The **North American Renewable Integration Study**: An Introduction

NARIS Study Team

August 2018

The North American Renewable Integration Study

State-of-the-art analysis of the U.S., Canada, and Mexico power systems, from planning through operations

Natural Resources Canada Ressources naturelles Canada

Canada

SENER SECRETARÍA DE ENERGÍA

WHAT WE'RE STUDYING

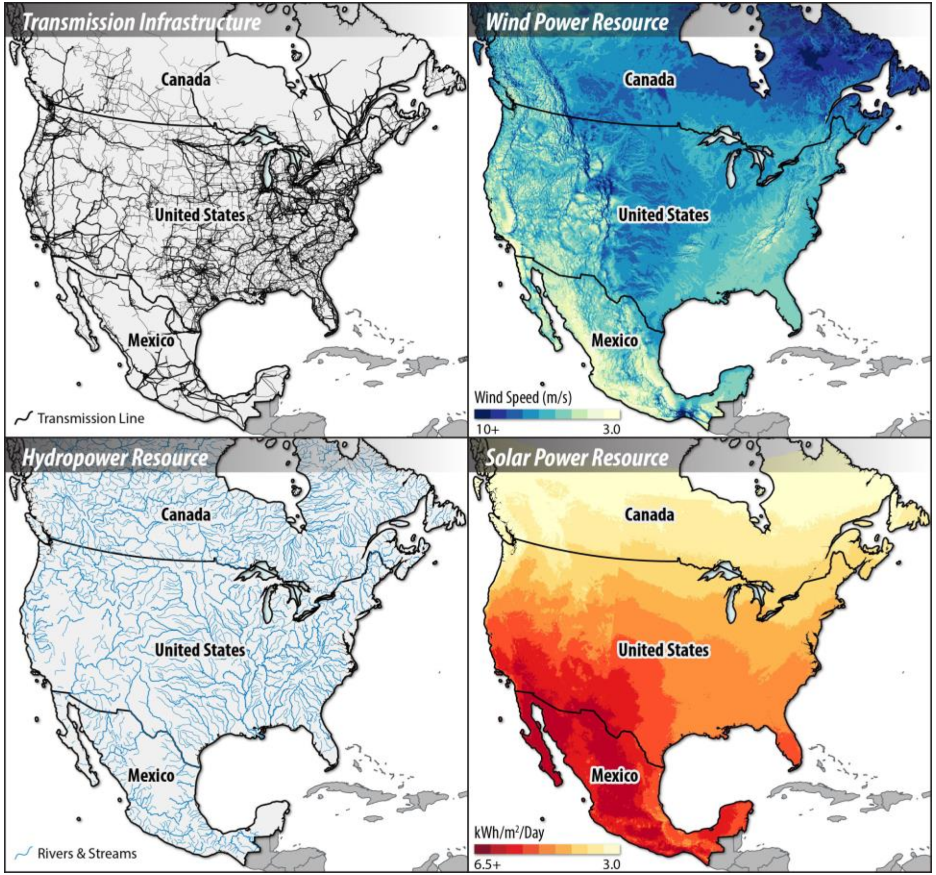
- Long-term pathways to a modern power system in North America
- Operational feasibility of very high-penetration scenarios
- Weather variability and uncertainty
- Value of enabling technologies: flexible hydro, thermal generation, demand response, storage, transmission
- Value of operating practices: interchange, enhanced scheduling, local generation, reserve provisions

North America Is Very Diverse in Energy Resources and Load

The availability of natural resources varies widely across regions.

So does how and when energy is used on the grid.

