



**Asia-Pacific  
Economic Cooperation**

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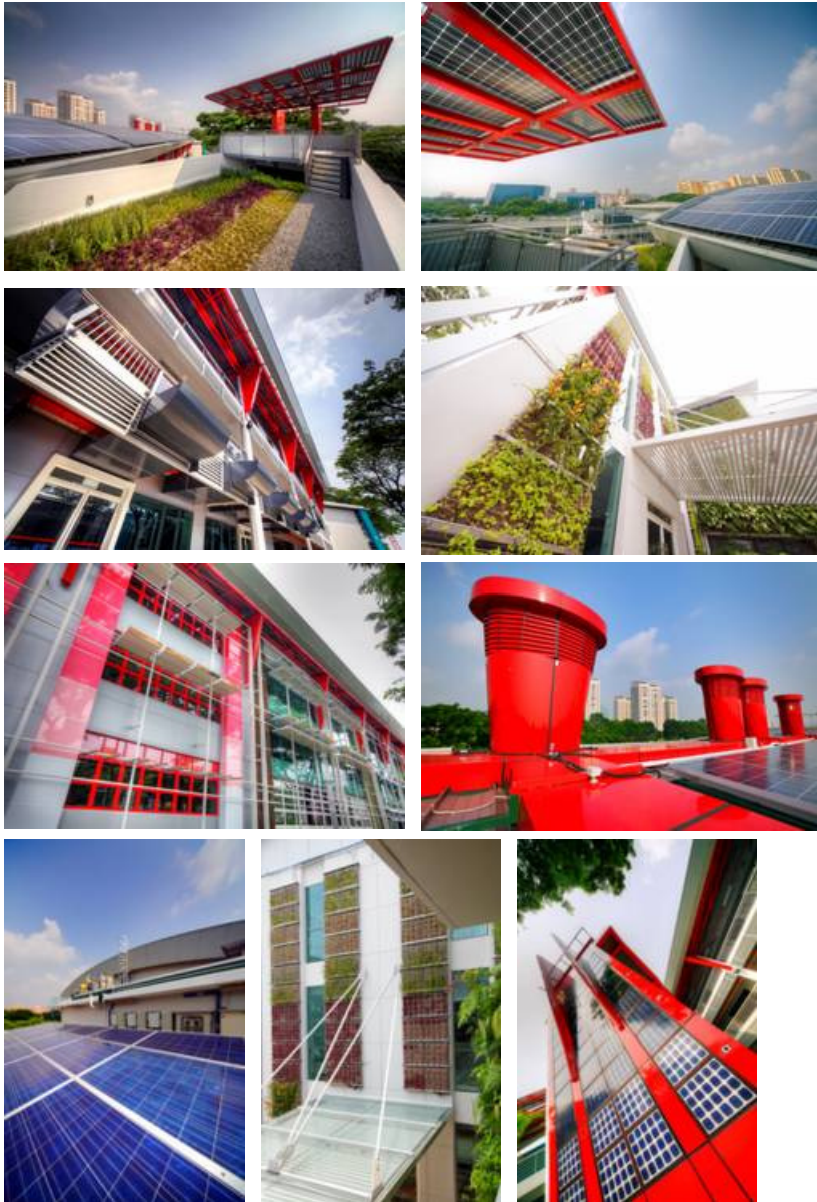
2011/EWG42/WKSP1/007

## **Zero Energy Building**

Submitted by: Singapore



**Knowledge Sharing Platform Workshop for  
the Energy Smart Communities Initiative  
Kaohsiung, Chinese Taipei  
17-18 October 2011**



  
**Zero Energy Building**  
© B C A A C A D E M Y

**Alice Goh,  
Building & Construction Authority**





# Objectives

- 1) To demonstrate that an existing building is able to achieve net zero energy
- 2) To serve as a test-bed for integration of Green Building technologies (GBTs) in existing buildings
- 3) To be a hub for practitioners and students in the study of energy efficiency and green buildings



# Project Team

- Owner - Building & Construction Authority (BCA)
- Project Manager - Beca Carter Hollings & Ferner (S.E. Asia) Pte Ltd
- Architects - DP Architects Pte Ltd
- M&E Engineer - Beca Carter Hollings & Ferner (S.E. Asia) Pte Ltd
- C&S Engineer - Beca Carter Hollings & Ferner (S.E. Asia) Pte Ltd
- Quantity Surveyor - Davis Langdon & Seah
- Main Contractor - ACP Construction Pte Ltd
- PV integrator - Grenzone Pte Ltd

