

Tools for Holistic Approach to Grid Integration Planning

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June 9, 2016

Grid Integration Study

- ***A grid integration study is an analytical framework for evaluating how a power system can be planned/operated with high levels of variable RE.***

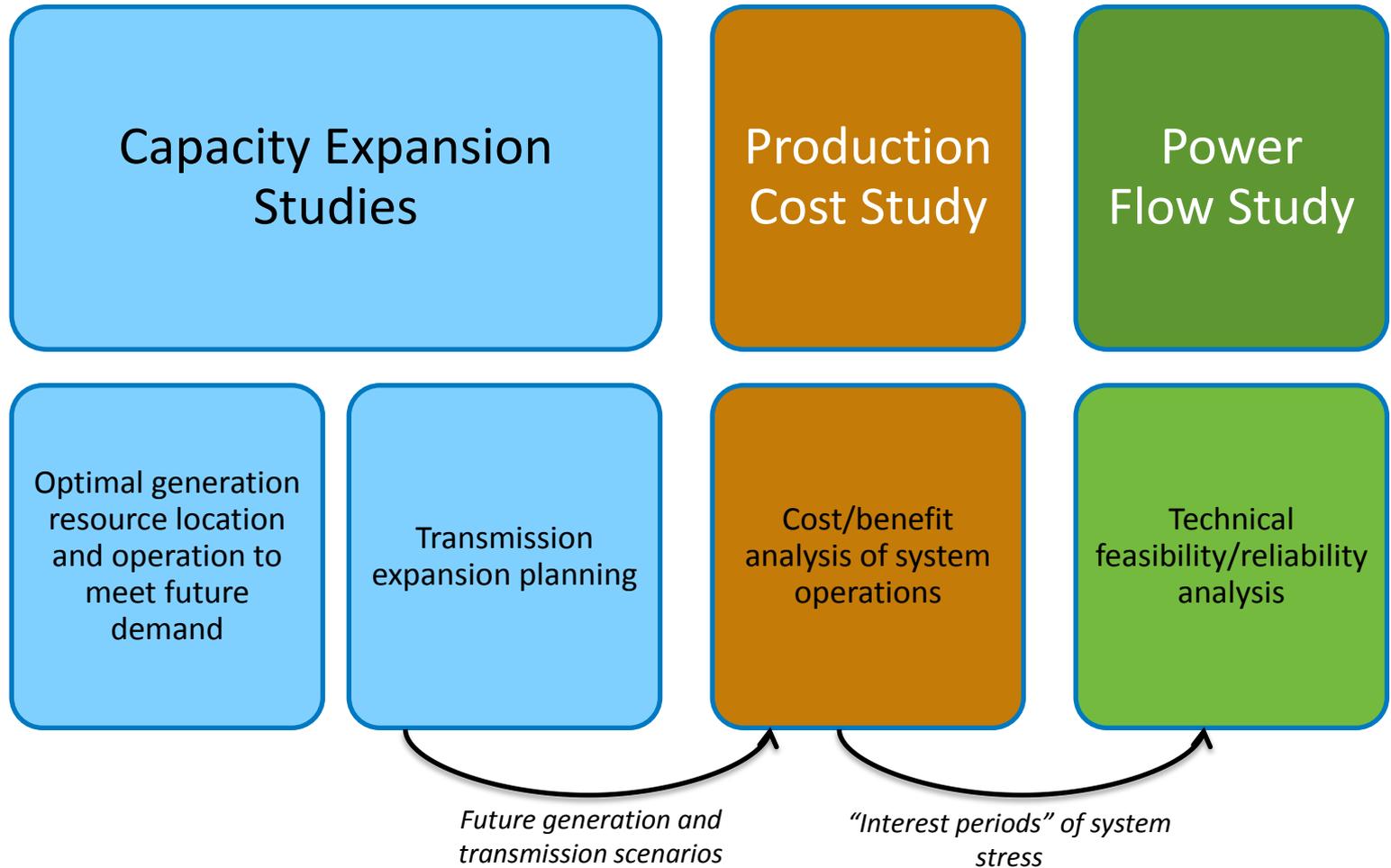
Outcomes

- **Simulates operation of the power system under different future scenarios.**
- **Identifies reliability concerns.**
- **Determines relative costs of actions to help integrate RE.**
- **Addresses system operator concerns that the system can work reliably and cost-effectively.**

Questions a grid integration study helps address

- Where, when, and what types of generation and transmission would achieve RE targets at least cost?
- What is the impact of wind and solar on unit commitment and economic dispatch?
 - Where are the transmission constraints?
 - How much RE curtailment will there be?
 - What reserves are needed?
 - What are the impacts on emissions and fuel requirements?
 - How can operations costs be minimized?
- How quickly can a power system with high RE respond to a real-time disturbance, such as an unplanned generator outage?
 - What is the magnitude and duration of frequency deviation?

