HARTLEY SOLAR PLUS STORAGE

BRET PENCE
ECOLIBRIUM3

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GREAT NORTHERN SOLAR

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MECHANICAL & INDUSTRIAL ENGINEERING

SWENSON COLLEGE
OF SCIENCE & ENGINEERING
University of Minnesota Duluth
• 11,000 students
• Over 500 full-time faculty
• Land-grant university
Mission: Our mission is to inspire and lead change in our community toward an equitable and sustainable future.

Solar Market Pathways:

1) Define barriers to solar adaptation

2) Develop pathways to reduce costs and increase adaptation of this technology in our community

3) End goal of 1MW of solar on the ground in Duluth
PROJECT OVERVIEW

• Hartley Nature Center is a City-owned, nonprofit operated green building.

• The Center serves as a park, environmental center and outdoor-based preschool with annual visitors ~ 30,000
PROJECT OVERVIEW

• HNC had one of the first PV systems in northern MN, installed in 2002–2003. There is 11 kW on the roof and 2 kW on a ground-mounted dual-axis tracker, with 6 inverters.

• By 2016, 4 out of 5 roof inverters were no longer operable, and replacing them all with 2 inverters and rewiring would cost ~$10,000.

• The installation is part of a larger energy retrofit of Hartley Nature center, which includes replacement of the HVAC controls and GSHP, separation of hot water from the GSHP, and lighting upgrades.
PROJECT TEAM

• Bret Pence, Ecolibrium3
• Alison Hoxie, UMD
• Alex Jackson, City of Duluth
• Tom O’Rourke, Director Hartley Nature Center
• Brett Amundson, Operations Hartley Nature Center
• Chris LaForge, Great Northern Solar
• Paul Helstrom, Minnesota Power
FUNDING

ecolibrium3
LOCAL ENERGY MATTERS

Minnesota Power Foundation

CleanEnergy Group
Innovation in Finance, Technology & Policy

UMD
UNIVERSITY OF MINNESOTA DULUTH
Driven to Discover

The City of Duluth,
MINNESOTA

Regional Sustainable Development Partnerships
UNIVERSITY OF MINNESOTA
Driven to Discover™
PROJECT GOALS

• Replace Inverters
• Create a public emergency shelter
• Move building to net-zero
• Explore added values with storage:
  • critical load backup and
  • behind the meter savings, including peak demand shaving
• Create an education platform for energy storage
BATTERY SELECTION

• Sunverge, only company to meet project needs
• Small Commercial Unit (<15 kWh) & DC coupled (high voltage)
• Software ~ Energy Arbitrage, coming soon more sophisticated Peak Demand Shaving
• Other resiliency option – SPS outlet SunnyBoy grid-tied inverter connected to 5 kW of roof array
### Critical Loads

<table>
<thead>
<tr>
<th>Critical Load Backup</th>
<th>Description</th>
<th>Surge Load</th>
<th>Operating Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Server, Wi-Fi, Phones</td>
<td>Plug load: mech. Room</td>
<td>135 W</td>
<td>15 W</td>
</tr>
<tr>
<td>Refrigerator</td>
<td>115 Volts, 7.7 Amps</td>
<td>250 W</td>
<td>250 W</td>
</tr>
<tr>
<td>Lighting</td>
<td>Bathroom</td>
<td>610 W</td>
<td>232 W</td>
</tr>
<tr>
<td></td>
<td>Mechanical Room</td>
<td>128 W</td>
<td>128 W</td>
</tr>
<tr>
<td></td>
<td>Classroom 1</td>
<td>46 W</td>
<td>46 W</td>
</tr>
<tr>
<td></td>
<td>Classroom 2</td>
<td>46 W</td>
<td>46 W</td>
</tr>
<tr>
<td>Plug Loads</td>
<td><strong>Exhibit Hall:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hartley: (1: 4 plug outlet)</td>
<td>32 W</td>
<td>32 W</td>
</tr>
<tr>
<td></td>
<td>Civil: (3: 4 plug outlet)</td>
<td>96 W</td>
<td>96 W</td>
</tr>
<tr>
<td></td>
<td><strong>Office:</strong> 2 desktops</td>
<td>1200 W</td>
<td>10 W standby</td>
</tr>
<tr>
<td></td>
<td><strong>Office Library:</strong> 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Laptops &amp; 6 phones</td>
<td>248 W</td>
<td>248 W</td>
</tr>
<tr>
<td></td>
<td><strong>Classroom 2:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hartley: (1: 2 plug outlet)- 100 W laptop</td>
<td>200 W</td>
<td>200 W</td>
</tr>
<tr>
<td></td>
<td>Civil: (5: 2 plug outlet)-(2) 100 W laptops, (8) 8 W/ phones</td>
<td>248 W</td>
<td>248 W</td>
</tr>
</tbody>
</table>

**Maximum Total Loads**

- **H:** 2895 W / C: 3007 W
- **C:** 1208 W / C: 1319 W
OPEN INSTALLATION PROCESS
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SOLAR PLUS STORAGE AWARENESS DAY
LESSONS – RETROFITS ARE HARD

• Code updates can upset the apple cart (increase cost)
  • Rapid shutdown and arc-fault protection

• Flex plans to accommodate the reality of the built environment – wiring, loads, etc.

• Initial project estimated cost ~20,000, actual ~45,000
RETROFITS HAVE VALUE

• Project Costs – $45,000, cost to Hartley?
  • $5000

• Financial benefit- $1500/year, 30 year payback

• Value of backup – Wind storm and the value of storage

• Change to a non-demand tariff – $5000/year

  • Below 10kW peak demand, not over 2500kWh/month energy limit for 3 months in a row

  • Believe this is possible with energy efficiency upgrades, increased solar production, and strategic use of energy storage – Ask us in 3 months!
THANK YOU.

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