Research Briefing: Cost of unintended consequences when shifting generation sources

Changing the source of power generation in islanded microgrids can have unintended consequences that often are overlooked, and frequently are ignored when economic models and engineering designs are developed. This leads to perceived underperformance of assets within the power generation and distribution system.

Problem Description

When novel generation sources are integrated into an existing islanded microgrid, often only electrical engineering considerations are taken into account when estimating overall anticipated system performance. Potential issues with integration of controls, upgrades to dispatch schemes, and loss of ancillary services are not fully evaluated. In part, this is a direct effect of ‘stove piping’ of design subtasks, but other times, inconvenient truths are either ignored, or sufficient data for a reasonable assessment of consequences does not exist.

When renewable power sources are integrated into a diesel-based islanded microgrid, there are several main effects that need to be regarded, and fully understood. Existing diesel generators were sized to meet the demand without another generation source being available. With that source feeding power to the grid, diesels then often operate at fairly low loading, which is detrimental to their efficiency. A byproduct of diesel power generation is low-temperature waste heat, which, at least in cold climates is a commodity. The amount of waste heat available is, at first order, directly proportional to the amount of power generated by said diesel. Thus, addition of other generation sources may reduce the amount of available waste heat to the point where other means have to be deployed to generate heat, e.g., for heating city water supplies to prevent distribution pipes from freezing. Furthermore, most manufacturers do not recommend low-load operation of diesel generators as it immediately may be detrimental to exhaust treatment systems, and, if sustained, may damage components of the engine with risk of catastrophic failures.

When sufficient renewable resources are available at times to operate without diesel generators online an additional consequence often not considered is that at this point heating of the diesel cooling system is required in order to be able to quickly start generators in contingency cases (drop of renewable power, or faults of the electrical system).

Research Needs

Unintended consequences can significantly impact economic and technical efficiency of islanded microgrids. For comprehensive design considerations to be improved the following research is necessary:

- Development of a comprehensive catalog of impacts stemming from addition of new generation and auxiliary equipment into an existing islanded microgrid. This should include cost functions, and suggestions for mitigation. An understanding of true cost of equipment integration is also required, i.e., not just the cost of the new equipment installation, but also retrofits and upgrades to control and hardware infrastructure to operate the entire system at maximum efficiency with the new equipment in the mix.