

Federal Energy Management Program

U.S. DEPARTMENT OF **ENERGY** | Energy Efficiency & Renewable Energy



FEMP FIRST THURSDAY SEMINARS
What you need to know...online, live, and anytime.

Rethinking Operations & Maintenance for High Performance Buildings
Instructor: Michelle Slovensky, National Renewable Energy Laboratory
FEMP Expert: Sarah Jensen

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Federal Energy Management Program

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Objectives/Competency Development

After completing this seminar, the learner will:

- Operate and maintain existing Federal facilities in a manner that is:
 - Efficient
 - Sustainable
 - Collaborative
 - Environmentally friendly
 - Occupant friendly
- Identify targets that maximize federal buildings in terms of renewable energy, comfort, productivity, adaptability, and facility life span



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Objectives/Competency Development (cont.)

After completing this seminar, the learner will:

3. Identify targets that minimize waste, greenhouse gases, occupant complaints, inefficiencies, complacency, and cost
4. Develop a process for increasing the performance of existing buildings involving:
 - Stakeholders
 - Stewardship
 - Performance and validation
 - Enablement and tools
 - Re-visiting and refining



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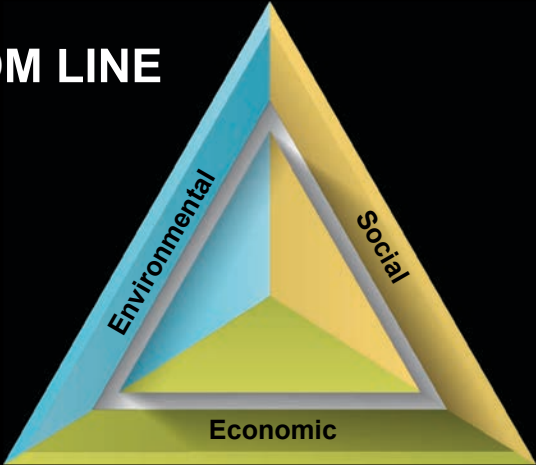
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TRIPLE BOTTOM LINE Considerations

- Environmental
- Social
- Economic



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Case Study: Research Support Facility (RSF)



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Operations and Maintenance

Operate efficiently,
sustainably,
collaboratively,
environmentally friendly,
and occupant acceptability.



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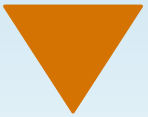
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Identifying Targets that Support Performance

Maximize:

- Renewable Energy
- Comfort
- Productivity
- Adaptability
- Facility life span



Balance:

- Energy Goal
- Amenities
- Expectations
- Technology choices
- Budget

Minimize:

- Waste and GHG
- Complaints
- Inefficiencies
- Complacency
- Cost

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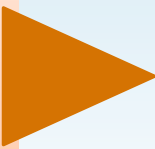
Managing Considerations

Financial Risk

- Cost/Benefit
- Payback
- Funding Source
- Operational Budget

Organizational Risk

- Staff Retention
- Enhanced Productivity
- Leadership
- Perception



Feasible

?

Practical

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Managing Considerations

Perceived Expectations
External Factors
Operations
Comfort

CHANGE / ADAPTATION

Integration of multiple influencing conditions




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Dynamic Process

- ↓ Stakeholders
- ↓ Stewardship
- ↓ Performance and Validation
- ↓ Enablement and Tools
- ↓ Revisit and Refine



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Identifying the Stakeholder Group



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Identifying the Stakeholder Group



- Owner / Investor
- Executive Management**
- Senior Sustainability Champion**

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Identifying the Stakeholder Group



Operator

Energy Manager

Facility Manager

Building Engineer

Identifying the Stakeholder Group



Occupant

Staff and Visitor

Identifying the Stakeholder Group



Third Party

Building Tech Group
Commissioning Agent
PPA

The Role of Stewardship



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The Role of Stewardship



Owner / Investor

- Set Goals and Scope
- Empower Process
- Financial backing




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The Role of Stewardship



Operator

- Investigate
- Implement
- Cultivate



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The Role of Stewardship



Occupant

- Educate
- Enable
- Engage



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The Role of Stewardship

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Documenting Performance and Validation



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The image shows two individuals, a woman with short brown hair and a man in a light blue shirt, viewed from behind as they look at a large digital display. The display shows a dashboard with various charts and graphs, including one labeled 'RSF Energy Monitoring' and another with the 'NREL' logo. The background is a plain wall.


