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Managing and Integrating Distributed Energy Resources Into the Grid

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INTRODUCTION

Installation and operating costs of inverter-based distributed energy resources (DERs) continue to decline. In many cases, these resources are making renewable energy solutions cost-competitive with traditional forms of electric power generation. Photovoltaic (PV) and battery are two inverter-based resources trending toward lower costs. These DERs offer unique technical and economic opportunities to optimize electric power delivery.

USE CASES

To take full advantage of these systems and to provide the maximum benefit to owners, operators, and the grid, the inverter-based DERs need accurate and reliable control. With appropriate control schemes, many use cases can be optimized by: 1) implementing inverters that connect to the grid, 2) supplementing local energy demands, 3) maximizing energy export, and 4) providing services to reduce the operating costs of local loads for industrial or utility users. Storage and battery assets offer an opportunity to meet various use cases, such as reducing peak demand, which reduces demand charge and enhances reliability schemes; however, to effectively utilize storage, assets typically need integration to be managed with other power system assets and DERs behind the point of common coupling (PCC). A controller that manages and coordinates with other resources allows optimization of use case and dynamic switching between operating modes. State of charge management, time-shifted generation, and peak demand reduction are a few applications with batteries that require a controller between multiple DERs.

Figure 1 Real-Time Automation Controller (RTAC) for DER Management

SEL SOLUTION

SEL developed an off-the-shelf control system that helps owners of renewable energy installations meet utility and regulatory interconnection requirements. SEL Grid Connect is an add-on feature available for the SEL Real-Time Automation Controller (RTAC) family. It is designed to simplify interconnection control and solve common interconnection issues, such as adapting for varying cloud cover, nonresponsive inverter controls, and unexpected voltage excursions. This control system contains pre-engineered function blocks for controlling the PCC between the utility grid and a power generation source. Using SEL's pre-engineered control system library helps get renewable projects online quicker and with reduced cost.

Grid Connect can be configured directly by end users or purchased with services from SEL Engineering Services.

Coordinate DER With Load Behind the Meter for Peak Demand Reduction and Solar Smoothing

DERs may be paired with load behind the meter to help reduce energy bills or sell energy back to the utility when load is minimal. When a DER is paired with load behind the meter, there are usually several fluctuating conditions that need to be balanced, including the load itself and the amount of energy that the DER is able to produce, depending on the current environmental conditions. Based on the use case, the PCC operates within a defined range set by the user-configured parameters in Grid Connect. In this operating mode, when the PCC meter detects power flow exceeding the maximum allowable export, Grid Connect automatically curtails inverter production to account for the maximum allowable output and consumed energy via the loads. This allows a facility to cover energy usage and sell back the most amount of energy when conditions allow.

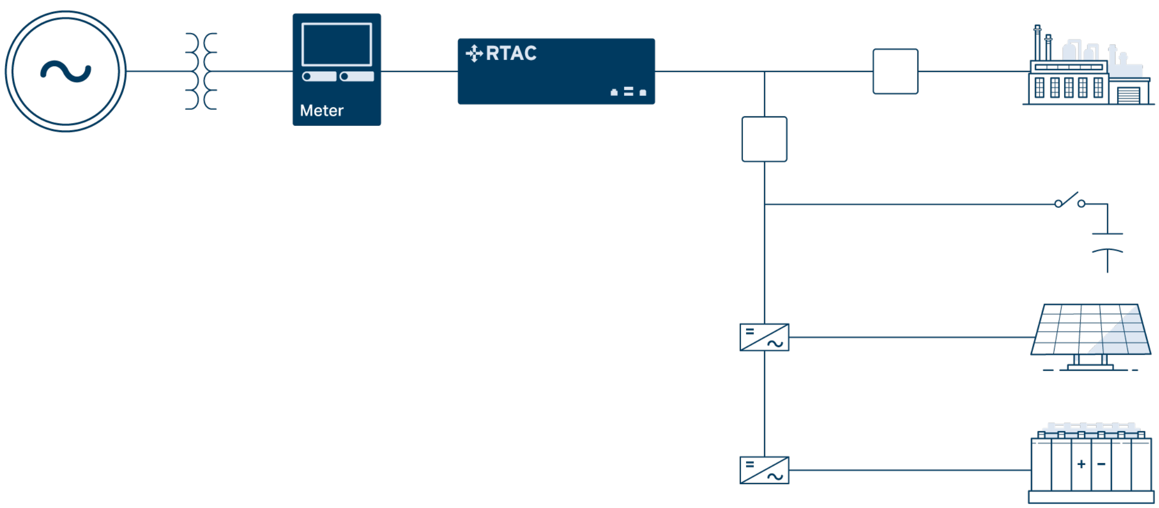

Figure 2 Example Topology of Integrated DER and Load Behind the Meter

Alternatively, when paired with storage and battery assets, Grid Connect will discharge energy from the storage assets to keep energy import at the current peak demand value, reducing any energy surcharge for peak consumption if Grid Connect detects import of more energy than the peak demand value for the billing cycle. In addition to providing peak demand reduction, battery assets also provide solar smoothing, ensuring ramp rates at the PCC stay within the interconnection agreement specifications.

State of Charge Management

While batteries provide important reserves at different times in power system operations, they need a controller to be told when the most optimal times are to discharge and charge their cells. Grid Connect provides this functionality while monitoring the best operating parameters of the battery. Recording battery operational data with the Dynamic Disturbance Recorder library is included with Grid Connect to maintain warranty data on the battery. Grid Connect knows when a battery has insufficient or sufficient charge to participate in its grid optimization algorithms, protecting all power system assets. Users can configure multiple levels of minimum charge to reserve energy for peak demand reduction and time-shifted generation applications dependent upon system conditions.

Grid Connect can be configured to either charge batteries from PV assets only or to import energy from the PCC. State of charge management includes an automatic charging algorithm that determines when the system is not using the battery to charge it for later use. The charging algorithm is configurable to keep the battery topped off between solar smoothing events during the day or to fully charge the battery after heavy discharge for peak demand reduction or time-shifted generation when the system is at low utilization and energy is at a reduced price.

Power Plant Management

Solar PV power plants can greatly impact the electrical networks they are integrated into. As a result, it is important to adjust the output of a solar plant (both real and reactive power) to minimize any effect the plant may have on grid reliability and other customers. Coordination of the PV plant and its intertie with the existing distribution and subtransmission electrical system is essential for reliable operations. By using the Grid Connect library, users can design and implement a control system that seamlessly adjusts the equipment operational points in response not only to commanded set point changes but also to variable conditions. Feature sets that allow for this seamless operation include concurrent control of both real and reactive power.

Figure 3 PV Power Plant

Real power control

- Curtail set points
- Maximize PV production
- Account for cloud cover
- Manage anti-inverter windup
- Account for generation or load Grid Connect does not manage

Reactive power control

- Power factor control at PCC
- Incorporation of capacitor banks to improve inverter power factor
- Voltage control at PCC
- Voltage compensation/droop at PCC
- VAR control at PCC

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