



Getting to Net Zero Today Through a Performance-Based Design/Build Process

Welcome to the Webinar! We will start at 12:00 PM Eastern Standard Time

Be sure that you are also dialed into the telephone conference call:

Dial-in number: (888) 889-6351; Pass code: 9095212

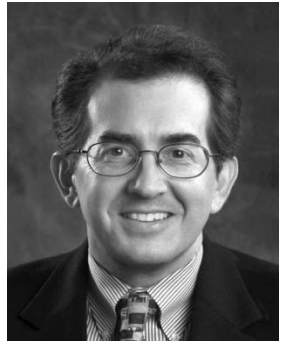
Download presentations at <http://www.buildings.energy.gov/webinars.html>

There will be a Q&A session at the end. Questions will be submitted electronically and answered verbally. Submit your questions by selecting “Q&A” on the menu at the top, click in the top box, type your question and click “Ask.”

Today's Speakers



Jeff Baker is Director, Office of Laboratory Operations for the Office of Energy Efficiency and Renewable Energy's (EERE) Golden Field Office located in Golden, Colorado. Mr. Baker oversees the National Renewable Energy Laboratory's (NREL) Management & Operating contract and leads a multi-disciplined team to ensure the Department of Energy's (DOE) mission and operational expectations of NREL are fulfilled. He has served in operational, management, and executive capacities in DOE field and headquarters organizations, and is a principal in the development of NREL's sustainable campus, including the Research Support Facility.



Phillip Macey, AIA, LEED AP, leads the Energy and Architecture delivery process at Haselden Construction and is the Design/Build Project Manager for the NREL Research Support Facility. As a licensed architect with more than 23 years of specialized expertise in the design of laboratory and biotechnology facilities, Mr. Macey has led teams in the creation of challenging advanced technology projects from medical device manufacturing to genomic research. He has recently moved from design into construction to provide leadership and expertise in the collaborative delivery of low and zero energy buildings.



Bill Glover is the Deputy Laboratory Director and Chief Operating Officer at the National Renewable Energy Laboratory. He has more than 35 years of experience including extensive DOE facilities operation and maintenance. Before joining NREL, he was an independent consultant and President/General Manager of TENERA Federal Services LLC, and Director of Performance Assurance with EG&G, Rocky Flats. Prior to that, Mr. Glover served for 26 years in the U.S. Navy with multiple tours, including managing a nuclear submarine squadron with more than 3,500 personnel. Glover has a B.A. in Chemistry from the University of Rochester and the equivalent of an M.S. in Nuclear Engineering from Navy Senior Officer Nuclear Power Training.



U.S. DEPARTMENT OF
ENERGY

GOLDEN FIELD OFFICE

Getting to Net Zero Energy Through a Performance-Based Design/Build Process

Jeffrey M. Baker

Director, Office of Laboratory Operations

Golden Field Office

Office of Energy Efficiency and Renewable Energy

U.S. Department of Energy

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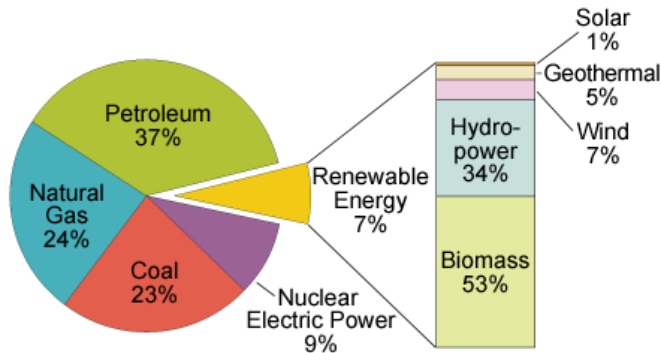
Our National Energy Goals

Security, Economic Competitiveness, Environmental Quality

U.S. Energy Supply

Renewable Energy Plays a Role in the Nation's Energy Supply, 2008

Total = 99.305 Quadrillion Btu Total = 7.301 Quadrillion Btu

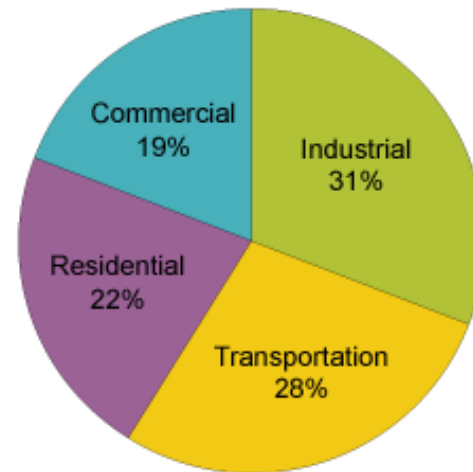


Note: Sum of components may not equal 100% due to independent rounding.

Source: EIA, *Renewable Energy Consumption and Electricity 2008 Statistics*, Table 1: U.S. Energy Consumption by Energy Source, 2004-2008 (July 2009).

U.S. Energy Consumption

Share of Energy Consumed by Major Sectors of the Economy, 2008



Source: Energy Information Administration, *Annual Energy Review 2008*.

Commercial Buildings Must Play a Significant Role in Achieving Our National Goals



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Addressing the Energy Challenge

Department of Energy's Mission

"...to advance the national, economic, and energy security of the United States; to promote scientific and technological innovation in support of that mission..."

Office of Energy Efficiency and Renewable Energy's Mission

"The Office of Energy Efficiency and Renewable Energy invests in clean energy technologies that strengthen the economy, protect the environment, and reduce dependence on foreign oil."

National Renewable Energy Laboratory's Mission

"...to conduct, manage, and integrate long-term, high-risk research and development; technology, policy, and market analyses; and commercialization activities that enable widespread adoption of renewable energy and energy efficiency technologies."

DOE's Overarching Project Goal

Demonstrate that highly energy efficient and marketable net zero buildings can be built using available technologies and techniques today



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Strategy for Superior Energy Design

- What Shaped Our Strategy?
 - Manic Focus on Energy Performance
 - Design and Culture Dictate Energy Performance
 - Whole Building Approach to Integrate Design Solutions
 - Owner/Subcontractor Dialogue Encourages Creativity and Trust
 - Superior Project Definition Reduces Project Risk and Cost to All
 - Traditional Design-Bid-Build Approach Would Not Work
- Key Components of Performance-Based Strategy
 1. Performance-Based Request for Proposals
 2. National Competition for Conceptual Design
 3. Design-Build Acquisition Strategy
 4. Power Purchase Agreement

Developing a Performance-Based Request for Proposals

Tier 1: Mission Critical Goals

- Mission Critical
- Attain Safe Work/Design
- LEED Platinum
- Energy Star “Plus”

Tier 2: Highly Desirable Goals

- 800 Staff Capacity
- 25k BTU/sf/year
- Architectural Integrity
- Honor Future Staff Needs
- Measurable ASHRAE 90.1
- Support Culture and Amenities
- Expandable Building
- Ergonomics
- Flexible Workspace
- Support Future Technologies
- Documentation to Produce “How To” Manual
- Allow Secure Collaboration with Visitors
- Completion by 2010

Tier 3: If Possible Goals

- Net Zero Energy
- Most Energy Efficient Building in the World
- LEED Platinum Plus
- 50% Better than ASHRAE 90.1
- Visual Displays of Current Energy Efficiency
- Support Public Tours
- Achieve National and Global Recognition and Awards
- Support Personnel Turnover

- \$64M Project Cost Limit
- Up-Front Planning Drives Success
 - Design Charrettes
 - Design Build Institute of America
 - Owner’s Representatives
- Design Challenge
 - Suite of Performance Goals to Challenge Team
 - Substantiation Criteria

National Design Competition

- National Request for Qualifications to Identify Field
- Draft RFP Provided to Best Three
 - Improve Understanding and Definition of the Project’s Goals
 - Separate Information Workshops
 - Information Shared with All Teams
 - Trade-Off Discussions
- Final RFP Included
 - Well Defined “Progressive” Design-Build Strategy
 - Performance Goals and Substantiation Criteria
 - Two-Step Design Effort with Off-Ramps to Control Risks for All
 - \$200K Stipend to Defray Conceptual Design Development Cost
- Competition Resulted in Multiple Solutions to the Problem
 - Team Selected on Strength and Solutions
 - DOE Owns Non-Selected Designs

Design-Build Acquisition Strategy

- Differs Dramatically from Traditional Design/Bid/Build
- Requires Strong Owner/Design-Build Team Commitment
- Energy Modeling Governs Performance/Cost Tradeoffs
- Two-Step “Progressive” Design-Build Strategy
 - Step 1: Preliminary Design Reduce Risk for All Parties
 - Results in Firm-Fixed Price DB Contract or Decision Not to Proceed
 - Step 2: Construction Initiated while Final Design Completed
 - “Progressive” Approach Uses Three Macro Design Packages
- Design-Build Benefits
 - Identifies, Reduces, and Allocates Risk to All Parties
 - Encourages Performance /Cost Trade-offs
 - Accelerates Project Delivery

Achieving Net Zero

- Super Energy Efficient Design Enables Net Zero
 - 50% or Better Efficiency Improvement is Required
- Photovoltaic (PV) Panels Added to Roof and Supporting Site Structures to Achieve Net Zero
- PV Panels Acquired through Power Purchasing Agreement
 - Third-Party Pays Capital Cost
 - Capital and Operational Costs Recovered through Long-term Energy Purchase

How Did We Do?

