PART II – ENERGY-EFFICIENT BUILDINGS IN ASIA

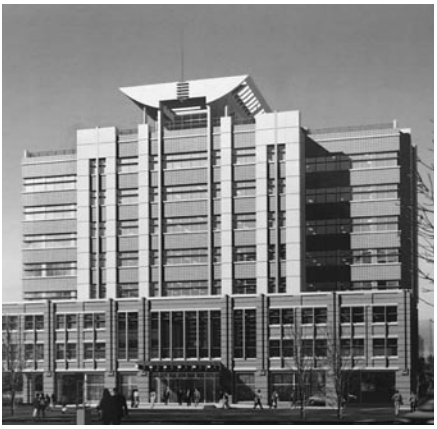
Asia has a growing number of energy-efficient buildings. This section highlights a number of them. We have included representative buildings from each of the 11 Asian economies where the Asia Business Council has members. This list is not intended to be exhaustive, but to give a sense of the range of buildings that use energy more efficiently. We have included both cutting-edge as well as more mainstream examples. Several are government buildings or are built with some form of government support with the explicit aim of demonstrating the effectiveness and economic efficiency of these designs.

One theme that emerges from these examples is what a big difference small adjustments can make. Using energy more efficiently in buildings requires a strong commitment from the top. And it is important to get the big pieces of energy-using equipment right—the proper size and operated as efficiently as possible. But getting the small things right—like lights and exhaust fans in parking garages, lights on fire stairs, natural lighting and natural ventilation—can add up to big efficiency gains. Eking out these gains also requires giving operating staff the training and tools to make needed changes as well as the freedom and the incentives to experiment.

Unfortunately, much of the relevant data is fragmentary, reflecting in part the reality that commercial buildings are not managed as scientifically as, say, factories. Wherever possible, we have endeavored to contact those involved with developing or managing the buildings. In many cases, however, we have relied exclusively on secondary sources, such as web sites, often at the request of the building management. But there is little doubt from these examples that real energy savings accrue with little additional cost.

China

Agenda 21 Demonstration Energy-Efficient Office Building



Source: Joe Huang, principal technical advisor for the schematic design of the Agenda 21 Demonstration Energy-Efficient Office Building

The Agenda 21 Demonstration Energy-Efficient Office Building was a joint effort of the Chinese Ministry of Science and Technology (MOST) and the U.S. Department of Energy. One of the goals of this project is to demonstrate that significant additional energy savings beyond the existing building energy standard in China are achievable in ways that are replicable and cost-effective in China's emerging buildings market. Joe Huang, technical advisor to the Asia Business Council on this research project, was the principal technical advisor for the schematic design of this building.

The building is located in the western part of downtown Beijing, overlooking Yuyuantan Park, the second largest green space in the metropolitan area. It has nine stories, with a total floor area of 13,000 square meters. Ground-breaking took place in February 2002, and it was completed in the first half of 2004. It is now the headquarters building of the MOST.

The building is intended to demonstrate significant cost savings without using the most advanced technologies. The building design

focuses on so-called "state-of-the-shelf" technologies (technologies that are advanced but already commercialized) and techniques that are either currently cost-effective, or likely to be so under market conditions that are likely to develop. At the same time, the project is flexible about showcasing more innovative technologies. If suitable opportunities arise, the project will incorporate emerging technologies into small portions of the building on a limited basis.

The building has a number of energy conservation features, including both building envelope and mechanical system measures. A cross-shaped building design was used to maximize daylighting potential, with windows located on the north and south facades to better control solar heat gain. A whole-building or integrated-design approach was used to identify the most cost-effective energy strategies for this building, including passive solar and other clean energy options such as photovoltaics (PVs) and geothermal power systems. Other cost-effective efficiency measures include:

- Light colored wall and roof surfaces;
- Recessed windows;
- High-efficiency lighting;
- Low-emissivity (low-e) window glazing;
- Bi-level light switches (daylighting);
- Reduced window height;
- Staged chillers; and
- Improved chiller efficiency.

Measured performance data indicated that the building is much more energy efficient than similarly equipped office buildings in East Asia and the U.S. In the feasibility study, the building design was estimated to be 40 percent more efficient than ordinary buildings. In the LEED analysis, it was found to be 60 percent more efficient than the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 90.1 energy budget benchmark and earned the full 10 points in the optimal energy performance section of LEED. The

utility data from the first year's operation match well the LEED analysis results, providing that adjustments are made for unexpected changes in occupancy and operations. Compared with similarly equipped office buildings in Beijing, this demonstration building uses 60 percent less energy per meter of floor area. (Significantly, however, given the pace of construction in China, the building uses slightly more energy per meter of floor area compared to conventional office buildings with less equipment and window air-conditioners.) Most of the energy features in this building are very attractive in the Chinese building market. In 2004, China's Ministry of Construction gave the building its top award for best green building in China. In 2005, the building received the first LEED Gold rating for a building in China.

Source: Joe Huang, a scientist at Lawrence Berkeley National Laboratory, the principal technical advisor for the schematic design of the Agenda 21 Demonstration Energy-Efficient Office Building, and technical advisor to the Asia Business Council in this research project.

TaiGe Serviced Apartments

Source: China Merchants Real Estate Co.

TaiGe is the first LEED-certified (Silver) commercial development in China. It is a high-end serviced apartment complex in the Shekou District of Shenzhen, consisting of a 25-story main building and six 4-6-story low-rise buildings with a total floor area of around 34,000 square meters and providing more than 230 apartments. The

complex was developed in 2004 by China Merchants Property Development Co., Ltd. (CMPD), a subsidiary of China Merchants Group Ltd., a conglomerate founded more than 100 years ago.

According to Hu Jianxin, Deputy General Manager of CMPD, TaiGe is a demonstration project that incorporates many green building features for water and energy savings, waste recycling, and a better indoor environment. For example, high-performance chillers with an energy recovery system and low-emissivity window glazing are used to save energy. Theoretically, TaiGe can save 75 percent of lighting power consumption and 50 percent of air-conditioner power consumption per square meter per hour compared with hotels to achieve the same brightness and temperature. "We see green property development as the way to achieve our corporate values, which consist of three elements: historical mission, social responsibility, and caring for human beings," Hu told the Council researchers when asked why CMPD initiated the green project.

TaiGe has targeted international professionals or senior staff working in multinational corporations in this area, who are more environmentally conscious, as renters. Hu said the project has turned out to be very successful financially. He told researchers that the rent of TaiGe is around 15 percent higher than CMPD's initial expectation, an expectation that itself was already higher than the market price.

