FACT SHEET

Zero-energy buildings

Key points

- ***Zero-energy buildings enable building owners to be isolated from fluctuating energy prices through the on- or off-grid renewable energy supply.***

- ***Zero-energy buildings help reduce peak electrical demand by self-supplying energy demands on site.***

- ***Zero-energy buildings should go hand in hand with the transformation of energy infrastructure and market.***

Zero-energy buildings explained

A zero-energy building (ZEB), which is an autonomous building energy option, is defined as a building that produces as much energy as it uses from renewable energy sources at the site. Zero-energy buildings can exchange energy with the power grid as long as the net energy balance is zero on an annual basis.[1]

In terms of the thermal energy transfer and storage, zero-energy buildings can achieve annual energy consumption levels down to 0 kWh per square metre through the use of renewable energy sources, which compares favourably with the passive house energy criteria per square metre. Energy plus houses, in contrast with both the passive houses and zero-energy buildings, focus on producing more energy per year than they consume, which can lead to an annual energy performance of -25 kWh per square metre.

How it works

Zero-energy buildings can be achieved by incorporating energy efficiency measures and on-site renewable energy generation technologies.[2]

- Energy efficiency measures include: creating a high-performance building envelope, installing energy-efficient appliances and lights, increasing the use of passive solar cooling and heating techniques and installing high-efficiency mechanical systems that match the lower energy requirements of the home.
- On-site renewable energy generation systems can be available within a building's footprint by using PVs, solar hot water and wind located on the building or at the site by means of PVs, solar hot water, low-impact hydro and wind located on-site not on the building.

Trends in development

Installing renewable energy generation system at buildings is not a choice but a must for some countries in their building energy policy. The European Union released an ambitious plan in 2009 that requires all buildings built after December 2018 to produce their own energy onsite – via solar panels or heat pumps, for example.[3]

[1] American Society of Heating, Refrigerating and Air-Conditioning Engineers, ASHRAE Vision 2020: *Producing Net Zero Energy Buildings Providing Tools by 2020 that Enable The Building Community to Produce Market-Viable NZEBs by 2030* (Atlanta, Georgia, 2008).

[2] Canada Mortgage and Housing Corporation, "Approaching net-zero energy in existing housing" *Research Highlights*, June 2008.

[3] The plan is an amendment to the 2002 Energy Performance of Buildings Directive. European Parliament, "All New Buildings to Be Zero Energy from 2019," *Press release*, 31 March 2009. Available from www.europarl.europa.eu/sides/getDoc.do?language=en&type=IM-PRESS&reference=20090330IPR52892 (accessed 13 January 2012).

The specific definition of a zero-energy building varies, depending on the region and on the perspective adopted for analysis, such as site energy, source energy, energy costs or emissions from energy uses. Because the definition can have a large impact on the design, international initiatives are looking to harmonize the concept and to promote it. The International Energy Agency's Net Zero Energy Buildings initiative is one such example.

Examples

Zero-energy building is still in the conceptual stage in the Asia-Pacific region. A few pilot projects have been applied to public buildings, such as research institutes, for demonstration purpose.

Sustainable Energy Technology Center in China: Sustainable Energy Technology Center at the University of Nottingham Ningbo is the first zero-energy building established in 2008. The building is designed to minimize its environmental impact by generating energy from renewable sources on site, storing rainwater and re-using grey water where appropriate. The building does not require conventional heating or cooling systems, and residual energy requirements are met by renewable sources, including wind turbines, a PV array roof, solar-powered chillers, ground source heat pumps, sterling engines and weather stations. The building will reduce energy consumption by an estimated 448.9 tonnes and carbon emissions by 1,081.8 tonnes over the next 25 years.[4]

Pusat Tenaga Malaysia's Zero Energy Office (ZEO) Building: PTM, as a showcase for sustainable and green buildings, emphasizes energy efficient features, including 100 per cent daylight, efficient lighting fixtures, floor slab cooling and double-glazed windows. With the installation of 92 kWp BIPV systems, the PTM ZEO building has been designed to be a super-energy-efficient building, using only 286 kWh per day and thus leading to energy savings of 576,000 kWh per year and mitigating 350 tonnes of CO_2 per year.[5]

