

# MEBS6020 Sustainable Building Design

<http://ibse.hk/MEBS6020/>



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## Introduction



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Jun 2024

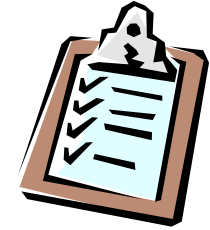


# About the Lecturer

- ***Ir Dr. Sam C. M. Hui*** 許俊民 博士 工程師 <http://ibse.hk/cmhui>
  - Adjunct Assistant Professor 客席助理教授, HKU Dept of Mech Engg
  - PhD, BEng(Hons), CEng, CEM, BEMP, HBDP, MASHRAE, MCIBSE, MHKIE, MIESNA, LifeMAEE, AssocAIA
    - CEng = Chartered Engineer
    - CEM = Certified Energy Manager
    - BEMP = Building Energy Modeling Professional
    - HBDP = High-performance Building Design Professional
    - LifeMAEE = Life Member, Association of Energy Engineers
    - AssocAIA = Associate Member, American Institute of Architects
  - ASHRAE Distinguished Lecturer (2009-2011)
  - President, ASHRAE Hong Kong Chapter (2006-2007)



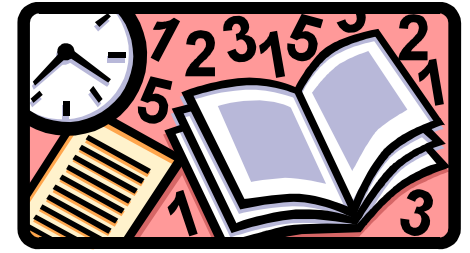
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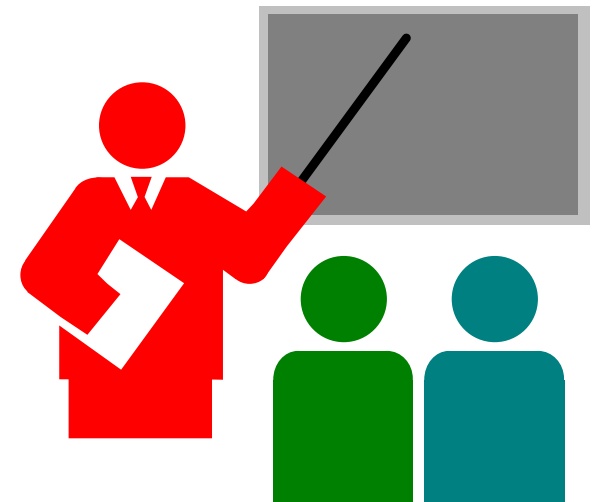
- Course background
- Green/sustainable building
- Green building trends
- Sustainability
- Hong Kong situation



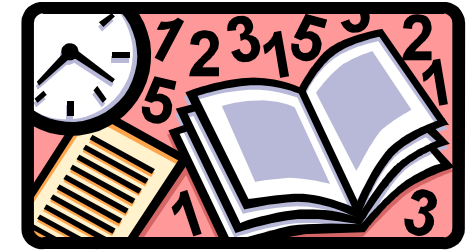
# Course background



- MEBS6020 Sustainable Building Design
  - Educational Objectives
    - To introduce the key concepts and important issues of sustainable buildings
    - To develop practical skills for planning and designing sustainable building projects
  - Assessment:
    - Examination (60%)
    - Continuous Assessment (40%)
      - Two assignments



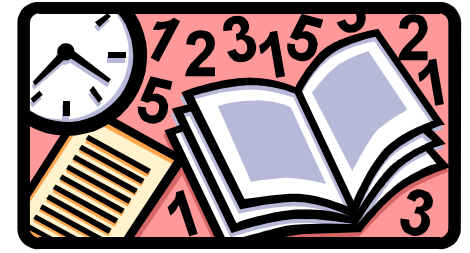
# Course background



- MEBS6020 Sustainable Building Design
  - Learning Outcomes:
    - Describe and apply the key concepts and design strategies to develop sustainable buildings
    - Understand the important issues and major considerations for planning and assessing sustainable buildings
    - Develop practical knowledge and information to study and implement sustainable building projects



# Course background



- Study topics of MEBS6020:
  - 1. Introduction
  - 2. Sustainable Building Concepts (Part 1 & 2)
  - 3. Sustainable Masterplanning (Part 1 & 2)
  - 4. Energy and Environmental Design (Part 1 & 2)
  - 5. Green Building Assessment (Part 1 & 2)
  - 6. Analysis Methods and Tools (Part 1 & 2)
  - 7. Practical Examples



**“What is  
green  
building?”**



An example of green building in Hong Kong ?!

(A building in Pokfulam; photo taken by Dr Sam C M Hui)

# Green building is NOT just adding a green outlook



Cologne

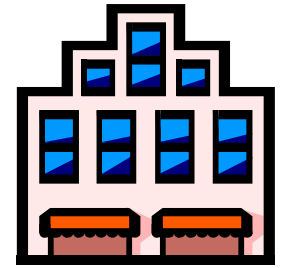
Building  
+  
Green

Toronto





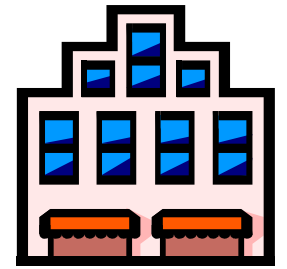
# Green/sustainable building



- A loosely defined collection of land-use, building design, and construction strategies that reduces the **environmental impacts**
- The term “green” is extremely wide ranging, encompassing many viewpoints and open to broad interpretation
  - Debate around green building/architecture
  - Complexity of environmental issues



# Green/sustainable building



- It involves a *holistic* approach to the design and operation of buildings. It considers:
  - *1) Economy and efficiency of resources*
  - *2) Life cycle design*
  - *3) Human well-being*
- Main objectives
  - Be environmentally friendly and responsible
  - Improve the quality of built environment

# Going Green. What is Green Building?

## Going Green

### What is Green Building?

The ideal green building would be a building project that allows you to preserve most of the natural environment around the project site

- The construction and operation promotes a healthy environment for all involved

- The Project will not disrupt the land, water, resources and energy in and around the building

By adopting greener practices, we can take maximum advantage of environment

Green buildings helps in reducing overall impact on environment and human health by

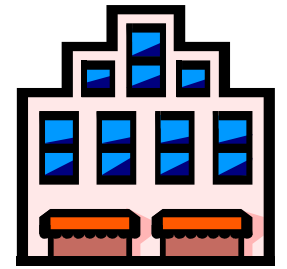
- Reducing trash, pollution
- Efficiently using energy and other resources



- Protecting occupant health and improving productivity.



# Green/sustainable building

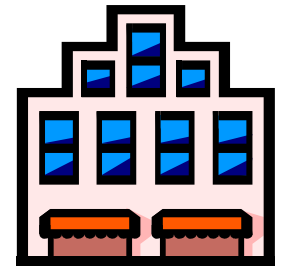


- **What is Green Building?** [World Green Building Council] <https://www.worldgbc.org/what-green-building>
  - It is a building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impacts, on our climate and natural environment
  - Green buildings preserve precious natural resources and improve our quality of life
  - Any building can be a green building, whether it's a home, an office, a school, a hospital, a community centre



WORLD  
GREEN  
BUILDING  
COUNCIL

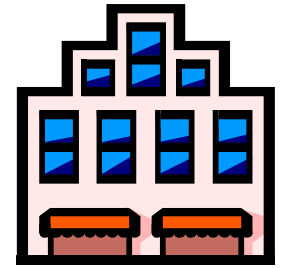
# Green/sustainable building



- **Green Building defined**

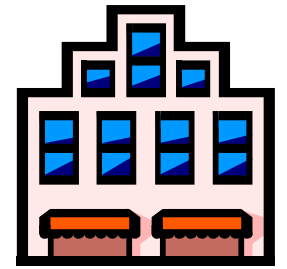
- [HKGBC = Hong Kong Green Building Council]  
<https://www.hkgbc.org.hk/eng/about-us/what-is-green-building/>
- A practice of reducing the environmental impact of buildings and enhancing the health and wellbeing of building occupants
- Provides a quality living amenity for its users and neighbours in terms of social, environmental and economic aspects while minimising negative environmental impact at the local, regional and global levels throughout its full life cycle

# Green/sustainable building



- **Definition of Sustainable Building** [by an OECD project]
  - Have minimum adverse impacts on the built and natural environment, in terms of the buildings themselves, their immediate surroundings and the broader regional and global setting
  - Apply practices which strive for integral quality (economic, social and environmental performance) in a very broad way

# Green/sustainable building



- Green buildings are
  - Energy and resource efficient
  - Non-wasteful and non-polluting
    - Sustainable design that helps minimise broad environmental impacts (e.g. ozone depletion)
  - Highly flexible and adaptable for long-term functionality
  - Easy to operate and maintain (lower running costs)
  - Supportive of the productivity and well-being of the occupants