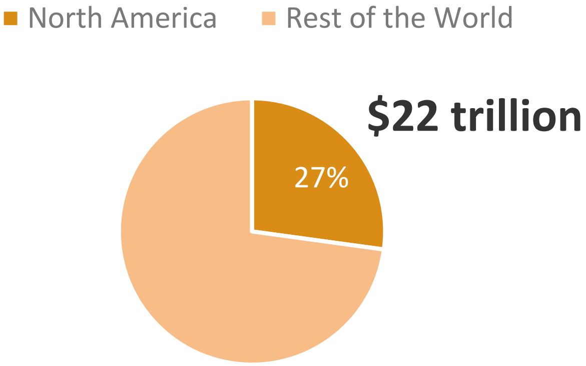
A modern power system can take advantage of this diversity to provide reliable, affordable, sustainable power.



How Big Is the North American Grid?

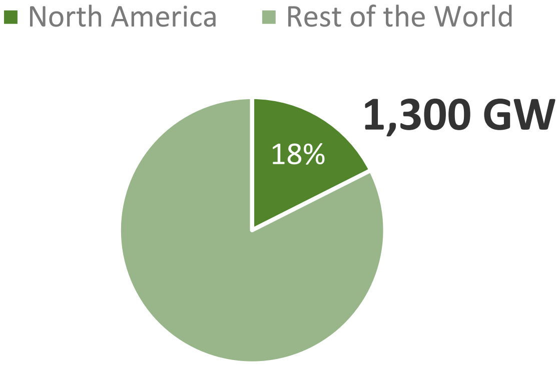
- Over **100,000 nodes** on the transmission grid
- Over **10,000 generators**
- Over **10,000 compute node-hours** required to run an operational simulation

GROSS DOMESTIC PRODUCT



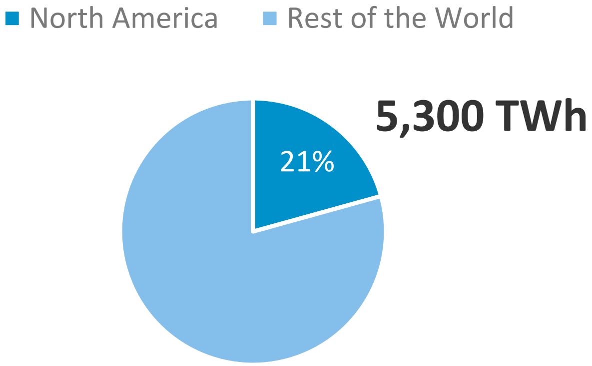
Source: World Bank

GENERATING CAPACITY



Source: CIA

GENERATION



Source: BP Statistical Review

Accelerating Grid Modernization in North America

INFORMING

grid planners, operators, market participants, and regulators of challenges and opportunities for the grid

- Is it reliable and affordable?
- What operating practices and technologies help the most?
- Are the “solutions” robust?
- What is the benefit of inter-regional and cross-border cooperation?

ENABLING

stakeholders to deepen and extend their understanding of renewables and modern power systems

