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Design of High Performance Green Buildings: Opportunities and Challenges

高效能綠色建築設計: 機遇與挑戰

1911-2011

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Acknowledgments

- ASHRAE Headquarters
- Mr. Kent W. Peterson
  - Past Chairman of ASHRAE Standard Project Committee 189.1 (SPC 189.1)
  - ASHRAE Past President

Kyoto Face House, 1998

“What is green building?”

An example of green building in Hong Kong ?!

(Photo taken by Dr Sam C M Hui)

Cologne

Building

+

Green

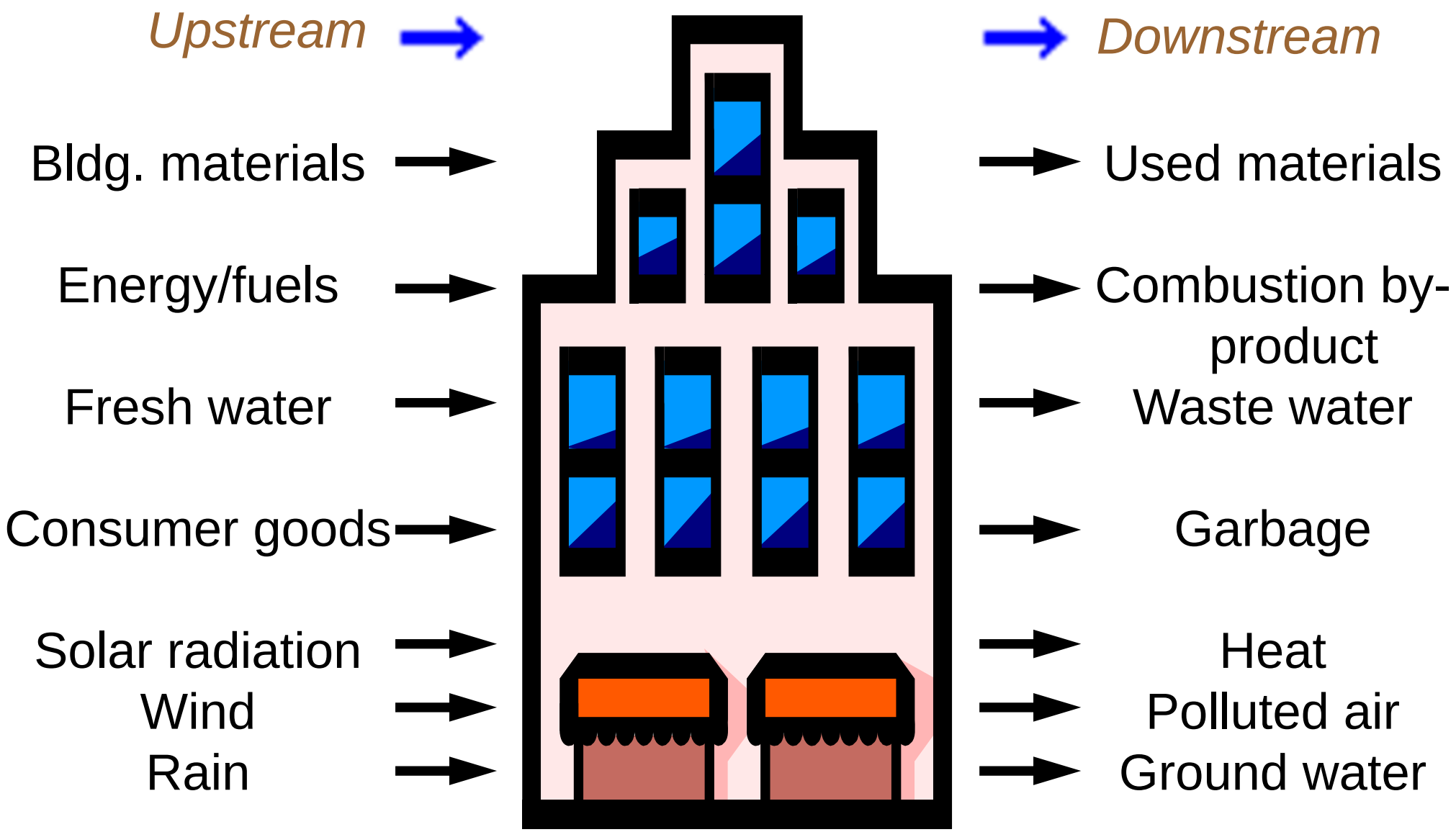
Toronto

Green building is NOT just adding a green outlook

(Photo taken by Dr Sam C M Hui)

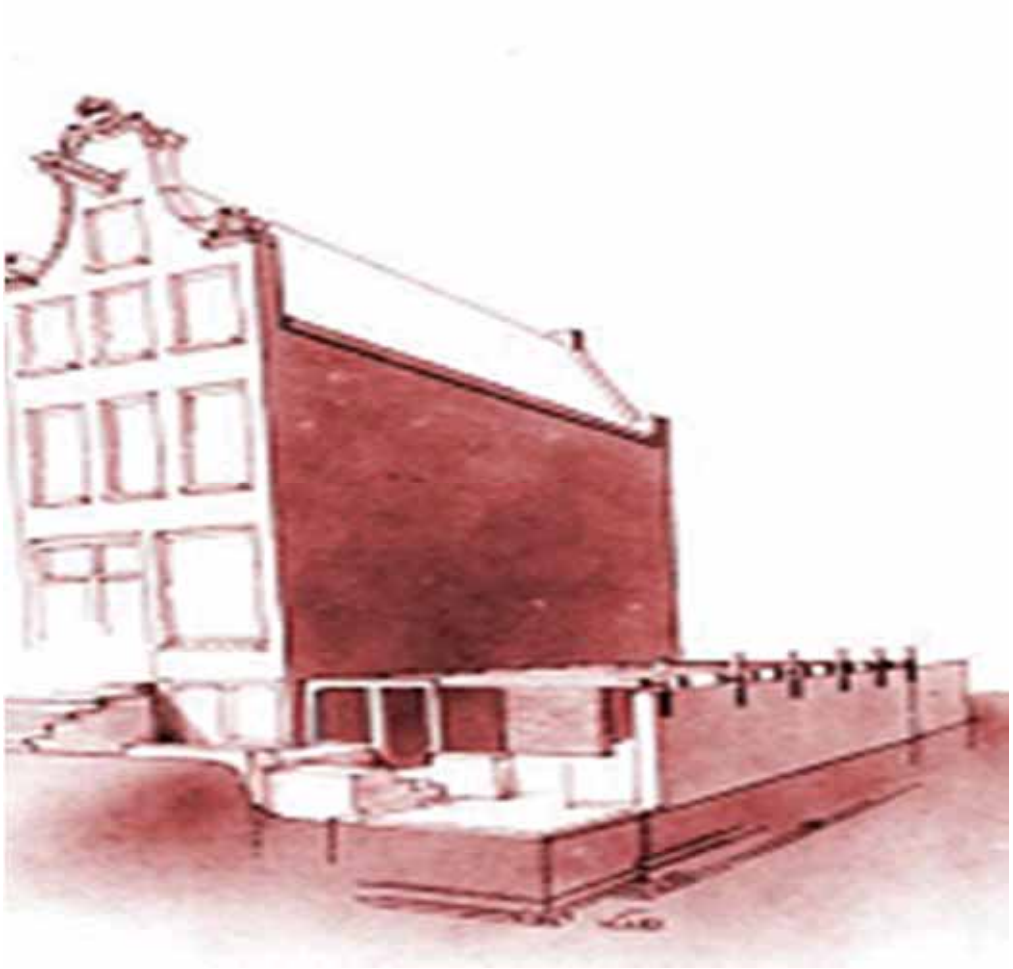
What is green building?

- It is a structure that is environmentally responsible and resource-efficient throughout its life-cycle
- Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:
  - Efficient use of energy, water, and other resources
  - Protecting occupant health and improving employee productivity
  - Reducing waste, pollution and environment degradation



Resource and material flow in the building ecosystem

Construction process and building life cycle (cradle-to-grave)



Construction Process

Cradle-to-Grave

What is green 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

"It's not easy being green." -- Kermit the Frog, 1972.

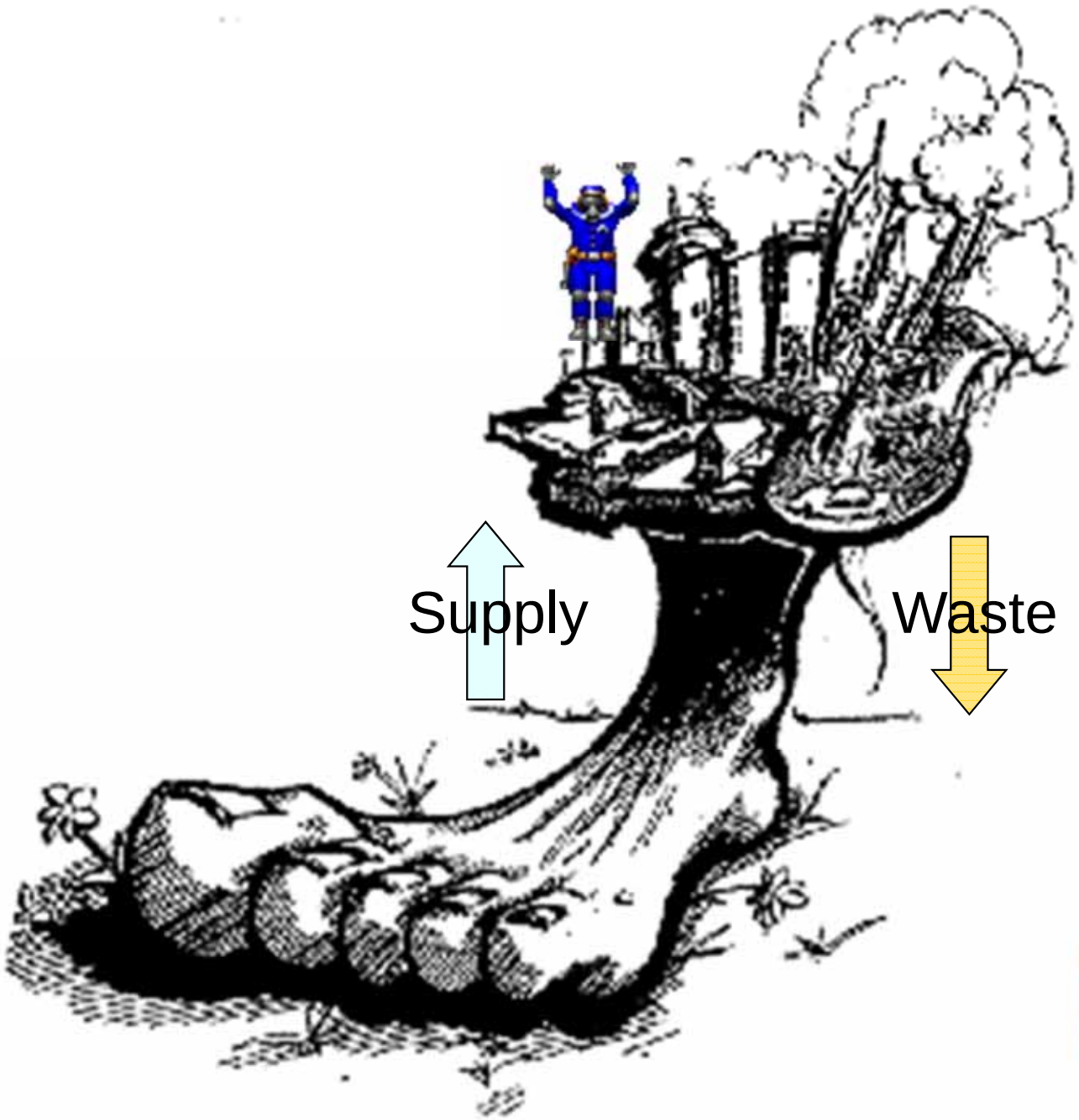
Why going green?

