New Waves of Policies and Information Technologies in the Hong Kong Construction Industry

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Presented by J.S. Kuang

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Outline

- Opportunities and Challenges in the HK Construction Industry
- Trend of Green Buildings and Construction
- Increasing Adoption of BIM in Hong Kong
- A Proposed BIM-based Lifecycle Assessment Framework for Waste and Carbon Management

1. Opportunities and Challenges in HK Construction Industry

1.1 Ten major infrastructure projects for Hong Kong economic growth

"Infrastructure development can bring about huge economic benefits... the value added would be more than $100 billion annually. In addition, some 250,000 additional jobs would be created."

2007-2008 Policy Address

1.1 Ten major infrastructure projects (cont'd)

1. South Island MTR Line (>15b)
2. Sha Tin to Central Rail Link (30b)
3. Tuen Mun Western Bypass (20.1b)

Local Railway & Highway

4. Guangzhou-Shenzhen-HK Express Rail Link (25b)
5. HK-Zhuhai-Macau Bridge (60b)
6. Chek Lap Kok to Shenzhen Airport Rail Link
7. HK-Shenzhen Joint Development of Lok Ma Chau

Cross-Border Development

8. West Kowloon Cultural District (19b)
9. Kai Tak Development (3.2b)
10. New Territories Northwest Development

Regional Development

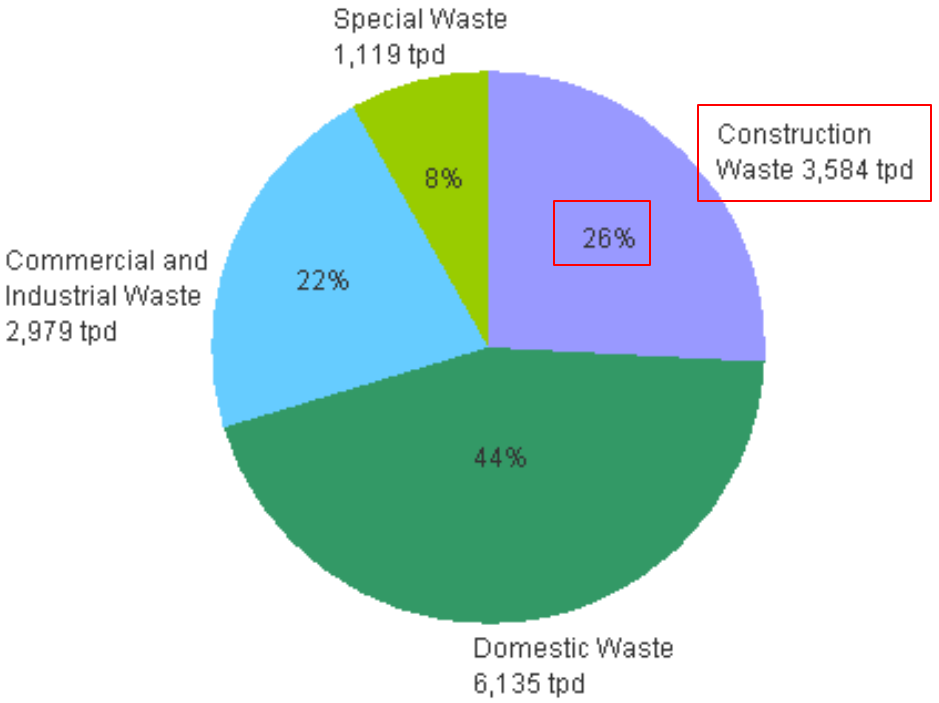
1.2 High speed rail, connecting to mainland China

1.3 Landfill sites running out in Hong Kong

- Space is limited in HK
- 3 landfill sites are currently operating in Hong Kong:
  - SENT: up to 2014
  - NENT: up to 2016
  - WENT: up to 2018
- Waste reduction is needed
- But the increase of infrastructure projects will lead to increase of C&D waste

Types of solid waste disposed of at landfills in Hong Kong (2010)

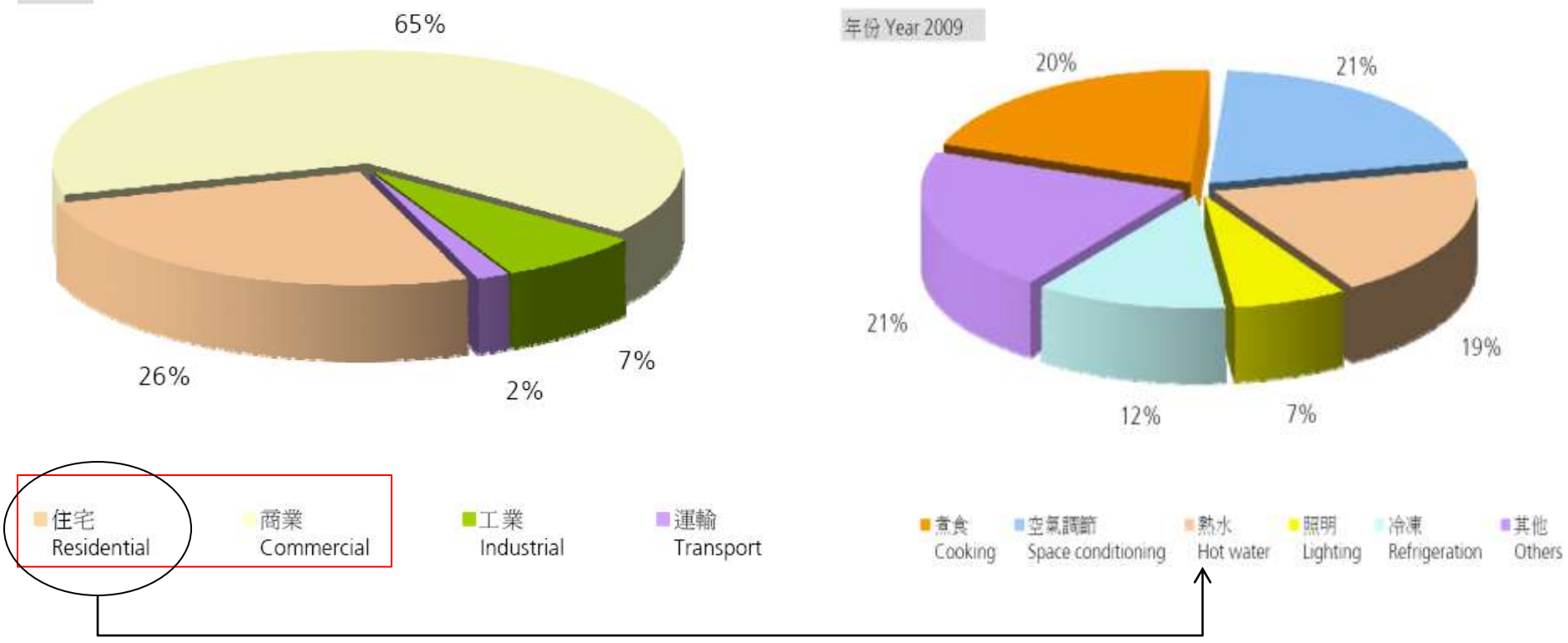
Total: 13,817 tonnes per day



HK Environmental Protection Department (2010)