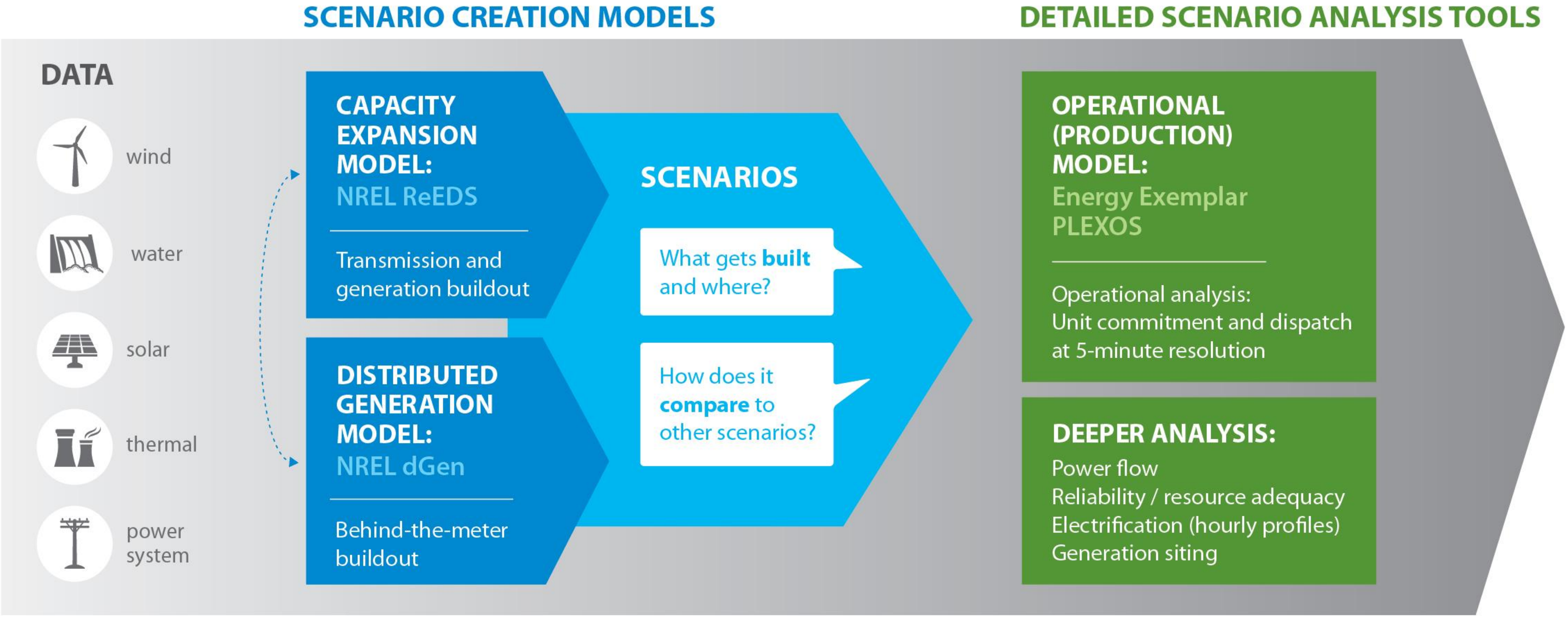
- Creating and disseminating new data
- Pioneering and deploying new methods and computational tools

CREATING

a framework for future analysis

- Stability (i.e., frequency, transient, voltage)
- Resilience to extreme events (e.g., weather)

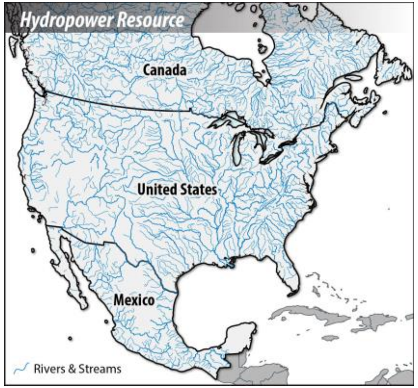
How it Works: Modeling Flow

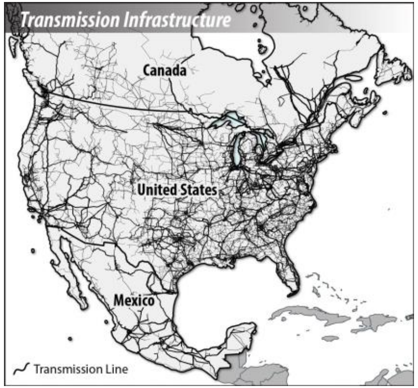


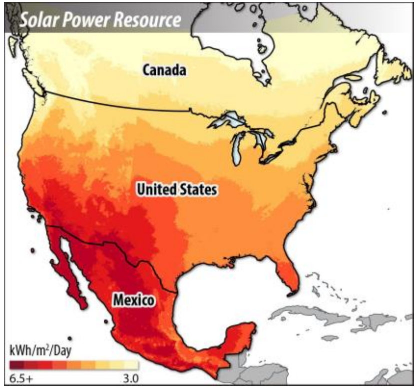
Input Data

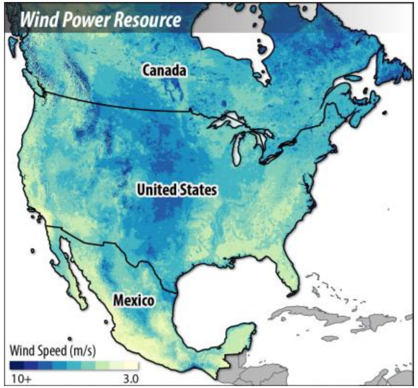
DATA DEVELOPMENT → ReEDS → dGen → PLEXOS