Why going green?

- Survival of our planet: environmental crisis
  - Air (destruction of Earth's atmosphere)
    - Global warming, climate change
  - Water (an undervalued resource)
    - Shortage and pollution
  - Fire (the problem of fuels)
    - Fossil fuel burning (coal, oil)
  - Earth (resources and materials)
    - Resources depletion


SUSTAINABLE
DEVELOPMENT
可持續發展

Sustain-able Future?



If all countries have ecological footprints same as current industrialized ones, we need four earth planets to support the living.

Why going green?

- Green buildings pay
  - Direct benefits (e.g. energy/cost savings)
  - Indirect benefits (e.g. healthier conditions)
  - Wider global benefits (e.g. reduced CO_2 emission)
- Life-cycle benefits
  - Total economic and environmental performance
  - Long-term "*sustainability*"

Why going green?

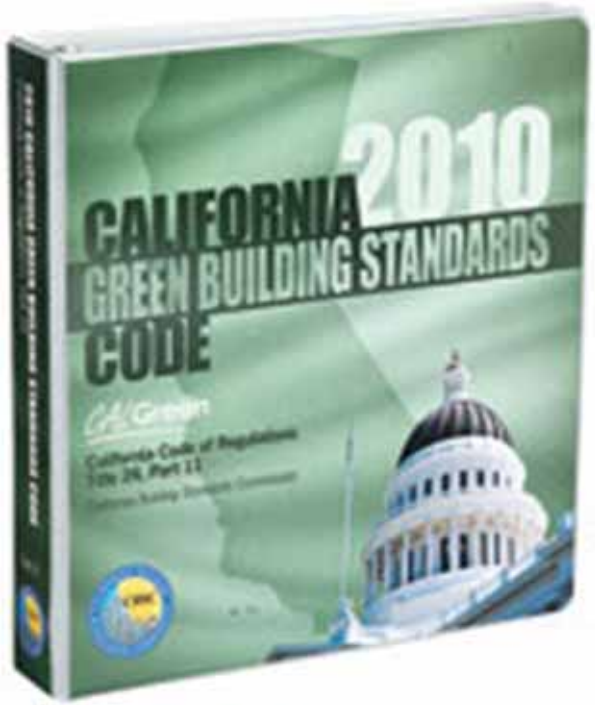
- Green building incentives, such as, in Hong Kong, exemptions of gross floor area (GFA) and site coverage (SC)
  - Joint Practice Notes No. 1 & 2: Green and Innovative Buildings
  - Practice Note APP-151, Building Design to Foster a Quality and Sustainable Built Environment
  - Practice Note APP-152, Sustainable Building Design Guidelines

Why going green?

- Promoted by building energy efficiency codes and guidelines, such as
  - In Hong Kong: the Building Energy Codes under the Buildings Energy Efficiency Ordinance
  - In Macau: the Macau Building Energy Optimisation Technical Guidelines (澳門建築物能耗優化技術指引)

Why going green?

- What happens when Green becomes code?
  - Overseas experience: mandatory codes



IgCC

SAFE & SUSTAINABLE BY THE BOOK

International Green Construction Code (IgCC)

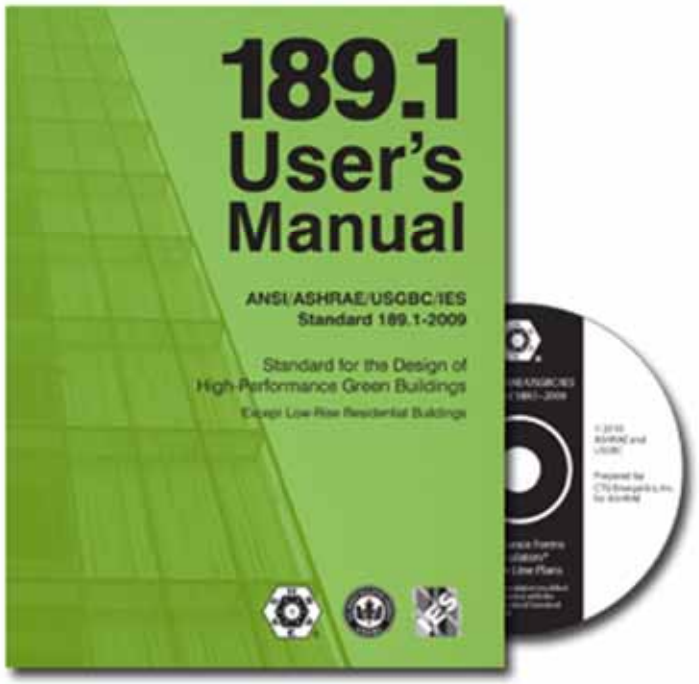
ASHRAE Standard 189.1

- What is Standard 189.1?
  - A standard developed in model code language
  - Provides minimum requirements for high-performance, green buildings
  - Applies to all buildings except low-rise residential buildings (same as ASHRAE Standard 90.1)
  - Optional compliance path to the International Green Construction Code (IgCC)
  - Not a design guide, not a rating system

ASHRAE Standard 189.1-2009 Preview

www.ashrae.org/greenstandard

Knowledge is power.
Understanding is power^2.



(Image source: ASHRAE)

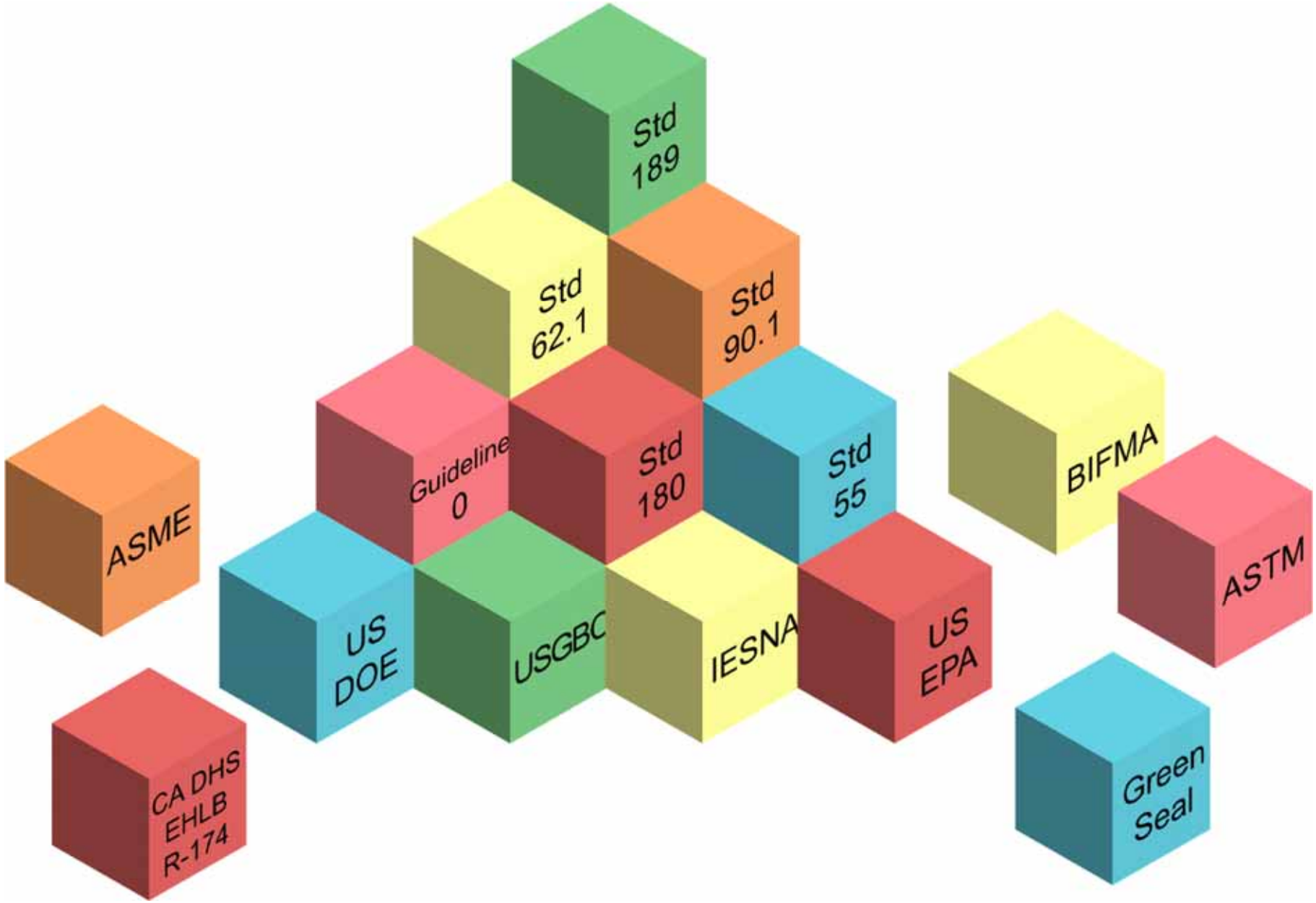
ASHRAE Standard 189.1

- It is jointly developed by:
  - ASHRAE (American Society of Heating,
  - Refrigerating and Air-Conditioning Engineers)
  - USGBC (U.S. Green Building Council)
  - IESNA (Illuminating Engineering Society of North America)
- It is also approved by American National Standards Institute (ANSI)

