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

Zero Energy Definition

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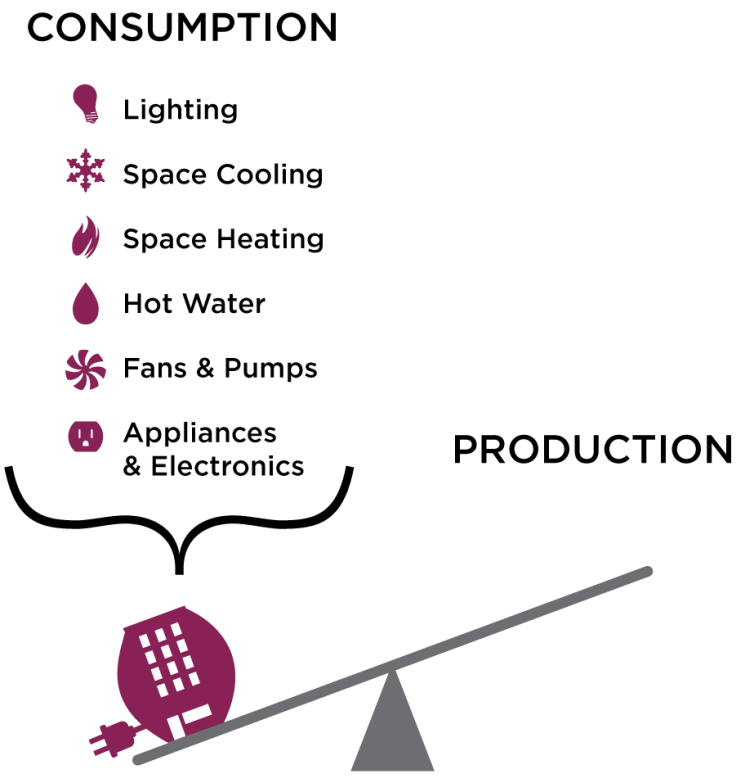
Guiding Principles for Zero Energy Buildings

- Create a standardized basis for identification of ZEBs for use by industry
- Be capable of being measured and verified, and should be rigorous and transparent
- Be clear and easy to understand by industry and policy makers
- Zero seen as the pinnacle of energy stewardship—drives owners and design teams towards excellence
- Influence the design and operation of buildings to substantially reduce building operational energy consumption
- Set a long-term goal and be durable for some time into the future

Zero Energy Building—creating balance



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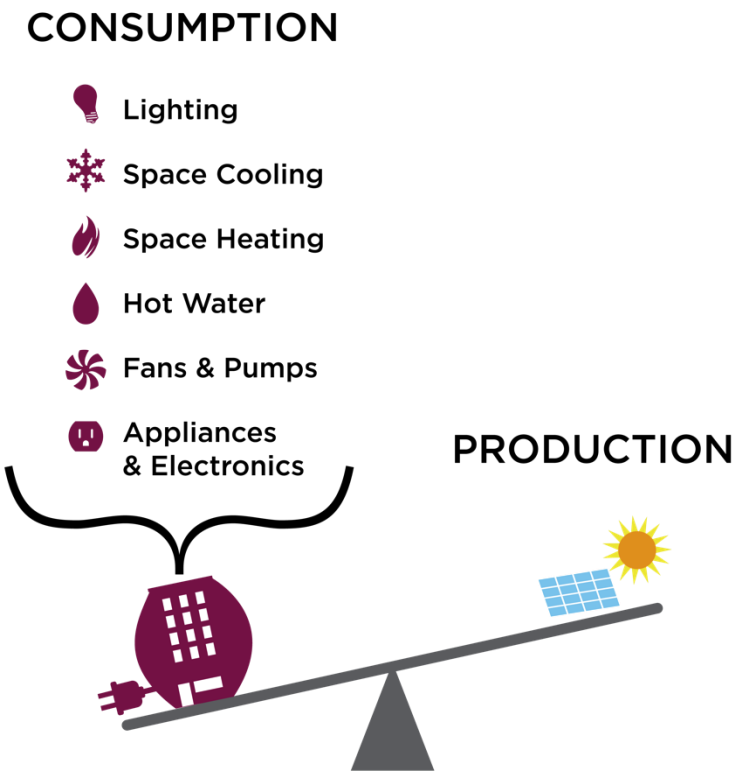
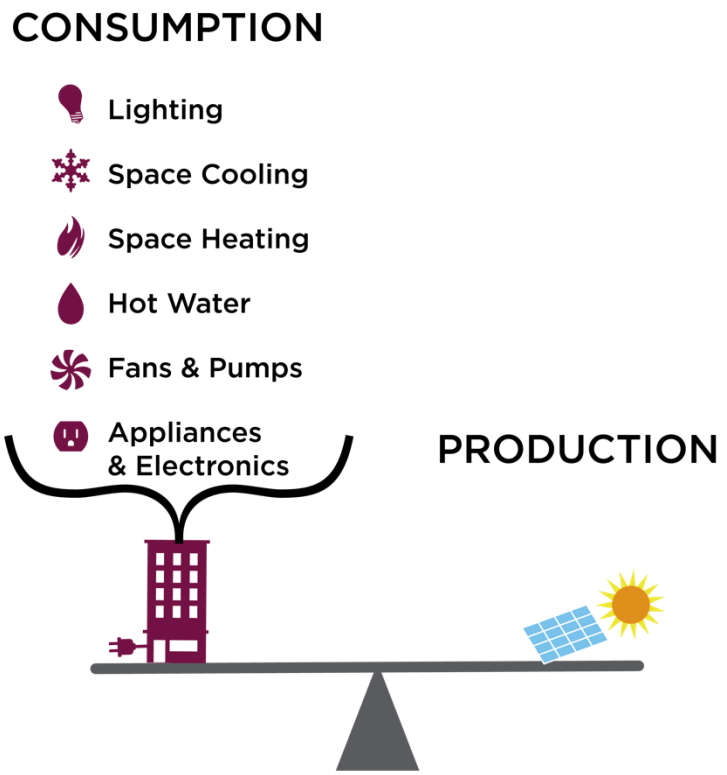
Adding Renewables