## NUS Principal Investigators:

- Assoc. Prof Lee Siew Eang (Lead) - Total Building Performance
- Assoc. Prof Wong Nyuk Hien - Natural Ventilation & Greenery
- Assoc. Prof Stephen Wittkopf - Photovoltaic System & Facade



# Guiding Principles

## Step 1 - Passive Systems

### Efficient Envelope

- Type of window glazing
- Type of wall/facade

### Minimise Solar Heat Gain

- Roof garden & vertical greenery
- Sunshades

### Capitalize Daylighting

- Mirror ducts
- Light pipes
- Light shelves

## Step 2 - Active Systems

### Efficient Lighting

- T5 Fluorescent lights
- LED task lighting
- State-of-the-art lighting control systems

### Efficient ACMV

- Personalised Ventilation
- Underfloor air distribution system
- Single coil twin fans
- Solar chimneys

### Active Control

- State-of-the-art building management system

# Building Envelope

## Innovative Solutions for Facade Passive Design - Elements with multiple functions



# Building Envelope

## Innovative Solutions for Facade

### Passive Design – Overcoming the weather

Photovoltaics  
on shading devices

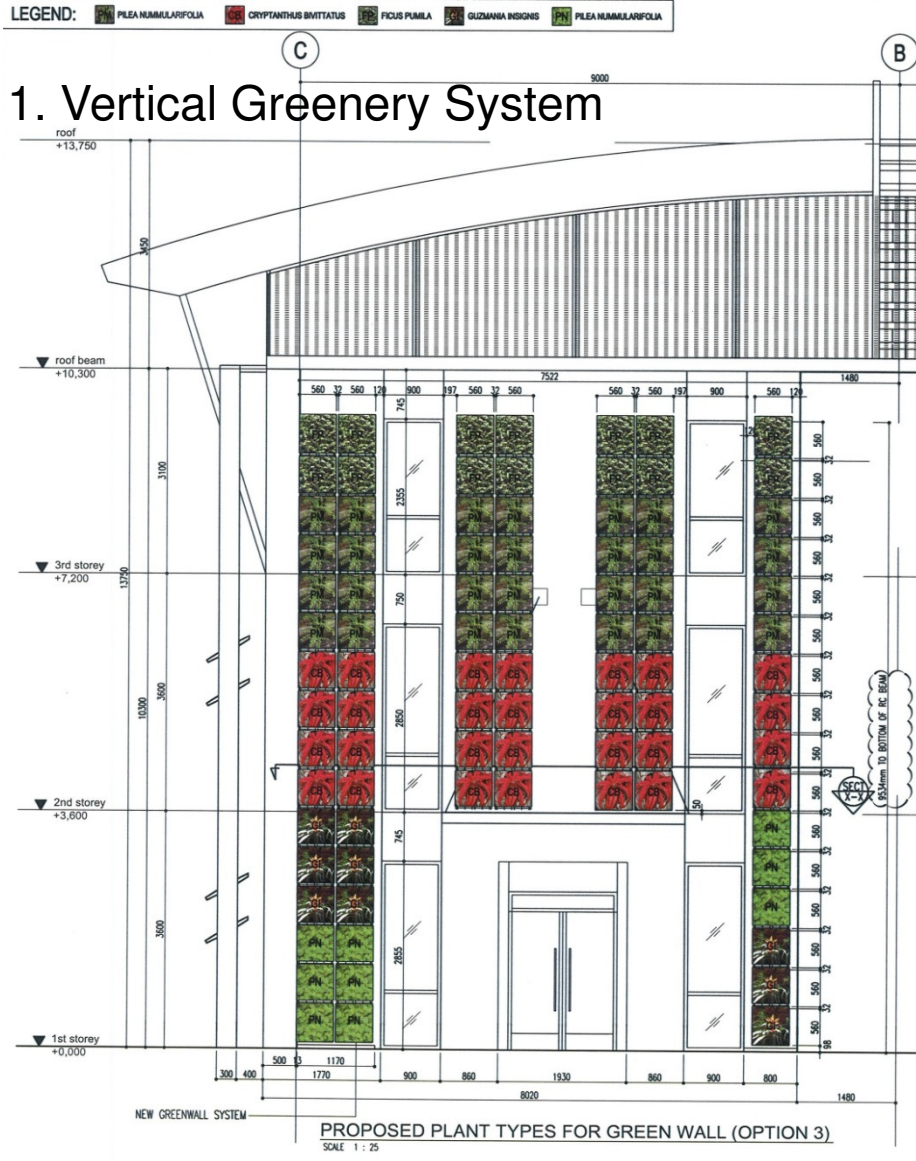
Vertical greenery



Light Shelves

# Building Envelope

## Unusual Aspects and Aesthetic Values



*Cryptanthus bivittatus*



*Guzmania insignis*



*Pilea nummularifolia*



*Phyllanthus myrtifolia*



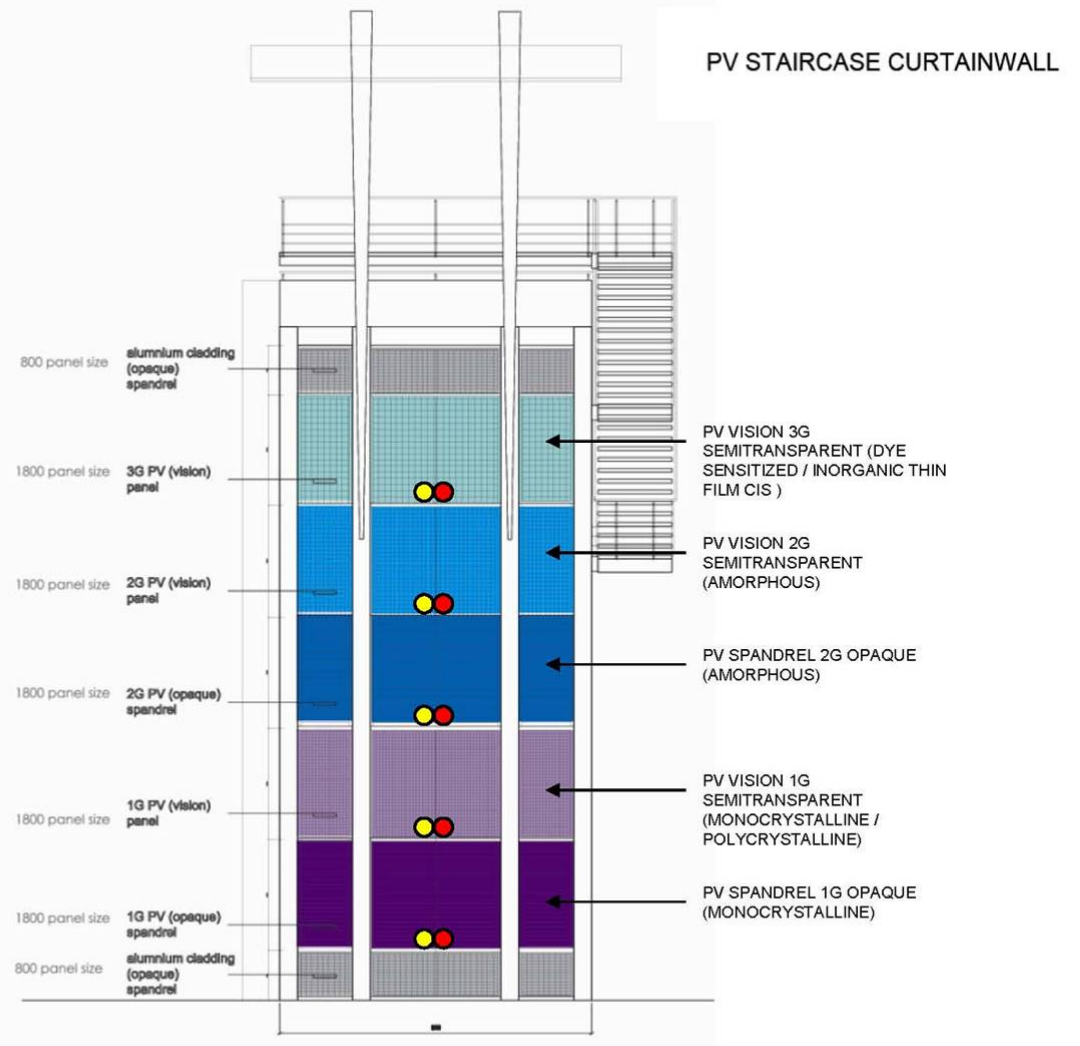
*Ficus pumila*



# Building Envelope

## Unusual Aspects and Aesthetic Values

### 2. PV Story Facade



#### LEGEND

- Cell Temperature Sensor
- Class-B Pyranometer mounted on vertical façade on PV panels

#### NOTE:

- I) Location of sensors are only representative
- II) This drawing is to be read in conjunction with technical specification section 1.