ASHRAE Standard 189.1

- Goals for Standard 189.1
  - Establish mandatory criteria in all topic areas
    - One “challenge” is existing green building rating systems contain few mandatory provisions
  - Provide simple prescriptive compliance options
  - Provide flexible performance compliance options
  - Complement green building rating programs
    - Standard is not intended to compete with green building rating programs (e.g. LEED)

Standard 189.1 building blocks



(Source: Mr. Kent W. Peterson)

Compliance paths of Standard 189.1

(simple option, very few calculations)

(more options, but more effort)

(Source: Mr. Kent W. Peterson)

ASHRAE Standard 189.1

- Standard 189.1 topic areas:
  - SS Sustainable Sites
  - WE Water Use Efficiency
  - EE Energy Efficiency
  - IEQ Indoor Environmental Quality
  - MR Building's Impact on the Atmosphere, Materials & Resources
  - CO Construction and Operations Plans

ASHRAE Standard 189.1

- Sustainable Sites Highlights

SS

  - Site selection
    - Allowable sites (e.g. brownfield)
    - Prohibited development activity
  - Reduce heat island effect
    - Site hardscape
    - Wall and roof
  - Reduce light pollution
    - Outdoor lighting
    - Light trepass limits

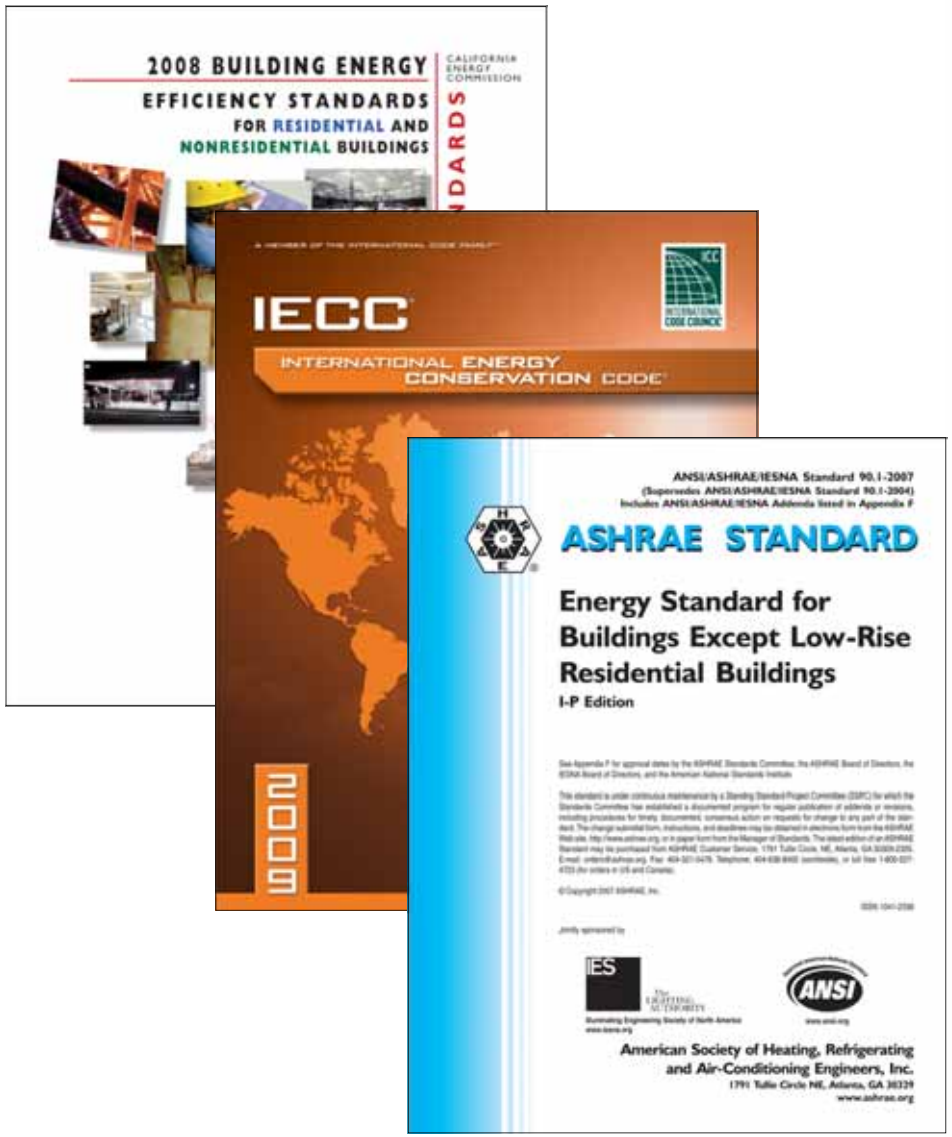
ASHRAE Standard 189.1

- Water Use Efficiency Highlights

WE

  - Site water use
    - Bio-diverse plantings, hydrozoning, and smart irrigation controllers
  - Building water use
    - Plumbing fixtures & fittings, appliances, HVAC systems & equipment
    - Cooling tower maximum cycles of concentration
  - Water measurement for building and subsystems

Building Energy Codes (e.g. ASHRAE 90.1)



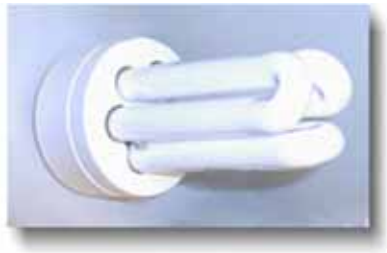
(Source: Mr. Kent W. Peterson)

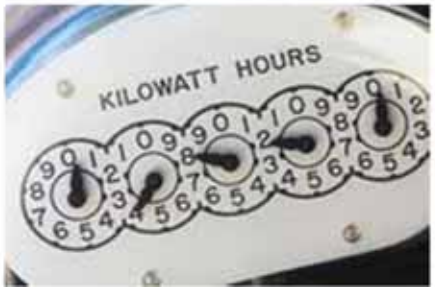
ASHRAE Standard 189.1

- Energy Efficiency Highlights

EE

  - More stringent than Standard 90.1-2007
    - Equipment efficiency compliance
  - Includes plug/process loads
  - Electric peak load reduction
  - Renewable energy provisions
    - On-site renewable energy systems
  - Energy measurement for verification





ASHRAE Standard 189.1

- Indoor Environmental Quality Highlights

IEQ

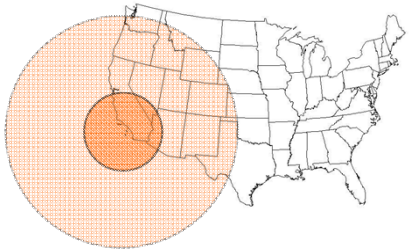
  - Indoor air quality
    - Ventilation rates per ASHRAE Standard 62.1
    - Outdoor air flow rate monitoring of min. outside air
    - MERV 8 filter (MERV 13 in PM2.5 non-attainment areas)
    - No smoking inside building
    - Source contaminant control
  - Daylighting
  - Acoustical control

ASHRAE Standard 189.1

- The Building's Impact on the Atmosphere

MR Highlights

  - Construction waste management
  - Reduced impact materials
  - Wood products
  - Refrigerants
  - Storage and collection of recyclables and discarded goods

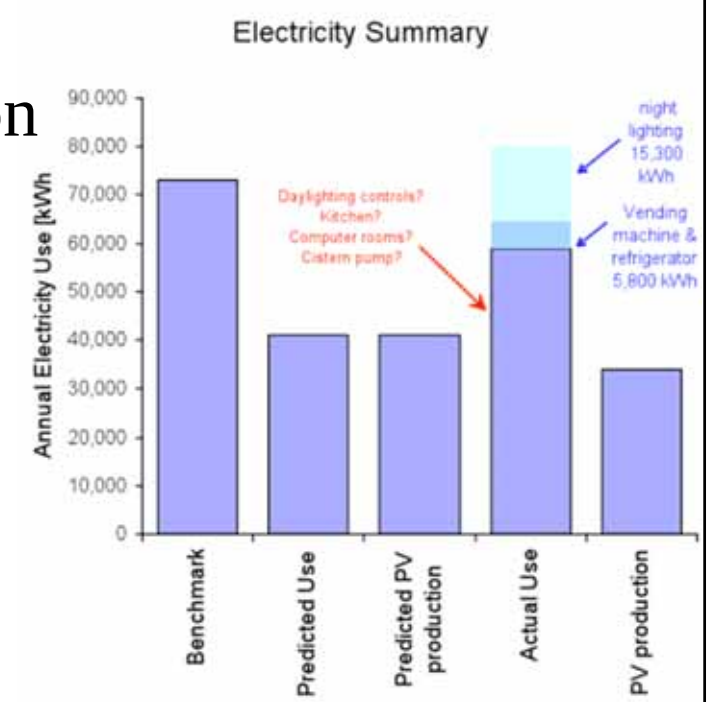


ASHRAE Standard 189.1

- Construction and Operation Highlights

CO

  - Acceptance testing / commissioning
  - IAQ construction management plan
  - Plans for Operation
    - High-performance building operation
    - Maintenance
    - Service life
    - Transportation management



