

Brian Atchinson, Project Manager
New York State Energy Research and Development Authority
Albany, NY

CARBON NEUTRAL HOMES and BUILDINGS

Description:

Carbon is essential to all life on the planet Earth. To be classified as organic, a molecule must contain the element carbon in the form of a carbon-hydrogen bond. As a greenhouse gas, carbon bonds with oxygen to form CO (carbon monoxide, ozone) and CO₂ (carbon dioxide, necessary for photosynthesis). During the day, carbon helps stop solar ultraviolet radiation from baking the surface of the Earth and at night helps reflect heat back so that we do not freeze. Carbon is also a critical part of the water cycle, which regulates the earth's temperature and weather.

The Earth's climate is constantly changing. Before humans inhabited the Earth, there were ice ages, hot ages, wet ages, and the age of the dinosaurs. We are now entering a period of increasing atmospheric temperature, the likes of which humankind has never seen. The debate over whether or not humans are causing these changes is not over. However, there is no debate that increased carbon levels in the atmosphere will result in increased atmospheric temperatures. This is commonly referred to as the greenhouse effect.

In the United States there has recently been an increased focus on becoming energy-efficient and decreasing carbon emissions into the atmosphere. The reasons for interest in energy efficiency include everything from national security to personal financial security. People are also concerned for future generations of humans. There is great concern that an increasingly warm climate will result in polar ice melting, deserts expanding, sea levels raising, infectious disease rates increasing, and many other depressing phenomena. While some might argue that humans are not causing the increasing temperature, no one argues that energy efficiency and carbon emission reduction is a bad thing.

"Driving" is the most common factor people think of when considering ways to decrease their carbon footprint, and it is true that motorized transport through driving and aviation is one of our largest contributions of carbon into the atmosphere. However, in the United States, emissions from energy use in homes and buildings make a much larger contribution of carbon into the atmosphere than does transportation.^{1, 2} Many people forget that the electricity our homes use must be generated by an electric plant somewhere else; in the United States, this electricity usually comes from burning oil, coal, natural gas, or some other fossil fuel.

The concept of a carbon neutral home or building is relatively new and the specifics of an agreed-upon definition is still in the works. However, some groups have taken the effort to standardize the definition:

- **Carbon Neutral - Operating Energy**

This basic definition for Carbon Neutral Design in homes and buildings is taken from www.architecture2030.org. Carbon neutral, with respect to operating energy, means using no fossil fuels that emit greenhouse gases to operate the building (operation includes heating, cooling and lighting). These targets may be accomplished by implementing innovative sustainable design strategies, generating equal on-site renewable power, and/or purchasing (20 per cent maximum) renewable energy and/or certified-renewable energy credits. At the present time, it is estimated that operating energy accounts for approximately 70 per cent of the carbon emissions associated with a building. The other 30 per cent is described below.

- **Carbon Neutral - Operating Energy + Embodied Energy**

This definition for Carbon Neutrality builds upon the definition above and also adds the carbon that is a result of the initial and recurring *embodied energy* associated with the materials used to construct a home or building. This value is far more difficult to calculate.

As described by Canadian Architect,³ "The *initial embodied energy* in homes and buildings represents the non-renewable energy consumed in the acquisition of raw materials, their processing, manufacturing, transportation to site, and construction. This initial embodied energy has two components:

- *Direct energy*— the energy used to transport building products to the site, and the energy used to construct the building.
- *Indirect energy*— the energy used to acquire, process, and manufacture the building materials, including any transportation related to these activities.

"The *recurring embodied energy* in homes and buildings represents the non-renewable energy consumed to maintain, repair, restore, refurbish, or replace materials, components, or systems during the life of the building.

"As buildings become more energy-efficient, the ratio of embodied energy to lifetime consumption increases. Clearly, for buildings claiming to be 'zero-energy' or 'autonomous,' the energy used in construction and final disposal takes on a new significance."

While, currently, design and implementation of carbon neutral homes and buildings is still in its infancy, with only scattered demonstration projects occurring worldwide, active interest is growing. For example, (1) SpringLeaf Boulder, which is in the planning stage in Colorado, will consist of 12 homes that are designed for LEED Platinum certification, will be fully powered by photovoltaic systems, and are very close to shops and restaurants—creating a little eco-community within Boulder, CO; (2) the Central Dallas Community Development Corporation's winning design has been chosen by *Urban Re: Vision—Dallas* to take a vacant inner-city block behind City Hall and transform it into a carbon-neutral, sustainable community that will run off the grid in Dallas TX; and (3) in 2010 in New York City,

Solar One expects to begin construction of Solar Two, an 8,000 sq. ft. Green Arts and Education Center that will be the City's first carbon-neutral, net-zero-energy building. As renewable power technologies, advanced construction techniques, HVAC (heating, ventilation, air conditioning) equipment, appliances and lighting, and consumer awareness all move towards increased efficiency and effectiveness—and as more new projects come on-line—the dream of carbon neutral homes will become a reality.

