



Singapore Promoting Clean Energy & Sustainable City

Site Visit of the Zero Energy Building

Abstract:

Zero Energy Building (ZEB) of Singapore BCA Academy was officially opened on 26 October 2009. It is intended as demonstration of application of clean and green technologies as well as intelligent building design, requiring no traditional energy (fossil fuel based) at all. ZEB is a retrofit of an existing building in BCA Academy featuring innovative green technologies such as sunrays collector and mirror ducts, green shading, solar chimneys and solar panels, coated glass for heat reduction, cool paint and cool pavement coating. Since its operation in October 2009, ZEB has been producing more energy than what it has been consuming. It is estimated that the building will save SGD 84,000/year energy cost compared to a typical office in Singapore (based on 21.69 cents/kWh). In this article, we share our knowledge of the green technologies that are adopted in the building.

The Singapore Government launched its initiative in clean technologies, which include clean energy, water and environment technologies, in March 2007, committing about SGD700 million in funds. Within three years, Singapore's Economic Development Board (EDB) has developed the clean energy and water technology industry, which includes multinational companies setting up their manufacturing plants; service and R&D centres supported by research institutions that are funded by the Government, and a number of SMEs.

One impressive achievement was the Zero Energy Building (ZEB) by the Building and Construction Authority (BCA) Academy (http://www.bcaa.edu.sg/zero_energy_building.aspx), which was opened in October 2009. The ZEB is a retrofit of an existing building in BCA Academy and a flagship R&D project under BCA's Green Building Masterplan. ZEB occupies about 4,500 square metres with SGD 11 million in retrofitting costs, which was funded by Singapore's Ministry of National Development (MND) Research Fund for the Built Environment and EDB's Clean Energy Research and Test-bedding (CERT) Programme. Besides housing classrooms, offices, and training centres, ZEB functions as a centre for to test green building technologies.

NanoGlobe team conducted a site visit to ZEB and were thrilled to find out how it was able to provide the power grid with excess solar energy that it has generated. The ZEB was designed in such a way that it reduces electricity needs (~5% reduction) through passive design, improves energy efficiency by 35%-45% using active solutions, and eliminates energy wastage through intelligent controls. Because of these features, ZEB consumes only ~130MWh of power cumulatively since October 2009 but produces ~149.5MWh. In comparison, a typical office of similar layout would consume ~285MWh of

power cumulatively for the same period of time. The net negative result of energy consumption/production in the ZEB justifies its name.

In the ZEB, we observed how the creative use of technology allows it to achieve net zero/negative energy consumption. Daylight collector at the rooftop and mirror ducts at the sides of the ZEB channel the light from the sun to indoor spaces through mirror reflections. Living walls and rooftop garden provide shade to reduce indoor temperature, which reduces the need for air conditioning. Smart functional coating on glass windows reduces the amount of solar heat from entering indoors. The creative ventilation design in ZEB consists of solar chimneys on the rooftop connecting to non-air-conditioned rooms. Using convection, the chimneys draws out the warm air and this allows cool air to enter the rooms. All three generations of solar panels –polycrystalline silicon, thin film amorphous silicon, and non-silicon— are installed to generate power from solar energy. It is estimated that the ZEB's solar panels generate ~207MWh of electricity/year. In total, the solar investment in ZEB takes up ~18% of overall building retrofitting cost.

The ZEB is also designed to make it comfortable for its tenants to work and study. Each desk in its offices is equipped with personalized ventilation of fresh and cool air. Displacement cooling – a system that is more efficient than traditional air-conditioning – is used in its offices. It supplies cool air from the floor and a mixture of cool and warm air in the room gets collected and drawn out at the ceiling. The single coil twin fan ventilation system – invented by the National University of Singapore (NUS) – is also installed to provide independent control of fresh and re-circulated air.

The ZEB also tests interesting products such as cool pavement coating developed by Nippo Corporation, and cool paint by Haruna Paint. Cool pavement coating contains fine hollow ceramics particles that reflects infra-red (IR) rays well, resulting in less thermal energy being absorbed by the pavement and less heat radiated back into the surrounding. Thermal insulating paint by Haruna Paint reflects more than 95% of near infra-red rays and is a good heat insulator.

We were excited to see many mature and new technologies being used at the ZEB that can benefit and improve the quality of life on Earth. The ZEB demonstrates how a building can be retrofitted with green energy. We hope to see more zero energy buildings being built in Singapore, tropical Asia and eventually all parts of the world.



The external view of Zero Energy Building



Mr Stephen Mok from BCA Academy explaining the concept of Zero Energy Building to Dr Lerwen Liu



Solar chimneys and full coverage of solar panels at the rooftop of ZEB



The application of cool pavement coating (blue color pavement), and mirror ducts at the side of the building for the rooms natural lighting