Building on a Diet



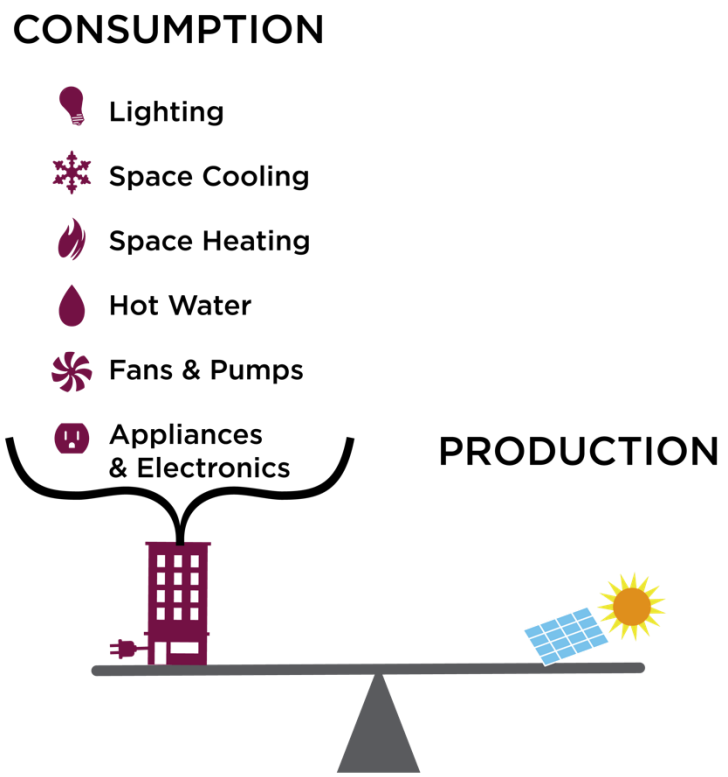
Zero Energy Building (ZEB) Concept

Goal 1:
Reduce Consumption
50 to 70 percent

Goal 2:

