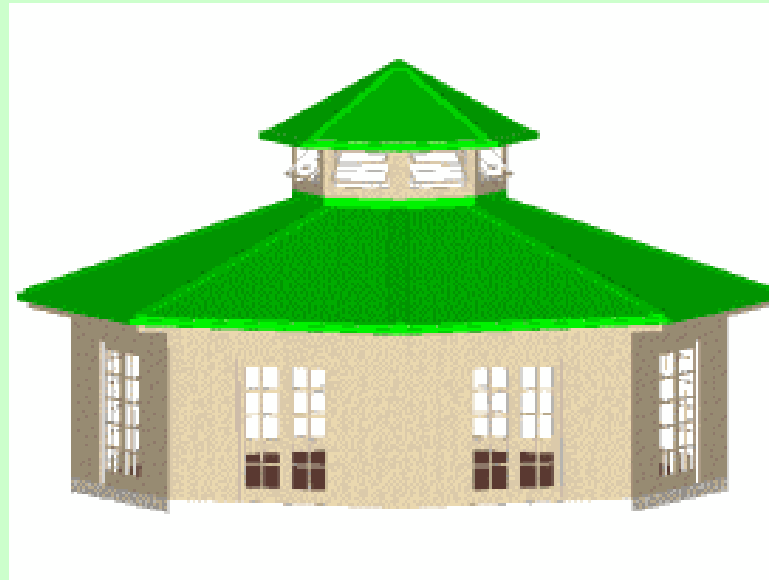


Green Buildings and Sustainable Historic Buildings



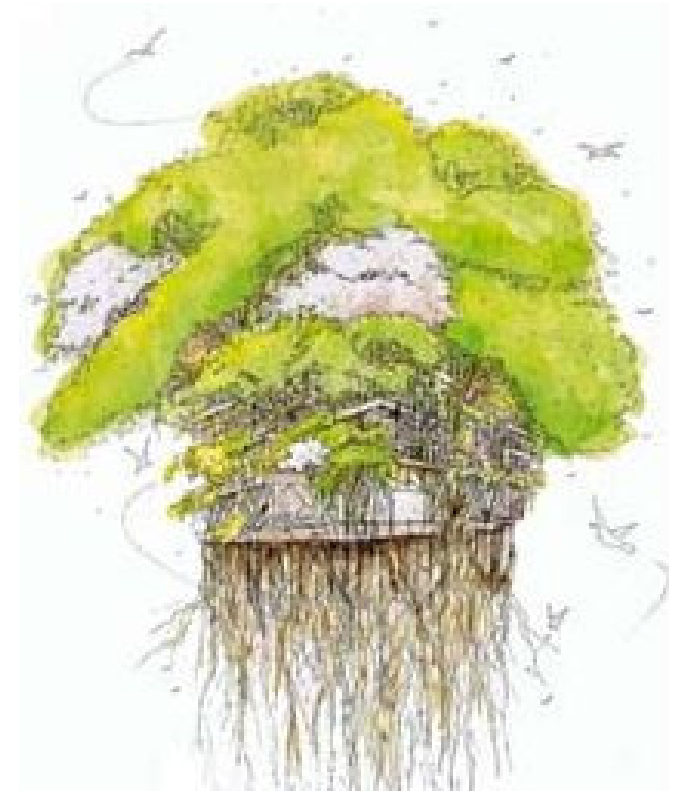
Dr. Sam C. M. Hui
Department of Mechanical Engineering
The University of Hong Kong
E-mail: cmhui@hku.hk

Sep 2015

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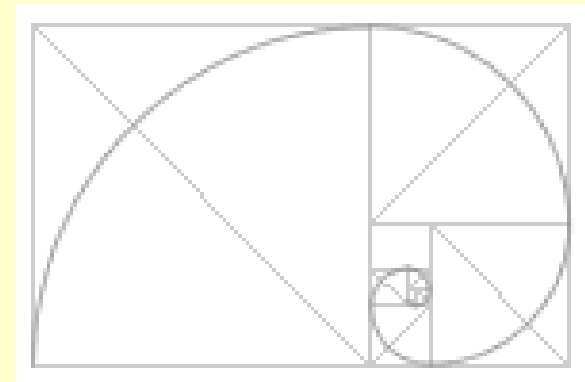
- What is green building?
- Design strategies
- Green building assessment
- Historic buildings



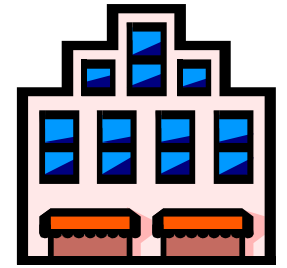


Kyoto Face House, 1998

**“What is
green
building?”**



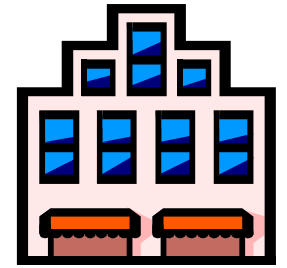
What is green building?



- 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

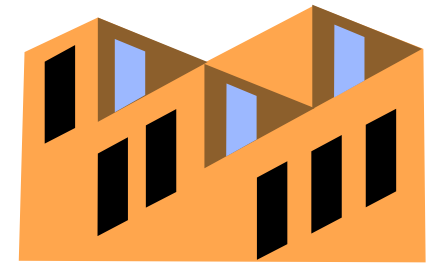


What is green building?

