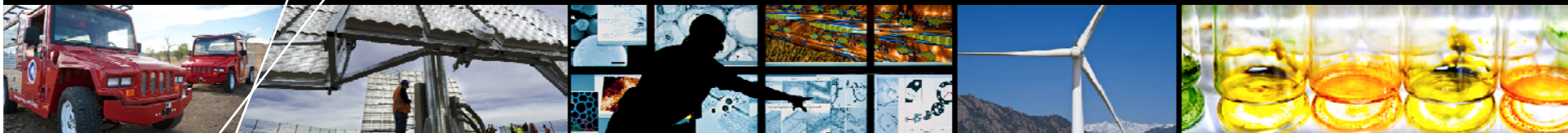




U.S. DEPARTMENT OF  
**ENERGY** | Energy Efficiency &  
Renewable Energy



# Low Energy Buildings: *Management, Operations, and Maintenance*



## NASA Net Zero Workshop

Jake Gedvilas, LEED™ AP O&M

Building Area Engineer

NREL Site Operations

*June 6, 2012*

# Design and Occupancy Considerations

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- **Systems and Design Intent**
- **Local Climate**
- **Staff Acceptance**
  - Open Office Systems Mock Up
  - Occupant Training
  - Staff Tours
  - Amenities

# Systems and Design Intent

- Management and Operations personnel need a strong understanding of the building's systems and design intent from architects and engineers
- *Preferably before*



# Local Climate

- Colorado enjoys 300 days of sunshine annually and a low average humidity.
- Local climate is a primary factor when designing a low energy building.

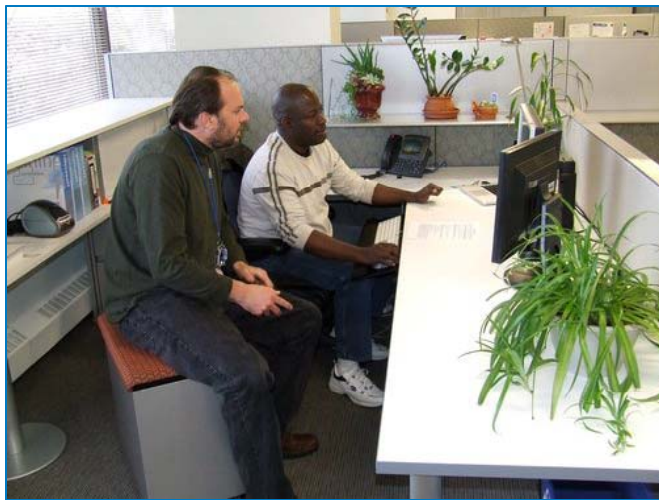




# Staff Acceptance



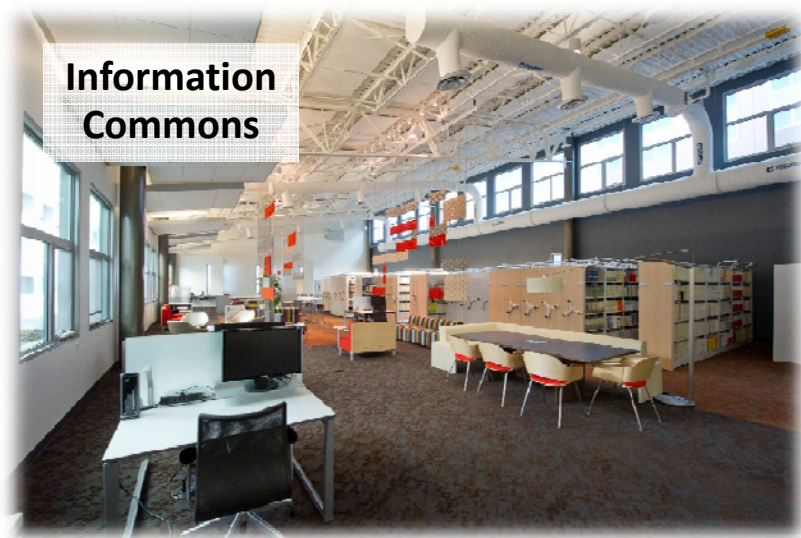
- Open office systems mock up
- Occupant training
- Staff tours
- Building amenities



