Green Building Roundtable:

Getting to Zero-Energy Building

April 17, 2009

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Time for Change

- Economic, environmental , agricultural, social health Impacts of global warming
- GHG from buildings and energy consumption (40% GHG and 40% energy consumption in US – 54 in MA!)
- Peak Oil
- Water
- Energy instability/price volatility
- Energy independence/national security

Tremendous impact….Tremendous opportunity

Clear need to reduce our carbon footprint to maintain ecological balance between nature and human and the planet as a whole:

- Reduce consumption
- Maximize efficiency
- Create clean, renewable energy sources
- Decentralized power supplies (localized sources of energy)
- Green Communities Act, the Green Jobs Act, and the Global Warming Solutions Act

What is Zero Net Energy Building?

Buildings that, over the course of a year, produce as much energy as they consume.

How is this done?

Two key steps:

1. Maximizing building efficiency through building design, insulation, material selection , construction techniques and operating systems and maintenance (High Performance buildings)

2. Offsetting grid source power through the use of on-site or district renewable energy systems

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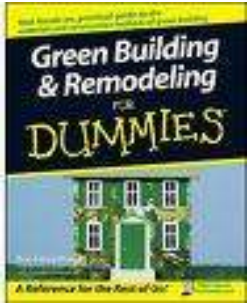
What Zero Net Energy Building is not:

- Current consumption patterns
- Current Building Codes and Energy Standards



- Current centralized and non-renewable energy supplies

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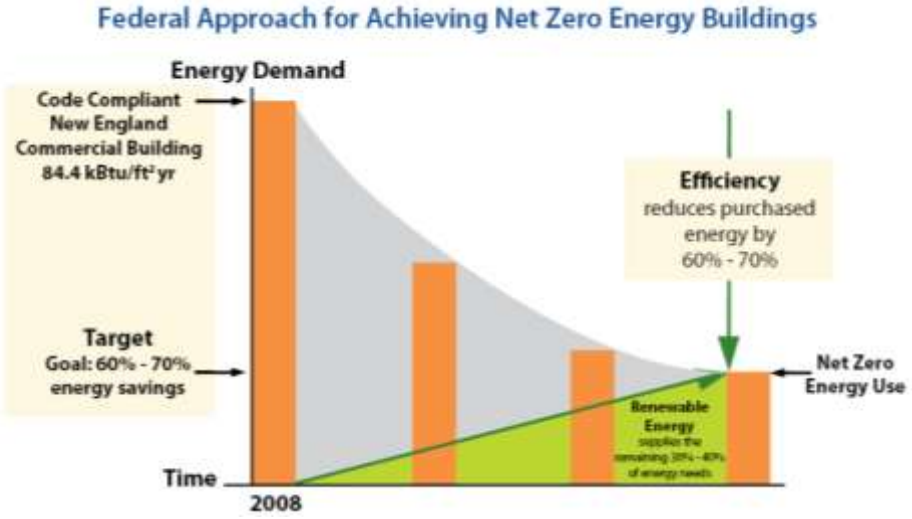
What is Zero Net Energy Building?



Source: Federal R&D Agenda for Net-Zero Energy, High-Performance Green Buildings, National Science & Technology Council, October 2008

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Solar Design Associates

Zero-Net Energy Building Techniques In Practice

(right here in New England!)

21st Century Farmstead:

- Northern New England
- All heat, hot water and electricity from renewables
- sufficient surplus solar-generated electricity to provide for the owners' local transportation needs when plug-in hybrids become widely available

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Carter Scott Transformations, Inc.

Zero-Net Energy Building Techniques In Practice

Townsend, MA

MA Proposed “Stretch” Code

- Alternative to base energy efficiency requirements of 780 CMR and new 8th edition (based on IECC 2009 energy code)
- ~30% more efficient building construction over code (first step toward 0)
- Green Communities Act of 2008 requires that MA adopt each new IECC within one year of its release.
- Applicable to NC and major renovations - Residential and Commercial
- Some exemptions (commercial buildings <5,000 sq.ft.)

