Integrated Sustainable Building Design

Case Studies:

Beijing Parkview Green &
China Resources Building Hong Kong

HKIFM – International Conference on Sustainable Integrated Design process for Buildings and Construction, SIDP Hong Kong

29 & 30 September 2009

Dr Raymond Yau
Arup Fellow & Director
Ove Arup & Partners Hong Kong Ltd.

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Beijing Parkview Green

- Dec 2000 Hong Kong Parkview Group plans for an ambitious mixed-use commercial development in Beijing.
- A site with potential for a development of 200,000 m^2 .
- Beijing's stringent planning regulations meant it would not be possible to fulfill the site's potential planning area with a standard development.
- The Group turned to IDA (Architect) and Arup (Engineers), who after careful analysis realized there might be a way of maximizing the site's potential and the building's environmental credentials at one and the same time.
- By enclosing the entire site in a glass and ETFE cushion skin.

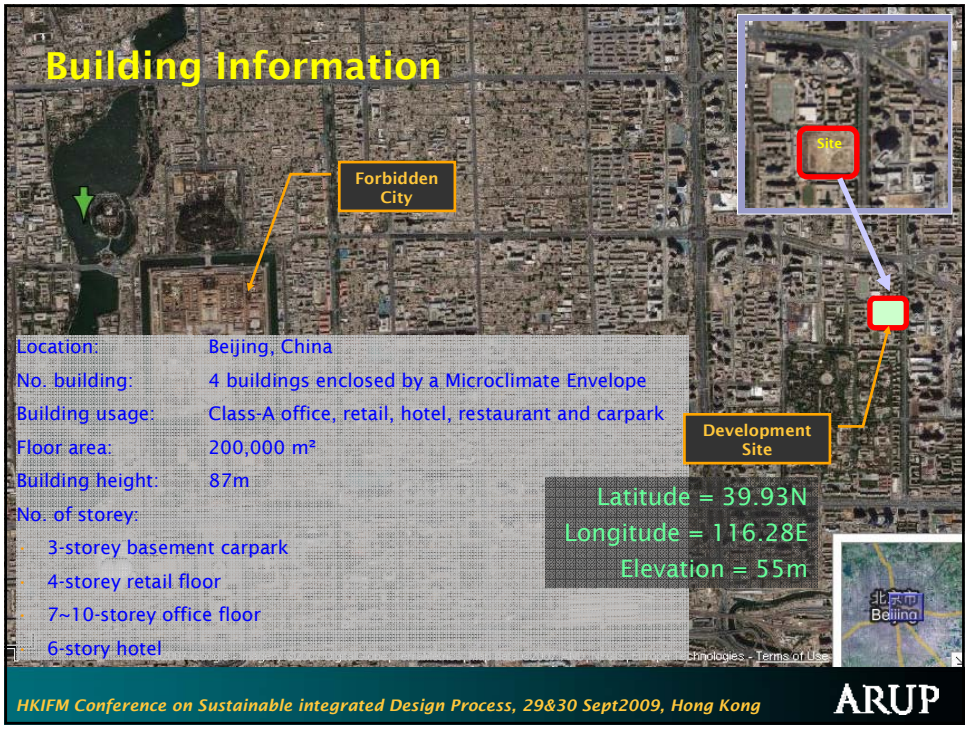
Beijing Parkview Green

Beijing Parkview Green

- This would allow the in-between spaces, roofs and terraces to be used year-round as supplementary space.
- While creating a tempered environment within that would provide a level of thermal comfort without the need to costly air-conditioning.
- Such a radical approach requires technologies that had never before been applied on such a scale.
- Parkview agreed to underwrite the necessary research and analysis.
- By 2004 the long term benefits were clear and, with the full support of the Beijing authorities, Preliminary Design Approval was finally granted in 2005.
- The building is due to be completed by end of 2009.

Beijing Parkview Green

- Recevied LEED Pre-certified Core & Shell Platinum on September 22, 2009.



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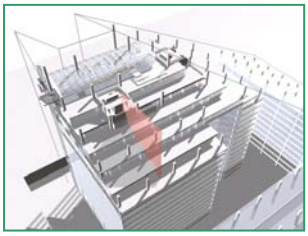
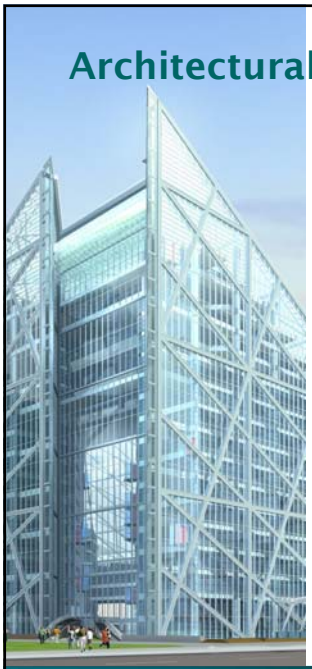
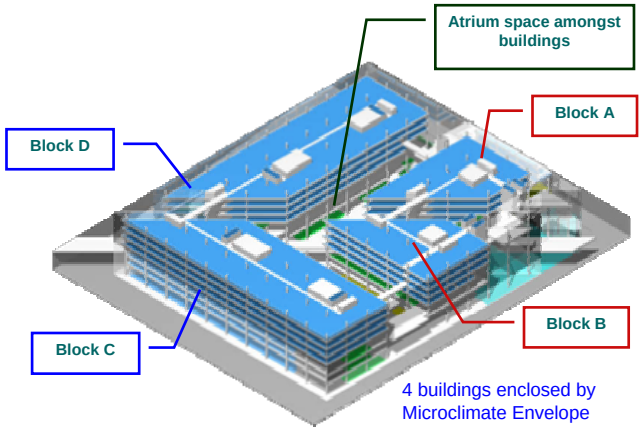
Architectural Mix



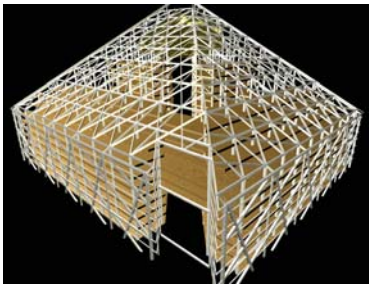
Architectural Design





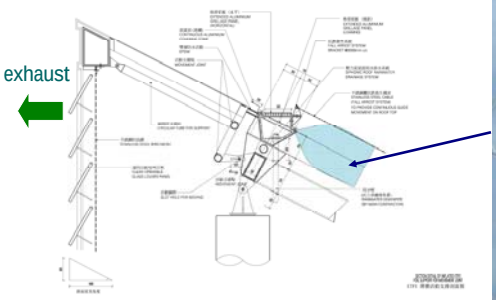
Fabric Construction of Microclimate Envelope

