BEAM Plus (Materials Aspects) - Hong Kong's Green Building Labelling Scheme for Promoting Sustainable Use of Materials in Construction

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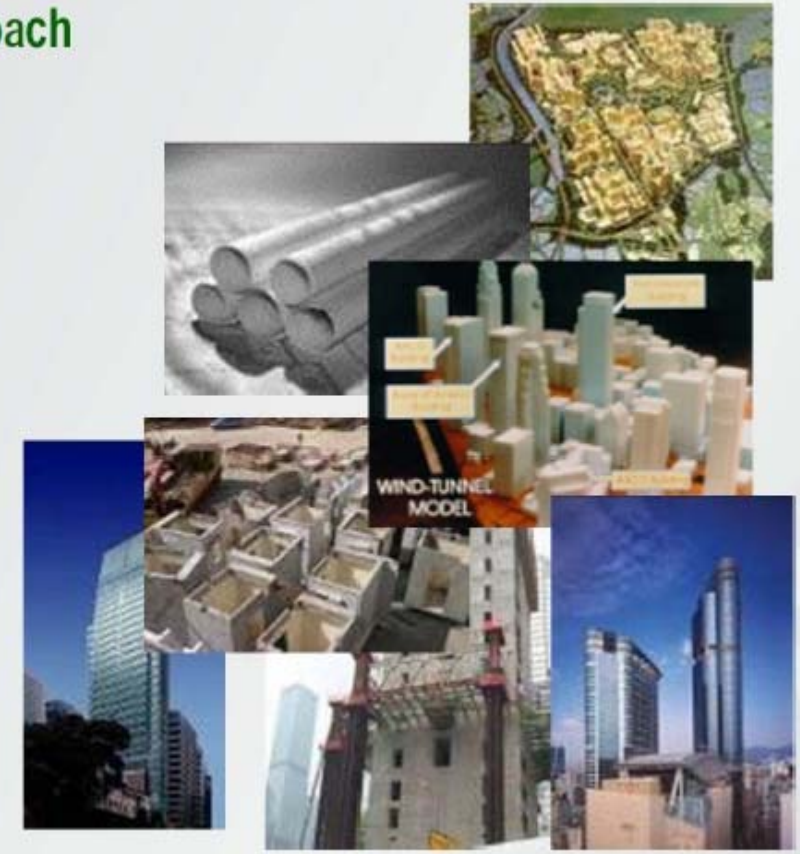
Hong Kong Green Building Council

What is BEAM Plus?

"Whole-Life" Approach

- Planning
- Design
- Construction
- Commissioning
- Completion
- Operation
- Maintenance
- Management



Site

Energy

IEQ

Materials

Water

History of Development

- First launched in 1996
- Revised in 1999, 2003, 2005, **2009** and 2012

Most Significant Upgrade in 2009

	HK – BEAM	BEAM Plus
Same	• Six categories (Site Aspects (SA), Material Aspects (MA), Energy Use (EU), Water Use (WU), Indoor Environmental Quality (IEQ), Innovations and Performance Enhancements (IA)) • Performance ratings (Platinum, Gold, Silver, Bronze and unclassified)	
Differences	• Local best practices	• Recommend new criteria and assessment methods in line with similar assessment methods overseas, local updated best practices and government programmes
	• No pre-requisites	• Assign relevant credits as "pre-requisites"
	• Beside the overall % , only IEQ is necessary to obtain a minimum %.	• Beside the overall % , SA, EU, IEQ & IA are necessary to obtain a minimum %.

Min. Levels for Obtaining the Grades

	Overall	SA	EU	IEQ	IA
Platinum	75%	70%	70%	70%	3 credits
Gold	65%	60%	60%	60%	2 credits
Silver	55%	50%	50%	50%	1 credit
Bronze	40%	40%	40%	40%	-

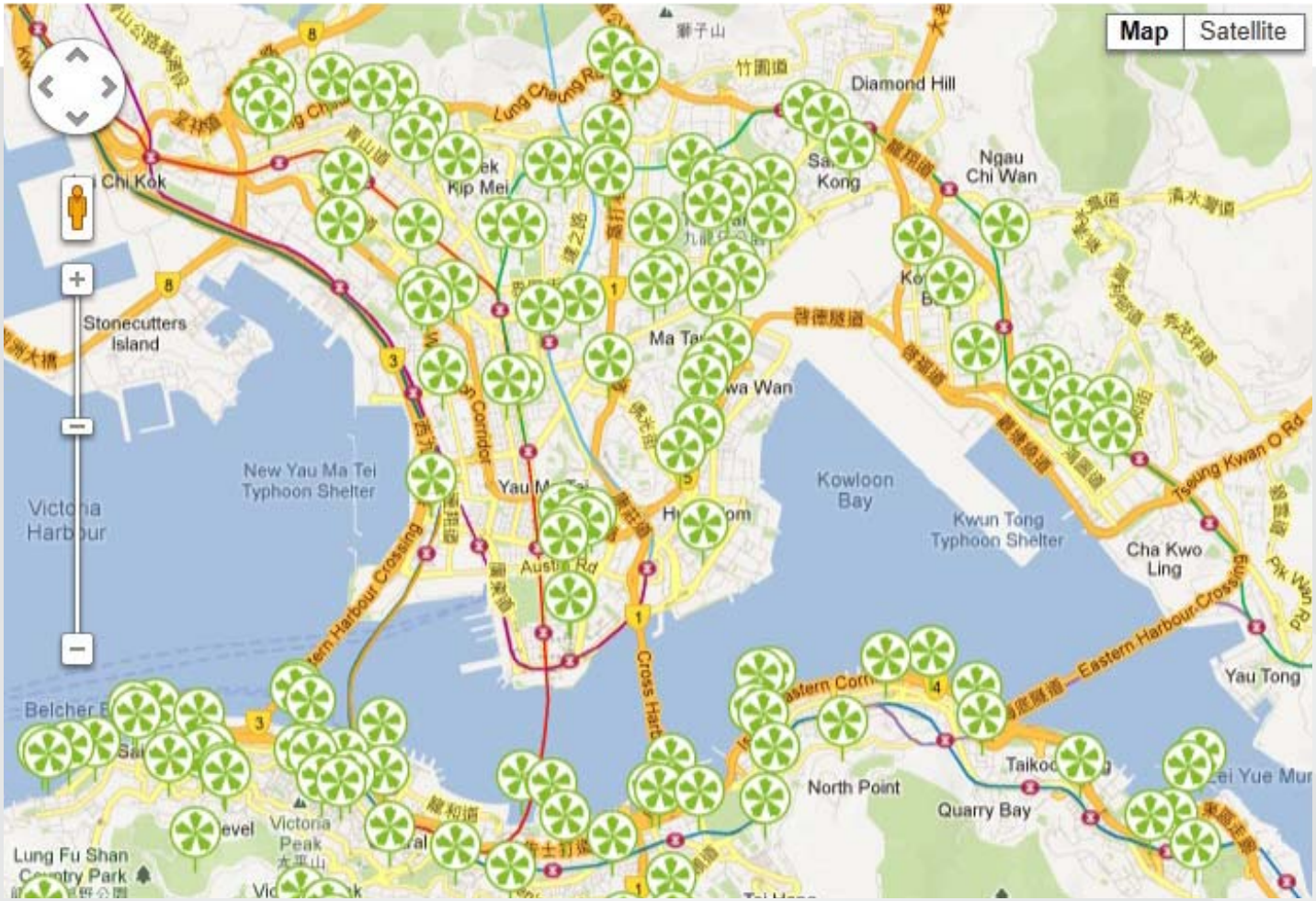
Weights of Different Aspects

Manual	SA	MA	EU	WU	IEQ
New Buildings	25 %	8 %	35 %	12 %	20 %
Existing Buildings	18 %	12 %	30 %	15 %	25 %

Pre-requisite for GFA Concession

PNAP APP-151:
Undergoing certification
is a pre-requisite for
Gross floor area concession

More than 300 Projects registered for BEAM Plus from Aug 10 to Dec 12



BEAM Plus
Materials Aspects

Principal Aims :

- Promote sustainable use of natural resources
- Minimize waste generation
- Encourage waste recycling
- Conserve landfilling resources
- Protect ozone layer/minmise green house gas

BEAM Plus
Materials Aspects

Materials Aspects	NB	EB
No. of Prerequisites	4	2
No. of Credits	22	11
No. of Bonus	1	2

Credit Summary for NB:

Ma P1	Timber Used for Temporary Works
Ma P2	Use of Non-CFC Based Refrigerants
Ma P3	Construction / Demolition Waste Management Plan
Ma P4	Waste Recycle Facilities
Ma 1	Building Reuse
Ma 2	Modular and Standardized Design
Ma 3	Prefabrication
Ma 4	Adaptability and Deconstruction
Ma 5	Rapidly Renewable Materials
Ma 6	Sustainable Forest Products
Ma 7	Recycled Materials
Ma 8	Ozone Depleting Substances
Ma 9	Regionally Manufactured Materials
Ma 10	Demolition Waste Reduction
Ma 11	Construction Waste Reduction

Credit Summary for EB:

Ma P1	Use of Non-CFC Based Refrigeran
Ma P2	Waste Recycling Facilities
Ma 1	Building Reuse
Ma 2	Modular and Standardized Design
Ma 3	Adaptability and Deconstruction
Ma 4	Rapidly Renewable Materials
Ma 5	Sustainable Forest Products
Ma 6	Ozone Depleting Substances
Ma 7	Waste Management

BEAM Plus
NB Ma P1

Ma P1 Timber Used for Temporary Works - Prerequisite

Exclusion:

None

Objective:

Encourage the well-managed use of timber.

Requirement:

It is required no virgin forest products were used for temporary works during construction, but wood products from well-managed or sustainable sources source are acceptable.

emarks:

00% fulfillment.

ustainable timber shall be certified by Forest Stewardship Council (FSC), the American Forest a
aper Association (AFPA) or "Known Licensed Sources".

BEAM Plus
NB Ma P2

NB Ma P1 Use of Non-CFC Based Refrigerants

Prerequisite
Exclusion:

None

Objective:

Reduce the release of chlorofluorocarbon into the atmosphere.

Requirement:

It is required that no chlorofluorocarbon (CFC)-based refrigerants is used in HVAC&R systems

BEAM Plus
NB Ma P3

Ma P3 Construction and Demolition Waste Management Plan

Prerequisite

Objective:

Encourage best practices in the management of construction and demolition wastes, including sorting, recycling and disposal of construction waste.

Requirement:

It is required to implement **with proof of documentation** a waste management system providing for the sorting, recycling and proper disposal of inert and non-inert construction / demolition materials.

Remarks:

If the demolition works were not conducted by the project proponent AND it was completed before 01 April 2010, the BEAM assessor can consider to exclude all the demolition related credit in the BEAM Plus assessment. However, relevant document shall be submitted to provide the completion date of the demolition.

For MA P3 - Supporting document for waste management in demolition stage should be provided as evident

BEAM Plus
NB Ma P4

NB Ma P4 / EB Ma P2 Waste Recycling Facilities

Prerequisite

Exclusion:
One single family domestic building with not more than 3 floors or domestic part of a composite building for one single family with not more than 3 floors.

Objective:

Reduce pressure on landfill sites and help to preserve non-renewable resources by promoting recycling of waste materials.

Requirement:

Provision of facilities for the collection, sorting, storage and disposal of waste and recovered materials.

Remarks:
for a domestic building or composite building on a site of an area of not more than 250 m^2, the provision of refuse storage and material recovery room on every floor of domestic building shall be exempted in BEAM Plus Assessment;

As an indication the space requirements for commercial building, industrial building and a building constructed or adapted for use principally as a church, a school, a carpark or similar buildings, are 2 m^2 per 1,000 m^2 of usable floor space.

BEAM Plus
NB Ma 1

NB Ma 1 Building Reuse – 2 + 1 Bonus credits

Exclusions:

Buildings on reclaimed land or greenfield sites.

Objective:

Encourage the reuse of major elements of existing buildings, to reduce demolition waste, conserve resources and reduce environmental impacts during construction.

Requirement:

1 credit for the reuse of 30% of more of existing sub-structure or shell.

2 credits for 60% or more.

1 BONUS credit for 90% or more.

Reusing Building Structure: Renovation

The Legislative Council building, Central, Hong Kong.

The old China Bank building, Central Hong Kong.

The Honest Motor Building external renovation, Causeway Bay, Hong Kong.

Reusing Building Structure: Rehabilitation

Tea Ware Museum, Central, Hong Kong.

Completed in 1846, the Flagstaff House was originally the home of the commander-in-chief of the British Forces. It was converted into a museum in 1984.

Sai Ying Pun Community Complex, Rehabilitation of the old mental hospital, Hong Kong.

The original arcade façade was built in 1897, and the new building addition was completed in 2001.

BEAM Plus
NB Ma 2

NB Ma 2 Modular and Standardised Design – 1 credit

Exclusions:

None.

Objective:

Encourage increased use of modular and standardised components in building design in order t
enhance buildability and reduce waste.

Requirement:

1 credit for demonstrating the application of modular and standardised design should over 50%
the major elements and modules.

BEAM Plus
NB Ma 3

Ma 3 Prefabrication – 2 credits

Exclusions:

None.

Objective:

Encourage prefabrication building elements in order to reduce wastage of materials and quantitie
of on-site waste.

Requirement:

1 credit when the manufacture of 20% of prefabricated building elements, which listed in corresponding submission template has been off-site.

2 credits when the prefabricated building element is 40% or above.

Remarks:

The manufacturing plant shall be located within 800km from the site.

- Major precast components used in housing projects in Hong Kong

ecast Façades

Dimensions (mm):
Various dimensions
Type 1:
4625 (L); 150 (T); 2700 (H)
Maximum dimensions:
5500 (L); 150 (T); 3000 (H)
Weight (tonne): Type 1: ~5.25 t
Component/typical floor: 8 to 16
Manufacturing:
-Cast with window frame
-Steel formwork
-Ceramic tile finish applied after casting concrete
Application:
-Public housing projects

Semi-precast Slabs

Dimensions (mm):
Various dimensions, e.g.
4655x2125 (L); 75 (T)
Maximum dimensions:
5500x2400 (L)
Weight (tonne): 1.28 t
Component/typical floor: covers 100% of floor area in recent projects
Manufacturing:
-Cast with reinforcement
-Steel formwork
Application:
-Public housing projects

Precast Staircases

Dimensions (mm):
2651x1645 (L); 195 (T
Weight (tonne): 2.8 t
Component/typical floor: 4
Manufacturing:
-Steel formwork
Application:
-Public housing project & private sector

ecast Bathrooms

Manufacturing:
-Cast with window frame
-Steel formwork
-Unit completed with waterproofing, tiling, concealed conduits, & sleeves for pipe work before delivery.
-Installation of pipes and sanitary fittings inside the precast bathroom at the factory
Application:
-Public housing projects & private sector

Precast mid-landings

Dimensions (mm):
3490 (L); 1730 (T)
Weight (tonne): 5 t
Component/typical floor: 2
Manufacturing:
-Steel formwork
Application:
-Public housing projects

Precast Beams

Dimensions (mm):
4200 (L); 500 (T); 800 (H)
Weight (tonne): 2.92 t
Component/typical floor: 2
Manufacturing:
-Steel formwork
Application:
-Public housing project

) Length; (T) Thickness; (H) Height

BEAM Plus
NB Ma 4

NB Ma 4 Adaptability and Deconstruction – 3 credits

Exclusions:

None.

Objective:

Encourage the design of building interior elements and building services components that allow modifications to space layout, and to reduce waste during churning, refurbishment and deconstruction.

Requirement:

1 credit for designs providing spatial flexibility that can adapt spaces for different use, and allows for expansion to permit additional spatial requirements to be accommodated.

1 credit for flexible design of services that can adapt to change of layout and use.

1 credit for designs providing flexibility through the choice of building structural system that allows for change in future use, and which is coordinated with interior planning modules.

Remarks:

At least, 50% for residential development and 70% for other building types, of the items listed in each corresponding submission template should be achieved.

Sub-items shall be considered in the whole-building where applicable.

Design Flexibility

Table 2: Consideration of design flexibility concepts to allow future fitting out in residential, office and commercial buildings.

	Removable partition		Open plan		Over design structure for change in usage	
In residential buildings						
Yes	29	43%	24	35%	15	22%
No	39	57%	45	65%	54	78%
Total	68	100%	69	100%	69	100%
In office buildings						
Yes	61	90%	67	96%	37	53%
No	7	10%	3	4%	33	47%
Total	68	100%	70	100%	70	100%
In commercial buildings						
Yes	58	87%	59	88%	44	65%
No	9	13%	8	12%	24	35%
Total	67	100%	67	100%	68	100%

BEAM Plus
NB Ma 5 / EB Ma 4

NB Ma 5 / EB Ma 4 Rapidly Renewable Materials – 2 credits

Exclusions:

None.

Objective:

Encourage the wider use of rapidly renewable materials in appropriate applications.

Requirement:

1 credit for demonstrating 2.5% of all building materials/products used in the project is rapidly renewable materials.

2 credits where 5% of all building materials/products used in the project is rapidly renewable materials.

Remarks:

The unit shall be mass/volume/dollar value.

BEAM Plus
NB Ma 6 / EB Ma 5

NB Ma 6 / EB Ma 5 Sustainable Forest Products – 1 credit

Exclusions:

None.

Objective:

Encourage the use of timber from well-managed forests.

Requirement:

At least 50% of all timber and composite timber products used in the project are from sustainable source/recycled timber.

Remarks:

The unit shall be mass/volume/dollar value.

Sustainable timber shall be certified by Forest Stewardship Council (FSC), the American Fores and Paper Association (AFPA) or "Known Licensed Sources".

This is to certify that

The Teal-Jones Group

Whitewood Lumber and Shake and Shingle Divisions
17897 Triggs Road, Surrey, British Columbia V4N 4M8 Canada

complies with the requirements of

PEFC Annex 4 - Chain of Custody of Forest Based Products - Requirements

for the following scope of registration

The registration covers the chain of custody as it applies to the tracking of forest products that have originated from a defined forest area registered to CAN/CSA-Z809 and SFI 2005-2009 standard. This includes the receipt of certified logs through the manufacturing process and shipping of shakes and shingles, sawn lumber and chips.

Certificate No:	CERT-0032476	Original Certification Date:	July 27, 2006
File No:	1034371	Current Certification Date:	July 4, 2007
Issue Date:	October 20, 2008	Certificate Expiry Date:	July 3, 2011

Wendy Tilford
President,
QMI-SAI Canada Limited

Alex Ezrakhovich
General Manager,
SAI Global Certification Services Pty Ltd

PEFC ANNEX 4

ANSI

PEFC

SAI GLOBAL

BEAM Plus
NB Ma 7

B Ma 7 Recycled Materials – 3 credits

Exclusions:

None.

Objective:

Promote use of recycled materials in order to reduce the consumption of virgin resources.

Requirement:

1 credit for use of recycled materials contributing to at least 10% of all materials used in site exterior surfacing work, structures and features.

1 credit where at least 10% of all building materials used for façade and structural components are recycled materials.

1 credit where at least 10% of all building materials used for interior non-structural components are recycled materials.

Remarks:

Materials which normally consist of recycled content will not be considered for this credit, for instance, steel and glass.

Examples of field application of Eco-Blocks

BEAM Plus
NB Ma 8

NB Ma 8 Ozone Depleting Substances – 2 credits

Exclusions:

None.

Objective:

Reduce the release of chlorofluorocarbons and hydrochlorofluorocarbons into the atmosphere.

Requirement:

1 credit for using refrigerants with a value less than or equal to the threshold of the combined contribution to ozone depletion and global warming potentials using the specified equation.

1 credit for the use of products in the building fabric and services that avoids the use of ozone depleting substances in their manufacture, composition or use.

Remarks:

Exclusion: small air-conditioning unit, other equipment such as standard refrigerators, small water cooler and any other cooling equipment, that containing less than 0.23kg of refrigerant.

BEAM Plus
NB Ma 9

NB Ma 9 Regionally Manufactured Materials – 2 credits

Exclusions:

None.

Objective:

Encourage the use of materials manufactured locally so as to reduce the environmental impacts arising from transportation.

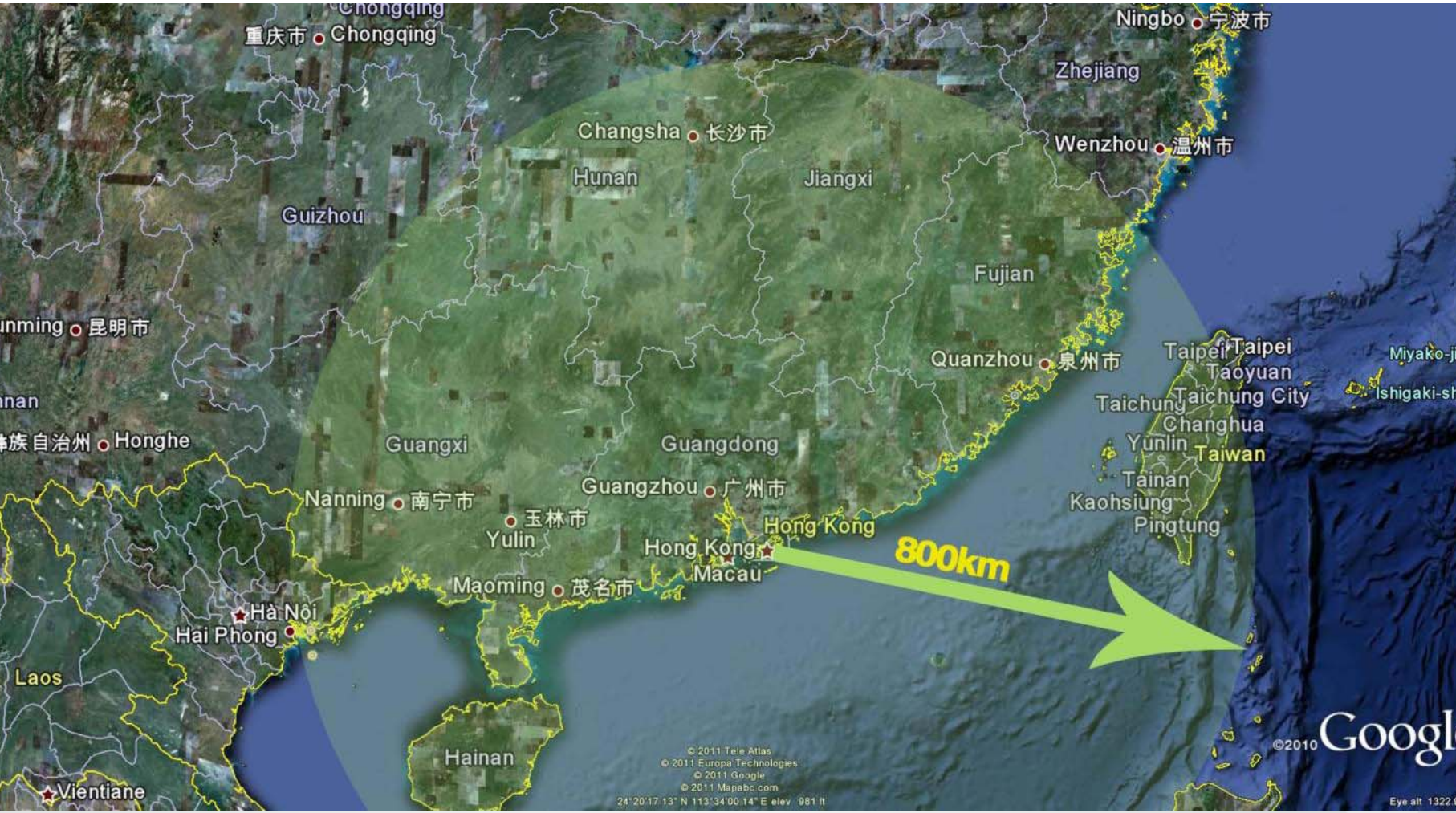
Requirement:

1 credit for use of materials manufactured locally within 800km from the site, which contribute to at least 10% of all building materials used in the project.

2 credits for use of materials manufactured locally within 800km from the site, which contribute to at least 20% of all building materials used in the project.

Remark:

Plumbing products, reused and salvage materials such as furniture may be included in the calculation, but mechanical and electrical system components shall not be included.


Chongqing
重庆市 Chongqing
Ningbo 宁波市
Zhejiang
Changsha 长沙市
Wenzhou 温州市
Hunan
Jiangxi
Guizhou
Fujian
昆明市
Quanzhou 泉州市
Taipei
Taoyuan
Taichung
Taichung City
Changhua
Yunlin
Taiwan
Honghe
Guangxi
Guangdong
Guangzhou 广州市
Tainan
Kaohsiung
Pingtung
Nanning 南宁市
玉林市
Yulin
Hong Kong
Macau
800km
Maoming 茂名市
Hà Nội
Hai Phong
Laos
Hainan
Vientiane
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BEAM Plus
NB Ma 10

NB Ma 10 Demolition Waste Reduction – 2 credits

Exclusion:

Project where demolition is not required or is not under the Client's control.

Objective:

Encourage best practices in the management of waste, including sorting, recycling and disposa of demolition waste.

Requirement:

1 credit for demonstrating that at least 30% of demolition waste is recycled.

2 credits for demonstrating that at least 60%.

Remark:

Disposal of inert waste to public fill will NOT be considered.

If the demolition works were not conducted by the project proponent AND it was completed before 01 April 2010, the BEAM assessor can consider to exclude all the demolition related credit in the BEAM Plus assessment. However, relevant document shall be submitted to provide the completion date of the demolition.

For MA P3 - Supporting document for waste management in demolition stage should be provided as evident

BEAM Plus
NB Ma 11

NB Ma 11 Construction Waste Reduction – 2 credits

Exclusions:

None.

Objective:

Encourage best practices in the management of waste, including sorting, recycling and disposal of construction waste.

Requirement:

1.credit for demonstrating that at least 30% of construction waste is recycled.

2.credits for demonstrating that at least 60%.

Remark:

The excavated waste will NOT be considered as construction waste.

The disposal of inert waste to public fill will NOT be considered also.

Way Forward

BEAM PLUS Major review

- Rationalize the distribution of marks in different aspects
- Incorporate min. score for MA
- Clarify assessment criteria
- Incorporate Green Building Product Labeling Scheme (CIC) and/or Carbon Labeling Scheme (CIC/HKUST) as criteria

  e.g. EU3: embodied energy in building structural elements

Thank You

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Environmental Division Annual Seminar
"Green Building and Construction Material
- Challenges for Innovation and Excellence" 22 March 2013

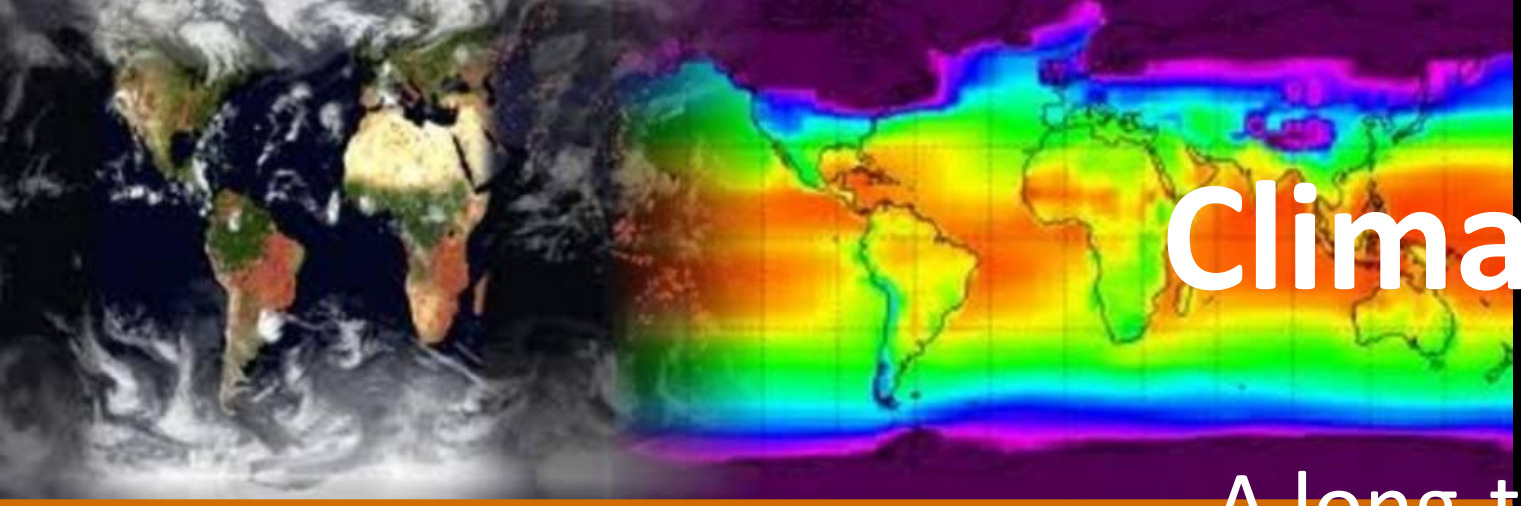
THE HONG KONG INSTITUTION OF ENGINEERS
香港工程師學會

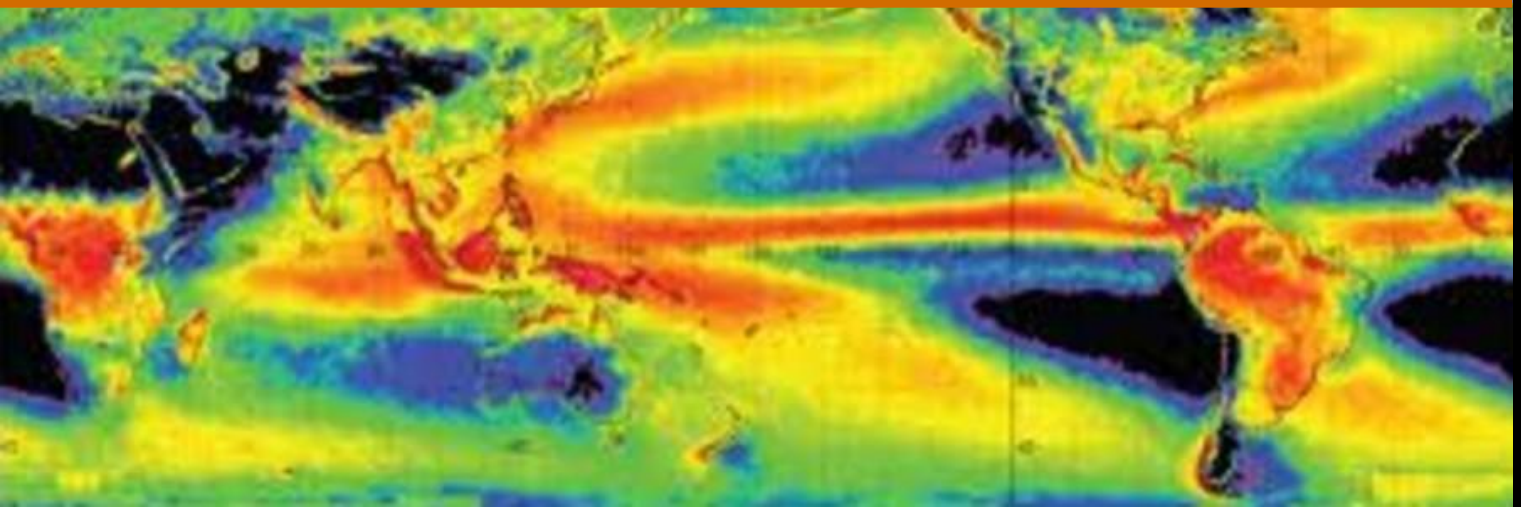
俊和建築工程有限公司
CHUN WO CONSTRUCTION & ENGINEERING CO., LTD.

