MASCORE: A Web-Based Tool for Microgrid Asset Sizing Considering Cost and Resilience

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ENERGY STORAGE PROGRAM

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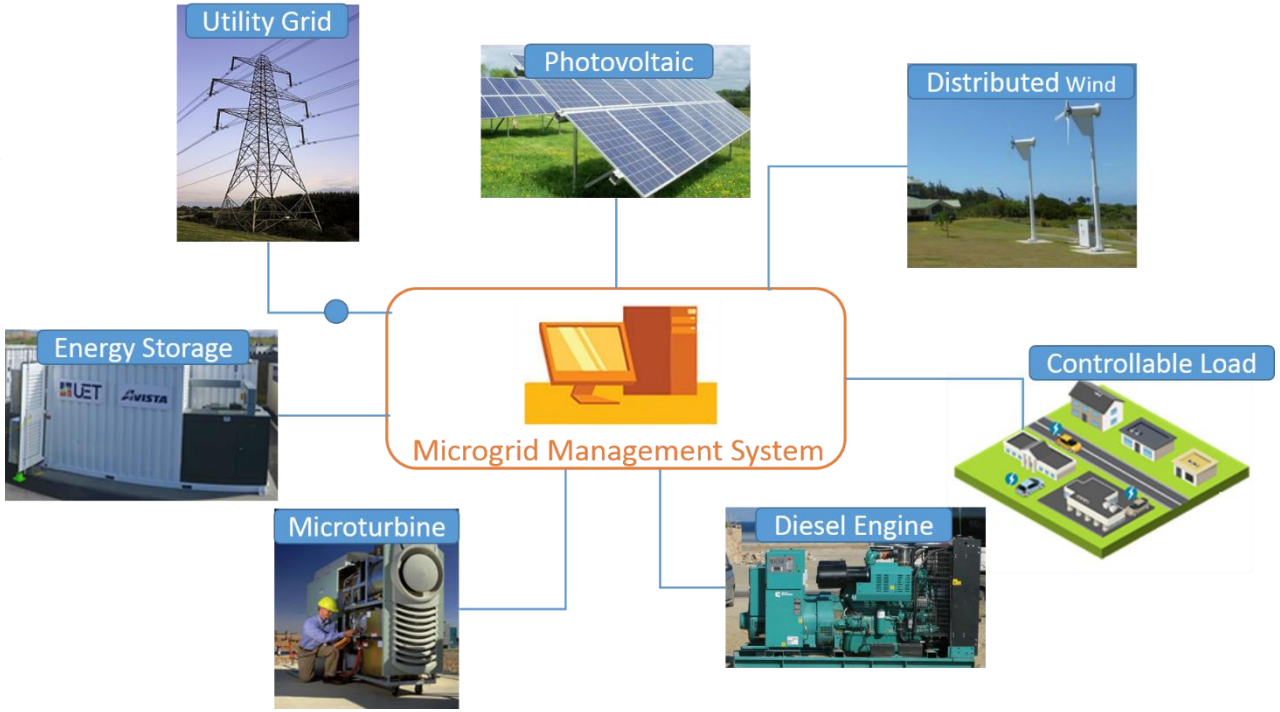
Project Overview

- This project develops methods and tools that allow energy managers for large industrial and institutional customers to select, size, and operate distributed energy resources (DERs) to enhance both the ***resilience*** and ***economic*** performance of their systems.

- The developed ***modeling and analytical*** methods and tools directly contribute to
  - ***Electric grid modernization and resiliency of energy infrastructure***
  - ***A resilient, reliable, and flexible electricity system***



Project Progress and Status

FY19

- Reviewed existing methods for evaluation and sizing of microgrid assets
- Developed evaluation and sizing methods
- Created a prototype of MASCORE

