



Zero Net Energy Buildings

“A ZNEB is one that is optimally efficient, and over the course of a year, generates energy on-site using clean, renewable sources in a quantity equal to or greater than the total amount of energy consumed on-site.”

Next Generation of Bold New Energy Initiatives

Ellen Watts AIA, LEED AP

Architerra Inc.

June 18, 2010

Getting to Zero

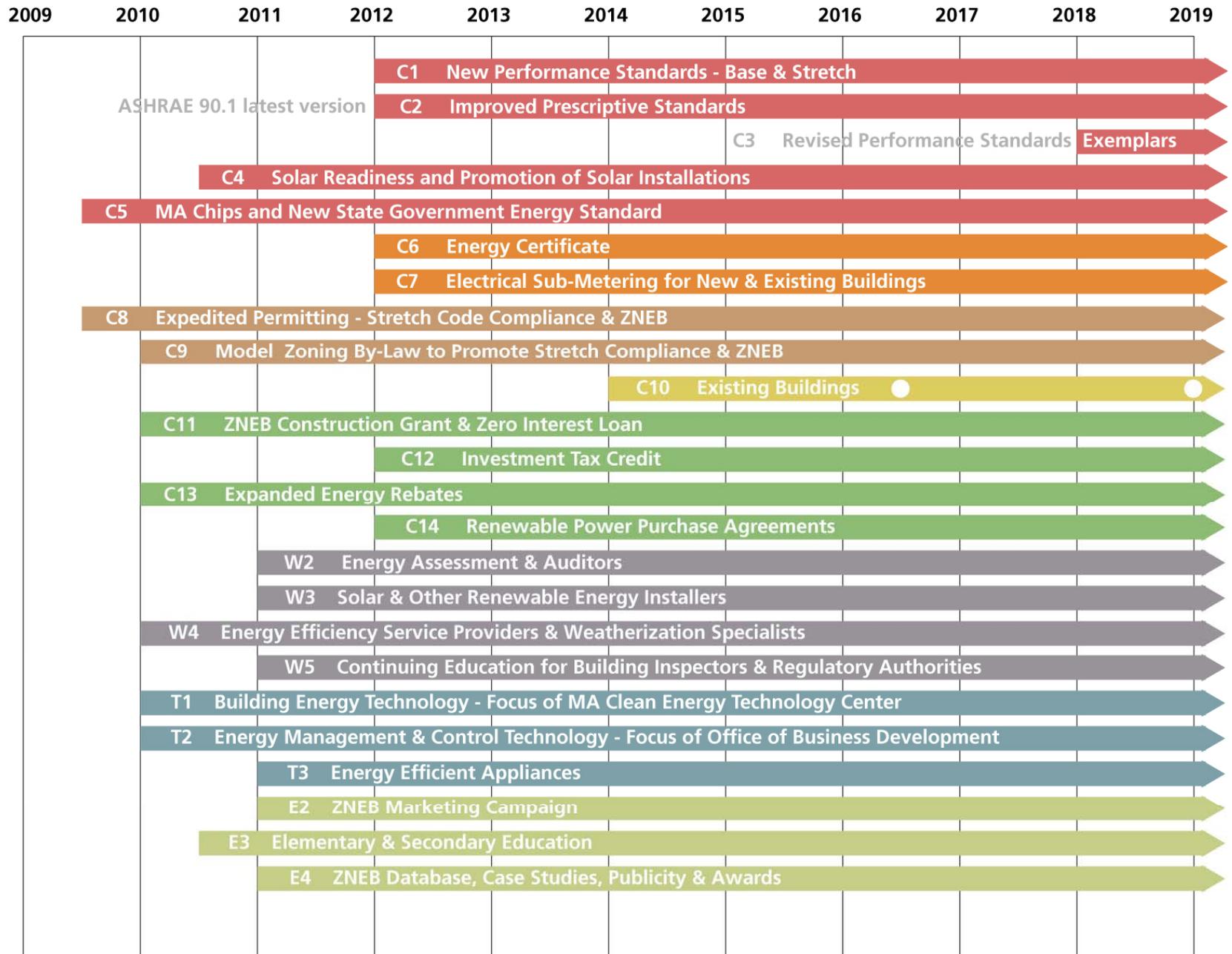
Final Report of the Massachusetts Zero Net Energy Buildings Task Force



