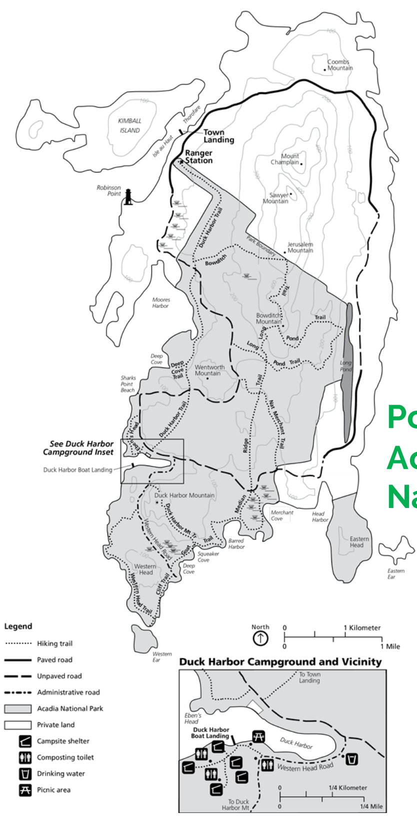
Isle au Haut Microgrid

Power for Isle au Haut (IaH), Maine is supplied by an aging seven-mile undersea cable. Anticipating cable failure, the local power company assessed many alternatives and concluded that migrating to a near-total reliance on solar is by far their best option. Peak electricity demand occurs in the summer when the island's population is largest. A solar project designed to match this seasonal pattern will generate excess power in the winter. Key aspects of the project call for the installation of active load demand management, air-to-water heat pumps, and thermal storage to use excess solar production at optimal times to make a microgrid that meets 100% of the island's needs feasible.



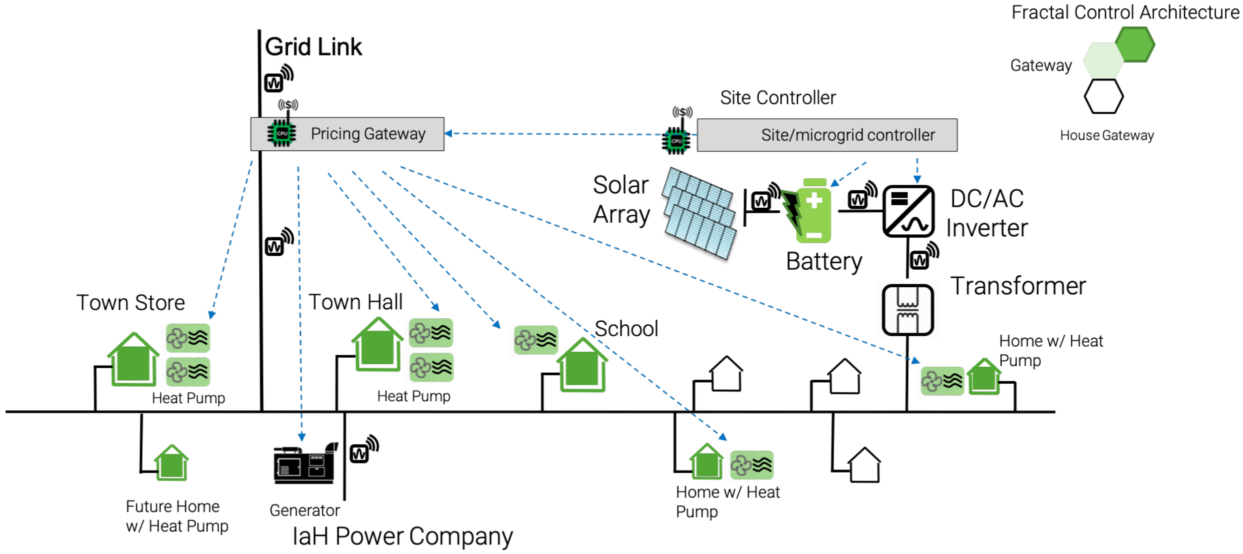
Portions of Acadia National Park

A traditional electrical grid is an on-demand system where generation output must follow load. Loads are uncontrolled; as demand rises, generation needs to keep up. As distributed energy resources, (primarily intermittent solar and wind) increase, the predictability of this generation is reduced, making load following even more difficult. To help address this, utility companies are implementing more aggressive demand-side management strategies to curtail load. However, these strategies often fall short when variable, intermittent renewable generation is a high percentage of the overall supply. Simple time-of-use strategies for commercial customers do not meet the needs of this new dynamic grid with distributed energy resources.

