U.S. DEPARTMENT OF ENERGY
GOLDEN FIELD OFFICE

Ultra-High Efficiency Commercial Buildings

Office of Energy Efficiency and Renewable Energy's

Research Support Facility

Defining a New National Building Energy Performance Standard
Using
Performance-Based Design-Build Acquisition

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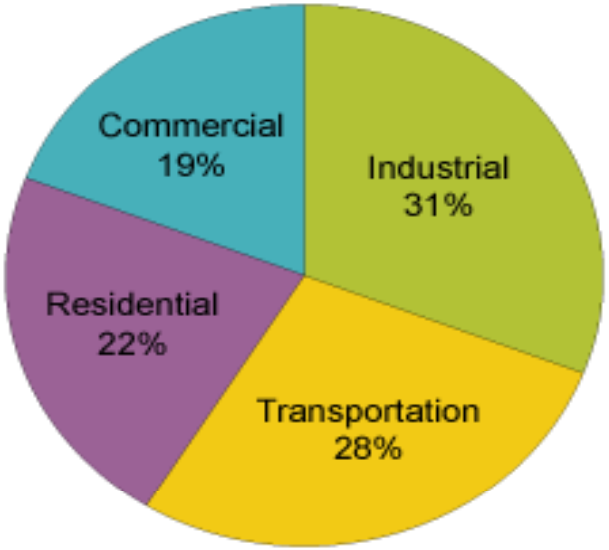
March 15, 2011

Energy Drives National Security, Economic Competitiveness, and Environmental Quality

U.S. Energy Consumption

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

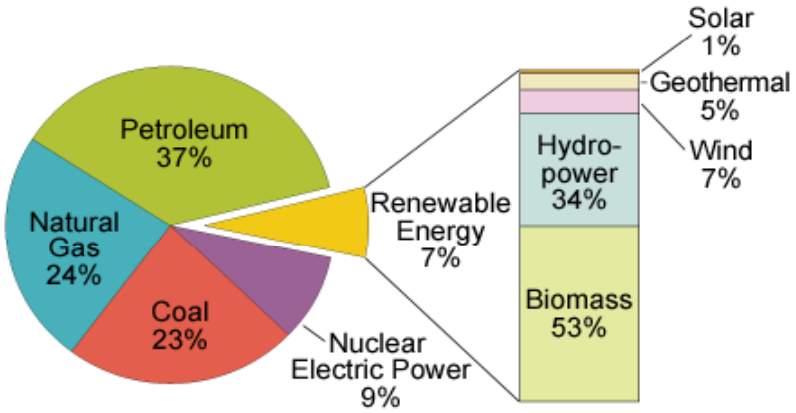


Source: Energy Information Administration, *Annual Energy Review 2008*.

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).

Two Key Components to Achieving Our National Energy Strategy:

- Increase Energy Efficiency Across All Sectors
- Increase Contribution of Renewable Energy Supply

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Fact or Fiction?

- Superior Building Energy Performance at Scale is Not Yet Possible
  - Undesirable Tradeoffs Between Energy Performance and Building Functionality
  - Dependent on Expensive Renewable Energy Technologies
- Design-Build Acquisition is Too Difficult

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Research Support Facility Goals

- Establish a New National Building Energy Performance Standard
  - Create Superior Energy Performance at Scale for a Competitive Cost
  - Change the Way the Nation Designs Buildings
- Develop a Replicable Project Design and Execution Model for Others to Use
  - Execution to Validated Baselines
  - Measurable Design Performance

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RSF Energy Design Key Features

- Efficiency: Using Nature's Gifts
  - 100% Daylit – Reducing Lighting and Cooling Loads
  - Thermal Management – Storing and Using Free Energy
    - Labyrinth
    - Shading
    - Precast Concrete Insulated Panels
    - Radiant Heating and Cooling
    - Energy Efficient Data Center with Heat Recovery
- Renewables: Responsible Use
  - Photovolatic Electric Modules
  - Hot Water through Renewable Fuels

ENERGY | Energy Efficiency & Renewable Energy

Research Support Facility—A Model of Super Efficiency

Imagine an office building so energy efficient that its 800 occupants consume only the amount of energy generated by renewable power on and near the building.

As employees of the U.S. Department of Energy (DOE) and the National Renewable Energy Laboratory (NREL) move into the new Research Support Facility (RSF) in Golden, Colorado, the idea of a highly energy efficient office space is becoming a reality. The building is expected to use 50 percent less energy than if it were built to current commercial code and to qualify for the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Platinum rating.

