Community Scale Generation at the Chemehuevi Community Center

Session 2B: High Penetration Renewable Distributed Generation

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Southern California Research Initiative for Solar Energy (SC-RISE)

www.scrise.ucr.edu

Center for Environmental Research and Technology (CERT)

www.cert.ucr.edu
Project Overview

• Objective: Deployment and demonstration of a microgrid system at the Chemehuevi Community Center.

• Location: Chemehuevi Indian Tribe, Havasu Lake, CA 92363

• Project duration: start date – 12/1/15, end date – 07/31/18

• Microgrid system composed of 90 kW solar PV system, 60kWh/30kW flow battery energy storage system, data historian, advanced control system, and energy management strategies.

• Energy management strategies include: 1) Peak Reduction, 2) Load Shifting, 3) Demand Response, and 4) Storage to Grid activities.
Project Benefits

Projected benefits to the CCC (over 20 years)

- Lower energy costs (i.e. demand charge reduction)
- Improved data and energy management
- Increased grid stability, robustness, and reliability
- Support increased renewables and market-ready technologies
- Decreased GHGs emissions
- Workforce development & best practices
Industry Partners

- Solexel, Inc. (http://www.solexel.com) – 40 kW solar PV system
- Congenra Solar (http://www.cogenra.com) – 50 kW solar PV system
- Primus Power (http://www.primuspower.com) – 60 kWh/30 kW flow battery energy storage system
- OSIsoft (http://www.osisoft.com) – EMS monitoring and control software
Solar Characteristics

One-Week Solar Generation

Active Power [kW]

0:00  3:00  6:00  9:00  12:00  15:00  18:00  21:00  0:00

8-Jun  9-Jun  10-Jun  11-Jun  12-Jun  13-Jun  14-Jun
Sustainable Integrated Grid Initiative (SIGI)

- **Load Management**
  - reduces risk of grid failure/blackout (due to decreased peaks)
  - increases predictability of demand (flattens peak demand)

- **Outage Prevention** - relieves stress on grid

- **Outage Support** – if system includes stand-alone battery dedicated to critical loads

- **Distributed Solar Systems** SUPPORT the grid.
What Should We Know Before Optimization?

- The Rate Schedule Time-of-Use (TOU) for Large General and Industrial Service

<table>
<thead>
<tr>
<th>Rate Period</th>
<th>Summer</th>
<th>Winter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>June to August</td>
<td>September to May</td>
</tr>
<tr>
<td>Off-Peak</td>
<td>11 PM—8 AM</td>
<td>9 PM—8 AM</td>
</tr>
<tr>
<td>Mid-Peak</td>
<td>8 AM—12 PM</td>
<td>8 AM—5 PM</td>
</tr>
<tr>
<td></td>
<td>6 PM—11 PM</td>
<td></td>
</tr>
<tr>
<td>On-Peak</td>
<td>12 PM—6 PM</td>
<td>5 PM—9 PM</td>
</tr>
</tbody>
</table>

- How to Design the Algorithm?
  - Charge the battery bank during Off-Peak rate period; discharge during On-Peak rate period
  - Time interval period is chosen to be 5 minutes
  - kW optimization and kWh optimization
One-Day Experiment with Three Different Time Periods Control Algorithms

![Graph showing Net Load, Battery Operation, Building Load, Solar Generation, and SOC over time. The graph is divided into Off-Peak, Mid-Peak, and On-Peak periods.](image)
# Cost Analysis: Comparison Between Different System Architectures

## System Comparison

<table>
<thead>
<tr>
<th>System Comparison</th>
<th>Energy kWh Savings($)</th>
<th>Load Demand Savings($)</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>On-Peak</td>
<td>Mid-Peak</td>
</tr>
<tr>
<td>Real vs. Schedule</td>
<td>209.65</td>
<td>105.92</td>
<td>17.24</td>
</tr>
<tr>
<td>Real vs. No Battery</td>
<td>104.38</td>
<td>381.12</td>
<td>17.24</td>
</tr>
<tr>
<td>Real vs. No PV or Battery</td>
<td>1182.82</td>
<td>584.56</td>
<td>126.26</td>
</tr>
</tbody>
</table>

### June 2015 Electricity Cost Comparison for Different System Architectures

<table>
<thead>
<tr>
<th>Different Situation</th>
<th>Energy kWh Savings($)</th>
<th>Load Demand Savings($)</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>On-Peak</td>
<td>Mid-Peak</td>
</tr>
<tr>
<td>Real vs. Schedule</td>
<td>84.26</td>
<td>59.5</td>
<td>0</td>
</tr>
<tr>
<td>Real vs. No Battery</td>
<td>97.44</td>
<td>472.3</td>
<td>24.84</td>
</tr>
<tr>
<td>Real vs. No PV or Battery</td>
<td>953.7</td>
<td>585.65</td>
<td>115.44</td>
</tr>
</tbody>
</table>

### May 2015 Electricity Cost Comparison for Different System Architectures

Real refers to real-time control algorithm.
In September 14, 2014, the triple digit temperatures lead to RPU reaching a new all-time high electricity demand of 610 megawatts (MW). In the days to follow RPU send out an appeal to larger customers to conserve electrical energy, specifically between 2 pm to 5 pm. In response, CE-CERT’s SIGI Testbed provided the flexibility to not only curtail the nominal power consumption of 365 kW from the three CE-CERT buildings, but also provided 225 kW back to the grid, resulting in a 590kW swing for three hours, as shown below.

- **CE-CERT Admin building net energy savings:** 95 kW
- **CE-CERT APL building net energy savings:** 180 kW
- **CE-CERT CAEE building net energy savings:** 315 kW
SIGI helps RPU during peak historic demand

- **Start of Solar Production**
- **Stop Battery Charging**
- **Start Battery Discharging**
- **Controlled Load**

**Power (kW)**

- CAEE Building
- Solar Inverter 3
- Battery System
UCR Research in Support of State Programs

- Integrate utility scale renewable energy, energy storage, and EV charging
- Demonstrate the functionality of Smart Grid protocols
- Provide real world Smart Grid test-bed platform
- Evaluate efficiency of energy storage
- Evaluate power quality issues
- Increased research collaboration with power utility companies, EV transportation, and technology providers
THANK YOU

For more information please visit www.scrise.ucr.edu

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