
Michael Wara is an Associate Professor of Law and the Justin M. Roach, Jr. Faculty Scholar at Stanford Law School. His research and teaching focuses on environmental and energy law with an emphasis on climate and electricity policy. He holds a J.D. from Stanford Law School and a Ph.D. in Ocean Sciences from the University of California, Santa Cruz.

Danny Cullenward is the Philomathia Research Fellow at the Berkeley Energy and Climate Institute (BECI) at the University of California, Berkeley. His work focuses on the design and implementation of science-based climate policy. He holds a Ph.D. in Environment & Resources (E-IPER) from Stanford University and a J.D. from Stanford Law School.

Rachel Teitelbaum is an MPP candidate at the Goldman School of Public Policy at the University of California, Berkeley, where she focuses on environmental policy. She is a Research Assistant at BECI and completed her undergraduate studies at Williams College.

The authors offer thanks to Jonathan Koomey and Jordan Wilkerson for their advice on the history and use of NEMS. They also are grateful to the Philomathia Foundation for funding Mr. Cullenward and Ms. Teitelbaum.



Peak Electricity and the Clean Power Plan

Key elements of EPA's Clean Power Plan rely on forecasted electricity sales from the National Energy Modeling System (NEMS), but NEMS has consistently over-projected electricity sales. An analysis of the model's bias as applied by EPA raises concerns about the stringency of the proposed emissions targets.

Michael Wara, Danny Cullenward and Rachel Teitelbaum

I. Introduction

Complex energy modeling is increasingly central to the development of electricity sector regulations, and perhaps increasingly necessary. But environmental agencies need to remain vigilant to avoid vulnerabilities created when models designed for broad energy system projections are repurposed for the design of detailed pollution control policies. All models are false, some are useful, and by implication, some are misused. Looking beyond the current proposal, it is critical that

legislators and environmental regulators recognize the limitations of energy models when they employ them to design future pollution control programs.

Here, we express concern about the way the Environmental Protection Agency uses the National Energy Modeling System (NEMS) in the design of the Clean Power Plan. We also suggest strategies for fostering policy integrity through a period of deep uncertainty in the U.S. electricity system. Now, more than at any time in the past century, it appears possible that from both technological and

regulatory perspectives, the future of U.S. electric power may look very different from its past. Yet in the formulation of key aspects of the Clean Power Plan, EPA relies on a model that assumes the power sector in 2030 will look much as it does today. Ultimately, this approach risks reducing the stringency of EPA's flagship climate policy.

In June 2014, the U.S. Environmental Protection Agency released the Clean Power Plan, a proposal to reduce carbon dioxide emissions from existing fossil-fueled electric power plants, based on Section 111(d) of the Clean Air Act.¹ The Clean Power Plan is perhaps the most economically and environmentally significant regulation in a generation. If implemented, it is expected to have far-reaching effects on the electric power, coal mining, and natural gas sectors; numerous other industries will experience indirect effects, too.²

At its core, the proposal sets state-level targets for fossil fuel-fired electric generating units in the years 2020 to 2029 and for 2030.³ Consistent with prior EPA practice under section 111(d),⁴ these targets are expressed as emission rates—in this case, in pounds of carbon dioxide per megawatt hour of electricity (lbs CO₂/MWh).⁵ The state-level goals, which “reflect the best system of emission reduction”⁶ (BSER), were developed by calculating the emissions savings from four “building blocks” that, when

combined, add up to the goal for each state.⁷ The four building blocks address, respectively, (1) heat rate improvements at existing fossil-fired power plants; (2) increased reliance on existing natural gas combined cycle electric power plants to displace generation from existing coal-fired power plants; (3) increased deployment of renewable energy and preservation of at-risk nuclear capacity; and (4) improvements in

In setting state energy efficiency goals, EPA matches each state to its corresponding region in the NEMS Electricity Market Module.

demand-side energy efficiency.⁸ In addition, states that prefer to limit total emissions from covered sources, rather than their emissions rate, may elect to translate EPA's statewide rate-based target into an “equivalent mass-based” standard, expressed in tons of CO₂.⁹

We focus here on two key components of the proposed rule that rely on a long-term forecast from the Energy Information Administration (EIA) Annual Energy Outlook 2013 (AEO2013) reference case projections, which EIA generates using NEMS.¹⁰

First, EPA relies on a NEMS reference case projection when it calculates the fourth building block, energy efficiency. As part of its “flexible” approach to regulating power plants, EPA proposes allowing states to offset emissions from covered sources through programs that increase energy efficiency and therefore reduce utilization of covered sources.

