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On Inaccuracies in a Published Journal Article

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On December 22, 2015, the journal *Energy* published online an article written by Alexander Q. Gilbert and Benjamin K. Sovacool titled "Looking the wrong way: bias, renewable electricity, and energy modelling in the United States." We[1] are concerned by the presence of factual errors and other misinformation in the article, which could mislead the journal's readership about the operation of the NEMS model, which is the subject of the article. We have corresponded with the authors and written to the journal editor-in-chief about our concerns, but have been unable to get either to correct the mistakes in the publication. This paper serves as a record of the inaccuracies.

The article referenced above analyzes the renewable electricity results from the Reference case scenarios of several successive historical editions of EIA's *Annual Energy Outlook* (AEO). It makes a retrospective analysis of these results, infers (incorrectly) that the NEMS model is fundamentally flawed, and on that basis calls into question its utility for policy analysis. We agree that a historical retrospective of AEO results is a valuable addition to the published literature, and EIA always welcomes the opportunity to receive rigorous criticism of its energy models, assumptions, and results. The unfavorable conclusion about the NEMS model is not itself at issue here. However, in the case of this paper, we believe that the authors' own misunderstanding of the operation of the NEMS model, perhaps by incorrectly interpreting the NEMS documentation, has led them to make several incorrect descriptions of the model and perhaps resulted in an erroneous conclusion in this paper. We see no evidence of deliberate misleading by the authors, and we assume that the errors are the result of honest mistakes.

We would like to correct the factual inaccuracies about the NEMS model in this published article, so that the journal readership may not be misled about its actual operation. Any conclusions one may infer about the utility of NEMS for policy analysis will be left to the reader.

There are four fundamental errors the Gilbert and Sovacool paper makes. In summary, these are as follows:

1. It misconstrues AEO's projection as a forecast. Since this underlies the framing of the analysis, the article's method of evaluation and interpretation of results are incorrect and misleading.
2. It misreads and/or misunderstands the published NEMS documentation, in which is detailed how NEMS meets state-level RPS requirements.
3. It incorrectly asserts that NEMS overlooks price volatility and the uncertainty associated with the potential for future legislation in decision-making.
4. It uses speculative assertions about how environmental externalities, such as water use and air pollution, drive the penetration of renewables as evidence of shortcomings in the NEMS model.

To detail the four errors, the following are statements that we believe to be in error, misleading, or otherwise unfit for publication in a scholarly journal:

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1. The article misconstrues AEO's projection as a forecast. Since this underlies the framing of the analysis, the article's method of evaluation and interpretation of results are incorrect and misleading.

   In section 1, the AEO is called "the chief energy forecast of the U.S. Federal Government." In fact, the AEO is not a forecast, and EIA takes great care never to refer to it as such.[2] The article generally and correctly refers to the AEO as a projection, but in this opening section when it is first introduced it is called a forecast. An energy forecast is an unconditional estimate of the future state of the energy system. EIA does produce such an energy forecast, the Short-Term Energy Outlook (STEO), which looks out 13-24 months. The AEO, however, is a conditional estimate of the future evolution of the energy system. In the Reference case, which was the only AEO case considered in this analysis, a key condition is that laws and regulations in effect when the model freeze occurred continue throughout the projection period as written. In particular, laws with sunset dates are not automatically renewed. To evaluate the accuracy of the AEO *as a projection*, one would need to compare its results with how the system in fact evolved *under the same conditions*.

   We believe that it can be interesting to compare a projection with how the subsequently revealed system in fact evolves; but, critically to the conclusions in this paper, differences between a projection and subsequent fact do not by themselves distinguish between inaccuracies in the model and changes in the underlying stated conditions. In the time period studied in this analysis, U.S. federal and state renewable electricity policies changed frequently; therefore, the analytic method illustrated in this paper could not distinguish between an inaccurate *projection* and an accurate projection that was simultaneously an inaccurate *forecast*. Whether the projection is accurate or not could not be determined by the analysis conducted for this paper, yet the authors conclude that NEMS produces inaccurate projections.

   Blurring the distinction between whether AEO is a forecast or projection and then pointing out that it exhibits large errors *if incorrectly interpreted as a forecast* – which, as we pointed out above, is a misguided framing question – led the authors to conclude, "Our findings have major implications for the reliability of using AEO in regulatory and policymaking in the United States." This demonstrates a misunderstanding of the purpose of the AEO Reference case and is a claim that is not supported by the subsequent evidence in the paper. The utility of the NEMS model as a tool for policy analysis does not derive from the accuracy of the AEO Reference case if interpreted as a forecast.