MA Proposed “Stretch” Code

Residential:

- New Homes - HERS index of 60 or less
- Major renovations - HERS index of 70 (85 if heating system retained).
- Performance-based approach – requires 3rd party certification
- Renovations less than 600sq.ft. and <30% of the building floor area, Prescriptive Code Option - Energy Star Homes Program (climate zone 5A) insulation greater than or equal to IECC 2009 requirements for climate zone 6A (slightly more stringent than the MA base code).
- 1,000 Energy Star homes built in MA in 2008 - 225 HERS of 60 or less

MA Proposed “Stretch” Code

Commercial:

- Performance-based code for buildings >100,000sq.ft - 20% below ASHRAE 90.1 2007 code (modeled)
- Prescriptive option for medium-sized buildings (4 stories or more <100,000sq.ft.) - based on Chapter 5 of the IECC 2009 energy code, plus:
  - Improved building envelope elements
  - Commissioning requirements for energy systems
  - More efficient lighting power densities and improved controls
  - Improved air leakage requirements (already in MA Code)
  - Alt.(high eff. HVAC, reduced lighting, grid-responsive buildings, RE
- Medium-sized buildings - option of meeting performance standard or prescriptive energy code
- Developed from Core Performance Guide of NBI
- Optional compliance path: more efficient HVAC equipment (perform significantly better than energy star) - significant energy savings

Stretch Code: Dollars and Sense

Task A – New Home	
HERS Index Modeled in REM/Rate	60 (energy use 40% below 2006 IECC code)
Improvement Measures (changes relative to base case) 	- Conditioned basement - Foundation Walls R10 insulation - Above grade walls R22 insulation - Window U-factor .33 - Attic ceiling R38 cellulose insulation - Slope ceiling R32 cellulose insulation - Infiltration 4 ACH50 - Natural Gas Furnace 94 AFUE, 65kBtuh - Central Air Conditioner 3 ton 15 SEER - Domestic Hot Water .62 natural gas tank - Programmable thermostat - 75% Fluorescent lighting
Improvement Costs	$ 8,103
Mortgage Interest Rate	5%
Loan Term (Years)	30
Annual Incremental Mortgage Payment	$527
Annual Energy Costs	$ 3,103
Annual Energy Savings from Baseline	$1,364
Annual Cash Flow Gain	**$ 837**

http://www.mass.gov/?pageID=eopsmodulechunk&L=3&L0=Home&L1=Public+Safety+Agencies&L2=Massachusetts+Department+of+Public+Safety&sid=Eeops&b=terminalcontent&f=dps_bbrs_build_code_changes_public_hearing&csid=Eeops

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MA ZNEB Task Force Report

Charge: State-wide adoption of deep energy reduction retrofits and zero net energy buildings for new residential and commercial construction by 2030.

Task Force Recommendations: Establish polices, mandates, programs and performance standards that will:

- Continuous improvement in energy performance standards (raise standards over next 20 years to get to Zero Net Energy)
- Measurement, reporting and verification to help advance the market for innovative green technology and design
- Incentives - reduce regulatory and financial barriers to energy efficiency and renewables. Also, address “incentive gap” between landlord & tennant
- Provide education and training (re-tool existing construction industry, new and expanded green jobs workforce, educate the public on consumption)

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MA ZNEB Task Force Report

Three Step Strategy:

1. Demonstration project (yes we can approach) State to issue specification for the first state-owned ZNE building by January 1, 2010;
2. Public construction standards (leading by example) develop interim standard for state-owned construction more stringent than LEED-Plus; and
3. Broad marketability of ZNE buildings to the private sector by 2020 and universal adoption by 2030

Report provides list of Key Recommendations by Sector, including timelines to reach goal of NZE by 2030