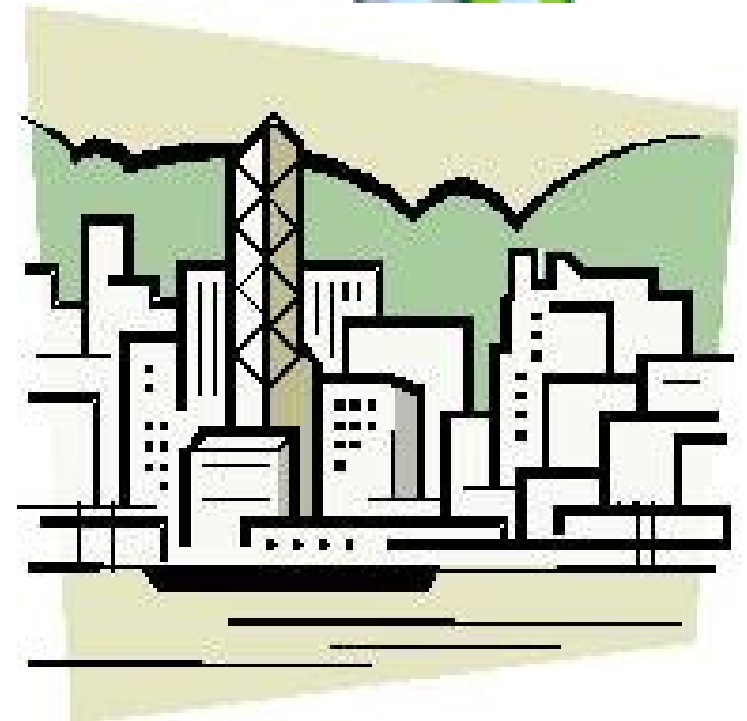


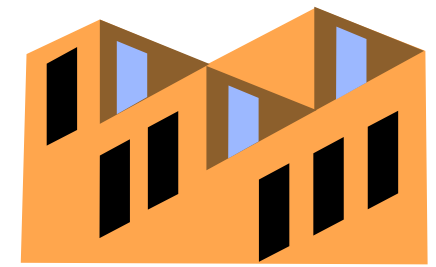
- It involves a *holistic* approach to the design and operation of buildings. It considers:
 - *1) Economy and efficiency of resources*
 - *2) Life cycle design*
 - *3) Human well-being*
- Main objectives
 - Be environmentally friendly and responsible
 - Improve the quality of built environment

Design strategies



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

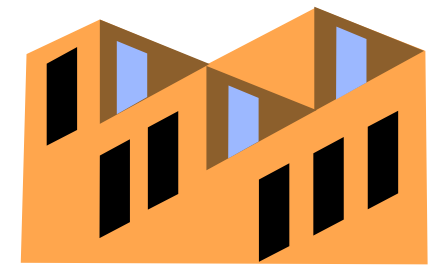




Design strategies

- Sustainable urban design should consider:
 - Spatial form
 - Movement
 - Design & development
 - Energy
 - Ecology
 - Environmental management
- Goal: to create livable cities

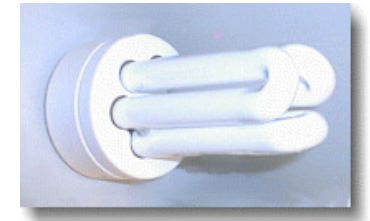




Design strategies

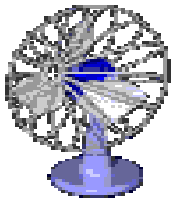
- Design issues:
 - Site selection (e.g. prefer brownfield site*)
 - Promote efficient movement network & transport
 - Control & reduce noise impacts
 - Optimise natural lighting & ventilation
 - Design for green space & landscape
 - Minimise disturbance to natural ecosystems
 - Enhance community values

[* Brownfield sites are abandoned or underused industrial and commercial facilities available for re-use.]

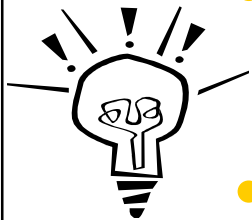


Design strategies

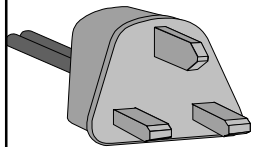
- Energy efficiency strategies:



- Minimise thermal loads & energy requirements
 - e.g. by reducing heat gains from equipment



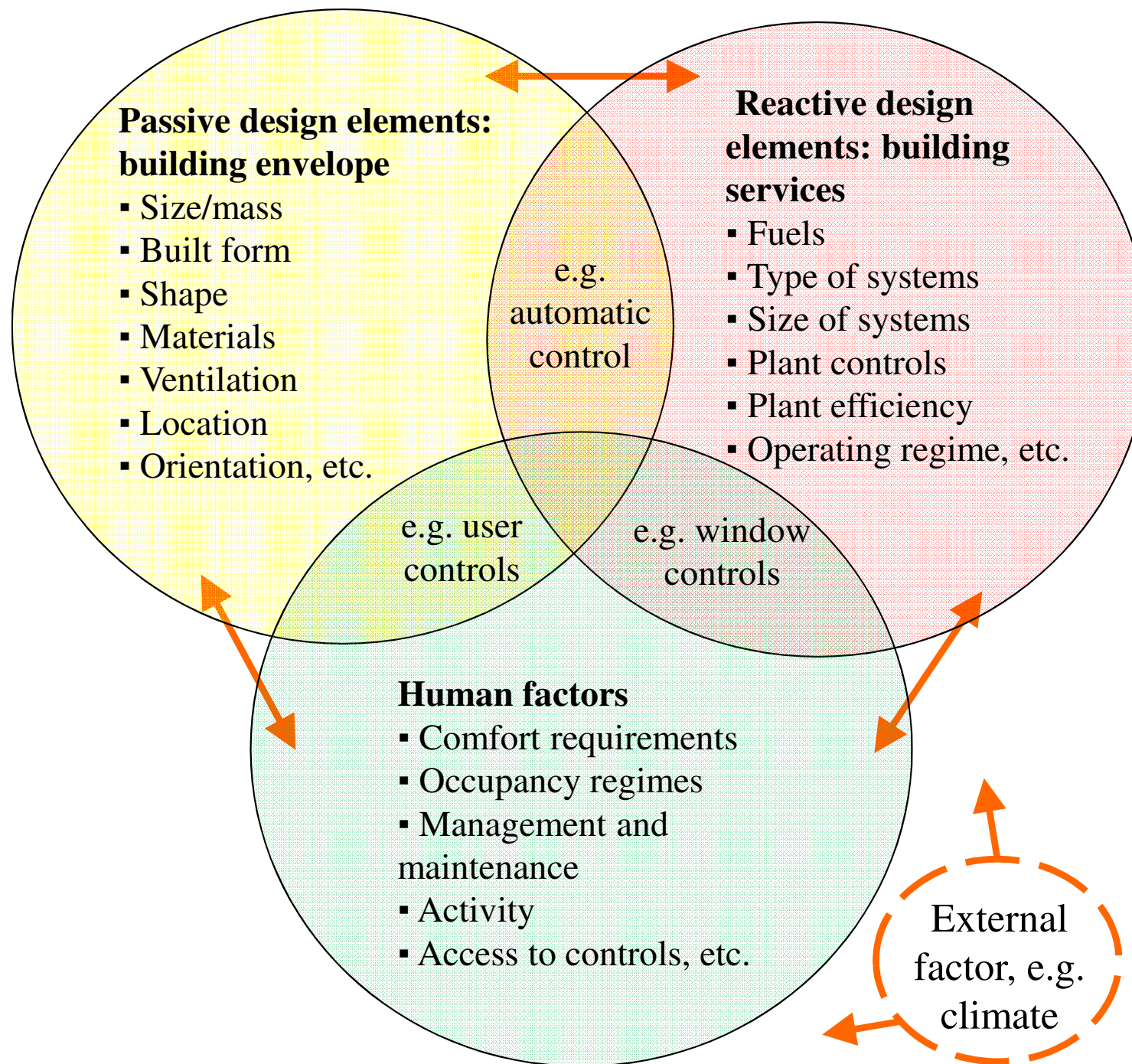
- Optimise window design & fabric thermal storage
 - Integrate architectural & engineering design



