

Session IV: Occupant Behavior



Moderator: Bobi Garrett

Panelists:

Nancy Carlisle

Nicki Johnson

David Mooney

Design Decisions and Occupant Behavior

Nancy Carlisle, AIA
Director, Integrated Applications
Center

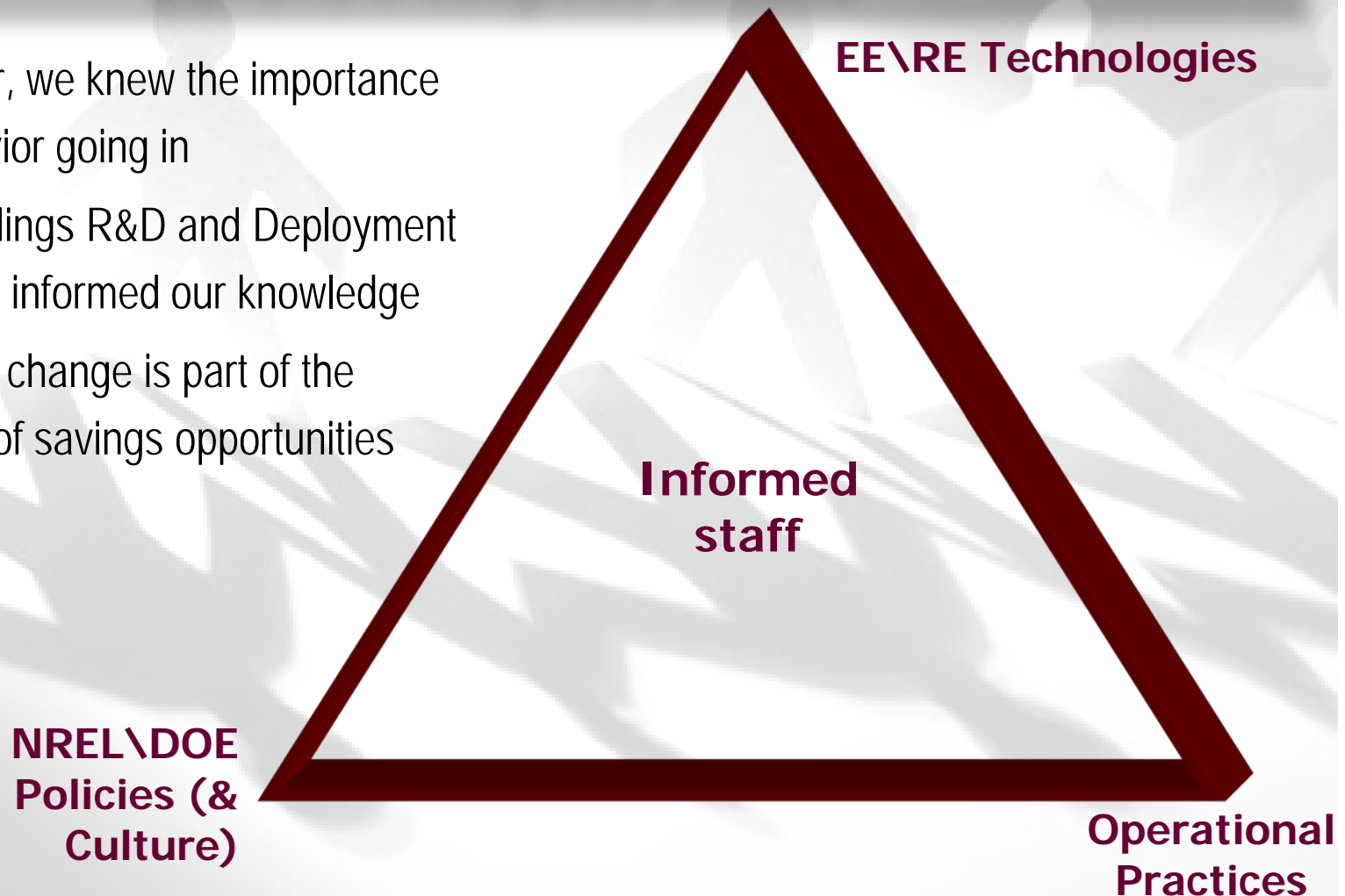
July 28 2011



Behavior is a component of an integrated solution.