[2] For example, the executive summary of the AEO2015, which was itself partially quoted at the top of p. 534 in the paper, also contains the following disclaimer:

> "Projections by EIA are not statements of what will happen but of what might happen, given the assumptions and methodologies used for any particular case. The AEO2015 Reference case projection is a business-as-usual trend estimate, given known technology and technological and demographic trends. EIA explores the impacts of alternative assumptions in other cases with different macroeconomic growth rates, world oil prices, and resource assumptions. The main cases in AEO2015 generally assume that current laws and regulations are maintained throughout the projections. Thus, the projections provide policy-neutral baselines that can be used to analyze policy initiatives."

Correspondingly, section 3 often uses the language of prediction, when it should be using projection instead. The general construction exemplified by "AEO reference cases over predict…" is generally incorrect since the AEO does not predict anything; "AEO reference cases over project..." would have been correct. With this small change, section 3 would become technically sound, and would remain a valuable contribution to the literature.

Section 4.2 correctly points out that the annual expiration of renewable tax credits makes AEO projections very different from the policy environment that actually evolved over time, and that therefore the AEO projection is not a reliable forecast. But, it yields very little information about whether the AEO projection is an accurate *projection* of what *would* occur under the stated conditions. Instead, the authors speculate, "If the PTC were to end, many wind projects would still be economic and eventually built, contrary to EIA's modelling." This is one of the few legitimate (i.e., testable) claims in the paper that NEMS *projections* are inaccurate, yet this claim is made without proof. Interestingly, there are a number of years when projected conditions for the tax credit were consistent with the realized state of the tax credit. For the four years after ARRA extended the PTC through 2012, EIA's Reference case renewable capacity projections bracket actual market outcomes on both the high and low end, and have generally been within 10% (and often within 5%) of realized outcomes. These results, which are not speculative and were certainly available to the authors, provide substantial evidence counter to the article's speculative conclusion.

2. The article misreads and/or misunderstands the published NEMS documentation, which details how NEMS meets state-level RPS requirements.

   In section 4.1 the article states:

   > "First, co-firing biomass with coal only counts as an eligible resource for some state RPS mandates; assuming that it can be used to meet renewable requirements does not match with the policy reality in many states."

   The first clause is correct; the second implies that NEMS allows essentially unlimited co-firing in all states, which is factually incorrect. In fact, EIA places restrictions on the use of biomass (including co-firing) in model regions where the use of this fuel is substantially restricted. Examining the results for co-firing suggests that these restrictions have the desired effect: co-firing is not significantly used to comply with RPS policies where it is not allowed to do so.

   Also in section 4.1 the article states:

   > "Second, the renewable constraints equation implies the potential for unlimited renewable credit trading between all regions in the country, regardless of whether states in regions even have their own RPS mandates or credit system."
   >
   > "[W]e conducted an analysis that assumed no trading between regions…Essentially, we tested whether NEMS actually models renewable energy mandates the way it claims it does."

This is simply a misreading and/or misunderstanding of the published NEMS documentation. NEMS does not allow unlimited renewable electricity (or credits, i.e., RECs) trading between all regions of the country. The model only allows electricity trading between regions that have existing, historical electricity trade, and trading is limited by the available transmission capacity (or transmission added with appropriate investment). Although the NEMS documentation does use the term "credit" to describe it, it is effectively modeled as a physical trade, not as a REC. It is not "unlimited" or allowed between "all regions" of the country. Furthermore, while some states have "in state" requirements or incentives, most states do allow for either credit trading or electricity that can be physically delivered to the state to meet RPS obligations. According to a 2014 report from DSIRE,[3] while 18 states have RPS provisions that encourage or incentivize in-state generation, only 3 states broadly exclude any out-of-state generation from compliance, including 2 (Hawaii and Texas) that are effectively isolated grids that cannot, within NEMS, import or export electricity; AEO 2015 projects that the third state (New York) can meet their RPS obligations with in-state generation. Since NEMS implements current laws and regulations for the AEO, conducting an analysis of renewable energy mandates assuming no trading between regions would not be consistent with current RPS laws that allow for trading.

