SUNDIAL – INTEGRATING PV AND STORAGE SYSTEMS

1 *Integration of Grid-Scale Energy Storage with Solar PV on the National Grid distribution system*

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Overview

As PV penetration increases, it becomes critical to develop technologies and methods that enable increased integration among generation, loads, and forecasting technologies. To address this challenge, the Fraunhofer Center for Sustainable Energy Systems (CSE) has developed SunDial, an integrated system of solar photovoltaics (PV), energy storage, and facility load management that can be used to cost-effectively "shape" the net load on a distribution feeder, enabling hosting capacities in excess of 100% of peak load. This project focuses specifically on exploring how dynamically shifting loads of aggregated Commercial and Industrial (C&I) facilities can supplement conventional battery-based energy storage.

The SunDial Project is a 3-year, $7.5M project funded by the Department of Energy's Solar Energy Technologies Office's (SETO) Sustainable and Holistic Integration of Energy Storage and Solar PV (SHINES) program. Fraunhofer has partnered with National Grid and IPKeys to test this technology on the National Grid distribution system in Massachusetts.

Project Objectives

- **Develop a New Framework to Enable Cost-Effective, Dispatchable Solar Power**: This project will quantify technical potential of demand-side management to limit the quantity of energy storage needed, and develop the underlying forecasting, communications, and controls algorithms needed to realize this vision.

- **Test Markets and Business Models that will Support High Solar Penetration of Solar**: As power generation becomes increasingly distributed, a new class of services will be needed to capture the locational value of electricity. For example, the SunDial system will be used to exchange load-shaping services within local distribution grids.

- **Derive Lessons Learned through Real-World Deployment**: Our 12-month demonstration on the National Grid distribution system with a portfolio of C&I Customers will offer valuable insight into the limitations of demand-side load shaping.

Description

The SunDial system shapes the net load on a distribution feeder by optimally controlling distributed generation, grid-connected energy storage, and one or more aggregated pools of demand-side assets (e.g., C&I customers with shiftable loads or residential smart devices) to achieve user-defined objectives.

By decoupling demand-side aggregation and control from the overall system-level control objective, the SunDial system enables load aggregators to offer distribution-scale "load shaping" services to utilities or plant operators that can supplement traditional battery-based energy storage. The demo of the SunDial system also explores the degree to which demand-management can be used to reliably shift load on a multi-hour time horizon to coincide with peak generation or other contingency events.

Modeling results indicate that tightly integrating demand side resources can reduce the size of energy storage by 10-20% for a typical scenario or reduce cycling on a storage system by 10-20%. Field testing in 2018-2019 will test these results over a range of use cases and deployment scenarios.
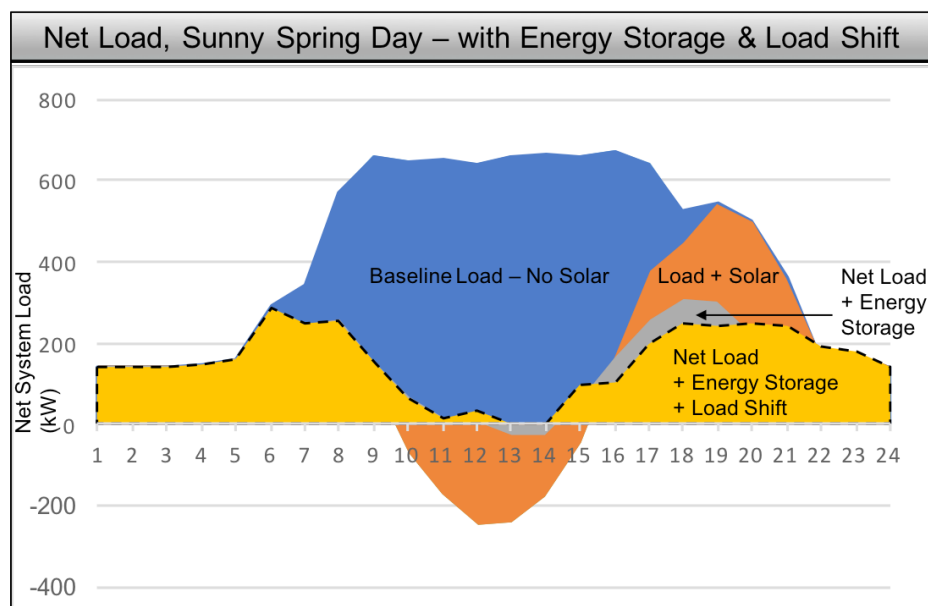
Tools & Methods

- Open-source control optimization platform is developed on PNNL's VOLTTRON toolset

- Facility Load Management uses state-of-the-art techniques to predict baseline loads and load-shift potentials for a 24-hour time horizon

- Optimal dispatch techniques based on a simulated annealing approach

- Open standards, including OpenADR & SunSpec, enable integration of decoupled resources

Future Work

Fraunhofer CSE has teamed with National Grid and IPKeys to demonstrate the SunDial system on the National Grid distribution system in Shirley, MA. The system has been developed and will be deployed in Q2 2018, and tested over a variety of use cases 2018-2019 to evaluate performance. The demonstration system will incorporate a 1MWh Tesla energy storage system, 1.5MW of utility-owned solar, and 1.5+MW of aggregated C&I loads.

2 *1MWh Tesla Battery at Shirley, MA solar PV site.*

3 *Shirley site's plant-level control and SCADA system*

Net Load, Sunny Spring Day – with Energy Storage & Load Shift

Baseline Load – No Solar

Load + Solar

Net Load + Energy Storage

Net Load + Energy Storage + Load Shift

A combination of forecasting, energy storage, and load management enable SunDial to decrease peak load by more than 50% relative to the baseline.