# What factors determine whether a building is sustainable?





# Eco sustainable building practices

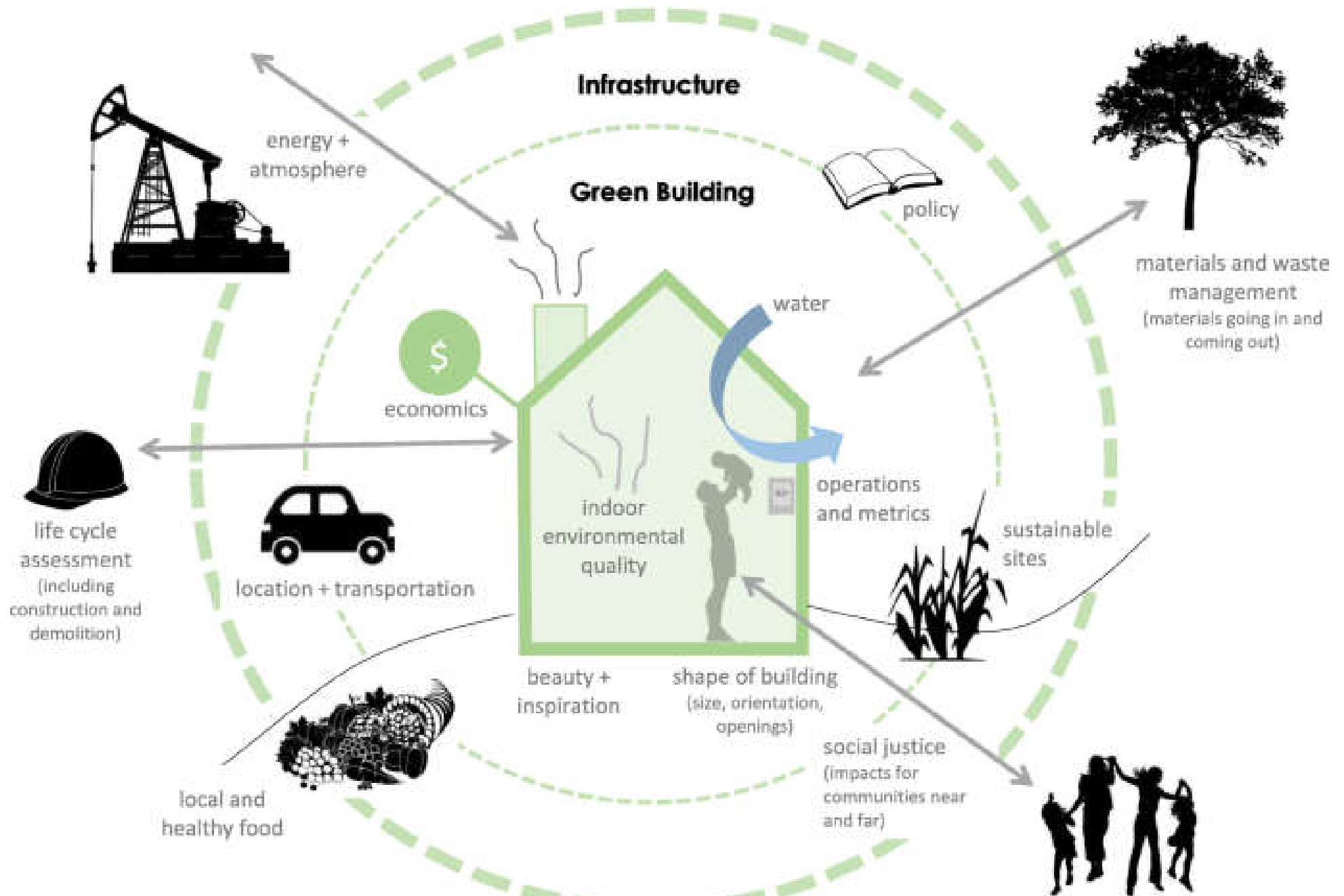


## Features which can make a building 'green'

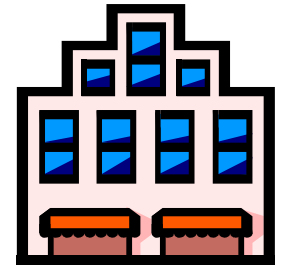
- Efficient use of energy, water & other resources
- Use of renewable energy, e.g. solar energy
- Pollution & waste reduction measures, and the enabling of re-use and recycling
- Good indoor environmental air quality
- Use of materials that are non-toxic, ethical & sustainable
- Consideration of the environment in design, construction & operation
- Consideration of the quality of life of occupants in design, construction & operation
- A design that enables adaptation to a changing environment

# Factual and conceptual green building knowledge

## Ecology



# Green/sustainable building



- Benefits of green buildings:
  - **Environmental**
    - Use less energy, water & natural resources
    - Reduce greenhouse gas (GHG) emissions
    - Increase biodiversity & address climate change
  - **Economic**
    - Utility cost savings (energy & water)
    - Lower construction costs & higher property value
  - **Social**
    - Provide better places for people to support healthier, happier & more productive lives

# How can we make our buildings green?

## 1. Taking an intelligent approach to energy

- Minimise energy use & integrate renewable/low-carbon technologies

## 2. Safeguarding water resources

- Improve water efficiency & management

## 3. Minimising waste & maximising reuse

- Use durable materials & generate less waste; promote reuse & recycling

## 4. Promoting health & wellbeing

- Ensure good quality for indoor air, natural light & acoustics

## 5. Keeping our environment green

- Preserve nature & diverse wildlife; create green spaces

## 6. Creating resilient & flexible structures

- Adapt to changing climate & design flexible spaces

## 7. Connecting communities & people

- Connect & enhance communities; improve transport & communication

## 8. Considering all stages of a building's life-cycle

- Reduce environmental impacts and maximise social & economic value

# Green building trends



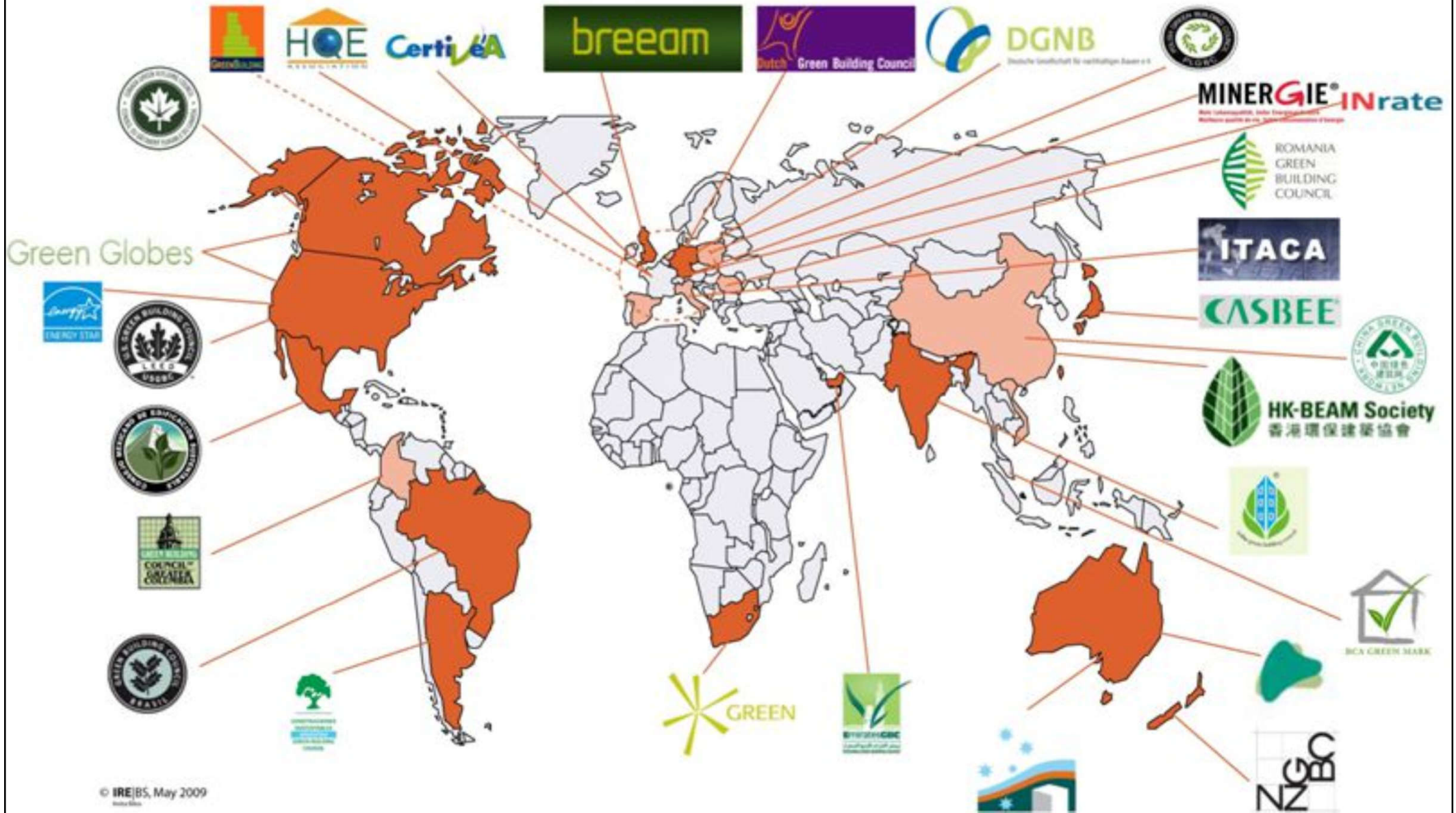
- Worldwide green building movement
  - Establishment of green building councils
  - Green building rating and certification
  - Advancing Net Zero and decarbonisation
- Driving factors:
  - Client demands
  - Environmental regulations
  - Healthier buildings
  - Sustainability



ADVANCING NET  
**ZERO**



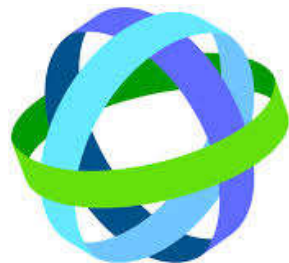
# Green building rating and certification in the world





## Green Building Evolution (3:47)

<https://youtu.be/MroerBD69bA>



WORLD  
GREEN  
BUILDING  
COUNCIL

[www.worldgbc.org](http://www.worldgbc.org)

The story of the evolution of the green building movement told through image and dance. At the opening of the WorldGBC Congress/GBCSA Convention in Cape Town in 2013.





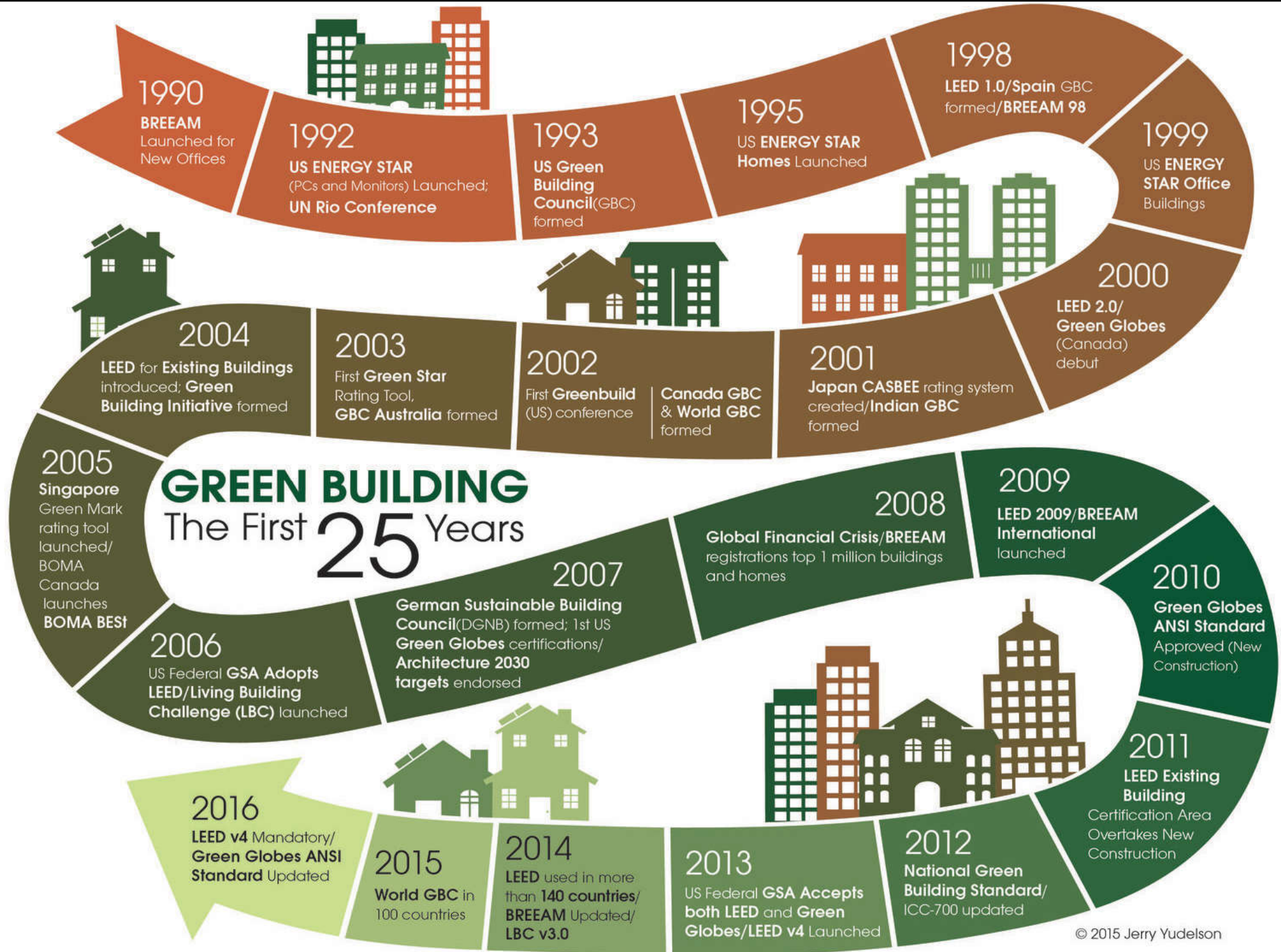
# Green building trends

- Green building (GB) research trends:
  - Project delivery & developments
    - Project management, performance & influential factors
    - GB cost, design, barriers, benefits
  - Green building certifications
    - GB rating systems, assessment methods
  - Energy performance
    - Energy efficiency, life cycle energy analysis
  - Advanced technologies (e.g. BIM, simulation)