Data sets are developed almost entirely based on public data, processed using novel, replicable methods









Putting It All Together:
The Scenarios

The Scenarios

Four overarching pathways for North American electric power system evolution **through 2050**

1

Business As Usual

System evolves as we plan and operate it today

2

Low-Cost Variable Generation

Same policies, but **lower costs** for emerging technologies

3

Carbon Constrained

New policies drive significant **carbon emissions reductions**

4

Carbon Constrained + Electrification

New policies drive significant carbon emissions reductions **plus electrification**

Scenario 1: Business As Usual

- U.S. has only state-level policies
- Canada reduces carbon emissions by 80%
- Mexico has 50% Clean Energy Standard

SENSITIVITIES TO RUN:

- With and without **coordinated transmission**
- With and without new **transmission between countries**
- Low, medium, and high **gas prices**
- Today's level of **hydro flexibility**, less flexible, and more flexible
- **Macrogrid** or **independent** transmission buildout
- Early or typical **thermal retirements**
- With and without **limit on instantaneous VG**

Scenario 2: Low-Cost Variable Generation

- Same policies as Scenario 1
- Wind and solar achieve lower costs than today's projections

SENSITIVITIES TO RUN:

- With and without **coordinated transmission**
- High or typical penetrations of **distributed generation**
- Low, medium, and high **gas prices**

Scenario 3: Carbon Constrained

- 92% reduction in carbon emissions in Canada; 80% in U.S. and Mexico
- Generally consistent with the Mid-Century Strategies in all countries

SENSITIVITIES TO RUN:

- With and without **coordinated transmission**
- With and without **new transmission between countries**
- Low, medium, and high **gas prices**
- Today's level of **hydro flexibility**, less flexible, and more flexible
- Wet or dry **hydro conditions**
- **Macrogrid** or **independent** transmission buildout
- Early or typical **thermal retirements**
- With and without **limit on instantaneous VG**
- High or typical penetrations of **distributed generation**
- Lower or typical **projected wind, solar, and storage costs**

Scenario 4: Carbon Constrained + Electrification

Same as Scenario 3, but with added electrification

SENSITIVITIES TO RUN: ?

WHY THIS SCENARIO?

Electrification could **double load** and **shift peaks** between seasons. This could have a substantial impact on the results of the study.