Application of Green Construction Materials & Products – A Contractor's Viewpoint

Presented by

Ir Dr Gary S K Chou PhD DIC CEng MHKIE MIStructE
Assistant General Manager (Technical)
Chun Wo Construction & Engineering Co Ltd





Climate Change

A long-term shift in Earth global or regional climate, measured by long-term changes in weather conditions such as **Temperature, Wind Pattern** and **Precipitation**

Causes…

Effects / Impacts…

Mitigations

Wind turbines on buildings

Thermal insulation in cavity walls

Replacing old refrigerators

Contractors' Green Initiatives

Construction-Only Projects

Use of construction materials is largely prescribed by Clients' Specification

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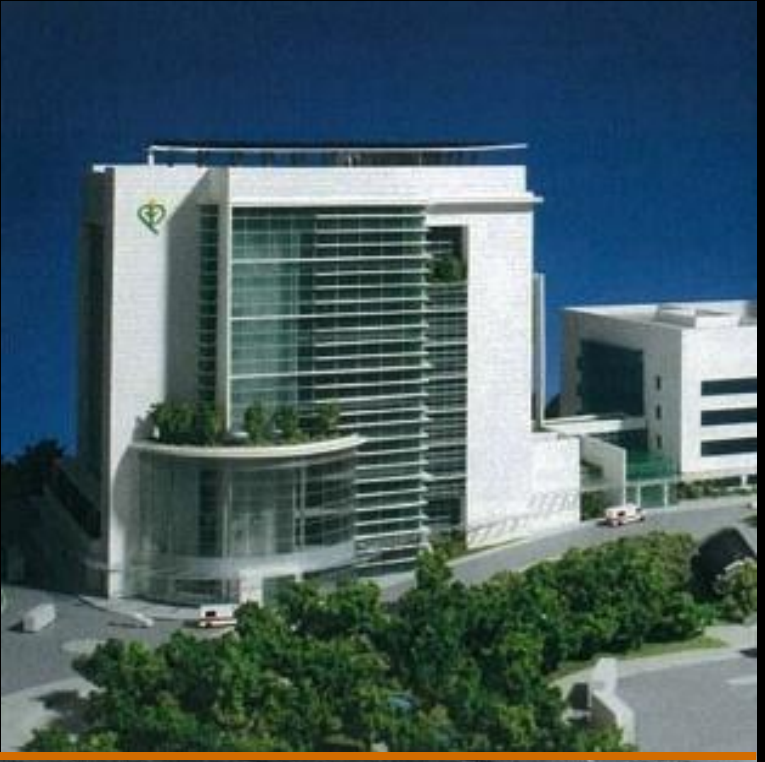
Design & Build Projects

Contractors have more freedom to choose which types of materials to be used



Selected examples of green construction methodology

Expansion of Tseung Kwan O (TKO) Hospital

Windsor House

Expansion of Tseung Kwan O (TKO) Hospital

A 9-level building with
total covered floor area 36,789 m2;
178 new in-patient beds and
22 consultation rooms
for out-patient services

Construction options:

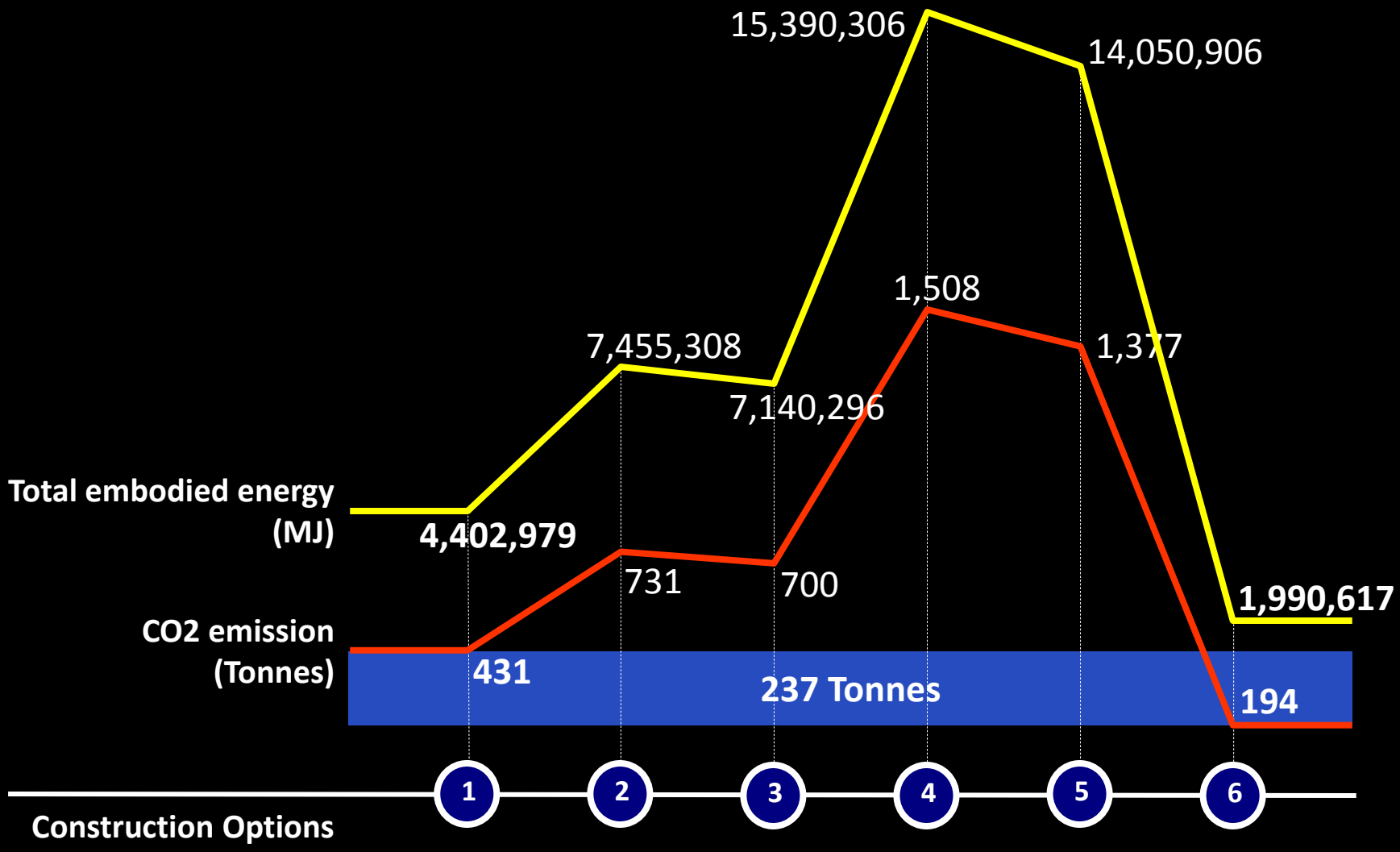
Semi-precast slabs + timber forms – Option 1
Semi-precast slabs + aluminum forms – Option 2
Semi-precast slabs + steel forms – Option 3
Aluminum forms only – Option 4
Steel forms only – Option 5
Timber forms only – Option 6

Construction options:

Semi-precast slabs + timber forms – Option 1
Semi-precast slabs + aluminum forms – Option 2
Semi-precast slabs + steel forms – Option 3
Aluminum forms only – Option 4
Steel forms only – Option 5
Timber forms only – Option 6

Concerns	Options 1 – 3	Options 4 – 5	Option 6
Waste generated	Low	Medium	Medium
Waste diversion applicability	Low	Medium	High
Structural flexibility	Low	Low	High
Work cycle time	12 days	11 days	9 days
CO_2 emission	Medium ~ High	Highest	**Lowest**
Construction cost	Medium	Low ~ Medium	High

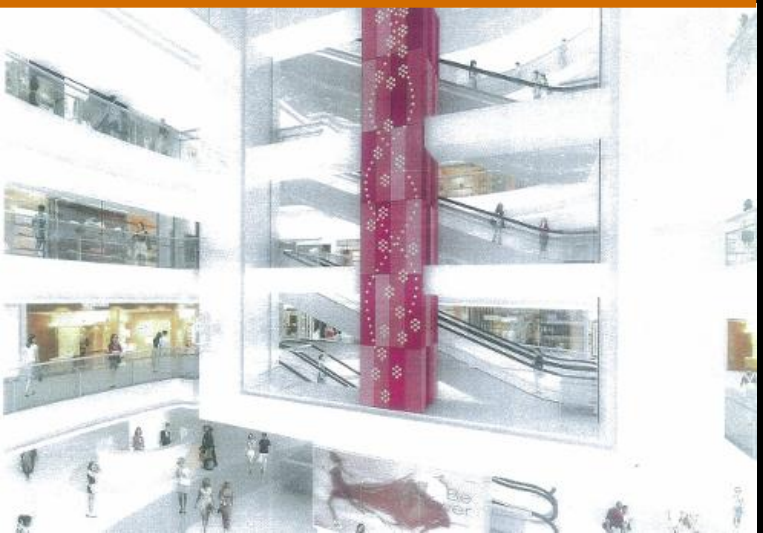
Total embodied energy vs Construction options



Converting scrap timber into fertilizers

for use in TKO Hospital

[HKUST was engaged to help test the concentrated limits of heavy metals]



Windsor House

Exceptional A&A works at shopping arcade while shops still **under operation**

Client's Directive: Sustainable development (social, environmental & economic) of an existing shopping arcade for the district with minimized nuisance

- Minimize environmental impact
- Minimize waste generation
- Improve energy efficiency of renovated shopping arcade (e.g. natural lighting)
- Adopt recyclable materials (e.g. structural steel)

Green construction methodologies & products

Waste reduction:

- 3,200 tones C&D material recycled

- 670 tones metal recycled

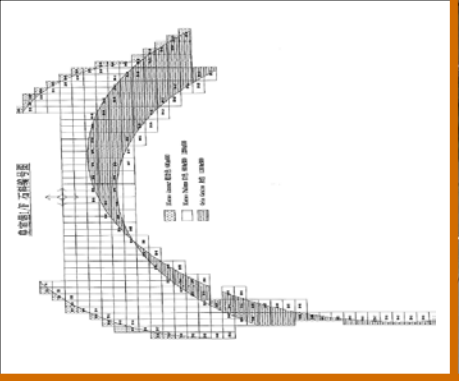
- 350 nos. fluorescent lamps reused

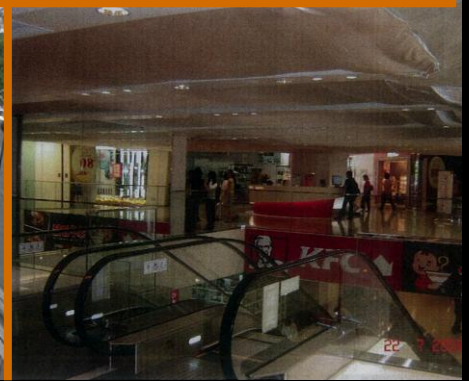
Green construction methodologies & products

Quiet demolition methods & equipments:

- Cost effectiveness & practicability

- Adopt practical quiet demolition methods to eliminate suspension of works due to exceeding of noise limit





Green construction methodologies & products

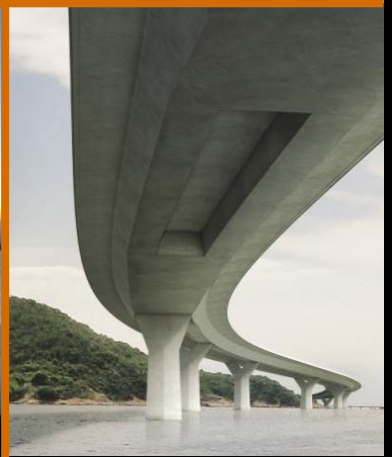
Other green measures:

- Computer-aided cutting of floor tiles (0% of wastage achieved)

- Timer control of site hoarding spot lights

- T5 florescent lamps in site office leading to around **25%** energy saving

- Infra-red sensor installed for escalators



Selected examples of design & build projects with focus on:

Use of green construction materials & products

Life cycle plan methodology

Expansion of TKO Hospital

Energy-saving features /
Green products :

- Energy efficient luminaries
- Controls for energy conservation
- Renewable energy systems
- Metering and monitoring

Expansion of TKO Hospital

Building Integrated PV (BIPV) Panels

Function also as sun shade
Electricity generated go back to hospital electricity system

Expansion of TKO Hospital

Mono-Crystalline PV Panels

More efficient in
sunny days,
but not working in
cloudy days

Expansion of TKO Hospital

Thin-Film PV Panels

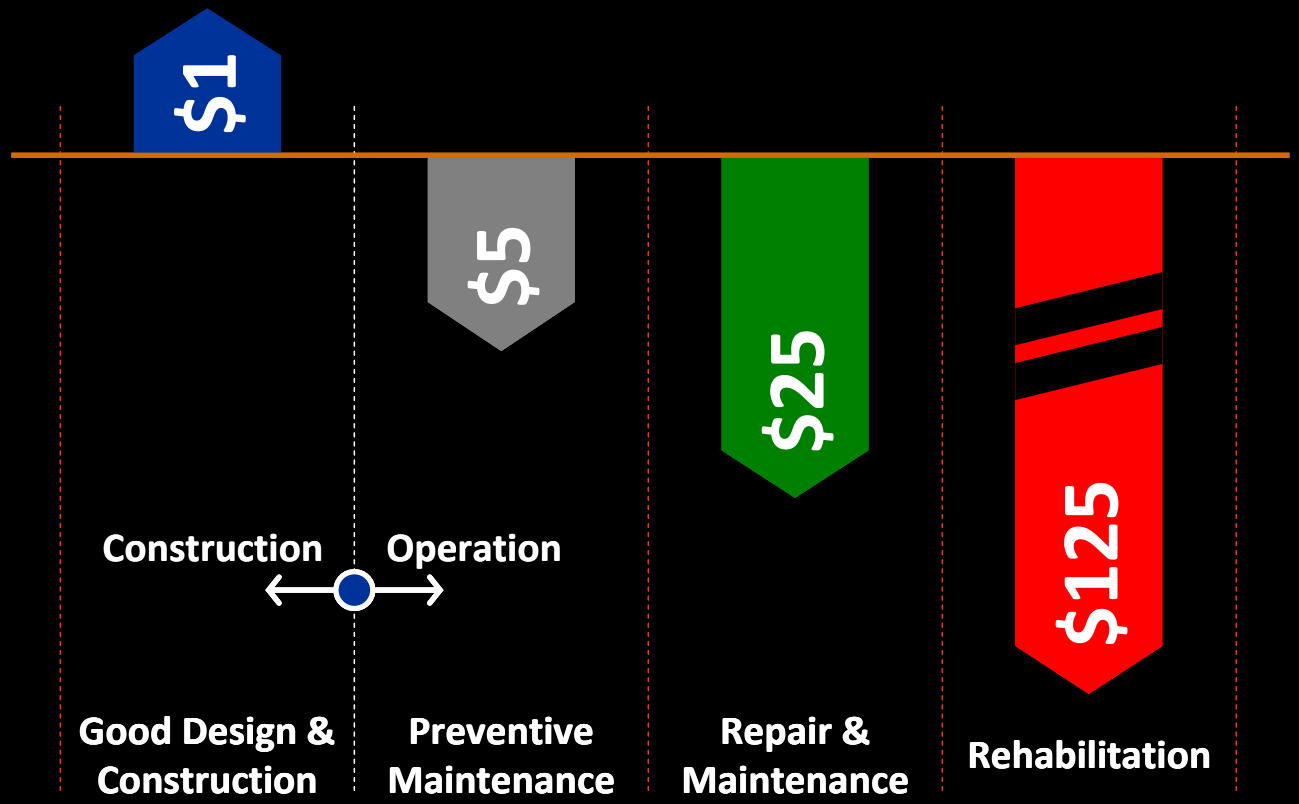
Not as efficient in sunny days, but working still in cloudy days

Expansion of TKO Hospital

Oil-free chillers to AHU

Magnetic bearings, eliminating high friction losses and mechanical wear, delivering chiller energy savings of 35% over conventional chillers

Life Cycle Plan (LCP) Methodology



Life Cycle Phases vs Maintenance Expenditure

Use of **LCP** for planning of key materials, equipment and systems used for architectural, structural and E&M work

Key elements considered in LCP:

Foundations; Pile caps;
Viaduct deck and piers; Bearings;
Ship impact protection;
Movement joints;
Maintenance walkway;
Under bridge maintenance gantry;
Light post; Handrail; FS main; ...

Cost-effectiveness of key elements:

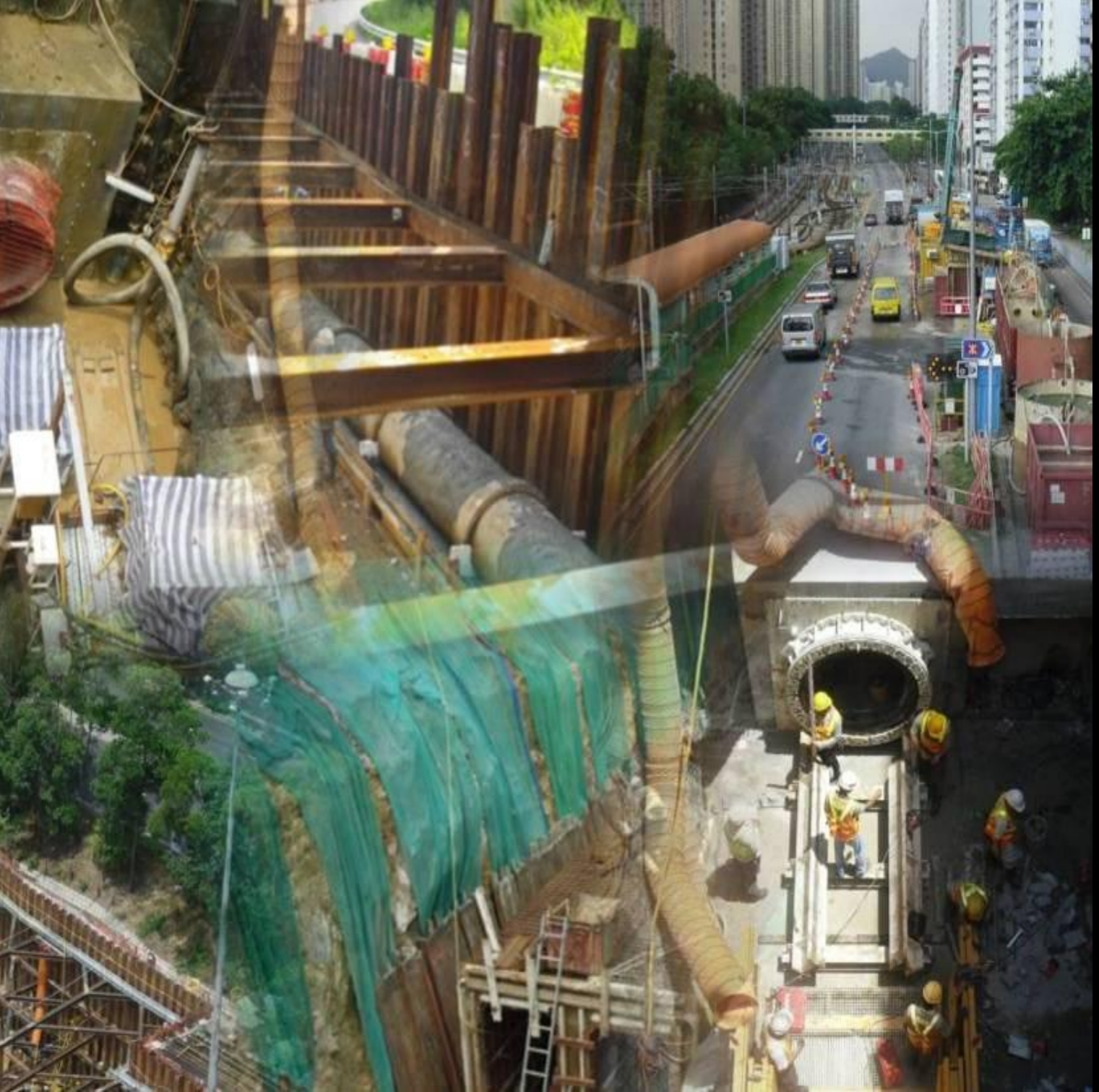
- Service life prediction
- Durability
- Maintenance and repair needs
- Replacement frequency and availability
- Economic benefits
- Recommendation for adoption in design
- Maintenance / replacement schedule

Lateral Thinking on Going Green...

Lateral thinking ...

Use of lesser construction materials in the first place

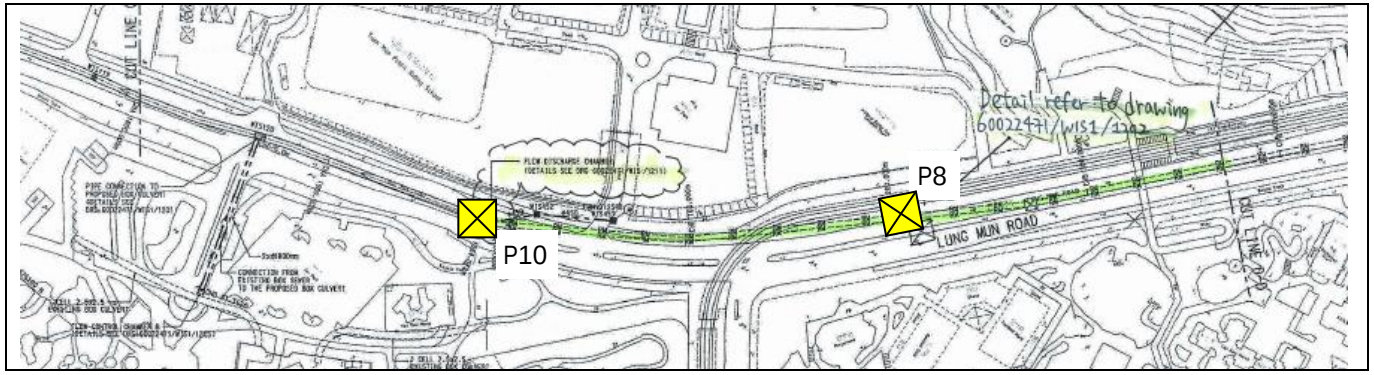
Contractors' Cost Savings Design

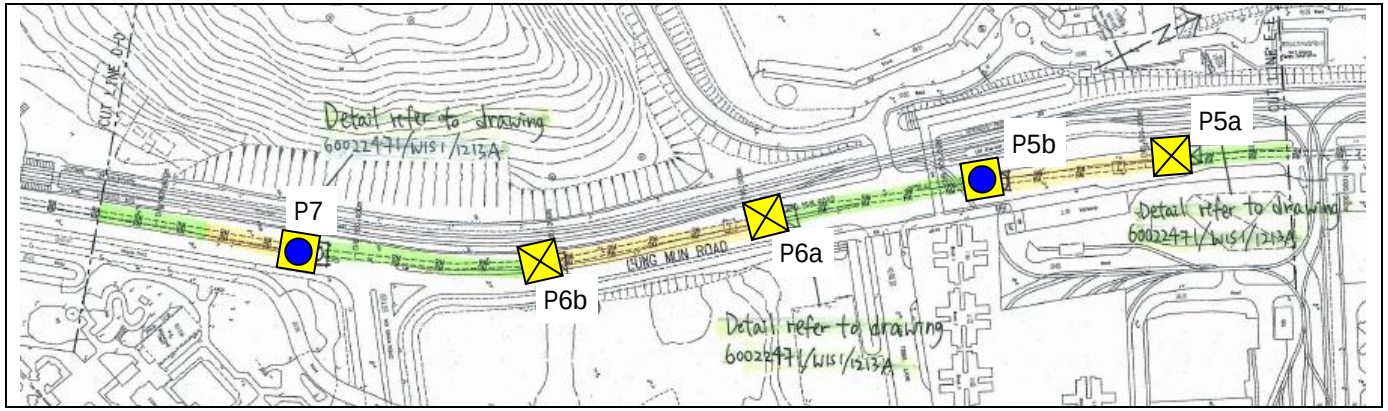


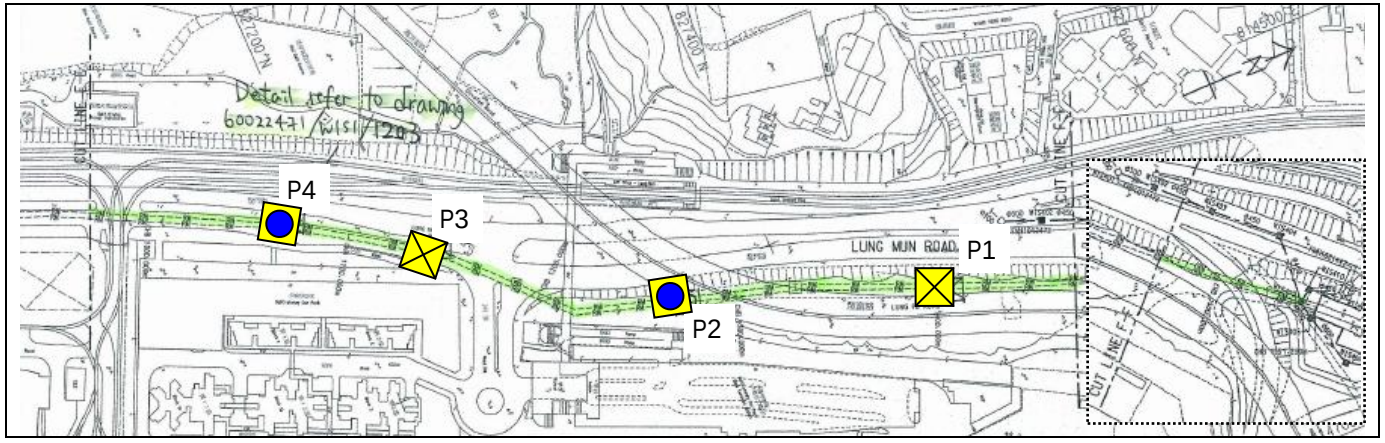
Trunk Sewerage in Tuen Mun

6km long trunk sewer & new sewerage pumping station

Trunk sewer being built using trenchless method





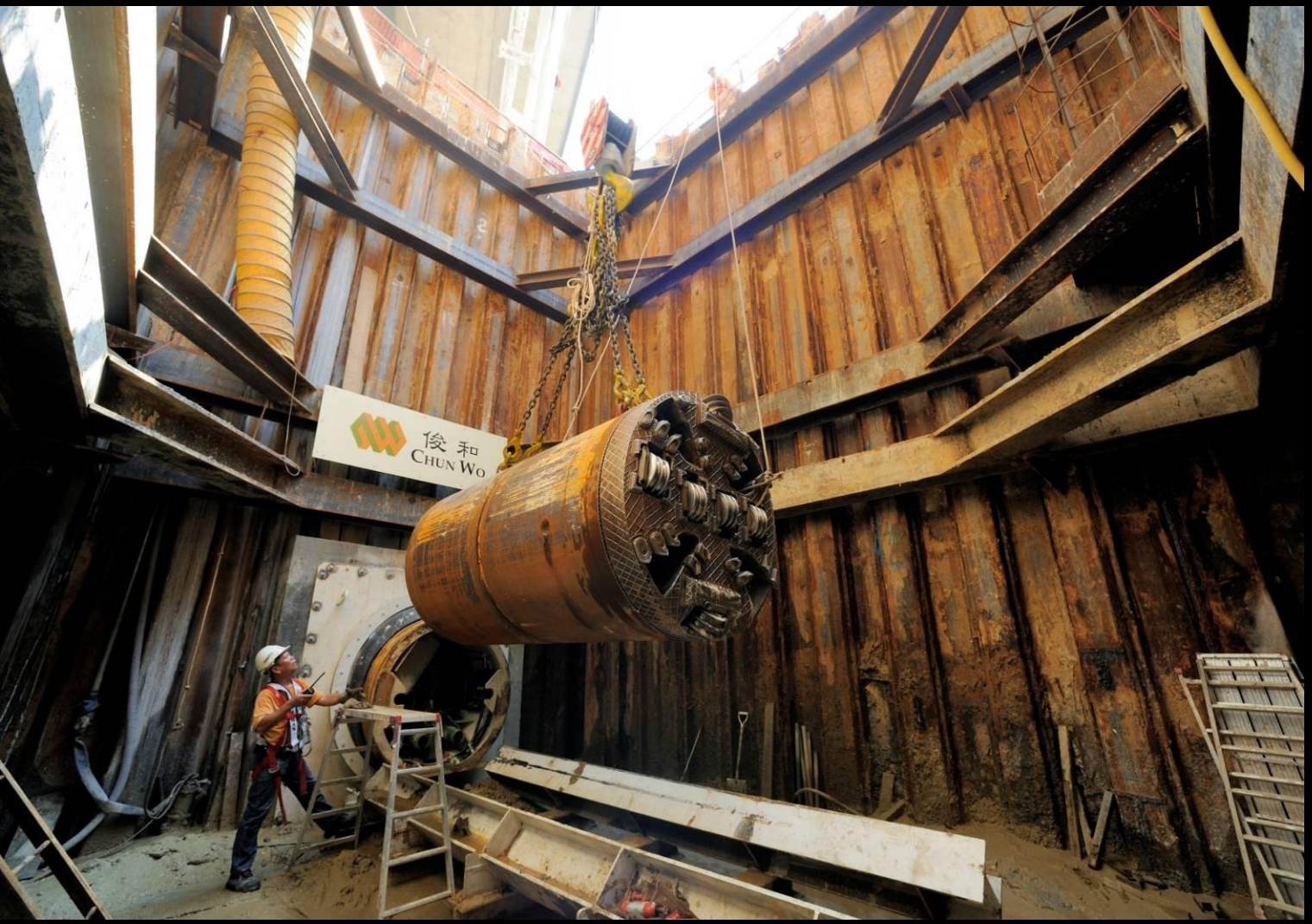


Jacking Pits Receiving Pits

Trunk Sewerage in Tuen Mun

Layout plan

Total 39 jacking & receiving pits (Cofferdam) to be formed using SSP with lateral support



Trunk Sewerage in Tuen Mun

REUSE
Cofferdam steelwork
via smart planning

Without reuse
5130t

With reuse
3500t
(32% Saving)

Trunk Sewerage in Tuen Mun

Treatment of excavated material

REDUCE

Environmental nuisance e.g. muddy water

Trunk Sewerage in Tuen Mun

Treatment of excavated material

Conventional separation plant for treatment of muddy water

Trunk Sewerage in Tuen Mun

Treatment of excavated material

Muddy water being separated using vibration

Trunk Sewerage in Tuen Mun

Treatment of excavated material

Disposal of treated excavated material;
Lots of lorries lining up

Trunk Sewerage in Tuen Mun

Different treatment of excavated material

Centrifuge separation plant for treatment of muddy water

Trunk Sewerage in Tuen Mun

Treatment of excavated material

Water separated from excavated material using Centrifuge (suitable for REUSE)

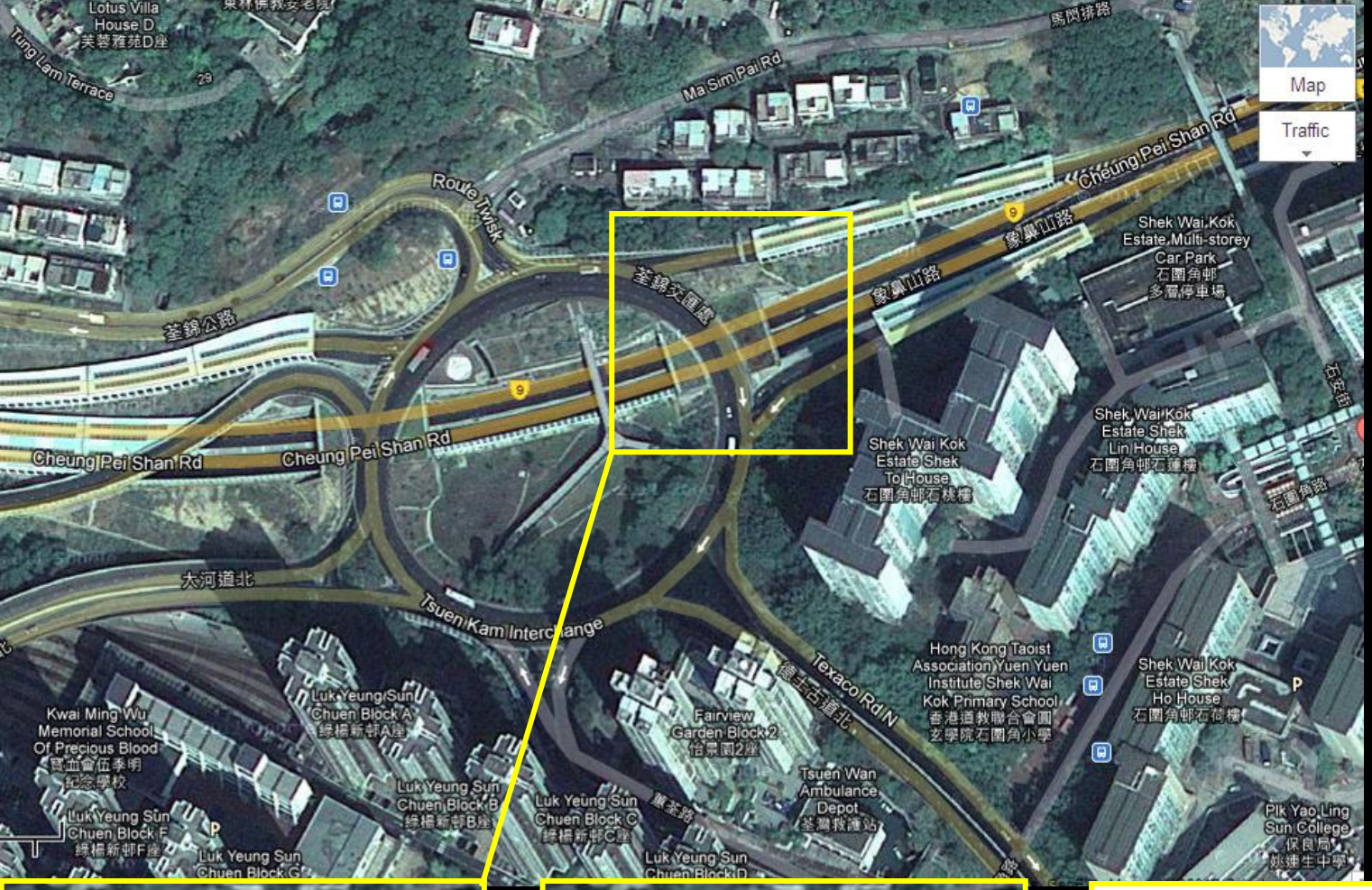
Trunk Sewerage in Tuen Mun

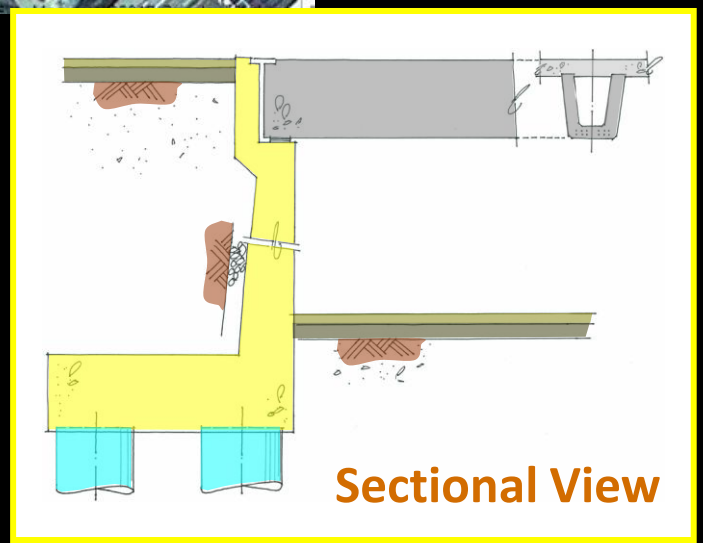
Treatment of excavated material

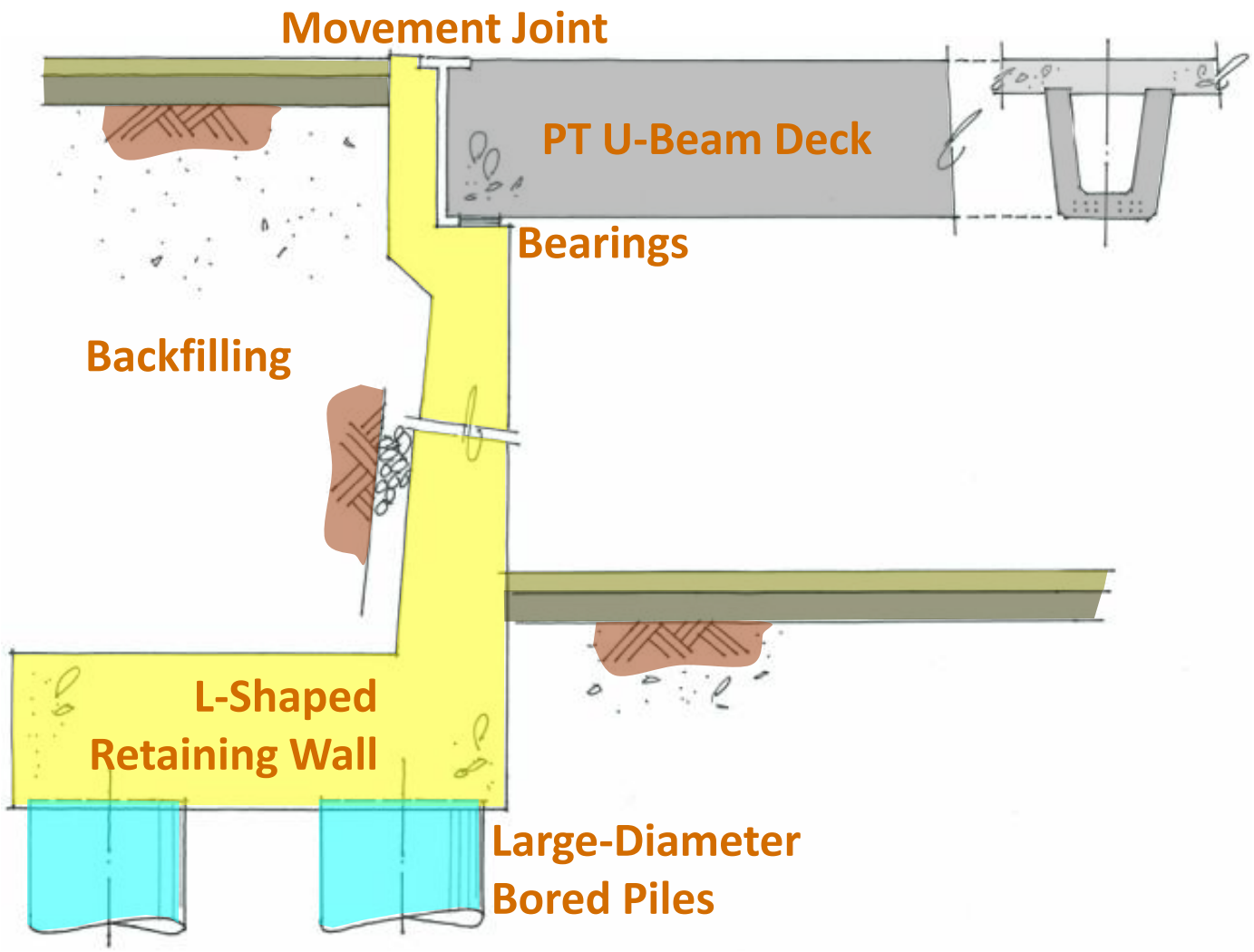
'De-watered' excavated material using Centrifuge; much more easy for disposal