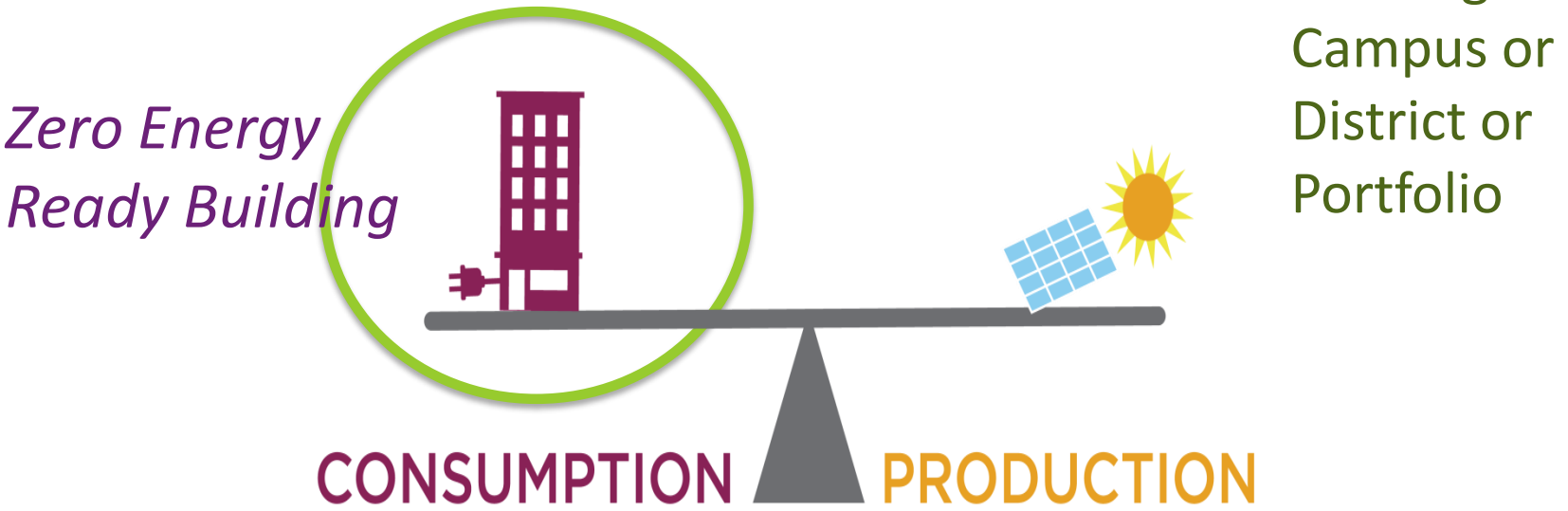
Apply On-site Renewable Energy

BALANCE!



Zero Energy Building (ZEB) Definition

An energy-efficient building, where on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy.



Building or Campus or District or Portfolio

Definition Breakdown – Energy-Efficient Building

*An **energy-efficient building**, where on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy.*

The Zero Energy Ready Building

- Energy savings of 50 to 70%
  - Triangulation of the savings target (three ways that yield similar results)
    - EUI based on solar availability on-site with overlay for efficiency consistencies
    - Optimization analysis showing what is possible with effective design decisions
    - Penetration of maximum technology
- Market is asking for EUI goals such that they can be zero
  - Having an EUI goal drives the owner, design team, and contractors to performance based solutions with measurable results
  - Allows the market to be “cost-effective” based on a set of goals

Definition Breakdown – Source Energy Basis

*An energy-efficient building, where on a **source energy basis**, the actual annual delivered energy is less than or equal to the on-site renewable exported energy.*

- Represents the total energy impact of the fuel source including inefficiencies in the energy extraction and distribution system
- Allows for the comparison of different energy sources
- Method of calculating source from site energy and source to site energy matter
- Less on-site renewable energy is required to reach zero energy under source basis than a site basis
- For all-electric buildings, the same amount of renewable energy is required to reach zero energy under source and site basis
- Allows for CHP comparisons

Methods of Calculating Site and Source Energy

Multiple Options

- Site Energy
- **Source - Equal Method (3.15 ratio in and out)**
- Source - Consumption (1.00 on all PB)
- Source - Grid Storage (import at 3.15, export at 2.34)

Definition Breakdown – On-Site Renewable

An energy-efficient building, where on a source energy basis, the actual annual delivered energy is less than or equal to the ***on-site renewable*** *exported energy.*

- Boundary must be specified in where to measure energy flows and the balance
- Boundary vary based on scale of zero energy noun (e.g. building, campus, district)
- For building, boundary could be either building or site footprint
- Districts aggregate buildings to allow for share and/or centralized systems such as CHP and larger scale renewable generation
- Technology and opportunities at every level
  - Building/site—owner investments in local EE and RE
  - Campus—owner investments
  - Districts—incorporates city planning and developer engagement