24 Recommendations



Target Implementation

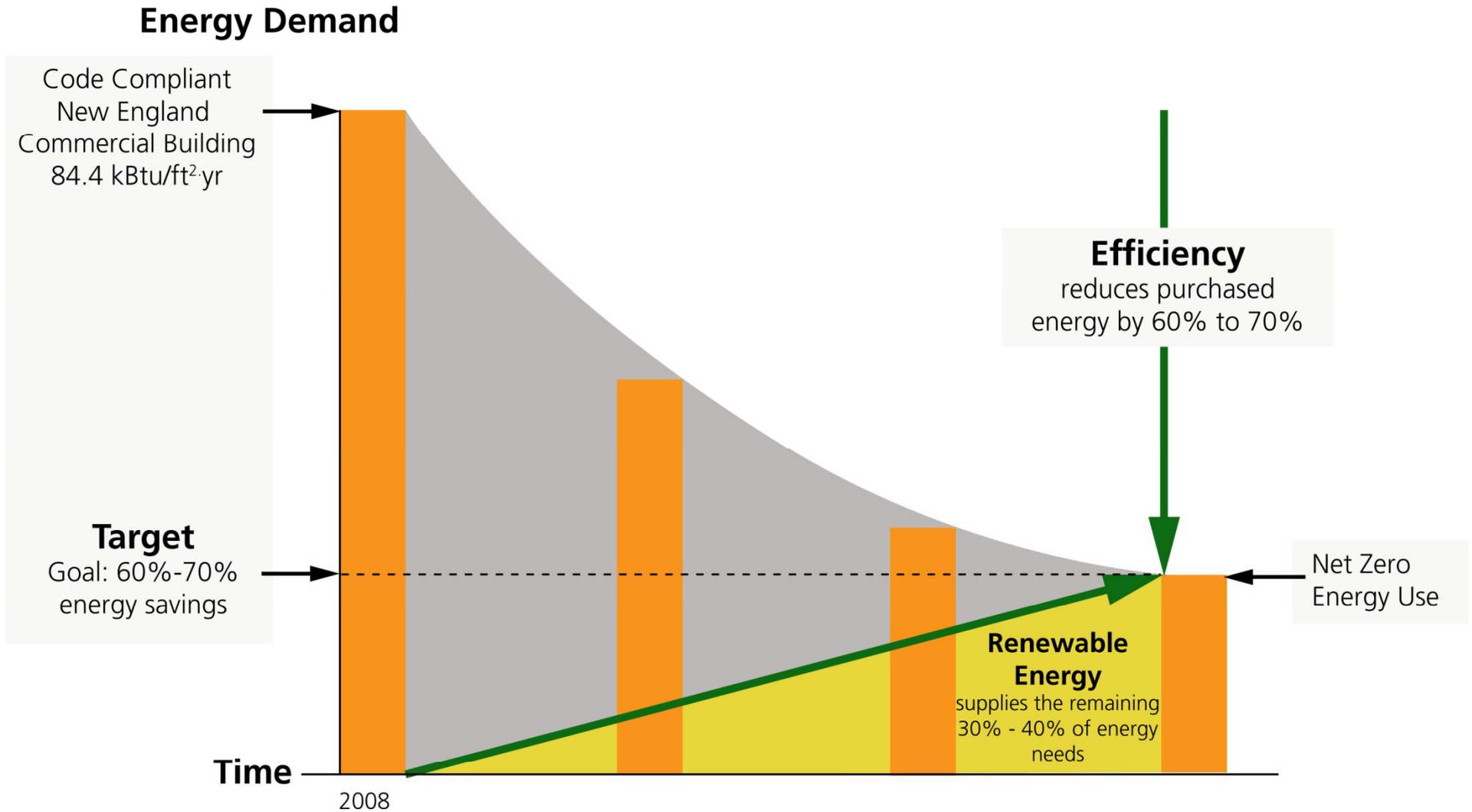


Pathway to ZNEB's by 2030



Adopt performance standards
Require measuring & monitoring
Create regulatory & financial incentives
Train, innovate & educate

Federal R&D Agenda Approach to ZNEB



NREL: Potential for ZNEB

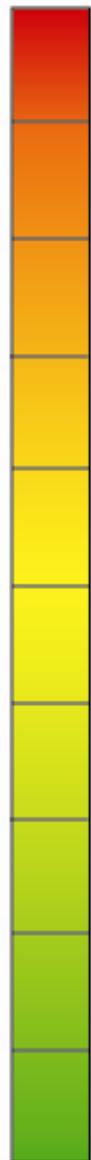
Least Likely Hospitals Laboratories	Below Average Offices (owing to plug and process loads and height)	Above Average Retail Educational
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Source: Assessment of the Technical Potential for Achieving Net Zero-Energy Buildings in the Commercial Sector, National Renewable Energy Laboratory, December 2007