- Promote efficiency in building services systems
 - Use of heat recovery & free cooling methods
 - Energy efficient lighting design & control
 - High-efficiency mechanical & electrical systems



• Adopt total energy approach (e.g. district cooling, combined heat & power)



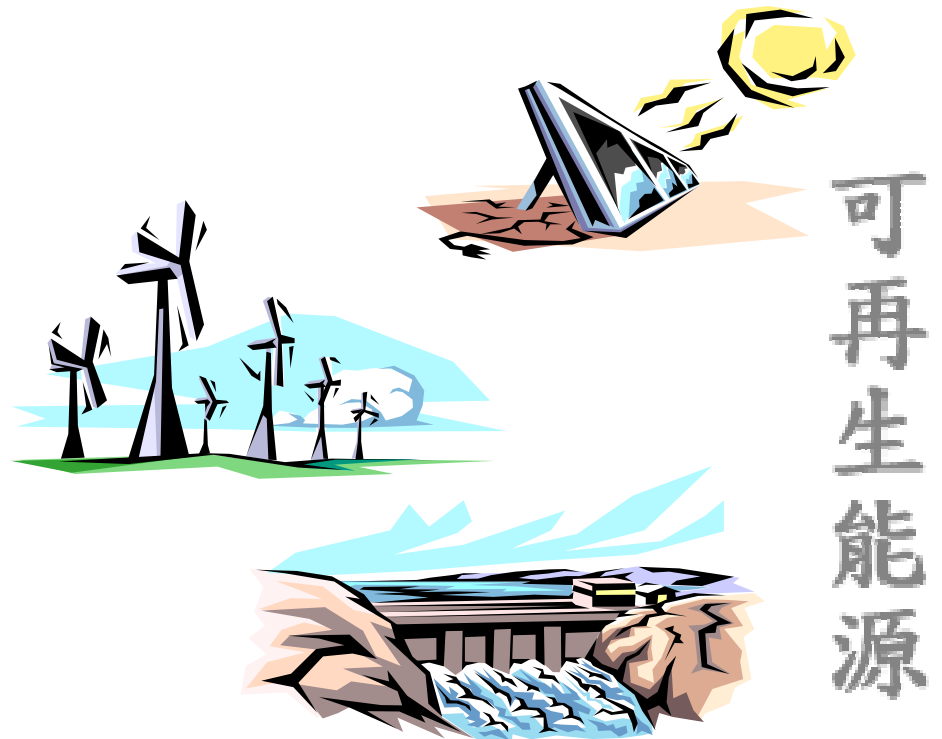
Key factors influencing energy consumption

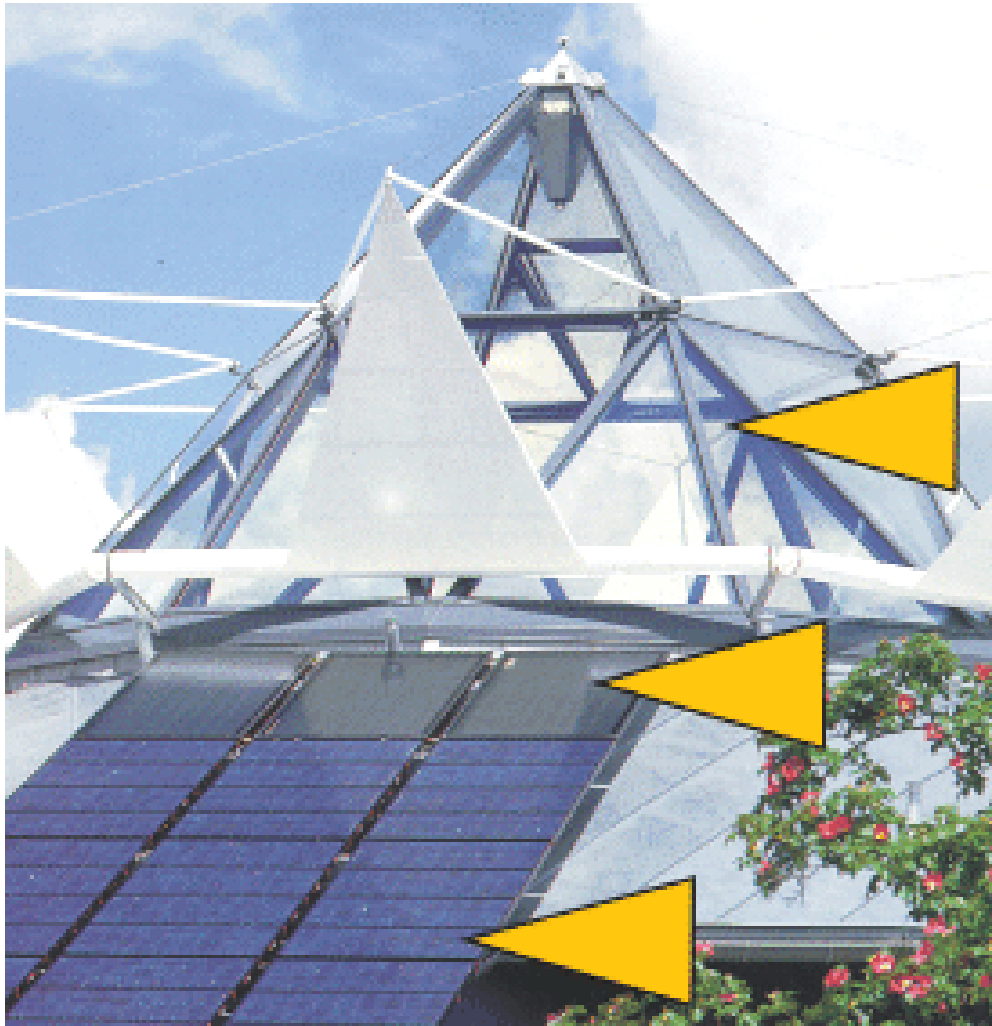
(Adapted from Energy Efficiency in Buildings: CIBSE Guide F)