The method by which the EPA quantifies energy efficiency contributions in the state goals—and by which state compliance plans could presumably claim credit for energy efficiency—is based on the AEO2013 reference case.¹¹ In setting state energy efficiency goals, EPA matches each state to its corresponding region in the NEMS Electricity Market Module (“EMM”). Next, EPA calculates baseline future electricity sales for each state by taking its 2012 actual sales and compounding them by the average annual growth rate over the period 2012 to 2040 from the matched EMM region, as projected in the AEO2013 reference case. EPA then measures the feasible contribution of energy efficiency against this baseline.¹² Thus, each state's energy efficiency potential is measured against baseline projections derived from the AEO2013 reference case.

Second, EPA relies on the AEO2013 reference case in its guidance for translating states' rate-based goals into mass-based equivalents.¹³ As a general matter,

translating a target emissions rate (CO₂/MWh) into a total mass target (CO₂) requires data on, or estimates of, actual generation (MWh). EPA offers two kinds of mass-based standards: one that applies only to existing power plants, and another that applies to both new and existing power plants.¹⁴ For a mass-based standard that applies only to existing sources, there is no need to project future generation, as EPA would allow states to use 2012 data.¹⁵ In contrast, mass-based standards for new and existing facilities require projections of future electricity consumption. We note that the two sub-national American carbon markets—California’s AB 32 and the Regional Greenhouse Gas Initiative (RGGI) in the Northeast—cover both new and existing electricity sources, suggesting that these states are likely to consider EPA’s methodology for calculating this type of equivalent mass-based standard.

EPA provides an “illustrative approach” to determining equivalent mass-based standards for new and existing facilities that relies on AEO2013.¹⁶ As it did for calculations of energy efficiency potential, described above, EPA matches states to their corresponding regions in the NEMS EMM. The Agency then projects each state’s future electricity sales based on the average regional growth rate for electricity sales from the

AEO2013 reference case over the period 2012 to 2029.¹⁷ Next, EPA calculates incremental demand for new generation by subtracting historical 2012 sales from these NEMS-derived projections for the year 2029, adjusted for transmission losses and natural gas-fired power plants already under construction.¹⁸ The Agency adds this incremental demand to existing sources, building block 3 contributions

For a mass-based standard that applies only to existing sources, there is no need to project future generation.

(new renewable energy and avoided nuclear retirements), and building block 4 contributions (energy efficiency), generating a total called the “Final Mass Equivalent Generation.”¹⁹ Finally, EPA calculates the equivalent mass-based target by multiplying the Final Mass Equivalent Generation (MWh) by the default rate-based targets (CO₂/MWh) to generate an equivalent mass-based target (CO₂). Accordingly, incremental new generation is based on projected electricity sales from the AEO2013 reference scenario.

Thus, under rate-based and mass-based approaches to compliance with the Clean Power Plan, electricity sales projections from AEO2013 drive EPA’s goal setting. Notably, however, EPA’s use of AEO2013 differs from how EIA describes its own modeling work. According to EIA, the AEO reference case “is a business-as-usual trend estimate, given known technology and technological and demographic trends”; the projections “should serve as an adjunct to, not a substitute for, a complete and focused analysis of public policy initiatives.”²⁰ Yet in its Clean Power Plan rulemaking, EPA uses EIA’s projection as a point forecast of future electricity sector demand.

To better understand the consequences of EPA’s approach, it is necessary to examine the accuracy of EIA’s projections as though they were forecasts. In what follows, we estimate the forecast skill of past AEO reference cases to show how this could affect the stringency of state targets under the Clean Power Plan.

II. A Dynamic Industry

Given the central role of future electricity sales in the design of the Clean Power Plan, some historical context is in order. In the past, when the U.S. economy was more dependent on energy-intensive manufacturing, large

increases in electricity sector demand went hand-in-hand with growth in GDP. Over time, however, the positive association between economic growth and load growth has weakened and might even have reversed sign (Figure 1).

In fact, annual growth in electricity demand has been on a steady downward trajectory. From the 1950s to the 1980s, growth in electricity demand fell from above 10 percent per year to below 5 percent per year. (This change is best remembered in the power sector for the role it played in the disallowance of many planned and partially completed nuclear units.²¹) After the recovery from the 1981 to 1982 recession, the rate of load growth resumed its downward trend to the present, concluding with essentially no load growth during the post-great recession recovery period (Figure 2).

