Malaysia's GREEN DIAMOND

BY T.L. CHEN, P.E., C.ENG., FELLOW ASHRAE; AND AHMAD IZDIHAR, P.E.

Gregers Reimann, IEN Consultants

INSPIRATION FOR THE "DIAMOND BUILDING" NAME

During one of the initial design workshops held in 2005, the building took its shape in response to the climatic design goals. The four slanting sides (which provide self shading), inverted pyramid form, and jagged corners led the principal architect to exclaim, "It looks like a diamond." The name stuck, and the façade cladding was intentionally designed to emulate a diamond ring.

The glimmering green façade of the Malaysia Energy Commission Headquarters known as the Diamond Building stands in stark contrast to the surrounding brown concrete government buildings. It stands apart in other ways, too: its sustainable design and building energy intensity of 20.6 kBtu/ft^2·year mean it uses on average four times less energy than typical Malaysian office buildings. The building is designed to showcase technologies that reduce building energy and water consumption, promote use of sustainable building materials and provide enhanced indoor environmental quality.

Energy efficiency was a top priority in 2005 when the Energy Commission of Malaysia, Malaysia's regulatory body for energy policies, standards and safety, embarked on building its own headquarters building in the country's administrative capital of Putrajaya. However, the project team decided to venture beyond energy efficiency by going green, a relatively new term in Malaysia at the time. The resulting double Platinum-rated building is now a tourist attraction within the global sustainable community and serves as an example for private industry.

This building demonstrates that a Green Building Index Platinum rating (Malaysia's green building rating system) can be achieved with an additional cost of 6%. As a result, the number of green buildings in Malaysia has exploded since the Diamond Building's construction in 2010. (More than 50 million ft^2 [4.6 million m^2] has been certified by Green Building Index [GBI] in the past four years.)

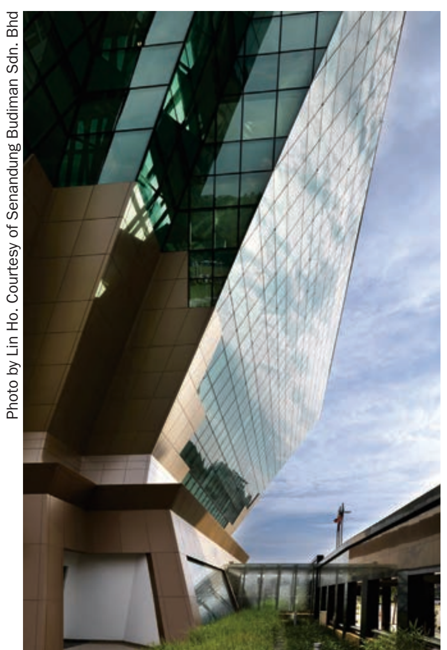


Photo by Lin Ho. Courtesy of Senandung Budiman Sdn. Bhd

Diamond Shape

Climate and the solar path of equatorial Malaysia (3° north) helped shape the building's diamond design. Solar studies showed that 25° tilting façades would provide self shading on the north and south façades. To maximize daylighting, a central atrium was introduced, and the diamond shape was born.

The diamond symbolizes transparency, value and durability, characteristics that represent the Energy Commission's role and mission as a regulatory body. The shape also represents an optimal design approach to achieve energy efficiency.

The building includes seven floors above grade and two underground levels for parking. The seventh floor includes a small theater, board room and dining room.

Low-e glazing helps reduce direct solar heat gain for the east and west façades. The glazing's visual light transmittance (VLT) of more than 0.5 allows for effective natural lighting to the office interior in conjunction with lightshelves. The inverted diamond shape increases the ground space available for landscaping, which helps reduce the heat island effect.

Photo by Lin Ho. Courtesy of Putra Perdana Development Sdn Bhd.

Above The Diamond Building is the headquarters of Malaysia's Energy Commission. The building is designed to showcase technologies that reduce building energy and water consumption, promote use of sustainable building materials and provide enhanced indoor environmental quality. Strategies include self-shading façades, daylighting and floor slab radiant cooling.

Below The inverted pyramid shape increases ground space for landscaping while maximizing roof space for PV panels.

Opposite The atrium dome provides internal daylight throughout the building core.