Design strategies

- Renewable Energy
 - Energy that occurs naturally and repeatedly on earth and can be harnessed for human benefit
- Common applications
 - Solar hot water
 - Solar photovoltaic
 - Wind energy
 - Geothermal
 - Small hydros



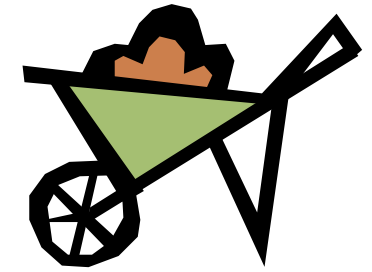


Passive solar (e.g. skylight)

Active solar (solar hot water)

Photovoltaics

Integration of solar energy systems in buildings

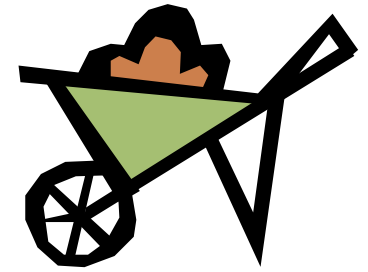


Design strategies

- What makes a product/material **green**?
 - Measured by their environmental impact
 - Life cycle of a sustainable material
 - Using local, durable materials
- Embodied energy*
 - ‘Lifetime’ energy requirement of a material
 - Energy input required to quarry, transport and manufacture the material, plus the energy used in the construction process

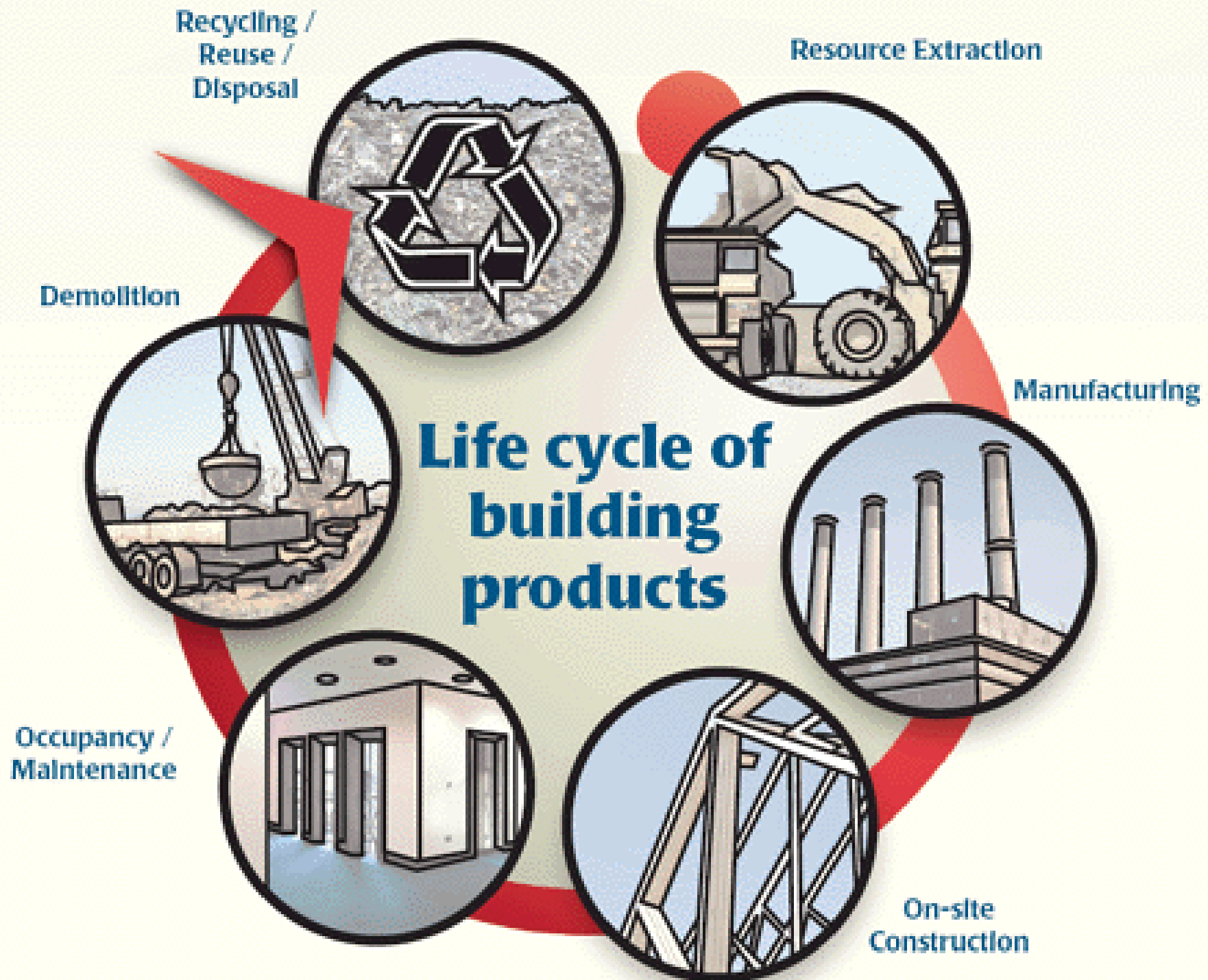
[* http://en.wikipedia.org/wiki/Embodied_energy]

Design strategies

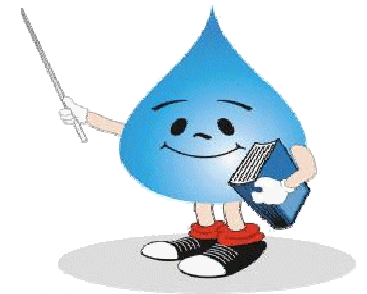


- Material conservation
 - Adapt existing buildings to new uses
 - Material conserving design & construction
 - Size buildings & systems properly
 - Incorporate reclaimed or recycled materials
 - Use environment-friendly materials & products
 - Design for deconstruction (“close the loop”)
- Life cycle assessment (LCA) is often used to evaluate the environmental impact of building materials and products





Design strategies



- Design strategy for water efficiency

- Reduce water consumption

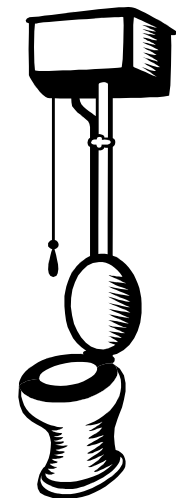
- Low-flush toilets & showerheads
 - Leak detection & prevention

- Correct use of appliances (e.g. washing machine)