NREL: Reducing Energy Loads = Top Priority

Site Energy Use Intensity (EUI) kBtu/ft²·yr

100



90

Existing U.S. Commercial Buildings
(2003 CBECS)

84.4

New England New Commercial Buildings
ASHRAE 90.1-2004

65.7

New England New Commercial Buildings
ASHRAE 90.1-2004 w/PV

31

New England New Commercial Buildings
Max Tech Energy Efficiency Scenario w/PV

0

Source: Assessment of the Technical Potential for Achieving Net Zero-Energy Buildings in the Commercial Sector, National Renewable Energy Laboratory, December 2007

NREL: Factors & Priorities

Number of stories

Plug and process loads

Use (Principal Building Activity)

Location (Climate Zone)

Thermal Insulation

Lighting Equipment

Plug and Process Loads

HVAC Components

Passive Strategies

Source: Assessment of the Technical Potential for Achieving Net Zero-Energy Buildings in the Commercial Sector, National Renewable Energy Laboratory, December 2007

Exemplars show standards are achievable



Building Type:

Office (small)

Name:

**Woods Hole Research
Center**

Location:

Woods Hole, MA

Date completed:

2003

Total annual energy use:

**16.0 + 5.4 Kbtu/sq ft
actual**

Exemplars show standards are achievable



Building Type:

Office, visitor center

Name:

**George Robert White
Environmental
Conservation Center,
Massachusetts Audubon
Society**

Location:

Mattapan, MA

Date completed:

2002

Total annual energy use:

12.6 Kbtu/sq ft

Exemplars show standards are achievable



Building Type:

Office (small)

Name:

SPNF

French Wing

Location:

Concord, NH

Date completed:

2001

Total annual energy use:

37.4 Kbtu/sq ft

Exemplars show standards are achievable



Building Type:

**Higher Education
Assembly, Classrooms**

Name:

**Vermont Law School
Oakes Hall**

Location:

Royalston, VT

Date completed:

1998

Total annual energy use:

27.2 Kbtu/sq ft

Exemplars show standards are achievable



Building Type:
Higher Education
Research & Teaching
Laboratories,
Classrooms
Name:
Clark University
Lasry Center for
Bioscience
Location:
Worcester, MA
Date completed:
2005
Total annual energy use:
80 Kbtu/sq ft
modeled

Exemplars show standards are achievable



Building Type:

**Higher Education
Teaching & Research
Laboratories, Assembly,
Library, Classrooms**

Name:

**University of New
Hampshire
DeMeritt Hall**

Location:

Durham, NH

Date completed:

2008

Total annual energy use:

**57 Kbtu/sq ft
modeled**

Exemplars show standards are achievable



Building Type:

**Secondary School
Science Building**

Name:

**Brooks School
Science Building**

Location:

North Andover, MA

Date completed:

2008

Total annual energy use:

**32 Kbtu/sq ft
modeled**

Exemplars show standards are achievable



Building Type:

**Secondary School
Science Building**

Name:

**Cambridge School of
Weston**

Garthwaite Center

Location:

Weston, MA

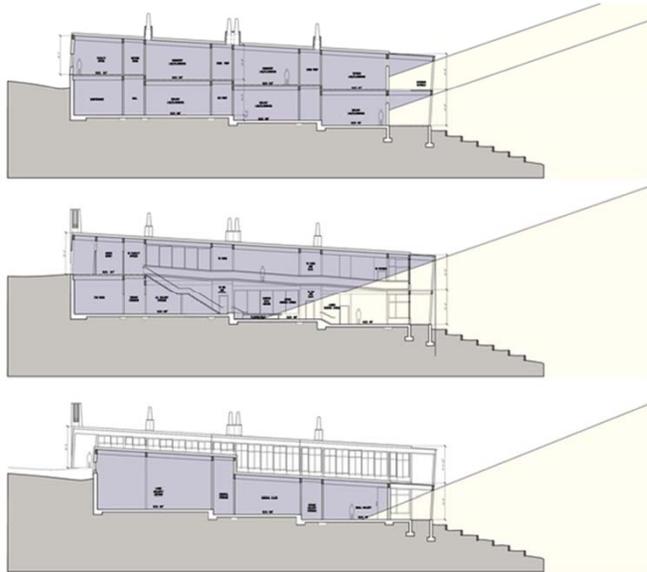
Date completed:

2007

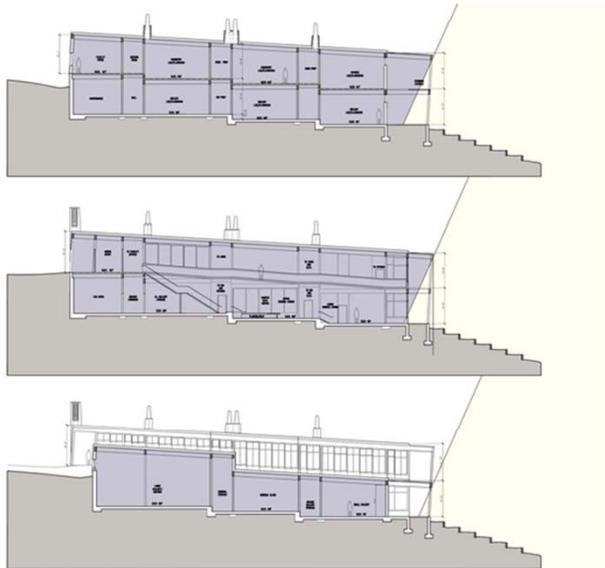
Total annual energy use:

**15.6 +11.5 Kbtu/sq ft
modeled**

Passive Strategies



WINTER SUN ANGLE



SUMMER SUN ANGLE









Renewable Energy



Mechanical Gallery & Sustainable Signage



Green Roof

The 1,000 square foot "green roof" is covered with living plants, educating students about the environmental benefits of this feature which is common throughout Europe. Green roofs mitigate the "heat island" effect caused by development. They help buildings stay naturally cool in the summer and warm in the winter. By retaining rainfall, they also minimize soil erosion and limit the need for storm sewers and tanks. Green roofs also provide habitat for birds and insects... and they look beautiful too!

Building Envelope

The single most effective sustainable design feature of the Garbawale Center is its high performance building envelope that enables the new building to operate using 60% of the energy of a traditionally designed structure.

Wood Pellet Fuel

The radiant floors at the Garbawale Center are heated by a high efficiency boiler that uses renewable wood pellets as its source of fuel.

Sustainable Materials

Sustainable materials are used throughout the Garbawale Center.

- Recycled content: 10% or more
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Radiant Floor

The Garbawale Center is heated by circulating hot water, supplied by the wood pellet boiler. Through the radiant floor, the heat is distributed evenly throughout the building. Radiant floors are more efficient than air at carrying heat and because people near a warm surface feel comfortable at lower air temperatures.

High Performance Lighting

Energy performance goals for the Garbawale Center limited lighting to 3 watts per square foot, 33% better than the Massachusetts Energy Code requires. By using Light Emitting Diodes (LEDs), Compact Fluorescent Lamps (CFLs) and occupancy sensors, this building actually exceeds that goal using only 0.67 watts per square foot.

World Energy Consumption

The world's marketed energy consumption is projected to rise by 75% over the next 25 years. The United States represents just 5% of the world's population, yet consumes 25% of its energy more energy than China, India and Russia combined. The five other largest countries which are home to 51% of the world's population, United States energy consumption per capita is roughly twice that of European countries, and up to twenty times that of developing countries.

World Energy Sources & Impacts

Burning fossil fuels (oil, gas and coal) has been linked to greenhouse gas emissions that have been connected to global climate change. Increasing temperatures are predicted to cause weather severity, famine, health problems, and species extinction.

Why build green?

Anyone who builds a building is making important decisions that have a direct impact on the long-term health of the planet - because buildings use as much energy as industry or transportation. Buildings generate vast amounts of waste materials. Beyond this, Americans spend 60% of their lives indoors, so the buildings we create have a fundamental effect on human health.

Passive Solar Design

How does this building collect passive solar energy?

- Orientation: South-facing windows
- Thermal mass: Concrete floors and walls
- Overhangs: Shading windows in summer
- Glazing: High-performance windows



Building Type:

Higher Education

Assembly, Retail, Co-generation Plant

Name:

SUNY ESF Gateway Building

Location:

Syracuse, NY

Location:

Syracuse, NY

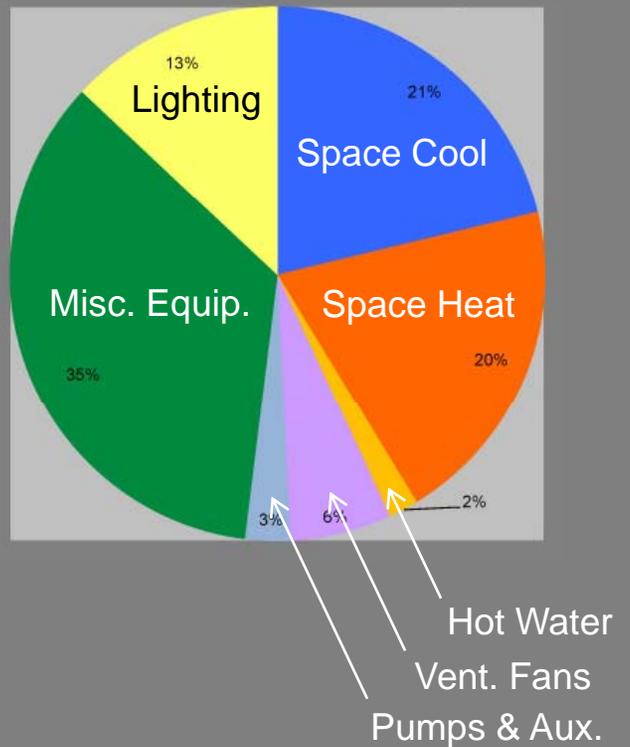
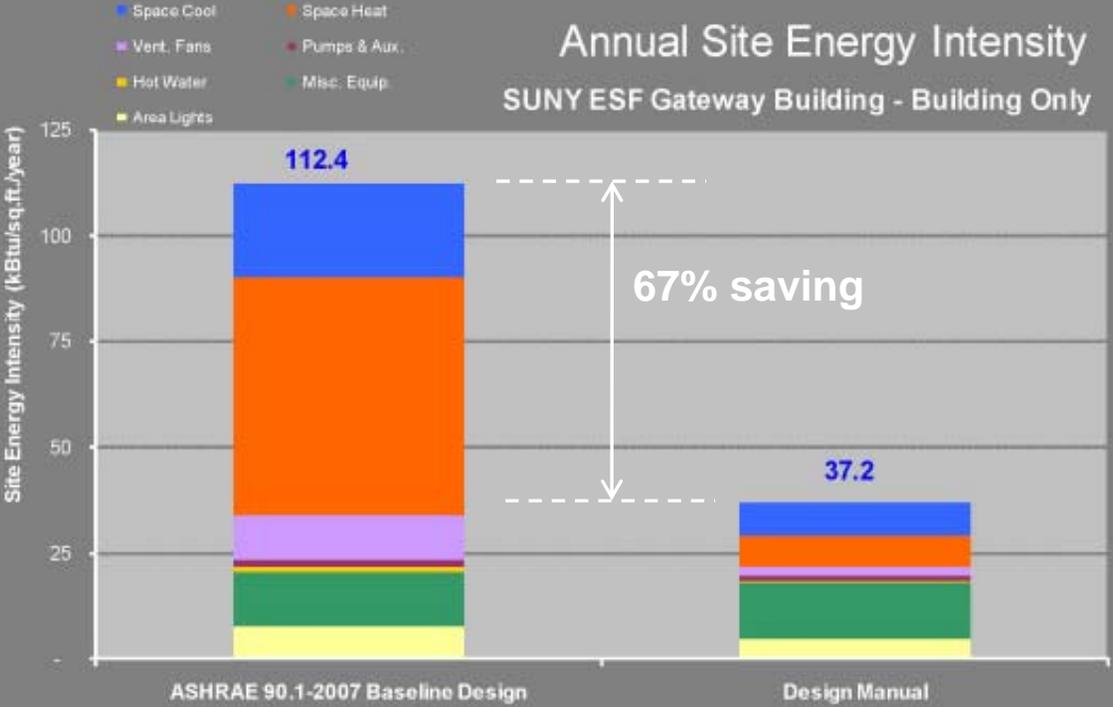
Date completed:

2012

Total annual energy use:

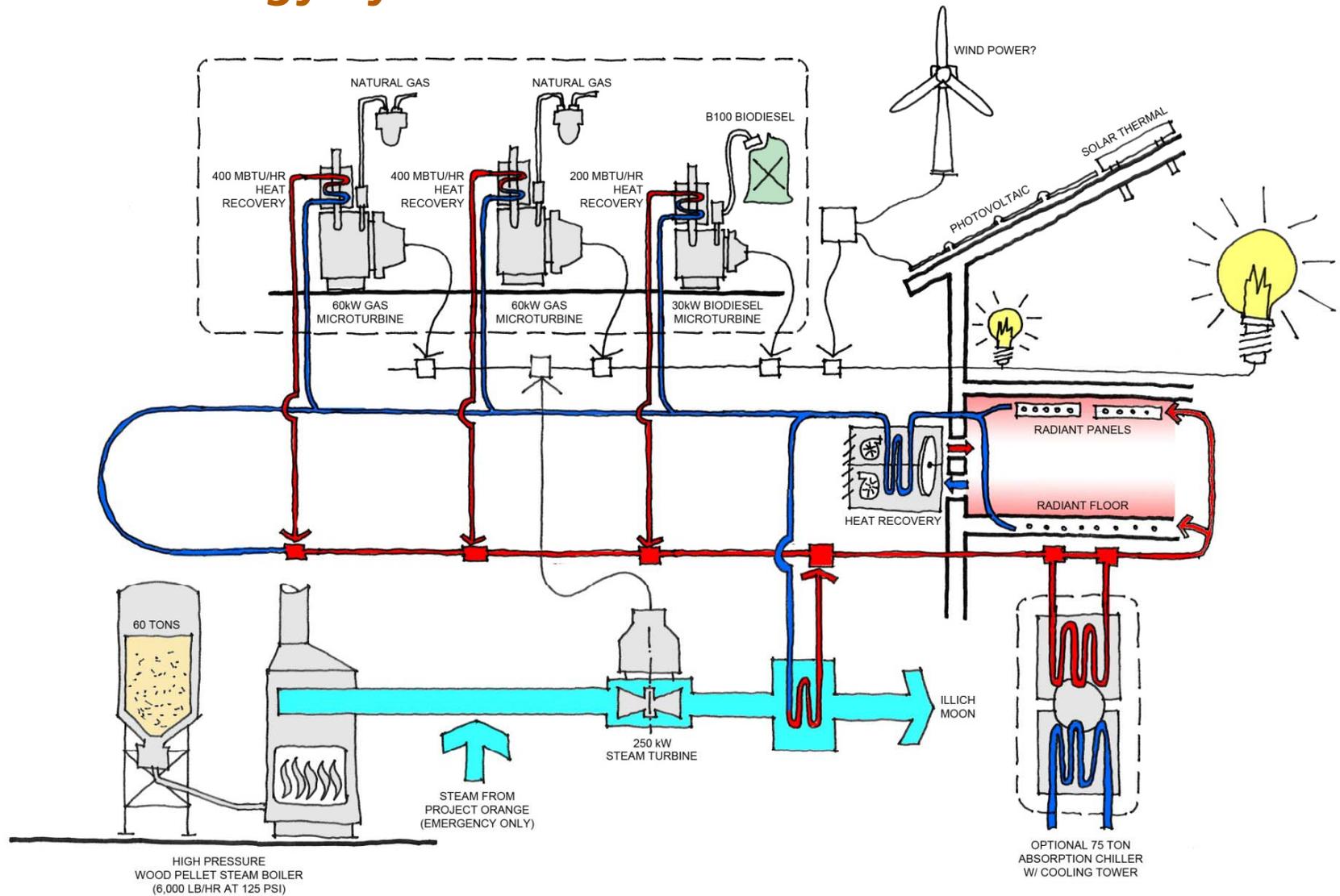
**37.2 Kbtu/sq ft
modeled**

Energy Model



Est. Annual Energy Use: **1,874 MBtu**
 Est. Energy Intensity: **37.2 kBtu/sf/year**

