EIPC Modeling Work Group Observations and Considerations for Future Analyses

Introduction

The Eastern Interconnection Planning Collaborative is the first-of-its-kind study to model such a technological, geographic, and time scope in such detail involving numerous Transmission Planning Authorities and various stakeholders. The scope, consensus based stakeholder input and the Planning Authority participation helped make the study unique.

The EIPC's objectives included the following:

1. Creating a single working power flow model ("Roll-up") and analysis of approved regional plans throughout the Eastern Interconnection (which includes 39 states, the District of Columbia, and large portions of Canada);

2. Development of future interregional expansion scenarios to be studied; and

3. Development of detailed generation expansion, and interregional transmission expansion, to reliably accomplish the policy goals of three future interregional expansion scenarios.

These objectives were accomplished. We should be pleased with the results that came from the EIPC process, while recognizing its limitations.

Background

Phase I used a capacity (i.e., electric generation resource) expansion model that selected different types of generation based on economics, generation characteristics, and numerous input assumptions. It was a "pipe and bubble" model that placed new generation in various regions ("bubbles") but could not automatically resize the transmission between regions (the "pipes"). Thus, the Phase I modeling focused on *economic* (i.e., least cost) generation additions/retirements within specific regions - using fixed transmission transfer capabilities. Within a region, generation was generally aggregated by type (except for some larger generating units), and no *intra*-regional transmission constraints were considered.

In the Phase I resource expansion model, a number of modeling runs relaxed the transmission constraints as a proxy for the co-optimization of transmission expansion and resource expansion. In hindsight, more runs could have been used to iterate and, as much as reasonably possible, co-optimize the transmission and generation (i.e., using more runs to adjust interregional transmission capacity to evaluate the effects on the generation builds/retirements, which may have resulted in a more co-optimized transmission and generation solution).

The purpose of Phase II was to develop three detailed transmission expansion scenarios that would meet certain reliability criteria. To achieve this goal, the Phase I generation builds/retirements in each region were disaggregated (as necessary) and sited on specific buses based on criteria developed with EIPC and the EIPC's Transmission Options Task Force. With generation dispersed within the regions, *inter* and *intra*-regional transmission expansion was developed by each power flow modeling focused on *reliability* - i.e., building a transmission system that could reliably incorporate all of the capacity additions (and retirements) from Phase I.

Observations

- Major policy goals were met, or possibly exceeded, in the three final scenarios. However, this was essentially a single pass through and first steps. The nature of the models used (capacity expansion, transmission build-out analysis, production costing) require internal feedback to improve the final results. Issues revealed in later models can require fixes in earlier models, or re-running of earlier models using different inputs or assumptions. For example, the production cost modeling results suggested that a different generation mix/placement and/or transmission build out might be more appropriate to support the goals of certain futures – but to analyze this would require re-running some of the earlier models to try and better optimize the results, and we were not able to do that in this study.

- The base case results for the GE MAPS production cost modeling runs for Scenario 1 (Combined Federal Climate and Energy Policy) showed large levels of wind curtailment (i.e., available wind energy was not dispatched to the grid). While some curtailment would be expected using an hourly security-constrained economic dispatch model such as GE MAPS, the level of curtailment was much larger than expected from an economic perspective. The effect of the curtailment was to significantly lower average annual capacity factors on aggregate wind production in certain high-wind regions of the Eastern Interconnection.

- The wind curtailment in the Scenario 1 production cost modeling base run suggested that there could be issues regarding whether (i) the generation mix was optimal, or should have been located in different areas, to support the Scenario; (ii) whether a different transmission build out that was based on economic criteria in addition to reliability criteria would better support the wind generation built in Scenario 1; and/or (iii) whether more wind was built than needed to support Scenario 1. These are questions for another day.

- Scenario 1 curtailments have gained significant attention. However, since the EIPC study is not iterative or optimized, the results of S1 may be a reasonable first pass. Scenario 1 shows aggressive decarbonization by 2030 of the Eastern Interconnect even with massive wind curtailments.

Considerations for Future Analyses

- Future interconnection-wide studies may wish to consider a more iterative analysis between production cost models and transmission expansion planning based on reliability and economic criteria for wind and other resources.

- Future interconnection-wide studies analyzing wind integration may wish to consider other load blocks in addition to the peak load and less-than-peak load blocks that were studied in EIPC's power flow modeling if substantial resource curtailment occurs during other load block periods.

- Future interconnection-wide studies may wish to select or develop models to co-optimize generation and transmission, as well as other resources and information, including:
    - other resources such as energy efficiency,demand response,energy storage,distributed generation,smart grid, etc.
    - fuel transport infrastructure

  If such a model is unavailable, it may be preferable to take an iterative approach through the use of multiple modeling runs.

- Future studies may also wish to employ models that take a comprehensive view of macroeconomic conditions and interactions between the power sector and the broader economy, such as impacts on demand.

- Future interconnection-wide studies using a capacity expansion model may wish to disaggregate regions into smaller areas to reflect more transmission constraints. These regions could perhaps be identified from the constraints and/or congestion shown in the production cost modeling.

- Future interconnection-wide studies may wish to dedicate sensitivities to iterate between the production cost model and the powerflow model to assess intra- and inter-regional transmission capacity as well as alternative generation location.

- Many systems carry excess capacity beyond reserve margin requirements, therefore future interconnection-wide studies may consider allowing for some capacity expansion beyond the reserve margins, in some circumstances beyond economic criteria.

- Through these iteration processes, future interconnection-wide studies may wish to try and develop least cost solutions to meet future goals and policies.

- Future studies may wish to reach a target policy goal first, and when achieved, may then wish to determine an acceptable level of wind or other resource curtailment for a region. For example, is it 5% of annual installed wind energy (or other resource) potential, or some other number? After obtaining the policy goal, future studies may wish to try to further refine through various modeling run iterations to try and optimize the generation and transmission build out to try and match the target curtailment rate.

- Incremental additions of transmission made to accommodate the additions of generation within the 20 year time period studied may have had significant impacts. Modeling incremental growth of both generation and transmission over time can be useful. Thus, future studies may wish to look at smaller time intervals – i.e., model 5, 10, and 15 years - in addition a 20 year interval all at once, throughout the various models used.

- Many Planning Authorities are already doing transmission expansion planning that considers economic criteria in addition to reliability criteria, and future interconnection-wide transmission planning exercises should consider doing so as well.