Opportunities

- Global trends – green building: there are significant and growing opportunities
  - Such as green building services and products
- Green building is being adopted at dramatic rates in every region of the world, e.g. China, India and Middle East
- A priority for Mainland China is to encourage green building and energy efficiency

LEED registered projects in international market

Top 10 Countries (Registered + Certified)

Country	# Projects	Floor area (ft²)
India (Includes IGBC data on LEED India)	1554	964,673,465
Canada (Includes CaGBC data on LEED Canada)	3768	766,416,439
China (incl. HK, Macau, and Taiwan)	690	593,888,157
UAE	748	483,227,607
Korea	139	249,356,337
Saudi Arabia	119	108,233,338
Brazil	327	105,651,273
Mexico	214	61,021,544
Germany	195	45,792,706
Qatar	92	31,299,005

(Source: Green Building Market and Impact Report 2011, www.greenbiz.com)

Opportunities

- Market sectors
  - Residential buildings
  - Commercial buildings
  - Public sector buildings
  - Industrial buildings
- Market drivers
  - The issue of climate change, energy efficiency, carbon emission reduction, energy price, government policies and legislation

Opportunities

- Major technology demand
  - Energy efficient lighting, HVAC systems, building controls & energy management, solar energy systems (e.g. PV), green building materials, water efficiency systems
- Green building services
  - Architectural and engineering services, urban planning & design, specialised green building consultancies, energy efficiency consultancies

Opportunities

- Key areas for green specialist advices
  - Building structure
  - Envelope design
  - Lighting services
  - Electrical power
  - Cooling and heating engineering
  - Water services
  - Ventilation
  - Cost estimating
  - Landscaping

Opportunities

- Growing importance of green building assessment/rating and certification, such as:
  - LEED (USA)
  - BEAM Plus (HK)
  - China 3-star Standard (China)
  - BREEAM (UK)
  - CASBEE (Japan)
  - BCA Green Mark (Singapore)
  - Green Building Label (Taiwan)

Green building assessment and certification

Opportunities

- LEED Green Building Rating System
  - **L**eadership in **E**nergy & **E**nvironmental **D**esign
  - By US Green Building Council
  - Current LEED systems:
    - New construction & major renovation (LEED-NC)
    - Existing building operations (LEED-EB)
    - Commercial interiors projects (LEED-CI)
    - Core and shell projects (LEED-CS)
    - Schools, Retail, Healthcare, Homes
    - Neighborhood development (LEED-ND)

Opportunities

- LEED Green Building Rating System
  - Evaluates and recognizes performance in accepted green design categories, including:
    - Sustainable sites
    - Water efficiency
    - Energy and atmosphere
    - Materials and resources
    - Indoor environmental quality
    - Innovation credits
  - Website: www.leedbuilding.org

(Source: USGBC)

For LEED version 3

Opportunities

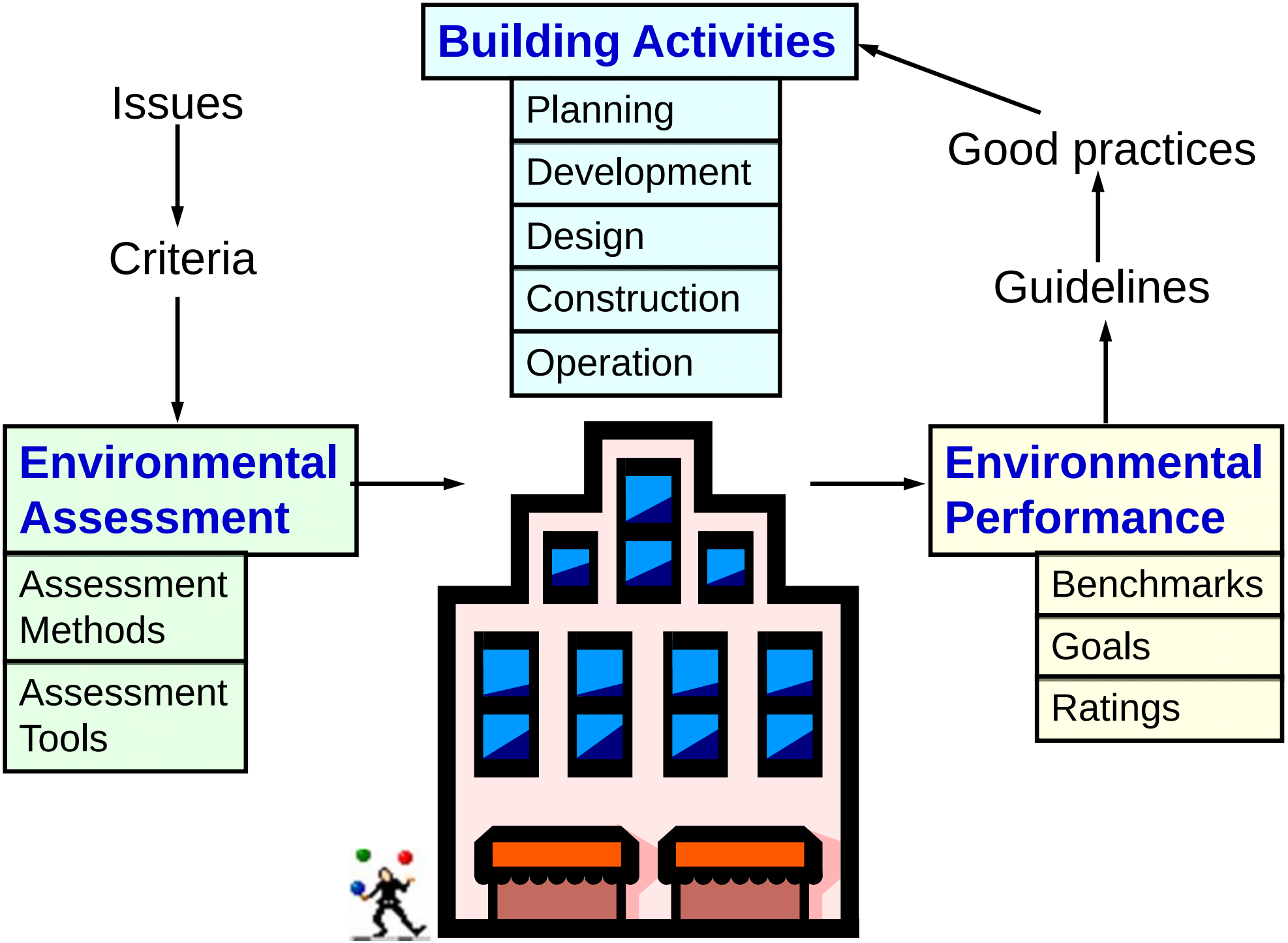
- BEAM Plus (launched 2009)
  - Version 2009: (start 1 Apr 2010)
    - BEAM Plus for New Buildings
    - BEAM Plus for Existing Buildings
  - Criteria [weighting]
    - Site aspects (SA) [25%]
    - Materials aspects (MA) [8%]
    - Energy use (EU) [35%]
    - Water use (WU) [12%]
    - Indoor environmental quality (IEQ) [20%]
    - Innovations & additions (IA) [credits 0-3]

BEAM Society
香港環保建築協會

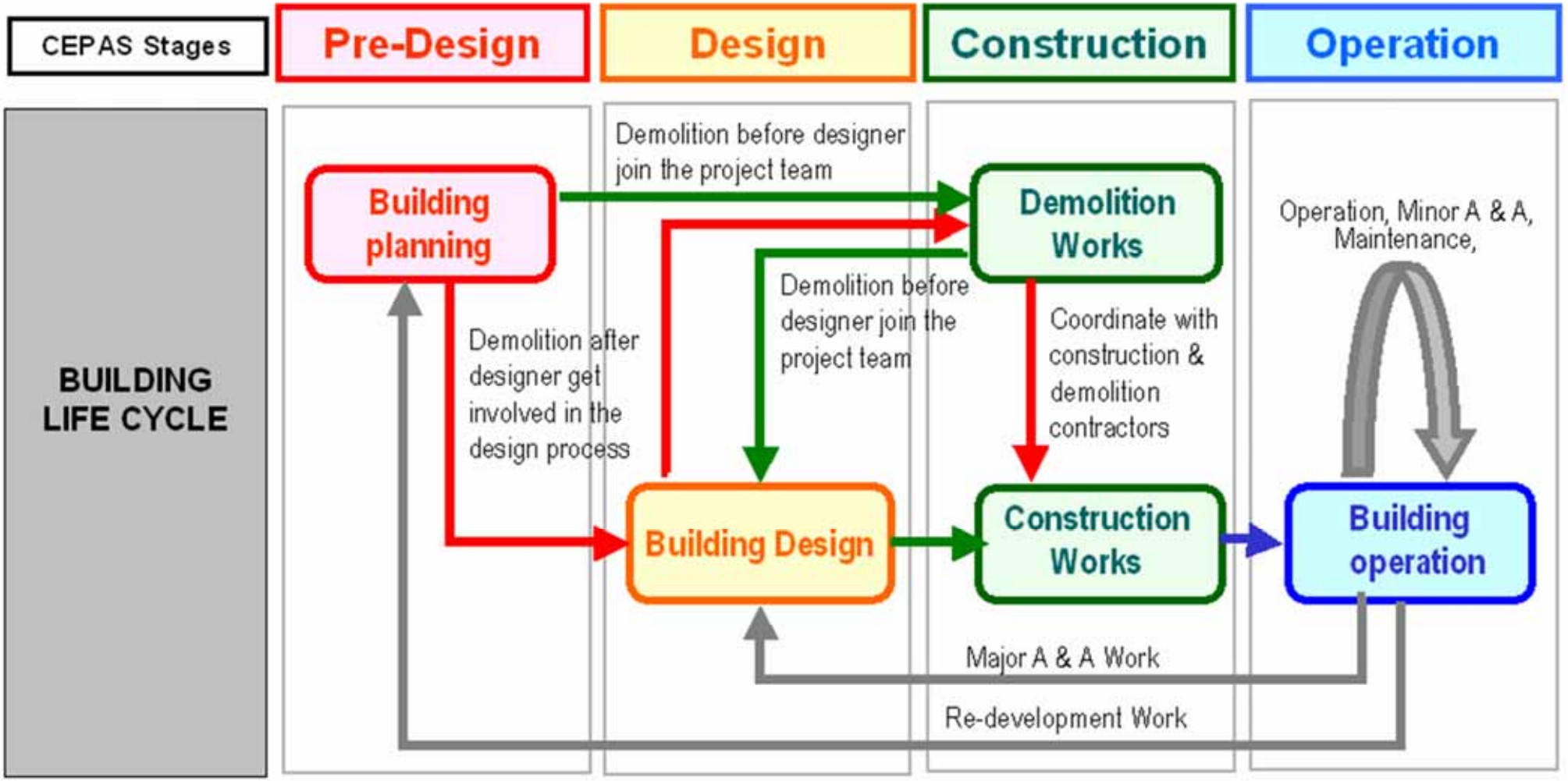
Opportunities

- BEAM Plus (launched 2009)
  - Overall grade: (with min. for SA, EU and IEQ)