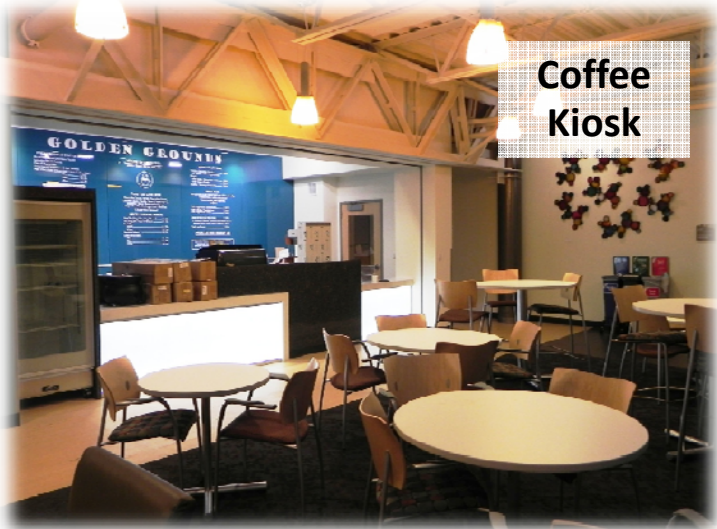
# RSF Amenities



Fitness  
Center



Information  
Commons



Coffee  
Kiosk



Courtyards



# RSF Amenities



**Lunchroom**



**Bicycle  
Lockers**



**Bike Repair Station**

# Construction

## O&M Staff Involvement:

- Integrated Project Team
- Quality Observations
- Changes and Design Modifications
- Commissioning

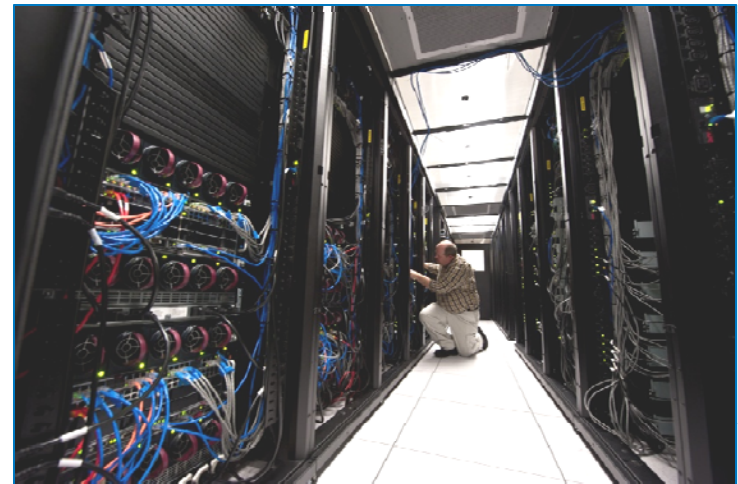




# Operations

## Building Systems

- Lighting/Daylighting
- Sound Masking
- HVAC
- Data Center
- Photovoltaics
- Plumbing/Water





**Triple-glazed windows with individual overhangs maximize daylighting and minimize glare, as well as heat loss and gain.**



**Glare**





## Window Technologies

The west elevation windows feature NREL-developed **electrochromic technology** in which the windows tint in response to a small electric current, reducing heat gain in the afternoon hours.

**Thermochromic windows** on the eastern balcony windows react to temperature change and have glass resistant to heat transfer.



# Sound Masking

- Open office environment
- RSF ventilation system VAV  
- *very quiet*
- Sound masking masks conversation



Sound Masking Speaker





## Daylighting

- Light enters through the upper daylighting glass and highly reflective louvers direct it toward the ceiling and deeper into the space.
- Light-colored, reflective surfaces, and low cubicle heights permit the penetration deep into workspaces.





