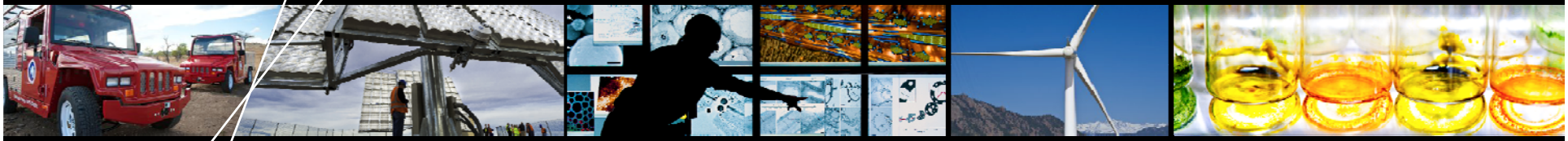
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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

FEMP
Federal Energy Management Program

Commercial Building Energy Efficiency:

Applied Research at Speed and Scale



NASA Net Zero Workshop

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Agenda

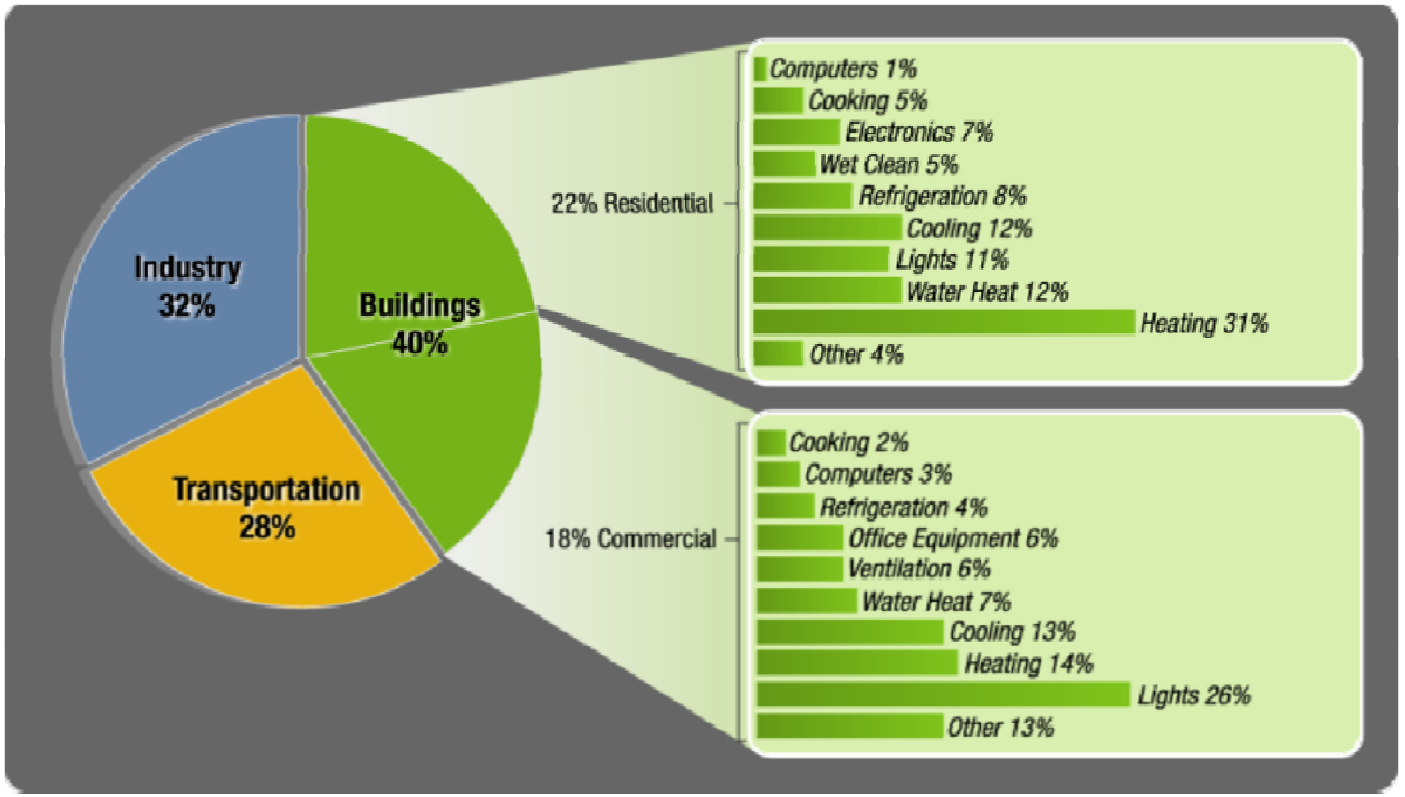
- **Overview and Goal Setting**
- **Implementation of the Process**
  - Contracts
  - Project Management
- **The "Solution"**
  - Hear from the design team and the contractor
- **Technologies**
- **Tours**

- **"Nature always tends to act in the simplest way." Bernouli**

- **Why are you here?**
  - Goals

Why Buildings' Energy Use is Important

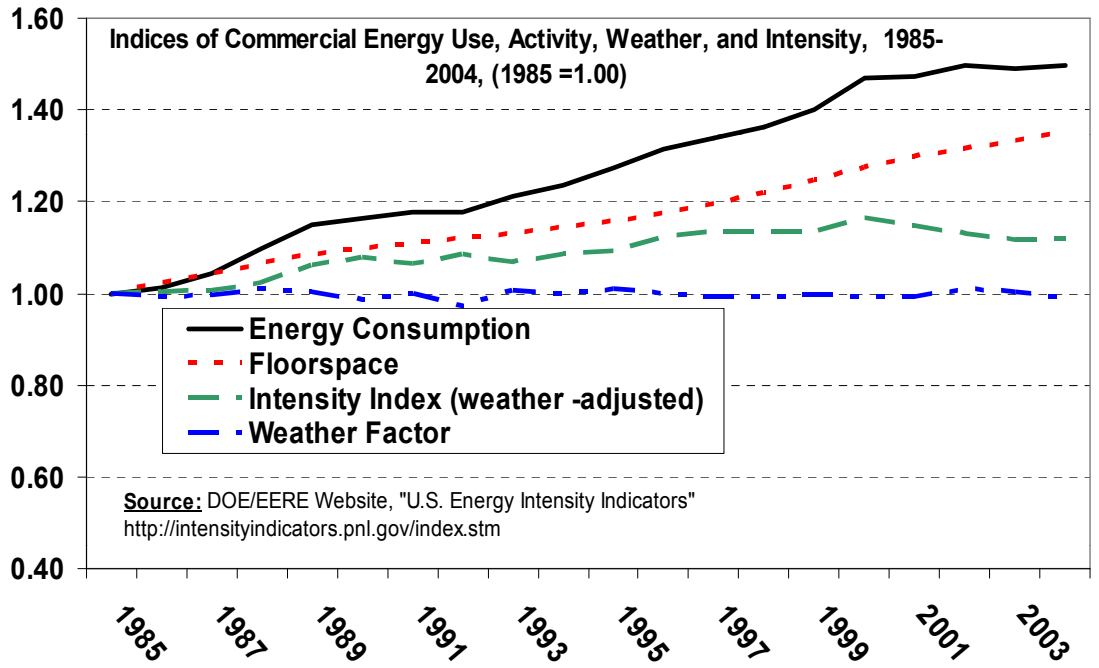
- Largest energy consumer in U.S.
- 40% of U.S. Primary Energy Consumption
- 72% of U.S. Electricity
- 55% of U.S. Natural Gas



