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A Green Construction Industry



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What is a Green Building

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- A Green Building
  - Is NOT always going to cost more
  - Is NOT about squeezing all the latest Green Building Technologies into the development
  - Involves an integrated design systems approach on energy usage, water usage, site considerations etc
  - Eliminates waste and redundancy wherever possible



Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

Going Against Green

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- Limited knowledge and expertise in sustainable design
  - Lack of life cycle costing analysis knowledge
- Lack of directives from top management
- Lack of integrated design team
- Separation of capital and operating budgets
  - Life cycle cost analysis not being taken into account
- Perception of longer completion period for Green buildings
- Perception of higher initial/capital costs



Different Type of Green Buildings

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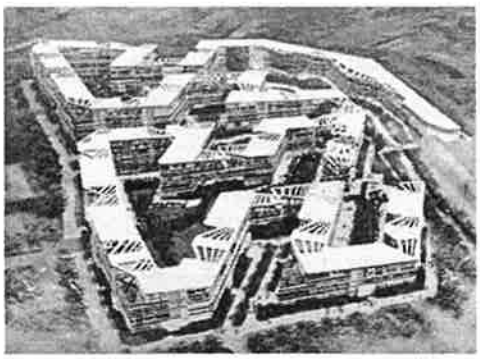

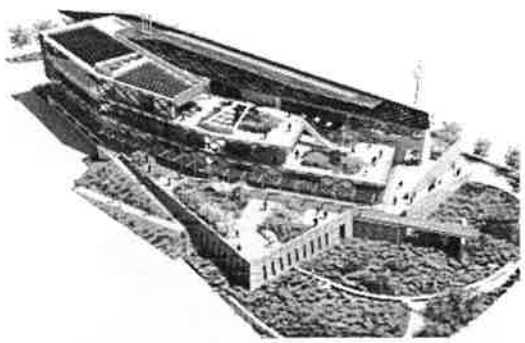

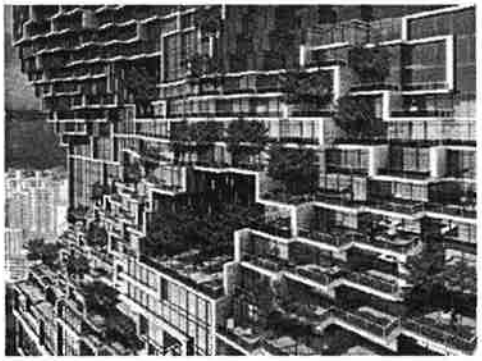

Different Type of Green Buildings

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Greening of the C.I

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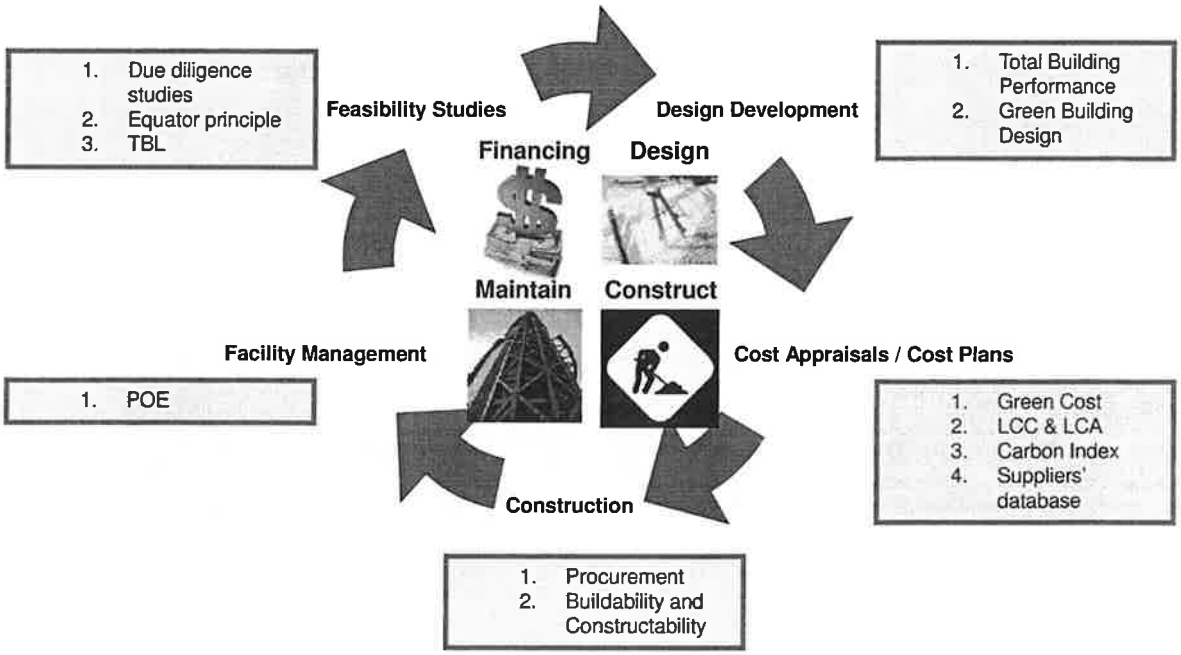

Agenda

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- Equator principle
- TBL

Feasibility Studies	Design Development	Cost Appraisals Cost Plans	Procurement	Construction	Facility Management

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Equator Principles (EPs)

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Feasibility Studies	Design Development	Cost Appraisals Cost Plans	Procurement	Construction	Facility Management

Equator Principles (EPs)

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- A financial industry benchmark for determining, assessing and managing social & environmental risk in project financing
  - Based on environmental & social standards of the World Bank and International Finance Corporation (IFC).
- The principles apply to all new project financings globally with total project capital costs of US$10 million or more, and across all industry sectors.
- The principles also apply to all project financings covering expansion or upgrade of an existing facility where changes in scale or scope may create significant environmental and/or social impacts, or significantly change the nature or degree of an existing impact.
- EPs commit the adoptee not to finance projects that fail to follow the processes defined by the Principles



Equator Principles (EPs) Criteria

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Principle 1: ***Review and Categorization (of projects)***

Principle 2: ***Social and Environmental Assessment***

Principle 3: ***Applicable Social and Environmental Standards***

Principle 4: ***Action Plan and Management System***

Principle 5: ***Consultation and Disclosure***

Principle 6: ***Grievance Mechanism***

Principle 7: *Independent Review*

Principle 8: ***Covenants***

Principle 9: ***Independent Monitoring and Reporting***



Benefits of Equator Principles (EP)

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- Branding
  - Demonstration of responsible project financing - corporate social responsibility.
- Lower Reputation Risks
- Better Access to Capital
- Effective Risk Management
  - Via the incorporation of screening process for projects which are based on IFC's environmental and social screening process.
    - Protect project cashflow
    - Reduce delays and overruns
    - Enhance project value

Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

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Triple Bottom Line (TBL)

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Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

Triple Bottom Line (TBL)

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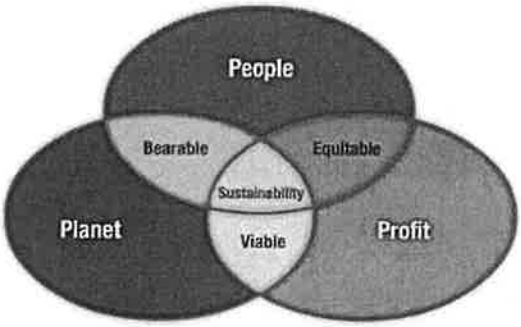
What is TBL?

- TBL reporting is becoming an accepted approach for organisations to demonstrate they have strategies for sustainable growth (environmental, social and economical impacts)

Why TBL?

- Demonstrates transparency and accountability beyond the traditional domain of financial performance includi
environment.



Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

Triple Bottom Line (TBL)

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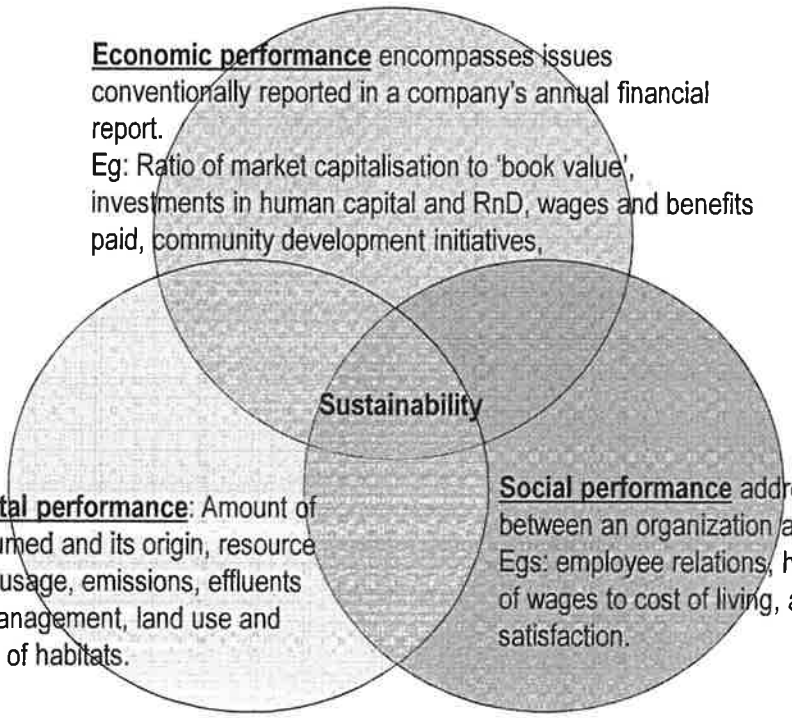
Economic performance encompasses issues conventionally reported in a company's annual financial report.
Eg: Ratio of market capitalisation to 'book value', investments in human capital and RnD, wages and benefits paid, community development initiatives,



Environmental performance: Amount of energy consumed and its origin, resource and material usage, emissions, effluents and waste management, land use and management of habitats.

Social performance addresses interactions between an organization and its community.
Egs: employee relations, health and safety, ratio of wages to cost of living, and customer satisfaction.

Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

Triple Bottom Line Approach to Sustainable Development

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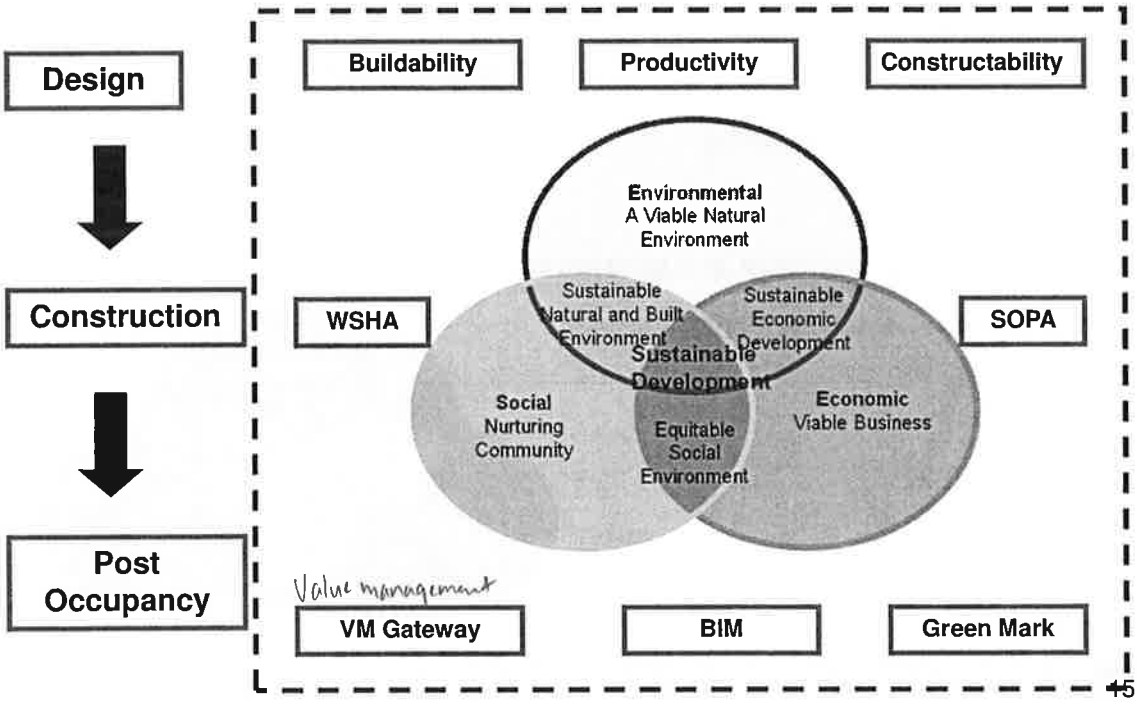

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Core Characteristics of TBL

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- Accepting accountability to shareholders and stakeholders for sustainable development
- Being transparent about their activities and impacts beyond financial performance for sound governance
- Integrated planning and operations for strategic planning and a basis for a company to measure and report according to the TBL
- Committed to stakeholder engagement: interacting with internal and external stakeholders is embraced as a core business strategy that adds value
- Multi-dimensional measurement and reporting: for making concrete what a company stands for, how it behaves and how it delivers on its promises

Benefits of TBL

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- Embedding sound corporate governance and ethics systems throughout all levels of an organization
- Improved management of risk through enhanced management systems and performance monitoring.
- Formalizing and enhancing communication with key stakeholders to have a more proactive approach to addressing future needs and concerns.
- Attracting and retaining competent staff by demonstrating an organization is focused on values and its long-term existence.
- Ability to benchmark performance both within industries and across industries.

Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

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Design Development





Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

Agenda

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- Total Building Performance
- Green Building Design

Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

Total Building Performance

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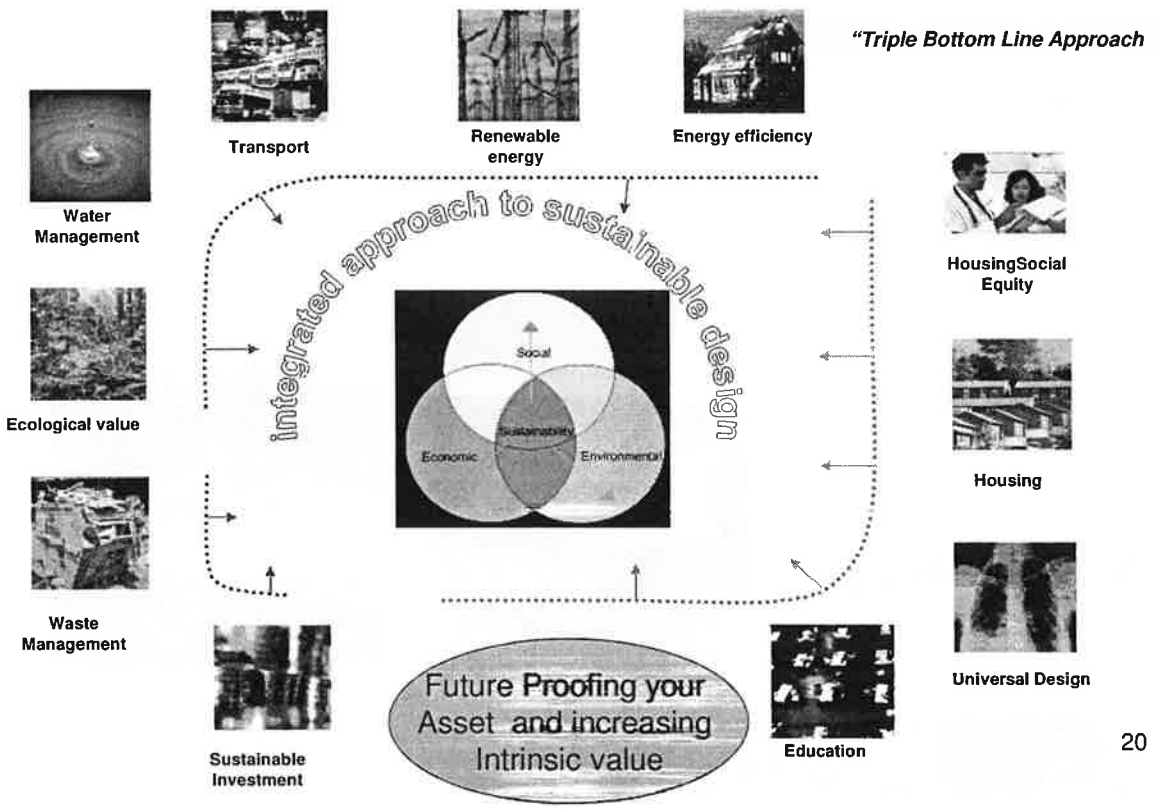

Total Building Performance

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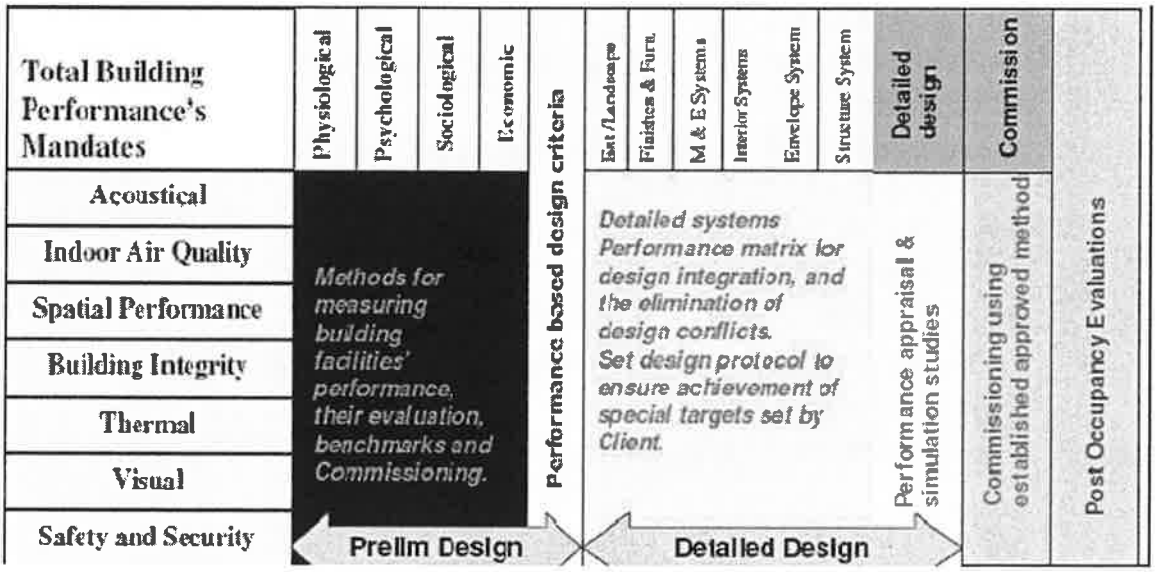
- Involves the Whole Project Team



Feasibility Studies | Design Development | Cost Appraisals / Cost Plans | Procurement | Construction | Facility Management

Total Building Approach

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- Energy
  - Energy Efficiency Façade
    - ETTV (Max 50 W/m2) & RETV (Max 25 W/m2)
    - Improved materials (insulation, glazing etc)
    - Bioclimatic architecture (natural ventilation, solar radiation etc)
  - Air-conditioning system
    - To meet min efficiency requirements in SS 530 & CP13
  - Building Envelope - Design / Thermal Parameters
    - Min direct west facing facades
    - Sun-shading provisions

Feasibility Studies | Design Development | Cost Appraisals / Cost Plans | Procurement | Construction | Facility Management

Total Building Approach

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- Energy
  - Natural Ventilation
    - Proper site orientation to reduce need for MV systems
  - Artificial Lighting
    - Meet max lighting power budget in SS 530 via energy efficient light fittings
  - Ventilation in Carparks and Common Areas
    - Promote NV where possible
  - Energy Efficient Vertical transportation
    - Promote the use of VVVF and other energy efficient features
  - Energy Efficient Practices
    - Innovative features that have a positive environmental impact



Total Building Approach

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- Water Efficiency
  - Fittings
  - Water Usage strategies
  - Leak Detections
  - Water harvesting
- Environmental Protection
  - Construction process to be Sustainable
  - Usage of Greenery
  - Waste Generation and management
  - Selection of environmentally friendly products



Total Building Performance

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- IEQ or Indoor Environment Quality
  - Thermal comfort
  - Noise
  - Indoor Air Quality (IAQ)



Product Uniqueness

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- Green Building Technologies
  - Light pipes
  - Mirror duct system
  - Light shelves system
  - Vertical greening
  - Roof garden
  - High performance glazing
  - Solar assisted stack effect ventilation system
  - Self cleaning facades



Attitude

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- Client
  - Greatest capacity to champion for sustainable construction by exerting pressure on firms and individuals involved in construction in a strategic way to foster innovation, benchmarking and information exchange.
- Consultants
  - Embracement of new technologies
  - Adoption of a holistic approach for the whole project
  - Dare to challenge the norm



Coordination & Communication

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- Facilitate integration of design intent
- Facilitate knowledge transfer
- Reduce abortive time
- Ensure the project goal is met



Cost / Procurement

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- Identify the GBTs suppliers
  - Establish contacts with the suppliers to gather the latest updates and information on their products
  - Understand how the product works and what are the considerations needed to construct and install.



Facilities Management Considerations

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- Design buildings with maintenance in mind

- Follow Code of Practice for Handing and Taking over of Completed Buildings.

- Training, Manuals, Technical Data etc to be recorded and transferred



Future Proofing your Assets

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- To keep up with the times. You do not want your building to be jaded before it has begun its life

- Studies overseas show better yield

- Assistance of legislations and voluntary programs e.g. LEED / GM office.



Avoiding GreenWash and Overselling

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- **Greenwash** is a term that is used to describe the act of misleading consumers regarding the environmental practices of a company or the environmental benefits of a product or service.

- The term **Green sheen** has similarly been used to describe organizations which attempt to appear that they are adopting practices beneficial to the environment - Wikipedia
  - Source watch, Corpwatch [Greenwash award], EnviroMedia etc

- Prevent hidden trade offs, no proof, vagueness and Irrelevance

- Better to under promise and over deliver.