Elements of Integrated Solution

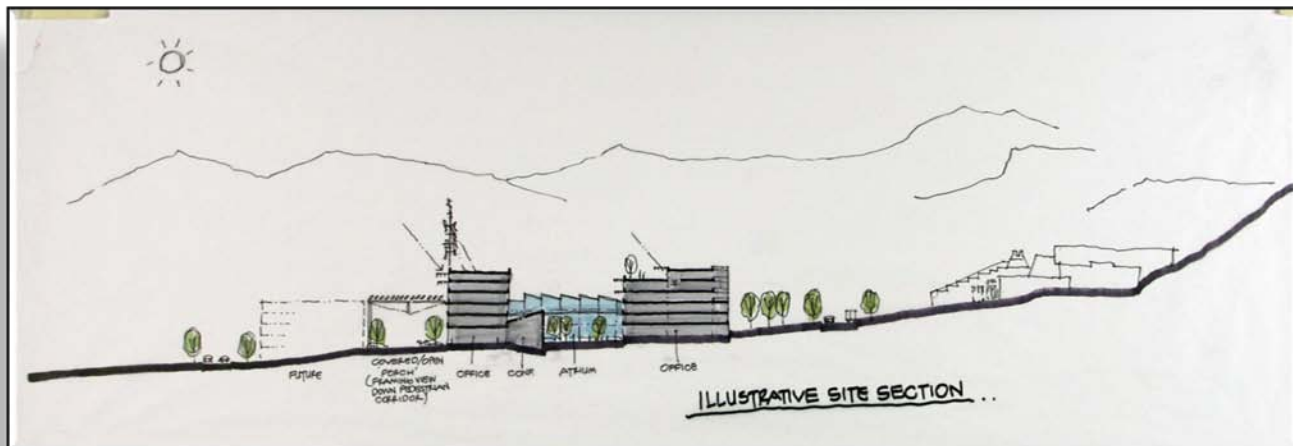
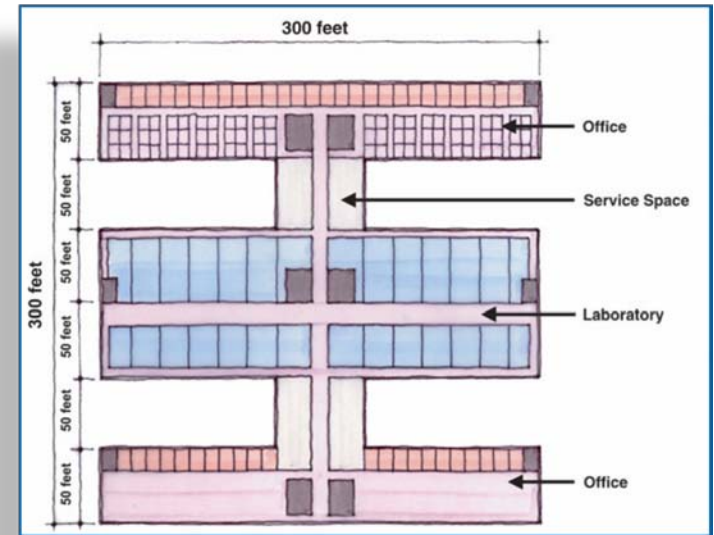
- As owner, we knew the importance of behavior going in
- Our Buildings R&D and Deployment expertise informed our knowledge
- Behavior change is part of the portfolio of savings opportunities



Pre-planning for the RSF Requirements

Examples

- General Development Vision suggested 3-4 story office modules at 50 feet by 300 ft to meet 100% of the daylighting requirement
- Design charrette held and recommendations made to achieve energy requirement
- Buildings research staff modeled the load and set the energy reduction target
- Construction staff and Executive Management toured examples of offices without ceilings and workstations with low walls during the design phase



The Owners Responsibilities

- Set an informed vision
 - Involves pre-work resulting in the RFP
- Willingness to change NREL\DOE Policies
 - Operable windows were not compatible with security
- Owner needs to involve multiple department and change procedures
 - IT staff in switched standard to lap top computers. (This required us to begin to purchase lap tops 3 years prior to move in)
 - IT staff supplied multi-function copiers\printers on each wing
 - Procurement staff purchased energy star fridges
 - Communications dept. ran the educational programs
- Socialized the building concept in order to shift the culture
 - Forbid individual printers, refrigerators, heaters, and many other appliances in work stations
 - Balance the need for equipment versus energy (software collaboration rooms)

Quantifying the Impact of Human Behavior in the RSF

Examples

- Human behavior can have a measurable impact on energy use
- Chart below shows importance of reducing nighttime use (i.e. use Motion Sensor Power Strips or Plugs enabled by Light Switch)
- Modeling assumptions were consistent with our expectations

Annual Plug Load Energy Use Intensity (kBtu/ft²)

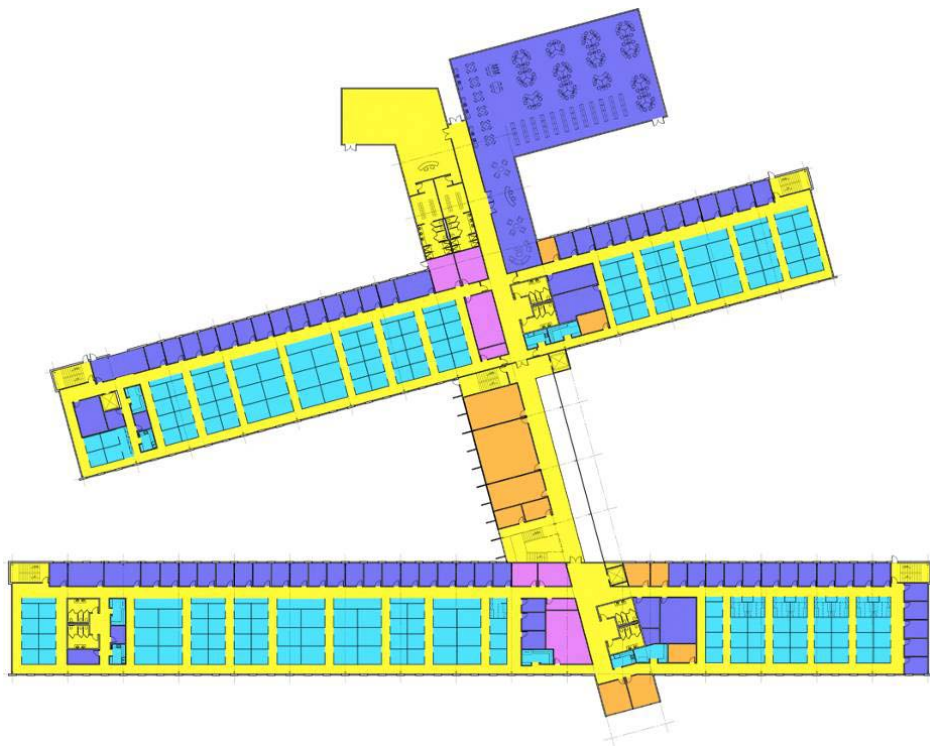
Night Plug Power Density (W/ft²)