Trend of Commercial Sector

- Commercial Sector Energy Use is Growing at 1.6% per year
- Growth is faster than energy efficiency measures
- Need to think about Zero-Energy Buildings to change overall

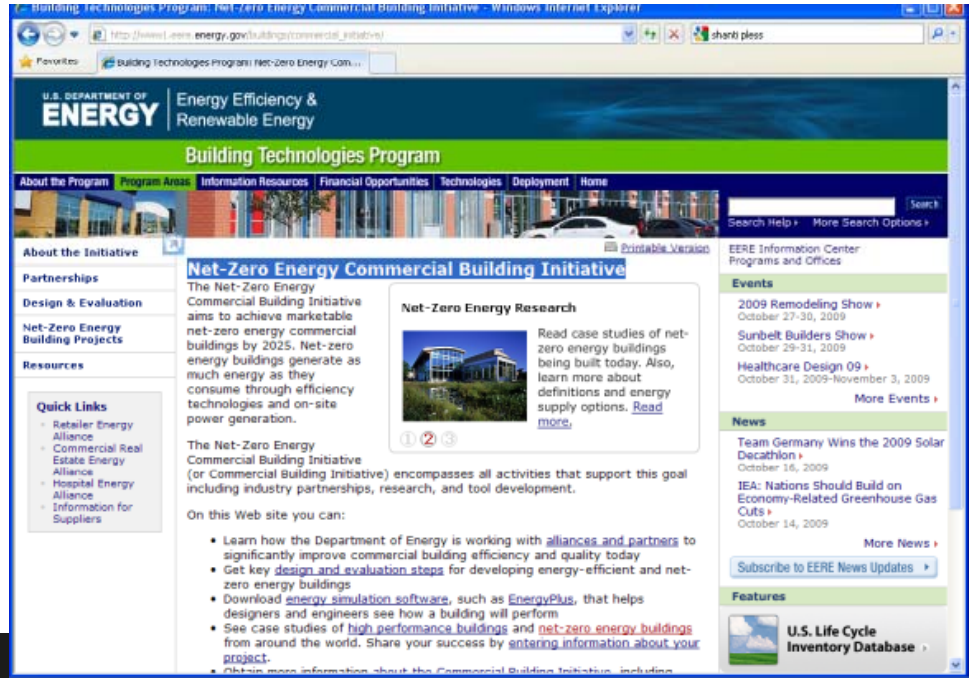
- Every Decision has an energy impact
- Buildings mortgage the energy futures of this country (and the world)



Advanced Commercial Building Research

- ***Applied Research RD+D to change the industry and move the market***

- **Commercial Building Energy Alliances (CBEA)**
- **Commercial Building Partnerships (CBP)**
- **Net Zero Energy Buildings (ZEB)**
  - DOE's Net Zero Energy Commercial Building's Initiative
- **Technical Support Documents & Advanced Energy Design Guides**
- **HVAC Test Facility**
- **Opt-E-Plus**
- **EnergyPlus**
- **Open Studio**



CBP: Partnering for Speed and Scale

Companies from the private sector working with national laboratories to achieve significant, unprecedented building energy savings.

- **DOE national labs (NREL & PNNL) teamed with 23 companies to:**
  - Retrofit at least **one existing building at 30% less energy**
  - Build **one new building at 50% less energy** than Standard 90.1
- **Labs provide technical assistance to biggest names in retail, commercial real estate, and financial sectors**
- **Early results: 75% of the CBP projects likely to meet or exceed energy savings goals**

Bank of America	ProLogis
ForestCity	Simon
IHG	Tishman Speyer
Kohl's	Whole Foods
PNC	CBRE
Ryan	Hines
Target	John Deere
Westfield	Opus
Best Buy	Regency Centers
Hilton	SuperValue
JCPenney	Toyota
Macy's	