From a long-term perspective, the United States may well be at a threshold moment in the evolution of its power sector—peak electricity. It is entirely conceivable that electricity sales (produced by the power plants regulated under the Clean Power Plan) will fall in absolute terms, even as GDP growth continues. Several drivers suggest this transition may already be in motion, as residential and commercial consumers continue to adopt key energy technologies such as LED lighting and high-efficiency

The Evolving Electricity Intensity of the U.S. Economy

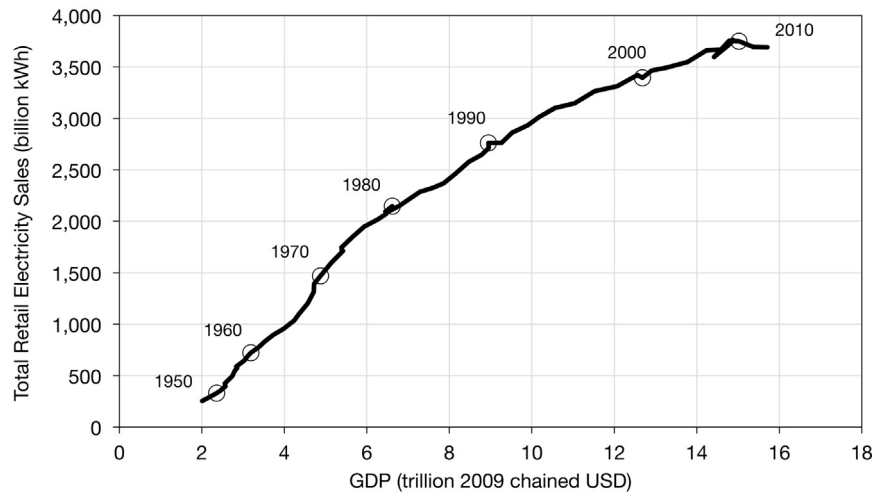


Figure 1: Trends in the electricity intensity of the post-WWII American economy reflect several major economic transitions. Not only did price shocks from the oil crises of the 1970s accelerate end-use energy efficiency and fuel switching in the electricity sector, but the structure of the economy shifted away from energy-intensive manufacturing and towards high-value service sectors. With the rise of distributed generation and advanced efficiency technologies, are we on the cusp of another transition?

HVAC, while distributed generation and storage technologies become more widespread.²²

Should the long-term trend of declining load growth continue on a linear path to 2030,

the final compliance year under the Clean Power Plan, demand for grid-supplied electricity will fall 35 percent to 2,500 billion kWh, down from current level of 3,800 billion kWh. But that is only one possible future. In its latest

Annual Growth in Total Retail Electricity Sales

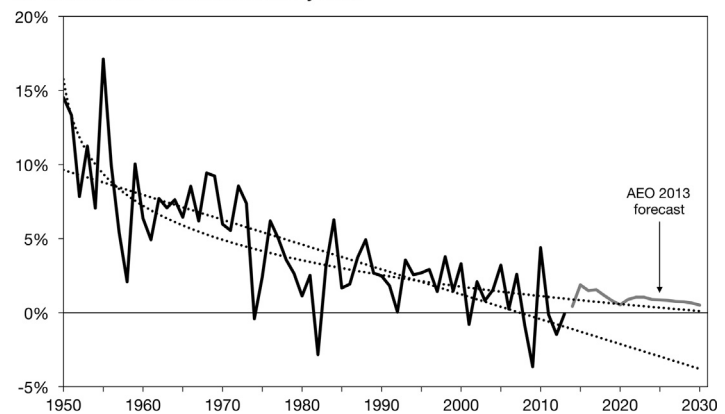


Figure 2: Annual growth in total retail sales of electricity has been declining over the past 65 years. Whether the trend should be modeled as a linear or logarithmic decline has significant implications for future sales, but national data do not support one approach over the other: the linear model has an R^2 of 0.59, whereas the logarithmic model has an R^2 of 0.63. EIA's AEO2013 reference case projections follow the logarithmic model.

Annual Energy Outlook reference case, EIA instead projects that electricity demand will grow at 0.9 percent per year through 2040 (Figure 2).²³ At this rate of growth, total electricity sales would be approximately 4,270 billion kWh in 2030—more than 75 percent above the forecast that results from assuming continuation of the linear trend in electricity growth rates over the past 65 years.

Although history is no guarantee of the future, it is impossible to statistically distinguish the exponential trend EIA projects from a simple linear trend projection using the same data. We emphasize that the EPA may well be right in selecting AEO2013 projection for development of the Clean Power Plan—the evolution of U.S. electricity productivity trends

might follow a logarithmic pattern going forward—but EPA may also be wrong. If so, the rule could be much weaker than intended.

For additional perspective, we compare the regional electricity growth rate projections from AEO2013 against recent trends at the state level from the period 2005 to 2012 (Figure 3). This is the actual method EPA adopts in the Clean Power Plan, with regional growth projections applied to individual state data. We note that only a few states have experienced trends comparable to what NEMS projects through 2030 for the states' corresponding electricity market regions.²⁴

In the next section, we assess the accuracy of past NEMS projections of total electricity sales to better understand what risks follow from treating these

projections as forecasts in the design of the Clean Power Plan.

