Building and Construction Authority



Programme

11th October 2002

08:30 am	Registration
09:00 am	Arrival of Guests
09:15 am	**Exemplary Energy Efficient Building - Shangri-La Hotel** by Mr. Harold Lee, Regional Director of Engineering
09:45 am	**Exemplary Energy Efficient Building - Alexandra Hospital** by Mr. Steward Tai, Manager
10:15 am	Refreshment
10:45 am	**Exemplary Energy Efficient Building - Ministry of Education** by Mr. Lawrence Khoo, Assistance Director
11:15 am	**Announcement on the Energy Efficient Building Awards 2003**
11:30 am	**Energy Efficiency: A Holistic Approach** by Mdm. Grace Wong, Industry Committee for Energy Efficiency (ICEE)
12:00 am	**Questions & Answers Session**
12:30 pm	End

Building and Construction Authority

Energy Efficient Building Awards 2003

Background

The purpose of the Energy Efficient Building Awards (EEBA) is to promote energy efficiency in buildings and to accord recognition to building owners, architects, engineers, energy consultants and energy service companies who have integrated energy efficiency into their building design, operation and maintenance.

Award Categories

The award is open to all buildings. Building owners can participate in any one of the four categories, namely:

- NEW & EXISTING BUILDING CATEGORY
  Air-conditioned building of less than 5 years old can participate under this category provided no major improvements have been made.

- RETROFITTED BUILDING CATEGORY
  This category is for air-conditioned buildings where major changes and improvements have already been introduced to improve energy efficiency.

- TROPICAL BUILDING CATEGORY
  This newly introduced category is for buildings with not more than 50% of its total gross floor area being air-conditioned and that they are not religious buildings. The primary focus is on its passive design.

- SPECIAL FEATURES CATEGORY
  The special features category is to recognise projects in buildings where innovative or advanced technologies are studied and applied and/or where special measures are implemented to enhance energy efficiency.

Assessment Panel

All entries will be judged by an Assessment Panel comprising of senior representatives from the following organizations:

- Association of Consulting Engineers Singapore
- Building and Construction Authority
- Energy Market Authority
- Institution of Engineers, Singapore
- National Environment Agency
- National University of Singapore
- Real Estate Developers' Association of Singapore
- Singapore Environment Council
- Singapore Institute of Architects

Assessment Criteria

Entries will be assessed based on the following criteria:

For New & Existing Building Category

1.	On-Site Natural Environment Considerations (e.g. use of vegetation, landscape, hardscape, water body and wind)	(15%)
2.	Passive Design Concepts (e.g. building orientation and design, envelope design, daylighting and natural ventilation)	(25%)
3.	Active Design Concepts (e.g. air-conditioning, lighting, building automation and energy recovery)	(25%)
4.	Management and Maintenance Scheme (e.g. energy management system and maintenance programme)	(25%)
5.	Environmental Impact Consideration (e.g. waste management and pollution management)	(10%)

For Retrofitted Building Category

1.	Actual / Measured Energy Savings	(25%)
2.	Passive Design Concepts	(25%)
3.	Active Design Concepts	(25%)
4.	Management and Maintenance Scheme	(20%)
5.	Environmental Impact Consideration	(5%)

For Tropical Building Category

1.	On-Site Natural Environment Considerations	(20%)
2.	Passive Design Concepts	(40%)
3.	Active Design Concepts	(15%)
4.	Maintenance & Management Scheme	(15%)
5.	Environment Impacts Consideration	(10%)

The decision of the Assessment Panel shall be final and the panel has absolute discretion to make or withhold an award. The Assessment Panel may also re-categorise any entry, which in their opinion, fits better in another category.

Eligibility

The EEBA is opened to all buildings in Singapore that meet the following pre-qualification criteria:

1. Energy Efficiency Index
   - <250 kWh/m^2/year based on Air conditioned area (for All Categories, excl. Tropical Building Category)
   - < 150 kWh/m^2/year based on Gross Floor area (for Tropical Building Category)

2. A/C Temperature and Other Settings
   - Between 23°C and 25°C
   - Relative humidity between 55% to 65%

3. Lighting Load
   - Maximum 25 W/m^2 (gross floor area) for other buildings
   - Maximum 15 W/m^2 (gross floor area) for office buildings

4. Occupancy Rate (average over the last 12 months)
   - Minimum 60% of total units for hotels
   - Minimum 80% of total area for other buildings

5. Operating hours/yr.: To be based on 2000 hours/year

6. At least 1 full-year of operation

7. Additional Criterion for Retrofitted Building Category
   - Total energy savings of at least 15% after retrofitting

8. Additional Criteria for Tropical Building Category
   - A/C area shall not exceed 50% of its total gross floor area
   - Total gross floor area shall not be less than 500m^2
   - Not religious building

9. Additional Criterion for New & Existing Building Category and Tropical Building Category
   - Building shall not be more than 5 years old

Trophies, Plaques & Certificates

Building owner of the top entry in each category will receive a trophy. The first and second runners-up will receive plaques. Project consultants will be presented certificates of recognition. Trophies, plaques and certificates will be presented at the BCA Awards Ceremony 2003.

ASEAN Awards

EEBA winners will also have the honour of representing Singapore at the ASEAN Building Energy Efficiency Best Practices Award (ASEAN Award) in 2003

Entry Form and Write-Up

Entries for the awards shall be submitted using the attached prescribed form, which are also available from BCA-NUS energy website at **www.bdg.nus.edu.sg/buildingenergy**. A following write-up of the energy efficient features is also required. The entry form and write-up must reach BCA **not later than 5pm on 20th Dec 2002**. *Type of font and size: Times Roman 12*

For New & Existing Building Category and Retrofitted Building Category
(For guidelines of the write-up please refer to Appendix)

1. Cover of report:	1 page
2. Overall on-site design: *(For **Retrofitted Bldg Category** will be **Total Energy Saving** instead of **Overall On-Site Design**)*	2 pages
3. Active design write-up **(up to 4 features)**	4 pages
4. Passive design write-up **(up to 4 features)**	4 pages
5. Maintenance & management write-up **(up to 4 features)**	4 pages
6. Environmental impacts:	1 page
7. Drawings (in A4 / A3 size): (Typical floor plan, site layout, roof plan and vertical cross section)	4 pages
Total:	20 pages (Max)

For Tropical Building Category
(For guidelines of the write-up please refer to Appendix)

1. Cover of report:	1 page
2. Overall on-site design:	2 pages
3. Active design write-up **(up to 2 features)**	2 pages
4. Passive design write-up **(up to 4 features)**	4 pages
5. Maintenance & management write-up	1 pages
6. Environmental impacts:	1 page
7. Drawings (in A4 / A3 size): (Typical floor plan, site layout, roof plan and vertical cross section)	4 pages
Total:	15 pages (Max)

For Special Feature Category

The write-up shall not exceed 10 pages highlighting the advanced technologies and/or special measures implemented to enhance energy efficiency.

Presentation to Assessment Panel

Shortlisted projects will be required to make a presentation to the Assessment Panel tentatively in the **first week of February 2003**. The presentation of not longer than 20 minutes should focus on the energy efficient features and their effectiveness.

Site Visit by Assessment Panel

Shortlisted projects will also be required to be accessible for site visits by the Assessment Panel tentatively in the **first week of February 2003.** The site visits will enable the Assessment Panel to verify and clarify the information presented. Generally, the site visit and presentation are held on the same day.

Participation in ASEAN Awards

All winning entries will be required to participate in the ASEAN Awards. Details of the ASEAN Awards will be available in March 2003.

Publication of Materials

All materials submitted in connection with the entry are non-returnable and shall become the property of the Building and Construction Authority. The Authority reserves the right, without the payment of fees, royalties or otherwise to make whatever use it may consider desirable of all materials submitted in connection with the entries, including the publication of photographs and names and exhibition & publication of materials.

Entries for the BCA Energy Efficient Building Awards or any enquiry should be addressed to:

The Secretariat
BCA Energy Efficient Building Awards
Building and Construction Authority
5 Maxwell Road #07-00
Tower Block MND Complex
Singapore 069110
Fax: 63254437

Attention:
Miss Alice Goh
Email: alice_goh@bca.gov.sg
Tel: 63258660
or
Mr Bok Chee Meng
Email: bok_chee_meng@bca.gov.sg
Tel: 63258636

Entry Form for Energy Efficient Building Award

Name of Building:
Name of Owner/Management Company:
Address:

Contact Person:
Email:
Tel. No.: Fax No.:

Instructions:

i. Please answer ALL the questions given in this questionnaire. If relevant information is not available, please indicate NA.

ii. Please indicate one category you wish to participate in:

- ☐ ***New & existing building***
- ☐ ***Retrofitted building***
- ☐ ***Tropical building***
- ☐ ***Special feature***

---

1 Physical Building Background:

1.1 Usage of the building:

☐ a) Single use development

☐ b) Mixed use development

If your answer is (a) please proceed to (1.1a), otherwise proceed to (1.1b)

(1.1a) For single use development

☐ Office ☐ Hotel ☐ Others (please specify) _____

(1.1b) For mixed use development (please indicate types)

☐ Office ☐ Hotel ☐ Retail ☐ Warehouse

☐ Light industry ☐ Shopping centre

☐ Others (please specify) _____

[1.1b (continue)] Please indicate the percentage space allocation for mixed use development

Types	Percentage of Designated Space (%)
Example: Office Retail	 80% 20%
Office	
Retail	

1.2 Age of building: _____(years)

1.3 Date of the last retrofit, if applicable: _____ (month/year)

If retrofitted:

(a) Complete retrofit ☐ Partial retrofit ☐

(b) Please tick if the following have been retrofitted:

Facades system ☐

Air-conditioning system ☐

M & E systems ☐

Transportation system ☐

Lighting system ☐

Others (please specify)_____

(c) Retrofitted area: _____ % of total area

1.4 Total number of storeys (including above ground car park): _____

1.5 Total number of basement floors (including basement car park): _____

1.6 Number of above ground car park levels: _____

1.7 Number of below ground car park levels: _____

1.8 Total gross floor area (m^2): _____

1.9 Car park area (m^2): _____

1.10 Lettable area (m^2): _____

1.11 Air conditioned area (m^2): _____

1.12 Non air-conditioned area excluding car park (m^2):_____

1.13 Total building height (m): _____

1.14 Floor to floor height (m): _____

1.15 Building operation hours (hrs/week): _____

1.16 Air-conditioning system operation hours (hrs/week): _____

1.17 Total number of occupants (estimated): _____

1.18 Ave occupancy rate (% of total area): _____

1.19 Surface area of the envelope incl roof to GFA ratio _____

1.20 Plot ratio (total GFA/ground area) _____

2 Building Energy Consumption:

2.1 Energy consumption for:

☐ Owner occupied

☐ Landlord and tenants

2.2 Please provide the total monthly energy consumption of the last 12 to 24 months in column A. Details of the monthly energy consumption of landlord and tenants may also be provided in columns B and C.