	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
0.1	2.39	4.52	6.66	8.79	10.93	13.07	15.20	17.34
0.2	2.64	4.77	6.91	9.04	11.18	13.32	15.45	17.59
0.3	2.89	5.02	7.16	9.29	11.43	13.57	15.70	17.84
0.4	3.14	5.27	7.41	9.54	11.68	13.82	15.95	18.09
0.5	3.39	5.52	7.66	9.79	11.93	14.07	16.20	18.34
0.6	3.64	5.77	7.91	10.04	12.18	14.32	16.45	18.59
0.7	3.89	6.02	8.16	10.29	12.43	14.57	16.70	18.84
0.8	4.14	6.27	8.41	10.54	12.68	14.82	16.95	19.09
0.9	4.39	6.52	8.66	10.79	12.93	15.07	17.20	19.34
1	4.64	6.77	8.91	11.04	13.18	15.32	17.45	19.59

Day Plug Power Density (W/ft²)

Design-Builder Response to RFP

- Selected D-B understood the tradeoffs in budget needed to meet the energy goal
- Budget tradeoffs included very limited interior drywall, no finished ceilings, narrow open office plan, less space for storage



Key Design Decisions That Impact Behavior

- Size of offices and workstations (primarily 3 size options only, finishes not size to distinguish grade level)
- No enclosed offices on south façade
- “Enclosed” offices on north façade – No ceilings, glass walls and doors, walls 66” high
- Workstation panel only 42” high
- Huddle rooms, phone closets, quiet rooms and balconies for private communications
- A variety of meeting and conference rooms for collaboration
- Outside space and lunch room for collaboration and privacy
- Central printing\copying
- Daylighting\lighting systems and controls, operable windows (with operation tied to PCs)

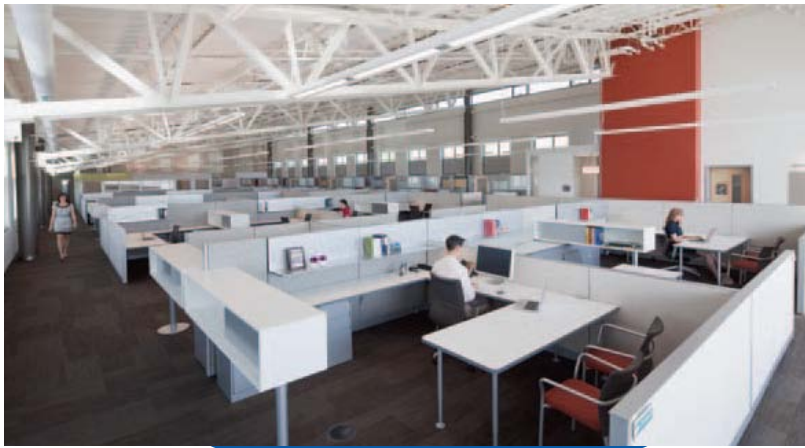
Standard Office Configurations



Student



Standard Office



Standard Work Station



Senior Manager Office



Design Solution – Workstation Equipment Choices Integrates Culture and Human Behavior

iGo Power Smart Towers

Reduces “vampire” energy use

VOIP phones 2 Watts

Removing personal space heater saves 1500 Watts

Sensor-controlled LED task lights - 3 Watts

Fluorescent task lights - 35 Watts

Multi-function Devices
100 Watts (continuous)

 Removing Desktop Printers Saves ~460 Watts/Printer

24" LCD Energy Efficient Monitors
18 Watts

Typical 19"-24" Monitors
30-50 Watts

Laptop
30 Watts

Desktop Computer (Energy Star)
300 Watts

Summary of Key Planning Steps

- Owners responsibility – pre-planning and setting the vision
- Design-builder – Understand and plan to achieve owners objective and priorities
- Design-Builder – understand and get the details right
 - Controls, parasitics, plug loads
 - Small thermal breaks around windows, overhang connection, insulation detail around parapet
- Owner—Align policies and practices to work with D-B to achieve objectives
 - Recognize the energy considerations of the large (and small) decisions
 - Plug loads, laptops, printers, etc.
- Owner -- Enable the design team to recommend high efficiency operations and owner installed equipment
- **It all comes down to trust and teaming to get the job done!**

Preparing Staff to Work in the RSF



**Research Support
Facility Workshop**

**Nicki Johnson,
Corporate
Communications**

July 28, 2011

Communicating with Staff

How we got the word out

- Developed key messages
- Began “socializing” building early
- Used variety of communication tools
- Found internal champions
- Involved employees
- Listened and responded to concerns



Key Messages

The RSF is one of the most energy-efficient buildings in the world.

- Showcase for energy efficiency and renewable energy technologies

The RSF is a living laboratory.

- Employees play a major role in the successful operation of the building

The RSF will help change the way commercial buildings are designed and built.

Communication Methods

Employee newsletter

Working in the RSF web page

Brown Bag lunch series

Workstation prototype

Tours and open house

YouTube videos

E-training

Blog

Polls

Research Support Facility : Working at the New RSF

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Building Features

In this lesson you will learn about some basic features of the Research Support Facility. The building was designed to help ensure your safety and productivity while supporting sustainability.

You will learn about:

- Building Entrances and Exits
- Energy-Saving Features
- Employee-Focused Amenities
- Copy / Printer Rooms.