BUILDING AT A GLANCE

Name Malaysia Energy Commission Headquarters (Diamond Building)

Location Putrajaya, Malaysia (15 miles south of Kuala Lumpur)

Owner Energy Commission of Malaysia

Principal Use Office

Employees/Occupants 400

Occupancy 100%

Gross Square Footage 158,075
Conditioned Space 123,450

Distinctions/Awards ASEAN Energy Award, 2012; ASHRAE Technology Award 2013 (Second Place, Category I); Green Mark Platinum, 2010 (Singapore); Green Building Index (GBI) Platinum, 2010 (Malaysia)

Total Cost USD$21.5 million
Cost Per Square Foot $136

Substantial Completion/Occupancy June 28, 2010

TABLE 1 ENERGY USE MODELED ENERGY SAVINGS

	Energy Savings (%)
Lighting	53.6
Air-Conditioning Plant	47.1
Air-Side Fans	90.9
Mechanical Ventilation	10
Elevators	10
Domestic Water System	30.3
Garage Lighting	60.2
Total Building Energy Consumption (with PV)	46.1

Note: Energy savings derived from reference model based on compliance with Malaysian Standard 1525:2007 with building energy intensity (BEI) of 64 kBtu/ft^2 · year instead of a typical office BEI of 79 kBtu/ft^2 · year. See note in *Energy at a Glance* (right) for definition of building energy intensity.

While the building may appear to be fully glazed, metal cladding replaces the exterior glazing for the first meter of each floor. Using glazing for this lower wall section does not serve any notable purpose in terms of energy efficiency and daylighting.

Extensive computer simulation of the diamond form was conducted to ensure that the building performed as designed in regard to daylight levels and energy use. To maintain the occupants' visual comfort, various daylight simulation exercises were conducted to verify that daylighting would be adequate and well distributed.

Energy Efficiency

The design building energy intensity (BEI) was 27 kBtu/ft^2 · year (85 kWh/m^2 · year), representing a 65% reduction compared to a typical office building in Malaysia with a BEI of 79 kBtu/ft^2 · year (249 kWh/m^2 · year). Energy simulation was performed with IES Virtual Environment software conforming to ASHRAE Standard 140-2004 and Standard 90.1-2007 (*Tables 1* and *2*).

Energy efficiency performance of the building recorded for the period from October 2010 to November 2011 is depicted in *Figure 1*. The actual BEI of 20.6 kBtu/ft^2 · year (65 kWh/m^2 · year) has surpassed the design target to achieve an annual energy savings of more than 70%.

HVAC System

The Diamond Building is designed to provide thermal comfort using the following strategies:

- Floor slab radiant cooling addressing the sensible load of the air-conditioned space; and
- Air-side system addressing the latent load, air movement and air filtration.

Primary chilled water is supplied by a district cooling system (DCS) plant. While the facility is called a gas district cooling plant, in reality the existing plant has more

TABLE 2 COMPARISON OF ENERGY CONSUMPTION AND COOLING LOAD, OCT 2010–SEPT 2011

	Total Electricity (kBtu/yr)	Total Electricity with PV (kBtu/yr)	Total Cooling Load (kBtu/yr)
Proposed Model	3,746,738	3,479,977	7,514,732
Reference Model	6,462,342	6,462,342	11,536,040
Total Savings	42%	46.1%	34.9%
Actual Performance	2,753,709	2,409,254	6,258,911

Note: Reference model based on compliance with Malaysian Standard 1525:2007.

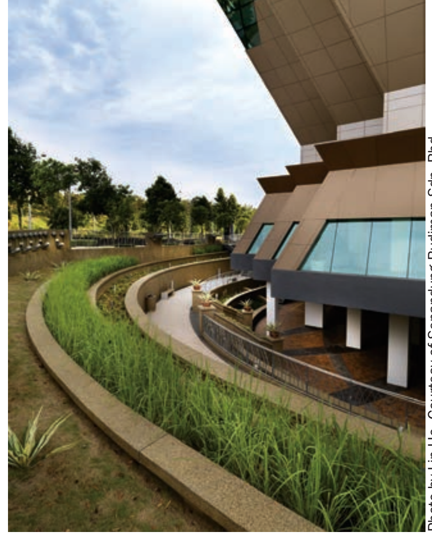


Photo by Lin Ho. Courtesy of Senandung Budiman Sdn. Bhd

Landscaping surrounding the building helps reduce the urban heat island effect. On-site composting provides nutrients for plants, reduces the need for fertilizers and reduces waste.