Integrating RE through informed policy

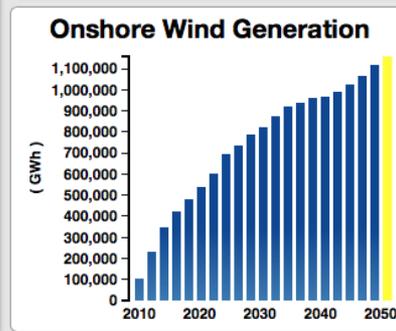
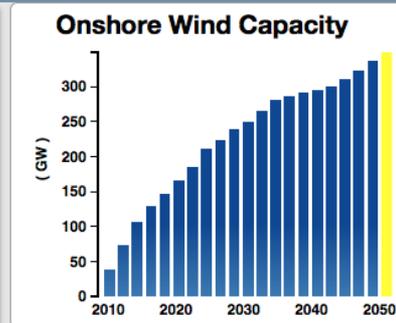
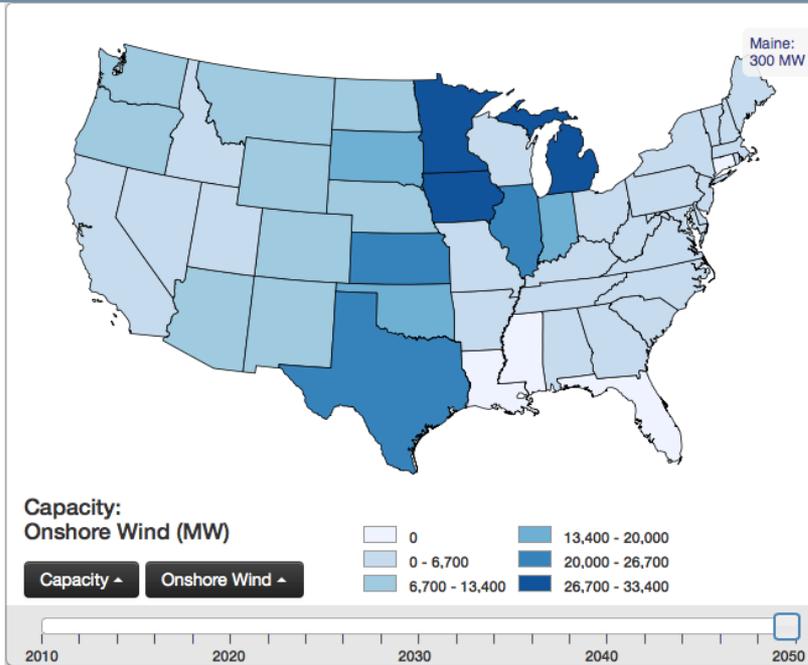


Policy development

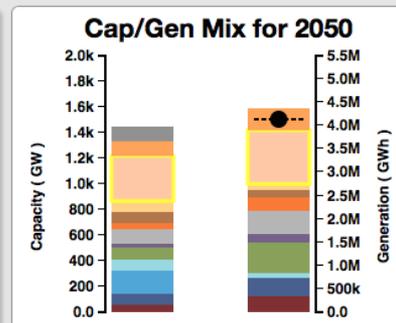
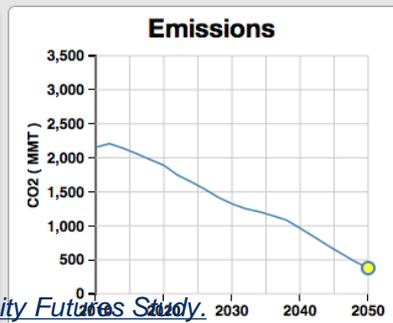
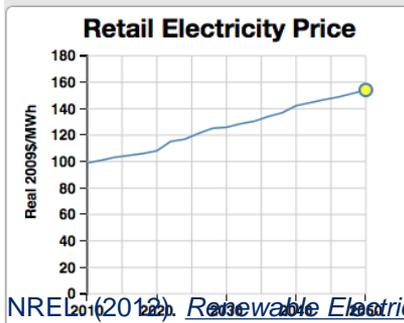
Optimized expansion planning example: RE Futures