Route 9 Underpasses

Two underpasses built under existing Tsuen Kam Interchange

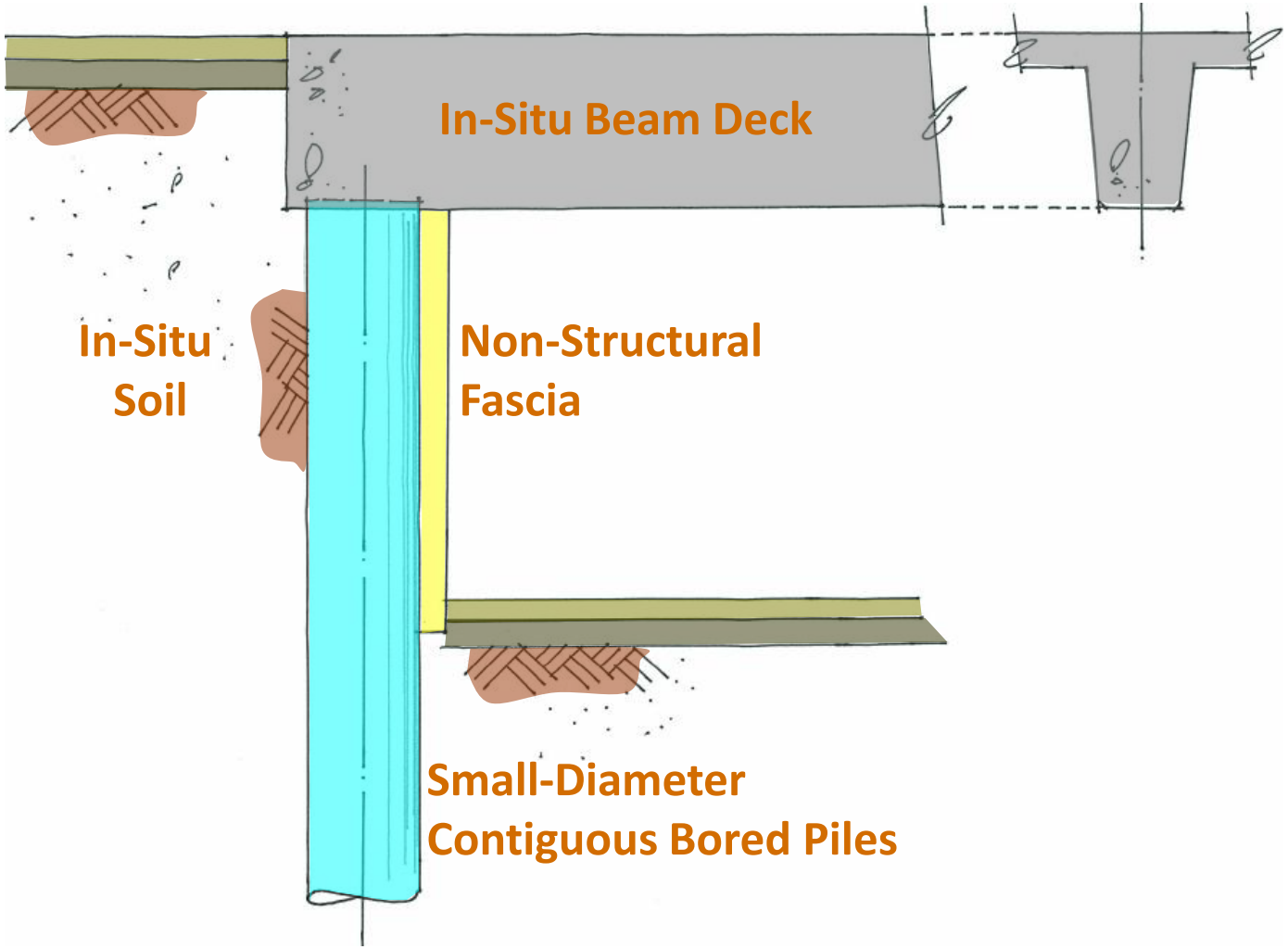






Route 9 Underpasses

Conforming Arrangement



Route 9 Underpasses

Contractor's
Alternative

REDUCE

Large-dia. bored piles
ELS steelwork
Excavation / backfill
Movement joint
Bearings

Route 9 Underpasses

Contractor's Alternative

Vision

To be an acclaimed contractor and developer in Asia with dynamic and sustainable growth

Mission

- Improve people's quality of life through city and infrastructure development
- Grow with our employees through fulfilling work environment and career development
- Create value for shareholders

Core Values (7Cs)

Commitment **Concern** Care Collaboration
Credit Courage Continuity

About Chun Wo

Vision

Mission

Core Values

www.chunwo.com

Concern

Safety, environment, and the public interest take priority

Behavioural Indicators

- Say ‘No’ to any action that compromises safety and the environment
- Take any issue related to safety, environment, and public interest as one’s own issue
- Start with ourselves and set good example for others to follow
- Develop an environment in our work that fosters a safe and environmentally-friendly culture

Concern

Safety, environment, and the public interest take priority

Thank you

Carbon Footprint Measurement of Construction Materials Using Life Cycle Assessment

Dr Jack C.P. Cheng (Speaker), ***Assistant Professor***

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Department of Civil and Environmental Engineering
The Hong Kong University of Science and Technology

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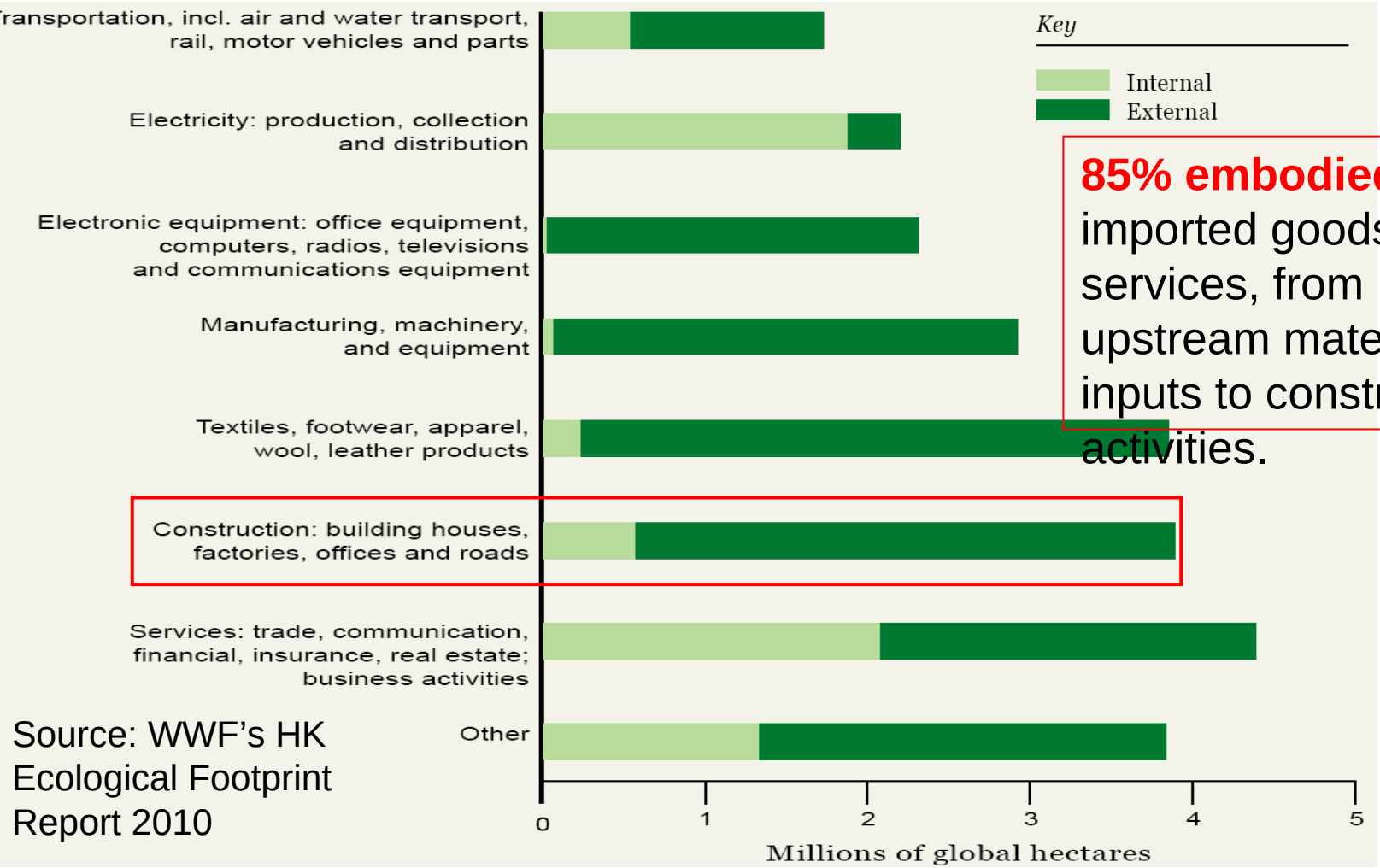
Mr Anfernee K.P. Chow, ***Environmental Officer***

Leighton Contractors (Asia) Limited

The HKIE Environmental Division Annual Seminar 2013
22 March 2013

Motivation – The Construction Sector is the 2nd Largest Contributor to Hong Kong Carbon Footprint



85% embodied in imported goods and services, from upstream material inputs to construction activities.

Source: WWF's HK Ecological Footprint Report 2010

Figure: Total carbon footprint by economic sector, 2007

Steel Formwork or Timber Formwork?

- Which one is more environmentally friendly, steel formwork or timber formwork?
  - What is the carbon emission of the transportation from suppliers?
  - What is the carbon emission of the material manufacturing process?
  - What is the amount of steel/timber required in each formwork?
  - What is the **carbon footprint embodied in each unit of steel/timber**?

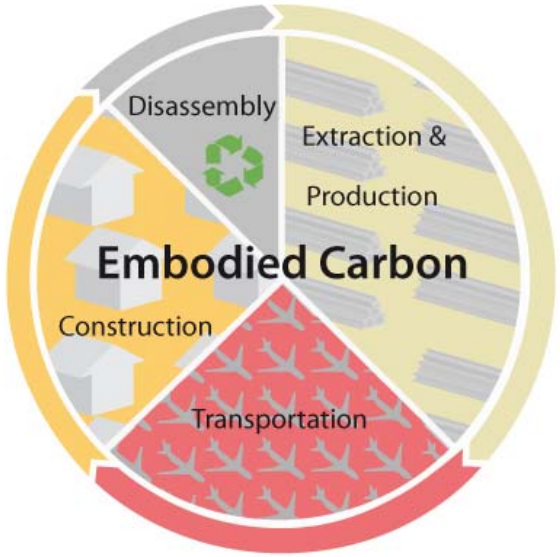
Steel Formwork

Timber Formwork

Embodied Carbon (EC)

- "The embodied carbon of a building material can be defined as the total carbon released over its life cycle. This would normally include (at least) extraction, manufacturing and transportation. Ideally the boundaries would be set from the extraction of raw materials (incl. fuels) until the end of the products lifetime."

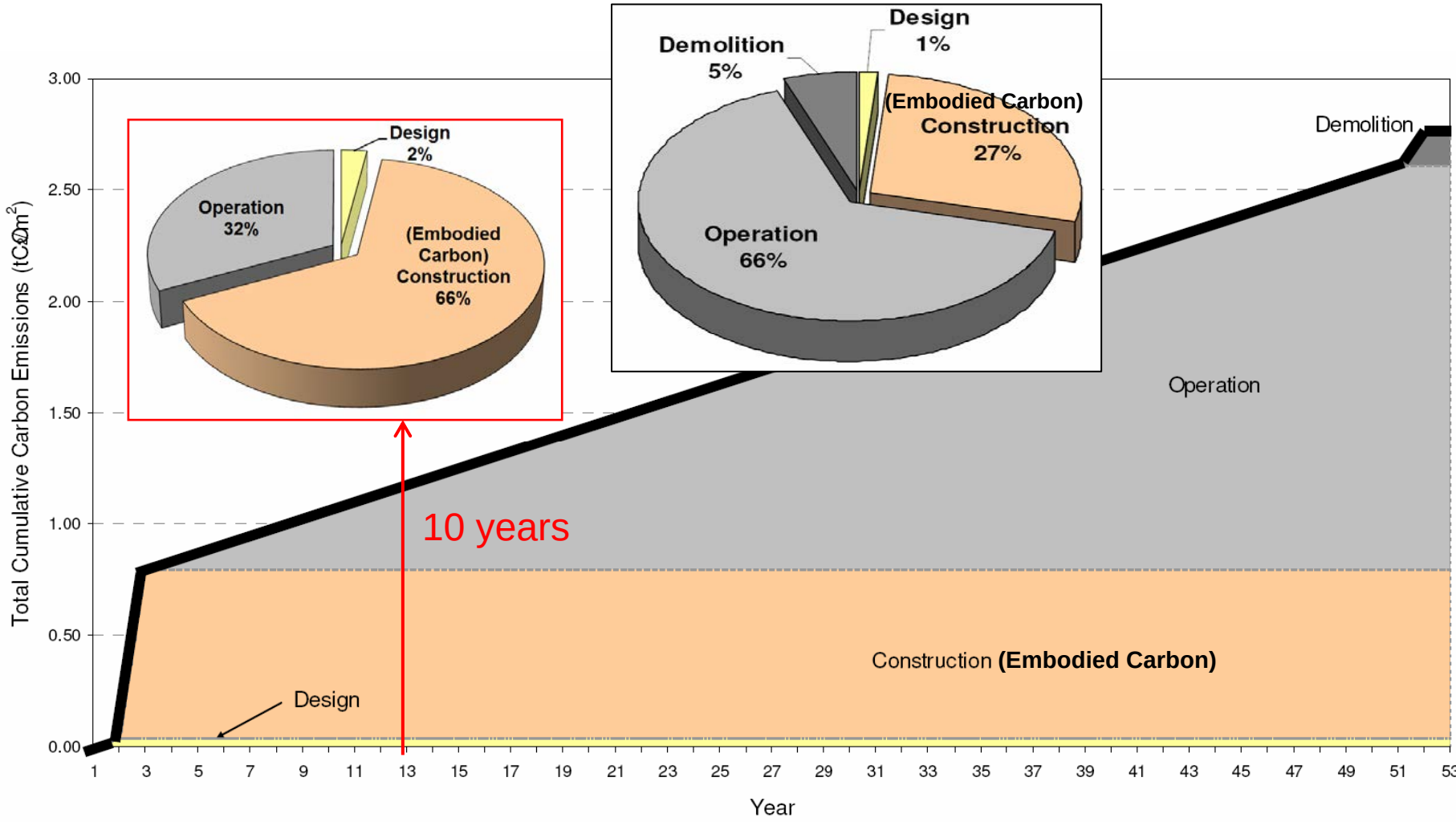
(Hammond and Jones, 2008)



- There is increasing recognition of embodied carbon for evaluation of low carbon buildings.

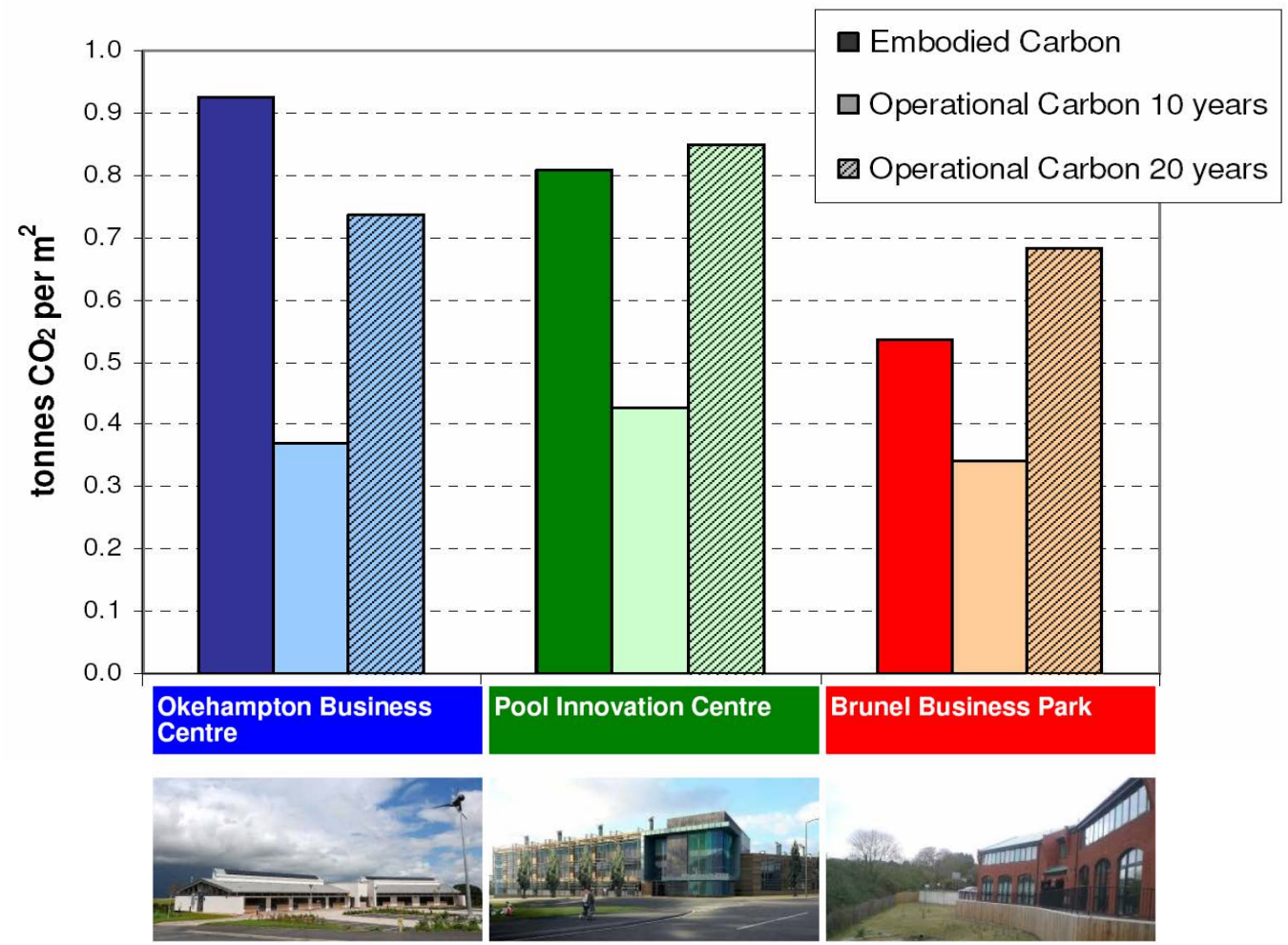
Importance of Embodied Carbon

- A typical carbon profile for an office building:



Source: South West of England Regional Development Agency. (2010). "Embodied Carbon – Sustainable Offices"

Importance of Embodied Carbon – Case Studies of 3 Office Buildings in UK



ource: South West of England Regional Development Agency. (2010). "Embodied Carbon – Sustainable Offices"

Motivation – We Need a Local Construction Material Embodied Carbon Database for Hong Kong

- An embodied carbon database for construction materials can (1) provide a benchmark for green material selection and green label development, and (2) provide a basis for prediction and estimation of carbon footprint.
- Embodied carbon values are **region-specific**.

Region	Construction Life Cycle Inventory (LCI)	Institution	System Boundary
Swiss	**Ecoinvent**	Swiss Centre for Life Cycle Inventories	Gate-to-gate
Europe	**ELCD** (European reference Life Cycle Database)	European Union	Cradle-to-gate
United Kingdom	**ICE** (Inventory of Carbon and Energy)	University of Bath, UK	Cradle-to-gate
China	**CLCD** (Chinese reference Life Cycle Database)	Sichuan University, China; IKE Environmental Technology Co. Ltd	Cradle-to-gate
Korea	**Korea LCI Database**	Korea Institute of Industrial Technology; Ministry of Environment	Cradle-to-gate
Hong Kong	**None**		

Motivation – We Need a Local Construction Material Embodied Carbon Database for Hong Kong

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Europe	**ELCD** (European reference Life Cycle Database)	European Union	Cradle-to-gate
United Kingdom	**ICE** (Inventory of Carbon and Energy)	University of Bath, UK	Cradle-to-gate
China	**CLCD** (Chinese reference Life Cycle Database)	Sichuan University, China; IKE Environmental Technology Co. Ltd	Cradle-to-gate
Korea	**Korea LCI Database**	Korea Institute of Industrial Technology; Ministry of Environment	Cradle-to-gate
Hong Kong	**ECO-CM Database**	Dept. of Civil and Environmental Engineering, HKUST	Cradle-to-site; C-to-G; G-to-G

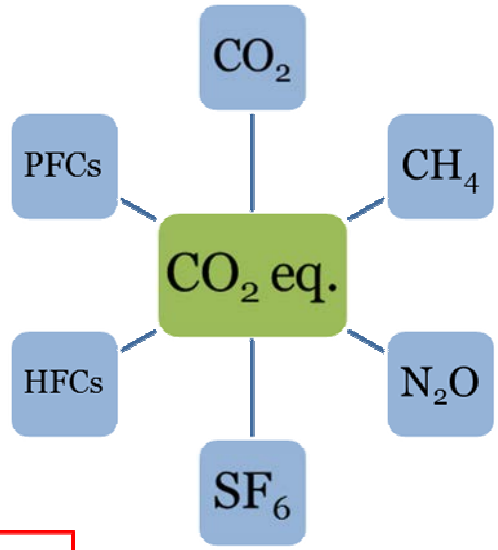
Objectives

- To investigate the **carbon footprint of Hong Kong construction materials** (e.g. cement) based on the concept of **Life Cycle Assessment (LCA)**, by collecting **first-hand data** from the industry.

- To **develop a carbon footprint database** of commonly used construction materials in Hong Kong for the **“cradle-to-site” life cycle**. Such a database could help to lower the construction’s carbon footprint by providing a benchmark and a basis for estimation.

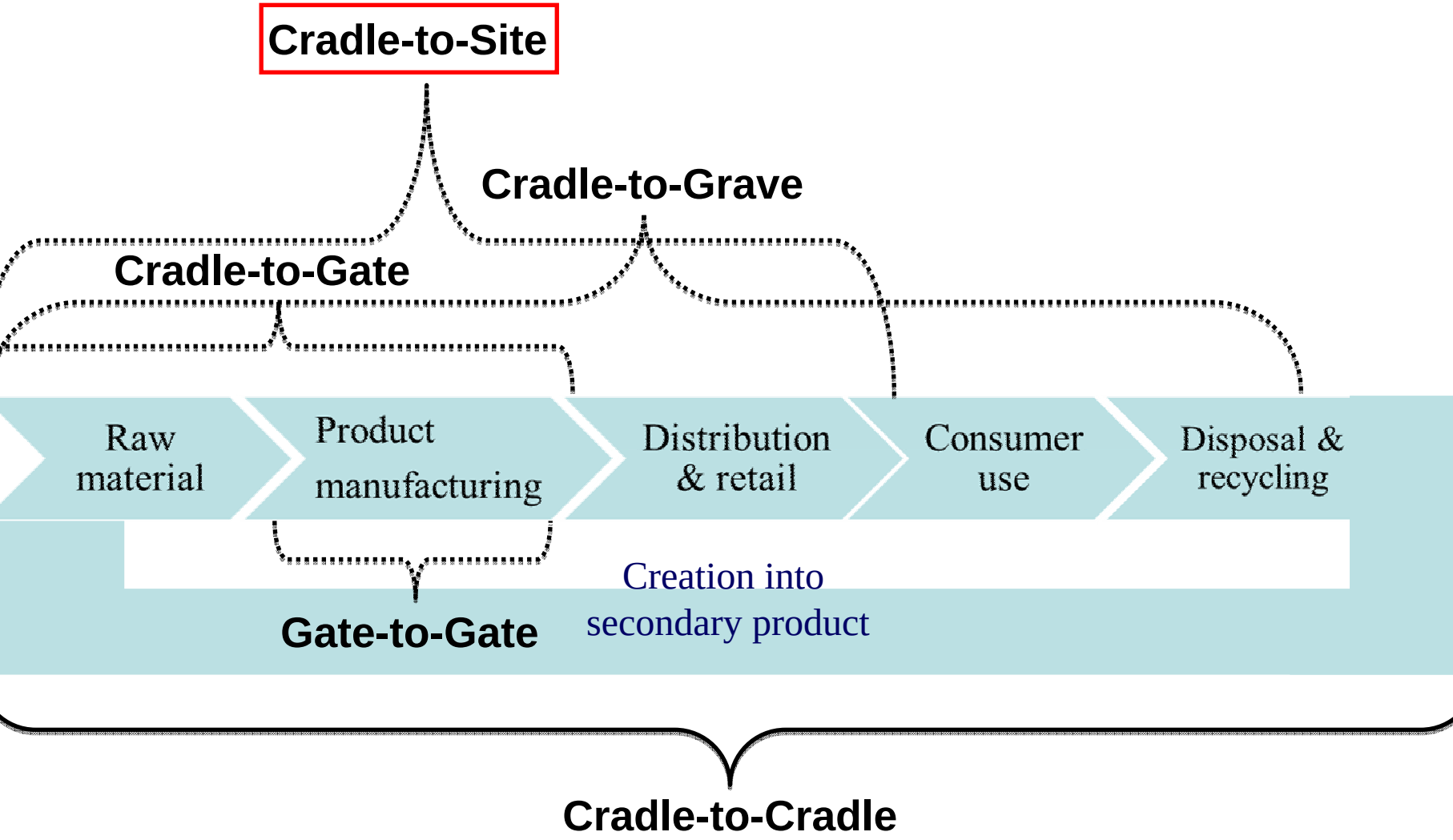
Both CO_2 and CO_2-e Are Measured

- Greenhouse gases (GHGs) refers to the gases that trap heat in the atmosphere. (USEPA, 2009)
- We not only measure the carbon footprint in terms of carbon dioxide (CO_2), but in terms of carbon dioxide equivalent (CO_2-e) using the six GHGs identified in Kyoto Protocol (1997):
  - Carbon dioxide (CO_2)
  - Methane (CH_4)
  - Nitrous oxide (N_2O)
  - Hydro-fluorocarbons (HFCs)
  - Per-fluorocarbons (PFCs)
  - Sulfur hexafluoride (SF_6)



$$CO_2\text{-}e = \sum_i (GHG_i \times Global\_Warming\_Potential_i)$$

Boundary of Life Cycle



Method 1: 'Localization' of Other Carbon Databases

Cradle-to-Gate

- Refer to embodied carbon databases in other countries
- Assume the same manufacturing process
- Adjust the fuel and electricity emission factors based on the supplier locations to "localize" the cradle-to-gate values

Cradle-to-Site

- Cradle-to-Gate + Transportation
- Consider transportation means, fuel types, distance, etc.

Example: Wood Boards from New Zealand

Energy sources for (plywood) wood boards production according to Bath U ICE				
Energy source	**% of Embodied Energy from energy source**	**Emission Factors for NZ (t CO_2/MWh)**	**Emission Factors for NZ (t CO_2/MJ)**	**Equivalent emission factor for NZ (t CO_2/MJ)**
Coal	0.0%			
LPG	0.0%			
Oil	5.6%	0.2667 [1]	7.40833E-05	4.14867E-06
Natural gas	39.5%	0.202 [1]	5.61111E-05	2.21639E-05
Electricity	54.9%	0.159 [2]	4.41667E-05	2.42475E-05
Other	0.0%			
Total	**100.0%**			**5.05601E-05**

Unit conversion:
1 MWh = 3600 MJ

(Multiply)

Embodied Energy of Timber, Plywood in ICE database: **15** MJ/kg

NZ-based Embodied Carbon of Timber, Plywood in ICE database: **0.77** kg CO_2/kg

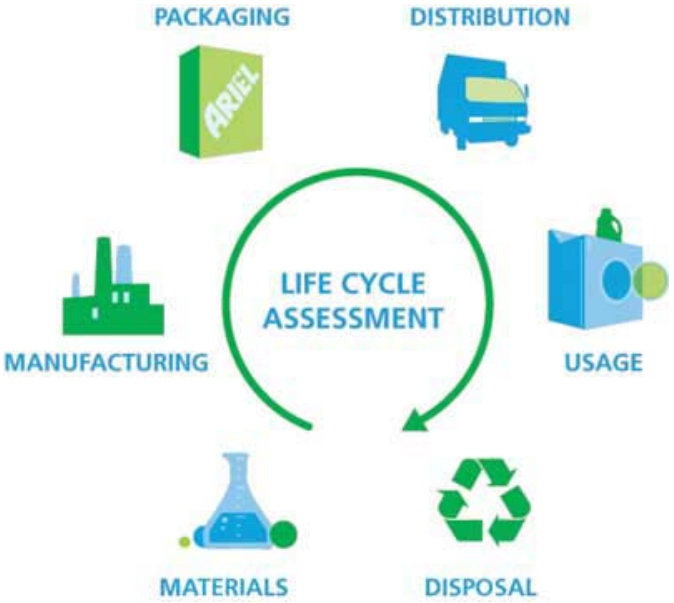
In Bath U ICE:
Timber, Plywood:
EE: 15 MJ / kg
EC: 0.81 kg CO_2/kg

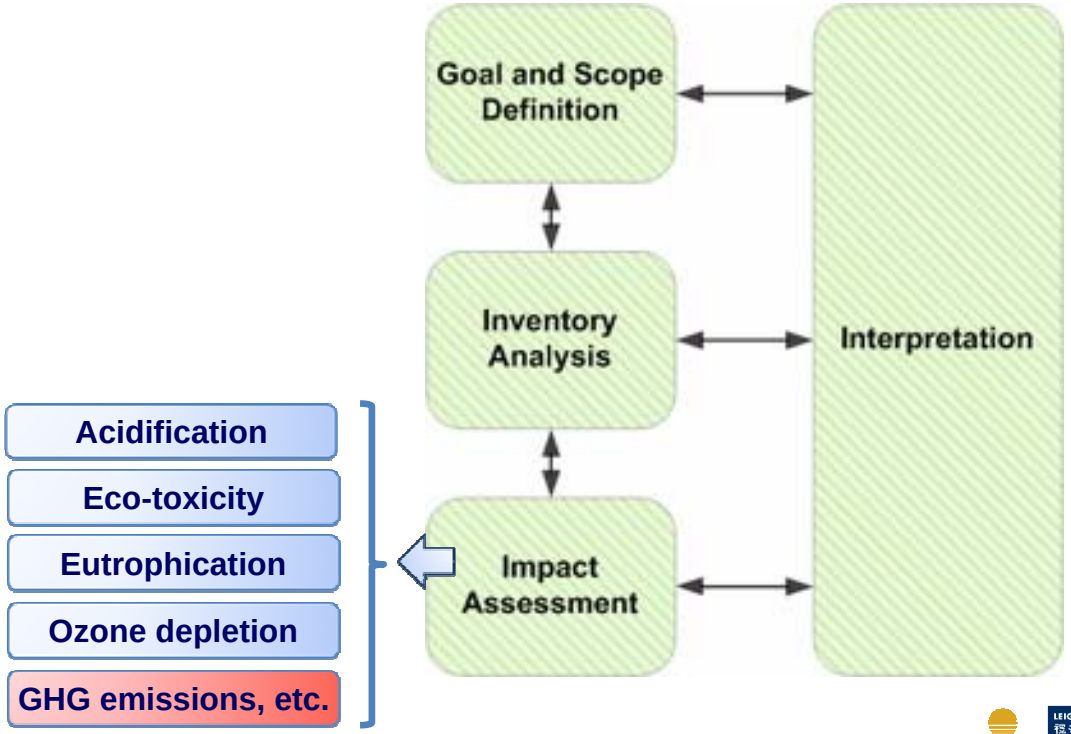
+ transportation ➔ Cradle-to-sit

[1] UNEP (2000): The GHG Indicator: UNEP Guidelines for Calculating Greenhouse Gas Emissions for Businesses Organizations
[2] International Energy Agency, Electricity Information Database 2007 and CO2 Emissions from Fuel Combustion Database 2006

Method 2: Life Cycle Assessment (LCA)

- **Life cycle assessment (LCA)** is a technique evaluating the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle. (ISO 14040:2006)
- LCA can assist in identifying opportunities to improve the environmental performance of products at various points in their life cycle.



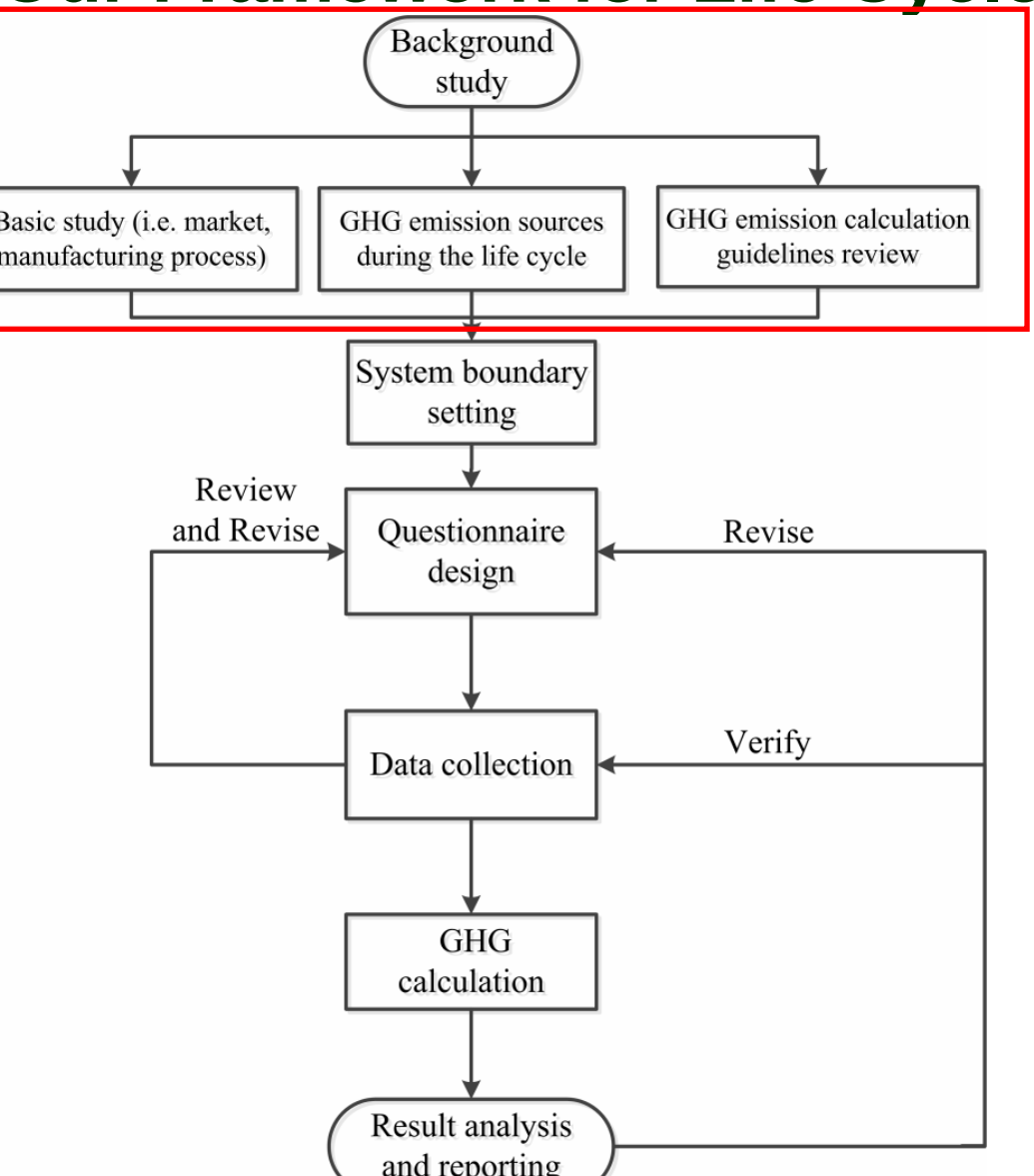


Standards

- The following standards are referenced when we developed our methodology framework.

