Engaging Building Occupants: How to Reduce Plug Load Energy Use

Rois Langner, NREL
Technical Lead, Plug & Process Load Technical Solutions Team
May 10, 2016
Engaging Building Occupants: How to Reduce Plug Load Energy Use

- Presentations:
  - Christine Wu, Sustainability Program Manager at the U.S. General Services Administration
  - Moira Hafer, Sustainability Specialist at Stanford University

- Discussion and Q & A
Join the Better Buildings Alliance!

Plug and process loads (PPLs) consume about one third of primary energy in U.S. commercial buildings. As buildings become more efficient, PPL efficiency has become pertinent in achieving aggressive energy targets. Through the PPL technology solutions team, partners participate in a platform to share experiences and learn from their peers, and work together to create resources on PPL energy reduction strategies and their applications, covering a wide variety of electronic, computer, refrigeration, and cooking devices, including equipment essential to information processing, medical treatment, and food service businesses.

Take Action
Participate in expert-led technology teams, test out an implementation model, join a technology campaign, or take part in a technology challenge or demonstration.

Join Alliance Activities

Events Calendar
Better Buildings partners participate in webinars, peer-exchange calls, meetings, and industry workshops and conferences. Browse upcoming events and opportunities to participate by month.

Get Involved

Find a Partner
Through the Better Buildings Alliance, over 200 public and private sector organizations across the country are working together to share and replicate positive gains in energy efficiency.

View Partners
Join the BBA PPL Tech Team

Featured Solutions

- **Decision Guides for Plug and Process Load Controls**: Guidance
  The decision guides found in this resource were created to help building owners find the right controls for their buildings.
  View Related Solutions

- **Technical Specifications for Advanced Power Strips (Version 1.0)**
  This specification provides detailed selection criteria for five model families of advanced power strips (APS). The objective of this specification is to help architects, engineers, and other building stakeholders select APS that best meet the needs of their projects.
  View Related Solutions

- **How To Use Advanced Power Strips in an Office Setting Fact Sheet**
  Each advanced power strip has three outlet types for equipment and light loads, and a single outlet for personal and task lighting loads. Each outlet type has a number of specific uses for each outlet type.
  View Related Solutions

- **Assessing and Reducing Plug and Process Loads in Office Buildings**: Guideline
  Using the process and strategies outlined in this brochure, the U.S. government was able to significantly reduce its electricity consumption.
  View Related Solutions

- **Assessing and Reducing Plug and Process Loads in Retail Buildings**: Fact Sheet
  This brochure provides an overview of PPLs in retail buildings and describes the process and strategies needed to effectively reduce their energy impact.
  View Related Solutions

Other Resources

- Fact Sheet
- Guidance
- Report
- Additional Information

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**Better Buildings**

**U.S. Department of Energy**
Thank you!

Rois Langner
National Renewable Energy Laboratory
Rois.Langner@nrel.gov
Plug Load Control: Real-World Testing and Application

Christine Wu, GSA
Plug Load Control:
Real-World Testing and Application

U.S. General Services Administration | Christine Wu, Green Proving Ground Program
“THE GOVERNMENT’S LANDLORD”

- 8,792 assets
  - Owned: 1,621 assets
- 374M square feet
  - Owned: 183M square feet
- 1.1 million federal employees
- $365M annual energy costs
FEDERAL MANDATES SET THE PACE

Energy Independence and Security Act, 2007

30 reduction in energy use intensity (EUI) by 2015 over 2003 levels

**GSA Response:**
-30.0 EUI reduction EOFY2015*

Executive Order 13693, 2015

2.5 annual reduction in EUI through 2025, over 2015 levels

**GSA Response:**
-2.4 EUI reduction as of FY2016 Q2*

GSA buildings are 33%* more efficient than typical U.S. office buildings.

* January 2016, GSA Average EUI = 52.2 kBTU/GSF/yr, as reported per legislative mandate; Commercial office average EUI = 77.8 kBTU/SF/yr, 2012 CBECS, eia.gov
Green Proving Ground leverages GSA’s real estate portfolio to evaluate innovative sustainable building technologies.
HOW DOES GPG WORK?