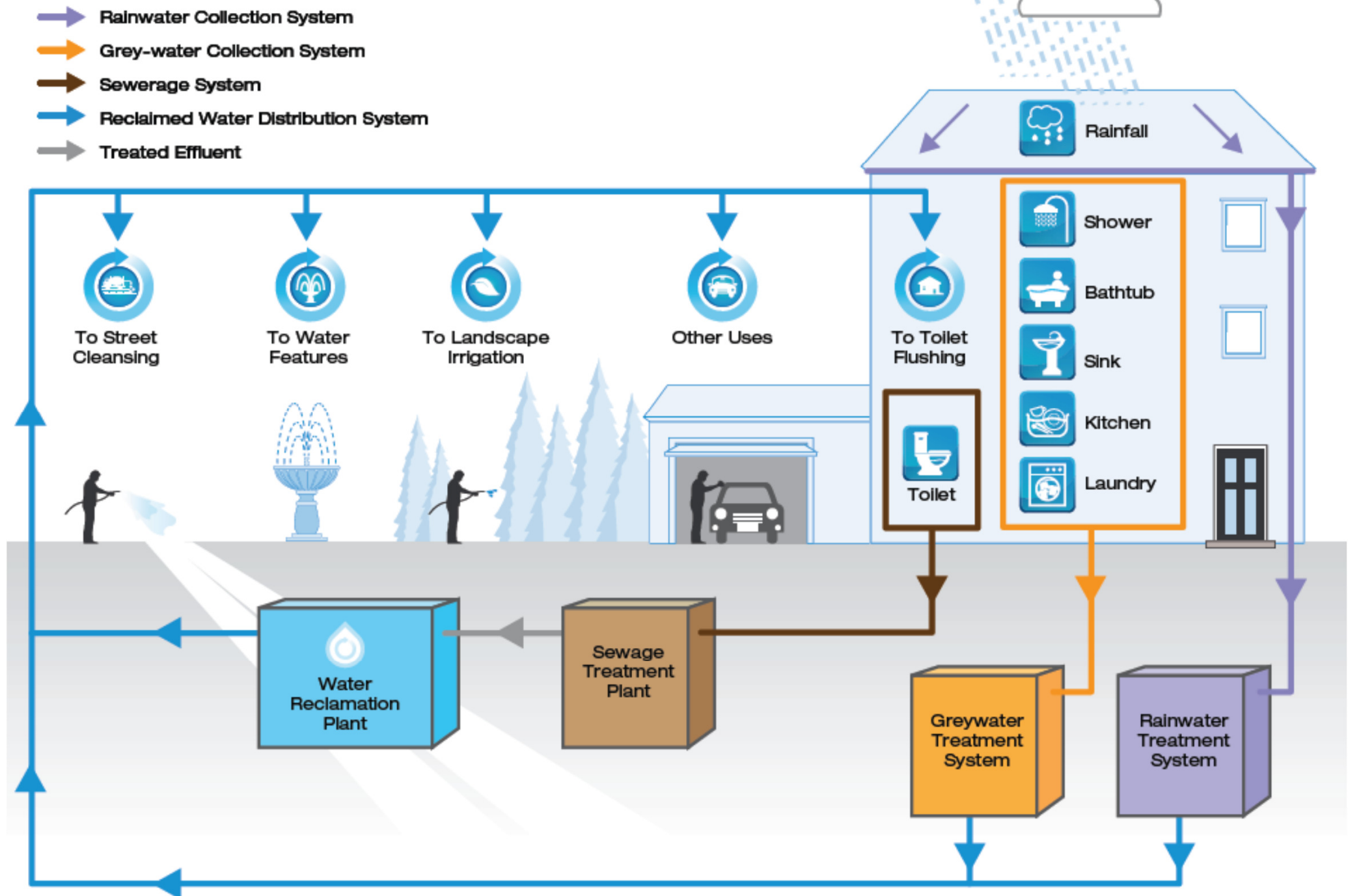
- Reuse and recycle water onsite

- Rainwater collection & recycling
 - Greywater recycling (e.g. for irrigation)

- No-/Low-water composting toilet

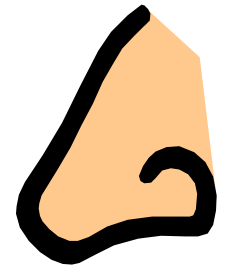


Water Reclamation Process



(Source: Water Supplies Department, www.wsd.gov.hk)

Design strategies



- Indoor environmental quality (IEQ)
 - Indoor air quality
 - Ensure health & well-being
 - Visual quality
 - Provide daylight & comfortable conditions
 - Acoustic quality
 - Noise control
 - Controllability
 - Allow occupant control over thermal & visual