With 19 percent of the primary energy in the United States consumed by commercial buildings, DOE's goal for the RSF project is to help change the way commercial office buildings are designed and built.

Fast Facts

Size: Approximately 222,000 sq. ft.

Occupants: Approximately 800

Energy Use: 35 kBtu/sq. ft./year*

Energy Performance: 50 percent better than ASHRAE 90.1 2004 standard

LEED Rating: Platinum** (including the maximum points for energy)

Cost: $57.4 million (construction cost); $64 million, including furnishings

*Includes high-performance data center
**Targeted

The RSF is expected to be the nation's largest ultra-efficient building.

Design-Build Approach

To meet stringent time and performance goals—while mitigating costs and risks—the RSF project team developed an innovative approach that relied on an integrated design and construction approach, extensive up-front planning, a national design competition, energy modeling, and a firm fixed-price contract. DOE and NREL invited nearly a dozen design-build teams to submit proposals. Three teams were short-listed to develop concept designs and submit proposals. The Haselden Construction and RNL team won the design-build competition and began work in July 2008.

Renewable Energy and Energy Efficiency Features

The RSF building showcases numerous high-performance design features, passive energy strategies, and renewable energy technologies. It is a prototype for the future of large-scale ultra-efficient buildings.

1. **Building orientation:** The relatively narrow floor plate (60' wide) enables daylighting and natural ventilation for all occupants. Building orientation and geometry minimizes east and west glazing. North and south glazing is optimally sized and shaded to provide daylighting while minimizing unwanted heat losses and gains.
2. **Labyrinth thermal storage:** A labyrinth of massive concrete structures is in the RSF crawl space. The labyrinth stores thermal energy and provides additional capacity for passive heating of the building.
3. **Transpired solar collectors:** Outside ventilation air is passively preheated via a transpired solar collector (a technology developed by NREL) on the building's south-facing wall before delivery to the labyrinth and occupied space.
4. **Daylighting:** 100 percent of the workstations are daylit. Daylight enters the upper portions of the south-facing windows and is reflected to the ceiling and deep into the space with light-reflecting devices.
5. **Triple glazed, operable windows with individual sunshades:** Aggressive window shading is designed to address different orientations and positions of glazed openings. Occupants can open some windows to bring in fresh air and cool the building naturally.
6. **Precast concrete insulated panels:** A thermally massive exterior wall assembly using an insulated precast concrete panel system provides significant thermal mass to moderate the building's internal temperature.
7. **Radiant heating and cooling:** Approximately 42 miles of radiant piping runs through all floors of the building, using water as the cooling and heating medium in the majority of workspaces—instead of forced air.

