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PUSAT TENAGA MALAYSIA'S ZERO ENERGY OFFICE

by **Yvonne Yoong**

Necessity—the mother of all inventions—lends her mark of approval to Pusat Tenaga Malaysia's (PTM) new Zero Energy Office (ZEO). While buildings play a fundamental role in providing the recreational and work structures that people work, play and live in, it is also impossible to ignore the negative effects they can have, especially when a sustained amount of massive energy is needed to power them.

Heeding the call to best manage energy resources, PTM's ZEO rises to the occasion by capitalising on energy efficient measures implemented through various facets of the overall design. Construction work on the building started in March 2006, which was followed by the successful installation and commission of the four solar building integrated photovoltaic (BIPV) systems in June 2007, leading to the completion of PTM's ZEO in October last year.

Fashioned after the Low Energy Office (LEO) building initiated by the Ministry of Energy, Water and Communications (MEWC) in Putrajaya, the PTM's ZEO building has placed Malaysia on the regional map as the first completely self-sustainable building in Southeast Asia. Spread over a 5-acre site in Bandar Baru Bangi, Selangor, the building, located 40 kilometres south of the city centre of Kuala Lumpur, operates on the dynamics of both passive and active techniques and on-site renewable energy generation, as exemplified in the solar BIPV system.

The building is seen as a feasible and timely solution to growing concerns surrounding the pressing issues of global warming and energy security. Figures point to the alarming reality that in developed nations, buildings tend to take up a third of total energy consumption.

The business of sustainability is big news, by any standards. The PTM's ZEO building serves as a pilot project that provides a platform for proof of concept in driving forward the goals of the Malaysian building industry (developers, consultants, architects, local professionals and academia at large) in the subject of sustainable building design. This is great news as most buildings in Malaysia are energy inefficient—most of them record higher Building Energy Index (BEI) beyond the benchmark for Energy Efficient Buildings (EEB) set at 135 kWh per square metre per year (the kWh per square metre of the BEI is derived based on dividing the total kWh or electricity used per year by the building area based on metre square calculations).

ENERGY EFFICIENT ARCHITECTURE

Pre-programmed into the building's DNA are energy efficient features and the BIPV system—they make up the backbone of this self-sufficient, fully sustainable landmark. As such, PTM's ZEO building does not use fossil fuels, driving home the point that an office building need not consume electricity derived from this source. Instead, all electricity needed by the building is being generated by its own solar BIPV systems.

In all, four different solar BIPV systems utilising four different technologies have been installed into PTM's ZEO. The first and biggest component features the 47.28 kWp polycrystalline BIPV system on the main roof; the second component lies with the 6.08 kWp amorphous silicon BIPV system incorporated into the second main roof; the third system stored in the atrium of the building highlights the use of the 11.64 kWp monocrystalline glass-glass BIPV system; and lastly, the car park roof is fitted with 27 kWp monocrystalline BIPV system.

The solar BIPV systems are all linked up to grid-connected inverters that convert the produced direct current (DC) electricity into alternating current (AC) electricity. For purposes of verifying the electricity production, electricity generation is recorded through the meter. In this case, no battery is installed as the generated solar electricity is directly consumed and the net surplus sold to Tenaga Nasional Berhad (TNB) on a net meter basis.

1 Atrium with glass semi-transparent PV modules (11.64kWp) **2** Monocrystalline PV modules (27kWp) on the carpark roof **3** Polycrystalline modules (47.28kWp) on the main roof **4** 'Window curtain' at the board room

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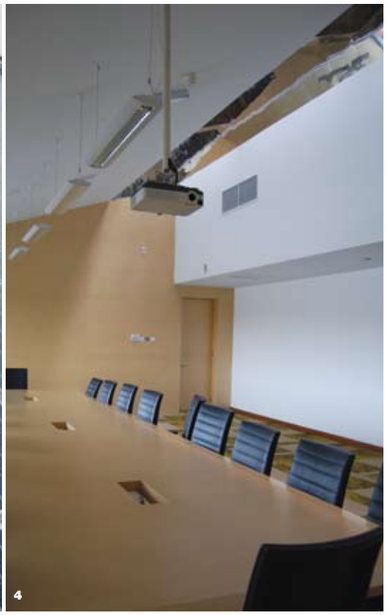