MA ZNEB Task Force Report

Commercial:

- Energy Performance Standards (establish, revise and categorize as more projects develop) – energy use per sq.ft. vs whole building
- Prescriptive energy requirements for new buildings and renovations (DOE building classification) – Stretch code, ASHRAE 90.1-2007
- Solar readiness to actively promote PV installation
- State funded school projects to comply with MA-CHPS standard
- Measurement and Reporting (Energy Certificates, Commissioning)
- Establish base performance standards for existing buildings
- Incentivize (expedited permitting, competitive grant and loan programs, investment tax credits for EE improvements, expand for RE rebates, allowing building owners to sell metered RE to tenants)

MA ZNEB Task Force Report

Residential:

- Energy performance standards for new homes based on HERS Index
- Develop MA Home Energy Rating System and require ratings with specific transactions
- Measure and provide annual energy use data in all homes
- ZEH Challenge (December 2009)
- Deep Energy retro-fit pilot
- Develop ZNEB performance monitoring protocol
- Incentivize (expand weatherization programs, State co-sponsor mortgage write-downs for deep energy retro-fits, ZNEB revolving loan fund

MA ZNEB Task Force Report

State-Owned Buildings:

- Prescriptive Standards for new buildings and major renovations (NBI Core Performance Standard, building orientation, solar ready roofs, min. on-site RE generation)
- Adopt a Performance Standard by building type (DOE – 30% above ASHRAE 90.1-2007)
- Advanced metering
- Verification and public reporting of energy performance
- Third-party commissioning and re-commissioning
- Building operator and occupant training
- Review and update state standards (raising the bar) and lead by example – beyond LEED Plus Program

MA ZNEB Task Force Report

Workforce Development, Technology Development, & Education:

- HERS Rater and Energy Audit and Assessment Professional training
- RE installer training
- Develop state-supported training to increase Energy Efficiency service providers and weatherization specialists
- Continuing education for MA building industry professionals & regulators
- Advance clean energy technologies & Energy measurement tools
- MA-specific energy efficiency rating system for appliances not currently covered under EPA's energy star
- Consumer education and awareness campaigns
- Elementary and Secondary building performance programs
- Publicize and promote ZNEB examples
- Coordinated Implementation (gov't, building ind., consumers, industry)

MA ZNEB Task Force Report

Case Study:

Division of Fisheries and Wildlife – 2-Story, 34,000sq.ft. Office/Lab

- Baseline – EPA's Energy Star Target Finder Tool
- Annual estimated energy costs: $67,000 – over 20yrs (4%annual)=+$2mil

mixed mode ventilation schemes incorporating natural ventilation and under floor air distribution

geo-thermal heat pumps

high performance building envelope

storm water collection systems

onsite photovoltaic power generation

CHP

MA ZNEB Task Force Report

Bottom line:

- Continuous improvement to reach goal of ZNEB in MA by 2030
- Long-term savings in operating costs from “deep energy” efficiency gains far outweighs upfront costs from an economic, environmental and social standpoint.

Read Full Report at: http://www.mazneb.org/

Other ZE initiatives:

US DOE: http://www.energy.gov/6454.htm

MA CHPS: http://www.chps.net/states/massachusetts.htm

Passive House (Passivhaus)

What is a Passive House?
A home that saves up to 90% of space conditioning costs through:

- super-insulated, virtually air-tight building
- Heating via passive solar gain and internal gains from people, electrical equipment, etc.
- Avoidance of heat gain and reduction of cooling load through shading and window orientation
- Energy recovery ventilators for balanced fresh air supply (and great IAQ)

Any remaining heat demand is provided by an extremely small source.

Comprehensive system relying on passive energy vs. active systems.