Example (not actual) types of visualizations

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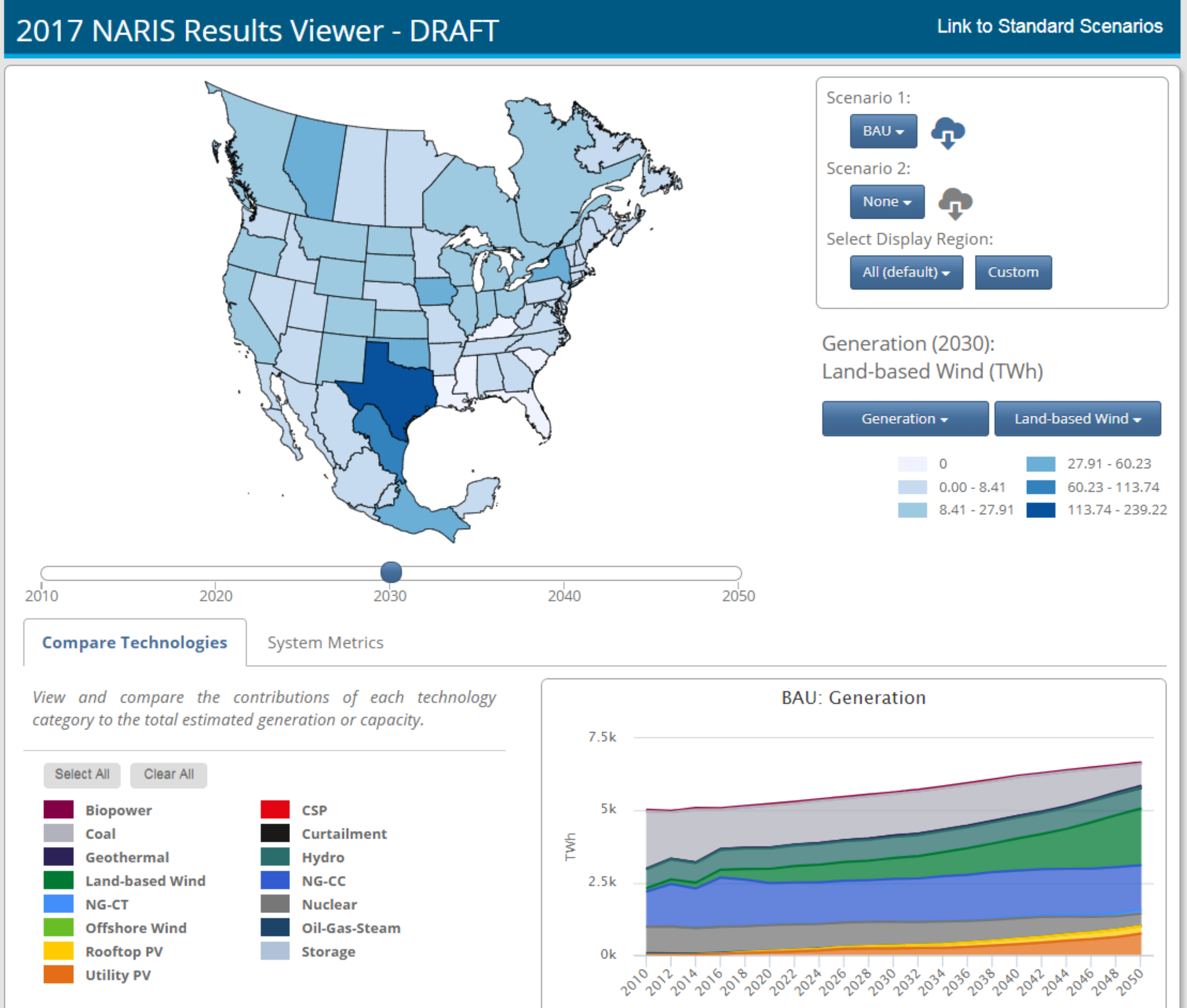
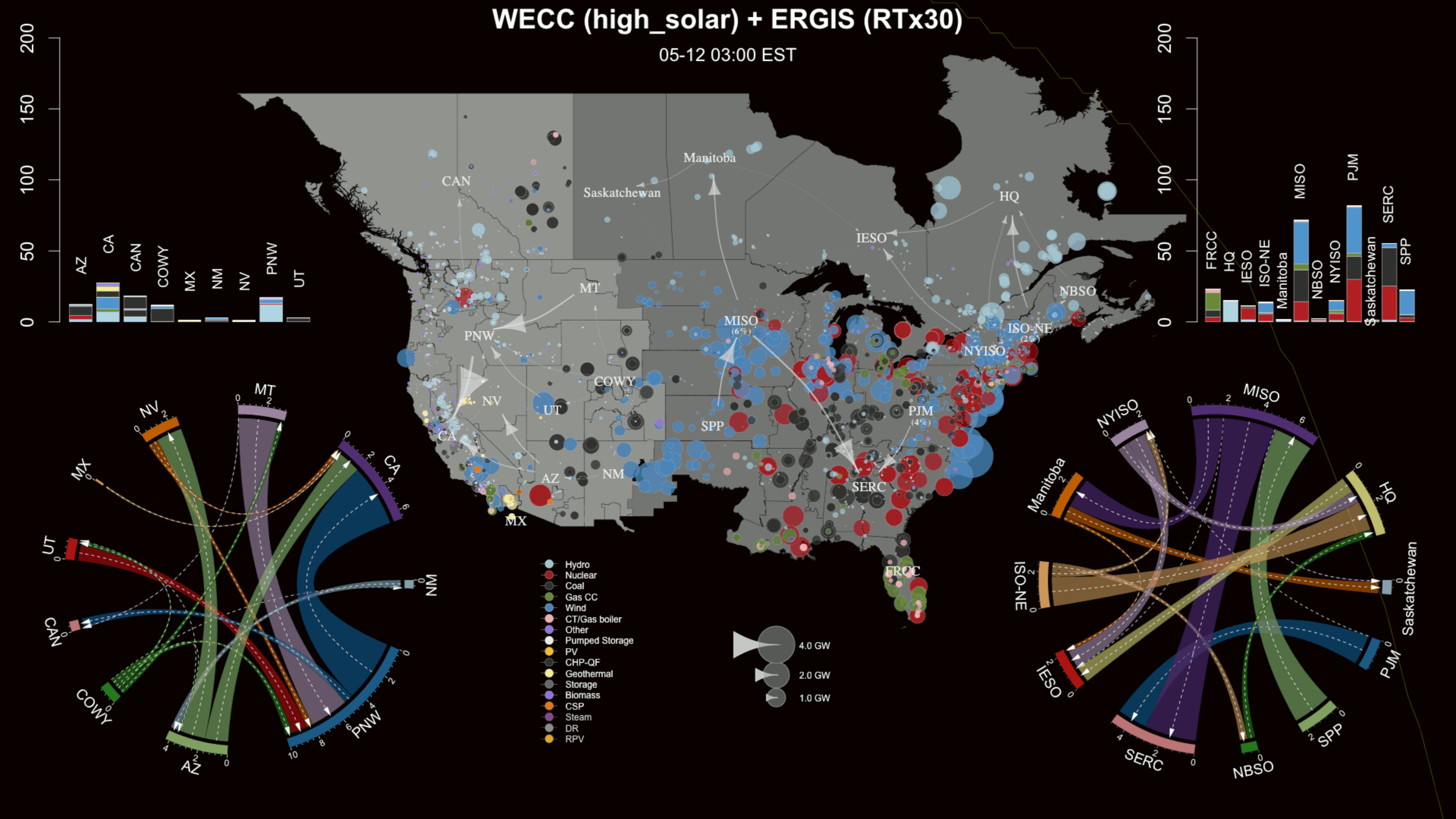
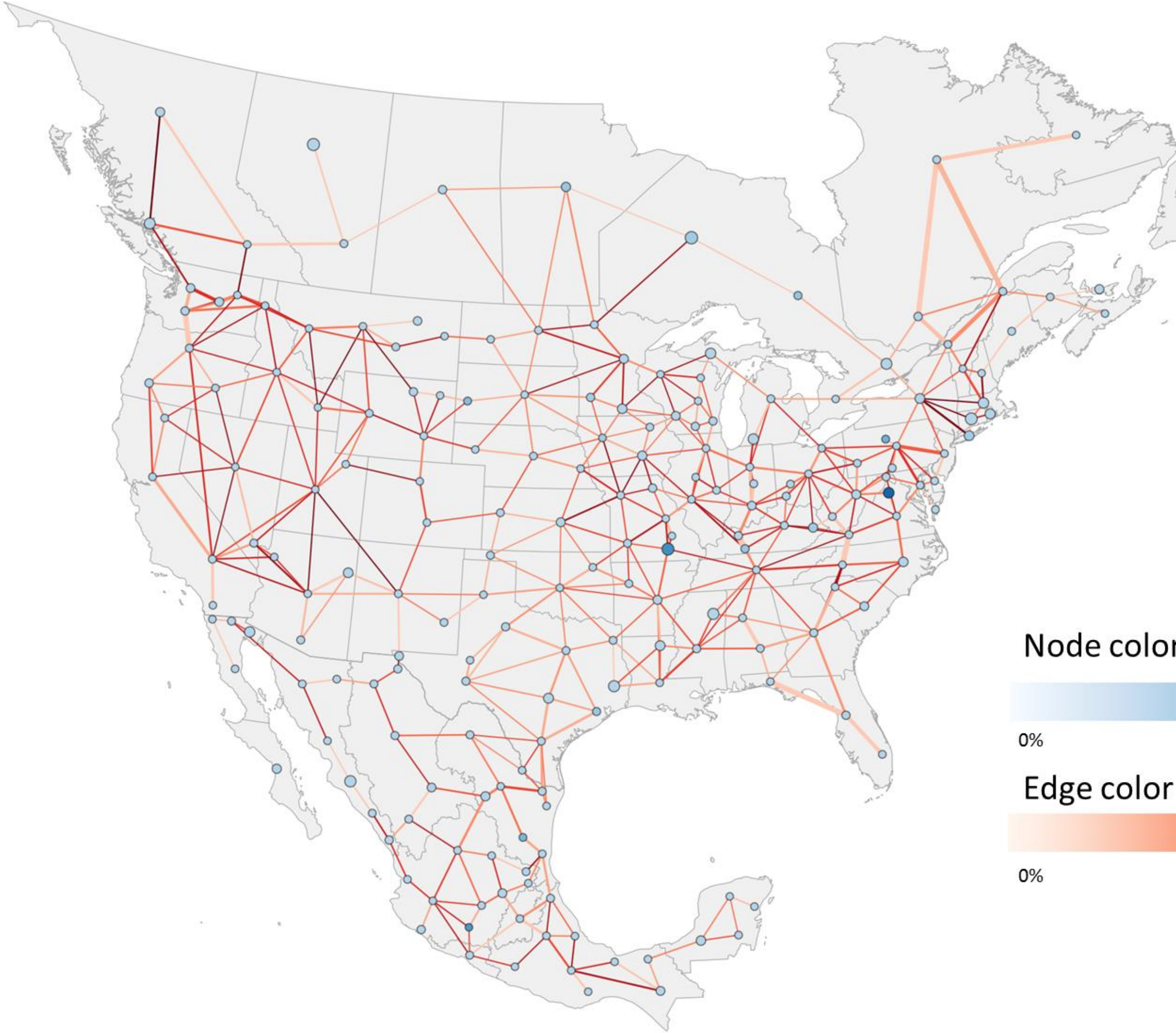
Scenario Viewer Tool

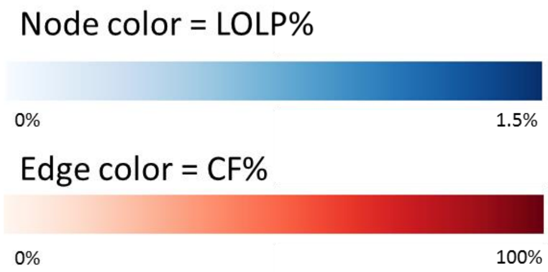




WECC (high_solar) + ERGIS (RTx30)
05-12 03:00 EST
AZ
CA
CAN
COWY
MX
NM
NV
PNW
UT
FRCC
HQ
IESO
ISO-NE
Manitoba
MISO
NBSO
NYISO
PJM
Saskatchewan
SERC
SPP
Hydro
Nuclear
Coal
Gas CC
Wind
CT/Gas boiler
Other
Pumped Storage
PV
CHP-QF
Geothermal
Storage
Biomass
CSP
Steam
DR
RPV
4.0 GW
2.0 GW
1.0 GW

PRAS LOLE early draft results (representative)





Questions?

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