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The Regional Energy Deployment System (ReEDS): An Open-Access Model for the North American Electricity System

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+ the NREL ReEDS Team

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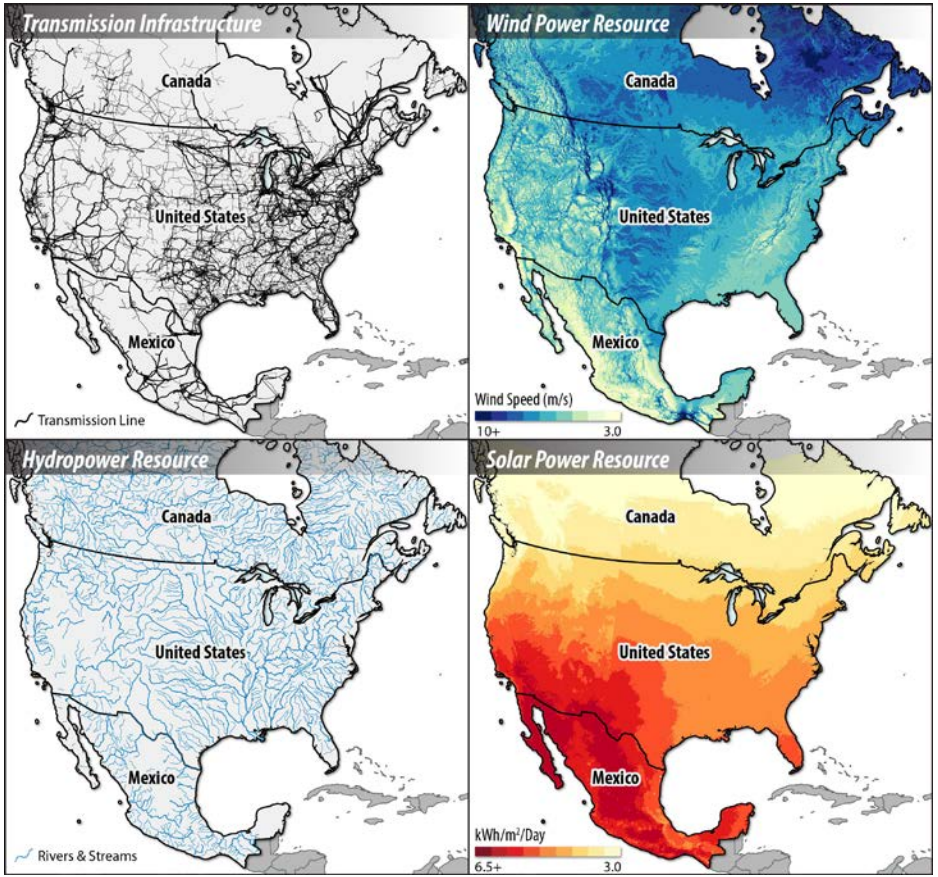
North America Is Diverse in Energy Resources and Load

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.



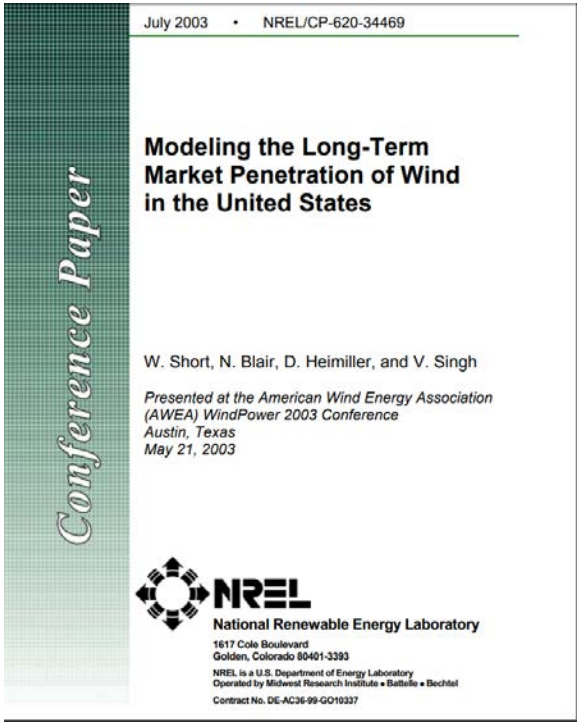
Goals of this presentation

1. History and Overview of ReEDS
2. North American Modeling using ReEDS
3. Brief Introduction to Open Access ReEDS

History of ReEDS

In 2003, NREL identified a need for advanced tools for modeling emerging wind technologies.

"The large scope and focus on today's dominant conventional energy forms [in existing models] do not allow a detailed treatment of the more important issues for wind energy technologies."



WinDS (2001) → ReEDS (2008) → ReEDS 2.0 (2019)

1999 – Spreadsheet model leveraging GIS data

2001 – Built an optimization model for wind called WinDS

2008 – Recast as ReEDS (expanded to more technologies)