References:

¹ M. L. Walser (August 23, 2008), "Carbon Footprint," *The Encyclopedia of Earth*.
http://www.eoearth.org/article/Carbon_footprint.

² "The Building Sector: A Hidden Culprit," *Architecture 2030*:
<http://www.architecture2030.org/>.

³ Measures of Sustainability," *Canadian Architect*:
http://www.canadianarchitect.com/asf/perspectives_sustainability/measures_of_sustainability/measures_of_sustainability_embodied.htm.

Benefits:

For consumers

- Zero energy bills—makes homeownership and renting more affordable for all residents, and supports business operations.
- Decreased or zero use of fossil fuels—makes the home living environment healthier (cleaner indoor air) for all residents, and, in particular, supports the ability of frail older people and younger-aged people with disabilities to successfully age-in-place.
- Off-the-grid houses are not susceptible to black outs or power failure.

For the community

- Decreased carbon footprint.
- Decreased load on electricity distribution infrastructure (the electric grid).
- Decreased emissions from power generation plants due to decreased demand.
- State and Federal programs to help in construction.

Impediments or barriers to development or implementation:

- Among the public, common misconceptions remain about renewable power and carbon neutral homes—many feel modern comforts must be sacrificed, thus decreasing market acceptance.

- Building construction techniques, renewable technologies, and workforce infrastructure is still young, decreasing availability and affecting cost-effectiveness of completing homes.
- Up-front development/installation costs can be large.
- Service can be costly or difficult to obtain if the technology breaks down.
- Not all utilities are set up to handle net metering, thus removing the option of selling energy back to the utility to offset times of drawing from the grid.
- Not all utilities offer clean energy source options.
- Homes must use electricity as a source of air heat and hot water, or else they have to offset those energy draws with increased electricity generation. Offsetting the fossil fuel draws is typically difficult to achieve.
- Local municipalities may not allow the installation of tall towers for wind power or photovoltaic cells on building roofs.

Resource—examples:

- United Kingdom: Lighthouse, the UK's first zero-emission, carbon-neutral home, was completed in 2008 and is a fine example of form and function: <http://www.jetsongreen.com/2008/02/lighthouse-uks.html>.
- United States: zHome, in Issaquah, WA, is the first multifamily zero energy, carbon neutral community in the United States. zHome is a revolutionary, ten-unit townhome development that uses smart design and cutting edge technologies to radically reduce its environmental impacts. zHome aims to prove that homes can use zero net energy and 60 per cent less water, emit net zero carbon emissions, have clean indoor air, and use only low-toxicity materials. It will also show that these goals and building techniques are attainable and scalable to mainstream home production. <http://www.z-home.org/>.

Resource-written and web:

- *The 2030 challenge* is an effort by Architecture 2030, a non-profit, non-partisan, independent organization established in Santa Fe, NM, in 2002 by Edward Mazris (architect, author, researcher, and educator) in response to global warming; Architecture 2030's aim is to achieve a reduction in greenhouse gas emissions among the building sector by changing the way buildings, homes, and developments are planned, designed and constructed. http://www.architecture2030.org/2030_challenge/the_2030_challenge.
<http://www.architecture2030.org/>.

- United States Department of Energy, Energy Efficiency and Renewable Energy Department: http://www1.eere.energy.gov/buildings/building_america/.
- United Kingdom: The British government has recently opened the comment period on a major plan to revise the building code, phasing in regulations to ensure that all new homes are built carbon-neutral by 2016.
<http://www.2people.org/pub/page/show/article/10596>.
<http://webarchive.nationalarchives.gov.uk/+http://www.communities.gov.uk/planningandbuilding/theenvironment/>.
- Australia: The government's guide to environmentally sustainable homes—*Technical Manual: Design for lifestyle and the future*, Section 1.4: "Carbon neutral"—extensive definitions, descriptions, and resources:
<http://www.yourhome.gov.au/technical/fs14.html>.

Resource—technical assistance contact names:

- Brian Atchinson, Project Manager
Residential Efficiency and Affordability Program
New York State Energy Research and Development Authority
17 Columbia Circle
Albany, New York 12203
(518) 862-1090 Fax: (518) 862-1091
bta@nyserda.org