



QuEST PCM: Production Cost Modeling Tool with Improved Energy Storage System Models

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Project Objective

Develop an open-source production cost modeling tool with high-fidelity energy storage system models

Motivation

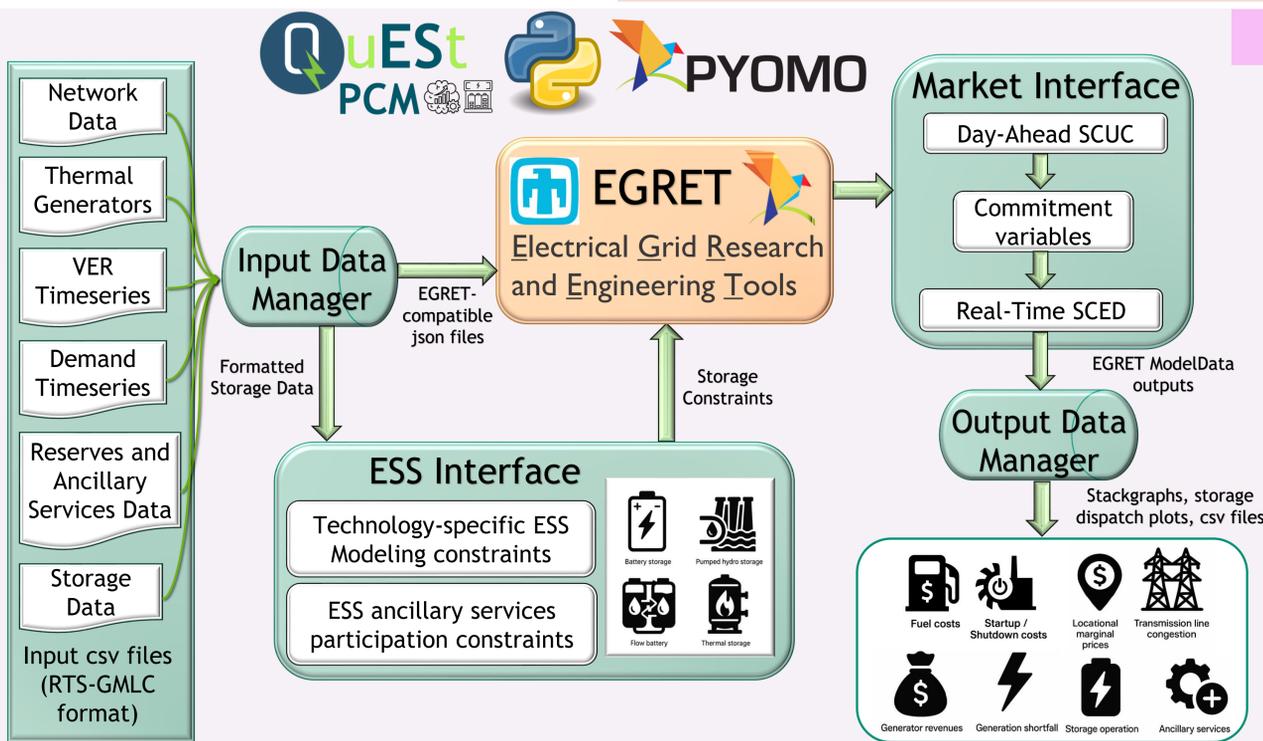
- Production cost models (PCMs) analyze power system operations with unit commitment, and economic dispatch over hourly and sub-hourly scales.
- Accurate modeling of energy storage systems (ESS) is essential in operations studies, as ESS influence system reliability, operational flexibility, and overall costs
- Most open-source PCM tools use low-fidelity ESS models, underestimating their contributions and potentially leading to suboptimal operational decisions.