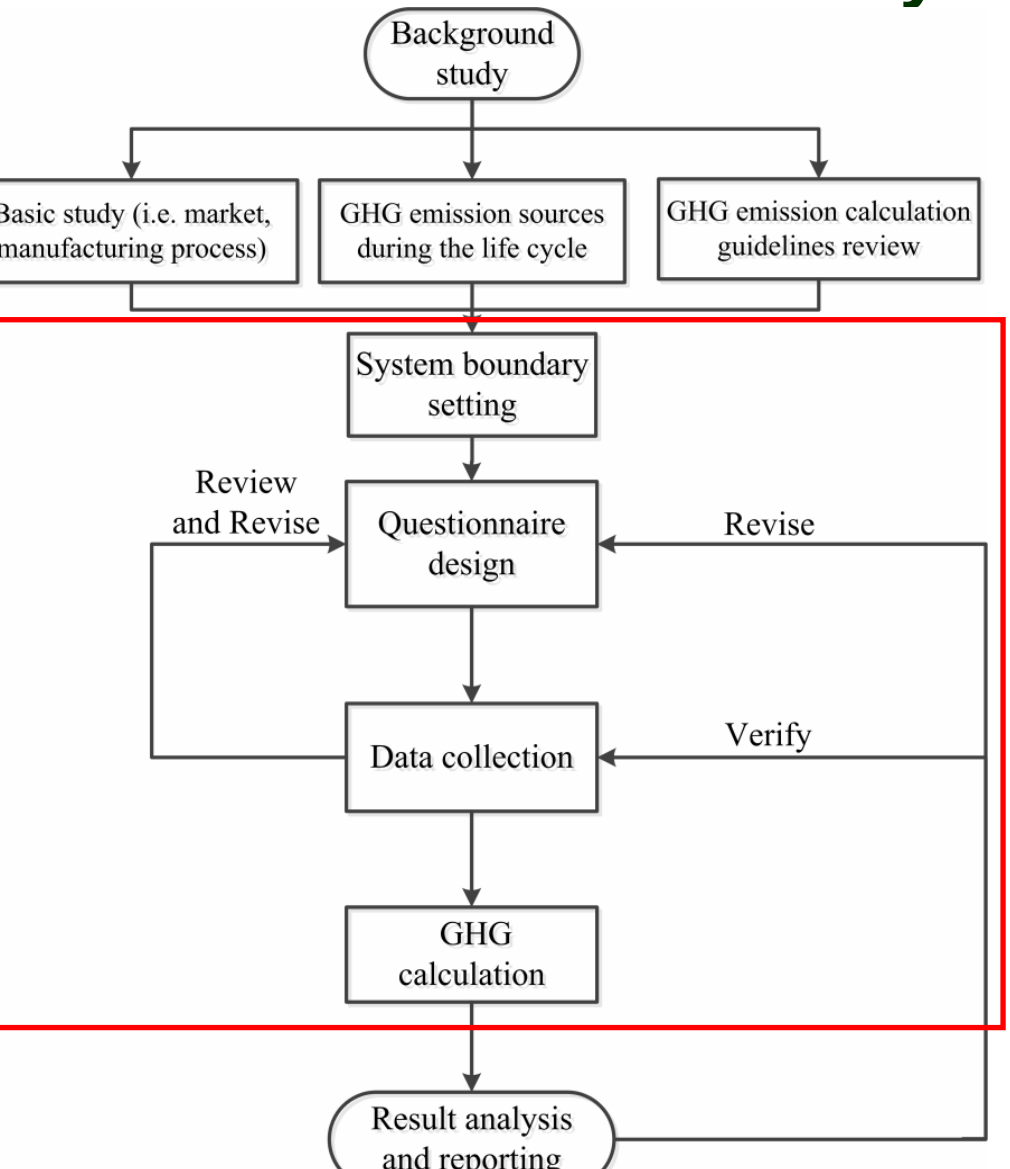
Standards	Areas
ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework	LCA
ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines	LCA
ISO 14064-1:2006 Greenhouse gases - Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals	GHG Auditing (Organizational)
PAS 2050:2011 Specification for the assessment of the life cycle greenhouse gas emissions of goods and service	GHG Auditing (Product)
ISO 14067 Carbon footprint of products -- Requirements and guidelines for quantification and communication **(Not yet released)**	GHG Auditing (Product)

Our Framework for Life Cycle Carbon Measurement

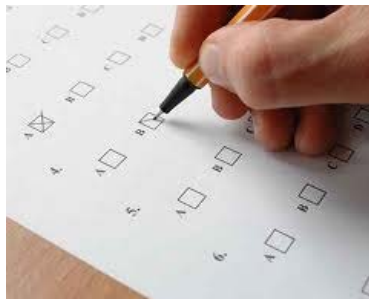


- **Background study** (for each construction material):
  - Identify the material suppliers who supply the construction material to the Hong Kong market
  - Study the material types and manufacturing process
  - Develop the process map and the possible GHG emissions in each process
  - Review standard GHG emission calculation and auditing guidelines for the material, if any

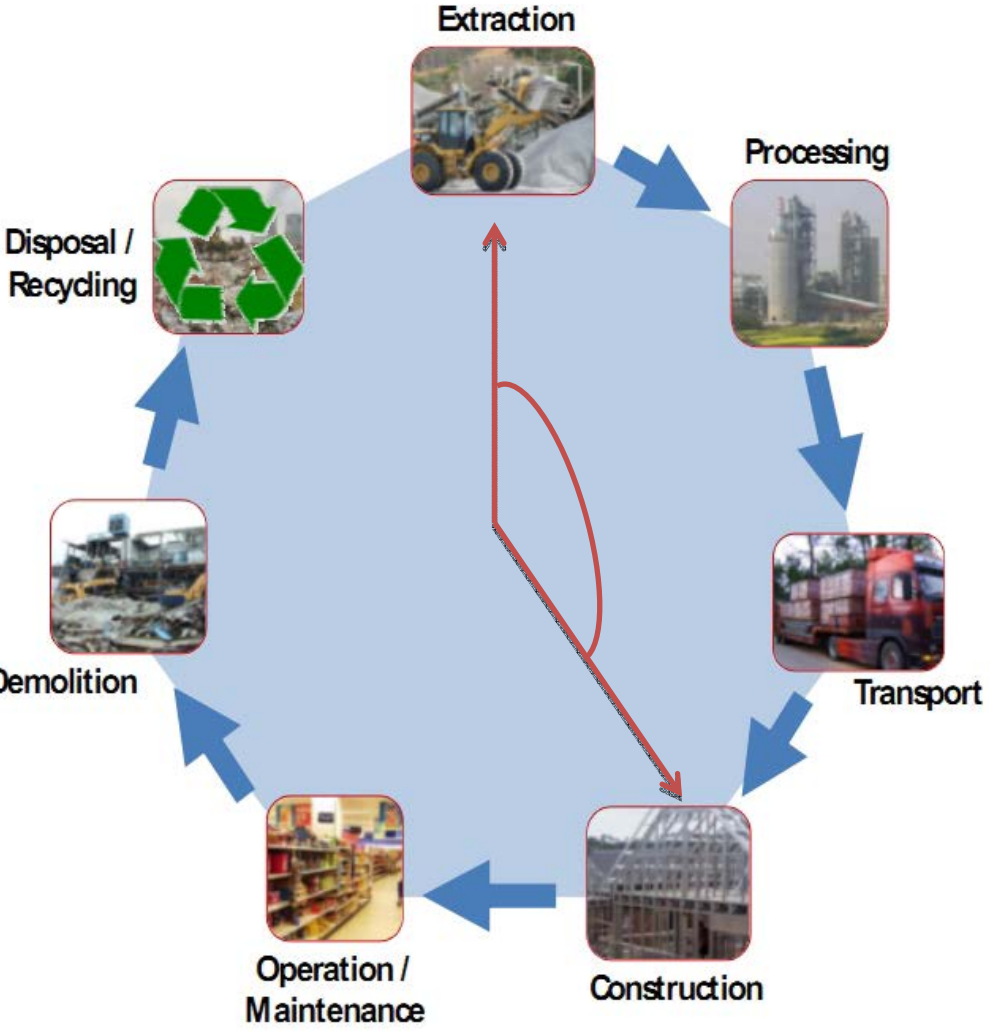
Our Framework for Life Cycle Carbon Measurement



- Set the system boundary
- Design the questionnaire according to the background study and system boundary
- Contact the suppliers for data collection
- Calculate using standardized methods, e.g. IPCC



Example: Cement – Scope of Measurement



Cradle-to-site life cycle:
- Raw materials extraction
- Manufacturing process
- Transportation to site

Cement is presented as an illustrative example in the following.
- One of the most important and commonly used building materials.

Types of Cement

- According to American Society for Testing and Materials (ASTM):

Types and Applications of Standard Portland Cement (ASTM C150)				
Types	**Name**	**Composition**	**Limitation**	**Application**
Type I	Ordinary	55% (C_3S), 19% (C_2S), 10% (C_3A), 7% (C_4AF), 2.8% MgO, 2.9% (SO_3), 1.0% Ignition loss, and 1.0% free CaO	$C_3A \leqq 15\%$	General use; when special properties are not required, floors, reinforced concrete structures, pavements, etc.
Type II	Moderate Sulfate Resistance	51% (C_3S), 24% (C_2S), 6% (C_3A), 11% (C_4AF), 2.9% MgO, 2.5% (SO_3), 0.8% Ignition loss, and 1.0% free CaO	$C_3A \leqq 8\%$	General use; has moderate sulfate resistance and heat of hydration; large piers, heavy abutments, retaining walls.
Type III	High Early Strength	57% (C_3S), 19% (C_2S), 10% (C_3A), 7% (C_4AF), 3.0% MgO, 3.1% (SO_3), 0.9% Ignition loss, and 1.3% free CaO	$C_3A \leqq 15\%$	When high early strength is required, fast-track construction, suitable in cold wheater.
Type IV	Low Heat of Hydration	28% (C_3S), 49% (C_2S), 4% (C_3A), 12% (C_4AF), 1.8% MgO, 1.9% (SO_3), 0.9% Ignition loss, and 0.8% free CaO.	$C_3A \leqq 7\%$, $C_2S \geq 40\%$, $C_3S \leqq 35\%$	When low heat of hydration is required, used when mass of construction, such as large dams.
Type V	High Sulfate Resistance	38% (C_3S), 43% (C_2S), 4% (C_3A), 9% (C_4AF), 1.9% MgO, 1.8% (SO_3), 0.9% Ignition loss, and 0.8% free CaO	$C_3A \leqq 5\%$, $(C_4AF) + 2(C_3A) \leqq 20\%$	High sulfate resistance is required, 0.2-2.0% weight mater soluble sulfate in soils or 1500-10800 ppm sulfate in water

Types of Cement

- According to National Standard of People's Republic of China:

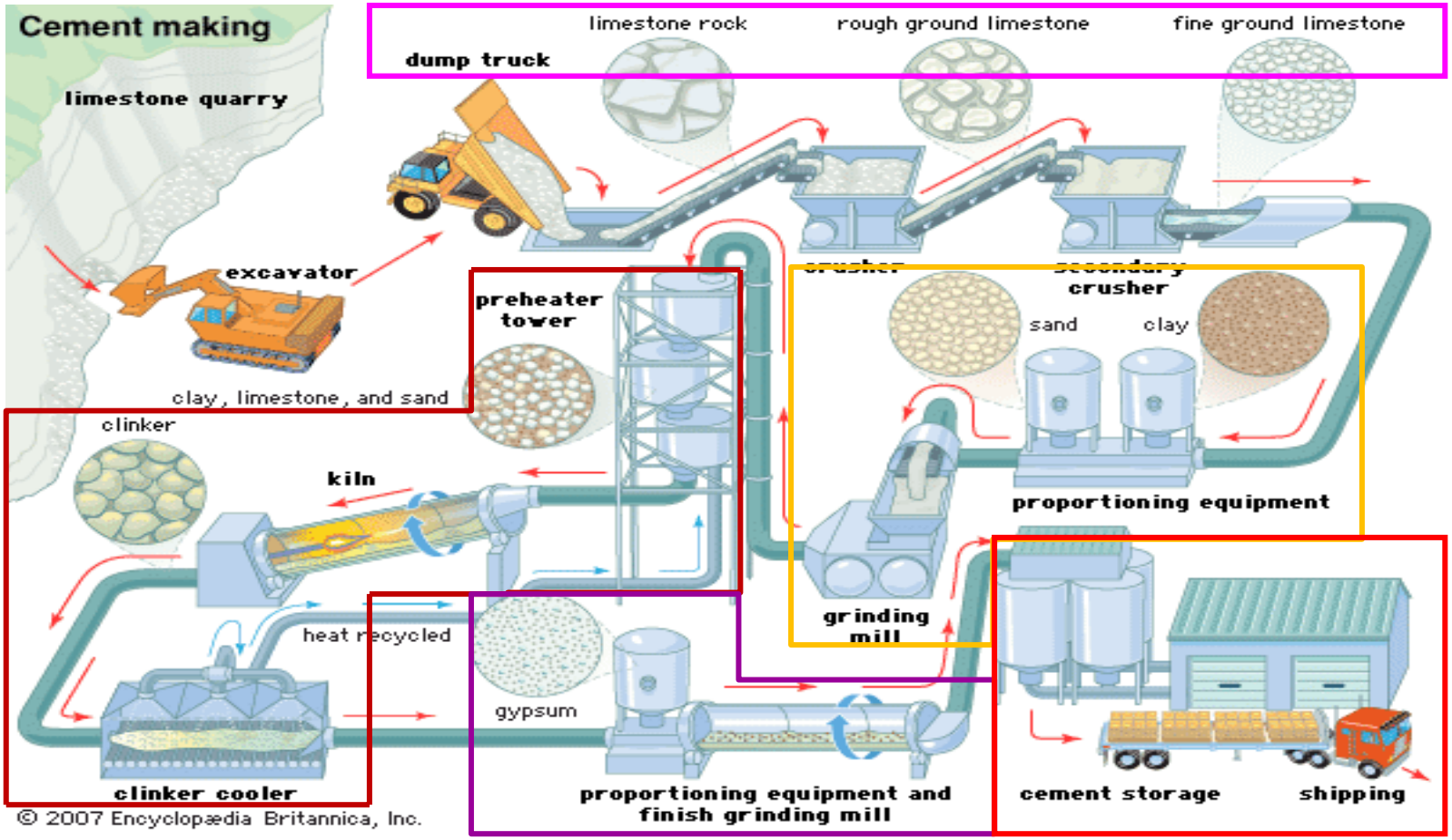
GB175-2007 Common Portland Cement				
Types	**Composition**	**Code**	**Additional constituents**	**Strength grade**
Portland cement	clinker, 0-5%mixed materials, gypsum	**P.I**	No	42.5/42.5R/52.5/ 52.5R/62.5/62.5R
		P.II	≦5% slag, limestone	
Ordinary portland cement	cilinker, 5-20%mixed materials, gypsum	**P.O**	5-20% slag, fly-ash, pozzolana	42.5/42.5R/52.5/ 52.5R
Slag portland cement	clinker, 20-70%mixed materials, gypsum	**P.S.A**	20-50% slag	32.5/32.5R/42.5/ 42.5R/52.5/52.5R
		P.S.B	50-70% slag	
Fly-ash portland cement	clinker, 20-40%mixed materials, gypsum	**P.F**	20-40% fly-ash	32.5/32.5R/42.5/ 42.5R/52.5/52.5R
Pozzolana portland cement	clinker, 20-40%mixed materials, gypsum	**P.P**	20-40% pozzolana	32.5/32.5R/42.5/ 42.5R/52.5/52.5R
Composite portland cement	clinker, 20-50%mixed materials, gypsum	**P.C**	20-50% slag, fly-ash, pozzolana, limestone	32.5/32.5R/42.5/ 42.5R/52.5/52.5R

Types of Cement

- According to European Committee for Standardization:

Types of Cement Under EN 197-1 (European Standard)				
Types	**Name**	**Description**	**Amount of clinker [weight-%]**	**Additional components [weight-%]**
CEM I	**Portland cement**	Comprising Portland cement and up to 5% of minor additional constituents	**95 – 100**	0 – 5
CEM II	**Portland composite cement**	Portland cement and up to 35% of other single constituents	**65 – 94**	0 – 5
CEM III	**Blast furnace cement**	Portland cement and higher percentages of blast furnace slag	**5 – 64**	0 – 5
CEM IV	**Pozzolanic cement**	Portland cement and up to 55% of pozzolanic constituents (volcanic ashes)	**45 – 89**	0 – 5
CEM V	**Composite cement**	Portland cement, blast furnace slag or fly ash and pozzolana	**20 – 64**	0 – 5

Cement Manufacturing Process Map



① raw materials extraction

② raw meal preparation

③ clinker production

④ cement production

⑤ cement packaging

source of picture: http://www.sbmchina.com/cement_plant/

Identify Possible GHG Emissions for Cement

Stages	Input	Process	Equipment	GHG emission
(1) Raw materials extraction (2) Raw meal preparation	Fuel	Extraction	Truck/Ship	Transport
	Electricity	Crushing	Crusher	Electricity consumption
		Proportioning	Weigh-feeders	
		Grinding	Raw Grinding mill	
		Homogenizing	Homo silo	
(3) Clinker production	Fuel	Preheating	Preheater	Fuel combustion + Chemical reaction
	Fuel	Calcination	Rotary kiln	
	Electricity	Rapid cooling	Grate Cooler	Electricity consumption
		Conditioning	Conditioning Tower	
		Dust Collecting	Electrostatic Precipitator	
		Gas driving	Induced draft fans (ID Fan)	
		Finish grinding	Finishing Grinding mill	
	Imported Clicker	Clinker production	N/A	Clinker production from other factory
(4) Cement production (5) Product packaging and transportation	Electricity	Finish grinding	Finish grinding mill	Electricity consumption
		Storage	Cement silo	
		Packaging	Packaging machine	
	Fuel	Dispatching	Truck/Barge	Transport

Chemical reaction: Carbonates + heat → CaO/MgO + CO_2 (Calcination)
($CaCO_3$/$MgCO_3$)

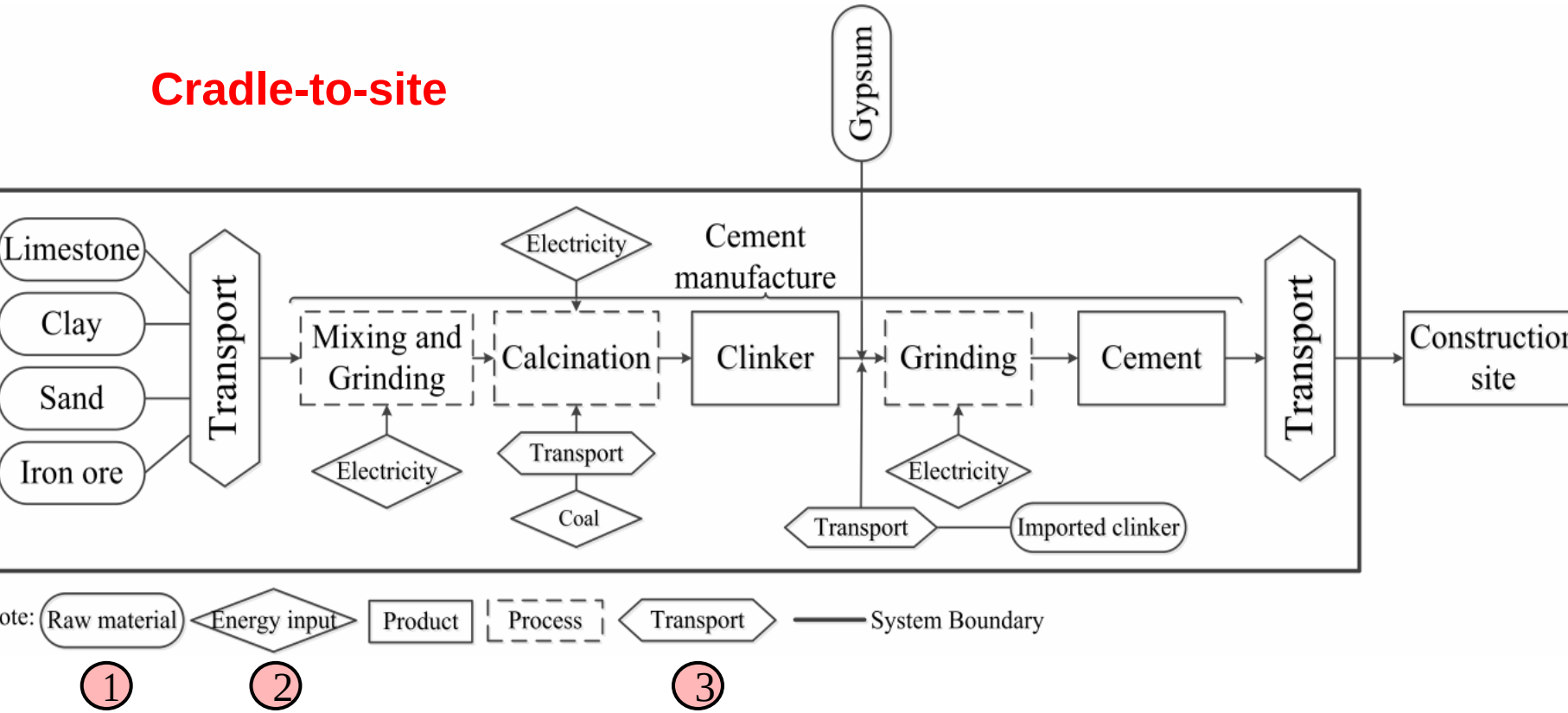
Guidelines for GHG Emission from Cement Manufacturing

- **IPCC Guidelines** for National Greenhouse Gas Inventories (IPCC, 2006)
- **GHG Protocol** Corporate Accounting and Reporting Standard (WBCSD/WRI, 2004)
- **CSI** - CO2 Accounting and Reporting Standard for Cement Industry (WBCSD/CSI, 2011)

IPCC: Intergovernmental Panel on Climate Change
WBCSD: World Business Council for Sustainable Development
WRI: World Resources Institute
CSI: Cement Sustainability Initiative

System Boundary for Cement

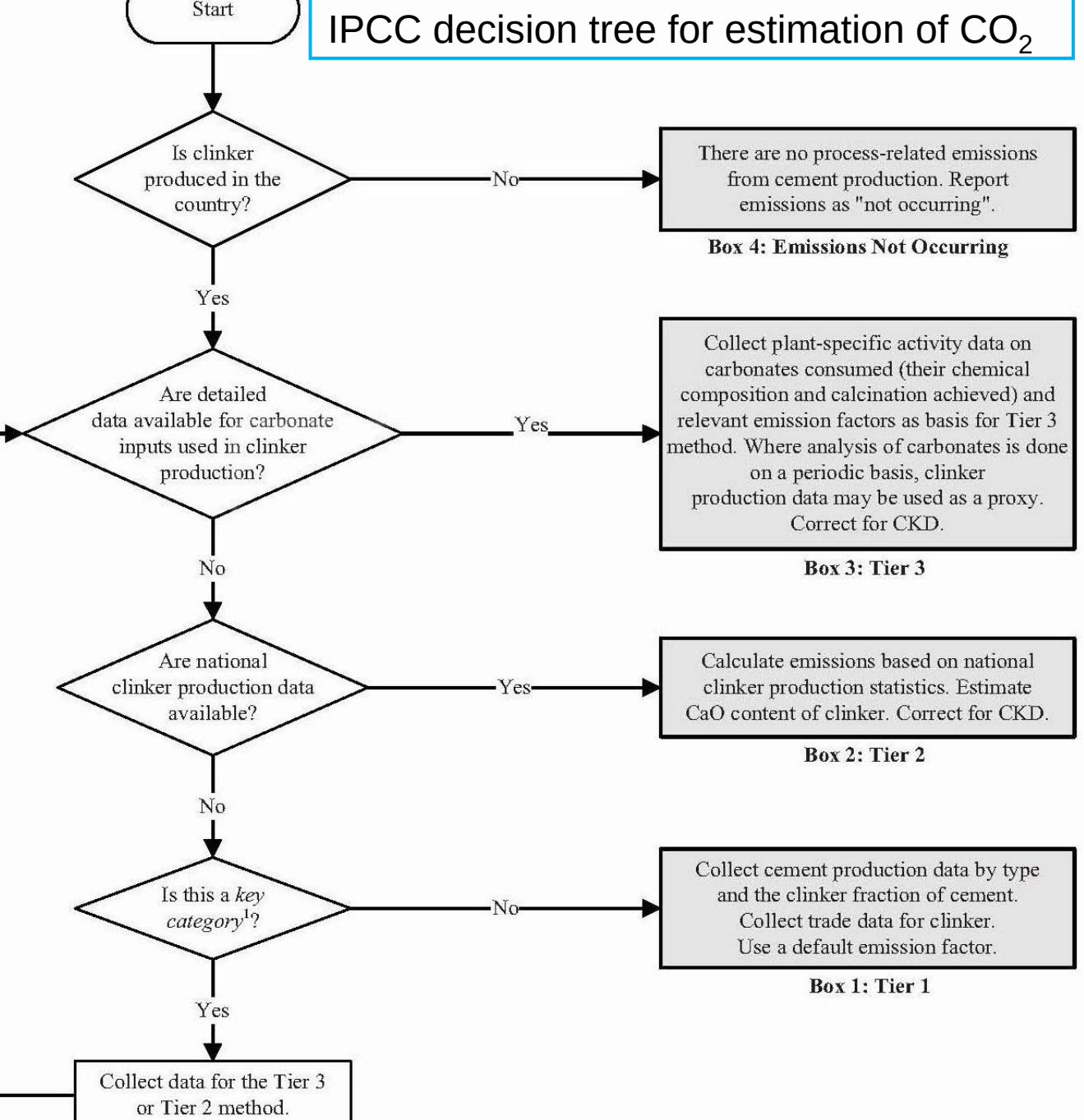
- According to the background study, system boundary for LCA is set.
- The system boundary for Portland cement in the study is as follow.



Questionnaire Design for Cement

- Questionnaire was designed based on the background study and system boundary.
- The questionnaire consists of three main parts:
  - **Part I: Calcination CO_2**
  - **Part II: Energy use**
    - Fuel combustion for manufacturing
    - Electricity consumption
  - **Part III: Transportation of raw materials and cement product**

IPCC decision tree for estimation of CO_2



Tier 3
Input-based method:
Raw materials

Tier 2
Output-based method:
Clinker production

Tier 1
Output-based method:
Cement production

(Source: IPCC, 2006)

Questionnaire Delivered to Collect Data for Cement

- Bilingual questionnaire (English and Chinese)
- The main body of the questionnaire contains 11 sections, consistent with the requirements of the methods:

A. Company information
B. Raw materials
C. Raw meal
D. Clinker
E. Cement kiln dust
F. Bypass dust

Part I: Calcination CO_2

G. Electricity consumption
H. Fuel combustion

Part II: Energy use

I. Raw materials transport
J. Product transport

Part III: Transportation

K. Other information and comments

Research Questionnaire on
"Developing a Database of Embodied Carbon of Building Materials in Hong Kong"

"建立香港建築材料碳排放資料庫"研究調查問卷

Carbon Calculation – Part I: Calcination CO_2

- CSI methods data requirements

Input-based method ↔ similar to IPCC Tier 3	
Simple method A1	Detailed method A2
Raw meal consumed for clinker; CKD/BypassD* leaving the kiln system	Raw meal consumed for clinker; CKD/BypassD leaving the kiln system; Additional raw materials
Output-based method ↔ similar to IPCC Tier 2	
Simple method B1	Detailed method B2
Clinker production; Raw meal : clinker ratio; CKD & BypassD leaving the kiln system; Emission factor default value = 0.525 tCO_2/tClinker	Clinker production; Raw meal : clinker ratio; CKD & BypassD leaving the kiln system; Emission factor corrected for MgO/CaO/Ca-Si, Mg-Si import

*CKD: cement kiln dust
*BypassD: Bypass system dust
Source: CSI, 2011

Carbon Calculation – Part II: Energy Use

Fuel combustion

- **CO_2 emission = Fuel consumption$_{type}$ × Fuel emission factor$_{type}$**
- Fuel emission factor:
  - Default value (IPCC, 2006; CSI, 2011)
  - Country-specific value (HKEPD, 2010)

Electricity

- **CO_2 emission = Electricity consumption × Electricity emission factor**
- Electricity emission factor
  - Supplier-specific value (HKEPD, 2010; CLP; HEC)
  - Country grid factor

IPCC: Intergovernmental Panel on Climate Change
CSI: Cement Sustainability Initiative
HKEPD: Hong Kong Environmental Protection Departmen
CLP: China Light & Power Company
HEC: Hongkong Electric Company

Carbon Calculation – Part III: Transportation

Parameters	IPCC	WRI	HKEPD
Fuel consumption and type	√	√	√
Vehicle type	√	√	√
Distance	√	√	
Weight of freight		√	

- The most accurate: based on fuel consumption and type
- Commonly applied: based on distance and weight

IPCC: Intergovernmental Panel on Climate Change
WRI: World Resources Institute
HKEPD: Hong Kong Environmental Protection Departmen

Results for the Cement Example

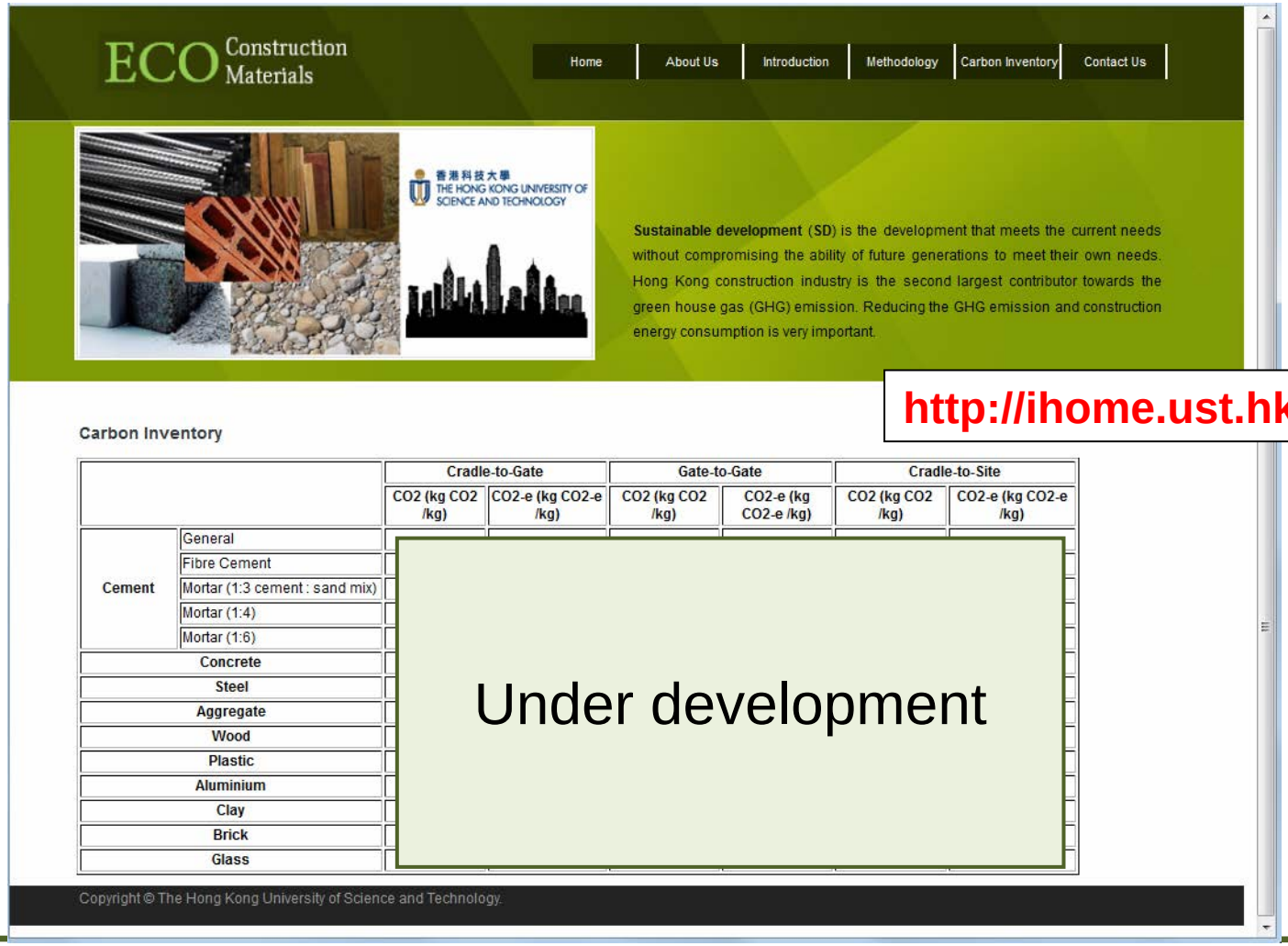
	GHG Source	kg CO_2 / kg clinker	kg CO_2–e / kg clinker	kg CO_2 / kg cement	kg CO_2–e / kg cement
A	Raw materials	8.385×10^{-3}	2.295×10^{-2}	7.267×10^{-3}	1.989×10^{-2}
B	Calcination	0.551	0.551	0.478	0.478
C	Energy use	0.397	0.399	0.379	0.381
D	Imported clinker	/	/	0.058	0.058
E	Transportation (Raw material & fuel)	0.060	0.081	0.052	0.070
F	Transportation (Product)	0.004	0.004	0.003	0.003
Cradle-to-site total (A+B+C+D+E+F)		1.020	1.058	**0.977**	**1.010**
Gate-to-gate total (B+C+D)		0.948	0.950	**0.915**	**0.917**
Cradle-to-gate total (A+B+C+D+E)		1.016	1.054	**0.974**	**1.007**

Selected Construction Materials

- The construction materials to be covered include but not limited to:
  - Aluminum
  - Brick
  - Cement
  - Ceramics
  - Concrete
  - Glass
  - Gypsum board
  - Steel
  - Wood/Timber

ECO Construction Materials Database

- **ECO-CM:** Embodied Carbon Of Construction Materials, or ECO-friendly Construction Materials



Benefits to the Industry

- Provide a benchmark for selection of green materials and development of green labels
- Provide a basis for prediction of carbon emissions in infrastructure and building construction
- Help lower the construction's carbon footprint
- Help meet the carbon footprint reduction target (e.g. 50-60% reduction of carbon intensity for Hong Kong)

	2005	2020	Reduction
Carbon intensity (kg CO_2-e/HK dollar)	0.029	0.012 - 0.015	↓ 50-60%
Total GHG emissions (million tonnes)	42	28-34	↓ 19-33%
Per capita GHG emissions (tonnes)	6.2	3.6-4.5	↓ 27-42%

- Thank You -

Questions and Answers

Contact

Dr Jack C.P. Cheng *(cejcheng@ust.hk)*

Ir Prof Irene M.C. Lo *(cemclo@ust.hk)*

Department of Civil and Environmental Engineering

The Hong Kong University of Science and Technology

Cream of BEAM Plus

Prof John NG
Director, Hong Kong Green Building Council
Vice Chairman, BEAM Society Limited

Content

Hong Kong Green Building Council (HKGBC)

The mission is to lead market transformation to a sustainable built environment and green building by

HKGBC 香港綠色建築議會

- GB certification and promulgation
- Advocate and drive for GB and sustainable built environment
- Develop and promote industry standards and good practices
- Education and research in GB

full member of

WORLD GREEN BUILDING COUNCIL

BEAM Society Limited

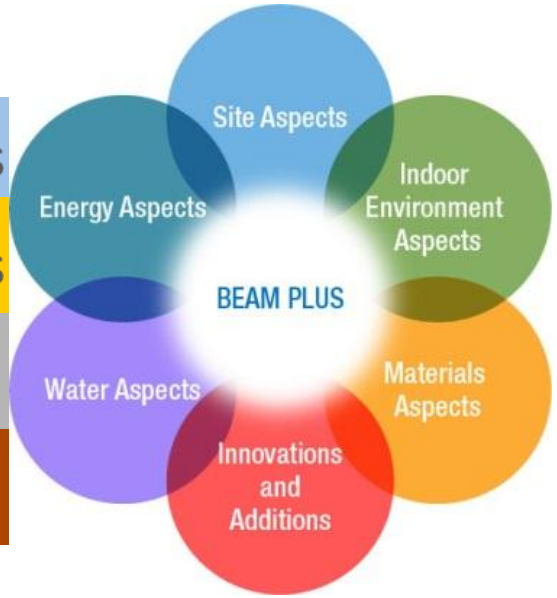
A non-profit organization which is committed to promote and develop the BEAM assessment tools, assessing green buildings and training professionals.