WATER AT A GLANCE

Annual Water Use 896,000 gallons

ENERGY AT A GLANCE

Annual Building Energy Intensity (BEI) (Site) 20.6 kBtu/ft^2
- Electricity (From Grid) 20.6 kBtu/ft^2
- Renewable Energy 2 kBtu/ft^2 (connected to the national grid to receive a higher feed-in tariff rate)

Annual Source Energy 61 kBtu/ft^2

Annual On-Site Renewable Energy Exported 2 kBtu/ft^2

Annual Net Energy Use Intensity 18.6 kBtu/ft^2

Savings vs. Standard 90.1-2004 Design Building 54.9%

Average Operating Hours per Week 52

Note: BEI is the total energy consumption, excluding parking garage, divided by the total gross floor area (GFA), excluding parking garage GFA, and rationalized for 2,704 hours operation per year (or 52 hours/week, the standard office working hours in Malaysia). It is also corrected for vacancy space if the building is not 100% occupied. See FAQ 9.5 at www.greenbuildingindex.org/FAQs-9.html for the formula for BEI.

Advertisement formerly in this space.

Photo by Lin Ho. Courtesy of Senandung Budiman Sdn. Bhd

The east and west façades receive morning and afternoon sun, but low-e glazing and blinds help reduce heat gain and prevent glare.

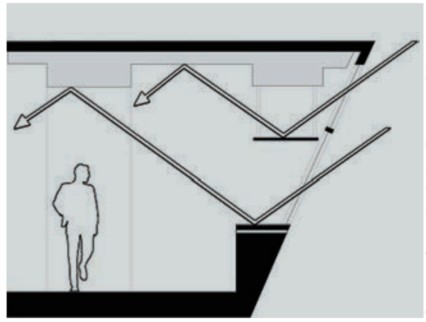
electric-driven chillers than gas-fired chillers. The building chilled water plant primarily consists of two heat exchangers, one duty and one standby, each of 4,197 kBtu (1230 kW) capacity.

Two distinct control strategies are used for office operating hours (cooling is provided via air-handling units) and for thermal mass charging mode. During the six to eight hours of thermal mass charging mode, chilled water from the building plant is directed to the concrete slab to achieve a slab temperature of 64.4°F (18°C) to 68°F (20°C) to provide radiant cooling during office hours. The slab-cooled concrete floors act as a cooling rechargeable battery, or thermal mass storage, being charged daily from 10 p.m. to 6 a.m. (during the off-peak tariff period).

Lighting Systems

The Diamond Building is designed to be at least 50% daylit, without glare and with minimal heat entry. The energy-efficient artificial lighting system is daylight responsive. The lighting load is 2.5 Btu/ft^2 (8 W/m^2) with an illumination level of 27.9 fc (300 lux) to 37.16 fc (400 lux), conforming to Malaysian Standard 1525-2007, *Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings*.