- Identify promising technologies at the edge of commercialization
- Pilot technology installations within GSA’s real estate portfolio
- Partner with Department of Energy national laboratories to objectively evaluate real-world performance
- Recommend technologies with broad deployment potential

ENERGY MANAGEMENT
12.15—Socially Driven HVAC †
09.12—Advanced Power Strips *
03.12—Wireless Sensor Networks *
Passive Thermal Storage Platform
Predictive HVAC Optimization
Variable-Speed Chiller Plant Control
Circuit-Level Energy Monitoring

LIGHTING
08.15—LEDs with Integrated Controls *
05.15—Wireless Lighting Controls †
08.14—Integrated Daylighting Systems *
09.12—Occupant Responsive Lighting *
LED Replacement Lamp for CFLs
Networked Lighting
T-LED Retrofit for Fluorescent Luminaires

BUILDING ENVELOPE
05.15—Electrochromic Windows for LPOEs *
01.15—Applied Solar Control Retrofit Films *
03.14—Chromogenic Windows
03.14—Vacuum Insulated Panels
10.13—High R-Value Window Panels †
Electrochromic Windows with Dynamic Controls
Low-Emissivity Window Film
Daylight Redirecting Window Film

ON-SITE POWER & RENEWABLES
01.15—Photovoltaic-Thermal Hybrid System
06.14—Wood-Pellet-Fired Biomass Boilers
10.13—PV Guidance
12.12—Photovoltaic Systems
Honeycomb Solar Thermal Collector
Building Integrated PVs for Windows

HVAC
03.15—Wireless Pneumatic Thermostat †
07.14—Condensing Boilers, Updated †
03.14—Multistaged Indirect Evaporative Cooler
03.14—Synchronous and Cogged Fan Belts *
10.13—Variable Speed Maglev Chiller †
12.12—Variable Refrigerant Flow
High Efficiency RTU
Variable Speed Screw Chiller
Continuous Combustion Control System
Intelligent Valves for Hydronic Systems
Smart Scrubbers for HVAC Load Reduction

More information available at gsa.gov/GPG

M&V STATUS (as of April 2016)
(00.00) = Completed —25
Continuing Evaluation —17
Deployed/Pending Deployment—9

* Identified for Broad Deployment —15
† Deployed through ESPC —6
GPG PLUG LOAD CONTROL EVALUATION

- **Opportunity:** 20-25% of building electricity consumption goes to plug loads.

- **What We Did:** In 2012, NREL tested three plug load reduction strategies at workstations*, kitchens, and print rooms in eight federal office buildings throughout GSA’s Mid-Atlantic Region.
  
  *Baseline for workstations include IT policy to perform daily computer shutdown.

- **Technology:** Tested strategies included:
  
  a. **schedule-based control** from 6a-6p
  
  b. **load-sensing** based on monitor draw
  
  c. **combined** schedule & load-sensing
Energy Reduction for Tested Control Strategies

- **Workstations** (32): Schedule Timer 26%, Load-Sensing 4%, Combined 11%
- **Print Rooms** (46): Schedule Timer 50%, Load-Sensing 32%, Combined 23%
- **Kitchens** (22): Schedule Timer 46%
- **TOTAL (100) (% of total plug load)**: Schedule Timer 41%, Load-Sensing 16%, Combined 24%
GPG PLUG LOAD CONTROL EVALUATION

Lessons Learned

Schedule-based

- Account for real-world variability in work schedules and habits. “Tight” scheduling may seem to save more energy, but may result in more dissatisfaction and higher rates of manual overrides or disabling of devices.

- Account for warm-up times (e.g., printers, kitchen equipment)

Load-sensing

- At workstations, account for sweep times (i.e., the amount of time required to sense a master load). If the device sweeps once per minute, is a one-minute lag in slave wake-up time acceptable?

- Meter master device draw states (e.g., “in-use,” “standby,” and “off” draws for monitors) prior to implementation in order to avoid sending faulty commands to slave devices.
GPG PLUG LOAD CONTROL EVALUATION

Lessons Learned

Tenant engagement

- Tenants must be knowledgeable of:
  - How the strategy will save energy
  - How individual actions may help to save energy
  - How to override, disable, and/or reset the plug strip

- Select a strategy that does not require tenants to prioritize energy savings over personal convenience.

General

- Minimize complexity for both installation and operations
- Employ strategies that minimize impact on tenants’ daily operations
**APS NATIONAL DEPLOYMENT**

16,359 **timer-based advanced power strips** deployed in 98 federal buildings in 35 cities across the US.