HKGBC 香港綠色建築議會 BEAM

BEAM Plus Awards

Award classifications:

	Overall	SA	EU	IEQ	IA
Platinum	75%	70%	70%	70%	3 credits
Gold	65%	60%	60%	60%	2 credits
Silver	55%	50%	50%	50%	1 credit
Bronze	40%	40%	40%	40%	-



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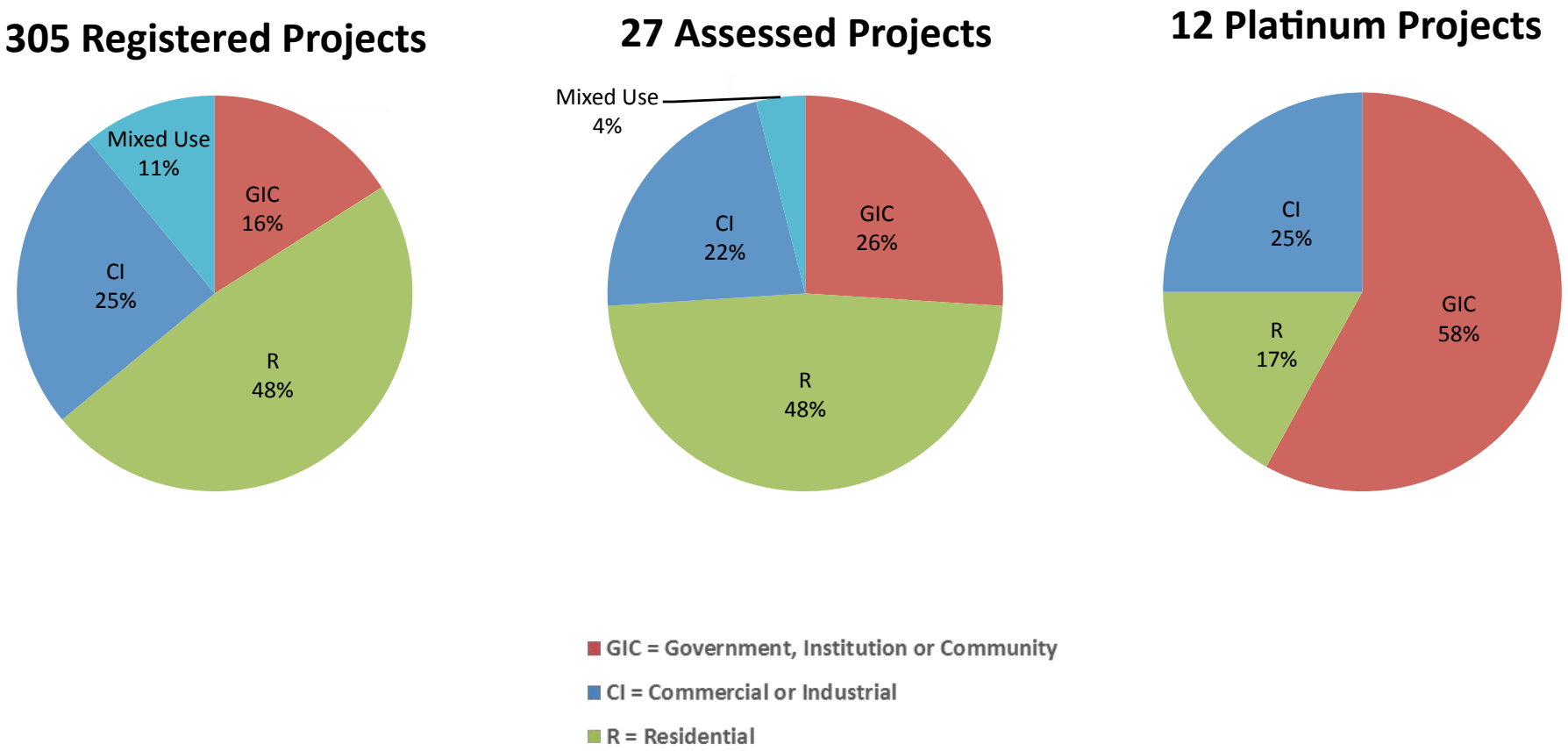
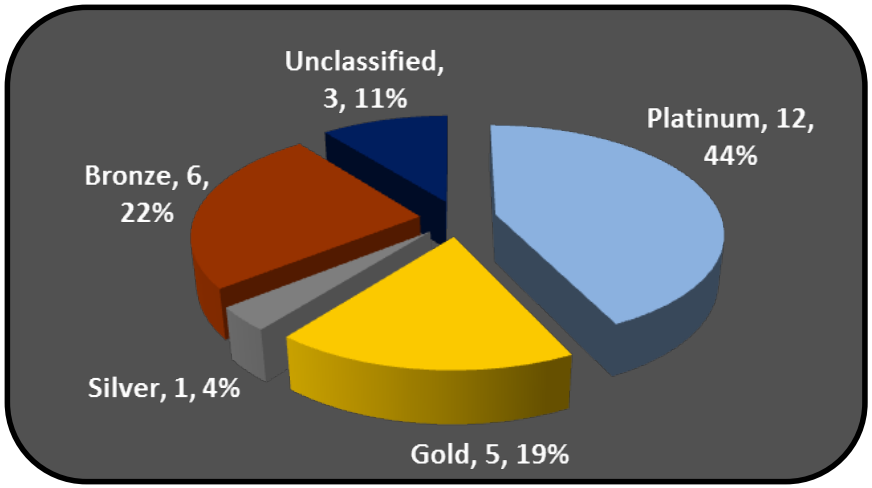
Analysis of the Platinums (8/2010 - 12/2012)

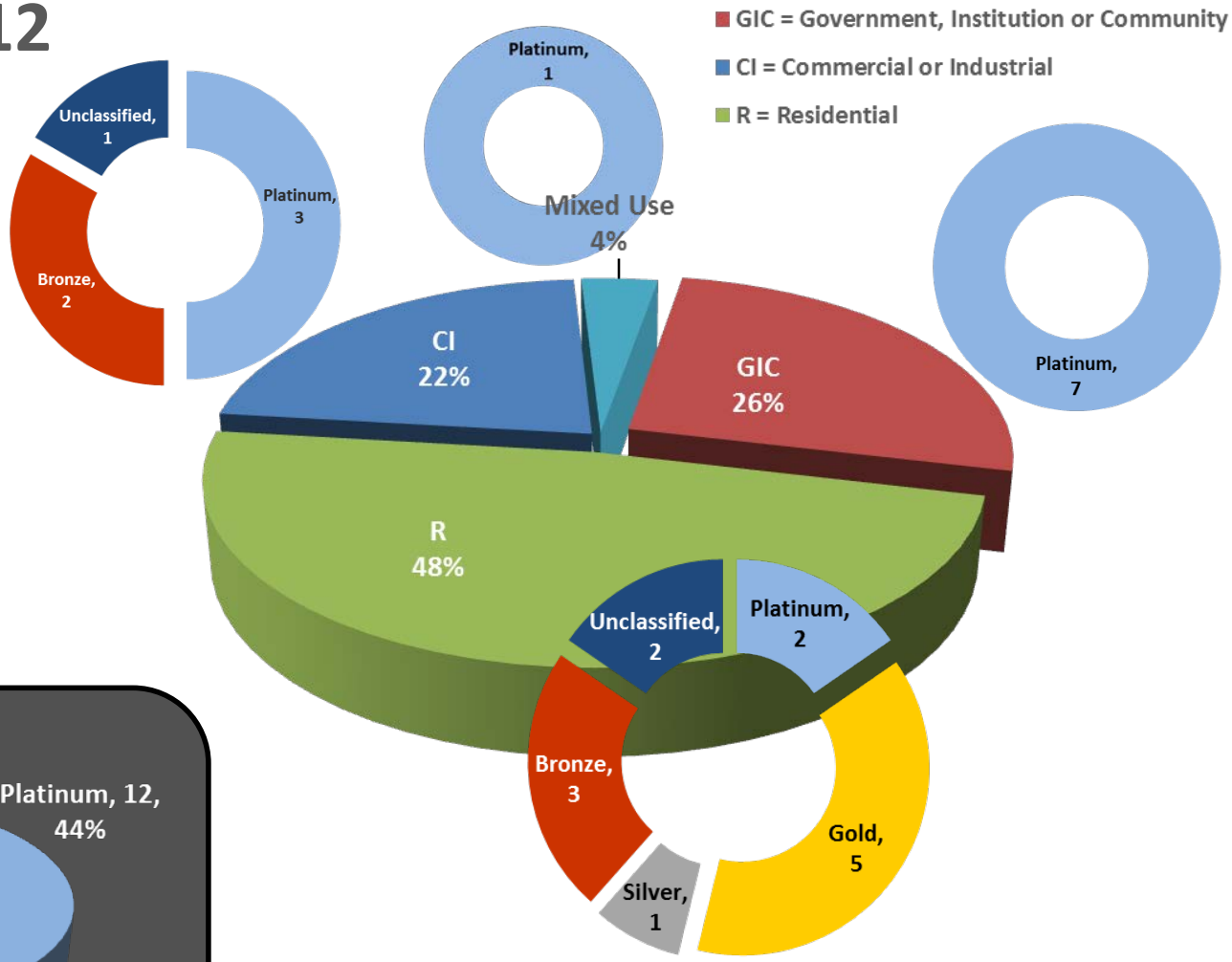


PA Rating 2010-2012

Platinum	12
Gold	5
Silver	1
Bronze	6
Unclassified	3

PA Rating of 27 Completed Projects

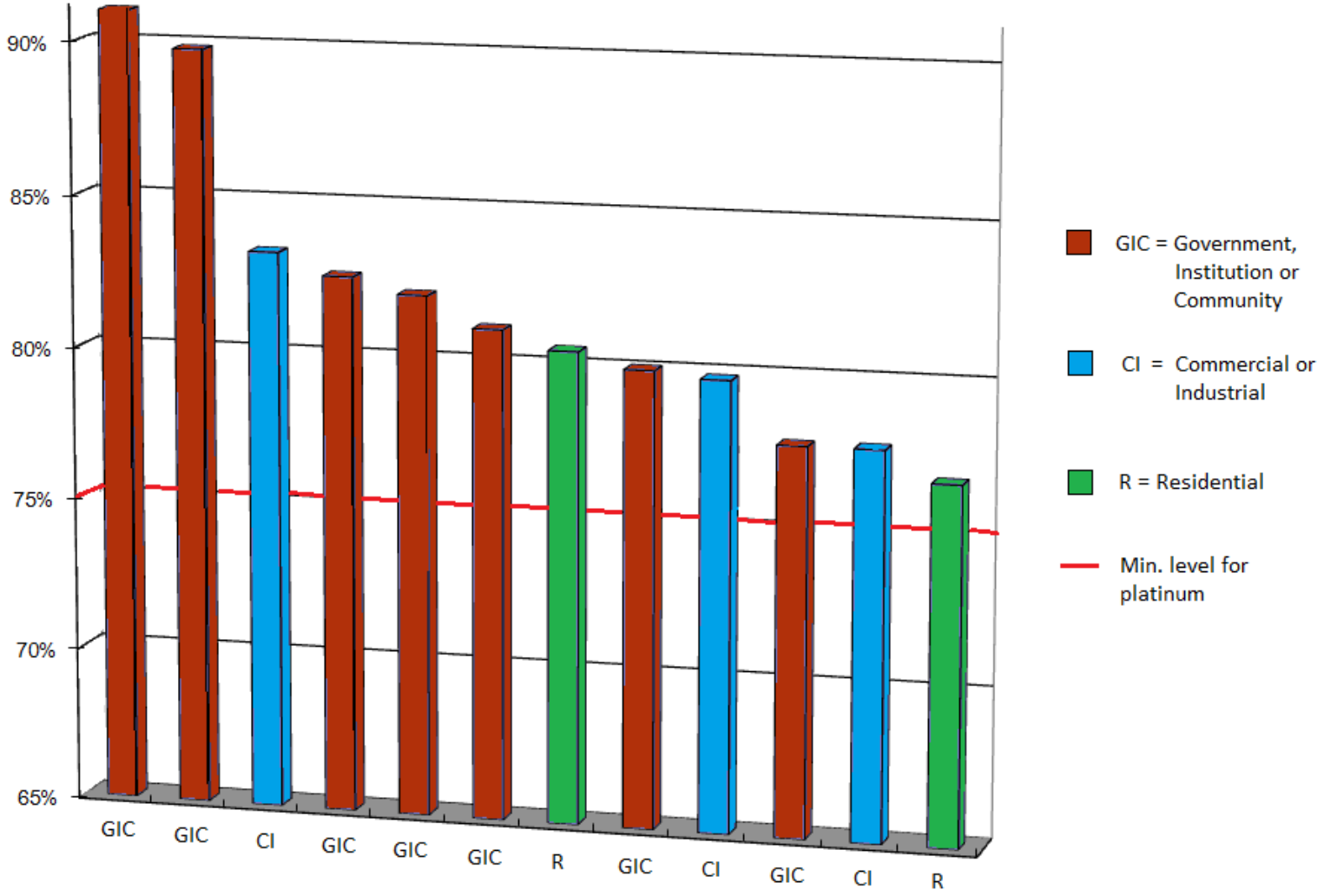




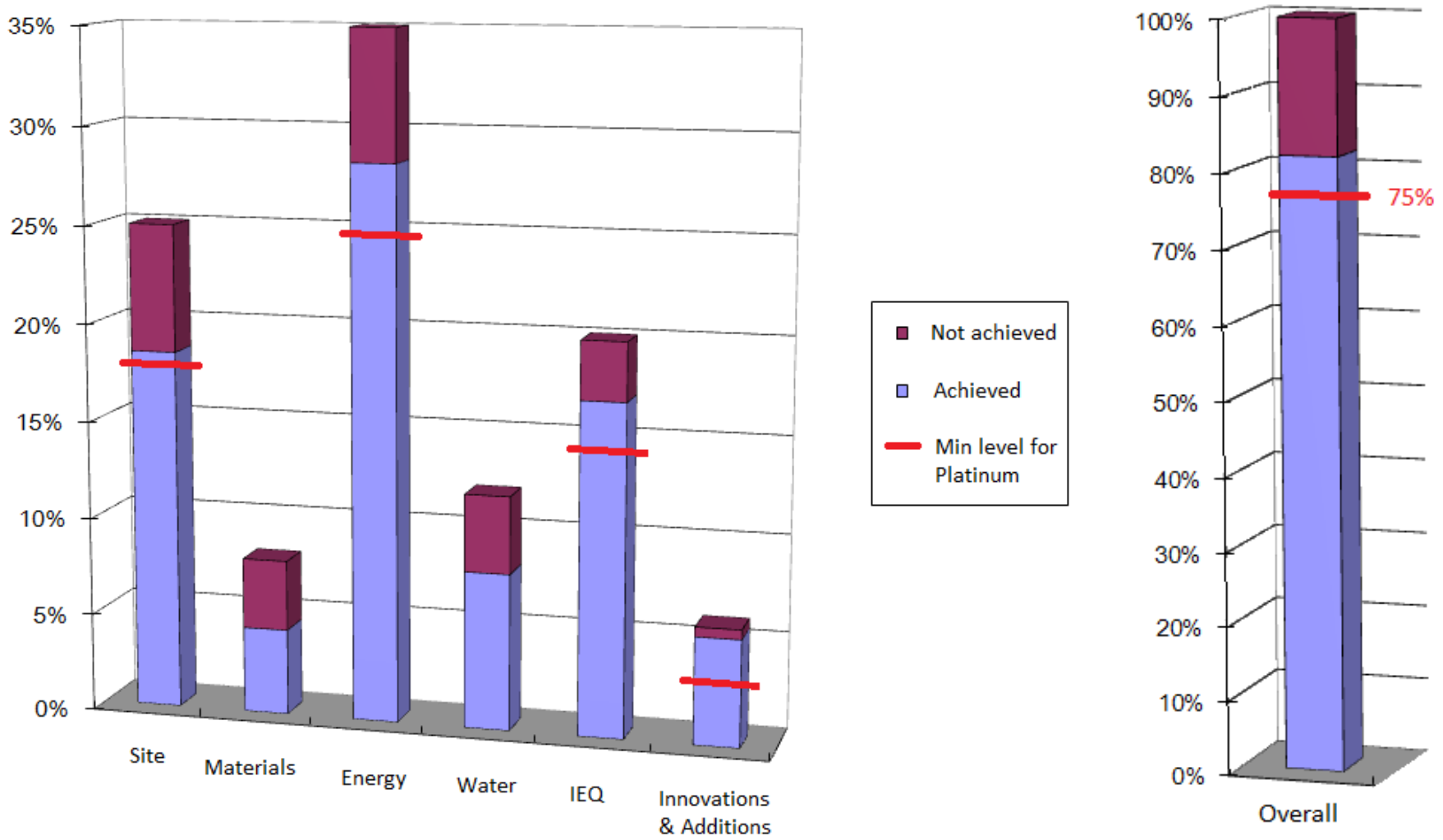
Building types of the 27 assessed projects

HKGBC 香港綠色建築議會 BEAM

Scores of 12 Platinum Projects

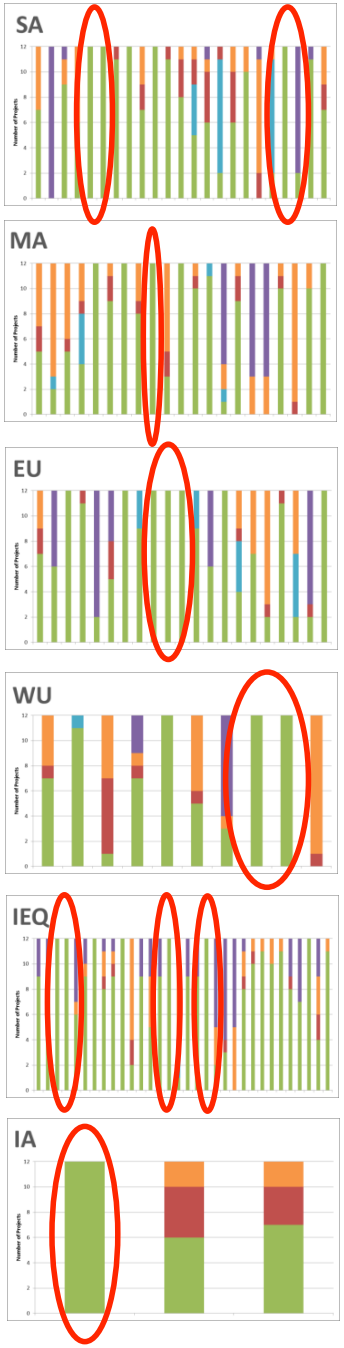


Average Aspect Scores



High score areas (100%)

- **SA** - Controlling noise from building equipment;
  Mitigate Air and Noise Pollution During Construction;
- **MA** - Avoiding Ozone Depleting Substances
- **EU** - Testing and Commissioning requirements; Operation and Maintenance requirements
- **WU**- Reduce Effluent Discharge to Foul Sewers
- **IEQ** – Adequate security measures; Reduce potential for transmission of harmful bacteria, virus and odour through drainage system; Good indoor air quality
- **IA**- Provision of Beam Pro



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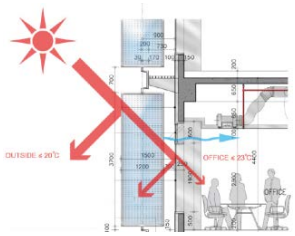
High Score Areas

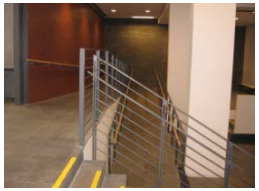
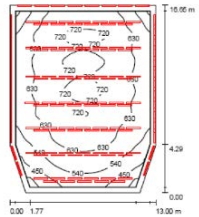
Item	% of Platinum projects achieved full scores
1. Site Aspects	
Controlling noise from building equipment	100
Pollution management during construction	92
Maintaining neighbourhood daylight access	83
Site greenery (planting area > 30% of the site)	75
2. Materials Aspects	
Regionally manufactured materials	92
Avoiding ozone depleting substances	83
Sustainable source/recycled timber	83
3. Energy Use	
Adequate meters for monitoring energy use	100
Testing and commissioning (T&C) requirements	92
Operation and maintenance (O&M) requirements	83
Reduction of CO_2 emissions and peak electricity demand	75
4. Water Use	
Low sewage discharge	100
Low annual water use	92
5. Indoor Environmental Quality	
Adequate security measures	100
Adequate measures to reduce potential for transmission of harmful bacteria, virus and odour through drainage system	100
Adequate measures to reduce risk of Legionnaires' Disease in building services	100
Good indoor air quality	100
Good lighting quality	100
Enhanced provisions for persons with a disability	92









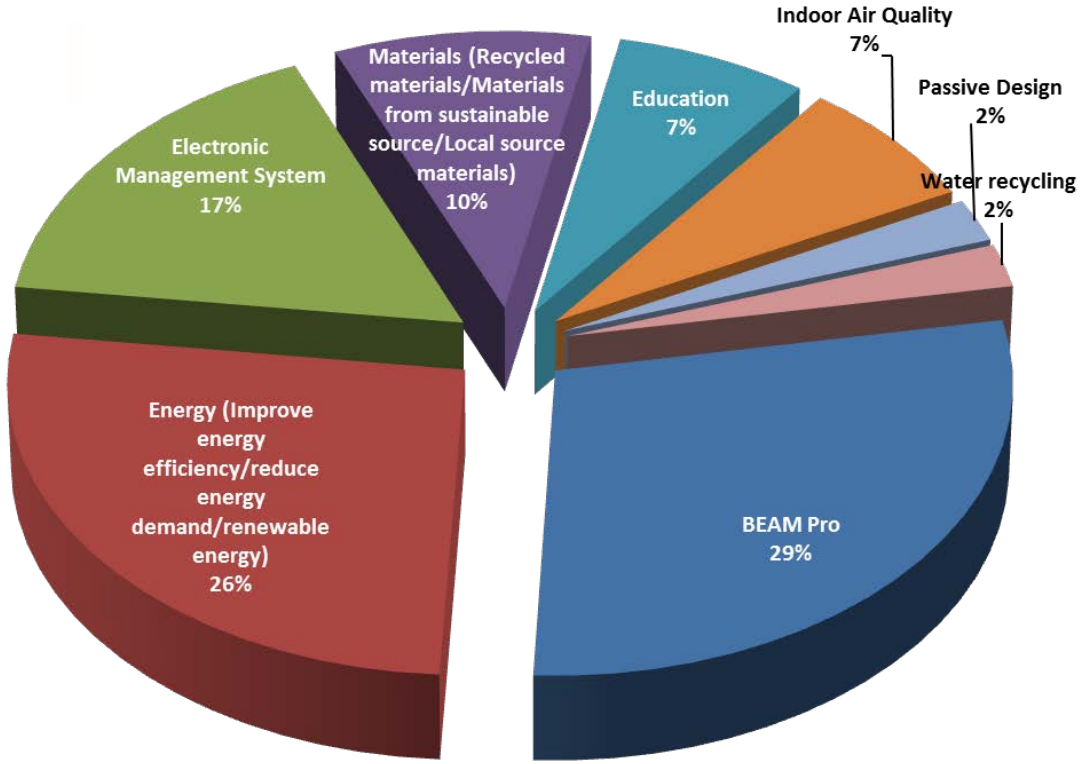



HKGBC 香港綠色建築議會 BEAM

IA

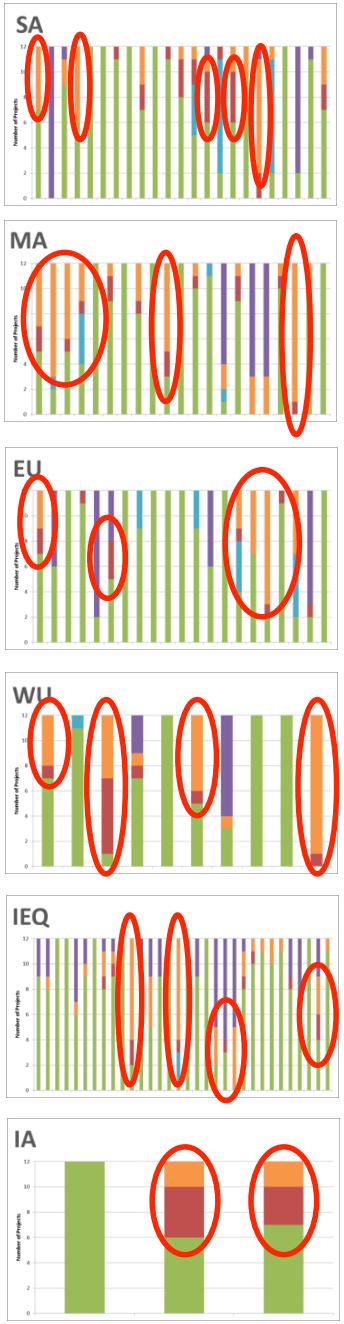
Innovations and Additions (IA)

Innovations	Achieved Credits
BEAM Pro	12
Energy (Improve energy efficiency/ reduce energy demand/renewable energy)	11
Electronic Management System	7
Materials (Recycled materials/ Materials from sustainable source/ Local source materials)	4
Education (Education signage)	3
Indoor Air Quality (Performance enhancements)	3
Passive Design	1
Water recycling	1



The Pinch Points

- SA - Contaminated land assessment and rehabilitation; Microclimate around buildings (AVA and CFD studies)
- MA – Prefabrication (at least 20%); Rapidly renewable materials (at least 2.5%)
- EU – Life cycle assessment of embodied energy in structural materials and minimization; Renewable energy systems (2.5% or covering whole footprint)
- WU- Leakage monitoring for distribution pipe works; Water saving through grey water recycling and rainwater harvesting
- IEQ – Adequate ventilation in common areas; At least 80% floor area has natural lighting



Reasons

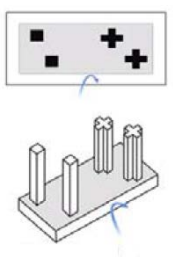
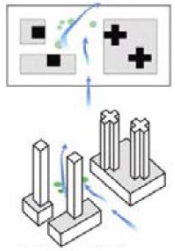
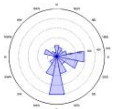
- Insufficient supporting materials
- Calculations errors
- Inconsistence/conflicting information
- Lack of justification

HKGBC 香港綠色建築議會 BEAM

The Pinch Points

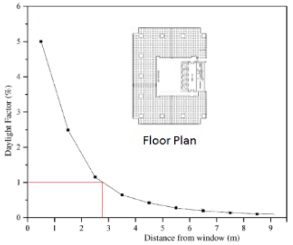
Item	% of Platinum projects achieved full scores
1. Site Aspects	
Contaminated land assessment and rehabilitation	None
Conserving and enhancing ecological value of the site	58
Demonstrating exterior lighting does not create light pollution	58
Microclimate around buildings (AVA and CFD studies)	8
2. Materials Aspects	
Rapidly renewable materials (at least 2.5%)	None
Prefabrication (at least 20%)	25
Modular and standardised design (at least 50%)	42
Construction waste recycling (at least 60%)	33
3. Energy Use	
Life cycle assessment of embodied energy in structural materials and its minimization	17
Renewable energy systems (supplying 2.5% of building energy or covering the whole of building footprint)	17
4. Water Use	
Leakage monitoring for distribution pipework	8
Extra water saving through grey water recycling and rain water harvesting	None
5. Indoor Environmental Quality	
At least 80% floor area has daylight factor not less than 1%	25





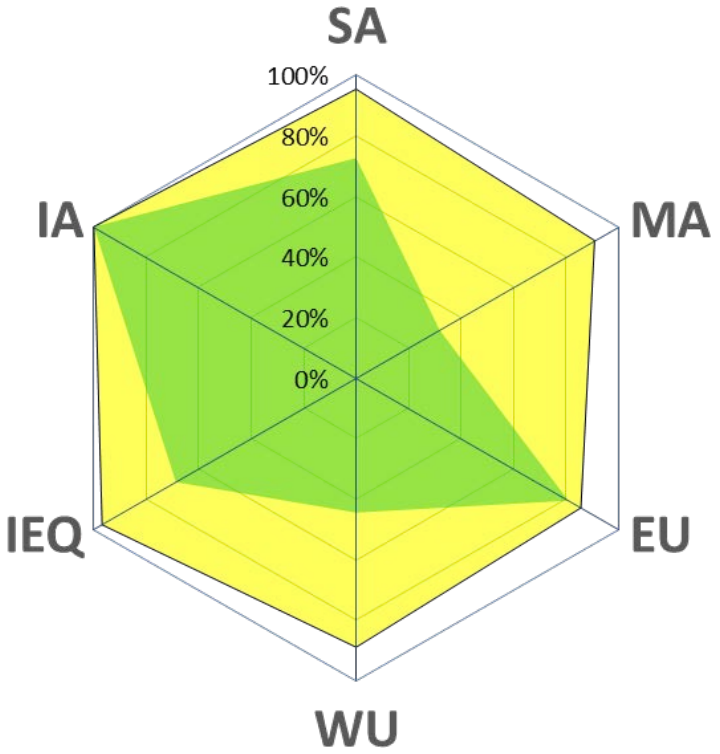




HKGBC 香港綠色建築議會 BEAM

CIC Zero Carbon Building

Building Functions: exhibition area, multi-purpose room and office
Outdoor Areas: urban forest , outdoor exhibition area, sitting-out area, circular path and walkways



Percentage of Applicable Credits

Percentage of Achieved Credits

HKGBC 香港綠色建築議會 BEAM

High Score Areas - CIC Zero Carbon Building

EU 1 Reduction of CO2 Emission & EU 2 Peak Electricity Demand Reduction

15 credits - reduction in annual energy consumption > 50%
3 credits - reduction in peak electricity demand > 30%

- *Chilled beams for radiation cooling; high volume low speed fans and underfloor displacement cooling for saving cooling energy; automatic window control for natural ventilation;*
  desiccant dehumidification for energy-efficient humidity control

EU 6 Renewable Energy System

5 credits

- *PV panels + bio-diesel generate more than 100 % of building energy demand*

EU 13 Energy Efficient Building Layout

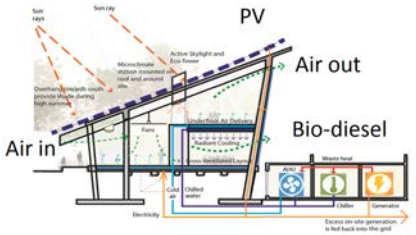
2 credits - passive design:

- *Building orientation and layout to facilitate cross ventilation; light pipes and wind catchers bring daylight*
  and wind into the interior zone; high-performance glazing and external solar shading to achieve an ultra-
  low OTTV of 11 W/m²

IA Innovations and Additions

4 bonus credits

- *Using bio-diesel for trigeneration, with grid feed-in (excess electricity fed back to CLP public grid)*
- *Extensive use of renewable energy and large extent of energy use reduction*

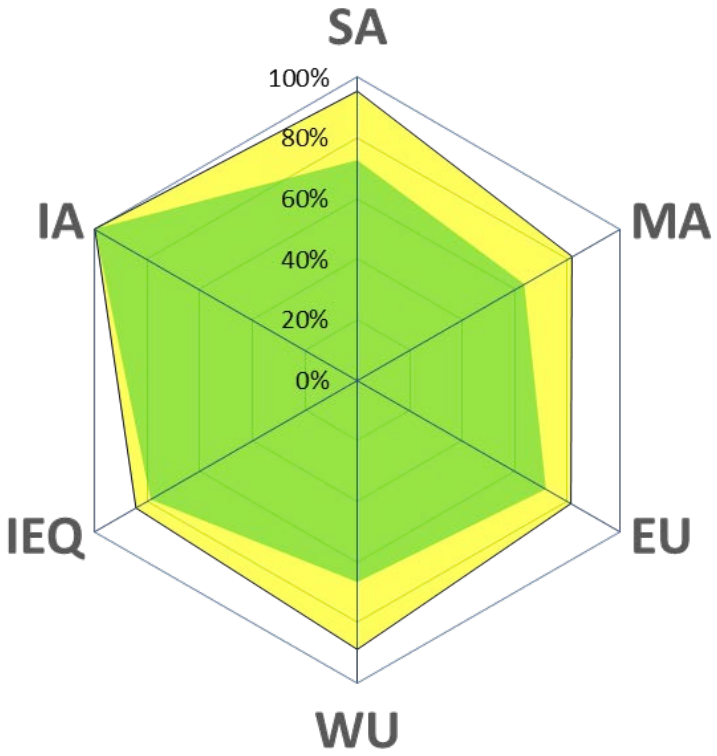


HKGBC 香港綠色建築議會 BEAM

Hong Kong Science Park Phase 3

Building Functions:

offices, laboratories, exhibition halls



Percentage of Applicable Credits

Percentage of Achieved Credits

HKGBC 香港綠色建築議會 BEAM

High Score Areas - Hong Kong Science Park Phase 3




EU 1 **Reduction of CO2 Emission** & EU 2 **Peak Electricity Demand Reduction**

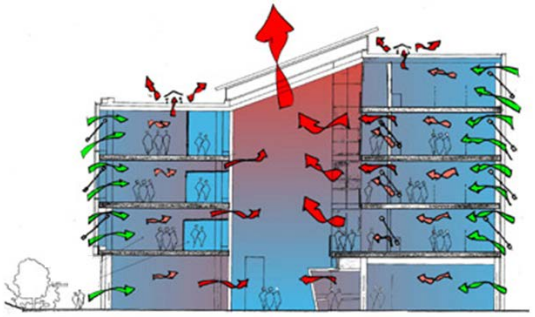
15 credits - reduction in annual energy consumption around 36%

3 credits - reduction in peak electricity demand around 34%

- *District cooling; demand control ventilation; heat recovery; free cooling; low lighting power density with daylight and occupancy sensors; hybrid street lamps*

EU 6 **Renewable Energy System**

2 credits - generate 1% of the building energy by *PV panels*



EU 13 **Energy Efficient Building Layout**

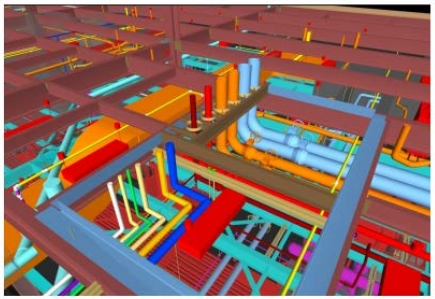
2 credits - passive design

- *Hybrid ventilation; high-performance façade; high solar reflective materials for roof / green roof*

IA **Innovations and Additions**

4 bonus credits

- *Flexibility for future trigeneration; building information modelling (BIM); on-line project collaboration; education signage*



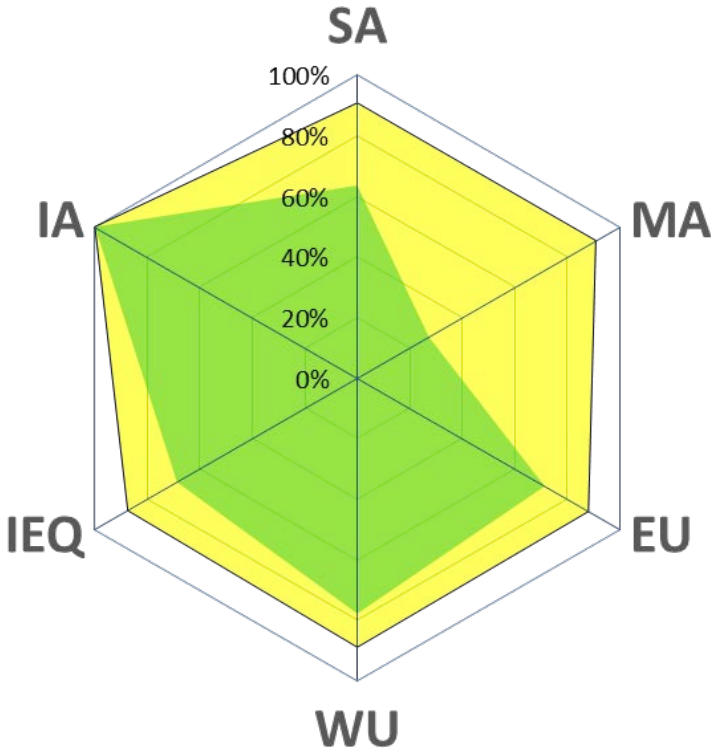
BIM

HKGBC 香港綠色建築議會 BEAM

Holiday Inn Express Hong Kong Soho FA Platinum

Building Function:

hotel, restaurant, car park

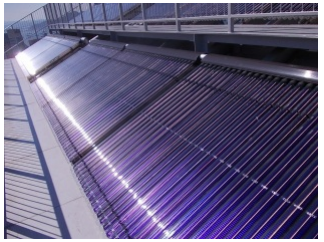


Percentage of Applicable Credits

Percentage of Achieved Credits

HKGBC 香港綠色建築議會 BEAM

High Score Areas - Holiday Inn Express Hong Kong Soho



EU 1 Reduction of CO2 Emission & EU 2 Peak Electricity Demand Reduction

15 credits - reduction in annual energy consumption around 60%

3 credits - reduction in peak electricity demand around 30%

- *heat pump water heaters; extensive use of renewable energy (solar thermal) on roof and at integrated solar hot water cladding; low-e glass, double glazing*

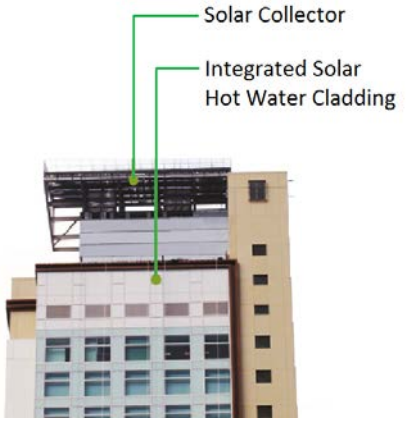
EU 6 Renewable Energy System

2 credits – Generate 1.3% of building energy by *solar hot water panels*

IA Innovations and Additions

3 bonus credits

- *Peltier bed headboard: A thermoelectric cooling device inside the bed headboard to provide low-energy cooling at night when the fan coil unit is switched off.*
- *iFCU (intelligent fan coil units): Speed of fans automatically adjusted according to temperature.*
- *Solar Energy Reclaimed: The system comprises inclined solar collectors on roof and vertical building cladding panels for reclaiming solar energy to heat up water.*



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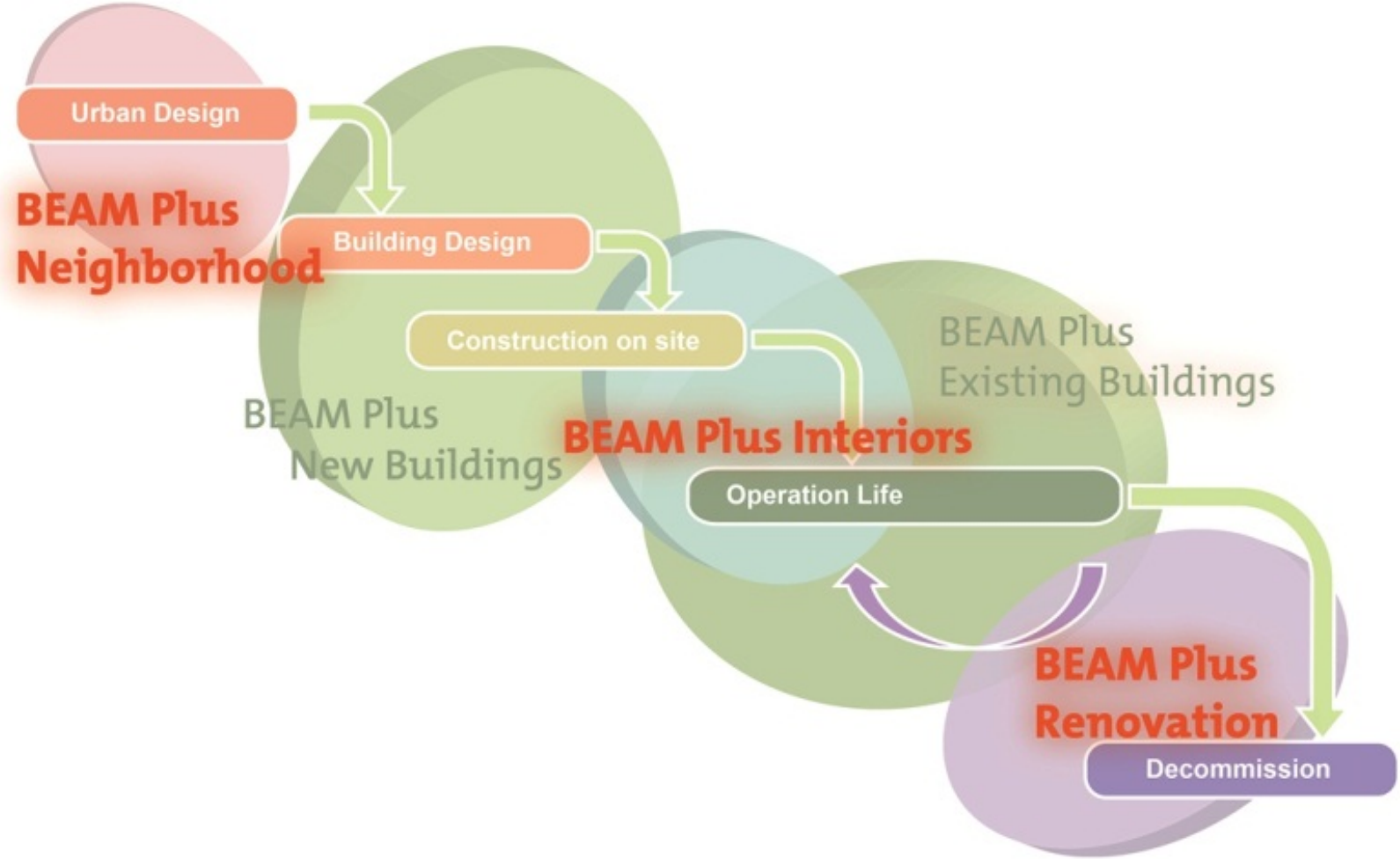
Future Development



How can you contribute ?