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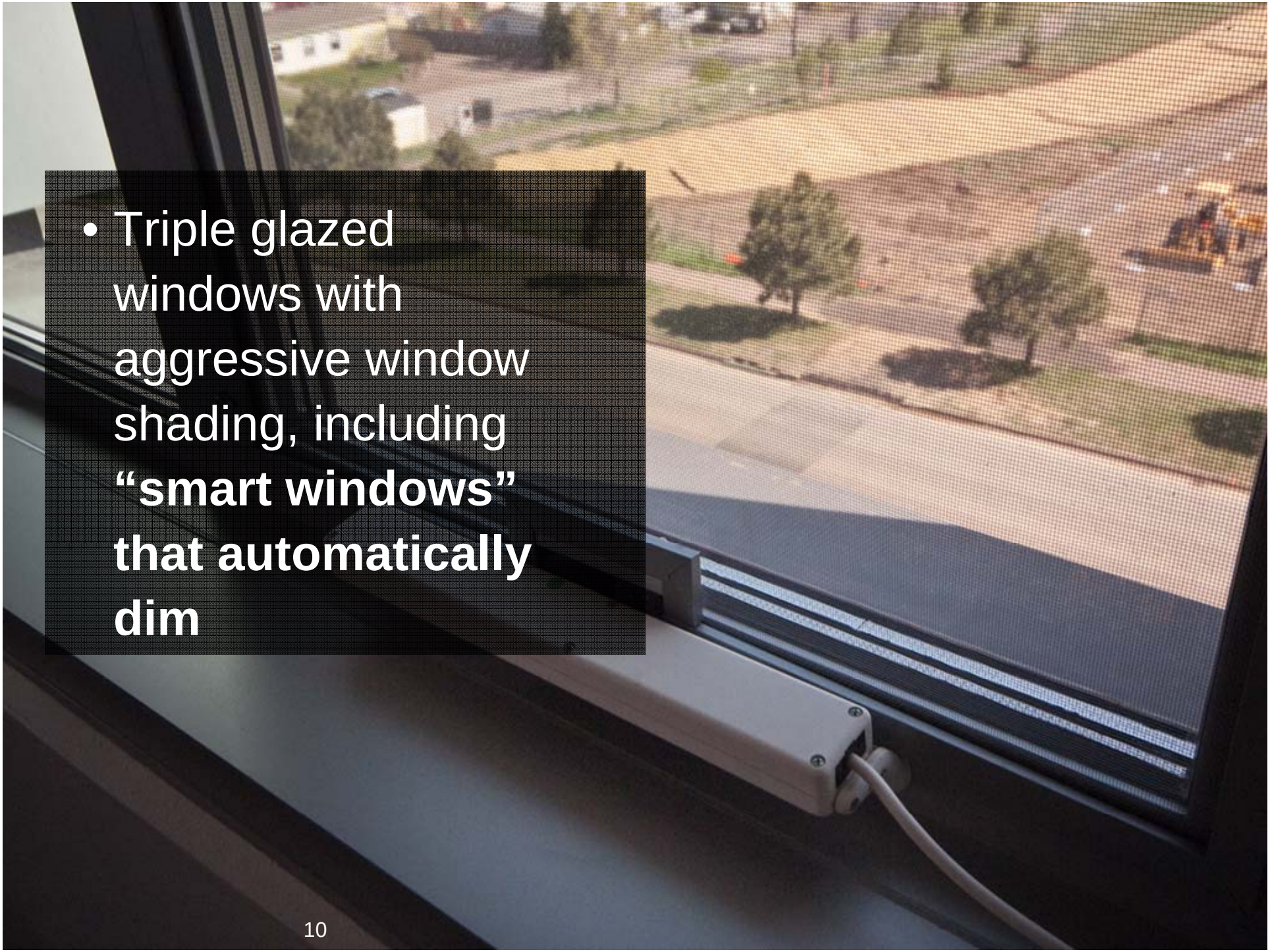
- RSF will use 50% less energy than if it were built to current commercial codes
- RSF increases space at NREL by 60% but only increases energy use by 6%

