Transforming grid planning with open-source software

PERSPECTIVES FROM AN ELECTRICITY INNOVATION LAB (E-LAB) ACTIVITY

JULY 2023

GridLAB

RMI
ENERGY. TRANSFORMED.

Background and context

- Planning is growing more complex with increased renewables and storage
- Common grid planning processes and software tools need to evolve to support planners and stakeholders in these changes
- Regulatory and other dimensions of the planning processes, particularly around software tools and modeling, can often lack transparency

Working Hypothesis:

Open-source modeling tools and datasets can support increased transparency and improved grid planning results

GridLab and RMI co-convened an e-Lab Initiative

- "e-Lab" is a collaborative problem-solving process that brings together practitioners.
- Participation involved group time, independent research and external interviews.
- The team explored the working hypothesis

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Objectives of the e-Lab process

1. Develop a clear understanding of the open-source grid modeling landscape including tools, stakeholders, and challenges faced to date
2. Create a roadmap for an initiative to increase the value and use of OS tools, including a long-term vision and interim activities
3. Test and refine the roadmap based on stakeholder input (during the e-Lab process and beyond)

e-Lab Team composition

- Team expertise included software development and use, utility consulting, clean resource development, and regulatory issues
- Worked over the course of 3 months in 2021 and 2022

** Disclaimer: The views contained in this presentation do not represent the views of any of the team members' organizations and cannot be attributed to any single team member.*

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FACILITATION PROVIDED BY:

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Purpose of this report

- Memorialize the work of the e-Lab team with a clear discussion of challenges that must be overcome to scale open-source tools
- We hope this report will inform:
  - Open-source modeling developers and practitioners
  - Regulators and policy makers
  - Grid planners and solution providers

Team aligned on this problem statement:

Today's grid planning software toolkit as commonly used in the U.S. does not meet the emerging needs of regulators or society

Technically limited

- Tools may have practical limitations in spatial and temporal granularity, and ability to value storage, DERs, renewables, market integration etc.

Inaccessible

- License fees can be cost-prohibitive for intervenors.
- Data access is a barrier for OS tool use.

Complex

- Open source tools may have poor maintenance, documentation, user support.
- Commercial tools may be designed for a specific use case.
- Both may require deep expertise and user training.

Inflexible

- Many existing open-source tools, and some commercial tools, are poorly maintained and inflexible to emerging use cases and grid needs.

Team aligned on a solution hypothesis and value proposition of open-source tools

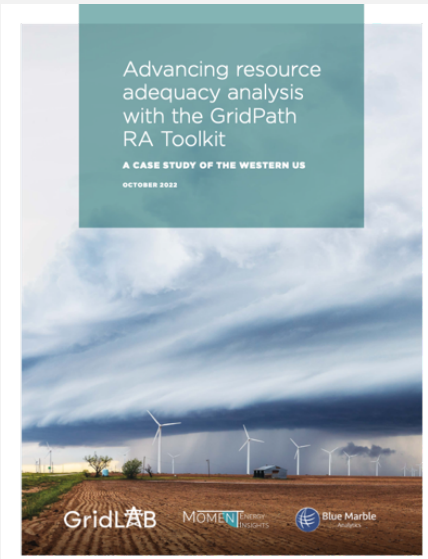
SOLUTION HYPOTHESIS:

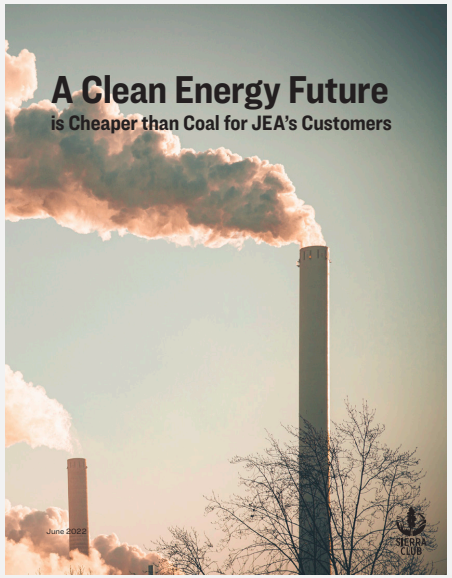
- Open-source tools have a timely opportunity to address major limitations and bottlenecks stalling regulated processes on grid planning.