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Passive House

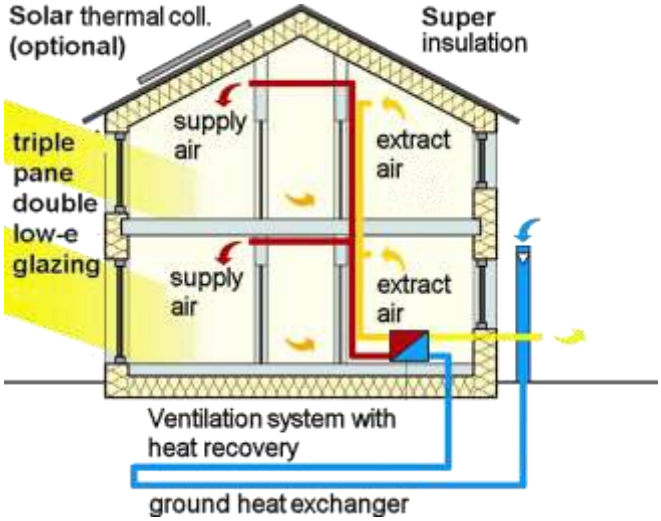
Performance Characteristics:

Super insulation:

- High R-Value or Low Thermal Heat Loss Coefficient **-** R-Values of 38 - 52 on all external walls, slab foundation and roofs.
- Construction Reducing Thermal Bridging
- Airtight Construction

High Efficiency Windows:

- R-Value of just over 7 (U-value of <0.20) using triple pane windows with two low-e coatings and Argon gas (Energy Star window in the US will be closer to the 0.30)
- Super-insulated frames
- “Warm Edge” spacers between the panes of glass



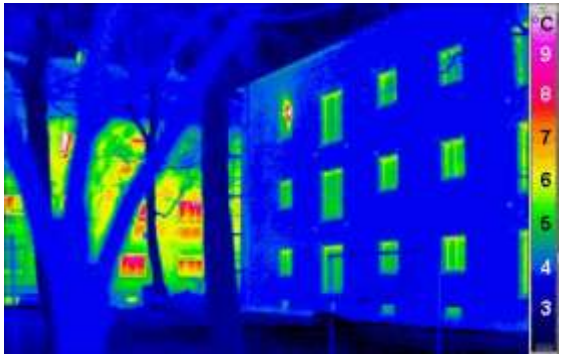
Passive House

Mech. Ventilation w/ Heat Recovery

- HRV or ERV recover 75% to 95% of the heat by passing warm exhaust air past the incoming cold air without mixing - only fresh air is vented into the home and no air is recirculated.

Inno. & Efficient Heating Technology

- Small heat pump
- Small condensing gas burner
- Small combustion unit for biomass fuel
- Compact unit for all in one heating, ventilation and domestic hot water