The image shows a dense array of white PVC pipes connected by blue metal risers. Numerous orange electronic control boxes are mounted on the pipes, each with various wires and sensors attached. The system is organized into vertical columns. Labels like 'P-7A AREA DYE INT. ZONE' and 'HOT WATER SU' are visible on the pipes. The background is a dark, textured wall.

## Diverse and Interconnected HVAC System

- Heating/Cooling separate from ventilation
- Allows operators more control
- Stages of heating/cooling

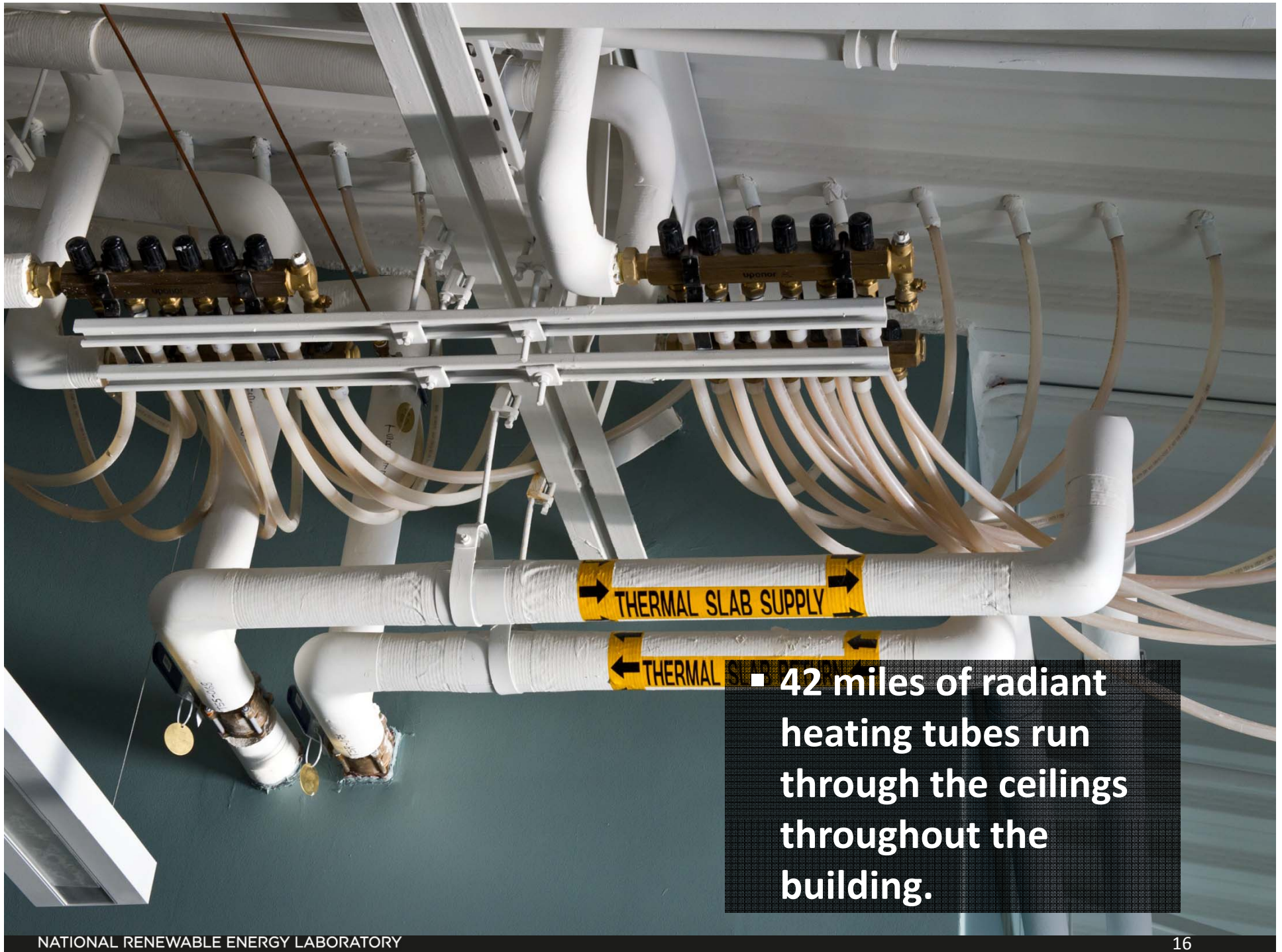