The success of TaiGe has gained attention from both local and national governments. It was one of the five residential projects of the Department of Construction's building technology demonstration, and was listed in the Guangdong government's Green Residential Building demonstration projects.

Source: Interview with Hu Jianxin, Deputy General Manager of China Merchants Property Development Co., Ltd., July 2006, Shenzhen, China.

Pearl River Tower

Source: Skidmore, Owings & Merrill LLP

The Pearl River Tower, which has been under construction since 2006 in Guangzhou, will be occupied by the China National Tobacco Corporation when finished in 2009. It is designed to be one of the first zero-energy buildings in the world. It will be 303 meters (994 feet) tall with 69 floors and a total floor area of more than 212,000 square meters.

This building takes advantage of both high energy-efficiency building design and solar and wind power to generate energy for its consumption. Among its features are turbines that turn wind into energy for the HVAC system. According to building designer Skidmore, Owings & Merrill, the building's facade was designed to accelerate the wind as it moved through the opening in the building. Skidmore, Owings & Merrill initially estimated that the design would increase wind velocity to 1.5 times ambient wind speeds. In tests, models showed wind speeds of up to 2.5 times ambient wind speeds in some cases. If this proves the case during actual operation, the building could generate power 15 times greater than a freestanding turbine. The turbines do more than generate electricity, though. The openings through which the wind flows help reduce the overall wind load on the skyscraper.

Other green features of the building include a solar collector for more power generation, and a rainwater collection system, part of which is heated by the sun to provide hot water. The building is cooled, in part, through heat sinks and vertical vents. Indeed, it is intended

that these systems will generate more energy than the operation of the building will use.

Source: Preston Koerner, 2006, "Pearl River Tower, Guangzhou, China", JETSON GREEN, August 13, see: http://jetsongreen.typepad.com/jetson_green/2006/08/pearl_river_tow.html; World Architecture News, "Innovative form embraces wind", see: http://www.worldarchitecturenews.com/index.php?fuseaction=wanappln.projectview&upload_id=462

Dongtan Eco-city

Source: Web site of Arup & Partners Hong Kong Limited, see: http://www.arup.com/

Dongtan Eco-city, a project currently being planned and designed, is the world's first sustainable city envisioned to be as close to carbon-neutral as is economically possible.

At three-quarters the size of Manhattan and located on Shanghai's Chongming Island, the third largest island in China at the mouth of the Yangtze river, Dongtan will be developed on 630 hectares of land as a sustainable city to attract a range of commercial and leisure investments. The site is adjacent to a huge wetland of global importance, so ecologically sensitive design will be a key element of the master plan.

Energy demands in Dongtan will be reduced by specifying high thermal performance standards for all new buildings and using energy-efficient equipment and mechanisms. Dongtan will produce its own electricity and heat from renewable sources, including a combined heat and power (CHP) plant that runs on biomass in the form of rice husks from local rice mills; a wind farm; and biogas produced from municipal solid waste and sewage. Individual buildings will have their own photovoltaic cells and micro wind turbines.

To be truly sustainable, the city must not only be environmentally sustainable, but socially, economically and culturally sustainable too. All housing in Dongtan will be within seven minutes' walk of public transport and offer easy access to social infrastructure such as hospitals, schools and work. Organic farming methods will be used to grow food for the Dongtan inhabitants and land will be fertilized using processed waste from the city.

The project sponsor is the Shanghai Industrial Investment Corporation (SIIC), which is partnering with Arup, an international design and consultancy firm, in the planning and design. The first phase of development for up 10,000 people should be in place in time for the Shanghai World Expo of 2010.

Sources: Raymond M.H. Yau and Andrew K.C. Chan, 2007, "Towards Delivering a Sustainable Dongtan: Dongtan—21st Sustainable City", presentation at the conference: "International Conference on Climate Change", May 29-31, Hong Kong; web site of Arup & Partners Hong Kong Limited, see: http://www.arup.com/

Hong Kong

Sunny Bay MTR station

Source: Jerry Crimson Mann on Wikimedia Commons

The Sunny Bay Mass Transit Railway (MTR) station is one of two stations on the Hong Kong MTR Disneyland Resort Line. Unlike other MTR stations in Hong Kong, the Sunny Bay station uses minimal energy because of its passive design features. It has no air conditioning and instead makes use of the natural environment to control the temperature and lighting inside. By using a canopy to harness the natural flow of the air for cooling, Sunny Bay has removed the need for most of a normal station's mechanical and electrical systems. These systems account for 30 percent of the capital cost of a typical building in Hong Kong. The canopy drops the air temperature by two degrees Celsius, which usually is enough to make people feel comfortable. During the day, the translucent material lets light in and at night high-efficiency lighting is used, allowing the station to cut 75 percent from the lighting cost of a typical station in Hong Kong. The architecture firm Aedas won the Hong Kong Institute of Architects Merit Award (2005) and the Green Building Grand Award (2006) from Hong Kong's Professional Green Building Council for its station design.

Source: Web site of Aedas, see: http://www.aedas.com; Barclay Crawford, 2006, "Green Street," South China Morning Post, 28 November.

Cityplaza III and IV

Source: Swire Properties

In the late 1990s, Swire Properties adopted a series energy-efficiency improvement measures to two of its grade-A office buildings, Cityplaza III and IV. These improvements include:

- Retrofitting of energy-saving light fixtures;
- Different lift programming suited for variable passenger flow;
- BMS control of lighting in back of house and loading bay areas;
- Installation of capacitor banks for power factor improvement in lift systems; and
- Installation of variable frequency drives for air handling units and primary air handling units.

By adopting these energy-efficiency measures in these two buildings at a cost of some HK$3 million (around US$380,000), building operators have realized annual savings in electric bills of around HK$1 million (around US$130,000), or 8 percent of annual operational energy costs. The investment was paid back in approximately 3 years. In 2001, these environmental achievements were recognized with the highest BEAM (Building Environmental Assessment Method) rating of Excellent (See later section for more about BEAM).

Source: HK-BEAM Society, see: http://www.hk-beam.org.hk/caseStudies/existing.php

Festival Walk

Source: Chong Fat on Wikimedia Commons

Festival Walk is a mixed-use commercial complex building featuring a shopping mall, an office tower, and related entertainment and amenity facilities, with a total floor area of about 130,000 square meters. The building was completed in 1998 by Swire Properties and has since been run by Swire Properties Management.