# Building Envelope

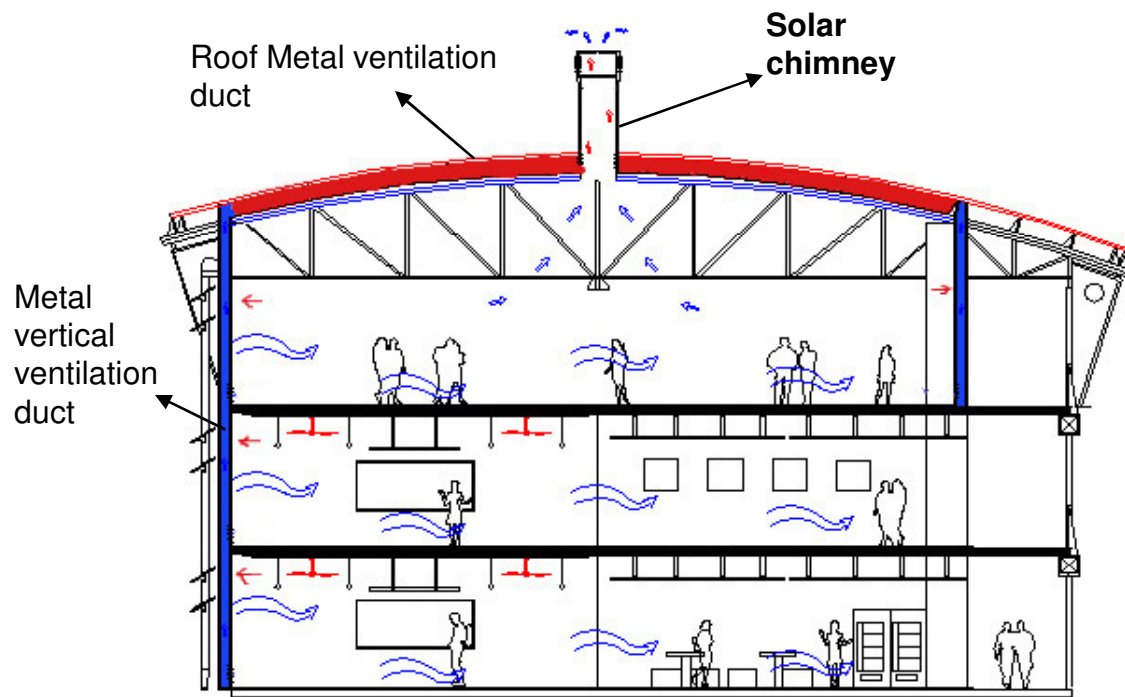
## Innovative Solutions for Roof



# Building Envelope

## Pioneering Use of Materials

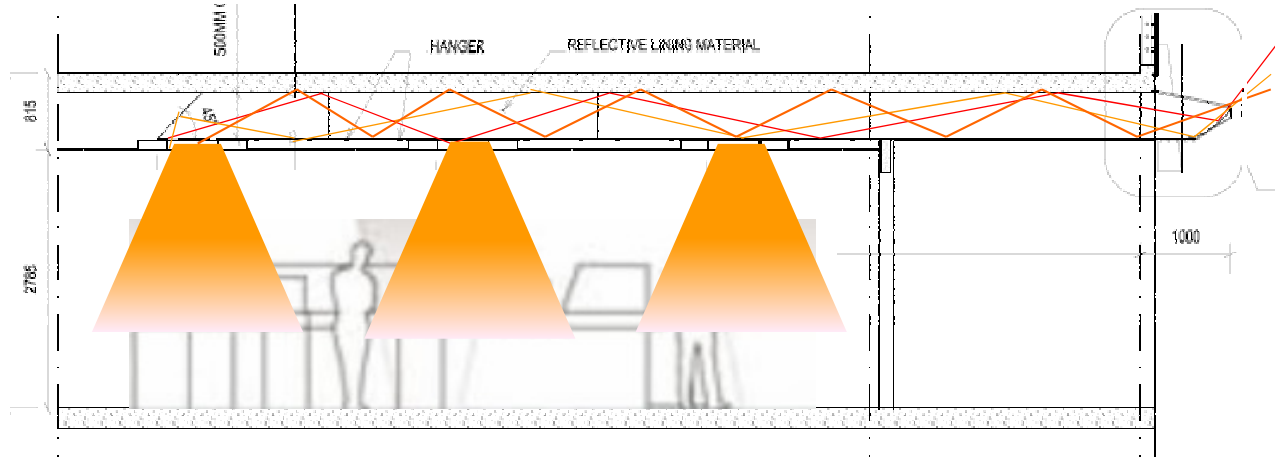
### Solar Assisted Stack Ventilation



# Inside Building

## Pioneering Use of Materials

### Mirror Duct



# Inside Building

## Experimental office

**Personalised ventilation**



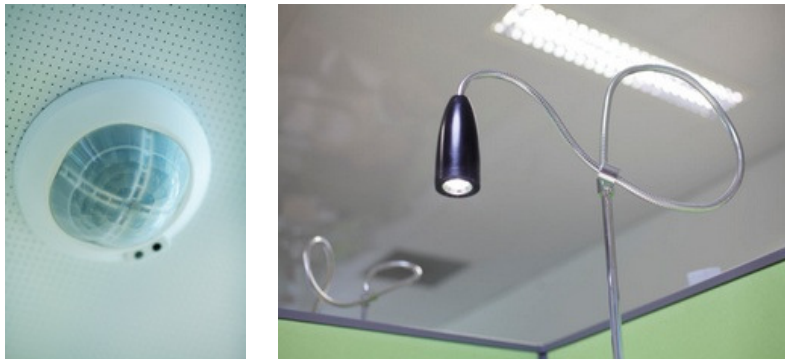
**Light pipes**



**Light shelves**



**Sensors, T5 lights, task lights**



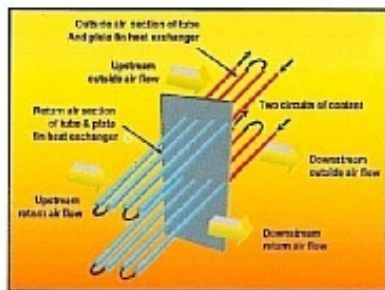