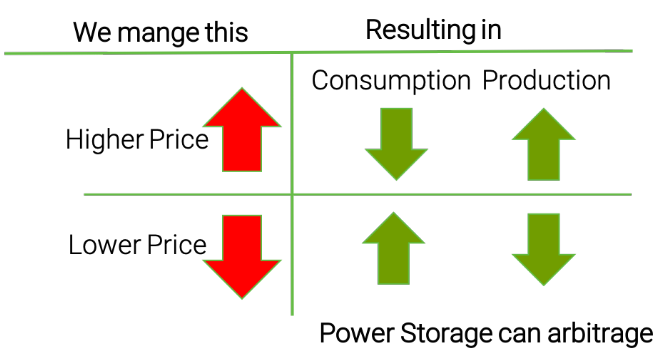
Transactive Energy

Transactive Energy:
Energy controls using market-based methods for managing supply and demand in the electric power systems.

Our unique method uses a distribution level real-time pricing signal capable of balancing distributed energy resources by applying real-time control of heat pumps and cost-effective energy storage. Introspective Systems, with renewable energy, building control systems integration, and energy efficiency experience - is currently using this method to design a community-scaled microgrid development as a non-transmission alternative for IaH. This is being done with the close collaboration of the Isle au Haut Electric Power Company and the island community. As has been shown in other non-transmission alternative projects, with the introduction of passive distributed energy resources and demand-side management, the peak demand hours occur later in the evening rather than at peak solar production times, making PV installations less effective. With the real-time control of space heating air-to-water heat pumps and cost-effective thermal energy storage, these negatives can be mitigated.



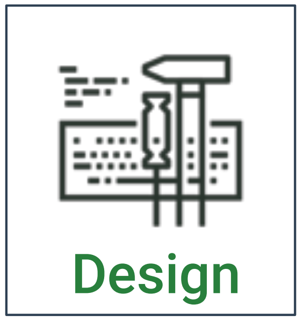
The IaH microgrid uses real-time pricing signals and controls to turn heating loads into flexible (active) demand resources that **respond to changes in the abundance or scarcity of power**. This integrated solution uses Air to Water heat pumps with thermal storage and machine learning algorithms allowing the heat pumps to respond adaptably, to a real-time distributional locational marginal pricing signal, thereby enabling the load to follow renewable generation. When solar and wind production is high, the heat pumps “soak” up the extra renewable energy by heating thermal storage tanks located within the buildings, **reducing the necessary electrochemical storage capacity** of the microgrid. This load shifting **provides heat to homes beyond the solar production period**, generates significant reductions for subscriber energy costs, and retains within the local community income that would otherwise be exported for the purchase of fossil fuels.



Beyond providing a cost-effective storage solution to the community microgrid, the value proposition of load-shifting and flexible demand response is applicable to the entire grid both in larger scale projects and smaller scale projects.

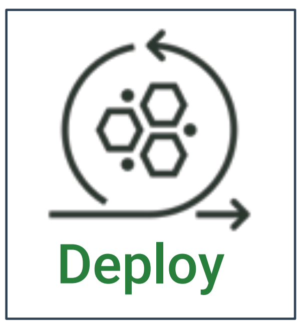
The Process

Introspective Systems used its experience in modeling and simulation with a unique optimization engine powered by artificial intelligence algorithms to model not only the financial performance of the project but also the financial performance over the entire lifetime of the assets being deployed.