	Overall	Site Aspects	Energy Use	IEQ	Innov. & Addn.	
Platinum	75%	70%	70%	70%	3 credits	Excellent
Gold	65%	60%	60%	60%	2 credits	Very Good
Silver	55%	50%	50%	50%	1 credit	Good
Bronze	40%	40%	40%	40%	---	Above Average


Building Activities
Planning
Development
Design
Construction
Operation
Issues
Criteria
Good practices
Guidelines
Environmental Assessment
Assessment Methods
Assessment Tools
Environmental Performance
Benchmarks
Goals
Ratings

Building life cycle stages (CEPAS, 2006)

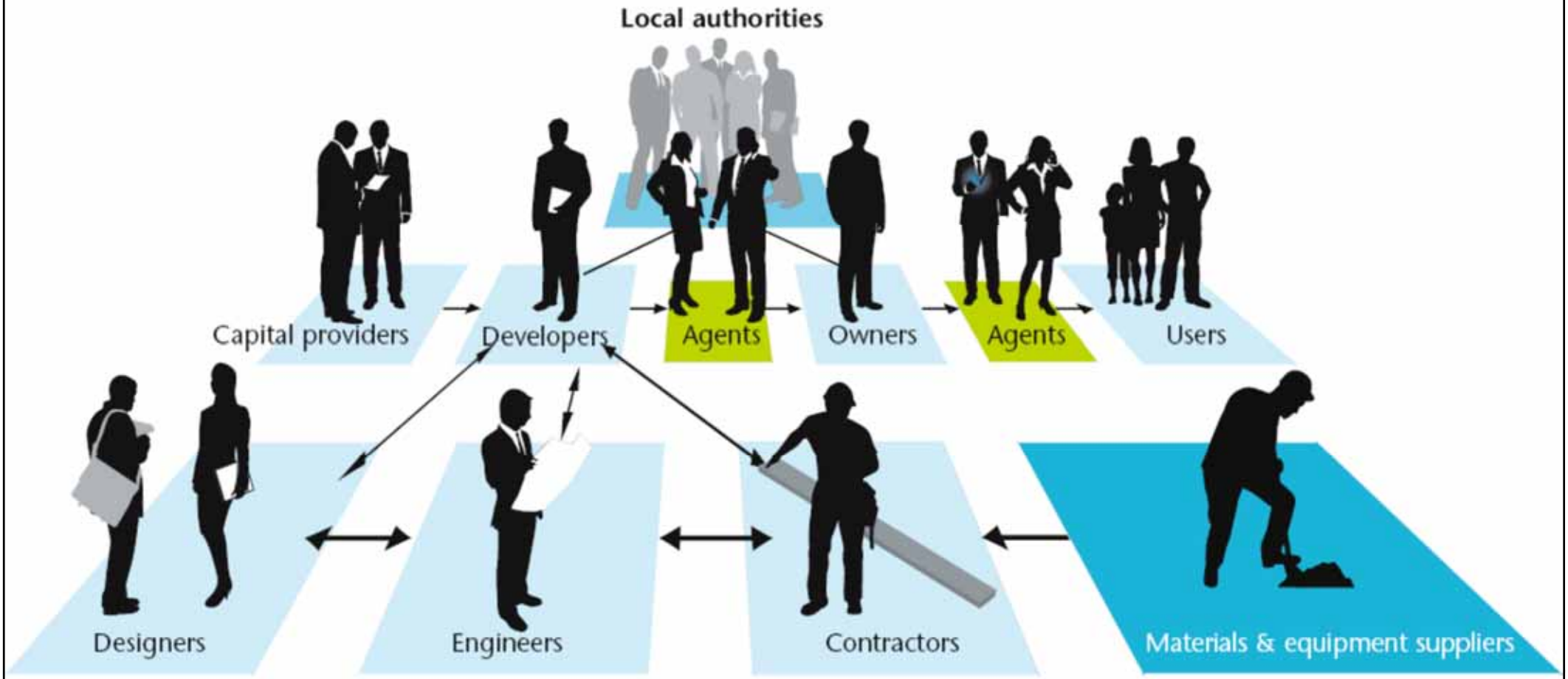


Note: CEPAS = Comprehensive Environmental Performance Assessment Scheme

(Source: Buildings Department, HK)

Challenges

- Main market barriers
  - High initial installation costs
  - No proper definition for green building concept
  - Separated interests of developers & building users
  - Short investment horizon & payback periods
  - Lack of reliable information & support
  - Slow progress in renewable energy sources
  - Uncertainty about green building performance



The complex value chain in the building sector

(Source: World Business Council for Sustainable Development, www.wcbsd.org)

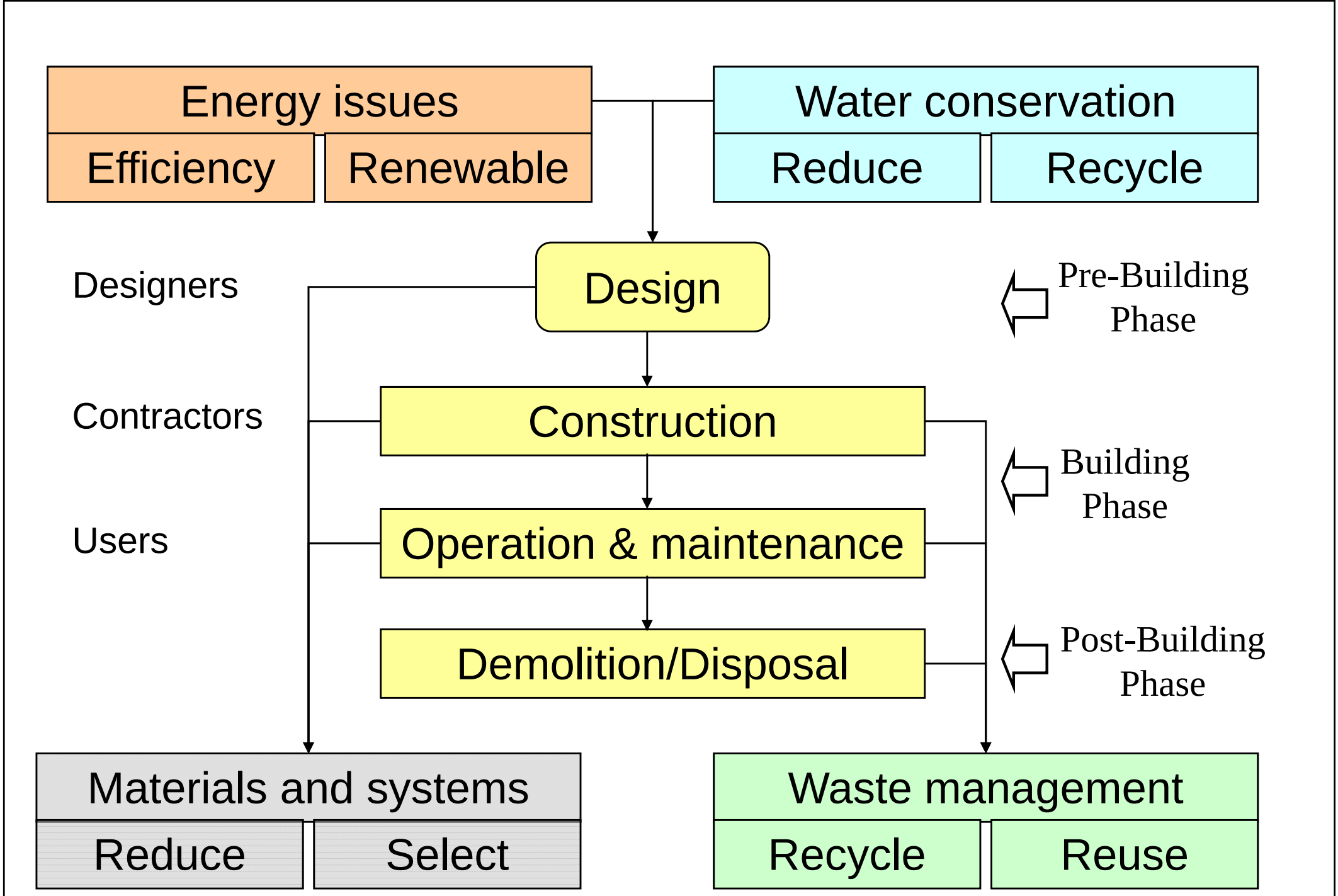
Challenges

- Green building design involves
  - Holistic approach (whole systems thinking)
    - Each aspect is considered in relation to all others
  - Interdisciplinary efforts
    - Understanding & contribution from all involved
  - Understanding of building performance
    - Assessment & evaluation of performance
  - Caring for people
    - Well being of the occupants and users


Green Building 綠色建築

Challenges

- Major concerns
  - Conserve non-renewable energy & scarce materials
  - Minimise life-cycle ecological impact
  - Use renewable energy and materials that are sustainably harvested
  - Protect & restore local air, water, soils, flora and fauna
  - Support pedestrians, bicycles and mass transit
  - Reduce human exposure to noxious materials