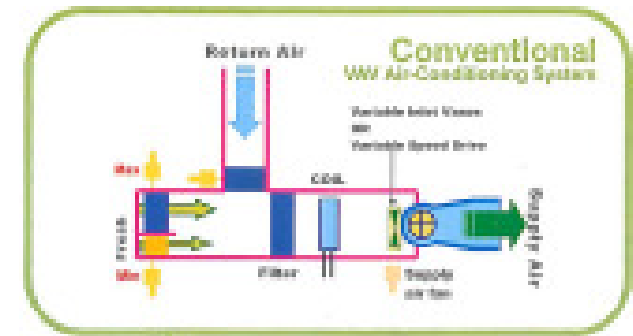
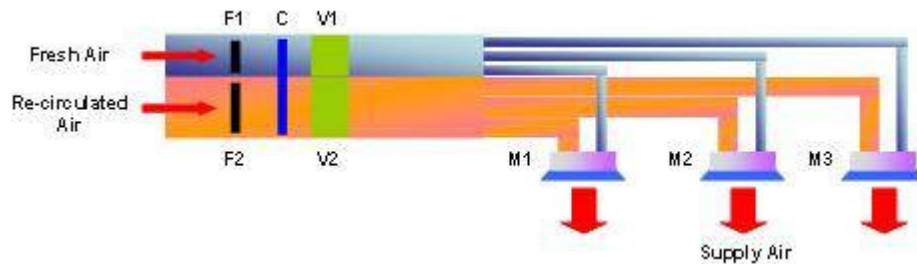
**Displacement  
Ventilation**



# Inside Building

## Innovation in Technology

### Single Coil Twin Fan

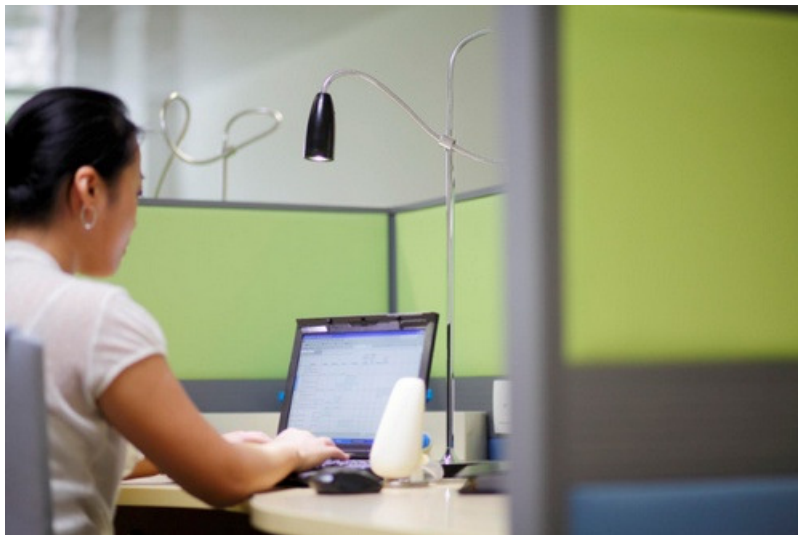


## Potential Benefits

- Estimated 7 - 8% capital cost premium
- Predicted overall energy savings of about 12%
- Improved indoor air quality and comfort
- Attractive payback period < 3 years