Visit NREL Now and theSOURCE for breaking news about new amenities as they become available.

Click on each topic to the right for essential information about building features.

When you are ready, click the Next button to continue.

Open Topic Document

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Screen 7 of 14 | Lesson One

Where I left Off | Table of Contents

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NREL Research Support Facility (RSF) Documentary

Like



Frequency of communications

Communication campaign:
Began in 2008 and is ongoing

Living laboratory:
Employee feedback and building performance data means ongoing education

- Power management
- Lighting



NREL Now
A weekly electronic publication for NREL Staff

Week of July 14, 2008

Sneak Peek at Proposed Research Support Facilities Design

NREL's Research Support Facilities (RSF) Integrated Project Team (IPT) met with the RSF design-build team, NREL staff and DOE Golden Field Office representatives July 8-10 to get a first glimpse of the proposed design and to discuss issues such as zero energy building features, daylighting, PV roof systems, operations, security, new library and fitness room, collaboration space, parking, how the building fits into NREL's Master Plan and much more.

Design-build team Haselden/RNL provided NREL staff with a sneak peek at the proposed design of the RSF. The design has been working earlier this year. Credit: ANL

While most of NREL's participants

NREL Now
A weekly electronic publication for NREL Staff



NREL Now
A weekly electronic publication for NREL Staff

Week of July 25, 2011

News This Week

- [NREL News](#)
- [Research Highlights](#)
- [DOE News](#)

NREL News

Another Award for the RSF

The RSF's use of renewable energy and energy efficiency technologies is catching the attention of the country and the state. In addition to the building's recent designation as [LEED Platinum](#), the sheer number of impressive and diverse awards the building has garnered proves it. And now, we have added yet another from the Colorado Renewable Energy Society (CRES), taking our grand total to 24.

The RSF was honored by CRES in the [Renewable Energy and Sustainable Design in Buildings Awards](#) competition with the *Institutional Buildings* award. The award recognizes NREL's contributions to Colorado's growing renewable energy economy.

NREL has added another award to our ever-growing trophy case for the RSF. PIX #: 17832

Employee concerns - before

Privacy

Noise

Adequate storage space

Time to move

Fear of change

...and more

Helping You Navigate NREL's Changing Landscape



« The Laboratory of the Future is HERE RSF Rewards Exceed Challenges »

From an Open Cube and an Open Mind—One Center Director's View

When we became a center with the start of the new Alliance contract in October of 2008, we had staff with offices in 10 different buildings at the wind site, the mesa top, the STM site, and buildings 3, 16, and 17. We were as scattered as any organization to be sure.

Not long after the start of that fiscal year, I learned that NREL was exploring leasing new office space to accommodate our anticipated growth. Learning this, and considering our own expected growth, I contacted Facilities to explore the possibility of consolidating some of our staff into a single location that would also afford us some room for growth.

We quickly began to focus in on the second floor of Building 52. I was excited that a move there looked like it would be plausible and allow us to bring together, on a single floor, all our staff from 16 and 17, as well as selected staff from the TTF—a total of about 70 people. Then I learned that the office-design plan for 52/2 was to implement the NREL "office-of-the-future." I must admit to an acute bout of apprehension when I found this out because I had in my mind during the move discussions the typical Denver West building layout—"closed offices around the perimeter with cubes in the center.

After spending a couple of days thinking about it, however, I realized that this was an opportunity for me to put into practice something I had preached and tried to implement at a company I worked for in the private sector—that communications and productivity increase in an open office environment. To really put it to the test, I also assigned myself an open cubicle space.

Ask rsf@nrel.gov

“Can you please dispel the rumor that we aren’t going to be able to have 2 monitors? Most of the analysts in my group use two monitors and consider them essential to their tasks.”

“Can you provide more info on what technology/method will be used to filter the tap water in the RSF? We are hoping that we will no longer need a have a bottled “water club” for our office when we move.”

“Smoking is an issue now with sealed windows. How is it being addressed for the RSF with open windows?”

“Can you let us know which windows will be operable and maybe we who have asthma and allergies can sit further from those open windows. Will we be hanging fly strips and given butterfly nets to catch the bugs & birds?”