1.3 Landfill sites running out in Hong Kong (cont'd)

- Residential buildings and commercial buildings take up most of the electricity use in Hong Kong (HK Energy End-Use Data 2011)



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2. Trend of Green Buildings

- **"Green Building"**?
  - (US ASTM): "Green building is a building that optimizes efficiencies in resource management and operational performance, and minimizes risks to human health and the environment."
- As of 2011, there were over 10,000 construction and renovation projects certified by LEED (Leadership in Energy and Environmental Design) in US.
- Green building certification standards worldwide:
  - United States: LEED
  - United Kingdom: BREEAM (BRE Environmental Assessment Method)
  - Australia: Green Star
  - **Hong Kong: HK-BEAM (Hong Kong Building Environmental Assessment Method)**
  - Etc.

U.S. GREEN BUILDING COUNCIL LEED USGBC

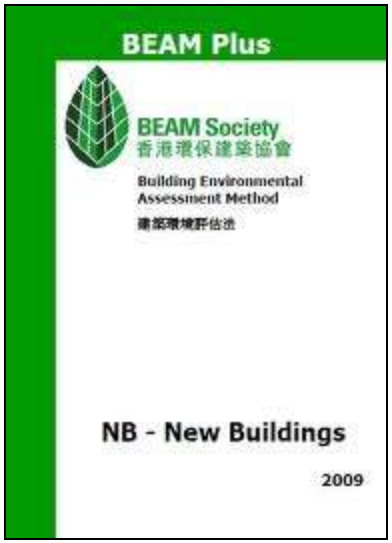
green star
environmental rating system for buildings

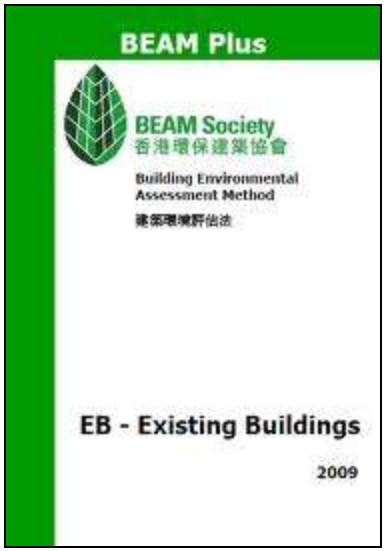
breeam

BEAM Society
建築環保評估協會

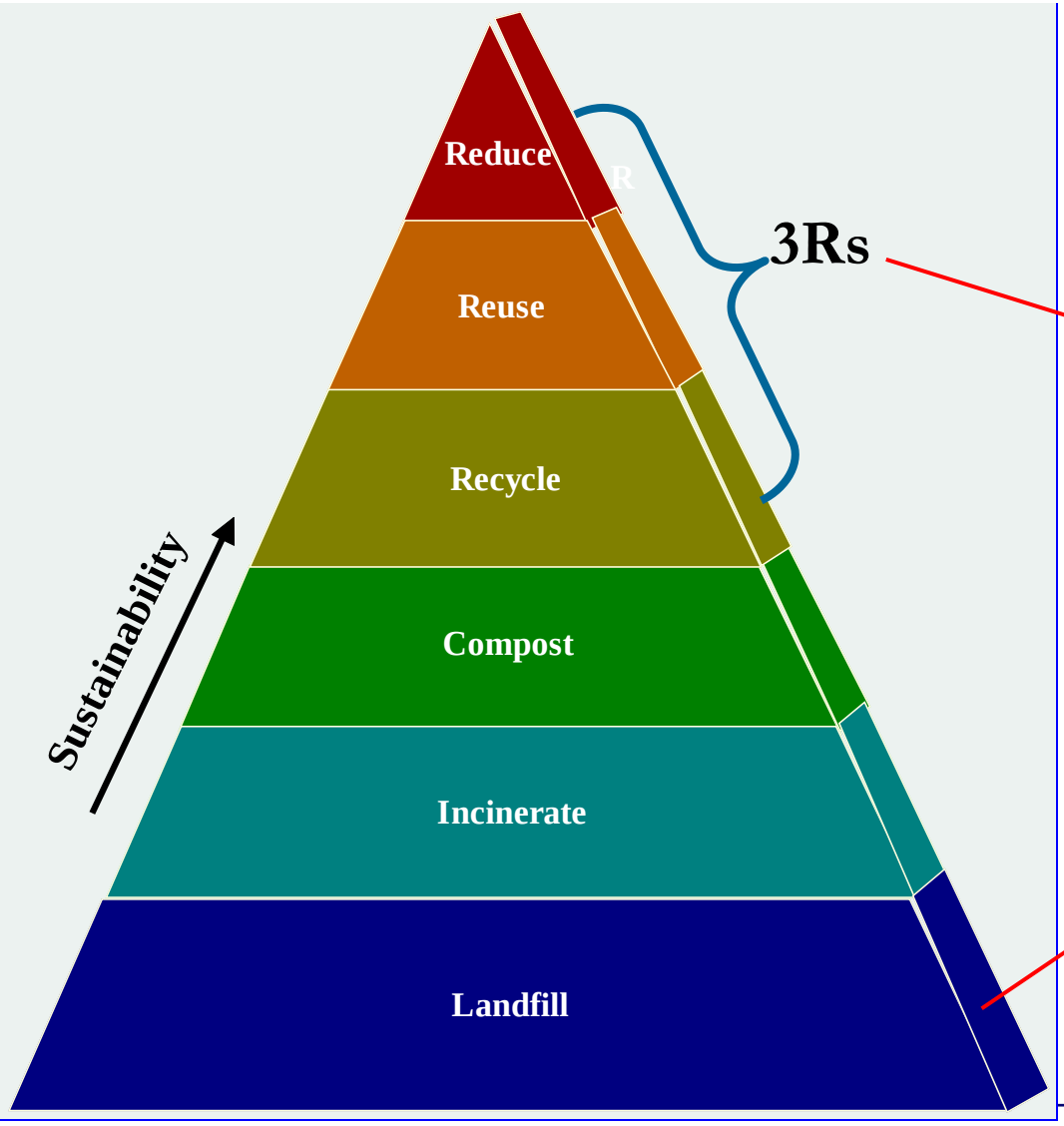
2.1 Hong Kong's Green Building Certification Standard: HK-BEAM / BEAM Plus