Month & year	Building energy consumption **(Total)** (kwh/month)	Building energy consumption **(Landlord)** (kwh/month)	Building energy consumption **(Tenants)** (kwh/month)
	Column A	**Column B**	**Column C**

Month & year	Building energy consumption **(Total)** (kwh/month)	Building energy consumption **(Landlord)** (kwh/month)	Building energy consumption **(Tenants)** (kwh/month)
	Column A	**Column B**	**Column C**

2.3 Does your building use other energy source?

☐ Yes ☐ No

If yes, please specify fuel and purpose.

☐ Gas, please specify purpose:_____

☐ Solar, please specify purpose:_____

☐ Wind, please specify purpose:_____

☐ Others, please specify purpose:_____

3 What are the on-site natural environment considerations? Please elaborate in your write-up.

☐ **Yes included in the write-up** ☐ **No not included**

4 Passive Design Information:

4.1 Envelope OTTV (W/m^2): _____

4.2 Roof OTTV (W/m^2): _____

4.3 Type of façade

☐ Stone ☐ Tiling

☐ Aluminum curtain wall ☐ Glass

☐ Others (please specify)_____

4.4 Colour of façade:

☐ Light ☐ Dark ☐ White

☐ Metallic ☐ Others (please specify)_____

4.5 Use of shading devices

☐ Blinds/curtains

☐ External sun shade

☐ Others (please specify)_____

4.6 Building orientation

☐ East facing

☐ West facing

☐ Others (please specify)_____

4.7 Location of service core:

☐ Central

☐ Perimeter

☐ Others (Please specify)_____

4.8 What are the other passive design features (e.g. daylighting and natural ventilation)? Please elaborate in your write-up.

☐ Yes included in the write-up ☐ No not included

5 Active Design Information

5.1 Office area building systems operating schedule:

Schedule	Weekdays	Saturday	Sunday	Public holiday
Start time				
End time				

Percentage of total area served:_____

5.2 Retail area building systems operating schedule:

Schedule	Weekdays	Saturday	Sunday	Public holiday
Start time				
End time				

Percentage of total area served:_____

5.3 Other areas: Please specify: _____

Schedule	Weekdays	Saturday	Sunday	Public holiday
Start time				
End time				

Percentage of total area served: _____

5.4 Building indoor environment

Indoor air setting : Temperature (°C) _____

: Relative Humidity (%) _____

5.5 Building air-conditioning system and equipment:

Fresh air exchange rate (m^3/h per m^2 floor area)_____

Efficiency of air-conditioning chiller (kW/ton) _____

5.6 Building lighting load (W/m^2 based on GFA)_____

5.7 Cooling Load _____ W/m^2 (air-conditioned area)

5.8 What are the other active design features (e.g. energy recovery system, energy saving lighting fixtures and control and building automation system)? Please elaborate in your write-up.

☐ Yes included in the write-up ☐ No not included

6 Management and Maintenance Scheme

6.1 Is there an energy committee to monitor and conserve energy consumption?

☐ Yes ☐ No

6.2 Does the Building Management have a clearly spelt out energy policy? If yes, please provide details of the policy and methods of implementation. Please elaborate in your write-up.

☐ Yes included in the write-up ☐ No not included

6.3 Is there a maintenance programme? Please elaborate in your write-up.

☐ Yes included in the write-up ☐ No not included

7. What are the environmental impact consideration (e.g. waste and pollution management)? Please elaborate in your write-up.

☐ **Yes included in the write-up** ☐ **No not included**

8. Additional Information for Retrofitted Buildings

8.1 Energy savings in air-conditioned area _____kWh/m^2/yr (based on 2000 operational hours/year)

8.2 Energy savings in lighting systems _____ kWh/m^2/yr (based on 2000 operational hours/year)

9 Project Team

Architect:_____

M & E Engineer:_____

Others (please specify):_____

10 Affirmation

We certify that the information given above is true and accurate and that the Assessment Panel may seek to verify them independently, if required.

a) Signature of Building Owner/Manager _____

Name: _____

Designation:_____

Contact: _____

Date: _____ Company Stamp: _____

b) Signature of Architect:_____

Name: _____

Designation:_____

Contact: _____

Date: _____ Company Stamp: _____

c) Signature of Engineer:_____

Name: _____

Designation:_____

Contact: _____

Date: _____ Company Stamp: _____

Appendix - Guidelines of the writeup

1. **Cover of Report**

   Name of building, photo, etc.

2. **Overall Site Design**

   General discussion to focus on the following: Use of vegetation, landscape and hardscape (effective application of ground covering plant and large plant, modification of landscape and topography, use of hardscape materials); use of water body (effective application of water body: location, quantity, etc.); use of wind (effective application of wind: natural ventilation, stack ventilation, etc.); and other use of on-site natural environment (the use of night sky radiation, others).

3. **Active Design**

   Discussion on the following areas: air-conditioning system (selection, layout and plant system design): __ kW/ton __ W/m^2 ; Lighting systems: _ W/m^2; Other systems (transportation, etc.) __W/m^2 ; Indoor air quality (thermal comfort, ventilation, _ m^3/hour/person, etc.); overall energy consumption per sq.m. of normal air-conditioned areas: __ W/m^2; other active design concepts (specify).

4. **Passive Design**

   Discussion on the following areas: orientation and building design (the orientation of building, the shape of building (surface area to gross floor area ratio), the location of service core, the position of entrances, the hardscape around building, spatial organisation for various functions, etc.); envelope design (material, shading, fenestration, etc.); material (heat transfer protection, humidity protection, MRT effect, color of envelope, infiltration protection and control, Etc.); shading (efficiency of shading devices, the use of natural shading devices, the use of shading from adjacent buildings, etc.); fenestration (Fenestration design: location, nature and size of opening, light to solar heat gain ratio (LT/SC), etc.); Overall heat transfer through building envelope: wall _ W/m^2; Roof _ W/m^2; daylighting (the use of diffuse radiation in building: hall, atrium, corridor, parking, toilet, etc., zoning for integrated lighting and daylighting, contrast ratio of brightness); natural ventilation; other passive design concepts.

5. **Maintenance & Management**

   Discussion on the following areas: energy management systems (building Energy Management System (BAS), energy consumption monitoring system, etc.); maintenance and management measures (manpower: __ man-hour/year, maintenance contractor, availability of energy management engineer, training of maintenance workers: ___cumulative no. of hours); training programmes (with description, etc.); others (specify).

6. **Environmental Impacts**

   Discussion to focus on the following areas: waste management; pollution management (air, noise, visual, exhaust, etc.); green/non-toxic materials; others (specify).

Enhancing Building Energy Performance

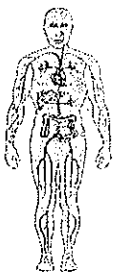
Energy Efficiency: A Holistic Approach



Grace Wong
CNA
11 OCT. 2002

ENERGY EFFICIENCY : A HOLISTIC APPROACH

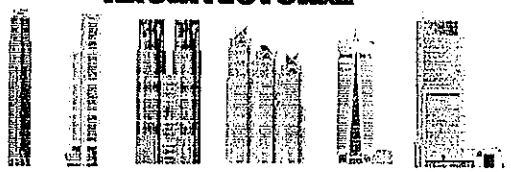
- Skeleton/Skin (Architectural)
- Circulatory System (Mechanical)



- Nervous System (Electrical)
- Brain (IBMS)

2

ARCHITECTURAL



The architecture of a building can have a very significant impact on its energy efficiency. Energy conservation considerations must start when the building is in the conceptual stage of architectural design.

Factors Affecting Energy Efficiency

- Building Shape
- Orientation
- Amount of Window Area
- Type of Glazing
- Shading Devices
- Amount of Mechanical Space

3

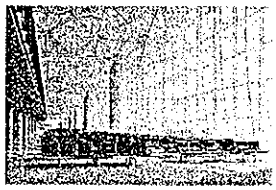
BUILDING SHAPE AND ORIENTATION



- More building perimeter means more cooling load. A rectangular building with 2 to 2.5 aspect ratio may need 5 to 6 % more cooling capacity than a square building.
- Building orientation affects building cooling load. A rectangular building with different orientation may have a 3 to 4 % cooling capacity difference.

4

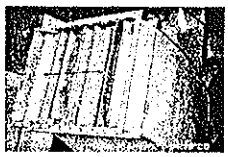
WINDOW AREA AND GLAZING



- If a 100,000 sq. ft. building has 60 % glazed façade as a base, every 20 % decrease in glazed area reduces the cooling load by 15 to 20 %. The cooling load due to a 60 % glazed façade contributes up to 50 % of the total cooling load.
- Double glazing can reduce cooling load. For a building with 60 % glazed façade, reflective double glazing can lower the cooling load by up to 25 % compared to ordinary tinted and draped glass.

5

AMOUNT OF MECHANICAL SPACE



Typical Scenario

- Customary for architects to make schematic designs without giving due consideration to space requirements for mechanical equipment and distribution.
- Architects believe mechanical needs are highly flexible and can be squeezed into leftover spaces.
- While this is true to a certain degree, a squeezed air con ductwork requires more power at the fan and a squeezed equipment room invariably results in an inefficient mechanical system.