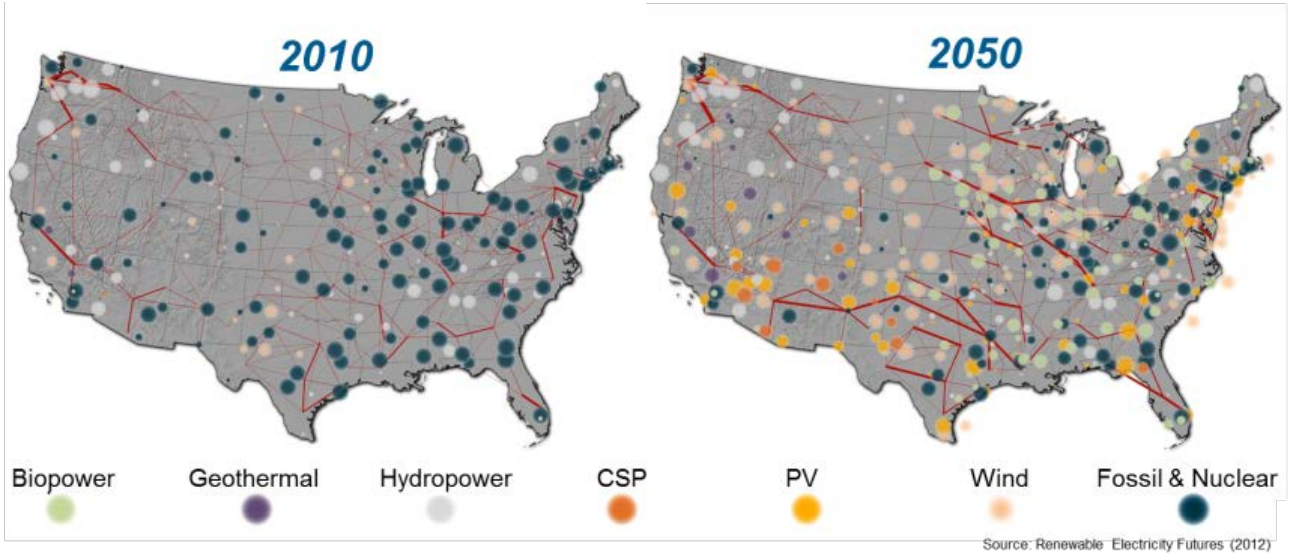
2016 – Incorporation of Canada and Mexico

2017 – ReEDS 2.0 development began (rewrite; new features)

2018 – North American Renewable Integration Study began

2019 – Open Access ReEDS (2.0) released

What does ReEDS 2.0 do?

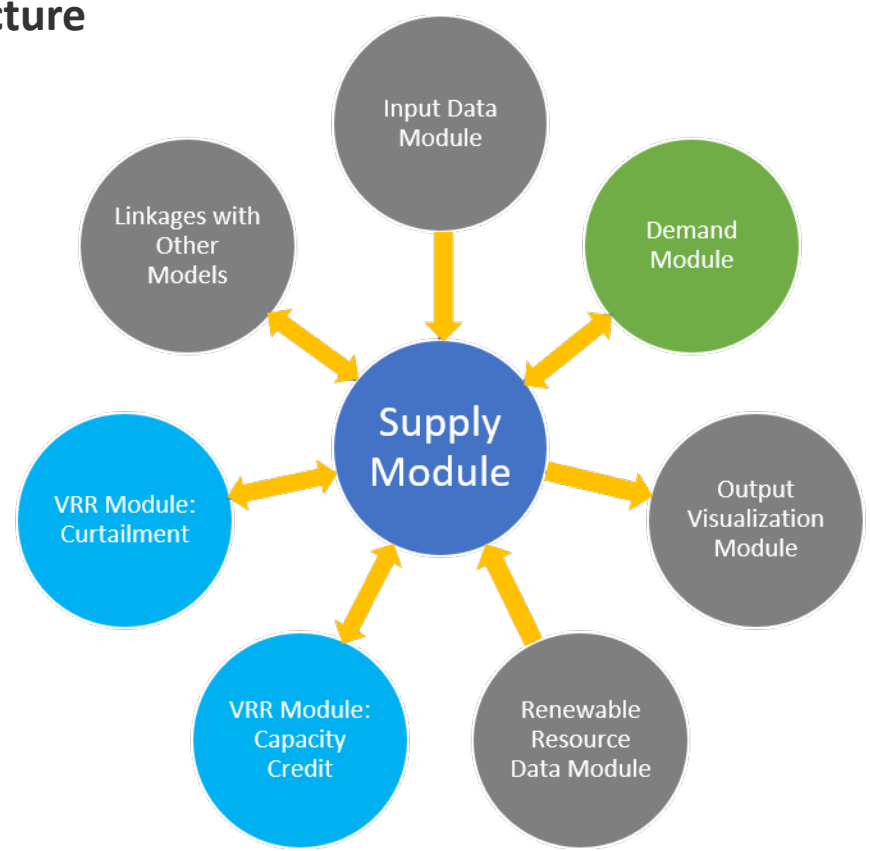


Given a set of input assumptions, ReEDS optimizes the evolution and operation of generation, transmission, and end-use demand and associated technologies.

ReEDS 2.0 Features

- **Uniform architecture**—highly generalized and flexible implementation
- **Flexibility in:**
  - Capacity detail—maintain high plant-level detail or aggregate; track vintages
  - Modeled years and time-horizon – user-defined resolution
  - Regionality – quickly shrink or expand model
  - Foresight – sequential (myopic), intertemporal (perfect), or sliding-window
  - Retirements – endogenous, exogenous, or mixed
- **Demand-side module:** includes a representation of consumer decision-making around energy service consumption, device adoption, and electricity consumption
- **Endogenous calculation of VRE integration challenges:** capacity credit and curtailment
- **Endogenous calculation of non-energy electricity service requirements:** e.g. frequency regulation, contingency, forecast-error

ReEDS Module Structure



How the supply-side module work?

The ReEDS supply-module identifies the *least cost mix and operation* of resources that simultaneously meets load, all other electricity service requirements (planning reserves, operating reserves), and physical and environmental constraints.