Prototyping the RSF workstations

Golden Hill, Bldgs 52 & 7

- Tested workspace configurations
- Tested new technology

Tours invaluable

We learned what worked

We learned the pain points



Employee concerns – post move

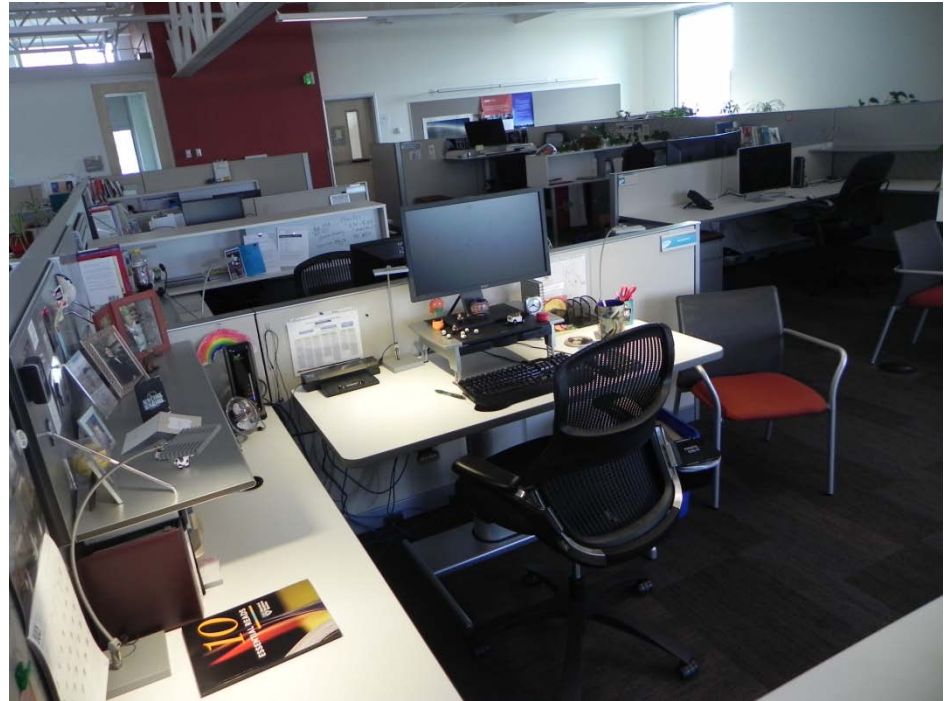
Noise

Lights

Temperature

Paper towels

... and more



“I heard there were mice in the RSF. Is this true? What types of things were done to exterminate or relocate them?”

Employee feedback

One year later

- Huddle Room availability
- Temperature
- Noise