---

**One-Touch Desktop Button**
Use the Desktop Button to turn your Timed Outlets on and off. These outlets automatically turn off after 11 hours to save power. The blinking LED status indicator notifies you when your outlets are about to be turned off. Press the button to keep outlets on for another 11 hours.

---

**6 Auto-Off Timed Outlets**
Timed outlets automatically turn off after 11 hours. Use these outlets for devices that don’t require constant power (24/7), such as laptop computers*, monitors, phone chargers, printers, and desk lights.

---

**2 Always-On Outlets**
Use these outlets for devices that require power at all times, such as desktop computers, phones and clocks.
APS NATIONAL DEPLOYMENT

**Why this device?**

- Manual on / Auto off
- Immediate wake-up signal
- Unlikely to be permanently disabled
- 2-year payback
- Plug & Play: Easy installation, no commissioning
- No IT component

**Lessons Learned**

- Train installers on standard always on / auto off devices
- Issue tenant reminders to turn off APS when they leave their workstation
APS NATIONAL DEPLOYMENT

Mar 16 2014 to Apr 20 2014

<table>
<thead>
<tr>
<th>Day</th>
<th>Baseline (Before)</th>
<th>After</th>
<th>Energy Reduced kWh</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday</td>
<td>1960.00</td>
<td>1842.50</td>
<td>-117.50</td>
<td>-6%</td>
</tr>
<tr>
<td>Monday</td>
<td>3194.00</td>
<td>3075.00</td>
<td>-119.00</td>
<td>-4%</td>
</tr>
<tr>
<td>Tuesday</td>
<td>3225.50</td>
<td>3063.00</td>
<td>-162.50</td>
<td>-5%</td>
</tr>
<tr>
<td>Wednesday</td>
<td>3480.00</td>
<td>3224.50</td>
<td>-255.50</td>
<td>-8%</td>
</tr>
<tr>
<td>Thursday</td>
<td>3345.00</td>
<td>3342.50</td>
<td>-2.50</td>
<td>0%</td>
</tr>
<tr>
<td>Friday</td>
<td>2988.00</td>
<td>2911.00</td>
<td>-77.00</td>
<td>-3%</td>
</tr>
<tr>
<td>Saturday</td>
<td>1949.50</td>
<td>1916.00</td>
<td>-33.50</td>
<td>-2%</td>
</tr>
<tr>
<td></td>
<td>20142.00</td>
<td>19374.50</td>
<td>-767.50</td>
<td>-4%</td>
</tr>
</tbody>
</table>
APS NATIONAL DEPLOYMENT

$1.6M lifecycle energy cost avoidance

1,500 MWh annual energy savings

2-year payback

$0.17 - $0.23/sf saved for office buildings.

Potential impact: $96M avoided lifetime energy costs, if distributed for every employee in GSA buildings.
Plug Load Management

<table>
<thead>
<tr>
<th>Plug Load Nuggets</th>
<th>Best practices and key strategies in short form (250 words) covering seven plug load topics. Learn what you need to know, fast!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plug Load FAQ</td>
<td>Find out the &quot;what&quot;, &quot;why&quot;, and &quot;how&quot; needed to effectively manage plug loads.</td>
</tr>
<tr>
<td>Plug Load Checklist</td>
<td>Utilize the checklist to assist your integrated team execute and monitor a plug load reduction program.</td>
</tr>
<tr>
<td>Plug Load Research Review Summary</td>
<td>For those really looking to learn more, get summaries of the forefront research findings that serve as the plug load knowledge foundation.</td>
</tr>
</tbody>
</table>
PLUG LOAD CHECKLIST

- Establish a plug load champion
- Develop a business case to address plug loads
- Benchmark the efficiency of current equipment and operations
- Identify occupants’ true needs
- Meet needs efficiently
- Turn unused equipment off
- Institutionalize plug load measures through procurement decisions and policy programs
- Promote occupant awareness
- Address unique miscellaneous plug loads
- Address plug loads in building design/retrofits
Thank You!