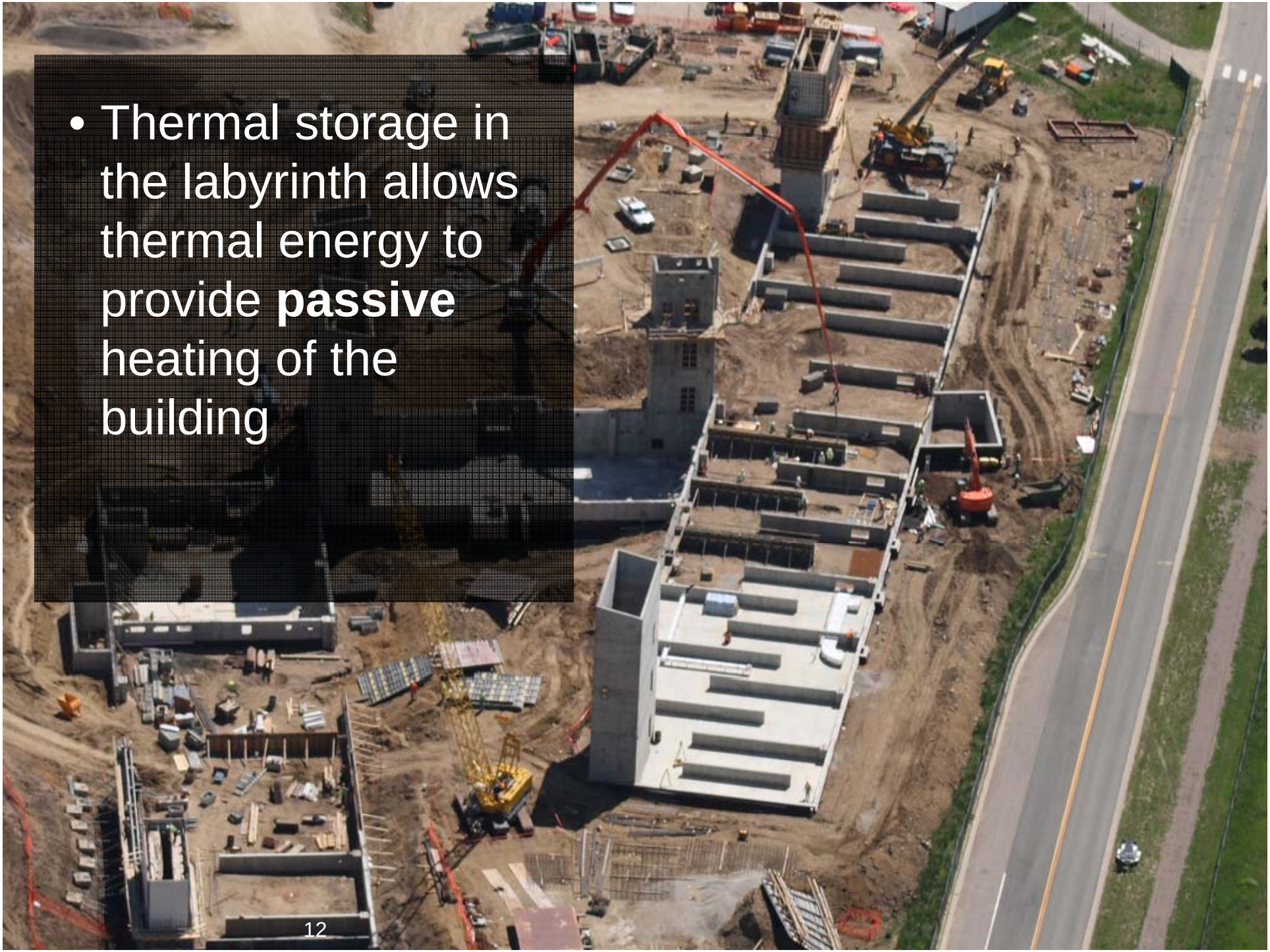

• Narrow east-west oriented floor plate (60’ wide) enables **daylighting and natural ventilation**


• **100%** of the workstations are **daylit**
• **No** employee more than **30 feet** from a window