- What We Wanted

- 800 Employees
- LEED Platinum
- 50% Better than ASHRAE 90.1-2007
- Net Zero Energy Goal
- Replicable Whole Bldg Design Process
- Competitive Cost for Class A Space
- As Many Mission, Desirable, and If Possible Goals as Achievable

- What We Got

- 825 Employees
- LEED Platinum (59 Points)
- 50% Better than ASHRAE 90.1-2007
- Net Zero Site Energy Using Photovoltaics
- Documented Design Process
- 220K gsf @ \$259/gsf of Class A Space
- Every Mission Critical, Highly Desirable, and If Possible Performance Goal Achieved



“We know the country that harnesses the power of clean renewable energy will lead the 21st Century”

President Obama to Congress, 2/09

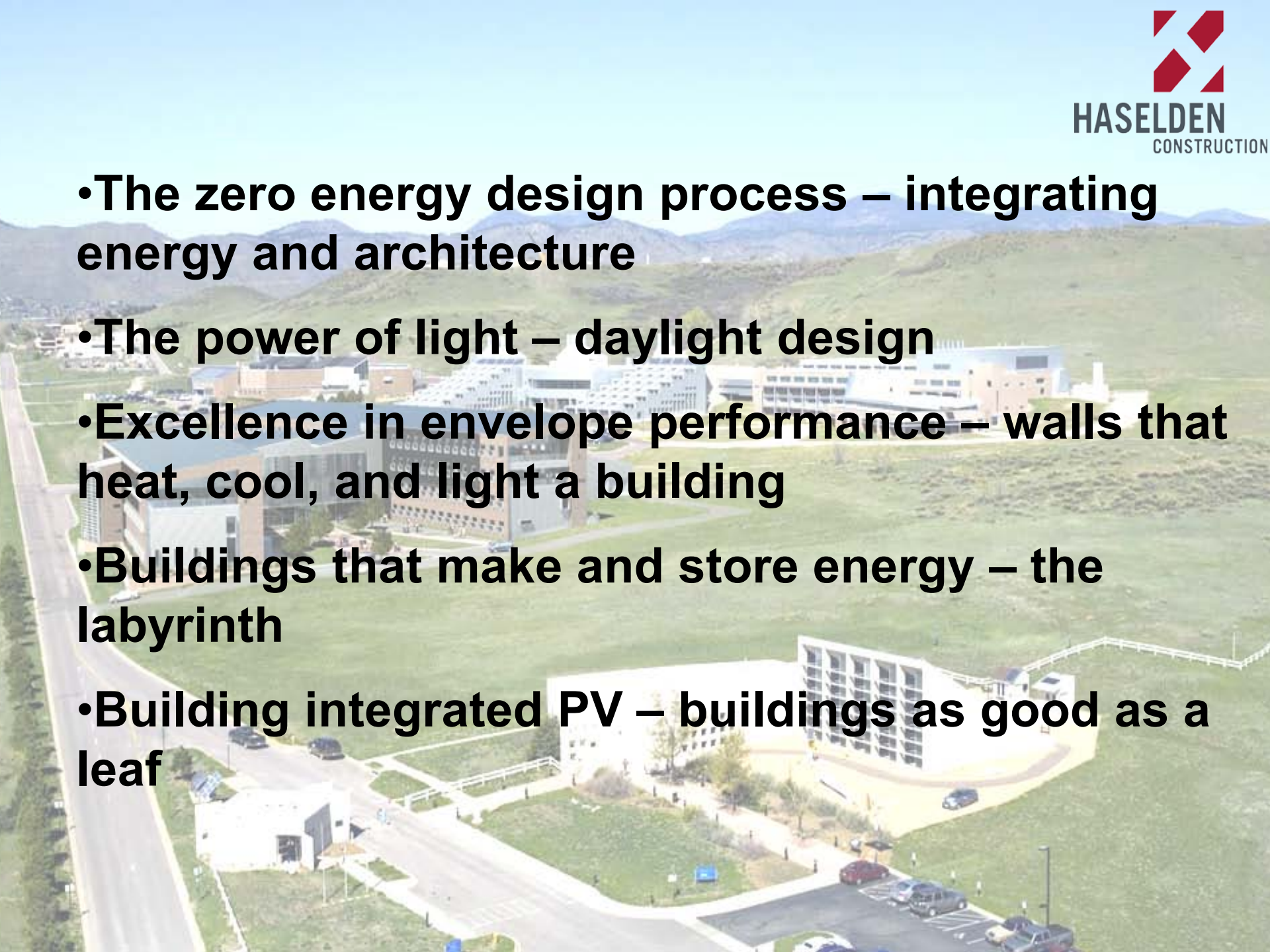


HASELDEN
CONSTRUCTION



Design elements & significant features of the RSF

Philip Macey, Design-Build Project Manager AIA LEED AP

- **The zero energy design process – integrating energy and architecture**
 - **The power of light – daylight design**
 - **Excellence in envelope performance – walls that heat, cool, and light a building**
 - **Buildings that make and store energy – the labyrinth**
 - **Building integrated PV – buildings as good as a leaf**
- 

Problem Definition – Proposal Objectives Checklist

MISSION CRITICAL

Attain safe work performance/Safe Design Practices
LEED Platinum
Energy Star first “Plus”

HIGHLY DESIRABLE

800 staff Capacity
25kBTU/sf/year
Architectural integrity
Honor future staff needs
Measurable ASHRAE 90.1
Support culture and amenities
Expandable building
Ergonomics
Flexible workspace
Support future technologies

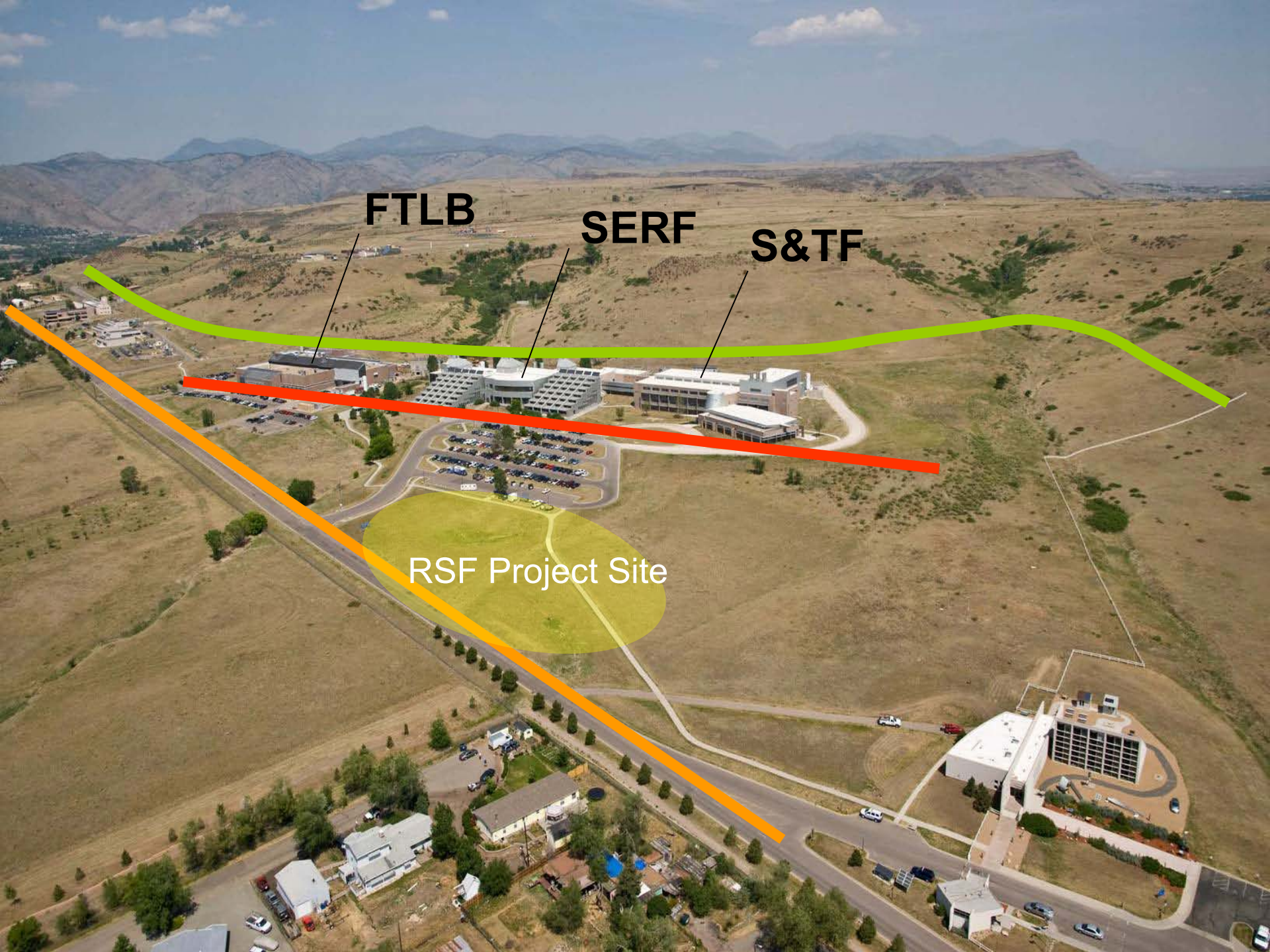
Documentation to produce a “How to” manual
“PR” campaign implemented in real-time
Allow secure collaboration with outsiders
Building information modeling
Substantial Completion by 2010

IF POSSIBLE

Net Zero/design approach
Most energy efficient building in the world
LEED Platinum Plus
ASHRAE 90.1 + 50%
Visual displays of current energy efficiency
Support public tours
Achieve national and global recognition and awards
Support personnel turnover

The image features a grid of solar panels with a blue tint. The panels are arranged in a regular grid pattern, and the overall color scheme is a vibrant blue. The text 'ZERO ENERGY BUILDING' is centered horizontally and vertically across the image in a bold, white, sans-serif font. The background image shows the texture of the solar panels and the grid lines, creating a sense of a large-scale renewable energy installation.