- Hong Kong Building Environmental Assessment Method (HK-BEAM)
- Established in 1996, by Hong Kong Green Building Council
- In 2009, renamed to BEAM Plus
- 2 groups: New Buildings, Existing Buildings
- As of March 2010, HK-BEAM has been applied in around 240 landmark properties in HK, Beijing, Shanghai, and Shenzhen, with over 10.5 million sq. meters, 56,000 residential units.
- 6 categories of credits:
  - Site aspects (Sa)
  - Materials aspects (Ma)
  - Energy use (Eu)
  - Water use (Wu)
  - Indoor environmental quality (Ieq)
  - Innovations and additions (Ia)





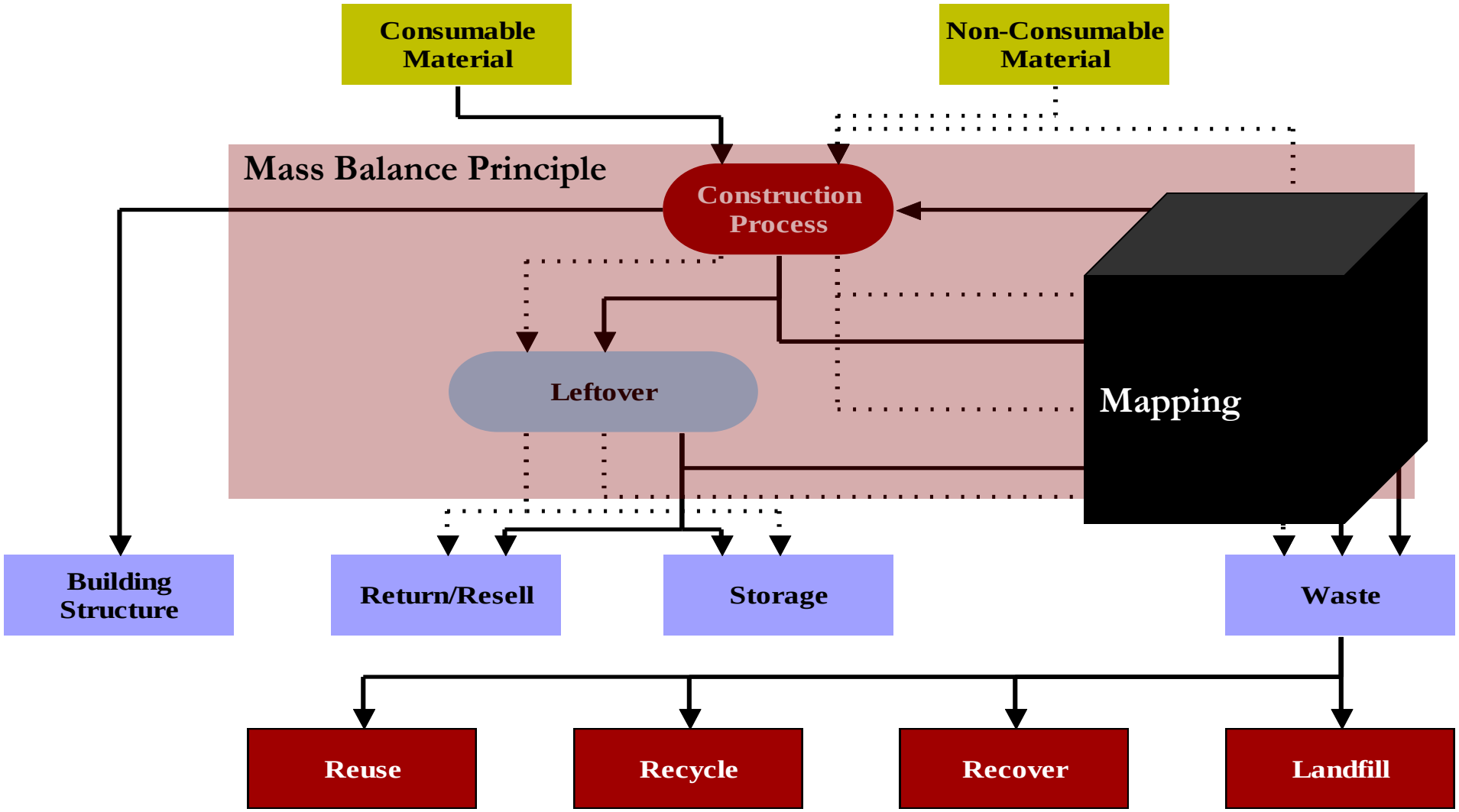
2.2 Construction Waste Management



Sustainable Construction Practices

Most Widely Used, Not Environmentally Friendly

2.3 Material Flows in Construction Processes

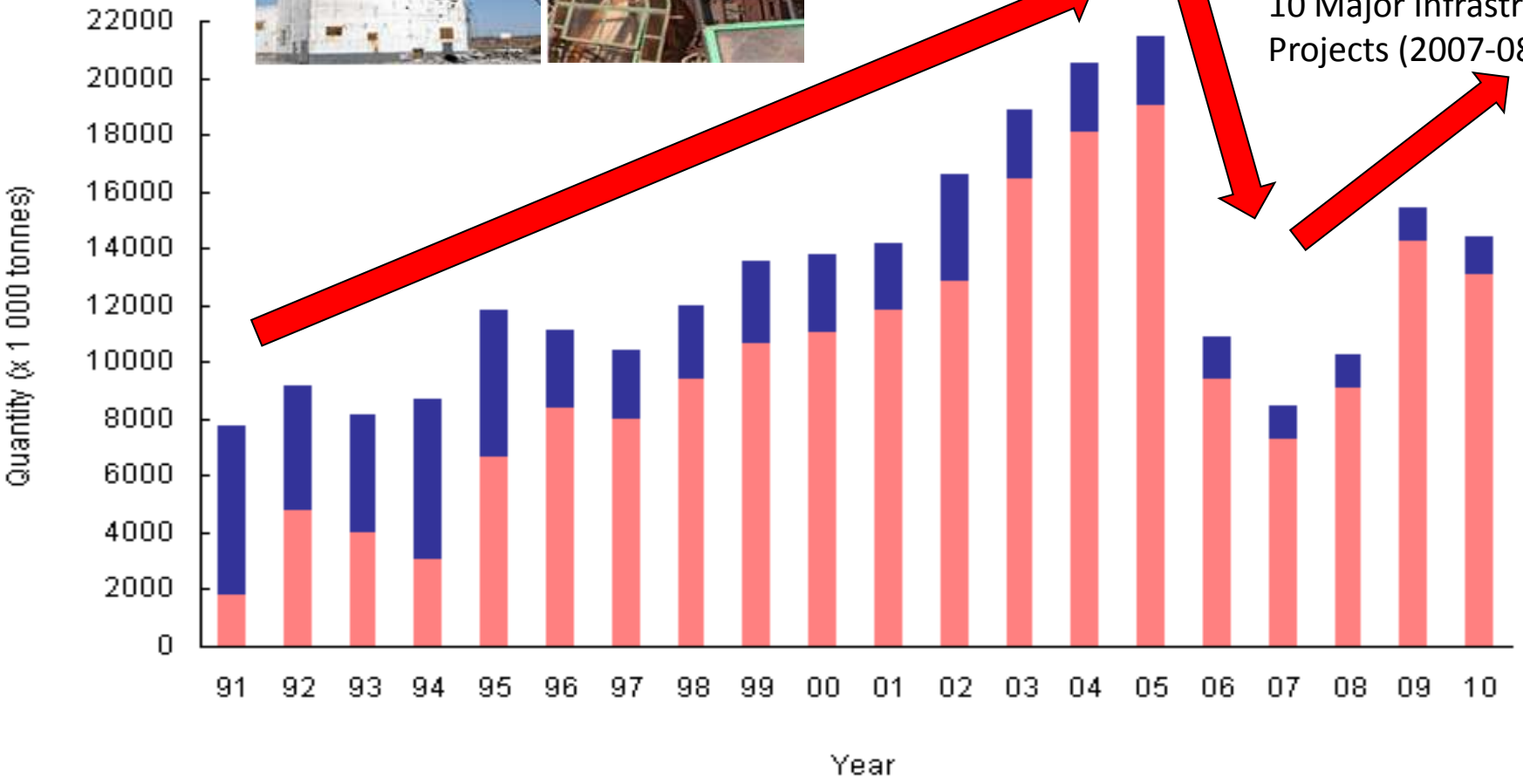


Bossink and Brouwers (1996), Construction waste: quantification and source evaluation.

2.4 Historical Construction & Demolition (C&D) Waste in Hong Kong (1991-2010)

Construction Waste Disposal Charging Scheme (2005)

10 Major Infrastructure Projects (2007-08)



HK Environmental Protection Department (2010)

2.5 Construction Waste Disposal Charging Scheme in Hong Kong

- Construction Waste Disposal Charging Scheme (2005)