6

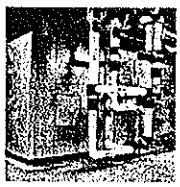
EFFICIENT CENTRAL PLANT



- Efficient Chilled Water System
  - Chiller sizing
  - Part-load efficient pumping
  - Cooling towers
  - Minimize flow resistance
  - Optimize chilled water temp
  - Target system and component efficiency in KW/ton
- Efficient Pumping System
  - Pump efficiency
  - Motor efficiency
  - Pipe sizing and layout to minimize resistance

7

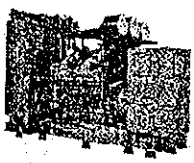
EFFICIENT AIR SYSTEM



- Adopt VAV and demand control strategies
- Aim for low pressure drop to meet required air supply
- Use of VSDs.
- Use efficient filters such as UVC Emitters
- Implement accurate, stable and reliable temperature and humidity control
- Consider heat recovery from exhaust systems

8

ELECTRICAL SYSTEM



- Arrangement and sizing of electrical distribution systems
- Efficient transformers (e.g. Amorphous Transformers)
- Addressable lighting controls
- Daylight harvesting
- Automatic (motion sensor) controls for areas with variable occupancy e.g. passenger holding areas
- Co-generation

9

IBMS ~ THE BRAIN OF A BUILDING



Data Collection

- Operating status and alarms of mechanical, electrical and lighting systems
- Outside weather and occupancy levels
- Utility and energy metering

Action

- Starting/stopping equipment
- Power demand forecast and load shedding
- Optimum start-stop / Duty cycling
- Advanced chiller optimization
- Night purge and night set-back
- Lighting automation

Insight & Analysis

- Plotting efficiency ratings
- High speed calculation of energy usage and operating efficiencies
- Spot trends, issues or problem areas across entire airport enterprise system

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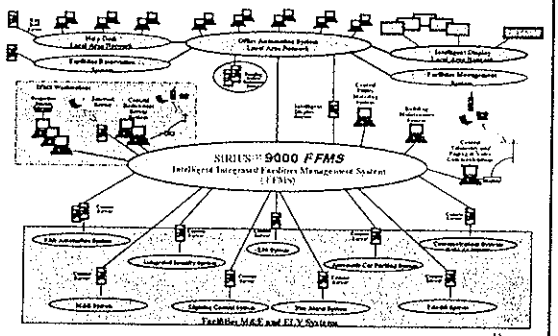
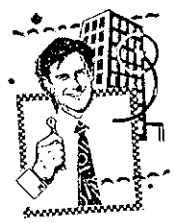
IBMS CONNECTIVITY



11

ROLE OF M&E CONSULTANT



- Plays key role in the design of green buildings – buildings that are energy efficient, highly flexible and adaptable, easy to operate and maintain, and provide a productive and healthy environment.
- Current industry practice
  - Low fees
  - Little room for hiring of skilled and experienced engineers
  - Fee structure does not encourage energy efficient design
- Solution : Performance-based design

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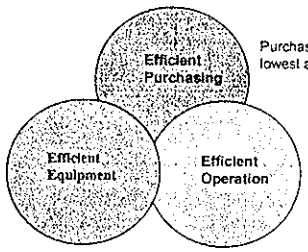
FUNDAMENTAL COMPONENTS OF ENERGY MANAGEMENT PROGRAMME



Purchasing energy at lowest available unit cost.

Upgrading or replacing existing equipment with more energy-efficient versions whenever it is cost effective to do so.

Operating equipment that consumes energy as efficiently as possible.

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TRADITIONAL ENERGY MANAGEMENT PROGRAMMES



- Focus on installing energy-efficient technologies
- A little focus on efficient purchasing
- Very little emphasis on efficient operation
  - Least understood
  - But highest potential for savings
  - Little or no capital outlay

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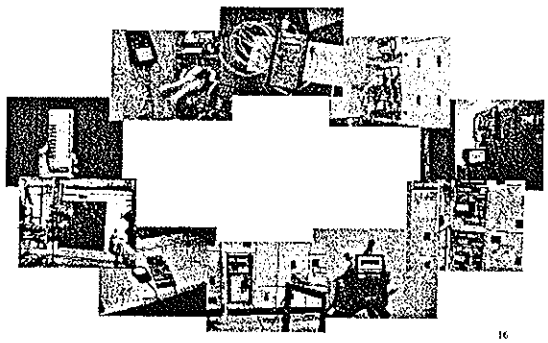
ENERGY AUDIT



- Perform site measurement and assessment
- Survey user needs
- Obtain/develop missing documentation
- Investigate problems
- Study building system operation
- Develop and execute diagnostic monitoring and test plans
- Analyse and evaluate findings
- Formulate cost-effective energy conservation measures

15

DATA COLLECTION PROCESS



16

BUILDING COMMISSIONING



- A term associated with new construction projects as a process of ensuring that new buildings / plants and their systems perform as designed.
- To ensure that owners and investors get good buildings for their investments
- Most commissionings are done under severe time constraints resulting in "quick and dirty" makeshift solutions that often lead to building problems that are invisible but costly.

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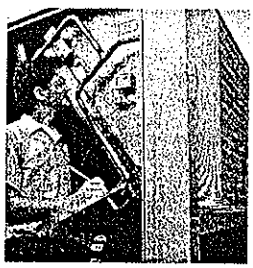
RETROCOMMISSIONING



- To improve existing buildings / plants and capture sizeable energy saving opportunities.
- Systematic optimization of building systems so that they operate efficiently and effectively.
- Reduce energy waste, improve building operation and comfort.

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DO YOUR BUILDINGS/ PLANTS NEED COMMISSIONING ?



- Many existing buildings are limping along in terms of performance.
- Most owners are not aware of it.
- As long as building systems maintain a reasonable comfortable environment, nothing appears to be wrong.
- Many problems are noticed only when a catastrophic failure or visible consequence occurs.

19

COMMON ENERGY PROBLEMS



- Automatic controls of VAV boxes being bypassed.
- Hydraulic/air balancing out of balance.
- Ineffective temperature controls (Wrong sensor location, out of calibration, outdated technology, inappropriate control algorithm, controllers not properly tuned).
- Equipment running more than necessary or running inefficiently because of improper operating strategies.
- Energy management systems that were never installed or programmed to take full advantage of their capabilities or that have degraded over time.

20

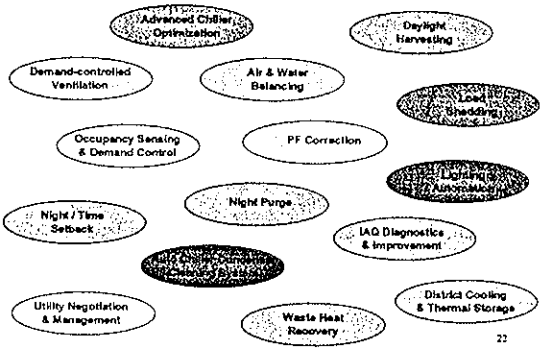
RETROCOMMISSIONING : ACT OR NOT TO ACT?



- Each of the preceding problems has a sizeable effect on the economics of owning and operating a building or plant.
- Not only can energy costs become excessive, but also capital dollars invested may cease to provide a return.

21

ENERGY MANAGEMENT STRATEGIES

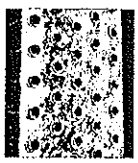


22

DIRTY COIL



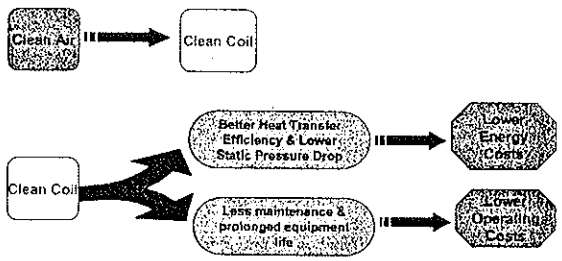




- Interior of coil is packed with dirt and grime, despite hours of cleaning effort
- Coil may appear to be clean but may actually be a hotbed for microbial growth. Increased pressure drop and reduced air flow through such coils increases energy costs.

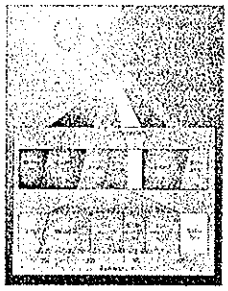
23

CLEAN COIL



24

HARNESSING UVC TECHNOLOGY



- Sunlight is nature's defense mechanism against harmful pathogens.
- UV radiation in the short wave or C band range (200 to 280 nanometers) has been used in a wide range of germicidal applications to destroy bacteria, mould, yeast and viruses
- In the dark, moist environment of an HVAC system, mould spores can proliferate year-round. With allergic individuals, these spores can cause symptoms leading to congestion, breathing difficulties or even asthma and other complications.

25

UVC APPLICATIONS IN HVAC





The "blue hue" is created by the ultraviolet light as it bathes the coil.

Drain Pan Water Coil



The top photos show samples taken before irradiation.

The bottom photos show samples taken after 19-hr exposure to UVC light.

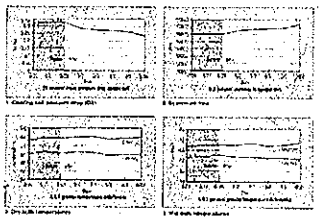
The reduction in mould is dramatic after less than one day's time.

26

UVC LIGHTS SAVE ON ENERGY

CLEAN COILS BRING MAINTENANCE AND ENERGY SAVINGS

CASE STUDY 1 : Southern California Air Conditioning Distributors (SCACD) Building



Based on 3000 annual operating hours and an energy cost of US$0.10 per KWH.

