Questions from ESIG Webinar (February, 2019)
Answers by Dr Christopher Clack, VCE

Q: It would be interesting to know the share of electricity as a fraction of total energy at the end of the modeling period

A: The electricity is about 80-90% of the total final energy by 2050 in the electrification and decarbonization cases.

Q: What are the carbon costs of electrification-- as in, building the new non-combustion infrastructure? Are they included?

A: Yes, those costs are included and are paid for by the electricity rates produced by the model. Since a higher fraction comes from fixed cost assets (wind and solar) and the demand is more flexible, there is a general lowering of the electricity rates with time. We compute the cost savings for Minnesota as $600-1200 per household when considering the additional electricity spending and the reduced spending on transportation and heating.

Q: And was this compared to hydrogen production?

A: We did not include hydrogen production in this particular study. We have found for the sectors we electrify in this study that hydrogen is not as cost competitive. It would become more useful in industrial process and some hard to electrify sectors.

Q: What kind of assumptions about energy storage were you using?

A: We assume a two capital costs ($/kW and $/kWh) to parameterize the storage. We also use fixed and variable as well as an economic life of 20 years. We include degradation of the storage, roundtrip efficiencies and internal self-discharge rates. Finally, the storage must purchase electricity to charge and sell electricity to gain revenue. The storage is only built if it can make a profit (the same for all assets within the model).

Q: Do these projections account for changes in the regional climate that would likely impact the seasonal variability of heating and cooling demand?

A: This modeling study only includes historic climate change – within the weather data provided to the model – however, WIS:dom has the ability to model future climate change stressing for future studies.

Q: There is much discussion about using battery storage to avoid building more transmission. How do you evaluate the tradeoff between these?

A: The WIS:dom model is co-optimizing, so it is constantly evaluating the value of different asset classes. The model determines the best balance of generation, transmission, storage, DSM, DERs, etc. to minimize the system costs over each footprint. The electrification also plays a role in altering the requirement of all assets. These technologies are not all a one-for-one replacement and WIS:dom tries to determine the best mix to meet constraints of reliable power while keeping costs low.

Q: What assumptions are made for storage costs

A: Storage cost assumptions are from NREL ATB and start at $476 / kW and $238 / kWh in 2017 decreasing to $98 / kW and $49 / kWh by 2050.

Q: You are modeling the weather variability of the wind and solar resources.

A: Yes, we are modeling the weather each 5-minute interval for each 3-km grid cell across the contiguous US for the current modeling. We use numerous years to parameterize the interannual variability. A single full calendar year is used for the dispatch for each investment period.

Q: Do the estimates for heating and cooling take into account a warming climate by 2050?

A: Not in this present study.

Q: Great talk! Trying to imagine the number of decision variables in here and how the model solves in a reasonable amount of time...
- Is the model formulated as one giant MILP? Or are the dispatch and investment models decoupled and soft-linked?

A: The capacity expansion and production cost are modeled simultaneously to enable WIS:dom to co-optimize across scales and determine the feedback from each scale.

Q: Any comments on the MN study which shows that solar curtailment is better than adding more storage (cont'd) the temporal resolution of the model looks like?

A: I think it is dependent on the grid itself. WIS:dom certainly chooses situations when "overbuilding" is better than building transmission and/or storage. I think it is dependent on the cost ratios and the actual local situation. We have found that storage can be very useful in weak grids and sites require better revenues for generators.

Q: Are you using representative days or time slices?

A: No, we are using historical 5-minute 3-km weather data for a full calendar year. In fact, we use multiple calendar years simultaneously, but the basic output is for a single chronological historical year.

Q: Is there a detailed modeling that needs to be done for individual generating utilities? Some winners and some losers, re cost of transformation?

A: The model considers each BAA remaining intact throughout the modeling period. The level of interconnection and cooperation is dependent on scenario choices. The modeling is done through the lens of minimum system costs, so some will benefit more than others on the utility side.

Q: Outstanding presentation. What was the cost savings or increase for the Eastern interconnect 80% carbon reduction case?

A: The cost savings are in excess of 20% compared to today's levels. The exact value was not output from the modeling.

Q: By the end, what percentage of solar is distributed versus utility-scale?

A: This is dependent on the scenario. Solar typically makes up 15-20% of end-use electricity in decarbonization scenarios. The breakdown of distributed vs utility is different for each region.

Q: Approval/building new transmission has an 8-10 year time lag. Is this built in?

A: The built-in time constant for construction is 3-5 years.

Q: How does your modeling deal with seasonal variations in intermittent renewables, and what kind of storage technologies are you proposing for that?

A: The model deals with the variable (not intermittent) renewables using a combination of geographic diversity, electric storage, natural gas, demand-side resources and covariances between renewable types.