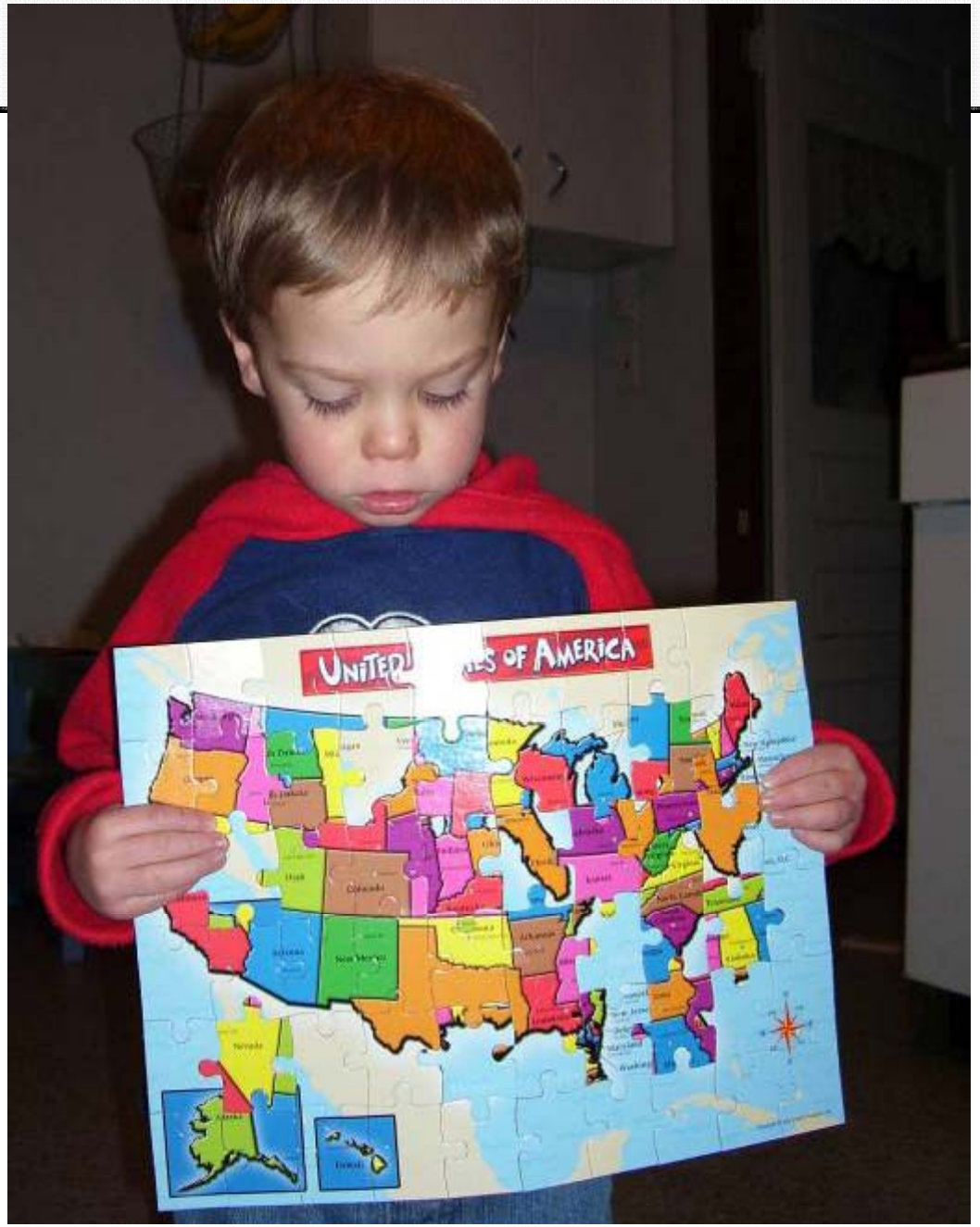
Commercial Building Partnerships

CBP: National Lab Advantages

- **Builds on Previous Research**
  - Reference Buildings Research
  - Technical Support Documents (TSDs)
  - Advanced Energy Design Guides (AEDGs)
- **Utilize Energy Assessment and Estimating Tools**
  - Opt-E-Plus
  - EnergyPlus
- **Provide Credible Information Dissemination**
  - Lab-conducted research adds credibility to findings

Many Pieces

- So many ways to assemble the pieces
- Design is about making decisions – need motivation to make the right decisions
- Need to work with decision makers



The Future of Zero Energy Buildings

- **The DOE Net-Zero Energy Commercial Building Initiative aims to achieve marketable net-zero energy commercial buildings by 2025**
- **ASHRAE Vision 2020**
- **AIA 2030 Challenge**
- **California Public Utilities Commission ZEB Action Plan**
  - All new residential ZEB by 2020
  - All new commercial ZEB by 2030
- **EU ZEB requirement by 2019**
  - International Energy Agency ZEB Definitions Task
- **All Federal Buildings ZEB by 2030**
  - October 2009 Executive Order
  - Beginning in 2020 all new Federal buildings that enter the planning process are designed to achieve zero-net-energy by 2030

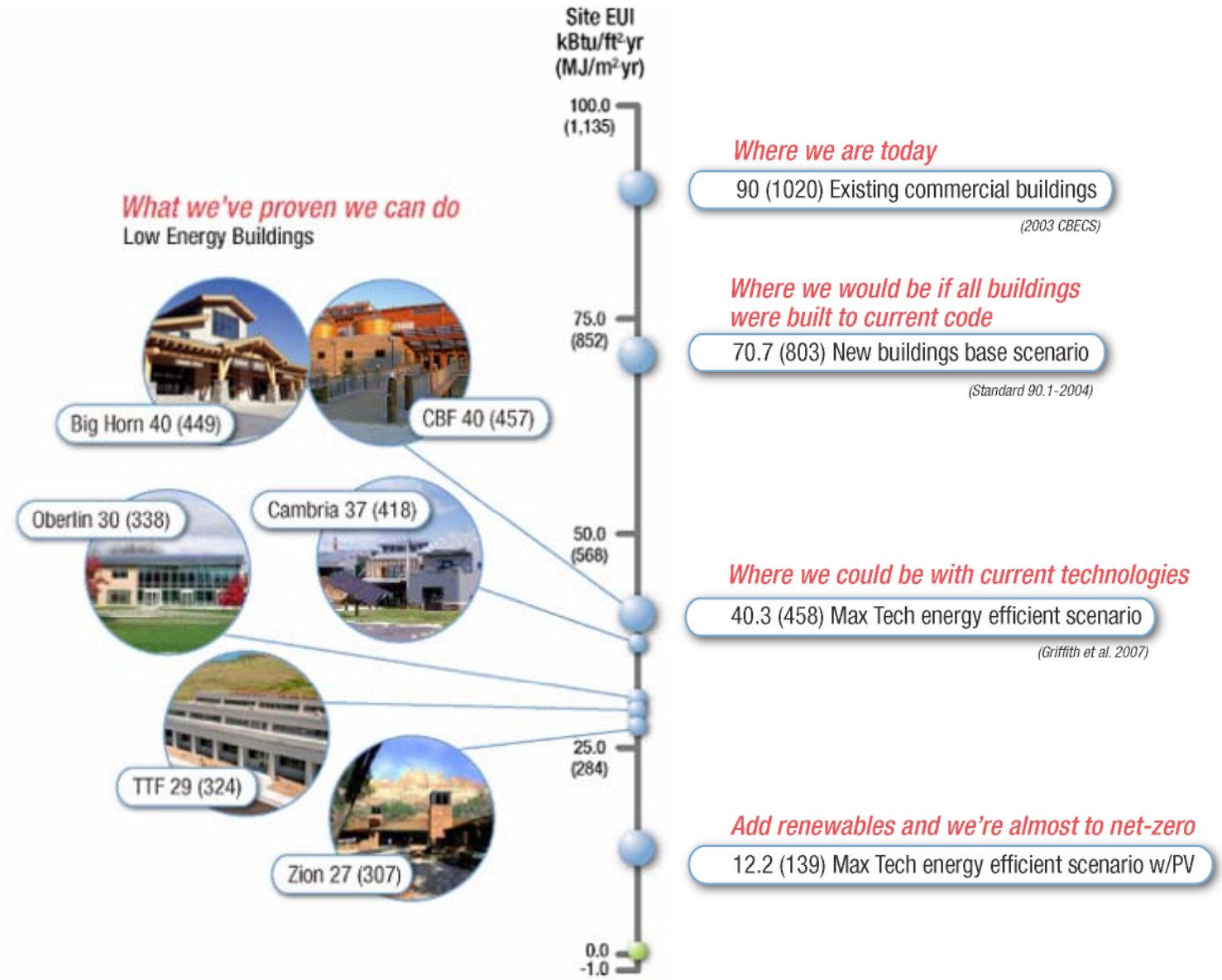
Federal Energy Legislation

- **Executive Order (E.O.) 13514; *Federal Leadership in Environmental, Energy, and Economic Performance*; was signed on October 5, 2009. It expanded upon the energy reduction and environmental performance requirements of E.O. 13423.**
- **The Executive Order also requires agencies to meet a number of energy, water, and waste reduction targets, including:**
  - 30% reduction in vehicle fleet petroleum use by 2020;
  - 26% improvement in water efficiency by 2020;
  - 50% recycling and waste diversion by 2015;
  - 95% of all applicable contracts will meet sustainability requirements;
  - Implementation of the 2030 net-zero-energy building requirement;

ZEB Assessment Methods

- **Scenario Analysis Using EnergyPlus Models for 4,820 Samples**
  - Forward modeling allows modeling "what if" scenarios
  - Annual, 15-minute modeling with historical weather files for 2003
  - Detail developed from probability, literature, engineering design, codes,
    and standards.