Four principles of indoor air quality design

1. Source Control

+

2. Ventilation Control

+

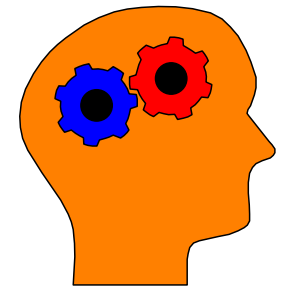
3. Occupant Activity Control

+

4. Building Maintenance

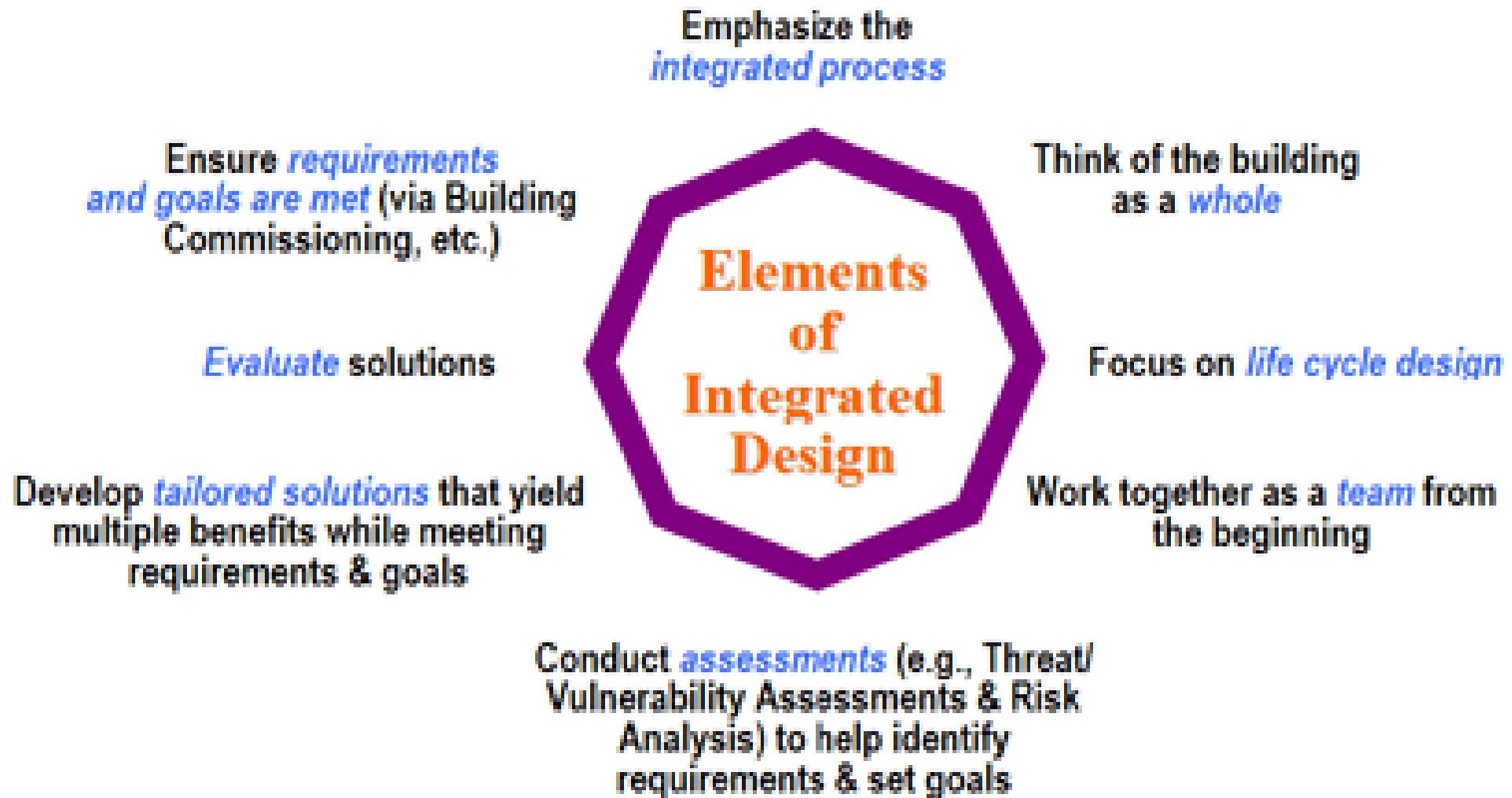
=

*Total
Indoor
Air
Quality*



Design strategies

- 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”*



Green building assessment



- **Building environmental assessment***
 - Identify & evaluate the environmental effects of building development or operation
 - Inform decision making and promote sustainable design & management
- An objective assessment is a useful starting point from which to make design and building improvements

For supporting decision making

- site selection
- urban design
- landscape planning

- CO₂ emissions
- acid rain
- ozone depletion
- rainforest depletion

- energy performance
- renewable energy
- water conservation

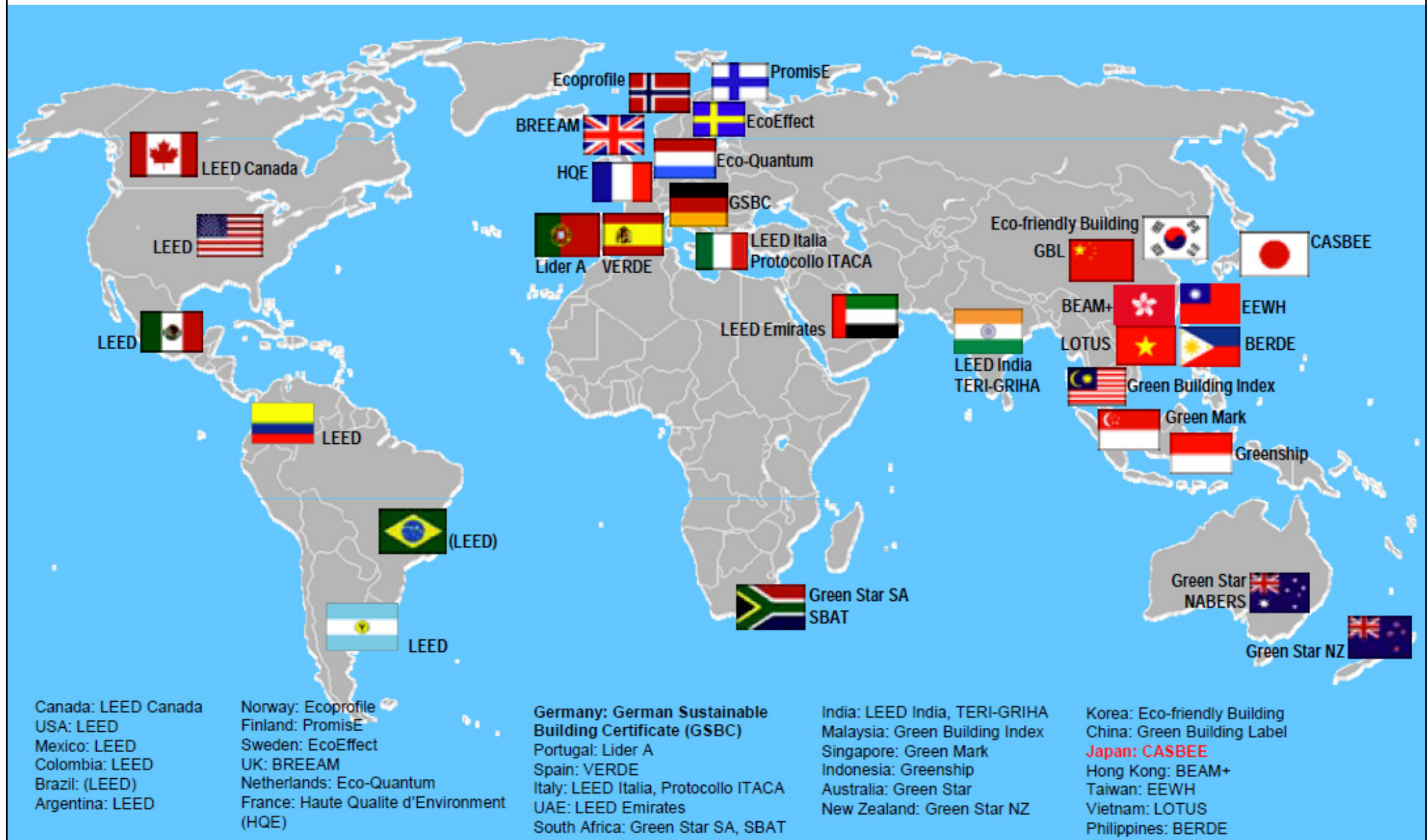
Environmental Criteria & Factors

- environmental policy
- transport strategy
- building maintenance

- material selection
- recycling of materials
- waste management
- disposal & reuse