ZERO ENERGY BUILDING



FTLB

SERF

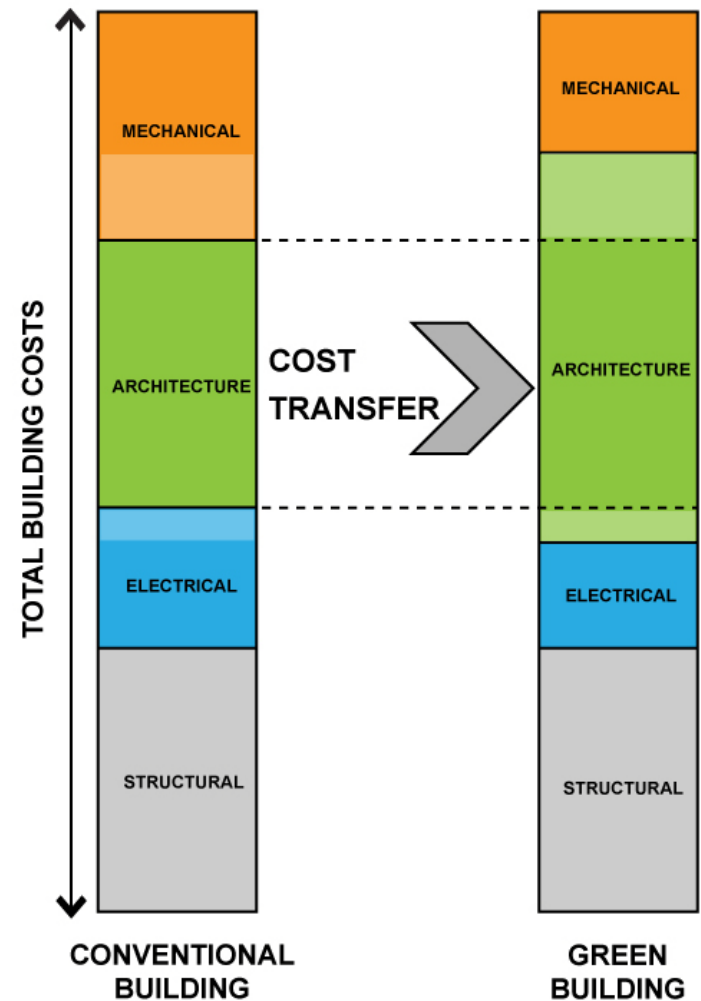
S&TF

RSF Project Site

Integrated Design

Cost Transfer

Transfer costs from mechanical and electrical systems to building architecture



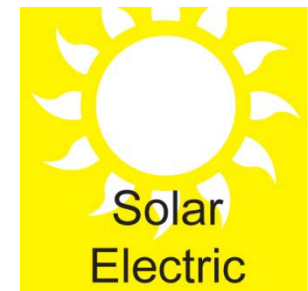
Integrated Design

Design Simulations

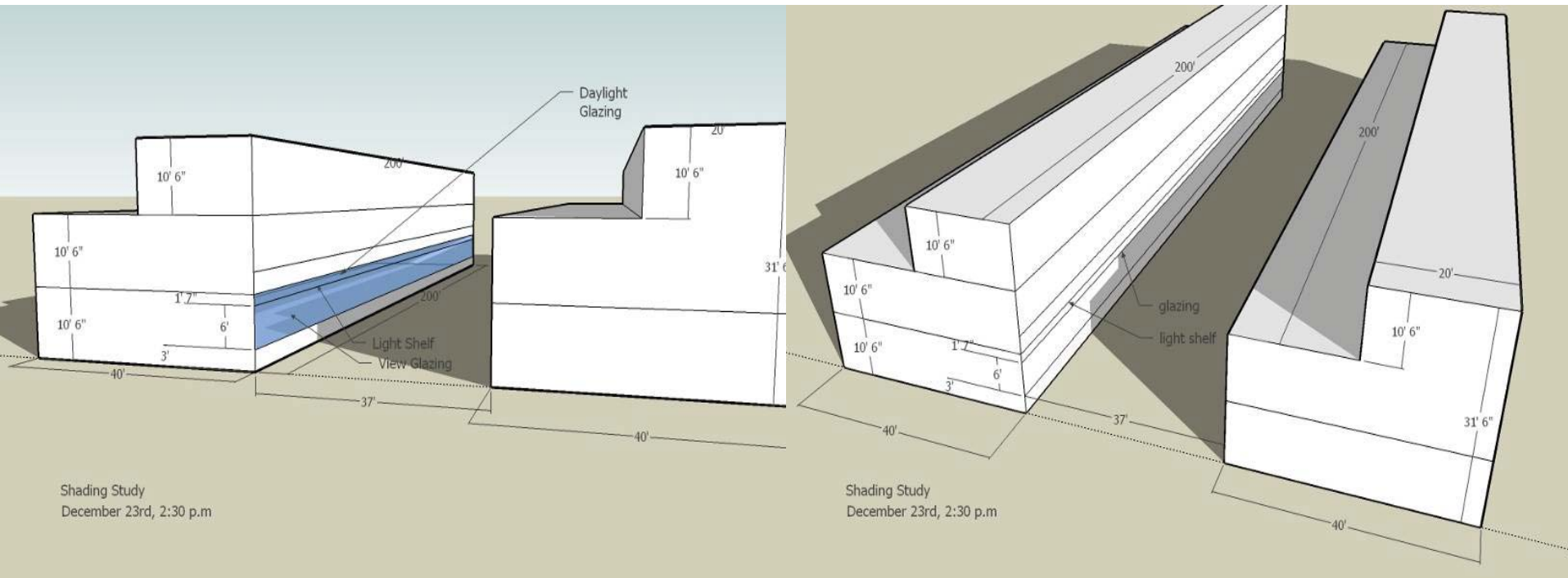
- Energy modeling
- Daylight modeling
- Natural ventilation modeling
- Thermal mass modeling
- **And all must meet the Cost Model**

