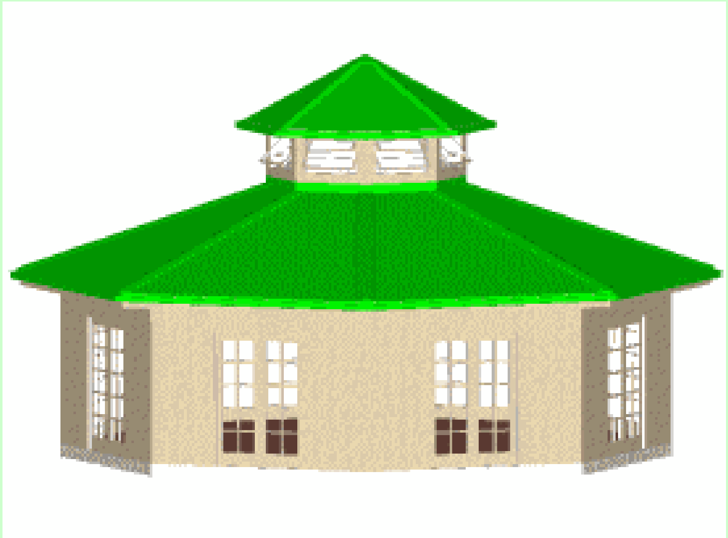
Trane Training Class 2016:
High Performance Building System in Smart City
11 Nov 2016 (Fri), The Joint Professional Centre, The Center, Hong Kong



Basics of High Performance Building Design

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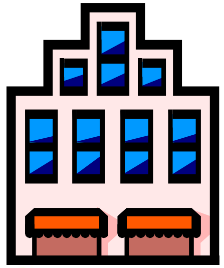
- What is high performance building?
- High-performance green building
- Potential benefits
- Design strategies
- ASHRAE Standard 189.1
- Building performance analysis

What is high performance building?

(Image source: Whole Building Design Guide http://www.wbdg.org)

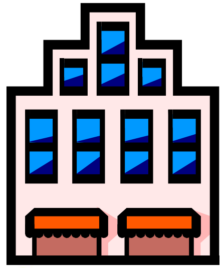
High performance building



- High performance buildings (HPB):
  - Are safe, comfortable and efficient
  - Help owners/occupants achieve business missions
  - Operate reliably with minimum unscheduled downtime and fast recovery
  - Enhance organization and occupant performance, retain/increase value
  - Maintain performance within acceptable tolerances throughout their lifespan

(* See also: High Performing Buildings Magazine http://www.hpbmagazine.org)