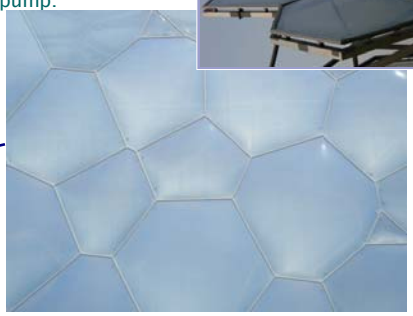
ETFE roof	overall U-value = 1.6, SC=0.4
Internal facade glaze	U-value = 1.6, SC=0.5
External facade glaze (facing buildings)	U-value = 1.6, SC=0.85
External facade glaze (4 facades connecting to atrium)	U-value = 1.6, SC=0.3
L9 glazed roof	U-value = 1.9, SC=0.3



ETFE Roof – Construction & Configuration

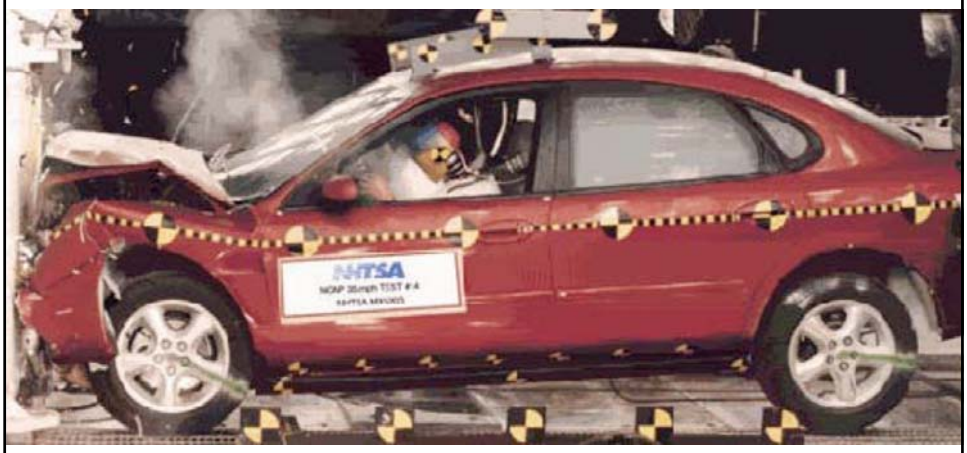
- All cushions are constructed from 2 or more layers of ETFE foil.
- Each foil layer is 100~250 microns thick.
- ETFE foils are highly elastic materials. Elongation at break point is approx. 400%.
- ETFE has a long-term memory, i.e. long-term elasticity.
- The cushion rise / dip for 15%~20% of span is allowed.
- Nominal inflation pressure 200Pa. (same as National Swimming Centre)
- Cushion foil and structure able to handle both wind up-lift and wind pr
- Cushion internal pressure to be controlled by air pump.



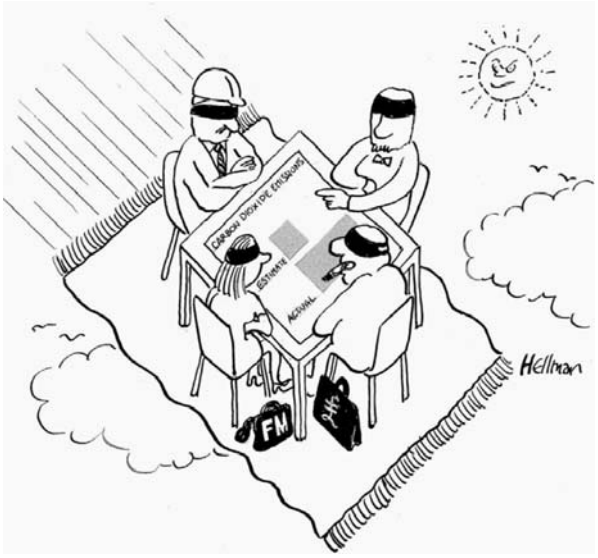


"Clients are the crash-test dummies of the design world"

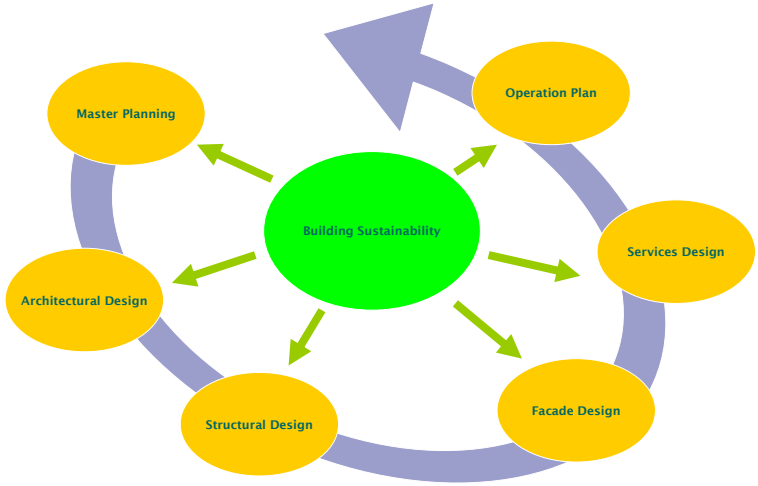
Sam Cassels (Usable Building, UK)



In buildings, is anybody monitoring the crash-tests?



Integrated Sustainable Building Design Approach

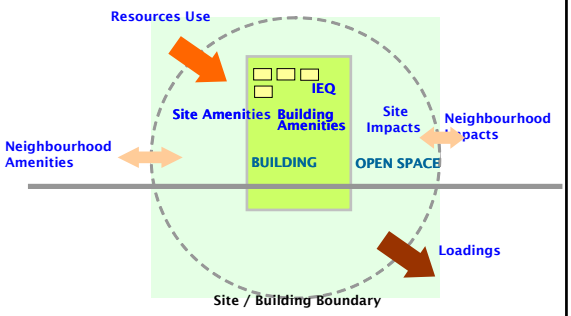


Stakeholders' Role as Driver

- Setup up goals and innovative targets
- Clearly declares the design intention & requirements
- Establish appropriate brief / programme
- Setup enough time and financial support
- Establish a good team with good designers & specialists
- Provide feedback to designer at the beginning, not to ask them to investigate failure problem later
- Procure what you can afford to manage
- Be management vigilance

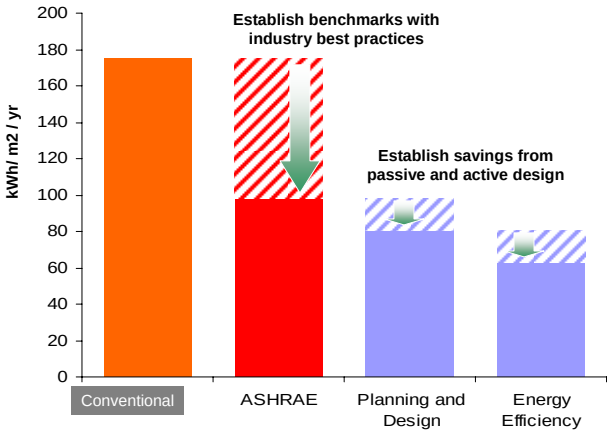
Sustainable Design Objectives

- New paradigm of sustainable building in China
- Sustainable & environmentally-friendly occupied areas
- Low natural resources consumption and energy efficient buildings
- Minimal social and environmental impact to surrounding building occupants
- Cost effective and low O&M cost green technologies
- Maximize use of hybrid ventilation
- Low environmental impact
- Good indoor environmental quality
- Safe, healthy and liveable space
- Integrated Design Aspects
  - Energy
  - Water
  - Material
  - Land
  - Indoor Environmental Quality
  - Operation and Maintenance