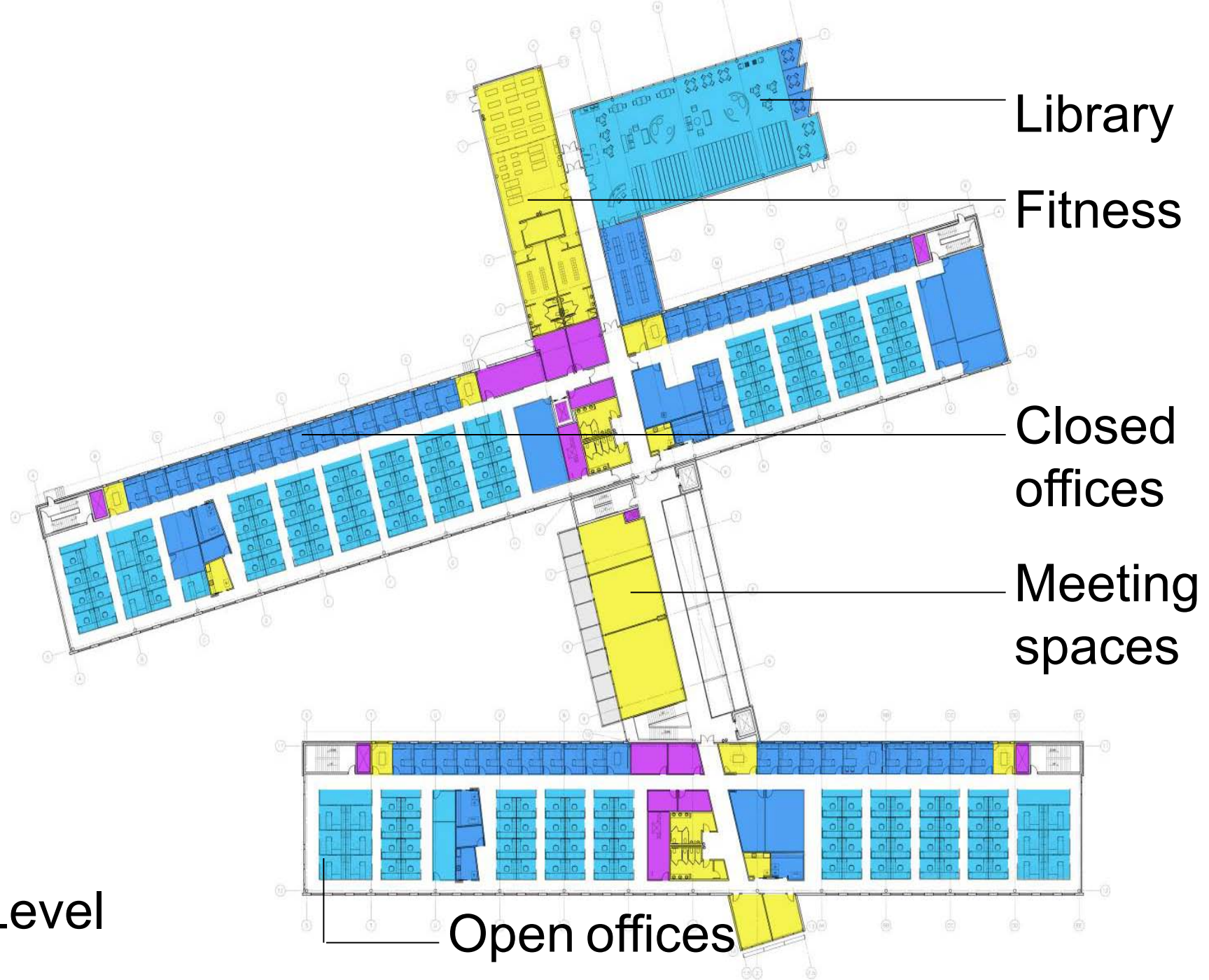
Zero Energy Strategies

DL Daylight	SD Shading	NV Natural Ventilation	TC Transpired Collector
UF Underfloor Air	LL Low Energy Lighting	RS Radiant Slabs	EV Evaporative Cooling
TM Thermal Mass	NP Night Purge	WP Wind Protection	GI Green IT



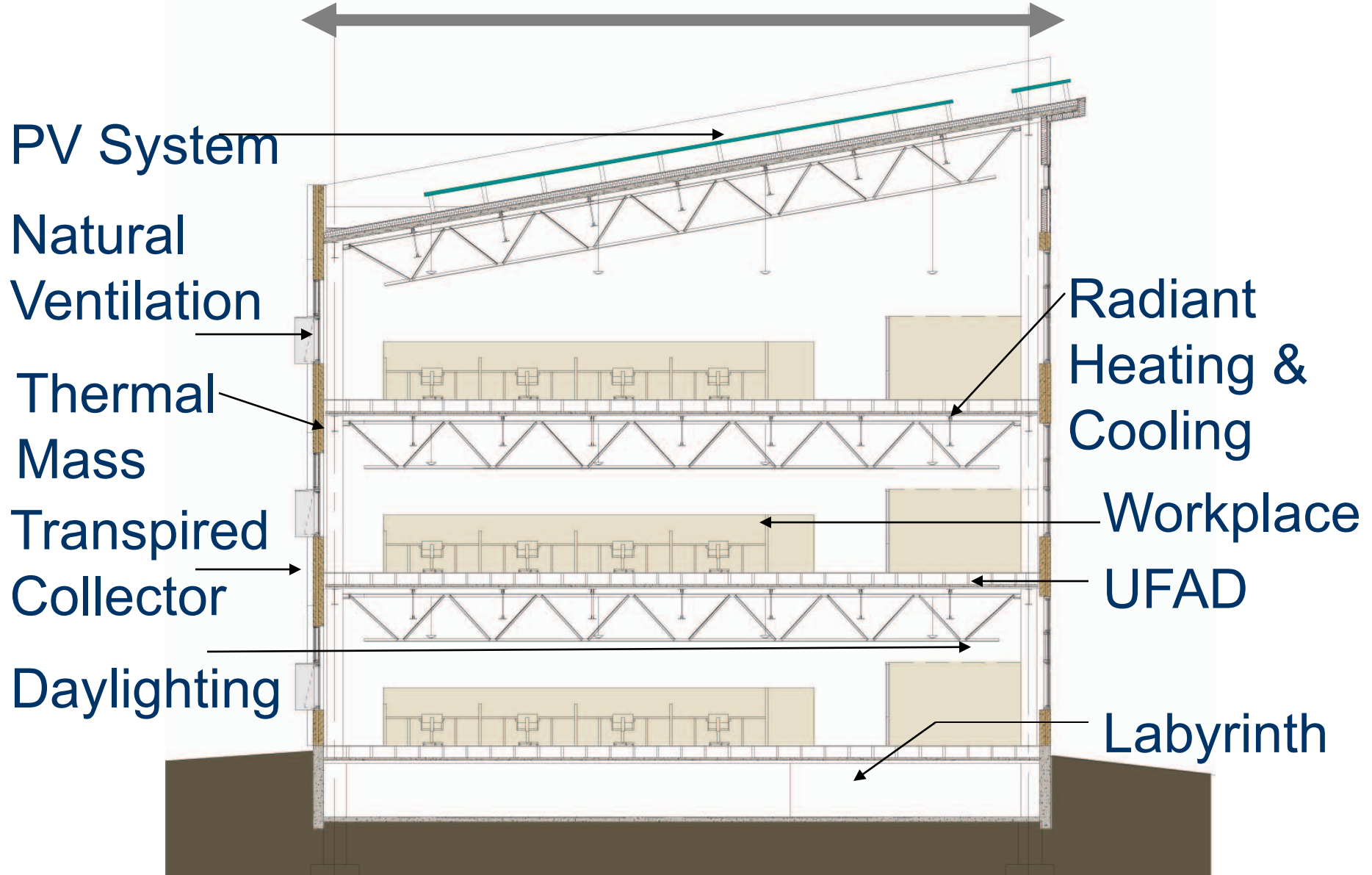
Energy and Architecture





2nd Level

The Section 60'