Photography by Lin Ho. Courtesy of Senandung Budiman Sdn. Bhd



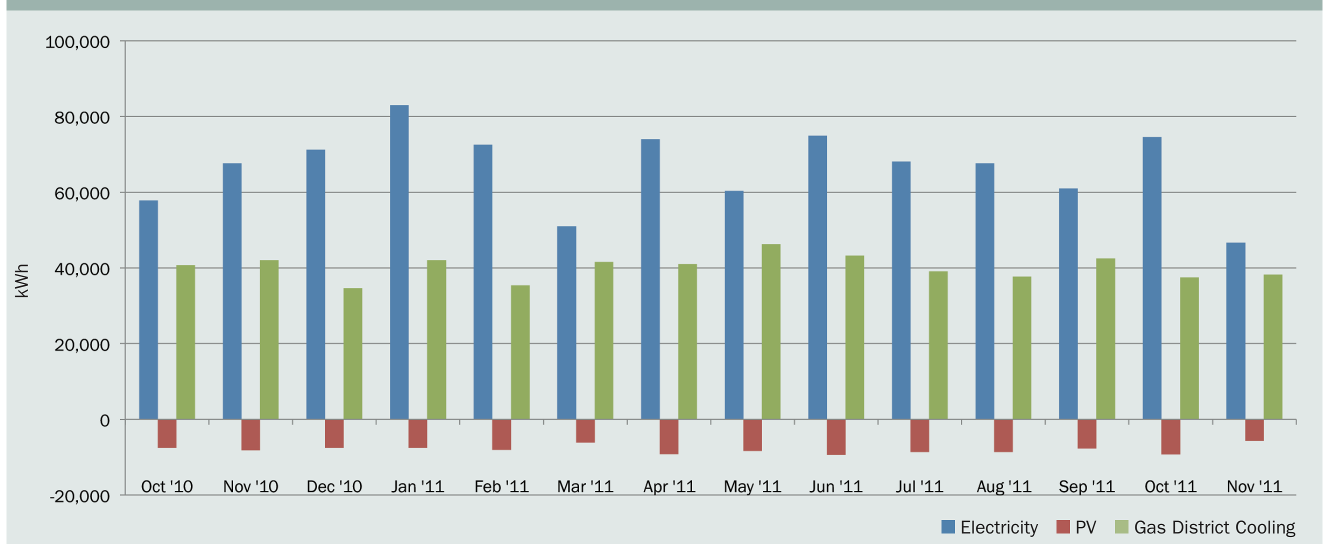
Source: Greening Asia–Emerging Principles for Sustainable Architecture

Diffuse light is deflected deep into the room by the mirror lightshelf and window sill.

Daylight Strategies

Façade Daylighting. Daylight is reflected off the mirror lightshelf and window sill, and cast onto the ceiling, deflecting it deep into the room. This design, along with fixed blinds, help prevent glare.

FIGURE 1 **ENERGY USE, PV GENERATION, OCT 2010–NOV 2011 (KWH)**



Note: While the facility district cooling system plant is called a gas district cooling plant, in reality the existing plant has more electric driven chillers than gas fired chillers.

Photo by Lin Ho. Courtesy of Senandung Budiman Sdn. Bhd

Graywater from the building is recycled in a mini wetland area, reducing potable water demand for irrigation. Microorganisms living on the root of the reed bed cleanse the water before it is released.

Atrium Daylighting. The daylight design of the atrium consists of three key design elements:

- An automated blind that regulates light penetration into the atrium;
- Different window sizes for each floor; and
- Reflective aluminum panels.

The automated atrium glazing roller blind consists of 24 individual blinds that can form six configurations depending on the outdoor light levels. The blinds allow 30% of the light through to ensure daylighting for the offices facing the atrium even when the atrium blinds are fully engaged.

Two light sensors on the atrium glazing control the blind operation. The principal control strategy aims to block direct sunlight penetration into the offices and to moderate the light level in the atrium, so it is "just right" throughout the day.

Daylight availability decreases deeper into the atrium. For the upper floors, windows are replaced with white walls (to reflect light deeper down the atrium), while floor-to-ceiling windows are used for the lower floors. Aluminum panels mounted on the fourth and fifth floor of the atrium walls reflect light to the first and second floors.

Skylight. At the lounge area outside the small theater on level seven is a skylight that takes in mostly diffuse light from the southern part of the sky. The skylight brings in sufficient light to illuminate the lounge area, eliminating the need for electric lights during the day.

Lighting System and Control

Daylight Responsive Lighting Control. To maximize daylighting, the artificial lighting system is daylight responsive. Two light sensors are installed on each façade with one additional sensor on the first floor to measure the atrium light level.

A building automation system (BAS) centrally controls electric lights in the daylight zones via light sensors. All work tables have individual task lights, providing flexibility and comfort of individual light control.