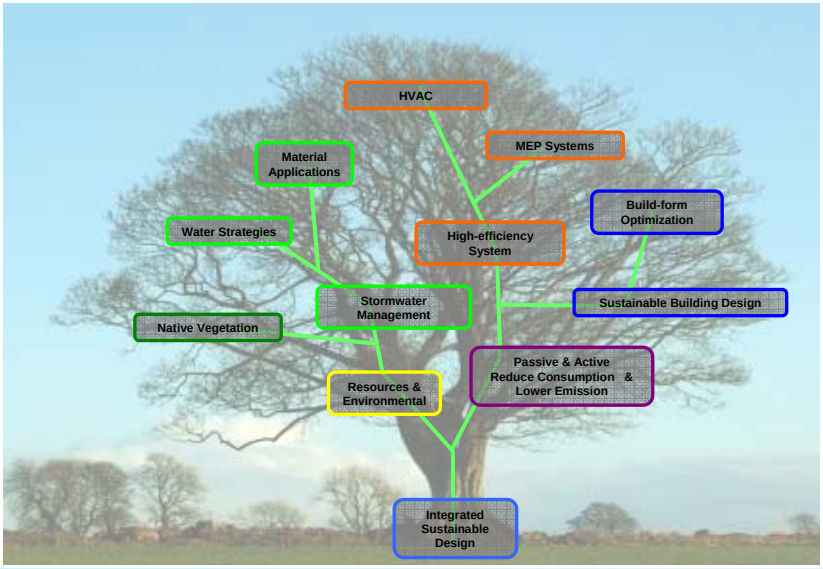


Critical Energy Strategies to Achieve Sustainable Design

1. Reduce energy consumption – Passive design
2. Energy efficient – Active system strategies
3. Renewable energy



Sustainable Design Tree



Sustainable Energy Solutions

Passive Design Strategies

- High performance facade
- Shading devices
- Thermal mass
- Green roof & green wall
- Sunspace design
- Natural ventilation strategies

Active Energy Efficient System

- Radiant heating
- CCHP

Lighting System

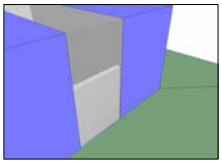
- Daylight utilization
- High efficiency lighting – LEDs
- Light pipe
- Lighting control system (Occupancy sensor)

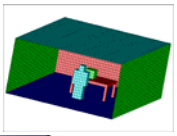
Renewable System/ Clean Power

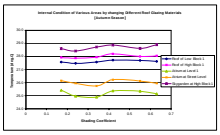
- PV system
- Solar thermal
- Wind turbine
- Biomass boiler

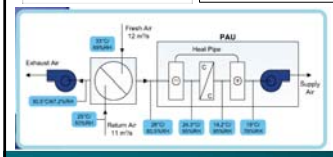
Green Features

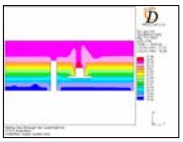
- Hybrid ventilation and Night cooling in office
- Free cooling for air-side systems
- Skygraden
- Thermal break on facade interior (double skin facade)
- Daylighting
- Rainwater recycling
- AC condensate resued for cooling tower
- Evaporative cooling
- Heat Pipe
- Earth cooling in basement (fresh air pre-cool)
- Variable speed pump and ventilation fans
- Evaporative type water cooled air-conditioning









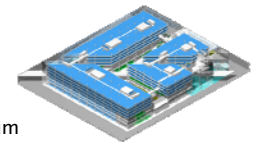


Technical Studies

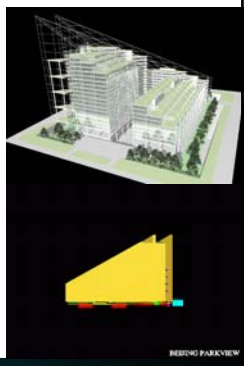
- Hybrid ventilation
- Ventilated facade
- Ground source heat pump
- Photovoltaic system
- Heat pipe application
- Radiant cooling / heating
- Heat recovery chillers
- Building thermal and pressure distribution
- Building solar and daylight access
- Building energy simulation
- Ecological enclosure thermal and ventilation study
- Energy efficient air distribution system
- Air-side and water-side free cooling
- Outdoor and indoor cooling tower schemes
- Chiller plant heat rejection study

Microclimatic Envelope Design

Function of Microclimatic Envelope



- **Spring & Autumn Seasons**
  - Introduce natural ventilation – enhance thermal comfort in Atrium and Sky-gardens
  - Introduce natural ventilation – reduce energy consumption for Office air-conditioning systems
  - Reduce energy consumption of air-conditioning system for other areas, I.e. Hotel and Retail by reduction of solar heat gain
- **Summer Season**
  - Reduce energy consumption of air-conditioning system for all areas, I.e. Office, Hotel and Retail by reduction of solar heat gain
  - Introduce natural ventilation – Increase the air movement inside the atrium and thermal comfort
- **Winter Season**
  - Isolation from freezing environment – Increase Atrium air temperature and thermal comfort
  - Reduce energy consumption of heating system by reduction of fabric heat loss