Government waste disposal facilities	Type of construction waste accepted	Charge per tons (HK$)
Public fill reception facilities	Consisting entirely of inert construction waste	27
Sorting facilities	Containing more than 50% by weight of inert construction waste	100
Landfills	Containing any percentage of inert construction waste	125

- Sorting C&D waste into non-inert and inert
  - Common non-inert waste: wood, metal, plastic, and other organic materials.
  - Common inert waste: concrete, bricks, asphalt, sand, rocks, rubbles, soil, etc.




2.6 Green Construction Sites

- Green roof and planting on site



- Water and waste recycling on site
- Renewable energy on site



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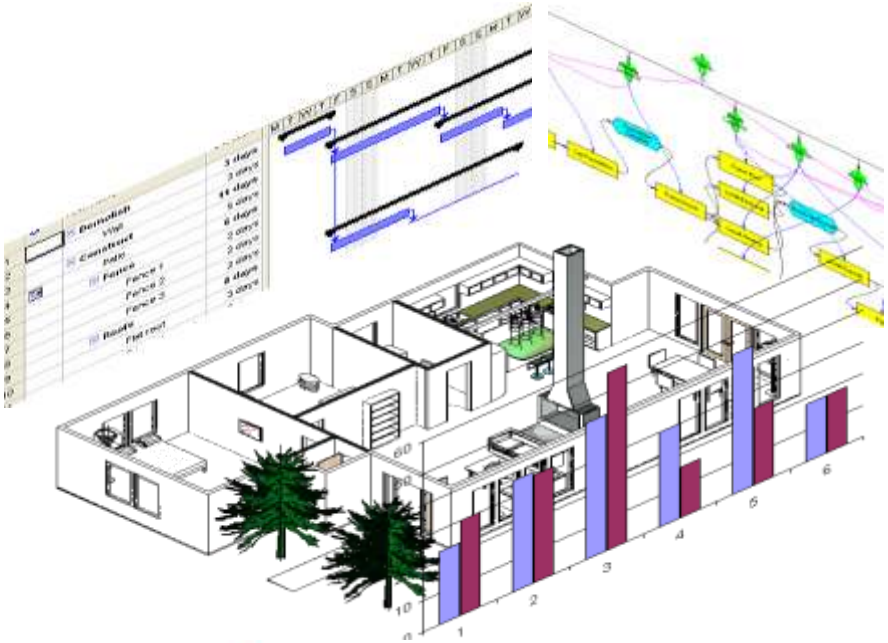
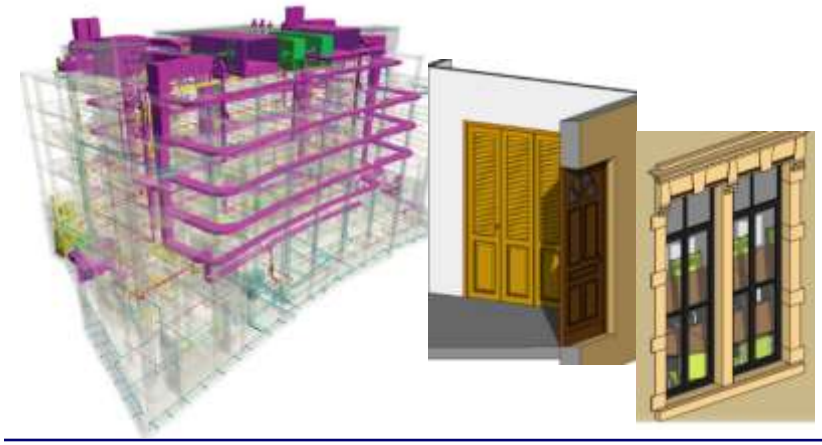
3.1 From 2D CAD to 3D to BIM

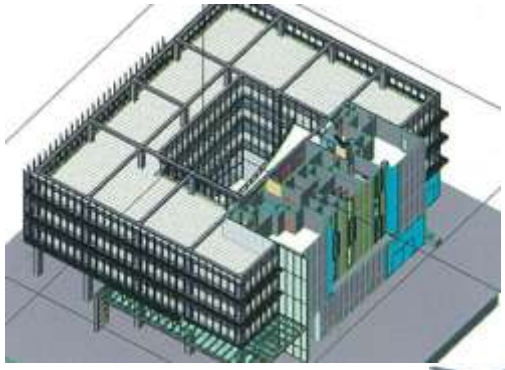


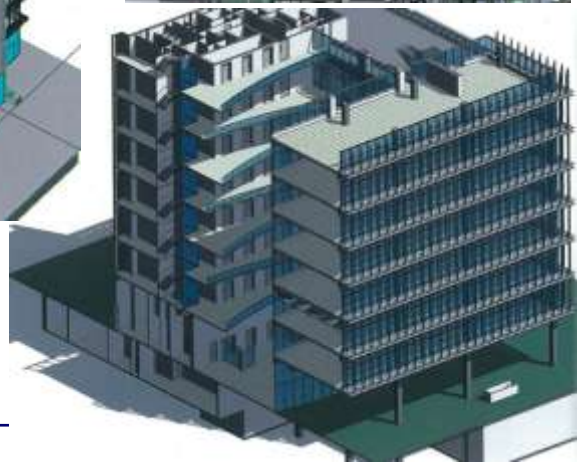


- **2D Drafting**
- **3D Modeling**
- **Building Information Modeling (BIM)**
  - Digital 3D representation
  - Consistency check
  - Object-based parametric modeling
  - Project/product information, e.g. cost, schedule, lighting analysis, structural analysis, organization, procurement