III. Electricity Sales Forecasts in Retrospect

Each year, EIA uses NEMS to produce a standard reference case and several side cases, collectively known as the Annual Energy Outlook. Again, these projections are intended to give a sense of the current trajectory of the U.S. energy economy given expected trends, available technologies, and current policies. And while no model is perfect, NEMS is widely recognized as one of the most advanced models of its type in the world.

To evaluate the model's past performance, we compare historical NEMS electricity sales projections with subsequent EIA data.²⁵ We collected EIA NEMS-based projections of "Total Electricity Sales" from the Annual Energy Outlook reference cases for each year from 1997 to 2013 ($n = 17$) (Figure 4). Next, we define forecast error as the difference between projected and measured sales. We collate the errors by forecast year, defined as the number of years that have elapsed since the corresponding AEO vintage. For example, AEO2005 projected electricity sales of 4,070 billion kWh in 2010, but EIA data indicate actual sales were 3,754 billion kWh. Thus, the error for AEO2015's fifth forecast year is 316 billion kWh, or about

Average Annual Growth Rate, Total Retail Electricity Sales

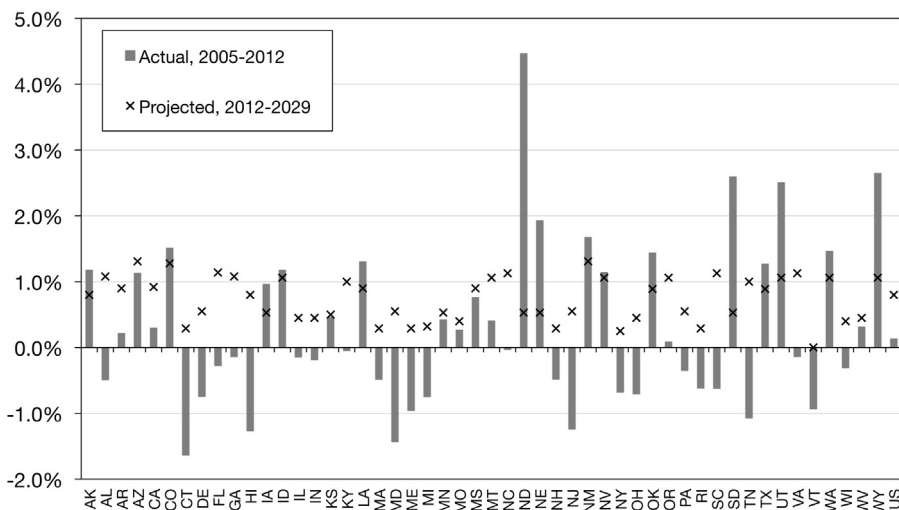


Figure 3: We compare the Electricity Market Module (EMM) regional growth projections from the AEO2013 reference case against actual changes in corresponding state-level retail electricity sales from 2005 to 2012. Recent history in some states greatly exceeds forecasted growth, while in many others, actual sales were far lower than AEO2013 reference case projects for the future.

Total Retail Electricity Sales, NEMS Forecasts vs. Actual (billion kWh)

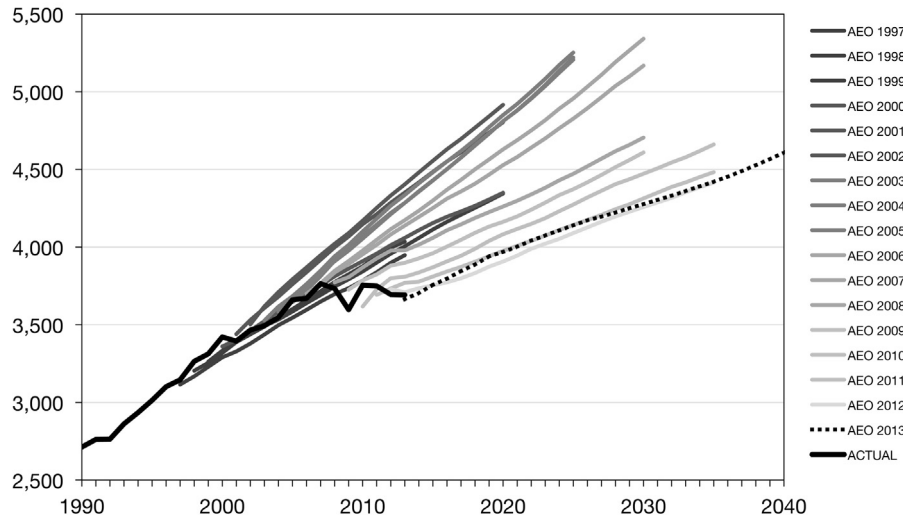


Figure 4: Although no model is perfect, NEMS has consistently overestimated total retail electricity sales since 1997. NEMS reference case forecasts for total retail electricity sales are shown here against the historical record, with AEO2013 highlighted as a dotted line.