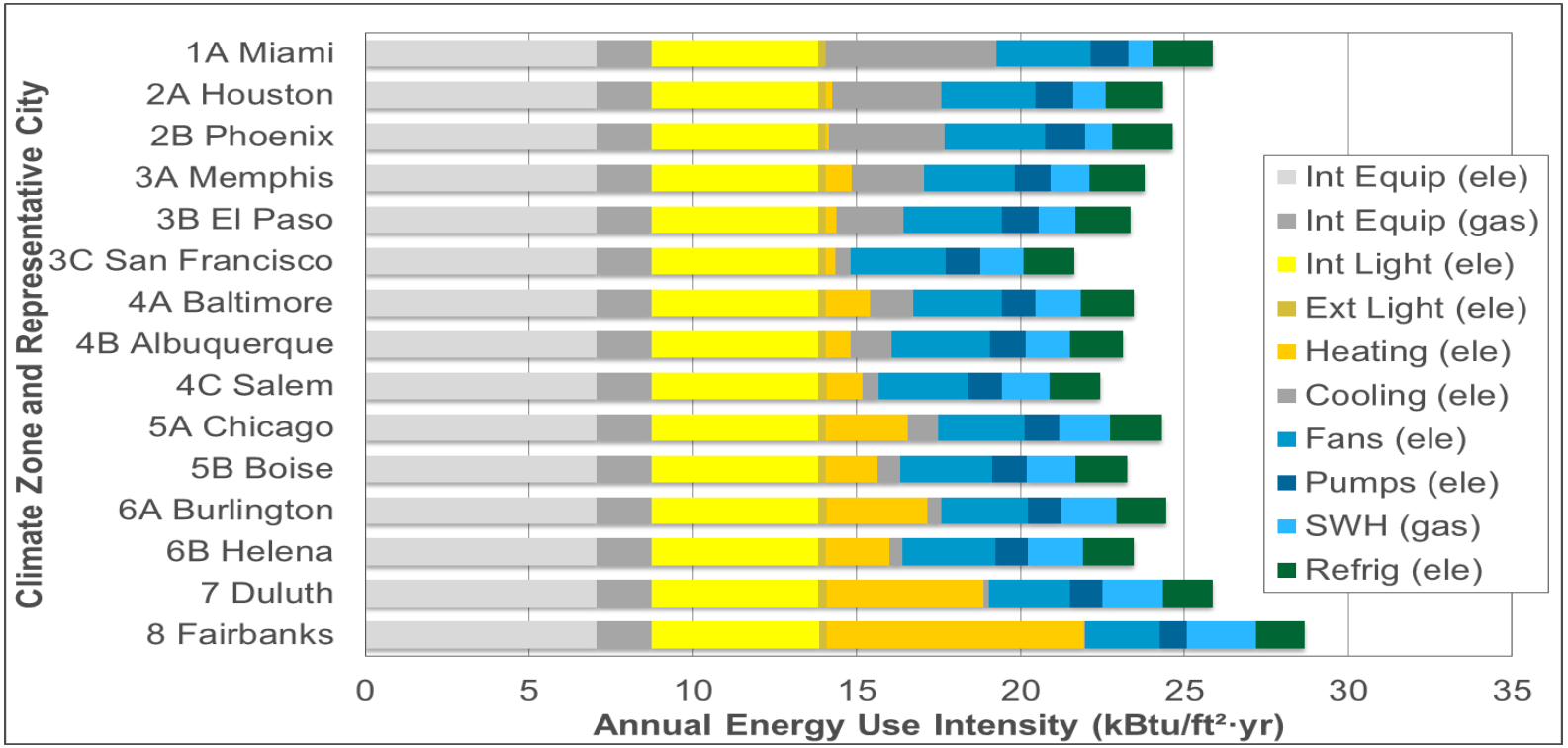
Benefits of a Standard ZEB Definition

- Provides guidance for a existing market direction
- Shows strong DOE leadership for energy efficiency and the adoption of technologies
- Provides motivation to the design and construction community to excel
- Establishes a framework to keep strong focus on operational energy impacts of buildings (which is still 40% of the energy consumption)

What does ZER look like?