Fossil

Nuclear

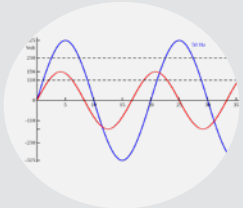
Transmission

Renewables

Regulations

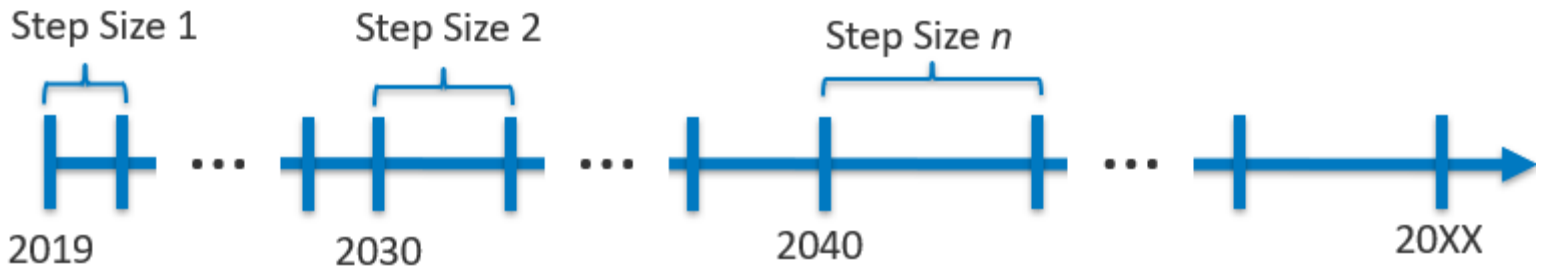
Load

(DC) Power-flow

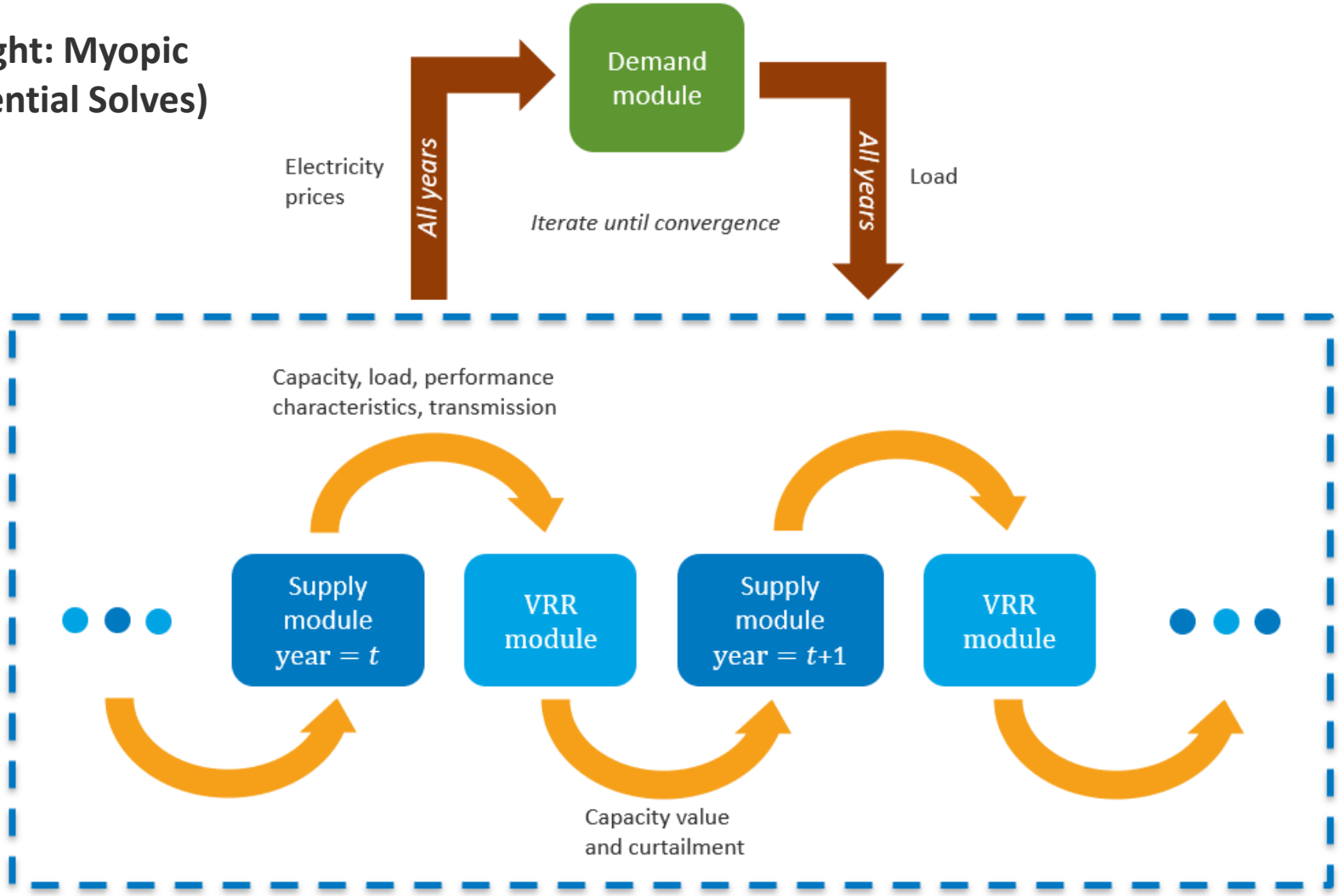


Ancillary Services

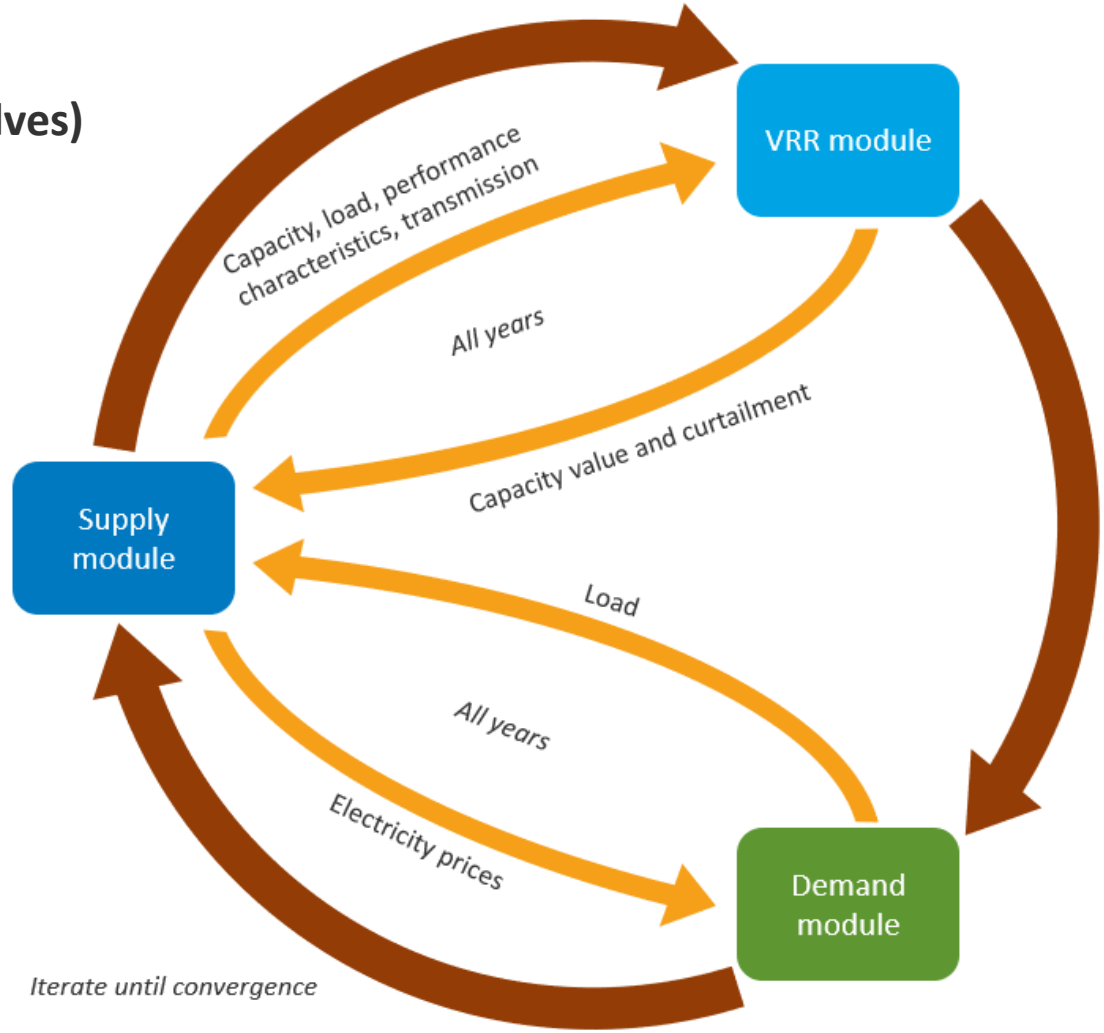
User-specified model years



Foresight: Myopic (Sequential Solves)



Foresight: Perfect (Intertemporal Solves)