Christine Wu
christine.wu@gsa.gov
gsa.gov/GPG
Stanford Equipment Inventory & Plug Load Reduction Programs

Moira Hafer, Sustainability Specialist
Office of Sustainability
Stanford University

Better Buildings Alliance Summit, May 10, 2016
Stanford Equipment Inventory Overview

- Comprehensive 260-building equipment inventory

- Goals:
  
  1. Quantify campus plug load energy consumption and understand its composition
  
  2. Identify viable plug load energy reduction opportunities
  
  3. Collect data that supports Office of Sustainability’s partners
Types of equipment included:
- Standard office equipment
- Standard lab equipment
- Common IT equipment
- Kitchen & break room equipment
- Gym equipment
- Other
  - EH&S hazards
  - Water fixtures
  - Occupancy data
- Attributes collected for each type of equipment to provide necessary details for estimating energy consumption
- Inventory covers 93% of campus square footage
Data Collection Tool

Interns used web application developed by LBRE IT to collect inventory data
### Results (A) – Campus-Wide Context

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Equipment Count</td>
<td>204,000</td>
</tr>
<tr>
<td>Total Energy Consumption (kWh/yr)</td>
<td>77.3 million</td>
</tr>
<tr>
<td>Total annual cost</td>
<td>$9 million</td>
</tr>
<tr>
<td>Plug Load as % of Total Campus Electricity Use</td>
<td>34%</td>
</tr>
</tbody>
</table>

**Equipment Count Diagram**

- Desk Lamp, 17%
- Personal Computer, 16%
- LCD Monitor, 11%
- Phone, 6%
- Common Refrigerator, 3%
- Microwave, 3%
- Personal Printer, 3%
- Server, 3%
- Fan, 3%
- Speakers, 2%
- TV / LCD Screen, 2%
- Other, 28%
Results (B) - Energy Consumption by Equipment Type
Results (C) - Energy Consumption by Equipment Type, cont’d

设备能源消耗

- 服务器，24%
- 实验室冷冻箱，14%
- 孵化器，9%
- 常规冰箱，7%
- 水浴，6%
- 实验室冰箱，5%
- 个人计算机，5%
- UPS，3%
- 洗碗机，3%
- 高压蒸气灭菌器/消毒器，2%
- 网络交换机，2%
- 液晶显示器，2%
- 个人冰箱，2%
- 其他，16%

Stanford Office of Sustainability
Results (D) – Energy Consumption by Building Type

Average Plug Load Energy Use Intensity by Building Type

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Energy Use Intensity (kWh/SqFt/Yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi Intensity Lab</td>
<td>9.00</td>
</tr>
<tr>
<td>Low Intensity Lab</td>
<td>7.00</td>
</tr>
<tr>
<td>Office</td>
<td>4.00</td>
</tr>
<tr>
<td>Shops</td>
<td>3.00</td>
</tr>
<tr>
<td>Commons</td>
<td>2.00</td>
</tr>
<tr>
<td>Classroom</td>
<td>1.50</td>
</tr>
<tr>
<td>Recreation Facility</td>
<td>1.20</td>
</tr>
<tr>
<td>Auditoriums</td>
<td>0.80</td>
</tr>
<tr>
<td>Library/Museum</td>
<td>0.50</td>
</tr>
</tbody>
</table>
### Plug Load Energy Savings Programs Summary

**Potential Savings: $2.3 million**

<table>
<thead>
<tr>
<th>Program</th>
<th>Total Potential Savings</th>
<th>Average ROI (years)</th>
<th>% Plug Load Reduction</th>
<th>% Total Electricity Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Retrofits</td>
<td>$183,000</td>
<td>0.5</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>Space Heating</td>
<td>$23,700</td>
<td>2.4</td>
<td>0.3%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Sustainable IT</td>
<td>$682,000</td>
<td>2.5</td>
<td>8%</td>
<td>3%</td>
</tr>
<tr>
<td>Green Labs</td>
<td>$1,457,000</td>
<td>3.4</td>
<td>16%</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$2.3 M</strong></td>
<td><strong>2.2</strong></td>
<td><strong>26%</strong></td>
<td><strong>9%</strong></td>
</tr>
</tbody>
</table>
Field Test of Basic Energy Efficiency Measures

- ROI = 0.2
- ROI = 0.4
- ROI = 0.9
- ROI = 0.5
- ROI = 0.6
- ROI = 1.2
- ROI = 5.8
- ROI = 4.9
- ROI = 6.3
- ROI = 53.7

- Timers on commercial coffee makers
- Timers on water coolers
- Timers on hot water dispensers
- Timers on cable boxes
- Timers on standard coffee makers
- Timers on single-cup coffee makers
- Replace incandescent light bulbs with LEDs in task lamps

