
centralplaza

# OVERALL ON-SITE DESIGN

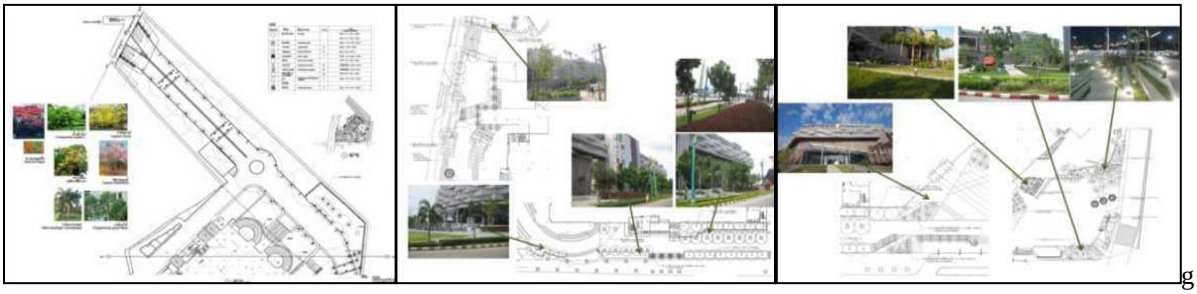
## The use of vegetation , landscape and hardscape:

The Central Plaza Khonkaen building was completed in 2009. It occupies around 45.35 % of the site area

- Total site area 71,761.3 $m^2$
- Building area (ground area) 32,546.3 $m^2$, accounted 45.35%
- Open spaces 39,215.0 $m^2$, accounted 54.65%

Large area of open spaces landscape of more than 54.65 % of site area is designed to give better outdoor ventilation. Various species of trees are plant on landscape around the building for giving shading to the surrounding outdoor ground in order to reduce heat reflectance to the building. Large tall trees are plant for giving shading to the building wall and landscape, controlling natural wind flow direction, giving better natural outdoor air quality and also increasing the urban green areas. People come to exercise and play sport in the evening.

Picture 1- various species of trees are plant around the buildin



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Picture 2- various species of trees are plant around the building

## The use of wind :

The building shape and orientation was designed by taking the direction of wind into consideration. Car park building is naturally ventilated by natural wind, so less fan ventilation

is operated for reducing heat in parking area. Tree layout is also be used to control the wind flow for reducing the building wall temperature and outdoor ambient temperature.

## The use of natural daylight :

Many areas were designed to take day lighting to be used, e.g. corridor, atrium hall, parking area, rest room, etc. Daylight through large skylight glaze on the atrium hall roof help reducing electricity used in artificial light consumption to be operated only at evening and night.

Picture 3– show the use of daylight in sub area, rest room, atrium hall

## The use of night sky radiation:

The outdoor lighting was installed with LED lamps in order to save energy comparing to energy consumed floodlight. Less lighting distance of light from LED can also reduce light pollution in order to keep the view of a star-lit sky. The visibility of night stars is still possible. The LED lamps are computer controlled and programmable to vary light color and be shut down on schedule time.


Picture 4 - night light illuminance of the building with LED lamps

# ACTIVE DESIGN

## High Efficient Chiller in Air-conditioning system :

The building has been installed with high efficiency chillers which efficient COP better than the Thai law regulation. The refrigerant is an ozone friendly type with lower greenhouse gas effect. The tubes are also automatically clean with ball cleaning systems and uses low-flow low-temperature technology, controlled through a CPM (Chiller Plant Management) computer controlled system and monitored in real-time, with the ability to refer to past operational data such as set-point adjustments, chiller flow tests of each operation, and water temperatures in the heat ventilation. Besides the chiller, other equipment such as the chilled water pump (CHP), condensate water pump (CDP) and cooling tower (CT) can also be efficiently controlled and monitored systematically.

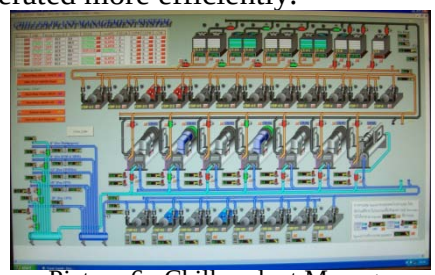
Additionally, sensors detecting refrigerant leakage are installed along with the installation. All motors used are high efficiency motor type. The cooling towers are placed in good location for convenience in maintenance, good place for bringing the fresh air into the building and no effect to adjacent areas. The location of the air intake pipe is not in a position near any pollution or heat source. The fresh air intake rate is well regulated according to the indoor air quality standard. For energy saving, the intake fresh air is circulated through the air-to-air heat exchanger.