Approach

- Develop an *open-source PCM tool* for evaluating the power system operations with *high-fidelity ESS models*
- Develop and incorporate *state-of-the-art ESS operation models* to evaluate the contribution of ESS towards system operation and costs
- Key contributions:**
 - Incorporating *technology specific ESS models* within PCM along with *ESS market participation models*
 - Developing an interface to evaluate system operations with ESS integration

Current Progress

- Surveyed existing PCM tools and reviewed literature on ESS modeling approaches within PCM frameworks
- Designed and implemented core components: input processing, ESS pyomo models, and market interface
- Developed a partial output interface to support result visualization
- Initiated case studies on synthetic test systems
- Started work on temporal decomposition of unit commitment



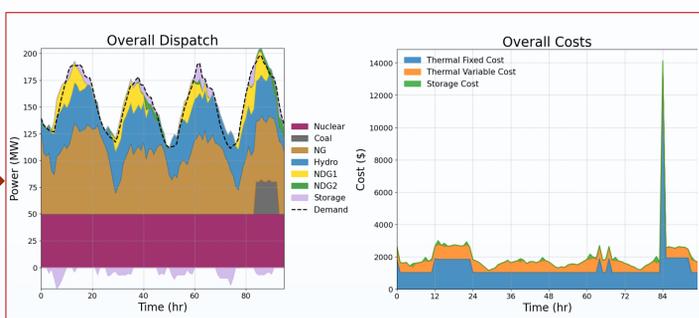
Overview of the tool

- Input Data Manager:** Transforms user-provided .csv files into EGRET .json files
- ESS Interface:** Formulates pyomo models of ESS and interfaces them with EGRET
- Market Interface:** Performs sequential SCUC and SCED using EGRET
- Output Data Manager:** Transforms EGRET ModelData into csv files and plots

ESS Modeling Capabilities

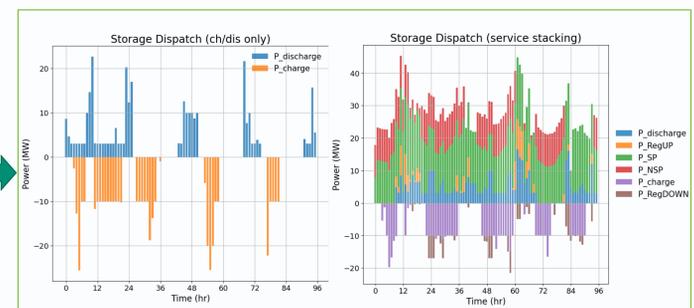
Modeling the impacts of ESS integration

- Impact of ESS charging and discharging on the scheduling of thermal and non-dispatchable generators (NDGs).
- Impacts of ESS operation in system production costs



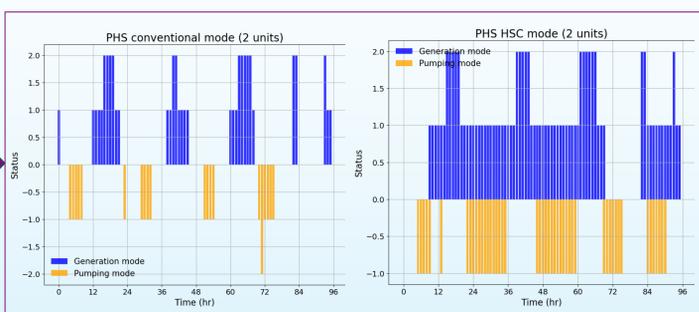
ESS market participation models:

- Participation in energy, regulation, and reserve markets
- ESS revenue, ancillary service SoC constraints, end-of-horizon SoC management



Technology-specific ESS operations models

- Battery ESS:** Chemistry-specific battery degradation, cycling constraints
- Pumped hydro storage:** Water flow constraints, Generator and pump constraints, hydraulic short circuit mode



Next Steps

- Incorporate battery ESS degradation models with the market interface and integrate additional ESS models
- Develop the complete backend code for the tool
- Perform case studies to analyze the impact of detailed ESS modeling on system operations and publish findings in a conference paper
- Design and implement a graphical user interface (GUI) for the tool
- Benchmark performance against existing open-source PCM tools
- Package and release the tool as part of QuEST 3.0

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