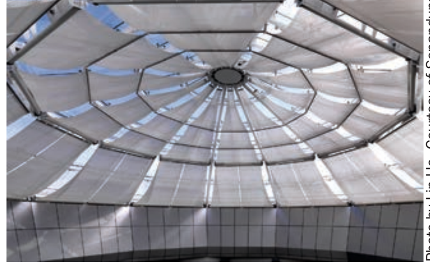


Photo by Lin Ho. Courtesy of Senandung Budiman Sdn. Bhd

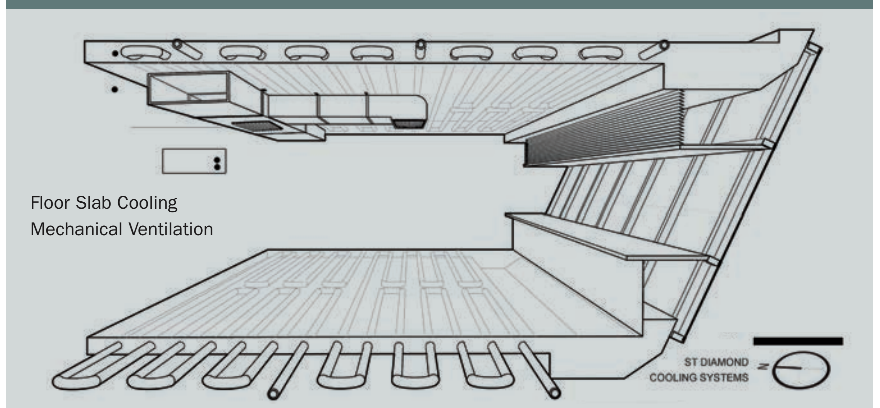
Photo by Lin Ho. Courtesy of Putra Perdana Development Sdn Bhd

Top An automated roller blind controls lighting in the atrium. Its various configurations help prevent direct sun while still illuminating the space. In this image, it is fully engaged.

Above The blinds open completely when conditions allow. White walls and aluminum panels deflect light into the lower floors.

Energy-Efficient Electric Lights. General office lighting is ceiling suspended with electronic ballasts and T5 tubes of 104 lumen/W efficacy. Compact fluorescent downlights are used in the common areas and T5 light fittings are used in the garage.

INTERNAL COOLING SYSTEM



Source: Greening Asia–Emerging Principles for Sustainable Architecture

Floor slab radiant cooling and a mechanical air-side system provide conditioning and ventilation. The concrete floors are charged each night, acting as a rechargeable battery as they release cooling throughout the day.

Photo by Lin Ho. Courtesy of Putra Perdana Development Sdn Bhd

Photo by Lin Ho. Courtesy of Putra Perdana Development Sdn Bhd

Above Ample glazing connects lobby occupants to the outdoors. Low-VOC paints and carpets help maintain good indoor air quality.

Right A skylight illuminates this internal lounge area on the seventh floor, eliminating the need for artificial lighting during daylight hours.

KEY SUSTAINABLE FEATURES

Water Conservation Water-efficient fittings save more than 67% of potable water compared to conventional water fittings.

Recycled Materials Represent 31% of material cost. Recycled contents in dry walls, ceiling boards, carpet and floor finishes.

Daylighting Façade daylighting, atrium daylighting (automated blinds, different window size on each floor and reflective aluminum panels), and reflected roof light.

Carbon Reduction Strategies Energy-efficient strategies such as daylighting, radiant floor cooling and efficient artificial lighting reduce CO_2 by 1,673 metric tons per year.

Transportation Mitigation Strategies Ten percent of parking garage spaces are designated for green/fuel-efficient vehicles and carpool vehicles; secure bicycle racks; location served by public transportation; and shaded walkways for pedestrians (linking with master development).

Other Major Sustainable Features Rainwater harvesting, graywater recycling via mini wetland, solar photovoltaic array, atrium stratification control, heat pipes, on-site composting, advanced air filtration, condensate harvesting, thermal mass storage, heat recovery from shower drain, and recycling of test water from fire sprinkler system.

Occupancy sensors are installed in the bathrooms to control lighting and exhaust fans. In the open office area, lighting is zoned so it can be limited to only the areas needing it.

The total lighting energy is reduced substantially from the baseline annual building load of 1,781 MBtu (522 MWh) to 1,160 MBtu (340 MWh), up to a 35% savings. In addition, the energy-efficient artificial lighting reduces the cooling load by 5.4%. The use of daylight helps to further reduce the total lighting energy from 1,160 MBtu/yr (340 MWh/yr) to 788 MBtu/yr (231 MWh/yr) which represents an additional 32% reduction from the base building.

IAQ, Thermal Comfort

The Diamond Building is designed to create a pleasant, healthy and comfortable working environment for occupants. Low volatile organic compound (VOC) paints (certified under the Carpet and Rug Institute Green Label) are used throughout the building. Likewise, only low VOC carpets (Green Label Plus certified) are used.

