Green Building Concept (Case Study: New LCC Terminal & KLIA 2 Sepang, Selangor, Malaysia)

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ABSTRACT

This document is about the Green Building Concept which is applied to the new airport in Malaysia. It emphasizes the energy efficiency in the building. This document also describes the ways to achieve energy efficiency based on Green Building Index and how to manage the energy efficiently.

Keyword:

INTRODUCTION OF CASE STUDY

The project of *'Design, Construction, Completion, Testing and Commissioning and Maintenance of Main Terminal Building, Satellite Building, Sky Bridge and Piers for Proposed Development of New LCC Terminal and Associated Works At KL International Airport, Sepang, Selangor'* is a project which is under responsible of two well-known construction companies in Malaysia which are UEM Construction Sdn. Bhd., a group of UEM Builders and Binapuri Sdn. Bhd.. It is a joint venture project between both companies and called as UEMC-BINAPURI JV. This project is worth MYR 997,227,000.00 and it is one of the mega projects in Malaysia. This airport will replace the existing Low Cost Carrier Terminal (LCCT) and also functioning as International Airport for low cost airplane around the world. The construction of the airport was divided into two packages. First package is for Main Terminal Building and the second package is for Satellite Building. Both of the buildings will be applied Green Building Concept as recommended by Government of Malaysia and also to protect the Earth from harm. the project was known as New LCC Terminal before this but currently changed to KLIA 2.

INTRODUCTION OF GREEN BUILDING

Green Building is the practice of creating structure s and using processes that are environmentally responsible and resource-efficient throughout a building's life cycle from sitting to design, construction, operation, maintenance, renovation and deconstruction (Wikipedia, 2010). It is also known as green construction or sustainable building

There are two types of ratings which are appropriate to be used in measuring the points for Green Building. They are Leadership in Energy and Environment in Buildings or known as LEED and Green Building Index, GBI.

The LEED Rating System was established by United States Green Building Council and promotes the sustainability in the way buildings are designed, constructed and operated. In LEED System, the building must satisfy certain prerequisites and earn credit points based on six categories which are:

- Sustainable sites
- Water efficiency
- Energy and atmosphere
- Material and resources
- Indoor environment quality
- Innovation and design process

GBI is developed by Pertubuhan Arkitek Malaysia (PAM) collaborate with Association of Consulting Engineers Malaysia (ACEM). This GBI Rating System proposed to promote sustainability in the built environment and raise awareness among construction players and also public so that the Malaysian property industry becoming more environmental-friendly. In GBI awarding system, there are also six criteria basis which are:

- Energy efficiency
- Indoor environmental quality
- Sustainable site planning and management
- Material and resources
- Water efficiency
- Innovation

STRATERGIES TO MEET LEED AND GBI REQUIREMENTS FOR ENERGY EFFICIENCY POINT

The KLIA 2 is predicted to be constructed for ease of expansion so it is a significant to construct both buildings; Main Terminal Building and Satellite Building to meet the current and projected needs without having a harmful effects on the environment. If this mission is achieved, it will be seen with pride by future generation.

The design of the airport is incorporated with the latest principles of environmental and state-of-the-art environmental technology. There are many features which are have properties of environmental friendly have been incorporated into the project so that they will contribute towards the LEED Gold and GBI Gold/Platinum points. The features are includes:

i) The KLIA 2 will target to achieve LEED Gold and GBI Gold/Platinum awards; seeking to reduce the consumption of energy by at least 50%, the use of portable water reduced by 50% and waste to landfill by 60%.

ii) The arched forms of the roof structure will promote natural cooling by harnessing the laminar air flow over its surfaces and channel rainwater for collection and use in building services.

iii) Reflective material and light colour will be used at the roof surface to reflect solar heat.

iv) The building structure will also incorporate light walls to channel natural daylight from the roof to the first floor.

v) A Cogeneration (Trigeneration) Plant shall be built to supply electricity, cooling and hot water requirements.

vi) Energy-efficient displacement ventilation system will be used in the high occupancy areas.

vii) Electric airside vehicles will be used wherever possible to reduce atmospheric emissions.

viii) High ceiling space of the terminal will have a forced air volume HVAC system employing stratification principles to conserve energy.

ix) High-performance glazing with ceramic frits will be used to reduce interior glare and solar heat build-up in the concourses.

ENERGY STRATERGY

Modern terminal buildings at airport place high demands on supplies of both electrical power and thermal/cooling energy. However airline schedules and the critical nature of an airport's health, safety and operational regulations make securing both of these especially the power supply, the almost important.

The Green Building Consultant, IEN Consultants which is appointed by the UEMC-BINAPURI JV to guide them in order to meet the requirements of LEED and GBI award. IEN Consultants aim to minimize the consumption of energy and the cost of energy by giving focus on the energy efficiency which is considering both energy supply and energy consumption. The use of energy efficient, innovation in building, engineering and designation will ensure a low-emissions terminal. It is becomes benefits from opportunities resulting from biogas energy, kinetic and photovoltaic technology.