1st Year energy savings = US$5,000

UVC initial installation and operating costs ~ US$5,000

Payback = 1 Year

27

UVC LIGHTS SAVE ON ENERGY

CASE STUDY 2 : Beverage Plant, Singapore

Net Cooling Capacity Gained	=	107,232 BTUhr
(After installation of UVC Emitters)	=	31.43 KW
Typical Chiller Efficiency	=	0.2 KW/KW
Electrical Power Saved	=	31.42 x 0.2
	=	6.28 KW
Energy Saved In 1 Year	=	6.28 KW x 8,760 hr
	=	55,012 KW-hr

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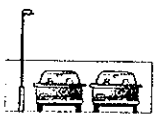
UVC LIGHTS SAVE ON ENERGY

Energy Cost Saved In 1 Year	=	55,012 KW-hr x $0.12 per KW-hr
	=	$6,600
Maintenance Cost Saved In 1 Year (Maintenance/Servicing Of Cooling Coil/Drain Pan Including Cleaning And Chemicals/Biocide at $300 x 3 times/year)	=	$900
Total Cost Saved In 1 Year	=	$7,500
Total Installed Cost Of UVC Emitters Plus Energy Consumed By UVC Emitters	=	$6,207
Payback Period Of Investment	=	$\frac{\$6,207}{\$7,500}$ x 12 months
	=	10 months

29

CAR PARK VENTILATION CONTROL



CP13 : 1999 Mechanical Ventilation For Car Park allows the mechanical ventilation system to be operated at a lower rate at times of low occupancy subject to the condition that the carbon monoxide concentration is maintained below the permitted level of 25 ppm.

Major energy savings achieved in a major government hospital:

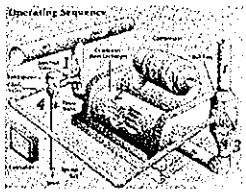
Investment = $35,000

Energy Saved Per Year = $290,000

Payback Period = 1.5 months

30

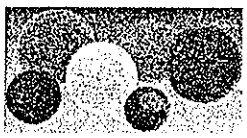
AUTO CONDENSER TUBE CLEANING SYSTEM



- Keeps condenser tubes clean and prevent corrosion
- Maintains high thermal transfer efficiency
- Improves efficiency by up to 40%
- Automatic cleaning saves labour costs
- Avoid chiller shut-down (1 - 2 days)

31

ENERGY EFFICIENCY IMPROVEMENT



- Calcium carbonate and microscopic plant matter deposit as scale and biological film on heat exchanger surfaces.
- Research shows that a 0.5mm layer of scale on heat exchanger tubes causes heat transfer loss of 30% and increases energy usage by 17%.

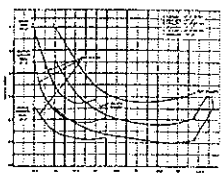
32

ADVANCED CHILLER OPTIMIZATION

- Optimum start/stop and sequencing of chillers, pumps and cooling towers to match the exact load requirements to minimize chiller/pump/cooling tower running time.
- Using global communication of DDC controllers, chilled water temperature will be reset higher whenever the opportunity arises. For every 1°C the chilled water temperature is raised, 3% to 4% of chiller compressor energy is saved.
- Primary/secondary pump system allows the secondary pumps to run at lower speed and enjoy energy savings under low load conditions.



- High level interfacing of chillers to BMS and expert chiller diagnostics resident in the BMS will quickly alert the building operator of any potential problem.



- A sophisticated chiller efficiency tracking system will ensure that chillers are maintained at peak condition at all times.
- In addition, chiller efficiency curves (non-linear) which are dependent on condenser water temp and loading of chillers, will be programmed into the BMS so that chiller start/stop can be further optimized.

33

SAVE ENERGY BY RAISING SPACE TEMPERATURE

THE STRAITS TIMES, FRIDAY, JUNE 21, 1996

Turn Up Your Air-Con Thermostats and Help Save $50m

Singapore can save about $50 million on its electricity bill if people here set their air-conditioner thermostats just 3 or 4°C higher

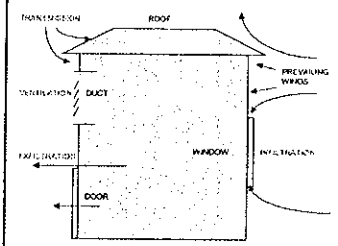
Most people would be comfortable in a room at between 23 and 25°C, but a check by the Straits Times found that the temperature in most buildings, trains and buses ranged from 20.8 to 22.5°C

CP 13 : 1999 Mechanical Ventilation and Air-conditioning in Buildings stipulates the following indoor design conditions

a) Max dry bulb temp : 25.5 °C
b) Min dry bulb temp : 22.5 °C
c) Max R/H : 70%
d) Max air movement : 0.25 m/s at sedentary occupant level

34

IMPACT ON RAISING SPACE TEMPERATURE



Heat Gain From A Building

- 2°C raise results in saving 15% cooling energy
- Heat gained
  - transmission
  - infiltration
  - ex-filtration
  - ventilation

35

LIGHTING CONTROL



Aircraft Warning Lights (Roof-top)

BCA

Signage

Car Parking Lighting



Landscape Lighting



A simple, maintenance-free hermetically-sealed cadium sulfide photocell will provide a cost-effective solution to control all outdoor lighting
- landscape lighting, signage, fountain lighting, foot-path and walk-way lighting.

"Last one out, turn off the lights"
A noble sentiment, easily forgotten.





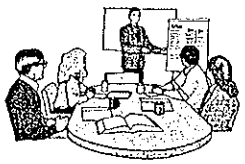
Occupancy sensors are ideal for offices and meeting rooms. These sensors automatically turn lights off, when the rooms are empty. In addition, the occupancy sensors can adjust temperature set-points higher (to save energy) when the rooms are unoccupied

36

ACCELERATING ENERGY SAVINGS

Creating Awareness & Publicity

Senior Management Involvement



Education

Long Term Life-Cycle Approach

Training

Strengthening The Regulatory Framework

37

HOLISTIC APPROACH



Body – Physical Attributes : Architecture, Structure, Mechanical & Electrical Systems



Mind – Intelligent Building Management Systems, Software, Knowhow : Insight & Analysis



Spirit – Energy Consciousness and Will

Body + Mind + Spirit = Maximum Energy Savings

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Questions & Answers

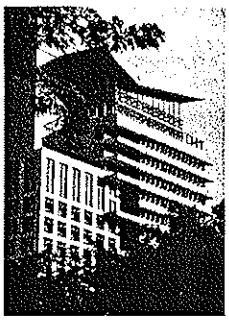

ThankYou

Enhancing Building Energy Performance

"*THE MOE EXPERIENCE*"



NEW MINISTRY OF EDUCATION HQ





Scope of Presentation

- ✓ Building Design
- ✓ Building Systems
- ✓ Management
- ✓ Maintenance
- ✓ Sustainability
- ✓ Conclusion

BUILDING DESIGN - Concept

The aim is to create a conducive and effective working environment for MOE officers

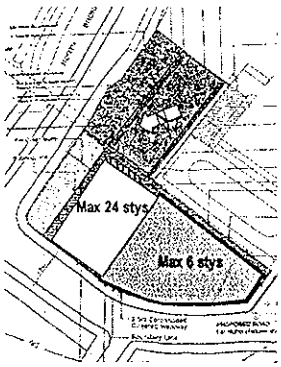
- Functional building
- Energy and water efficient
- Use of natural daylight and ventilation





BUILDING DESIGN - Concept

- Limited site area of 0.64 ha
- Restricted orientation for building
- Maximise use of site area for build up space

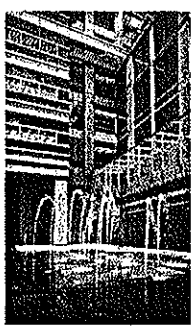


BUILDING DESIGN

Building complex is planned around

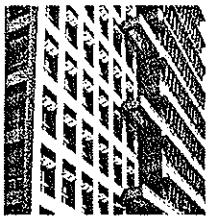
- Central open courtyard
- Naturally ventilated
- Well-lit by daylight
- As a natural cooling transit

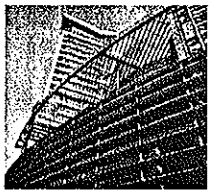




BUILDING DESIGN – High Performance Envelope System

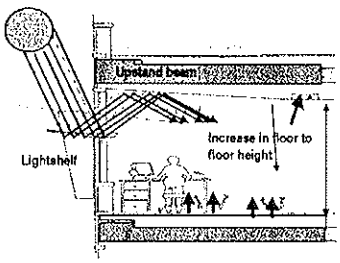
- Façade acted as an 'environmental filter' rather than a 'barrier'
- Low-e double-glazing with 0.43 shading coefficient
- Well-shaded building, with louvres, trellises & fins
- Low envelope OTTV of 34.87 W/m²





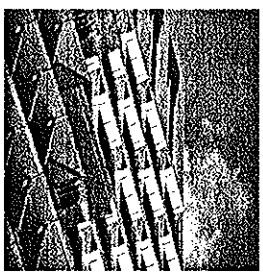
BUILDING DESIGN – Use of Daylight

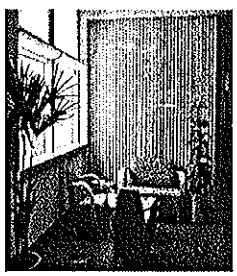
- Sunshades used as light-shelves
- Use of high performance low-E glass
- Clearer glass (37% transmission)



BUILDING DESIGN – Use of Daylight (cont'd)

- Lightshelves as part of façade system





BUILDING DESIGN – Use of Daylight (cont'd)

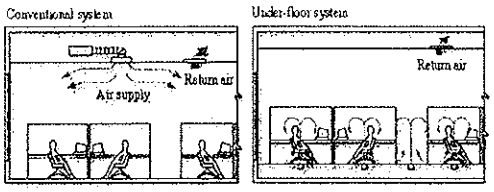
- Ceiling profile designed to ensure even gradation of light





BUILDING SYSTEMS – Under-floor Air-con System

- First time such system is implemented in Singapore on a large scale
- Shares the raised floor space for OA equipment
- Moves air in the same direction as the thermal lift



Comparison between conventional and under-floor air-conditioning systems

BUILDING SYSTEMS – Under-floor Air-con System (cont'd)

Advantages:

- Improved indoor air quality
- Reduced energy consumption
- Better controlled environment
- More flexibility for changes
- Lower capital cost - saving in floor to floor height