## Natural Ventilation

- During mild weather, operable windows allow for natural ventilation.
- Automatic windows take advantage of outdoor air conditions and purge heat build-up at night.
- Occupants are notified when conditions allow for manual windows to be opened.







- 42 miles of radiant heating tubes run through the ceilings throughout the building.





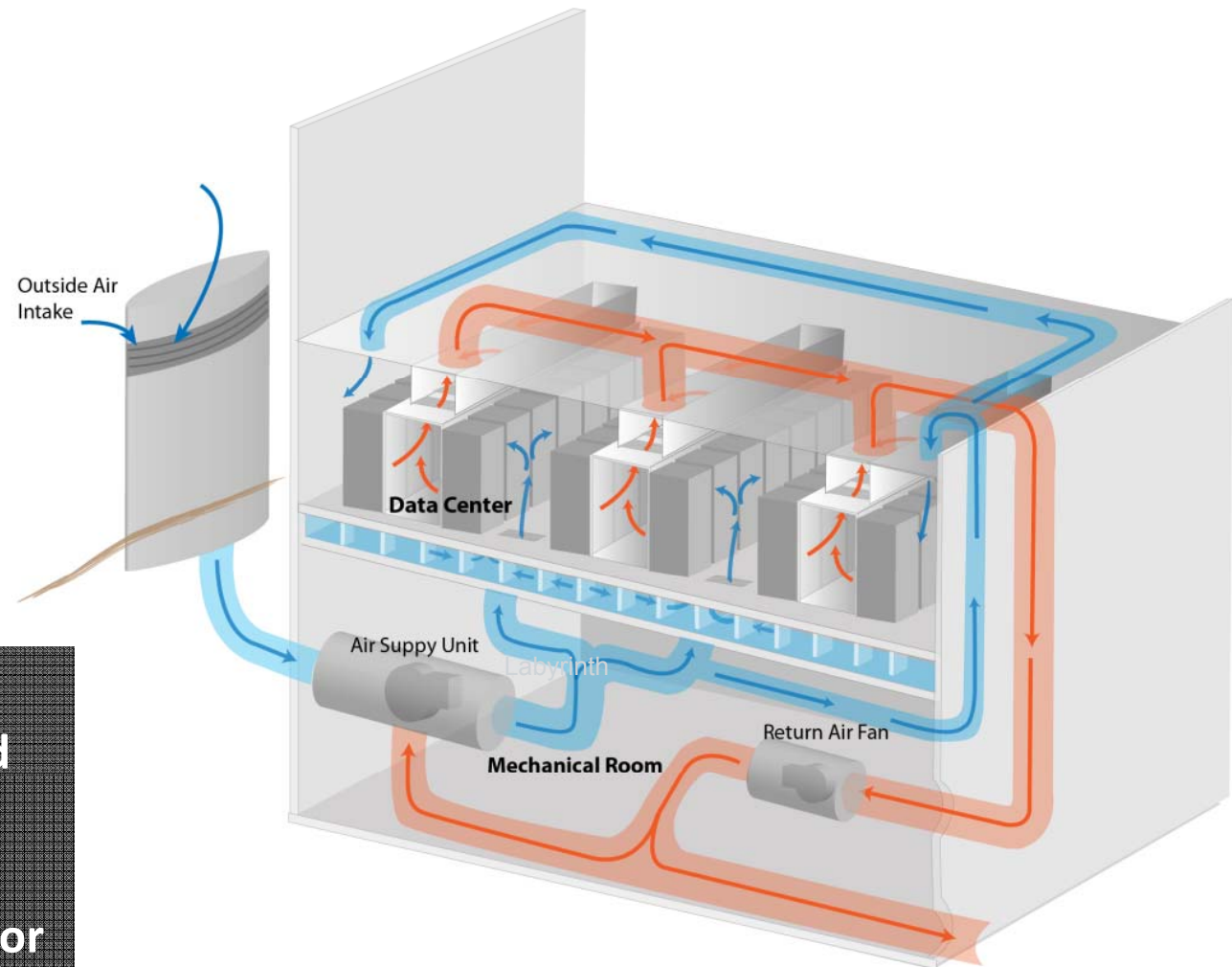
- Open System
- Air Intake System brings in outside air for the majority of the Data Center's cooling needs.