Ventilation air is provided via a primary air-handling unit located at the roof, which precools the air to 68°F (20°C). Heat pipes are installed for the primary air-handling unit to aid in relative humidity control without energy penalty.

The precooled air is distributed through floor air-handling units except at the ground floor where it is introduced directly into the conditioned space. The ventilation rate complies with ASHRAE Standard 62.1-2007.

The primary air-handling unit also is designed for space dehumidification. Demand-control ventilation is regulated by CO_2 sensors. This system is designed to provide good IAQ and energy-efficient operation, which is critical in an equatorial climate where ventilation air is hot and humid throughout the year.

The variable air volume (VAV) system with a default minimum airflow setting also helps maintain good IAQ. Following construction, a pre-occupation air flush out was performed by supplying outdoor air to provide 10 ach for at least 30 minutes for the whole building. A permanent air flush-out system, which also meets fire code requirements for a smoke spill system, is provided.

The dehumidified ventilation system also keeps the air dry to obviate the possibility of condensation on the surface of the chilled floor slab, which is maintained at 64.4°F to 68°F (18°C to 20°C) to be sufficiently above the dew-point temperature of 60.8°F (16°C).

A 12-month post-occupancy comfort survey was carried out to collect occupants' responses regarding thermal comfort, visual comfort, acoustic comfort, glare comfort and odor problems. Over 80% of the occupants expressed satisfaction. The

BUILDING ENVELOPE

Roof
Type Eight in. reinforced concrete insulated with 4 in. Styrofoam of k-value 0.194 and finished with 0.5 in. autoclaved fiber cement board and waterproofing membrane
Overall R-value 24 (bare) and 25 (green roof)
Solar Reflectance Index (SRI) >29

Walls

Type*	Opaque Glass Curtain Wall	Metal Clad Wall	Brick Wall
Overall R-value	13.9	13.2	1.9

Glazing Percentage 40%

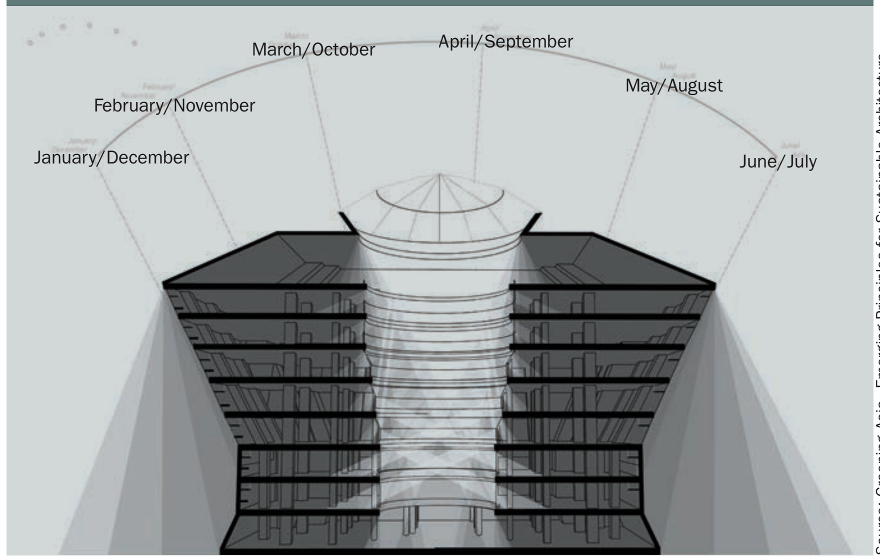
Windows
East/West Orientation
- U-value 0.072
- Solar Heat Gain Coefficient (SHGC) 0.37
- Shading Coefficient (SC) 0.43
- Visual Transmittance 52%

North/South Orientation
- U-value 0.956
- Solar Heat Gain Coefficient (SHGC) 0.46
- Shading Coefficient (SC) 0.53
- Visual Transmittance 55.9%

Location
Latitude 2.93° N
Orientation 101.7° E

*Curtain wall and metal clad wall are insulated, while the brick wall is not insulated.

ANNUAL LIGHT-RAY TRACING



Source: Greening Asia–Emerging Principles for Sustainable Architecture

As daylight angles shift throughout the year, the building design still allows for ample internal daylighting via the atrium and self shading on the north and south façades.

only complaint identified a lack of air movement in two stagnant areas, which has since been addressed.