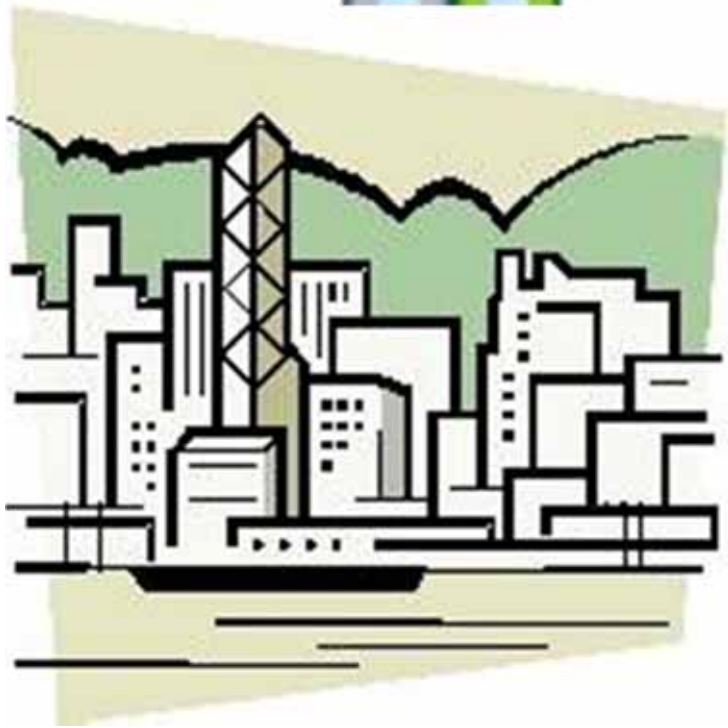
Building life cycle and sustainable construction

Challenges

- How to achieve Green Building?
  - 1. Planning and design
  - 2. Energy efficiency
  - 3. Water efficiency and conservation
  - 4. Material conservation and resource efficiency
  - 5. Environmental quality

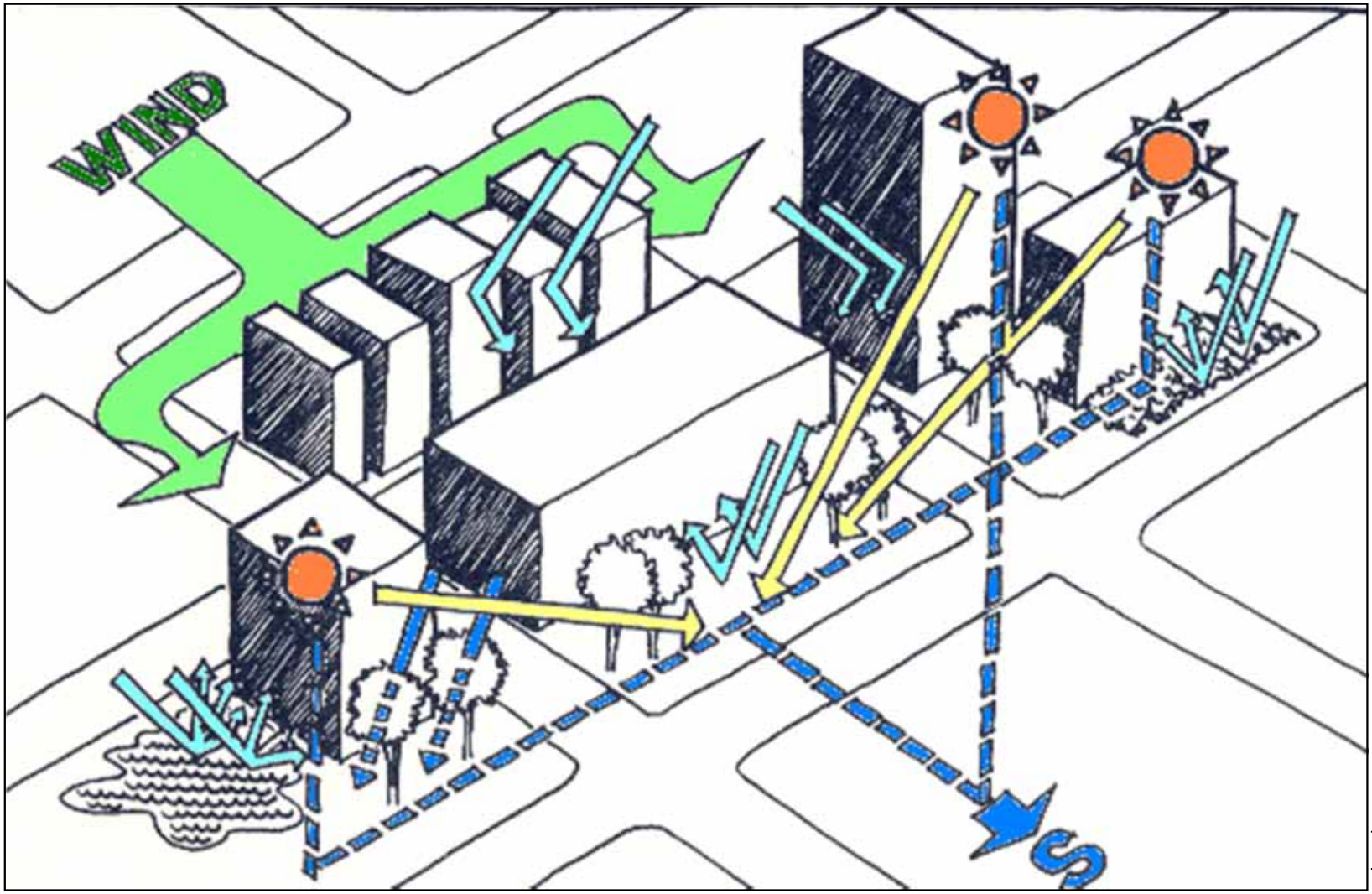
Challenges

- Green building design strategies
  - Urban and site design
  - Energy efficiency
  - Renewable energy
  - Building materials
  - Water issues
  - Indoor environment
  - Integrated building design