Microclimatic Envelope Design

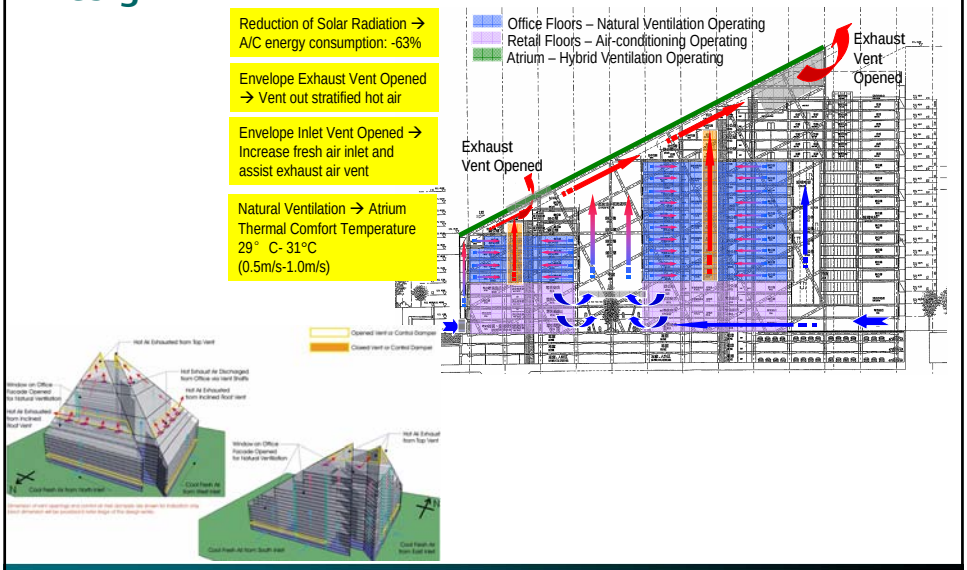
Spring & Autumn Seasons

Reduction of Solar Radiation → A/C energy consumption: -63%

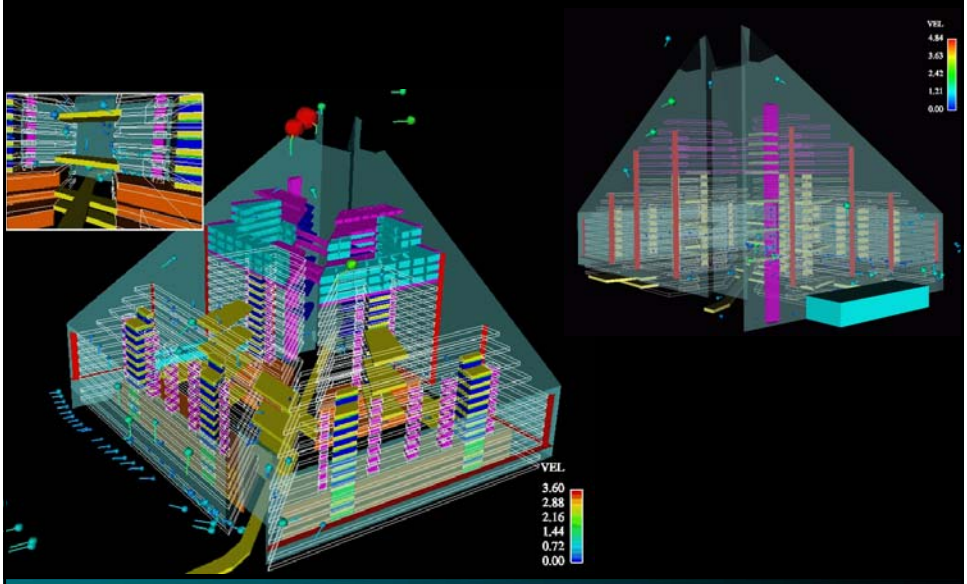
Envelope Exhaust Vent Opened → Vent out stratified hot air

Envelope Inlet Vent Opened → Increase fresh air inlet and assist exhaust air vent

Natural Ventilation → Atrium Thermal Comfort Temperature 29° C- 31°C (0.5m/s-1.0m/s)

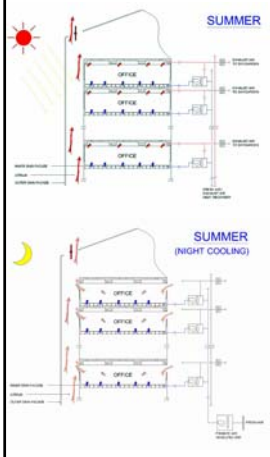


Natural Ventilation – windy condition



Microclimatic Envelope Design

Summer Season



Reduction of Solar Radiation → A/C energy consumption: -13%

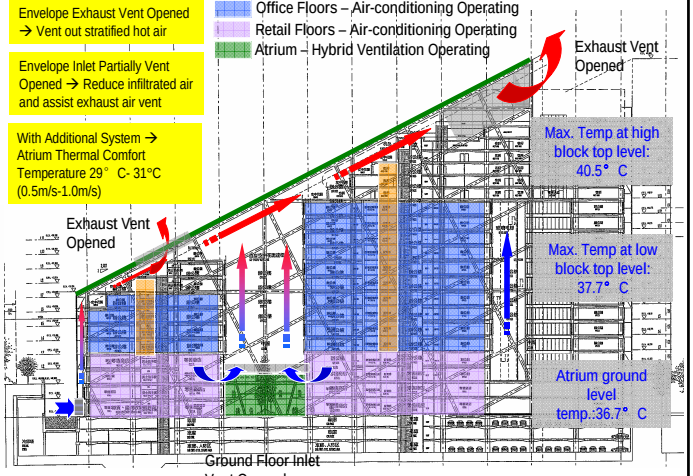
Envelope Exhaust Vent Opened → Vent out stratified hot air

Envelope Inlet Partially Vent Opened → Reduce infiltrated air and assist exhaust air vent

With Additional System → Atrium Thermal Comfort Temperature 29° C- 31°C (0.5m/s-1.0m/s)

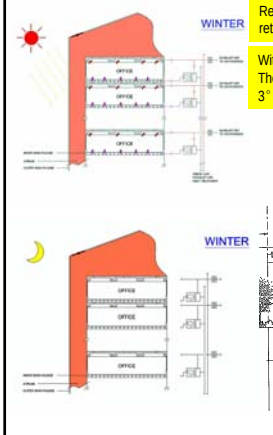
Summer outdoor temp: 35° C

Office Floors – Air-conditioning Operating
Retail Floors – Air-conditioning Operating
Atrium – Hybrid Ventilation Operating



Microclimatic Envelope Design

Winter Season



Additional Fabric Insulation → Heating energy consumption: 80%

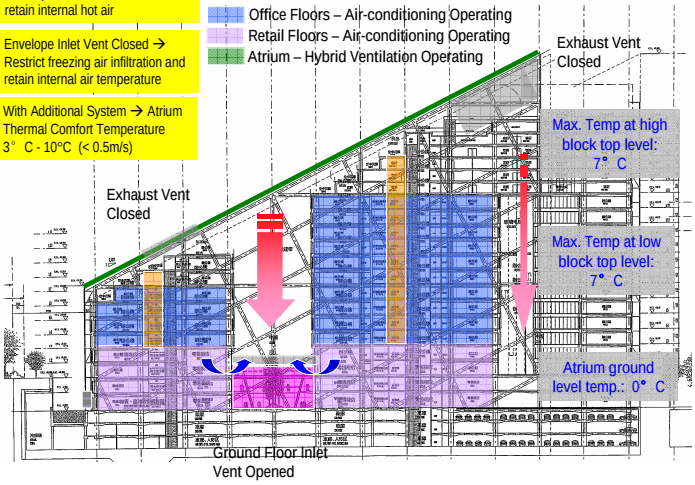
Envelope Exhaust Vent Closed → retain internal hot air

Envelope Inlet Vent Closed → Restrict freezing air infiltration and retain internal air temperature

With Additional System → Atrium Thermal Comfort Temperature 3° C - 10°C (< 0.5m/s)

Winter outdoor temp: -10° C

Office Floors – Air-conditioning Operating
Retail Floors – Air-conditioning Operating
Atrium – Hybrid Ventilation Operating