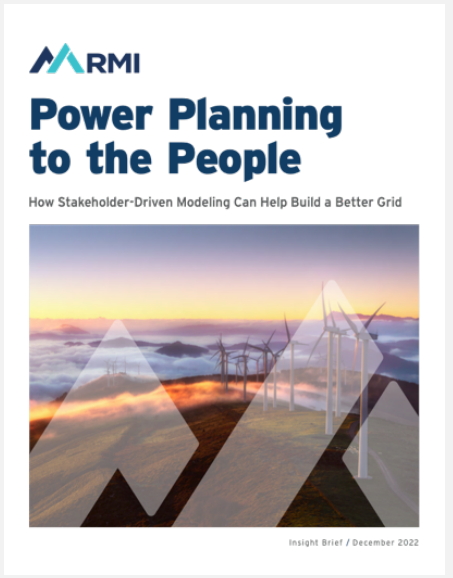
VALUE PROPOSITION:

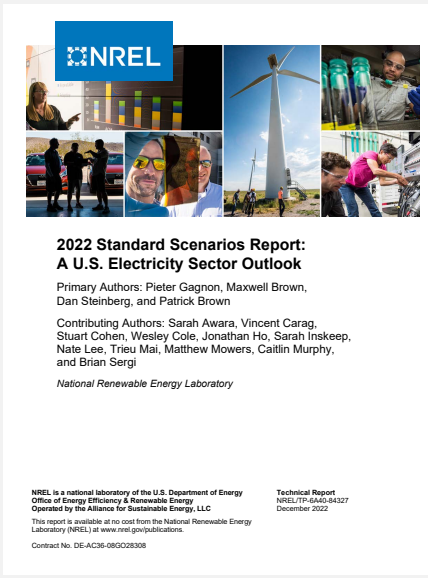
- Open-source tools can support broader engagement in resource planning, and support the energy transition.
- Commercial tools and open-source tools can cohabitate and push one another towards increased features and usability.
- The time is right to explore open-source tools in a focused way since they are being used more extensively beyond research and academic environments.

Recent examples of open-source tool projects









Open source and commercial tools can cohabitate

Examples of commercial and open source/user tools commonly used in planning studies:

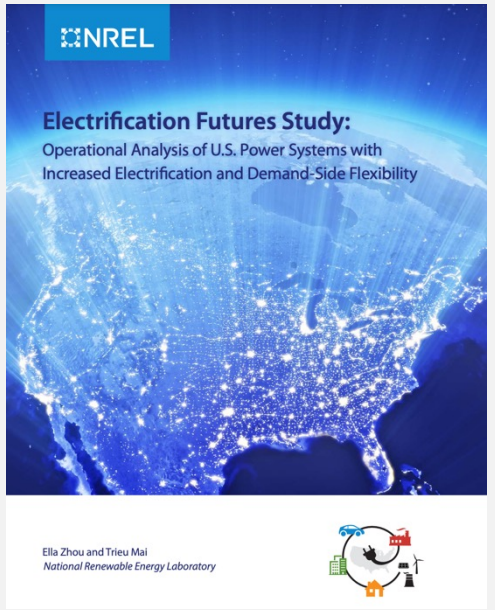
Commercial

- PLEXOS
- PROMOD
- Encompass
- SERVM

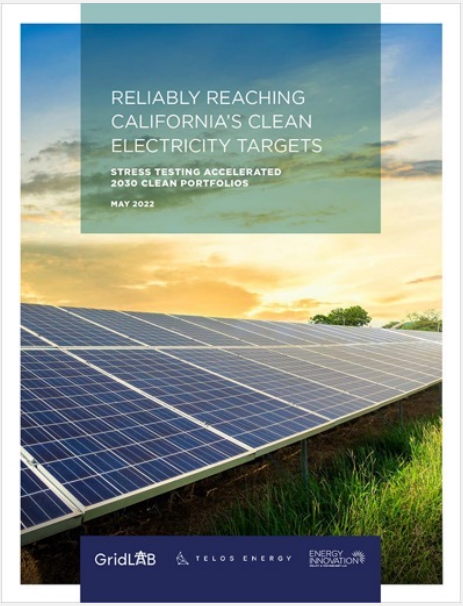
Open source/user

- GridPath
- ReEDS
- GenX
- SWITCH
- RESOLVE (CA)