# Inside Building

## Well-being of People



# ZEB@BCA Academy

Before





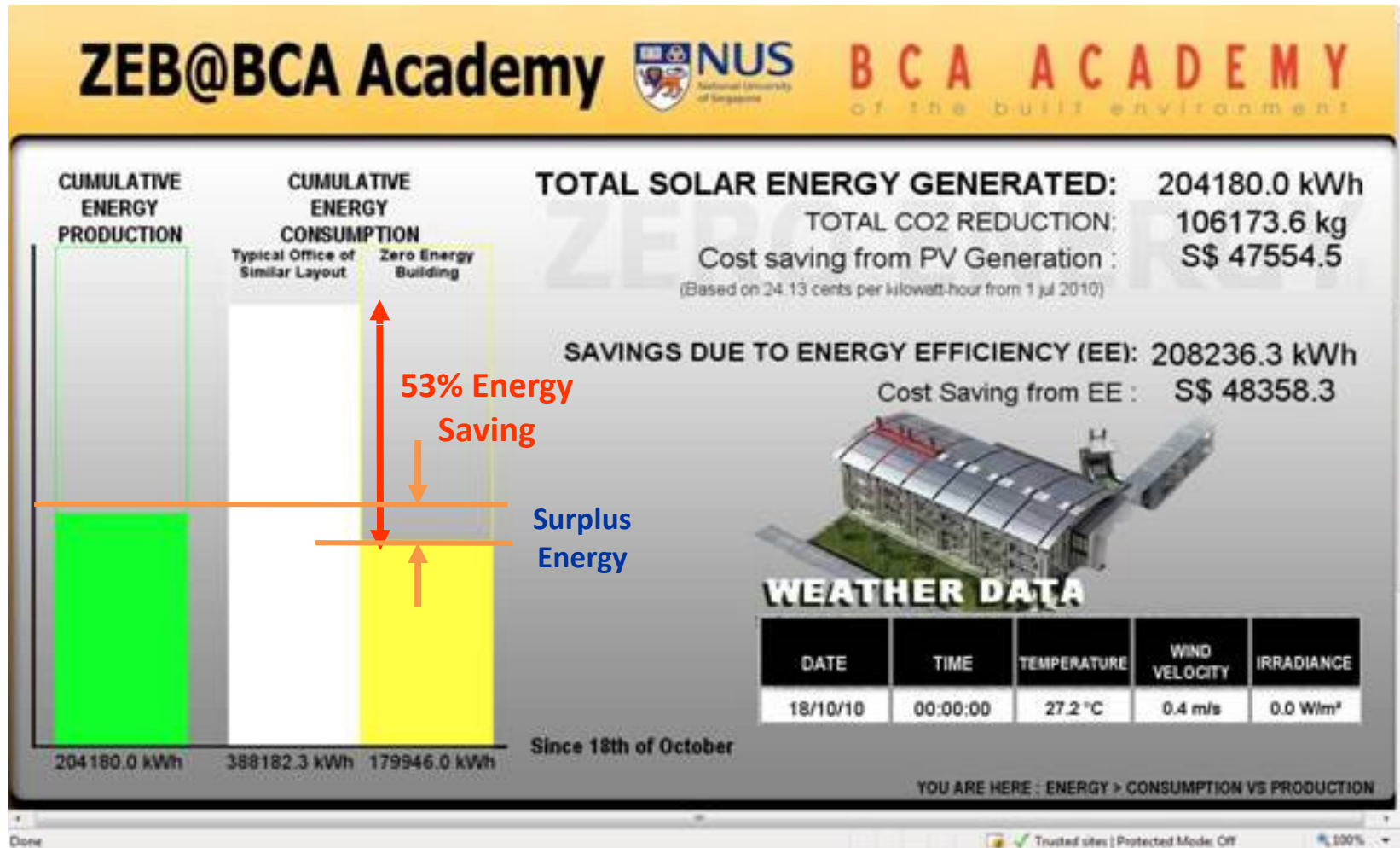
# ZEB@BCA Academy

After



# ZEB@BCA Academy

## Results

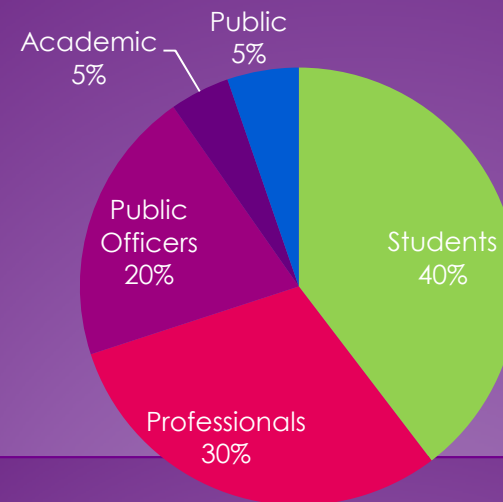


# Sharing ZEB Experiences

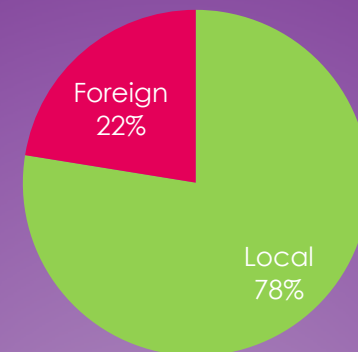
## 13,102 Visitors since Oct 2009



### Cumulative Visitorship since Oct 09



### Local vs Foreign Visitorship since Oct 09



# Accolades

**BCI Green Design Award 2010**  
**GREEN LEADERSHIP AWARD**  
 Institutional Architecture

**ZEB@BCA Academy**  
 DP ARCHITECTS PTE LTD  
 Singapore



BCI GREEN DESIGN AWARD 2010 ENTRANT USER ID : P\_111374 | CATEGORY : INSTITUTIONAL  
**ZERO ENERGY BUILDING @ BCA ACADEMY**

**INTRODUCTION**

BCA Academy - Zero Energy Building is a 3-storey Addition & Alteration to an existing institutional building. The new premises comprises of exhibition, multipurpose rooms, open concept classrooms on the 1st storey, library, classrooms and test chambers on the 2nd storey and offices and school hall on the 3rd storey.

Apart from targeting to achieve Net Zero energy for the operations of the building, ZEB's design considers combining social, educational, economic and environmental considerations to ensure that a pleasant environment exists for the occupants to appreciate nature.