# Green building trends

- Green building rating tools & certification
  - To assess & recognise buildings which meet certain green requirements or standards
    - Examples: BEAM Plus, BREEAM, CASBEE & LEED
  - Often voluntary, to encourage good practices
  - Can be applied to the planning & design, construction, operation & maintenance, renovation, and eventual demolition phases
  - For different building types (e.g. homes, commercial buildings or even whole neighbourhoods)



© 2015 Jerry Yudelson

(Source: <https://www.reinventinggreenbuilding.com/news/2016/9/14/reinventing-green-building-a-review>)



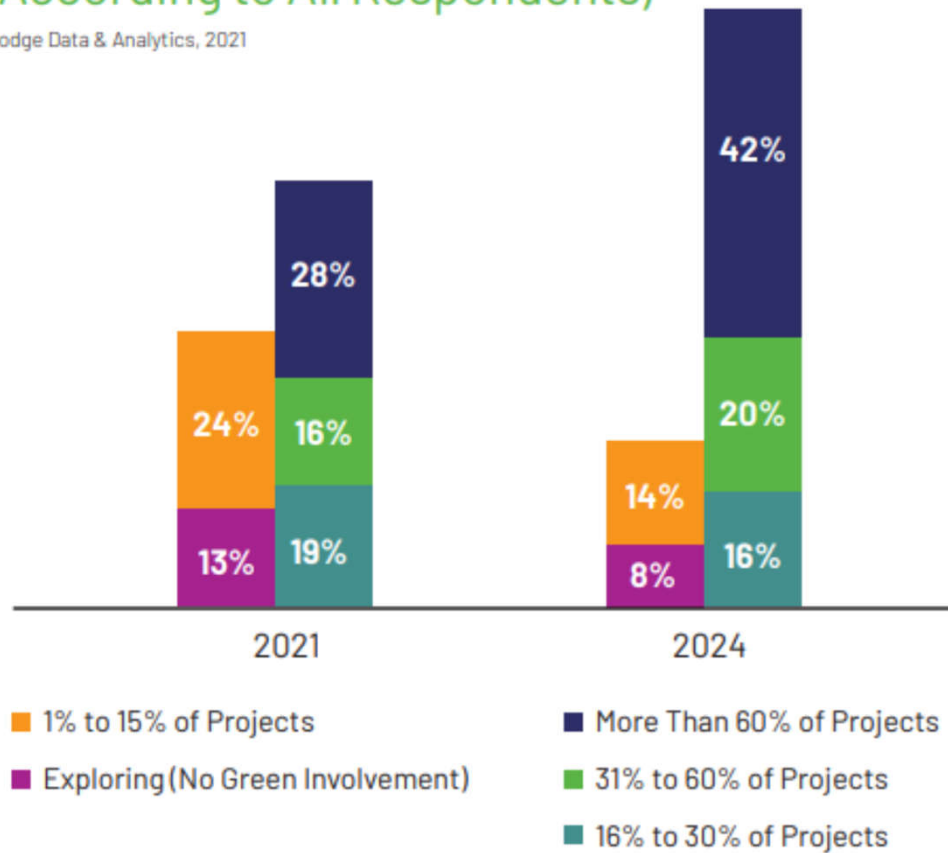
# Green building trends

- Top 5 most important trends:
  - Life cycle thinking and management
  - Health and wellbeing
  - Increased focus on carbon neutrality
  - Resilience (multi-functioning & adaptability)
  - Digitalisation
- Driven by regulatory issues, financial benefits, environmental awareness & responsibility

# World green building trends 2021

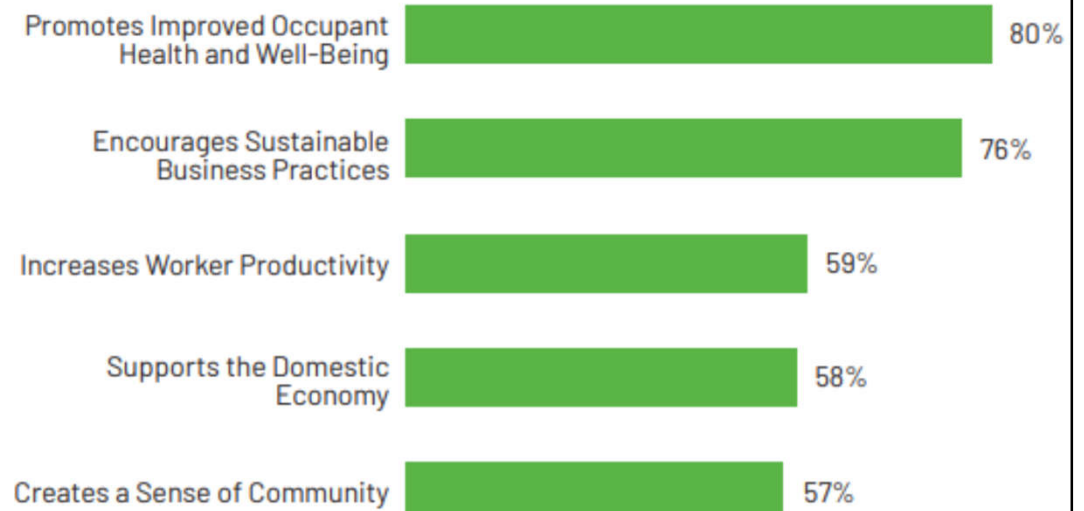
## Level of Green Building Activity (According to All Respondents)

Dodge Data & Analytics, 2021



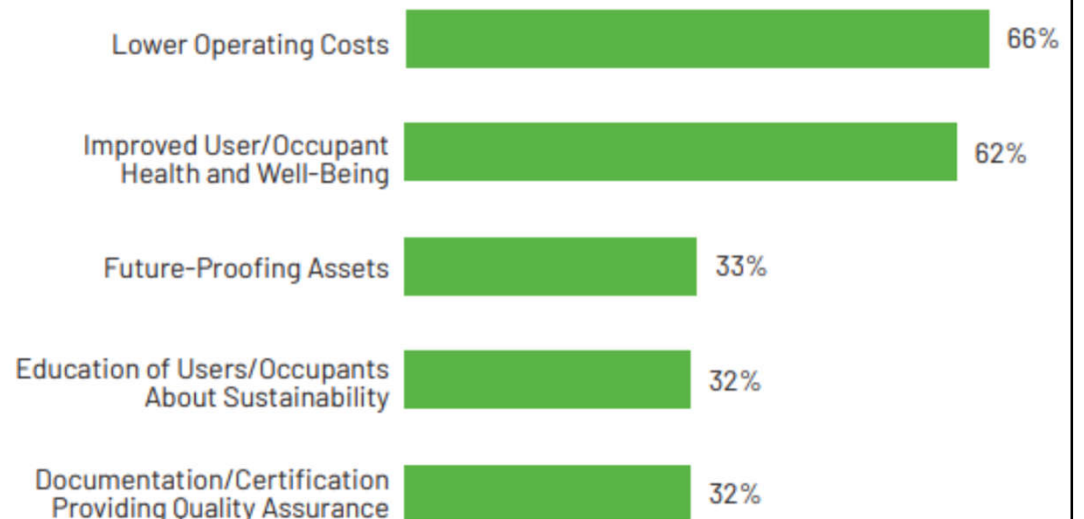
## Social Reasons to Build Green Rated Important/Very Important

Dodge Data & Analytics, 2021



## Most Important Business Benefits of Green Building

Dodge Data & Analytics, 2021



Emerging approaches to building green:

- Reduce embodied carbon
- Create net-zero/net-positive buildings
- Design for disassembly and recovery
- Design for manufacturer and assembly

# Green building trends



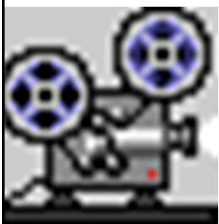
- Top green building trends for 2022 & beyond:
  - Resilient building design
  - Design for health, wellness, and indoor air quality
  - Net zero energy design
  - Water self sustainable design
  - Passive building design
  - Biophilic design
  - Adaptive reuse





# Green building trends

- An example of green building rating tool:  
LEED by U.S. Green Building Council
  - Video: What is green building? (1:16)  
<https://youtu.be/MyIOtsx3wDs>
- Green, sustainable and healthy buildings
  - How are they different in concepts?
  - Video: Green sustainable and healthy buildings explained (2:25) [https://youtu.be/dDATY3av\\_48](https://youtu.be/dDATY3av_48)