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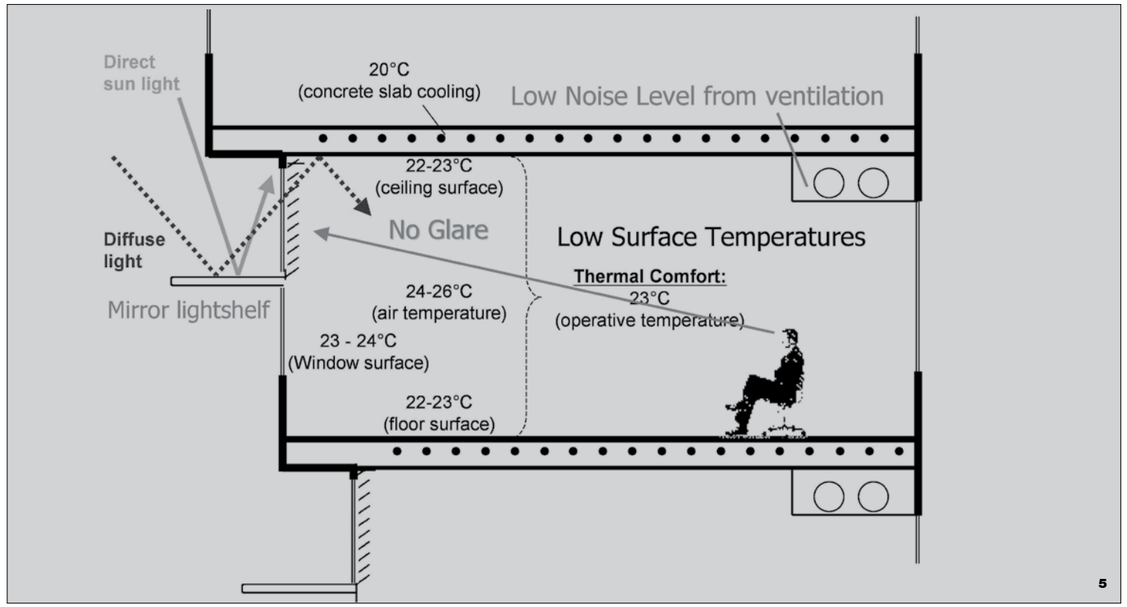

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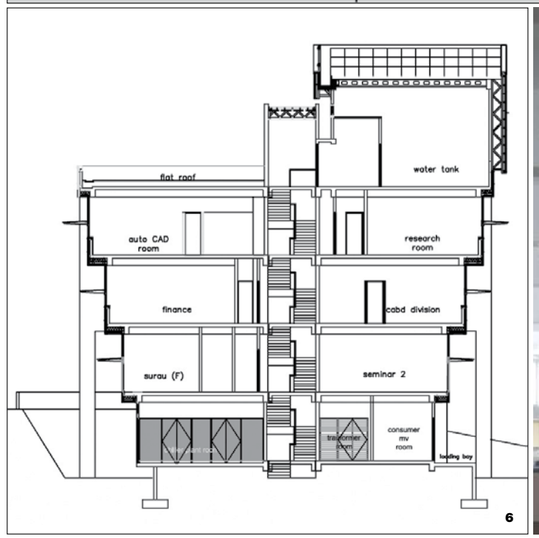

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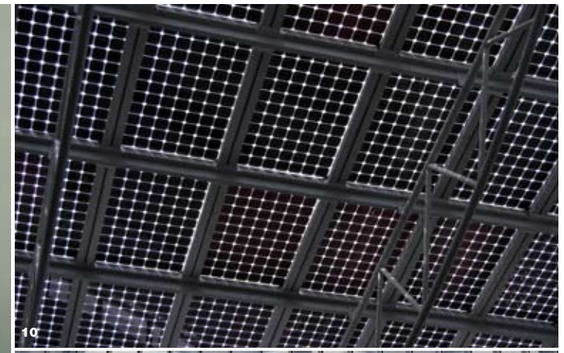