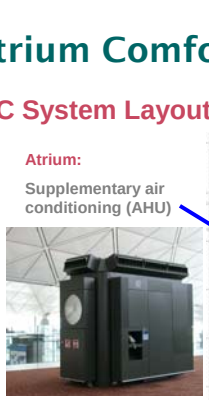
Energy Saving for HVAC System

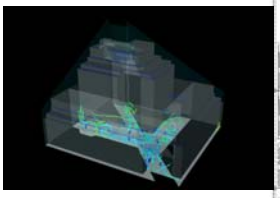
Function of microclimate envelope – reduce system energy consumption

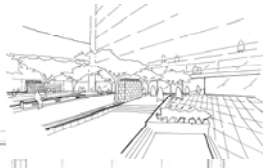
	System cooling / heating load (without microclimate envelope)	System cooling / heating load (with microclimate envelope)	Total AC energy saving
Spring & Autumn	Office = 10300 MWh Hotel = 530 MWh Retail = 4100 MWh	Office = 1700 MWh Hotel = 470 MWh Retail = 3300 MWh	**63%**
Summer	Office = 9100 MWh Hotel = 540 MWh Retail = 3300 MWh	Office = 8000 MWh Hotel = 470 MWh Retail = 2700 MWh	**13%**
Winter	Office = 4000 MWh Hotel = 340 MWh Retail = 1400 MWh	Office = 800 MWh Hotel = 70 MWh Retail = 280 MWh	**80%**

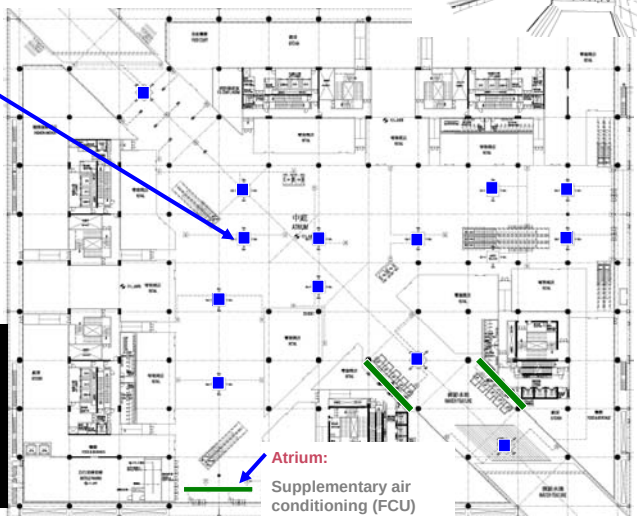
Atrium Comfort Improvement

AC System Layout Plan at SL2 Atrium









Atrium Comfort Improvement

Summer – SL2 Atrium Environment

Optional thermal environment improvement system	
Exhaust air reuse	Utilize retail exhaust Exhaust air flowrate 32 m^3/s SA temp **25.0°C**
Atrium air supply system	Utilize office exhaust / atrium cooling unit SA flowrate 70 m^3/s SA temp **25.0°C**
Radiant cooling	Less effective than supply air system, require chilled water supply, pipeworks cannot be laid under EVA
Pool evaporative cooling	Less effective than supply air system, require large amount of make-up water, condensation at retail shop glass surface adjacent to the pool

Key Issues in Hybrid Ventilation

- Operational strategy for the microclimate envelope and all buildings in different seasons
- Air circulation and temperature distribution within the microclimate envelope
- Air circulation for hybrid ventilated space – office and circulation area
- Materials selection for the included roof of microclimate envelope
- Materials selection for different elevation of microclimate envelope and buildings
- Vent (intake & exhaust) openings design on microclimate envelope
- Air intake locations (orientation & level) and adjacent usages
- Control interface with HVAC systems
- Performance monitoring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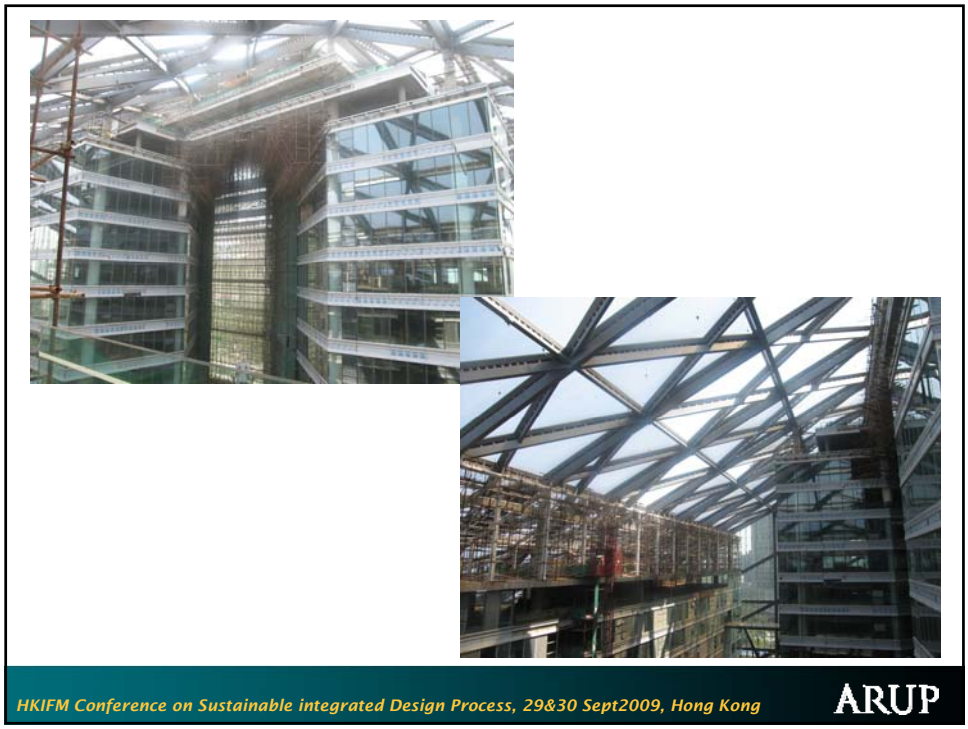


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Parkview Green
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Parkview Topping Out Ceremony 2 July 2009
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Assessing How Green a Building is

What is LEED ?