RE-Futures Key Question:

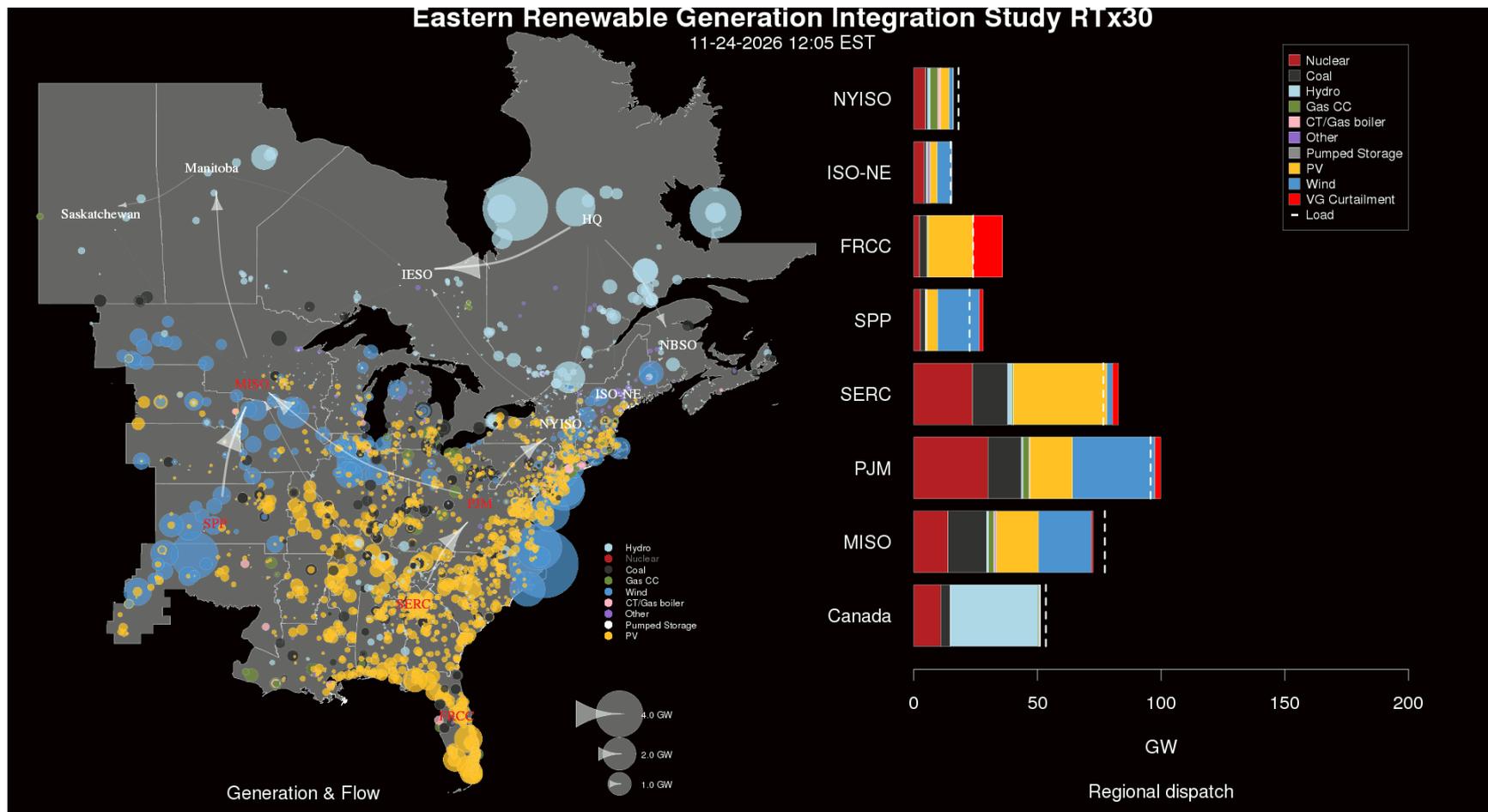
To what extent can RE supply meet the electricity demands of the continental U.S. through 2050?



80% RE scenario



Impacts of RE example: What effect could 30% energy generation by wind and solar have on the US Eastern Interconnection?