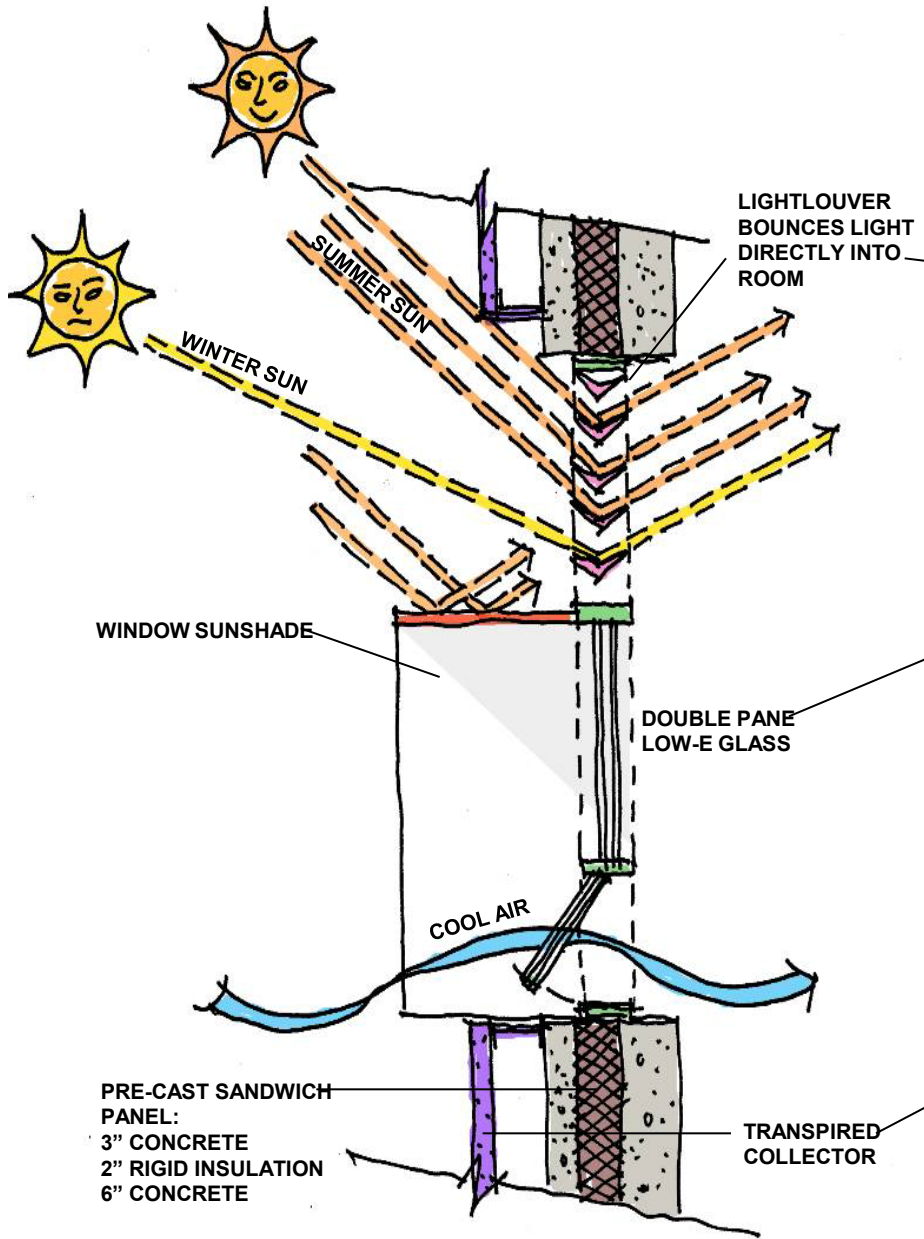
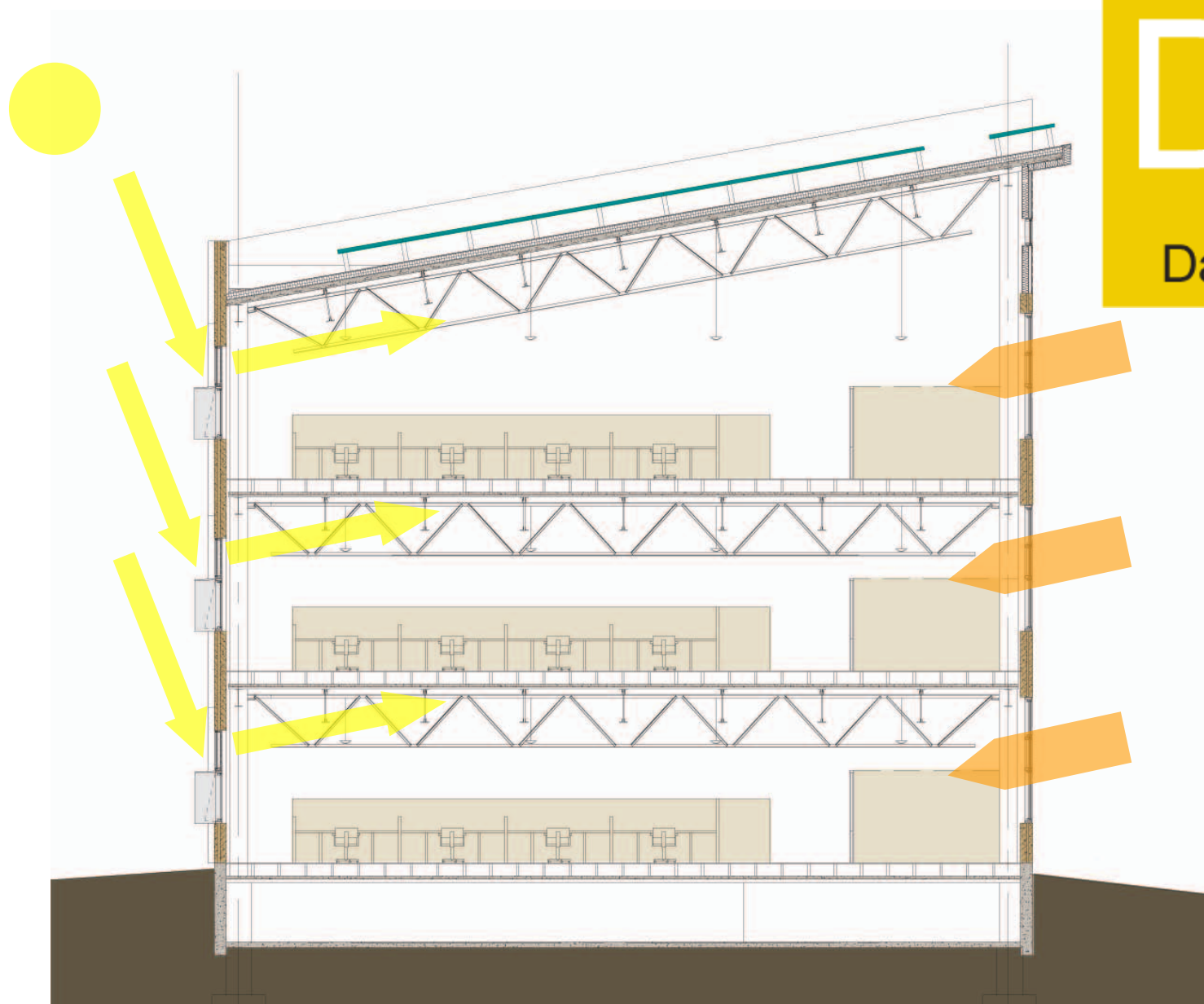