Passive Features

i) Building Envelope

- Walls

Walls that are connected to air-conditioned spaces shall have a maximum effective U-value of 1.2 W/m^2K. in example including cold bridges at connections.

- Roof

The roof of KLIA 2 shall be insulated. The maximum allowable U-value of the roof is:

a) Light weight roof shall have a maximum U-value of 0.4 W/m^2K.

b) Concrete flat roof shall have a maximum U-value of 0.6 W/m^2K.

Table 1 Simulation Result Based On the Variation Thickness of Roof Insulation

Thickness	***Cooling***	***Auxiliary***	***Light***	***Equip.***	***Total***
50mm	28912.816	24544.574	21699.129	18806.18	93962.699
100mm	28088.037	24204.352	21699.004	18805.949	92797.342
150mm	27797.43	24084.477	21699.004	18805.949	92386.86

- Roof light

Any roof lights above 6 meter height from floor level shall be single glazing or laminated glazing with high U-values to promote conduction heat loss out of the space. Double glazing with air-gaps should be used where necessary for acoustic considerations.

- Glazing

The properties of glazing for the airport shall have a minimum Light to Solar Heat Gain Ratio (LSG) of 1.65. The visible light transmission of the glazing shall meet the requirements as set forth by the daylight requirements.

Table 2 : Maximum U-Value

Window to Wall ratio	Max. Allowable U-Value
Below 40%	4.5 W/m2K
Between 40% and 60%	3.5 W/m2K
Higher than 60%	W/m2K

ii) Day lighting and Views

Day lighting and sun lighting have a significant effect on the character of the KLIA 2 and on the way occupants perceive the building. The physiological and psychological benefits of day lighting are tangible and include:

- Good colour rendering and visual recognition, because day lighting has a continuous spectral composition.
- Connection to day light facilitates time orientation, synchronizing occupants' metabolic rhythms.
- Windows provide psychological connection to the outside world.
- View through windows create a visual rest and reduce visual fatigue.
- Reduce electric lighting can lead to energy savings so helping to conserve the world's resources.
- Day lighting depravation and flicker from fluorescent lamps have been linked to 'Sick Building Syndrome'.

Whilst day lighting is desirable, it has a high variability in distribution and intensity and may therefore create visually difficult condition. Care is required in designing facades to give comfortable viewing conditions.

The objectives for KLIA 2 project are 75% of Terminal's should be day lighting which is regularly occupied spaces and direct line of sight to outdoor environment in 90% of all regularly occupied areas. In determining the quantity of day lighting required, a day lighting simulation was performed by using a model called "Radiance" as it is incorporated in the Building simulation toolkit IES VE. The simulation was based on the following assumptions:

Table 3: Day lighting Simulation Assumption

Reflectances	***Glazing (VLT)***
0.8 (ceiling)	0.4 (external)
0.5 (wall)	
0.3 (floor) 0.1 (specular)	
0.5 (check-in counter)	

iii) Orientation of the Building

Orientation is the main key to reduce the heat gain especially in Malaysia's climate due to the East-West sun path throughout the year. The orientation of the current proposed KLIA 2 for Main Terminal Building and Satellite Building is slightly oriented to the North-South and East-West. These provide some benefits including exposure to the diffuse skies on southwest corners which will be alleviated with recommended extended louvers of these glazed facades.

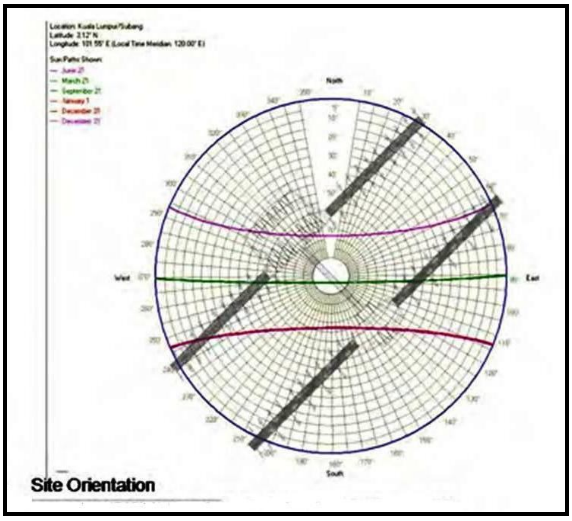

Figure 1. Orientation of the building on proposed site.

To quantify the effects of orientation of the building, LEED procedures need four aspects of simulation be carried out to general the base line of building performances.