3.2 BIM Examples in Hong Kong

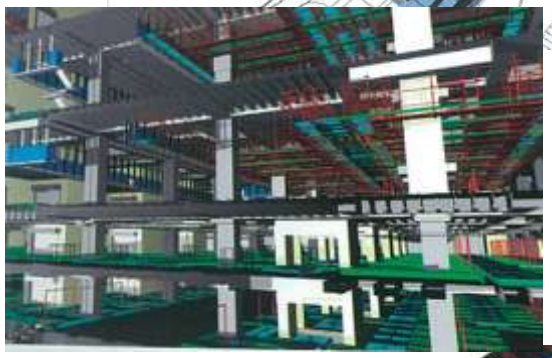
- **Building 20, at Hong Kong Science Park**
  - Visualising before built
  - Clash detection
  - Minimise unavailing work on site
  - Cut construction and coordination costs
  - Assessing sustainable features (e.g. use of nature sunlight)
  - Accelerated design process





3.2 BIM Examples in Hong Kong (cont'd)

- **Cathay Pacific Cargo Terminal, at Hong Kong International Airport**
  - 260,000 square meters (the world's largest air cargo terminal)
  - With Materials Handling System (MHS), structure, architecture, and building services in BIM model
  - 3D and 4D modeling
  - Identified potential coordination problems
  - Produced 760 architectural drawings, 845 structural drawings, 1600 MEP drawings
  - Significant cost savings



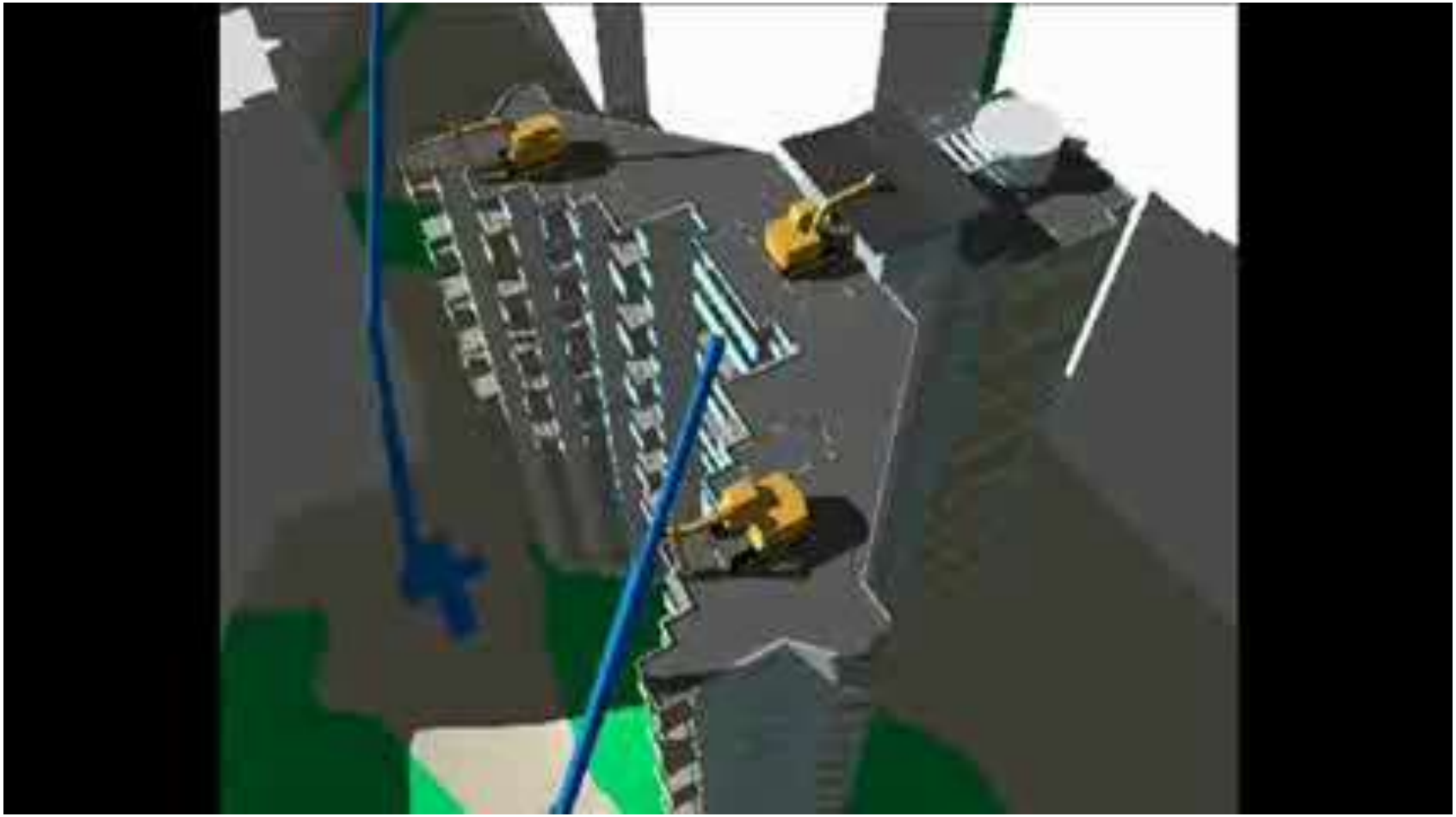
3.3 BIM in Underground System in Hong Kong

- MTR (Mass Transit Railway) re-created BIM models of its stations for maintenance and used BIM for planning and constructing new stations

MTR

3.4 BIM in the Government Housing Authority

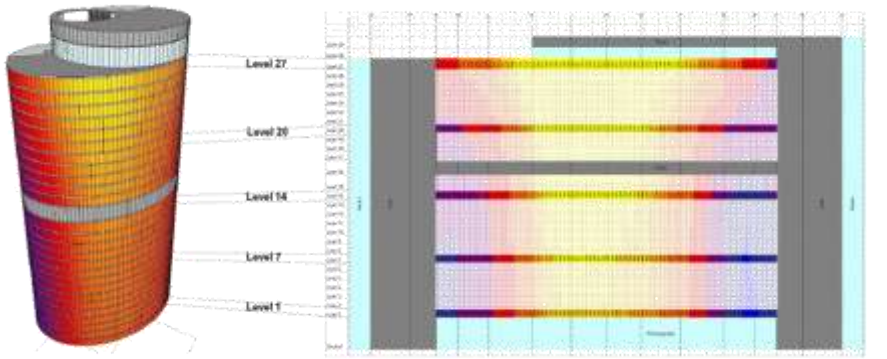
- Modeling of the demolition process in So Uk Estate (1970's precast public housing buildings)