8 percent of demand. We apply this methodology to every forecast year/pair for the 17 AEO reference case forecasts analyzed for this study. Finally, we compute the mean and standard deviation of forecast

error for the dataset by forecast year. This allows for an assessment of forecast skill—that is, the skill of NEMS forecasts in predicting total electricity sales at various time horizons (Figure 5).

We selected two timeframes over which to judge forecast skill. The first, extending from 1997 to 2013, begins at the time that the model was first modified to assess prospective climate policies—in particular, implementation of the Kyoto Protocol.²⁶ This interval has the further advantage of containing multiple business cycles. In the years that followed, however, the model structure and inputs changed considerably. Thus, we also consider a second timeframe, from 2004 to 2013. This shorter interval is perhaps less ideal as a sample of model performance in that it contains the global financial crisis, which hopefully will not become a common occurrence; nevertheless, it has the advantage of better representing the current state of the model.²⁷

NEMS Forecast Error, Total Retail Electricity Sales (billion kWh)

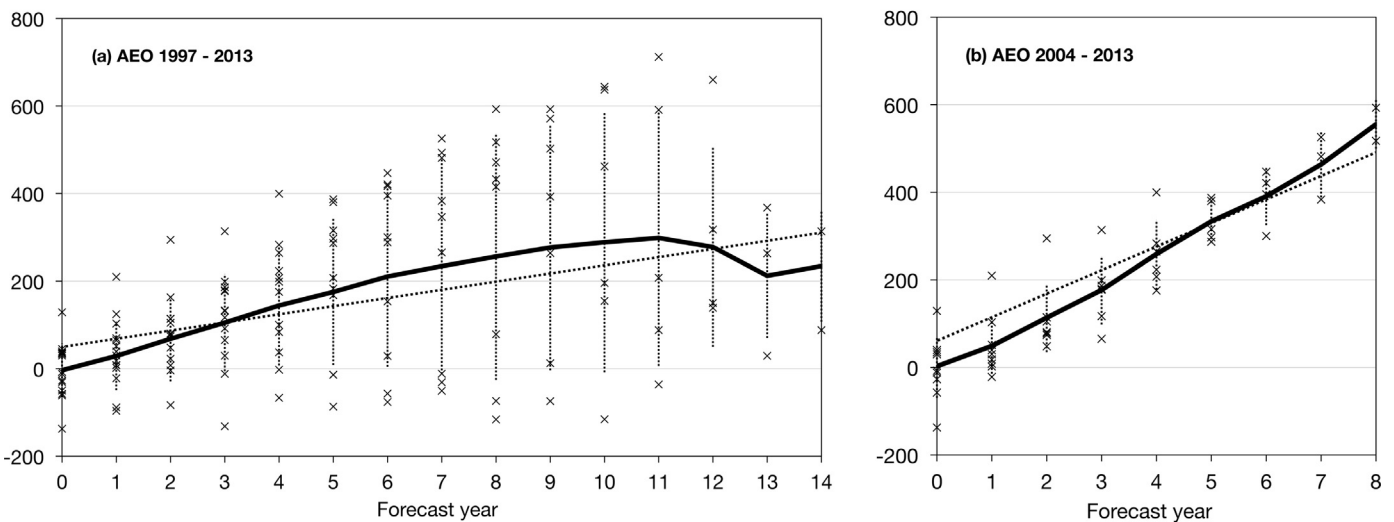


Figure 5: Displaying forecast errors by forecast year gives a measure of NEMS projections' accuracy over two time horizons, (a) AEO1997 to AEO2013, and (b) AEO2004 to AEO2013. The black line shows the average error in each forecast year; the horizontal dotted line shows the best linear fit; and the vertical dotted lines show one standard deviation above and below the average.

IV. Four Views of the Future

As discussed above, the rate of annual electricity sales growth has been falling for over six decades. We note that this trend can be modeled as a linear or exponential trend with equal statistical validity. While we cannot claim to know which of the two trends will prove correct, if either, EPA has premised the stringency of the Clean Power Plan on the exponential model in its adoption of the AEO2013 reference forecast.

To further illustrate how uncertainty about future electricity sales impacts key Clean Power Plan design parameters, we describe four different scenarios here (Figure 6).

First, we include EPA's preferred scenario, the AEO2013 reference case, which features annual electricity sales growth of 0.91 percent per year through 2030.

