Net Zero Energy Buildings (NZEBs): Building the Future

Net Zero Energy Buildings (NZEBs) aim to reduce the carbon footprint by generating as much energy as they consume. Government legislation has made green buildings a priority, ensuring an increased market share of NZEBs in the buildings of the future. This article reviews the current state-of-the-art in NZEB design, the market growth and the prospects for the future.

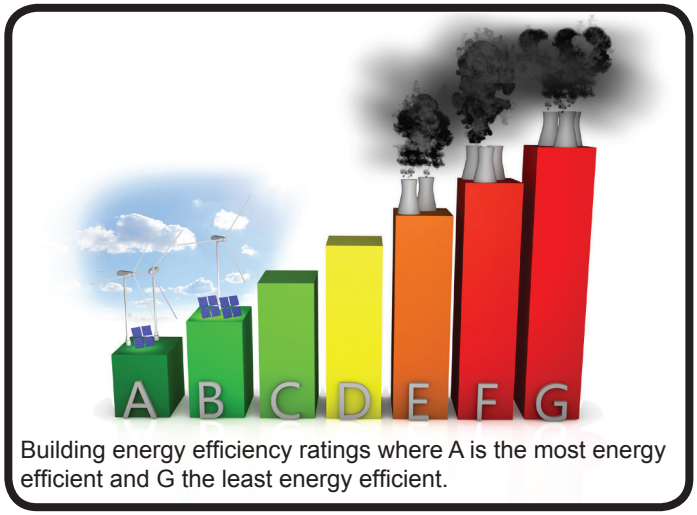
The global construction industry has a high growth rate; it is expected to grow 67% by 2020.[1] Since buildings account for more than a third of the energy we consume, the building industry is re-thinking the way buildings are designed to reduce the carbon footprint and bring them closer to becoming net zero energy- generating as much energy as they consume averaged over the period of a year.

NZEB DESIGN

The design of NZEBs starts with a site evaluation to take advantage of the local natural resources and evaluate the main energy consumption needs. Optimising the use of passive energy, the evaluation considers the orientation of the building to make use of natural light and heat, prevailing breezes and ventilation. Depending on the location, it may be advantageous to reflect away some of the heat/light (for example in hot climates), or absorb as much heat/light as possible (in cooler climates). Optimization of the building energy efficiency typically considers the following: (1) lighting, (2) the walls and roof, (3) glazing, (4) heating, (5) ventilation, (6) air conditioning, (7) renewables and (8) soft costs. Energy efficient lighting replaces incandescent lamps with fluorescent or LED lamps.

Thermal solar water heater

The walls, roof and glazing are designed taking into consideration the need for thermal insulation, making use of materials with a high thermal mass to help retain heat in the building. Human behaviour can play an important part in reducing energy consumption, for example turning off the lights when leaving the room. Typically NZEBs incorporate sensors to automatically control the lighting and water usage. In fact, a centralised energy control system is at the heart of every NZEB design. By monitoring the energy usage and differentiating the primary energy loads, the control unit allows the consumer to dynamically minimise the energy consumption. NZEBs also incorporate renewables for energy generation. Water heating can be provided by thermo-solar or geothermal installations. Thermo-solar uses the energy from the sun to heat water, and geothermal uses the heat which is naturally stored in the ground. Electrical appliances can be powered by photovoltaic modules mounted on the roof or integrated into the building structure with battery backup power. NZEBs represent a shift towards intelligent building design, where the amount of energy that we expect to consume is already taken into consideration before construction even begins.



Building energy efficiency ratings where A is the most energy efficient and G the least energy efficient.

Future buildings will not only consume less energy- they will become distributed energy generation centres.