In 2003, Festival Walk became the largest commercial building in Hong Kong that converted its air-cooled air conditioning system to a more efficient water-cooled system. But what makes this building even more notable is the adoption in 2004 of an innovative chiller control strategy for the water-cooled air conditioning system that saves energy with minimal investment. Although the conversion to water-cooled chillers from air-cooled ones in 2003 made the air conditioning system more energy-efficient, technical staff of Swire identified a shortcoming in the control logic of the new system that compromised its energy performance.

In a conventional system, a computerized pre-set constant chilled water flow rate passes through each of the chillers. The more cooling needed, the more chillers will be activated. When a pre-set deficit flow rate is detected in the chilled water loop, an additional chiller is activated. This setup can waste energy if the chiller already in operation

has not reached its maximum cooling capacity and thus triggers the operation of an additional chiller.

After monitoring data, a new control strategy was developed. The new control strategy minimized this mismatch of cooling load demand and chilled water flow demand. The investment was minimal since it only required modification of the program logic, but the annual energy savings can reach approximately 400,000 kWh and reduce the release of CO_2 by 240,000 kg.

The project demonstrated the potential energy savings in existing buildings that can be achieved by improving the building management system with minimal investment. This achievement was recognized by the Hong Kong Eco-Business Award (2004) and the ASHRAE Technology Award (2006).

Source: Interview with Cary W.H. Chan, Head of Technical Services, Swire Properties Management Ltd, July 2007, Hong Kong.

India

CII-Godrej Green Business Center Building

Source: Godrej & Boyce Manufacturing Co., Ltd.

The CII-Godrej Green Business Center (CII-Godrej GBC) Building is the office of CII-Godrej GBC, a joint initiative of the Government of Andhra Pradesh, Confederation of Indian Industry (CII) and Godrej, with the technical support of USAID. It is an unique model of a successful public-private partnership that is dedicated to promote efficiency and equitable growth leading to sustainable development.

The building is the first green building in India. It is the first LEED Platinum-rated building outside the US, and was the most energy-efficient building *in the world* at the time it was rated. It was built to promote the green building concept and demonstrate that India can build to global environmental standards. The building incorporated such features as water efficiency, energy efficiency and construction waste recycling. According to CII-Godrej GBC, the building is capable of reducing its total energy consumption by 55 percent and its lighting energy consumption by 88 percent.

The building is centered around a circular courtyard, with a series of smaller interior courtyards. Energy-efficiency features of this building include:

- North light for indoor daylighting: Almost 90 percent of the interiors are day-lit, with north lighting and windows facing onto the courtyards. (The site uses north light to minimize heat gain in its tropical location.)
- Wind towers integrated with HVAC: The wind tower is a traditional passive cooling technique of the sub-continent. Here, it has been combined with the HVAC system to reduce energy consumption. The fresh air that goes in the Air Handling Unit (AHU) is pre-cooled in the wind tower, reducing the intake air temperature by three to five degrees Celsius. The wind tower itself is made of hollow masonry, and acts as a thermal mass. It is cooled periodically by trickling water from the top of the tower.
- Solar energy photovoltaic panels: Photovoltaic panels installed on part of the roof provide about 20 percent of total energy consumption, with the roof orientation and inclination designed to maximize the solar panels' efficiency.
- Roof garden insulation: A roof garden prevents formation of heat islands on the roof and acts as insulation, while providing an aesthetic benefit at the same time.

The features incorporated in the building drew high praise from the president of India as noteworthy steps towards energy efficiency, renewable energy and water management. The Platinum rating for this building has garnered attention, particularly in the construction industry, and generated considerable public awareness about green buildings in India.

Source: CII-Godrej Green Business Center and Confederation of Indian Industry.

Indonesia

The Plaza BII Building

Source: Eka Permana

The Plaza BII Building is located on the most prestigious boulevard in Jakarta, Jalan M.H. Thamrin. This 10-year-old building consists of a 39-story tower and a 3-story basement, with a gross floor area of 80,000 square meters. In 2005, the Plaza BII Building won the ASEAN Energy-Efficiency Award (Retrofit Category) because of the following energy-efficiency upgrading measures:

Energy-Efficiency Operational Discipline and Procedure

- Rescheduling and reduction of some essential electrical loads for equipment rooms.
- Eliminating some of the building's ornamental, vicinity and perimeter lighting.

Retrofitting

- Upgrading the building automation system by installing outside temperature sensors. The system can adjust the chilled water supply of the air handling unit based on the outdoor temperature.

- Modifying the power outlet circuit and integrating it with the operating schedule of floor lighting.
- Installation of door switches to all equipment rooms that switch off the room lighting when the door is closed.
- Opening up a part of the parking building wall to allow natural air and light into the area.

Tenants Participation in the Conservation of Energy

- Lighting is switched off during the noon-time break from 12:15 to 12:45 daily (Monday to Friday).
- Setting up a fixed room temperature of 25 degrees Celsius on one of the floors, at the request of the Japanese tenants who occupy that floor.

These measures enabled the building operator to achieve a 22 percent savings in electricity consumption and contributed to a rise in the occupancy rate from 84 percent before 2002 to 96 percent in 2006.

Source: Duta Pertiwi, "Energy Efficiency and Conservation: Best Practices of Plaza BII Building, Jakarta, Indonesia", see: http://www.aseanenergy.org/download/projects/promeec/2006-2007/building/vn/ID_Plaza%20Bii%20Indonesia%20Presentation.pdf

Japan

Osaka Municipal Central Gymnasium

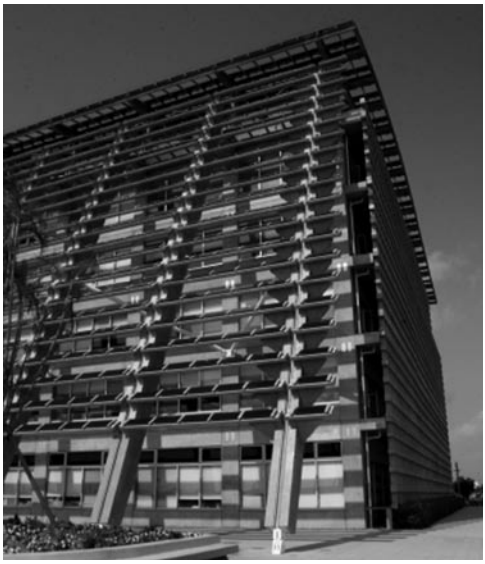
The Osaka Municipal Central Gymnasium was built by the Osaka City Government in 1996. One of the unique features of the gymnasium is that the entire complex is built underground. Even the foundations of the two circular arenas are covered with earth, forming two hillocks, and the area appears to passersby to be an attractive green park. This design solution minimizes the cooling and heating load for the arena. The base and sides of the building are beneath street level, allowing geothermal heat to warm the building in the winter, while the earth's temperature ensures its coolness in summer. Other energy-saving measures adopted in this project include:

- Daylighting via membrane roof (skylights);
- Cooling/warming tube effect produced by underground concrete ducts;
- Arena lighting system capable of changing illuminating directions;
- Dynamic escape guiding system (buried-type guiding light);
- Air-conditioning during event only (cooling only; heating is not necessary);
- Temperature setting adjustment according to the size of the audience (for the arena, which is equipped with a Variable Air Volume system, adjustment of air temperature setting); and
- Natural ventilation on other occasions.