Table 1 – Capacity of Chiller installed in the building

| System | Equipment | Capacity | | Unit | Efficiency | |
|---|---|---|---|---|---|---|
| | | Size | Unit | | Value | Unit |
| Air-conditioning system | Chiller | 1,000 | Ton | 4 | 0.616 | kW/TR |
| | | 500 | Ton | 2 | 0.641 | kW/TR |
| | | 250 | Ton | 1 | 0.645 | kW/TR |

Picture 5 – High Efficiency Chiller plant

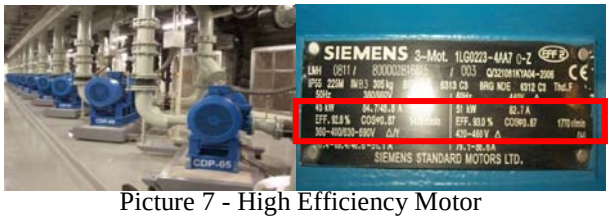
The Chiller Plant Manager System is controlled by the Building Automation System (BAS). It makes the chiller plant to be operated more efficiently.



Picture 6 –Chiller plant Manage

## HEM Water Pumps

All installed water pumps are high efficiency motors.




Picture 7 - High Efficiency Motor

## Cooling Tower

The cooling towers are cross flow type, which have good effective heat exchange. The amount of water loss is low. The cooling towers are placed in good location for convenience in maintenance, good place for bringing the fresh air into the building and no effect to adjacent areas. The location of the air intake pipe is not in a position near any pollution or heat source.

Picture 8 – Cooling Tower and working area

## The air handling fan motor are controlled via VSD (Variable Speed Drive)

Motors in AHU system are closed loop control via VSD in order to control temperature, humidity and indoor air quality at appropriate levels, set through an IBMS (Intelligent Building Management System) for ease of management , energy saving and IAQ comfort of appropriately adjustment to different climates and weather seasons.

Picture 9 –VSD control the AHU motors

## Lighting systems:

There are separate lighting control systems in separate area section for saving energy. Each sub area can be individual controlled. Motion sensors are installed to dim lighting in some restrooms or shut down lighting in some stores. Ceiling and floor material are selected with high light reflectance. All luminaire are considered to be high efficient luminaire with high luminaire efficiency. Luminaires with energy saving No.5 label are preferable. All lamps are considered to be only energy saving types, e.g. compact fluorescent lamps with electronic ballasts are used instead of old incandescent lamp type. High efficient HID lamp, e.g. metal halide lamps are used instead of old spot light type. Lighting is control, 0-100% dimming and switching on-off, via lighting computer controlled system.

Picture 10 - Compact fluorescent lamp downlight with high luminaire efficiency and controlled with electronic ballast