- Designed and managed by the USGBC
- "Score Based" Rating System – *Platinum*, *Gold*, *Silver*, *Certified*
- Design Guide

LEED Assessment – Categories

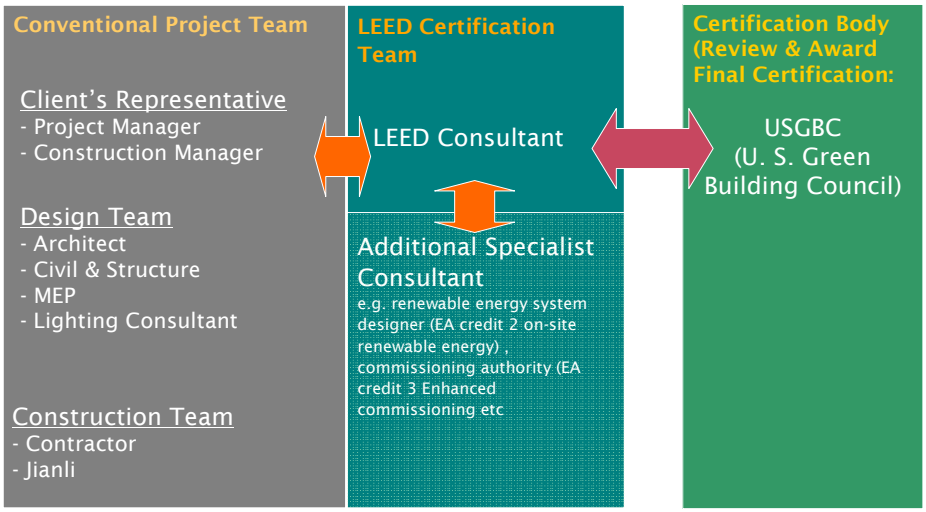
Sustainable sites	• landscaping, transportation, neighborhood, onsite infrastructure
Water efficiency	• greywater system
energy and atmosphere	• passive design (orientation, glazing, insulation) • active design (solar PV)
Materials and resources	• recycled concrete, wall/roof/flooring • construction waste management
Indoor environmental quality	• painting, ventilation
Innovation and design process	• think out of the box

Key to Success

Elements of Success

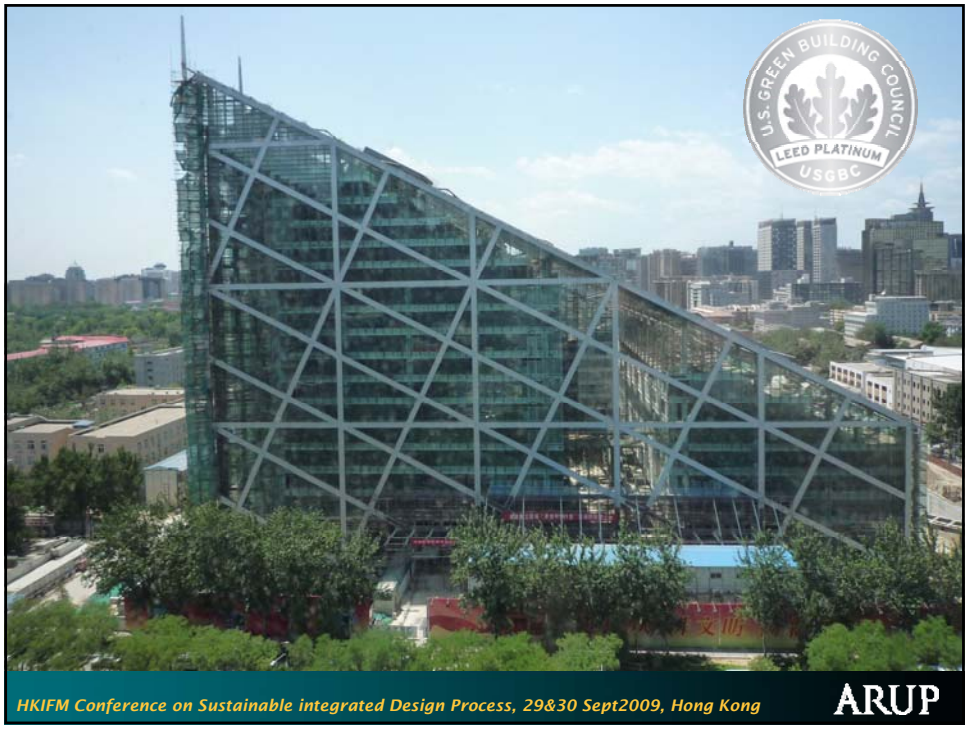
- Owner and Team Buy-in (Life Cycle Thinking)
- Quality Design, Green Construction and unambiguous Documentation
- Cost-effective and Innovation Concepts
- Team Collaboration (Integrated Design)
  - **Owner**
  - **Design Team**
  - **Contractor**
  - **LEED™ Coordinator**

Key Roles of Project Team Members in LEED Certification



- Project Manager (Client's Representative):
  - Oversee the overall progress of LEED Assessment
  - Coordinate within project team members for LEED
- Designers (Architects, Civil & Structure, E&M, Lighting Consultant etc):
  - Incorporate the LEED requirements and reflect in design
  - Incorporate the particular LEED requirements in contracts.
  - Provide Supporting Document to LEED Consultant for Certification
- Construction Manager (Client's Representative):
  - Supervise the construction work related to LEED and the work quality of contractors
  - Check the site work documentation submitted by contractors
  - Prepare construction plan, e.g. sedimental control plan for designer review.
- Contractor:
  - Undergo the construction work and site work documentation related to LEED
  - Implement construction planning prepared by Construction Manager
- Jianli:
  - Independent third party to oversee the construction work, i.e. CM
  - Contribute to meeting the requirement of EA C3 Enchanced Commissioning Requirement

- Determine the appropriate level of LEED accreditation with client, PM, designer
- A "care-taker" to oversee the process of LEED Certification
- Support PM to effectively achieve the LEED Certification
- Give guidance to design & construction teams on achieving LEED requirements
- Prepare documentation for LEED certification submission, i.e. Letter Template, Design Narratives, Supporting Calculation
- Conduct Detail Analysis to meet LEED requirements:
  - Thermal Comfort Analysis (EQ credit 7.1 thermal comfort)
  - Daylight Simulation (EQ credit 8.1 daylight and view)
- Review supporting documentation provided by design & construction teams
- Liaison and answer queries from USGBC



China Resources Building Hong Kong: A Sustainable Transformation and Role Model of Existing Building Renovation

Dr. Raymond Yau
Arup Fellow and Director of
Ove Arup & Partners Hong Kong Limited

29 September, 2009

ARUP

Presentation Highlights

1. Project Background
2. Challenges
3. LEED Certification
4. Design Consideration
5. Construction Consideration
6. Benefits

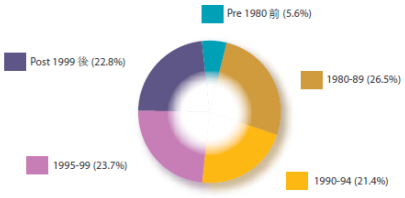
1. Project Background

Project Background

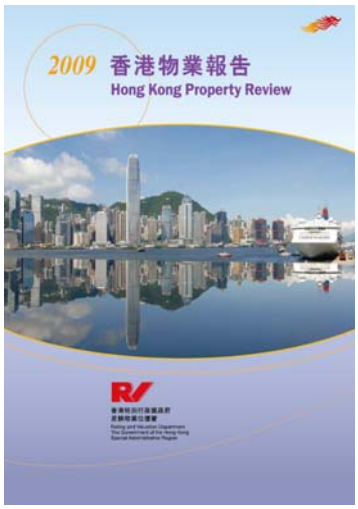
Our challenge – Why and How to bring a 25 year-old development into the 21st Century?

