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ZERO-NET-ENERGY HOMES

Description:

Anyone who has ever paid a utility bill has inevitably thought to himself, “What if I didn’t have to pay this bill?” There are two simple ways to achieve such a goal. The first is to live in a home that does not use any energy—unfortunately, this means not having electricity, heat, or hot water. This does not sound like a home anyone would want to live in. Now imagine living in a home that contains all the modern amenities, but there is still no utility bill—such a home would need to generate all of the power it needs to operate through a "zero-net-energy" approach.

Zero-net-site-energy homes typically use electricity to heat the air and water of the home—no use of gas or oil needs to be considered. In such a home, the amount of energy provided by *on-site renewable energy* sources (for example, wind, solar, biomass, geothermal) is equal to the amount of energy used by the home. These homes are connected to the electric grid and may draw electric power when needed, but will also give back to the grid when producing more than the home needs. By definition, the amount of electricity put back into the grid must equal the amount used from the grid.

Two major trends are resulting in zero-net-energy homes becoming more and more of a reality: (1) The progress of new construction technologies and techniques, as well as the commercialization of advanced renewable/sustainable technologies; and (2) the development of zero-net-energy home projects throughout the world, providing academic researchers and public policy designers with great insight into the most effective and least costly paths to achieving their goals.

Although this section focuses on zero-net-energy *residential homes*, this approach is beneficial for a variety of buildings, which is evident in the several definitions of what a zero-net-energy approach means in practice. Below are brief descriptions of some of the nuances of this concept:

Net-zero-site-energy use—
This describes a home or other type of building in which the amount of energy provided by on-site renewable energy sources is equal to the amount of energy used by the building.

Net-zero-energy emissions—
Outside the United States and Canada, a zero-net-energy home is generally defined as one with zero-net-energy emissions—also known as a zero-carbon building or a zero-emissions building. This definition also considers the carbon emissions generated from on-site or off-site fossil fuel uses, which need to be balanced by the

amount of on-site renewable energy production. In addition to considering the carbon emissions generated by the building while in use, true net-zero-energy-emissions homes also consider the emissions generated during the construction of the building, as well as the energy required to make the building materials for the structure. Over the life of the home, the clean on-site energy produced must make up for these other emissions. Homes that use natural gas or some other fossil fuel to heat its air and water must consider the emissions from combusting these materials and make up for it through clean energy generation.

Off-the-grid—
Off-the-grid buildings are stand-alone zero-net-energy homes that are not connected to an off-site energy generation facility. They require distributed renewable energy generation and energy storage capability (for when the sun is not shining, the wind is not blowing, etc.). These homes are the most difficult to design and construct and are also more costly than grid-connected homes. True off-the-grid homes require great dedication from their owners.

In the United States, the concept and general definition of net-zero-energy homes is understood to be the point where all electricity demands from the home are met through on-site renewable power generation. Great care is taken through advanced building techniques to decrease the power-demand of the homes, while not sacrificing functionality or comfort. Items that need to be combined for a successful zero-net-energy home include:

- Passive solar designs
- Advanced insulation and air sealing techniques
- Energy-efficient appliances and lighting
- High-efficiency heating, cooling, and hot water systems
- Renewable power generation through wind, solar, or biomass
- Net metering with the utility
- Consumer education

On-site power generation is the most costly and unreliable portion of the zero-net-energy home. Because of this, it is advantageous to design a home so that it does not require excessive amounts of electricity in the first place. A highly efficient home is much easier to make zero-net-energy. As more research occurs and more demonstration projects are undertaken, the process for achieving this goal will become clearer.

The final part of the process is the consumer. A house is only as efficient as the people operating it. Human activities, such as washing clothes in cold water, using

clothes lines, turning off lights when not in use, taking faster showers, and reading instead of watching television, all combine to greatly decrease energy demands.

Benefits:

- *For homeowners and building owners:*
  - Year-round reduced or zero energy bills.
  - Off-the-grid houses and buildings are not susceptible to black-outs, brown-outs, or power failures.
  - Healthier living environment because of decreased or no emissions.
  - As the use of this concept expands—bringing installation and service costs down—the health benefits and reduced operating costs will help make homeownership and rental more affordable—supporting the ability of residents to continue living in the community.

- *For communities:*
  - Decreased load on the electricity distribution infrastructure (electric grid).
  - Reliable, renewable, sustainable energy sources.
  - Decreased emissions from power generation plants due to decreased demand provide environmental benefits.
  - Reduced operating costs support businesses.
  - State and Federal programs to help in construction.

Impediments or barriers to development or implementation:

- This concept is new, so technologies and market penetration have not yet reached a sufficient level to (1) reduce large up-front costs and service costs, and (2) engender a network of service providers to accommodate break-downs in the technology.

- Not all utilities are set up to handle net-metering; where net-metering is not available, users do not have the option of selling energy back to offset times of drawing from the grid.

- Homes must use electricity (instead of fossil fuels) 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 energy 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.

- There are common misconceptions about renewable power and zero-net-energy homes—for example, many erroneously feel that modern comforts must be sacrificed—which decrease market acceptance.

- Building construction techniques, renewable technologies, and workforce infrastructure are still young, decreasing their availability and affecting the cost-effectiveness of completing homes.