FY20

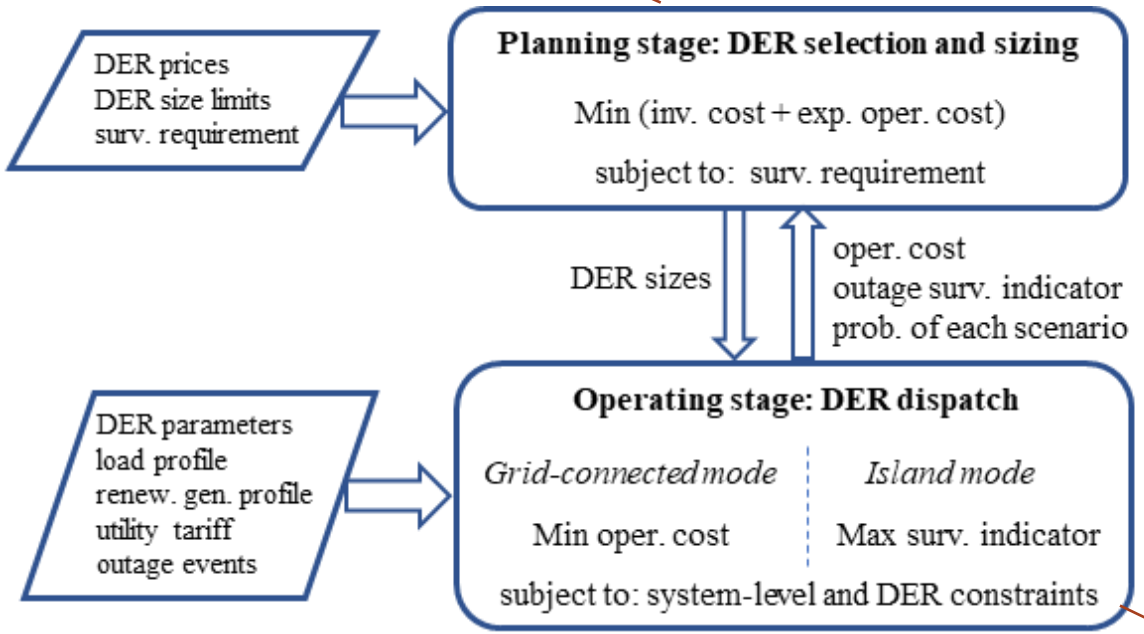
- Enhanced the stochastic evaluation and sizing methods
  - Additional models/constraints and increased flexibility
  - Two peer-reviewed journal articles published
- Completed MASCORE development and its integration into a web-based platform
  - Modular generic architecture with a configurable environment for front-end, engine, and database
  - Accessible at http://eset.pnnl.gov/
- Performed evaluation analysis for three microgrid systems in MA, HI, FL

Key Features

- Incorporation of both economic and resilience performance into the DER evaluation and sizing
- Modeling various DER technologies with different economic and technical characteristics
- Simultaneously determining the optimal sizes of different DERs
- Explicit optimal sizing formulation instead of the enumeration method that visits a limited number of combinations
- Modeling and capturing diversified system conditions in both grid-connected and islanding modes
- Capturing the interdependency between optimal size and dispatch

Two-stage Stochastic Sizing Formulation

Max Survivability
s.t.: budget constraint



A finite number of realizations (scenarios)