Hardware database and modeling environment

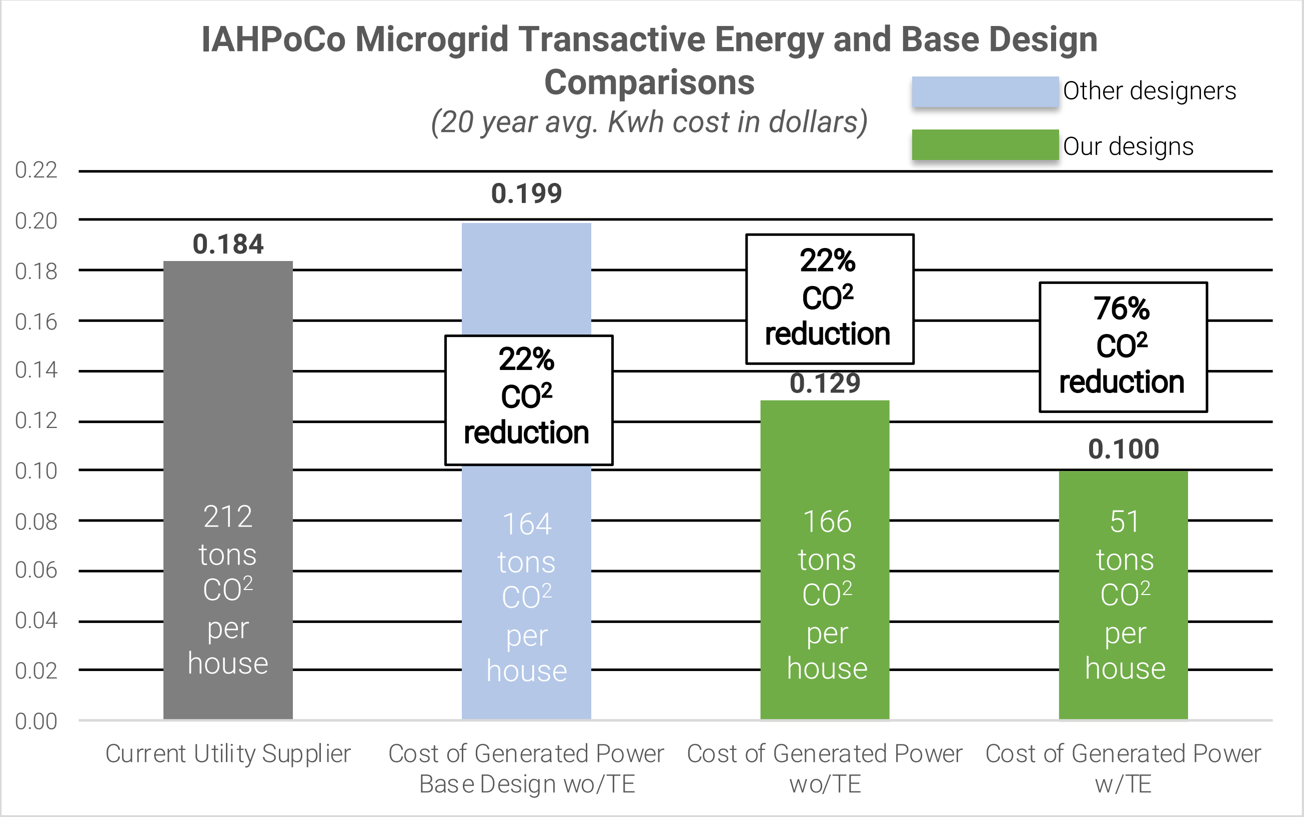
Multivariate simulation optimizes hardware



Transactive Energy hardware/software creates collaborative system

Using detailed models of a range of equipment that can be installed into a microgrid, Introspective Systems uses AI algorithms to explore the entire range of possible configurations. This exploration optimizes the project to make it the most cost-effective in both capital expense and operating expense by lowering the cost of power to the consumer.

The Results



When Introspective System's transactive energy controls are added to the microgrid, further increases in energy efficiency, renewable energy utilization, and peak shaving can be achieved. In certain applications, like on IaH, significant additional carbon dioxide reductions can be achieved by offsetting fossil fuel space-heating with renewable power that would otherwise be curtailed in typical microgrids with very high renewable penetration (microgrids aiming for above 70% renewable generation).

The IaH microgrid is expected to **stabilize the prices** consumers pay to much below the rate of inflation over the next 20 years while maintaining significant financial reserves for equipment replacement in the future.

The full design, over a 20-year time horizon, will see a reduction of over 8 cents per kWh in the delivered price of power to the community. Additionally, the system saw a **76% reduction in carbon emissions** for the typical building that implements the A2W heat-pumps. Other projects with different active loads can see similar improvements.