Modeling the North American Power Systems with ReEDS

ReEDS US + Canada (2013, 2015, 2017)

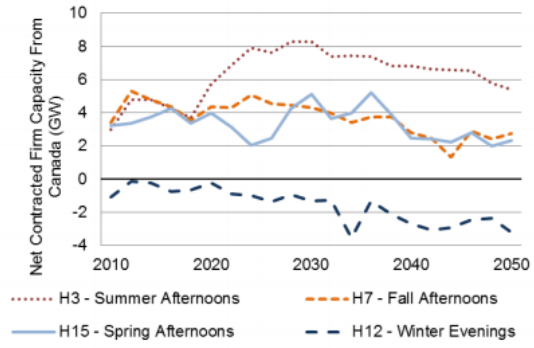
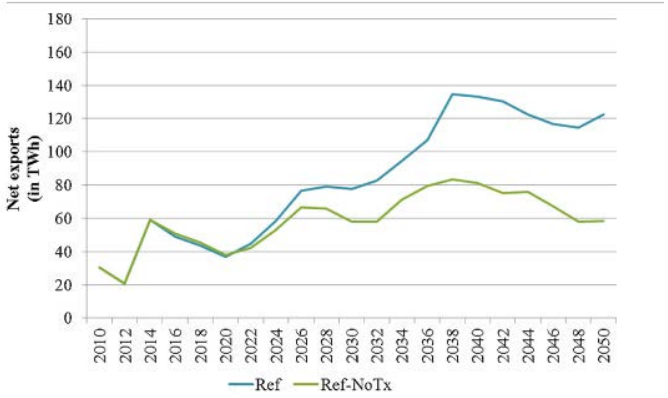


Figure 21. Net exported contracted firm capacity from Canada for the reference scenario



Goals:

- Demonstrate the Canada-US modeling capability
- Analyze international transfers of grid services
- Quantify the potential value of cross-border transmission