Great Potential in Commercial Buildings



Lessons Learned from Case Studies

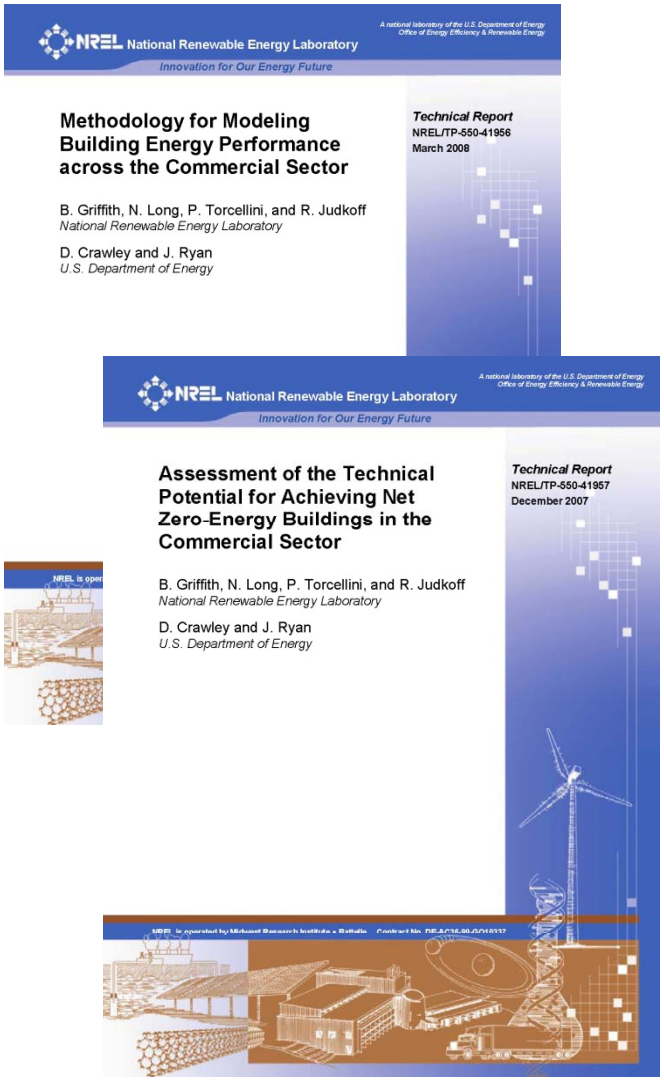
- Each had committed owners
- Each had aggressive energy goals (next generation)
- Each used computer simulations for design
- Each was monitored for at least one-year
- Each building was successful
- Each one had some problems
- Many of the problems similar—

- http://www.nrel.gov/docs/fy06osti/37542.pdf

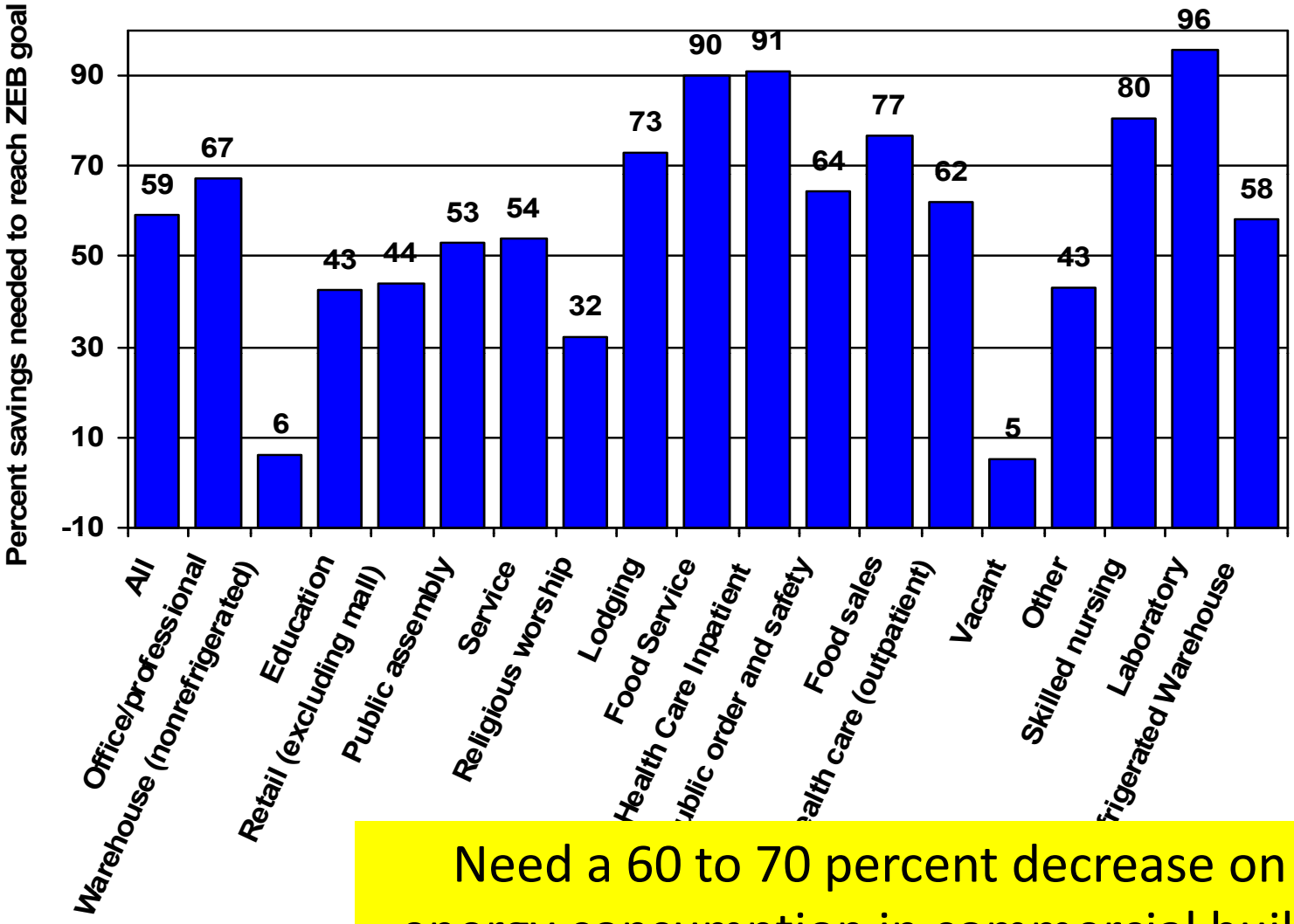
Assessment of Technical Potential

- ***Assessment of the Technical Potential for Achieving Net Zero-Energy Buildings in the Commercial Sector***
  http://www.nrel.gov/docs/fy08osti/41957.pdf

- ***Methodology for Modeling Building Energy Performance across the Commercial Sector***
  http://www.nrel.gov/docs/fy08osti/41956.pdf