CURRENT STATUS

Today, hundreds of pilot ZEBs, encompassing commercial and residential buildings of all types (retail, office, educational, government, etc.), are being developed, many as pilot projects to showcase technology. While several pilots are trying to prove the investment savings in lower energy bills, a stronger driver for the adoption of NZEBs is regulation. Policies like the EU's Energy Performance of Buildings Directive (EPBD) and California's evolving Title 24 building code are forcing NZEB markets to come into place for new commercial, new residential, and retrofitted commercial space.

The EU's ultimate objective is to make all new buildings nearly zero energy by 31st Dec 2020, with intermediate objectives in the years prior to 2020.

Of course this ambitious goal affects not only the building sector, but also suppliers of electrical appliances for use in the buildings, e.g. air condition-

ing units, washing machines, dishwashers, etc. Electrical appliances are already obliged to indicate their energy efficiency ratings, and government programmes such as Energy Star in the US have been implemented to provide certification of energy performance.

Energy Star boasts that as of December 2012, families and businesses have realized estimated savings of more than $239 billion on utility bills and prevented more than 1.9 billion metric tons of greenhouse gas emissions over the past two decades.

In the UK, Energy Performance Certificates (EPCs) are required whenever a building is built, sold or rented. Apart from the environmental benefits, the growing energy efficient buildings market is also bringing about a wealth of new job opportunities. In the UK alone there are an estimated 200,000 commercial properties which are expected to require a commercial Energy Performance Certificate (EPC) each year. This has brought about the need for qualified energy performance assessors, and courses are being offered at universities throughout the UK. The upfront costs for NZEBs tend to be higher- American real estate development company Meritage Homes Corporation claims that NZE features add on $15,000 to $25,000 to the home cost depending on utility offsets. The corporation already commercialises NZE homes and recently won the 2014 Energy Star Partner of the Year Sustained Excellence Award.

IMPLEMENTATION

Some people argue that the biggest barrier to the implementation of NZEBs is changing our mentality with respect to spending. Buyers have to embrace the idea of pre-buying energy- making a larger initial investment with the promise of gaining a longer term saving. A break through project which addresses reducing the cost of ZEBs is the Twin Cities Habitat Northside NZE home, which won the 2014 Environmental Initiative Award.[2] A collaborative project involving many partners, the goal was to build an affordable NZE house aimed at low income families. The total cost for the two-storey three bedroom NZE home project was $213,000- which includes the cost of solar and land. The project results raise expectations for affordable NZEBs in the future.

The NIST Net Zero Energy Residential Test Facility

Another hurdle to overcome for the successful implementation of NZEBs is clarity- the house buyer would like to understand better the technologies involved, their advantages, and the potential for long term saving. In order to address these questions the National Institute of Standards and Technology (NIST) in the US built a Net Zero Energy Residential Test Facility.[3]

Centralised remote control of the energy usage in a house using an ipad

Both a laboratory and a house, the two-story, four bedroom, three-bathroom building serves as a test bed for demonstrating the performance of new NZE concepts. The house simulates the occupancy of a typical family of four (two adults and two children), mimicking the energy usage in terms of electricity, heating and water by defining a daily schedule. For example, in the morning the lights are turned on, and then the shower is turned on with hot water etc. The house even incorporates energy usage due to consumer electronics such as televisions and computer games. The centralized energy monitoring system records data about how the energy is consumed, allowing researchers to focus in on how to reduce energy consumption. Recent test results have demonstrated how to optimize the air tightness of the building to reduce heating/cooling bills.

SCALING-UP TO NZE COMMUNITIES

Planning beyond individual buildings, examples of larger scale NZE projects are already in place. For example UC Davis's West Village Net Zero Energy campus community, which is the largest planned NZE community in the US. This landmark project was designed as a public-private partnership and goes beyond the design of individual buildings to provide the energy requirements for an entire University campus with 3000 students, faculty and staff.

FUTURE PROSPECTS

Market research from Navigant Research predicts that the worldwide revenue from ZEBs is expected to grow from $629 million annually in 2014 to more than $1.4 trillion in 2035.[4]

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