	Conventional System	Under-floor System	Increase(+)/ Reduction(-)
Clear room height	2.7m	2.7m	0%
Height of under-floor space	0.2m	0.4m	+100%
Height of ceiling space (assuming a beam depth of 0.6m)	1.4m	0.8m	-43%
Total floor to floor height	4.3m	3.9m	-9.3%

BUILDING SYSTEMS – Intelligent Passenger Lifts

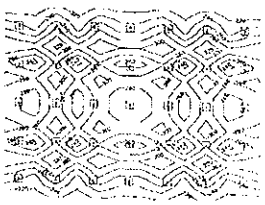
- Algorithm that pools passengers by similar floor destinations
- Reduced number of stops
- Saves lift waiting and travel time
- Optimises on energy usage





BUILDING SYSTEMS - Ambient Lighting System

- Design overhead artificial lighting system for ambient needs only with 300 lux
- Task lighting to supplement for occasions of low daylighting
- Low building lighting load of 4.7 W/m²
- Lighting energy use reduced by about 880,000kWh/yr (54%) as a result of daylighting
- Cooling energy use lowered by an estimated 310,000kWh/yr (19%) as a result of reduced lighting loads and solar gains



Lux Level Contour of Ambient Lighting System

BUILDING SYSTEMS – Integrated Building Management System (IBMS)

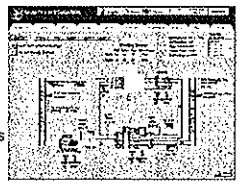
- Direct Digital Control (DDC) for fast response and accuracy
- Monitors and controls the mechanical and electrical (M&E) systems
- Optimises start/stop of chillers for efficient operation
- Variable air volume system to supply air for areas with variable heat load



Main Menu of Integrated Building Management System

BUILDING SYSTEMS – Integrated Building Management System (cont'd)

- Modules for real-time alarm management and reporting
- Automatic paging for maintenance personnel upon activation of alarm
- Scheduling of equipment maintenance programme
- Allows energy auditing for the comparison and analysis through trend logging
- Use of data collected to further fine-tune all equipment
- Lighting automatically off by a preset time and extension switches provided for extension of lighting operation by half hour



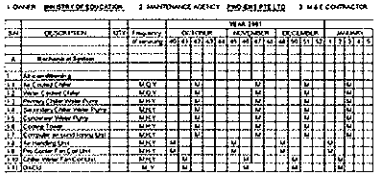
Real-time Status Monitoring through IBMS

MANAGEMENT – Management Commitment

- Believes in the benefits derived from energy efficient and conservation practice
- Committed to maintaining an office environment that is conducive to the occupants and efficient to operate
- MOE's Energy and Water Management Steering Committee (EWMSC) was set up
- Chaired by Deputy Secretary (Services), MOE and include representatives invited from EMA and PUB
- EWMSC formulates policies and set guidelines and targets to ensure that energy and water utilisation and costs are kept as low as possible while ensuring that standards of comfort and services are maintained

MAINTENANCE – Maintenance Guidebook

- Good maintenance is essential to ensure that all equipment are operating at good efficiencies and therefore optimising on energy usage
- Use of Maintenance Guidebook for maintenance planning and monitoring
- M&E Master Maintenance Schedule
- Preventive maintenance for all equipment and systems



Sample of Master Maintenance Schedule

MAINTENANCE – BMC (Building Management Centre)

- Nerve centre for monitoring building systems
- Energy consumption monitoring
- Front desk customer service with Duty Manager
- Ready accessibility thru telephone, email or walk-in for job request and fault reporting
- Speedy dispatching of service personnel
- Job request tracking and status monitoring



SUSTAINABILITY – Audits and Programs

- Energy and Water Annual Audits proposed for MOE HQ and Schools
- Annual program includes campaigns, seminars, exhibitions to create mass awareness on energy and water conservation
- Posters and stickers to constantly remind users to turn off power and lights



SUSTAINABILITY – Monitoring and Reviews (cont'd)

- Fortnightly Facility Management Meetings between MOE and CPG FM (Maintenance Agent)
- Reviews maintenance energy conservation program status, results, building systems downtime and other projects in progress
- Monthly Management meetings between senior management of MOE and PWD EMS
- Direction setting and approve new initiatives for improvements



CONCLUSION

- Conducive and energy efficient working environment for occupants
- Achieved through :
  - ✓ Management commitment
  - ✓ Sustained by management & maintenance practices
  - ✓ Good building & façade design
  - ✓ Application of innovative M&E systems



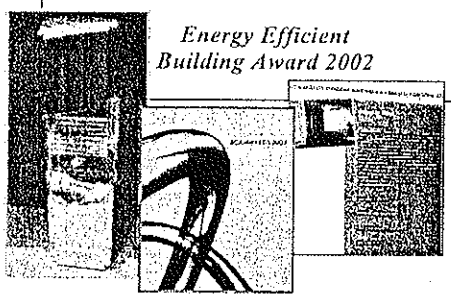
Shangri-La hotel

BUILDING ENERGY ENHANCEMENT

The Shangri-La *EXPERIENCE*

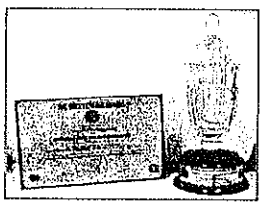
BUILDING & CONSTRUCTION AUTHORITY

Energy Efficient Building Award 2002



ASEAN ENERGY AWARDS

3rd ASEAN Energy Efficient Building Award 2002

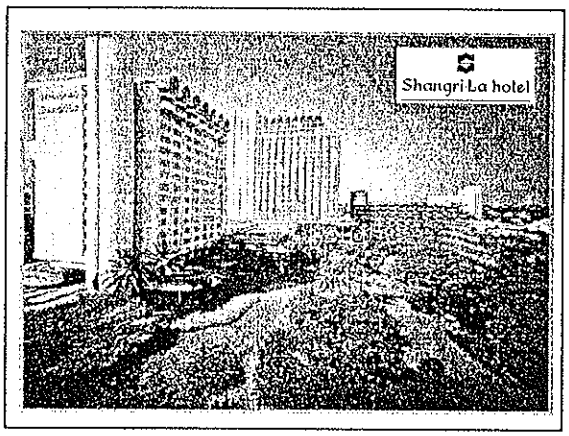


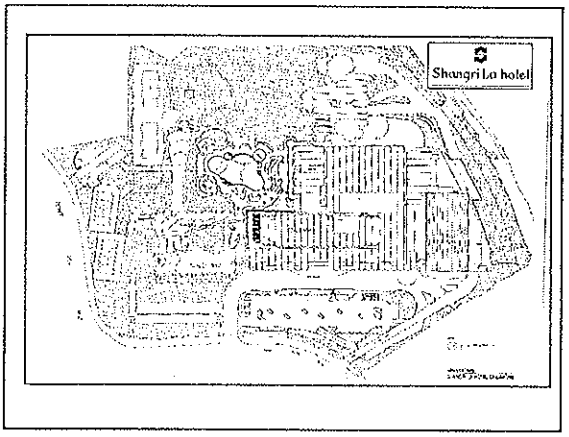
- Being in the Hospitality industry, the competitions are not something we normally participate in. However,

We believe we have done something right and it should be shared.

There is always a better way of doing anything.

This presentation is a summary of our experiences !!

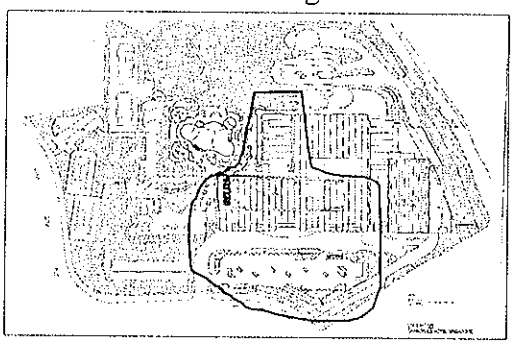




THE SHANGRI-LA HOTEL, SINGAPORE

Overall Site :	15 ha
Plot Ratio :	1.84
Landscaped gardens :	30,000 m2 (in green)
Total GFA :	94,000 m²
Carpark area :	21,074 m²
Airconditioned area :	77,505 m²
Non Aircon area :	16,226 m²
Operations :	24 hrs daily
Occupants :	28,000 persons per month
OTTV:	43.8 W/m²
Façade Colour:	White

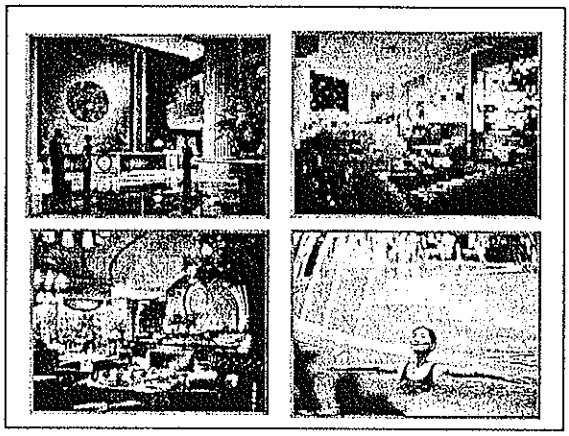
Tower Wing



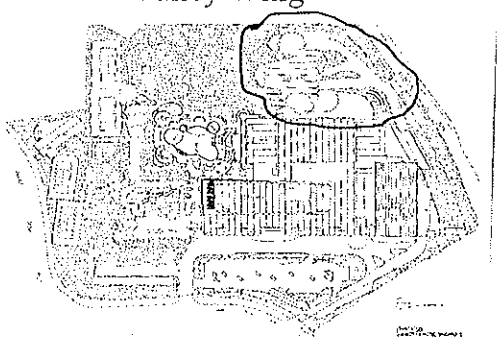
Tower Wing, 31 years (1971)

- Building height : 84 m
- GFA : 48,902 m²
- Air-con area : 45,905 m²

- 24 guest related areas with 2 Basements, Podium, F&B Outlets, Kitchens, Lobbies, Guestrooms and Corridors.
- Major retrofit for centralised air-conditioning chilled water plant
- Major refurbishment of the entire Wing with Interior and Building, M&E systems, Lighting, Swimming Pool and Filtration, Garden and Landscape works.

