, the results for most states are generally similar as well. There are however a number of states where the two goal estimates vary more significantly. On a percentage basis, the largest of these are South Carolina, New York and New Hampshire. As mentioned in the earlier discussion of national emission results, this methodology reduces the amount of fossil generation re-dispatched when incremental building block resources (energy efficiency, renewables and new nuclear) exceed load growth. In contrast, the TSD accounts for imbalances in load and resources by effectively reducing the contribution of all sources on a pro rata basis. And on an absolute basis, the single largest difference is for Texas. This is caused by the same issue, as well as the large size of Texas.

[14] Percentages represent the reduction in total electric sector emissions (from covered and uncovered sources)
[15] Alaska and Hawaii, which have a combined 7 million metric tonne goal, are not included in this figure

Figure 7

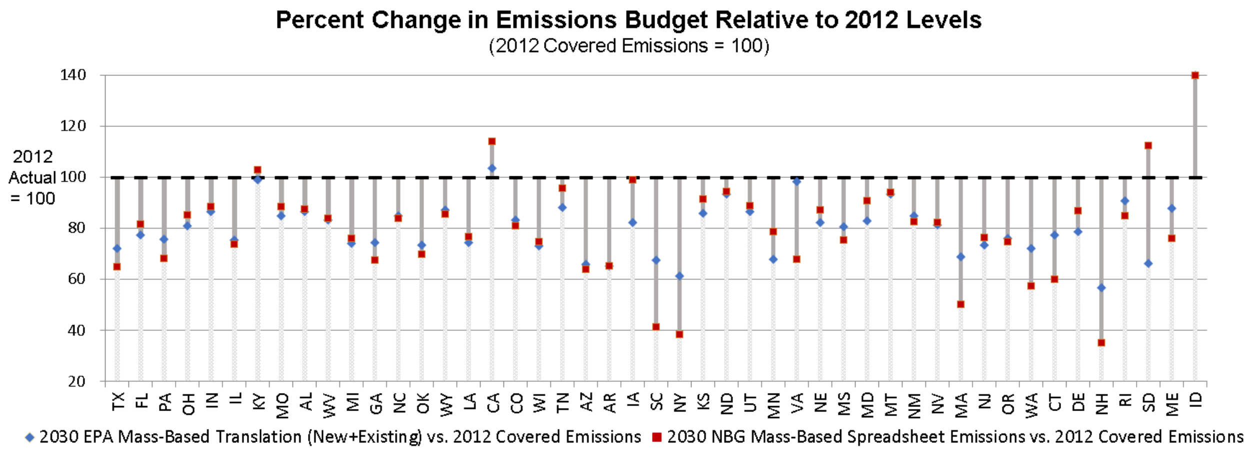
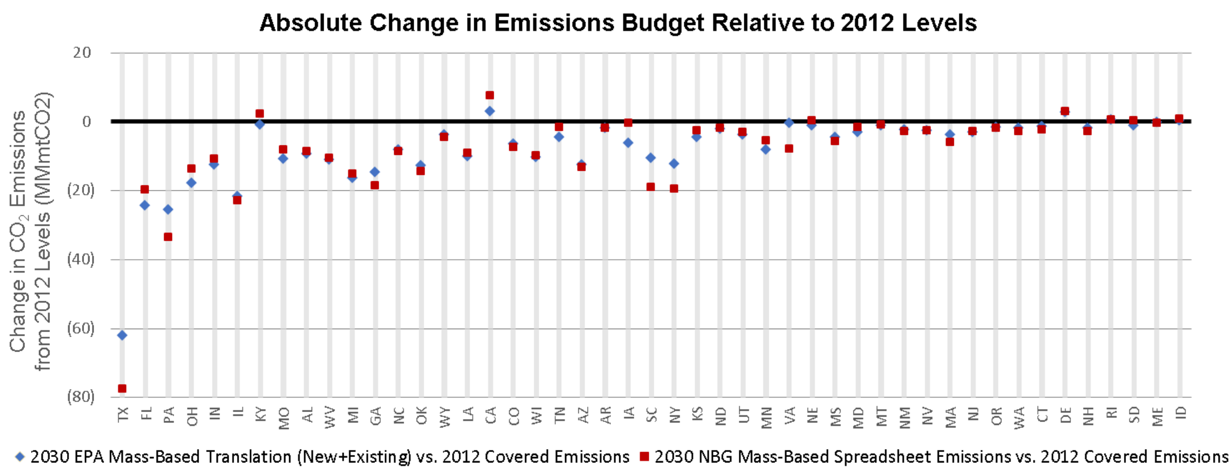