Green Building Design

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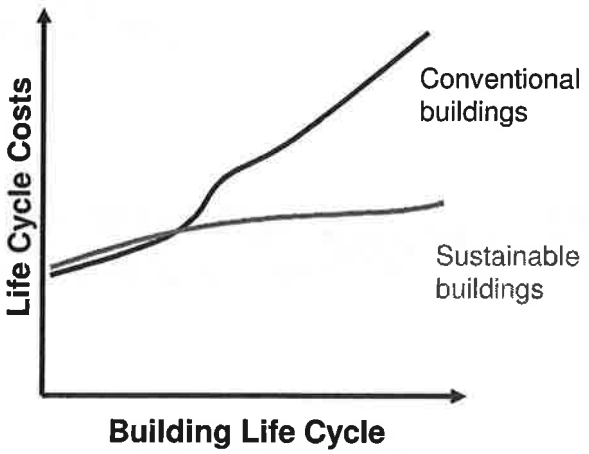
Green Building Design

- Green Building Design Principles
  - Focus on Integrated Design from the onset
  - Reduce Demand for Energy, Water and Material
  - Increase Efficiencies for Energy, Water and Materials
  - Cutting Edge Technologies to further enhance the building's efficiency



Energy Demand

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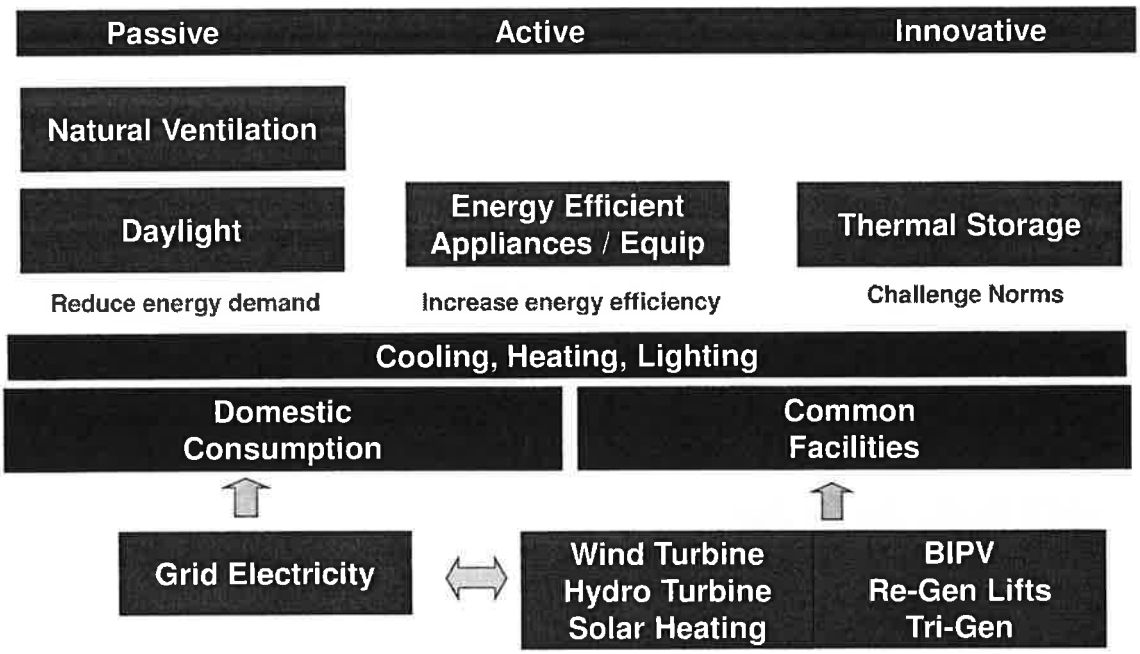

Water Demand

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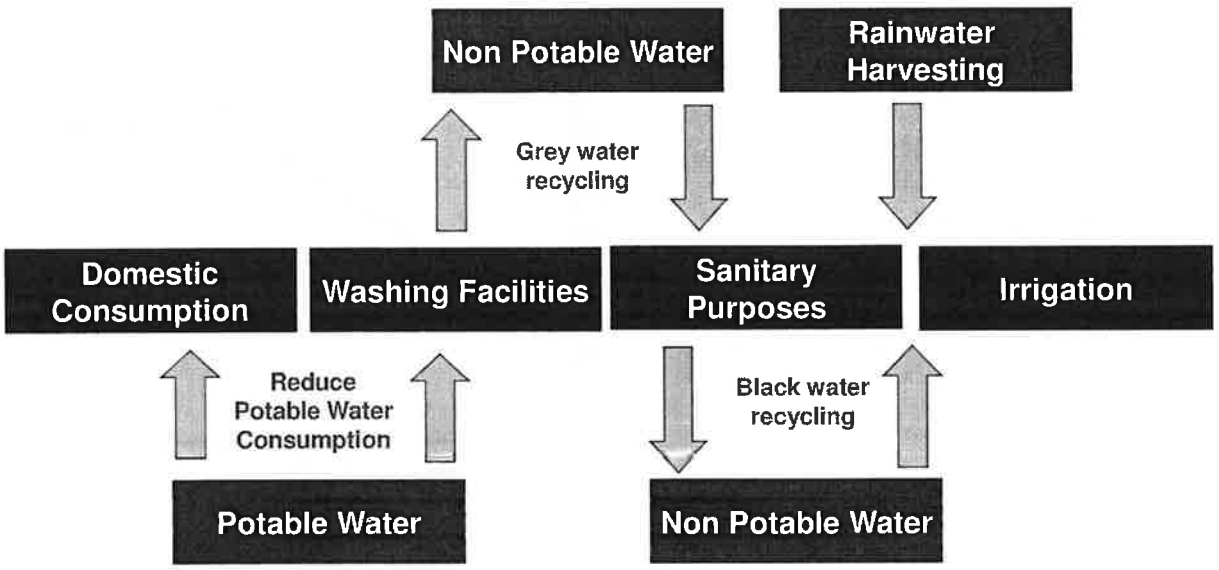




Materials Demand

BIM

CUI

Challenge Norms

Precast

Prefab

Reduce Wastage

Green Materials

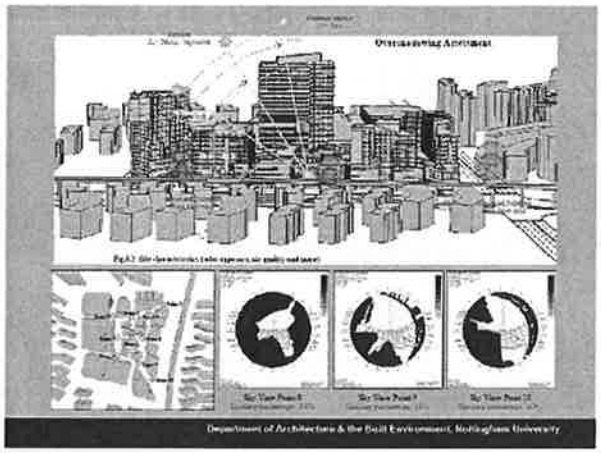
Conserve Resources

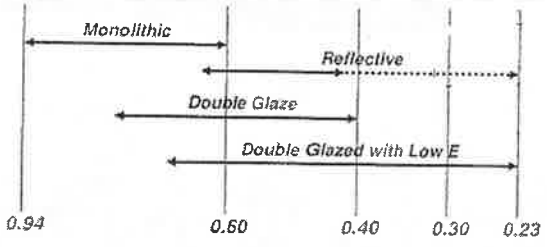
Design — Construction



Case Example 1: Design of Facade







EAST

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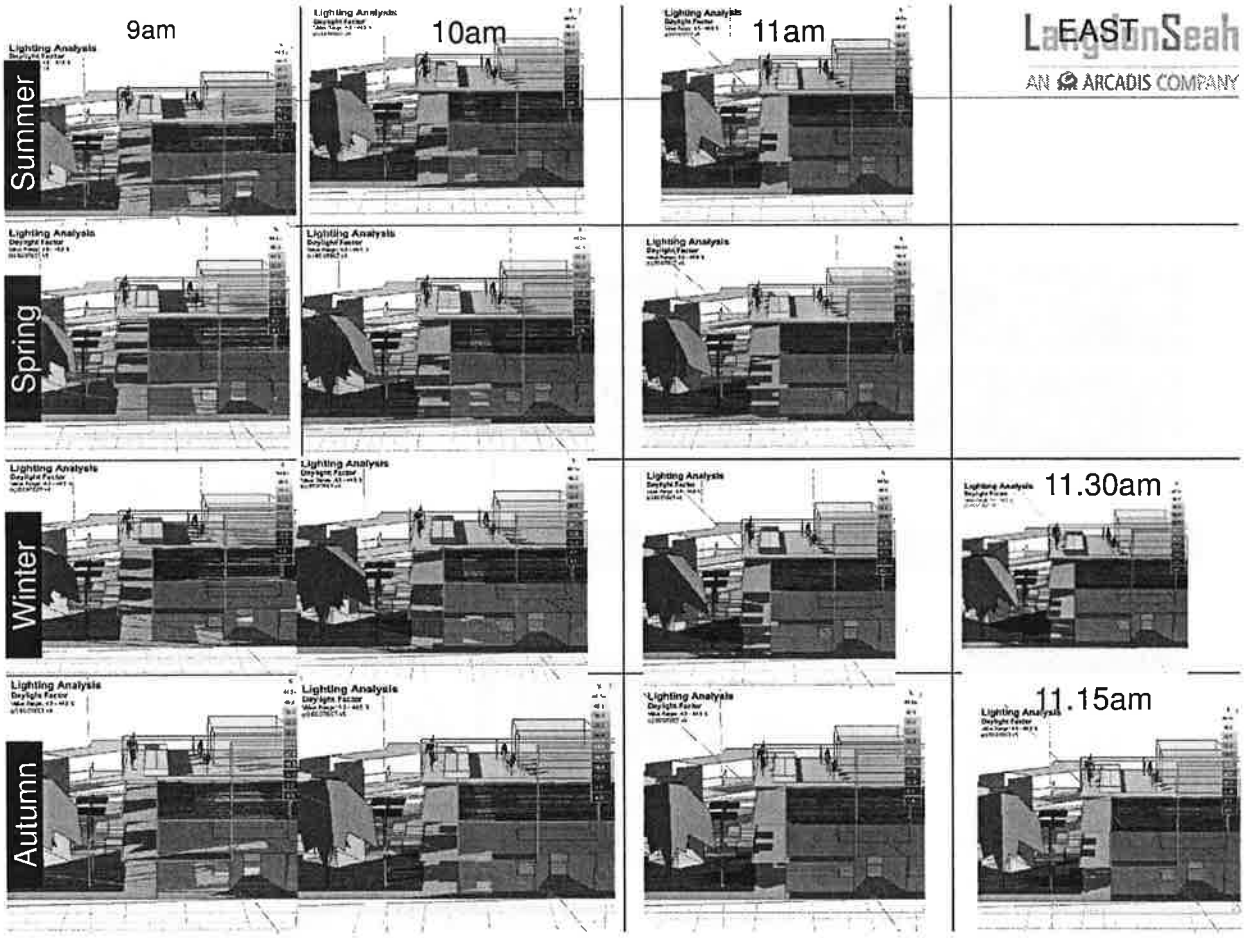
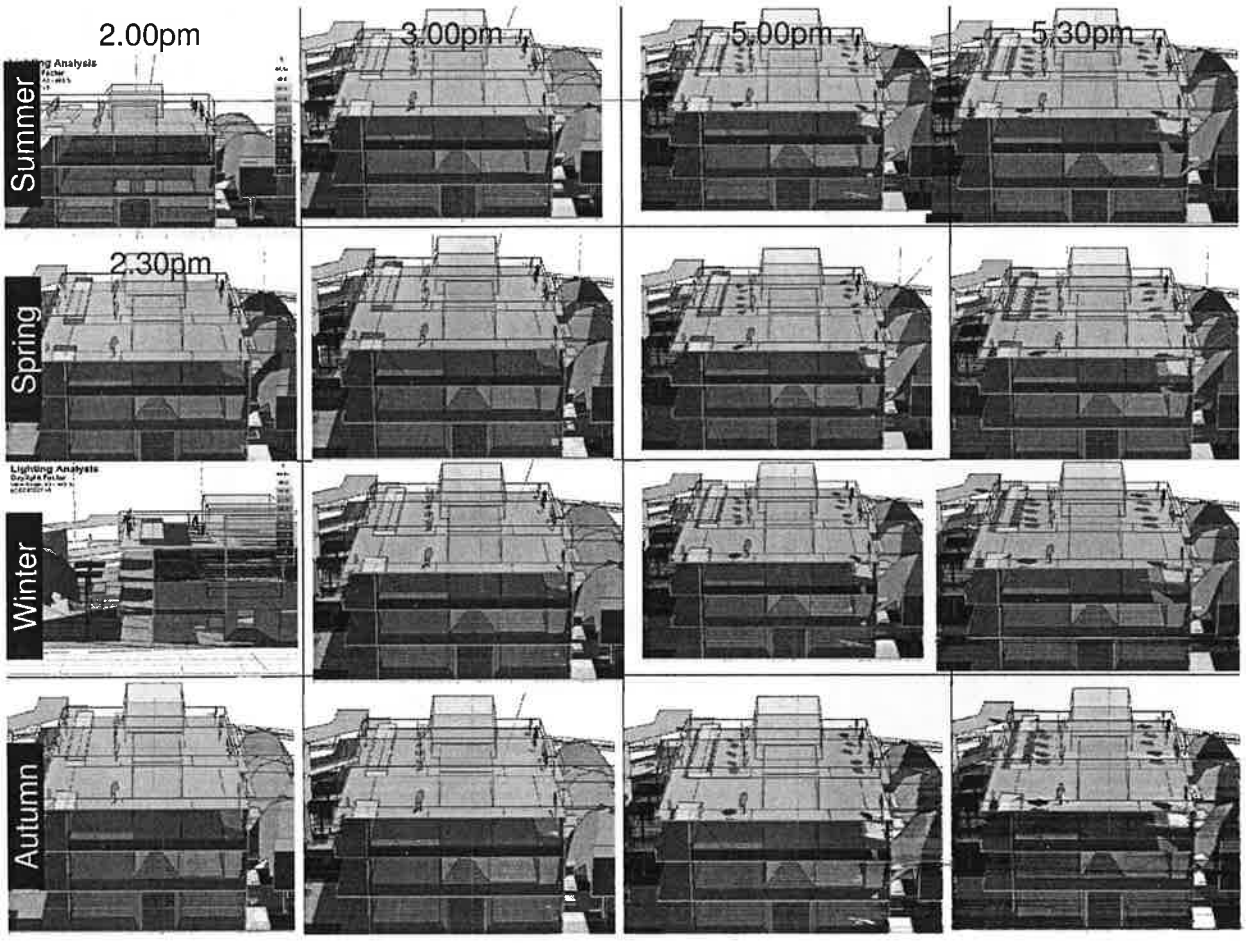
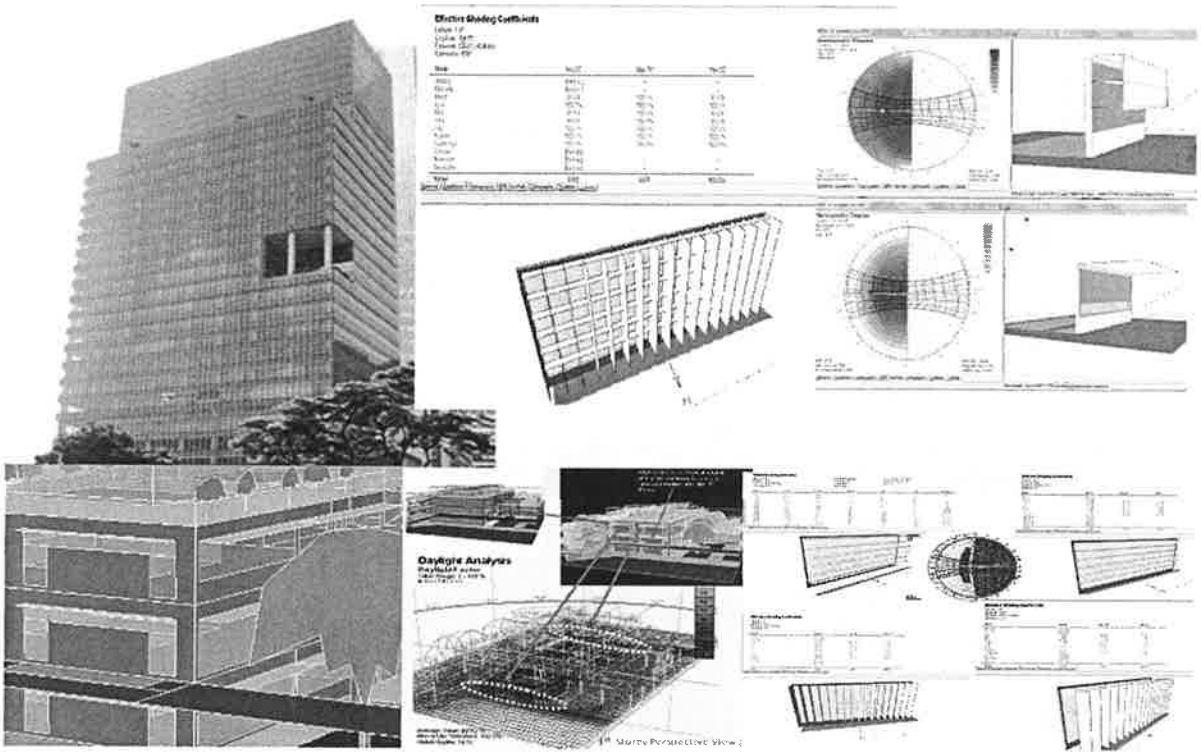