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Documenting Performance and Validation



Owner / Investor
Furnish Finance and Commitment for Energy Efficiency



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The image is split into two parts. On the left, a woman in a black business suit stands with her arms crossed. To her right, the text reads 'Owner / Investor' in bold, followed by 'Furnish Finance and Commitment for Energy Efficiency'. On the right side of the slide, three people are shown: a woman in a black suit, a man in a blue shirt, and another man in a purple striped shirt. They are gathered around a tablet computer, which the man in the purple shirt is holding. In the background, there are informational posters on a wall, one of which is titled 'BUILDING Agency'.

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Documenting Performance and Validation



Operator

- Measurement
- Validate
- Troubleshooting




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Documenting Performance and Validation



Occupant

- Expectations
- Observations
- Feedback



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Documenting Performance and Validation

NREL | Energy Tracker

5:00 PM 69.4% Outside Relative Humidity
23.5° F 1.4 mph Wind Speed out of Northwest

IBRF xxx kW TTF xxx kW FTLB 800 kW SERF -400 kW S&TF -400 kW
OTF xxx kW Cafeteria (under construction) ESIF (under construction)
Parking Structure (under construction) RSF 1 -500 kW RSF 2 -300 kW
Parking Structure Visitors Center 100 kW
SEB

■ Better than Target
■ Within Target Range
■ Above Target Range

STM SITE XXXX kW
XXXX kW

Home STM Campus as a Whole RSF 1 RSF 2 SERF S&TF FTLB TTF OTF IBRF Shipping

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vs.

COMFORT

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What energy does an occupant influence?

Category	Percentage
Heating	12.5%
Cooling	9.5%
Fans	2.8%
Pumps	1.5%
DHW	1.0%
Lighting	28.0%
Equipment	44.7%

DOE Commercial Reference Building:
Large Office, Boulder, CO

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Documenting Performance and Validation

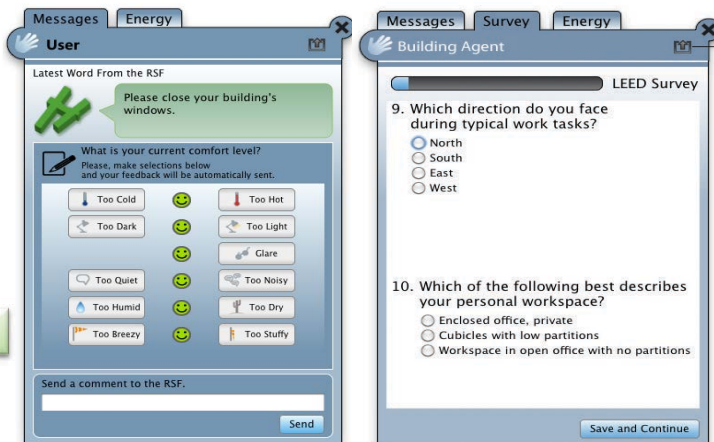
Comfort Survey

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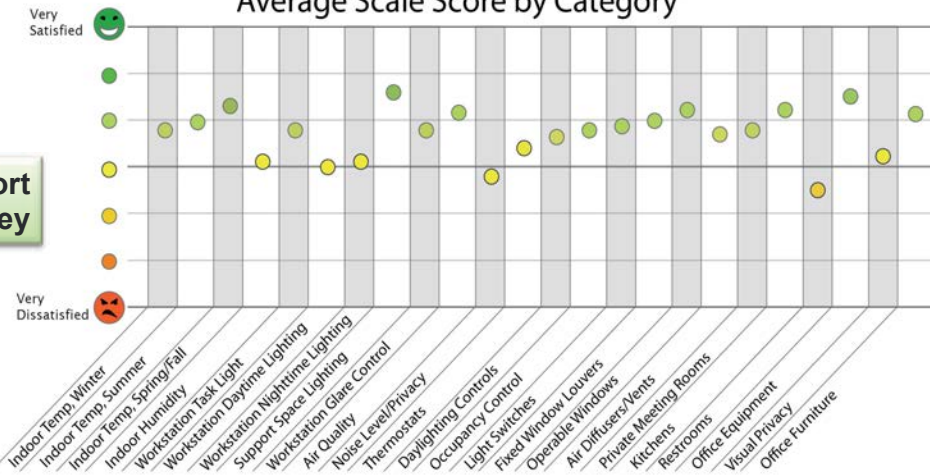
Documenting Performance and Validation