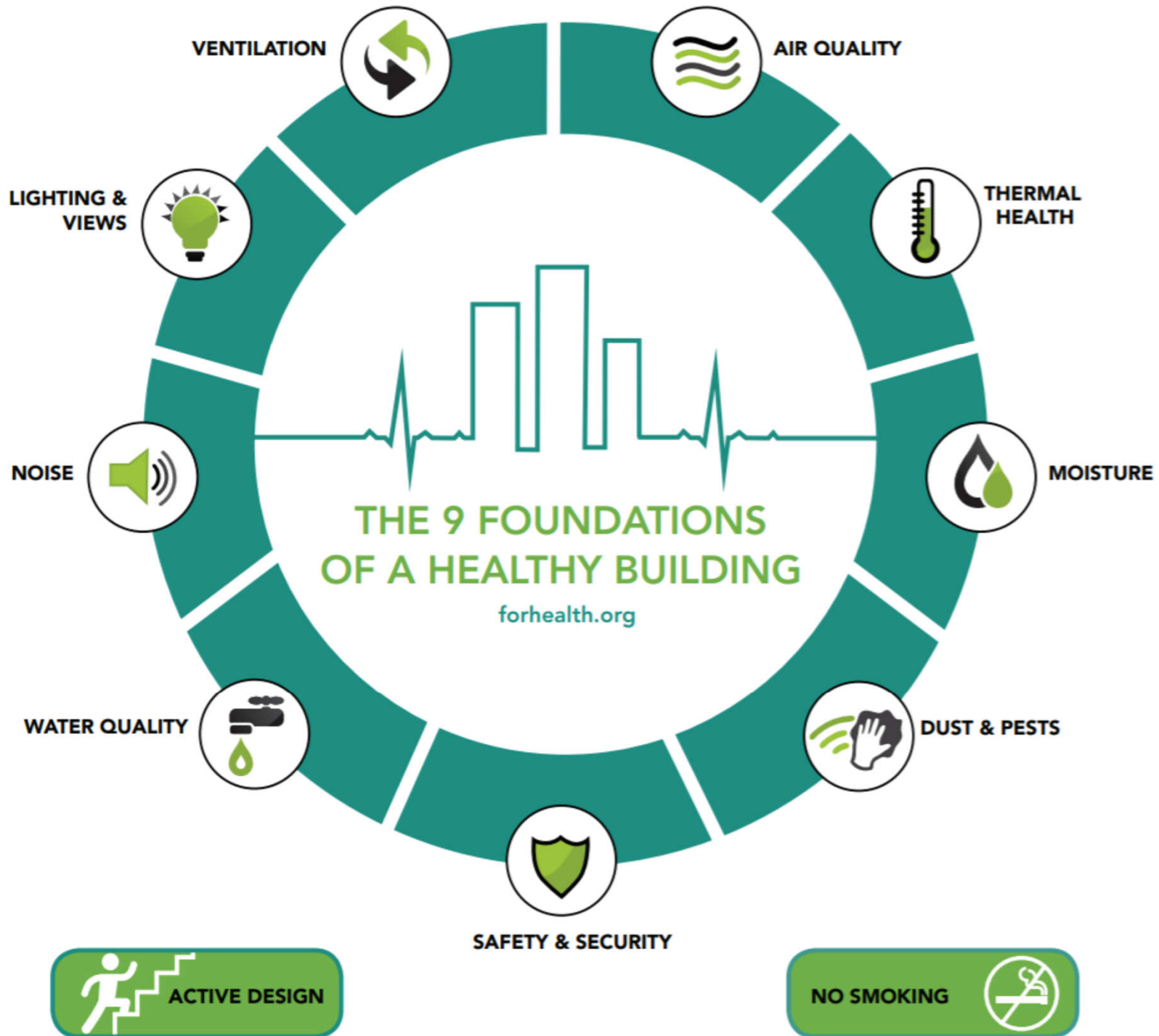
# Green building trends

- Healthy building 健康建築
  - It refers to an emerging area of interest that supports the physical, psychological, and social health and well-being of people in buildings and the built environment
  - Components:
    - Site selection
    - Building design
    - Indoor environmental quality (IEQ), e.g. daylighting
    - Diet and exercise





# The 9 Foundations of a Healthy Building

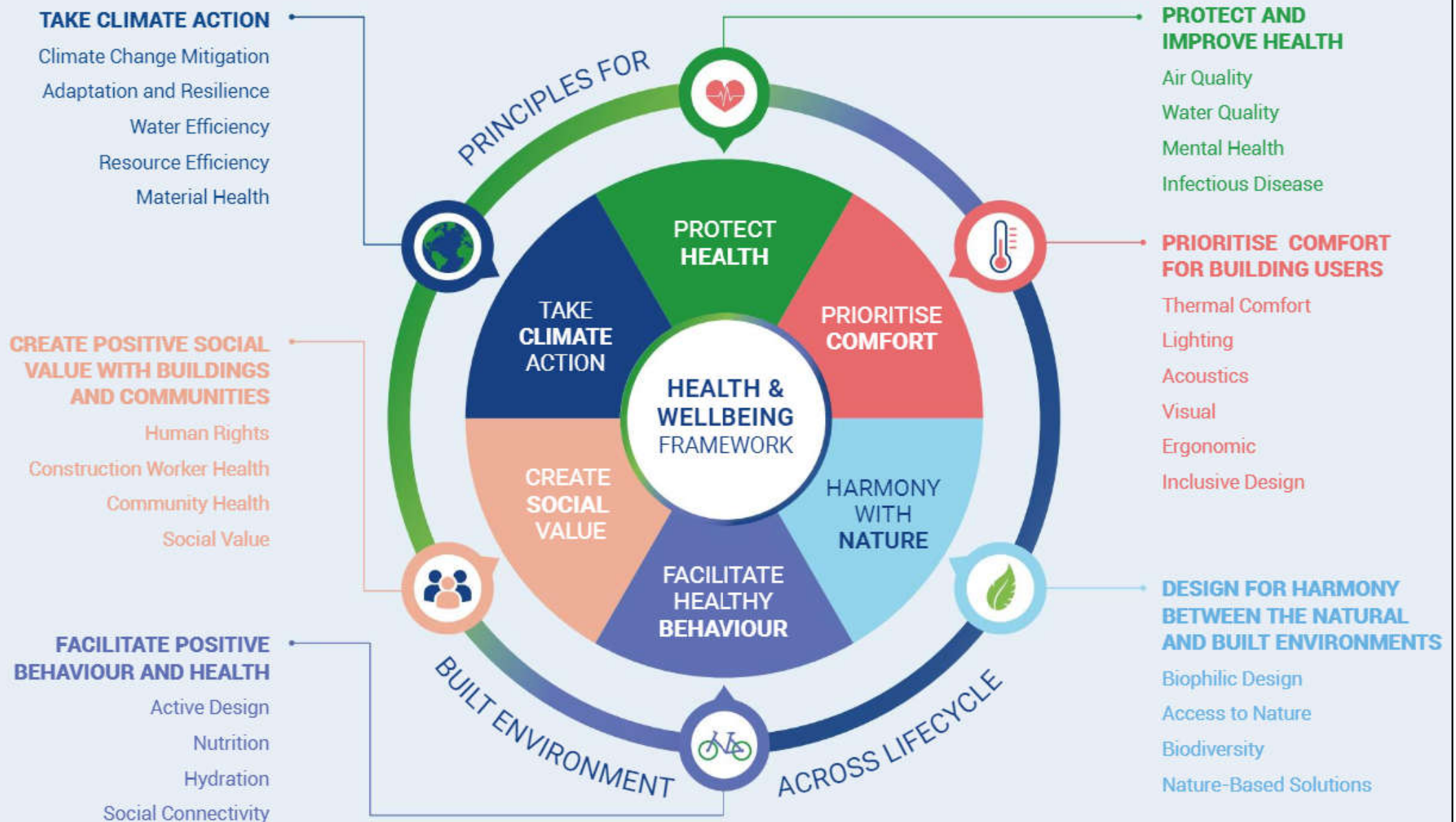


# Elements of healthy buildings and green buildings

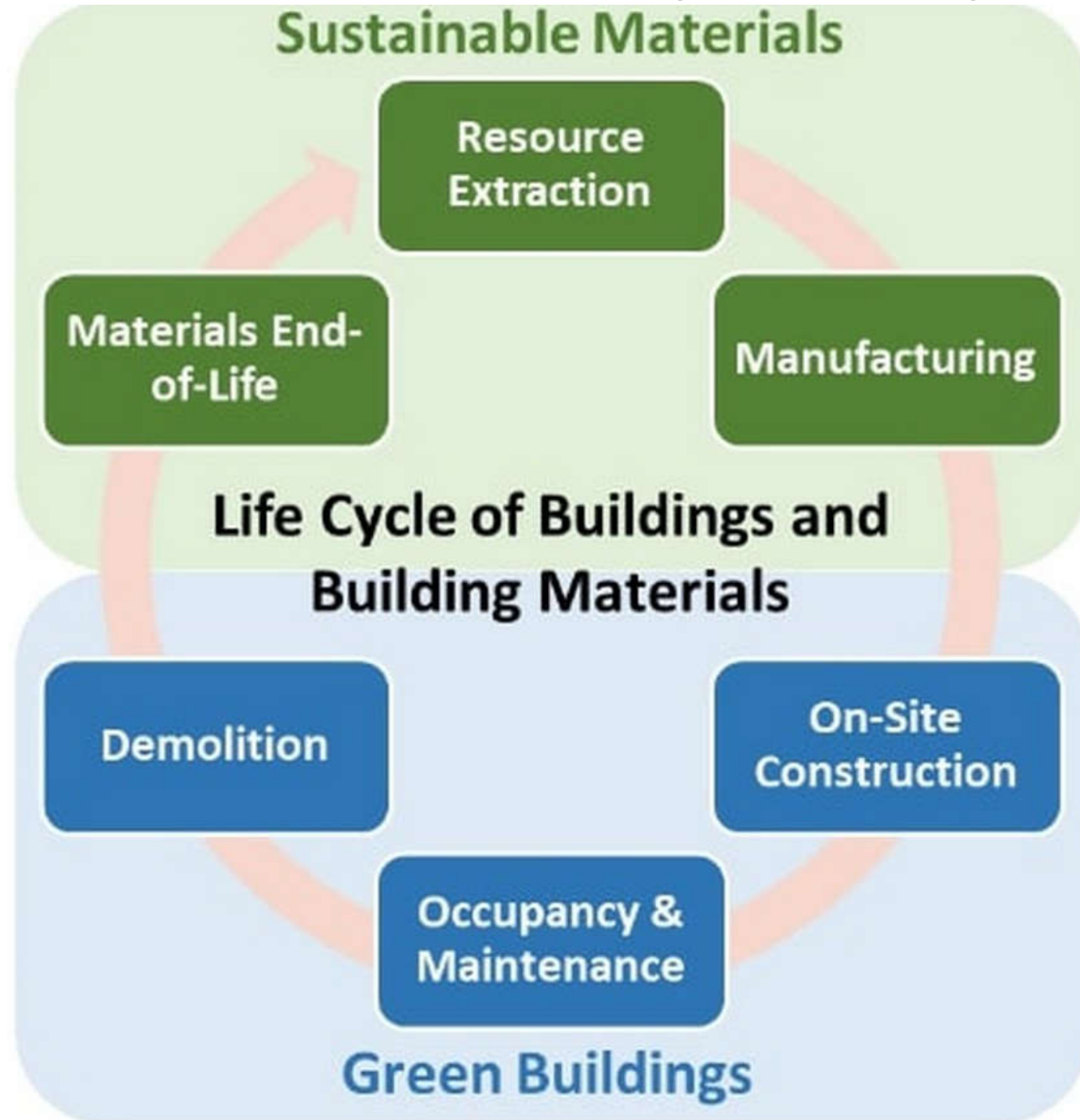
 <b>Natural Elements</b>	 <b>Health &amp; Wellness</b>	 <b>Materials &amp; Resources</b>	 <b>Community</b>	 <b>Energy</b>		
 1 Collect Rainwater	 9 <sup>50 PA</sup> Tight Building Envelope	 16 One Planet Living 1/5	 38 Low Water Landscape	 2 Highly Insulated	 22 Battery Back-up	
 3 Rain-screen Technology	 15 Indoor Air Quality	 17 Healthy & Happy Homes	 45 Green Building Certifications	 39 Kitchen Sink Faces Central Courtyard	 5 Daylight	 23 Electric Car Charging
 4 Extreme Climate	 25 Passive Cooling	 18 FSC Eco-friendly Lumber	 46 Faster Construction	 40 Community Garden	 6 Wind Energy	 31 Insulated Floors
 8 Greywater System	 35 No Off Gassing	 26 Reduce, Reuse & Recycle Materials	 47 Durability	 41 Urban Infill	 7 Solar Hot Water	 32 Energy Star
 14 Water Savings	 27 Renewable Resources	 10 Kid and Pet Friendly	 48 Local Labor	 11 Direct Current Electricity	 33 Heat Recovery Ventilation	
 24 <sup>100 mph</sup> Wind & Seismic	 28 Compost	 19 Porches Face Each Other	 49 Financially Accessible	 12 LED Lighting	 42 <sup>\$ 0.00 / yr</sup> Net Zero Energy	
 34 <sup>100 psf</sup> Snow Load	 36 Living Wall & Roof	 20 People Inside, Cars Outside	 50 Sound Attenuation	 13 Solar Powered Electricity	 43 Passive Solar	
 44 Fire & Earthquake Protection	 37 Roof Garden	 29 Homes Around Central Courtyard	 21 Home Automation			

