Renewable Energy Integration Tool

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Introduction

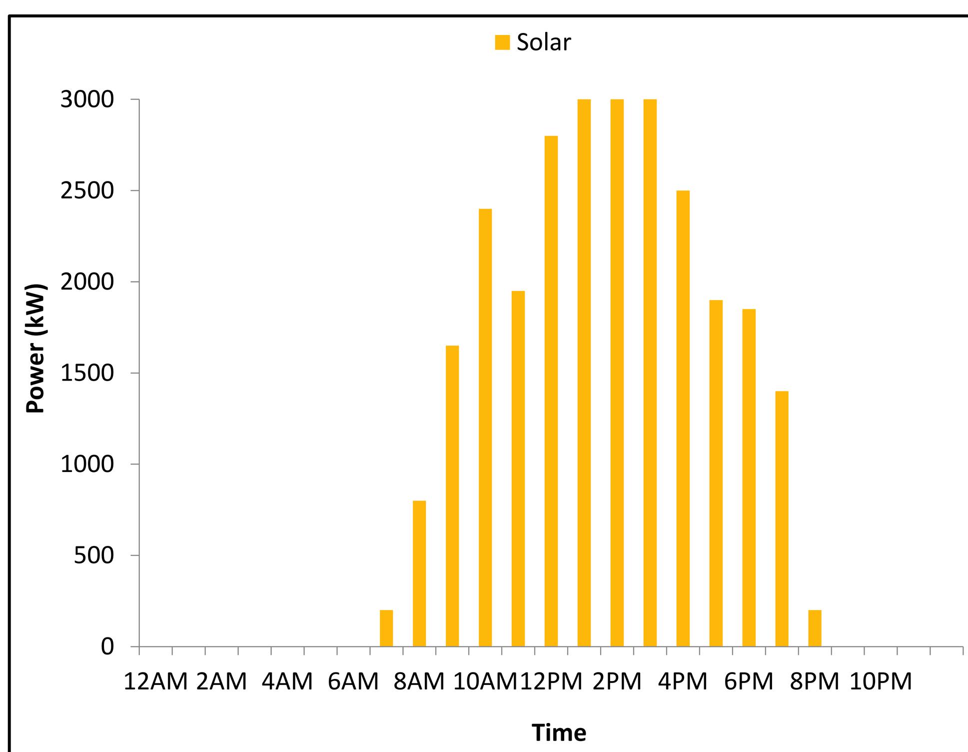
The Navy relies heavily on fossil fuels to power its operations which poses a threat to its energy security. Therefore, the Navy has a mandate to increase its consumption of renewable energy. However, the variable nature of renewable energy creates a challenge to the Navy's needs for continuous operation and mission success. Additionally, interconnect agreement requirements restrict feeding excess energy back into the grid. A feasible solution to the problem "How much renewable energy can the Navy add to their existing grid without a loss in reliability or compromising mission success without further engineering?" was needed. We researched academic journals, interviewed multiple experts in the field, and conducted in-depth field studies. With this knowledge we developed a tool that determines the specific amount of each renewable energy resource that you can add to any electrical grid depending on multiple factors – such as location, weather, and rate of consumption – without requiring further engineering. This tool is a first step towards maximizing the Navy's renewable energy integration and reducing their dependence on fossil fuels.