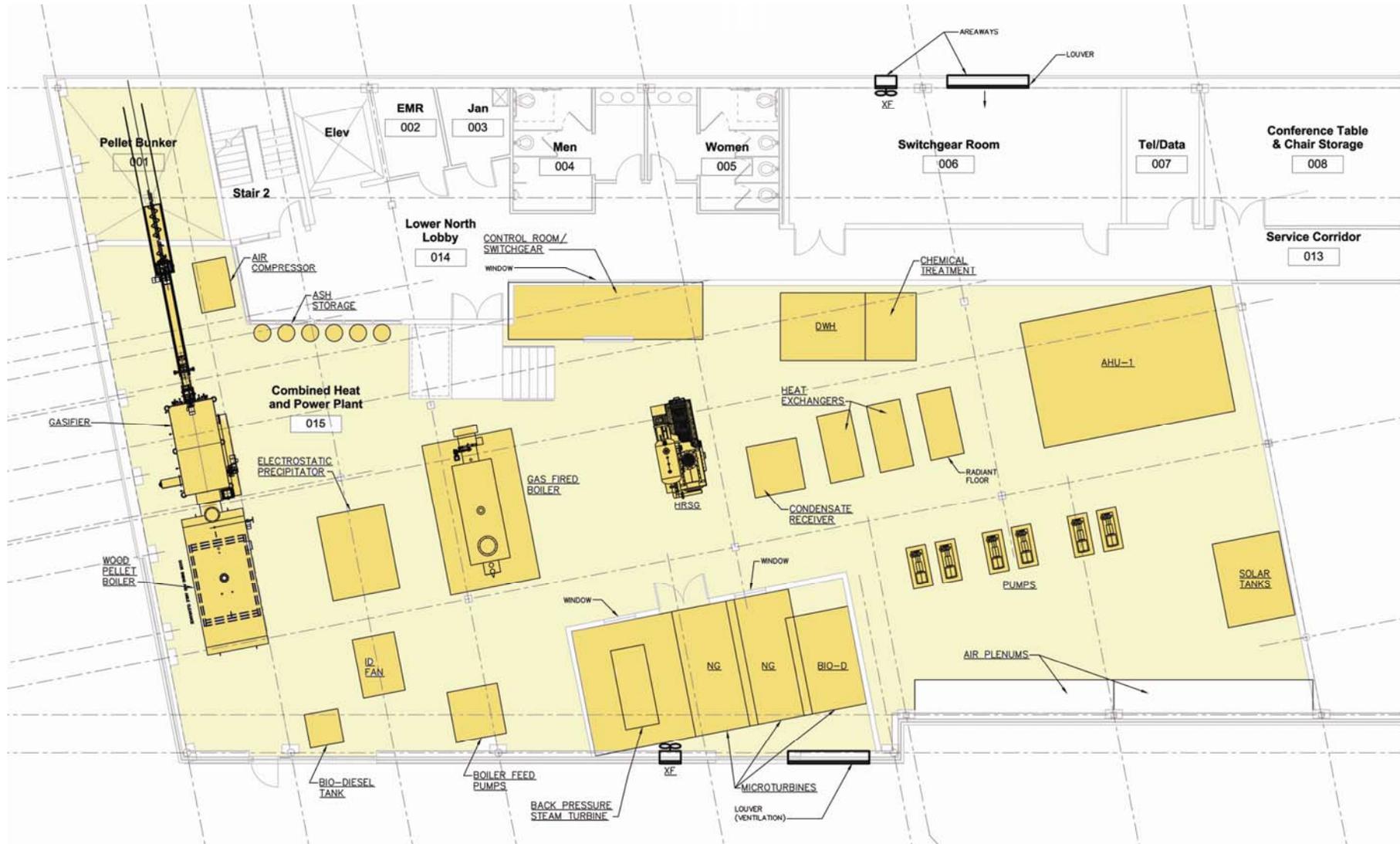
Renewable Energy System



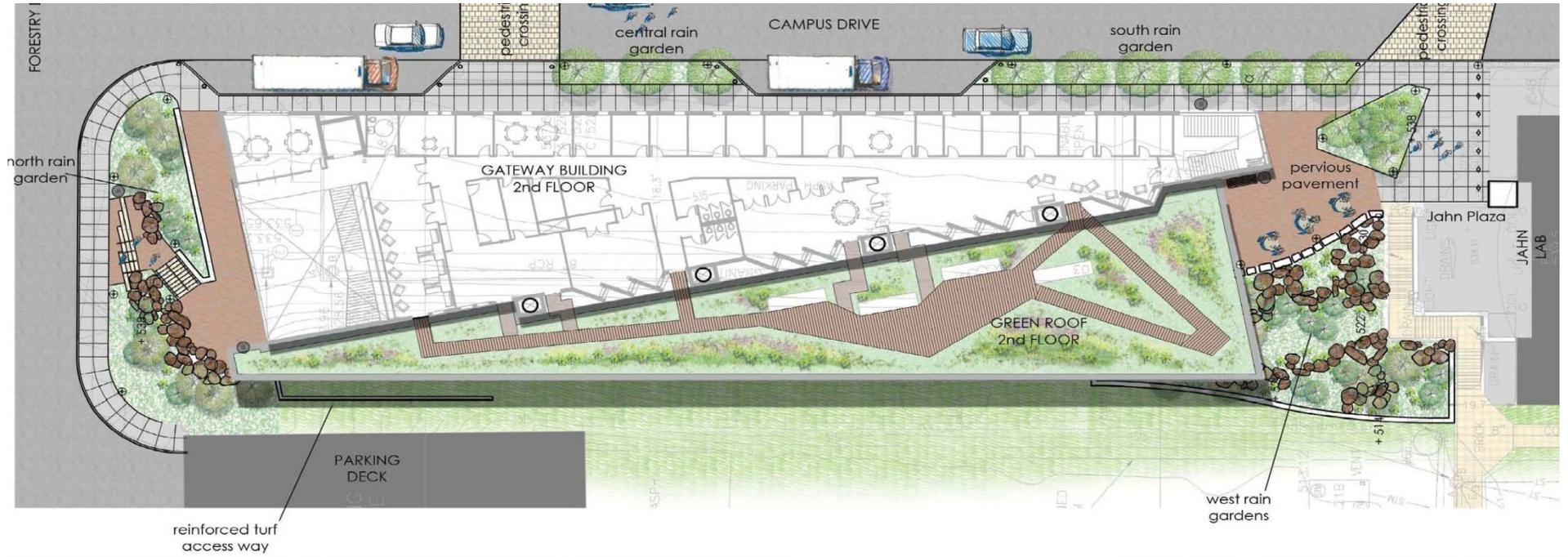
Heat: 7,500 MBTu/Hr, Power: ? kW max

- Wood Pellet boiler produces steam
- Steam generates power and hot water
- Alternate for micro turbines to generate power and heat