Deterministic equivalent

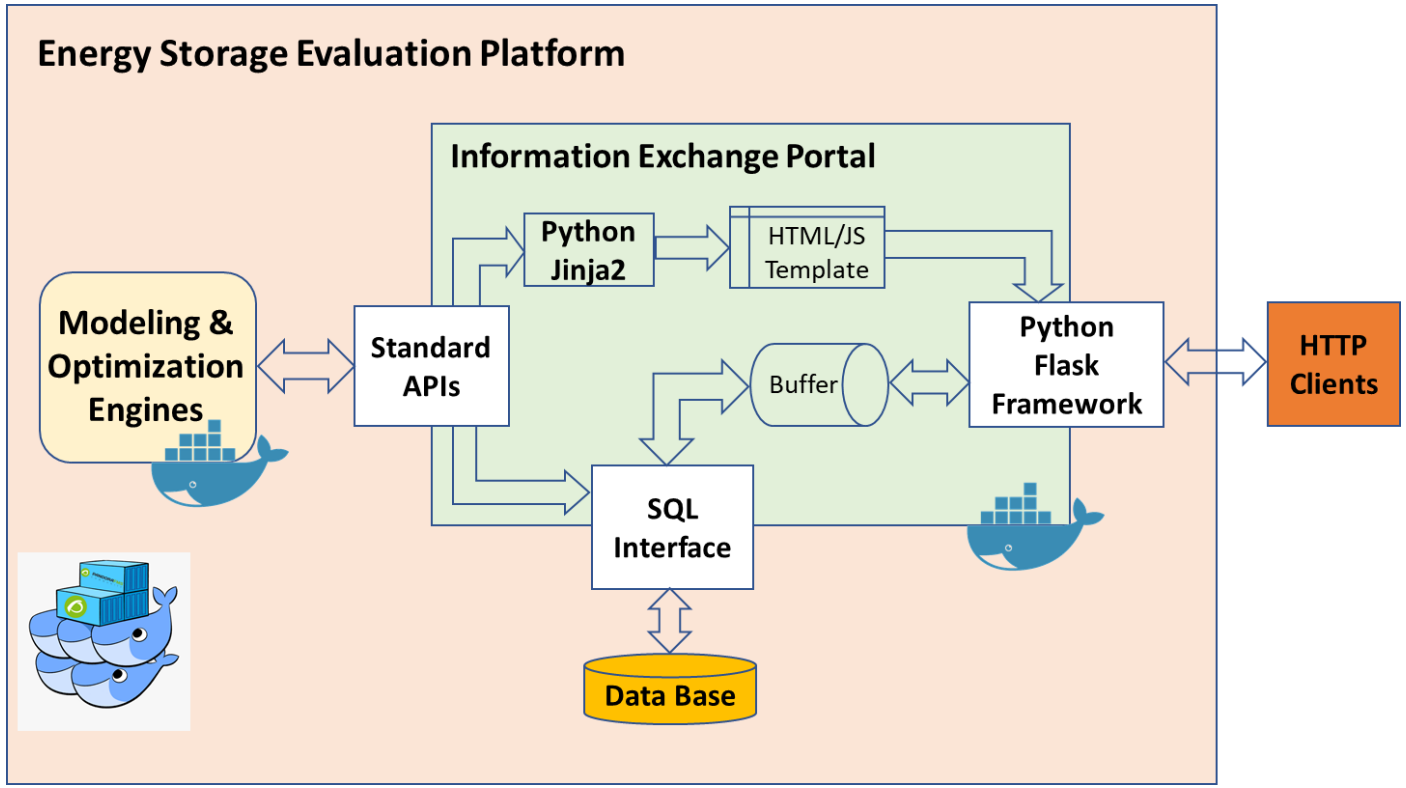
Probability distribution for uncertain parameters

- Additional models/constraints
  - Power adequacy and intra-hour variability in island mode
  - Rules on power exporting in grid-connected mode
- Increased flexibility
  - Optional DG operation in grid-connect
  - Critical vs noncritical load

D. Wu, X. Ma, S. Huang, T. Fu, and P. Balducci, “Stochastic optimal sizing of distributed energy resources for a cost-effective and resilient microgrid,” *Energy*, vol. 198, May 2020, 117284

