Grid-Interactive Building Project Roundup

Kevin Carbonnier, NBI
Alexi Miller, NBI
Audience Poll

• How many people have heard the term grid-interactive building before this conference?
• How many people feel like they could define what a grid-interactive building is?
• How many people know of a building in the world that has grid-interactivity measures?
Grid-Interactivity Basics

Graphic shows relative (normalized) circuit load intensity on a high-stress SCE distribution circuit near Los Angeles, CA.

SCE is working with NBI to assess the distribution grid implications of building electrification and building-grid integration.
Grid-Interactivity Basics

Where’s the carbon?

Source: The Brattle Group Report

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Grid-Interactive Building Demand Management

- Solar + Storage
- All-Electric
- Dual-fuel

Net Energy Demand vs. Hour of Day

Peak Cost or Carbon
Why Do We Need Grid-Interactive Buildings?

- Decarbonization
- Cost Savings
- Resiliency
- Regulations
Thermal Energy Storage Spotlight:
Burr & Burton Academy – Founder’s Hall
Manchester, VT

Photo: Burr & Burton Academy
## Burr & Burton Academy – Project Details

<table>
<thead>
<tr>
<th>Building Type</th>
<th>K-12 School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Type</td>
<td>New Construction</td>
</tr>
<tr>
<td>Year Complete</td>
<td>2021</td>
</tr>
<tr>
<td>Site description</td>
<td>3 stories, 25,000 sf</td>
</tr>
<tr>
<td>Project Team</td>
<td>ZGF, KATO, The Rowland Project, Efficiency Vermont, SE Group, Integral Group, NBI</td>
</tr>
<tr>
<td>Measure</td>
<td>2,000-gallon thermal energy storage tank</td>
</tr>
</tbody>
</table>

Photo by Tony Cirelli
Thermal Energy Storage Impact

7% Energy Savings
8% Emissions Savings
2-3 Hours of HVAC Load Shift
Resiliency spotlight: GSA Federal Building
Oklahoma City, OK

Photo: U.S. General Services Administration
GSA Federal Building – Project Details

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Type</td>
<td>Retrofit</td>
</tr>
<tr>
<td>Year Complete</td>
<td>2022</td>
</tr>
<tr>
<td>Funding</td>
<td>Part of $9 million UESC project including 5 GSA buildings. Partial funding from DOE AFFECT grant.</td>
</tr>
<tr>
<td>Site description</td>
<td>4-stories, 178,342 sf</td>
</tr>
<tr>
<td>Project Team</td>
<td>GSA, Ameresco, Oklahoma Gas and Electric (OG&amp;E), NREL</td>
</tr>
</tbody>
</table>
| Measures       | • 300-kW solar PV array  
                  • 250kW/500kWh battery energy storage with microgrid controls  
                  • BAS, lighting and HVAC controls upgrades  
                  • Transformer upgrades |

**UESC Project Highlights**

- $8.9 million in energy efficiency and infrastructure improvements
- Year 1 cost savings of more than $412,000
- 41% total energy use reduction
- 13% total water reduction for the smart irrigation systems
- Greenhouse Gas reduction of more than 3,100 metric tons/yr.

Summary of service contract highlights (total for 5 buildings)

Source: Federal Energy Management Program
### GSA Federal Building - Results

- Bundling buildings and measures helps cost-benefit justification
- Battery Energy Storage System (BESS) provides resiliency benefits that are hard to quantify financially

<table>
<thead>
<tr>
<th>Measure</th>
<th>Projected Annual Cost Savings</th>
<th>Projected Annual GHG Savings (Metric Tons CO₂e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting controls</td>
<td>$3,021</td>
<td>41</td>
</tr>
<tr>
<td>BAS Upgrades</td>
<td>$47,762</td>
<td>1,278</td>
</tr>
<tr>
<td>Advanced Power Strips</td>
<td>$1,776</td>
<td>22</td>
</tr>
<tr>
<td>Solar PV</td>
<td>$40,635</td>
<td>325</td>
</tr>
<tr>
<td>BESS</td>
<td>$5,928</td>
<td>-9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$98,882</strong></td>
<td><strong>1,657</strong></td>
</tr>
</tbody>
</table>

*Source: Federal Energy Management Program*
Grid benefits spotlight: McKnight Lane Affordable Housing

Waltham, VT

Photo: Clean Energy Group
<table>
<thead>
<tr>
<th>Building Type</th>
<th>Affordable multifamily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Type</td>
<td>New construction</td>
</tr>
<tr>
<td>Year Complete</td>
<td>2016</td>
</tr>
<tr>
<td>Project Cost</td>
<td>$3.6 million; $132,156 for storage systems</td>
</tr>
<tr>
<td>Site description</td>
<td>14 modular homes @ 925 or 980 s.f. each</td>
</tr>
<tr>
<td>Project Team</td>
<td>Addison County Community Trust, Cathedral Square, Clean Energy Group, Clean Energy States Alliance, Green Mountain Power, High Meadows Fund, Sandia National Laboratories, sonnen, US DOE Office of Electricity, VERMOD, Vermont Community Development Program, Vermont Community Foundation Sustainable Future Fund, Vermont Energy Investment Corporation, Vermont Housing and Conservation Board</td>
</tr>
<tr>
<td>Measures</td>
<td>• All-electric, high efficiency appliances</td>
</tr>
<tr>
<td></td>
<td>• 6kWh/4kW AC energy storage systems</td>
</tr>
<tr>
<td></td>
<td>• 6kW rooftop solar arrays</td>
</tr>
</tbody>
</table>