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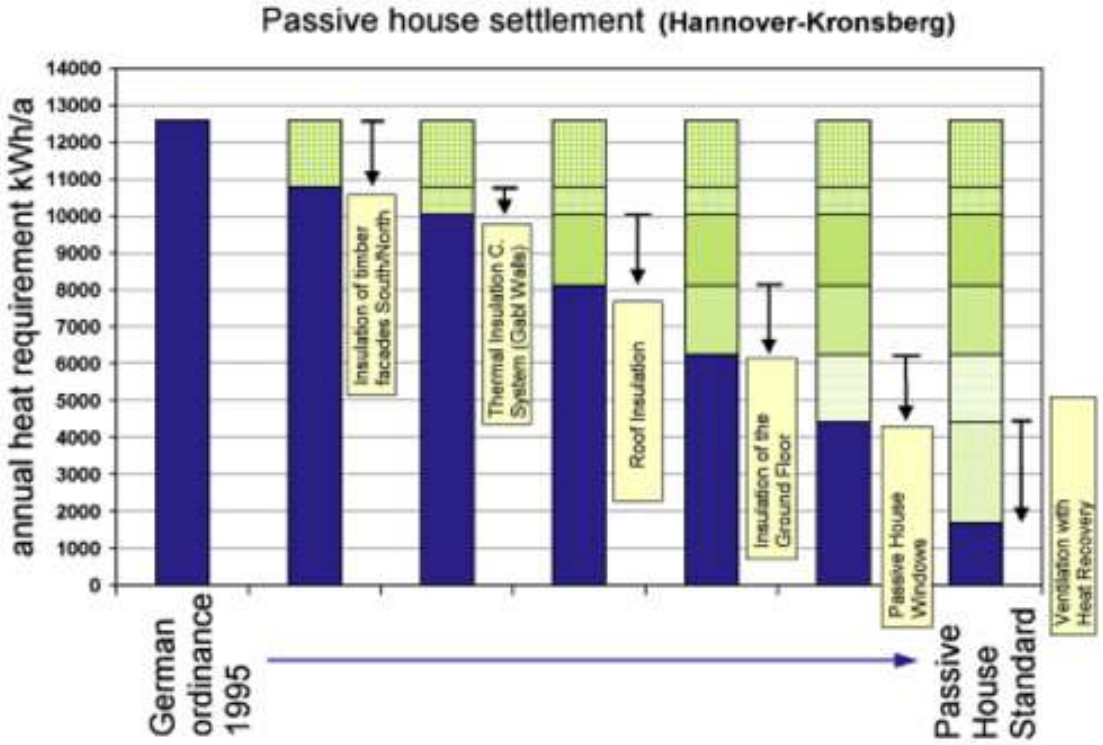
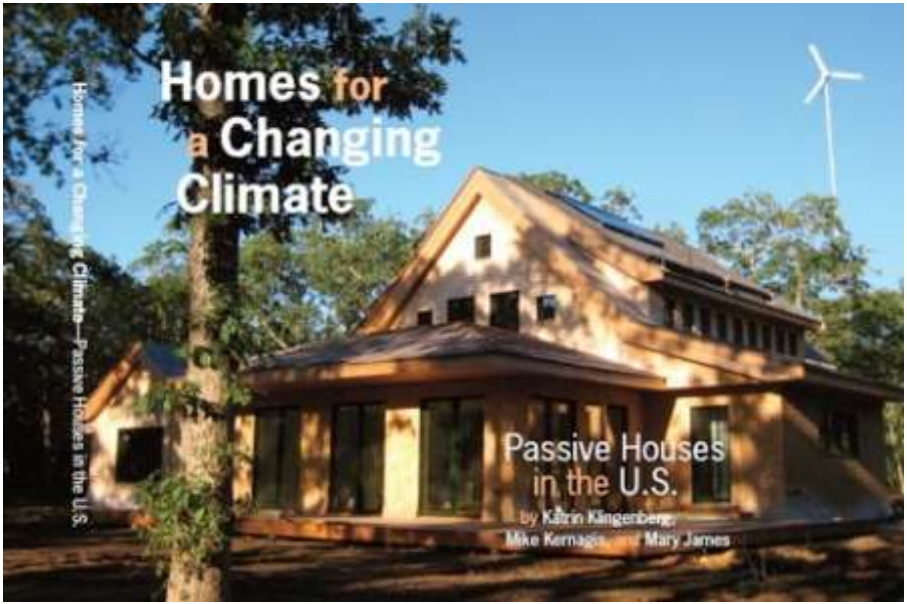
Passive House



Passive House



Passvie House Institute US – Certification Program:
http://www.passivehouse.us/passiveHouse/PHIUSHome.html

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Plus-Energy Homes

Produce more energy from renewable energy sources over the course of a year, than it imports from external sources.

This is achieved using some combination of:

- Micro-generation technologies (wind, geo, solar PV, solar thermal)
- Low-energy building techniques (passive)
- careful site selection and placement

With Net-metering, these buildings become decentralized power suppliers.

Total disconnect from the grid possible (but need storage)

Plus-Energy Homes

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