

## **ERGIS Technical Review Committee Meeting: February 5, 2014, Golden, CO**

The purpose of this meeting was to review the results of 2010 benchmarking runs, discuss initial modeling results from study year runs, and demonstrate the use of new visualization tools developed by the ERGIS team.

### **2010 Model Benchmarking**

NREL reviewed the benchmarking activities for the Eastern Interconnection model and the types of revisions that have been made to the database since the modeling effort began in February 2013. The database was thoroughly overhauled, including major changes to the load, generation, transmission, and reserves data. Since the November 2013 TRC meeting the NREL team discovered that the electrical properties for the transmission elements (lines and transformers) did not correspond to the MMWG load-flow case that the database was created from; the NREL team replaced the electrical properties with the correct properties. Additionally, the NREL team identified the binding transmission constraints that needed to be enforced in order to allow the model to run while still achieving reasonable runtimes. The NREL team presented the current results from the 2010 model and the TRC agreed that the results were acceptable and that NREL should proceed towards modeling the study-year scenarios.

NREL presented an animated visualization of the transmission flows resulting from the full-nodal transmission model and solicited ideas from the TRC on how the visualization tool could be made more useful for analysis or communication of the results. The TRC suggested that the visualization tool should color-code the regions according to their net imports or exports.

#### *NREL Action Items:*

- NREL will move forward with the study-year scenarios.
- NREL will modify the transmission flow visualization tool to show net imports or exports.

### **Study Year Simulations**

NREL has begun the additions to the database to model all four of the 2026 study year scenarios. Modifications are necessary to represent the thermal fleet retirement and expansion; transmission expansions; wind and solar fleet expansions; load growth; ancillary services; and fuel prices. Of these, the wind and solar fleet expansions and load growth are complete and the transmission expansions, thermal fleet modifications, ancillary services, and fuel price modifications are in the process of being incorporated.

NREL presented initial results from running selected weeks of the study-year scenarios. As mentioned above, the database is still under modification; however these runs are intended to test the

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modifications as they are implemented. NREL has run selected weeks in January, April, and August, and intends to increase the resolution of the models as more of the changes are incorporated. The initial results are as expected: wind and solar generation displaces both gas and coal generation and shows the expected diurnal and seasonal variations. The TRC requested that the gas generator types of combined cycle and single cycle be shown separately to illustrate which is being displaced.

*NREL Action Items:*

- NREL will continue modifying the Eastern Interconnection database to incorporate the study-year scenarios.

### **High Performance Computing**

NREL presented the results from a laboratory-directed research and development (LDRD) project in which the PLEXOS software was parallelized on NREL's high-performance computer (HPC). The unit-commitment and dispatch problem solved by PLEXOS is difficult to parallelize without introducing errors due to the dependence of system's behavior on the previous day. The NREL LDRD team has developed a method to minimize errors to negligible levels by starting each parallel execution with multiple days of initialization time so that the partitioned solutions "forget" about the initial conditions during the initialization time and the saved parallel solutions are equivalent to a solution generated without parallelization. NREL has been able to speed up the simulation by about 25, resulting in a reduction from 67 days to 2.7 days for executing the day-ahead portion of the ERGIS model. The parallelized solution has production costs that are within 0.57% of a full-year solution and the small differences in annual generation by region and generator type are due to degeneracy in the system (i.e. equivalent-cost generators) rather than the partitioning.

The TRC pointed out the need to be consistent with the parallelization method used for final runs so that any small differences are not due to differences in parallelization.

The TRC then took a short tour of NREL's HPC facility during the lunch break.

*NREL Action Items:*

- NREL will execute all final simulations using the same parallelization method so that differences are not attributable to parallelization.

### **Solar Data Review**

The NREL team presented an update to the ERGIS solar data. NREL has generated 5-minute solar data from the hourly satellite data, and found isolated hours where missing hourly data caused unreasonably

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large changes in power output in the 5-minute data. NREL has identified a solution to the problem and will release a corrected dataset in the coming month.

The NREL team also generated day-ahead and four-hour-ahead forecasts for the solar generation data. Two forecast methods were used. The first forecast method is termed “persistence” and simply assumes that the sky conditions will persist into the future. This forecast does not assume that the power output will persist, as the movement of the sun with respect to the earth will change the solar power output in a predictable way. NREL also created solar forecasts using a numerical weather model (WRF). NREL presented analysis of these two forecast methods and showed how the WRF forecast has a consistent bias. The NREL forecast team hypothesizes that the bias is due to the WRF model having inaccurate representation of aerosols in the atmosphere, and has identified a method of correcting the forecasts so that they have error distributions similar to the (few) known forecasts that have been published.