Comfort Survey



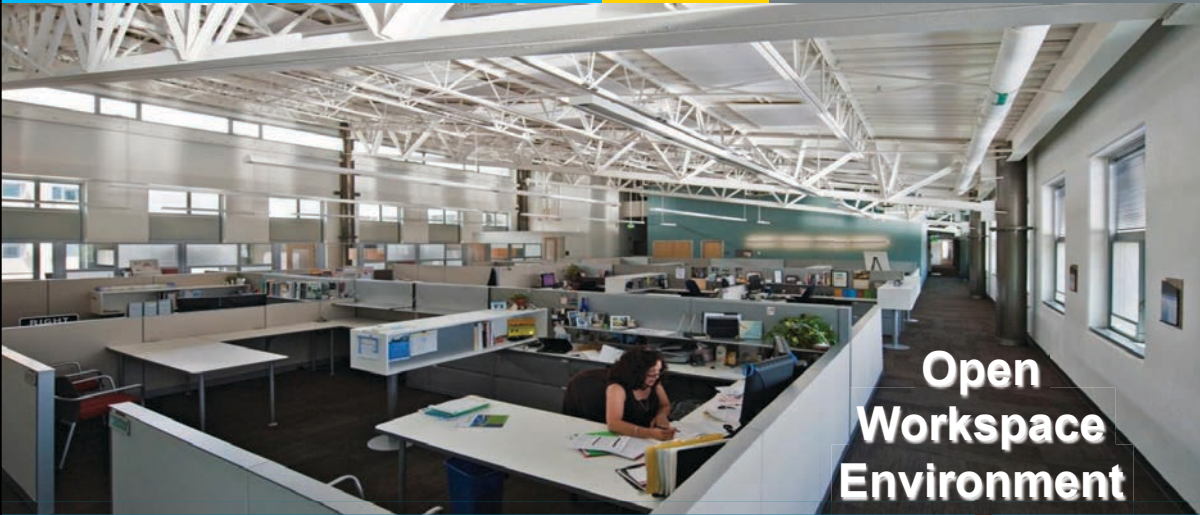
Comfort Survey

Average Scale Score by Category



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**Open
Workspace
Environment**

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**Noise / Privacy:
Change Behavior Management**

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The diagram illustrates two methods of noise mitigation in a building. On the left, a person stands on a floor with a sound masking speaker below them, emitting sound waves that fill the space. On the right, a person stands on a floor with a sound absorption panel on the ceiling above them, which reflects sound waves away from the person.

Sound Masking Speaker

Sound Absorption Panel

Noise Mitigation: Building Systems or Features

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Noise Mitigation

Integration of Group Behavior and Function with Sound Masking System Ranges

The image shows six rotary switches arranged in two rows of three. Each switch has a dial with numbers 0 through 10 and a pointer. The switches are labeled as follows: 1C WEST, 1C EAST, 1X, 2C WEST, 2C EAST, and 2X.

1C WEST

1C EAST

1X

2C WEST

2C EAST

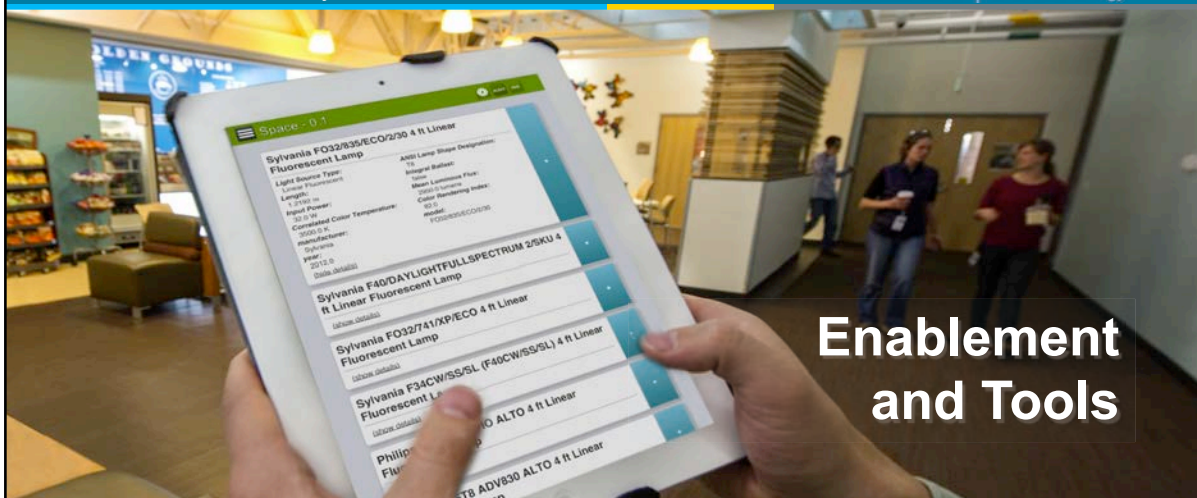
2X

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Comfort Survey

"What if a building occupant complains about thermal comfort issues that an operator cannot adjust without impacting the building performance?"

