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

Jeffrey M. Baker
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Our National Energy Goals

Security, Economic Competitiveness, Environmental Quality

U.S. Energy Supply

Total = 99.305 Quadrillion Btu
Total = 7.301 Quadrillion Btu

- Petroleum 37%
- Natural Gas 24%
- Coal 23%
- Nuclear Electric Power 9%
- Renewable Energy 7%
- Hydropower 34%
- Solar 1%
- Geothermal 5%
- Wind 7%
- Biomass 53%

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

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

U.S. Energy Consumption

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

- Commercial 19%
- Industrial 31%
- Residential 22%
- Transportation 28%

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
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
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
ZERO ENERGY BUILDING
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

- Bio-fuel
- Solar Electric
- Wind
Energy and Architecture

Shading Study
December 23rd, 2:30 p.m.

Daylight Glazing
Light Shelf
View Glazing

Shading Study
December 23rd, 2:30 p.m.
WINDOW SUNSHADE

PRE-CAST SANDWICH PANEL:
3" CONCRETE
2" RIGID INSULATION
6" CONCRETE

LIGHTLOUVER BOUNCES LIGHT DIRECTLY INTO ROOM

WINTER SUN

SUMMER SUN

DOUBLE PANNE LOW-E GLASS

COOL AIR

TRANSPIRED COLLECTOR

FIGURE #1
NREL
The Section – Day lit Interiors
Natural Ventilation - Summer Day

50 F to 75 F
The Section – Thermal Mass

Crawl space / Labyrinth
The Section – Transpired Collector
Labyrinth – the energy battery
Photovoltaic System

- Power Purchase Agreement (PPA) provides full rooftop array
- Zero energy = building, parking lot and future parking garage arrays
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
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
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
    o Workstation panels 42” high
    o 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
  o 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

Sensor-controlled LED task lights 15 Watts
Fluorescent task lights 35 Watts

Desktop Computer (Energy Star)
300 Watts

24” CRT 200 Watts

VOIP phones 4 Watts

Laptop 60 Watts
Thin Client 35 Watts (future)

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
- Thermochromatic (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
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](http://www.nrel.gov/sustainable_nrel/rsf.html)

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

Video
- Vision for RSF
- Virtual tour
Questions?