



ES4G: Energy Storage to Support Generation

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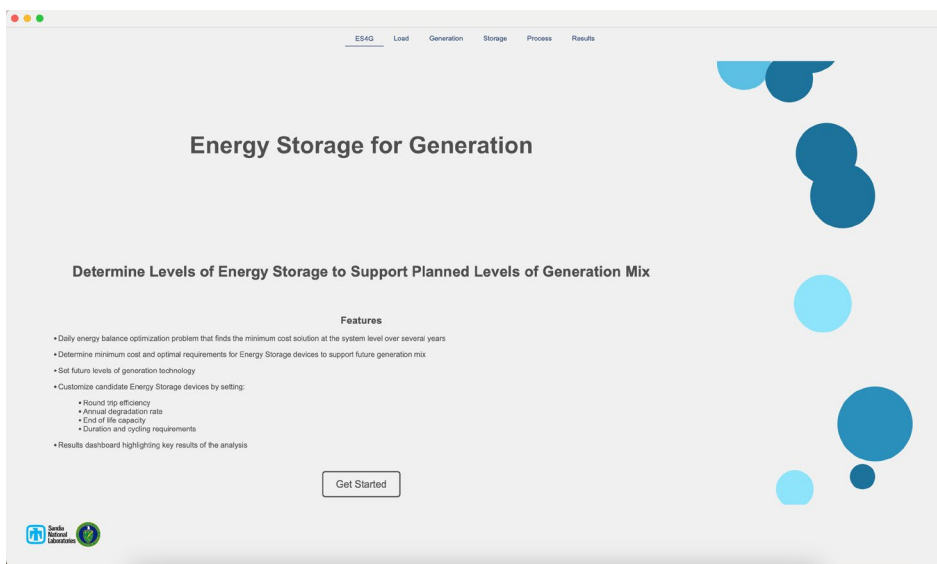
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Project Objective

Develop a software tool designed to deliver high-level estimates of the energy storage capacity needed to support generation. Energy storage has emerged as a critical asset, playing a vital role in enhancing the reliability and resilience of the electric grid. ES4G empowers utilities, grid operators, and energy planners to evaluate the storage requirements necessary to support their specific generation mix objectives, promoting DOE goals for delivering affordable and reliable energy.

Why This Work Is Needed

ES4G is an innovative software tool designed for grid and energy planners, providing critical insights into the deployment of energy storage technologies while accounting for sensitivities related to future generation expansion. As a free and open-source resource, it is readily accessible to support informed decision-making through its advanced features. By enabling users to analyze various future scenarios, ES4G enhances grid reliability and resilience, focusing on the specification of generation mix targets and the evaluation of potential energy storage solutions.



What We Do

- Leverage energy reservoir models (ERMs), along with degradation rates, end of life considerations, and cycling constraints to model energy storage technologies
- Incorporate models into a system wide energy balance optimization considering future generation mixes, reserve requirements, and capacity factors

Features

- User-Friendly Interface:** Designed with usability in mind, QuEST ES4G offers a intuitive interface that simplifies the process of inputting data and interpreting results.
- Generation Scenarios:** Users can create future generation mix targets with traditional, variable, and custom technologies to identify optimal investments.
- User Customizable ES technologies:** Custom energy storage devices allow for investigation of commercial and early stage technologies defined with key characteristics such as: Capital Costs, Round-Trip Efficiency, Annual Degradation Rate, and End of Life capacity.
- Fast Results:** High level analysis translates to quick simulations that provide minimum requirements to support future generation targets.
- Dashboard Output:** The results dashboard provides users with several graphics to assist interpretation of the optimization output.

Progress

FY25 Activity:

- Developed optimization formulation with system wide energy balance for future generation mix and custom energy storage technologies
- Developed user interface to effectively gather data, run scenarios, and interpret results

Formulation

- Minimum cost optimization of energy storage investment over time horizon
- Generation constraints
 - Daily energy balance
 - Desired generation mix
 - Reserve requirements
 - Capacity factor
- ES constraints
 - Daily state of energy
 - Degradation
 - Cycling
 - Power & Energy sizing
 - End of Life