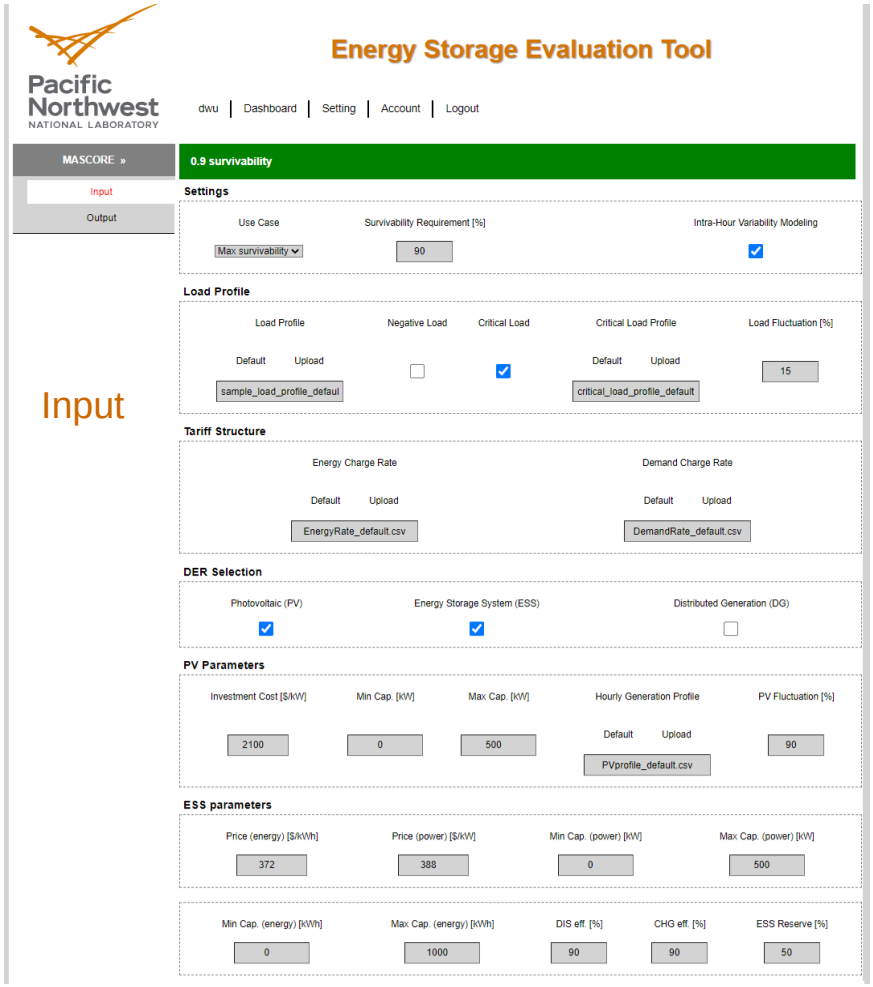
Software Architecture

- The modular structure facilitates maintenance and expansion
- The encapsulated environment with Docker eliminates the need for customized settings
- The separation of data and applications improves data security
- The dynamic GUI provides an interactive interface for easy configuration and settings