## Energy Consumption in Lighting System

**Lighting fixtures**

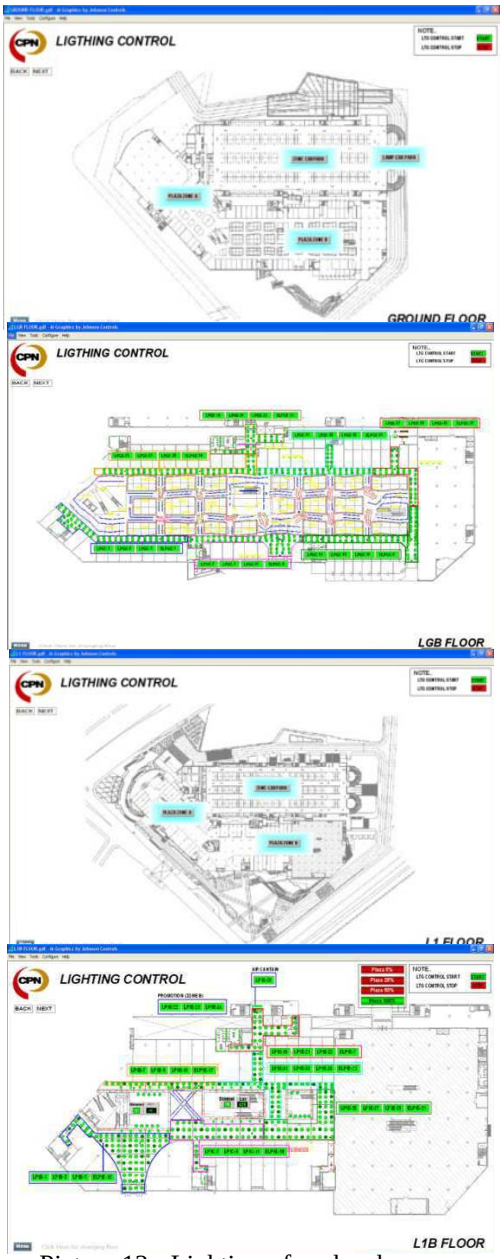
**13.30 W/m$^2$ (for gross area)**

**Lighting load**

**13.30 W/m$^2$ (for working area)**

Picture 11 – computer controlling lighting in each sub area, Place where is enough daylight the dimable electronic ballast will be automatically dimmed via daylight sensor control.

- There are separate lighting control for each zone area.




Picture 12 - Lighting of each sub areas are electronically controlled via computer system For maximizing energy saving.

- 29.10 % of main area were designed to receive natural daylight

Picture 13 : Atrium , walkway, corridor , rest room , etc are designed to receive daylight

## Indoor air quality:

Many Carbon dioxide sensors are installed in various distributed location. For good indoor air quality according to ASHRAE standards, fresh air intake from the outside of the building is regulated to ensure good air quality in the building.

Picture 14 – Fresh air intake

## Other systems:

- **Air-to-air heat exchanger**

Picture 15 - Wheel air-to-air heat exchangers are installed.

- **Air Intake Pipe location of the building**

The location of the air intake pipe is not in a position near any pollution or heat source.

Picture 16 – Location of the Air Intake Pipe of the building

- **The use of water saving toilets and faucets**

High technology faucets installed to work via controlling by motion detection sensors. Water will flow if a hand is moved near the sensor. Water flow will automatically stops when there is no hand movement in order to save water. No faucet touch is necessary means no bacteria contact. It will make users more hygienically convenience.

Picture 17 - water saving toilets and faucets

- **Water Pump**

All water pumps are equipped with high efficiency motors

Picture 18 - High Efficiency Motor

- **Water Usage and Leakage Monitoring**

Many water meters are distribute installed in main water pipe and various water equipment, e.g. cooling tower, in order to monitoring water usage and water leakage.

Picture 19 - water meters are installed in various places ,e.g main section pipe, cooling tower

- **The water storage system**

On the roof, rain fall water is collected and stored for being used in the building (restroom, gardening).

Picture 20- water storage tank

- **The waste water treatment system**

Picture 21 - the waste water treatment ponds, grease traps and trap debris

- **The waste water recycling system**

Picture 22 - the waste water recycling system

**Overall Energy Consumption:** 132.44 kWh/$m^2$-year (Air - conditioning area)

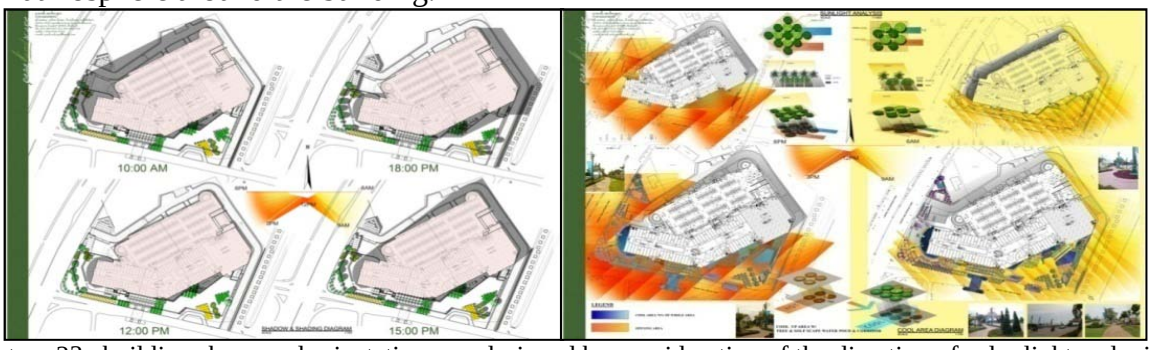
# PASSIVE DESIGN

## Orientation and building design:

### The orientation of building

The building shape and orientation was design by taking the direction of wind and solar into consideration. Wall areas on the East and West side were reduced into small area walls in order to reduce to solar heat gain into the building. Skylight roof was placed on roof for receiving daylight.Window were placed on the North and South for receiving natural daylight. Some kind of trees were designed to be planted in places where shading can reduce heat transfer to the building wall. Tree layout is also be used to control the wind flow for reducing the building wall and outdoor floor temperature.