National Institution of Environmental Research in Republic of Korea: Recognizing that greenhouse gas emissions in buildings account for 20 per cent of the total emissions in the Republic of Korea, the Government is pursuing various initiatives to reduce emissions in the building sector. To demonstrate zero-energy technologies, the National Institution of Environmental Research, with government funding, constructed a carbon-zero building. The project took three years to complete (2008–2010), at a cost of US$3,000 per square metre. Its expected benefits in terms of energy saving and carbon reduction are US$93,577 of annual budget saving through energy reductions and 100 tonnes per year of CO2 emissions. The total annual energy consumption in the carbon-zero building amounts to 123.8kWh per square metre. The technologies applied in the building include 30 energy consumption reduction technologies, 18 energy efficiency technologies, and 13 new and renewable energy technologies.[6]

Strengths with a zero-energy building

- **Saves energy:** With site energy savings ranging from 25 to 68 per cent, compared with conventional buildings,[7] zero-energy buildings can radically reduce or eliminate utility costs.
- **Increases thermal comfort:** The uniform interior temperatures and enhanced indoor air quality and occupant health create soothing environments.
- **Reduces air pollution and greenhouse gas emissions**
- **Creates jobs:** Constructing zero-energy buildings can generate local jobs by increasing demand in the renewable energy market, which is a critical task for many countries.
- **Increases housing value:** Due to a demand that is higher than the available supply, the resale value of zero-energy buildings is generally higher than for conventional properties, especially in times of high energy prices.

[4] Alex Pasternak, "China's First Zero-Emissions Building: Ningbo's Sustainable Energy Technology Center", *Treehugger*, September 25, 2008. Available from www.treehugger.com/files/2008/09/china-first-zero-emission-building-ningbo.php (accessed 23 October 2011).

[5] Pusat Tanaga Malaysia, "KTAK low energy office (LEO) building & PTM-zero energy office (ZEO) building", PowerPoint presentation, 20 February, 2008. Available from www.uniten.edu.my/newhome/uploaded/coe/arsepe/2008/UNITEN%20ARSEPE%2008%20L24.pdf (accessed 23 October, 2011).

[6] National Institution of Environment Research, *Carbon Zero Building* (Incheon, Republic of Korea, 2010).

[7] American Society of Heating, Refrigerating and Air-Conditioning Engineers, *ASHRAE Vision 2020: Producing Net Zero Energy Buildings Providing Tools by 2020 that Enable The Building Community to Produce Market-Viable NZEBs by 2030* (Atlanta, Georgia, 2008).

Considerations for replicating

Special attention is required for setting up the enabling condition allowing the generation and penetration of renewable energy from buildings. For instance, provision of the feed-in tariff help individual power generators to enter the market by lowering the market entry barrier. In addition, building regulations such as development permit and building permit need to be reformed in a way to allow the generation of renewable energy, for instance, by adjusting land-use by laws, roof loading, and mechanical fastening of solar systems.

Further reading

Federal Research and Development Agenda for Net Zero Energy, High Performance Green Buildings, by US. National Science and Technology Council (Washington D.C., 2008).

Maximizing Residential Energy Savings: Net Zero Energy Home Technology Pathways, by R. Anderson and D. Roberts (Golden, Colorado, National Renewable Energy Laboratory, 2008). Available from www.nrel.gov/docs/fy09osti/44547.pdf

Net-Zero Energy Buildings: A Classification System Based on Renewable Energy Supply Options (Golden, Colorado, National Renewable Energy Laboratory, 2010).

SHC Task 40 ECBCS Annex 52 IEA Joint Project: Towards Net Zero Energy Solar Buildings, by IEA and OECD (Paris, 2009).

Zero and Net-Zero Energy Buildings + Homes, by Building Design Construction Network (Arlington Heights, Illinois, 2011).

Zero Energy Buildings: A Critical Look at the Definition, by P. Torcellini, S. Pless, M. Deru and D. Crawley (Golden, Colorado, National Renewable Energy Laboratory, 2006