Themes from EIA's Challenges in Modeling International Climate Policies Workshop on June 29, 2022

Background

The U.S. Energy Information Administration (EIA) held a workshop on June 29, 2022 on the modeling of international climate policies. This workshop brought together both industry representatives and modeling practitioners to explore market forces faced by corporations as corporations look to reduce carbon emissions, as well as the methods external analysts use when modeling international climate policies. The information in this document represents the views and opinions of the workshop participants and does not necessarily reflect the views or opinions of EIA.

Theme 1: Understanding how issues and questions relate to models

Workshop participants stressed that modelers must be thorough and rigorous in linking analytic tools to today's crucial questions around energy: Ask the right question, use the right tool for the job. If a modeler is considering feedback loops in climate policy, perhaps the modeler should use general equilibrium models. If a modeler is considering trends in technology capital investment, efficiency, cost reductions, and market penetration, the modeler should use optimization-based models.

For example, a modeler would need to tailor a model that projects the use of renewables-based hydrogen (H_2) for decarbonization in the electric power sector to reflect the fuel's unique characteristics. Although H_2 is primarily intended to back up renewable generation, it can be misaligned with the generation trends of other renewable fuels on a seasonal, not just daily, basis. Therefore, a modeler would need to modify the model to quantify this particular difference of H_2 in that it provides renewable-derived energy during times of the year when other renewable fuels are producing less.

The workshop participants identified some challenges to renewables-based H_2 modeling:

- No clear fuel to benchmark against
  - Participants suggested comparing H_2 against battery storage
  - They suggested against comparing H_2 with fossil fuels because of differences in inventory trends. For example, in California, H_2 inventory rises from January to June, as opposed to fossil fuel inventories which typically rise from December to February (gasoline) or June to August (propane).
- Load duration curve binning is problematic
  - This approach loses the renewables-based H_2 value
  - The model should see the entire year so it doesn't lose chronology
- Computational time and resource needs can be problematic for more detailed or different model specifications
- Regional profiles must be captured
- Technology improvement potential is limited

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  - 50 years of technology to produce H_2 is already known, similar to hydrocarbon extraction
  - Most H_2-generating technologies have limited room for further improvement; electrolyzer stacks may have some improvement
- H_2 value differs by location
- Economics of scale matter
  - Batteries have more challenges than H_2 at larger scales
  - Lots of resources are used and needed for both, although comparatively less for H_2

The workshop participants proposed the following modeling considerations:

- What aspects are being modeled? In some cases, empirical data is more important than assumptions or more structural detail.
- What are the most important levers in your models? Understand them better and collect appropriate data.
- Maintain a clear distinction between what's inside the model and what's outside the model. Models can be updated to add in other Earth system details such as gas interactions and dynamics in the atmosphere as well as projections of the impacts of climate change.
- Interdisciplinary model inputs are essential in this field. You cannot answer important questions by insulating within a single discipline.
- Technology detail is important for energy systems at every stage and in every sector. For example, optimism about BECCS (biomass energy with carbon capture & sequestration) has been criticized in the past, but EIA should look into those systems.
- Trade coalitions are likely to form in the international world based on global emissions policies, so one must consider trade models and trade implications. Under the Paris agreement (Article 6)—which allows countries to cooperate in a variety of different ways—sectors have already created "emissions clubs" with rules.

Theme 2: Incorporating uncertainty into models

Because many variables will affect future energy demand, nobody knows what the future holds; be humble. Add value. Question what is actually needed. It's critical to acknowledge uncertainty up front—to incorporate it explicitly both for analytic integrity and for communicating results. Workshop participants suggested documenting policy assumptions so fuels and regions are consistent. It was also suggested to distinguish policy and goals between those that are aspirational versus those that more closely reflect real behavior. A greater focus on domestic energy supplies is anticipated for security and trade reasons.