The solid paving surrounding the building may absorb 50% of solar heat from the sun light and 40% is reflected to the surrounding building. So tree shading to outdoor solid paving can reduce heat absorbing from the solar radiation. It is also reduce heat reflection to the building. That can reduce heat radiation and the ambient temperature of the atmosphere around the building.




Picture 23– building shape and orientation was designed by consideration of the direction of solar light and wind

### The shape of building wall

Building wall was constructed from autoclaved aerated concrete (AAC) which can reduce heat entering into the building. Outdoor paint is in light color with high thermal reflectance.

Building roof was constructed from metal sheet. Roof color is selected in light color with high thermal reflectance. The metal sheet is also attached with thermal insulation made from Polyethylene foam sheet (10mm sheet thickness) and aluminum foil. Some area of the inside roof was sprayed with insulation foam in order to reduce heat transfer from the roof into the building.

Picture 24 - walls and roof of the building

Total heat transfer of the building (see attached calculations):

OTTV value = 30.78 W/m $^2$
RTTV value = 4.52 W/m$^2$

Picture 25– 4 side views of the building

## The location of service core

Smart control lift and energy saving escalator were located in the central atrium. The lift controlling computer will command the nearest lift car to meet the caller. When there is no usage, lighting and fan ventilation in the lift will be shut off after the set period. The energy saving escalator will automatically stop for saving energy in case of no walker moving near the escalator motion sensor (located near the floor of the first step). Walking route for the shoppers is design for convenience in walking.

## The position of entrances

The building has entrance and vehicle entrance are located on the ground floor the vehicle entrances have direct access to , and are close to, the parking areas. Double doors are installed in passenger walking doors in order to prevent cooled air leakage through opening door. Clear PVC strip curtains are installed in store doors. Air curtains are also installed in frozen or food store area.

## Envelope design:

The designs of the roof of the building are installed with light color, high heat reflectance metal sheet. The metal sheet is also attached with thermal insulation. Some area of the inside roof was sprayed with insulation foam in order to reduce heat transfer from the roof into the building. The result is low heat transfer and lower heat load of the air conditioning system. Walls are built with autoclaved aerated concrete (AAC).

Picture 26– wall and roof

Picture 28 – Rooftop and building view from sky

**Total heat transfer of the building (see attached calculations)**

OTTV value = 30.78 W/m $^2$
RTTV value = 4.52 W/m$^2$

## Daylighting

Many area were designed to take day lighting to be used, e.g. corridor, atrium hall, parking area, rest room, etc.

Areas where day lighting was designed to be used with artificial light, lighting sensors were installed in order to automatically controlling the illuminance light level. If there is enough daylight, then the artificial light will be automatically dimmed or switched off.

- The main area : 29.1 percent can receive daylight
- The sub area : more than 20 percent can receive daylight ( some are rent area )

Lighting luminaire are electronically controlled via electronic ballasts, drivers. General lamps used are fluorescent lamps, compact fluorescent lamps, and LED (light emitting diode) lamps.

Picture 29 – show the use of daylight in sub area, rest room, atrium hall

## Natural ventilation.

Orientation of the building and car park area were designed to facing the South. The South wind can naturally flow through building and car park area for natural ventilation. Car park building is designed to get benefit of natural ventilation without necessary to operate electrical fan cooling.

## The other design concept

The unique outdoor structure in shape of ***"Keankadeeb"*** (Thai local sticky rice container) is an innovative design of heat shading to the building. The outdoor lighting were installed with LED lamp in order to save energy at night comparing to energy consumed floodlight. The LED lamp can also been programmed to vary light color.


Picture 30– outdoor LED lighting system and be color changed at night.

# MAINTENANCE AND MANAGEMENT

## Energy management systems :

The Building's Energy management systems are in compliance with Thai regulations and practices. Action and activities related to each process are shown in the table below.