With these features, the gym is able to save 31 percent of annual electricity consumption compared with the building standard in Japan. This standard itself is already higher than other Asian economies.

Source: Global Environmental Center Foundation, Japan,
see: http://www.gec.jp/ESB_DATA/EN/building/html/esb-087.html

Itoman City Hall



Source: Hiroki Toyosaki

Itoman, a city on Japan's southern island of Okinawa, in 1996 announced its "Itoman City New Energy Vision," which called for all new public buildings to be equipped with sustainable energy sources. The Itoman City Hall, completed in 2002, is a public demonstration of the installation of a photovoltaic power generation system, with a capacity of 195.6 kW—the largest among Japanese local government buildings. The photovoltaic power generation system has the dual function of both producing electricity and, through its shading effect, reducing the need for air conditioning. The solar panels generate 12 percent of the energy requirements of the building; the panels on the roof and southern side of the building also act as sunshade louvers. They diffuse the strong sub-tropical sun of Okinawa, reducing the air conditioning load by 25 percent. In addition, a large semi-open space is created by staggering the photovoltaic louvers so they provide maximum shade and protection from wind and rain, while providing natural ventilation and daylight.

In addition to the photovoltaic power generation system, the building also implemented other energy-efficiency measures, including:

- A highly efficient heat source with thermal storage HVAC system;
- A natural air ventilation system; and
- An automated lighting system in the perimeter zone and high-efficiency, high-speed switching fluorescent lamps.

The building itself is a demonstration center showing the utilization of renewable energy in buildings. The power generated by the system and the CO_2 emissions avoided as a result are indicated in real time in the public gallery on the first floor of the city hall. Educational videos showing the importance of energy conservation and the possibilities for photovoltaic power generation, as well as the conservation efforts of Itoman, are also presented in the gallery.

Source: Kennichi Chikamiya, 2003, "BIPV Showcase: Itoman City Hall", Renewable Energy World, May-June; Atsuhito Oshima, Ministry of Land, Infrastructure and Transport, "Website of High-performance Buildings", Presentation for High-Performance Buildings and Developments project, Asia Pacific Partnership on Clean Development and Climate, see:http://www.asiapacificpartnership.org/BATF-HPBADUpdate.htm

Art Village Osaki Central Tower

Source: Ken Torii

The Art Village Osaki Central Tower was completed in December 2006 in Osaki, metropolitan Tokyo. It is a 22-story office tower with a total gross floor area of some 82,500 square meters. The building highlights some of the best green technologies available. The windows feature low-emissivity (low-e) double-glazed glass. The building's high-efficiency HVAC system reduces power consumption by using thermal storage systems, allowing for wide variation in tem-

perature settings, controlling the quantity for volume and flow, and using natural ventilation. The lighting systems automatically adjust in tandem with the window blinds to maximize the use of natural light. Intelligent elevators regulate their voltage and frequency according to real-time demand. This building won the Excellent Building Mark issued by the Institution for Building Environment and Energy Conservation (IBEC).

Source: Dylan Robertson, 2006, "Environmentally Friendly Office Buildings in Tokyo", J@pan Inc, No. 68, see: http://www.japaninc.com/mgz_summer_2006_green_building

Malaysia

Low-Energy Office Building (LEO)

Source: Ministry of Energy, Water and Communications, Malaysia

The LEO building is the first government building in Malaysia to be built with integrated energy-efficient design. Located in the recently built government complex of Putrajaya, the LEO building was designed as a showcase building to demonstrate energy-efficient and cost-effective features in Malaysia. The building exceeded its targeted energy savings of more than 50 percent compared to buildings without energy-efficient design. An energy analysis based on consumption monitoring results revealed that actual energy savings reached 58 percent.

The building was finished and occupied in 2004. It is a 6-story office building with a total gross floor area of 38,600 square meters.

The building uses a wide variety of design elements and innovative technology. The approach to the building's use is integrated. For example, a comprehensive procurement system requires the purchase of energy-efficient appliances.

Building orientation and envelope:

- The windows are primarily orientated to the north and the south, with less direct sunshine.

- In addition to their optimum orientation, the windows are protected by appropriate shading mechanisms to allow for maximum light to penetrate while minimizing the transfer of heat. Towards the east, shading is deeper to protect against the low morning sun. The western façade has virtually no windows. The window glazing allows 65 per cent of the available daylight in while keeping 49 per cent of the heat out.
- The thick, light-colored walls of the LEO building reduce solar heating of the walls and insulate 2.5 times better than a traditional brick wall.
- The roof of the building is insulated with 100 mm of insulation, compared with the typical 25 mm of insulation. A second canopy roof also protects the roof surface, preventing direct solar radiation. Along the perimeter of the roof, green landscaping provides shade and improves the aesthetics of the roof areas.

Natural Air Ventilation:

- In the LEO building, the four-story high atrium provides daylight deep into the heart of the building. At the top of the atrium is a solar wall, or "thermal flue", which naturally cools the air by a few degrees.

Interior Space Layout Design:

- Permanent working areas are concentrated along the perimeter where there is maximum daylight. Secondary functions, such as storerooms and smaller meeting rooms, are relegated to the interior, where there is only artificial lighting.

Air Conditioning:

- Air conditioning in the LEO building has been made efficient in three ways. First, the air conditioning is not controlled from one central point. Instead, it can be switched off in individual rooms.

- Second, the air conditioning is set to keep occupied areas in the building at 25 degrees Celsius. Computer modeling shows that if the room temperature is 20 degrees Celsius, rather than 24 degrees Celsius, total electricity consumption of the building increases by one-third due to the higher cooling load.
- Third, Putrajaya as a whole receives chilled water from a district cooling plant, which operates on natural gas and which pumps cold water through underground pipes to all the buildings in the area, reducing the need for individual electric air-conditioning chillers in the different ministerial and commercial buildings.

Innovative Lighting System

The building uses high-efficiency light fixtures that automatically switch off when there is sufficient daylight. Additionally, a motion detector automatically switches off the lights and air conditioning in a room once no physical motion is detected.