# The WorldGBC Health & Wellbeing Framework

Six Principles for a Healthy, Sustainable Built Environment



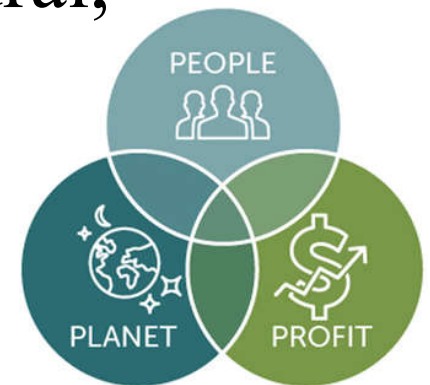
# Sustainable materials and green buildings



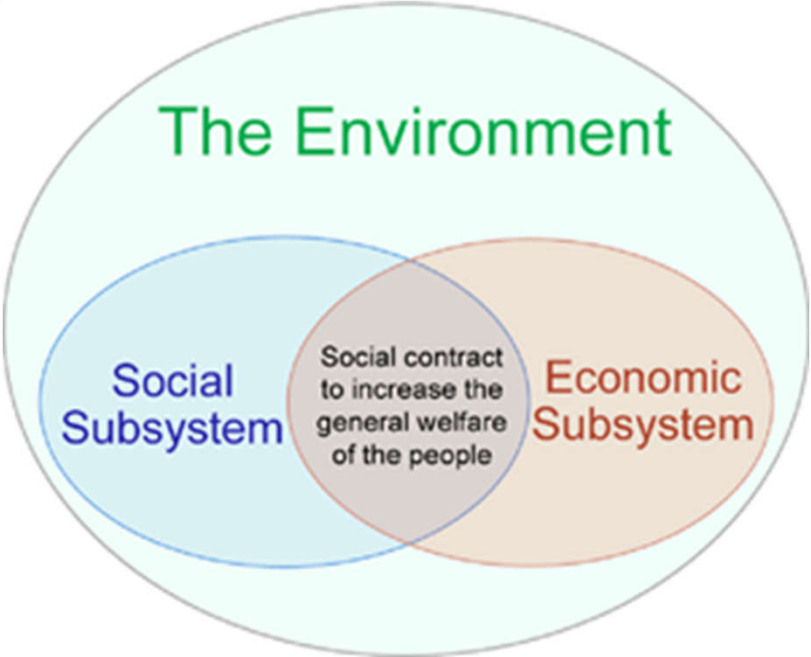
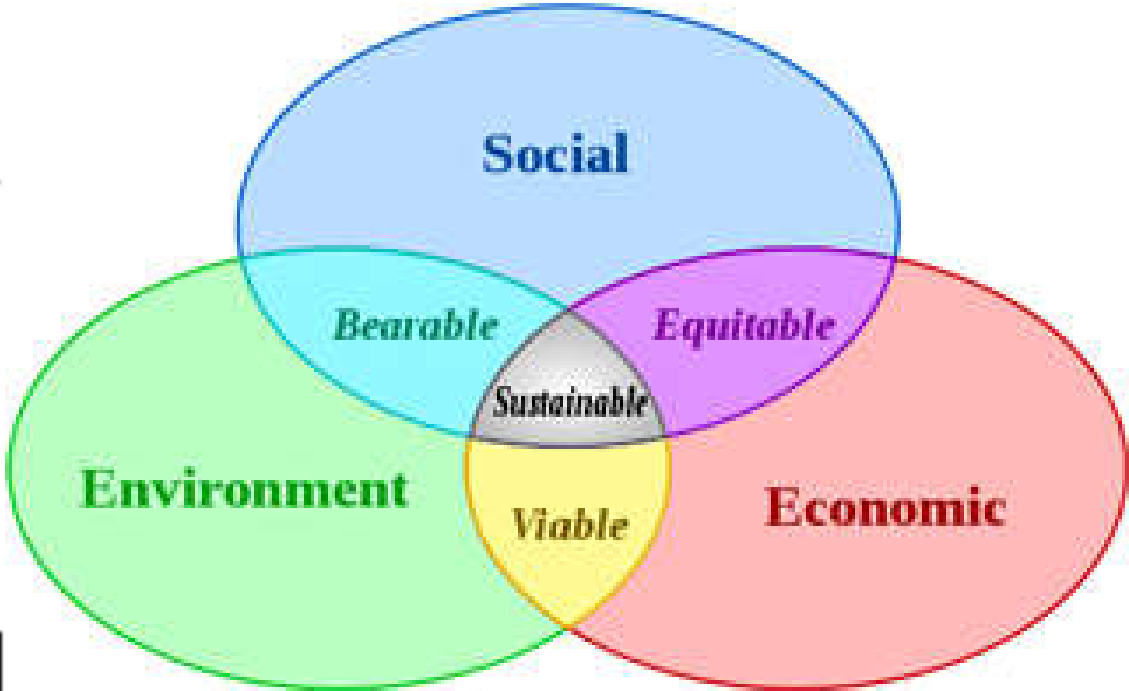
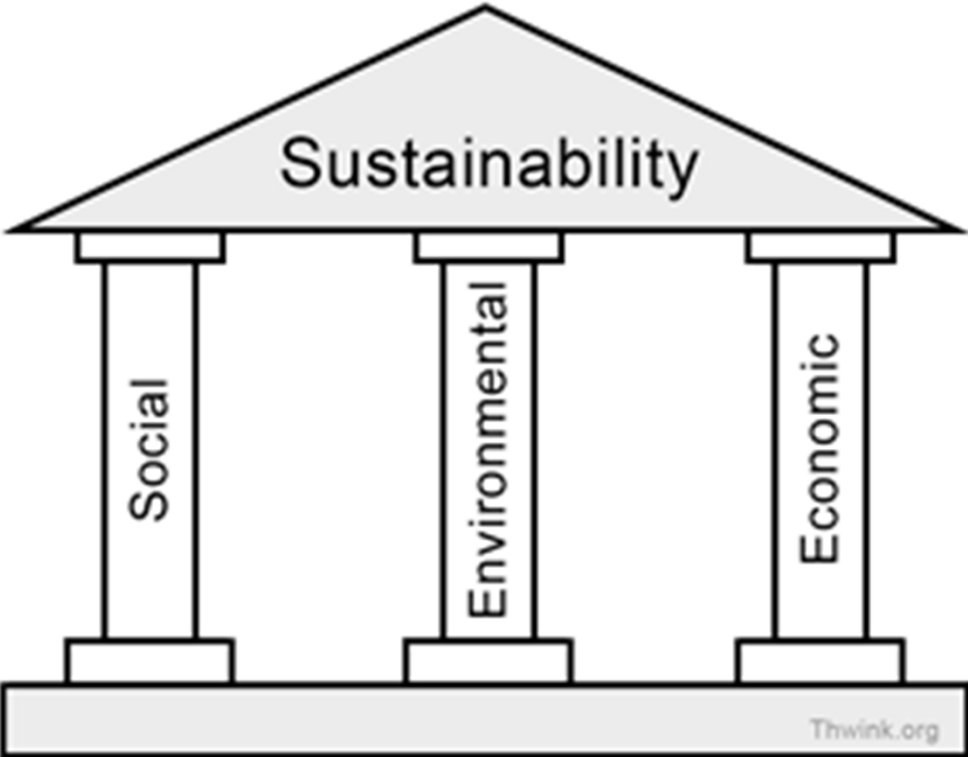
# Sustainability



- Sustainability focuses on meeting the needs of the present without compromising the ability of future generations to meet their needs
  - Three pillars of sustainability: economic, environmental, and social (also known informally as profits, planet, and people)
  - Five domains: environmental, social-cultural, technological, economic, public policy



# Three pillars of sustainability

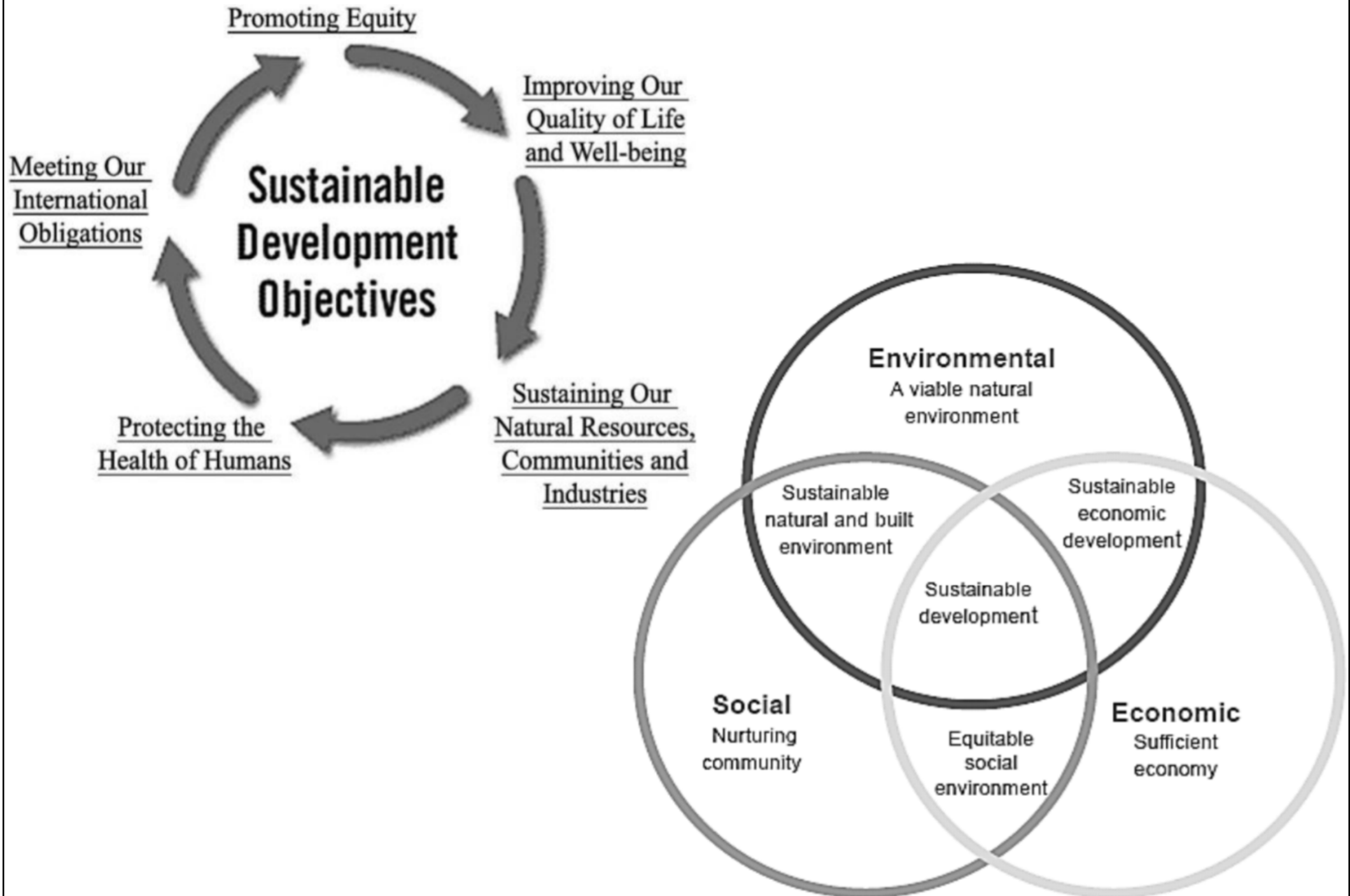


(Source: The Three Pillars of Sustainability <https://www.thwink.org/sustain/glossary/ThreePillarsOfSustainability.htm>)