BEAM Pro

integrate the green building standards and practices into building planning, design, construction, O&M and to assist clients to achieve the desired **green building rating level**.

BEAM Assessor (BAS)

undertake the BEAM Plus assessment.

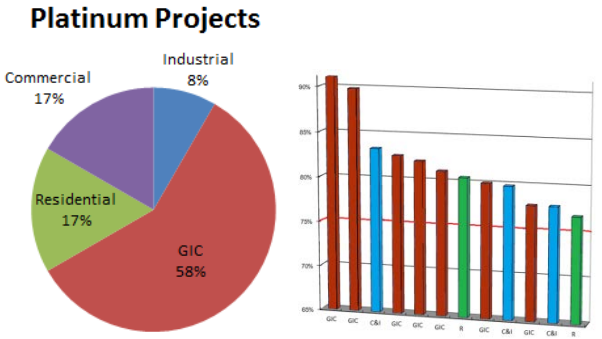
GB Faculty

supports the **initiatives** of green building and sustainable environment, and the standing committees of HKGBC & BSL.

HKGBC 香港綠色建築議會 BEAM

Conclusions

- Wide range of projects in the Platinum grade with GIC projects in the lead.
- Most projects did more than the minimum.
- High score credits include good IEQ, low water use, good energy provisions and excellent pollution management.
- Room for improvement in embodied energy, renewable energy, grey water recycling, micro-climate study, etc.
- Beam Plus sets out best practices/targets and drives more healthy, efficient and sustainable buildings.
- Continuous upgrading and development



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thank you

www.hkgbc.org.hk
www.beamsociety.org.hk

Acknowledgement
Thanks to the Secretariats of HKGBC and BSL for providing data.
Particular thanks to Ir. Eddy Lau of HKGBC and Mr. Leo Chan of BSL for their assistance in compiling.
Mr. John Herbert for his valuable advice, and
project owners for agreeing to use their project information.

HKGBC 香港綠色建築議會 BEAM

Green Related Testing, Inspection and Certification for Construction Materials and Buildings

Mr. John Hung

Secretary-General,

Hong Kong Council for Testing and Certification

22 March 2013

Contents

A. Hong Kong Council for Testing and Certification
B. Green Related Testing for Construction Materials
C. Greenhouse Gas Validation and Verification
D. Green Related Inspection and Certification for Buildings
E. Enhancing Quality – Hong Kong Accreditation Service (HKAS)

Part A:
Hong Kong Council for Testing and Certification (HKCTC)

Hong Kong Council for Testing and Certification (HKCTC)

- An advisory body established in September 2009
- Terms of Reference : to advise the Chief Executive on –
  - the **overall development strategy** of the industry
  - **new business opportunities** worth exploring for the industry, having regard to latest developments in the Mainland and overseas markets
  - **measures needed to raise the professional standing and community awareness** of the industry

- Chairman – Prof. P.C. Ching, Pro-Vice-Chancellor of The Chinese University of Hong Kong
- Members come from :
  - testing and certification industry
  - business sector
  - professional bodies
  - public bodies
  - Government departments

- Secretariat support – provided by Innovation and Technology Commission

- Vision –
  - To develop Hong Kong into a testing and certification hub in the region
- Dual Approach -
  - To make general improvements to the accreditation service and factors of production
  - To assist the industry to seize further business opportunities in specific trades

- **Dedicated Panels** set up for 6 trades to act as platforms for stakeholders to develop and promote new testing and certification services –
  - Chinese medicines
  - **construction materials**
  - **environmental protection**
  - food
  - information and communications technologies
  - jewellery

Part B :
Green Related Testing for Construction Materials

What is “Green Material”?

- General understanding –
  - cause minimal adverse environmental impacts
  - incorporate both human health and environmental concerns

Examples of “Green Material”

- Materials –
  - with improved recyclability, high recycled content
  - which emit fewer irritating or toxic substances during installation or use
  - which result in smaller production of toxic substances, or of less toxic substance, upon disposal
  - manufactured with resource-efficient processes including reducing energy consumption, minimising waste, and reducing greenhouse gas emissions

Recycled Contents – PFA in Cement/Concrete

- Pulverised fuel ash (PFA)
  - a by-product (waste) of the combustion of coal used in coal-fired power stations
  - used as a raw material in cement manufacture
  - can be used as a partial replacement for cement in concrete

- Environmental, technical and financial benefits

- Relevant testing services available –
  - Tests on properties of PFA
    - **Physical:** e.g. fineness, initial setting time, moisture content, particle density, soundness, strength factor, water requirements
    - **Chemical:** e.g. loss-on-ignition, magnesium oxide content, sulphuric anhydride content, sodium oxide content, potassium oxide content, total alkali content
  - Other tests
    - PFA in cement / concrete
    - Various properties of PFA cement

Irritating / Toxic Substances – Volatile Organic Compound

- Volatile organic compound (VOC)
  - Organic chemical compounds
  - Evaporate under normal room temperature and pressure
  - Cause air pollution and smog
- Health effects, e.g.
  - eye, nose, and throat irritation; headaches, loss of coordination, nausea; some organics can cause cancer in human
- Sources, e.g.
  - paints, adhesive, sealant, organic solvent, wood preservatives

- Air Pollution Control (Volatile Organic Compounds) Regulation (Cap 311W, Laws of Hong Kong)
  - Controls the VOC contents of 6 types of products, e.g. architectural paints, adhesives and sealants

- Test methods for determining VOC content
  - Method 24 and Method 24A as adopted by US Environmental Protection Agency
  - Method 303 as adopted by US California South Coast Air Quality Management District

Toxic Substances – Asbestos

- Asbestos
  - Fibrous silicate minerals
  - Intact and undisturbed asbestos ➔ no health risk in general
  - Works (e.g. maintenance, renovation, demolition) disturb asbestos containing materials ➔ health risks (e.g. lung cancer, mesothelioma, asbestosis)
- Air Pollution Control Ordinance (Cap 311, Laws of Hong Kong) (sections 51-80) and Air Pollution Control (Asbestos) (Administration) Regulation (Cap 311P, Laws of Hong Kong)

- Air sampling
  - Test to asbestos air-borne fibres and dust
  - Examples: background, environmental & reassurance test, leakage test, personal & work area static test, clearance test

- Asbestos – bulk sampling
  - Identification of asbestos containing materials, e.g. amosite, crocidolite, chrysotile, fibrous actinolite, fibrous anthophyllite, fibrous tremolite

Government's Green Procurement - Green Specifications

Product Code	Product Items	Recommended green specifications
	Building and construction supplies (Category Code – 01)	
01	Flooring materials	• The plastic floor parts should contain no less than 10% by weight of recycled plastic materials against the total weight of plastic contained in the product
		• The product containing paint should not contain any heavy metals or their compounds as listed below: i. Cadmium ii. Mercury iii. Hexavalent chromium iv. Lead v. Arsenic vi. Antimony
		• Total emission: Discharge of VOC should not exceed 2g/m^2
		• Emission rate: Discharge of VOC should not exceed 500μg/m^2/hr
		• Emission of formaldehyde from the product should not exceed 0.13mg/m^3 air
		• Product should not contain chlorinated / brominated paraffins, organic tin compounds, phthalates or PBDEs content
		• The product should be marked with an appropriate plastic resin identification code
02	PVC pipe and fitting	• The product should contain at least 30% by weight of plastic waste
		• The product should be marked with an appropriate plastic resin identification code
		• The product should not contain cadmium and lead
		• The product should not contain phthalates
03	Solvent-based/Water-based paint	• Shall comply with the VOC content requirements on regulated paints stipulated in the Air Pollution Control (VOC) Regulation of Hong Kong
		• Products should be free of CFCs
		• The paint should not be formulated with mercury, arsenic, selenium, lead, cadmium and hexavalent chromium
		• The paint or any thinner should not be formulated with formaldehyde or substances that have the potential to release formaldehyde during use
04	Carpet	• Should include a post-consumer or post-industrial recycled content of at least 5% in the carpet backing
		• Emissions of Total Volatile Organic Compounds (TVOCs) should not exceed 0.5 mg/m^2 per hour
		• The product should be sold as removable tiles
		• The product should not be manufactured with topically applied biological inhibitors
		• Water-based adhesives or adhesive-free should be used
		• Carpets should be completely free of PVC
		• Carpet backings should be PVC free, and the carpet backing materials should be cotton, jute, resin or polyurethane
		• The product should be recyclable into either new carpet or other products, or should be capable of being refurbished

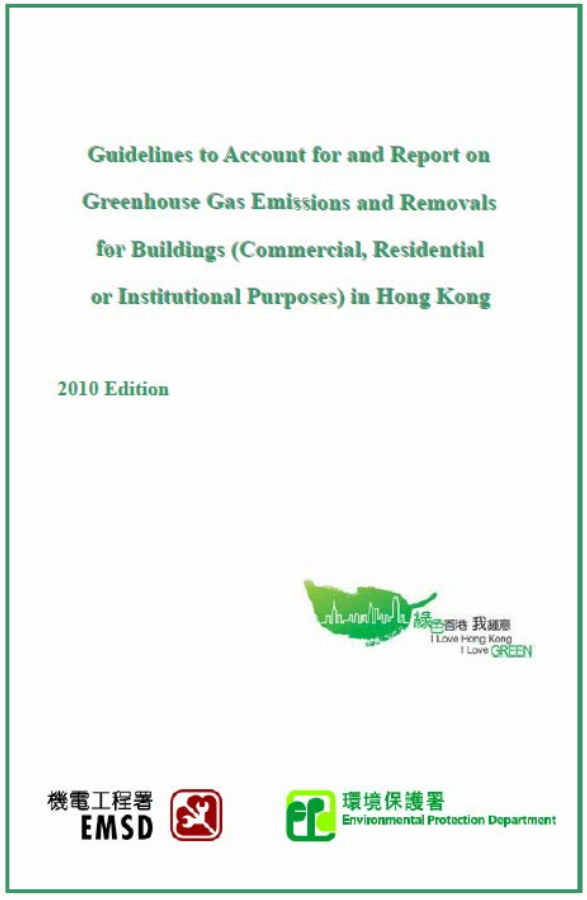
- 103 items, including building and construction supplies
- Recommended green specifications for each item
- "Testing" is a means to determine if a item conforms to specifications, e.g. heavy metal testing for flooring materials

Part C :
Greenhouse Gas (GHG) Validation and Verification

GHG Quantification

- What is “GHG Quantification”?
  - Process/means of measuring, recording and reporting GHG emissions within a defined system

- International standards
  - ISO 14064 Part 1 – Organisation level
  - ISO 14064 Part 2 – Project level
  - Applicable to the building and construction industry

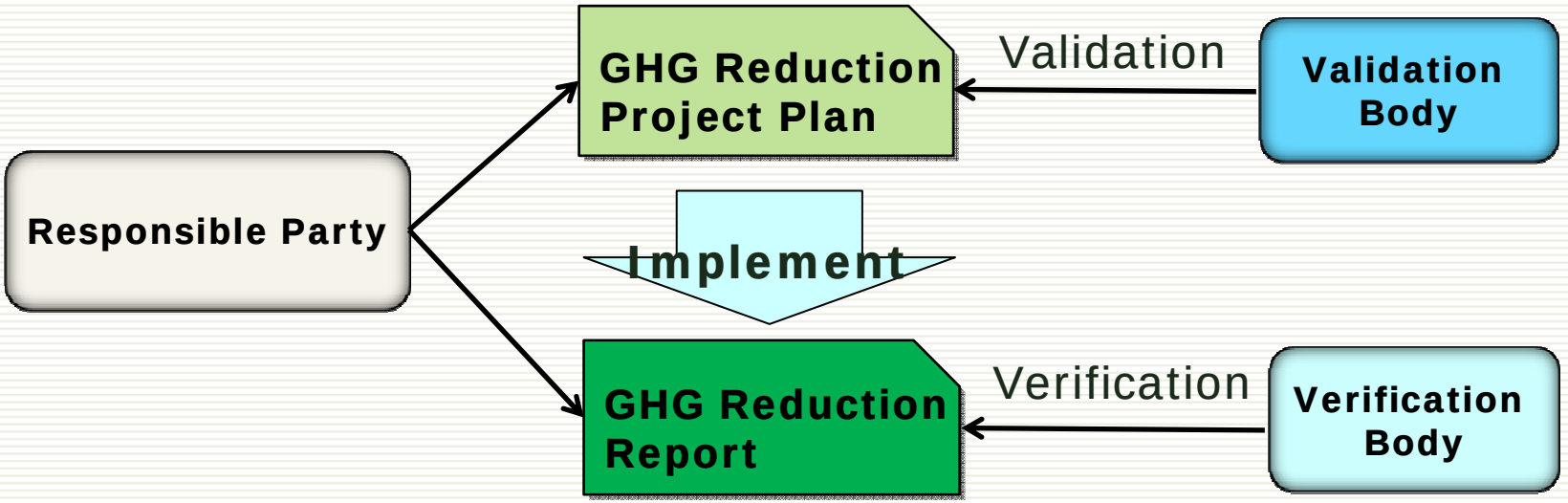


- Guidelines to Account for and Report on GHG Emissions and Removals for Buildings (Commercial, Residential or Institution Purposes) in Hong Kong
  - Published by Electrical and Mechanical Services Department and Environmenta Protection Department
  - Information reference from international standards

GHG Validation and Verification

For Organisation

For GHG Emissions Reduction / Removal Enhancement Proje



Future Development – Product Carbon Footprint

- Product carbon footprint
  - Sum of greenhouse gas emissions and removals of a product based on a lifecycle assessment
- Specification/Standard –
  - PAS 2050:2011 (published by BSI, UK)
  - ISO 14067 (under development)
- Development of carbon labelling schemes for construction materials

Part D:
Green-related Inspection and Certification for Buildings

Inspection – Indoor Air Quality (IAQ) Certification Scheme

- Launched by Environmental Protection Department in Sep 2003
  - To improve IAQ and promote public awareness
  - Voluntary
  - 12 IAQ parameters
  - 2-Level IAQ objective (Excellent and Good)
  - Inspection bodies require accreditation from Hong Kong Accreditation Service

環境保護署
ENVIRONMENTAL PROTECTION DEPARTMENT

Indoor Air Quality Certificate (Excellent Class)
室內空氣質素檢定證書《卓越級》

Valid period 有效日期 _____ to 到 _____

I hereby certify that the indoor air quality of the following location(s) has fully complied with the Excellent Class of the Indoor Air Quality Objectives.
本人證明下列地點的室內空氣質素完全符合「卓越級」室內空氣質素指標。

Name of building 建築物名稱 : _____
Address 地址 : _____
_____
Certified location(s) 已檢定地點 : _____
_____

Approved HKIAS IAQ Signatory
香港認可處核準室內空氣質素簽署人員

Name 姓名 : _____
IAQ Certificate Issuing Body 室內空氣質素證書簽發機構 : _____
Signature 簽署 : _____
Date of issue 簽發日期 : _____
Certificate No. 證書編號 : _____

Organisation Chop 機構印鑑

(This certificate is issued based on the results of the HKIAS endorsed inspection report no. _____)
(此證書是根據香港檢驗機構認可計劃檢驗報告編號 _____ 所得之結果發出)

Indoor Air Quality Certification Scheme for Offices and Public Places
辦公室及公眾場所室內空氣質素檢定計劃

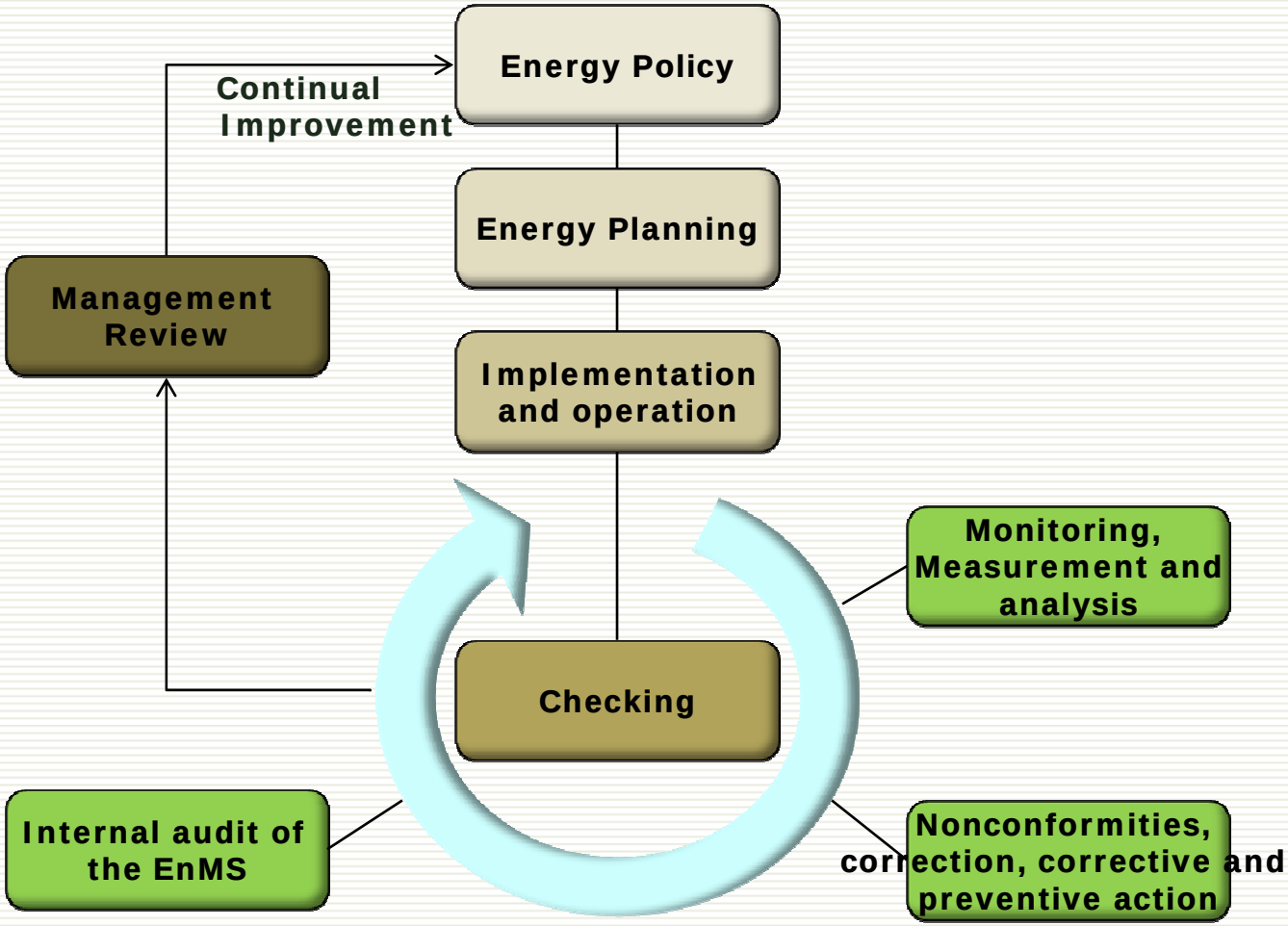
Indoor Air Quality Information Centre
室內空氣質素資訊中心

Parameter	Unit	8-hour average [a]	
		Excellent Class	Good Class
Room Temperature	°C	20 to < 25.5 [b]	< 25.5 [b]
Relative Humidity	%	40 to < 70 [c]	< 70
Air movement	m/s	< 0.2	< 0.3
Carbon Dioxide (CO_2)	ppmv	< 800 [d]	< 1,000 [e]
Carbon Monoxide (CO)	$\mu g/m^3$	< 2,000 [f]	< 10,000 [g]
	ppmv	< 1.7	< 8.7
Respirable Suspended Particulates (PM_{10})	$\mu g/m^3$	< 20 [f]	< 180 [h]
Nitrogen Dioxide (NO_2)	$\mu g/m^3$	< 40 [g]	< 150 [h]
	ppbv	< 21	< 80
Ozone (O_3)	$\mu g/m^3$	< 50 [f]	< 120 [g]
	ppbv	< 25	< 61
Formaldehyde (HCHO)	$\mu g/m^3$	< 30 [f]	< 100 [f, g]
	ppbv	< 24	< 81
Total Volatile Organic Compounds (TVOC)	$\mu g/m^3$	< 200 [f]	< 600 [f]
	ppbv	< 87	< 261
Radon (Rn)	Bq/m^3	< 150 [i]	< 200 [f]
Airborne Bacteria	cfu/m^3	< 500 [j, k]	< 1,000 [j, k]

Certification – Energy Management System Certification

- ISO 50001 Energy Management System (EnMS) – Requirements with guidance for use
  - International standard, compatible with 9001 and ISO 14001
  - Specify requirements for establishing, implementing, maintaining, and improving an EnMS
  - Applicable to any types of organisation including building operations

- Improve energy performance, reduce operation cost and enhance reputation



(Source: ISO 50001:2012)

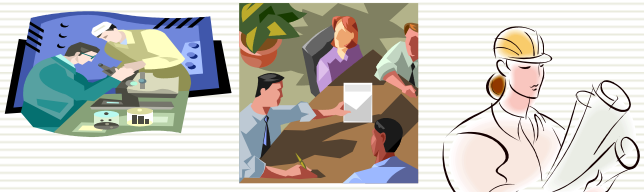
Part E:
Enhancing Quality – Hong Kong Accreditation Service (HKAS)

Hong Kong Accreditation Service (HKAS)

- Part of Innovation and Technology Commission
- The official accreditation body in Hong Kong

創 新 科 技 署
Innovation and Technology Commission

What is Accreditation?



Accreditation Body (e.g. HKAS) provides the quality assurance

Are they competent?

Test, inspection, certification, GHG validation and verificatio

Are they acceptable?

International Recognition

- HKAS has signed multilateral recognition arrangements (MRAs) administered by –
  - International Laboratory Accreditation Cooperation (ILAC)
  - International Accreditation Forum (IAF)
  - Asia Pacific Laboratory Accreditation Cooperation (APLAC)
  - Pacific Accreditation Cooperation (PAC)
- HKAS accreditation is recognised by about 80 accreditation bodies in over 65 economies

To know more about Hong Kong's testing and certification services, you may visit –

www.hkctc.gov.hk

www.hkas.gov.hk

Thank You!

Nick Lewis

K.Wah Construction Materials

The Hong Kong Institution of Engineers

22nd March 2013

What have we done?

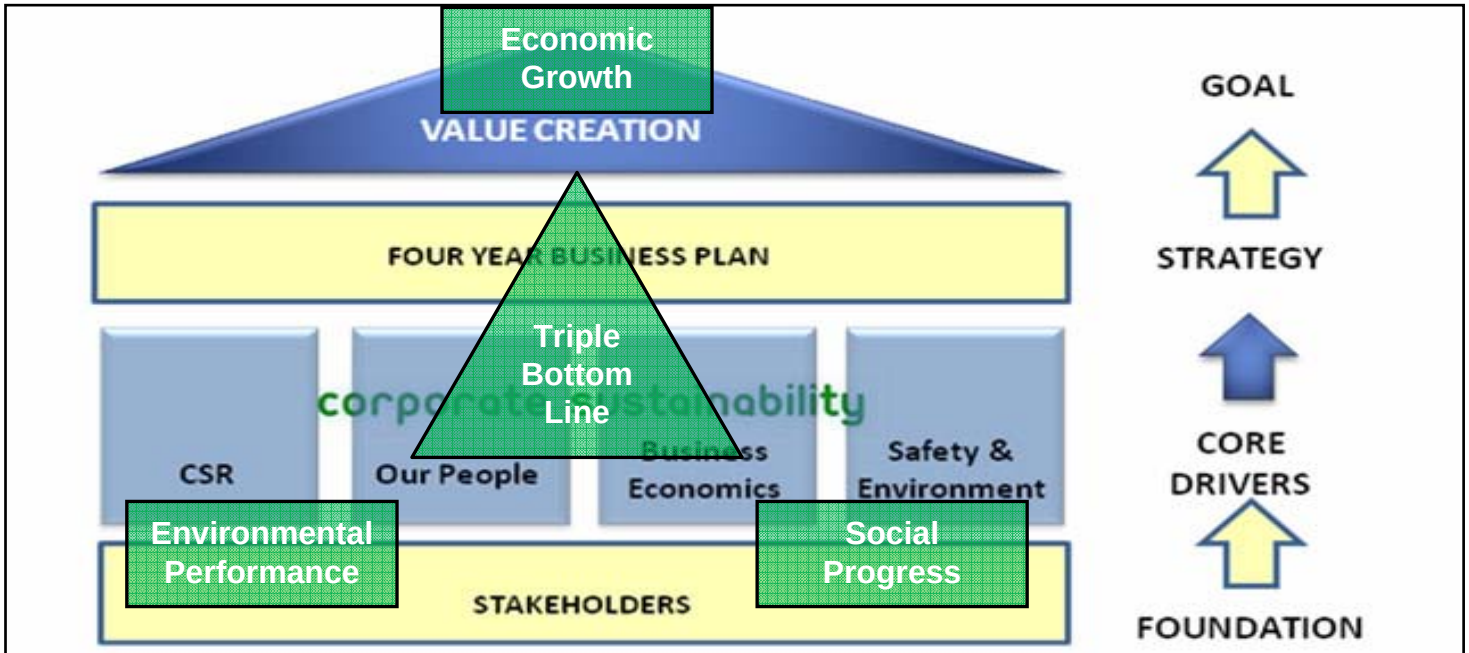
One tenth of the Amazon Rainforest has been cut in the past 10 years...

“ We are using 50% more resources than the Earth can provide, and unless we change course that number will grow very fast – by 2030, even two planets will not be enough”

World Wildlife Fund,
Living Planet Report 2012

Sustainable Development is Embedded within our Business Strategy

Corporate Sustainability *is our business approach to creating long-term shareholder value by integrating* ***economic***, ***environmental*** *and* ***social*** *concerns in our business operation and in our interaction with our stakeholders, not only fulfilling legal expectations but going beyond compliance*



KWCM's Value Creation Model

urce: KWCM

Mineral Products - Low-Carbon Construction Materials

Aggregates

Cement

Slag

Ready mixed Concrete

Vertical & lateral integration

Asphalt

Block / Paver

Piles & Pipes

Infrastructure construction

Non-residential construction

Residential construction

Low-Carbon Construction Materials – Focused Group

Concrete & Slag Cement

Concrete Pavers

Asphalt

Low-Carbon Construction Materials – Focused Group

Concrete & Slag Cement

Concrete Pavers

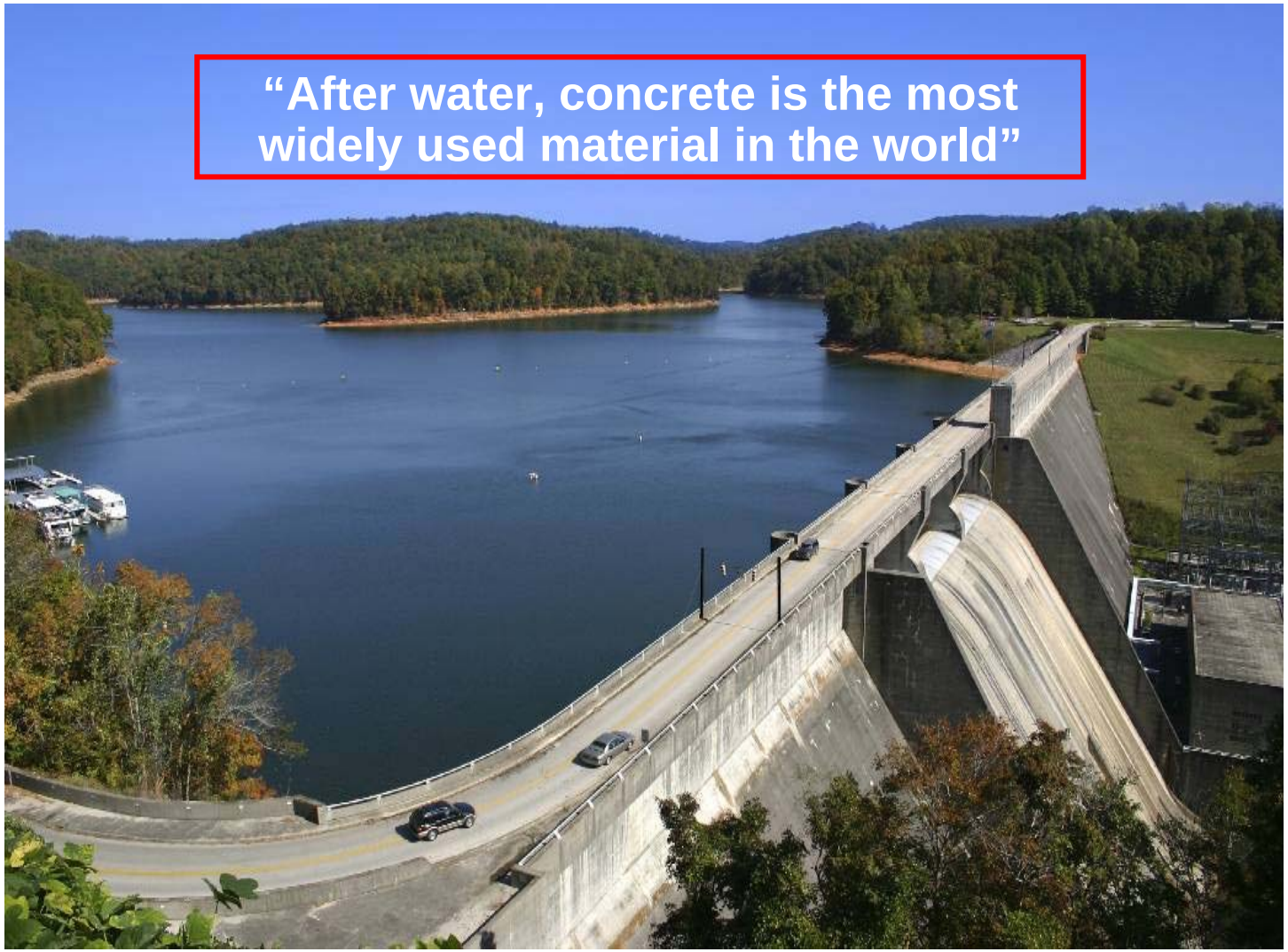
Asphalt

Concrete and Slag Cement

Concrete is the most widely used building material, 3 tonnes used for each man, woman & child

Increased population growth and urbanization, drives demand

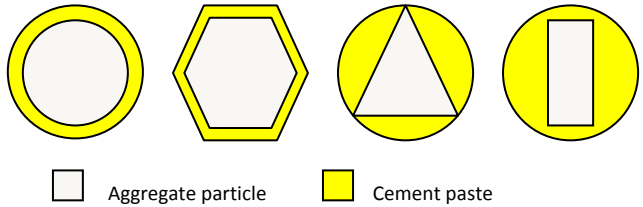
Worldwide, buildings account for up to 40% of primary energy consumption and 33% of Co_2 emissions



urce: Aitken P. C, 2000, CJSI, WBCforSD

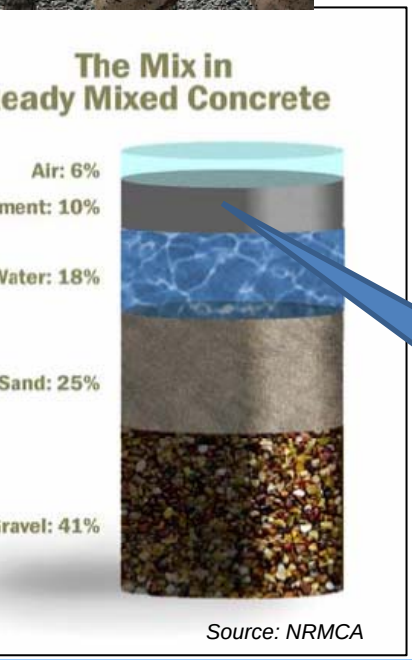
Concrete Production Techniques to Reduce Embedded CO_2

- Reduce cement in concrete through:
  - Selection of most suitable aggregate



  - Efficient chemical admixtures
  - State-of-the-art mix design and optimization tools
  - Low variability in quality

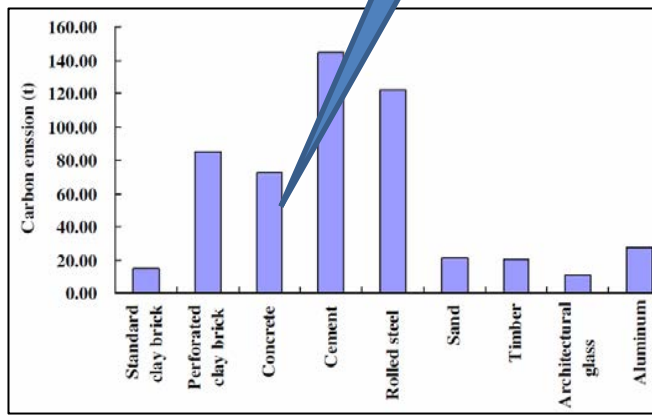
Accurate batching and mixing
Accurate batching (less variability)
ficient mixing (less variability &
d reactivity)



Source: NRMCA

Only 10% by volume but >90% contribution to GHG emissions!