Methods

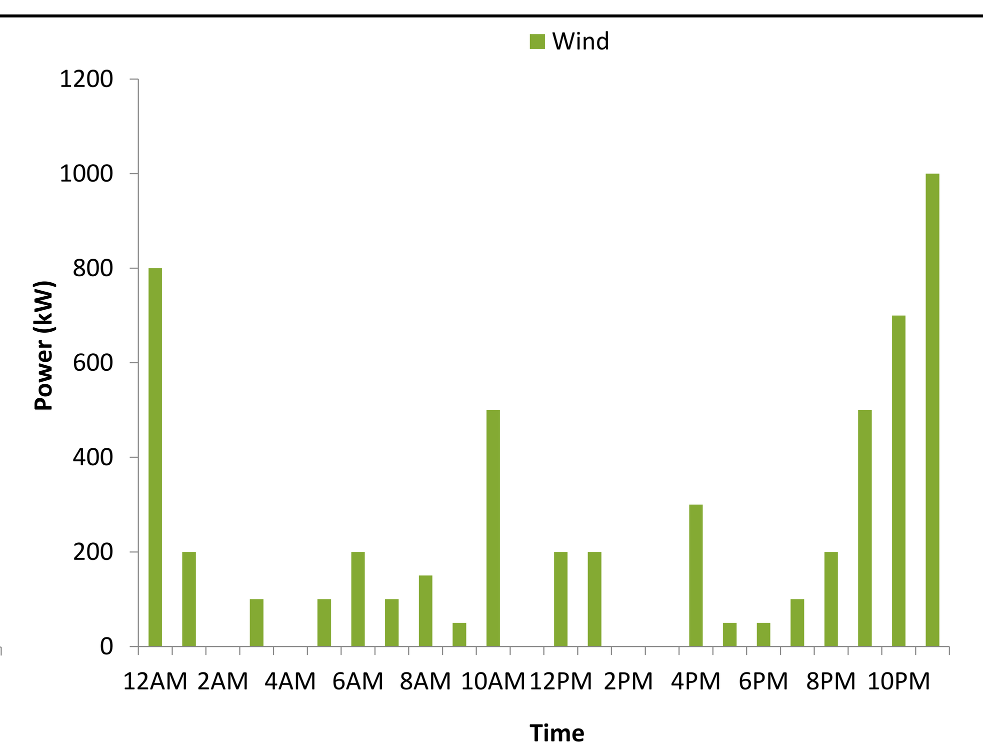
Research:
Interviewed various experts in the fields of renewable energy and power distribution. Conducted on site field studies to evaluate current grid situation on various naval bases.

Development:
Created a flow chart to prioritize the different factors that affect renewable energy penetration.

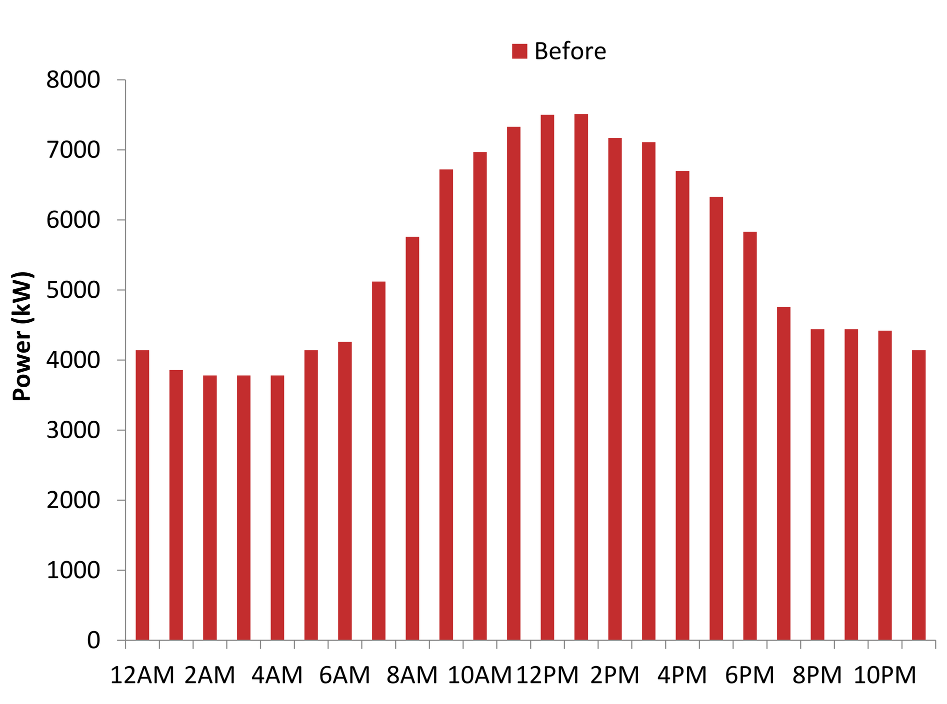
Testing & Evaluating:
Ran multiple simulations in different scenarios to test how the model compares to current and historical data.