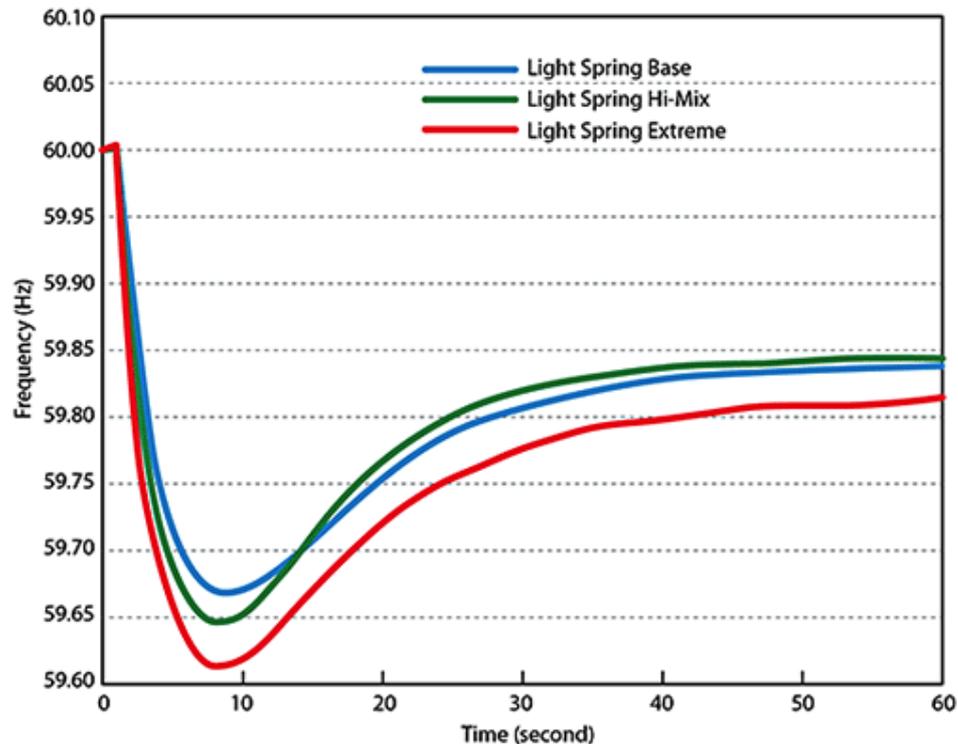


High resolution representation of power system (60,000 lines, 7500 generators, 5-min dispatch, etc.)

Technical feasibility example: Western Wind and Solar Integration Study, Phase 3

WWSIS-3 Key Question:

How could high penetrations of wind and solar impact the large-scale transient stability and frequency response of the U.S. Western Interconnection?



Stakeholder engagement is critical to ensure the study is relevant to industry and technically accurate

Technical review committees (TRC) are an example mechanism to engage stakeholders

- Assist modelers in guiding study objectives, scenarios, and sensitivities
- Reviews study assumptions and results on multiple occasions throughout course of study.
- Endorses technical rigor of the study.

Example TRC members:

- System operators
- Utilities (if distinct from system operator)
- RE plant owners/operators/developers
- Conventional plant owners/operators/developers
- Transmission developers
- Regulators
- Public Advocates

Stakeholder engagement is critical across all stages of a study

Tips for your own studies

- **Clearly defined study questions**
 - What is it that you want to learn?
 - How are you measuring reliability? At what time scale?
 - Cost efficient for whom, when?
- **Best tools for the question**
 - Are the right tools being used to answer your questions?
- **Data**
 - Do you have the data to answer your questions?
 - Where can you get the data?
- **Transparency**
 - Is the process for developing methods and assumptions for analysis transparent?
- **Peer reviewed**
 - Do impartial external experts review the results?

Additional considerations for external assistance to conducting studies

- 1. To make the study credible and usable, stakeholder process becomes even more critical**
 - The study should be led (or co-led) by relevant institution (e.g., system operator, energy ministry)
 - Transparency and public availability of results can improve buy-in
- 2. The model is not static**
 - Need in-country capacity building to reflect in the model changes to the power system and emerging questions
- 3. Time-synchronous data in many countries is scarce**
 - Solar can be purchased relatively cheaply
 - Wind data is more expensive to produce
- 4. Software and data sharing**
 - May need to purchase and provide training
 - Time necessary to establish data sharing can be considerable

QUESTIONS

For more information: <http://greeningthegrid.org>