...Be responsive to person's complaints within reason: explore options, tweak systems, relocate the occupant to another space in the building that might alleviate the problem.



Enablement and Tools

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Enablement and Tools

Owner / Investor
(OPR)
Owner Project Requirements




Requirements :

- 800 employees
- LEED Platinum
- 50% better than ASHRAE 90.1-2004
- Net zero energy goal
- Replicable whole building design process
- Competitive cost for Class A space
- As many Mission, Desirable, and If Possible goals as achievable

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Enablement and Tools

Operator
(BAS)
Building Automation System
Custom Tools




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Enablement and Tools

Occupant

Webinars/Training

Workshops

Focus Groups

User Guides




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NREL | Energy Tracker

5:00 PM 69.4 % Outside Relative Humidity
23.5° F 1.4 mph Wind Speed out of Northwest

Temperature and Comfort

Map color by: Sensor Temp, Comfort

Overlay: Sensor Temp, Comfort

Too hot
Area of 8 people
6 reports in last hour

Cubicle #	Temp (F)
B202-1	76
B202-2	76
B202-3	77
B202-4	80
B203-1	76
B203-2	77
B203-3	79
B203-4	80

Too hot: over 5 reports in area

Too cold: over 5 reports in area

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Operational Controls


Name	Value	Unit	Status	Object
RSF CV 1CB	OFF		Overridden	B01
RSF CV 2CB	OFF			B02
RSF CV 1HB	OFF		Overridden	B03
RSF CV 2HB	OFF		Overridden	B04
RSF DHW CP1 SS	ON			B05
RSF DHW CP2 SS	ON			B06
RSF DHW CP3 SS	ON			B07
RSF B CHWS TEMP	56.5	°F		A11
RSF B CHWR TEMP	57.1	°F		A12
RSF B CHWS PRESS	43.9	psi		A13
RSF B CHW SYSTEM DIFF PRESS	2.3	psi		A14
RSF B HWS TEMP	71.4	°F		A16
RSF B HWR TEMP	71.7	°F		A17
RSF B HWS PRESS	44.8	psi		A18
RSF B HW SYSTEM DIFF PRESS	2.1	psi		A19
RSF SP2 ALARM	NORMAL			B15
RSF DHW CP1 STATUS	ON			B110
RSF B GENERATOR ALARM	OFF			B111
RSF DHW CP2 STATUS	ON			B112
RSF DHW CP3 STATUS	ON			B113
AHUB PHW VLV ROS AV	0.0	%		AV1
AH07 PHW VLV ROS AV	0.0	%		AV2
AH06 PHW VLV ROS AV	0.0	%		AV3
4TH EAST TEMP AV	71.8	°F		AV5
5TH EAST TEMP AV	72.4	°F		AV6
2ND EAST TEMP AV	71.5	°F		AV7
3RD EAST TEMP AV	72.0	°F		AV8

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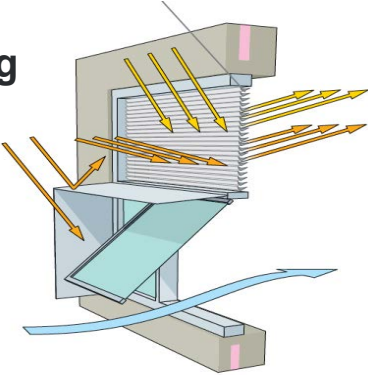
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Enablement and Tools

Maximize Daylighting

A light louver daylighting system reflects sunlight to the ceiling, creating an indirect lighting effect.



Fixed sunshades limit excess light and glare.