Unit Energy Savings (kWh/yr)
1. Data from pilots showed significant savings from installing programmable timers on:
   - Coffee makers
   - Water coolers & hot water dispensers
   - Cable boxes
2. Direct Install program developed for timers to complement existing voluntary Cardinal Green Office Program
3. Feedback positive from standard office occupants but challenging in 24/7 buildings
4. Persistence was a concern but follow-up checks showed only 5% of water cooler timers removed and no coffee maker timers removed
5. Considering similar program for advanced power strips, especially new technologies that connect to a mobile app (pilot will run June – August 2016)
**Timer Program Materials**

**SUSTAINABILITY OPPORTUNITY**

In spring and summer 2015, the Office of Sustainability (OOS) conducted studies on the potential energy savings from implementing several energy efficiency measures that were revealed through the Plug Load Equipment Inventory. The pilots definitively showed that campus-wide installation of timers on water coolers, commercial coffee makers, cable boxes, and hot water dispensers would lead to significant savings. In fact, this simple measure is expected to save the university $16,000 per year once times are installed on all qualifying equipment across campus. To facilitate this process, timers are now available to be installed on these select equipment types for free through the ERP Express program and installed in your building by interns in the Office of Sustainability.

**HERE’S HOW:**

1. **Find out** when your building is scheduled to receive its timers. The Office of Sustainability will be in contact with each building manager to schedule an installation time.

2. **Share** details about the equipment identified to receive timers with the intern who is installing them. The Office of Sustainability has predetermined which equipment qualifies for timers, but we want to hear from you! Here are some things we encourage you to share during the installation visit:
   - How often the equipment is used
   - If you typically experience any problems with the equipment
   - If the equipment is ever used during non-working hours
   - At what times you prefer the equipment to be turned off at night and back on in the morning

3. **Learn how to use the timer.** The Office of Sustainability intern will show all interested occupants how to use the timer. The timer is approximately the size of a coffee mug and is

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**Pledge to save energy in your building!**

Your building is doing its part to save energy at Stanford by participating in the ERP Express Free Timer Installation Program. Show your support by adding your name to the list below, indicating that you’re willing to keep this timer running optimally!

Details on timer functionality are below.

A building-wide event will be awarded to buildings with the most names below—help your building win!


**Timer Instructions:** Office of Sustainability interns have installed timers on water coolers, commercial coffee makers, cable boxes, and hot water dispensers in your building. All timers have been scheduled to turn equipment off at night and usually on weekends based on building hours and preferences. The timer’s scheduled hours are recorded on the sign posted next to the timer.

If you need to override the timer at any point, please don’t unplug the equipment from the timer! Instead, press the “ON/AUTO/OF” button until the digital screen shows the word “OFF” in the lower right-hand corner. When you’re ready to turn the timer back on again, press the “ON/AUTO/OF” button until the word “AUTO” appears at the bottom of the digital screen, which will make the timer follow the schedule that was previously set. If you need to adjust the timer’s schedule, see the Sustainable Stanford How-To Guide that was sent to you by your building manager, which is also available at [https://sustainable.stanford.edu/sites/default/files/How_to_Raise_Free_Timers_ERP_Express_10.13.pdf](https://sustainable.stanford.edu/sites/default/files/How_to_Raise_Free_Timers_ERP_Express_10.13.pdf). For questions, contact Moe Hafer in the Office of Sustainability at mohafer@stanford.edu.

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<table>
<thead>
<tr>
<th>Name</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample: Moe Hafer</td>
<td>Sample: Davianna Oster</td>
</tr>
</tbody>
</table>

More spots for names on reverse side
Space Heater Minimization

<table>
<thead>
<tr>
<th>Program</th>
<th>Expected Annual Savings</th>
<th>Average ROI</th>
<th>% Plug Load Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Heater Minimization</td>
<td>$23,700</td>
<td>2.4 years</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

1. Follow-up study conducted in the 20 buildings with the highest number of space heaters to determine most effective energy-saving strategy
   - Results showed only 6% of people use space heaters excessively
   - 45 space heaters automatically removed
2. Space heater swap as part of fall energy savings campaign
   - 50 individuals volunteered to turn in space heaters, 25 actually did so (and were very excited!)
   - 1.5 year ROI to provide fleece jacket as incentive
1. Power management:
   - Partnerships with department-level IT groups are critical, although it can be a difficult ask if IT groups are focused on other projects
     - Familiarity with computers and unique use cases in their departments
     - Can set appropriate and consistent sleep schedules throughout the department
     - Occupants generally OK with pushing out new settings (similar to security, patches, etc.), unless they need remote access

