

Introduction



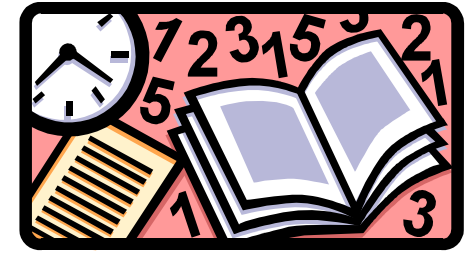
Ir. Dr. Sam C. M. Hui
Faculty of Science and Technology
E-mail: cmhui@vtc.edu.hk

Contents



- Background
- Building sustainability
- Green building assessment
- Ecological footprint
 - Basic concepts
 - Ecological footprint calculators
 - Classroom exercise





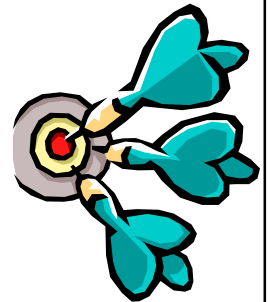
Background

- Module Aim(s):

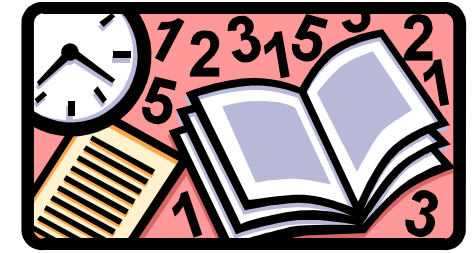
- The module aims to deal with the issue of **environmentally sustainable buildings**, focusing on alleviating the major environmental impacts whilst sustaining living and working built environments. This module is primarily focused on high-rise dense environments.

- Related modules:

- SBS4114 Built Environment
- SBS5222 Indoor Environmental Engineering
- SBS5421 Building Energy Efficiency cum Carbon Emission



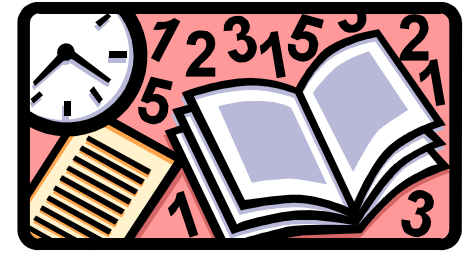
Background



- Learning Outcomes:

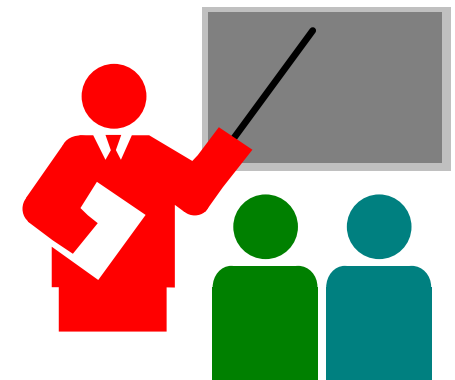
- 1. explain the different **environmental impacts** produced by high-rise buildings;
- 2. analyse and evaluate **built environmental issues** related to safety, health and environment quality;
- 3. interpret and evaluate the criteria that defines ‘**sustainability**’ and referenced sustainable buildings;
- 4. benchmark **building environmental performance** in terms of local regulations, practices and policies;
- 5. interpret and advise Clients on the environmental performance aspects of buildings, especially with regard to performance of technical systems; and
- 6. conduct benefit-cost analyses to improve the environmental performance of buildings.

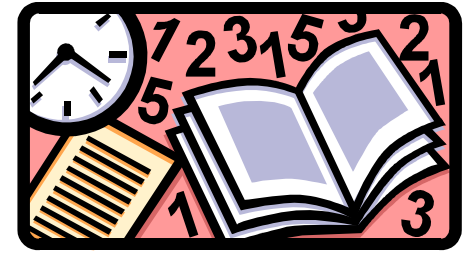




Background

- Lecturers:
 - Ir Dr. Sam C. M. Hui (cmhui@vtc.edu.hk)
 - ASHRAE High-Performance Building Design Professional (HBDP)
 - Dr. PAN Yan, Penny (pennypan@vtc.edu.hk)
- Course Website: (with links and resources)
 - <http://ibse.hk/SBS5413/>
- Moodle system
 - <http://moodle.vtc.edu.hk/>



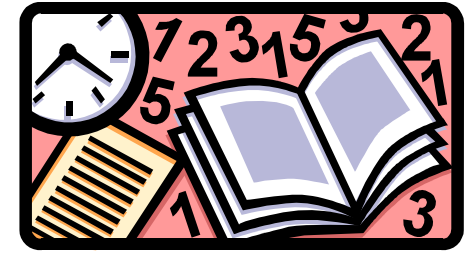


Background

- Assessment Components:
- Assignments (30%)
 - Assignment(s) by Dr. Hui (15%)
 - Assignment(s) by Dr. Pan (15%)
- Project (10%)
 - Group project, 6 students each group
 - Poster presentation
- Examination (60%) (3 hours)
 - Section A by Dr. Hui (4 out of 5 questions @ 9 marks)
 - Section B by Dr. Pan (4 out of 5 questions @ 16 marks)



Background



- Study topics:

- 1. Introduction
- 2. The rise of sustainability
- 3. Life cycle assessment
- 4. Building greening and green roof systems
 - - Guest lecture on green building



Dr. Hui



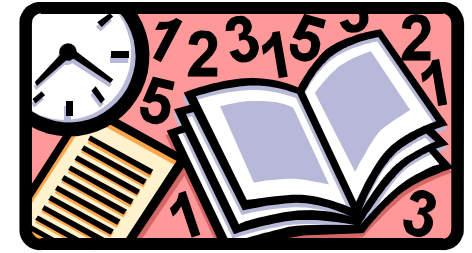
- 5. Green building movement in Hong Kong
- 6. BEAM Plus assessment
- 7. BEAM Plus application examples
- 8. LEED assessment method
- 9. ASHRAE Standard 189.1
- 10. Sustainable masterplanning
- 11. Post-occupancy evaluation



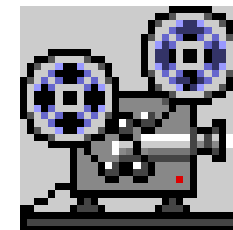
Dr. Pan

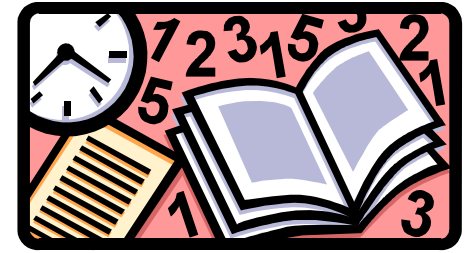


Background



- Learning Methods:
 - Lectures + Further Reading
 - Individual Assignments
 - Discussions
 - During lectures/tutorials
 - When doing the group project
 - Guest lecture
- Resources:
 - Video presentations
 - Web links + References

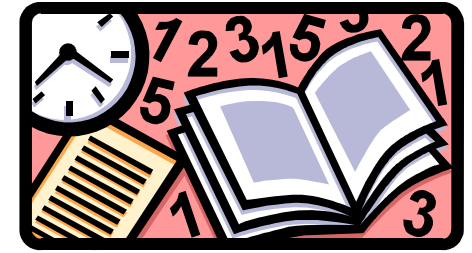




Background

- Useful knowledge:
 - SBS5222 Indoor Environmental Engineering
<http://ibse.hk/SBS5222/schedule1617.htm>
 - Sustainable development principles
 - Sustainability science
 - Environmental issues
 - Building environmental performance
 - Green building assessment (overview)
 - Suggest to review the above if you have not studied the module SBS5222

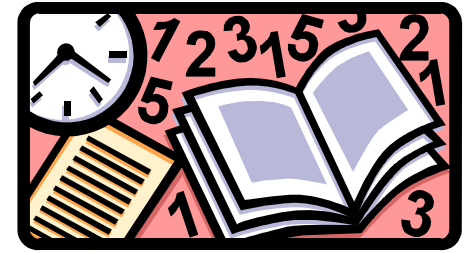




Background

- Useful references:

- Cheng, V. S. and Tong, J. C., 2017. *Building Sustainability in East Asia: Policy, Design and People*, John Wiley & Sons, Chichester, West Sussex.
 - <http://webpac.vtc.edu.hk/record=b11463429>
 - <http://books.google.com.hk/books?id=eNyHDgAAQBAJ>
- UN-Habitat, 2017. *Building Sustainability Assessment and Benchmarking: An Introduction*, United Nations Settlements Programme (UN-Habitat), Tanzania.
 - <http://webpac.vtc.edu.hk/record=b11463429>
 - <http://unhabitat.org/books/building-sustainability-assessment-and-benchmarking/>



Background

- Useful references: (cont'd)

- Edwards, B. and Naboni, E., 2013. *Green Buildings Pay: Design, Productivity and Ecology*, 3rd ed., Routledge, London.
 - <http://webpac.vtc.edu.hk/record=b11074290> (ebook)

- Useful websites:

- Rating tools <http://www.worldgbc.org/rating-tools>
- Green Building Standards and Certification Systems [WBDG] <http://www.wbdg.org/resources/gbs.php>
- ASHRAE Standard 189.1
<http://www.ashrae.org/greenstandard>