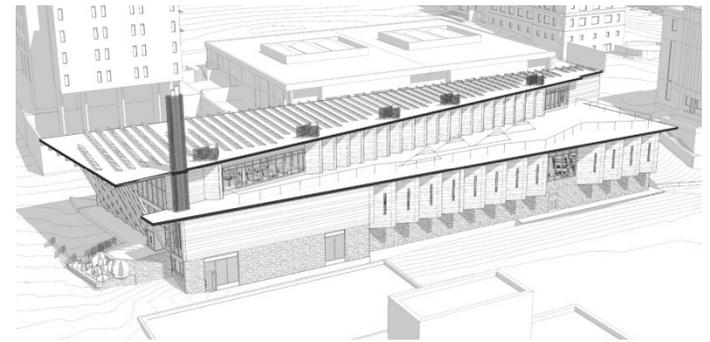
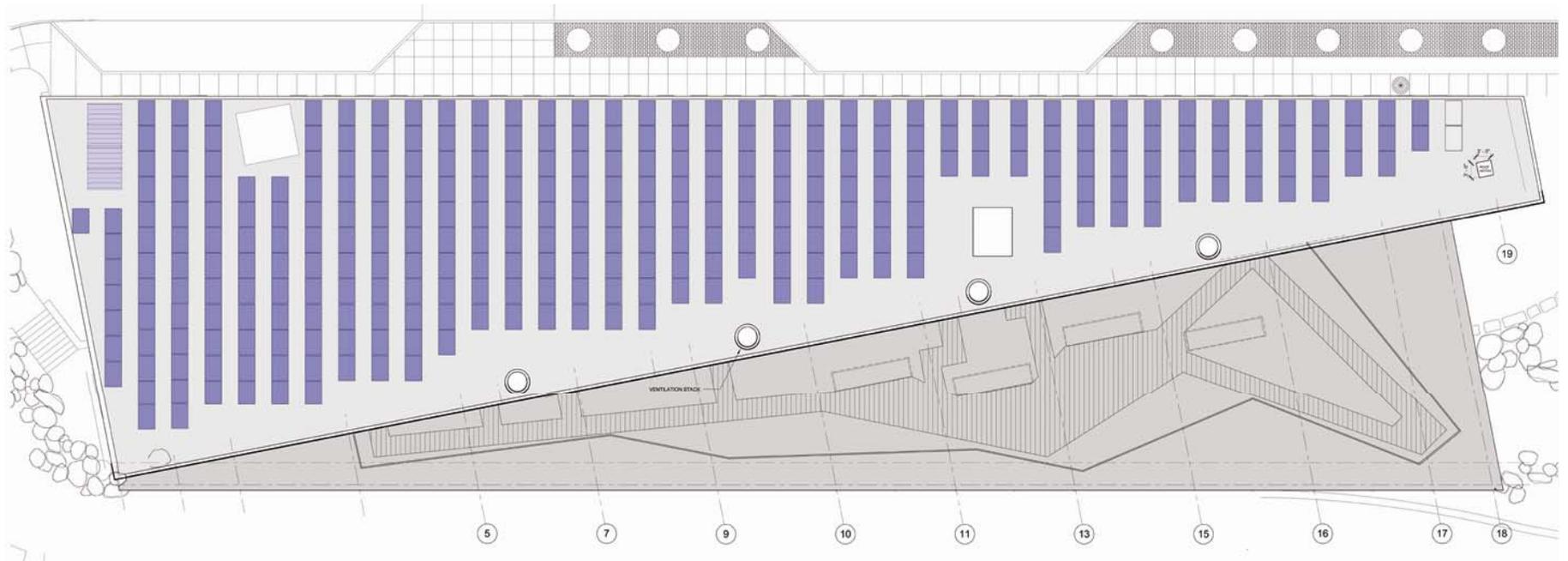
Combined Heat & Power Plant



Green Roof



Photovoltaic



**Sunpower 315 (B.O.D.) @ 30 degrees
389 Modules @ 315W = 122 kW**







Energy Plus Building

60% of the Campus Peak Heating Load in Winter + 19% Annual Power Needs