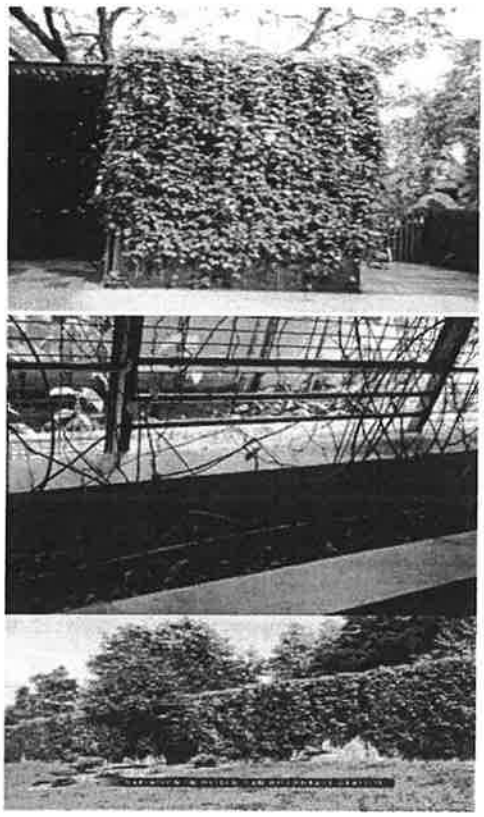


Case Example 2:
Design of Sun Shades



Case Example 3:
Greenery Provisions





Case Example 4: Material Selection

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- Comparison for Different Types of Internal Wall

3 M Height, 9 M Span = 27 M2, VERTICAL Installation

No.	Description/Meter Square	J.O.E Green Wall	Other Hollow Core Wall		Brick Wall	ALC Block*	Dry Wall
		70/90/100mm	75 mm	100mm	100mm	102mm	102mm
1	Material Panel/Brick per m2	25.00	19.00	19.50	9.90	13.33	30.00
2	Installation (Labor)	17.00	17.00	17.00	15.00	10.00	25.00
3	Grouting + Joint Mortar**	0.50	2.00	2.00	10.00	10.00	5.00
4	Fibre Glass Mesh (2 sides)	0.50	0.50	0.50	0.00	0.00	0.00
5	Additive for Adhesive Strength of Mortar	0.00	0.50	0.50	0.00	0.00	0.00
6	Skim Coat Material + Labor (2 sides)	18.00	0.00	0.00	0.00	0.00	0.00
7	Plastering Material + Labor (2 sides)	0.00	36.00	36.00	36.00	36.00	0.00
8	Wastage Material	1.15	3.80	3.90	3.94	3.94	3.00
	Sub Total Per M2	62.15	78.80	79.40	74.84	73.27	63.00
	Sub Total 3 M Height, 9 M Span = 27 M2	1,678.05	2,127.60	2,143.80	2,020.68	1,978.24	1,701.00
9	Stiffener Cost (SGD 30.00 Meter Run)	0.00	0.00	0.00	180.00	180.00	???
10	Lintel Cost (SGD 30.00 Meter Run)	0.00	0.00	0.00	0.00	0.00	???
	Total 27 M2 Area	$1,678.05	$2,127.60	$2,143.80	$2,200.68	$2,158.24	$1,701.00
	Cost Per Meter Sq	$62.15	$78.80	$79.40	$81.51	$79.93	$63.00
	Total Savings (SGD) per Meter Sq		$16.65	$17.25	$19.36	$17.78	$0.85
	Total % Savings per Meter Sq		26.79%	27.76%	24.56%	22.40%	1.04%

SINGAPORE GREEN BUILDING COUNCIL

GreenLabel SINGAPORE

Case Example 5: Integration of Technology

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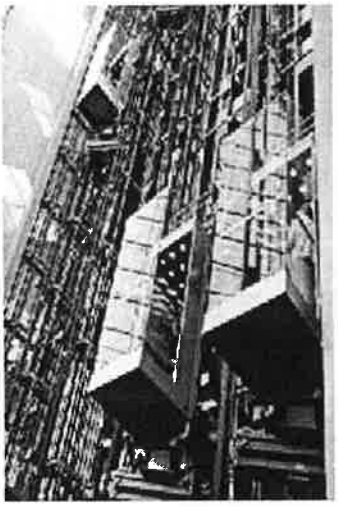

Regenerative Elevators

Duty / Speed	Lift with Regenerative Drive		Lift without Regenerative Drive	
	Energy (kWhr / Yr)	Annual Cost (@ 22.87 cents per kWhr)	Energy (kWhr / Yr)	Cost (@ 22.87 cents per kWhr)
1600 kg / 1.5 m/s	5,000	$1,143	9,000	$2,058
Saving	4,000	$915	-	-

Source: DLS Executive Summary, 2010

Quick facts

- Recovers excess braking energy from the elevator and converts it for use e.g. in lighting the building
- The counterweight or elevator car becomes the motor and KONE EcoDisc® becomes a generator and converts the power into current
- Can recover up to 25% of the total energy used by an elevator

Energy saving

- 13,250 kWh/year compared to a non-regenerative drive

Carbon footprint reduction

- 6,400 kg CO2/year compared to a non-regenerative drive

The basis for the calculations for regenerative systems is: an elevator speed of 3.5 m/s, load of 1600 kg, travel distance of 150 m, and 600,000 starts/year.