Commercial and open-source tools have been coupled in some projects:



ReEDS and PLEXOS



RESOLVE and PLEXOS

Landscape assessment included model type, open source or proprietary, business model, maintenance, user characteristics, and temporal/spatial resolution*

COMMERCIAL/PROPRIETARY:

- PowerGEM
- Encompass
- RPM
- PowerSIMM
- Aurora
- PLEXOS
- FormWare
- WIS:dom

OPEN SOURCE:

- GenX
- SWITCH 2.0
- GridPath
- RESOLVE (CA)
- PyPSA

** Was not an exhaustive technical assessment*

Landscape assessment highlights

1. Proprietary tools' dominant model is software as a service (SaaS)
2. Most open source (OS) tools are supported by grants
3. OS options favor capacity expansion over production cost and RA analysis (exceptions GridPath, PyPSA)
4. OS tools users tend to be researchers with a few exceptions (GridPath is being used by 3 load serving entities)
5. OS tools tend to have temporal and spatial flexibility

Expert interview takeaways

The team interviewed 14 experts including consultants, users, policymakers, regulators, tool developers, and data specialists.

Today's planning process and toolkit are inefficient, limit stakeholder engagement, don't value clean resources/markets/weather risks adequately, and are difficult to use.

Open-source power system data is inaccessible, inconsistently formatted, time-intensive to clean; open-source tools are poorly documented; data gaps limit accuracy to model utility systems.

Benchmarking tools can create a better standard of comparison (user experience, technical attributes, data processing, reporting).

Open-source value proposition exists for utilities (new features, no fee), regulators (transparency/engagement), and researchers (impact).

Barriers to realizing open-source modeling

CORE BARRIERS:

- Lack of viable and sustainable business model limits the ability to maintain/improve tools
- Trust and credibility are lower for open-source tools
- Open-source landscape is complex/fragmented
- Lack of high-quality, low-cost data

ADDITIONAL IMPORTANT BARRIERS:

- Not designed to be user friendly
- Utility regulatory commissions tend to be agnostic/reactive with regards to tool selection
- Cybersecurity and data protection may be lacking for open-source tools
- Both open source and commercial tools are technically limited

Potential value proposition of open-source tools for key stakeholder groups

UTILITIES

- Tool provides added value (e.g., new feature) addressing a critical long-term pressure point such as modeling clean firm resources, or regional resource adequacy
- Capacity building and education lead to full utilization of tools
- Efficiency in IT for cloud solutions
- No license fee

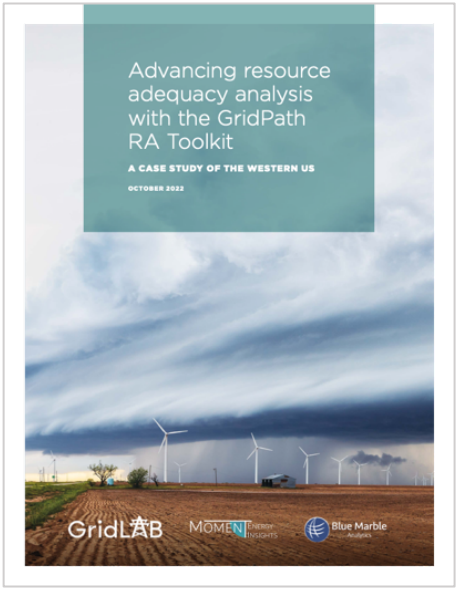
REGULATORS

- Improved quality of stakeholder engagement processes given transparency, accessibility, and education
- Increased pace of planning (assuming rigor and accuracy are maintained)

