NET ZERO-ENERGY BUILDINGS

by
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In recent years, there has been a movement to promote greater energy efficiency for buildings. With this movement, net zero-energy buildings have become highlighted as a way to increase energy efficiency, to a point where, after the structures are completed, their net energy use is negligible. A net zero-energy building is a structure with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies. According to a United States Energy Information Administration (EIA) report in 2005, commercial and residential building use approximately 70% of all the electricity produced in the United States. [1] With a reduction of energy consumption by utilizing more efficient building components, coupled with generating electricity through renewable energy such as solar, buildings can meet all their energy requirements from low-cost, locally available, nonpolluting, renewable sources, generating enough renewable energy on site to equal or exceed its annual energy use.

Ways to Achieve Net Zero-Energy Buildings

The keys to designing a zero net-energy building are design and technology. From the design aspect, the need to create a building which naturally tempers down energy consumption is important. This is currently being utilized in smaller buildings; however, with recent advancements in technology, the growing trend in net zero-energy buildings is with larger structures. The most efficient way to reach net zero-energy consumption is to focus on increasing efficiency.

One such more efficient technology utilized in net zero-energy buildings is Light Emitting Diode (LED) lighting, which uses approximately 85% less energy than their incandescent bulb predecessor.[2] While LED technology has been available since 1961, recent developments in the amount of lumens (the amount of visual light emitted) have allowed LED lighting to become more energy efficient than traditional incandescent lighting. LED lighting uses less power per lumen when compared to a traditional 60 watt incandescent light bulb, and produces less heat. All of these factors coupled together mean a more efficient, cost effective way to light a structure, making it easier to achieve a Net Zero-Energy building.

Another technology being utilized is high efficiency Heating, Ventilation, and Air Conditioning (HVAC) units, which use heat recovery, cool roofs, radiant heating and cooling, and under floor ventilation, with all being more efficient than standard HVAC units. Traditional HVAC units generally account for 39% of energy used in building in the United States; high efficiency HVAC units typically save 10-40% of that energy, and, when designed in conjunction with the structure, can save up to 70%.[3] This can include something as simple as installing an HVAC unit that is the right size for the building. If the unit is too small for the building, the unit will be insufficient to heating or cooling the structure, while constantly using energy. If the unit is too large, the HVAC unit will operate less efficiently and cost inherently more to purchase and install than properly sized equipment.

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[1] Zero Energy Buildings: A Critical Look at the Definition (http://www.nrel.gov/docs/fy06osti/39833.pdf)
[2] Energy Saver Tips on Saving Money and Energy at Home, (http://energy.gov/sites/prod/files/2014/09/f18/61628_BK_EERE-EnergySavers_w150.pdf)

[3] Energy Savings Potential and Research, Development, & Demonstration Opportunities for Residential Building Heating, Ventilation, and Air Conditioning Systems, (http://energy.gov/sites/prod/files/2014/09/f18/residential_hvac_research_opportunities.pdf)

Another HVAC option for Net Zero-Energy buildings is geothermal heating and cooling systems. Geothermal systems use the earth to heat and cool structures. Outdoor temperatures may fluctuate with the seasons, but underground temperatures don't change as quickly. Under ground, temperatures remain constant year-round. A geothermal system typically consists of an indoor handling unit, a buried system of pipes, and a pump for reinjection. Geothermal heating and cooling systems utilize the ground's constant temperatures to provide the cooling and heating from the ground.

Another strategy employed is utilizing the design of the building in order to maximize the cooling effect (such as the direction that the building faces) and also maximize natural sunlight with skylights to lower their lighting needs. There are new, energy saving materials that can add to the efficiency of a structure, which can be utilized to improve the energy efficiency. One such improvement to the efficiency is to use materials which are temperature absorbent. Windows which use modern technology are more efficient than their predecessors. Dynamic glazing, reflective glass, and multi-pane windows have the ability to improve the efficiency of thermal transfer, allowing less heat to be radiated indoors in the warm temperatures and more heat when the temperature falls. Other technology which has been utilized in Zero Net-Energy buildings includes advanced framing techniques and materials (such as composites, vacuum insulation, and fly ash concrete), and the orientation of a building, such as southern facing windows, to maximize natural solar heating and cooling effects.

The largest perceived impediment for implementing net zero-energy buildings deals with energy production in order to off set the energy which the building uses. Currently, photovoltaic panels are being used to provide the buildings with renewable energy. Photovoltaic is the conversion of light into electricity at the atomic level. Some materials exhibit a property known as the photoelectric effect that causes them to absorb photons of light and release electrons. When these free electrons are captured, an electric current results, which can be used as electricity. Multiple panels can be wired together to form an array. These arrays are used in zero net-energy buildings to produce electricity, which the buildings use for their energy needs. One of the main concerns of the use of photovoltaics is the efficiency of solar power.

Currently, the photovoltaics only convert approximately 38% of the potential energy; however, that has increased from less than 30% a decade ago. [4] In addition, since 2010, the price of photovoltaic panels have decreased by 62% due to both better technology and efficiency and an oversupply of panels produced in China, dropping the price from $1.87 per watt to $0.71 per watt produced.[5] While still more expensive than fossil fuel production, the difference in price is becoming closer to parity between the two, and on a smaller scale, net zero-energy buildings are becoming more affordable and realistic for future development.

While a Net Zero-Energy building does have more up-front costs to build, that extra money can be recovered from the overall saving features that the building incorporates. With the cost of technology decreasing, Net Zero-Energy construction methods typically cost between 15 to 100 percent more than traditional buildings, which is dependent on where the building is being constructed, the size of the building, and the materials used. Not only are Net Zero-Energy buildings constructed to be more efficient, the buildings also generate the electricity used. As technology improves, greater efficiency with regards to not only the building materials but also photovoltaics will be recognized, allowing more structures to be built in accordance with Net Zero-Energy standards.

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4 Solar Spectrum Conversion for Photovoltaics Using Nanoparticles (http://www.intechopen.com/books/third-generation-photovoltaics/solar-spectrum-conversion-for-photovoltaics-using-nanoparticles)

5 Shift Expected from Concentrated Solar Power (CSP) to Solar PhotoVoltaic (Solar PV) **(**http://www.criticalsystemsinc.com/industry-advancements/shift-expected-from-concentrated-solar-power-csp-to-pv-solar.html)