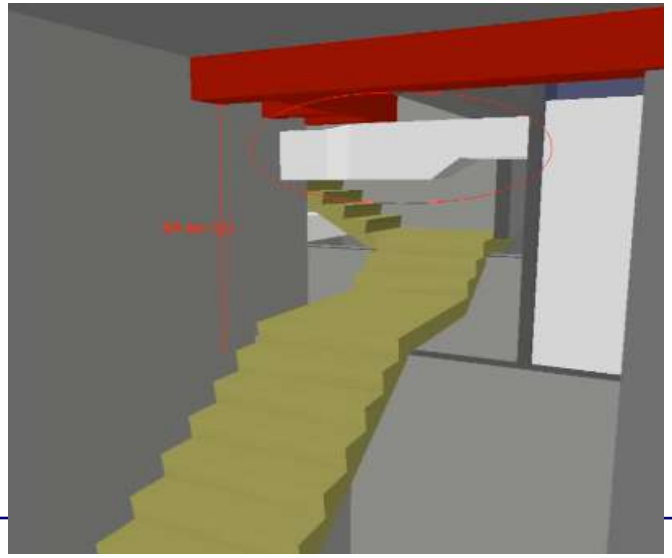
3.5 Other Possible Applications of BIM – Better Planning of Construction and More Energy Efficient Buildings

- Virtual mock-ups

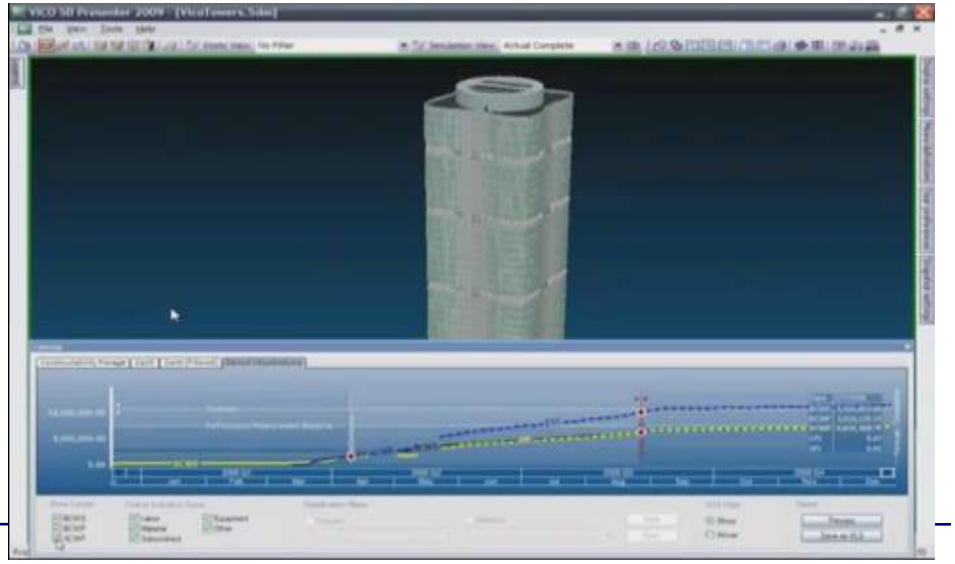
- Solar and energy analysis



- Clash detection (MEP)



- 4D, 5D modeling, Etc.



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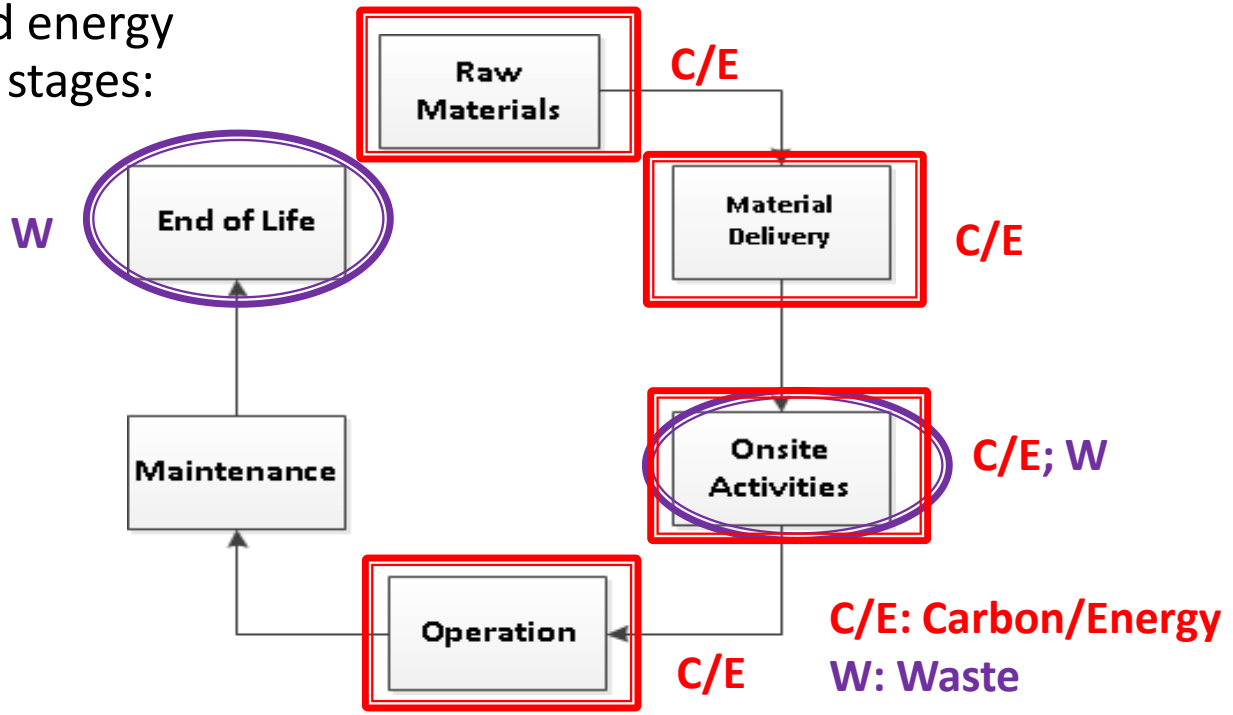
4.1 Lifecycle Consideration of Buildings