Table: The status of implementation of Energy Management System complying with Thai regulation

| Process | Action/Result |
|---|---|
| 1. Appoint energy management committees | Appoint according to the order dated March 2011 |
| 2. Assess the preliminary status of energy management system | Evaluated all of department |
| 3. Establish the energy conservation policy | The energy policy has been publicly announced |
| 4. Review the potential of energy conservation | Completed |
| 5. Set up energy conservation targets and plan as well as training program and related energy conservation promotion campaigns | Completed |
| 6. Implement, evaluated and analyze plans and activities set on item 5 | Completed, energy conservation promotion campaigns through tenants' participation. |
| 7. Monitor and evaluate energy management | An energy Internal auditors have been set up. |
| 8. Analyze the results and implement the corrective action of the energy conservation management | Conducted in February 2012 |

- **Energy Policy**

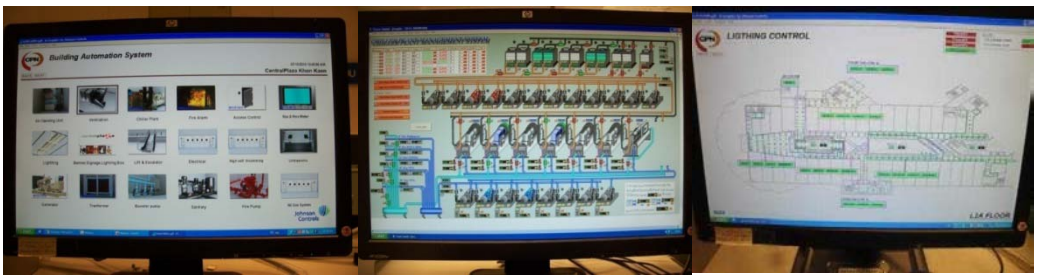
The management announced energy conservation policy, appointed a team responsible for energy conservation and approved target and plans.

Picture 31 – Announced Policy and Order establishing a team responsible for energy management

Picture 32– Energy Management Team Organization chart

- **Building Automation System**

The building engineering system was designed to be controlled via the efficient BAS (Building Automation System) , e.g. lighting system, air conditioning system , etc. The system show effective result in the past building management.




Picture 33 - Building Automation System

Each lighting and air conditioning area zone were separately monitored and controlled via BAS system.

Picture 34 – energy meters monitoring energy consumption in lighting and air conditioning in various zones

## Maintenance and management measures:

The management appointed a team responsible for maintenance system in the building. The team takes responsible for various aspects and have regular monthly meeting for taking care of electrical power systems, communication systems, air conditioning systems, sanitary system, waste water treatment plant, fire alarm and suppression systems, security alarm and CCTV systems. Energy Conservation Plan was set, conducted and monitored regularly.

- Manpower: 34 officer , working everyday 365 days/yr, 8,760 hr/yr
- Availability of energy management engineers 2 engineers
- Training of maintenance workers: 144 cumulative hours/yr.

## Other

### Training programs

Various energy training courses and activities were conducted regularly.

Table – Sample of Energy Training and Activities program conducted in 2011

| No. | Training /Activity | Target/Trainee | Responsible Person |
|---|---|---|---|
| 1. | Energy Law & energy management systems. | Energy conservation team | Mr. Pratcha Plangkanta |
| 2. | Guidelines for the assessment of enterprise energy management systems. | Energy Auditors | Auditor Team |
| 3. | Energy conservation mind | All working Staffs | Mr. Pratcha Plangkanta |
| 4. | Energy Day | All working Staffs | Energy conservation team |
| 5. | Conservation motivation via Short movie | All working Staffs | Energy conservation team |
| 6. | energy conservation slogan contest | All working Staffs | Energy conservation team |
| 7. | energy conservation logo contest | All working Staffs | Energy conservation team |
| 8. | Energy conservation Campaign to the customer shops | Shop Customers | Energy conservation team |

- Energy conservation campaigns

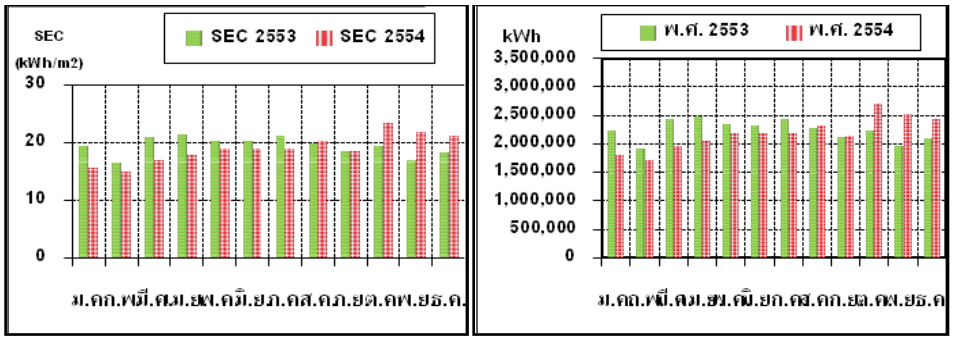
  Various energy activities were conducted according to the energy conservation plan, e.g. Energy Day, short energy movie, slogan and logo contests .