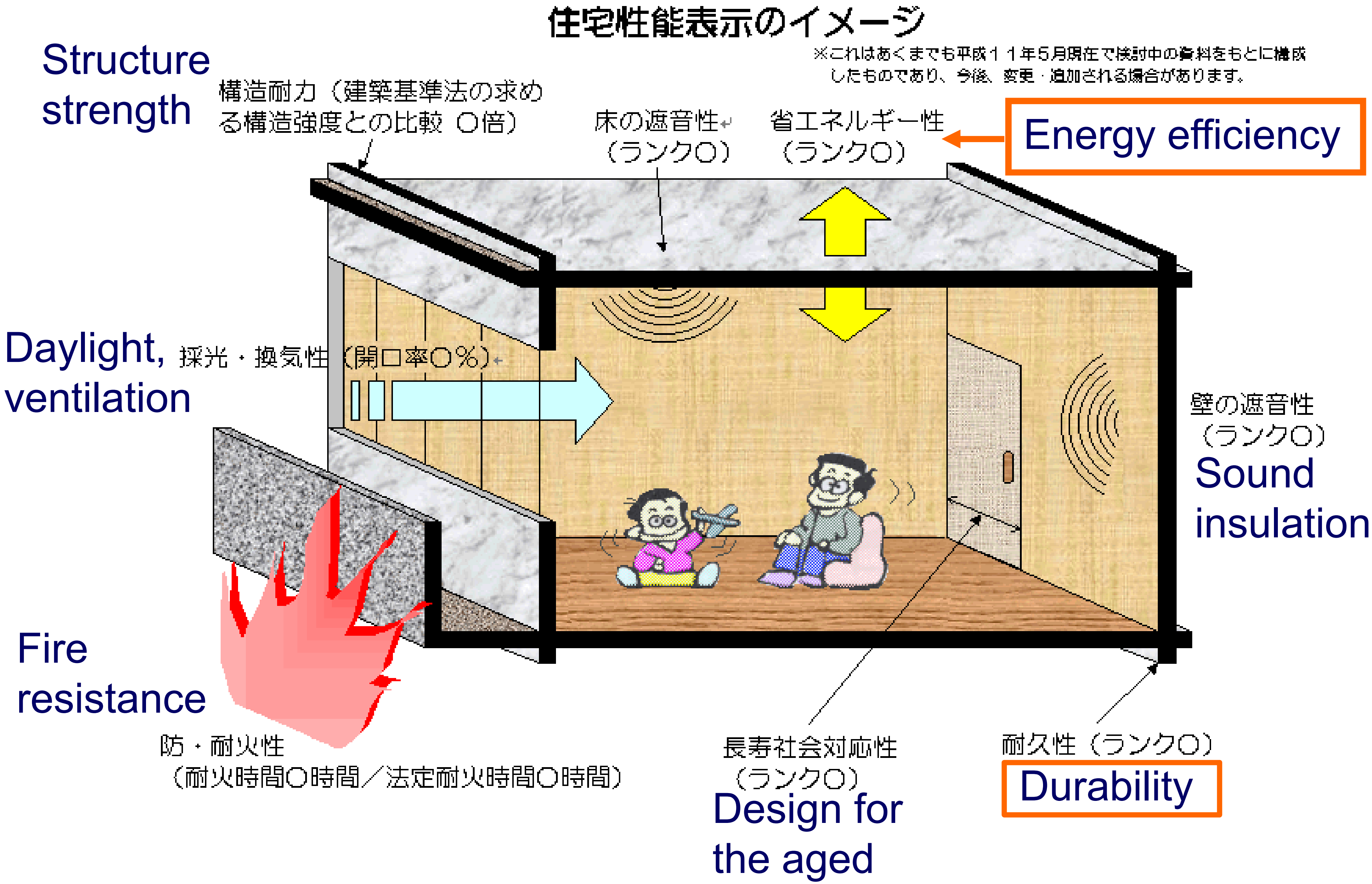
High performance building



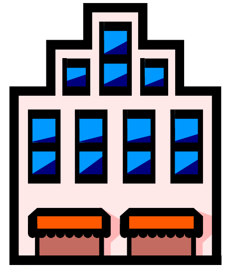
- Many issues are involved; not easy to define
- Definition of high performance building from US Energy Policy Act of 2005:*
  - A building that integrates and optimizes all major high-performance building attributes, including
    - Energy efficiency,
    - Durability,
    - Life-cycle performance, and
    - Occupant productivity.

(* Source: http://www.nibs.org/?page=hpbc)

Index of Building (Houses) Performance (Japan)