- An energy efficient building may not be environmental friendly in pre-construction stage and/or end-of-life stage.
- We should perform a lifecycle environmental assessment of buildings.
- Currently, BIM is often used for building performance and energy consumption simulation, not for other stages.
- Current waste, carbon and energy quantification in different stages:
  - Not automated
  - Not detailed
  - Not convenient

➔ **BIM-based**

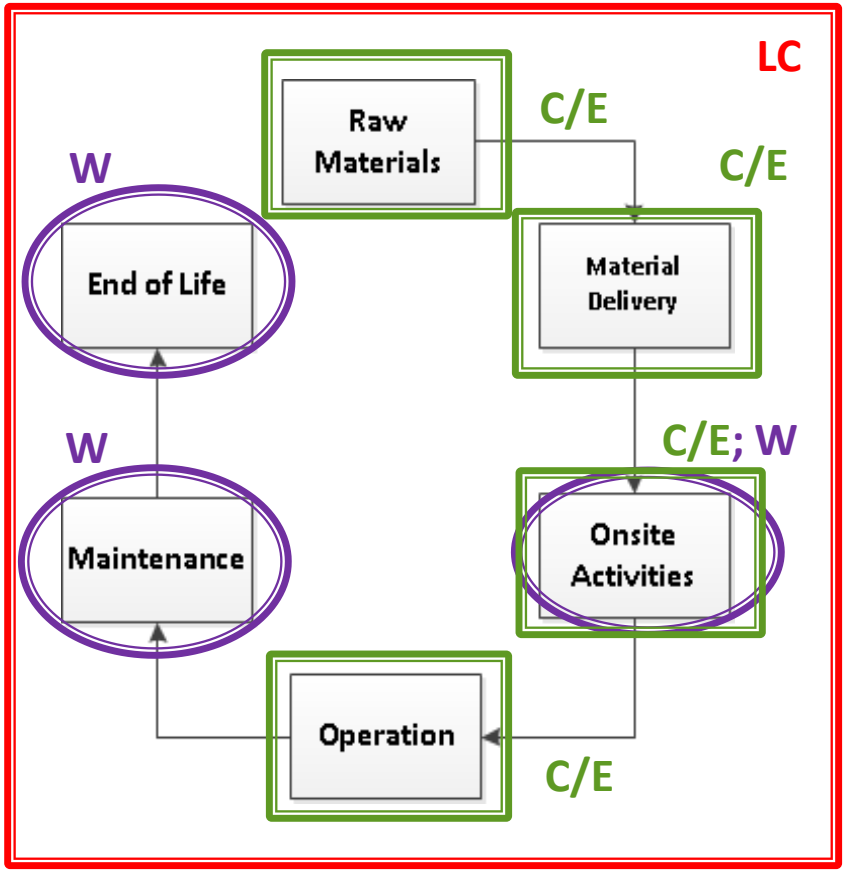


4.2 BIM-based Lifecycle Assessment Framework for Waste and Carbon Management

1. Quantitative Waste Management: BIM-based System for C&D Waste Management

2. Quantitative Embodied Carbon Management: BIM-based System for Embodied Carbon Estimation

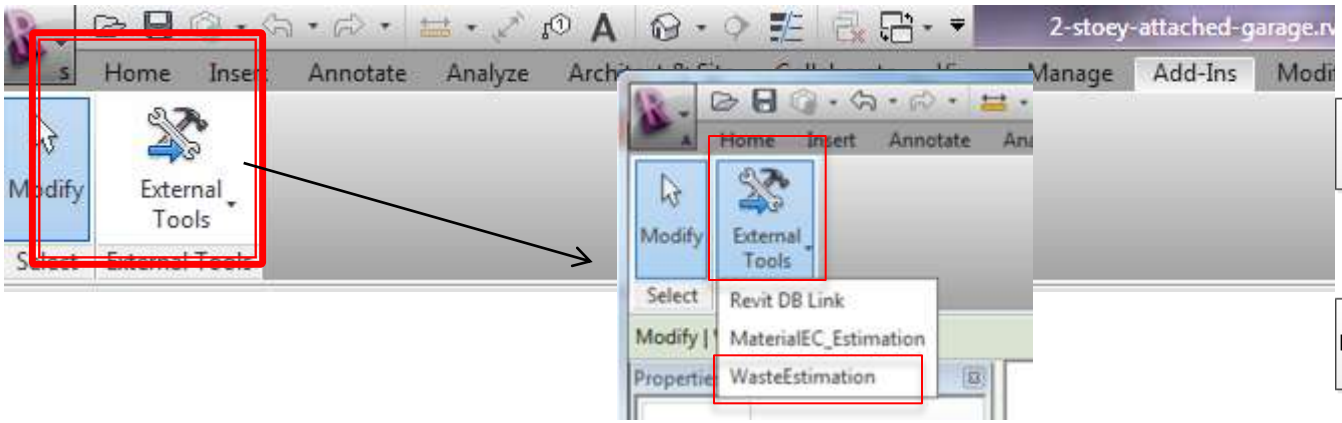
3. Integrated Lifecycle Carbon and Waste Analysis

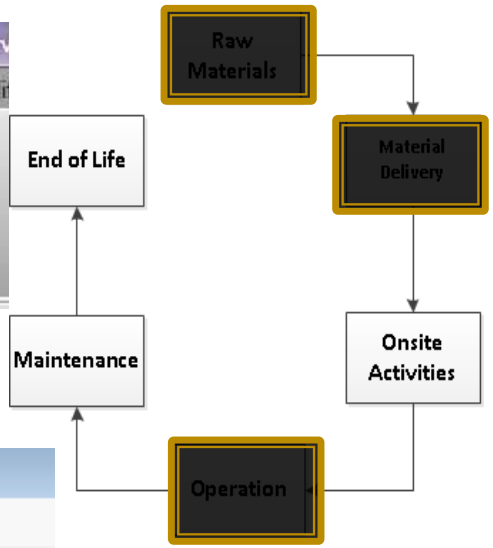


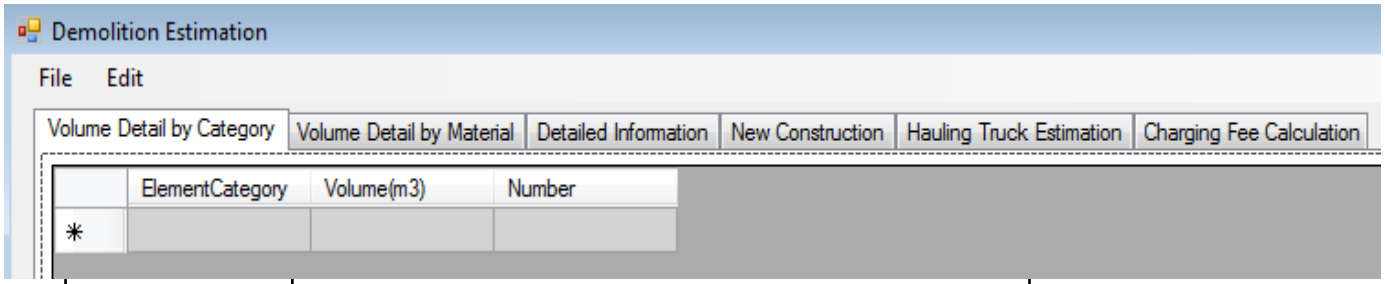
1. W: Waste
2. C/E: Carbon/Energy
3. Lifecycle