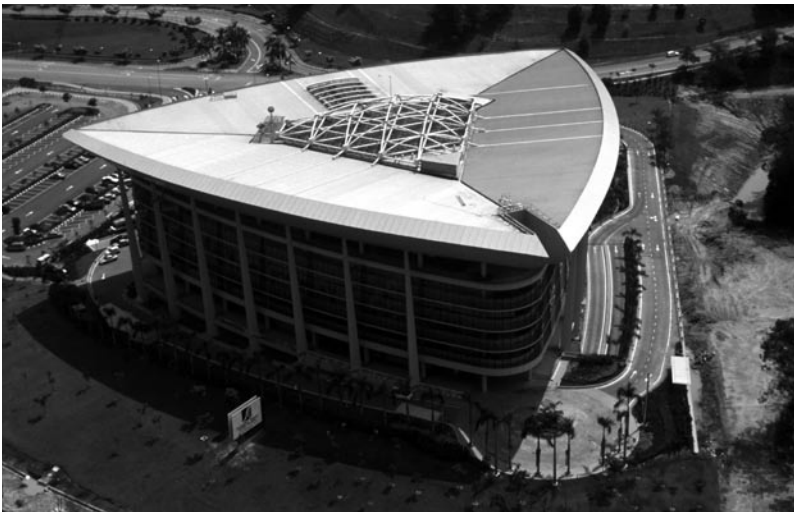
Mechanical Ventilation

In the LEO building, air intake rises with higher CO_2 levels which in turn are affected by occupancy—the more people there are in the building, the higher the CO_2 as a result of breathing, and therefore the greater the intake of fresh air. A high-quality filtration system improves indoor air quality.

The LEO building was awarded the ASEAN Energy Award in 2006.

Source: Malaysian Ministry of Energy, Water and Communications, see: http://www.ktak.gov.my/leo/index.asp

Securities Commission Building



Source: H. Linho / Aga Khan Trust for Culture

The Securities Commission of Malaysia, the ASEAN Energy Awards (2001) Winner, is housed in an eight-story office building with a total gross floor area of about 94,000 square meters. Built in 1998, the building's sustainable features include:

Landscaping

Landscape features include water and greenery. A moat that runs around the building allows natural light to illuminate the rooms below. Other landscape features are an irrigation system, decorative lighting, soil moisture meters and localized shading structures.

Roofing System

Overhanging roof structures provide shading from direct sunlight. A deep roof insulates the building from the sun's heat and houses the building services plant room, atrium and main corridors. Acting as an internal courtyard, the atrium allows natural daylight to filter through the glass roof. Daylight is maximized and energy consumption is greatly reduced.

Facade and Shading Design

The double-skin façade, with horizontal and vertical shading devices within two glass layers, achieves a high level of transparency for daylight and minimizes the impact of solar heat and glare. A ventilated air gap walkway, automatic blind control, louvers, and air exhaust vent are also features that reduce the amount of heat the building absorbs.

Air Conditioners

The building has an efficient air-conditioning system. The air handling units are double-skin and variable-speed-drive-controlled. Variable air volume and terminals ensure optimum control of air conditioning. The under-floor discharge flows in the same direction as the thermal lift and thus consumes less energy to cool the building.

Lighting Systems

Automated solar blinds, which are directed by photo sensors, are connected to the Building Automation System (BAS).

Management and Maintenance Scheme

A high degree of control, management and automation is built into the building. In addition to computerized systems designed to maximize energy efficiency, skilled staff are on site during working hours.

Environmental Impact Consideration

No CFC or ozone depletion refrigerants are used. The low-emissivity glass on the façade is not highly reflective. The double-skin facade and roof plant room act as a climatic buffer and reduce noise pollution from the surrounding highways.

Source: The ASEAN Energy Cooperation, see: http://www.aseanenergy.org/energy_sector/energy_efficiency/energy_efficiency.htm

Zanariah Library of the Universiti Teknologi Malaysia (UTM)

The Sultanah Zanariah Library of the UTM is a 4-floor building with a total gross floor area of about 22,500 square meters. During the period 1993-1997, the University implemented an energy-efficiency retrofit, including a lighting retrofit, air handling units retrofit and chiller load reduction.

Lighting

The building uses white light lamps with electronic ballasts and high-efficiency reflectors. The light level of the library was reduced where it was found to be too high.

Air Handling Unit

Work undertaken to reduce the flow rates and increase the efficiency of the HVAC system included:

- Replacing an old oversized motor with a new efficient one;
- Replacing an old oversized fan and motor pulleys with optimally designed ones;
- Aligning pulleys to reduce transmission losses;
- Electrical connection to motor and adjustment of over-load relay setting; and
- Control and monitoring.

After the retrofit, total savings amounted to 36.5 percent of the original load. The retrofit also improved the comfort level for users of the library. In 2001, this project was runner-up for an ASEAN Energy Award (Retrofitted Buildings).

Source: The ASEAN Energy Cooperation, see: http://www.aseanenergy.org/energy_sector/energy_efficiency/energy_efficiency.htm

Philippines

Makati Stock Exchange Building

Source: Ayala Corp.

The Makati Stock Exchange Building is an eight-story office building with a total leasable area of around 30,000 square meters. Owned by the Ayala Corporation, the building was built in 1971 and formerly served as the headquarters of both Ayala Corporation and Ayala Land, as well as of the Makati Stock Exchange.

Because the building was 25 years old when the retrofit began, upgrading its energy efficiency was a challenge. In addition, the 24-hour-a-day, seven-days-a-week operations of the building's largest tenant, Accenture, meant that any retrofitting work would have to be done in a low-impact manner. From 1996-2005, the building went through continuous energy-efficient improvements, including equip-

ment upgrades, introducing new technologies and implementing energy-saving projects. Savings generated by these improvements total around US$127,000 (or 941,000 kWh) per year. The building retrofit included the following measures.

Air Conditioning

- Replacement of the chiller units with more efficient ones.
- Installation of a condenser cleaning system. The system keeps chiller condenser tubes clean and thus increases efficiency.
- Replacement of cooling coils of all the Air Handling Units. This restored the cooling efficiency of the Air Handling Units to their designed efficiency.
- Installation of high-efficiency Air Handling Unit motors. To improve the efficiency of the Air Handling Units, all motors were replaced with high-efficiency units.
- Installation of Variable Frequency Drives (VFDs). VFDs were introduced in all condenser and chilled water pumps to improve efficiency.

Lifts

- All elevator units of the building were replaced with more efficient units.