Building Sustainability

建築可持續性



Building sustainability



- **Sustainability** is:
 - the capacity of the earth's natural systems and human cultural systems to survive, flourish, and adapt into the very long-term future
 - thinking about tomorrow TODAY
- It requires:
 - a transition in human attitudes toward the environment, and a shift in behaviour, can lead to a much better future for the planet in the future (i.e. paradigm change/shift)

Three dimensions of sustainability

Environmental Sustainability

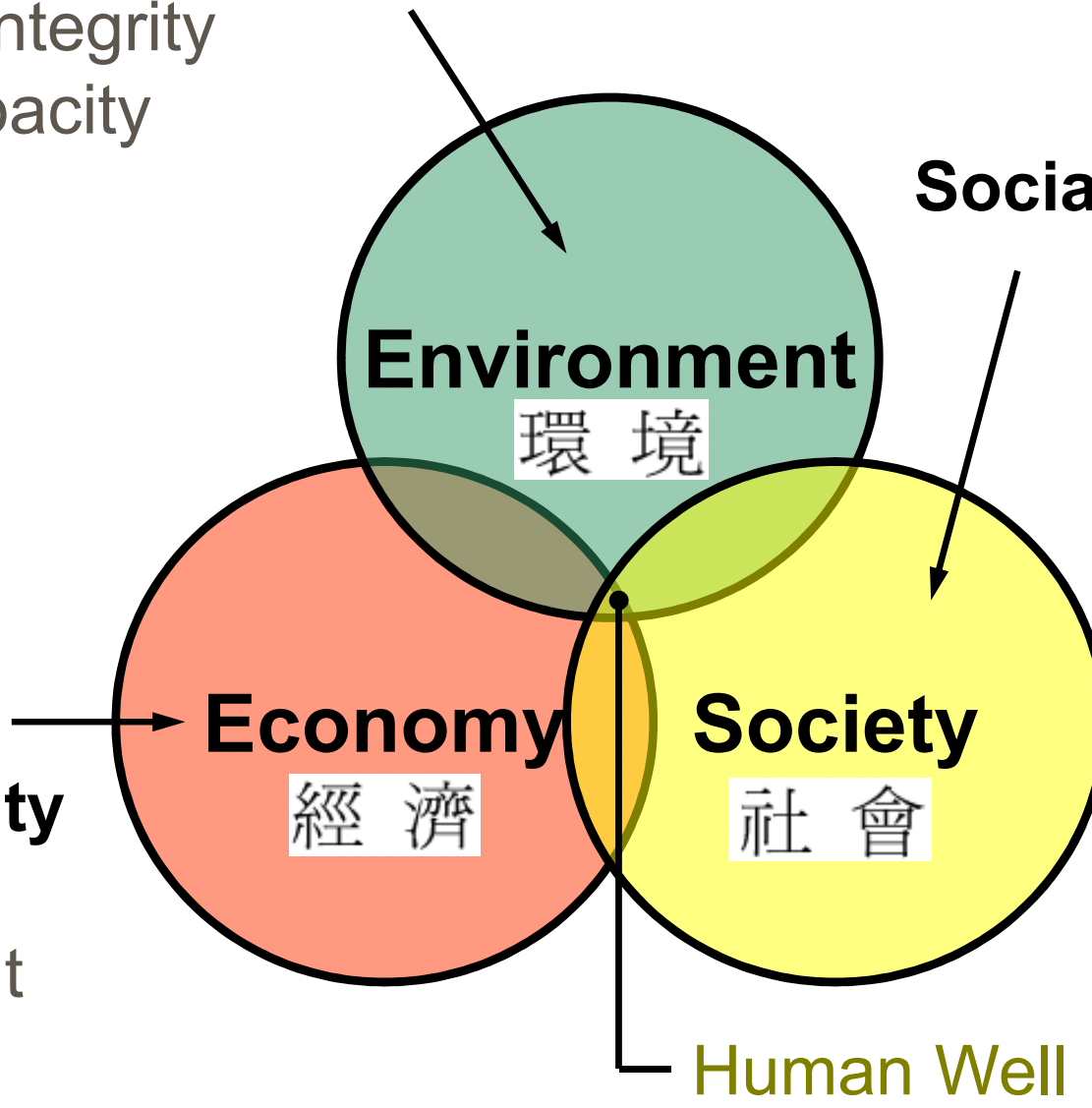
Ecosystem integrity
Carrying capacity
Biodiversity

Social Sustainability

Cultural Identity
Empowerment
Accessibility
Stability
Equity

Economic Sustainability

Growth
Development
Productivity
Trickle-down



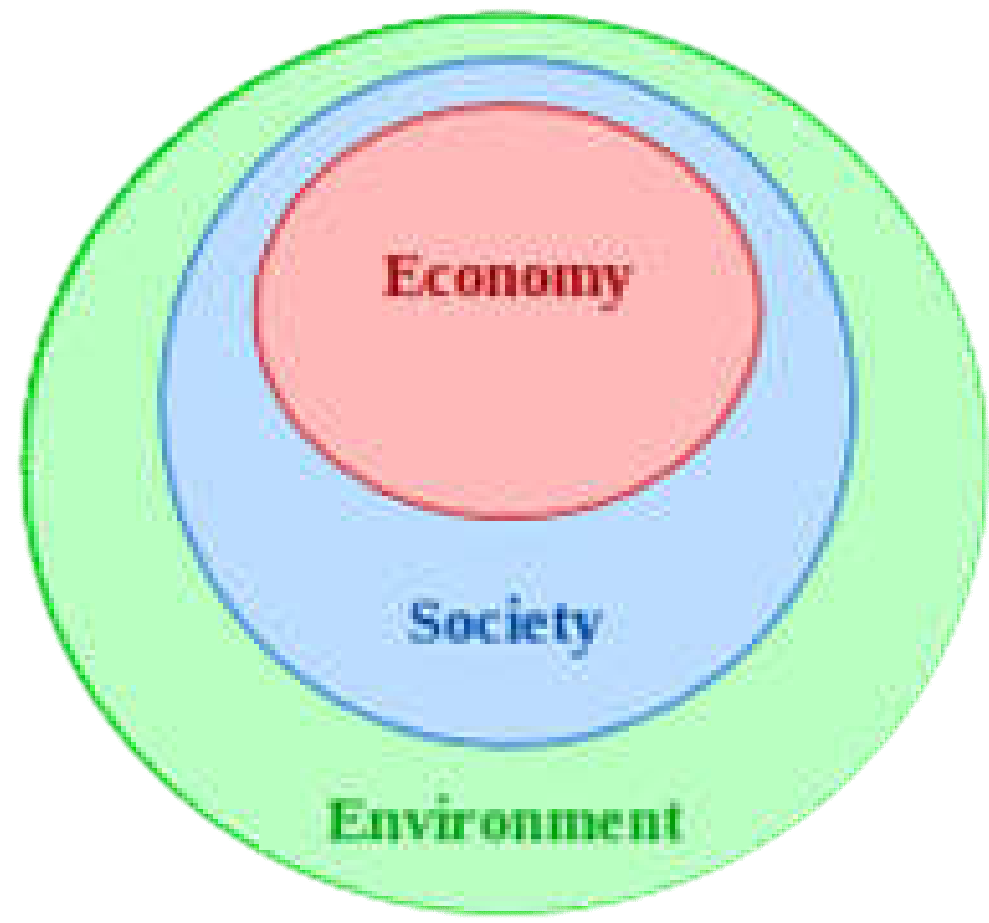
Human Well Being



Sustainable view of community to bring three elements into

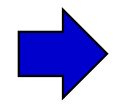
harmony

和諧

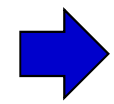
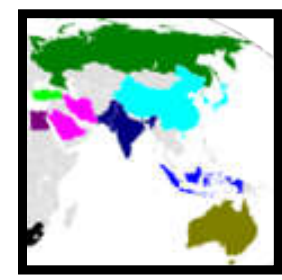


Different scales of environment:

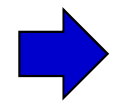
Global



Regional



Local



Internal



Four major areas for improving sustainability: food, cities, population, and energy

Food



How we meet one of our most basic needs—food—is a powerful way to influence sustainability. Sourcing food locally and avoiding highly processed foods can lower the Ecological Footprint. [Learn More](#)

Cities



Eighty percent of the world population is expected to live in cities by 2050. Consequently, city planning and urban development strategies are instrumental to balancing the supply of natural capital and population's demand. [Learn More](#)

Population



Being committed to everyone living secure lives in a world of finite resources requires addressing population growth. Empowering women is essential for global sustainability. [Learn More](#)

Energy



Decarbonizing the economy is our best possible chance to address climate change, and would improve the balance between our Ecological Footprint and the planet's renewable natural resources. [Learn More](#)