RESEARCHERS

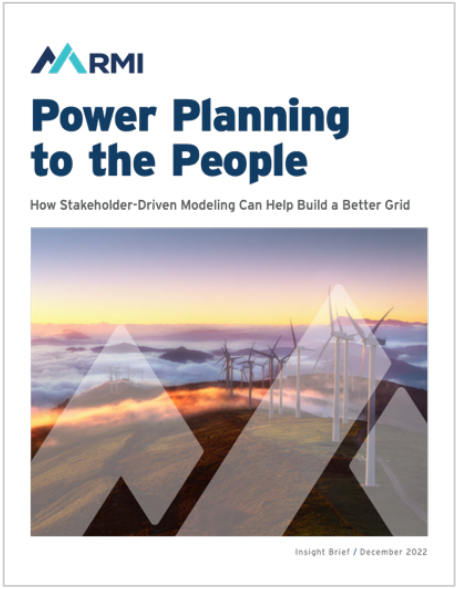
- Enhanced knowledge and experience in practical applications
- New standards for benchmarking (ease of use, documentation, technical specs) to increase consistency and knowledge sharing
- Tailored and targeted research projects leading to industry impact
- Attract top analytical talent, and sustainable funding resources

Recent open-source case studies



GridPath RA Toolkit

- Dataset and algorithms for modeling resource adequacy across the Western United States



Power planning to the people

- GenX capacity expansion tool used in the Kentucky IRP process

What might success and failure look like for an open-source initiative?

Technical capabilities

Success: provides at least 1 additional function

Failure: development stops

Usability

Success: flexibility/default options, strong documentation and support, GUI

Failure: tools difficult to use, maintenance and upkeep is prohibitively expensive

Credibility

Success: adopted in high profile projects

Failure: OS tools cannot be validated against commercial counterparts; dismissed by regulators

Mitigating strategies for key risks

- **Lack of credibility among regulators/utilities**: build credible case studies and socialize the benefits of transparent and open planning processes
- **Complexity of OS tools limits access:** training support/targeted funding to support software best practices, expand skilled users
- **Utility level data restrictions:** collaborate with FERC/EIA to develop model-agnostic datasets
- **Lack of incentives for grid planners:** support technical advancement of OS tools so grid planners see them as helpful
- **Insufficient long term funding perpetuates fragmented /siloed development:** multi-year funding, facilitate centralized crowd-sourcing and coordination
- **Insurmountable technical complexities:** fostering online OS community of top talent with crowd sourcing, coordinated research efforts, shared codebases, creating supply of people/computing/funding

Defined 4 pillars of roadmap activities to address the barriers towards scaling open-source solutions

Pillar	**FACILITATE STANDARDIZATION OF OS DATA**	**ADVANCE OS PLANNING TOOLS**	**BUILD CREDIBILITY AND REGULATORY SUPPORT**	**FOSTER COMMUNITY OF ANALYTICAL TALENT AND EXPAND THE USER BASE**
Goal	Promote the creation and use of robust, open-source datasets that can be used in grid modeling	Facilitate technical advancements in OS tools and support development of enterprise-grade tools to software maturity	Build credibility and regulatory support for OS grid planning tools and scale the adoption of enterprise-grade tools in regulated proceedings	Bolster the pool of analytical talent to collaboratively improve tools, expand the base of users who can integrate and apply these tools during planning and procurement processes

Activities of an open-source initiative

Facilitate Standardization of OS Data	Support the creation of a US-wide standardized bulk energy system dataset, generate funding support to fill critical data gaps, and integrate OS data into regulatory proceedings
Advance OS Planning Tools	Evaluate and benchmark tools, coordinate research pipelines, and support sustainable business models that prioritize comprehensive documentation and maintenance support
Build Credibility and Regulatory Support	Promote transparent grid planning processes, and support the use of OS tools in high-profile planning studies and proceedings
Foster Community of Analytical Talent and Expand the User Base	Build collaborative platforms and a centralized community to increase the supply of analytical talent, offer audience-targeted trainings and curricula for intervenors, advocates and key decision-makers.

Next steps

- e-Lab provided a structured approach to assess the value and opportunities for open source models
- We are soliciting feedback from a wide variety of stakeholders on the roadmap and concepts in this report
- The Team is focusing on addressing the barriers described in this report by working on tool development, testing, and trust building
- The Team will continue identifying opportunities to leverage OS tools to improve grid planning outcomes