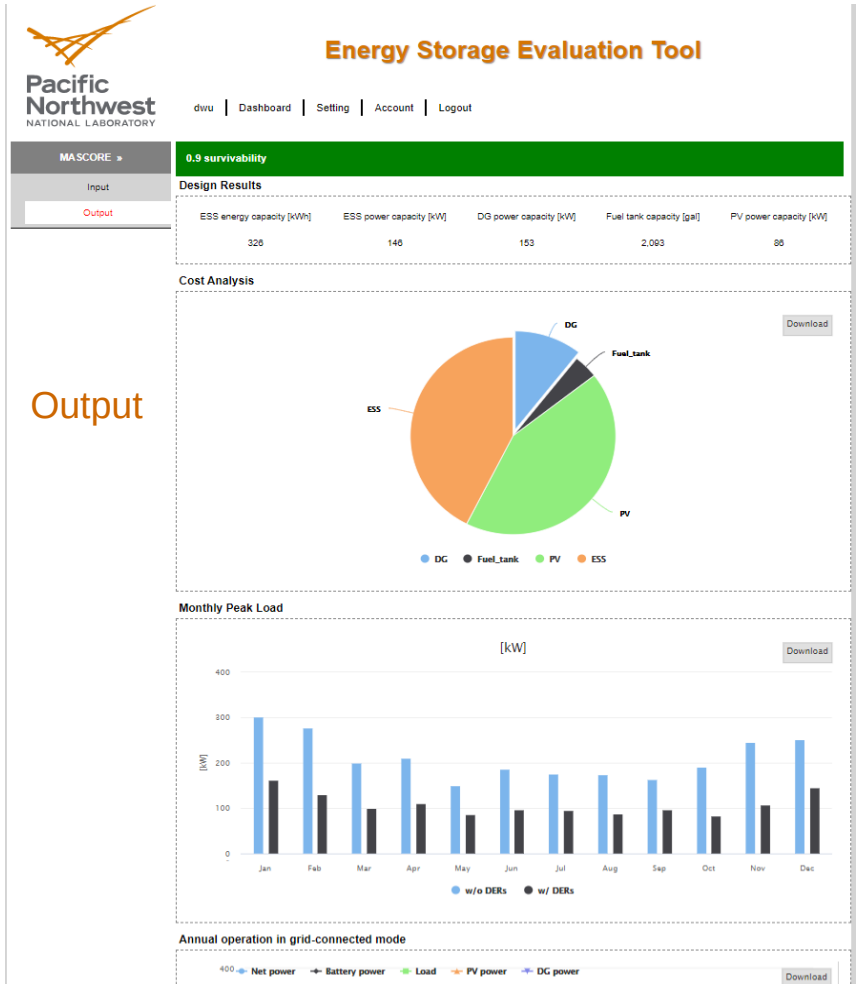


MASCORE User-Friendly Interface

Input



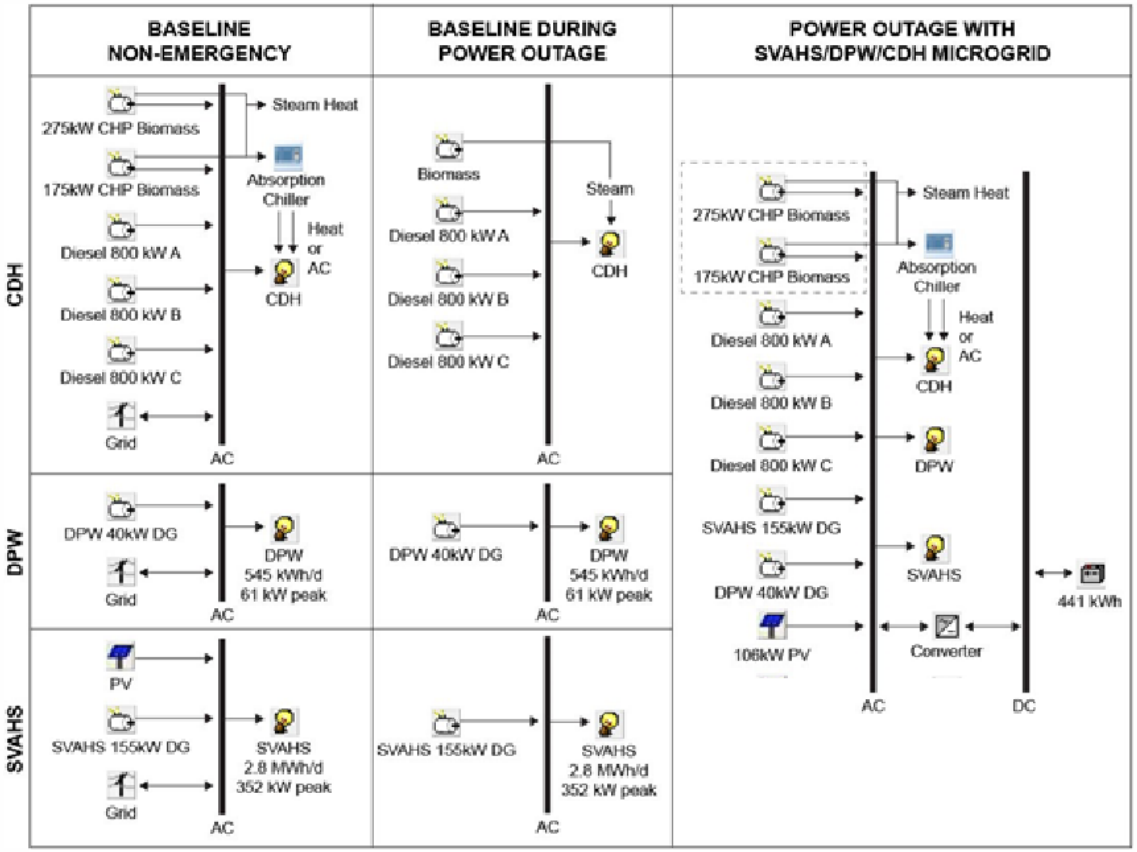
Output



Accessible at: https://eset.pnnl.gov/

Evaluation of a Microgrid in Northampton, MA

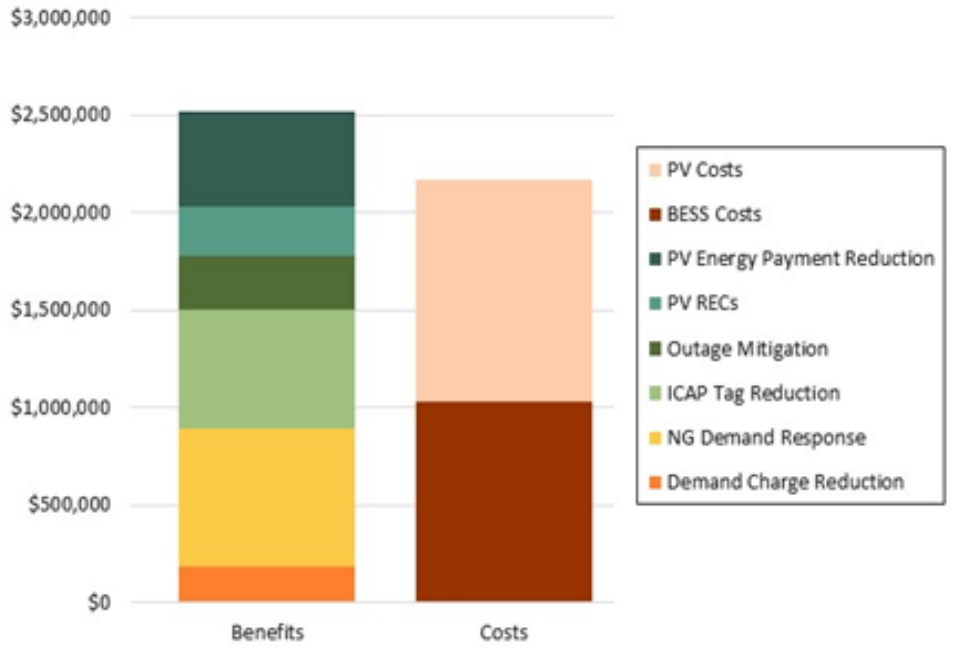
- Economic
  - Demand charge reduction
  - Demand response program participation
  - ISO-NE installed capacity tag reduction
  - Energy purchase reduction
  - PV renewable energy credits
- Resilience
  - Outage duration: 3, 7, and 14 days
  - Season: summer vs. winter
  - System connectedness: separation, limited power-sharing, and full power-sharing
  - DG failure: fail to start, load, and run



