## <u>Bethany Frew, National Renewable Energy Laboratory Recommendations to the</u> <u>Committee on the Future of the Electric Power in the United States</u>

Additional thoughts for capacity expansion models (CEMs), building off of my presentation and the panel discussion:

- 1) Model resolution is and will continue to be a critical area for improvement
  - a. This can be done explicitly, and especially so as the necessary computational capabilities improve, e.g., add time periods that capture critical weather/resource/load combinations, or increase to all 8760 hours of the year, or include each individual generator unit, instead of the coarser "timeslices" and aggregated generator technology "bins" as is typically done.
  - b. It can also be done implicitly, which has worked well so far, e.g., capacity credit calculation in between solve years to capture the declining value of capacity as more renewables with coincident resource profiles are built. This ideally requires validation (and sometimes subsequent tweaking) from external, more resolved operational models, like production cost models, and also probabilistic resource adequacy models. This is another reason why inter-model operability is critical.
  - c. Data inputs are also critical for properly representing the more granular temporal and spatial/device-level resolution, as well as the associated economic attributes. The price assumptions for renewable resources, storage, and natural gas are especially important. At NREL, we produce an updated, vetted dataset of cost assumptions, called the Annual Technology Baseline: <u>https://atb.nrel.gov/</u>
- 2) Wholesale electricity market design is an important aspect that needs to be better represented in our planning models
  - a. A key goal here is to determine how to properly value the full set of grid services needed for reliability. This involves investment and operational timescales, and ideally accounts for uncertainty and investor risk. Traditional LP CEMs effectively guarantee cost-recovery, and this is not how real markets work; the focus should be on value for services.
  - b. This reflects a growing need for capturing the ever-increasing complexity of investment decisions and the interactions between multiple energy sector components and the broader economy.
  - c. This also points to the growing need for inter-model operability to link multiple modeling domains that reflect various combinations of temporal and spatial resolution. We cannot (at least at present) co-optimize everything, so having an integrated and modular framework to support these linkages is key. This requires a unified code language and consistent data structures.
- 3) There is a difference between model resolution and resolution of the results. Just because a model can resolve certain details at a very granular resolution doesn't mean that it is appropriate to report results at that resolution.
- 4) Model comparison efforts can be HIGHLY valuable for making all models involved in that effort better. But this requires having a group of teams that are comfortable sharing details, and having a small enough group size to support the in-depth conversations required to "learn" each other's models. In the multi-model comparison effort ReEDS led several years ago, we found that 4 modeling teams was an ideal size. Too many cooks in the kitchen can make it hard to compare recipes.

- a. Two papers from that activity: <u>https://www.nrel.gov/docs/fy18osti/70528.pdf</u> and <u>https://www.sciencedirect.com/science/article/pii/S0140988318304213</u>
- b. Another key factor to the success of this activity was having a public full-day seminar on the participating models and project outcomes with various DOE, policy experts, and others in DC. Communicating the methods and limitations of our models to non-modelers is critical for ensuring that the results from these models are interpreted appropriately.
- 5) Work force issue: hiring is a big challenge. We need researchers with skills in coding, data handling, operations research, power systems engineering, economics, and critical thinking.