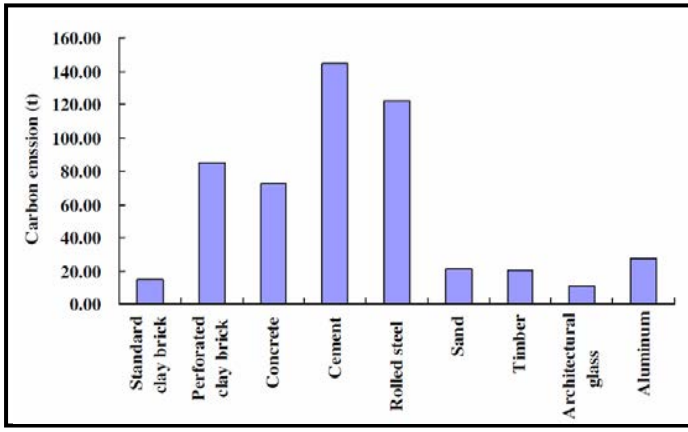
350kg CO2e/m3



Source: Building & Environment 5

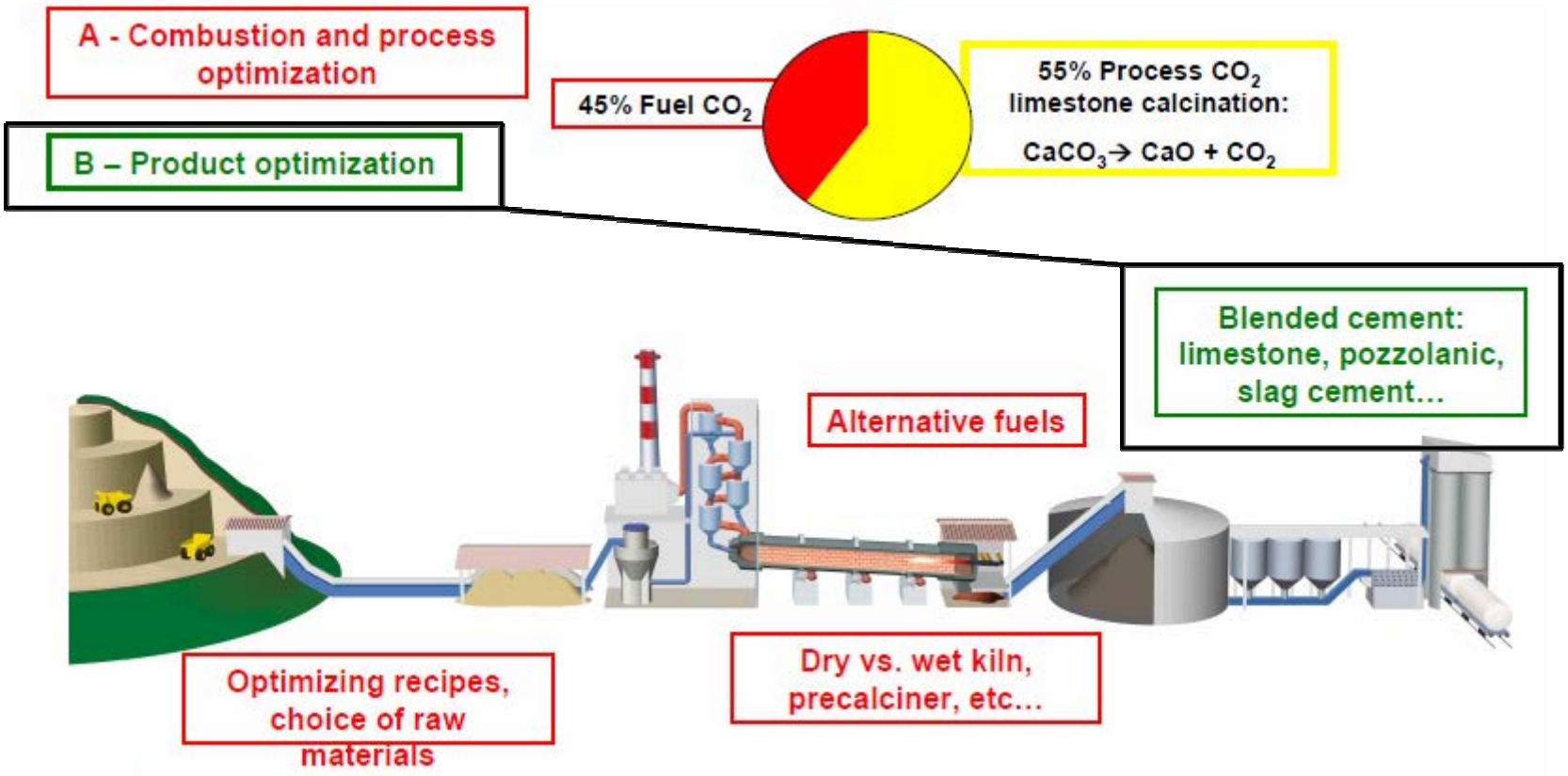
Reducing CO_2 Emissions in Cement Production is a Priority . . .

- The building sector consumes about 40% of global energy and contributes about 36% of CO_2
- The global cement industry contributes around 5% of all man-made CO_2 emissions
- A cement plant releases 0.5~1.0 tonne of CO_2 for every tonne of cement produced (Global average 0.88t CO_2)
- 3.4 billion tonnes of cement production per year; 60% is produced in China
- In an assessed residential building cement emits most carbon dioxide; its proportion is about 27.8%



Source: Building & Environment 59

Approaches to Reduce CO_2 in Cement Production . . .



- **Lowering the clinker factor is one of the best approaches to reduce CO_2**

urce: Holcim

Slag - A Long History of Use

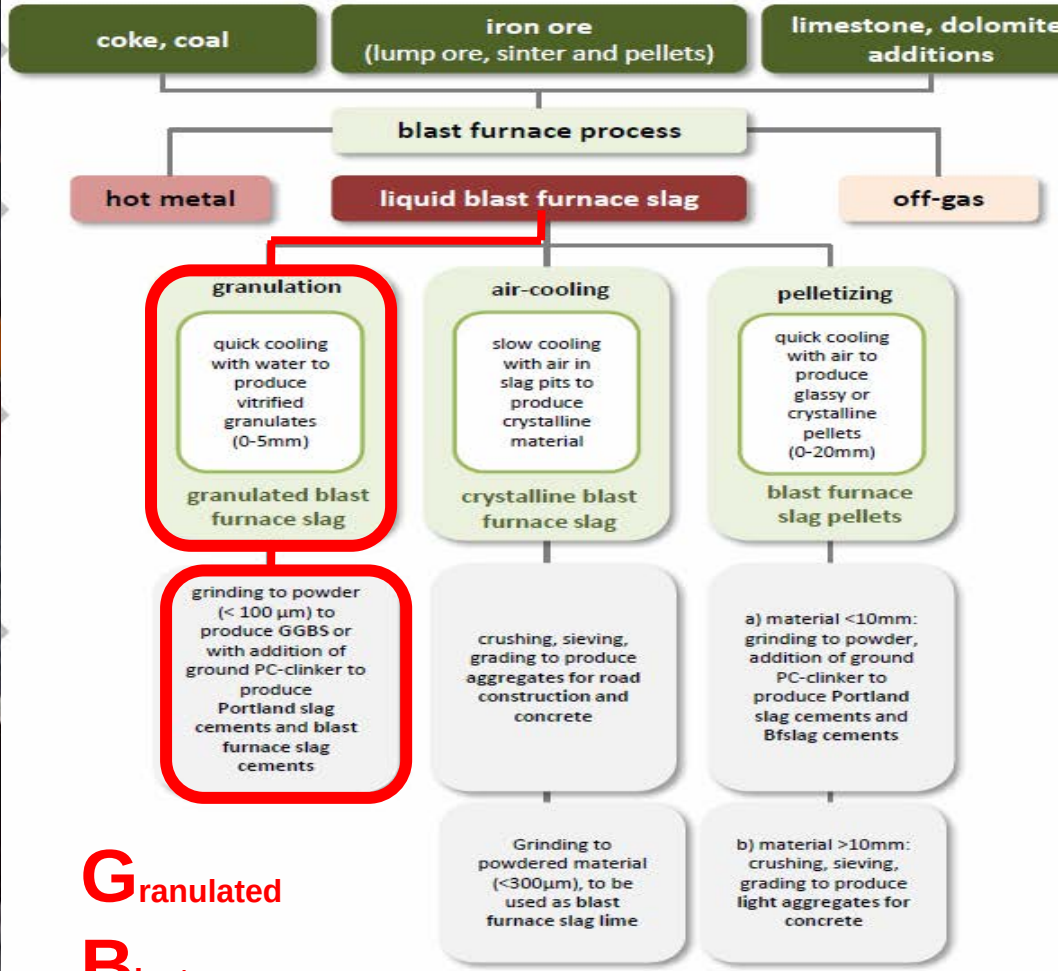
- Slag usage in road building dates back over 2000 years ago to Roman road building.

The Appian Way in Italy

Cast iron slag stones were used for masonry work in Europe in the 18th century.

Blastfurnace Slag Production . . .

urce: Euro Slag



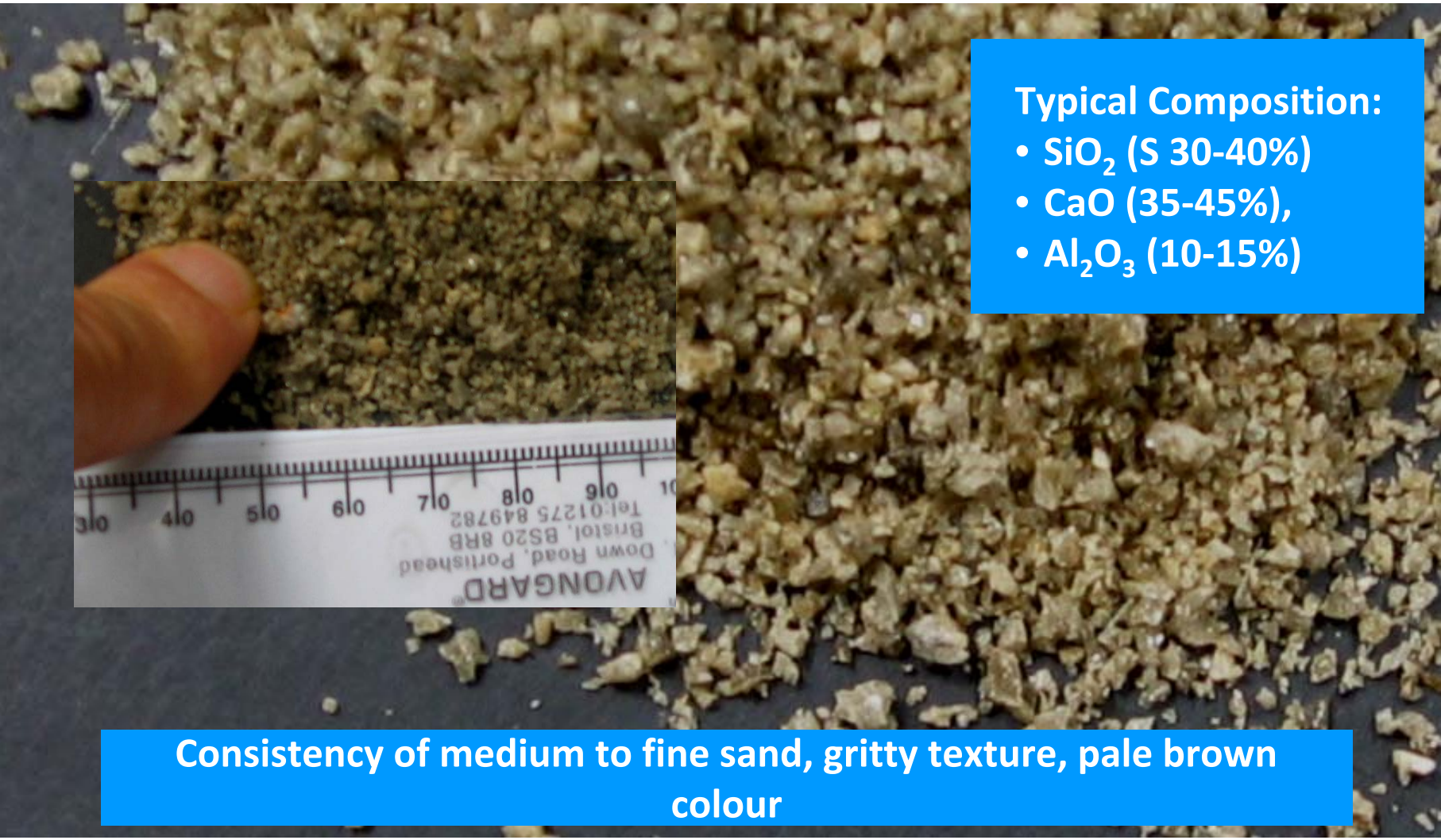
Granulated

Blast

Furnace

Slag

Granulated Blastfurnace Slag (GBFS)



Typical Composition:

- SiO_2 (S 30-40%)
- CaO (35-45%),
- Al_2O_3 (10-15%)

Consistency of medium to fine sand, gritty texture, pale brown colour

Vertical Grinding Mill (VGM) for Ground Granulated Blast Furnace Slag (GGBFS)

urce: UBE

K.Wah GGBFS Processing Facility, Qin Huang Dao, China

Summary of GGBFS Key Technical & Environmental Benefits . . .

- Cost effective
- Significantly reduces clinker content
- Lighter colour than OPC
- Enhances concrete durability, better sorptivity
- Continued strength gain
- Reduces heat in concrete
- Better chloride diffusion resistance
- Typically replaces 60-70% of cement (compared to 25-40% PFA) and can replace up to 90%
- Low carbon construction material

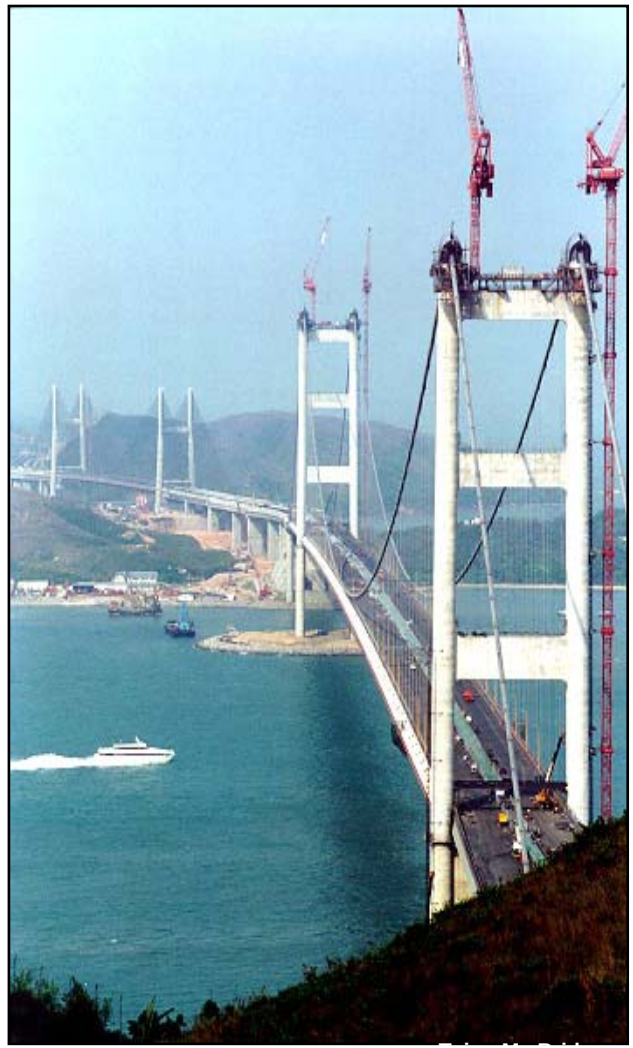
urce: G Anderson & KWCM

High Profile Engineering Applications in Hong Kong . . .

- 55% GGFBS can reduce the embodied CO_2 content of a typical C32/40 concrete from approx. 115kg CO_2 h/t to approx. 60kg CO_2 e/t

- 30% PFA can reduce the embodied CO_2 content of a typical C32/40 concrete from approx. 115kg CO_2 h/t to approx. 85kg CO_2 e/t

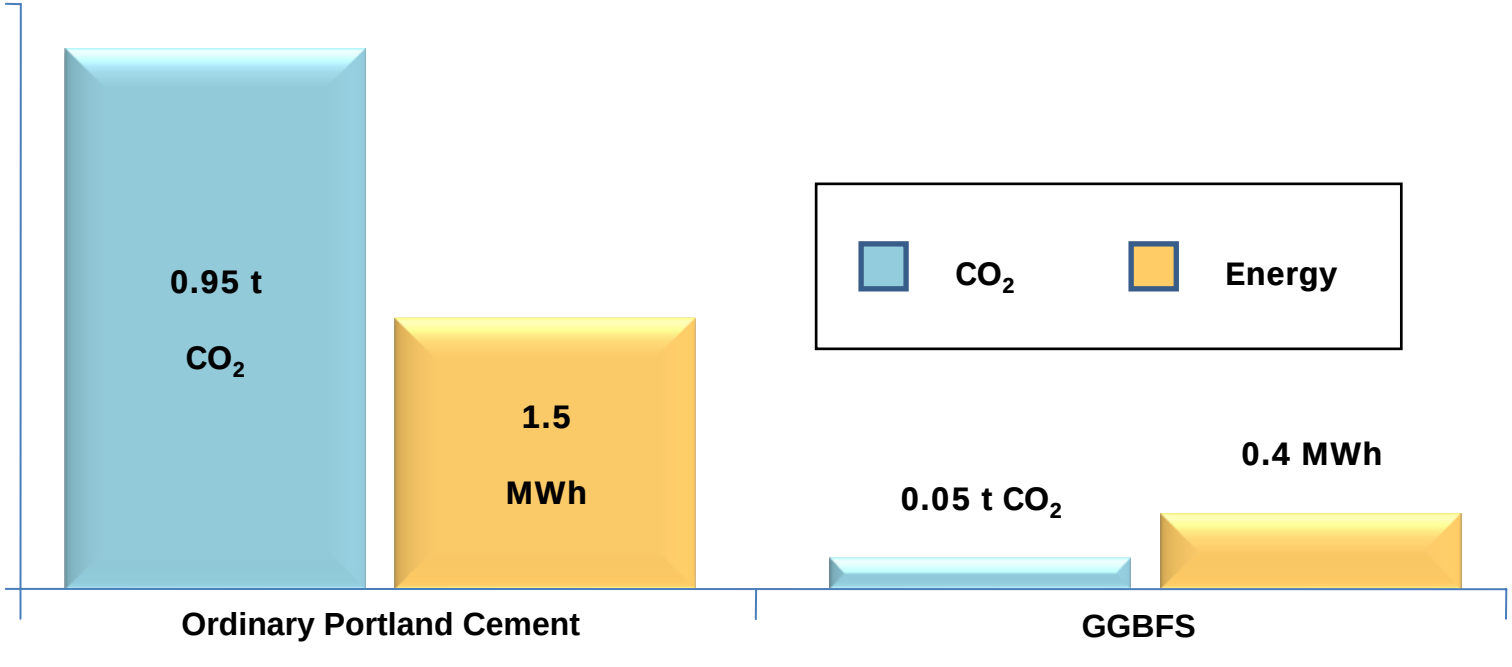
Stonecutters Bridge



urce: Arup

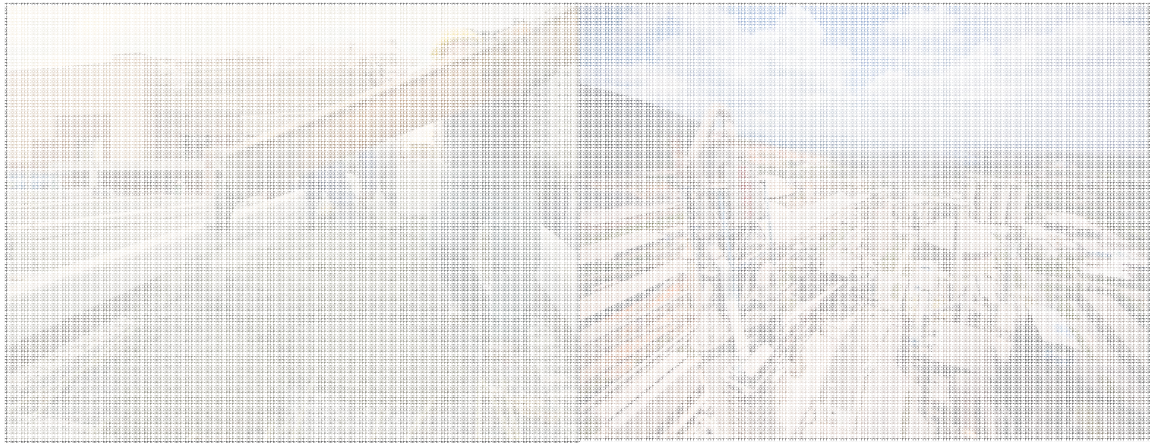
Environmental Benefits in CO_2 Reduction . . .

- By comparison with OPC, the manufacture of GGBFS requires less than a fifth of the energy, and produces less than a fifteenth of the carbon dioxide emissions



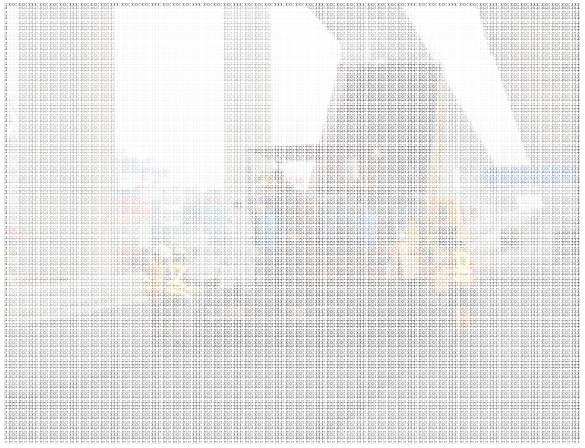
urce: Cementitious Slag Makers Association & Civil & Marine

Low-Carbon Construction Materials – Focused Group



Concrete & Slag Cement

Concrete Pavers



Asphalt

A “Cradle to Grave to Cradle” Recycling Approach . . .

“Life Pave” Program

Building Environmental Assessment Method

BEAM Society 建築環保評估協會

No.	Measure
MA9	Locally manufactured
MA7	Use of recycled products
MA11	Reduction of construction waste
WU4	Water recycling
WU3	Water efficient irrigation

Source: BEAM

Waste Glass Bottle Collection Programmes . . .

Pilot program on source separation of glass at public housing estate

Recycling program in community (EPD) – 43 collection points

Sustainable / Aesthetic / Functional . . .

SUSTAINABLE:

- Using over 50% recycled materials and 20% recycled glass
- Supported by HKSAR Government - green procurement policy
- Same performance as standard products

AESTHETIC:

- Enhanced the surface colour using slag cement
- Multi-colour pattern to enhance the visual attraction
- Exposed aggregate surface to create antique appearance

FUNCTIONAL:

- High strength - supports heavy load traffic & resist defamation
- Resistant to oil / fuel contamination
- Complied with international specifications
- Permeable pavers – protects water resources

Permeable Pavers using Recycled C&D Wastes & GGBFS

- Providing a structural pavement while allowing rainwater to infiltrate into the pavement construction for temporary storage playing an important part in removing a wide range of pollutants from water
- Suitable for a wide variety of residential, commercial and industrial applications
- Optimizing land use by combining two functions in one construction: structural paving combined with the storage and attenuation of surface water
- Handling rainwater from roof drainage and impervious pavements as well as the permeable paving itself

Source: Interpav

Permeable Pavers using Recycled C&D Wastes & GGBFS

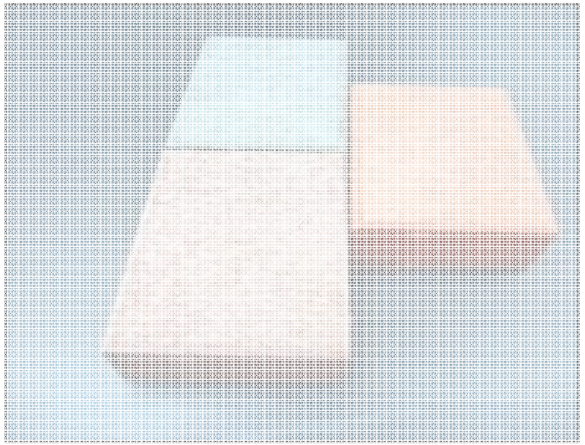
Our permeable pavers are designed to have:

- Permeability around 25mm per hour, to allow rain water to penetrate and capture for reuse
- Compressive strength ~ 8000 psi

urce: Interpave

Low-Carbon Construction Materials – Focused Group

Concrete & Slag Cement



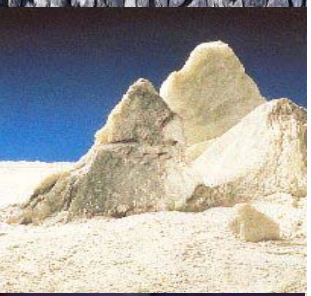
Concrete Pavers

Asphalt

Asphalt Production is Energy Intensive . . .

Sand

Aggregates



Filler

Bitumen

+

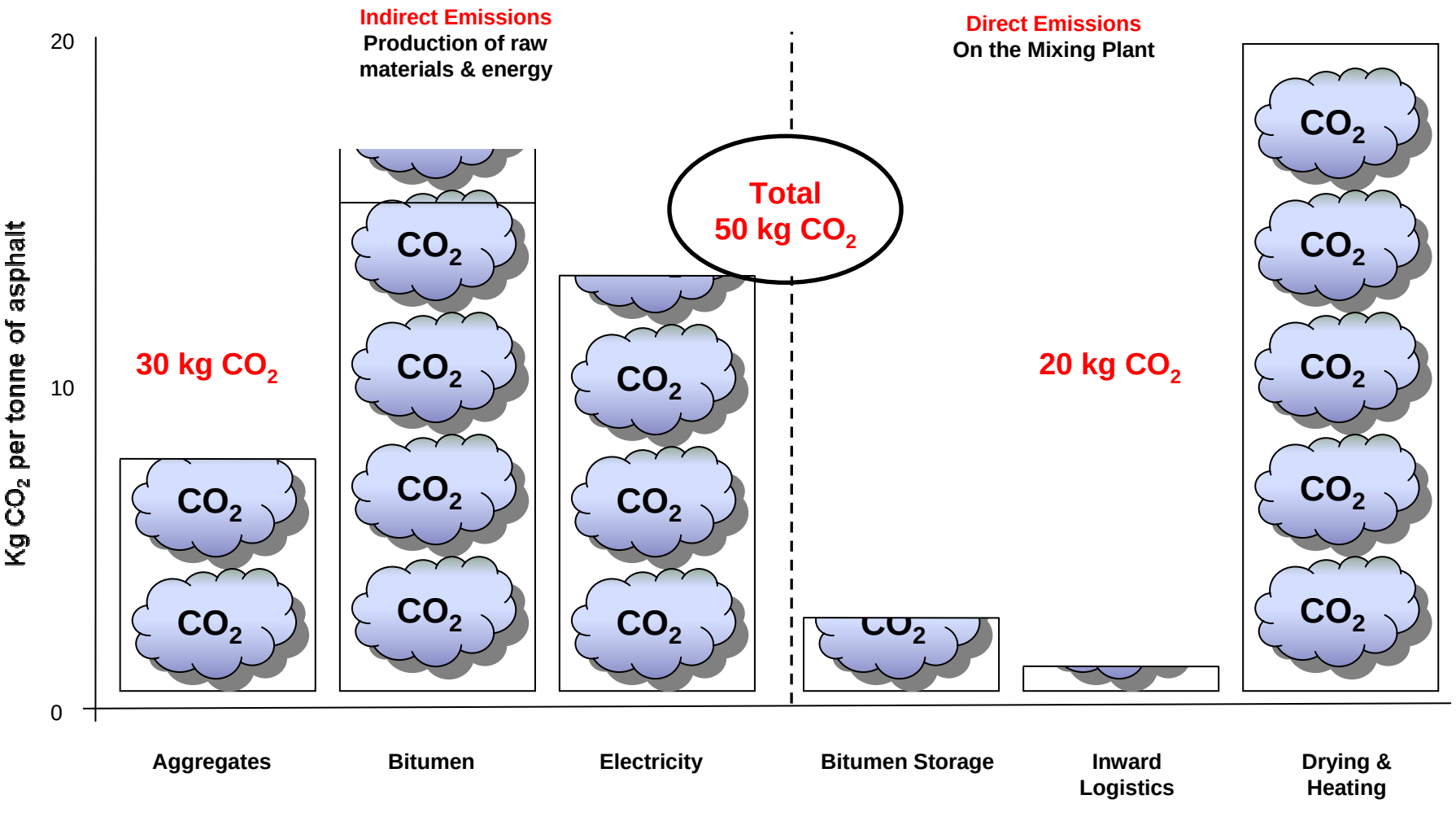
=

HEAT!

Asphalt Plant

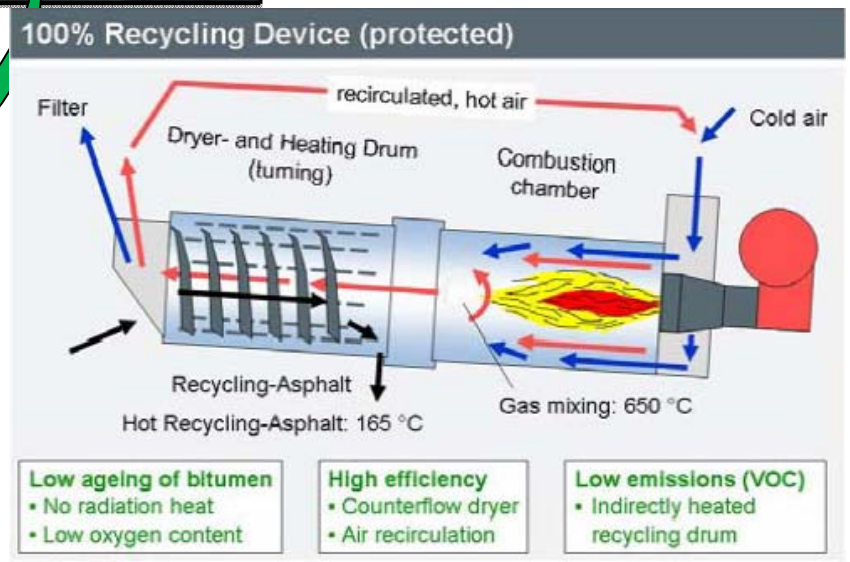
Asphalt Laying

Typical CO_2 Emissions Per Tonne (cradle to gate)



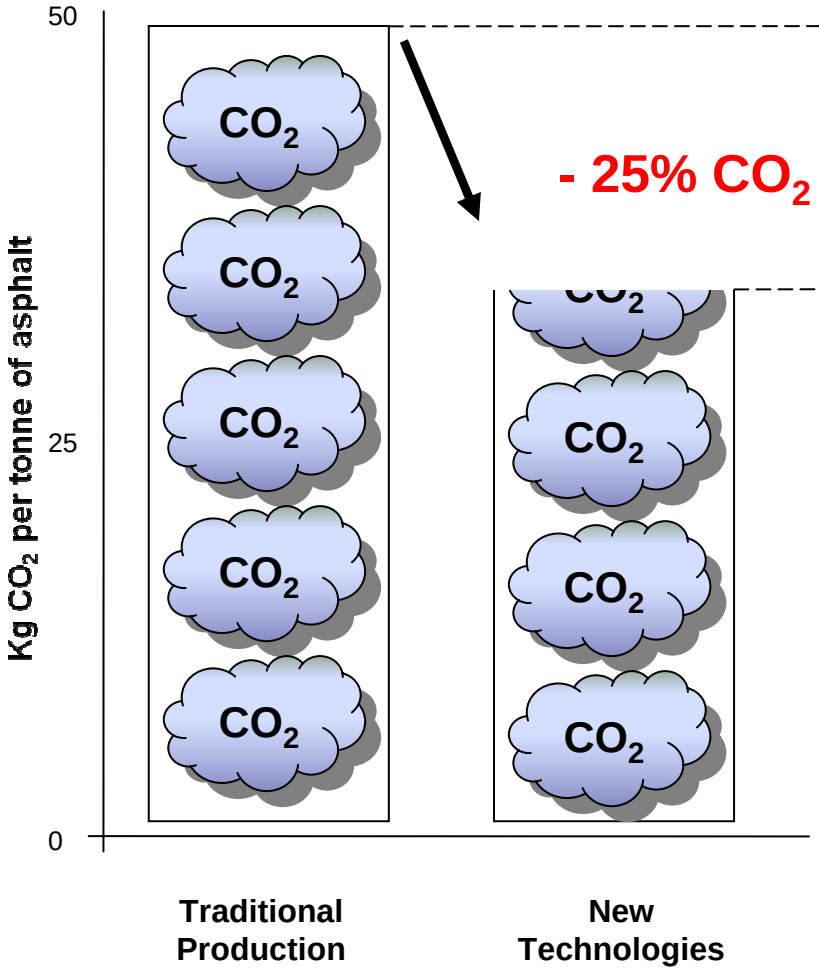
Reclaimed Asphalt Pavement (RAP)

Recycling
Asphalt
Pavements

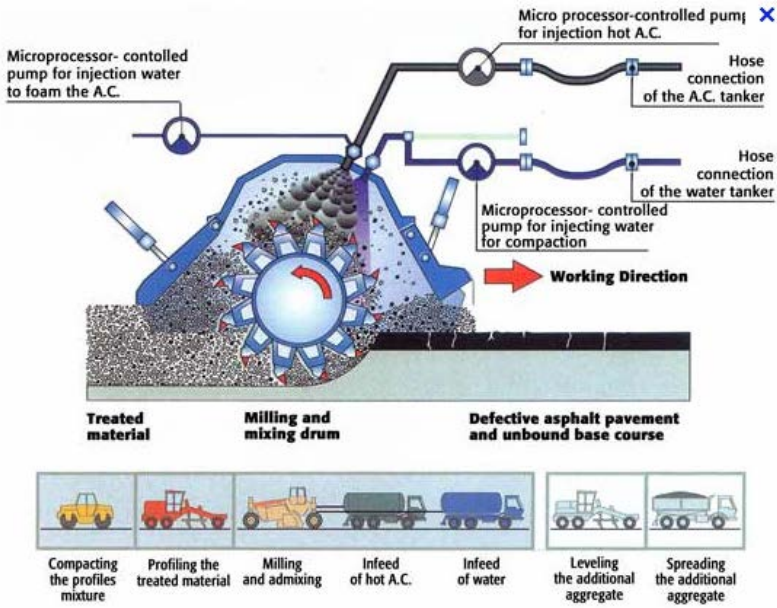


Source: Benninghoven

Massive Reductions in CO_2 Available with New Technologies



- RAP Addition
- Warm Mix Asphalts
- Cold (Foam) Mix Asphalts
- In-Situ Recycling



Achievements: Low-Carbon Construction Materials

KWCM - actively participates in environmental programs organized by the Government and private sector

Productwi$e Logo

10 years Gold
Wastewi$e Logo


節能減碳
全速啟動!
• 提高設備效率
• 減少熱能損失
• 改善功率因數
• 定期檢查維修
• 應用替代燃料及可再生能源
• 提升技術和工藝
• 減少燃料消耗
• 減少電力消耗
• 減少原材料消耗
• 良好廢物管理
• 節約用水
減少碳
實踐低碳文化
加強營運管理
• 執行<<能源和碳管理政策>>
• 實施<<能源和碳管理系統>>
• 提升產品質量
• 提供能源和碳管理培訓
• 推行綠色採購
• 進行能源和碳排放審計
• 參與節能減排計劃
• 實踐低碳辦公室
• 開展低碳生產
• 推廣低碳生活
K. WAH CONSTRUCTION MATERIALS
嘉華建材

Thank you!

Extra Notes

- **Concrete containing ground granulated blast furnace slag** increases the workability and placeability since the total volume of the fine particles become higher when compared with concrete not containing ground granulated blast furnace slag. Moreover, it is also stated that the static electric charges of slag particles are much lower than those of the cement particles and this results in an easier dispersion in the mixture. Finally, Fulton19 investigated in detail the effect of ground granulated blast furnace slag on workability and he stated that cementations' matrix containing ground granulated blast furnace slags exhibited greater workability due to the increased paste content and increased viscosity of the paste.
- When ground granulated blast furnace slag is used as a replacement for part of the Portland cement in concrete mixtures, an increase in time of setting can be expected. Fulton19 stated that the time of setting is dependent on the initial curing temperature of the concrete, the proportion of the blend used, the water to cement plus slag ratio, and the characteristics of the Portland cement
- Separately grinding the slag and cement clinker is more economical in terms of electrical energy consumption. By separately grinding the slag and cement clinker, the fineness of each product can be optimized so that the amount of power wasted on “over-grinding” the cement clinker can be minimized.
- When slag and clinker are ground separately to different product finenesses and then blended, the results show that combined slag cement exhibits the highest strengths. This allows for the reduction of the combined cement mixture product fineness and therefore the overall power consumption is reduced for a given target strength The main advantage of vertical mills (Fig. 18) is their process simplicity with drying, grinding, separation and material-conveyance all taking place in one unit, combined with their very good energy utilization and low wear rates. In the meantime they achieve an equally high fineness of grinding > 6000 g/cm^2 (Blaine) as ball mills.