Second, we describe an alternative scenario in which electricity sales growth follows a linear trend, based on data since 1950. Although it may seem controversial to imagine a world in which electricity sales fall as GDP grows, the data suggest it is no less plausible than the AEO2013 reference case (Figure 2). We interpret this scenario as a lower-bound estimate: in it, electricity sales have already peaked and will decline by an average of 2.44 percent per year through 2030.

We also develop two bias-corrected NEMS projections. For these scenarios, we assume that NEMS reference case is a biased

estimator that can be corrected by observing the average forecast error by forecast year from past Annual Energy Outlook projections. Specifically, we adjust the AEO2013 reference case by the best-fit linear estimate of the projection error (in billion kWh) by forecast year over a given bias correction period. We note that this assumes statistical independence between forecasting years and individual forecasts, neither of which is strictly true. Nevertheless, the approach provides a transparent method of correcting for a well-documented pattern of overestimates of electricity sales.

Thus, our third scenario corrects for bias as measured over the period from AEO1997 to present. This scenario features modest increases in electricity sales, with an average growth rate of 0.34 percent through 2030.

Our fourth scenario corrects for bias as measured over the period AEO2004 to present. This scenario features a fairly substantial decrease in electricity sales, with an average growth rate of -0.66 percent through 2030.

Point estimates of future electricity demand in the NEMS reference case forecasts imply certainty about the future. Consistent with best practices, however, EIA intends that NEMS be used to provide insights, not mere numbers.²⁸ EPA's reliance on the AEO2013 reference case suggests that demand will automatically increase over 2012 values, whereas a broader range

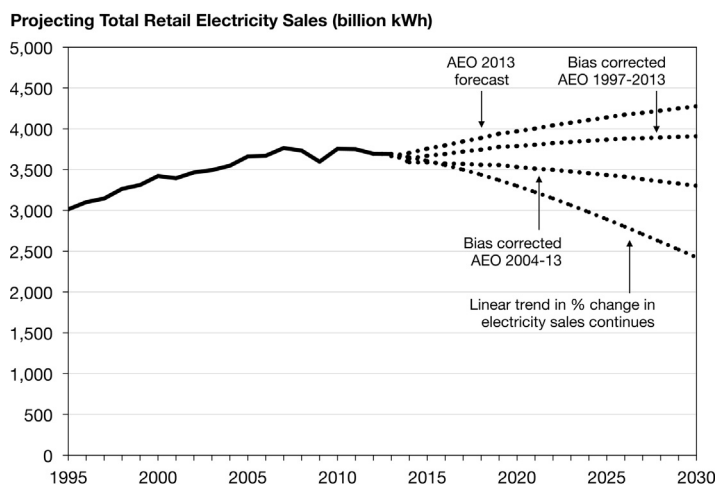


Figure 6: EPA's decision to use the AEO2013 reference case to drive fundamental aspects of the Clean Power Plan risks establishing an artificially high baseline scenario against which states can measure energy efficiency and convert rate-based to mass-based targets. As shown in Figure 2, the AEO2013 reference case roughly matches a continuation of the logarithmic trend in total electricity sales over the past 65 years. If the trend is instead linear, actual sales will be significantly lower in the coming years. Adjusting the AEO2013 reference case by the forecast error trend since 1997 results in only modestly higher sales by 2030; adjusting by the forecast error trend since 2004 results in significantly lower sales by 2030.

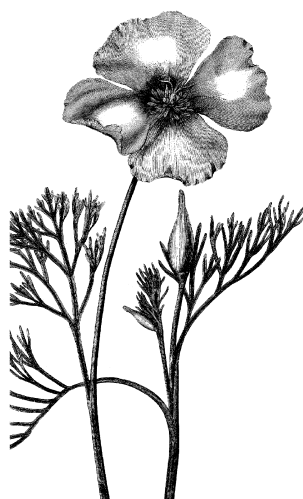
of scenarios shows how the future of electricity demand is highly uncertain within plausible constraints. When possible, energy and environmental policies should be designed to be robust to the range of reasonable possibilities. Unfortunately, the structure of the Clean Power Plan appears highly sensitive to unavoidable uncertainty about the U.S. electricity sector's future.

V. Implications for Rate-Based Targets

If actual electricity demand is less than projected in AEO2013, the default, rate-based policy framework could end up imposing less stringent requirements than intended. Fundamentally, building block 4 of EPA's Best System of Emission Reduction relies on AEO2013 to generate a top-down estimate of electricity demand from which energy efficiency improvements are then deducted. Given the uncertainty around this projection, EPA should consider to what extent its approach to assessing energy efficiency potential would change under different baseline scenarios.