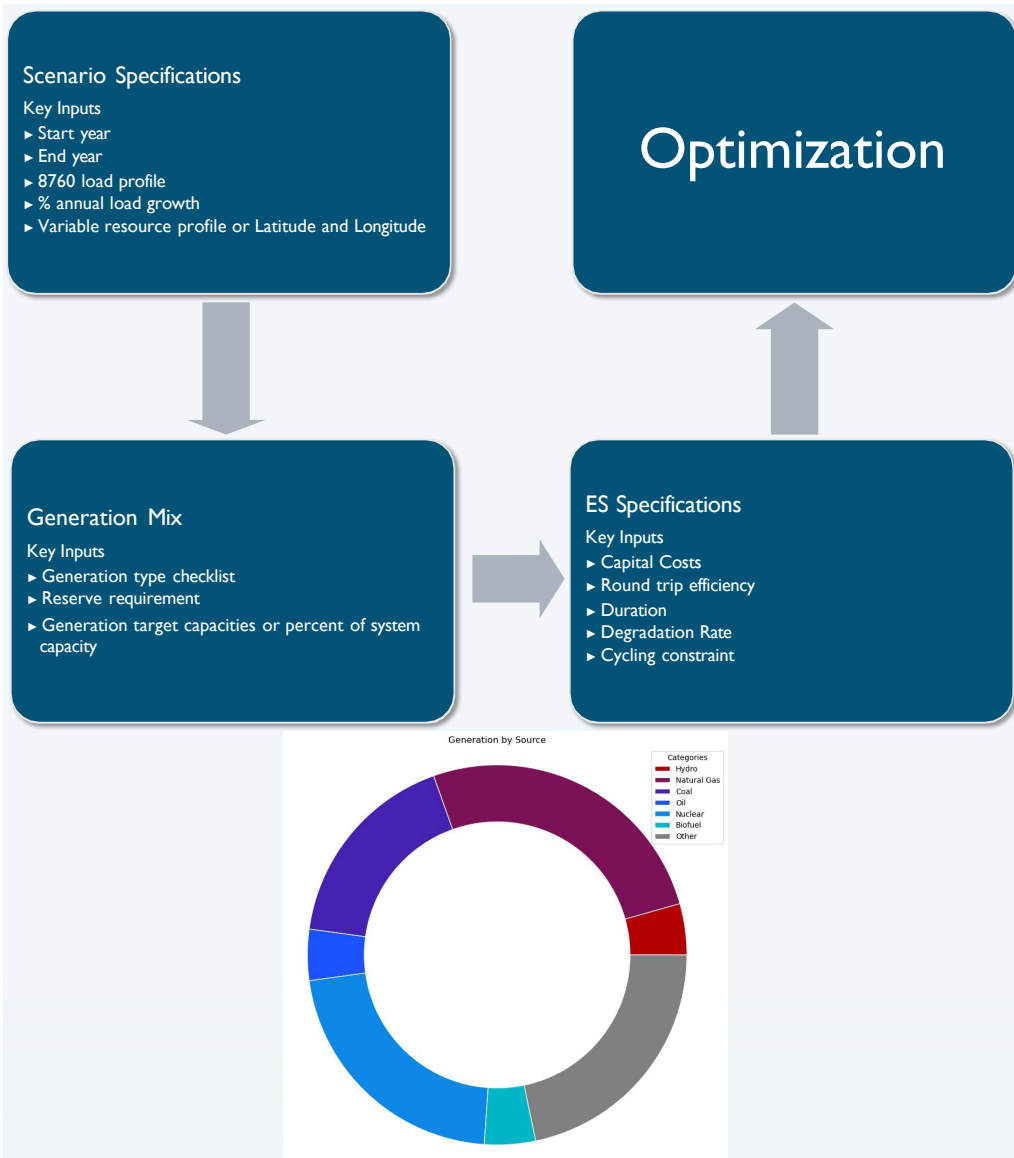


Fig 3. Example of resulting plot showing generation by source.

Workflow

Results

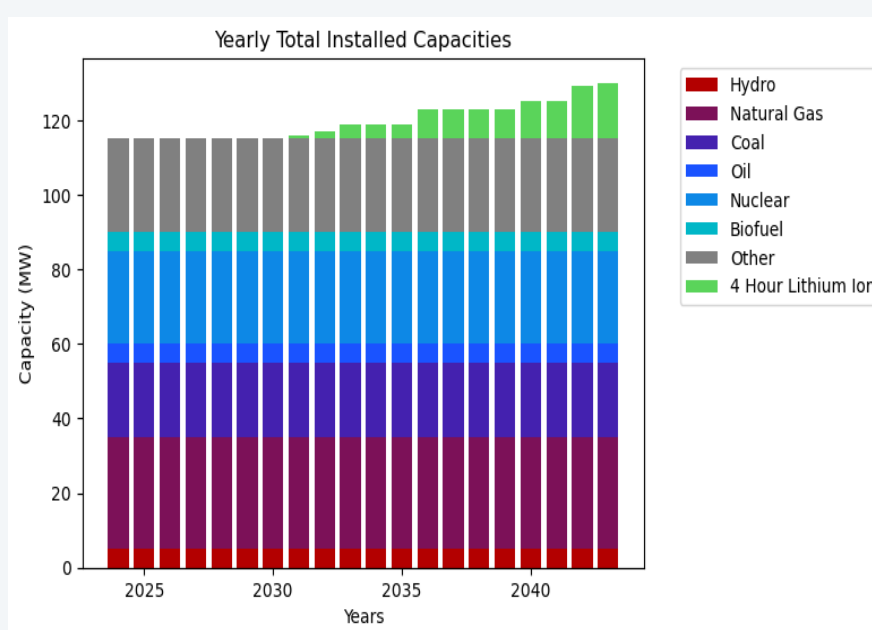


Fig 1. Example of resulting plot showing total installed capacities over time horizon.