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Looking at the example of a total BIPV capacity of 92 kWp, the anticipated target for annual electricity generated from solar BIPV systems stands at 102 MWh. To date, the BIPV systems have produced about 103 MWh/year average, based on actual output over three months. Buildings that are not energy efficient would need more than 92 kWp as compared to PTM's ZEO. This is because the super energy efficient (EE) features of ZEO reduces the energy consumption of the building and complements the 92 kWp solar BIPV to make the total payback time for the whole systems to be less than 22 years. And this is based on current subsidised electricity tariff and technologies that are mostly imported today. It is acknowledged that the costs of future electricity would increase and the EE as well as the solar technologies would reduce. Furthermore, it is important to bear in mind that there is no payback price for the environment.

To achieve the super EE outputs, the building incorporates features utilising passive techniques as well as orientation and vegetation, balanced with active features seen in efficient lighting systems, floor slab cooling, double-glazed windows as well as a thermal wall at its east- and west-facing façades.

The implementation of high performance glazing and sealed double-glazing also complements the call for energy efficiency. This is reflected in its ability to harness high visible light at low infra-red (IR) and ultra-violet (UV) transmittance. The result is the effective harnessing of natural daylight minus, to a great degree, unnecessary heat radiation into the building. Playing an unseen yet fundamental role in the sustainable design feature of PTM's ZEO, the floors of the building take on a cooling effect role, thanks to the insertion of embedded tubes within the concrete floor slabs. During the day, the stored cooling effect is released from the floor slabs to the rooms above and below them, directly contributing to the cooling effect of the building that is also supplemented minimally by air-cooling systems. Careful thought has also gone into the preservation of air quality achieved via the process of dehumidification. Given the fact that dehumidification of air quality in buildings consumes a great amount of electricity, a desiccant heat wheel that operates by replacing incoming hot and humid fresh air with cooler and drier exhaust air is used to counteract this effect.

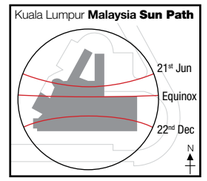
EMPHASIS ON HOLISTIC DESIGN APPROACH

The critical approach towards ZEO is the holistic design involving all consultants, led by the architect, working together in order to achieve the client's zero energy vision. The initial architectural concept of the building was enhanced with super EE features, followed by the solar BIPV capacity to offset the remaining energy demand. The usage of solar BIPV technology not only displaced conventional building materials, but also adds value to the architecture of the building.

Today, PTM's ZEO continues to function as a showcase building to facilitate and explore the concept of sustainability in buildings, while assisting to create opportunities for the involvement of other relevant industries. The building is exemplifying the use of energy efficiency, with solar BIPV setting a new standard for sustainable building in the ASEAN region.

PROJECT DATA

Project Name
Malaysia Energy Centre: Zero Energy Office
Location
Section 9, Bandar Baru Bangi, Bangi, Selangor
Completion
July 2007
Site Area
2 hectares
Gross Floor Area
4,000 m²
Number of Rooms
41 rooms
Building Height
47.50 metres
Client/Owner
Malaysia Energy Centre (Pusat Tenaga Malaysia-PTM)
Architecture Firm
Ruslan Khalid Associates
Principal Architect
Professor Dato' Ruslan Khalid
Project Manager
KLCC Projeks
Main Contractor
Putra Perdana Construction Sdn Bhd
Mechanical & Electrical Engineer
Five-H Associates Sdn Bhd
Civil & Structural Engineer
Arup Jururunding Sdn Bhd
Quantity Surveyor
Jurukur Bahan Majubina
Interior Designer
Onions Design Consultants
Energy Consultant
IEN Consultants
Images/Photos
Nie O One Design, Poul Kristensen



5 Typical section **6** Step-in design (self-shading) **7** Colour of office interior reflects light **8** Colour of building exterior minimises heat gain **9** Maximising daylighting **10** Glass semi-transparent PV modules (11.64kWp) **11** Daylighting