Table 4: Result of Simulation Based on Differences of Orientation

Building Orientation	***Cooling***	***Auxiliary***	***Light***	***Equip.***	***Total***
0^{o}	28088.037	24204.352	21699.004	18805.949	92797.342
90^{o}	28080.326	24201.17	21699.004	18805.949	92786.449
180^{o}	28087.311	24204.049	21699.004	18805.949	92796.313
270^{o}	28079.842	24200.969	21699.004	18805.949	92785.764

Mechanical and Electrical System

i) Lighting

The performance of lighting in KLIA 2 shall meet the following maximum allowable power density:

- Airport concourse area = 0.45 W/ft^2
- Air/Train/Bus baggage area = 0.75 W/ft^2
- Terminal ticketing area = 1.1 W/ft^2
- Offices = 0.8 W/ft^2
- Retail sales area = 1.3 W/ft^2
- Food preparation area = 0.9 W/ft^2
- Dining area for bar lounge/leisure dining = 1.0 w/ft^2
- All other area to have lower lighting power density by 25%

ii) Lighting Management

Lighting control system shall be in place for scheduled management. In addition, sub-circuiting shall be planned for possibilities of switching off at least 90% lights whenever spaces are not used. A minimum number of lights are allowable to remain on for safety and security reasons.

Day light sensor shall be used at all day lit spaces. Occupancy sensor shall be used for all toilets and other occasional use spaces. A minimum number of lights are allowed to remain on for safety and security reasons.

iii) Air Handling Units (AHUs)

All air handling units shall be Variable Air Volume type. It shall be designed to have maximum of 500Pa total static pressure or lower wherever possible. The fan shall be of air foil type and shall have a minimum efficiency of 77%. In addition, the motor shall be type 1 efficiency as provided by the MS 1525. Carbon dioxide, CO^2 controlled modulating fresh air intake shall be used on all AHUs.

iv) Chilled Water Pumps

Chilled water pumps shall be fitted with a variable speed drives to regulate chill water flow as demand. The piping system shall be designed for minimum pressure losses and where spaces permits, 90o elbows shall not be used compared to 45o elbows are preferred. Low pressure loss valves and cooling coil system shall be used. A maximum allowable pressure for the chill water pipe system is 2 Bar. The motor for the chill water pump shall of type 1 efficiency as per MS 1525.

Renewable Energy Sources

By adapting the application of renewable energy sources, it can supply 1 to 5 percent of the overall energy requirements in KLIA 2. Besides the renewable energy sources also provide technology that are cost effective, inventive, and attractive and create a visual sustainability statement to the airport's visitors.

There are few strategies that can be considered in encouraging the use of renewable energy sources in KLIA 2:

- Biogas generation at the septic tank to fire the co-generation plant.
- Energy Harvesting Speed Bumps at the car parks to generate the electricity.

- The application of Photovoltaic (PV) panels at the car park canopies for generating the electricity.

i) Biogas Generation

Biogas can provide a considerable amount of free energy for the KLIA 2. It is estimated that 1 kWh of electricity and 1 KWh of heat will be generated per m^3 of inflow wastewater. The process will be able to create biogas from the organic food waste from restaurants and catering facilities (estimated 260 KWh per ton of food waste). As additional benefit, the process will reduce the overall amount of wastewater and waste to the landfill. It is also produce compost and can be used as a fertilizer for landscaping.

By using biogas generation, it can benefits to the economics such as simple payback, equivalent uniform annual cash flow, present worth and have prospective rate of return.

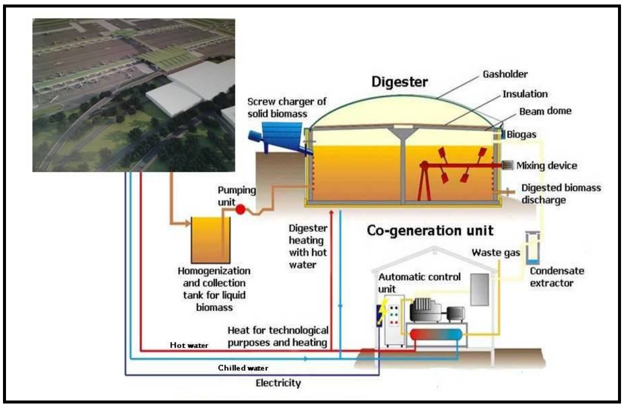

Figure 2. Biogas fired Trigeneration at the KLIA 2 Terminal.

ii) Energy Harvesting Speed Bumps

The operation of Kinetic Speed Bumps is by producing energy when the vehicles driving on the bumps during the visitors going in and out of the KLIA 2 Terminal's car park. The plates of the speed bumps will be moving when the cars driven on them and automatically creating kinetic energy which is enough to drive the generator. This is how the Kinetic Speed Bumps works and how it can harness the energy. This technology is projected to produce 30kW of energy for one hour without causing any interruption to the motorists when they ride over the plates.

If KLIA 2 uses this technology, it will be the first airport in the world apply to the new renewable energy sources and also becomes the first project in Asia.

Figure 3. Kinetic Speed Bumps.

iii) Shading Photovoltaic Canopy
To generate electricity from solar energy, Photovoltaic panels shall be installed at the canopies of the car park. To reduce the relative high cost of PV's panels, only limited number of panel is advised to use. It is also due to the long payback period when using this method. The PV's panels shall be installed at the suitable location and selected properly in the district of visitors.


Figure 4. Example of the application of Photovoltaic panels.

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