Figure 8



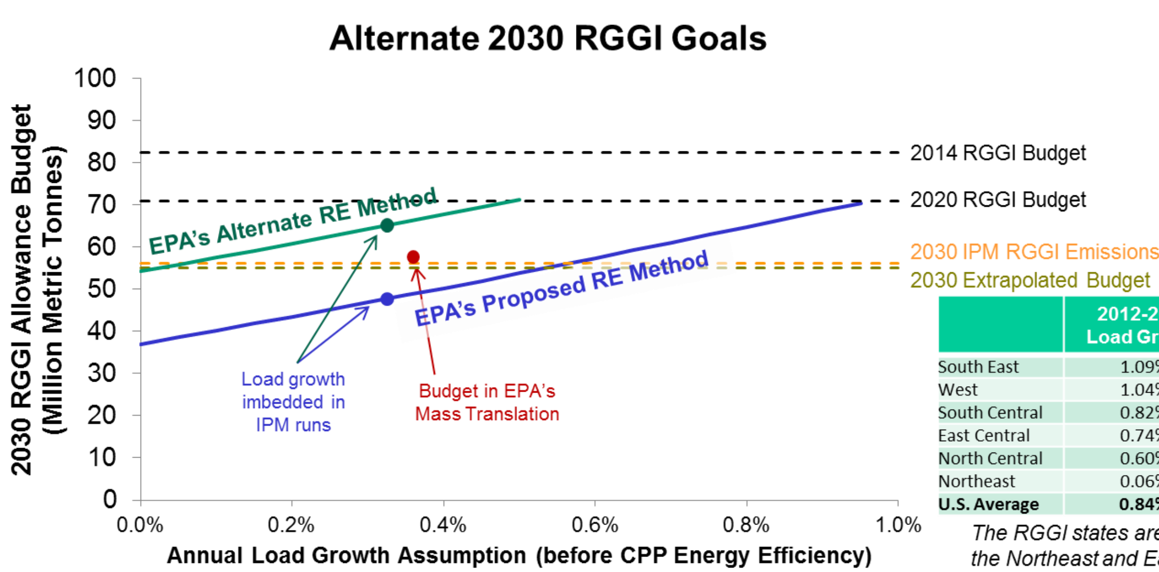
V. The Importance of Building Block and Load Growth Assumptions

While some readers may review these results, focus immediately on what they imply for their own state and if disappointed be tempted to look no further, it is important to understand the reasons why the mass goals turn out as they do. In fact, a small number of state-specific assumptions, primarily the size of each BSER building block and the rate of load growth, are the primary drivers of mass goals. The simplicity and transparency of this methodology highlights this point and the value of focusing policy discussions on the reasonableness of those assumptions and whether they should be modified. Other more complex translation methodologies may obscure these most fundamental assumptions and unnecessarily divert the policy discussion away from what most matters. Further, this type of translation methodology can be readily refined if and when the EPA modifies its building block and other assumptions underlying the goal development calculations.

The following figure, number 9, illustrates the impact of just a few key assumptions on possible mass goals for the RGGI states, as an example of this broader point. The figure illustrates a range of possible RGGI budgets as a function of load growth expectations and building block assumptions. For context, it shows RGGI's 2014 budget (at just over 80 million metric tonnes), RGGI's 2020 budget (at just over 70 million metric tonnes), an illustrative benchmark assuming the 2020 budget is reduced by 2.5 percent annually between 2020 and 2030, and the EPA's IPM results for 2030. Both of these last two benchmarks are somewhat above 55 million metric tonnes. In this context, the result of this methodology (and EPA's underlying building block and load growth assumption) and the EPA's TSD goal for existing and new sources are 48 and 58 million metric tonnes respectively. These estimates, which are 30 to 42 percent below the 2020 budget, are shown by the blue and red dots in the figure. But higher load growth assumptions would increase the goal estimate under this methodology, as shown by the rising blue line. In fact, just a 0.2% increase in annual load growth would bring the goal estimate in line with the two 2030 benchmarks. And using the EPA's alternate renewable energy (RE) assumptions by themselves would raise the goal to 65 million metric tonnes, as shown by the green dot. Finally, combining the alternate RE assumptions with modestly higher load growth would result in a RGGI budget at 2020 levels.

This illustrates how modifying just two key assumptions, load growth and the RE building block, could impact the RGGI budget. Alternative assumptions for the other three building blocks could also materially impact the budget. And, importantly, modifying the building block and load growth assumptions for other states would also materially alter their mass goals. This methodology provides a simple and transparent way to explore those relationships and better understand the impact of alternative building block decisions on mass goals.

Figure 9



	2012-2030 Load Growth
South East	1.09%
West	1.04%
South Central	0.82%
East Central	0.74%
North Central	0.60%
Northeast	0.06%
U.S. Average	**0.84%**

The RGGI states are in the Northeast and East Central regions.

VI. Conclusions

All this points to the importance of facilitating state compliance through mass goals rather than rate goals and focusing on mass goals that cover both existing and new sources, not just existing sources; relying on a rate to mass translation methodology that is simple, intuitive and transparent; and focusing policy discussions regarding the appropriate level of mass goals on a small number of key factors including the building blocks and load growth.