Project Background

Hong Kong Grade A Offices – Stock Distribution by Age



- **341,000m2 Completion of Private Offices in 2008**
- **97% of the new supply are Grade A office**
- **In terms of quality and performance, buildings newly constructed are more sustainable.**
- **Existing building owners have to prepare if they hope to attract and retain future tenants.**



Project Background

Renovation

Architect Ronald Lu & Partners (Hong Kong) Limited

Sustainability Consultant Ove Arup & Partners (Hong Kong) Limited

2. Challenges

Challenges - Climate Change

"One important way for cities to reduce energy use and greenhouse gas emissions is to retrofit their existing buildings with more energy efficient products and technologies."
– **Clinton Climate Initiative 2007**

"We will make early preparations to meet the challenge of climate change. In particular, we will enhance energy efficiency, use clean fuels, rely less on fossil fuel, and promote a low carbon economy – an economy based on low energy consumption and low pollution."
– **2008-2009 Policy Address**

Existing Buildings Survival Strategies

Six Easy Steps – A survival strategy for your building

Step #1 Determine Your Baseline

Step #2 Establish Your Goals & Targets

Step #3 Review Your Building Maintenance, Housekeeping & Energy Purchase Strategy

Step #4 Crunch Time: Refurbish or Demolish?

Step #5 Select Your Optimal Upgrade Initiatives

Step #6 Make It Happen

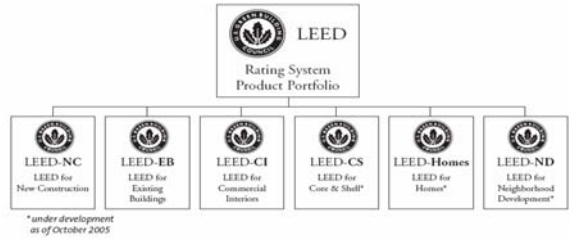
3. LEED Certification

Sustainable Framework

Leadership in Energy and Environmental Design (LEED)

1. **Recognised U.S. standard for high performance and sustainable buildings**
2. **Provides a holistic framework to assess the building performance and achieve sustainable objectives**
3. **Emphasises advanced strategies for:**
   - **sustainable site development**
   - **water saving**
   - **energy efficiency**
   - **material use**
   - **indoor environmental quality**
   - **Innovation in design**

LEED Certification



- **LEED Family**

1. **Neighborhood Development (ND)**
2. **New Construction (NC)**
3. **Core & Shell (CS)**
4. **Commercial Interior (CI)**
5. **Existing Building (EB "O&M")**
6. **Homes (Homes)**

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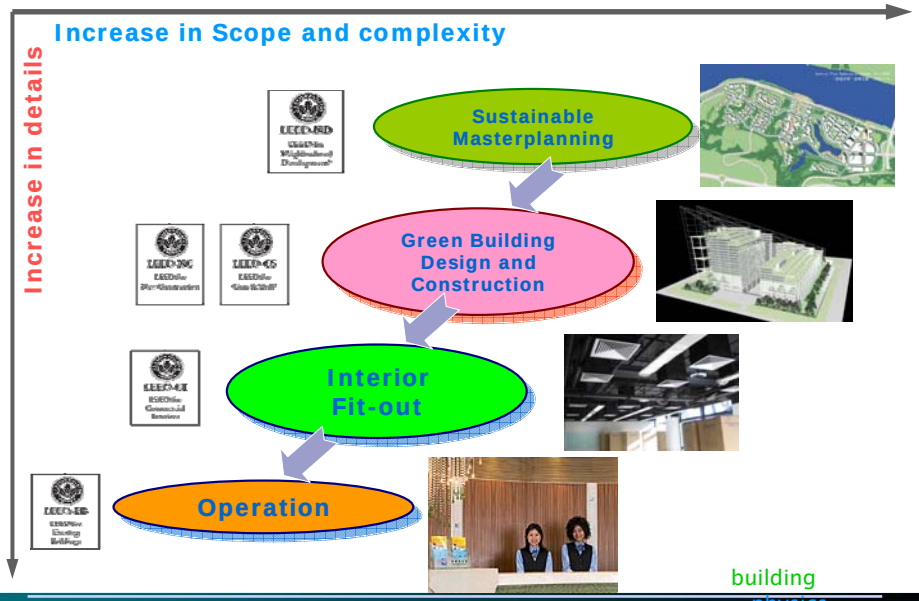
Implementation Framework



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LEED Projects in Hong Kong

Project Name	Owner	City	State	Country	LEED Rating System
MMoser Hong Kong		Hong Kong		HK	LEED CI 2.0
Macquarie Bank HK Relocation Project		Hong Kong		HK	LEED CI 2.0
T Rowe Price - Hong Kong		Central		HK	LEED CI 2.0
HOK International (Asia/Pacific) Limited		Hong Kong		HK	LEED CI 2.0
Charles Schwab Hong Branch Relocation		Hong Kong		HK	LEED CI 2.0
Citi One Island East		Quarry Bay		HK	LEED CI 2.0
RENOVATION OF CHINA RESOURCES BUILDING		Hong Kong		HK	LEED CS 2.0
KC215	Sun Hung Kai Properties Ltd.	Kwai Chung		HK	LEED CS 2.0
Redevelopment of 500 Hennessy Road		Hong Kong		HK	LEED CS 2.0
Tai Yuen Street Development		Hong Kong		HK	LEED NC 2.2
Caine Road Residential Development		Hong Kong		HK	LEED NC 2.2
Kai Tak Government Office		Hong Kong		HK	LEED NC 2.2

- **For CS Project, the rating is as follows:**

1. **Certified (23-27 points)**
2. **Silver (28-33 points)**
3. **Gold (34-44 points)**
4. **Platinum (45-61 points)**

China Resources Building will be the first renovation project to obtain LEED-CS 2.0 GOLD Level in Hong Kong

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Sustainable Framework

Carbon Audit

Carbon Audit · Green Partners

- **Aims of conducting carbon audit:**

1. **Identify areas of improvements**
2. **Promote and facilitate Green House Gas (GHG) emission reduction by supporting offsetting activities to compensate for the GHG emissions from buildings**
3. **Promote awareness and acceptance from the tenants and users of buildings regarding the GHG emission reduction measures**

綠色香港 我鍾意
I Love Hong Kong
I Love GREEN

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Energy Use and GHG Emission Reduction

CO2 Emissions
二氧化碳排放
Reduction: **7.5%**

Reduction of **1,370 tons** CO2 per year = annual absorption of CO2 by approx. **200,000 Pine Trees**
每年減少**1,370噸**二氧化碳, 相等於**二十萬棵松樹**一年的吸收量

Water 用水
Reduction: **30%**

Saving **11,180m³** of water per year = filling of **4.5 Olympic pools**
每年節省用水**11,180**立方米,相等於**4.5個奧運標準泳池水量**