In our view, the most pressing risk is that states will copy EPA's method for estimating the contribution of energy efficiency towards rate-based targets. EPA proposes that states will have to submit plans that indicate how state policies will achieve Clean Power Plan targets,²⁹ but has yet to

provide a specific method or process for approving state-level evaluation, measurement, and verification (EM&V) of energy efficiency policies.³⁰ If EPA were to allow a state to adopt EPA's own method for estimating building block 4, those states that expect lower electricity sales growth than AEO2013 projects will be able to claim credit for business-as-usual



trends. As a result, they will be able to emit more CO₂ at existing facilities, reducing the stringency of the rule.

We note that successful state energy efficiency programs do not typically attempt to forecast future demand beyond 5 years. By contrast, EPA has attempted to set energy efficiency goals in building block 4 for a period more than three times farther into the future. Therefore one option for increasing the robustness of the Clean Power Plan would be to require that short-term energy forecasts be used by states as baselines for claiming credit for energy efficiency reductions.

Another alternative would be to only allow credit based on bottom-up assessment of energy efficiency program performance. In any case, EPA should prohibit state plans from copying the Agency's approach to quantifying energy efficiency in the BSER.

VI. Implications for Mass-Based Targets

Some states—most notably the RGGI states and California—are already considering whether to convert their rate-based goals to mass-based goals that cover both new and existing sources. If actual electricity demand is less than projected in AEO2013, however, mass-based targets will impose less stringent requirements than the default rate-based approach.

Although EPA's mass-based option was designed to accommodate states that wish to pursue emissions trading policies, the risk of substantial forecast error raises the possibility of states strategically adopting the weaker of two options under the Clean Power Plan. In the proposed framework, some states might find that mass-based targets require significantly fewer emission reductions than their corresponding rate-based alternatives. These states might opt for mass-based compliance specifically as a means of reducing their obligations under the Clean Power Plan.

The bottom line is that using estimates of electricity demand

that look far into the future creates significant risks that a mass-based compliance regime will not create the same level of environmental improvement that would occur under a rate-based regime.

To address this problem, EPA could use a recent empirical proxy or delayed projections of future trends in electricity consumption to establish the equivalent mass-based standard. Examples include the trends in electricity observed from 2005 to 2012, 2012 to 2020, or some other combination of data prior to the compliance period. EPA could also choose to use demand forecasts generated closer to the time of regulation, such as the reference scenario from a future Annual Energy Outlook issued just prior 2020; or EPA could generate its own scenario if none is available from EIA. While these approaches would reduce regulatory certainty about the specific requirements of mass-based goals in the short term, states that elect these targets would presumably be well positioned to assess the necessary information closer to the compliance period.

VII. Conclusions

Our analysis indicates that the electricity sales projections underlying key aspects of the Clean Power Plan are uncertain, and most likely overestimate true demand for power. Based on historical forecast error experience, the magnitude of this overestimate is likely of the same scale as the

reductions envisioned under the plan, and may even be larger.

The consequences of EPA's approach manifest in both the rate- and mass-based targets. If EPA allows state plans to count energy efficiency using the methods the Agency used in calculating building block 4 of the BSER, then states will be able to earn credit for demand reductions



that would have occurred in the absence of policy. Similarly, if the method for converting rate-based targets into equivalent mass-based targets for new and existing sources relies on an overestimated consumption projection, the mass-based targets will be diluted. In both cases, the likely forecast errors would lead to less action to reduce carbon dioxide emissions from existing sources than the EPA intended.

Given the risk of large forecast errors, we believe that the EPA should revisit its determination of equivalent mass-based targets for new and existing sources. The Agency should also be careful to rule out reliance on long-term

energy forecasts as a basis for measuring energy efficiency program compliance under rate-based targets. Whether these alternatives or others are preferable from the EPA's perspective, additional analysis is needed in order to confidently assert that energy efficiency programs and mass-based targets under the Clean Power Plan will generate intended levels of emission reductions.

Finally, we hope this episode will raise awareness about the risks of using point estimates from complex energy model projections when designing detailed pollution reduction targets over the medium and long term.³¹ Whatever directions EPA takes in its final rule—as well as any action future Congresses take to limit greenhouse gas emissions from the energy sector³²—these issues will not go away. They deserve much greater attention in this and subsequent efforts to limit air pollution, from both environmental regulators and the energy modeling community.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.tej.2015.04.006>.

Endnotes:

1. Environmental Protection Agency, Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Generating Units, 79 Fed. Reg. 34830 (June 18, 2014).