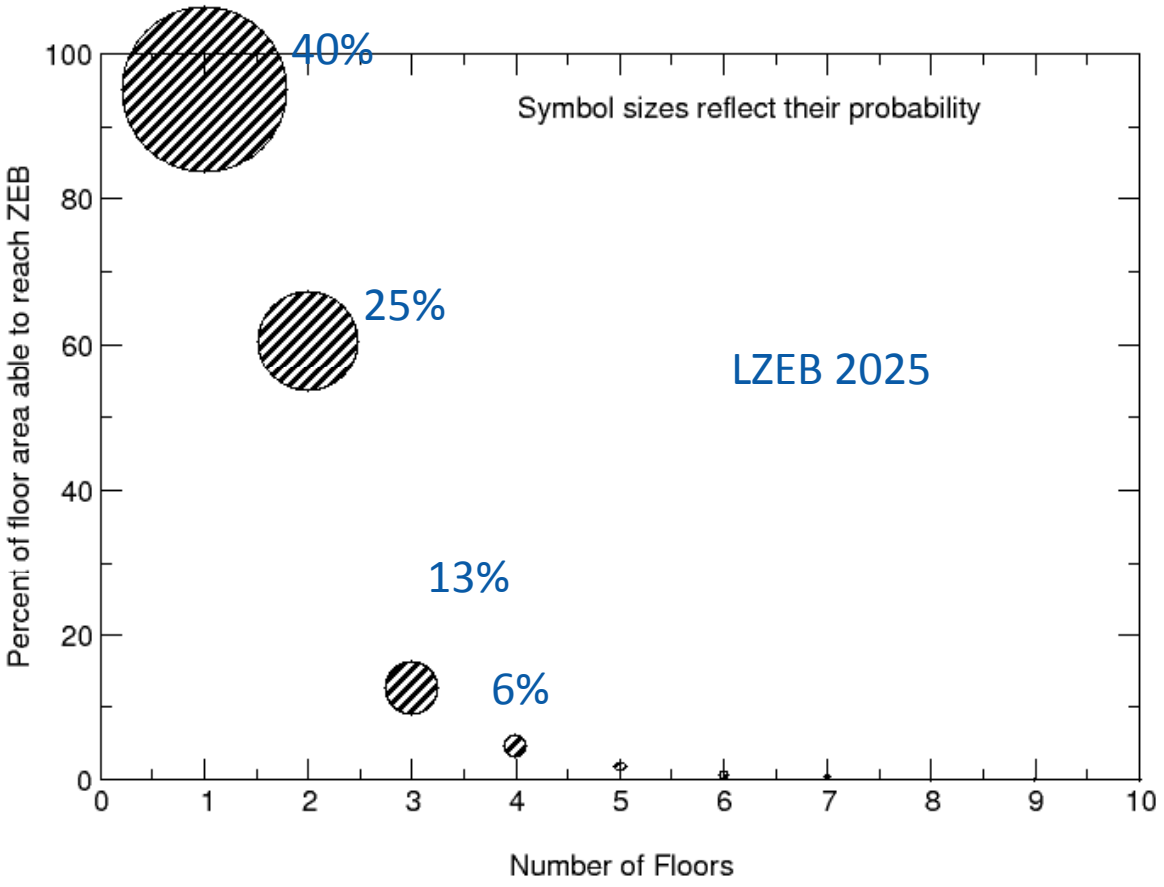
Energy Efficiency Needed for ZEBs



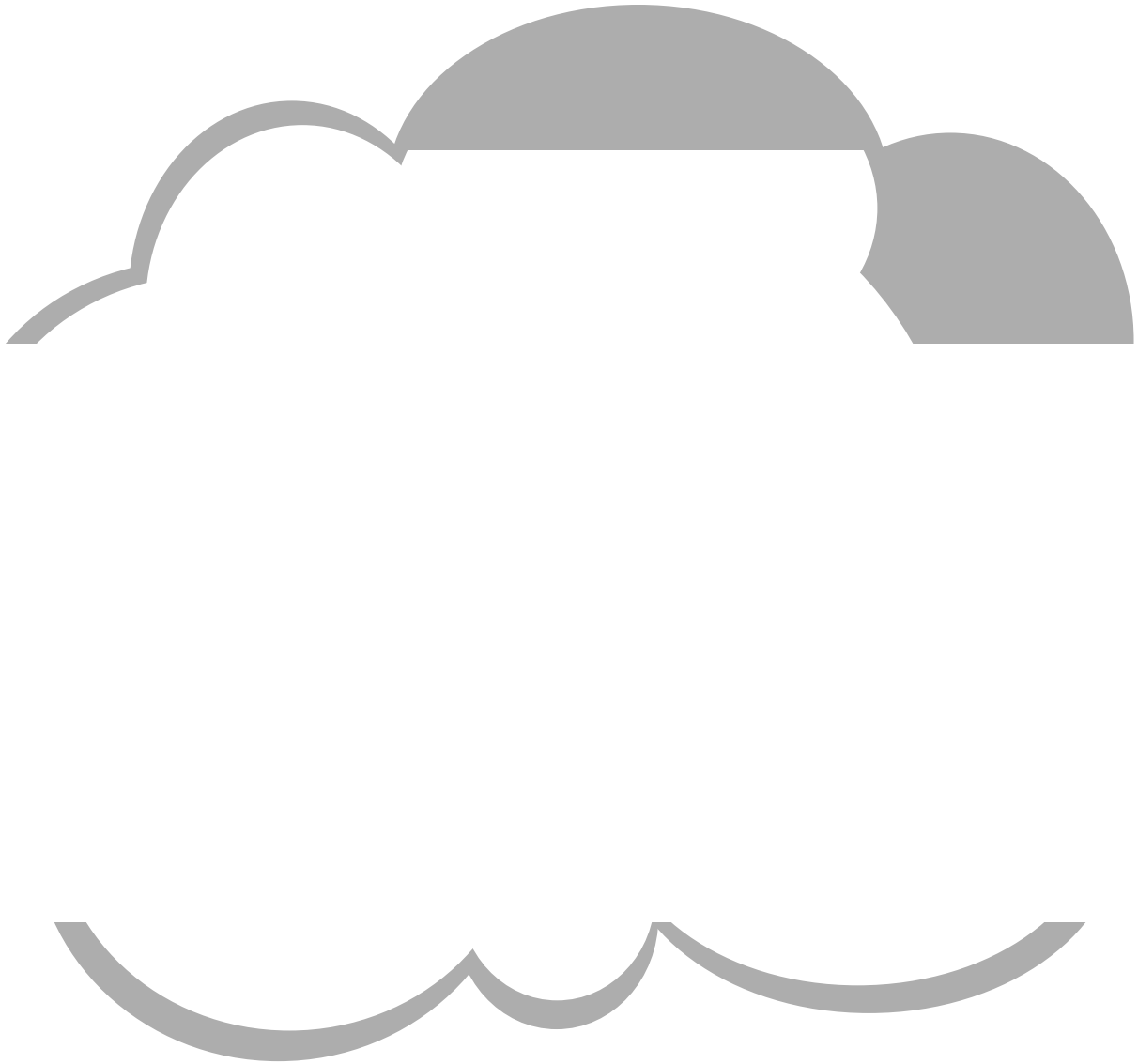
Need a 60 to 70 percent decrease on the energy consumption in commercial buildings.

