Finding Pennsylvania's Solar Future Public Meeting: September 14, 2017

Memo on Modeling Presentation

The intentions of the modeling presentation at the 9/14 stakeholder meeting were three-fold: reviewing the refined scenarios, sharing the cost inputs and results, and discussing key questions that will drive future modeling.

Refined Scenarios:

In response to stakeholder feedback, and, recognizing that different scales of customer-sited or distributed solar would have different associated costs and performances, the modelers split the "distributed solar" category into "residential" and "commercial" categories.

- Grid supply, grid-scale, utility-scale solar all refer to large scale solar systems that are selling power to the utility or to other wholesale consumers. These systems may be connected to the sub transmission system, and always have their own meter, that is, they are not connected on a customer's side of the meter. Utility-scale systems operate as independent power producers.
- Customer-sited, distributed, behind-the-meter, residential, commercial solar all refer to solar systems that are offsetting electricity usage of one or more retail electric accounts. These systems are connected to the distribution grid, often on the customer side of the meter.

Neither category specifies who owns the system, and either may be owned by the entity receiving the power, or not.

The modelers also changed what had been a single solar scenario with 50% grid-scale solar and 50% distributed scale solar in to two scenarios:

- SolarA: 65% grid-scale, 17.5% residential, and 17.5% commercial
- SolarB: 90% grid-scale, 5% residential, and 5% commercial.

These scenarios better reflect current installations in PA and stakeholder's view of likely future patterns.

Added Costs to the Model:

The team added costs for fuels, solar projects, and operations and maintenance costs for all types of electricity generators. The model is meant to include the entire energy economy in PA, from resource mining through final end use. Not everything has a cost associated with it in this model. Instead costs are only assigned to quantities that differ by scenario. This greatly reduces the amount of data needed, but means the model cannot output today costs by scenario, only the different in costs between scenarios.

The sources for these costs are detailed in the slides and included in the modeling source sheet. The costs are primarily derived from national datasets such as the National Renewable Energy Lab's Annual Technology Baseline and the Energy Information Administration's Annual Energy Outlook (AEO). The AEO comes by scenario and region. We used the reference scenario and the Mid-Atlantic region.

Preliminary Economic Results:

With the costs in the model, we are now able to calculate the difference in costs between the scenarios. The table shows the cumulative cost difference between scenarios. The two solar scenarios are similar to each other and different from the reference. For both solar scenarios, there is a little less than $500 million of additional investment in solar installations beyond the reference scenario. This results in over $500 million of reduced spending on fossil fuels, giving a net benefit around $50 million. These cumulative numbers pale in comparison to Pennsylvania's annual energy spending: $45 billion.[1]

Key Questions:

The bulk of the discussion focused on four key questions for future modeling.

1) Should there be more efficiency?

Currently, the model includes efficiency based on the AEPS projections: 0.8% per year for electric efficiency and 0.1% per year for natural gas. While the AEPS only goes through 2021, the model includes a continuation of the annual savings through 2030. This does not reflect efficiency that would come from a transformation in markets for appliances or electronic goods that might also contribute to efficiency. Additionally, it does not reflect any concerted effort to increase efficiency beyond the targets. Efficiency is usually the lowest cost resource and can probably even compete with Pennsylvania's low cost in-state fuels. States which lead the nation in energy efficiency programs achieve 2% annual savings. Growing Pennsylvania's annual energy efficiency to 2% may be a reasonable scenario to test in the model.

2) What if wind grew to 10% of in-state sales too?

The team has modeled wind growing 7.8% per year until 2021 to meet the AEPS standards, but not continuing to grow once the portfolio standard is met. However, wind

[1] EIA, Table F30, Total Energy Consumption, Price, and Expenditure Estimates, 2015https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_fuel/html/fuel_te.html&sid=US&sid=PA.

will likely continue to become more cost effective as technology improves. Wind energy also complements solar energy on the grid, as wind and solar are often generating at different times of the day, and have different energy generation profiles throughout the year. Stopping wind growth in 2021 probably isn't realistic and in many places, PA included, there is more wind power than solar power, so should we assume wind grows to the same level that solar does (at least)? 10% of in-state electricity from wind would require about 5.2 GW of capacity, less than the 7 GW of viable sites in Pennsylvania mapped by the National Renewable Energy Lab.[2]

3) Will geothermal or new cold climate heat pumps complement or compete with natural gas?

The model does not currently project changes in the way Pennsylvania homes and businesses are heated. However, growing gas infrastructure, new air source heat pump technology, and good economics for geothermal heat pumps in Pennsylvania all suggest that heating choices may change by 2030. This graph is a back of the envelope comparison of the annual fuel cost to provide 100 MMBtu of heating, the amount needed in a typical home. New heat pumps can provide heat even when it's -20°F outside, are reasonably priced and can be installed in a day or two. Ground source heat pumps are much more efficient, though more costly. Both also provide cooling. These features mean heat pumps can compete with natural gas, yet they require no new infrastructure.

Fuel switching from oil and propane to heat pumps or natural gas are two pieces of the Pennsylvania state climate change action plan.[3] The modeling team seeks input on the extent to which each type of fuel switching should be included in the model.

4) Are electric vehicles about to take off? What if they grow faster than we project?

Electric vehicles are becoming more popular and cost effective, and many areas have invested in electric vehicle charging infrastructure. The model currently includes modest annual growth rates for electric vehicles: 30% per year from 2015-2025, 50% per year from 2025-2035, and 8% per year from 2035-2050. Given the near-zero initial market share and the typical adoption curves for new technology, the modeling team seeks stakeholder input on increasing the uptake rate. One proposed alternative would be an annual growth rate that replaces nearly all gasoline vehicles with electric vehicles by 2050: 100% annual growth from 2015-2025, 20% annual growth from 2025-2035, and 10% annual growth from 2035-2050. These growth rates are occurring in some places for EVs and in many places for solar, so are not unheard of for new technology.

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2 NREL Eastern Wind Dataset, https://www.nrel.gov/grid/eastern-wind-data.html

[3] http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-114163/FINAL%202015%20Climate%20Change%20Action%20Plan%20Update.pdf

The modeling team will use stakeholder feedback on these questions to refine the model and develop additional scenarios as appropriate to reflect the discussion. The next meeting will include an update on the revisions to the scenarios as discussed in this meeting, a discussion of future modeling efforts, and possibly a review of regional analyses.