2. See, e.g., Larsen, J., et al., 2014, November. Remaking American Power: Potential Energy Market Impacts of EPA's Proposed GHG Emission Performance Standards for Existing Electric Power Plants, Center for Strategic & International Studies and the Rhodium Group. Available from <http://rhg.com/reports/remaking-american-power>.
3. EPA, *supra* note 1 at 34951.
4. *Id.* at 34953.
5. See, e.g., Environmental Protection Agency, Standards of Performance for New Stationary Source and Emission Guidelines for Existing Sources: Large Municipal Waste Combustors; Final Rule, 71 Fed. Reg. 27324, 27325–26 (May 10, 2006) (expressing emission limits for New Source and Existing Source standards under Clean Air Act § 111 in units of pollutant mass per dry standard cubic meter).
6. 42 U.S.C. §§ 7411(d), 7411(a)(1).
7. EPA, *supra* note 1 at 34855.
8. *Id.* at 34856.
9. *Id.* at 34953 (describing the general requirements for converting default rate-based standards into equivalent mass-based standards) (to be codified at 40 C.F.R. § 60.5770).
10. U.S. Energy Information Administration, 2013, April. Annual Energy Outlook 2013, Report #DOE/EIA-0383(2013).
11. U.S. Environmental Protection Agency, GHG Abatement Measures, Technical Support Document (TSD) for Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units (June 2014), Docket ID No. EPA-HQ-OAR-2013-0602, at 5-40 (hereinafter "GHG Abatement Measures TSD").
12. *Id.* at 5-39 through 5-48 (describing the method in full).
13. EPA, *supra* note 1, at 34953.
14. U.S. Environmental Protection Agency, 2014, November. 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, at 2 (hereinafter "Mass-Based Equivalents TSD").
15. *Id.* at 4–6.
16. *Id.* at 6.
17. *Id.* at 6, note 21 21 (clarifying that the period over which average annual growth rates are determined for this purpose is 2012 to 2029). Note that this period is different than the period used to determine the contribution of energy efficiency as building block 4 in the BSER, where the relevant period of analysis is 2012 to 2040. See GHG Abatement Measures TSD, *supra* note 11 at 5–40.
18. Mass-Based Equivalents TSD, *supra* note 14 at 7 (see the equation describing "Incremental Demand for New Generation").
19. *Id.* (see the equation describing "Final Mass Equivalent Generation").
20. EIA, *supra* note 10 at ii.
21. Duquesne Light Company v. Barasch, 488 U.S. 299, 302–304 (1989).
22. For additional analysis on this possibility, see Afsah, S., Limodio, N., Salcito, K., 2015, March 19. Did Energy Efficiency Break the Utilities' Business Model? CO₂ Scorecard. Available from: <http://co2scorecard.org/home/researchitem/32>.
23. Energy Information Administration, 2014, April. Annual Energy Outlook 2014, Report #DOE/EIA-0383(2014), Figure MT-29. Available from: http://www.eia.gov/forecasts/aeo/MT_electric.cfm.
24. Of course, the comparison depends on historical period selected. The period 2005 to 2012 is conservative in that it predates the global financial crisis, which exogenously depressed electricity sales. Had we selected a more recent time period, growth would be strongly negative in many more states.
25. Energy Information Administration, 2015, March. Monthly Energy Review, Table 7.6. Available from: <http://www.eia.gov/totalenergy/data/monthly/>.
26. Interlaboratory Working Group, Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy-Efficient and Low Carbon Technologies by 2010 and Beyond (1997) (the "Five-Lab Study": ORNL, LBNL, PNNL, NREL, ANL) (using the AEO1997 version of NEMS); U.S. Energy Information Administration, 1998, October. Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity, Report #SR/OIAF/98-03 (using the AEO1998 version of NEMS); Interlaboratory Working Group, Scenarios for a Clean Energy Future, Report #ONRL/CON-476 and #LBNL-44029 (Nov. 2000) (using the AEO1999 version of NEMS).
27. EIA regularly updates NEMS, but there is no objective threshold between the Kyoto-era version of the model and more recent versions that most closely resemble the AEO2013. We chose the 2004 date based on our experience with the model and consultation with longtime model users, but recognize this is a judgment call.
28. EIA, *supra* note 10 at ii; see also Huntington, H.G., Weyant, J.P., Sweeney, J.L., 1982. Modeling for insights, not numbers: the experiences of the energy modeling forum. *Omega Int. J. Manag. Sci.* 10(5), 449–462.
29. EPA, *supra* note 1 at 34951–34952 (to be codified at 40 C.F.R. § 60.5740).
30. U.S. Environmental Protection Agency, State Plan Considerations, Technical Support Document (TSD) for Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units (June 2014), Docket ID No. EPA-HQ-OAR-2013-0602, at 34.
31. See also Craig, P.P., Gadgil, A., Koomey, J.G., 2002. What can history teach us? A retrospective examination of long-term energy forecasts for the United States. *Annu. Rev. Environ. Res.* 27, 83–118.
32. Wara, M., 2015. Instrument choice, carbon emissions, and information. *Mich. J. Admin. Environ. Law.* Available from: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2469397 (forthcoming).