ZEB Characteristics

- **Number of floors impacts ability to reach ZEB goal**



Vision

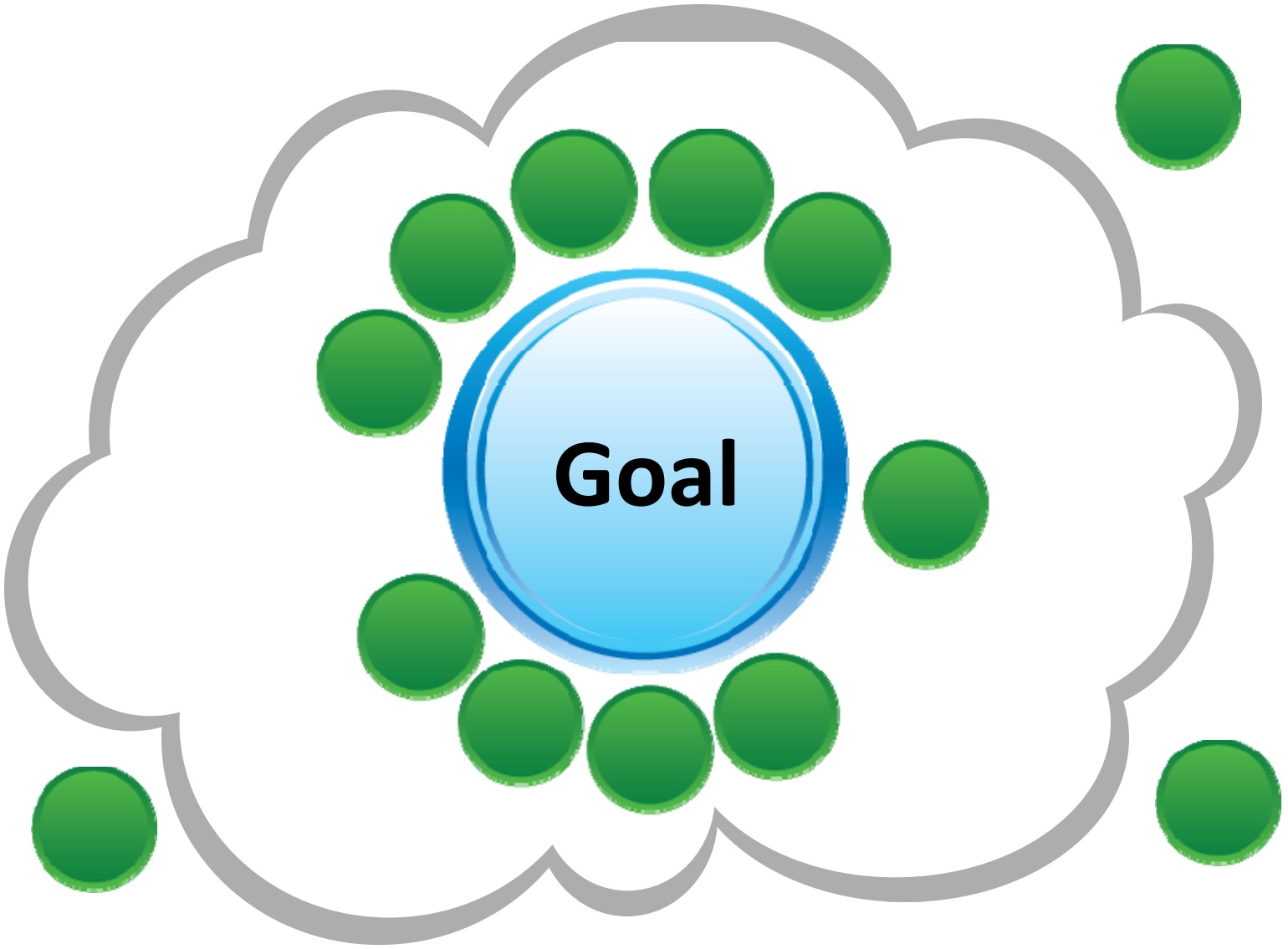


Setting Goals

- **Measurable goals are better**
- **From bad to good…**
  - I want a green building
  - Design a LEED <rating> building
  - Design a building to use 30% less energy than ASHRAE 90.1-2004
  - Design a building to use less than 25,000 BTU/sqft
  - Design a [NET] ZERO ENERGY BUILDING
- **Influencing purchasing decision—the owner**