Source: KONE

Additional cost: $10k to $30k

Payback: 3 years to 11 years

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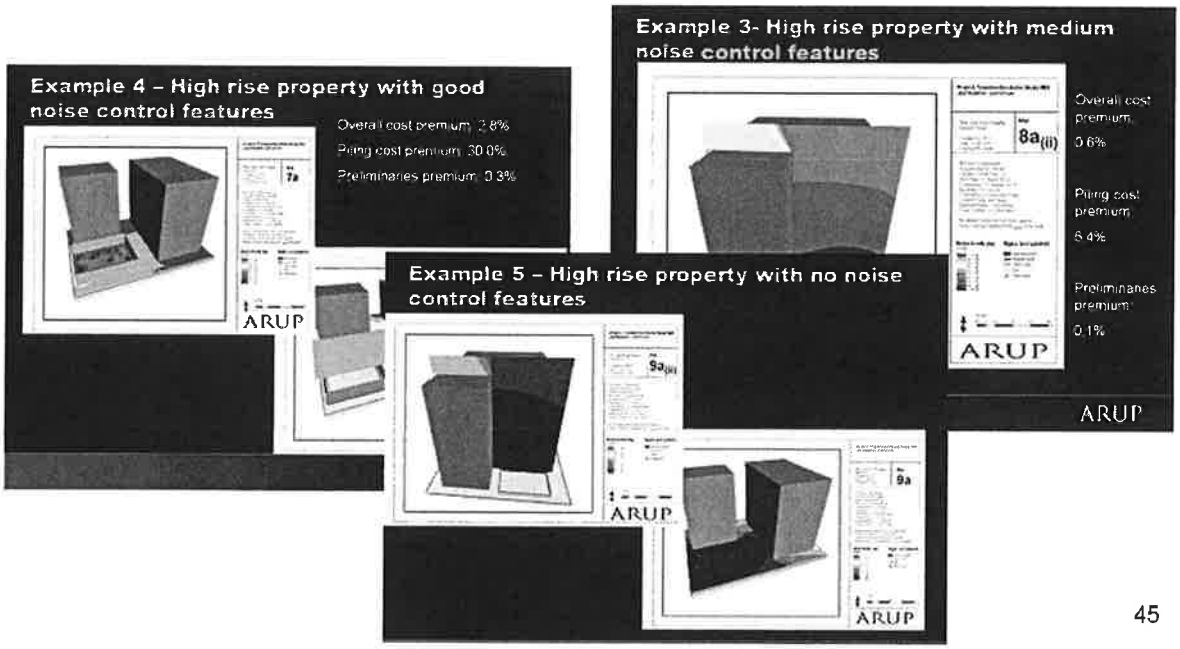
Case Example 6:
Cost Benefit Analysis

- Eg Construction noise studies



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Costing Appraisal / Cost Plan

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Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

Agenda

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- Green Costs
- Life Cycle Costing & Life Cycle Assessment
- Carbon Index
- Suppliers' Database

Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

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Green Costs & Contracts

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Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

Is Going Green Costly?

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- Green Star (AU)
  - Platinum (4%-7%); Gold (3%-5%)
- Green Mark (Singapore)

PREMIUMS FOR COMMERCIAL AND RESIDENTIAL GREEN MARK DEVELOPMENTS

× Based on 27 Green Mark Buildings

Commercial Buildings		
BCA Green Mark Award Type	Average Green Premium (%)	Average Payback (years)
Platinum (5)	4.0%	6.0
Gold^{plus} (1)	1.8%	7.0
Gold (3)	0.7%	3.1

Residential Buildings		
BCA Green Mark Award Type	Average Green Premium (%)	Average Payback (years)
Platinum (4)	3.1%	6.1
Gold^{plus} (3)	1.7%	3.1
Gold (11)	1.2%	2.2

Cost of Not Going Green

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- Social pressures due to increasing public awareness of going "Green"
- Retention and productivity of employees is of increasing importance
- Growing likelihood of carbon tax being imposed on energy consumption

Green Buildings

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- Future proofing of asset by minimizing the effects of future energy price hikes
  - Energy Focused
  - Water Focused
- Growing trend of socially responsible investments
  - Carbon emissions as a real cost => Climate change
  - Be prepared for possible future tax imposition on energy consumption
- Increasing public awareness of climate change
  - Influence public policies planning
    - Possible legislation on carbon trading
    - Tax implications



Passive & Active Designs

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- *Passive designs elements*
  - Site and Orientation
  - Building Shape and Mass
  - Landscape and Green wall/roof
  - Space Planning
  - Windows
  - Solar Shading
  - Thermal Insulation
  - Air and Moisture Tightness
  - Natural Lighting
  - Natural Ventilation

+

- *Active designs elements*
  - PV Panels
  - LED Lighting
  - Pneumatic waste system
  - VVVF
  - Wind Turbines
  - Tri-Generation
  - Thermal Energy Storage
  - Condensing Boliers
  - Solatube
  - Building Management Systems
  - Rainwater Harvesting

Integrated Design

How to Cost

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1. Keep GBTs separately
2. Measure/ track the Extra over either by % or by $/m2 CFA (Construction Floor Area)
3. Keep Database of GBT Suppliers
4. Know the specifications and data well.
5. Formulate a Database based on cost data from point 1-4 so that you can forecast cost trends and analysis for Cost Appraisals.
6. Know the GBT well so that is a correct match to the climate to the GBT. You do not encourage stack effect for ventilation in the dessert.

General Conditions

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- Preliminaries
- Preamble
- Specifications
- VM/ VE (Efficiencies, Proof of LCC, earlier completion but lower carbon)
- EHS- Risk and Tripple Bottom Line
- Requires to 3 R. Reduce, Reuse, Recycle
- Wastage Reduction
- Energy Generation - 5% Renewable Energy.
- Energy and water saving and usage
- Emission reduction
- Use of sustainability materials
- Effect on Biodiversity, Ecology and Habitat

Key Performing Indexes

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- Waste
- Energy Consumption and Generation
- Water recycling and Harvesting
- Co2 General
- Use of Materials
- Vehicle Movements
- Maintenance and optimization of biodiversity, ecological habitat
- Whole Life Performance
- EHS
- Training

Facilities Management Considerations

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- Design buildings with maintenance in mind
- Follow Code of Practice for Handing and Taking over of Completed Buildings.
- Training, Manuals, Technical Data etc to be recorded and transferred



Life Cycle Costing (LCC) & Life Cycle Assessment (LCA)

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Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

What is LCC?

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- ISO 15686 Part 5, defines Life Cycle Costing (LCC) as a methodology for systematic economic evaluation of the life cycle costs over a period analysis, as defined in the agreed scoping.
- Life cycle costs are cost of an asset/ material or its parts throughout its life cycle, while fulfilling the performance requirement.

Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

What car to buy

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•X (G)- Continental	•Y (M)- Asian
•$86,000	•$80,000
•Servicing - 15000	•Servicing -10,000
•Service cost $200	•Service cost $450
•Euro 5 Star	•?
•0-100 4.9s	•0-100 9.2s
•13kl/l	•11kl/l
•OMV 33,000	•OMV 22,000
•400kl/wk -30l petrol-$80/wk	•400kl - 36L petrol-$90/wk
•3 years =$12,480 Petrol	•3 Years = 14,000
•Servicing $3000 Lumpsum (4x)	•Servicing 7 times in 3 years- $3150
•$18,480 (Petrol +Service)	•$17,000 (Petrol + Services)
•Total =$104,000	•$97,000

Difference=$7,000. OMV= 11,000 difference. Value - $3,000 (X has over Y)

What is LCC?

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- LCC in construction industry can be broadly classified into two categories.
- Macro Approach - Whole Life Cycle Costing
  - LCC investigation into the Externalities, Acquisition Cost, Design Cost, Construction Cost, Non-construction cost and income in the whole life cycle
- Micro Approach
  - Focus on the construction, operation, maintenance, and end of life cost. Occupancy costs are included in the ISO as part of the 'Non Construction Costs' - but it is normal practice in construction to include them within LCC.

What is LCC?

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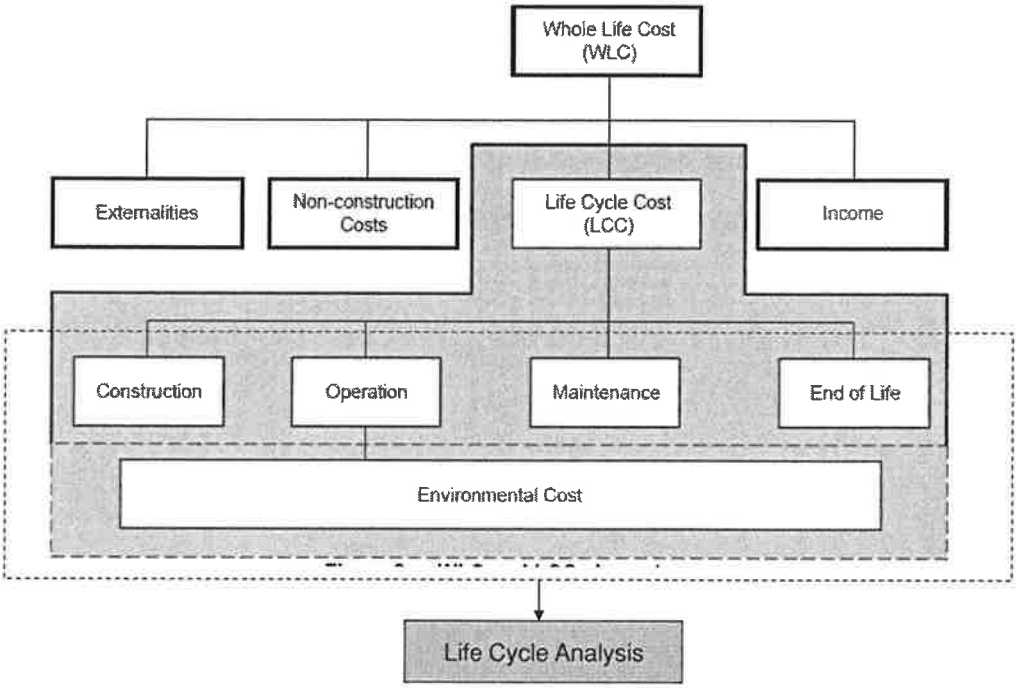



Why LCC?

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- Viewed over a 30 year period, initial building costs account for just 2% of the total, while operations and maintenance costs equal 6%, and business/personnel costs equal 92%.
  - Construction cost is only a fraction of the total cost



Uses of LCC

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- Effective decision making with regards to investment
- Establish priorities between competing proposals; comparative analysis
- Considers total cost implications; real cost of resources assessed; balanced view of cost over time rather than shorter view of capital cost



LCC Methodology

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1. Gather basic financial data such as utility rates, projected energy and general inflation rates, discount rates, interest rates and financing terms.
2. Estimate annual energy costs using a building energy simulation program, such as eQUEST.
3. Estimate building construction costs using the most accurate information available.



LCC Methodology

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4. Estimate operation and maintenance costs, replacement costs and service life.

5. Calculate life-cycle costs. Eg present value of energy, construction and ongoing costs using discount factors that account for the time-value of money.

6. Compare life-cycle costs of each alternative. The alternative with the lowest life-cycle cost is the best economic option for the investor.



LCC Techniques

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- Net Present Value (NPV) Technique
  - Sum of initial investment (less salvage value), replacements, operations, maintenance and repair over the life cycle of an investment express in present value of dollars
- Internal Rate of Return (IRR) Technique
  - Compound rate of interest which when used to discount the life-cycle costs and benefits of a project, will cause the two to be equal



NPV Technique

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- 2 techniques of LCC
  - Discount rate
  - Internal Rate of Return (IRR)
- Difficult to select the discount rate
  - Varies with time
  - Long periods involved
- Ways of assessing
  - Social time preference rate
  - Rate of interest at which Govt borrows and lends
  - Opportunity cost of interest



Limitations of LCC

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- Lack of data
  - Running costs & maintenance costs
- Discount rate
  - Unpredictable due to long time span
- Lack of awareness and knowledge
  - Few people are trained in LCC
- Long term predictions based on present knowledge
  - Wrought with uncertainties ie change in client's needs, technology obsolescence, energy costs
- Many qualitative decisions will be made
  - Too many assumptions made



Limitations of LCC

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- Owners regard capital costs more than running costs
  - Buildings are sold after some time
  - Tenants pay for maintenance
- Intangible factors
  - Value of new image, prestige etc
- Time and money constraints
  - Addition time, effort and costs incurred (professional fees etc)
- Accuracy
  - Based on too many assumptions, may not be accurate
- Data Error
  - Incorrect treatment on parameters like choice of discount rate, inflation rates, life of building and materials, salvage value etc



Life Cycle Assessment

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- LCC could be applied to include environmental, social and sustainability analysis, commonly known as Life Cycle Analysis (LCA).
- Life-cycle assessment is a holistic methodology that attempts to quantify the environmental impacts of a product (or a larger system such as a building) through all stages of its life, including extraction and processing of the raw materials used to make it, manufacturing or construction impacts, operation and maintenance, and eventual recycling or disposal.