# Five domains of sustainability



# Sustainable development objectives







# Sustainability

- Green building can help to achieve the UN Sustainable Development Goals (SDGs)
  - <https://www.worldgbc.org/news-media/green-building-improving-lives-billions-helping-achieve-un-sustainable-development-goals>
  - A challenge for humanity to decouple economic growth from climate change, poverty & inequality
  - Not only save energy, water & carbon emissions but to educate, create jobs, strengthen communities, improve health & wellbeing

# SUSTAINABLE DEVELOPMENT GOALS





# Sustainability

- Green building affects 9 nos. SDGs:
  - 3. Good health and well-being
  - 7. Affordable and clean energy
  - 8. Decent work and economic growth
  - 9. Industry, innovation and infrastructure
  - 11. Sustainable cities and communities
  - 12. Responsible consumption and production
  - 13. Climate action
  - 15. Life on land
  - 17. Partnerships for the goals

# Green building & the Sustainable Development Goals (cityscape)



WORLD GREEN BUILDING COUNCIL

SUSTAINABLE DEVELOPMENT GOALS



# How green homes help to achieve sustainable development goals



WORLD GREEN BUILDING COUNCIL

SUSTAINABLE DEVELOPMENT GOALS

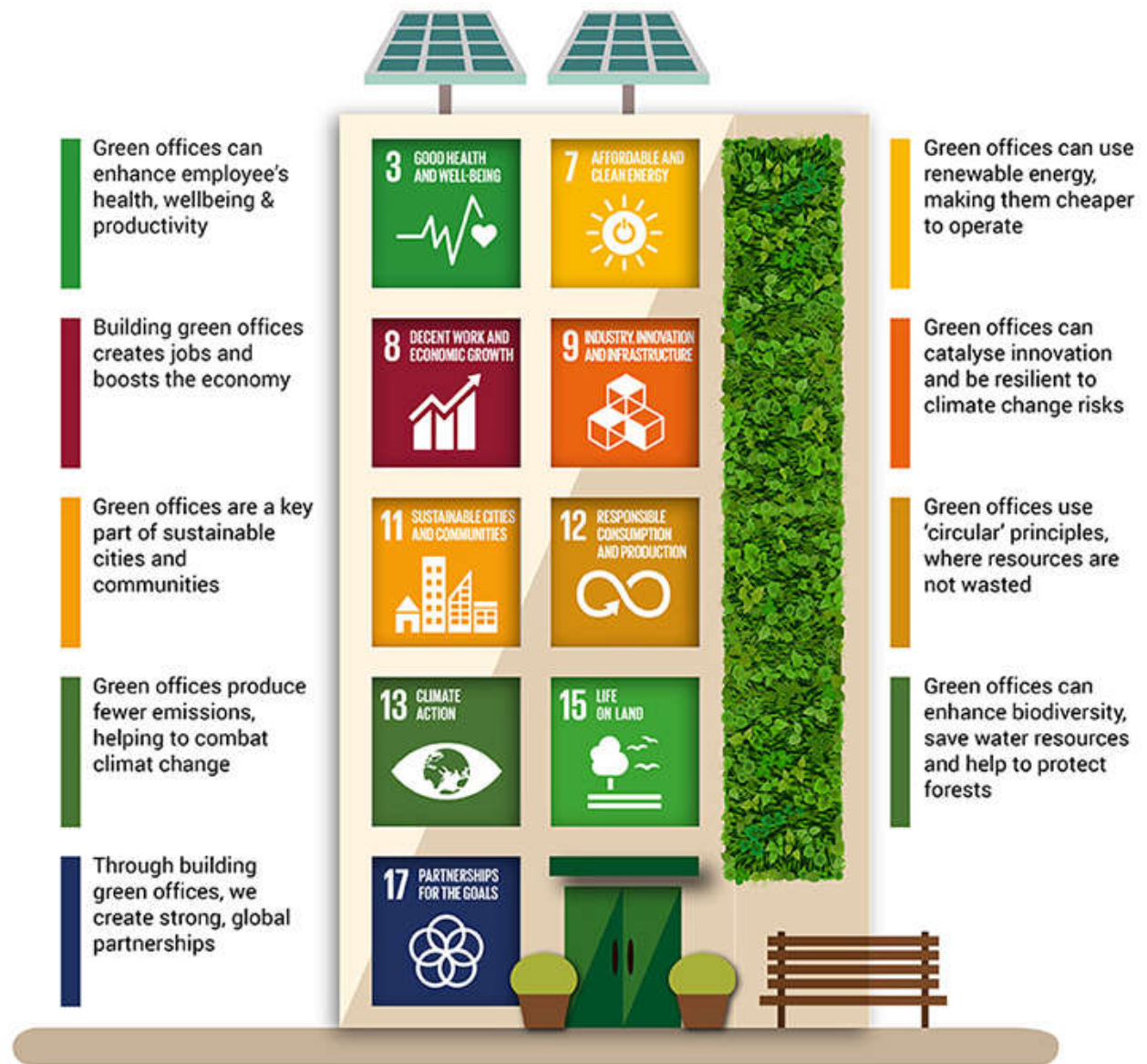
# How green offices help to achieve sustainable development goals

How **green offices** can provide the foundations towards meeting several **Sustainable Development Goals**



WORLD GREEN BUILDING COUNCIL

SUSTAINABLE DEVELOPMENT GOALS



# Sustainability



- Corporate Social Responsibility (CSR) 企業社會責任
  - Refers to a company's commitment to practice environmental and social sustainability and to be good stewards of the environment and the social landscapes in which they operate
  - Business ethics + Green business + Eco-certification
- Sustainability and CSR reporting
  - CSR initiatives for green buildings
  - Make public their environmental performance in accordance with the Global Reporting Initiative
    - Example: <https://www.hanison.com/eng/CSR/Reports.aspx>





# Sustainability

- Companies that include green buildings in their CSR strategy will have a higher stock market performance because:
  - Green buildings are more efficient in their operation and reduce costs which improves the cost structure of companies
  - Green building investments signal a commitment to CSR which in turn positively affect consumer, employee and other stakeholder attitudes towards the company



## Asset Management Results 4 -CSR Activities-

- Contributing to neighboring communities through CSR activities and application of environmentally friendly measures

### Yoyogi Place : Enhancing energy saving measures (May 2013)



#### Low-Carbon Small and Medium-Sized Model Buildings

- On May 2013, Tokyo Metropolitan Government publicized buildings that shall be ranked more than A1 based on the benchmark for low-carbon building (CO2 emissions within a year/gross floor area) as "Low-Carbon Small and Medium-Sized Model Buildings" which actively worked for energy saving
- Improved environmental performance of building through energy efficient facilities
- Co-worked for energy saving with each tenant while maintaining tenant service level

Benchmark for low-carbon building  
A2



### TLC Ebisu Building : Joined energy-saving program (2008~)



#### "Reduction of CO2" Program for Small and Medium-Sized Office Buildings

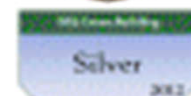
- Joined "Reduction of CO2" Program for Small and Medium-Sized Office Buildings hosted by Tokyo Metropolitan Government since 2008
- Changed to better electrical equipment such as installing a heat source system
- Changed the lighting to more energy saving types in exclusive area

Continuous power-saving effect

### CSR activities : Awarded DBJ Green Building Silver (March 2013)



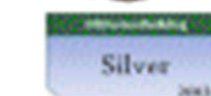
- High-reflectance paint on the rooftop
- Automatic dimming in exclusive area
- Moist pavement (water sprinkling)
- Roof gardening
- LED lighting in common space
- Wallgreening



(A-PLACE Ikabukuro)



- Automatic switching of kitchenette lights
- Automatic dimming in exclusive area
- West outer wall louver
- LED lights

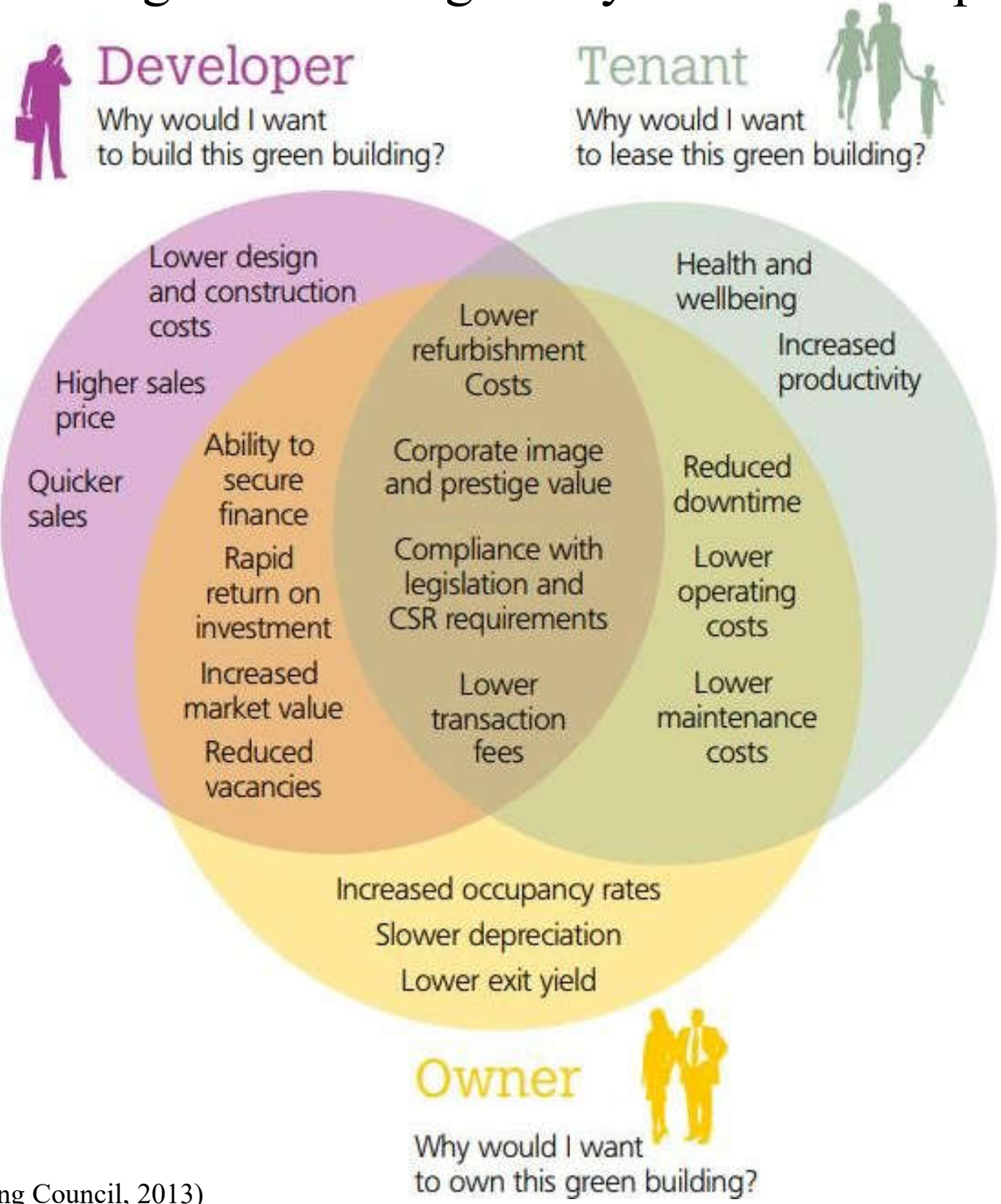


(Kanayama Center Place)