Innovation and Green Features

Rainwater Harvesting. Using rainwater for toilet flushing and irrigation has reduced annual potable water consumption by 35% compared to potable water otherwise used for industry standard water fittings and irrigation as defined by the Green Building Index. Rainwater is collected from the 7,530 ft^2 (700 m^2) catchment area dome and stored in four 2,600 gallon (10,000 L) rooftop tanks.

Wastewater Recycling. Wastewater (graywater) is collected and discharged to a mini on-site wetland area that incorporates a reed bed planting system. The graywater irrigates the plants within the wetland via a subsoil soaker hose.

Microorganisms living on the root system of the reed bed cleanse the graywater. The wastewater is stored for no more than 24 hours, and any excess is channeled to the town sewage system.

Water-Efficient Fittings. These reduce potable water use by more than 67% compared to conventional plumbing fittings. These fittings include toilets with dual flush systems; faucet aerators; showerhead aerators; and urinals modified to provide a small amount of water, making them suitable for Muslim use.

Muslim practice requires males to use water to clean up after using a restroom. A water flush with limited cleansing water of 0.03 L/s (0.475

TABLE 3 IAQ MEASUREMENT

Location	Total Volatile Organic Compounds ppb	CO_2 ppm	CO ppm	Temp. °F	RH %	Formaldehyde (HCHO) ppb	Particulate Matter 10 μg/m^3
COP limit	<3,000	<1,000	<10	22 to 26	40 to 70	<100	<150
Level 2	786	470	0.5	72.9	63	30	14.3
Level 3	609	414	0.4	71.8	65	45	12.5
Level 4	706	455	0.5	72.9	60	50	15.1
Level 5	370	453	0.4	72.0	57	45	10.5
Level 6	435	433	0.4	71.6	59	30	11.2
Level 7	609	400	0.3	71.6	65	90	9.6

Photo by Lin Ho. Courtesy of Putra Perdana Development Sdn Bhd

The building is designed to be at least 50% daylit. The building automation system controls the energy-efficient artificial lighting via daylight sensors.

BUILDING TEAM

Building Owner/Representative
Energy Commission of Malaysia

Architect NR Architect

General Contractor
Putra Perdana Construction Sdn Bhd

Mechanical, Electrical Engineer
Primetech Engineers Sdn Bhd

Energy Modeler IEN Consultants Sdn Bhd

Structural, Civil Engineer
Perunding SM Cekap

Landscape Architect
KRB Enviro Design Sdn Bhd

Lighting Design Primetech Engineers Sdn Bhd, Megaman (Malaysia)

Green Building Index (GBI) Consultant
Exergy Malaysia Sdn Bhd

gpm) per flush is incorporated for their use. Non-Muslims do not need to press the flush button to clean up. In Malaysia, such modified urinals are referred to as "less water" (water-less) urinals, rather than "no water" (waterless) urinals.

Energy-Efficient Office Equipment. A procurement policy allows for the purchase of only energy-efficient labeled equipment and appliances with five-star ENERGY STAR ratings. Centralizing and networking printers also increases efficiency.

Renewable Energy. A 244 kBtu (71.4 kW) photovoltaic installation consisting of 1,112 rooftop panels provides 10% of the building's energy needs. The generated energy is now connected to the national utility's grid under the Feed-in Tariff scheme (2012). The panels have generated a monthly average of 28,320 kBtu (8,300 kWh) and 341,200 kBtu (100,000 kWh) annually.

Atrium Stratification Control. An elevated 137 ft (41.8 m) atrium contains the hot air pocket (about 104°F [40°C]) below the atrium glazing. Only the circulation space on the ground floor level of the atrium is air conditioned.

Advanced Air Filtration (Electrostatic Precipitator). This air cleaner ensures good IAQ, especially during the time open burning in Indonesia causes haze.

On-Site Composting. Landscaping and food waste is composted, and the end product is used on site for landscaping. This strategy reduces fertilizer costs and recycles resources rather than increasing the waste stream.

Condensate Water Harvesting. Especially productive for Malaysia's year-round humid climate conditions, plans in the near future include using the harvested cool water to provide evaporative cooling around the external walkway paths.