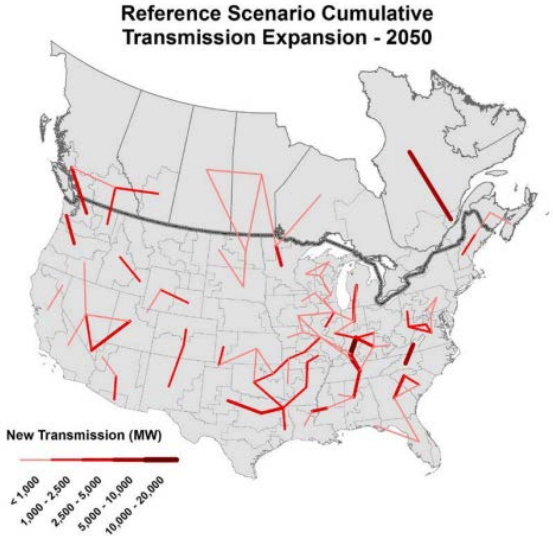


Figure 19. Inter-BA transmission lines deployed between 2010 and 2050 in the reference scenario

ReEDS Mexico (2017)

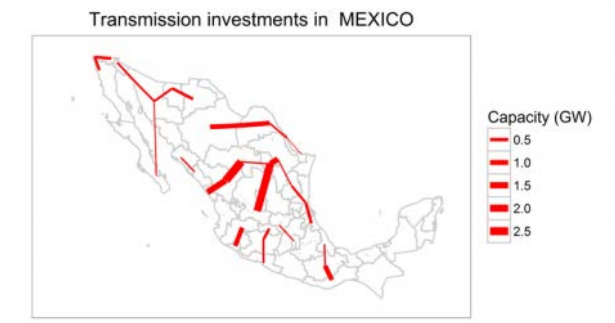


Figure 16. Transmission investments up to 2050 under Reference scenario

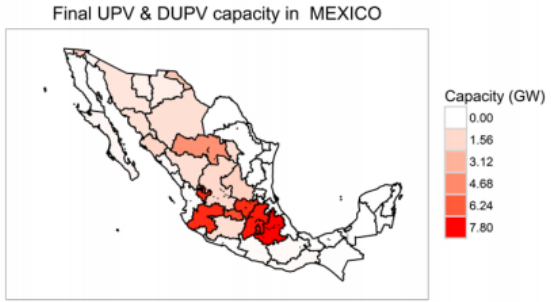


Figure 18. 2050 Wind capacity per region under Reference Scenario

Goals:

- Demonstrate the ReEDS Mexico modeling capability
- Final step in preparation for North American analysis

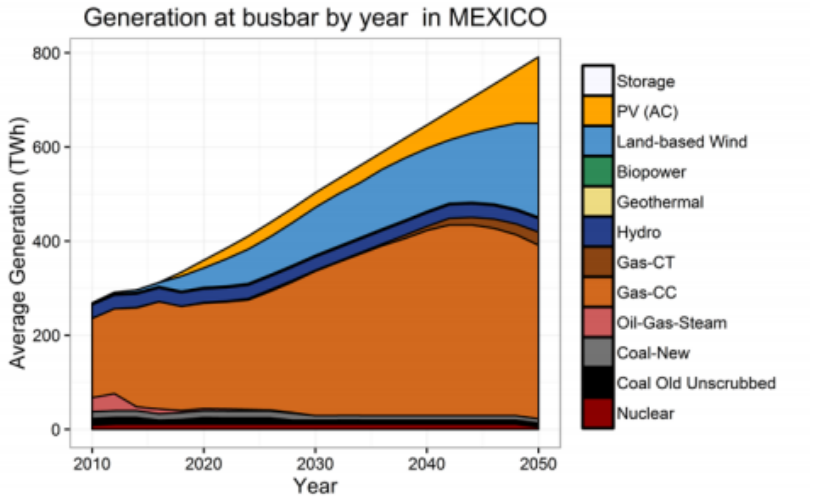


Figure 15. Mexican power system generation mix from 2010-2050 under Reference scenario.