Modules of LCC/LCA

- Budget
- Sketch Design
- Tender Document
- Activity Report
- Management Action Plan
- Cost/Carbon Check
- Value Management Study
- Occupancy Costs/Carbon
- Client requirement analysis

Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

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Carbon Index

Global Construction Consultants

Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

Comparison of Carbon Intensity

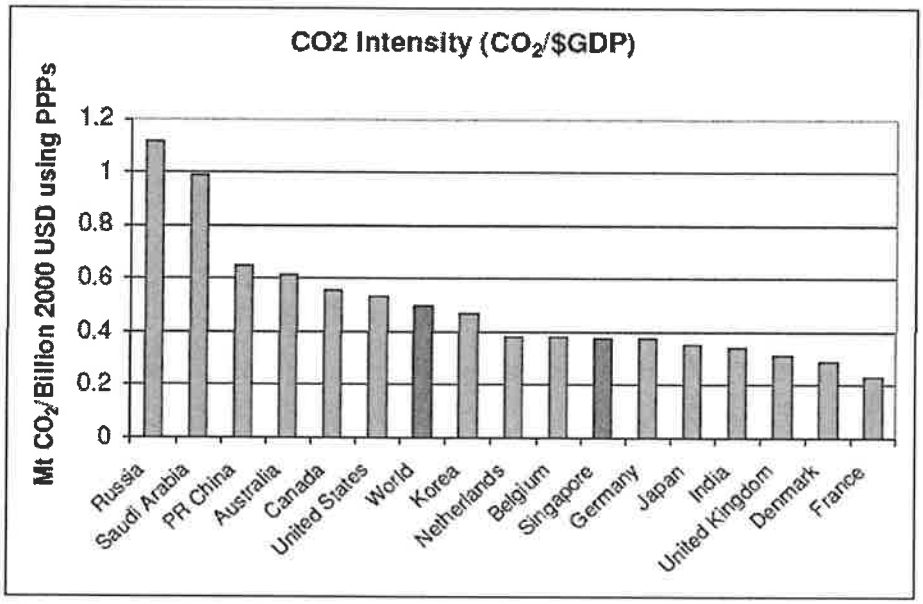

Figure 3.1. Comparison of CO_2 intensity
Source: IEA 2005

Carbon Indexing

- A Carbon Index would enable a standardized measure of carbon ratings and facilitate in embodied carbon measurements
- The Carbon index can be pegged to the cost plan, that is to say, each index is pegged to a material/ trade or bunched together in a common arrangement of work sections.
- The objective is to be ready before carbon trading, carbon neutral offices and carbon footprints become common or legislated.
- Currently, DLS is collaborating with NUS and BCA on developing a Carbon Index for the Construction Industry.

Carbon Footprint

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- Carbon footprint measures the current level of carbon emissions which is essential for building owners to set benchmarks to measure carbon performance and to compare amongst other properties.
- The carbon footprint for buildings includes embodied carbon and operational carbon.
- The embodied carbon of a building are from the CO2 produced during the manufacture of materials to installation and demolition.
- Operational carbon is carbon emissions due to the operations of the building.
- Rule of thumb: 75:25 operational to embodied carbon ratio for buildings
  - Projection for the future?



Carbon Calculator

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What are the key components of the calculation?

- Carbon significant building components
  - Substantial quantities
  - Heavy
  - Associated with carbon intensive manufacturing processes
- Measured quantities
- Embodied carbon library items
  - Measured quantities
  - Mass and mix of components
  - Notional scope of components



Generic Carbon Library Item

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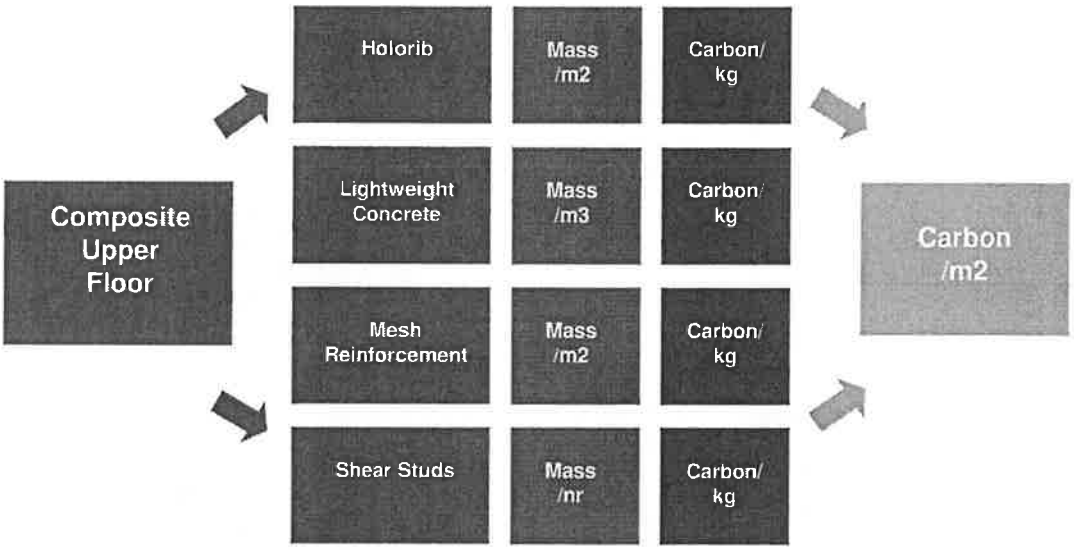

Methodology

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- Align with normal cost planning methods as far as possible
  - For example, per m2 for upper floors, wall, and windows, per m3 for pile caps
  - Developing a 'carbon library' comparable with the CP 80 library
- The library converts embodied energy data into a form which can be associated with a cost plan
- Normally use one of three methods.
  - Simple. Qty x carbon rate = Carbon emitted (For simple items like finishes)
  - By volume. Qty x volume / qty x density = weight, x energy /kg = Carbon emitted
  - By output or intensity (for service items)
- Find the best sources of data

Test model

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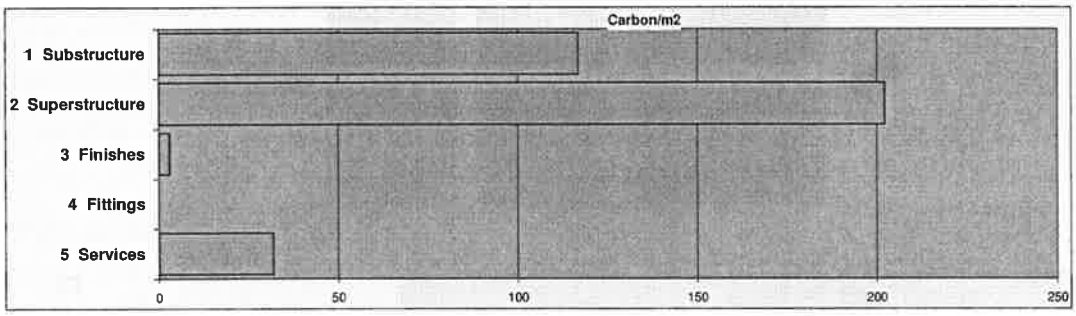
TOTAL CARBON = 17,694,188 kg	Carbon kg/M^2 353

50,058 m2

Carbon Total Carbon /m2	Carbon kg	Carbon kg/m2
1 Substructure	5,842,698	117
2 Superstructure	10,122,557	202
3 Finishes	144,788	3
4 Fittings	0	-
5 Services	1,583,740	32
TOTAL CARBON	17,693,783	353





Benchmarking

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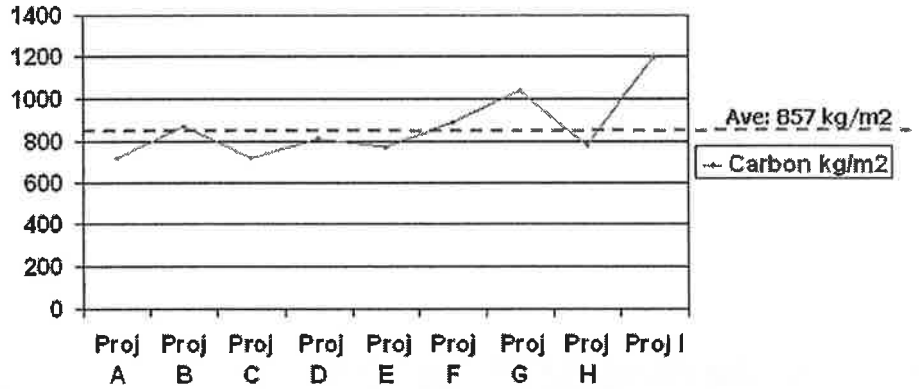
- In time, benchmarks will be established for various building types, expressed in grams of Carbon/m2
- The benchmarks could be associated with those for operational energy in grams of Carbon/m2/year to help optimisation



Challenges: Limited Data

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- Published data is for basic materials or part processed items (such as chipboard) only
  - We have to create most composite items from first principles
  - We have to make assessments of the carbon impacts of manufacture
- Composite and highly processed items are hard to assess, and
- Little or nothing is available for highly engineered items such as M & E services generally
  - We have developed solutions to deal with this



Mitigation - Alternative Specifications

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- Cement substitutes or partial substitutes; including:
  - PFA in concrete
  - Geo-polymeric cements
- Consider the extent of glass and glass treatments
  - Triple glazed facades/laminates
  - Coatings/fittings
- Consider alternatives to structural steel and concrete
  - Engineered timber



Mitigation - Conserving Materials

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- Recycled - examples:
  - Steel reinforcement
  - Recycled aluminium
  - Bricks
- Downcycled - examples:
  - Aggregate can be obtained from crushed concrete.
  - Some sand and bricks from recycled glass.
  - "Foamaster" uses road arisings and other recycled aggregates to produce new binder course and base materials.



Mitigation - Conserving Materials

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- Re-use
  - For example, steel beams from dismantled buildings?
  - Bricks recovered from dismantled buildings.
- Refurbished
  - For example, "Milliken" carpets
  - Internal doors
- Conserving materials normally saves energy as well as landfill space but sometimes costs more.