- Generally 50-70% reduction in EUI
- Infrastructure & information to integrate renewables where appropriate

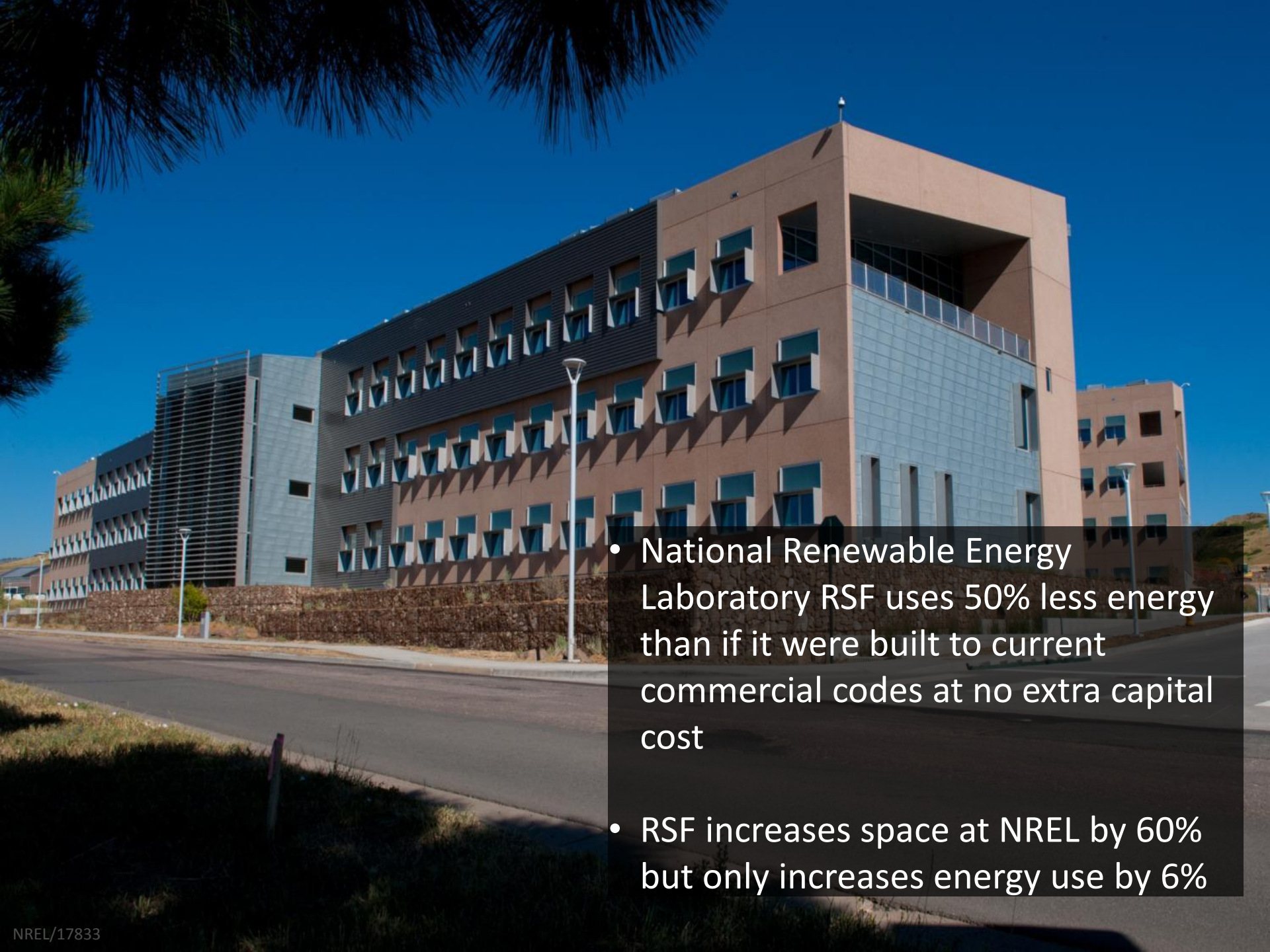
Site energy intensity targets for zero energy (primary school)



Case Study

National Renewable Energy Laboratory Research Support Building (RSF)

Lessons in Innovation around Procurement



- National Renewable Energy Laboratory RSF uses 50% less energy than if it were built to current commercial codes at no extra capital cost

- RSF increases space at NREL by 60% but only increases energy use by 6%

NREL/17833

Problem Definition: RFP Objectives

MISSION CRITICAL

Attain safe work performance/Safe Design Practices

LEED Platinum

Energy Star "Plus"