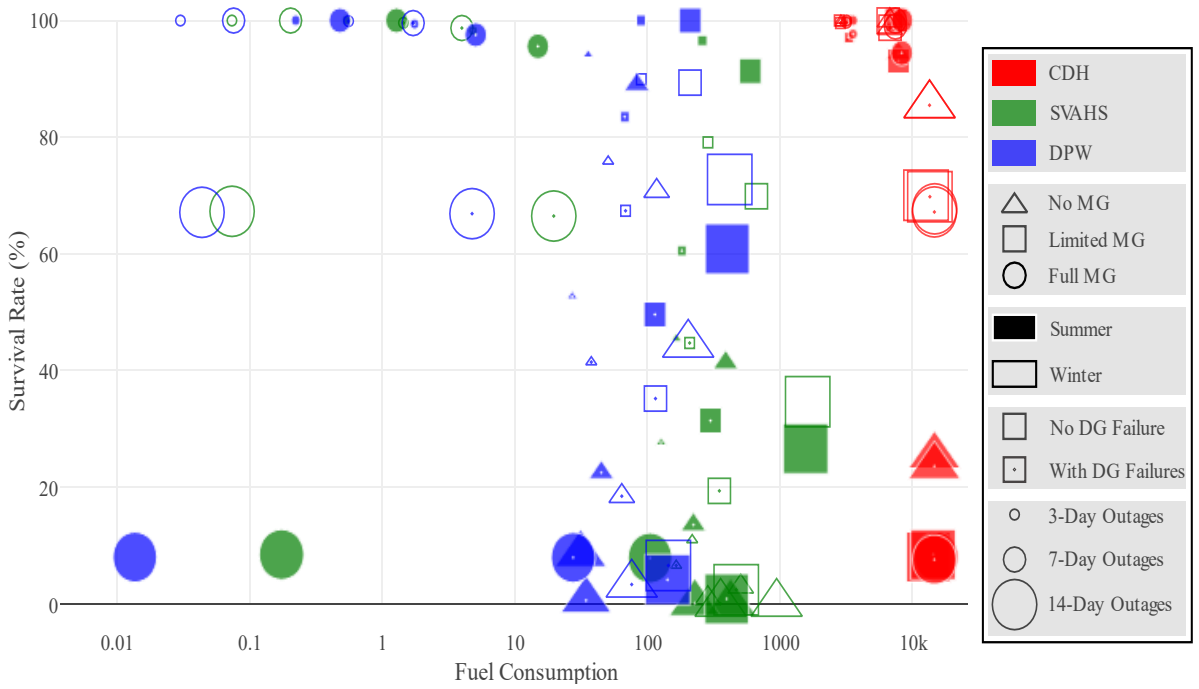
New DERs: 386 PV + 441 kW/441 kWh BESS at CDH

Evaluation of a Microgrid in Northampton, MA (cont.)

$2.5 million present value benefits (1.16 ROI)



Survivability and fuel consumption (with new DERs)



P. Balducci, K. Mongird, D. Wu, D. Wang, V. Fotedar, and R. Dahowski, “An evaluation of the economic and resilience benefits of a microgrid in Northampton, Massachusetts,” *Energies*, vol. 13, September 2020, 4802.

Looking Forward

- Complete the user's guide
- Maintain and update the tool based on users' feedback
- Continue to use the tool to support microgrid evaluation analysis
- Integrate new models developed in microgrid evaluation studies

Acknowledgment

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Mission – to ensure a resilient, reliable, and flexible electricity system through research, partnerships, facilitation, modeling and analytics, and emergency preparedness.

https://www.energy.gov/oe/activities/technology-development/energy-storage

Q/A and Further Information

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