FIGURE #1
NREL



The Section – Day lit Interiors

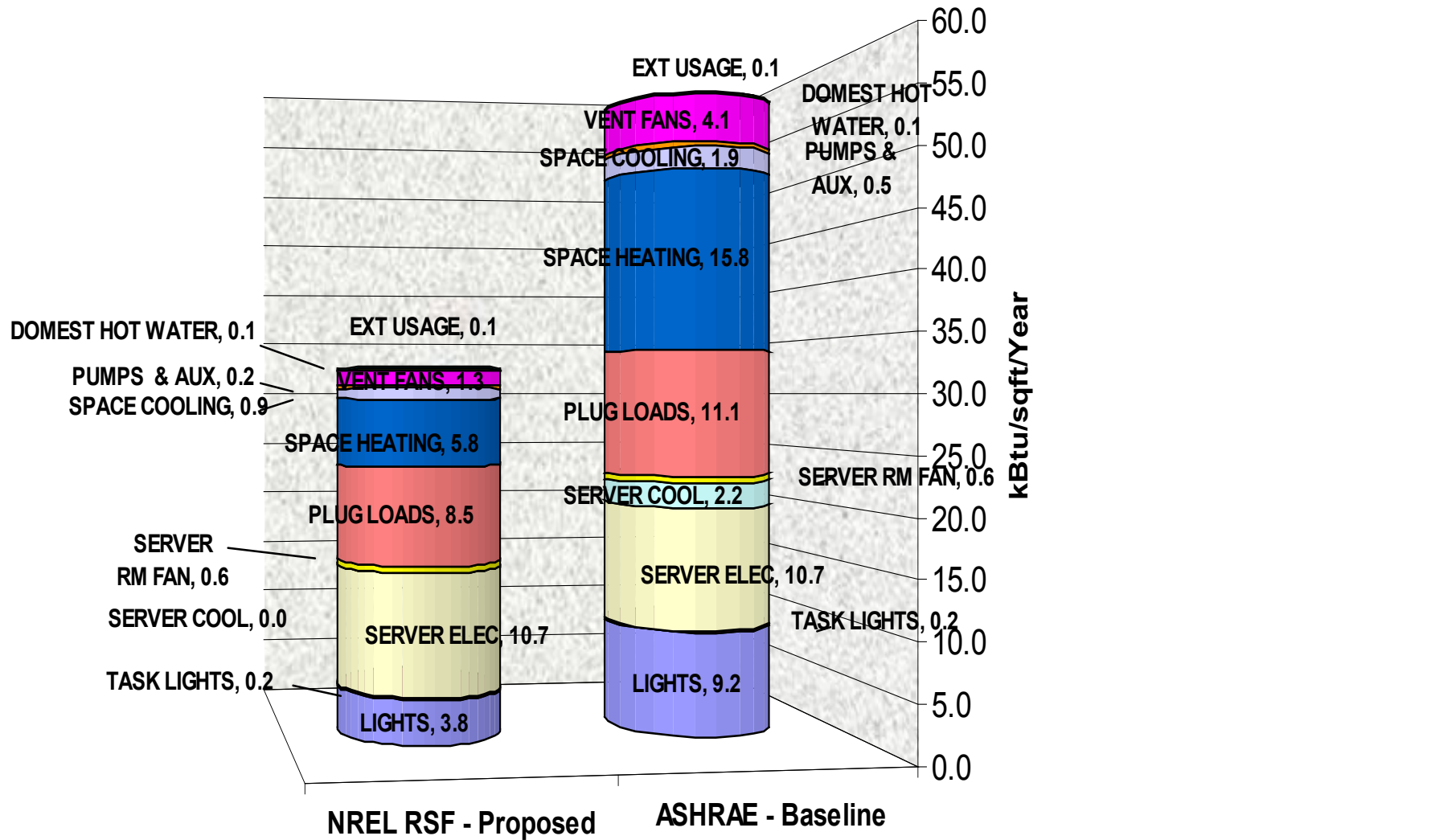


DL
Daylight

Workplace - Interiors



NREL RSF Annual Energy Consumption Comparison

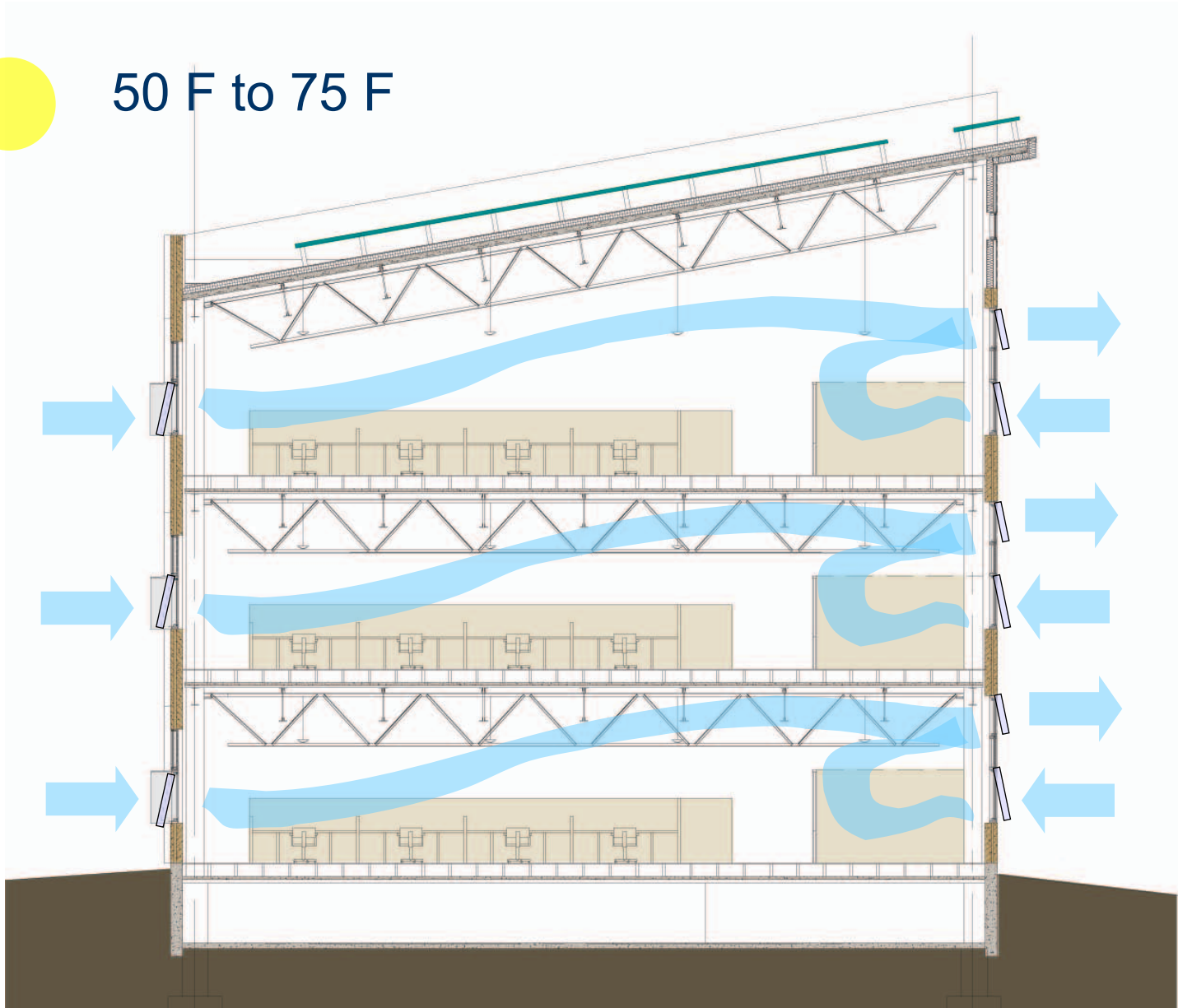


- LIGHTS
- TASK LIGHTS
- SERVER ELEC
- SERVER COOL
- SERVER RM FAN
- PLUG LOADS
- SPACE HEATING
- SPACE COOLING
- PUMPS & AUX
- VENT FANS
- DOMEST HOT WATER
- EXT USAGE