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

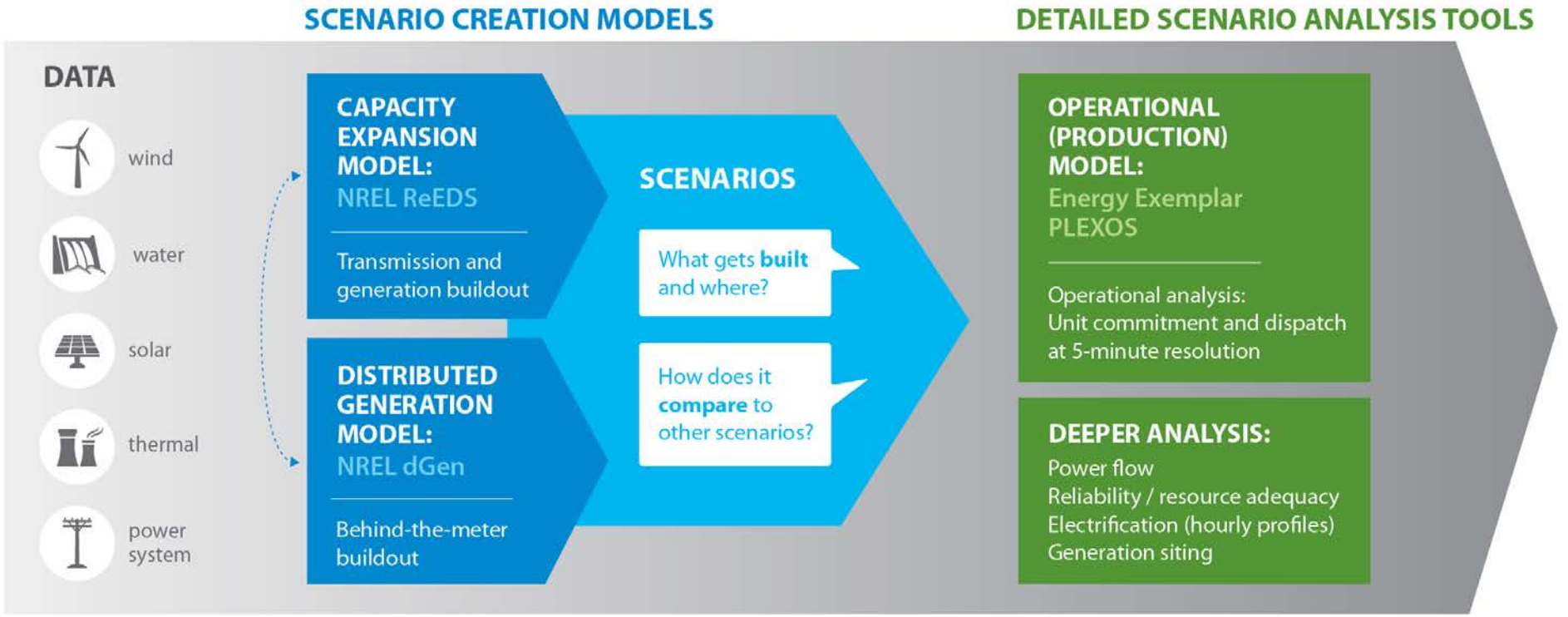
Canada

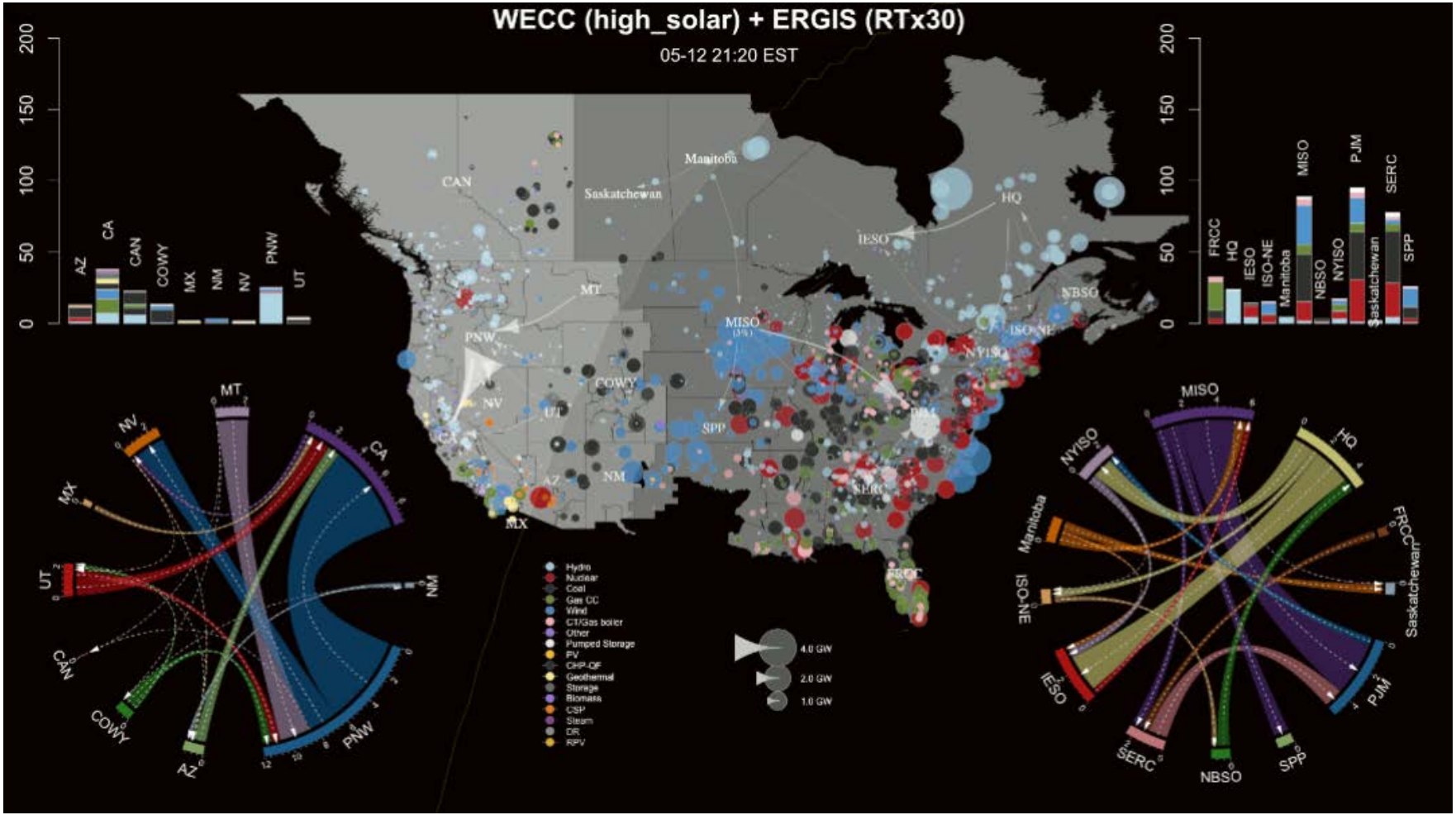
SENER
SECRETARÍA DE ENERGÍA

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

How it Works: Modeling Flow




WECC (high_solar) + ERGIS (RTx30)
05-12 21:20 EST
AZ
CA
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NV