Goal


Goal


Goal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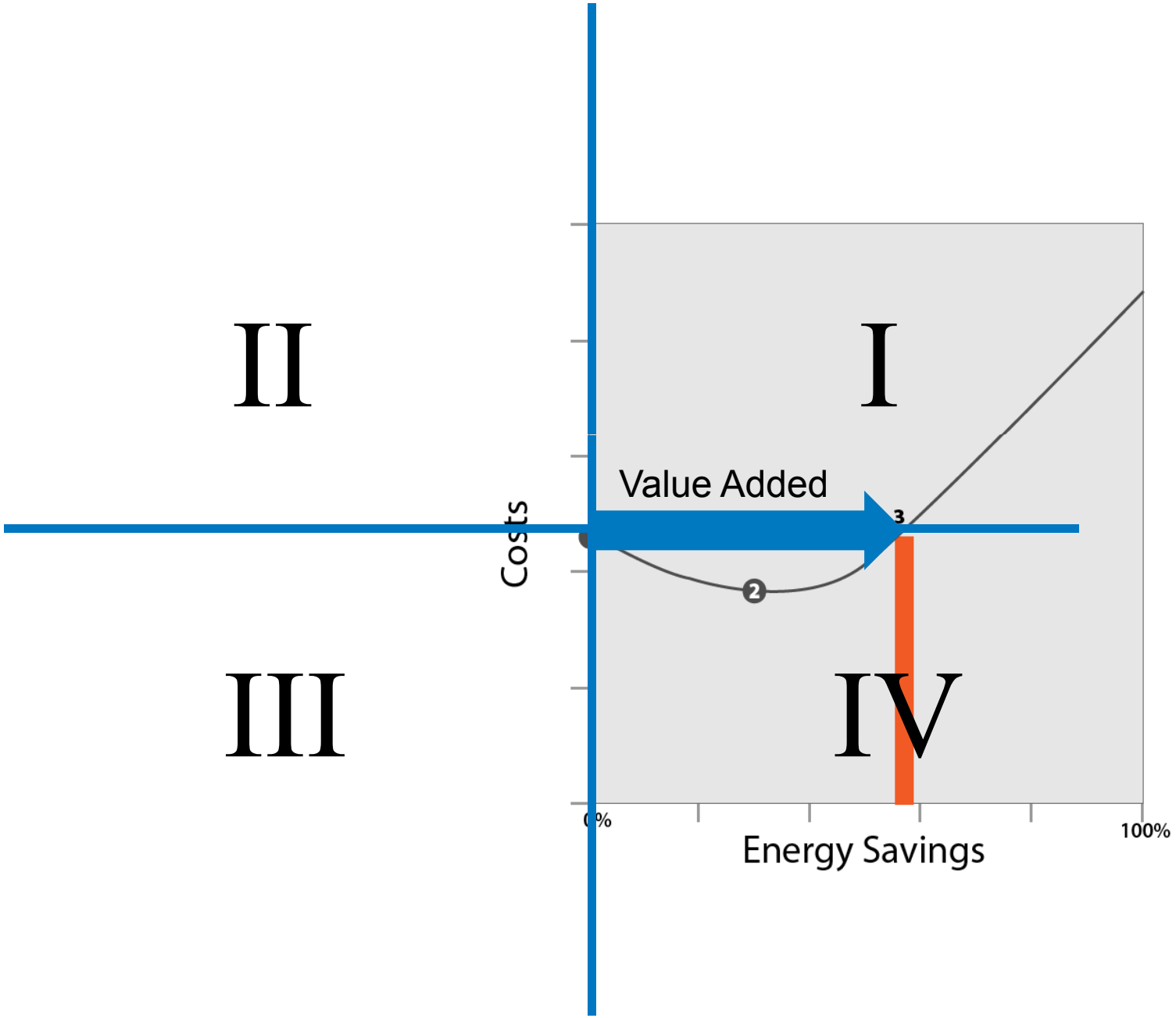
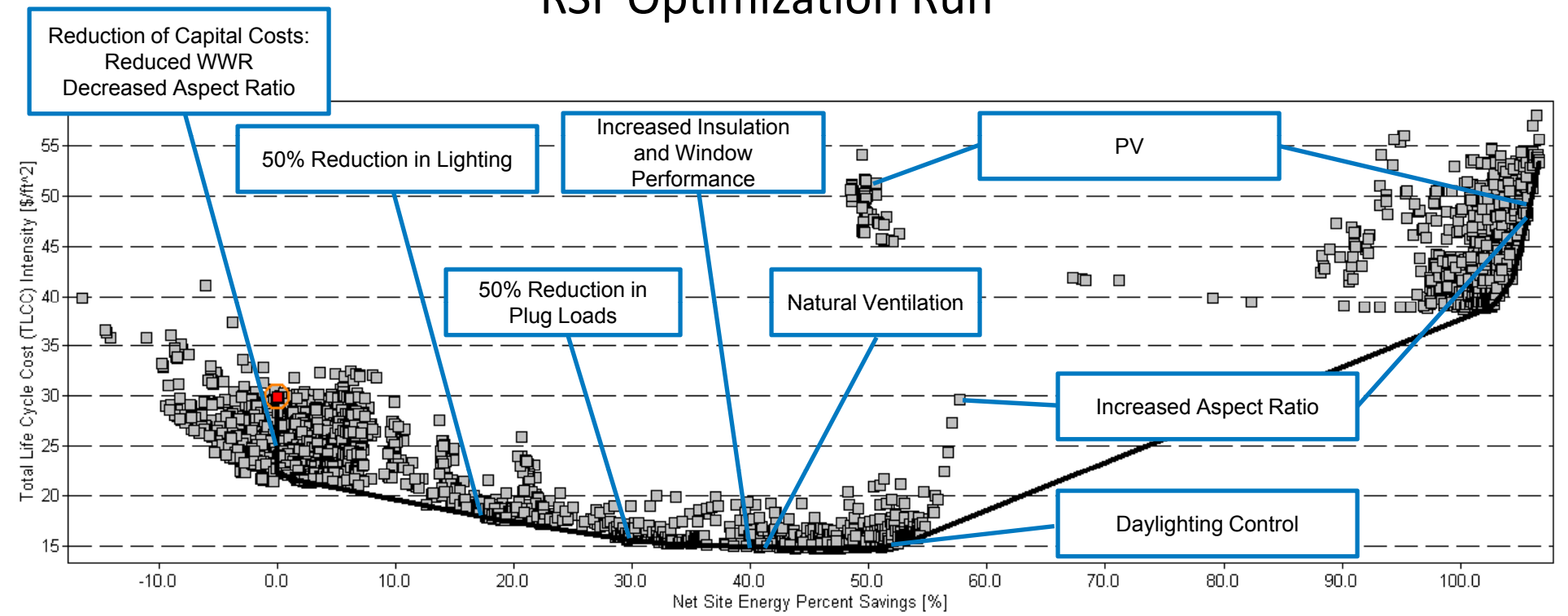
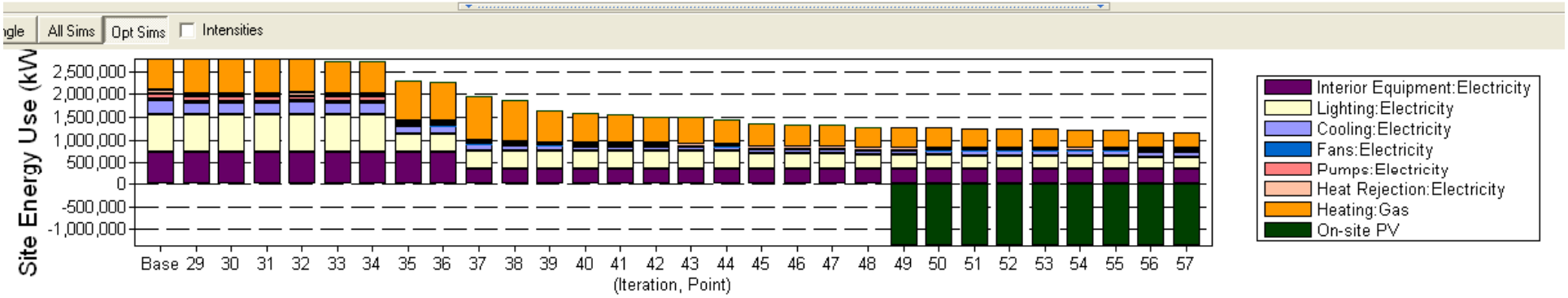