Lighting

- Installation of energy-saving equipment for the lighting system. Voltage controllers for fluorescent lighting units were installed to help cut the electrical consumption of the common area lighting by reducing the input voltage once the lamps are turned on.
- De-lamping of parking level lighting. All parking levels with 2x40-watt fluorescent lamp fixtures were replaced with 1x40-watt fluorescent lamps and mirrorized reflectors. Individual switches were also provided so lights can easily be turned off at night time.

- Re-lamping of basement parking. The existing rapid-start ballasts were replaced with electronic ballasts.
- De-lamping of hallway lighting. The existing 4x40-watt lighting was reduced to 2x40-watt lighting.
- Re-lamping of fire exit stairs. The existing 50-watt incandescent bulbs used to light the fire exit stairs were converted to fixtures using 11-watt compact fluorescent lamps (CFLs).
- Calibration of kWh meter. All electric meters in both the tenant spaces and common area were calibrated.

Recently the building management system was also upgraded to effectively control and monitor the centralized air-conditioning system and ventilation equipment of the building. The building administration and staff have established an Energy Conservation Management Team to manage the schedule of all operating equipment within the building. In 2006, the building received the ASEAN Energy-Efficiency Award (Retrofit Category) (2nd Runner-Up).

Source: The ASEAN Energy Cooperation, see: http://www.aseanenergy.org and e-mail communication from the Office of the CEO, Ayala Corp., August 2007.

Singapore

Headquarters of Urban Redevelopment Authority

Source: Sengkang on Wikimedia Commons

The Urban Redevelopment Authority (URA) Centre, a runner-up for the 2001 ASEAN Energy Award, is the headquarters of the Urban Redevelopment Authority of Singapore. Built in 1999, the building has a 5-story podium and a 16-story office tower, with a total gross floor area of around 38,000 square meters. The podium and tower is connected by a 5-story glass atrium, which functions as an amenity centre. Energy-efficiency features of the building include:

- Integrated Building Design: As noted throughout this study, the most energy-efficient buildings start with integrated design. In this case, the building envelope includes low-emissivity (low-e) double glazed, light green glass windows. These reduce solar radiation and transmission without compromising visibility. The building's granite cladding exterior provides good insulation, while horizontal louvers, vertical fins and aluminum sunshades provide shade and reduce heat.
- Highly Efficient Mechanical & Electrical (M&E) Equipment: The lighting system uses highly efficient fluorescent lighting, which includes dimmable electronic ballasts. Motion detectors cut down

energy waste by shutting down systems when no one is present. The air-conditioning system is flexible. Variable speed drives regulate the supply of air flow of the air handling unit in accordance with load changes in order to save energy.

- Advanced elevator system: The building's elevator control system allows the passenger to select the desired floor at the lift lobby. Such a system provides fewer stoppages, shorter average waiting time and faster turn-around, thus lowering energy consumption.
- Management and Maintenance Scheme: An integrated Building Automation System (BAS) monitors and logs energy use and searches for trends. A work improvement team conceptualizes and implements energy-saving projects. A comprehensive computer-aided facility management system pre-determines and tracks all the required maintenance work. Staff members each receive 100 hours of training to ensure that they keep pace with the latest facility management knowledge and skills.

Source: The ASEAN Energy Cooperation, see: http://www.aseanenergy.org/energy_sector/energy_efficiency/energy_efficiency.htm

The Tresor

Source: Keppel Land

Keppel Land, a unit of the Keppel Group, has been incorporating systems that enhance energy efficiency in its residential projects. Environmental

protection features that ameliorate the greenhouse effect, ozone depletion and depletion of energy resources have become important standard features in its building designs. One example of Keppel's commitment to energy-efficient building design is The Tresor, a residential complex in the Bukit Timah area that consists of two 5-story building blocks with a total floor area of about 110,000 square feet (around 10,200 square meters).

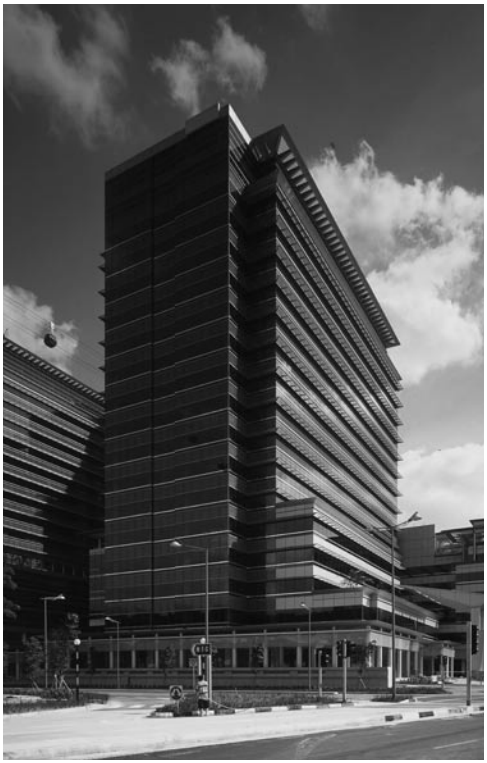
At The Tresor, the facade of the buildings is oriented to the north and south to minimize heat from the sun. The building has an energy-saving envelope that includes energy-conserving double-glazed low-emissivity glass that reduces cooling load, as well as energy-saving lighting, lift and air-conditioning system. Carbon monoxide sensors added to the car park exhaust fans allow fans to be automatically switched off whenever the carbon monoxide concentration is at safe levels. The cost for these sensors is around SGD$10,000 (around US$6,600), but about SGD$15,000 (around US$10,000) of energy cost be saved per year because of the sensors.

Other environmentally friendly design features include those for water efficiency, indoor environmental quality and outdoor environmental protection, such as adoption of solar-powered lights, electrical and water sub-metering and conservation of existing plants and trees. Care was also taken to minimize environmental impact during construction, such as noise, water and air pollution.

It is estimated that the project will save about SGD$36,000 (around US$ 24,000) per year in electricity costs. In 2006, The Tresor received the Green Mark Gold Award 2006 from the Building and Construction Authority in Singapore.

Source: E-mail interview with Lee Kia Young, Project Manager of The Tresor, Keppel Land, July 2007.

Keppel Bay Tower



Source: Keppel Land

Given rising energy prices, environmental degradation and improved managerial oversight, members of the Asia Business Council are interested in enhancing competitiveness of their companies through enhanced energy efficiency. Beginning in 2005 and continuing into 2006, the Council developed a program to assist member companies to improve energy efficiency by providing a free initial energy audit. In the program, the Council contracted with an energy service company and performed initial energy audits for 6 building or industrial facility projects for member companies in 2006, including the Keppel Bay Tower, a commercial office building also developed by the Keppel Group.