Food system

Sustainable cities

Sustainable energy

Urban farming, building greening, green roofs

Green/Sustainable buildings

Building energy efficiency, Renewable energy

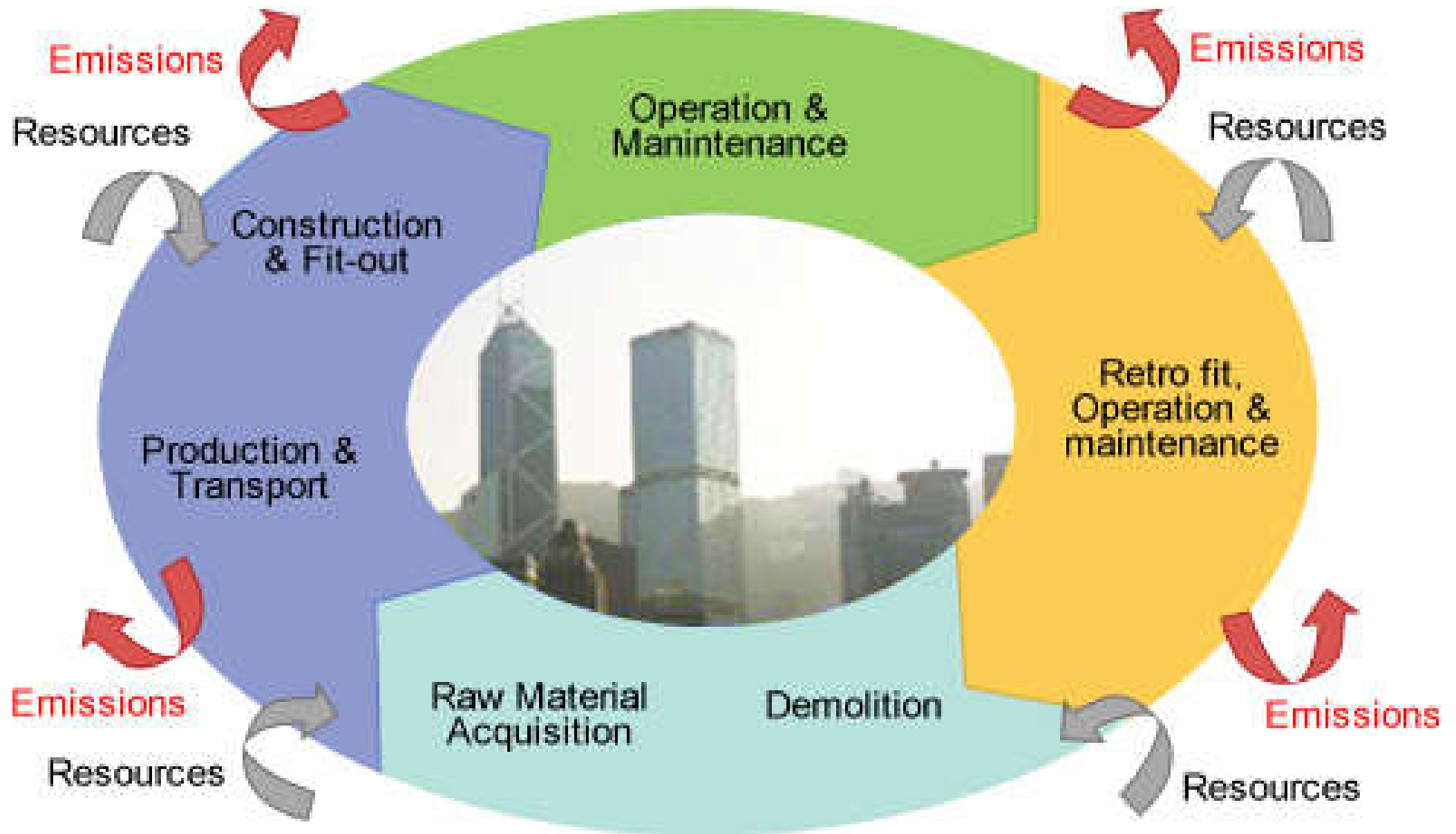
Issues related to this module



Building sustainability

- Impacts of buildings on the environment
 - Global, local and indoor aspects
 - Such as energy, carbon, materials, waste & water
- Business case for sustainability
 - How to consider the costs and benefits
- Business case for **green building**
 - Life cycle environmental impacts
 - Health, wellbeing and productivity

Life cycle assessment of buildings

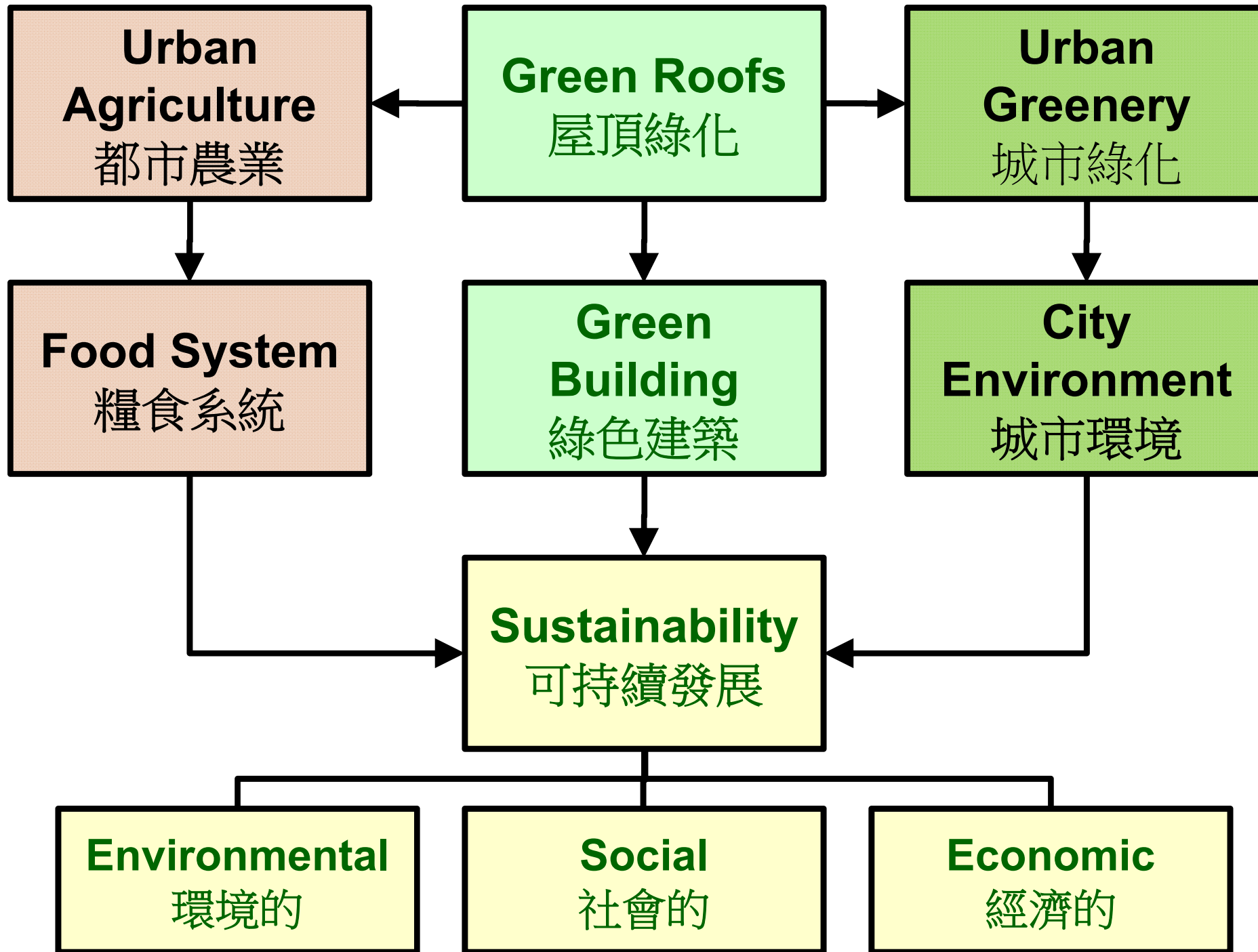


Hong Kong



High-density urban city







Building sustainability

- Green building movement in Hong Kong
 - Green technology applications
 - Local codes, good practice guides, rating systems
 - Challenges and constraints
- Environmental performance criteria
 - Important issues, aspects and indicators
 - Benchmarks and assessment criteria

How to
measure
building
sustainability?