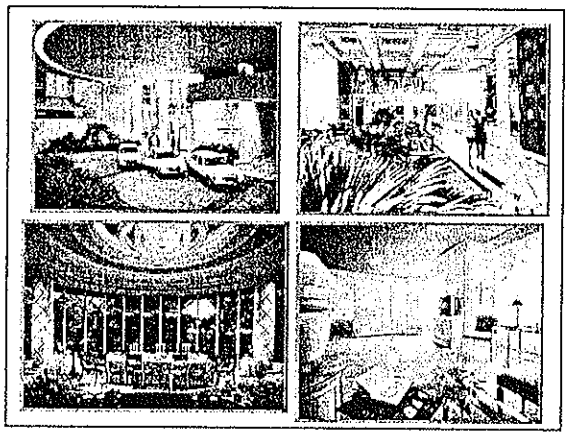


Valley Wing

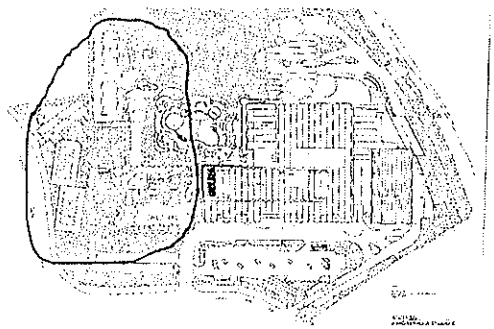


- **Valley Wing,** 17 years (1985)
- Building height : 67 m
- GFA : 18,997 m²
- Air-con area : 16,037 m²

- 17 guest related floors with 1 Basement, Podium, Main Lobby, Function Rooms, Major Suite rooms and supporting operational areas.
- Under planning for upgrading and refurbishment.

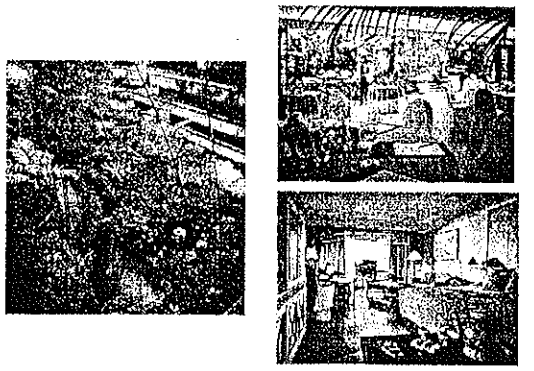


Garden Wing

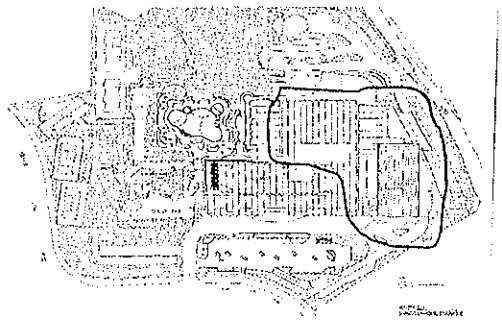


- **Garden Wing**, 24 years (1978)
- Building height : 40 m
- GFA : 19,810 m²
- Air-con area : 10,696 m²

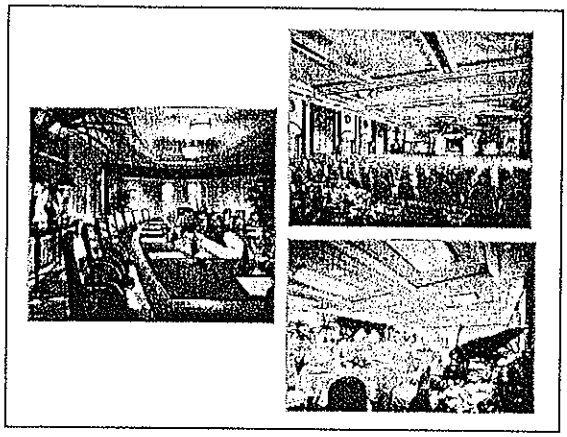
- 9 guest related floors with 3 Basement Storey, Function Rooms and Kitchens, Guestrooms and Lobbies and operational areas.
- Major refurbishment in year 2000, inclusive of Interior, Building, and M&E systems works.



Banquet Wing



- **Banquet Wing**, 8 years (1994)
  - 5 Storeys plus 3 Basement
  - Ballroom and Function Rooms
  - Building height : 20 m
  - GFA : 6,652 m^2
  - Air-con area : 4,867 m^2



Upgrading Program

- Tower Wing - Upgrading in 1998/99
- Garden Wing - Upgrading in 2000

Shangri-La hotel

The Team

Operator	: *Shangri-La Hotel Limited*
Project Mgrs	: *Leo Property Management*
Architects	: *Chao Tze Ann & Partners*
M&E Engineers	: *Alpha Engr Consultants*
	Supersolutions (Chiller Plant)
Landscape Designers	: *Belt Collins Int'l*

& Others

Objectives of Upgrading

- Product and Facilities to suit the needs of current travelers
- Re-capture the image of the Shangri-La
- Facilities to suit the manpower needs
- **Energy efficient building**
- Use of technology to facilitate business and operations

Scope of Upgrading

- Major Structural,
- Architectural and Building,
- M&E systems
- Interior Decorations
- Swimming Pool
- Landscape and Gardens
- Operating systems

- Increased in number of Function Rooms
- Better working environment for employees
- Extended Public Areas with Air-condition
- Improved lighting and ambience
- Landscaped and Garden lighting
- Larger swimming pool

- Initial fear that there would be greater energy consumed
- However, with appropriate application of technology and operating strategies ***the eventual energy consumed is lower than pre-upgrading days.***

Savings in Energy Consumed

Shangri-La hotel

Year	Monthly kWh	kWh Savings	Increase in A/C Areas	kWh per sq m of A/C area	% Savings
1997	2,387,199			34.4	
2001	2,129,837	257,362	11.60%	27.5	20.1%

Savings Achieved Through

1. Passive Design Concept
2. Active Design Concept
3. Management of Energy Consumption
4. Maintenance Policies

1. *Passive Design Concepts*

Natural Environment

- Ground Vegetation
- Vertical Vegetation
- Water Features
- Wind

1. *Passive Design Concepts*

- The various buildings of the Shangri-La Hotel, Singapore built on a 15 ha rolling land have been **carefully planned to rest within a green belt.**
- The approximate 30,000 sq m of dense garden setting has a cooling effect on the buildings.

1. *Passive Design Concepts*

- Building Envelope and Design
  - Barrel Roofs
  - Balconies
  - Tinted Glass
  - Semi Open Areas
- Daylight & Natural Ventilation
- Architectural Sun Shading
- Interior Sun Sun Shading

1. Passive Design Concepts

- Buildings with layered vegetation for shade and light penetration
- Extensive use of vertical vegetation for cooling effect







1. Passive Design Concepts

Architectural features to enhance energy efficiency in building

- Glass panels shaded by large barrel vault over the podium (blue and yellow on site plan
- Glass panels shaded by layered vegetation
- Open balconies for natural ventilation and daylight
- Extensive use of water features
- Layout of building allows breeze to cross flow and cools the building

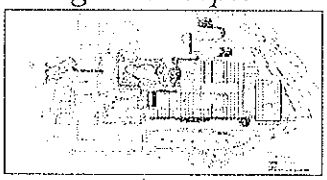






1. Passive Design Concepts

Water Features







2 *Active Design Concepts*

- Efficient Main Chiller Plant
- Tracer Chiller Plant Optimisation System
- Building Automation system
- Extensive use of dimmer systems
- Networked Guestroom Control and Management System

2 *Active Design Concepts*

Chiller Plant Centralisation

- Prior to centralisation we have 3 separate chiller plants
- Inefficient, obsolete, R-11 chillers, too many redundancy, high operating and maintenance costs etc.
- Central chiller plant completed commissioned in 1999

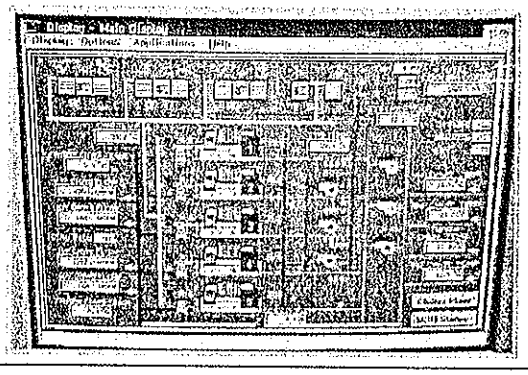
Savings in Energy Consumed - Central Chiller Plant

- Annual electrical consumption savings from chiller plant about **4,270,000 kWh -39.6%**
- Highlights of Project
  - Full Instrumentation Audit
  - Design and operations of chiller plant match building heat load
  - Efficient chillers - 0.527 kW/RT
  - Variable Speed Drives for pumps and CTs
  - System Plant Efficiency Index used

Savings in Energy Consumed – Central Chiller Plant

Year	Daily kWh	kWh Savings	% Savings	System Plant Efficiency
1996	29,572			1.22
1999	19,606	9,966	33.70%	0.699
2001	17,869	11,703	39.60%	0.66

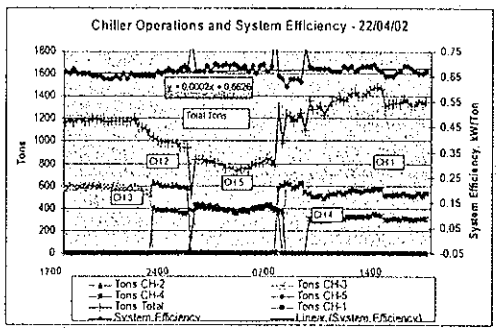
2 *Active Design Concepts*



2 *Active Design Concepts*

- Chiller Plant operations controlled by Chiller Management System to continuously match the plant operating capacity to the building cooling capacity. Chiller operating combinations are:
  - 2 x 400RT = 800 RT
  - 1 x 600 RT + 1 x 400 RT = 1000 RT
  - 2 x 600 RT = 1200 RT
  - 1 x 600 RT + 2 x 400 RT = 1400 RT
  - 2 x 600 RT + 1 x 400 RT = 1600 RT
  - 3 x 600 RT = 1800 RT