Through this research study, a prototype for the future green schools will be developed which is green, sustainable, energy efficient but at the same time ensuring the indoor environment is conducive for teaching and learning. This should provide the impetus for the implementation of the prototype for future schools in Singapore. This facility therefore exemplifies a project built for the community, designed for the well-being of the occupants and demonstrates the economics of adaptability to climate change and our sustainability.

**PASSIVE DESIGN FOR SCHOOL**

**Natural Ventilation Design**  
 - Naturally ventilated classrooms  
 - Solar assisted stack ventilation system  
 - Flexibility for classroom reconfiguration

**Daylighting Design**  
 - Minor ducts  
 - Light pipes  
 - Light shelves

**Thermal Envelopes Design**  
 - Energy efficient glazing (low-e glass)  
 - Shading devices  
 - Composite wall panels

**Greenery Design**  
 - Extensive green roof  
 - Vertical greenery system



**ACTIVE DESIGN FOR SCHOOL**

**ACM**  
 - Highly efficient chiller system & CT  
 - Variable speed drive pumps  
 - Single Coil Train Fan (SCTF)  
 - Displacement ventilation  
 - Personalized ventilation

**Artificial Lighting**  
 - Energy efficient lamps  
 - Task lighting  
 - Photocell Daylight sensors  
 - Occupancy zoning controls