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Enablement and Tools

Glare Control

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Enablement and Tools

Glare Control

Of the 273 survey responders **glare** was reported as a problem for:

- 36% of those facing east
- 46% of those facing north
- 31% of those facing west
- 58% of those facing south

Duration	East	North	South	West
1 hour or less	8	25	40	7
1 to 4 hours	5	10	20	2
More than 4 hours	0	7	3	3

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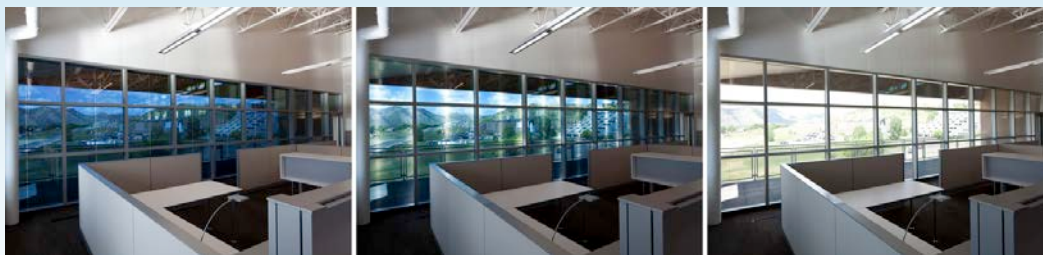
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Glare Control

- ✓ Glare evaluation
- ✓ Monitor support solutions
- ✓ Computer orientation
- ✓ Glare screens
- ✓ Relocation

Enablement and Tools

Glare Control





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Plug Loads

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Enablement and Tools

Building Automation Systems

Be Proactive - Not Reactive

- Calibrate / enhance building controls
- Adjust operating schedules / setbacks
- Observing, documenting and assessing trends
- Understanding equipment synergies
- Follow ASHRAE standards
- Lead occupants towards acceptance

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Enablement and Tools Recognition

Express individual or team is valued as employees

Rewards: Visibility in organizations communications
 Facilitate peer to peer recognition
 Non-monetary incentives
 Amenity funded celebrations
 Empowerment
 Nurture self esteem
 Increased responsibility

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Revisit and Refine

NREL U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy **RSF Energy Monitoring**

The dashboard displays several energy metrics:

- Daily Energy Summary:** A bar chart showing energy consumption in kWh for different building systems.
- Hourly Lighting k/W (Previous 24 Hours):** A line graph showing lighting energy use over the last 24 hours.
- Hourly Plug Load k/W (Previous 24 Hours):** A line graph showing plug load energy use over the last 24 hours.
- Hourly Cooling k/W (Previous 24 Hours):** A line graph showing cooling energy use over the last 24 hours.
- Hourly Heating k/W (Previous 24 Hours):** A line graph showing heating energy use over the last 24 hours.
- Hourly Energy Summary k/W (Previous 48 Hours):** A line graph showing total energy use over the last 48 hours.
- Daily Water Use:** A bar chart showing water consumption in gallons for indoor, outdoor, and M&M (Mechanical & Maintenance) uses.
- Annual Energy Summary:** A bar chart showing annual energy consumption in kWh for different building systems.

Global Energy Legend:

- Lighting
- Data Center
- Plug Loads
- Mechanical
- Cooling
- Heating
- Total Building Load
- PV Production
- Net Energy Use

Outside Temperature: 64.5 °F
 Outside Relative Humidity: 44.3 %RH
 Wind Speed: 8.9 mph
 Wind Direction: NW

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Revisit and Refine



Owner / Investor

- Assess and Re-evaluate Direction
- Re-affirm Commitment




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Revisit and Refine



Operator

- Data Reporting
- Conducting Audits
- Plan to Re-Cx



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Revisit and Refine

Occupant

Adopt New Behaviors
Continuous Feedback
Modifications




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Revisit and Refine

Re-Commissioning

Does the building operate as intended and are operational needs being met?

Benefits: Average 15% energy savings with rapid payback
Increased occupant comfort and productivity

Process: Assess design versus current operations
Perform gap analysis
Prioritize actions
Train your staff
Implement continuous commissioning

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Revisit and Refine

Lower the cost of Level III energy audits by **75%**

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Revisit and Refine

Integrated Project Team

- Representation from the critical three stakeholder groups
- Collaborative forum of multi-disciplined professionals
- Multiple sustainability champions
- Coordinated efforts for successful project strategy and outcomes
- Adhere to compliance in implementing Guiding Principles

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Dynamic Process

- ↓ Stakeholders
- ↓ Stewardship
- ↓ Performance and Validation
- ↓ Enablement and Tools
- ↓ Revisit and Refine



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Questions?

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