EPD has recently released a consultation document, on the implementation of a mandatory producer responsibility scheme for glass beverage bottles. The consultation period is 3 months and will end on 6th May 2013. In the consultation paper, the Government is considering:

- To appoint a (single) contractor to collect and recycle glass beverage bottles.
- The cost incurred will be covered by suppliers of glass-bottled beverages – some kind of “polluter pays principle.
- Beverage retailers should provide recycling information.
- Glass recyclers should be licensed.

Weight of concrete Paver (200mm x 100mm x 60mm) = 2.75kg/pc Weight of Red Wine Bottle (Empty) = 0.45kg/bottle
The recycled glass cullet shall be included as recycled fine aggregates and shall constitute 20% to 25% by weight of the total aggregates = ~0.414kg (Glass Cullet) Thus, 1 red wine put in 1 concrete paver. Sales of recycled glass paver / yr = 120,000m2 (50pc/m2) = 6,000,000pcs 5. We recycled 6millions of red wine bottles 6. Total glass recycled (t) = ~2,500t 2013 target 4,000 tonnes of waste glass (Est. 70,000t in HK)

Clinker Factor – Mostly depends on the nature of raw meal (generally of limestone),on the LOI. Simple conversion factor = 100 / (100-LOI). But Preheater gases carry with them quantity of dust depending upon the efficiency of the cyclones which is generally between 0.92 - 0.94. Thus if efficiency is 90 %, and raw meal factor 1.59, raw meal to clinker ratio for kiln feed would be 1.59/0.90 = 1.75. (calculations losses from cooler included)

Construction Materials: Steel

Presented by Ir Shirlee Algire
Group Sustainability & CSR Manager
Gammon Construction Limited

22 March 2013, The HKIE Environmental Division Annual Seminar

Use Wisely, Waste Less, Emit Less

Gammon's Sustainability Framework

Case Study

Contract No. HY/2009/08 Widening of Tolo Highway/Fanling Highway between Island House Interchange and Fanling Stage 1 – Between Ma Wo and Tai Hang

Sustainability in the fast lane

The Tolo Highway project is a HK$2.38 billion contract awarded by the Hong Kong Highways Department for widening a 3.5km section of the Tolo and Fanling highways to alleviate traffic congestion. The 40-month contract started construction in late February 2010.

Incorporating all four elements of our sustainability framework, the project demonstrates how an integrated approach can resolve engineering challenges in a sustainable manner.

Project savings

Less steel
Total steel and rebar savings
= 12,112 tonnes

Less concrete
35,924 cubic metres
(5,132 truckloads of concrete)

Less spoil removed
Total project savings
81,865 tonnes

Trees saved
2,585

Value for our client

From the outset, our client recognised the potential benefits of a creative review from its chosen contractor and invited alternative designs for major elements of the slope works involved in this complex project. We won the contract on the basis of our alternative solution, which adds significant economic value for the client by dramatically reducing construction time and waste.

Planning for safety

The project design originally proposed would have required working on a very steep slope, with massive temporary platforms and heavy equipment for installing very large-diameter bored piles. Employing our alternative design, we can use small-diameter piles to provide temporary support during slope excavation and anchor the large concrete retaining walls. We are also able to make use of smaller equipment, carry out fewer in-ground works and cut 40% less slope, all of which leads to significantly safer working conditions for our workforce.

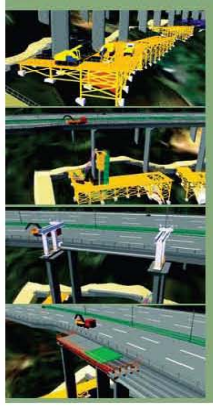
Green solutions

In addition to mitigating noise and air pollution, we have reused 79% of the excavation spoil generated on the project. Reductions in the amount of materials used, such as steel and concrete, mean fewer trucks are needed, which helps improve the project's carbon footprint and associated air pollution. The less steep slope in our design also allows us to retain more trees and minimise soil erosion on the site.

Concern for the community

We anticipated the needs of motorists and the local community by planning a comprehensive Temporary Traffic Arrangement system that keeps traffic on the Tolo Highway moving, minimises inconvenience to the public and allows access to the villages in the area. To reduce noise nuisances, we have erected additional temporary noise barriers and enclosures, installed noise-absorbing materials on temporary access roads and scheduled works to avoid operating at night.

Lambeth Associates, our in-house consultancy, has developed the capability of generating 3D computer visualisations, which allow the architect and client to appreciate the final product and gain greater confidence in its outcome.



A model of sustainability

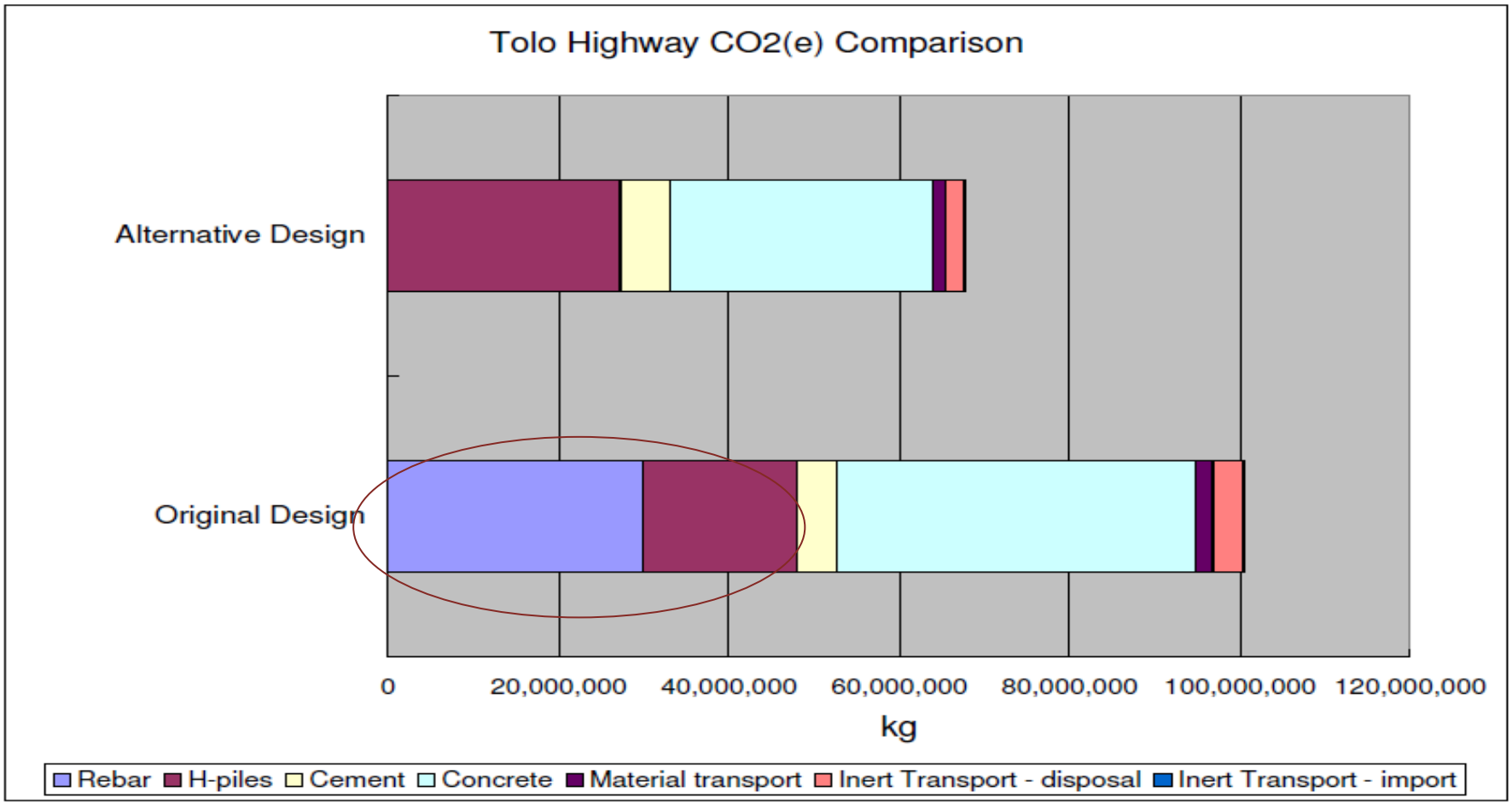
When visiting the Tolo Highway project site office, you might think you had taken a wrong turn and entered a country park by mistake. Unlike most site offices, the Gammon Green Site office near Tai Po is distinctive for its abundance of replanted trees, solar panels and recycled materials that provide comfort and visual relief to the road works outside.

The Gammon Green Site office is not only an oasis in the midst of a busy highways project, but also a demonstration of pride in our ability to achieve high standards of sustainability in construction. Our workers can see visible proof of this every day in our morning briefings at the site office, where they are inspired to recreate the same high standards throughout the project and deliver our vision for sustainable construction.

For further details on the Tolo Highway project, please visit www.tolo2.com.hk/tolo2/Project.htm.

Environmental Stewardship

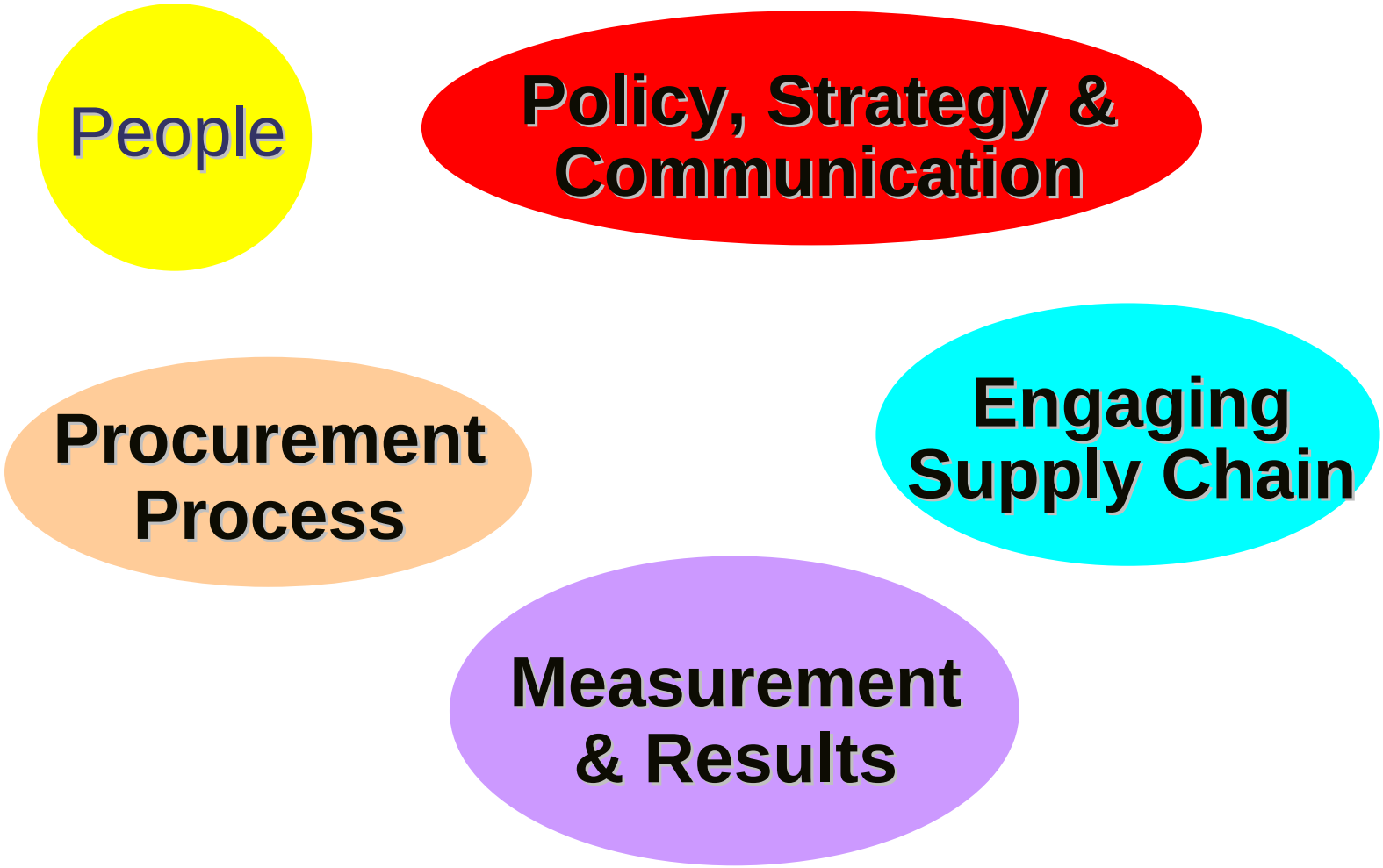
Use Wisely, Waste Less, Emit Less



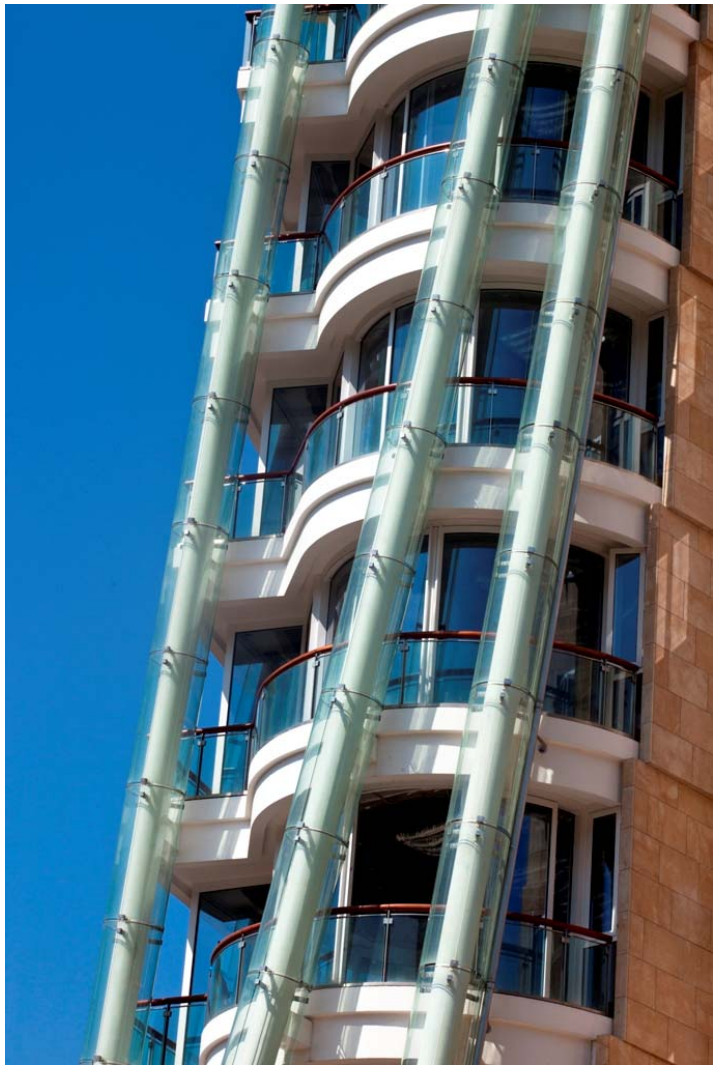
Environmental Stewardship

Sustainability – Procuring the Future

Sustainable Procurement Framework



Understanding Steel

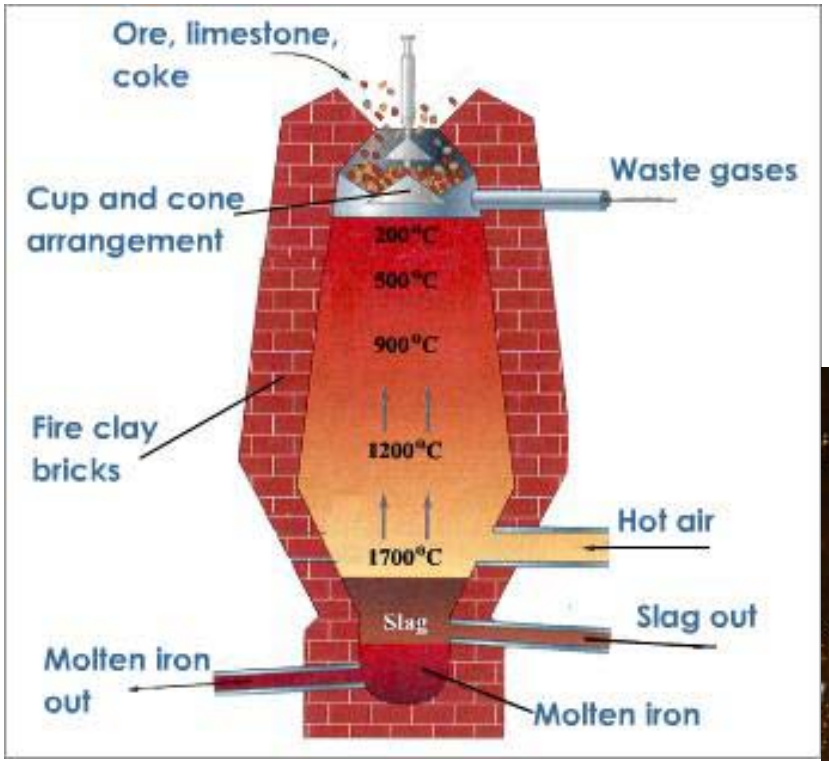



Gammon

An Indian woman carries lumps of iron ore in mine.

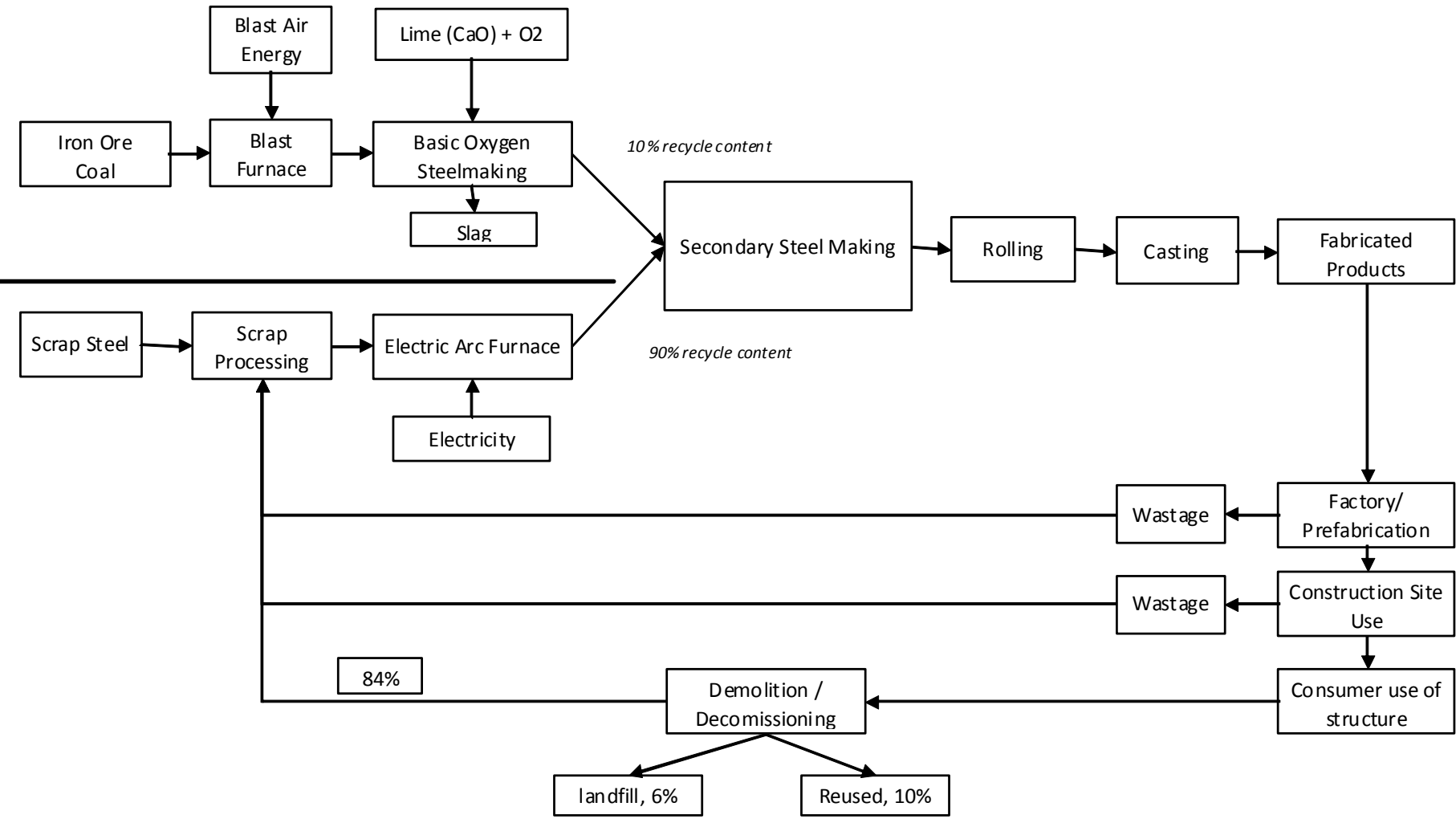
Photograph: Adam Ferguson / Bloomberg News

Blast Furnace



Electric Arc Furnace

Basic Steel Process for Construction



Is Steel Green?

Table 1: Compare Electric Arc Furnace and Integrated Steelworks

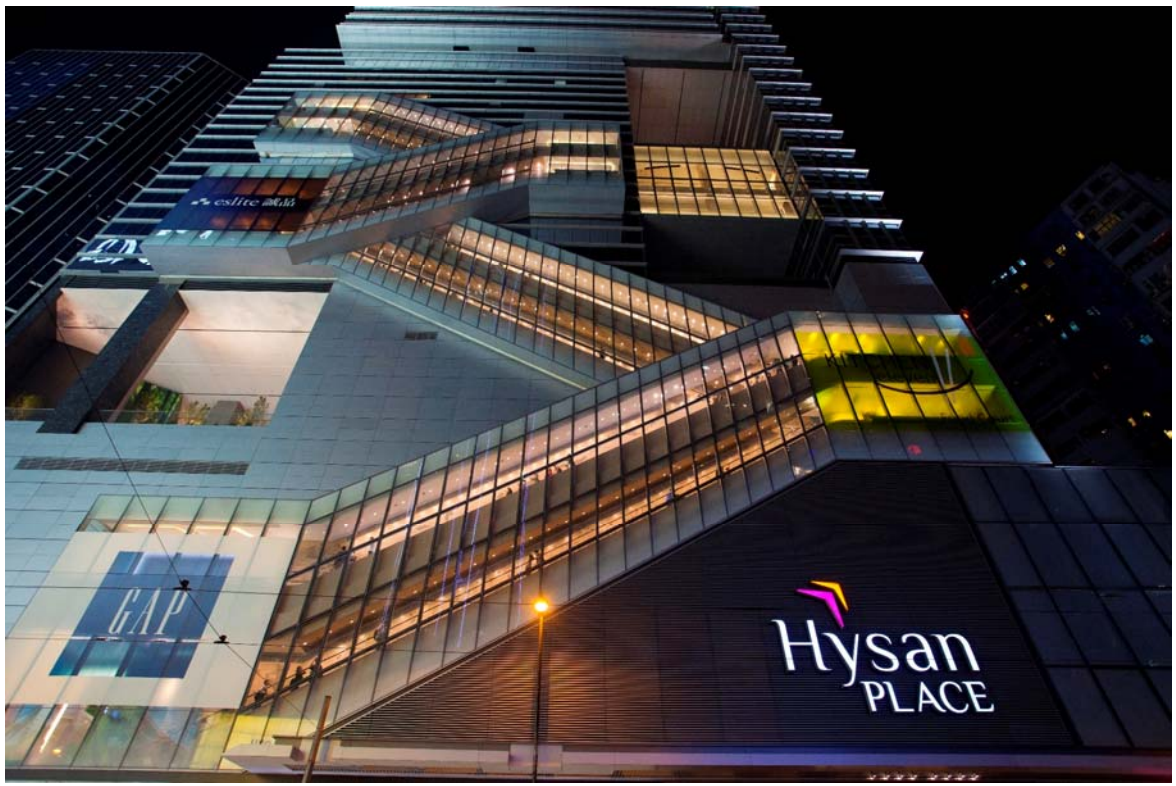
	Units	BOF	EAF
Inputs			
Total Primary Energy	MJ	21.71	7.43
Embodied carbon	$gCO_2(e)$	1,720	970
Outputs			
Steel Product	g	1,000	1,000
Waste	g	1,520	122

Source: www.worldsteel.org

Procurement Realities

Rebar:

- 800 km
- 70% had 90% recycle content (1,000 MT → 630 MT scrap)



Science Park Foundation

- 20% regional billet
- 90% manufactured in HK
- 46% recycle scrap

↓ 2,760 tCO_2 embodied

↓ 13,817 tCO_2 transport

Drivers for Green Procurement

BEAM Plus v1.2

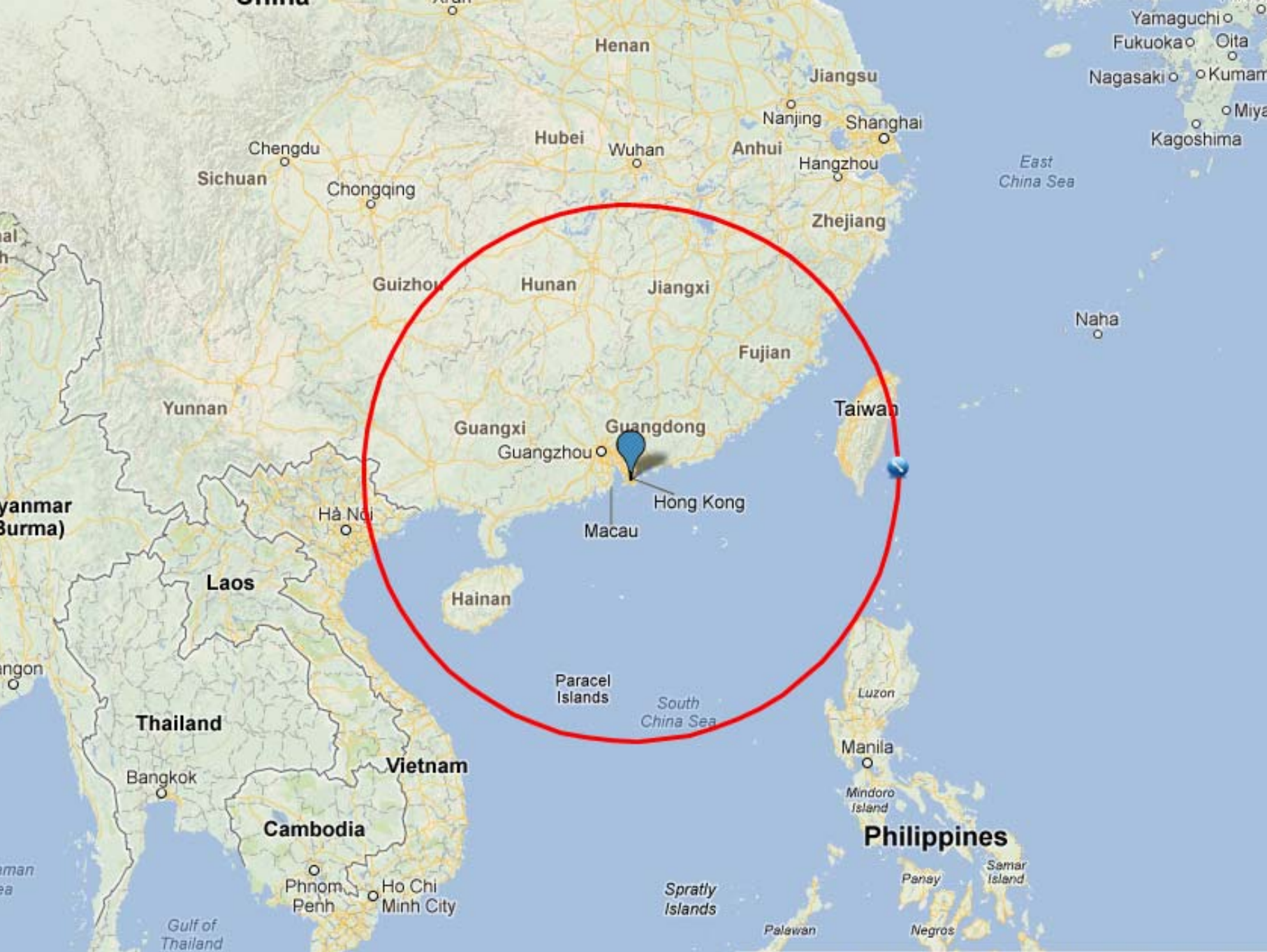
MA7 – Recycle Content (not include steel)

MA9 – Regional Source (800 km)

LEED

MRc4 – Recycle Content

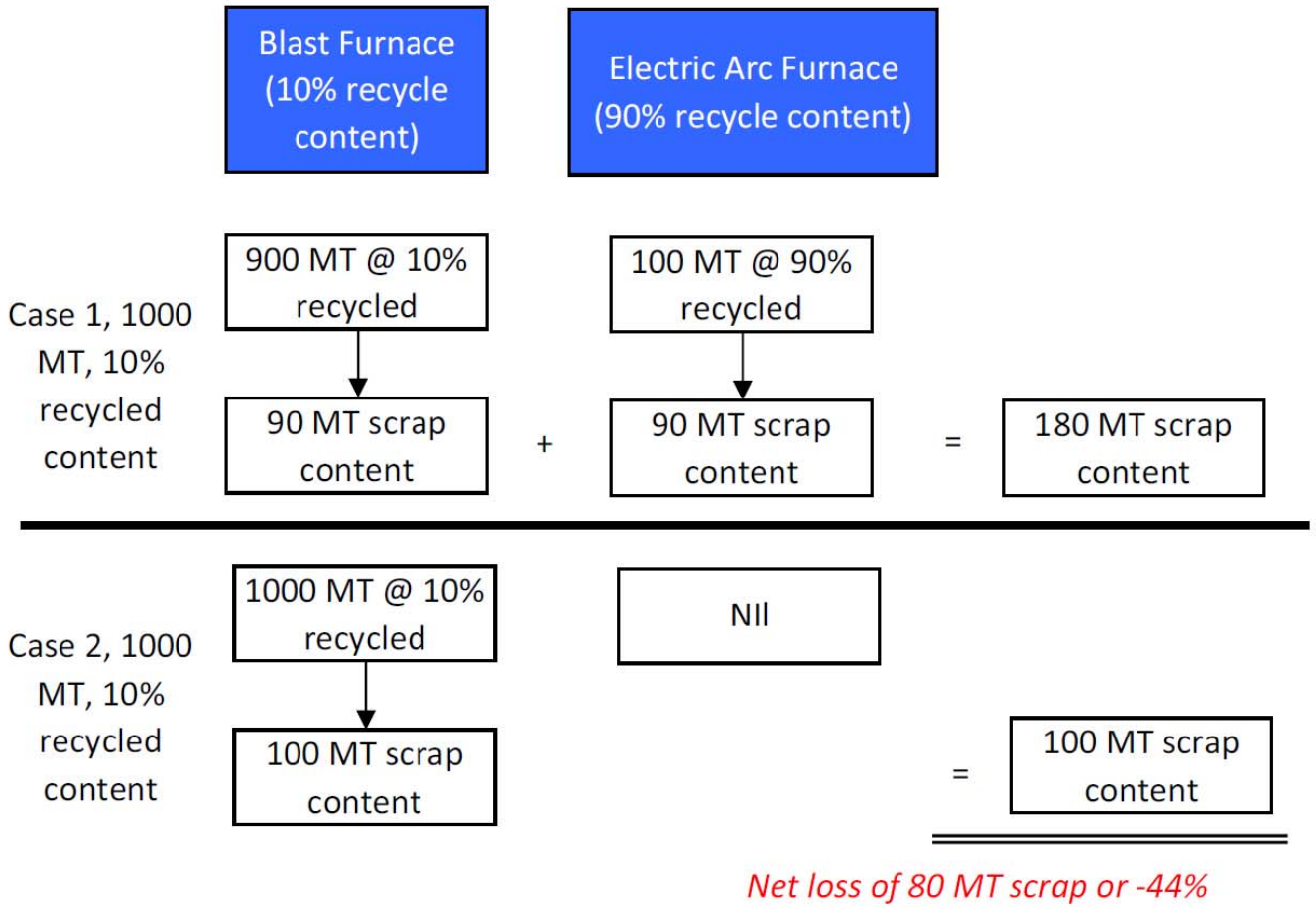
MRc5 – Regional Source (800-1,200 km)


Henan
Jiangsu
Nanjing
Shanghai
Hubei
Wuhan
Anhui
Hangzhou
Chengdu
Sichuan
Chongqing
East
China Sea
Zhejiang
Guizhou
Hunan
Jiangxi
Naha
Fujian
Yunnan
Taiwan
Guangxi
Guangdong
Guangzhou
Hong Kong
Macau
Hà Nội
Laos
Hainan
Paracel
Islands
South
China Sea
Luzon
Thailand
Manila
Vietnam
Bangkok
Mindoro
Island
Cambodia
Philippines
Phnom
Penh
Ho Chi
Minh City
Spratly
Islands
Samar
Island
Panay
Palawan
Negros
Gulf of
Thailand
Yamaguchi
Fukuoka
Oita
Nagasaki
Kagoshima

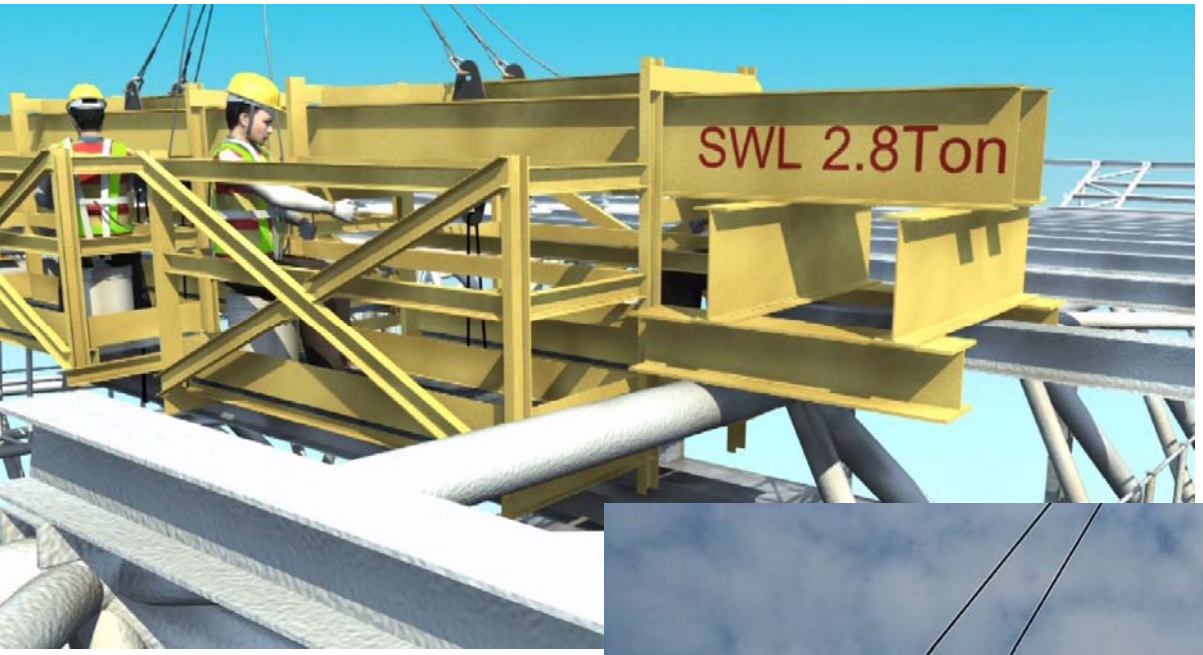
H-Piles - EAF

- Taiwan Manufacturer
- Within 800 km
- Source of billet or scrap?
- Won’t meet MA9.
- Price volatility
- Surety of delivery

H-Pile Case Example



Mole I and II, Singapore


SWL 2.8Ton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New Circular Economy