HIGHLY DE

800 staff Cap

25kBTU/sf

Architectural

Honor future

Measurable A

Support cultu

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

ilding in the

y efficiency

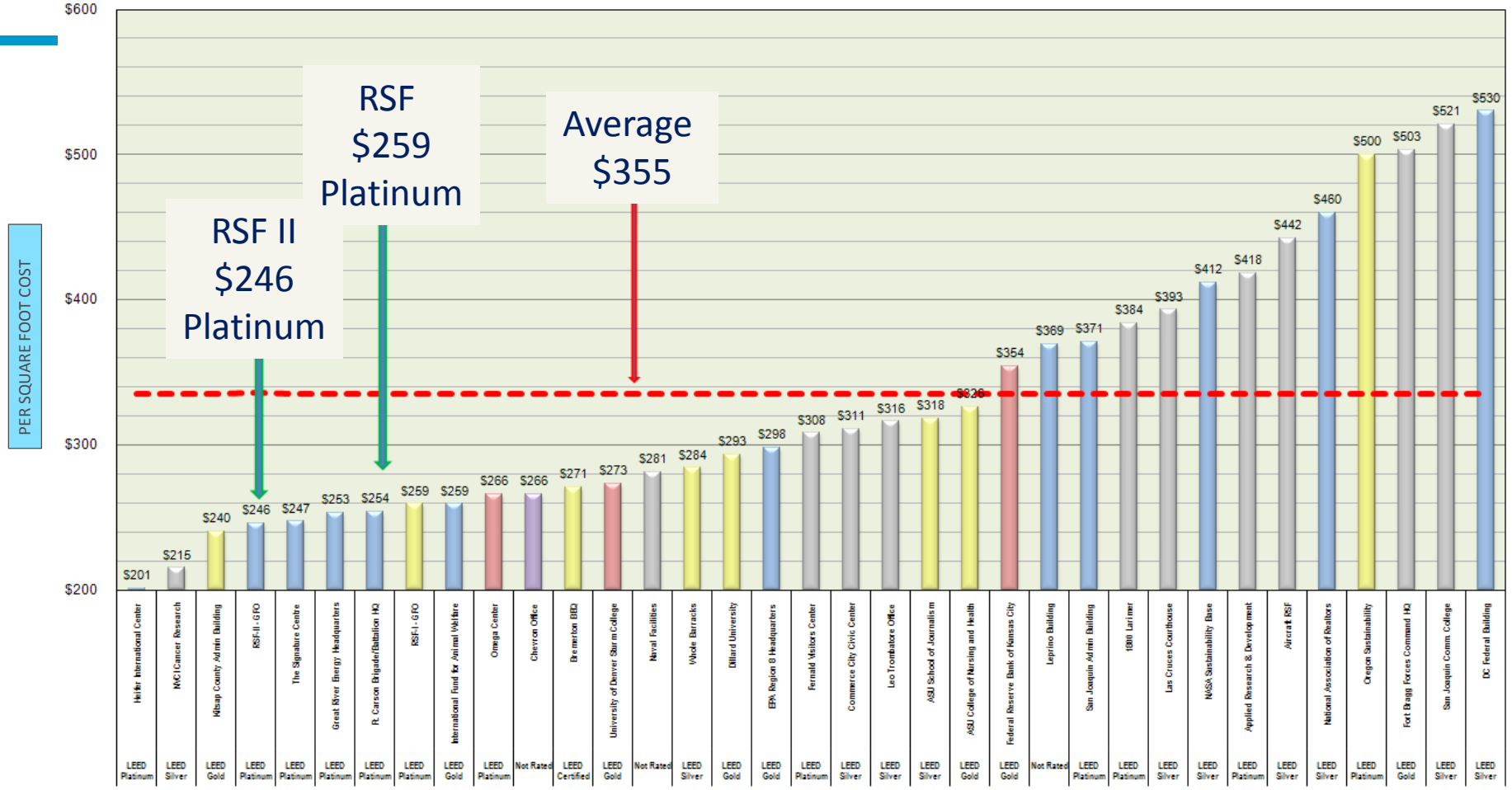
ognition and awards

Support personnel turnover

Used an Innovative Performance Based Procurement Process that Prioritized Criteria including Energy Goals in a Competitive Process

RFP also required maximum use of natural ventilation and 90% of floor space fully daylit

COMMERCIAL BUILDING CONSTRUCTION COST



LEGEND:

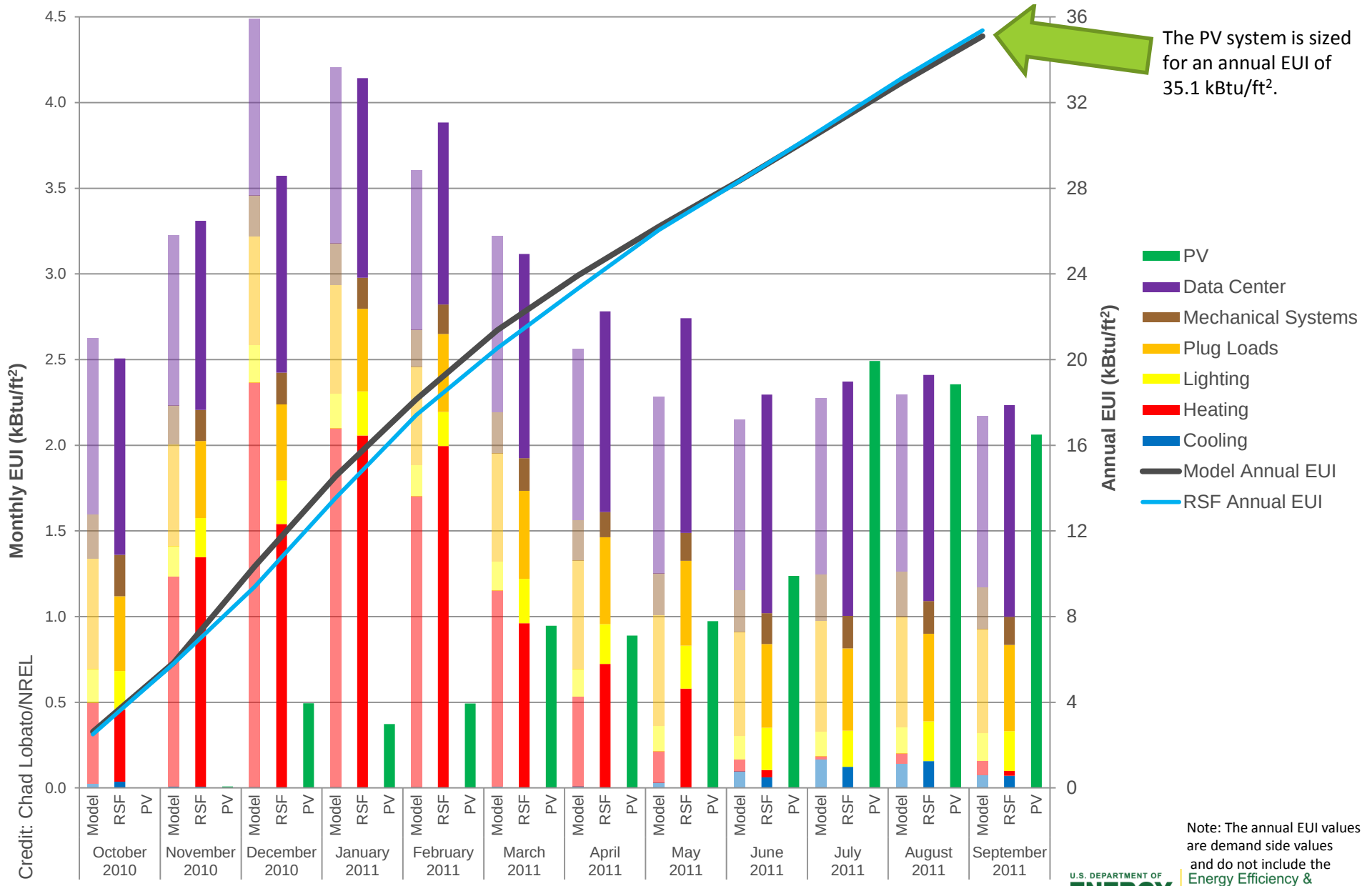
- NOT RATED
- LEED CERTIFIED
- LEED GOLD
- LEED SILVER
- LEED PLATINUM

PROJECTS AND LEED CERTIFICATION

SOURCES:

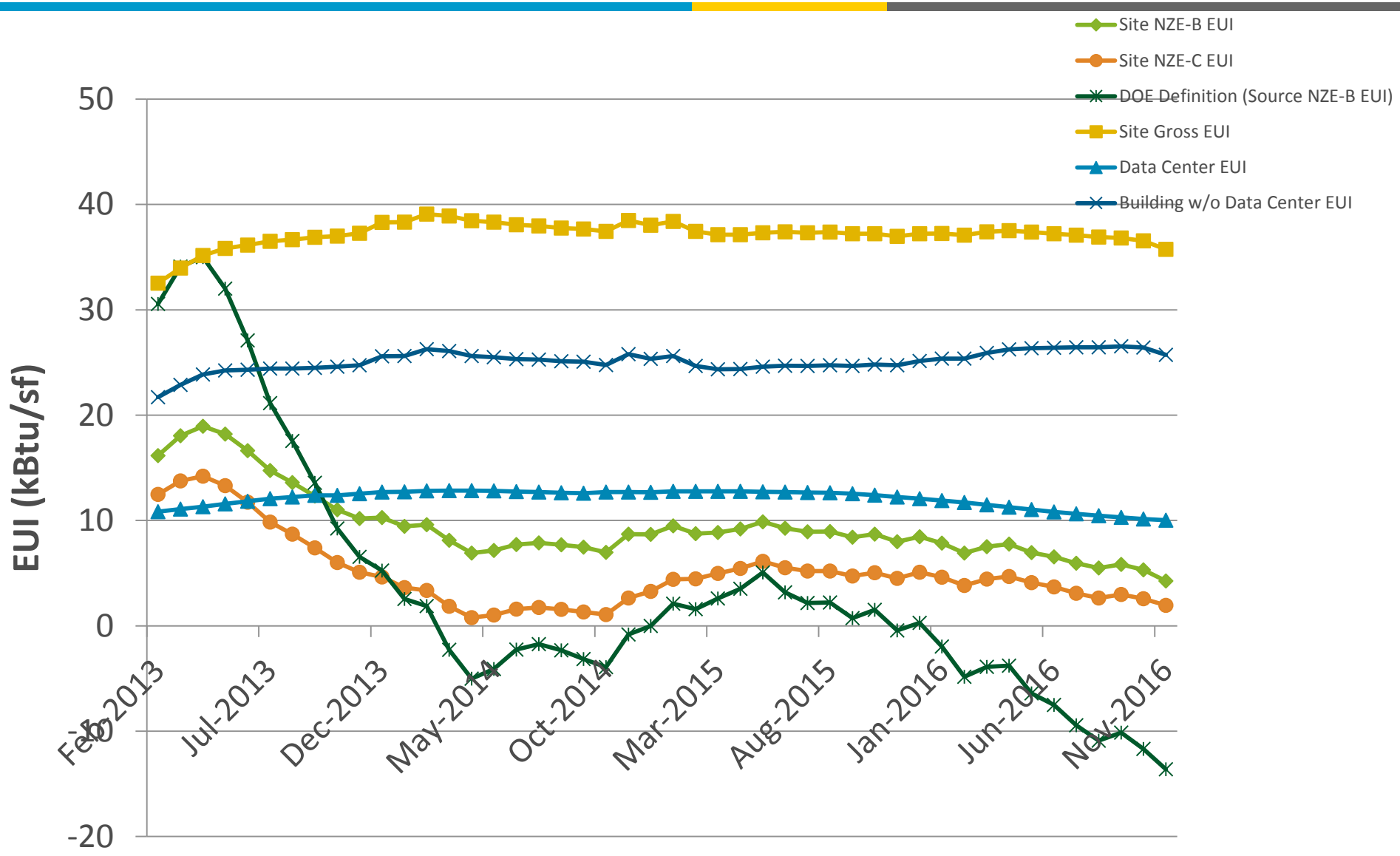
- www.fayobserver.com
- www.dbia.com
- www.nasa.gov
- www.eomega.org
- www.oregonsustainabilitycenter.org
- www.americas.rlb.com
- http://greensource.construction.com
- www.1800larimer.com
- www.usgbc.org
- www.smithgroup.com
- www.cronkite.asu.edu

Measured Versus Modeled Monthly and Cumulative EUI



Note: The annual EUI values are demand side values and do not include the

RSF I and II - Trailing 12-month Energy Use Intensity



RSF by the Numbers

- 800 person occupancy
- 220,000 ft^2
- 25 kBtu/ft^2 nominal EUI
  (35 kBtu/ft^2 with full datacenter)
- 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