2 *Active Design Concepts*



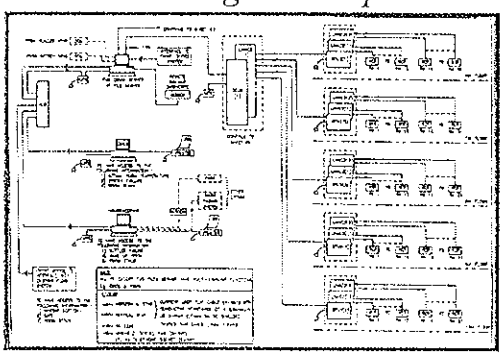
2 *Active Design Concepts*

Intelligent Guestroom Management System

Each room equipped with an Intelligent Room Control System, IRCS connected on a Local Area Network to the Engineering Control Room. Acts like a BMS with these additional energy conservation functions. (See System in Appendix)

Welcome Mode – Guest inserts keycard and selected pre-preprogrammed lights switches ON. This psychologically prevents the guests from switching on all the lights as he usually would if he enters it in darkness

2 *Active Design Concepts*

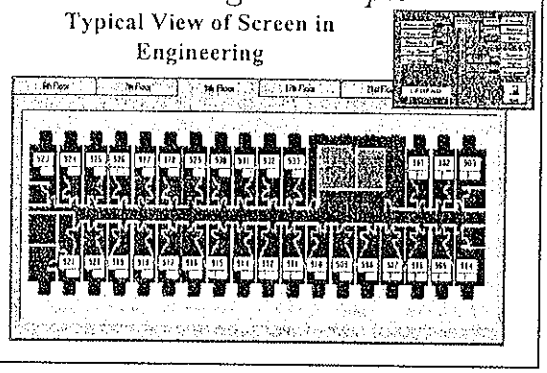


2 *Active Design Concepts*

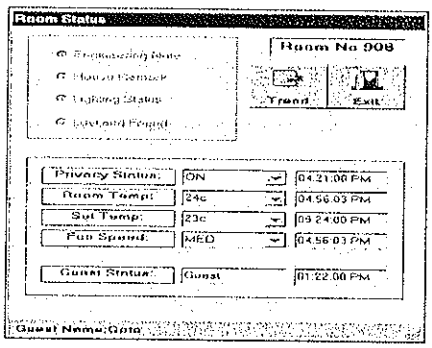
- Guest Leave Room – Removal of keycard switches OFF all lights (vestibule light delayed for 1 minute). The fan coil unit speed turns to LOW and the thermostat reverts to a preset value.
- Sleep Mode – The room thermostat is automatically raised by 1-2 ° C after midnight when the system does not record any activity, indicating that the guest may be asleep.
- Continuously monitors, control and sound alarm of temperature condition in the rooms and remote adjustment of set-points, from Control Room.

2 *Active Design Concepts*

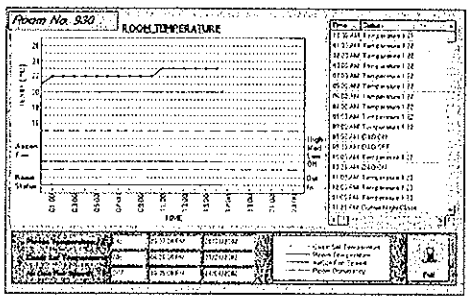
Typical View of Screen in Engineering



2 *Active Design Concepts*



2 *Active Design Concepts*



3 *Management Schemes*

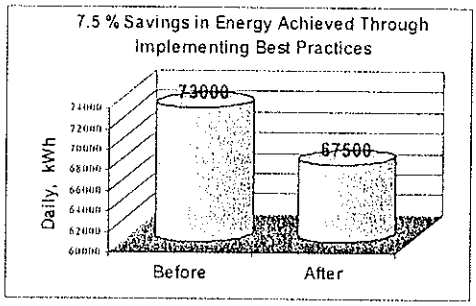
A. **Energy Conservation Policy :**

3 *Management Schemes*

Energy Conservation Policy :

- The implementation of this policy is through the Energy Conservation Best Practices Program.
- This is mandated throughout the entire Shangri-La Hotels chain

3 *Management Schemes*



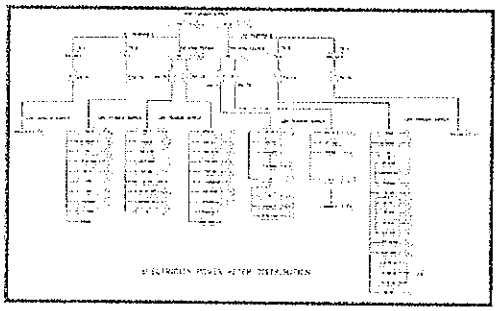
3 *Management Schemes*

B. Extensive Sub-Metering system

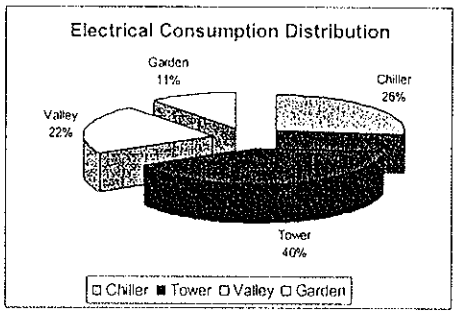
- Strong emphasis is knowing where and how much energy has been consumed
- Over time a clear consumption trend has been established
- Energy Conservation targets are set and measured against, as the consumption is monitored.

3 *Management Schemes*

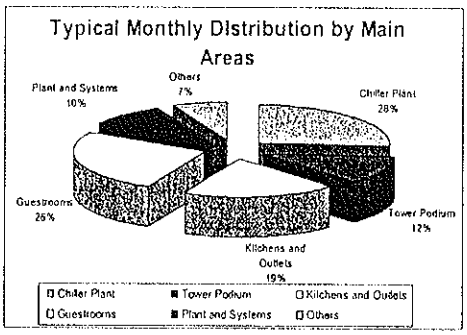
Electrical Sub-meters Distribution



3 Management Schemes

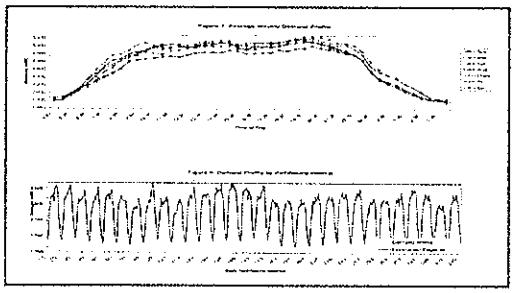


3 Management Schemes



3 Management Schemes

Electrical Consumption Trend



4 *Maintenance Policies*

C. **Maintenance Management**

- Annual Engineering Audit by Corporate Office.
- Emphasis on Preventative Maintenance being carried out.
- Emphasis on system and operating condition
- Scoring system used and benchmarks can be set and measured against

4 *Maintenance Policies*

Maintenance programs established based on

- Maintenance standard
- Scope of maintenance
- Frequency of maintenance
- In-house or contract service
- Regulatory requirements
- Manufacturer's recommendation
- Historical operating experience

4 *Maintenance Policies*

E.g. Maintenance Standard

All equipment that has been maintained or serviced must be re-commissioned to pre-set operating standards. E.g. AHUs or FCUs must be tested for on and off coil temperatures, air velocity, thermometer and modulation of valves etc.

4 *Maintenance Policies*

TRAINING POLICY

EVERY STAFF OF THE HOTEL MUST UNDERGO A MINIMUM 4 HOURS OF TRAINING PER MONTH.

Training of Maintenance Manpower :3,880 man-hr/yr

Training of Operations Manpower :4,750 man-hr/yr

Replicability and Sustainability

Replicability

- Is our approach to establishing an energy efficient building replicable?
  - I believe the answer is YES.
  - Of course there is a balance between capital investment and returns.

Replicability and Sustainability

Replicability

- In the chiller upgrading project, an index called Plant System Efficiency has been established.
- This can be applied to all buildings using central chilled water system where chillers, pumps and cooling towers are common.
- We have set a target of 0.7 kW/RT but are now operating at 0.66 kW/RT

Replicability and Sustainability

Sustainability

Typical Example

- Over time we have set and established operating parameters with the view of optimising the chiller plant.
- These are monitored and reviewed regularly
- Chiller operating parameters are monitored almost by the hour

Conclusions

- Although the upgrading projects have increased the air-conditioned spaces considerably, the resultant energy consumed is much lower than before we commence.
- This was achieved through judicious application of technology and energy conserving designs.

Conclusions

- Management involvement is critical in establishing an energy conserving climate.
- This is further enhanced by the application of sound Maintenance Policies.
- The Shangri-La's energy conserving efforts are both replicable and sustainable.

Replicability and Sustainability

Replicability

- Similarly the monitoring of consumption and establishing benchmarks can also be implemented in any building where sufficient sub-meters are installed.
- Rewards and Penalty schemes can also be implemented as deem fit.

Replicability and Sustainability

Replicability

- However, the success of any program is conditional upon the Management taking an active role.
- In this respect, the Management in Shangri-La Singapore as well as the Corporate Office is keenly monitoring the monthly performance of each and every property.

Replicability and Sustainability

Are our efforts Sustainable?

- Much efforts have been spent, to establish policies, targets, operating procedures and installation of sub-meters.
- The maintenance efforts have been continuous and we are constantly kept on out toes through the annual Engineering Audit.