風
Wind

光
Light



水
Water

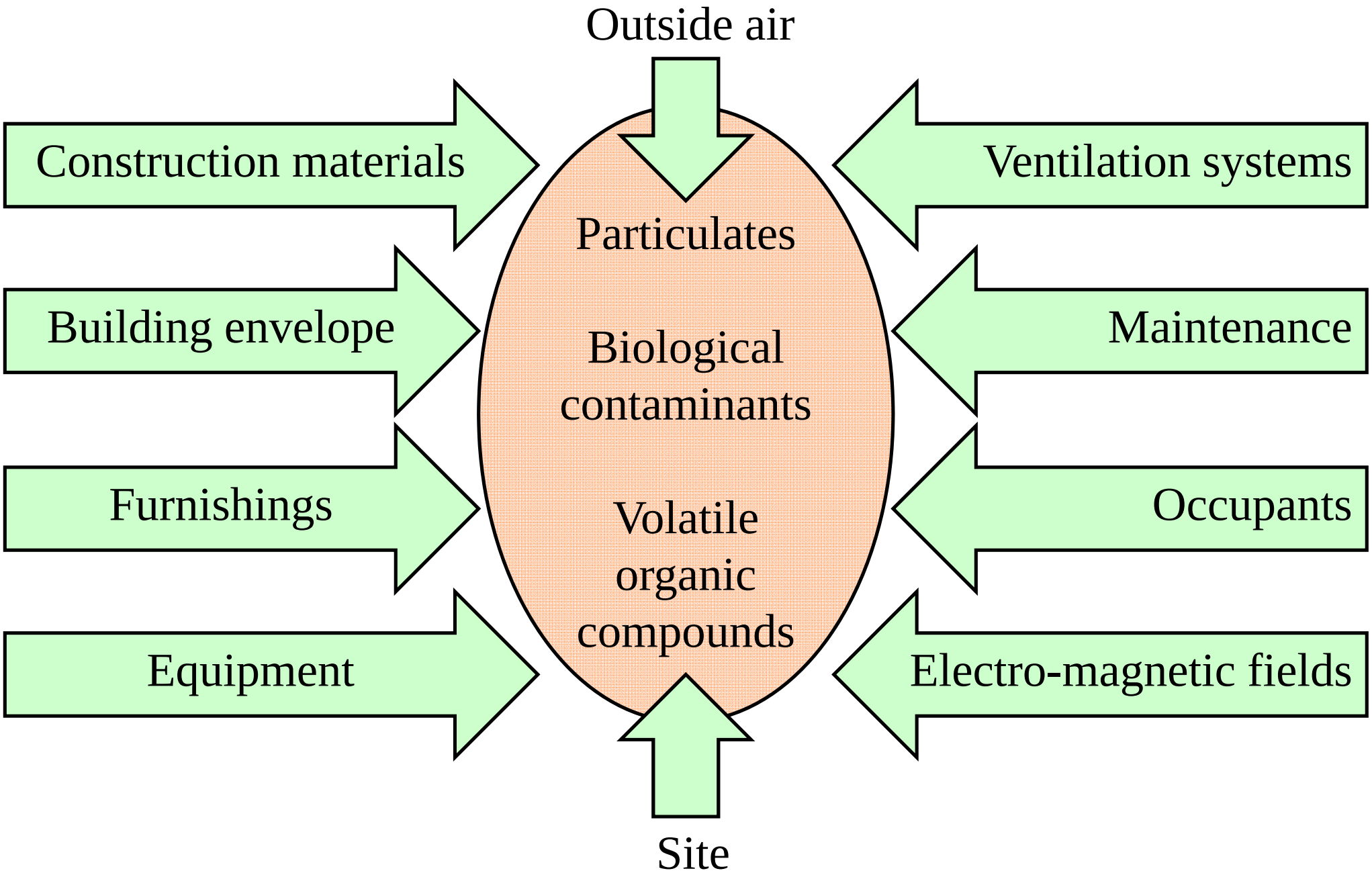
物
Matter

Site analysis and understanding of the environmental factors is important

Advanced Energy Design Guides

www.ashrae.org/freeaedg

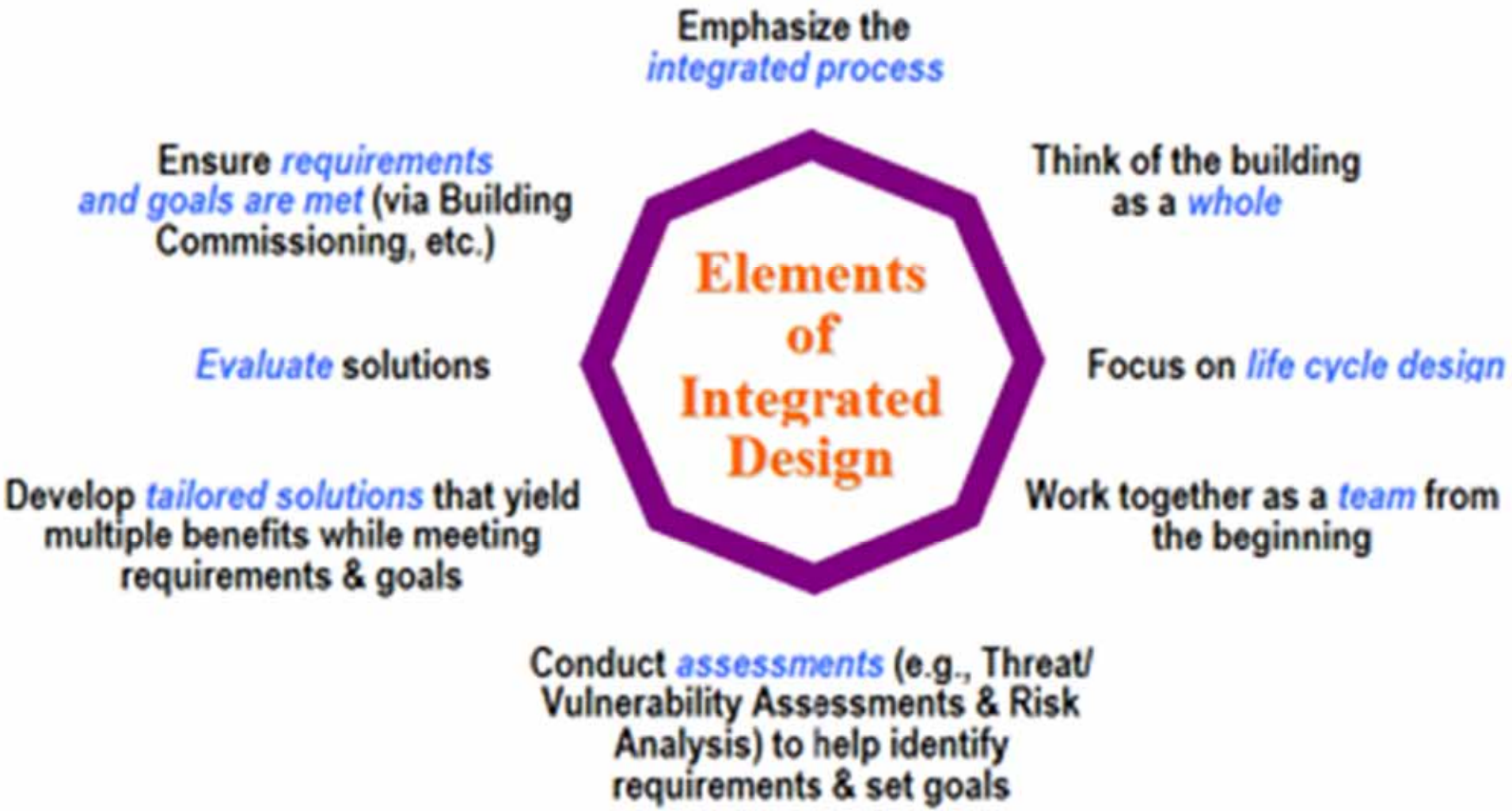
Major factors contributing to indoor air quality (IAQ)



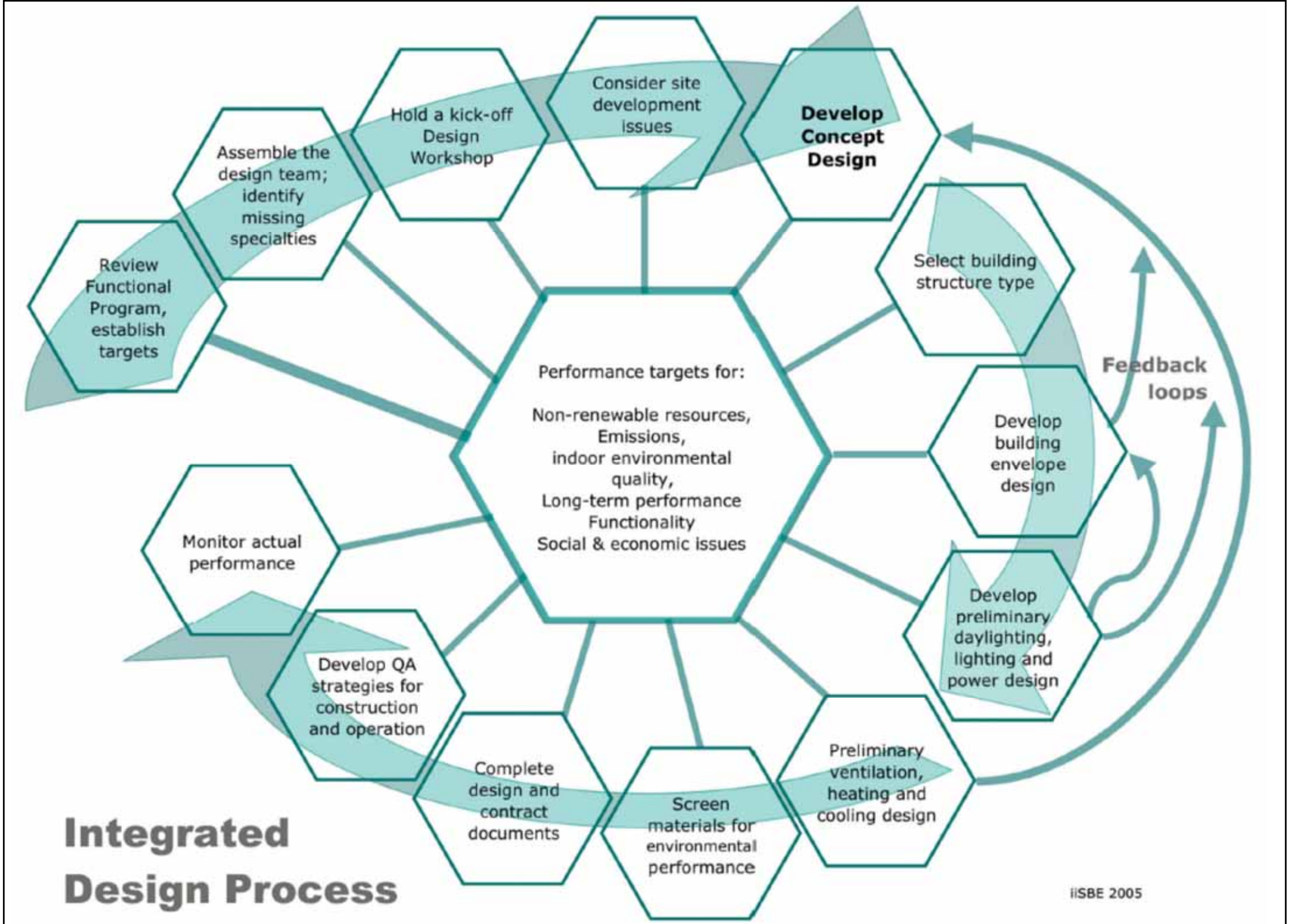
(Source: PTI, 1996. *Sustainable Building Technical Manual*)

Challenges

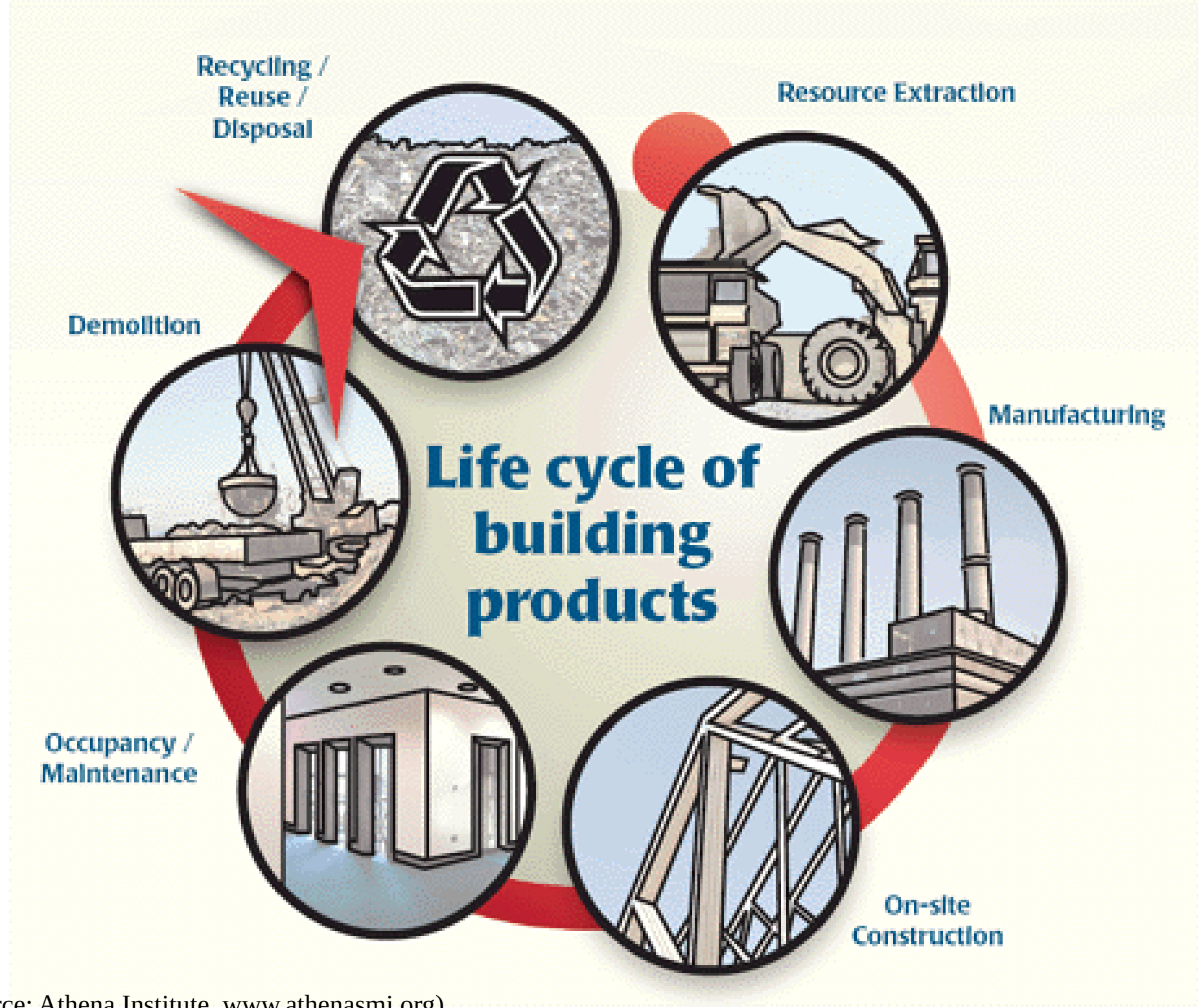
- WBDG - The Whole Building Design Guide
  - www.wbdg.org
- Two components of whole building design:
  - Integrated design approach
  - Integrated team process
- A holistic design philosophy
  - Holism + Interconnectedness + Synergy
  - "*The whole is greater than the sum of its parts*"