Located at Singapore's new waterfront business hub, Keppel Bay Tower is one of the twin towers of the HarbourFront Office Park and was finished and occupied in November 2002. This 18-story office building has a total lettable area of 394,745 square feet (around 36,680 square meters).

The energy audit highlighted several areas for increased energy efficiency and made recommendations for improvements. Based on

the findings of the audit, Keppel has been implementing the proposed efficiency upgrading measures since early 2007. As of July 2007, all proposed equipment and systems had been installed and were being fine-tuned. Systematic monitoring of savings will start in August 2007. Measures implemented include:

Optimization of chiller performance
Tuning of refrigerant pressure to ensure that chillers operate at optimum level.

Re-configuration of chilled water pumping strategy
Variable speed drives (VSD) for pumps and differential pressure sensors were installed to regulate the chilled water circulation.

Optimization of cooling towers operations
Variable speed drives were installed at cooling tower fans to regulate fan speed to achieve optimum condenser water temperature.

Demand-controlled car park ventilation system
Carbon monoxide and temperature sensors were installed at various locations in the car park.

Installation of S-Optimizer
This is an intelligent monitoring and control system for the items above. Additional temperature sensors and water flow sensors were installed at various locations in the systems. Power transducers were also used to monitor the electricity consumption of each piece of equipment.

Fine-tuning of the air handling unit
Site readings (temperature, pressure, airflow, humidity, etc.) were taken with calibrated instruments and compared with existing sensors. Inaccurate sensors were replaced and set points re-adjusted.

Reduction in car park lighting consumption

Twin-tube conventional light fittings were replaced with single high-efficiency lamp fittings using electronic ballasts. Reflectors were also fixed onto the fittings to maintain brightness.

The total cost of these measures was around SGD$300,000 (around US$200,000), with targeted savings of 14 percent in electricity consumption, or SGD$136,000 (around US$90,000) per year. The payback period is around 2.2 years.

Source: E-mail interview with Lim Tow Fok, General Manager, Property Management, Keppel Land International Limited, July 2007.

South Korea

The Kolon R&D Institute of Technology Building

Source: Kolon Group

The office building of the Kolon R & D Institute of Technology was completed in October 2004 in Yongin-Si, Gyeonggi-Do, Korea. Energy-efficient features of the building reduced its energy costs by more than 50 percent, compared to a typical building, and the building was awarded the top grade in the Korean system of green building certification.

The design maximized the efficiency of daylighting and natural ventilation.

Natural Ventilation

The building was designed to maximize the positive characteristics of the construction site. The siting of the building allows the prevailing

wind to pass between the north and south sides of the institute. A central atrium creates an upward draft for additional ventilation.

Solar Tube System

A solar tube system, which effectively pipes light into the interior of the building and is twice as cost-effective as alternatives, was installed on the third floor of the building—the first case in Korea to utilize such an indirect daylighting device.

Energy-Efficient Envelope Design

The environment-friendly, energy-saving envelope design of the building is the first of its kind in Korea. It has two layers, or a double skin, which dramatically increases its insulating properties. A study showed that the average temperature differential between areas with and without the double skin exceeded 3 degrees Celsius. The company also developed a number of installation procedures that resulted in a 75 percent cost savings compared to existing double-skin installations.

Geothermal Heat-Pump System

Despite Korea's harsh climate, the institute uses a geothermal heat-pump system as its only means of temperature control. Since completion of the building, system efficiency has been continuously monitored and the result is better than anticipated. A heat exchanger, developed with in-house technology, contributes to building temperature control. The system enables a 60 percent reduction in building maintenance costs compared to similar-sized buildings, is easy to operate, and provides a pleasant environment.

Photovoltaic System

An experimental photovoltaic system, one that Kolon calls the BIPV (Building Integrated Photovoltaic) scheme, functions as both an exterior structure and an electricity generator. Forty-five square meters of

glass-type solar cells have been installed on a southeast-facing vertical wall. The system produces 6 kW, which is enough electricity to light 120 fluorescent bulbs, so it has great potential for use as a building exterior finishing material. Kolon Engineering & Construction plans to distribute the system after further performance verification.

Rooftop Landscape and Biotope

Ordinary rooftop landscapes with shrubs planted in 80 cm of soil often create overweight situations that require larger frames, making them expensive to build and difficult to manage. Kolon R & D Institute of Technology's rooftop landscape uses only 20cm of soil and hardy, easy-to-care-for ground cover plants. This landscape not only provides a recreation space with a small eco-system, but also insulates the building to reduce cooling and heating energy requirements.

Source: Seong-jin Lee, 2006, "The Kolon R & D Institute of Technology", International Initiative for a Sustainable Built Environment, Advanced Building News 09, see: http://iisbe.org/ABNnews/ABN_09.pdf

Taiwan

Taipei Metro

Source: Far Eastern Group

The Taipei Metro complex, Taiwan's first hybrid development project, was developed by the Far Eastern Group. This complex consists of two 41-story twin towers and a 5-story basement, accommodating the group's headquarters, a five-star hotel and a shopping mall. Taipei Metro has incorporated a series of energy-efficiency measures in its building design, although this complex has never pursued any certification for its high energy performance. Its energy-efficiency features include:

Ice-Thermal Storage HVAC System

The building has an ice-thermal storage HVAC system that provides the flexibility to make ice in large silver tanks in the late night, when electricity demands are low and rates are much cheaper. The ice is melted during the day to cool the air. This system reduces peak demand, shifts energy usage to non-peak hours, saves energy, reduces energy costs, and reduce CO_2 emissions. Benefits of the system include:

- Installation at the same or lower first cost than traditional systems because of the use of smaller chillers and cooling towers, reduced pump and pipe sizes and less horsepower. These offset the cost of the ice thermal storage equipment.
- Lower peak electrical demand for the HVAC or process-cooling system by 50 percent or more, thus reducing strain on electrical grids.
- Substantial savings, as the charge for power during non-peak hours is lower during peak hours. In Taiwan, electricity charges during peak daytime are 3.4 times those during the night. Moreover, ice storage HVAC systems enjoy an extra 25 percent off regular rates in Taipei.
- Reduced greenhouse gas emissions. Electricity generated at night generally has a lower heat rate (lower fuel use per power output), and therefore lower greenhouse gas emissions. The California Energy Commission concluded that nighttime electricity production resulted in a 31 percent reduction in CO_2 emissions compared with daytime production.[74]

In the Taipei Metro, the total cost for the ice-thermal storage HVAC system was around TWD$100 million (more than US$3 million), while annual savings in electricity bill is around TWD$12 million (around US$365,000), with a payback period of less than 8.5 years.