Suppliers' Database

Global Construction Consultants

Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

GBPTs Database

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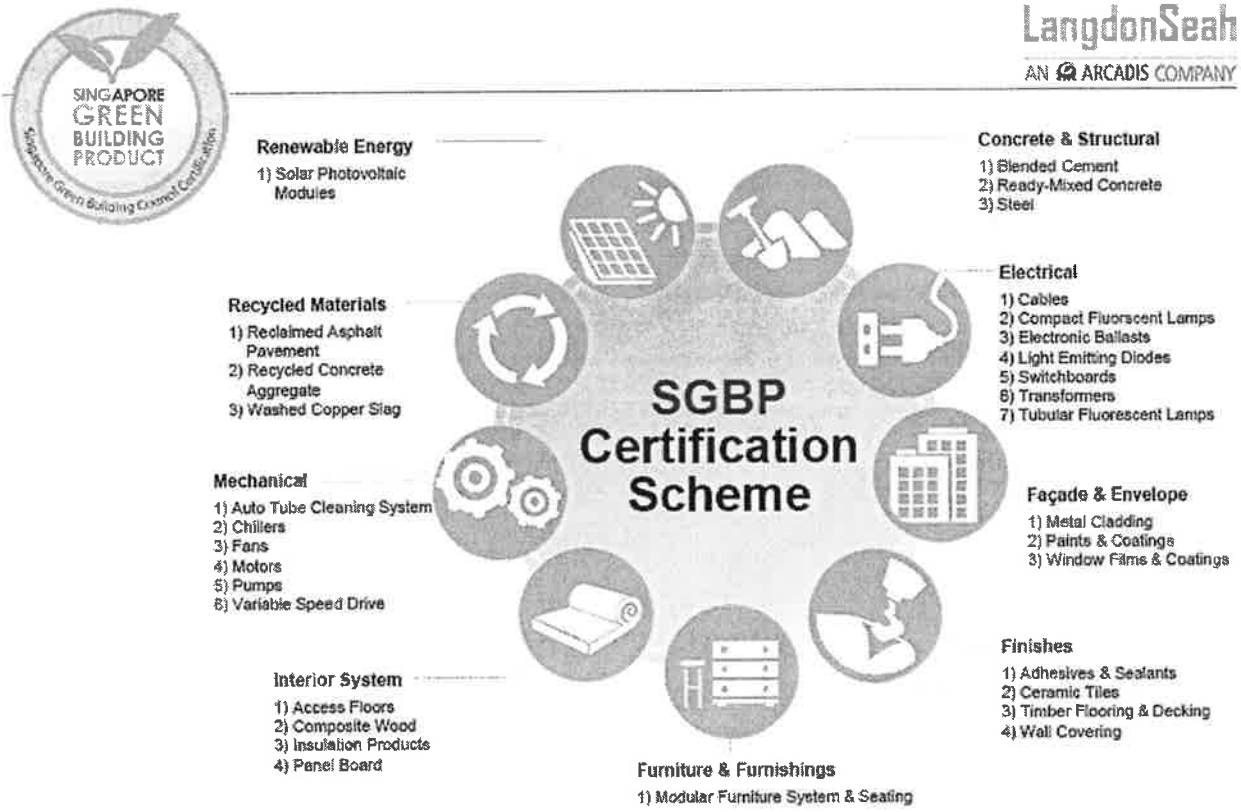
Card Index

Category	Card No
Energy Efficiency	No.1-33
Water Efficiency	No.1-8
Environmental Protection	No.1-10
Indoor Environmental Quality	No.1-8
Other Green Features	No.1-11

Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management



GBPTs Database

No.	Attribute:	No.	Attribute:
EE-1	Absorption Chillers	IEQ-3	Formaldehyde
EE-2	AC Variable Voltage & Variable Frequency (VVVF) for Lifts	EE-11	Fuel Cells
EE-3	Bio-Mass	OGF-5	Future Green Mark (GM) Initiatives
WE-1	Black Water	OGF-6	Glare
EE-4	Building Management Systems (BMS)	IEQ-4	Green Boards
EE-5	Chilled Beams (Active)	EP-1	Green Mark Manager / Professional
EE-6	Chilled Beams (Passive)	EP-2	Green Roofs
OGF-1	Climate Change	EP-3	Green Walls
IEQ-1	CO_2 Monitoring	WE-3	Grey Water
IEQ-2	Computation Fluid Dynamics (CFD) Analysis	EE-12	Heat Recovery
EE-7	Condensing Boilers	IEQ-5	High Frequency Ballasts and Luminaries
OGF-2	Cool Paints	IEQ-6	Indoor Air Quality
WE-2	Cooling Tower Water Treatment Systems	OGF-7	Integrated Design Approach
EE-8	Double Skin Façade	EE-13	Internal Sun Shading
EE-9	Environmental Friendly Lamps	EE-14	Light Emitting Diodes
EE-10	External Sun Shading: Aluminium Louvre Systems	OGF-8	Light Shelves
OGF-3	External Views	EE-15	Lighting Controls
OGF-4	Forest Stewardship Council		

No.	Attribute:	No.	Attribute:
EE-16	Low Emissivity Glass	EP-9	Recycled Concrete
EP-4	Low Oxides of Nitrogen (NOx) Boilers	EP-10	Refrigerant Leak Detection Systems
EE-17	Low Velocity & Floor Diffusers for Displacement Ventilation	EE-25	Sandwich Walls
EE-18	Micro-Hydro Systems	EE-26	Site Orientation
EE-19	Mixed Mode Ventilation	EE-27	Solar Heating Systems
EE-20	Motors and Controls for Sun Shading Devices	EE-28	Solar Light Systems
EP-5	Native Landscaping	EE-29	Solar Powered Applications
EE-21	Natural Ventilation	EE-30	Solatube Day Lighting Systems
WE-4	NEWater	OGF-11	Swale Drains
EE-22	Non Compressor Air Conditioning	EE-31	Variable Refrigerant Volume (VRV) Systems
EP-6	Organic Waste Recycling Compost	EE-32	Variable Speed Drives
EP-7	Ozone Depletion Potential / Global Warming Potential (Refrigerant)	IEQ-7	Volatile Organic Compounds (VOCs)
OGF-9	Phase Changed Materials	WE-6	Water Efficient Fixtures & Flow Restrictors
EE-23	Photovoltaic (PV) Modules	WE-7	Water Meters
EE-24	Power Factor Correction (PFC)	WE-8	Waterless Urinals
OGF-10	Pre-Fabrication	IEQ-8	Wind Catchers / Wind Scoops
EP-8	Public Transportation Accessibility and Cyclist Facilities	EE-33	Wind Turbines
WE-5	Rainwater Harvesting		

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Attribute: External Sun Shading: Aluminium Louvre Systems | **Category: Energy Efficiency** | **10**



Information Source:
Hunter Douglas Singapore Pte Ltd

Description:
The fin-like structure of aluminium louver allows for the most effective solar heat and light control by applying shading elements externally. The closer the sunshade to the window, the lower is the SC (better performance). Vertical sunshade performs slightly better at North-South orientation than East-West orientation. Horizontal sunshades performs similarly at every orientation.

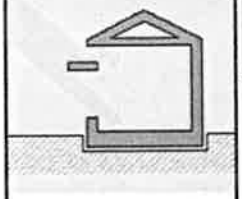
Capital Cost: S$200 to S$800/m²
Lead-time: 2.5 months upon colour confirmation.

Pro's:
1. Reduction in energy costs and Greenhouse gas emissions.
2. Visual properties of the sun shading can become an integral feature of the façade.

Con's:
1. Extra capital and maintenance cost.

Applications:
1. It can be applied over a wide range of projects.
2. Ventilation screens in multi-storey carpark.

Key Drivers:
1. Optimise natural lighting and visual comfort, improve thermal comfort, save energy.
2. Enhance overall thermal performance of building envelope to minimise heat gain thus reducing the overall cooling load requirement.

Attribute: Light Shelves	Category: Other Green Features 8
 Information Source: Davis Langdon Australia	**Description:** Light Shelves are passive architectural element that permits daylight to enter deeper into a building, by reflecting light from its upper surface to the ceiling and then down again, deeper into the floor plate.
	Capital Cost: Indicative cost range is about S$550 to S$2,000/m². **Note:** Light shelves may be interior or exterior and can serve a dual purpose as a sunshade.
Pro's: 1. Enhances daylight quality. 2. Increases occupancy comfort and potentially productivity. 3. Conserves energy by allowing perimeter lighting to be dimmed or switched off.	**Con's:** 1. Requires higher floor to ceiling heights to be effective. 2. Increases maintenance requirements. 3. Requires open plan office arrangement.
Applications: 1. It can be applied over a wide range of projects. 2. Preferably to carry out a sunlight simulation exercise.	**Key Drivers:** 1. Reduce glare and bring light deeper into the interior building.

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Procurement (FOR INFORMATION ONLY)

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Understanding the ESD Scope of Works

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- Pre-Contract Phase
  - Greenmark consultancy and co-ordination
  - Design review and Environmentally Sustainable Design (ESD) concepts
    - ETTV,ACMV system, Ventilation, Lighting, Renewable energy etc
  - Energy modeling
  - Liaise with Authorities and Greenmark presentation to BCA
- Construction Phase
  - Monitoring and review of greenmark provisions in the construction phase
- Post Occupation Phase
  - Post occupancy evaluation
  - Greenmark "Existing Building" consultancy

Understanding the ESD Scope of Works

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- Key Highlights
  - ESD Consultant is not a M&E Consultant although there may be some overlap in the scope of works
    - Review and evaluate M&E Consultant's design with a view to optimize energy and water usage and enhance operational effectiveness and maintenance efficiency but not actual design of the systems.
  - Avoid point mongering at all costs.
    - A sustainable building is not about getting the requisite amount of greenmark points
  - The role of the ESD consultant is to assist the Client to futureproof its asset

Impact of ESD on DBB Projects

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•DBB = Traditional form of contract

•To align to the green wave in the industry, the key project personnel need to redefine their roles and responsibilites

- Project Manager - Overall responsible for the success planning, execution, monitoring, control and closure of a *green building*
- Architect - Plan, design and review the construction of buildings and structures *based upon green building principals*
- Structural Engineer - Responsible for structural engineering *based on sustainable construction techniques*
- M&E Engineer - Able to engineer *energy efficient* mechanical and electrical services solutions
- Quantity Surveyor - *Understand the green building principals* and be able to appraise the *cost of GBTs* and monitor the cost of the project
- Environmentally Sustainable Design Consultant - Have broad knowledge and track record in *sustainable building design and technology* and is familiar with *BCA Green Mark Certification*

Impact of ESD on DBB Projects

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•Scope of works

- Role of ESD Consultant may be more restrictive as
  - Design has already been developed by the design consultants; and
  - Partial scope of ESD may have been undertaken by the design consultants
  - Liaise with design team for energy modeling and other simulations

•Contract Provisions

- Going beyond Greenmark
  - Buildability
    - Modularity, design efficiencies
  - Constructability & Productivity on site
    - Prefab, Precast, System formwork etc
    - Use of BIM, CCTV surveillance

Impact of ESD on DBB Projects

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- Contract Provisions
  - Key Performing Indicators (KPIs) to be agreed with Client and incorporated into Preliminaries
    - Waste Management
    - Energy Consumption and Generation
    - Water recycling and Harvesting
    - CO2 emissions in general
    - Use of Materials
    - Vehicle Movements
    - Maintenance and optimization of biodiversity, ecological habitat
    - Whole Life Performance
    - EHS
    - Training

Impact of ESD on D&B Projects

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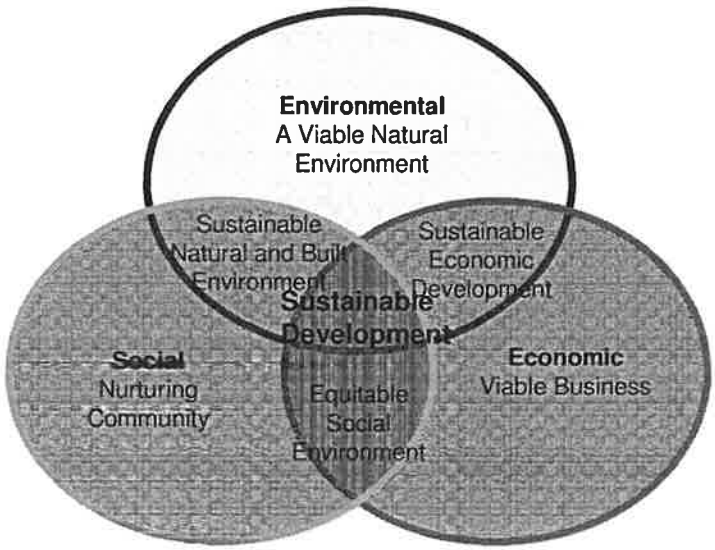
- Employer Requirements may be based on Triple Bottomline approach



Sustainability Model (Adapted from CIRIA, 2001)

Impact of ESD on D&B Projects

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- An example of Employer Requirements based on Triple Bottomline approach
  - Social
    - Universal design approach
    - Social acceptance by end users
    - Adequate social and open spaces
  - Economic
    - Within budget or life cycle costs
    - Site productivity
  - Environmental
    - Attain KPIs for energy, water, waste and the like
    - ABC design guidelines
    - Passive design strategies

Impact of ESD on D&B Projects

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- More leeway for design consultants to develop design concepts
- The design requirements should be clear and detailed and without any ambiguities.
  - Design Constraints
  - Project Briefs and Requirements
    - Development Requirements
    - Architectural Requirements
    - Authorities Provision
    - Other Requirements
    - List of Exclusion
  - Dos and Don'ts Checklist

Contract Documentation

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•With the increased popularity in green buildings, the contract provisions have been amended/updated to deal with the new green building requirements. Some of the means to alleviate risks and to avoid liability pitfalls are as follows:-

- The **process** for obtaining green building certification should be **explicitly** addressed in the contract documents.
- The **responsibility** for obtaining green building certification should be **assigned** in the contract documents to the **appropriate parties**, including responsibility for registering the project, compiling and maintaining the documentation necessary to obtain the points, applying for certification, responding to requests from the certifier for clarification or additional information and prosecuting the appeal process in the event that the initial request for certification is denied.