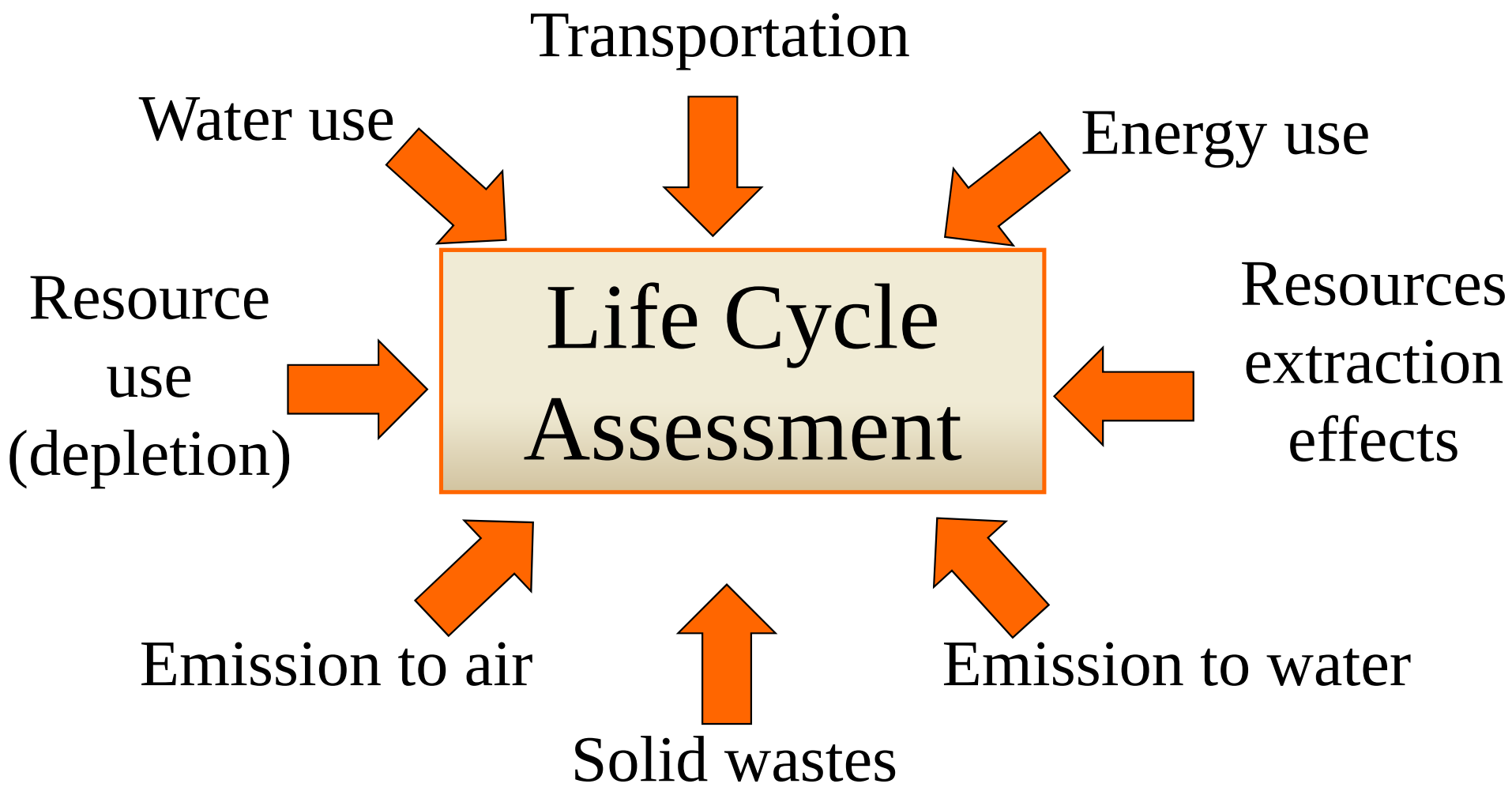
(Source: www.wbdg.org)



(Source: International Initiative for a Sustainable Built Environment (iiSBE), www.iisbe.org)



(Source: Athena Institute, www.athenasmi.org)



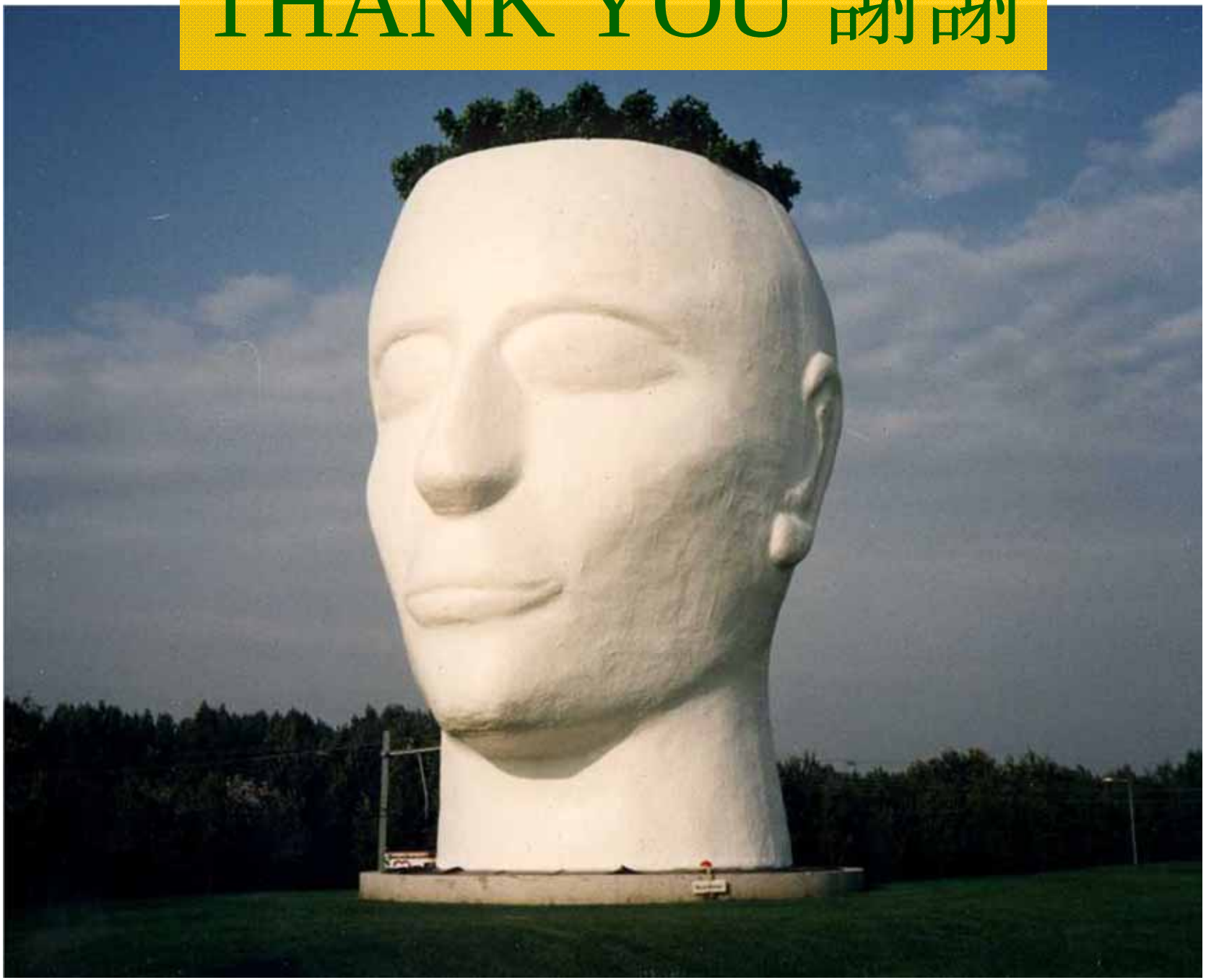
LCA: a methodology for assessing the life cycle environmental performance of products and processes

(Source: Athena Institute, www.athenasmi.org)

Conclusions

- Green building movement is critical to every society including Hong Kong and Macau
- There are good opportunities for building and construction professionals to contribute
- More efforts are needed to develop policies, technologies, research studies and design collaboration to overcome the market barriers
- It is also important to educate GREEN people!

THANK YOU 謝謝



(More information: www.hku.hk/bse/sbs/)