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IESO
ISO-NE
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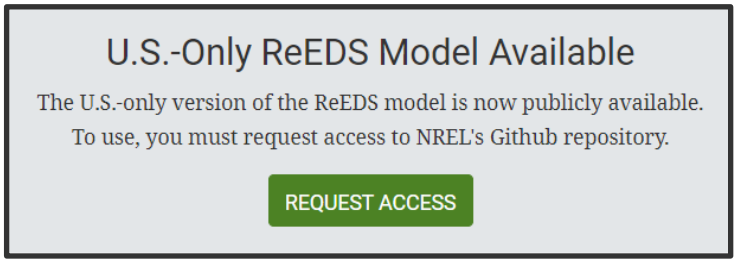
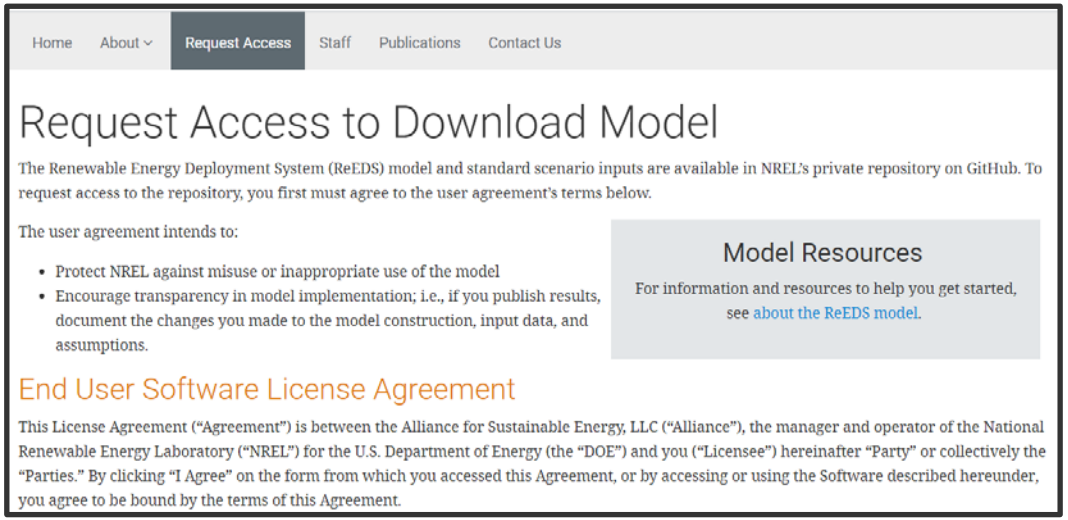
MISO
NBSO
NYISO
Saskatchewan
PJM
SERC
SPP
Hydro
Nuclear
Coal
Gas CC
Wind
CT/Gas boiler
Other
Pumped Storage
PV
CHP-QF
Geothermal
Storage
Biomass
CSP
Steam
DR
RPV
4.0 GW
2.0 GW
1.0 GW