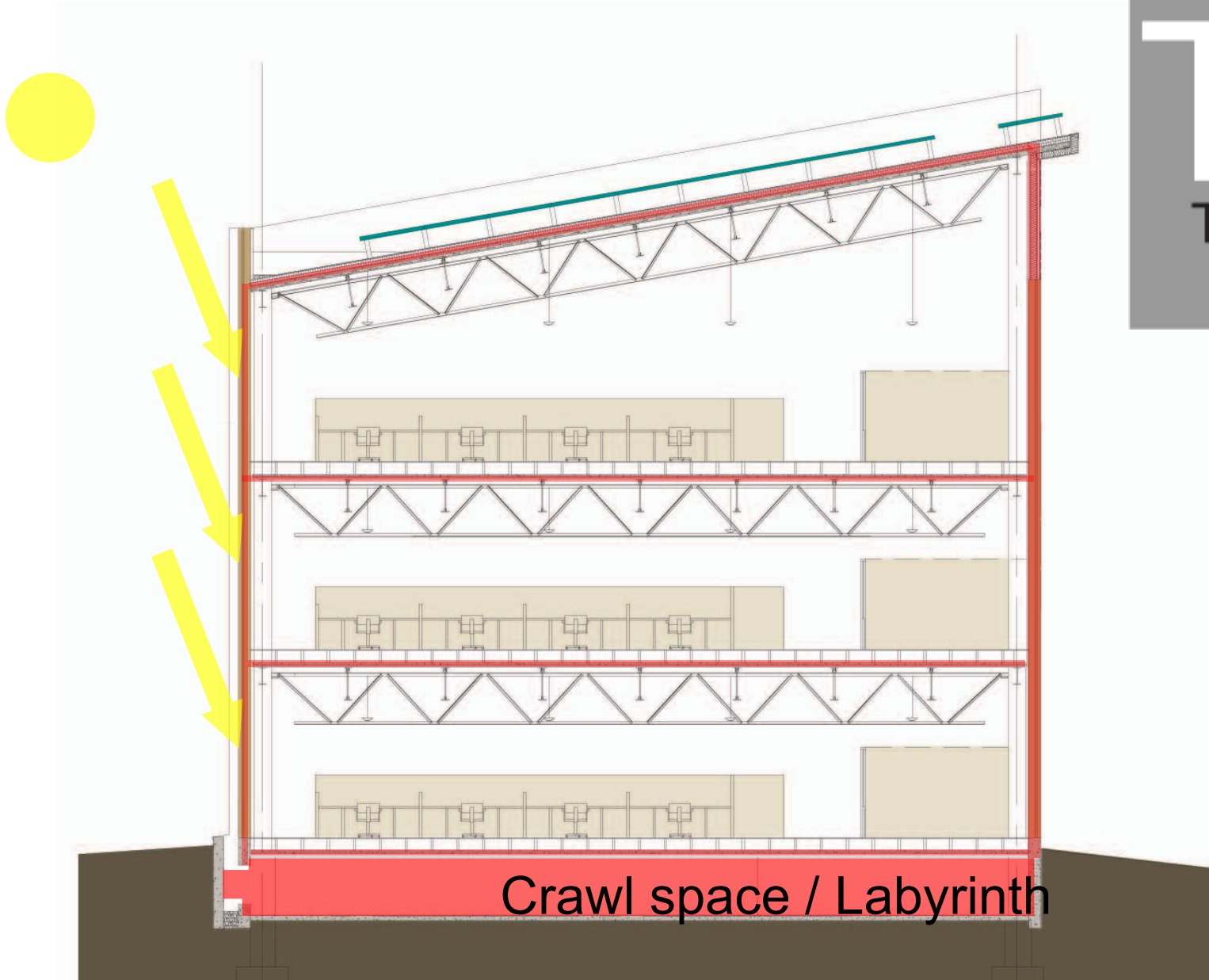
Natural Ventilation - Summer Day



50 F to 75 F

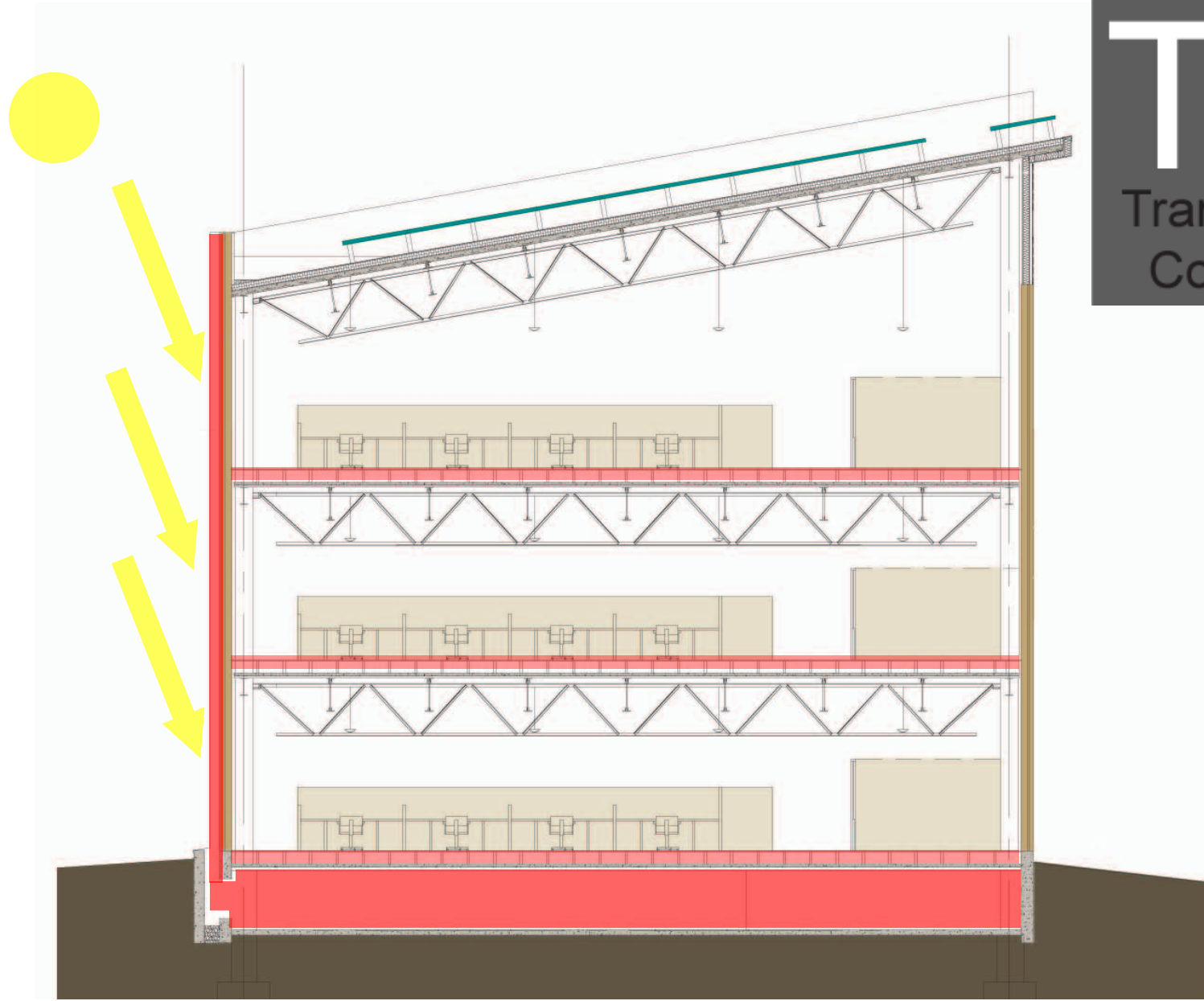


The Section – Thermal Mass



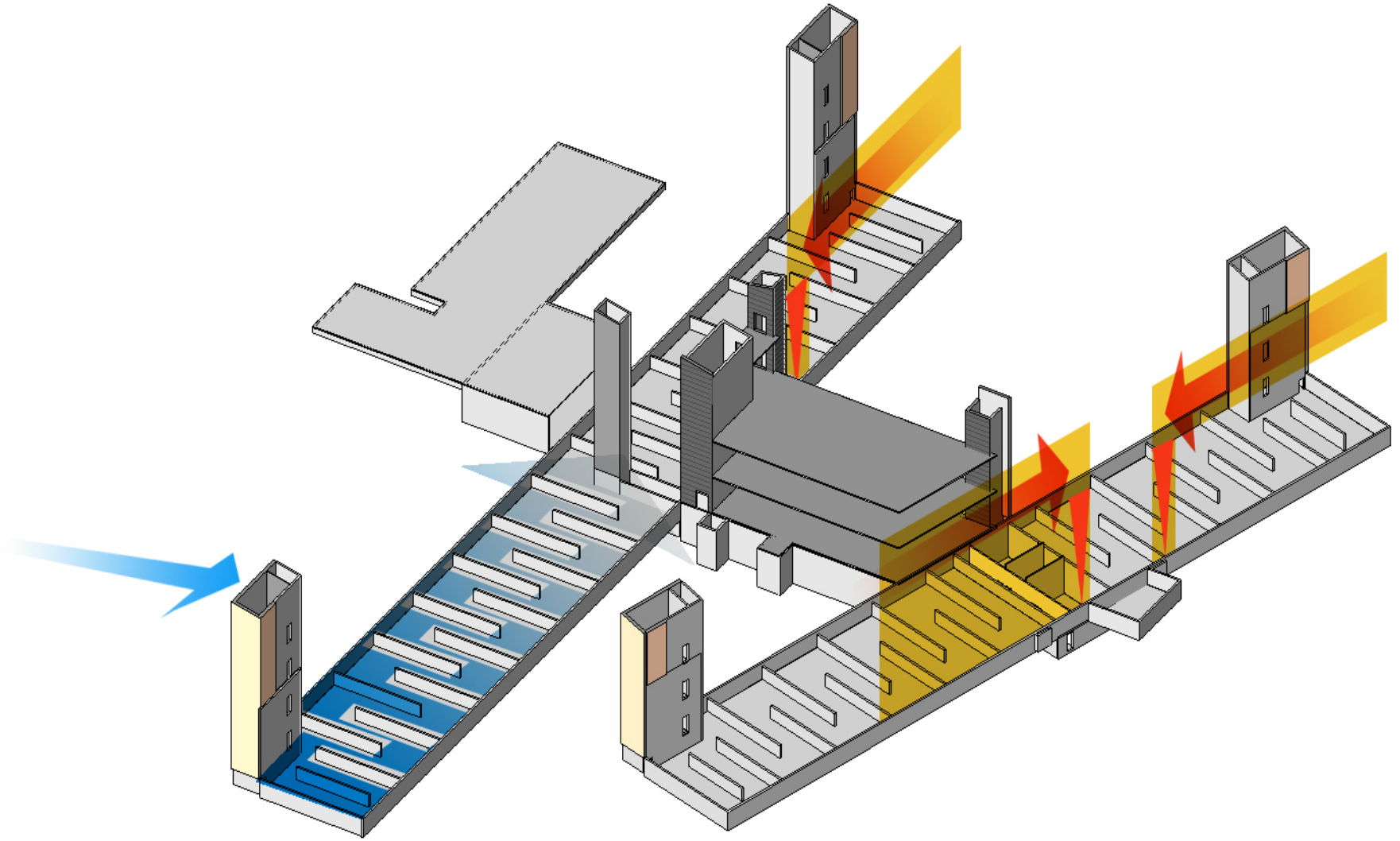
TM
Thermal
Mass

The Section – Transpired Collector

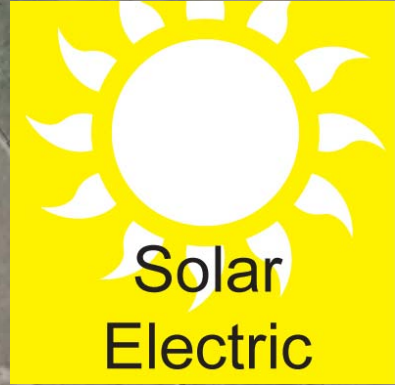


TC
Transpired
Collector

Labyrinth – the energy battery



Photovoltaic System



598 KW

- Power Purchase Agreement (PPA) provides full rooftop array

- Zero energy = building, parking lot and future parking garage arrays

668 KW



Office Place of the Future



**Building Technologies
Program Webinar:
Getting to Net Zero
Today**

**William Glover, NREL
Deputy Laboratory
Director and COO**

March 18, 2010

Research Support Facility

Upon completion, RSF I will be the largest net zero office building in the U.S.

- ~ 800 Staff
- 220,000 sf

Cutting-edge workplace

- Open work environment
 - Natural daylight and operable windows
- Embodies NREL technologies and high-performance building design

Living laboratory

- Real-time building performance data will allow NREL researchers to study building energy use



Research Support Facility

National benchmark for affordable large-scale sustainable commercial building design

- Designed to use 50% less energy than standard office building
 - Money that's saved goes back into R&D
- LEED Platinum energy performance requirements
- Recycled materials used throughout
 - Beetle-kill pine materials
 - Reclaimed natural gas pipelines as structural columns
- Additional sustainable practices
 - ~78% of RSF construction waste is being diverted from landfills
 - Aggregate in the RSF foundations and slabs came from Stapleton Airport
 - RSF will increase NREL's campus square footage by 60%, but increase campus energy use by only 6%



Agenda

- Staff Collaboration and Interaction
- Efficient Design
- Training and Awareness



Collaboration & Interaction

Work environment

Open Workspace

Prototyped and evaluated workspace

- Addressed early staff concerns about privacy, noise

RSF

- Pink noise installed throughout
- Furniture has noise-absorbing fabric
- Acoustic noise-absorbing panels on ceiling and some walls

Workstations

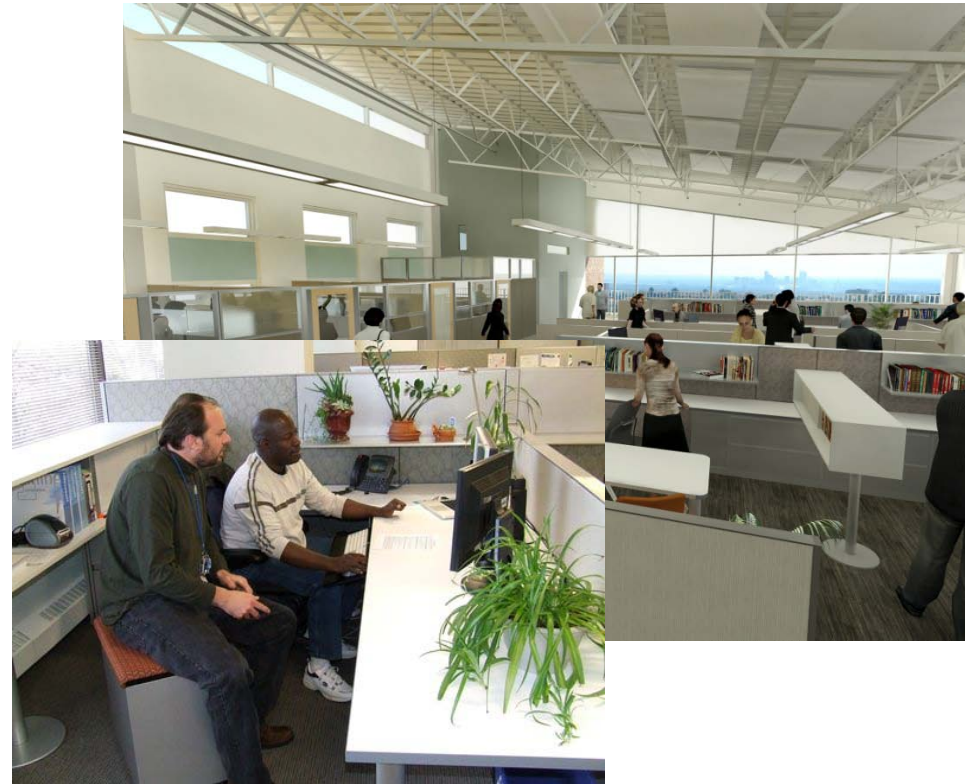
- Low walls
 - Workstation panels 42" high
 - Bookshelves between workstations at 54"

