EATON – GROUP 8

DER OPTIMIZATION

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OBJECTIVE

This project, sponsored by Eaton, focuses on developing a DER Optimization Algorithm that dynamically analyzes user-defined variables and system requirements to recommend optimal configurations. The goal is to improve energy efficiency and grid resilience in energy-intensive settings like manufacturing plants, while supporting Eaton's broader objective of minimizing environmental impact and expanding access to sustainable power solutions across applicable industries. [3]

This DER optimization program uses data from NREL's PVWatts API for solar potential, NASA POWER for wind data, and LocationIQ for geolocation services. These APIs provide essential inputs like irradiance, temperature, and coordinates to support accurate renewable energy system modeling.

CONTEXT
Eaton provides power management across multiple industries in 75 + countries

REASON
Traditional centralized energy models are outdated; rising electricity demand requires new solutions

NEED
Sustainable energy infrastructure is essential to meet future energy demands

Minimize overall environmental impact

WHO
Industries and consumers will gain access to energy solutions

CUSTOMER PROBLEM AND BACKGROUND

About Eaton:

- Global power management company operating in over 75 countries.
- Serves industrial, commercial, and utility sectors.
- Committed to advancing next-generation energy solutions as demand and sustainability needs grow.
- Actively explores Distributed Energy Resources (DERs) like solar, wind, and battery systems.
- Aims to help customers:
  - Optimize energy use
  - Reduce environmental impact
  - Meet future demand with scalable, sustainable technologies

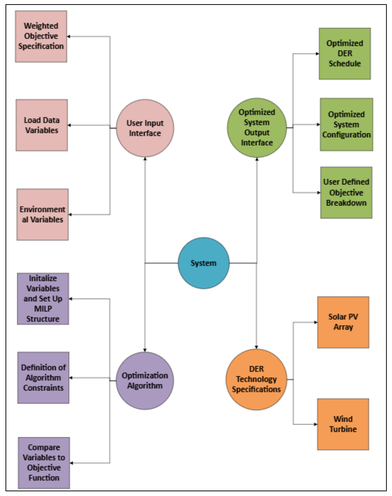
CONCEPTS AND EXPERIMENTATION

The DER Optimization project started with a sketch of what everyone on the team knew about DERs and grew into a software program with mainstream capabilities. The concepts brought below were critical in designing the final product below:

- Preliminary GUI Sketch
- Cad GUI Sketch
- Optimization Algorithm Flowchart
- System Decomposition

Experimentation played a huge role in this project, with many different program designs being incorporated into a combined module. The following stages of experimentation were used to produce the final program design:

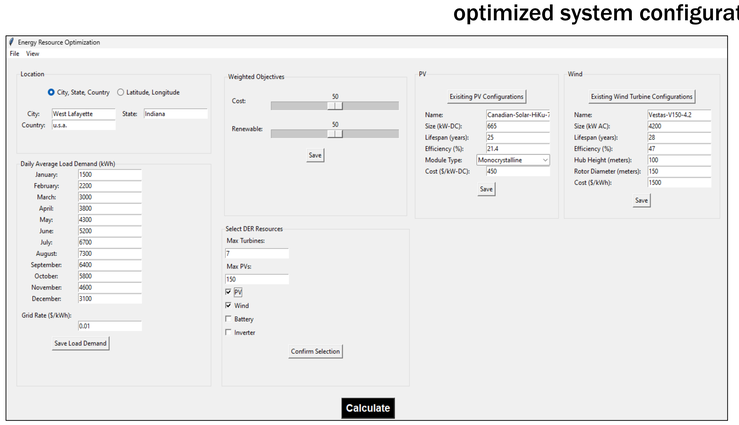
- Preliminary API Environmental Data Program
- Power Calculations For DERs
- Stand Alone Optimization Function [1]
- Merged Final Program



System Decomposition

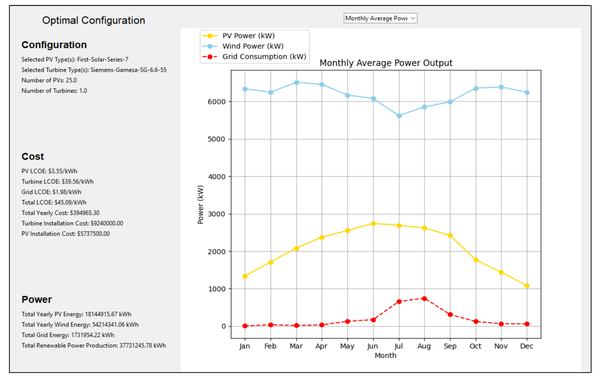
REQUIREMENTS AND FINAL DESIGN

- Meets key functional requirements essential for real-world energy planning [2]
- Capable of optimizing any DER system, in any area of the world through global environmental databases
- Supports weighted objectives, allowing users to prioritize between cost savings and efficiency
- Features configurable PV and wind turbine parameters, enabling tailored system setups based on specific user needs
- Allows input of load demand profiles and location data, returns site-specific renewable resource availability
- Returns annual hourly power data and optimized system configuration results



Final GUI Design

TESTING RESULTS



CONCLUSION AND RECOMMENDATIONS

Key Highlights:

- Shows how optimization helps design cost-effective, renewable-friendly DER systems.
- Uses hourly solar and wind data to explore cost vs. environmental trade-offs. [4]

Recommended Improvements:

- **Add batteries and inverters** for energy storage and better grid control.
- **Make it a standalone app** for easier use by engineers, policymakers, and non-programmers.
- **Include power quality features** like voltage and frequency control to ensure grid stability.

REFERENCES

[1] "MIP Solvers," Gurobi Optimization. Accessed: Nov. 15, 2024. [Online]. Available: https://www.gurobi.com/faqs/mip-solvers/

[2] K. Twaisan and N. Barışçı, "Integrated Distributed Energy Resources (DER) and Microgrids: Modeling and Optimization of DERs," *Electronics*, vol. 11, no. 18, Art. no. 18, Jan. 2022, doi: 10.3390/electronics11182816.

[3] "Benefits of Distributed Energy Resources: Shifting the Energy Landscape - IEEE Blockchain Technical Community." Accessed: Oct. 17, 2024. [Online]. Available: https://blockchain.ieee.org/verticals/transactive-energy/topics/benefits-of-distributed-energy-resources-shifting-the-energy-landscape

[4] A. Omu, R. Choudhary, and A. Boies, "Distributed energy resource system optimisation using mixed integer linear programming," *Energy Policy*, vol. 61, pp. 249–266, Oct. 2013, doi: 10.1016/j.enpol.2013.05.009.