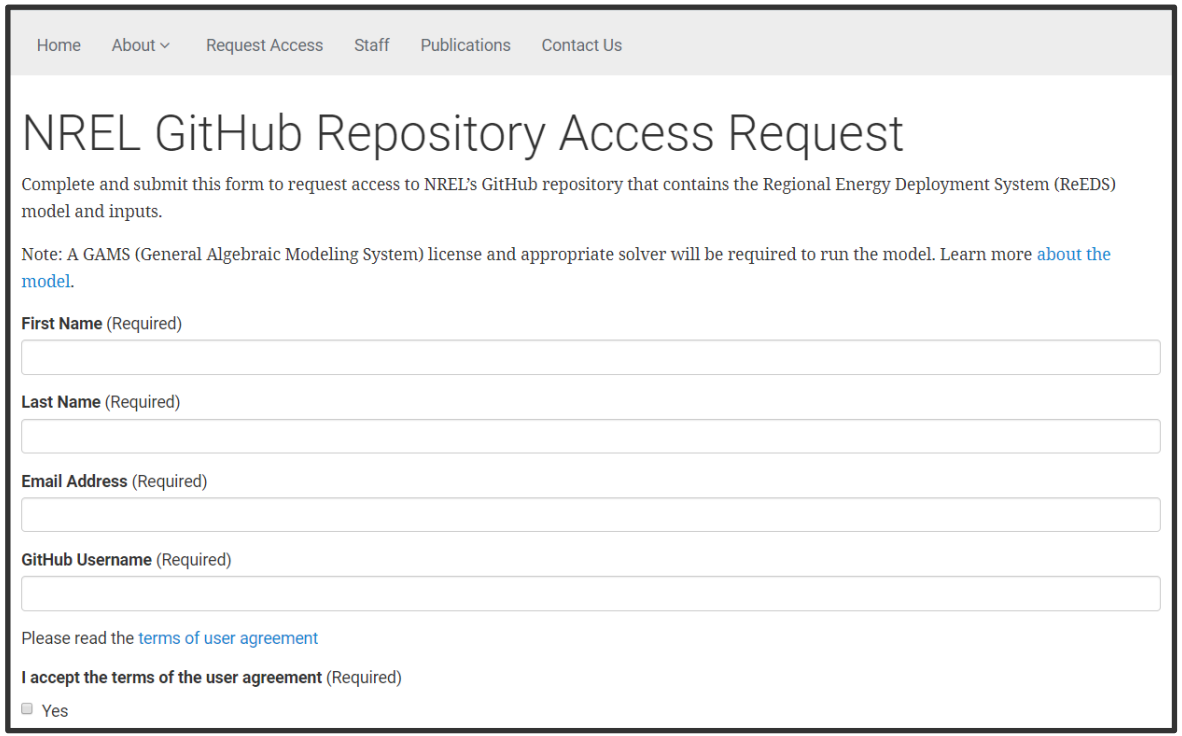
Open Access ReEDS

Requesting Access



https://www.nrel.gov/analysis/reeds/

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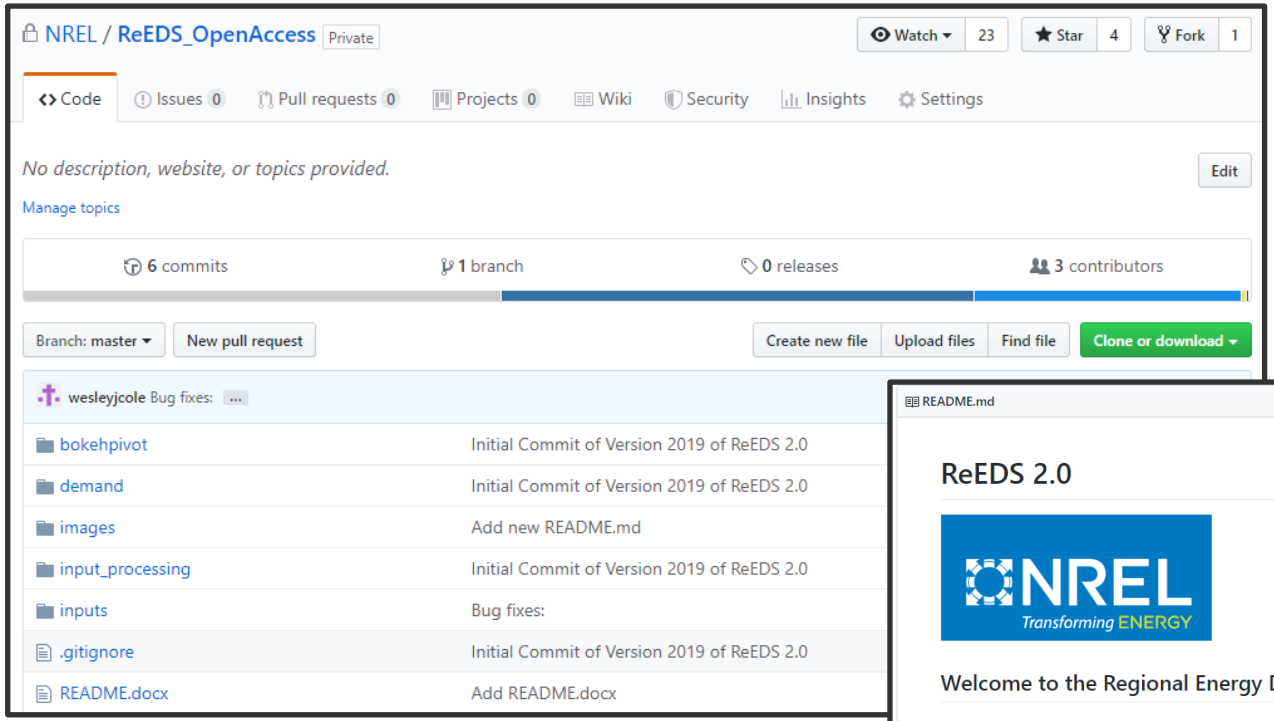
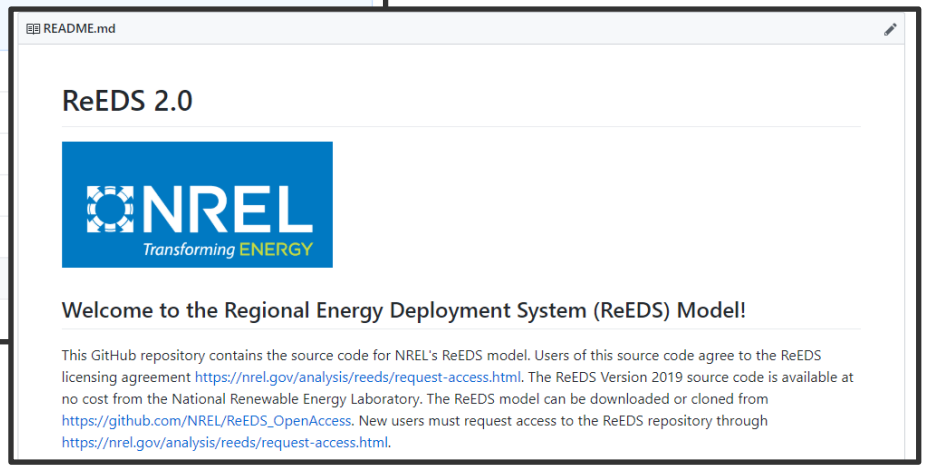
NREL GitHub Repository Access Request
Complete and submit this form to request access to NREL's GitHub repository that contains the Regional Energy Deployment System (ReEDS) model and inputs.
Note: A GAMS (General Algebraic Modeling System) license and appropriate solver will be required to run the model. Learn more about the model.
First Name (Required)
Last Name (Required)
Email Address (Required)
GitHub Username (Required)
Please read the terms of user agreement
I accept the terms of the user agreement (Required)
Yes

https://github.com/NREL/ReEDS_OpenAccess





Get a ReEDS 101 on Oct. 31

- On Thursday, Oct. 31, at 11 a.m. Mountain Time, NREL will host a free webinar explaining the ReEDS model and its uses, as well as opening the floor for Q&As.

- Please join us to learn more about how ReEDS can lead to better-informed energy decisions, policies, and infrastructure planning.

Thank you!

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