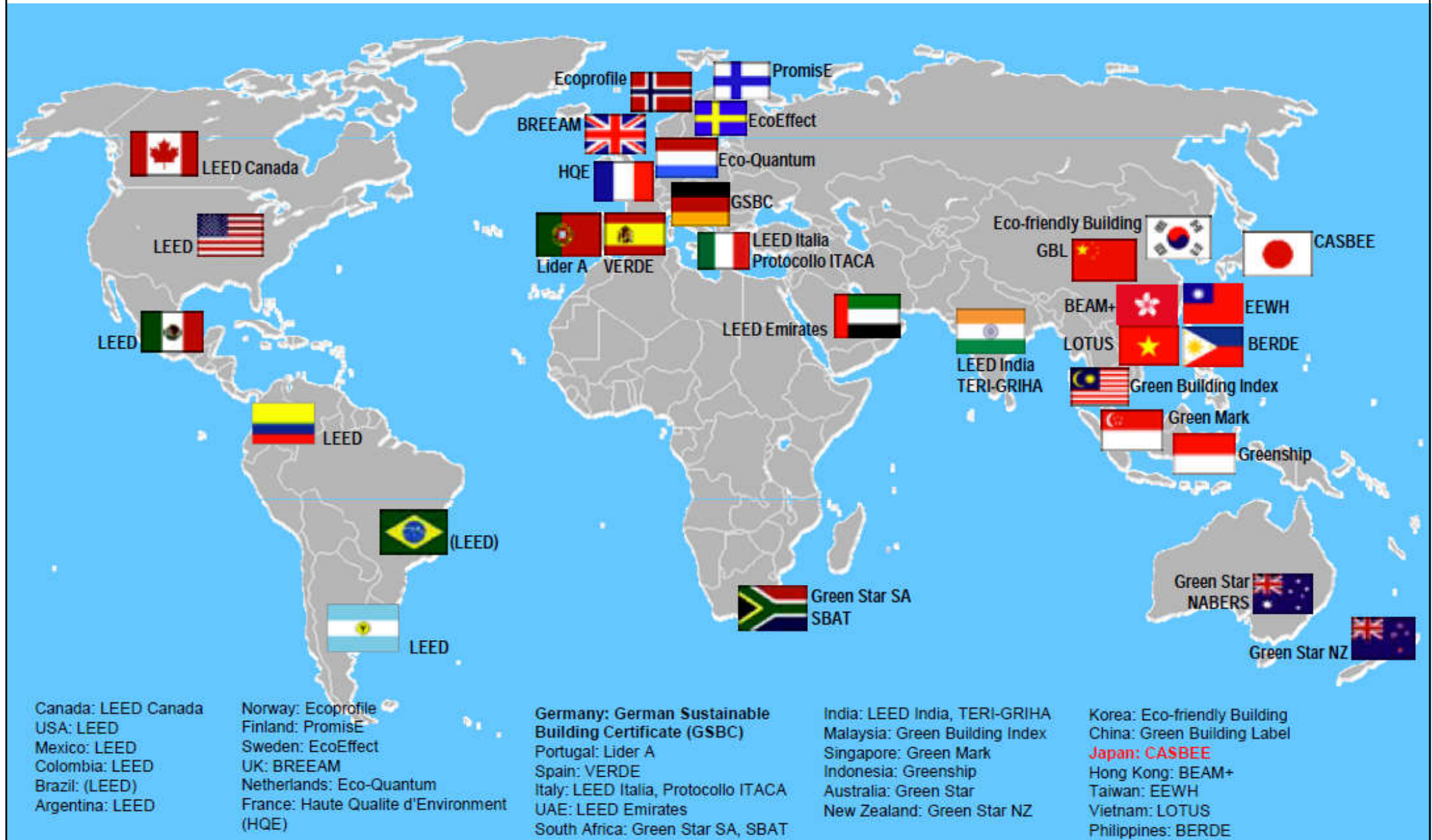
**Building Design vs
Environmental Performance Criteria**

Green building assessment

綠色建築評估



Rating tools of building environmental performances around the world



Further info: http://en.wikipedia.org/wiki/Green_building

See also: <http://www.worldgbc.org/rating-tools>

(Adapted from *CASBEE in Progress for Market Transformation in Japan*, by Prof. Kazuo Iwamura, Tokyo City University)

Green building assessment



- The BEAM Plus Family

- <http://www.hkgbc.org.hk/eng/BEAMPlus.aspx>



- Neighbourhood (ND): Masterplanning stage of building development projects



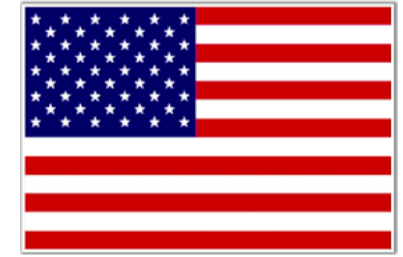
- New Buildings (NB): New building projects and major renovation/alteration works on existing buildings



- Existing Buildings (EB): Operation and maintenance performance of existing buildings



- Interiors (BI): Fit-out works of non-domestic premises



Green building assessment

- LEED Green Building Rating System
 - Leadership in Energy & Environmental Design
 - By US Green Building Council
 - Current LEED systems:
 - New construction (LEED-NC) or Building design and construction (BD+C)
 - Existing buildings operations & maintenance (LEED-EBOM) (O+M)
 - Commercial interiors (LEED-CI)
 - Core and shell (LEED-CS)
 - Homes, Schools, Healthcare, Retail
 - Neighborhood development (LEED-ND)