\* Rank of certification

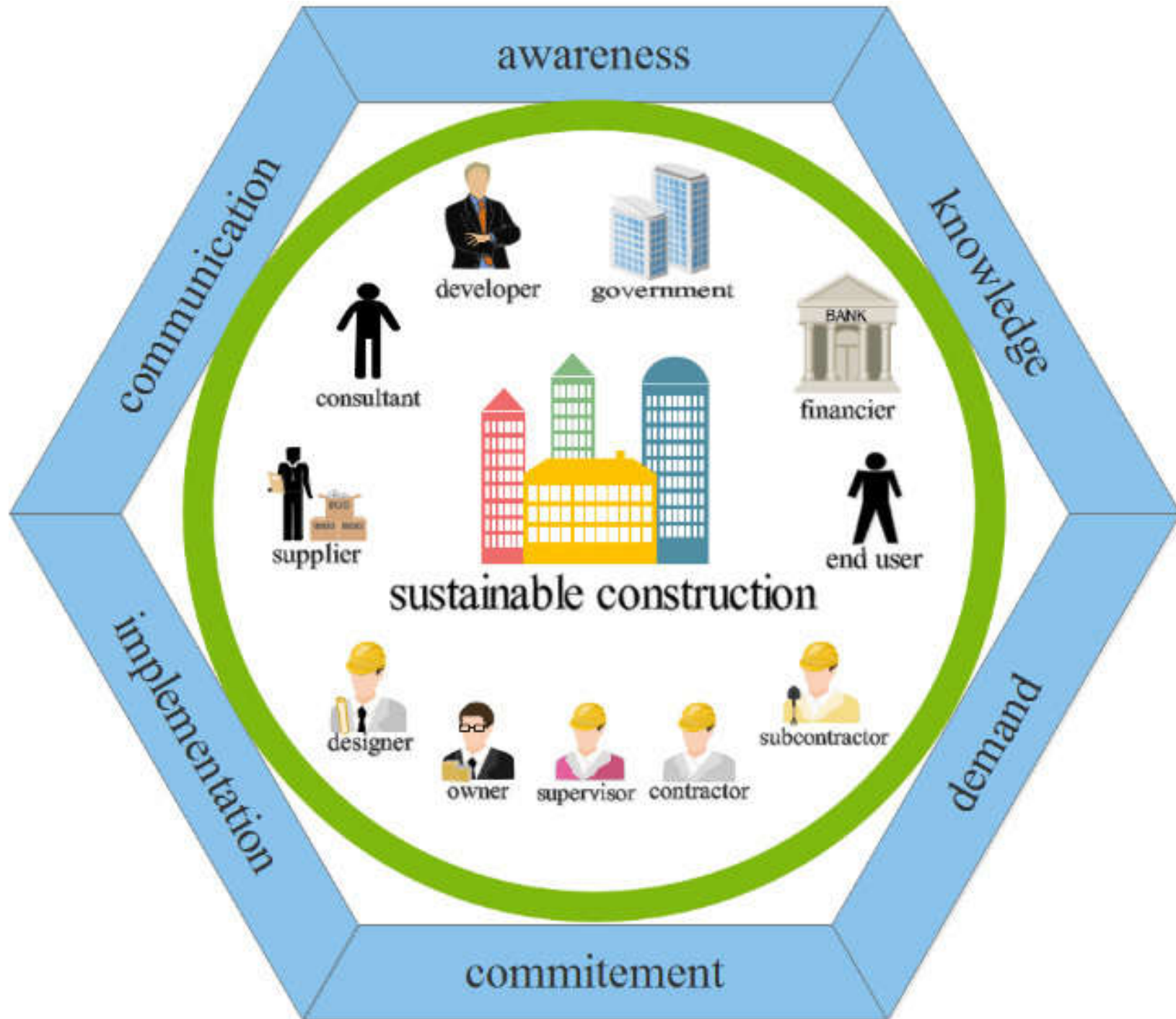
Platinum
Gold
Silver
Bronze
Certified

# The benefits of green building in key stakeholders' perspective



(Source: World Green Building Council, 2013)

# Stakeholders and factors surrounding sustainable construction



# Hong Kong situation



- Subtropical climate
- Population > 7.4 million, land area 1,106 km<sup>2</sup>
- Hilly and mountainous terrain
- High-rise, high density urban areas
- Building-related activities account for 90% of Hong Kong's total electricity consumption and 60% of the city's greenhouse gas emissions



# Hong Kong Context

**42,000+**



42,000+ buildings  
in private sector

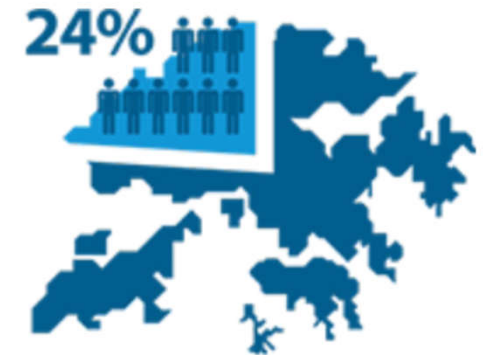
**8,000**



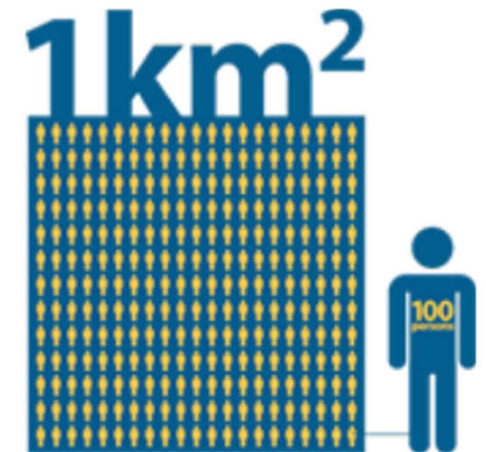
8,000 high-rise buildings  
and skyscrapers



Our activities in buildings account for  
**90% of electricity consumption** or  
**60% of carbon emission** in Hong Kong



People live and work in  
**24% of Hong Kong's**  
total area



Average population  
density of built-up areas  
reaches **27,330**  
**persons/km<sup>2</sup>**



# Hong Kong situation

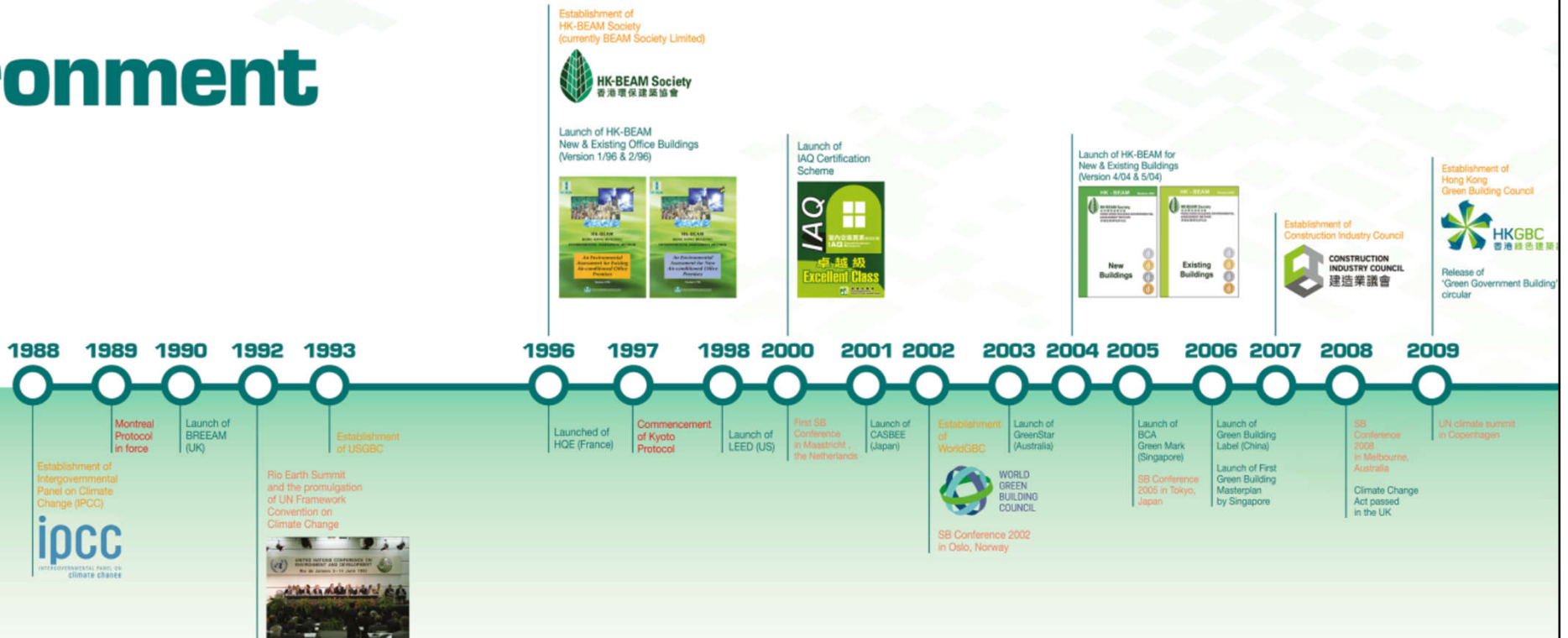
- Hong Kong's first green building benchmark was launched in 1996 (i.e. HK-BEAM)
- Hong Kong milestone and timeline  
[https://www.hkgbc.org.hk/eng/about-us/file/HKreport2017\\_Timeline.pdf](https://www.hkgbc.org.hk/eng/about-us/file/HKreport2017_Timeline.pdf)
- 2009: Establishment of Hong Kong Green Building Council (HKGBC)
- Government actions on energy saving and climate change