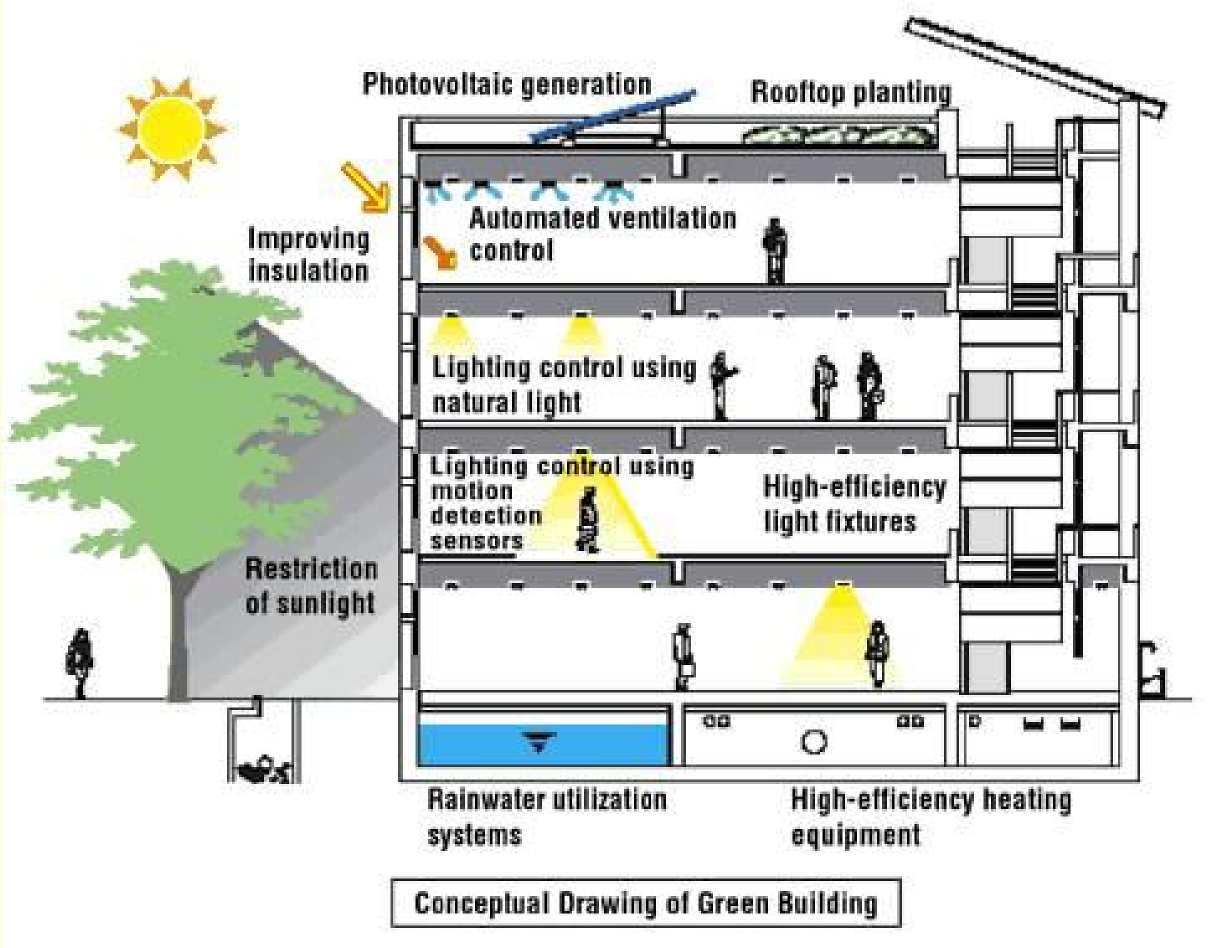


High performance building



- Building performance issues
  - Functionality
  - Serviceability
  - Building-occupant comfort
- Trends
  - Use performance as the major criteria for building design (*performance-based*)
  - The need to study, measure, and predict the level of building performance (*to quantify*)

High performance green building



(Image source: http://nems.nih.gov/)