Picture 35 – Activities on Energy Day

## Specific Energy Consumption (SEC)

Many SEC values are regularly monthly monitored, e.g.

| SEC [ Specific Energy Consumption ] | |
|---|---|
| SEC 1 [No include parking area] | Energy Usage in whole building (kWh) / Whole building area ) include air conditioning and no air conditioning area ) ($m^2$) |
| SEC 2 [No include rented area] | Energy Usage in whole building – Energy Usage in Rented area (kWh) / Whole building area – rented area )($m^2$) |
| SEC 3 ( A/C system ) | Energy Usage in air conditioning system (kWh) / Air conditioning area )($m^2$) |
| SEC 4 ( common area ) | Energy Usage in common area (kWh) / Common area) ($m^2$) |




Picture 36 – Energy statistics is regularly monitored in plotted in SEC Chart

System Maintenance manual handbooks have been developed , covering important topics, e.g. energy saving, IAQ, emergency lighting, waste treatment system maintenance, etc.


Picture 37 – many energy measures and activities are implement , including developing Usage and Maintenance manual for sustainable working standard in the future

# ENVIRONMENTAL IMPACTS

## Waste management:

Wastes produced in the building are classified by separate waste bins. Wastes of paper, plastic, glass, metal can are separated for being sold to be recycled material. It can reduce the waste amount to be collected by the city and reduce the waste to be buried or burned and also reduce the waste smell.

Picture 38 – separate segregation waste room

## Reduction the pollution (air, noise, water) impact:

Air circulation fans and air purifiers were installed in some area , e.g. restroom, kitchen, food court etc.

## Green/Non – toxic materials:

The building was constructed with eco concept. The concrete parts were molded with reused metal mold. The wooden part were used with reused part , if it is possible. All the material used and decorated with eco-marked logo are priority preferred .

For example, paint used in the building was selected with eco-friendly type, TOA brand in model of shield-1 type, with no mixture of lead or mercury. The paint is also certified to get the green eco-label marked from TISI standard institute.

## Other

During the construction, many shielding material were placed in order to protect the dust, noise or waste to disturbed the surrounding area for safety of the people.

Picture 40 - wall around the construction area during the construction.

- Green mesh is installed for preventing debris and dust from construction areas.

Picture 41- Use of green mesh to prevent fall of material and dust pollution

- Plants were designed to increase green area as much as possible, e.g. on the roof or vertical wall of the car park area

Picture 42 – plant on vertical wall of the building

# BUILDING INFORMATION

## 1. General Information

Building name: Central Plaza Khonkaen
Company name: Central Pattana Public Company Limited
Address: 99/1 Srichan Road, Naimeang, Khonkaen, Khonkaen 11120
Telephone: (6643) 001-0000
Fax: (6643) 001-209
E-mail : buamonrat@cpn.co.th

## 2. Building Physical Information

**History:** Central Plaza Khonkaen shopping center in located in Khonkaen province which is the second largest province in the Northeast of Thailand. The building located at the mettarprab-srichan intersection, near Khonkaen city gate. The fallow land used to be an ex-rice mill. The Construction was finished at the end of 2009. And the building was opened on December 3, 2009.

Picture 43- Land prior to construction


The building Won the Thailand Green Building Label Award in 2011

| | | |
|---|---|---|
| Building age: | 2 | years |
| Number of floors: | 6 | floors |
| Number of floors below ground: | 1 | floor |
| Parking area: | 6 | floors |
| Total gross floor area: | 224,481.71 | $m^2$ |

Surface area of the envelope including the roof to gross floor area ratio: 1:4.9

| | | |
|---|---|---|
| Car park area | 80,608.17 | $m^2$ |
| Gross Table Area | 143,873.54 | $m^2$ |
| Air-conditioned area | 119,594.67 | $m^2$ |
| Non-air conditioned area | 24,278.87 | $m^2$ |