NREL also plans to make the solar data available to the public via a website once the corrections have been made.

Finally, the solar data will be incorporated into the reserves calculations, which are described in a later section.

*NREL Action Items:*

- NREL will correct the real time and forecast datasets as described in the presentation.
- NREL will make the solar data available to the public via a website.

## **Net Load Analysis**

The NREL team presented an analysis of the net load (load minus potential wind and solar generation). The net load analysis focused on the ramps in net load created by the generation patterns of wind and solar generation. Because the Regional scenario has twice as much solar as the National scenario, the Regional scenario has larger ramps in net load. The larger ramps are particularly true in FRCC, where solar provides 30% of the annual generation. In the regional scenario the ramps in net load were found to be dominated by the wind and solar for time-horizons below 4 hours and by load for time-horizons of greater than 4 hours. In contrast, in the national scenario the net load ramps were dominated by load for even very short time-scales.

NREL presented an animated visualization of the net load for each region of the U.S. E.I., which highlighted the large impact of wind and solar on the net load in certain regions (SPP and FRCC). The TRC suggested that the visualization allocate the wind to the region it is exported to rather than the region it originates in; that the net load graphs be converted into dispatch stacks; that the imports and exports be shown on the graph; and that aggregations of SPP + SERC and SPP + SERC + FRCC be shown on the graph. The TRC also suggested that NREL develop a “sparkle map” showing generation by each region. This document is for discussion and development purposes only. Any data or statements contained in this document are subject to revision without notice. Do not cite or quote. Contact [aaron.bloom@nrel.gov](mailto:aaron.bloom@nrel.gov) with any questions.

plant similar to the one developed for the Renewable Energy Futures Study (available at <http://rpm.nrel.gov/refhighre/dispatch/dispatch.html>).

The TRC had a question about how much capacity credit solar is given in the ReEDS capacity expansion model. NREL responded that ReEDS uses a statistical method in each of the time-slices and in each region to determine solar capacity credit, so there is no single capacity credit that can be given.

## **Reserves**

NREL presented an animated visualization of the changes in the 5-minute solar generation data in order to demonstrate how the solar data varies from region to region and interval to interval.

NREL then presented an approach for modeling reserves. While there are many different reserves requirements in the E.I., modeling each BA's reserves requirements and provision exactly as they are currently implemented is impractical. Based on input from the TRC, NREL proposes to model the US EI as closely as possible to the current reserve sharing groups (RSGs) using reserves products and requirements that resemble current practice. These reserves include contingency and regulation reserves. NREL presented the plan for determining the regulation reserve requirements for each region as the geometric sum of the requirements for load, wind, and solar, and proposed which types of generators could provide each type of reserve product.

### *NREL Action Items:*

- NREL will perform the reserve requirements for each operations sequence step (day-ahead, real-time, 4-hour-ahead), each reserve sharing group, and each scenario.

## **Sensitivity Analysis**

NREL and the TRC discussed the broad categories of sensitivities that the NREL team could explore once the four base scenarios are complete. The potential sensitivities include reserves products, sources, and sharing; market operations sequences; and others. The TRC expressed interest in sensitivities in the areas of:

- alternative thermal expansions
- ramping or flex reserve products
- wind or solar providing regulation
- demand response providing reserves
- aggregation of reserve sharing regions
- rolling intra-day unit commitment
- multi-period look-ahead dispatch
- sensitivity on shape of load growth

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#### 4-Month Plan

NREL's 4-month plan is to implement all of the modifications to the E.I. database, run all four of the study-year scenarios in their base configurations, and review the results. Depending on the timing and outcome of these results one or more working group calls might be held before the next TRC meeting.

The next TRC meetings are currently planned to be in June and December. Both are likely to be in Washington, D.C. In addition, the NREL ERGIS team will be presenting in May at the WindPower conference in Las Vegas, NV.

The TRC suggested considering a July meeting in conjunction with the IEEE PES meeting July 27-31 in Washington, D.C.

#### Meeting Participants

Aaron Bloom	NREL
Aaron Townsend	NREL
Aidan Tuohy	EPRI
Brendan Kirby	NREL Contractor
Caitlin Callaghan	DOE
Cesar Silva-Monroy	Sandia
Charlie Smith	UVIG
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