The good news

- Open workstations mean improved collaboration

The bad news

- Open workstations mean more noise



Celebrating our success



**We continue to celebrate our building's success with staff...
and they continue to learn how they impact that success.**



Innovation for Our Energy Future

NREL's Research Support Facility Workshop – Occupant Impact on Energy Consumption



David Mooney

Energy Systems Integration Center

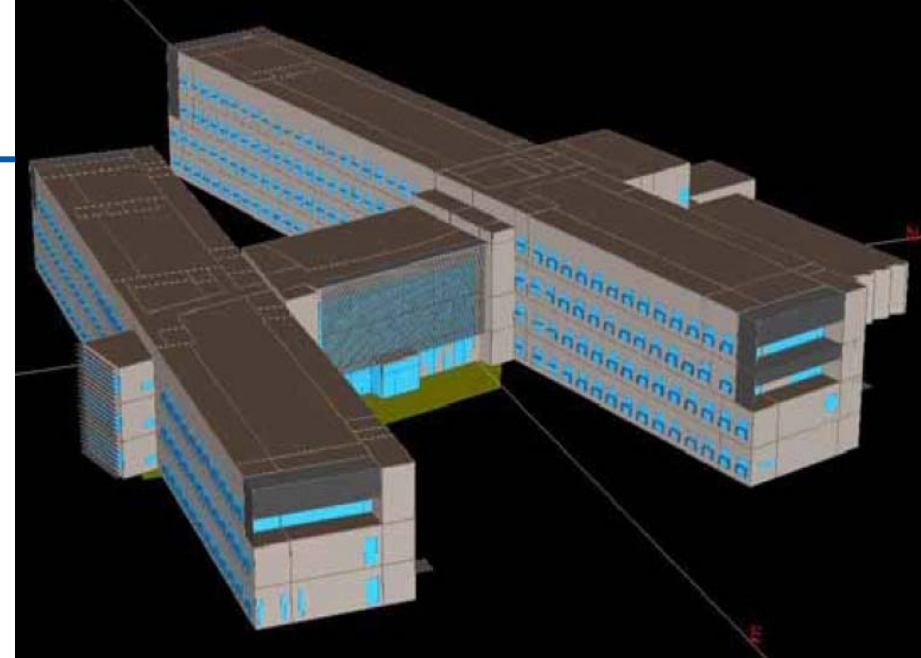
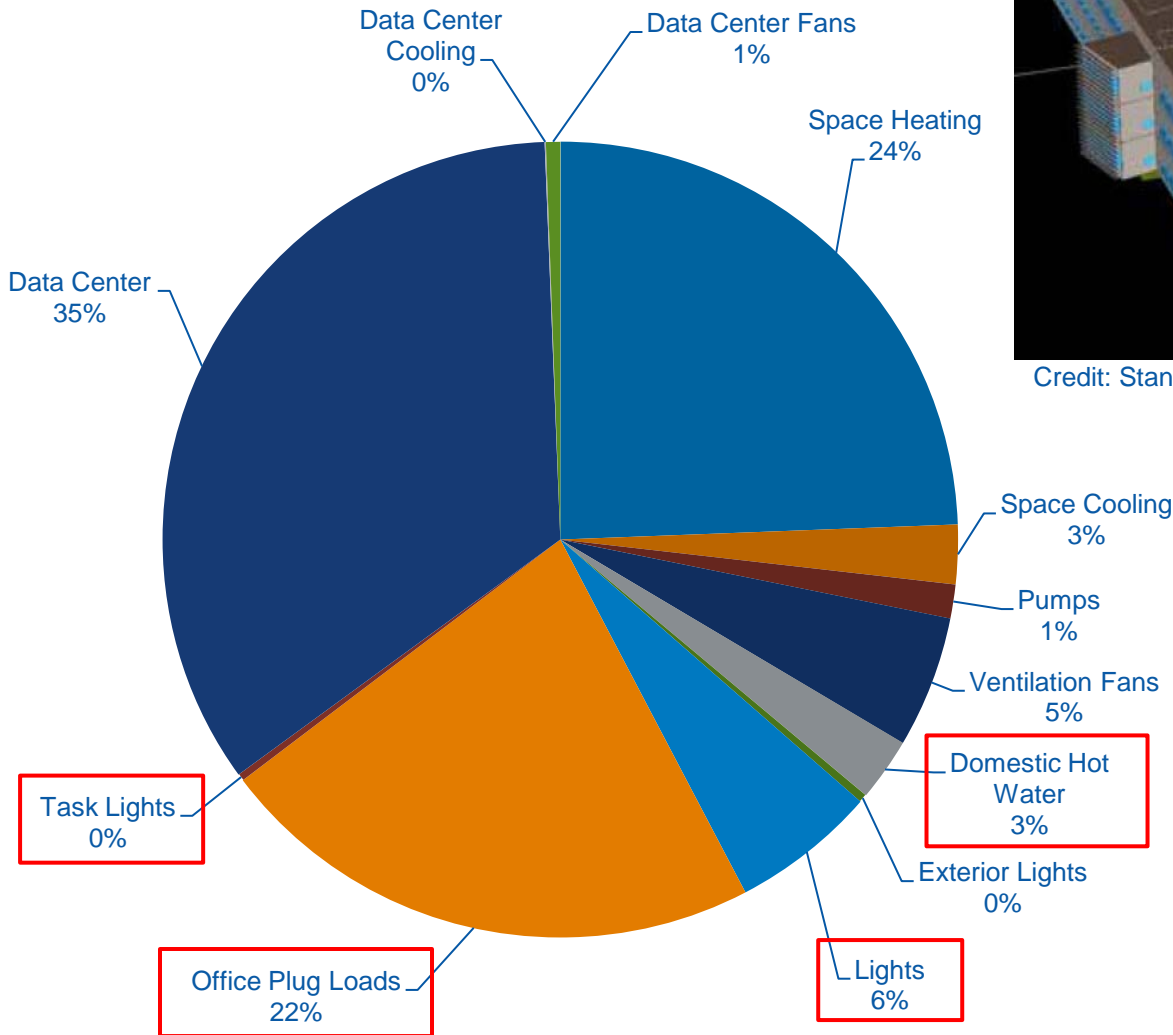
July 2011