Contract Documentation

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•Apart for stating the certification process, the benefits of obtaining and the consequences of failing to obtain green building certification should be explicitly set forth in the primary contract documents.

•The contract documents should always mandate the Contractor to have proper documentation of the sustainable construction methods adopted on site and this process should be ongoing throughout the construction period.

- The responsibility for such documentation may fall on more than one contracting party.

Contractual Liabilities

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- The push for sustainable development have lead to the growth of green buildings.
  - ➢ Poses new liability risks.
- Southern Builders, Inc. v. Shaw Development, LLC
  - Developer sued the Contractor for failing to construct a building that met LEED Silver Certification requirements
  - → Loss $635,000 in tax credits
- Settled out of court.

Contractual Liabilities

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- Lessons Learnt
  - Contractors need to be extremely wary of the general contract provisions and the unintended responsibility for compliance with green building requirements that are imposed on them.
  - The contracting parties need to be familiar with the incentives available in the locality or otherwise for achieving green building standards and be aware of local building requirements and the mandatory compliance with green building standards imposed.
  - Contract documents for green projects where green building certification is sought need to be tailored specifically to the project.

Contractual Liabilities

•The developer must also take note that the performance of the completed green building may only be verified after completion of project and operate for a period of time.

- Consider shifting the project endpoint from completion of the physical construction to the issuance of the certification.

•The obligation of the contractor should be stated in terms of achieving the criteria that are necessary to achieve the required certification instead of getting the contractor to guarantee a particular certification or rating.

•Contractors, and architects as well, should not state overtly or inadvertently their expertise and experience in this area.

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Construction

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Productivity

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- Buildable Designs
  - Modular design
  - Economies of Scale
  - Design efficiencies
  - Sustainable materials
- Construction methods
- Raise site productivity
- Implementation of labour saving methodologies

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Facility Management

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Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

Agenda

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- Post Occupancy Evaluation

Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

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Post Occupancy Evaluation (POE)

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Feasibility Studies	Design Development	Cost Appraisals / Cost Plans	Procurement	Construction	Facility Management

Post Occupancy Evaluation (POE)

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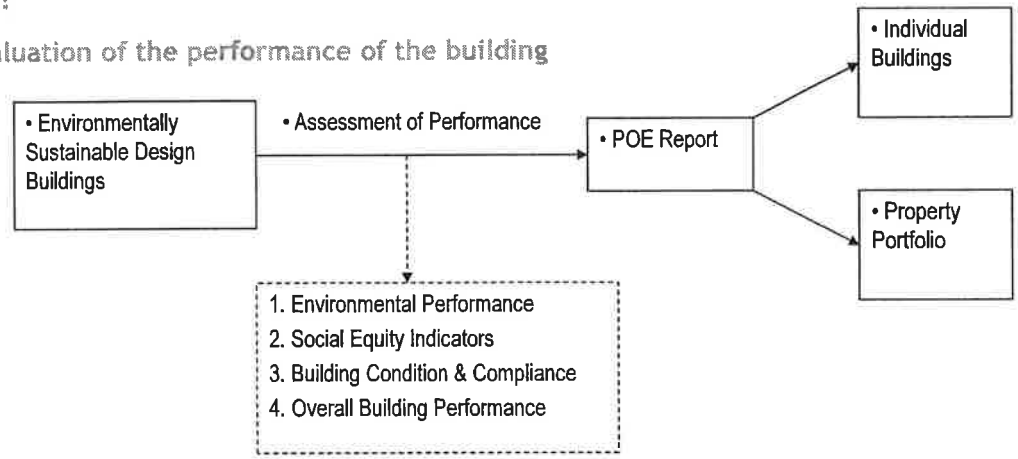
What is POE?

•Annual evaluation of the performance of the building



Why is there a Need for POE?

•Without POE, the sustainability of buildings in occupation may only be assumed rather than measured.

•POE allows for feedback of evaluation results and consequent lessons into the planning stages of future projects.



Benefits of POE

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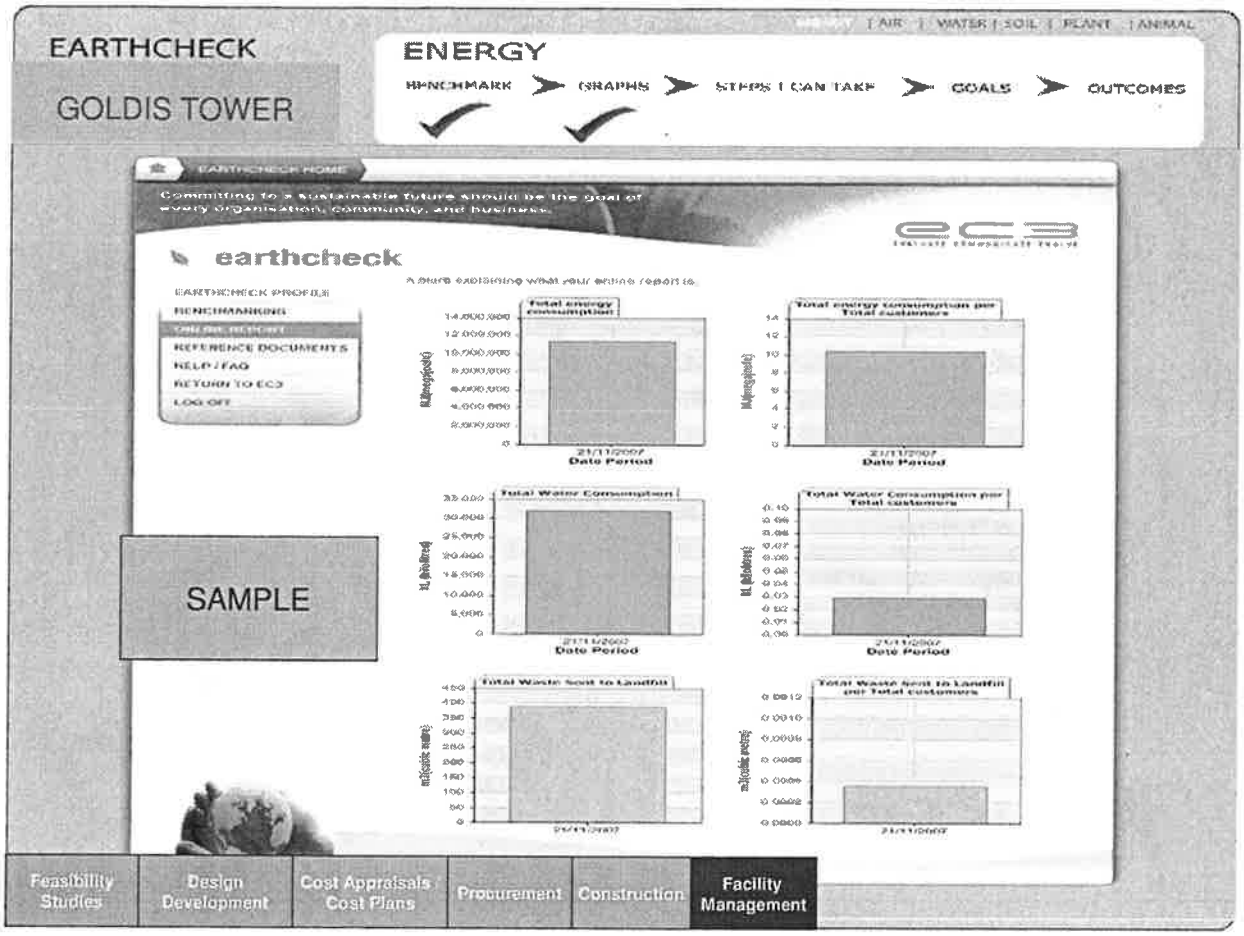
- Fine tuning new buildings
- Improving design for future buildings
- Accountability
- Cost savings
- Renovating existing buildings
- Staff and/or customer relations
- mitigated personal asset risks
- insurance premium reduction options
- savings in legal fees and court cases
- property continuity and maximized returns
- optimised tenant occupancy rates





Greening of the C.I

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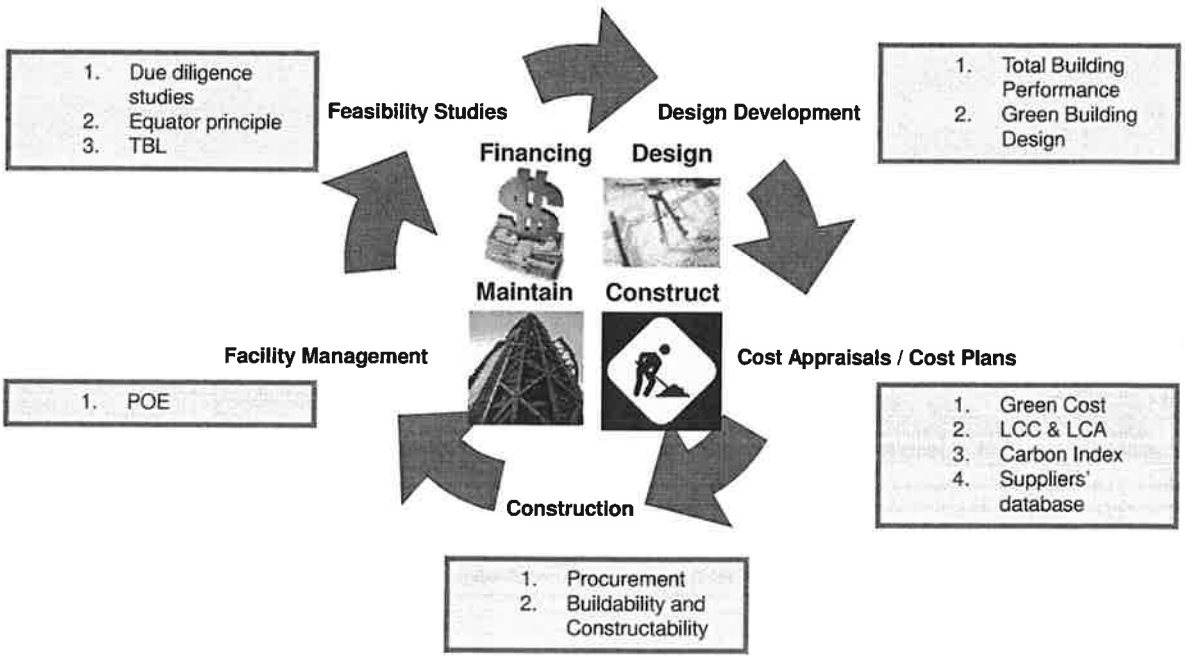



nstruct