Photo: Clean Energy Group
McKnight Lane - Results

• Benefits of solar plus storage at McKnight Lane:

<table>
<thead>
<tr>
<th>Occupants</th>
<th>Utility</th>
<th>Society</th>
</tr>
</thead>
<tbody>
<tr>
<td>• $5/month average energy bill</td>
<td>• $350-$400/month transmission charge</td>
<td>• GHG emission reduction of 32 metric tons CO₂e</td>
</tr>
<tr>
<td>• 148 hours of resilience from outages</td>
<td>management savings</td>
<td>every year</td>
</tr>
<tr>
<td></td>
<td>• 52% lower coincident grid peak contribution</td>
<td></td>
</tr>
</tbody>
</table>

• NREL analysis shows that dispatch strategies can be optimized to minimize energy cost, lifecycle costs, or climate costs

Source: NREL
Advanced controls spotlight:
Sonora Elementary
Costa Mesa, CA

Photo: Orange County Department of Education
## Sonora Elementary – Project Details

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Education K-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Type</td>
<td>Retrofit (controls only)</td>
</tr>
<tr>
<td>Project Year</td>
<td>Fall 2022</td>
</tr>
<tr>
<td>Funding</td>
<td>DOE Building Technologies Office</td>
</tr>
<tr>
<td>Site description</td>
<td>Two, 6-classroom buildings</td>
</tr>
<tr>
<td>Project Team</td>
<td>Community Energy Labs, LBNL, Newport-</td>
</tr>
<tr>
<td></td>
<td>Mesa Unified School District</td>
</tr>
<tr>
<td>Measure</td>
<td>Two-level model predictive control to</td>
</tr>
<tr>
<td></td>
<td>optimize HVAC</td>
</tr>
</tbody>
</table>

Source: Community Energy Labs
Sonora Elementary - Results

- Reduced peak power by **24%**
- Shifted **16%** of cooling load from on-peak to low price period

Source: Community Energy Labs
Incentive program spotlight:
“Advanced Grid Responsive Technologies for Existing Multifamily Properties”

Austin, TX

Photo: Austin Energy
Project Details

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Affordable multifamily</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Year</td>
<td>2022-2025</td>
</tr>
<tr>
<td>Funding</td>
<td>Building Technologies Proving Ground</td>
</tr>
<tr>
<td>Project Team</td>
<td>Austin Energy, NBI, EcoBee, Armada</td>
</tr>
<tr>
<td>Measure</td>
<td>Control technologies for thermostats and water heaters</td>
</tr>
</tbody>
</table>
| Goals             | • Quantify DR potential of smart thermostats and water heater controllers in existing multifamily buildings while maintaining tenant satisfaction  
                        • Evaluate impact of incentives on resident participation |
Forward-looking program spotlight: Distribution Circuit Bottom-Up Electrification Measure Impact Coincidence Analysis

Southern California Edison

Graphic: Southern California Edison DRPEP tool
Project Details

**Building Type**
Residential (current), Commercial (future)

**Project Year**
2022-2023

**Funding**
Southern California Edison

**Project Team**
SCE, NBI, 2050 Partners

**Objective**
Quantitatively assess distribution grid impacts of building electrification

**Activities**
- Calibrate models to historical circuit load data
- Gather measure-level baseline and proposed (post-electrification) load shapes across building types
- Stochastically (or similarly) model circuit-level impacts of electrification in terms of circuit-level peak load timing, magnitude, and other metrics
Summary
Roundup Takeaways

- Grid-interactivity options to take home:
  - Smart thermostats
  - Energy storage (not just batteries)
  - Water heater controls
  - Advanced HVAC controls
  - Smart power strips
  - Others in further resources
Resources

• Find factsheets, webinars, articles, and other info:
  • https://newbuildings.org/gridoptimal/

• Upcoming ASHRAE Guide: *Design and Operation of Grid-Interactive Buildings for Decarbonization*
  • Includes additional international case studies!

• Upcoming electrification impact scenario resources and findings supported by Southern California Edison
Call to Action

- Existing dispatchable demand is about **1.2% of peak system GW**
- High adoption scenario in 2030 would reach about **5% of peak**

Peak system demand in 2020 is approx. 800 GW (NREL Cambium)

Source: DOE [GEB Roadmap](#)
Thank you

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 alexi@newbuildings.org