Power 能源
Reduction:
More than 10%

Energy consumption savings of **1.65 GWh** per year = 24-hr operation of **5,200 fluorescent tube** for a year
每年節省**1.65** 百萬千瓦時能源, 相等於**5,200 支24小時運行的光管**一年電耗量

Resources 資源
Reduction: **75%**

Recycling **53 tons of waste during construction**[1]
工程進行期間回收**53噸建築廢棄物**[1]

Gold Award

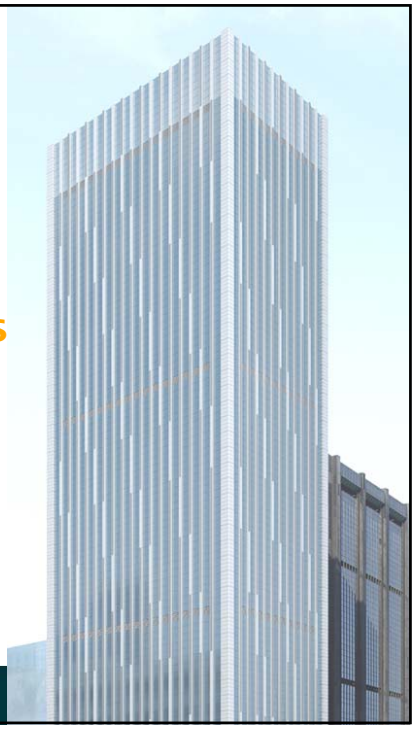
金獎

[1]The estimated figure is based on a typical fitting-out project

Project Highlights

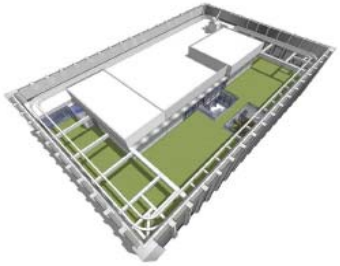
1. **Reuse Structural Frame**
   - **Reuse the existing structural frame so as to reduce construction waste and the demand of resources**
2. **High Performance Facade**
   - **Low-e Laminated Glass**
   - **Good Air Tightness**
3. **High Quality Interior Spaces**
   - **Increase Ventilation Rate**
   - **Use Low-VOC materials for renovated spaces**
4. **Upgrade of Electrical and Mechanical Equipment**
   - **Upgrade Air Handling Unit (AHU) for the whole buildings**
   - **Install CO2 Demand Control Ventilation System**
   - **Install innovative and high efficient lighting equipment**

4. Design Considerations



Design Considerations – Sustainable Site

1. **Reduce Urban Heat Island Effect**
   - **Use Solar Reflective Roofing Materials**
   - **Use Green Roof**
2. **Reduce Pollution from Automobile Use**
   - **Preferred Parking for Low-emitting/ Energy Efficient Cars**
   - **Bicycle Storage**



Design Considerations – Water Efficiency

Water Use Reduction

1. **Landscape Design**
   - **Design the landscape area with native or locally adapted plants to reduce irrigation water use**

2. **Potable Water Use**
   - **Use water-saving fixtures such as low-flow faucets with sensing devices**

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Design Considerations – Energy Efficiency

High Efficiency Lighting

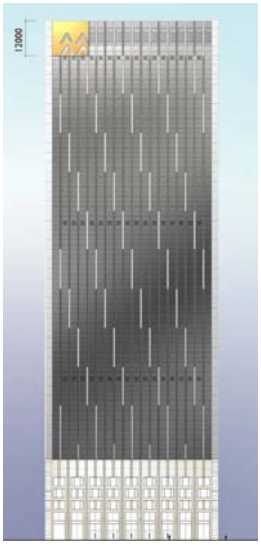
High Performance Facade

Daylight Sensor

Upgrade AHU

Occupancy Sensor

CO2 Demand Control Ventilation



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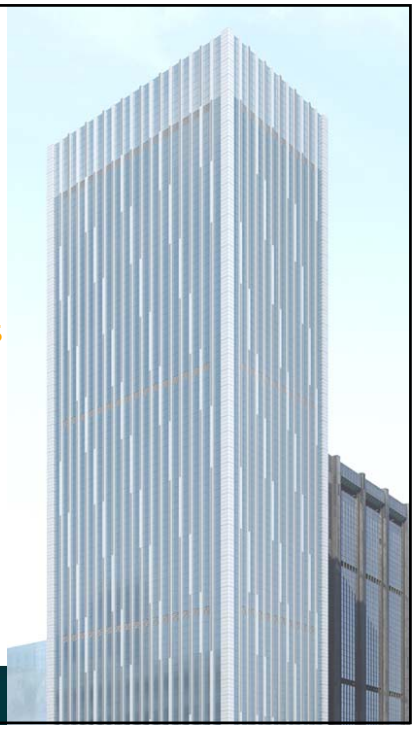
5. Construction Considerations



Construction Considerations – Materials and Resources

Reduce Waste and Encourage Recycling

1. **Recycling plan for tenants:**
   - **paper**
   - **corrugated cardboard**
   - **glass**
   - **plastics**
   - **metals**
2. **Construction Waste Management Plan**
3. **Use materials with recycled content**
4. **Use regional materials for the project**

Construction Considerations – Indoor Environmental Quality

To reduce odorous indoor air contaminants, which are irritating and harmful to occupants, the following measures will be taken:

1. **Increase ventilation rate above the ASHRAE Standard 62.1-2004 by 30%**
2. **Use low volatile organic compounds (VOC) materials:**
   - Adhesives, Sealants, Paints & Coatings - SCAQMD & Green Seal Standards
   - Carpet Systems - Carpet and Rug Institute's Green Label Plus Programme
3. **Implement Construction IAQ Plan**

6. Benefits

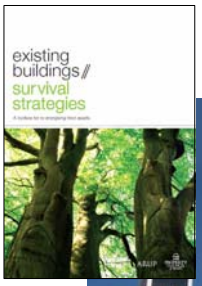
Benefits

Societal:
- Provide a model for existing buildings transforming to GREEN in HONG KONG!
- Raising public awareness of sustainability
- Improving company image

Economic:
- Reduce the building operating cost
- Increase property asset value

Environment:
- Lower waste generation and treatment cost, encourage recycling
- Reduce Energy Use and GHG Emissions
- Extend building life cycle

Natural Resources:
- Renovating existing buildings reduces demands on natural resources



Benefits – Increase of Property Asset Value

Extra cost for LEED:
- Extra cost for LEED is around 7-8% of the total project cost, higher than new construction project due to the renovation nature.

Capital Investment:
- The capital investment for those green features is 20%.

Return of Investment:
- The Return of Investment (ROI) is 10 years.

Annual Energy Saving:
- The annual energy saving is around 1.65M HKD.

Benefits – Public Awareness


灣仔華潤 6億綫綠色商廈

設泊位沖涼房 實現踩單車上班

環保建築認證 提升商廈形象

China Resources green path is one to follow


蘋果日報

華潤總部環保大翻新

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