DRAFT 11-15-12

NGO initial comments on results of sensitivities and Phase II results for Scenario 1 – Combined Federal Climate and Energy Policy – for inclusion in the Phase II report.

* The base case results for the 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. As the Modeling Work Group explained in its October 23, 2012 “Modeling Work Group Phase II Sensitivities Recommendations” to the Stakeholder Steering Committee (“SSC”), there was “[u]neconomic curtailment of wind in model. Some curtailment expected, but not to the extent seen”. The Modeling Work Group further explained that the reductions in wind “capacity factors” demonstrated that the curtailment was too high. For example, “MISO W uncurtailed wind resource is 38% annual capacity factor (CF). Reduction in actual output in model to 28.5%.”
* The effect of the curtailment was to significantly lower average annual capacity factors on aggregate wind production in key high-wind regions of the Eastern Interconnection. The table below contains average annual capacity factors for wind resources resulting from Scenario 1, and the benchmark level for the expected average annual capacity factor if there was no curtailment.

* As shown above, three of the richest wind regions in terms of both potential energy and performance (average capacity factor) – MISO West, Nebraska, and SPP North - saw curtailments of 25, 40, and 15 percent respectively from their benchmark levels (i.e., expected capacity factor with no curtailment) in Scenario 1. The curtailments dramatically lowered the achieved capacity factor for aggregate wind resources in those regions. This result was somewhat surprising because one of the intentions of the transmission build out in Phase II was to reliably access the installed capacity resources from Phase I, including the ability to accommodate increased inter-regional transfers of electricity. However, it must be emphasized that the intent of the transmission build out in Tasks 7 and 8 was to ensure reliability in the system operation; it was not intended to reflect a full economic build out of transmission.
* The wind curtailment in Scenario 1 was also surprising because one of the important reasons why the Phase I NEEM model arrived at an economical capacity resource expansion that included wind generation resources of 67.5 GW in MISO West, 15.6 GW in Nebraska and 41.7 GW in SPP North was because those resources had higher capacity factors – and thus they could deliver more “bang for the buck” (i.e., more energy for a given installed capacity investment).
* After receiving the base Scenario 1 results, the Modeling Work Group determined that the wind curtailment issue in Scenario 1 was perhaps the most important issue to try and understand with the six available production cost modeling sensitivities.
* The Modeling Work Group spent some time trying to understand the possible causes for the high wind curtailment in the Phase II production cost modeling to try and come up with appropriate sensitivities to reduce the wind curtailments. The Modeling Work Group discussed the fact that the large wind curtailments in Scenario 1 could have been caused by (1) modeling assumptions or limitations in the Phase II production cost modeling (e.g. the “spin” requirements); and/or (2) the transmission build out in Phase II (which was intended to reliably support the generation mix and placement for that future).
* It is important to note that the transmission build out in Phase II was able to reliably meet the NERC transmission planning standards that were tested. However, some Modeling Work Group members believed that targeted additional transmission appeared to be needed in order to support the resource scenario because the transmission build out did not seem to be able to economically dispatch all the wind generation that was added in Phase I during all hours of the year (thus contributing to the unexpected wind curtailments). One possible explanation for why this happened involves the differences between the GE MAPs model used for the Phase II production cost modeling runs and the Phase II power flow modeling tools used for the transmission build outs. The GE MAPs model is an economic production cost model that tries to minimize overall production costs over all 8760 hours of the year, using transmission constraints from the previously-run EIPC power flow modeling transmission build out. For the power flow modeling/transmission expansion portion of Phase II, the Planning Authorities built two separate power flow cases for each Scenario, using a different load block for each case– the peak demand (top 10 hours of electrical demand for the year, averaged to produce one peak hour to model) and Block 13 (a shoulder or low load block containing 600 hours, averaged to produce one peak hour to model). The Planning Authorities then built out a reliable system that dispatches the generation appropriately during those load blocks. However, the wind curtailments may be a result of the GE MAPS trying to be economic for all 8760 hours of the year. So, although the transmission build out in Phase II appears appropriate for the load blocks studied, it is not the optimal build out for all 8760 hours. In any event, and whatever the cause, a number of Modeling Work Group members believed that transmission constraints used in the GE MAPs modeling runs could be causing some of the wind curtailments, and thus at least one sensitivity should try and further explore that possibility.
* The Modeling Work Group recommended that the SSC should use a number of the six available sensitivity runs to try and understand and address the wind curtailment issues. In the end, the SSC agreed to use four sensitivities on Scenario 1, at least the first three of which were intended to try and reduce the wind curtailments:
	+ Spinning reserve reduction and increased flexibility characteristics for Combined Cycle units (“High Spin Availability” sensitivity),
	+ Flowgate (transmission constraint) relief - including the attributes of the High Spin Availability sensitivity ( in effect a combined sensitivity) ,
	+ Reduction of installed wind capacity, and
	+ A high load sensitivity.
* The results of those sensitivities on curtailment levels are shown below:

* The flowgate relief sensitivity reduces the overall level of curtailed wind resources from 15.3% (base case) to 12.8%. While the overall curtailment fraction change does not initially appear very significant, a closer look at individual region curtailment changes, while understanding the relatively limited extent of flowgate relief used in the sensitivity, demonstrates an important result of the sensitivity. The curtailment percentage changes between the base case and the flowgate relief sensitivity in Entergy (30 to 17 percent), MISO\_MO-IL (26.5 to 14.8), MAPP\_US (12.1 to 6.0), SPP\_N (14.6 to 9.9), and IESO (12.6 to 6.0) all reflect fairly significant reductions in curtailment. Even looking at the changes from the perspective of the High Spin Availability sensitivity values, the curtailment change is still significant.
* The flowgate relief in the sensitivity reflects a 50% increase in flowgate capacity for only seven monitored elements (six lines, and one transformer), all of which are 345 kV voltage level components and all of which are electrically close to the regions that experienced the greatest reduction in wind curtailment in the FG relief sensitivity. Those flowgates are shown in the table below.

* The extent of transmission system capacity increase represented by the flowgate relief, or increased flowgate capacity, is relatively modest. Generally, these increases can be seen as akin to “economic” transmission increases, i.e., over and above the levels of transmission required for reliability reasons. The primary effect of such increase is to allow greater levels of economic generation from available wind resources. The line segments in total represent approximately 300 miles of 345 kV line segments. While detailed costing has not been done for this sensitivity, a rough approximation using $2 million per mile, and $10 million for a 345/230 kV transformer would lead to an approximate cost of $610 million. At a fixed charge rate of 0.2, this would imply incremental annual costs of roughly $120 million. The incremental production cost savings seen from the sensitivity runs exceed this value, as shown below, and thus these transmission enhancements may be economically justified. However, it must be cautioned that a revised reliability analysis to determine if any potential reliability issues would be created (and thus would need to be fixed) by increasing these transmission elements, and much more detailed cost estimating, would have to be completed before these enhancements could be justified.
* The incremental wind output obtained with this flowgate relief was roughly 10 TWh over the wind output levels seen in the High Spin Availability sensitivity (120 – 110 TWh), and roughly 20 TWh over the base case S1 results (131 – 110 TWh). As seen in the production cost result summary table below, the value of this relief is significant. Excluding carbon effects, the savings in production costs from the flowgate relief alone is roughly $182 million (High Spin Availability minus FG relief, $46.010 – $45.828 billion). Including carbon, the value totals $509 million annually. Whichever value is chosen, the benefits do seem to exceed the costs associated with the incremental transmission improvements.

* This sensitivity seems to demonstrate that incremental transmission reinforcement that relieves important flowgate constraints should be further studied, and may be economically justified. The most binding flowgates in the S1 base run were limited to lower voltage – 345 and 230 kV – elements. In general, the major interregional paths designed – and added to the power flow models in Phase II - were more than sufficient to reliably carry interregional flows. If certain specific targeted lower voltage elements are reinforced, reductions to the curtailment of wind can be achieved, in line with the aims of the resource scenario.
* The reduced installed wind sensitivity also results in a significant reduction to curtailed wind. However, even after reducing installed wind from 270 to 235 GW in the EI, there is still a 9% level of wind curtailment, suggesting that there may still be some transmission constraints causing more than expected wind curtailment that may warrant further investigation in future studies.