ASHRAE Standard 189.1 Preview

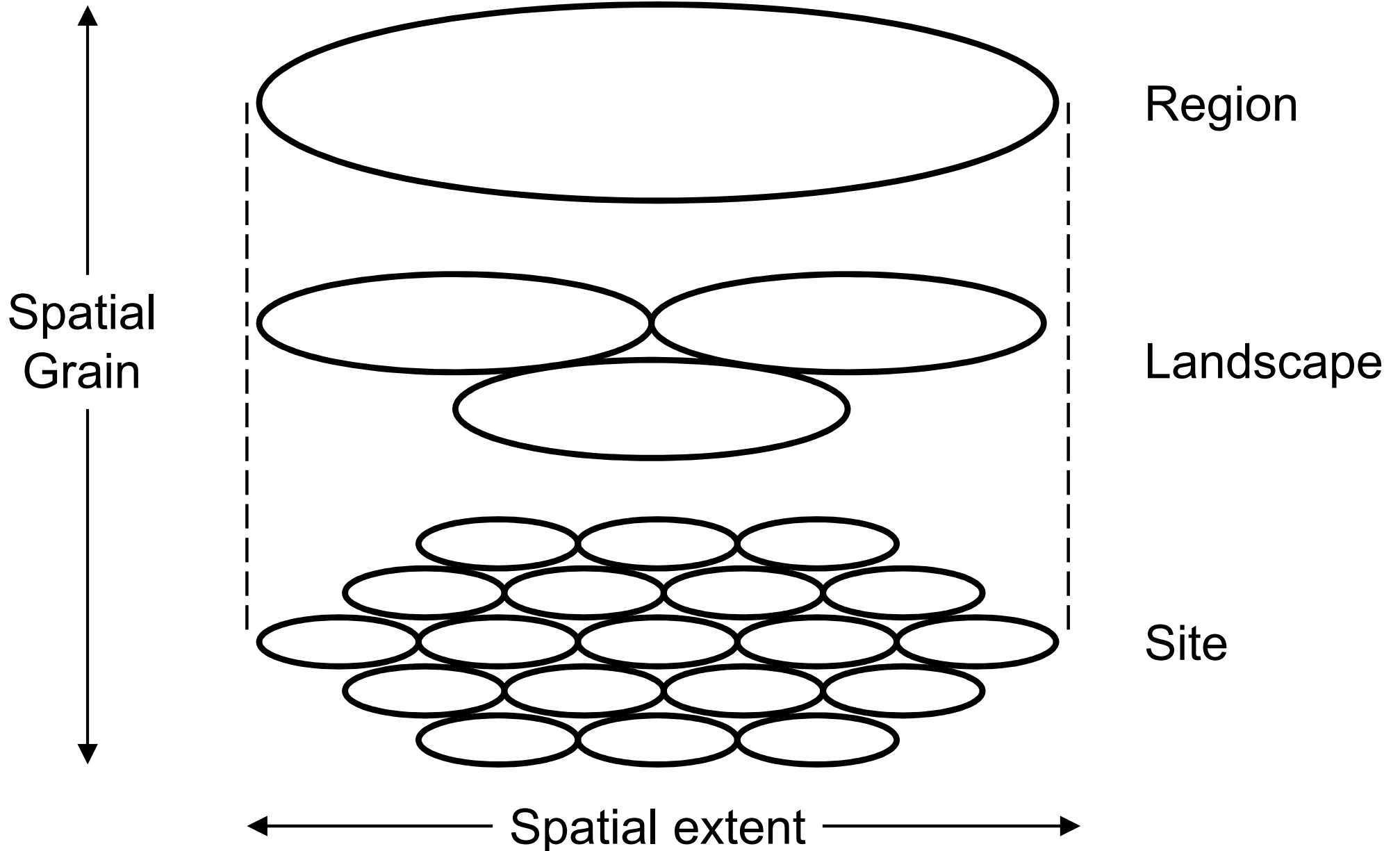
www.ashrae.org/greenstandard

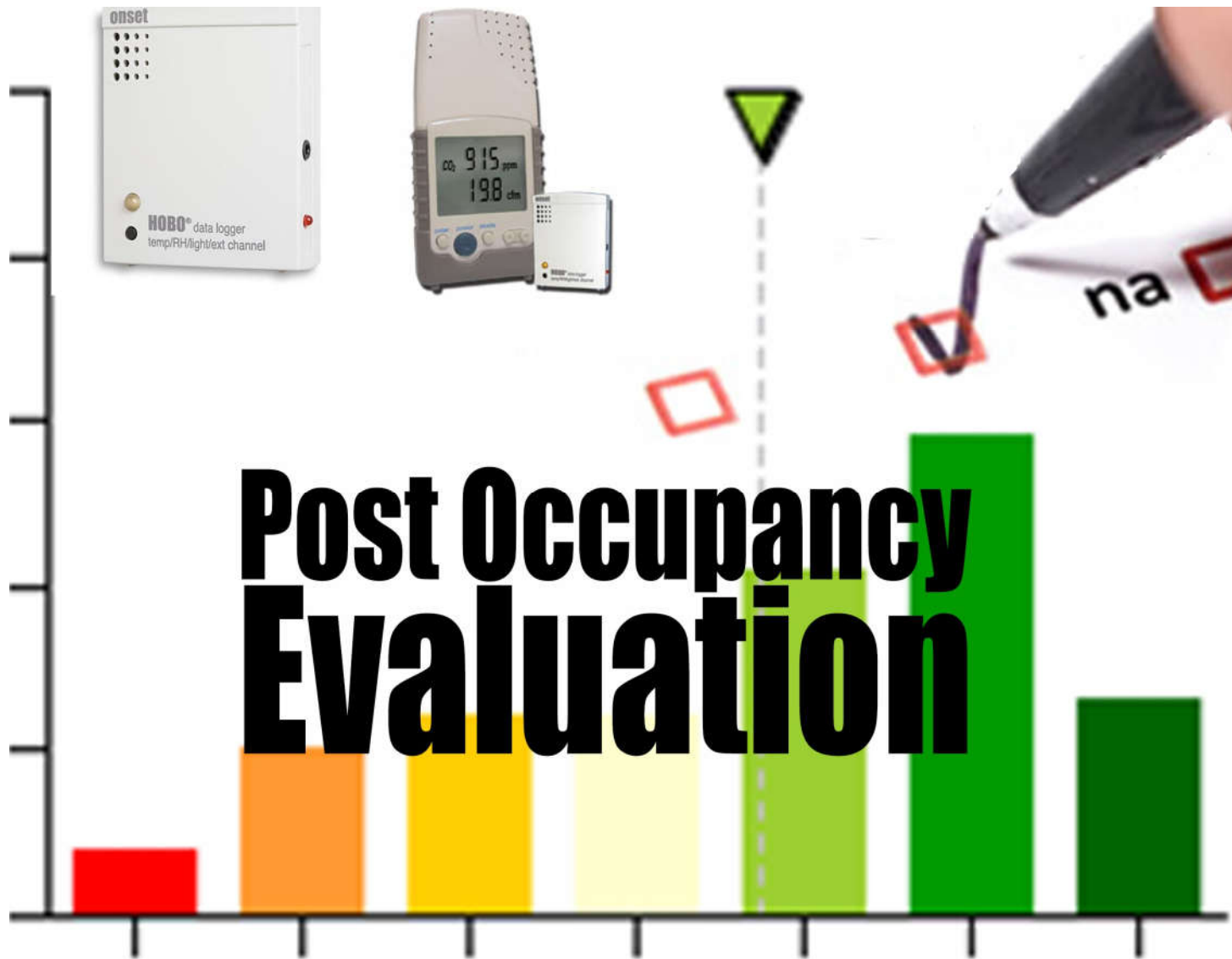


**Knowledge is power.
Understanding is power².**



Spatial hierarchy: regions, landscapes, sites
(for **sustainable masterplanning**)





Post Occupancy Evaluation (POE): the process of evaluating buildings in a systematic and rigorous manner after they have been built and occupied for some time.

Ecological footprint

生態足跡



Ecological footprint



- It is the metric that measures how much **nature** we have and how much **nature** we use
 - Accounting the demand on and supply of **nature**
- On the demand side:
 - Ecological assets that a given population requires to produce the natural resources it consumes and to absorb its waste, especially carbon emissions
 - Track the use of 6 categories of productive surface areas: cropland, grazing land, fishing grounds, built-up land, forest area, and carbon demand on land

The Ecological Footprint

MEASURES

how fast we consume resources and generate waste



Energy



Settlement



Timber & Paper



Food & Fiber



Seafood

COMPARED TO
how fast nature can absorb our waste and generate new resources.



Carbon Footprint

Built-up land



Forest

Cropland & Pasture

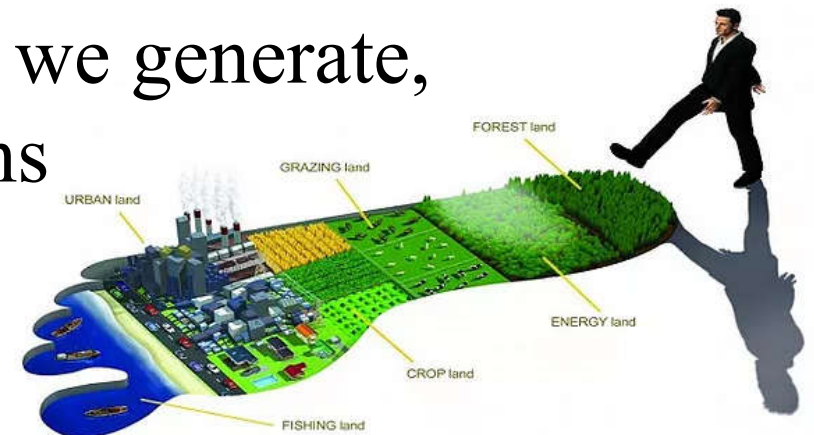


Fisheries

Ecological footprint



- On the supply side:
 - A city, state or nation's **biocapacity** represents the productivity of its ecological assets (including cropland, grazing land, forest land, fishing grounds, and built-up land)
 - These areas, especially if left unharvested, can also absorb much of the waste we generate, especially our carbon emissions
- Expressed in global hectares



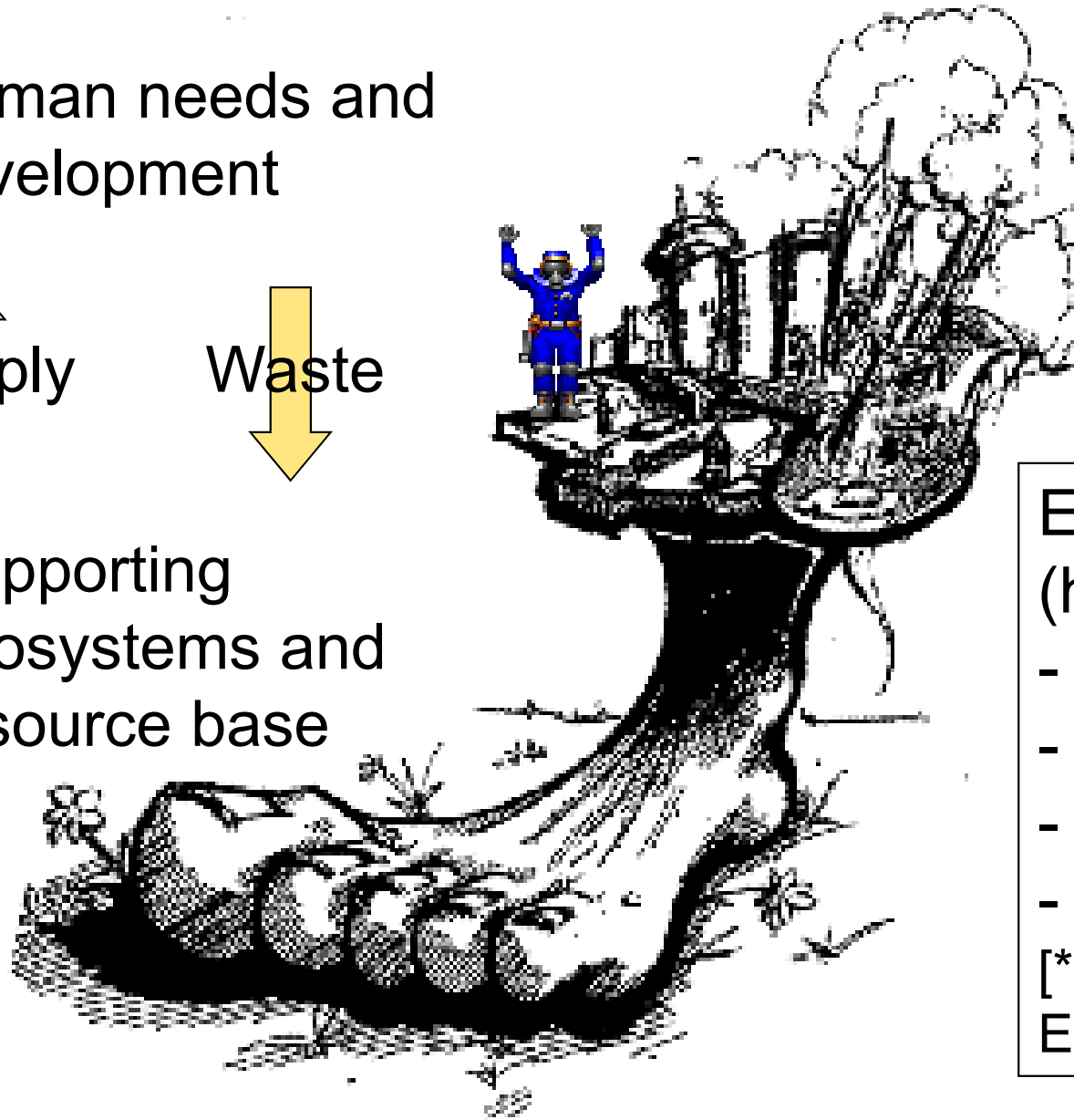
Carrying capacity and ecological footprint

Human needs and development

Supply

Waste

Supporting ecosystems and resource base



Ecological footprint (hectares/person) *:

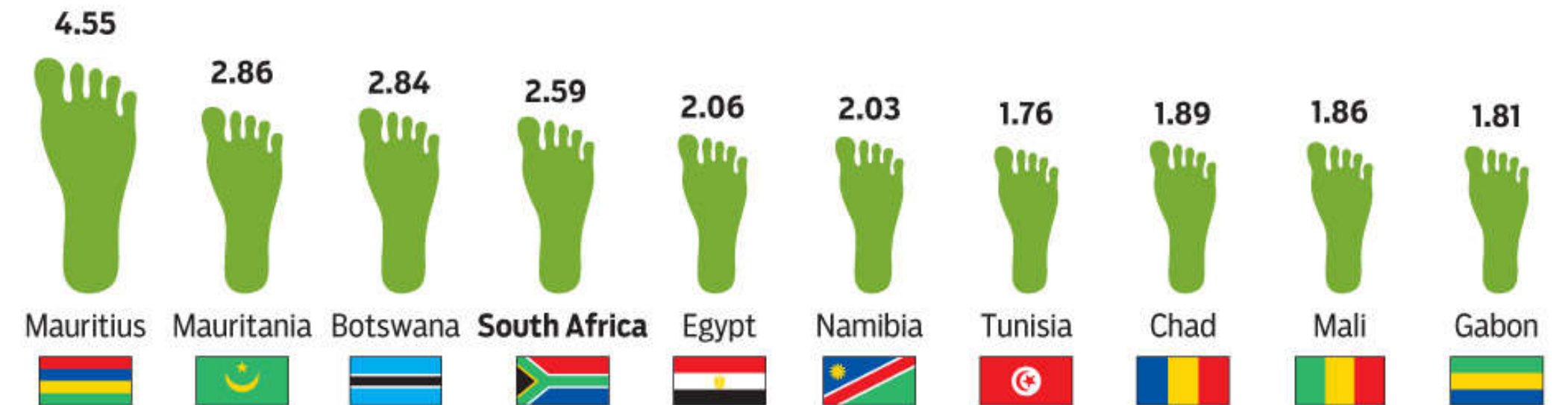
- world average = 2.3
- USA = 10.3
- **Hong Kong = 6.0**
- China = 1.2

[* Source: Friends of the Earth (HK)]

Top 10 countries with the biggest ecological footprint per person



Top 10 African countries with the biggest ecological footprint per person

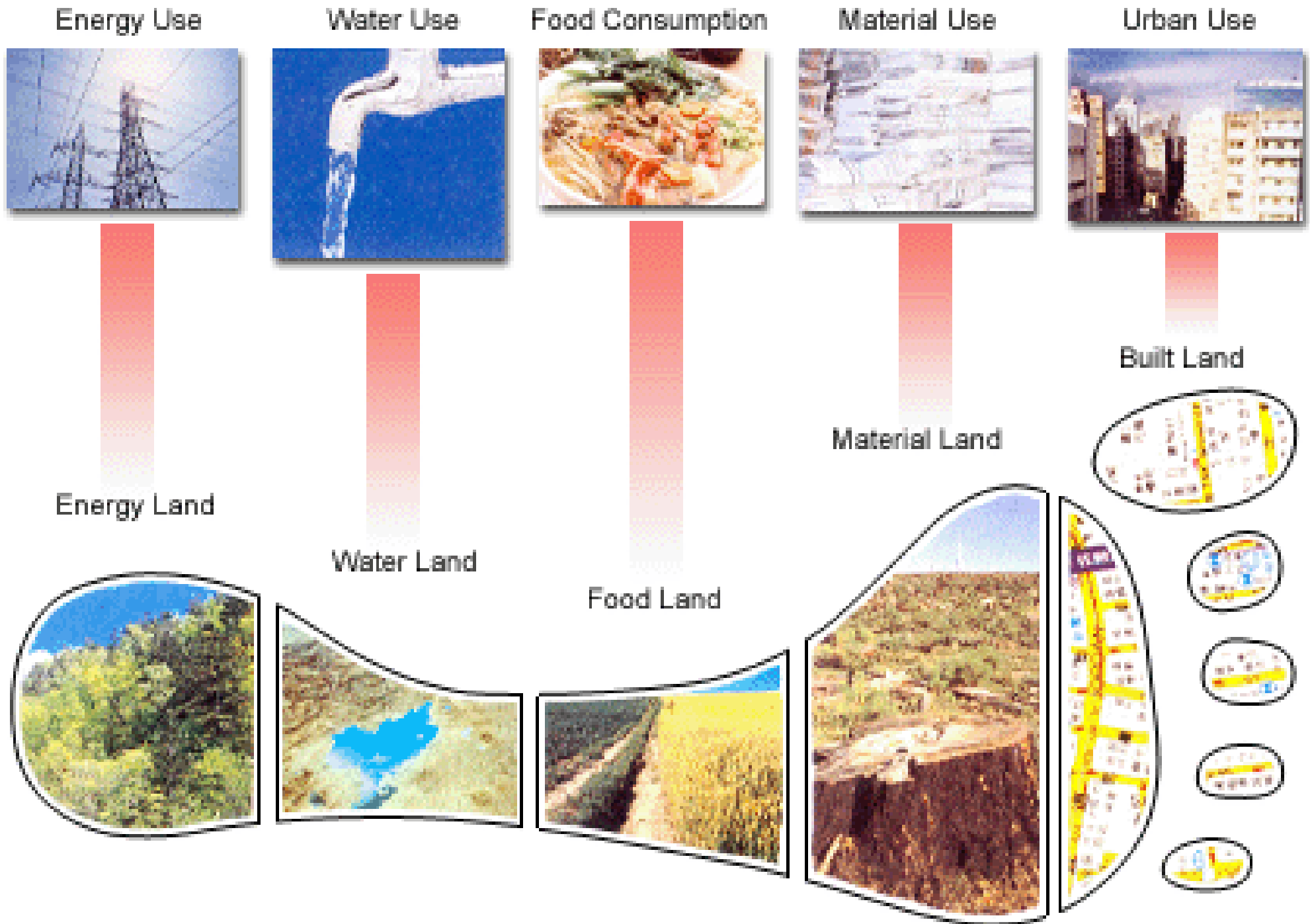


* United Arab Emirates

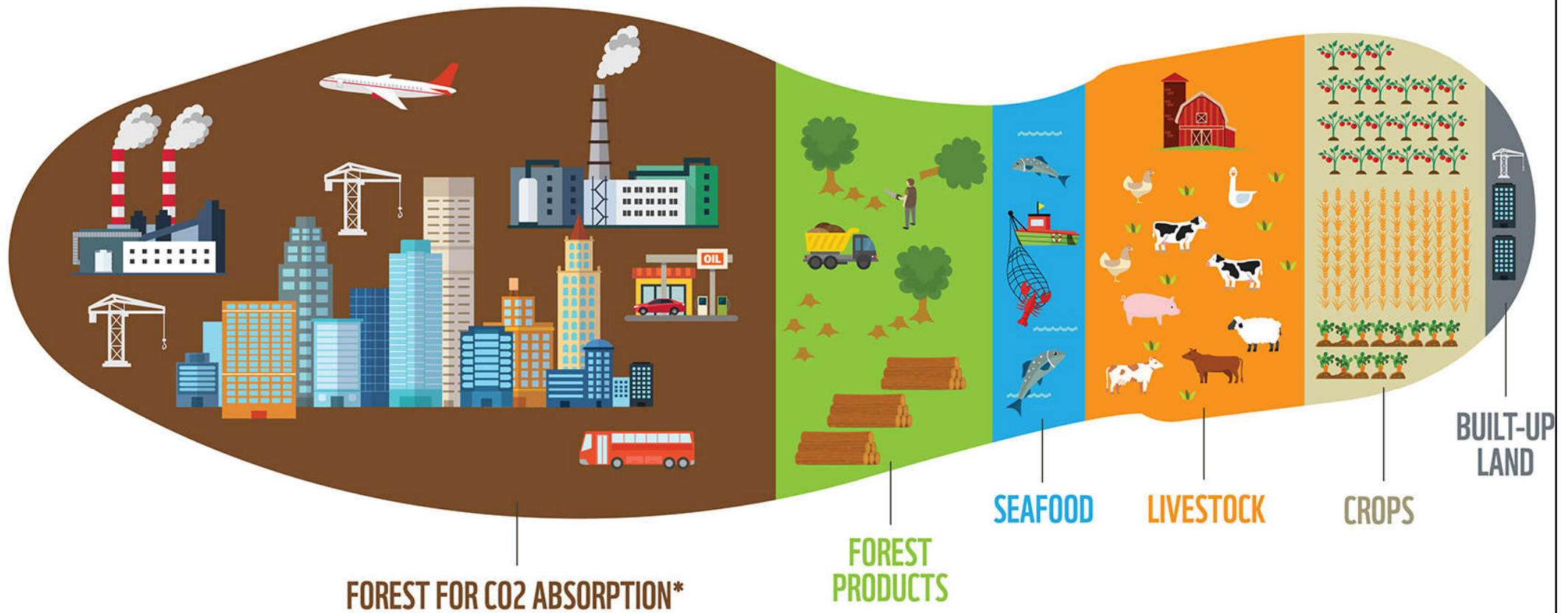
Source: WWF

Graphics24

The 5 sectors of ecological footprint (for Hong Kong)



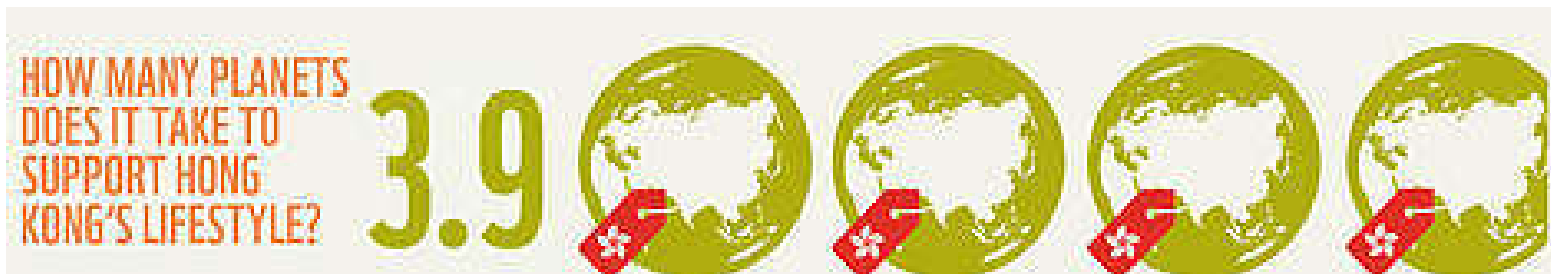
Sustainable city and ecological footprint



HONG KONG'S ECOLOGICAL FOOTPRINT

* Local emission and CO₂ generated during production and transportation of imported products

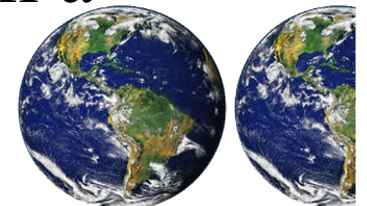
Do you know why
HK's EF is 3.9?