Shangri-La hotel

Thank You

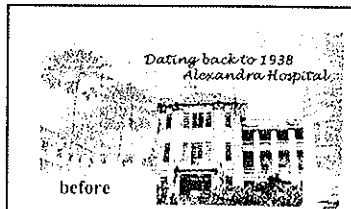
The End

Alexandra Hospital

History

British Military Hospital - 1935

Transfer to Ministry of Health - 1971



before



present

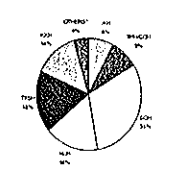
The Condition of Hospital 2000

Public Image of AH

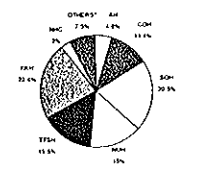
- One-star hospital
- A historical site
- Underground tunnel
- Hospital for the old and poor
- Cheap

Declining Market Share (1990 – 2000)

1990



2000

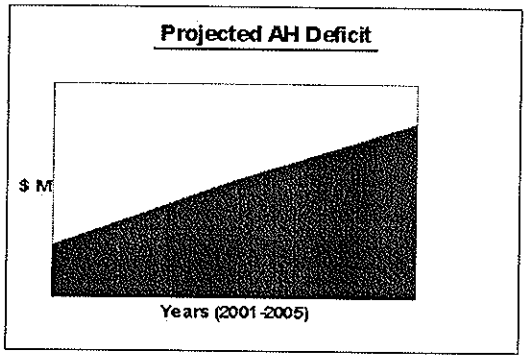


Mother of All AH's Problems

Low Patient Demand

- Poor public image
- Limited range of services
- Lack "unique" competitive edge







MOH to provide interim fundings but with strings attached.



Overview of Energy Retrofitting Program in Alexandra Hospital

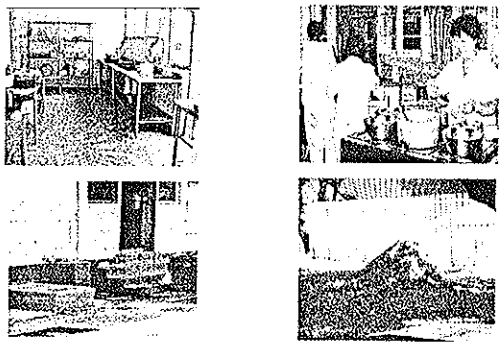
Being as energy efficient as possible is the one thing that each of us can do to help ourselves, our children and our environment.

Quote from BCA

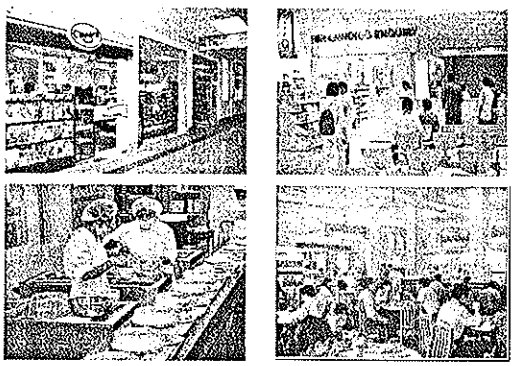
Before Restructuring (2000)



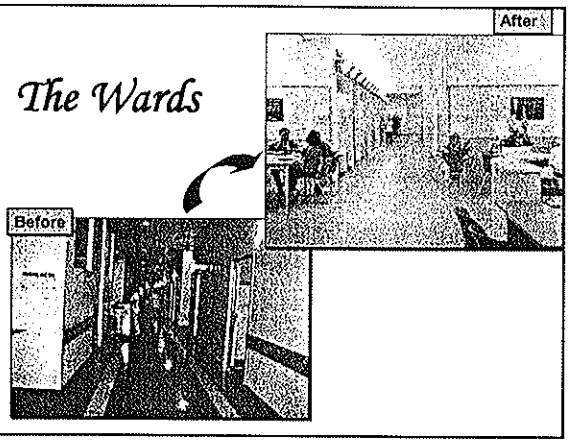
Before Restructuring (2000)

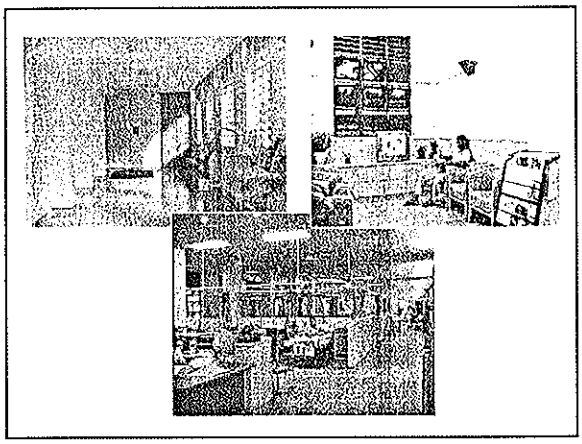


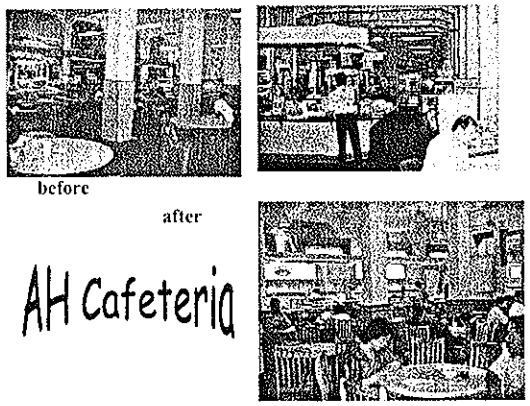
After Retrofitting (2001)

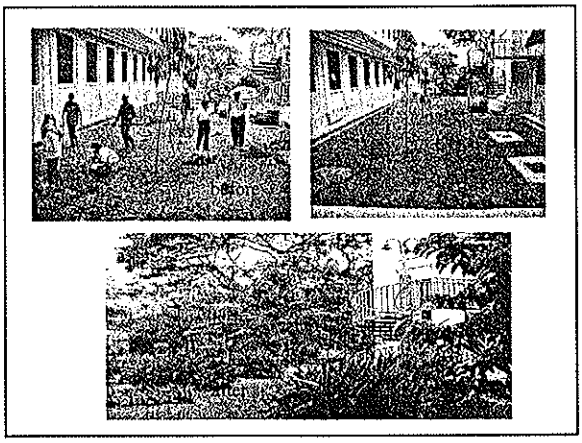


The Wards






before
after
AH Cafeteria



STAFF WELFARE



Childcare centre before renovation
(previously was a surgical store w/o aircon)





Childcare centre
after Renovation
(with 100% aircon)







AUDITING PROCESS

1. Data collected & analyzed

2. Compared with Benchmarks

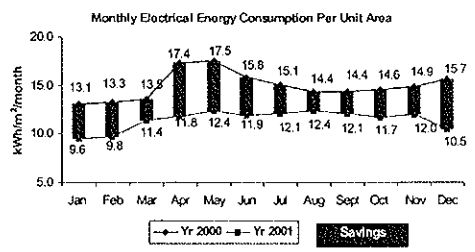
Findings

Improvements can be made to 3 areas:

- Air-con
- Lighting
- Compressed Air System

Actual/measured energy savings

	Before Restructure	After Retrofitting	% Change
Date	31/12/2000	31/12/2001	
Air-con Area (nearest 1000 m²)	10,000	14,000	↑ 40
Non Air-con Area (nearest 1000 m²)	25,000	23,000	↓ 8
Electricity(kWh/m²/yr)	180	138	↓ 23.3



Reason for Success

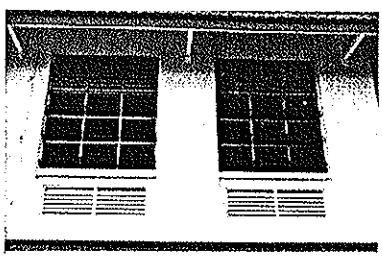
- Effective Leadership under CEO
- Human Factors
- Ground Factors
- Maintenance Practice

Environment Impact Consideration

- Waste Management
- Pollution Management
- Green/Non-Toxic Materials
- Others

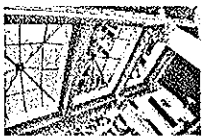
Ventilation Louvers

- Install at patient's bed level
- Enhanced cross ventilation
- Lower energy cost



Infusion of Daylight

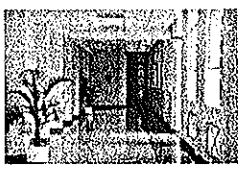


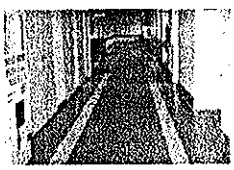


Water Features




Natural Ventilation


After

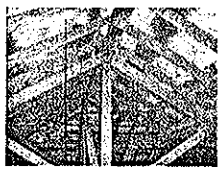
Before


Architectural Design



Before

After



Landscaping

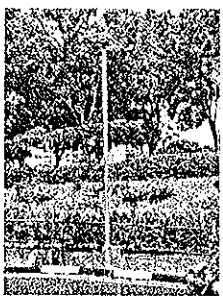
Before

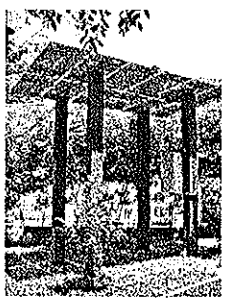




After

Renewable Energy

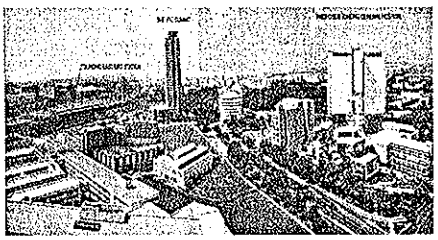




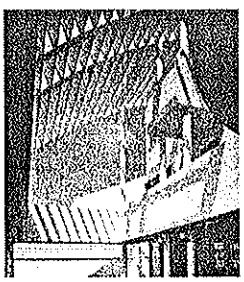
Alexandra Hospital

Moving Ahead To Year 2006

The Future Alexandra Hospital



Energy Efficient



- At least 66% more energy efficient
- Tropical building
- Natural ventilation
- Overhangs
- High ceilings
- Use of solar and wind power

THE END

Thank You