- air quality
- thermal comfort
- lighting & noise
- hazardous materials

Rating tools of building environmental performances around the world



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

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)
 - Existing buildings operations & maintenance (LEED-EBOM)
 - Commercial interiors (LEED-CI)
 - Core and shell (LEED-CS)
 - Homes
 - Schools, Healthcare, Retail
 - Neighborhood development (LEED-ND)



Green building assessment



- 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

LEED® for New Construction

Total Possible Points 110***

	Sustainable Sites	26
	Water Efficiency	10
	Energy & Atmosphere	35
	Materials & Resources	14
	Indoor Environmental Quality	15

** Out of a possible 100 points + 10 bonus points*

*** Certified 40+ points, Silver 50+ points,
Gold 60+ points, Platinum 80+ points*

	Innovation in Design	6
	Regional Priority	4



LEED® for Existing Buildings

Total Possible Points 110***

	Sustainable Sites	26
	Water Efficiency	14
	Energy & Atmosphere	35
	Materials & Resources	10
	Indoor Environmental Quality	15

** Out of a possible 100 points + 10 bonus points*

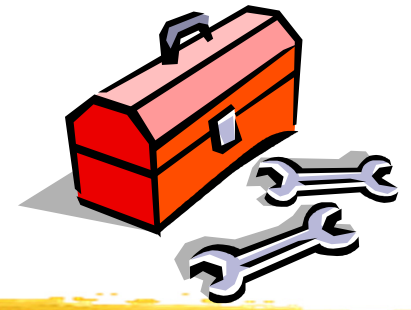
*** Certified 40+ points, Silver 50+ points,
Gold 60+ points, Platinum 80+ points*

	Innovation in Operations	6
	Regional Priority	4

(Source: USGBC)

For LEED version 3

Green building assessment



- LEED v4 (launched in 2014)*
 - Location & Transportation (LT)
 - Sustainable Site (SS)
 - Water Efficiency (WE)
 - Energy and Atmosphere (EA)
 - Materials and Resources (MR)
 - Indoor Environmental Quality (EQ)
 - Innovation (IN)
 - Regional Priority (RP)

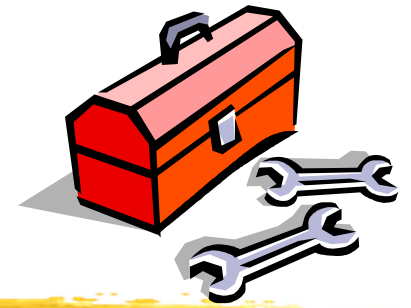


(* See also <http://new.usgbc.org/leed/v4>)

LEED v4



Green building assessment



- BEAM Plus development
 - Version 2009: (Nov 2009)
 - BEAM Plus for New Buildings
 - BEAM Plus for Existing Buildings
 - Version 1.1 (Apr 2010)
 - With minor refinements
 - Introduce BEAM Professionals
 - Version 1.2 (Jul 2012)
 - Addresses issues on passive design
 - Minor amendments to other aspects
 - Starting from 1 Jan 2013, version 1.2 must be used



BEAM Society
香港環保建築協會



HKGBC
香港綠色建築議會

BEAM Plus assessment criteria [credits] [weighting]

New Buildings	Existing Buildings
Site aspects (SA) [22+3B] [25%]	Site aspects (SA) [18+1B] [18%]
Materials aspects (MA) [22+1B] [8%]	Materials aspects (MA) [11+2B] [12%]
Energy use (EU) [42+2B] [35%]	Energy use (EU) [39+2B] [30%]
Water use (WU) [9+1B] [12%]	Water use (WU) [7+2B] [15%]
Indoor environmental quality (IEQ) [32+3B] [20%]	Indoor environmental quality (IEQ) [30+3B] [25%]
Innovations and additions (IA) [5B+1]	Innovations and additions (IA) [5B+1]



Green building assessment



- BEAM Plus (Version 1.1 or 1.2)
 - Overall grade: (with min. for SA, EU and IEQ)

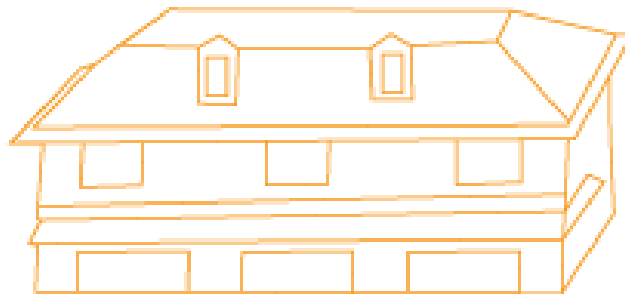
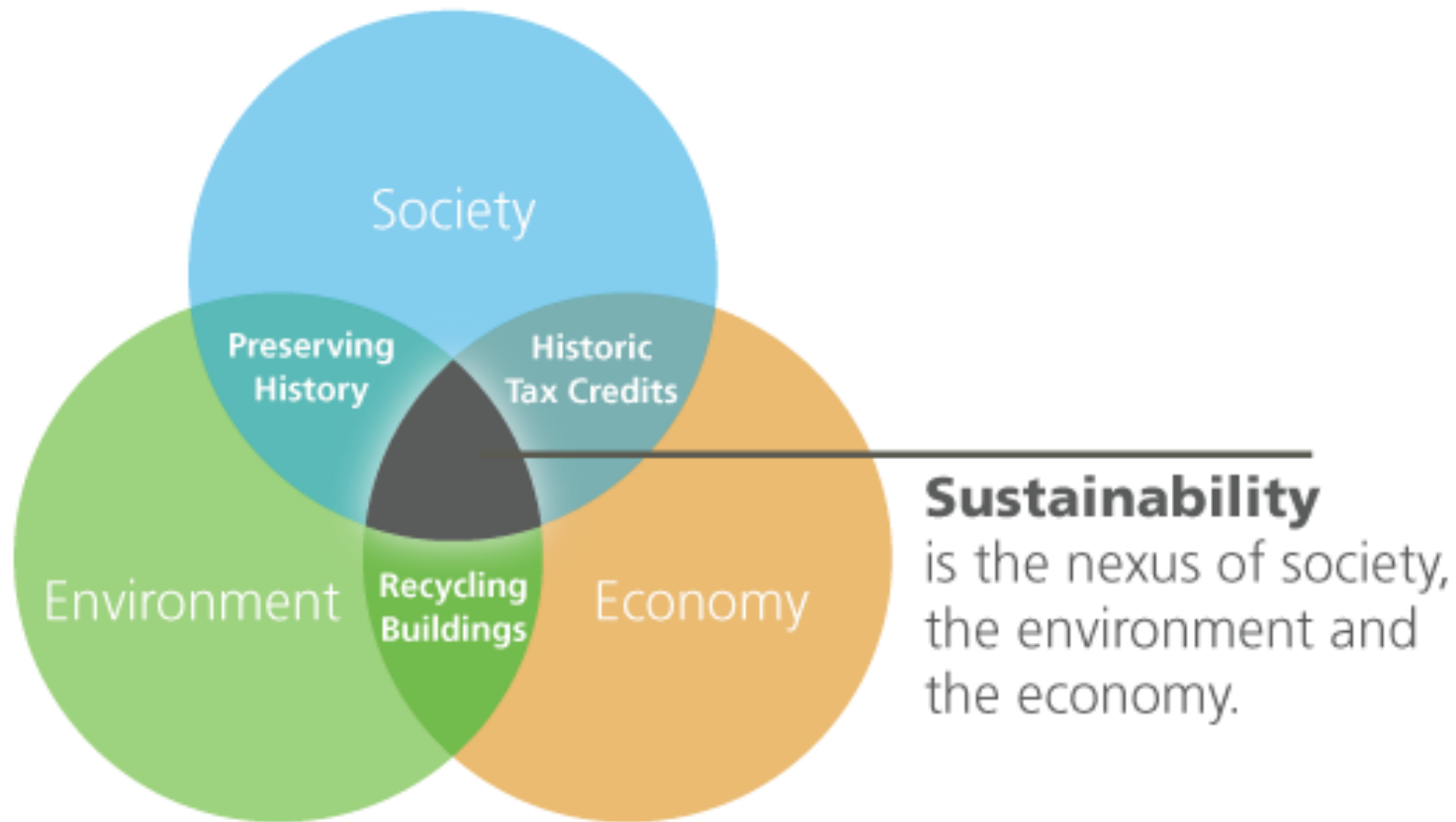
	Overall	Site Aspects	Energy Use	IEQ	Innov. & Addn.	
Platinum	75%	70%	70%	70%	3 credits	Excellent
Gold	65%	60%	60%	60%	2 credits	Very Good
Silver	55%	50%	50%	50%	1 credit	Good
Bronze	40%	40%	40%	40%	---	Above Average