**Tracking & Controls**  
 - Building Management Systems (BMS)  
 - Motion and CO<sub>2</sub> sensors

**Renewable Energy (Photovoltaic)**  
 - 1st, 2nd and 3rd generation PV panels



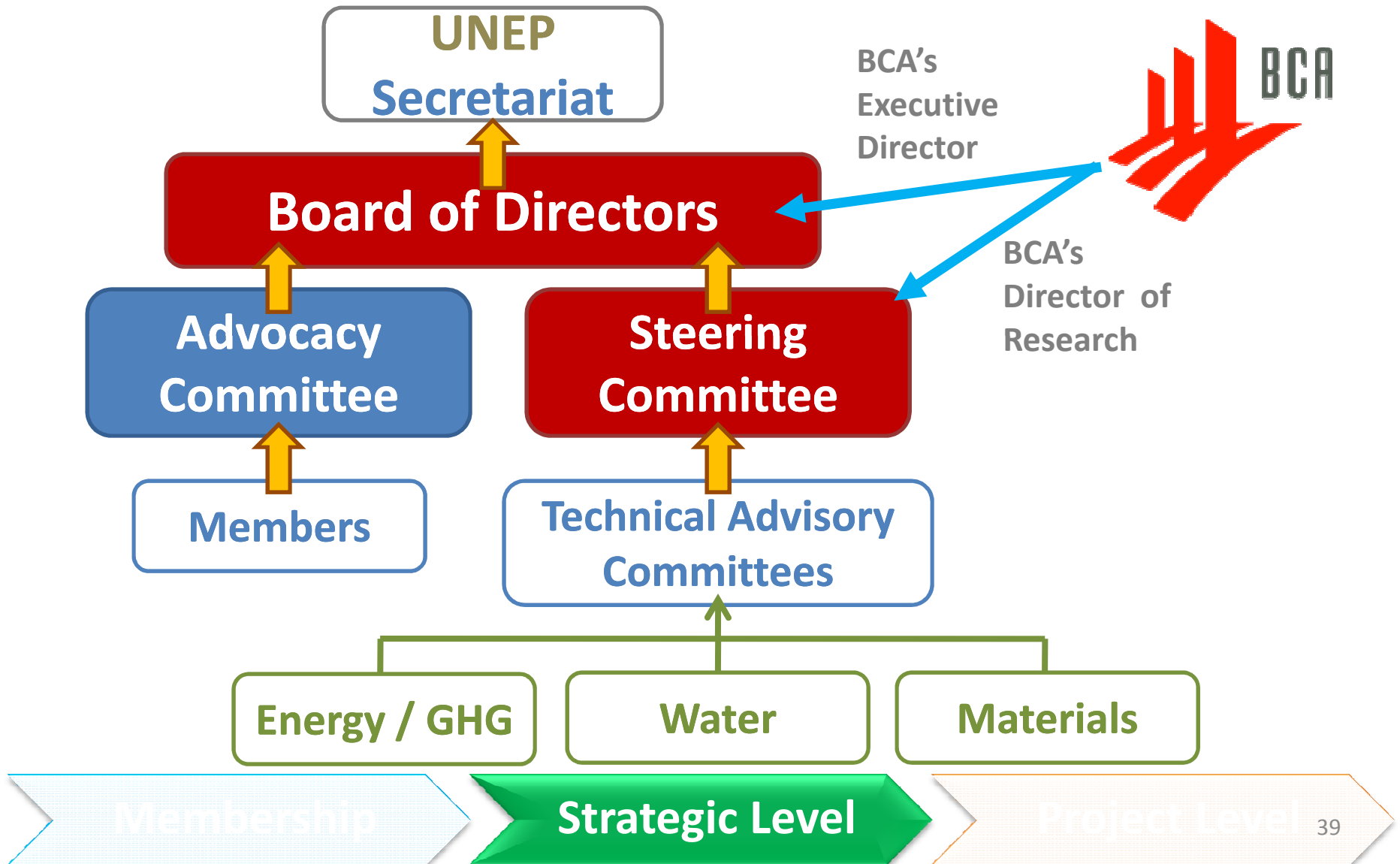
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A Centre Collaborating with UNEP

# Involvement in UNEP-SBCI

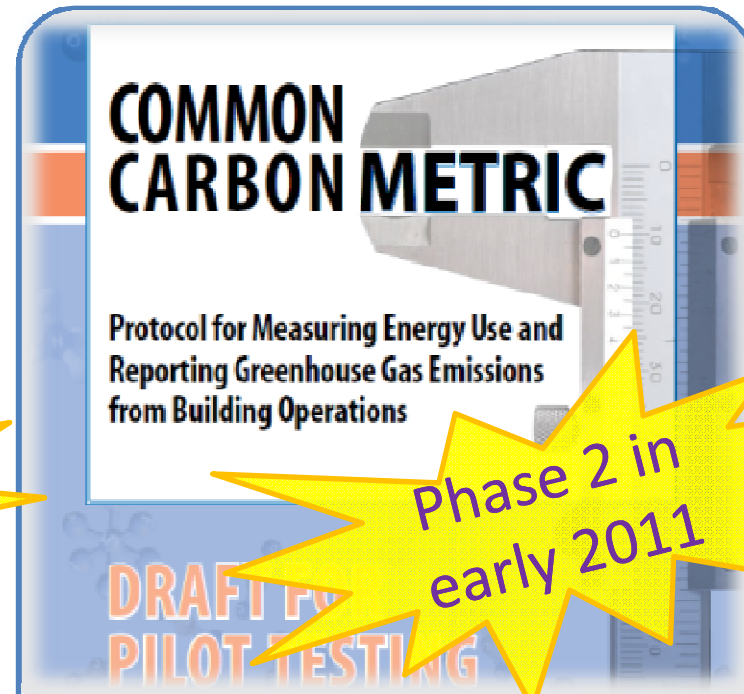


# Involvement in UNEP-SBCI



2<sup>nd</sup> Regional  
Workshop

**Regional Status Report  
on SB Policies in SEA**



Phase 2 in  
early 2011

**Common Carbon Metric  
& Protocol Pilot Test**

Membership

Strategic Level

Project Level

谢谢 Thank you  
Alice\_goh@bca.gov.sg



We shape a **safe**, **high quality**, **sustainable** and **friendly** built environment.