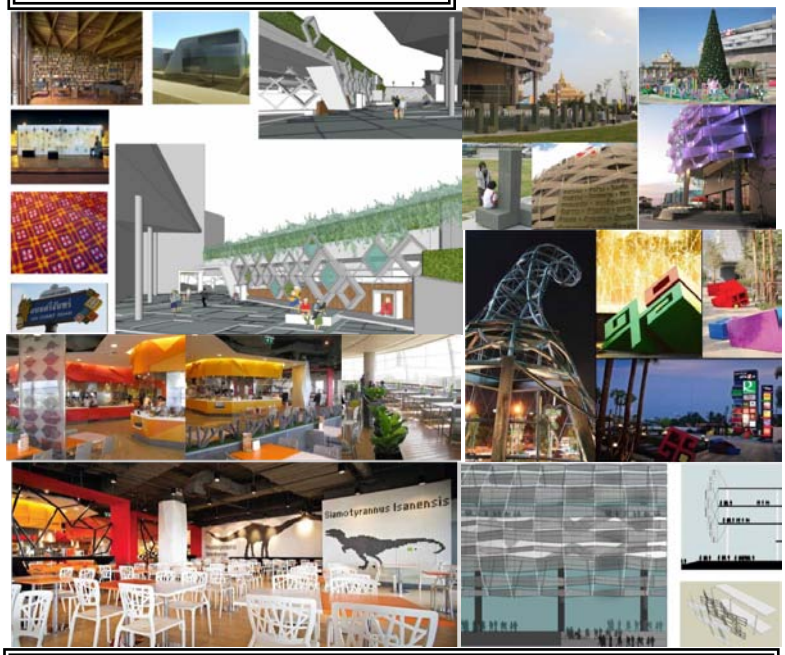
Plot ratio (total GFA / ground area): 1:2.29

## 3. Building Design Information

CentralPlaza Khonkaen building was designed with the blend of the beauty and the Thai cultural stylist art. The team of famous architects designed the unique outdoor structure in shape of “Keankadeeb” (Thai local sticky rice container) in height of 30 meters and 138 meters in length. The Keankadeeb structure is also the sun light shading for the building wall. The interior is also furnished with modern design of the inspiration of the Northeast Thai cultural style. Surrounding landscape is decorated with trees and dinosaurs

Picture 44 - Large front yard, wide open spaces supporting variety activities promoting a sense of elegance to the Khonkaen city gate.

Picture 45 - Many trees are plant surrounding the building , harmonizing with areas for various outdoor activities.



Picture 46 - Outdoor architecture of the building is installed with solar shading in shape of “Keankadeeb” (Thai local sticky rice container)

- Indoor area near window is lighted by natural daylight. Interior was decorated with Thai woven in pattern of the Northeast style for reflection of local idenity.

## Facade and shading design

The designs of the roof of the building are installed with light color, high heat reflectance metal sheet. The metal sheet is also attached with thermal insulation. Some area of the inside roof was sprayed with insulation foam in order to reduce heat transfer from the roof into the building. The result is low heat transfer and lower heat load of the air conditioning system. Walls are built with autoclaved aerated concrete (AAC).

Picture 47 - Wall and Roof

## Central Atrium

Smart control lift and energy saving escalator were located in the central atrium. The computer controlled lift will command the nearest lift car to meet the caller. The energy saving escalator will automatically stop for saving energy in case of no walker moving near the escalator motion sensor nearing the floor of the first step. Walking route for the shoppers is design for convenience in walking.

### Overall Heat Transfer through Building envelope

Overall Thermal Transfer Value) OTTV) : 30.78 $W/m^2$
Roof thermal transfer value )RTTV) : 4.52 $W/m^2$

### Lighting System

Lighting fixtures 13.30 $W/m^2$ (for gross area)
Lighting load 13.30 $W/m^2$ (for working area)

### Building air - conditioner system and equipment

Type of air - conditioner system : Centralized Water-Cooled Air-Conditioning System
Fresh air exchange rate : 1.84 $m^3/hr.m^2$
Energy Efficiency of air - conditioning chiller :
- 4 Chillers with capacity of 1,000 Tons each. 0.616 kW/TR (COP = 6.39)
- 2 Chillers with capacity of 500 Tons each. 0.641 kW/TR (COP = 6.25)
- 1 Chiller with capacity of 250 Tons each. 0.645 kW/TR (COP = 5.93)