Historic buildings



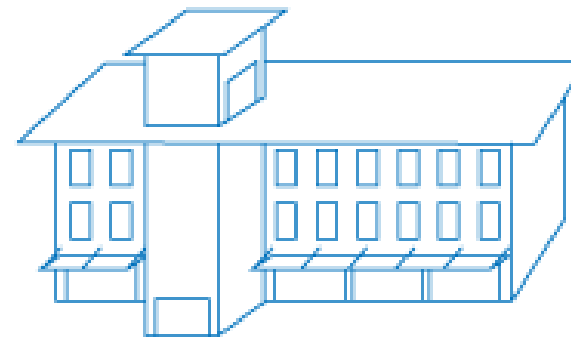
- Historic Preservation and Green Building: A Lasting Relationship [Environmental Building News]
 - <http://www2.buildinggreen.com/article/historic-preservation-and-green-building-lasting-relationship>
 - Old buildings and sustainability
 - They tend to be simpler, more long-lasting and durable
 - Main issues:
 - Embodied energy in old buildings
 - Operating energy
 - Green and historic conflicts (e.g. solar panels)

Historic preservation is inherently a sustainable practice



Rehabilitated & retrofitted mixed-use building

Embodied energy of existing materials
production, transport, & assembly



Newly constructed mixed-use building

42–80 years to overcome negative
environmental impact of construction

Historic buildings



- Sustainable Historic Preservation [WBDG]
 - http://www.wbdg.org/resources/sustainable_hp.php
- Historic Preservation
 - http://www.wbdg.org/design/historic_pres.php?ce=sshp
- Apply the Preservation Process Successfully
 - http://www.wbdg.org/design/apply_process.php?ce=sshp
- Update Building Systems Appropriately
 - http://www.wbdg.org/design/update_systems.php?ce=sshp
- Sustainable Historic Preservation
 - http://www.wbdg.org/resources/sustainable_hp.php?ce=sshp
- Historic Structure O&M Practices
 - <http://www.wbdg.org/resources/omhs.php?ce=sshp>

Historic buildings



- Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings
 - <http://www.nps.gov/tps/standards/rehabilitation/guidelines/index.htm>
 - Sustainability
 - Planning, Maintenance, Windows, Weatherization, Insulation
 - HVAC, Solar Technology, Wind Power, Roofs, Site Features, Daylighting

Historic buildings



- Preservation Briefs (National Park Service)
 - <http://www.nps.gov/tps/how-to-preserve/briefs.htm>
 - Preservation Brief 3: Improving Energy Efficiency in Historic Buildings
 - <http://www.nps.gov/tps/how-to-preserve/briefs/3-improve-energy-efficiency.htm>
 - Preservation Brief 24: Heating, Ventilating, and Cooling Historic Buildings -- Problems and Recommended Approaches
 - <http://www.nps.gov/tps/how-to-preserve/briefs/24-heat-vent-cool.htm>

Historic buildings



- U.S. General Services Administration (GSA)
 - GSA Technical Preservation Guidelines
 - <http://www.gsa.gov/portal/content/101402>
 - Fire Safety Retrofit
 - Upgrading Historic Building Lighting
 - HVAC Upgrades in Historic Buildings
 - GSA Historic Preservation Technical Procedures
 - <http://www.gsa.gov/portal/hp/hpc/category/100371/hostUri/portal>

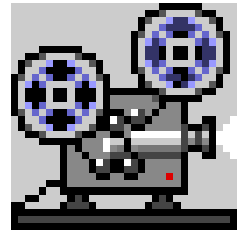
Historic buildings



- Example:

- Video: From Historic to Sustainable (9:00)

- <http://www.youtube.com/watch?v=bHnUbYtb0DQ>



- The Georgia Trust for Historic Preservation is taking its 1904 headquarters, Rhodes Hall, From Historic to Sustainable, transforming it into an asset that provides a modern workplace and active educational center.
 - The Trust is implementing a sustainable rehabilitation of Rhodes Hall which features water and energy conservation achieved through state-of-the-art HVAC and installation systems, repaired and resealed historic windows, and many other innovations. This will be achieved alongside a sensitive historic restoration, providing a modern model for the stewardship of historic buildings.