(Jack Cheng, 2012)

4.3 A BIM-based C&D Waste Estimation System







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4.3 A BIM-based C&D Waste Estimation System (cont'd): Demolition Waste Calculation

=

- Unit Conformation
  - Volume to Weight

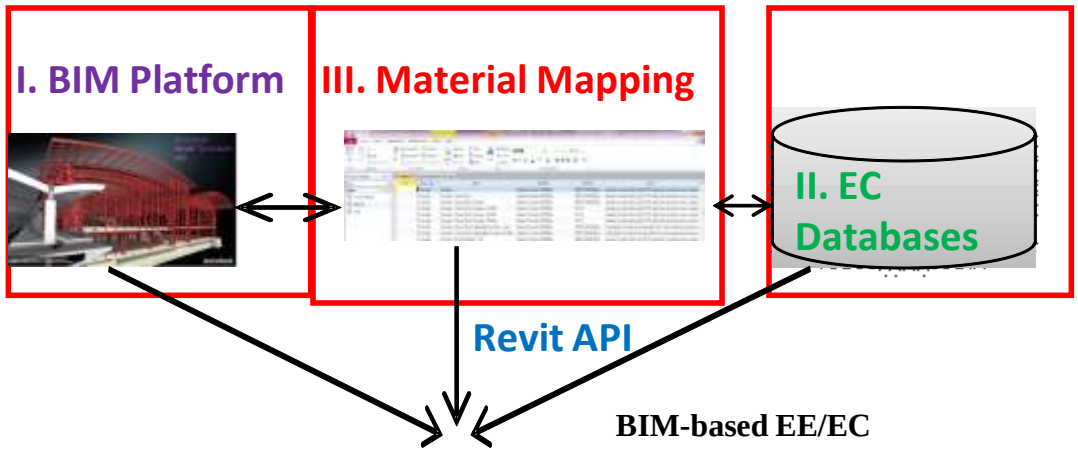
Density →

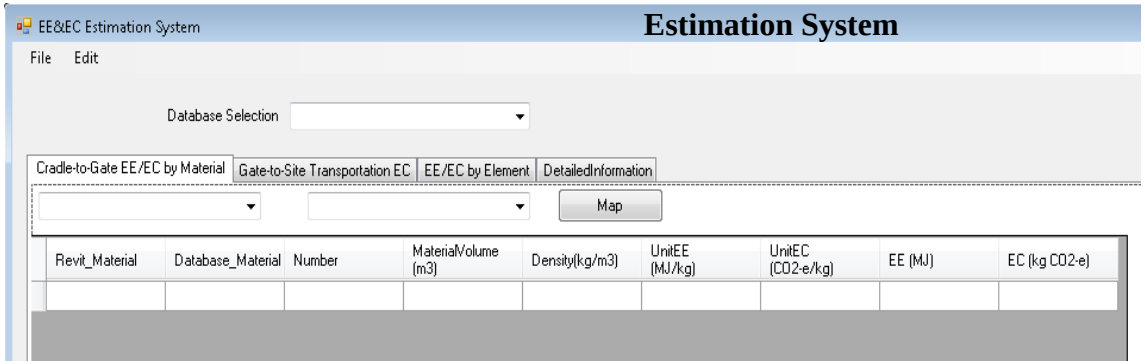
Material Type	Default Density (tons/m3)
Concrete	2.4
Wood	0.7
Glass	2.5
Drywall	2.3
Bricks	1.9
Metal	7.2

4.4 A BIM-based Embodied Carbon Estimation System

- Embodied carbon and energy:
  - The carbon emissions and energy associated with the processes of raw material extraction, processing, manufacturing, and transportation to site of use.
- If the operational energy decreases (e.g. enhanced energy efficiency), the embodied carbon can rise up to 50% of total carbon impacts.
- Boundary of embodied carbon:

4.4 A BIM-based Embodied Carbon Estimation System (cont'd): System Architecture





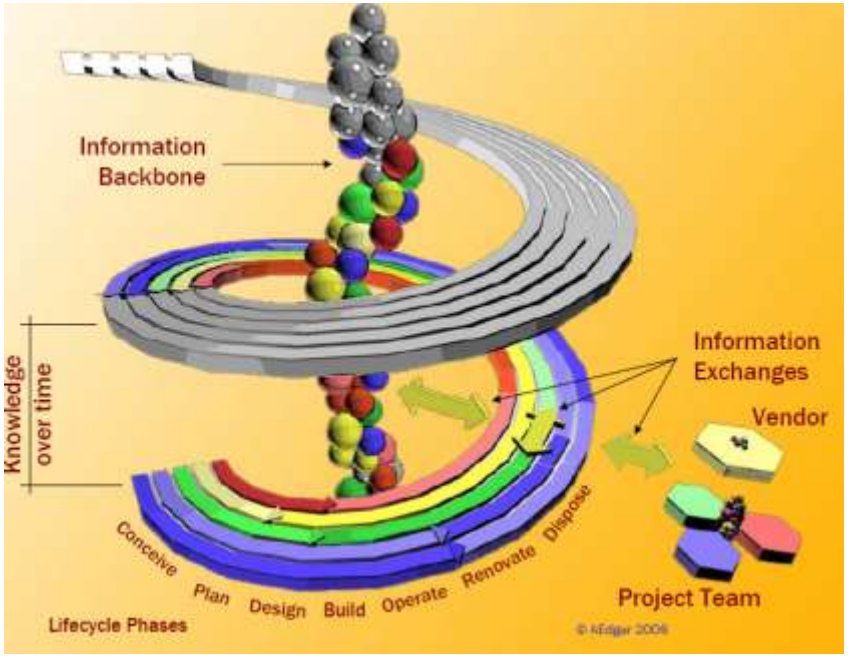
I. BIM software platform (BIM models)

II. EC databases (values of EC/EE of different materials)

III. Mapping between the material categories in Revit and EC databases

Summary

- Environmental consideration of building construction will be a trend in Hong Kong, as well as worldwide.
- BIM can facilitate building design and construction planning, and is now increasingly used in Hong Kong.
- We should have a life cycle view on buildings.
- Building information and project knowledge should accumulate, be shared, and reinforce each other in the future.



Thank You

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Waste Disposal Facilities in Hong Kong