Resource—examples:

United States:

- In the United States, zero-net-energy building research is currently (2010) being supported by the U. S. Department of Energy's (DOE) Building America Program, including industry-based consortia and researcher organizations at the National Renewable Energy Laboratory (NREL), the Florida Solar Energy Center (FSEC), Lawrence Berkeley National Laboratory (LBNL), and Oak Ridge National Laboratory (ORNL). DOE has announced plans to award $40 million to four Building America teams: the Building Science Corporation; IBACOS; the Consortium of Advanced Residential Buildings; and the Building Industry Research Alliance, as well as to a consortium of academic and building industry leaders. The funds will be used to develop net-zero-energy homes that consume 50 per cent to 70 per cent less energy than conventional homes. http://www1.eere.energy.gov/buildings/building_america/.

- Carr Street, Wheat Ridge, Colorado: Habitat for Humanity of Metro Denver and the National Renewable Energy Laboratory "collaborated to build a 1,280 sq. ft., three-bedroom house to demonstrate how net-zero-energy technologies work in a challenging climate — in this case, searing triple-digit summers and below-zero winters." The home has demonstrated 12 months of data showing net-zero-energy performance:
  http://www.nrel.gov/news/press/2005/360.html.
  http://www.renewableenergyworld.com/rea//news/article/2005/09/solar-a-key-component-of-habitat-for-humanity-home-36739.

Canada:

- In Canada, the Net-Zero-Energy Home Coalition is an industry association promoting net-zero-energy home construction and the adoption of standards for a near-net-zero-energy home (nNZEH), NZEH Ready, and NZEH. Examples:
  - EcoTerra™ House: Canada's first nearly net-zero-energy housing built through the Canada Mortgage and Housing Corporation's EQuilibrium Sustainable Housing Competition. The house was designed by Dr. Masa Noguchi of the Mackintosh School of Architecture for Alouette Homes and engineered by Dr. Andreas K. Athienitis, a professor at Concordia University.
    http://www.newswire.ca/en/story/198175/official-opening-of-alouette-homes-ecoterra-tm-house-a-cmhc-equilibrium-sustainable-housing-demonstration-home.
    http://www.highbeam.com/doc/1G1-174061558.html.
    http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/buildings_communities/buildings/pv_buildings/success_stories/ecoterra_home.html.

  - Alstonvale Net-Zero House: Dr. Athienitis and his research group also participated in the design of the Alstonvale Net-Zero House project, led by the Montreal-based architect, Sevag Pogharian:
    http://www.cmhc-schl.gc.ca/en/inpr/su/eqho/alnezeho/index.cfm.
    http://web.me.com/sevagpogharian/alstonvale/Project.html.

http://greenbuildingbrain.org/items/alstonvale_net_zero_house.
http://www.spd.ca/Sevag_Pogharian_Design/Sevag_Pogharian_Design.html.

United Kingdom:

- In the United Kingdom, in December, 2006, the government announced that by 2016 all new homes will be zero-energy buildings. To encourage this, an exemption from Stamp Duty Land Tax is planned. Large-scale research projects and small-scale deployment programs are currently occurring. http://news.bbc.co.uk/2/hi/science/nature/6176229.stm. http://www.hmrc.gov.uk/ria/9-zero-carbon-homes.pdf.

Resource—written and web:

- R. Anderson and C. Christensen (National Renewable Energy Laboratory) and S. Horowitz (University of Colorado) (April, 2006), "Analysis of Residential System Strategies Targeting Least-Cost Solutions Leading to Net Zero Energy Homes," conference paper presented at the 2006 Annual Meeting of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), Quebec City, Canada. National Renewable Energy Laboratory #CP-550-38170: http://www.nrel.gov/docs/fy06osti/38170.pdf.

- Sevag Pogharian Design, et al., *Alstonvale Net-Zero House: Montreal ZERO*—provides specifications for single-family, detached, site-built house in Hudson, Quebec, Canada—designed for incremental growth, uses graywater and harvests rainwater, uses P-V thermal technology, award winner in Canadian government's EQuilibrium Initiative: http://www.cmhc-schl.gc.ca/en/inpr/su/eqho/alnezeho/index.cfm.

- United States Department of Energy, Energy Efficiency and Renewable Energy Department, Washington, DC: http://www1.eere.energy.gov/buildings/building_america/.

- Zero Net Energy Homes Coalition, a Canadian coalition of organizations whose mission is to "advance the benefits of the more efficient use of zero or very-low-impact resources, including cleaner air and healthier homes, climate protection, and economic development opportunities resulting from the expanded manufacturing and deployment of energy-efficient technologies and appliances and onsite renewable energy generation in Canada's residential marketplace": http://www.netzeroenergyhome.ca/.
  - The Coalition's Net-Zero-Energy Home Awards for 2011: http://www.netzeroenergyhome.ca/2011-award-winners.
  - The Coalition's Net-Zero-Energy Home Awards for 2009: http://www.habitat-studio.com/pdf/NetZeroEnergyHomeCoalitionAwards2009.pdf.

- U. S. Environmental Protection Agency, ENERGY STAR® Program: www.energystar.gov.

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