Relationships between human-caused emissions, atmospheric concentrations, radiative forcing, temperature changes, and equilibrium temperature are all uncertain. As climate conditions and fuel prices change, the process of picking a global temperature cap now and assuming it remains enforced and unchanged for the next 100 years begins to appear less effective.

One approach to address this is to build the model from the problem backwards. This way, as the problem evolves, so does the model—inputs, outputs, and functionality can be added to it as necessary. Regardless of the specific approach, it's useful to quantify uncertainty in socioeconomic and greenhouse gas futures at both global and sub-global levels while ensuring cohesion between the different size scales. This formal quantification of the uncertainty about the future can inform climate policy, planning, and risk management.

For example, some recent MIT research takes a probabilistic approach to modeling using the Economic Projection & Policy Analysis (EPPA) model from MIT. The MIT model links directly to an earth system model, so emissions numbers can be used to predict weather and climate changes. Uncertainty quantification happens using a traditional Monte Carlo approach with an ensemble of scenarios for different policy levels and designs, including increasingly stringent global policies and regional greenhouse policies. MIT uses optimistic and pessimistic outlooks for the climate strategy to reach different levels of international emission cooperation, coverage of land use, and availability of carbon dioxide removal technologies. For a given global pathway, usually a wide range of probabilistic outcomes can occur at the regional level, which are nonetheless quite different in the optimistic and pessimistic cases. In the optimistic case, Brazil, Africa, and other Latin America (regional names used in the EPPA model) sell emission permits to other regions of the world because they emit below their emissions caps; one hypothetical scenario shows Brazil and other Latin America producing net-negative emissions.

The bottom line is that uncertainty is unavoidable, but quantifying uncertainty allows us to conduct analyses and make decisions.

Theme 3: Decision frameworks across multiple dimensions

When companies explore different emissions-reducing options, they often weigh several factors, including:

- How will changes in technology or policy affect profit
- How will the value of current and future fuels change over time
- To what extent will government investment play a part
- What would happen if investor goals and government policy come into conflict

Various agencies in Europe have collected lots of data on emissions gaps that could theoretically be incorporated into WEPS, but the data cover thousands of policies and would perhaps be too much. EIA may want to consider running a special case that includes all this data, rather than including it wholesale into WEPS. The gap between realistic on-the-ground type policies and the idealistic international cooperation assumed in many models is currently creating a mismatch that needs to be addressed.

As an example, from a modeling perspective, an effective way to model carbon taxes is to *not* use a carbon tax in models. With a carbon tax, emitters can just pay the tax and do nothing to lessen carbon emissions. As a result, countries would have to finance clean energy projects to meet clean energy goals, causing overall inefficiencies stemming from the likelihood that some low-cost emission reduction options would not be pursued (such as energy efficiency or process modifications).

Instead of modeling soft caps such as carbon taxes, it was suggested to model hard caps on emissions, for example decarbonization of 100% by 2050. By modeling hard caps, companies would have to reduce emissions themselves, rather than pay a tax and let the government fund clean energy indirectly.

Theme 4: Transparency and communication of results

Over the past few decades, interest in climate change and its effect on the modeling of future energy markets has grown.

Workshop participants talked about how even though a reference case is supposed to be a point of comparison, that doesn't mean it has to be policy-free. A reference case can simply be the base that makes the sense for the given analysis. It can include best guesses at future policies and can model the expected effects of climate change. EIA has tried to address these sorts of concerns using special case scenarios and Issues in Focus analyses in the past.

GCAM is an open, community model with open-source code (Github JGCRI/gcam-core), open data, and open documentation, which make results transparent and reproducible. Workshop participants recommended to make models agnostic to data—to use the same model, but to change the data. There are advantages to the uniformity of the modeling framework—it reduces the uncertainty around the model itself, and focuses the effort on examining how inputs change modelled outcomes. What fundamentally changes when models change regions, for example?

Lastly, some stakeholders commented that they found the recent change of *International Energy Outlook* data also being published in CSV format rather than only Excel to have been helpful.