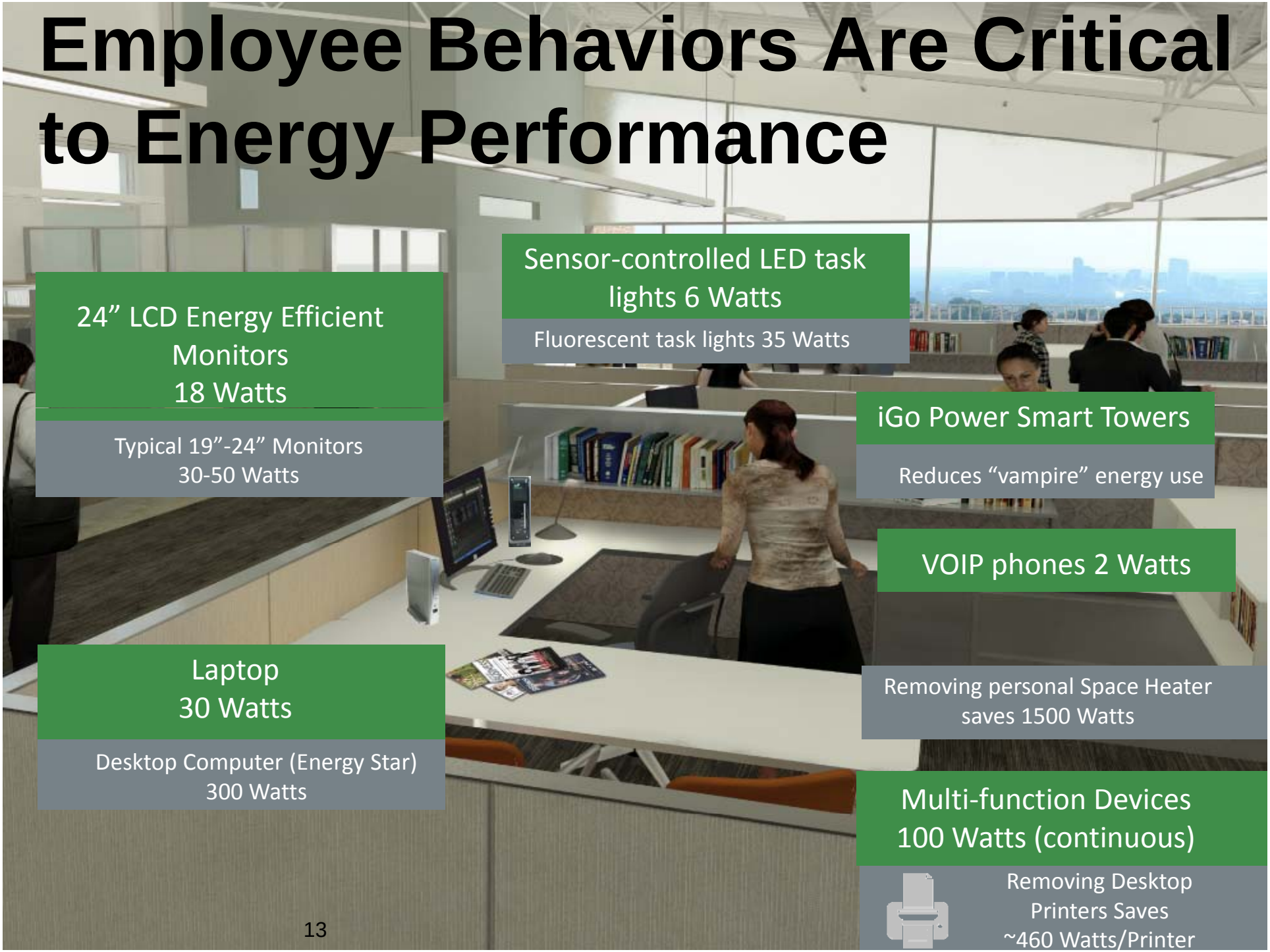


- Triple glazed windows with aggressive window shading, including **“smart windows” that automatically dim**

- The transpired solar collector on the RSF is EERE technology **originally developed at NREL**


• Thermal storage in the labyrinth allows thermal energy to provide **passive** heating of the building