Even with high-performance, innovative building features, we have found that **30% of building performance** is related to occupant behavior.

Energy Modeling

NREL RSF Energy Use Breakdown



Credit: Stantec

End Use	kBtu/ft ²
Space Heating	8.58
Space Cooling	0.85
Pumps	0.48
Ventilation Fans	1.88
Domestic Hot Water	0.90
Exterior Lights	0.12
Lights	2.07
Office Plug Loads	7.87
Task Lights	0.10
Data Center	12.11
Data Center Cooling	0.02
Data Center Fans	0.20

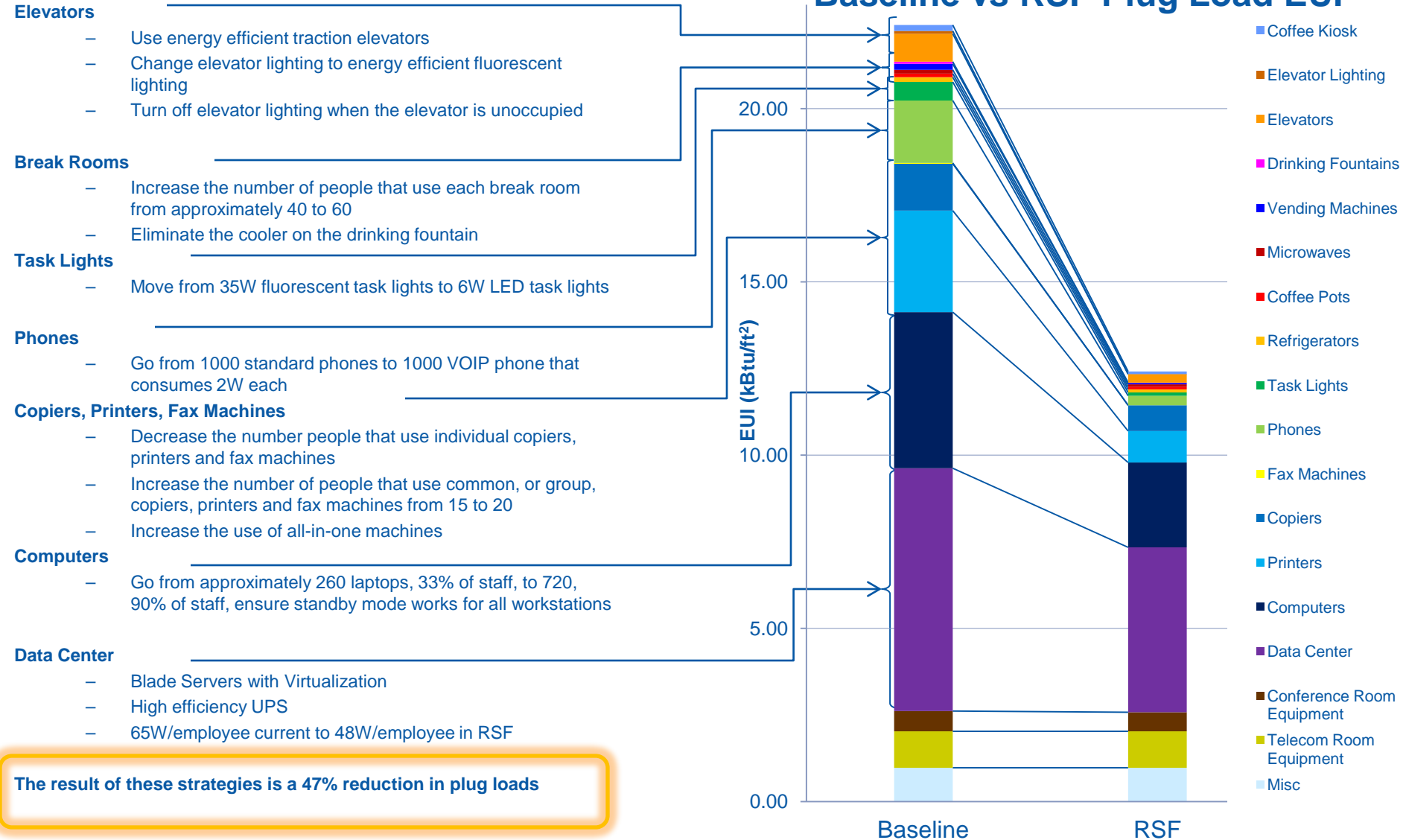
Credit: Chad Lobato/NREL

Occupant Interactions and Controls

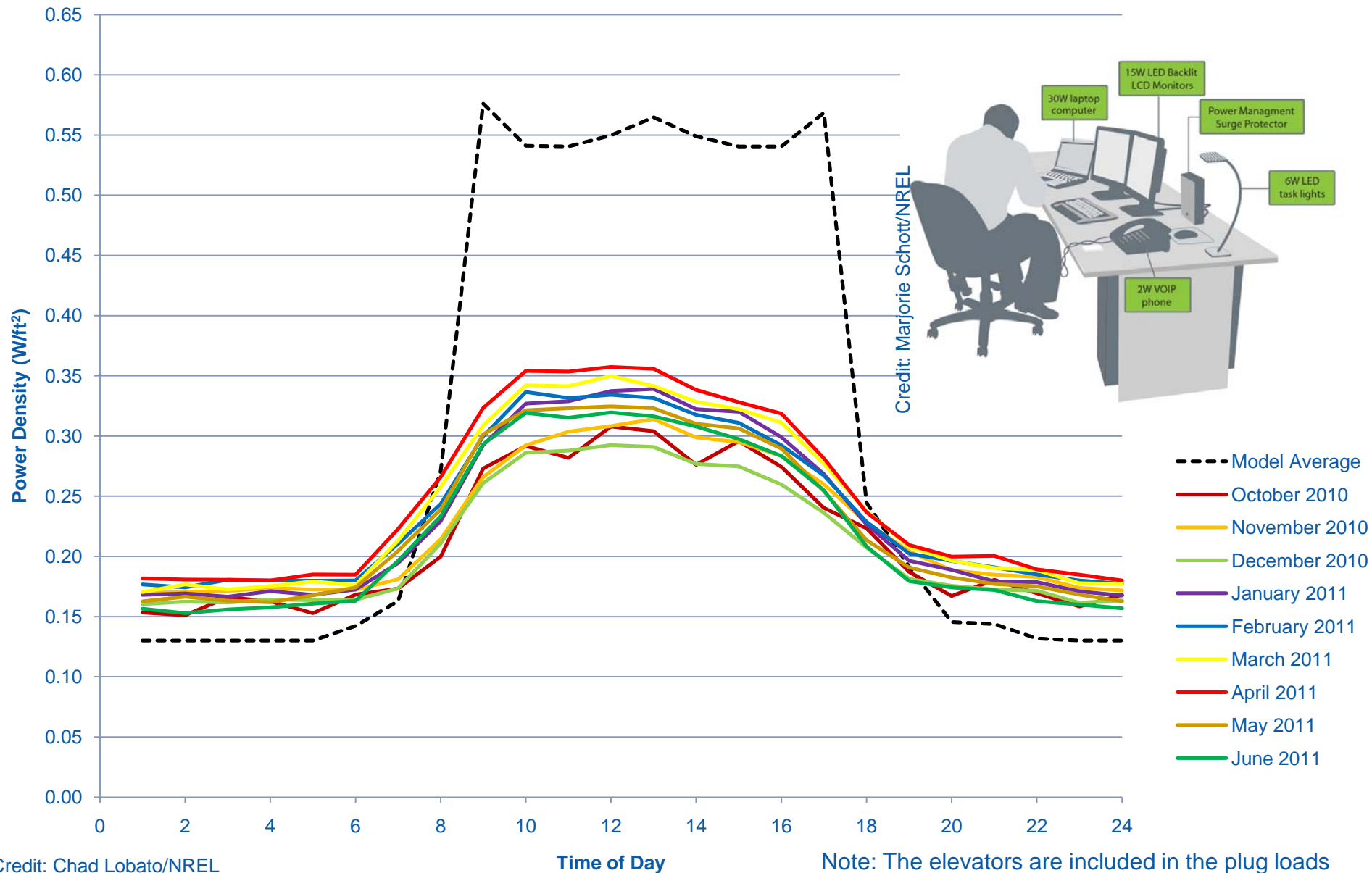
- Occupant control of the lighting system
 - Manual on, auto off
- Operable windows
 - Manual open – occupant notification
 - Auto open overnight