Total cooling load 154.39 $W/m^2$ (air-conditioned area only)

## 4. Operation Information (for the past 12 months)

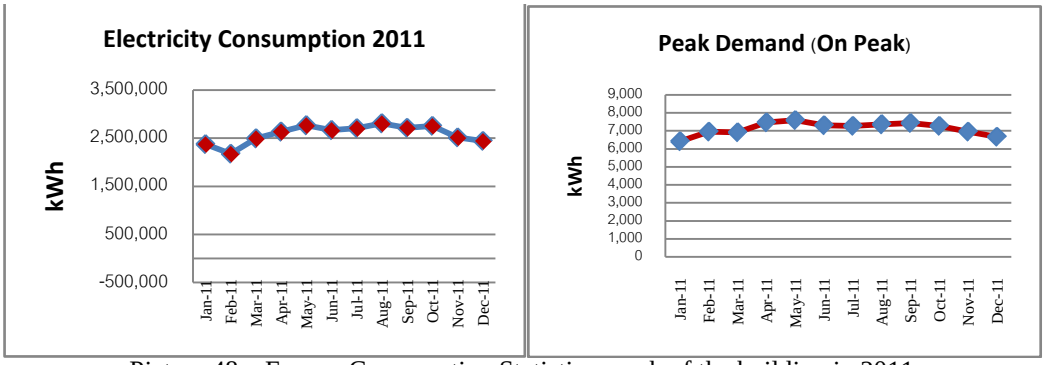
Area Occupancy rate : 100%
Number of users (customers) : approx. average 27,500 persons/day
Ownership of building : Central Pattana Public Company Limited
Shopping Mall operating hours
Monday – Friday (248 days/year) : 10:30 – 21:00 (10.5 hours/day)
Saturday – Sunday (117 days/year) : 10:00 – 21:00 (11.0 hours/day)
Total operating hours per year : 3,923 hours/year
Building indoor environment : Indoor air quality setting
Temperature : 25° C
Relative humidity (RH) : 60 - 70 %

## 5. Energy Consumption Information (for the past 12 months)

Electricity Consumption

| | | | |
|---|---|---|---|
| Peak Demand over the course of one year | : | 7,960.00 | kW |
| Total electricity consumption | : | 31,068,640.00 | kWh/year |
| Average monthly electricity consumption | : | 2,589,053.33 | kWh/month |

Energy efficiency index : 132.44 kWh/$m^2$-yr (air-conditioned area)
: 110.09 kWh/$m^2$-yr (all usable area) (Energy Consumption)
(Based on 2,000 operating hours/year)




Picture 48 – Energy Consumption Statistics graph of the building in 2011

## 6. Energy Management Information

| Energy Saving Measure | Year | | energy saving per year | | | | | Investment (Baht) | Pay back Period (Year) |
|---|---|---|---|---|---|---|---|---|---|
| | start | finish | Electricity | | | Fuel (Specify type) | | | |
| | | | kWh | (kW) | (Baht) | volume | (Baht) | | |
| Group 1 : measures with low investment | | | | | | | | | |
| - Controlling On-Off time of lighting | Jan 2011 | Dec 2011 | 195,205.65 | - | 659,795.10 | - | - | - | - |
| - Controlling operating hours of air conditioning chiller | Jan 2011 | Dec 2011 | 2,301,690.00 | - | 7,779,712.20 | - | - | - | - |
| - Commissioning and Controlling operating of air handling system | Jan 2011 | Dec 2011 | 472,426.80 | - | 1,596,802.58 | - | - | - | - |
| - Controlling air intake and exhaust system | Jan 2011 | Dec 2011 | 815,702.00 | - | 2,757,072.76 | - | - | - | - |
| Summary of Group 1 | - | - | 3,785,024.45 | - | 12,793,382.64 | - | - | - | - |
| Group 2 : measure with high investment | - | - | - | - | - | - | - | - | - |
| **Total 2 groups** | - | - | 3,785,024.45 | - | 12,793,382.64 | - | - | - | - |

## 7. Maintenance Information

- Manpower: 34 staffs , working 365 days/yr 8,760 hr/yr
- Availability of energy management engineers 2 engineers
- Training of maintenance staffs: 144 cumulative hours/yr.

## 8. Environmental Impact

- Impacts of waste : Waste management (garbage)
- Impacts of pollution: Air, noise, odor
- Other : Use of equipment and materials from non-toxic