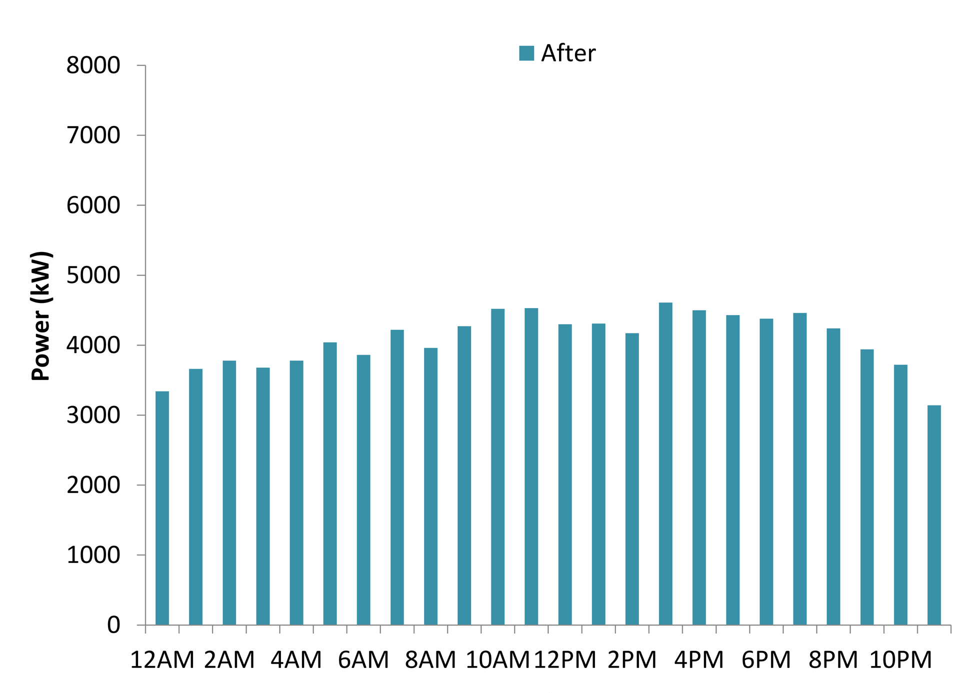
Solar power generation of a 3MW system over 24 hours



Wind power generation of a 1MW system over 24 hours



Load profile over 24 hours *before* adding renewable energy



Load profile over 24 hours *after* adding renewable energy

Analysis

Constraints:
- Interconnect agreement requirements
- Over & under generation
- Power quality: power factor; frequency; harmonics; transients
- Availability of renewable energy generation

Solutions:
- Controls systems
- Energy storage

Results

- Developed a tool that works within the given constraints to determine the optimal amounts of different renewable energy resources based on location, time, and efficiency.
- By adding renewable energy the base and peak loads were significantly reduced.
- Reduces the Navy's $10 million/day energy bill

Discussion

Positive: In order to increase the Navy's energy security the model contributes to the increase of renewable energy penetration which in turn reduced the reliance on fossil fuels. The model also contributes to reducing the Navy's energy demand and brings them closer to their goal of producing 1 GW of renewable energy by 2025.
As the Navy becomes independent of the commercial grid, the cyber security risks decrease, and the need to transport fuel which is both expensive and dangerous, becomes obsolete.
Negative: Due to the complexity of each individual system we are limited to how much renewable energy we can add. Our model is only a short term solution to a larger problem to be addressed by conducting individual grid analyses.
Conclusion: Based on our research and experiments, we found that 15% of the instantaneous load is the ideal amount of renewable energy that can be added to any grid without the need for further engineering.
Next steps: Demand response, energy storage, controls systems, renewable energy culture, power quality.

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