Operation and Maintenance

The Diamond Building was the first building in Malaysia to engage the services of a GBI registered commissioning specialist, whose services helped improve building operating efficiency.

LESSONS LEARNED

Overcoming Skepticism. Convincing clients to adopt new concepts and emerging technologies in a developing country is often more challenging than the design itself. Stories of failures or unsatisfactory performance, especially within the region, had not helped, although such failures are often traced to such technologies not being "tropicalized" to suit the local climate and environment.

Prior to the Diamond Building's construction, a government demonstration building adopted slab cooling, which required various modifications for over two years before it could finally achieve acceptable occupant comfort.

Fortunately, two favorable factors convinced the client to pursue sustainable strategies for this project. The developer/contractor is a leading proponent of sustainable construction and had been involved in government funded demonstration projects to showcase energy efficiency. In addition, the MEP engineer successfully implemented emerging technologies in the Malaysia Securities Commission Headquarters, an award winning energy-efficient building built a decade earlier.

Slab Cooling. Minor condensation was spotted at the chilled water pipe manifold riser cupboards. With a congested piping manifold, proper pipe insulation is difficult and a risk of cold spots on the slab exists due to the looped pipe bottleneck area at the riser. Future designs should consider smaller zones served by each riser, since more risers would allow adequate spacing for proper pipe insulation to mitigate such problems.

The slab charging strategy involves presetting a fixed charging duration based on the best estimated calculations. To achieve uniformity of slab temperature during chilled water charging and eliminate the risk of overcharging, temperature sensors to control the duration of charging should be installed. These sensors can have setpoints to allow for dynamic control of the charging process.

Air Movement. Recognizing that air handlers sized to remove only the latent load will provide insufficient air movement for a year-round hot and humid climate application, higher air movement was originally addressed by incorporating fan-assisted VAV units. However, due to the extremely high escalated metal costs (when the project was bid out in 2008–09 at the height of the world metal price crisis), these were replaced with normal VAV units. The redesign uses enlarged ringed ducts to maintain a minimum of 4 ach. Unfortunately, due to space constraints, the compromised ringed ducts did not achieve the desired minimum airflow, resulting in a few "stagnant" areas.

District Cooling Commercial Charge Rates. The Diamond Building has prompted the district cooling plant operator to consider storing cooling thermal energy generated during the off-peak tariff period in buildings rather than investing in costly thermal storage plants.

Owners of projects that incorporate charging thermal mass with chilled water and that are served by a district cooling system (DCS) should negotiate the after-hours chilled water cost. Negotiations for lower rates can be based on the cost-effective higher charging temperature (46°F–48°F for the DCS versus 60°F for the Diamond Building) and the capital cost savings to the DCS operator who can use the building slab for thermal mass storage rather than construct additional thermal storage plants.

Integrated Design. Early integrated design is key to achieving successful sustainable building design and operation. The planning process began with trips to visit other green projects in Singapore and Thailand, and design workshops/brainstorming sessions, which included all of the key consultants. Any "crazy idea" to advance the goals of energy efficiency and sustainable design was welcome during this session. The energy efficiency consultant created building simulations quantifying performance (energy, daylight, thermal comfort, etc.), iteratively aiding the building design development.

Cost-Effectiveness

The building's eco-friendly measures cost USD$1 million, representing about 6% of the total construction cost. Savings of almost USD$333,000 annually in operating costs from energy efficiency (USD$317,000) and solar power generation (USD$15,000) result in an estimated payback of 3.5 years despite Malaysia's subsidized utility tariff rates.

Environmental Impact

The operational carbon (CO_2) reduction achieved by the Diamond Building (as verified by the GBI Assessor) amounts to 1,673 metric tons per year, which is akin to taking 900 cars off the road (assuming each car travels 7,500 miles/year). This reduction is derived from savings of electricity energy alone and does not include reduction due to water savings, waste discharge, refuse recycling and embodied carbon.

Conclusion

The Diamond Building represents a new approach toward climate responsive building design in Malaysia. Energy savings of four times that of typical office buildings demonstrate the environmental and financial benefits of strategies such as climatic design, daylighting and in-slab radiant cooling. Good indoor air quality access to sunlight provides a pleasant working environment. Practices such as on-site composting and graywater recycling reduce demand for resources while also reducing the waste stream. ●

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