II
I
III
IV
Value Added
Costs
2
3
0%
100%
Energy Savings

Research Efforts Yield Practical Results

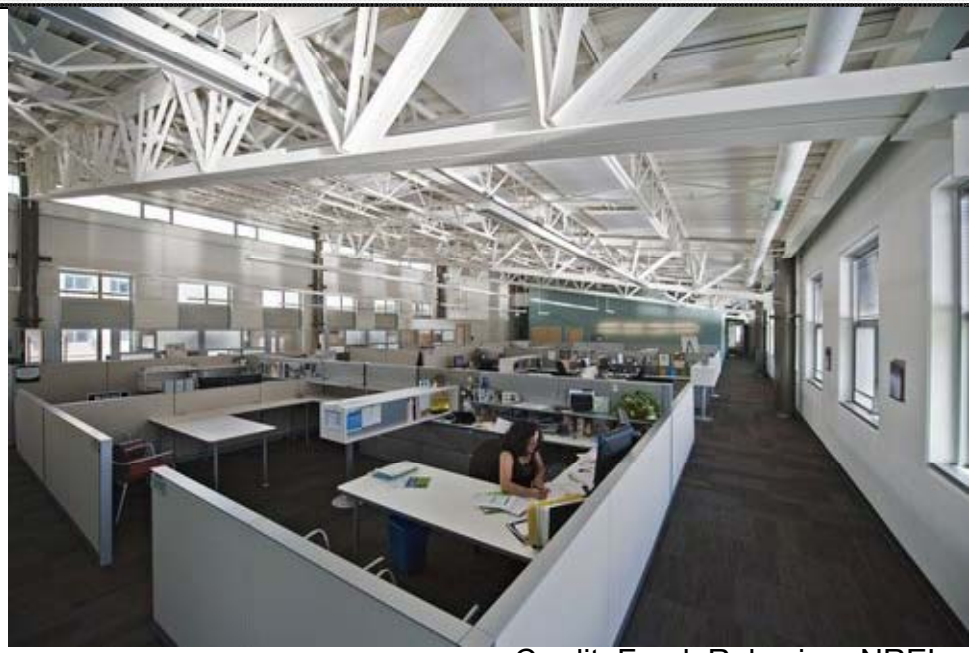
RSF Optimization Run





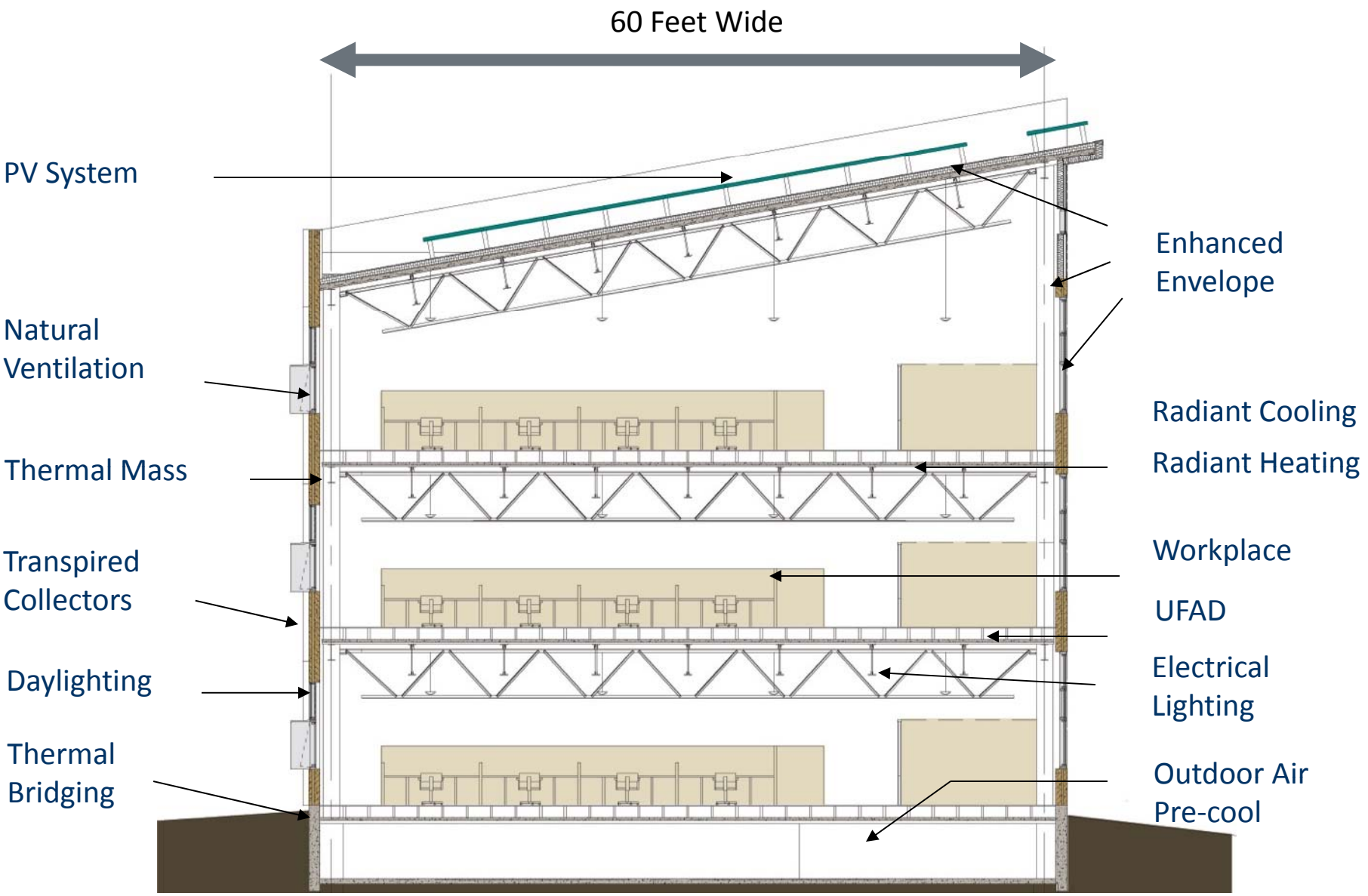
Research Support Facility

- 800 people
- 220,000 ft^2
- 25 kBtu/ft^2
- 50% energy savings
- $259/$ft^2$
- LEED Platinum
- Replicable
  - process
  - technologies
  - cost
- Site, source, carbon, cost ZEB
  - Includes plugs loads and datacenter
- Design/Build Process with required energy goals



Credit: Frank Rukavina- NREL

Credit: NREL PIX


60 Feet Wide
PV System
Natural Ventilation
Thermal Mass
Transpired Collectors
Daylighting
Thermal Bridging
Enhanced Envelope
Radiant Cooling
Radiant Heating
Workplace
UFAD
Electrical Lighting
Outdoor Air Pre-cool

- **Owner made tough decisions up-front**
  - Set budget
  - Sought maximum value for that budget
  - Prioritized goals
- **Design-Build procurement process**
  - Managed the team to the RFP and its substantiation criteria
  - Rewards
- **Allowed design-build team to use creativity to maximize value--innovation**
- **Owner did not solve the problem (but knew the solution existed)**

It is Really About the Details

- **Combinations of 1000's of little things that cause buildings to use energy**
- **Conceptually, zero-energy buildings can be done**
  - fail on the details
  - and the replication…
- **Difference between expectations and actual operation?**
- **ZEB is a challenge! Work needed to:**
  - understand cost effective pathways to zero
  - Plug loads efficiency measures
  - Address daily and seasonal mismatch with the grid
- **Optimize efficiency measures**
  - 50%-70% Energy Savings
- **Optimize available renewable energy generation options**
  - Weighted toward technologies available within footprint
  - "Dedicated" to the building
  - Require energy efficiency to reach ZEB

Ending Thoughts…

- **Zero is Possible**
- **Zero takes a coordinated effort with the owner (and all user groups), architect, builder, and the engineering**
- **The little things make the difference in getting to zero**
  - as you get to zero, little is significant
  - Thermal breaks
  - 4 W/phone!
- **The owner needs to set measurable goals and communicate these goals to the design team**
  - $ incentive helps too
- **The solution is not bigger supplies**
- **How can we reduce plug loads?**

Questions?

Next session on the details…

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