**It brings in more  
than just outside air.**

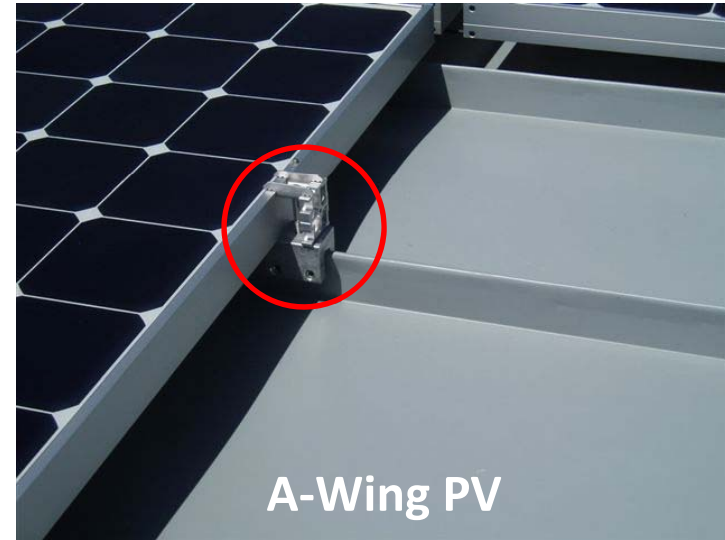


# Data Center Cooling and Heat Reuse



Waste heat from the data center is directed into and stored in the labyrinth, then mixed with cold outside air for use in the building.

# Photovoltaics



- PV contractor involved with installation
- Installation technique improvements
- Standing Seam Roof

# Water and Plumbing

- Planning: *Costs vs. Benefits*
- Fixture Performance
- Metering
  - HVAC
  - Landscape
  - Domestic





# Understand System Engineering and Design Intent

## NREL RSF II HVAC System Overview

**March 5, 2012**

M. Tatoyan PE, J. Lim PE



One Team. Infinite Solutions



# Lessons Learned

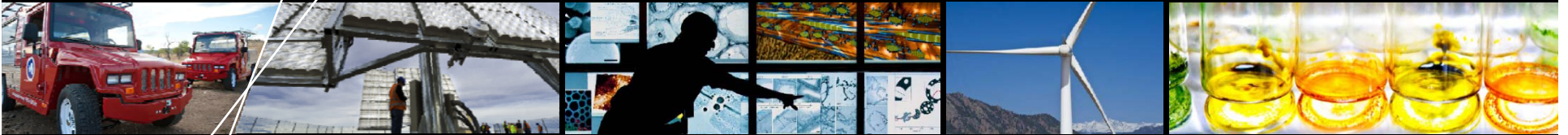


- Understand the System and Design Intent
- PV- Improved installation techniques and contractor
- Roof- Standing Seam
- Data/Power Distribution – Cube vs. Floor Box
- Data Center – Open System
- Waste Venting – AAVs Waterless fixtures
- Indoor Air Quality – Copy/Break Rooms
- Windows – Improved insulation
- Circuit labels for all switches/receptacles
- *Adherence to campus standards*

# Simple Reminders...







## Final Thoughts:

- Consider occupant comfort and space use
  - Walk the line (change vs. adaptation)
  - Generate creative solutions