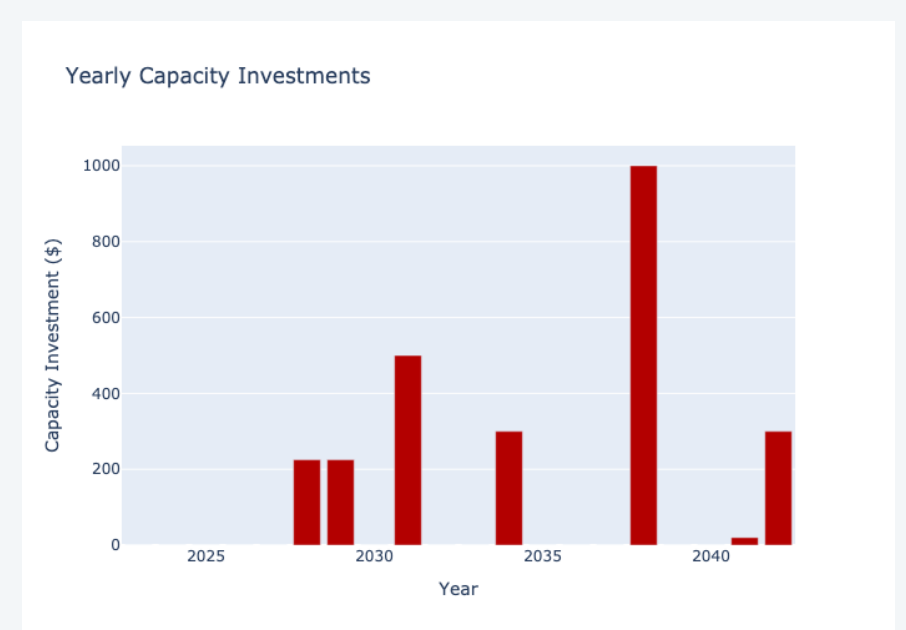


Fig 2. Example of resulting plot showing yearly investments in energy storage.

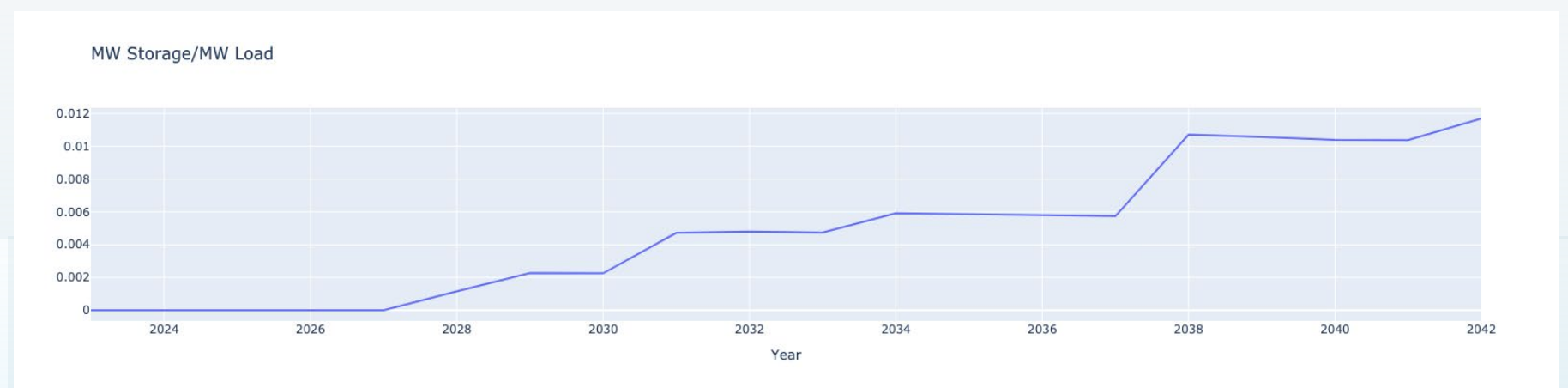


Fig 4. Example of resulting plot showing the ratio of energy storage per MW peak load.

Next Steps

- Release tool as part of QuEST Platform
- Improve User Interface with advanced dashboard capabilities

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