Employee Behaviors Are Critical to Energy Performance



24” LCD Energy Efficient Monitors
18 Watts

Typical 19”-24” Monitors
30-50 Watts

Sensor-controlled LED task lights 6 Watts

Fluorescent task lights 35 Watts

iGo Power Smart Towers

Reduces “vampire” energy use

VOIP phones 2 Watts

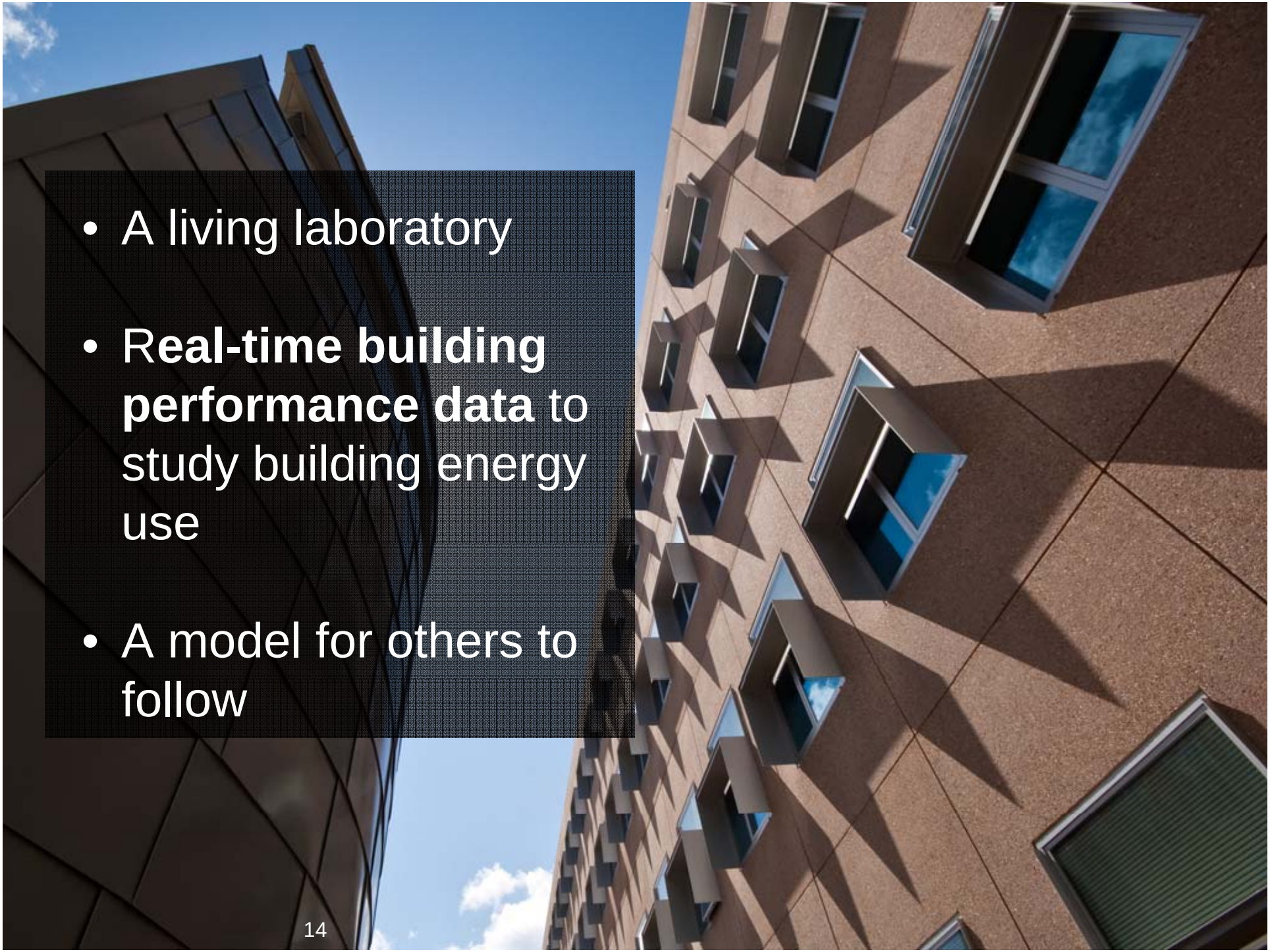
Laptop
30 Watts

Desktop Computer (Energy Star)
300 Watts

Removing personal Space Heater saves 1500 Watts

Multi-function Devices
100 Watts (continuous)

Removing Desktop Printers Saves ~460 Watts/Printer


• A living laboratory
• Real-time building performance data to study building energy use
• A model for others to follow

Creating the Environment for Success

- Request for Proposals (RFP) Development and Competition
  - Draft RFP Provided to Three Best Qualified Teams
  - Extensive Collaboration Between Teams and EERE/NREL
    - Ensure Understanding and Build Trust
    - Improve Request for Proposals and Ensure Project is Achievable
    - Identify and Mitigate Risk for All Parties
  - Success Required an Integrated, Whole-Building Design Approach
  - Design Competition to Select Best Team
- Final Acquisition Strategy
  - Performance-Based, Progressive, Phased, Firm-Fixed Price Design-Build with Incentives
  - No Bridging Documents to Inhibit Creativity

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Project Performance Goals

Tier 1: Mission Critical Performance Goals
- Mission Critical
- Attain Safe Work/Design
- LEED Platinum
- Energy Star “Plus”

Tier 2: Highly Desirable Performance 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 Performance 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

- Owner Leadership in Planning
  - Energy Modeling
  - Design Charrettes
  - Design Build Institute of America
- Performance Goals vs. Project Specifications
- Substantiation Criteria
- Third Party Resources to Facilitate Culture Change

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Firm-Fixed Price Design-Build

- Two Phase Firm-Fixed Price Design-Build Reduces Risk
  - Phase 1: Preliminary Design
  - Phase 2: Final Design and Construction
- Progressive
  - Phase 1: Combined Critical Decision-2/3
  - Phase 2: Three Major Design Packages to Accelerate Delivery
- Incentives
  - Ensure Management Engagement

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Project Results

- Set a New National Building Energy Standard
  - World-Class Performance at Affordable Cost
- Accelerated Delivery at Lower Cost and Risk to the Government
  - Sixteen Months from Shovel to Move-In
  - Contractor Shouldered Performance Risk
  - Substantially Reduced Management Reserve/Contingency Use
- Developed a Replicable Model

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Keys to Successful Design-Build

- Learn About Design-Build Practice
  - Design Build Institute of America
- Owner's Commitment
  - Defining Scope and Performance Goals
  - Funding Availability
- Selecting the Right Contractor
- Refocusing Acquisition Teams on Results
  - Government and Private Sector Both Challenged!
- Changing the Project Management Culture
  - Directing vs. Oversight
  - What Does the Contract Say?

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Research Support Facility: A New National Standard for Commercial Building Energy Performance at $259/ft^2

Request for Proposals and Additional Information on High-Efficiency Building Design Available at:

http://www.eere.energy.gov/topics/buildings.html
www.nrel.gov/sustainable_nrel/rsf.html

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