The discussion of "regional renewable 'misses'" in section 4.1 and illustrated by Figure 3 is misleading and simply wrong. It fails to convey a correct understanding of how the approximately 30 state RPS policies are written and implemented. The figure and accompanying discussion seem to imply that the NEMS model, and the AEO publication, does not show enough renewable electricity production to meet state-level RPS laws and regulations. The figure, which is captioned "under-projections of regional renewable energy induced by state RPS mandates," essentially shows the portion of RPS compliance that is traded among NEMS regions. Per the discussion above, this represents either a gross misunderstanding or misrepresentation of state policies, which, for the most part, allow for some form of interstate trading. For example, the paper states, "the most consistently missed state was California," yet the AEO consistently shows California to be in compliance with their RPS mandates through allowed imports of renewable electricity. Interestingly, the authors characterize California as having "one of the most stable and consistent policies for renewable electricity", despite the fact that its RPS policy was modified 4 times in the 10 years following first implementation, and has just recently changed for a fifth major revision in 15 years. Since these regulatory changes appear directly contradictory to the paper's claim, and since the claim itself is unsupported by evidence within the paper, we suggest the claim either be clarified or removed.

[3] http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2015/01/2014-Daniel-In-State-RPS-Requirements.pdf

The discussion in section 4.1 would lead the reader to believe that the AEO significantly under-projects regional renewable energy or uses unallowed trading of electricity to maintain RPS compliance. In fact, neither suggestion is accurate. The AEO shows national production of renewable electricity in significant excess of what would be implied by the cumulative state-level RPS mandates, insignificant trade in renewable electricity between regions that do not allow such trade to achieve RPS compliance, and in-state compliance for those states that broadly require it.

3. The article incorrectly asserts that NEMS overlooks price volatility and the uncertainty associated with the potential for future legislation in decision-making.

   Section 4.3 incorrectly asserts that NEMS overlooks price volatility. ("By not accounting for this significant financial benefit of renewable energy, NEMS is likely to under count the financial incentives of using renewable energy.") The contention that NEMS does not account for volatility is not supported by corroborating evidence in the paper, and it is in fact incorrect; therefore, the claim in this section is unsupported. NEMS, although not capturing price volatility directly as a stochastic model might be able to do, uses several techniques to capture the effect of the uncertainty of future prices. The principle method is to publish side case results with different fuel prices, which were not considered by this analysis. Even in the Reference case, the technology-specific hurdle rates that are used to determine whether each technology is economically competitive are designed to capture the higher costs of capital required by technologies that are dependent on fuels with highly-volatile prices. While the authors could have argued that NEMS does not do *enough* to account for volatility, to claim that it does not account for price volatility is incorrect.

   The contention in section 4.3 that "the current structure of NEMS is limited in its ability to determine how decisions to build renewable energy may be driven by decisions to limit emissions that are not currently controlled by regulations" implies that such considerations are not included in NEMS infrastructure build decisions. This is not true; uncertainty surrounding the potential for future regulations can be captured on a technology-by-technology basis via adjustments to the technology hurdle rates for new construction. In fact, NEMS currently employs a hurdle rate supplement that causes the model to effectively limits the construction of certain types of coal plants in the future specifically because of the uncertainty surrounding the potential for future regulation affecting those technologies.

4. The article uses speculative assertions about how environmental externalities, such as water use and air pollution, drive the penetration of renewables as evidence of shortcomings in the NEMS model.

   The discussion of water usage in section 4.3 was interesting; however, the authors do not establish that water usage was a significant driver of renewable energy in the time frame of this analysis. It was therefore not clear how this discussion related to the hypothesis that

> "flaws in modelling structure that do not monetize the full benefits" contributed to errors in NEMS projections in the time frame considered in this analysis. Without establishing that connection, this speculative discussion does not belong in this section. Perhaps it could fit in another section at the end of the paper on "other recommendations for NEMS" or something similar.

In summary, there is some value in this article, and we believe that it could have been written in a way that would have added to the body of knowledge instead of introducing misinformation into it. Specifically, the comparison of AEO renewable projections with history in section 3, the discussion of the importance of expiring tax credits to the AEO projections, and the retrospective of capital costs in section 4.5 are all useful additions to the literature. But, many of the descriptions of the NEMS model are inaccurate, and we hope to have addressed the inaccuracies in this white paper. Since the hypotheses in section 4 of the article are based on this incorrect understanding of the NEMS model, we call into question whether the evidence presented in the article supports its conclusions. We leave that issue for the informed reader to consider.