Double-Glazed Curtain Wall

An energy-efficient, double-glazed curtain wall was installed for better heat and sound insulation. Energy savings because of the curtain were around 2-3 percent of total consumption, or around TWD$2-3 million (around US$61,000-91,000) per year.

Honeywell Auto-Control Monitor System

This auto-control system integrates and centralizes the various building systems (for example, the power supply system, plumbing system,

emergency generator and uninterruptible power supply system, HVAC system, lighting system, fire alarm and smoke exhaust system). The system is designed to optimize energy performance of the building. The cost for the auto-control system in Taipei Metro was around TWD$200 million (more than US$6 million), while the improved efficiency led to a reduction of 3-5 percent in annual energy consumption, or TWD$3-5 million (more than US$91,000-152,000) in the electricity bill per year.

Auto-Frequency Converters

Auto-frequency converters are used for converting power frequency, voltage and phase according to actual loading in order to avoid overloading power wastage. In Taipei Metro, the investment for converters amounted to around TWD$9 million (around US$274,000), while annual savings achieved were around 10-15 percent of total energy consumption, or around TWD$1.1-1.35 million (around US$33,000-41,000) per year.

High-Efficiency Lighting System

Fluorescent ballasts and light emitting diodes (LED) were used in the building.

Auto-Power Factor Correction Equipment

The building installed auto-power factor correction equipment to stabilize power factor to achieve higher efficiency. The costs for the equipment was around TWD$5 million (around US$152,000), and annual savings achieved was around TWD$300,000 (more than US$9,000).

These energy-efficiency measures have enabled Taipei Metro to achieve savings of around TWD$ 20 million (around US$ 610,000) in energy bills every year.

Source: E-mail interview with the Office of the Chairman, Far Eastern Group, July 2007.

Delta Electronics Complex

The Delta Electronics Complex was the first building in Taiwan to pass all nine benchmarks of the EEWH (ecology, environment, waste reduction, and health) system, the official green building rating system of Taiwan's Ministry of Interior. It received Taiwan's first "gold-rated" Green Building Certificate and was awarded "2006 Green Building of the Year" by the Ministry of Interior.

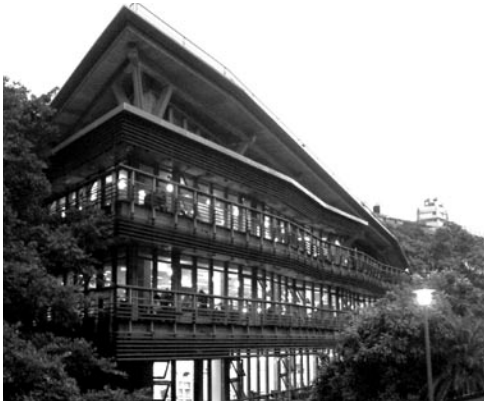
Situated on 1.89 hectares of land in the Tainan Science Park, the 12,800 square-meter building accommodates around 300 staff. It is built entirely using green building methods, and is intended for R&D, manufacturing and general office space—a mixed office-factory building.

The energy-efficient design of the building begins with its building envelope. The building's recessed openings are shaded to reduce direct solar heat gain, while the solar panels on the roof provide both an energy source and insulation. A roof garden also helps reduce heat gain. Inside the building, a well-ventilated high-ceilinged atrium provides both light and a refreshing effect. In the underground car park area, light wells on two sides allow sunshine to reach down and illuminate the otherwise dark space. Energy-saving lighting devices and high-efficiency HVAC systems are also used.

According to Delta, this building achieves up to 31 percent in energy savings, compared with average office buildings in Taiwan. Other benefits include an improved working environment for staff and enhanced corporate image.

Sources: Website of Delta Electronics Inc., see: http://www.deltaww.com/; Oscar Chung, "Greening the Gables", Taiwan Review, May 01 2007, see: http://taiwanreview.nat.gov.tw/

Beitou Library



Source: KaurJmeb on Wikimedia Commons

The Beitou Library is a two-story 1,990 square meter structure largely made of timber. It is a branch of the Taipei Public Library, and was formally opened to the public in November 2006.

The building incorporates a passive design approach to maximize daylighting and natural ventilation. Large French windows help cut electricity usage in two ways. An abundance of natural light for the interior means less lighting is required. The windows can be opened to provide ventilation, reducing the need for fans and air-conditioning.

One part of the roof is covered by photovoltaic cells that are expected to convert sunlight into at least US$1,000 worth of electricity per year. Another part is covered by plants and shrubs to provide thermal insulation. During Taipei's chilly winters, the garden cuts heat loss through the ceiling and thereby makes the interior more comfortable. In the summertime, the foliage blocks some of the heat of the sun.

Source: Steven Crook, "Green Buildings Paint Bright Future", Taiwan Journal, Vol. XXIV, No. 24, June 15 2007.

Thailand

Mike Shopping Mall

Mike Shopping Mall is the largest shopping mall in Pattaya, Thailand. It has nine floors and a basement, with a total gross floor area of around 42,000 square meters. It is a multi-function complex consisting of a department store, a shopping plaza and an office. Oriented towards a beach, the mall is a favorite shopping destination of both Thai and non-Thai tourists.

In 1996, Mike Shopping Mall was designated for an energy retrofit under the Energy Conservation and Promotion Act of Thailand. The Thai government provided technical guidance and financial assistance to complete the retrofit.

An energy service company (ESCO) conducted an energy audit for the mall. To eliminate the risks on investment, the services of the ESCO were engaged to deliver a level of guaranteed savings without compromising the building's design and comfort. If the projected savings fall short of a guaranteed amount, the ESCO pays the difference.

More than 20 energy-retrofitting measures have been implemented using both passive and active concepts. They range from no cost to low-cost to easy-to-do measures. An energy audit is conducted every six months to highlight further efficiency improvements.

The retrofit turned out to be successful. Energy savings are about 31 percent annually and investments were paid back in 1.3 years. The project also pioneered the promotion of a performance guarantee business concept between an ASEAN building owner and an ESCO. The concept is critical in convincing building owners to undertake an energy retrofit for a project that requires a significant amount of invest-

ment. The building won the ASEAN Energy Award for Retrofitted Buildings in 2001.

Source: The ASEAN Energy Cooperation, see: http://www.aseanenergy.org/energy_sector/energy_efficiency/energy_efficiency.htm