# Our journey to sustainable built environment (1988-2009)

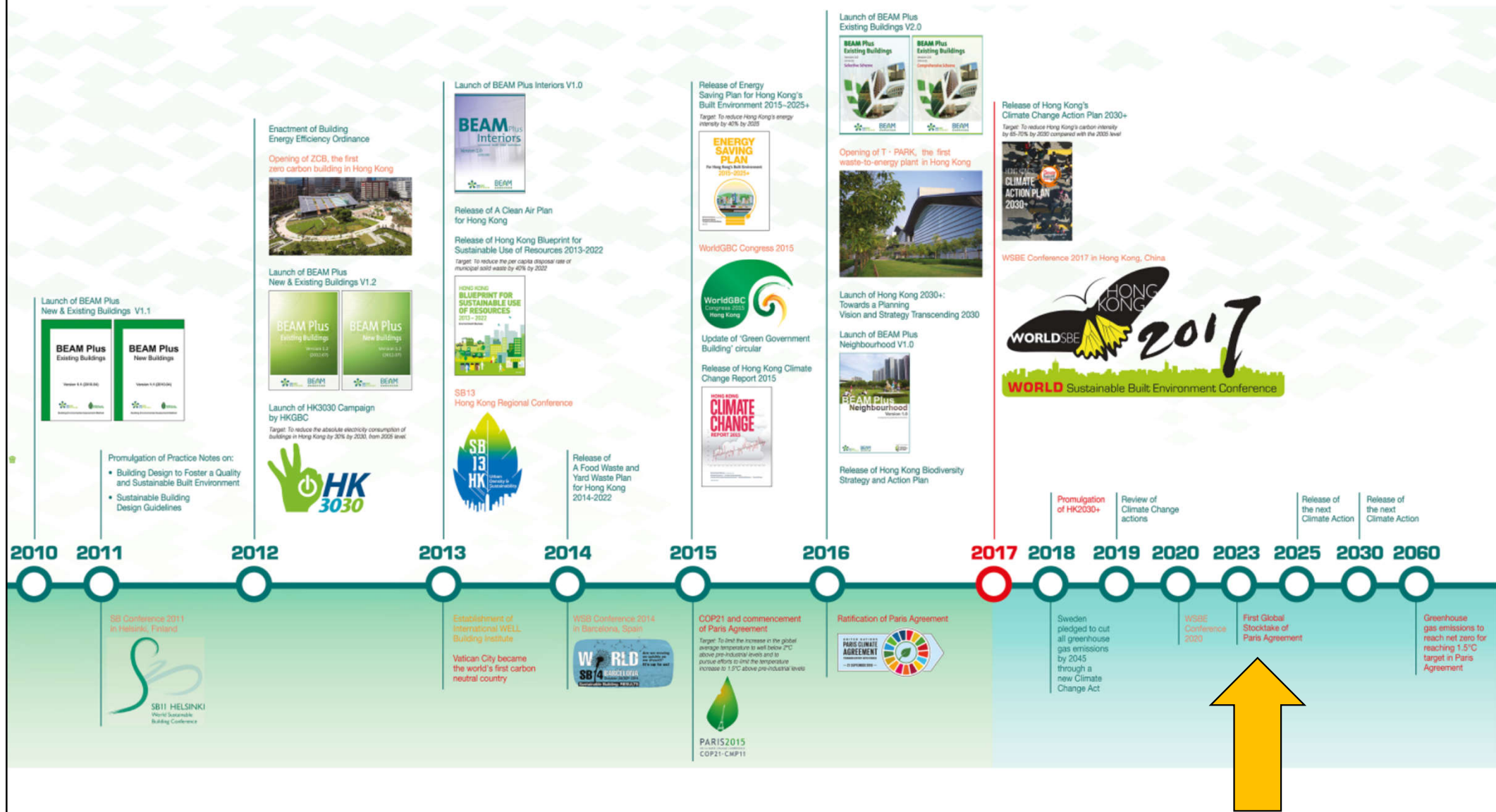
## Our Journey to Sustainable Built Environment

### Hong Kong Milestone

### Global Milestone



# Our journey to sustainable built environment (2010 and beyond)



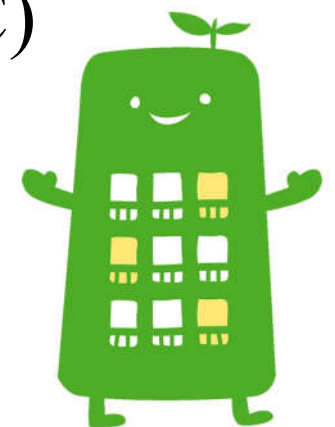
(Source: Hong Kong milestone and timeline [https://www.hkgbc.org.hk/eng/about-us/file/HKreport2017\\_Timeline.pdf](https://www.hkgbc.org.hk/eng/about-us/file/HKreport2017_Timeline.pdf))



# Hong Kong situation



- Four founding members of HKGBC:
  - Construction Industry Council (CIC)
  - Business Environment Council (BEC)
  - BEAM Society Limited (BSL)
  - Professional Green Building Council (PGBC)
- Major issues
  - Green building assessment and certification
  - Related government policies
  - Education and information



HONG KONG  
GREEN BUILDING WEEK  
香港綠色建築週

# Hong Kong Green Building Week (HKGBW)



主辦機構 Organised by



全力支持 Fully Supported by



Environment and Ecology Bureau  
The Government of the Hong Kong Special Administrative Region



World Green Building Week

<https://worldgbc.org/world-green-building-week/>

(See also: <https://www.hkgbc.org.hk/eng/engagement/public-initiatives/hkgbw/>)



【綠築仔綠袖子話你知】一星期「綠」檔案—綠色建築 (3:10) <https://youtu.be/8PfWe9r5aok>

# 星期「綠」檔案 綠色建築

Green Building Connection

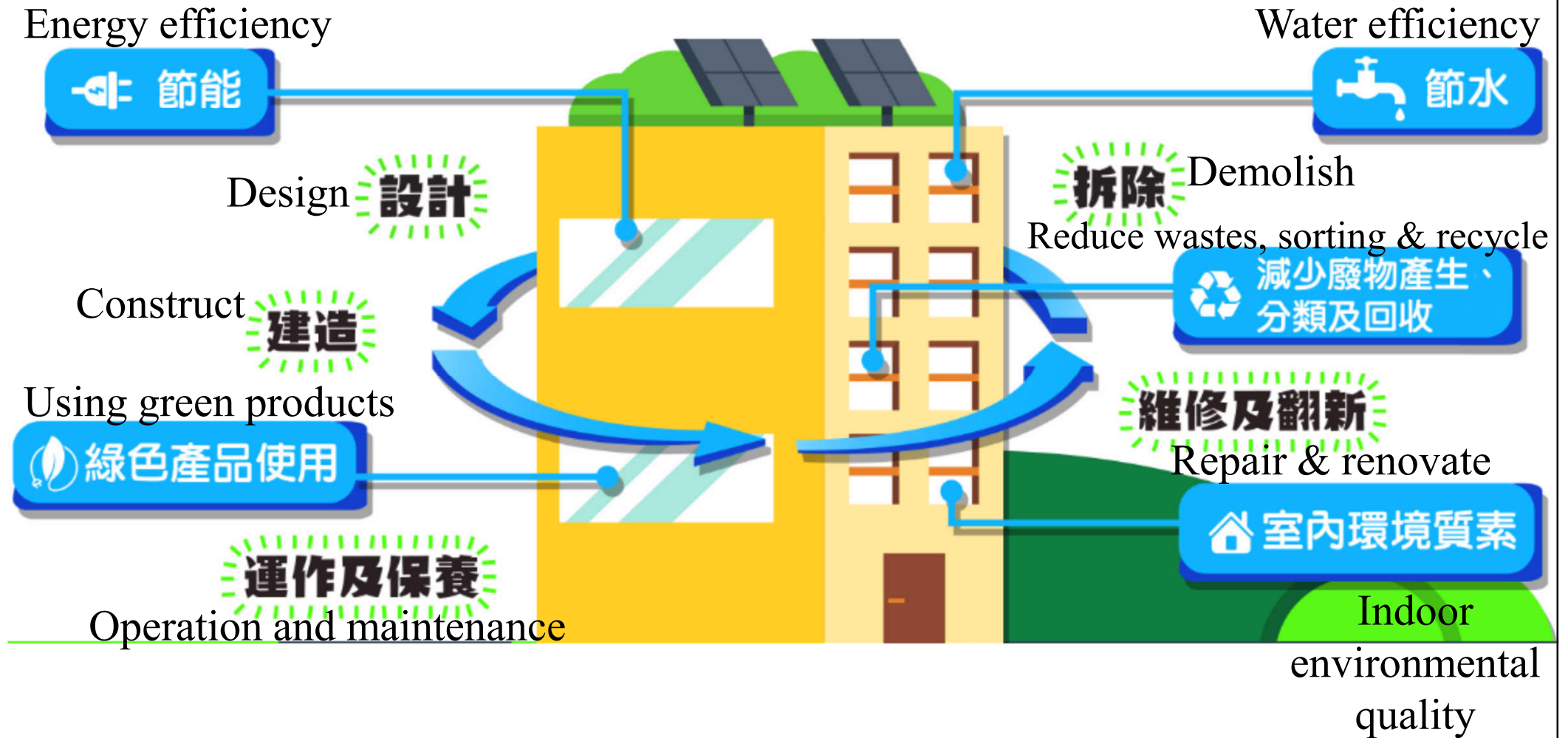


▶ ⏪ 🔊 0:03 / 3:10



# What is Green Building? Hong Kong Context

## 甚麼是綠色建築?



# Climate Action Plan and Energy Saving Plan in Hong Kong



# Hong Kong situation



- Related policies and practices in Hong Kong
  - Hong Kong Planning Standards & Guidelines
    - [www.pland.gov.hk/pland\\_en/tech\\_doc/hkpsg/](http://www.pland.gov.hk/pland_en/tech_doc/hkpsg/)
  - Town planning (by outline zoning plans OZP)
  - Buildings Ordinance (Cap. 123) and the Building (Planning) Regulations
  - Practice Notes for Authorized Persons and Registered Structural Engineers (PNAPs) and Joint Practice Notes (JPNs)
  - Building energy codes

# Joint Practice Notes (JPNs) on protection and improvement of the built and natural environment

JPN1 Green and Innovative Buildings (Sep 2019)

JPN2 Second Package of Incentives to Promote Green and Innovative Buildings (Jul 2022)

JPN 3 Landscape and Site Coverage of Greenery (Apr 2019)

JPN 4 Development Control Parameters (Oct 2021)

JPN 5 Development Control Parameters Building Height Restriction (Apr 2019)

JPN 6 Sustainable Building Design Guidelines: Building Separation and Building Setback (Sep 2019)

JPN 7 Development Control Parameters Site Coverage Restriction (Aug 2021)

JPN 8 Incentive to Promote Green and Innovative Buildings Enhanced Facilitation Measures for Buildings Adopting Modular Integrated Construction (Jul 2022)





# Hong Kong situation

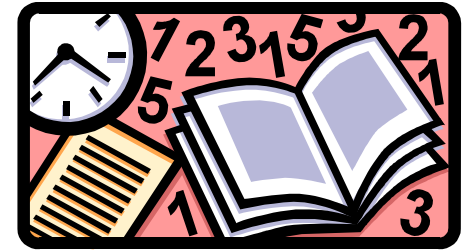
- Joint Practice Note JPN1 Green and Innovative Buildings
  - (a) Adopting a holistic life cycle approach to planning, deconstruction and maintenance;
  - (b) Maximizing the use of natural renewable resources and recycled/green building material;
  - (c) Minimizing the consumption of energy, in particular those non-renewable types; and
  - (d) Reducing construction and demolition waste.





# Further Reading

- Green building -- Wikipedia  
[http://en.wikipedia.org/wiki/Green\\_building](http://en.wikipedia.org/wiki/Green_building)
- Green vs. Sustainable Building  
<https://www.geeksforgeeks.org/green-vs-sustainable-building/>
- What is Green Building? [HKGBC]  
<https://www.hkgbc.org.hk/eng/about-us/what-is-green-building/>
- Benefits of green building [USGBC]  
<https://www.usgbc.org/press/benefits-of-green-building>



# References

- Appleby P., 2011. *Integrated Sustainable Design of Buildings*, Earthscan, London & Washington, DC.
- Keeping M. and Shiers D., 2017. *Sustainable Building Design : Principles and Practice*, Wiley-Blackwell, New York.
- Tam, A., 2006. *Sustainable Building in Hong Kong: the Past, Present and Future*, Insitu Pub. Ltd., Hong Kong.