Ecological footprint



- If ecological footprint exceeds biocapacity, it is an ecological deficit (or ecological overshoot)
- If biocapacity exceeds ecological footprint, it is an ecological reserve
- Since the 1970s, humanity has been in ecological overshoot. Today humanity uses the equivalent of 1.7 Earths to provide the resources we use and absorb our waste. This means it now takes the Earth one year and 7 months to regenerate what we use in a year

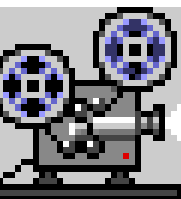




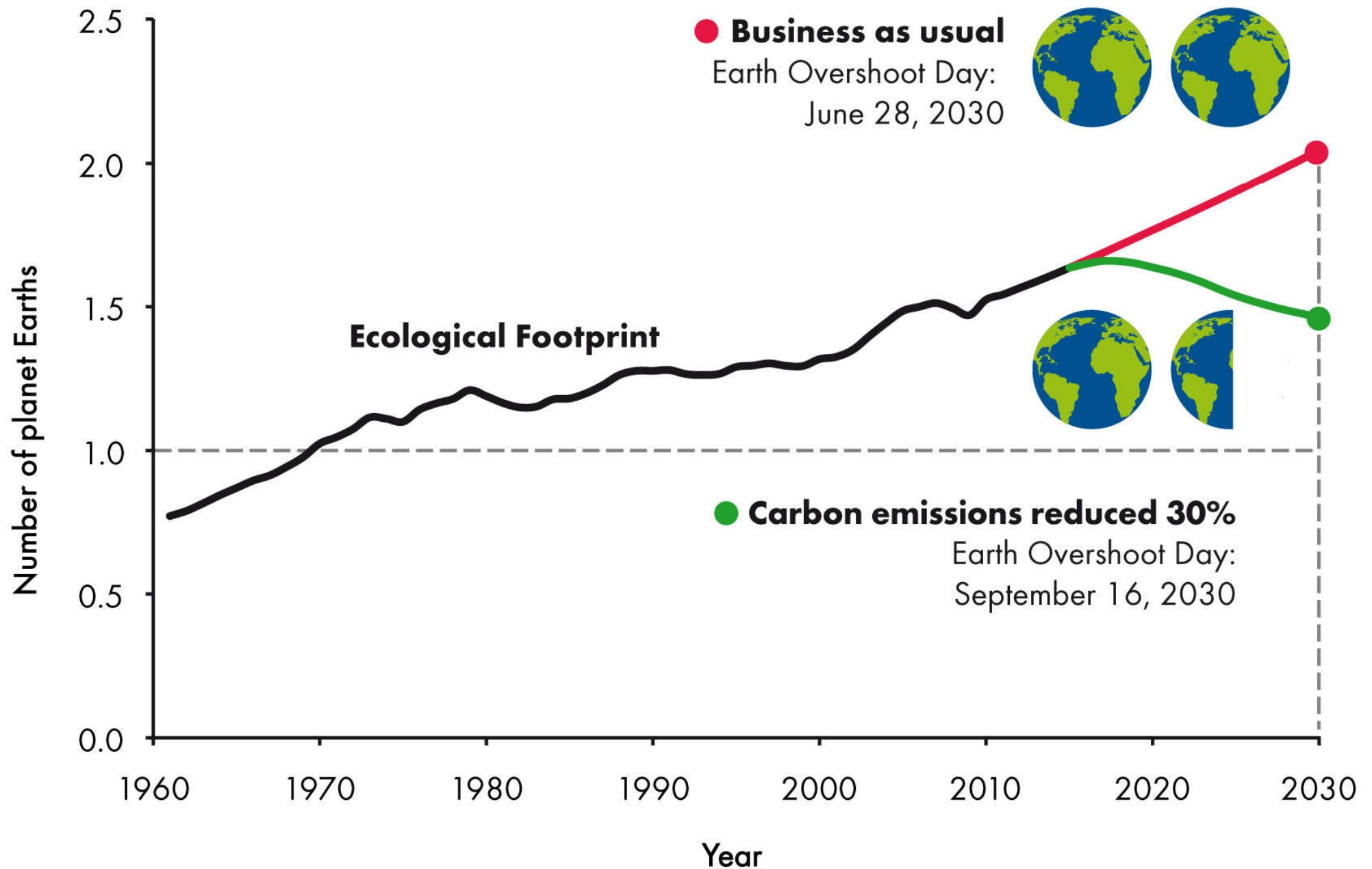
Ecological footprint

- Earth Overshoot Day is the day on the calendar when humanity has used the resources that it takes the planet the full year to regenerate
- We must begin to make ecological limits central to our decision-making and use human ingenuity to find new ways to live well, within the Earth's bounds

(Video: Earth Overshoot Day 2017 lands on August 2 (3:35) <https://youtu.be/oPO2-KCyFvc>)



How many Earths does it take to support humanity?