RSF Plug Load Reduction Strategies

Baseline vs RSF Plug Load EUI



October 2010 – June 2011 Plug Load Power Density

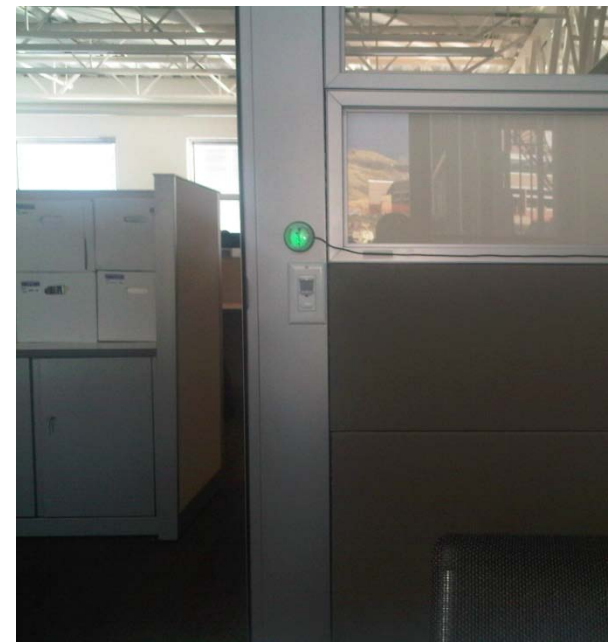


Credit: Chad Lobato/NREL

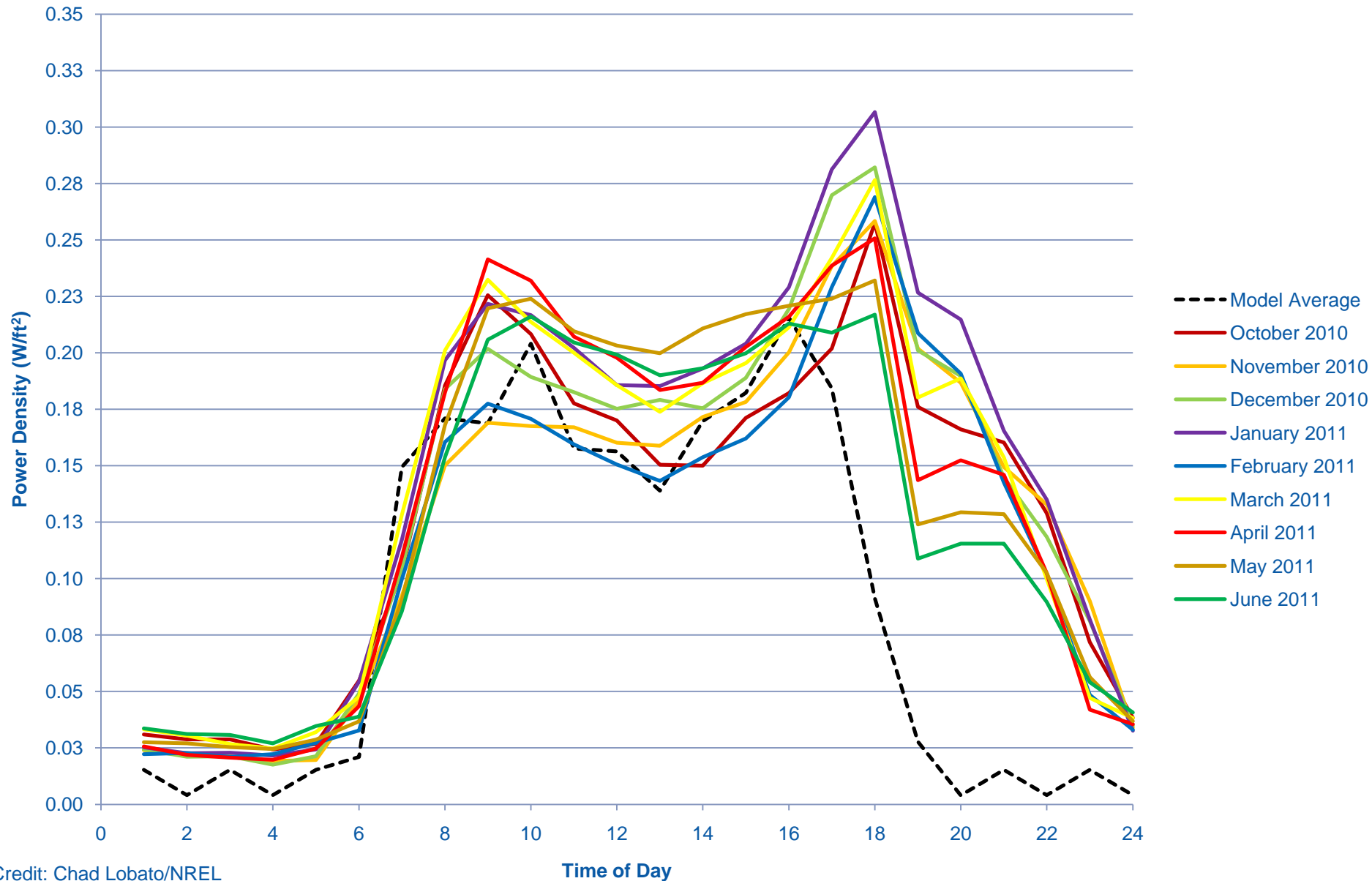
Note: The elevators are included in the plug loads

Operations Lessons – Plug loads

- Daytime loads lower than predicted
 - Model did not account for actual occupancy
- Nighttime loads still difficult
 - Programmable outlets added after the fact
 - Automatic Laptop standby/hibernate functionality deployed system-wide
 - Staff have not fully utilized desktop based power strip controls
- Need to develop an optimal workstation plug load control system
 - Programmable power strips to disconnect all plugs at night?
 - Easy to use office plug load disconnect switch?



October 2010 – June 2011 Lighting Power Density



Credit: Chad Lobato/NREL

Operational Lessons- Lighting Controls

- Vacancy sensors in enclosed offices successful
- Night sweeps turn off all lights (almost)
 - 2-3 kW of lights (1%) on at night (~700 W are control parasitic)
- Have had to provide a few control modifications to unique workstations
 - 2 task lights
 - Remove daylighting controls in one space because daylighting blocked by datacenter and break room

www.nrel.gov/rsf