2. Server virtualization and relocation – move servers out of closets!

### Sustainable IT

<table>
<thead>
<tr>
<th>Program</th>
<th>Expected Annual Savings</th>
<th>Average ROI</th>
<th>% Plug Load Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable IT</td>
<td>$682,000</td>
<td>2.5</td>
<td>3%</td>
</tr>
</tbody>
</table>
Incorporate plug load measures into existing Green Labs Program:

1. Equipment timers on heating blocks, water baths, etc.
2. Rebates for energy efficient ULT freezers
3. Free room-temperature storage sample kits
4. Chill-up ULT freezers - part of fall energy savings campaign
5. Outreach is biggest challenge!

<table>
<thead>
<tr>
<th>Program</th>
<th>Expected Annual Savings (kWh)*</th>
<th>Average ROI</th>
<th>% Plug Load Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Labs</td>
<td>1,457,000</td>
<td>3.4 years</td>
<td>5%</td>
</tr>
</tbody>
</table>

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**FACT SHEET: CHILL UP YOUR ULTRA LOW TEMPERATURE FREEZER**

**SUSTAINABILITY OPPORTUNITY**

If you work in a lab that uses cold storage (e.g., refrigerators or freezers) you are undoubtedly already keenly aware that these types of equipment consume a significant amount of energy. But did you know that a standard -80°C freezer can consume nearly as much energy as a single-family home?

One easy way to reduce the energy consumption of your ultra-low temperature (ULT) freezer is to change the setpoint from -80 degrees Celsius to -70 degrees Celsius. Chilling up your freezer will save over $1000/kWh and over $100 in energy costs every year. It also prolongs your freezer’s lifespan.

**FREQUENTLY ASKED QUESTIONS**

Is it safe to store samples at -70°C?

Most samples—such as proteins, bacteria, and viruses—are generally safe at -70°C. In fact, fifteen years ago all ultra-low freezers were set to -40 or -70. The drive to continually lower freezer temperatures has more to do with marketing and selling freezers than it has to do with science.

What about Nucleic Acids? (FAQ)

Most of the time, nucleic acids can safely be stored in a regular freezer at -20°C. They can also be stored at lower temperatures using a technology that mimics the extracellular biology of denaturation. This technique eliminates the need for cooling during shipping and storage, cutting down on energy costs and reducing the risk of having valuable research data destroyed due to a power outage. More information on long-term storage and how to obtain the full rebate can be found here:


When is chilling up a freezer to -70 not a good idea?

Freezers that are only partially full may not be the best candidates for chilling up because a lower thermal mass reduces higher temperature swings when the freezer is opened. Watch the temperature of your freezer closely. If you decide to chill it up when not full, if your freezer is not full, offer the share the space with another laboratory.

Has anyone else tried it?

Labs at the following universities are chilling up their ULT freezers to -70°C:

- CU Boulder
- Dartmouth
- Harvard
- UC Davis
- UC Santa Barbara
- University of Pennsylvania

CU-Boulder has 60% of their ultra-low freezers set to -70°C. A complete list of examples that they have stored at -70°C can be found at this link:

https://flickr.com/cta

What else can I do?

The Cardinal Green Labs program offers many resources for reducing energy and improving sustainability in lab operations, including: reducing energy and water use, reducing equipment use, and improving freezers. More information on these topics and more can be found on the Cardinal Green Labs website and at sustainable.stanford.edu/cardinalgreen/cardinalgreen-labs.

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**MORE INFORMATION**

www.stanford.edu/campusgreen/cardinalgreen-labs

**CONTACT**

Facilities Services, Laboratory Design and Operations, sustainable@stanford.edu
Conclusion

- **Summary:**
  - Equipment inventory data helped narrowed focus by revealing biggest savings opportunities (i.e. labs and IT equipment, including computers)
  - “Low-hanging fruit” still valuable to go after
  - With 4 new programs developed, approximately $66,000 saved in electricity costs in one year

- **Ongoing Challenges:**
  - Outreach
  - Boots on the ground to get the work done
  - Persistence is still a concern, although it was not shown to be a problem with timers on select equipment
  - Occupants tend to receive programs well, except in unique environments/use cases

- **Next Steps:**
  - Widespread active monitoring and control technologies could have a big impact
Thank you!