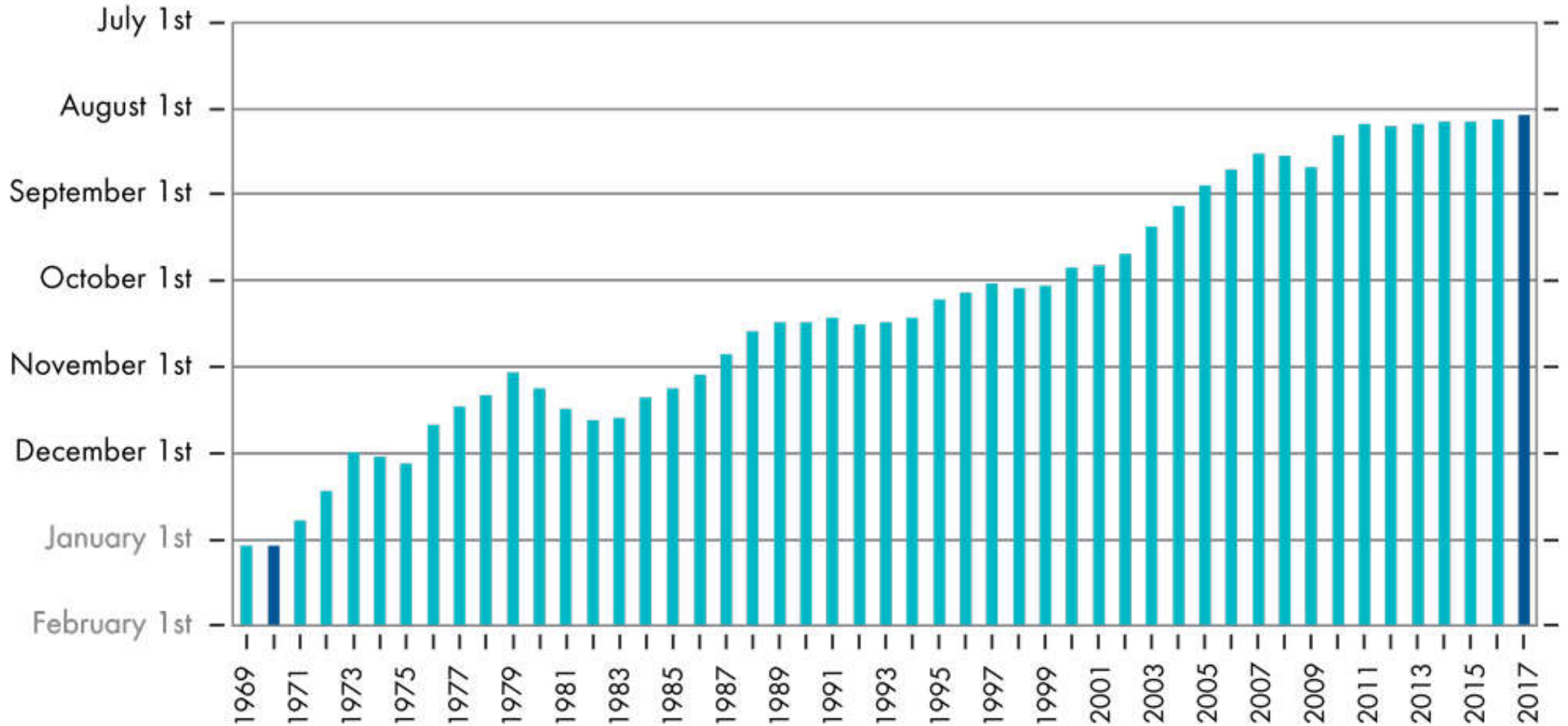


1 Earth

Earth Overshoot Day 1969-2017



1.7 Earths

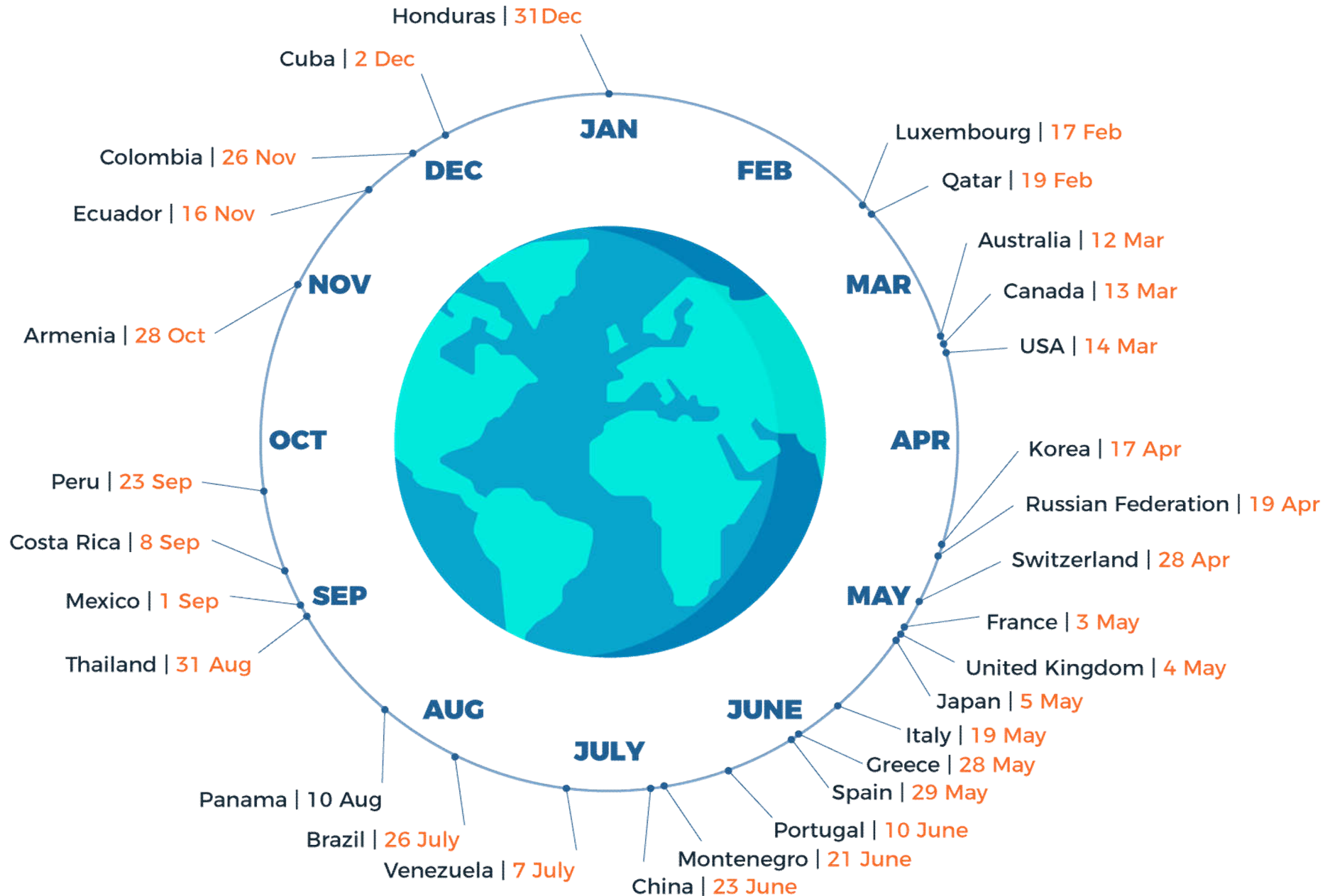


Source: Global Footprint Network National Footprint Accounts 2017

(Source: <https://www.overshootday.org/why-past-earth-overshoot-day-dates-keep-changing/>)

Country Overshoot Days 2017

It is the date that Earth Overshoot Day would fall if all of humanity consumed like the people in this country.



Ecological footprint



- Ecological footprint calculators (examples):

- Footprint Calculator

<http://www.footprintcalculator.org/>

- Ecological Footprint Calculator

<http://ecologicalfootprint.com/>

- WWF Footprint Calculator (UK)

<http://footprint.wwf.org.uk/>

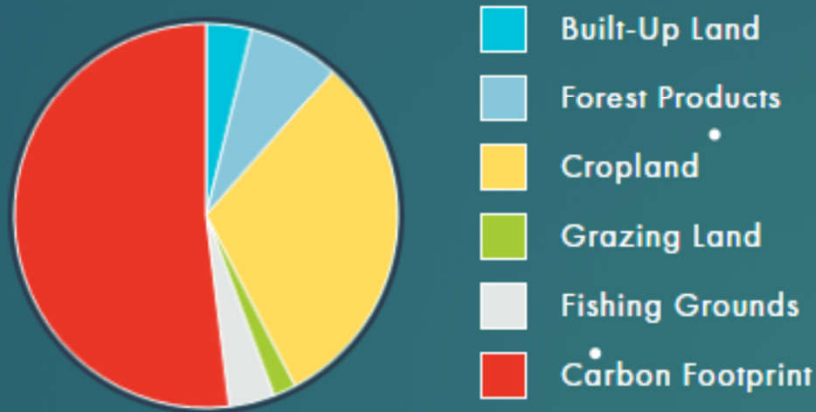
- Carbon Footprint Calculator (US-EPA)

<https://www3.epa.gov/carbon-footprint-calculator/>

Please try out
and test by
yourself.

RESULTS

By Land Type



By Consumption Category



5.2

Your Ecological Footprint
(global hectares or gha)

7.8

Your Carbon Footprint
(CO2 emissions in tonnes per year)

52

Your Carbon Footprint
(% of your total Ecological Footprint)

Explore Solutions

Ecological footprint



- Carbon footprint calculators for Hong Kong:
 - My Carbon Footprint 碳足印計算器 - 低碳行動
 - <http://www.lowcarbonaction.com/footprint.aspx>
 - Carbon Calculators 碳排放計算器
 - http://www.carboncareasia.com/eng/Carbon_Solutions/Carbon_Calculators.php
 - Individual Calculator
 - Local Travel Calculator
 - Lifestyle Calculator
 - Flight Calculator

How to reduce
or offset the
carbon?

Ecological footprint



- Carbon footprint toolkits for Hong Kong:
 - Carbon Calculators 碳排放計算器
 - https://www.climateready.gov.hk/education_centre.php?section=carbon_calculator
 - For Individuals 個人計算器:
 - Carbon Footprint Management Toolkit
<http://www6.cityu.edu.hk/aerc/CFT/>
 - For Organisations 團體計算器:
 - SME Carbon Audit Toolkit
<http://www6.cityu.edu.hk/aerc/sme/>

Carbon Footprint Management Toolkit

<http://www6.cityu.edu.hk/aerc/CFT/>

CARBON FOOTPRINT MANAGEMENT TOOLKIT for Sustainable Low-Carbon Living

中文

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About Us

What is Carbon Footprint?

Carbon Audit Guidelines

Carbon Footprint Calculator

Tips for Carbon Reduction

Links



Utilities Carbon Footprint

Next >

Type of Utilities	Consumption	Interval	Unit	Equivalent CO ₂ Emissions (kg CO ₂ -e)
1. Electricity (<input checked="" type="radio"/> CLP <input type="radio"/> HEC)	<input type="text" value="0"/>	Average monthly ▾	<input checked="" type="radio"/> Unit <input type="radio"/> HKD	0
2. Town Gas	<input type="text" value="0"/>	Average monthly ▾	<input checked="" type="radio"/> Unit <input type="radio"/> HKD	0
3. LPG	<input type="text" value="0"/>	Average monthly ▾	<input checked="" type="radio"/> Unit <input type="radio"/> Litre <input type="radio"/> HKD	0
4. Fresh Water	<input type="text" value="0"/>	Average monthly ▾	<input checked="" type="radio"/> Unit <input type="radio"/> HKD	0



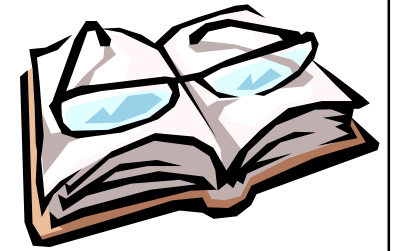
Do you know what are the aspects considered in this carbon footprint calculation?



Classroom exercise

- Make use of your mobile phone, tablet or computer
- Access the following calculators to evaluate your own ecological footprint (EF) & earth overshoot day
 - Footprint Calculator
 - <http://www.footprintcalculator.org/>
 - Ecological Footprint Calculator
 - <http://ecologicalfootprint.com/>
- Discuss with your classmates the following issues:
 - What are the major components of your own EF?
 - What actions/solutions can reduce your EF and impacts?





Further reading

- Videos:
 - The Ecological Footprint Explained (1:20)
<https://youtu.be/fACkb2u1ULY>
 - Ecological Footprint and Carbon Footprint Explained (9:10)
<https://youtu.be/nMn59yNwoZ8>
- Ecological Footprint (Global Footprint Network)
 - <https://www.footprintnetwork.org/our-work/ecological-footprint/>
- Why the Ecological Footprint is the most comprehensive climate change metric available
 - <http://www.footprintnetwork.org/2017/11/09/ecological-footprint-comprehensive-climate-change-metric-available/>