Management-level workstations

- 6' with doors
- Open ceilings to support efficiency

Daylighting

- Certified daylighting
- Low walls allow for circulation of air and light



Common Spaces

38 Huddle Rooms

22 Shared Conference Rooms

Lunch area

Information Commons

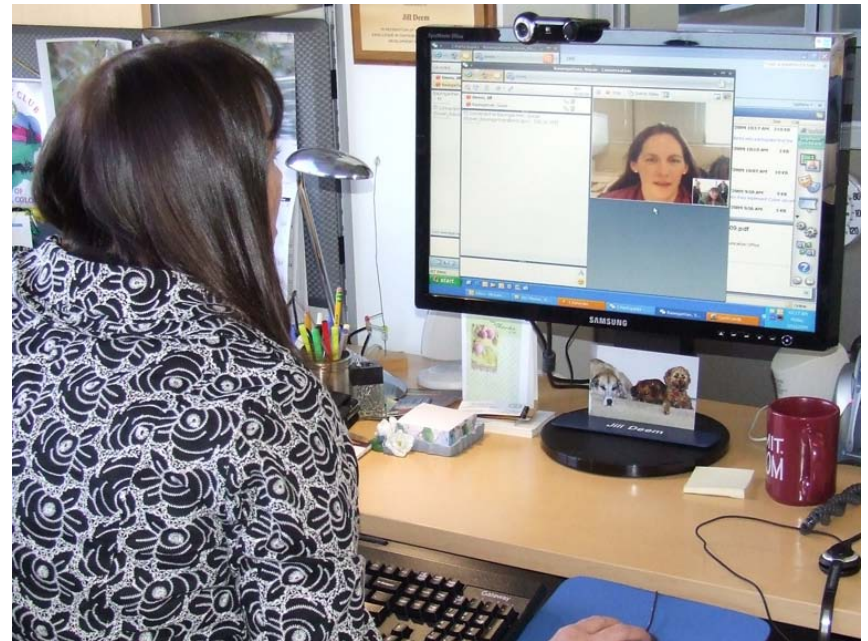
Exterior spaces

- Courtyard
- Balconies



Connectivity

Wireless throughout building
Research and administrative staff
co-located
Virtual meetings
Voice over IP
Telecommuting



Efficient Design

Every Watt Counts

- Whole building energy use = 283 watts continuous per occupant
 - Equivalent to 4-5 incandescent light bulbs per occupant continuous
- For every 1 watt continuous we save, we avoid \$33 of PV needed to offset this 1 watt
- Every watt counts!



Energy Efficient Workspace

24" LCD Energy Efficient
Monitors
25 Watts

24" CRT 200 Watts

Sensor-controlled LED
task lights 15 Watts

Fluorescent task lights 35 Watts

VOIP phones 4 Watts

Laptop 60 Watts
Thin Client 35 Watts
(future)

Desktop Computer (Energy Star)
300 Watts

Removing personal Space
Heater saves 1500 Watts



Removing Desktop
Printers Saves
460 Watts/Printer

Building-wide

Centralized multi-function equipment

- Printers, faxes, copiers

Globally regulated temperature controls

Operable Windows

- Window shading
- Triple glazed
- Temperature controlled operation
- Electrochromic (electric current) windows
- Thermochromic (heat) windows



Building-wide

Radiant heating and cooling

Raised floor (voice and data, power, radiant heating, ventilation)

Building acoustics

Onsite power generation

- Rooftop PV system

Transpired solar collector

- NREL patent



Green Data Center

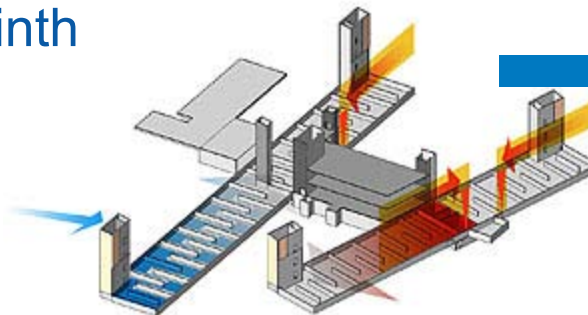
High Efficiency Servers

- Previous individual servers
 - 1 unit servers use 700 watts
 - 4 unit servers use 800-1200 watts
- Blade servers
 - Up to 16 servers in a chassis
 - Uses up to 3600 watts of power or 225/blade virtualized server
 - Running many logical servers on one physical server
 - NREL averages 20 virtualized servers/ individual blade server
 - Equivalent of 320 servers on a chassis @ ~ 13 watts per virtualized server



Power and cooling

- Waste heat recovery for building use
- Outside air via labyrinth
- Evaporative cooling



Training & Awareness

Transition to New Work Space

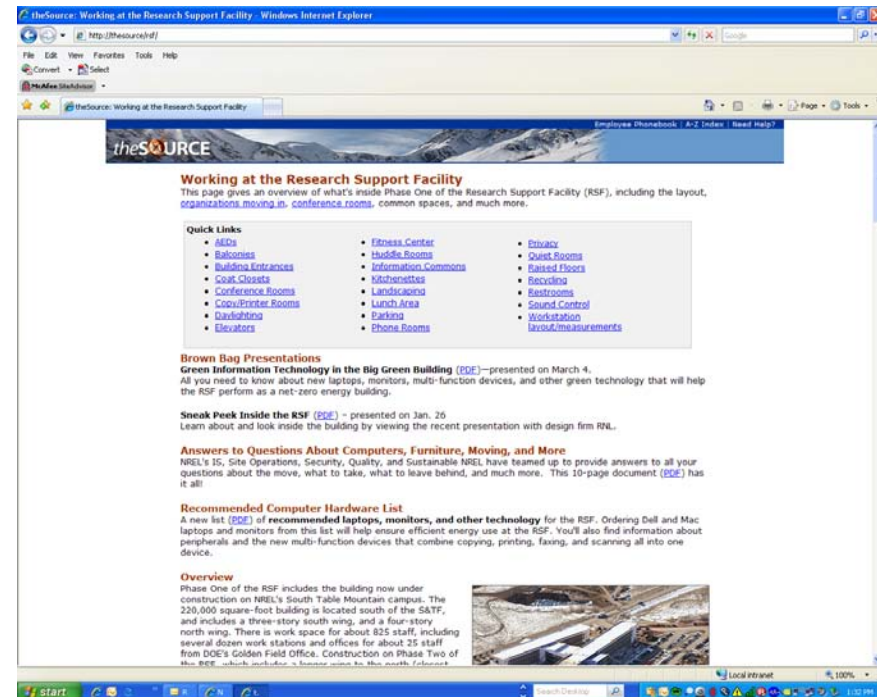
Significant change in work environment = Cultural impacts

Multi-generational workforce

- Acceptance varies

Addressing staff issues and concerns

- Tested and evaluated open work space design
- Education and awareness campaign



Staff Awareness and Education—Internal

Brown bags

Web site

Articles in weekly employee newsletter

RE new Campaign for laboratory employees—Laboratory of the Future

- Blog
- Tours of prototype workspaces
- Brown bags
- E-learning modules
 - Working in the RSF
 - Alternative commuting
 - Tools and resources
- Employee open house

The logo for RE new features the letters 'RE' in a large, bold, green font. The 'R' and 'E' are connected at the top. To the right of 'RE', the word 'new' is written in a smaller, lowercase, green font.

LABORATORY OF THE FUTURE

Stakeholder Outreach—External

Media outreach

- 14 articles to date
- Press kit

Exhibit

Technical papers

- Design/build documentation

Conferences

- NREL speakers/panel discussions

External Web site

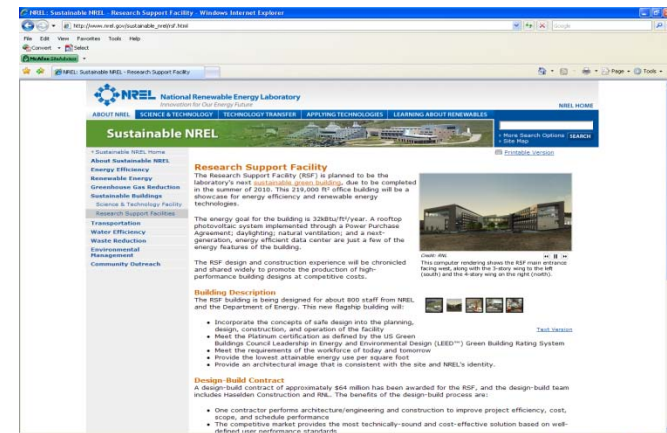
- www.nrel.gov/sustainable_nrel/rsf.html

Community

- Construction updates
- Brown bags
- Economic development organizations
- Community forums

Video

- Vision for RSF
- Virtual tour



Questions?