High-perform. green building

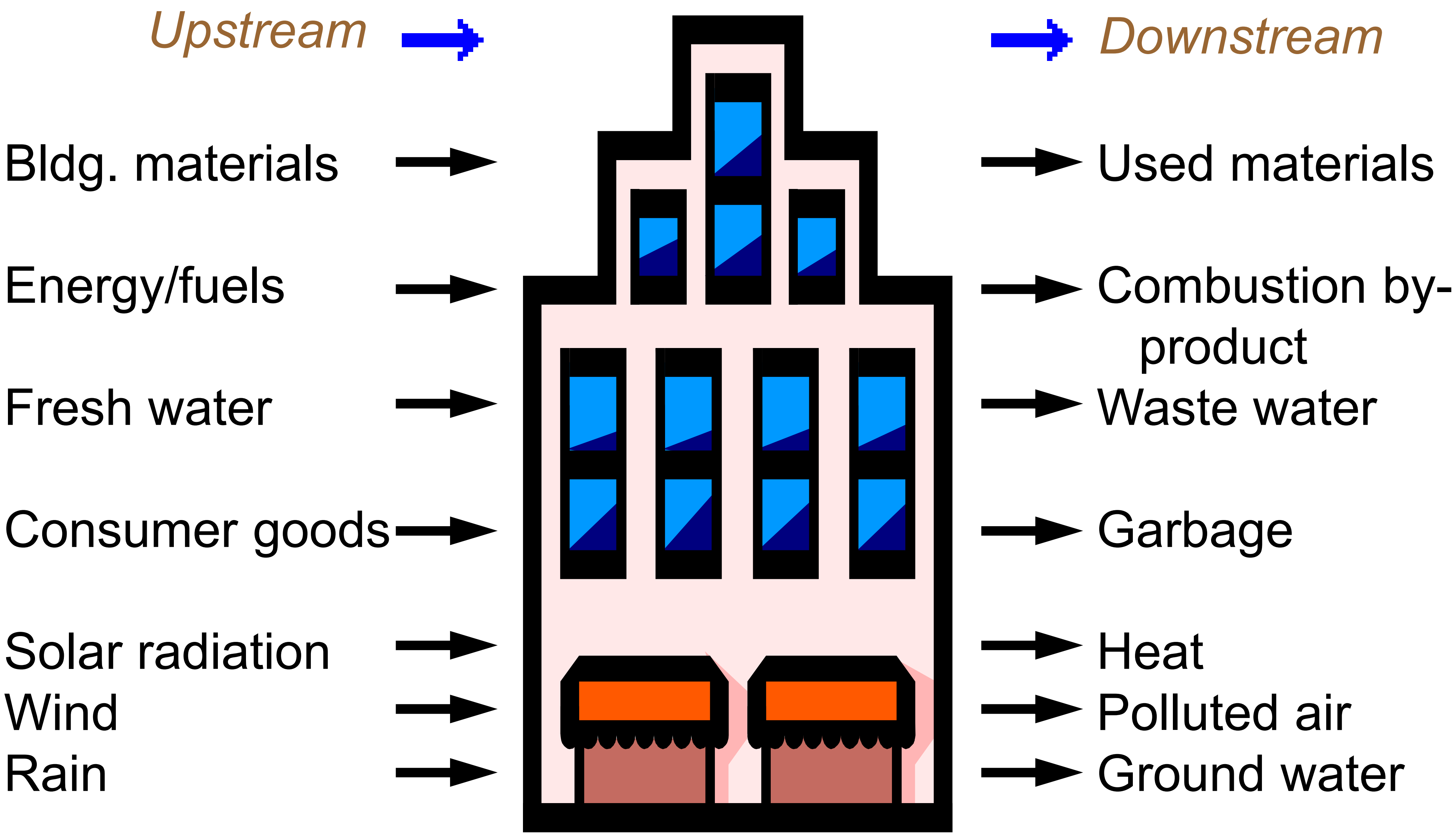
- The terms "high performance", "green", and "sustainable" are often used interchangeably
  - Focus on ecological, environmental, social, and economic issues of a building
  - Concern over the impacts of built environment on natural environment, economy, health, and productivity
- Encouraged by green building assessment and ratings (e.g. LEED, BREEAM, BEAM Plus)

High-perform. green building

- **Green Building (GB)**
  - A loosely defined collection of land-use, building design, and construction strategies that reduces the environmental impacts
- **Sustainable Building** [HKGBC]
  - 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

High-perform. 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

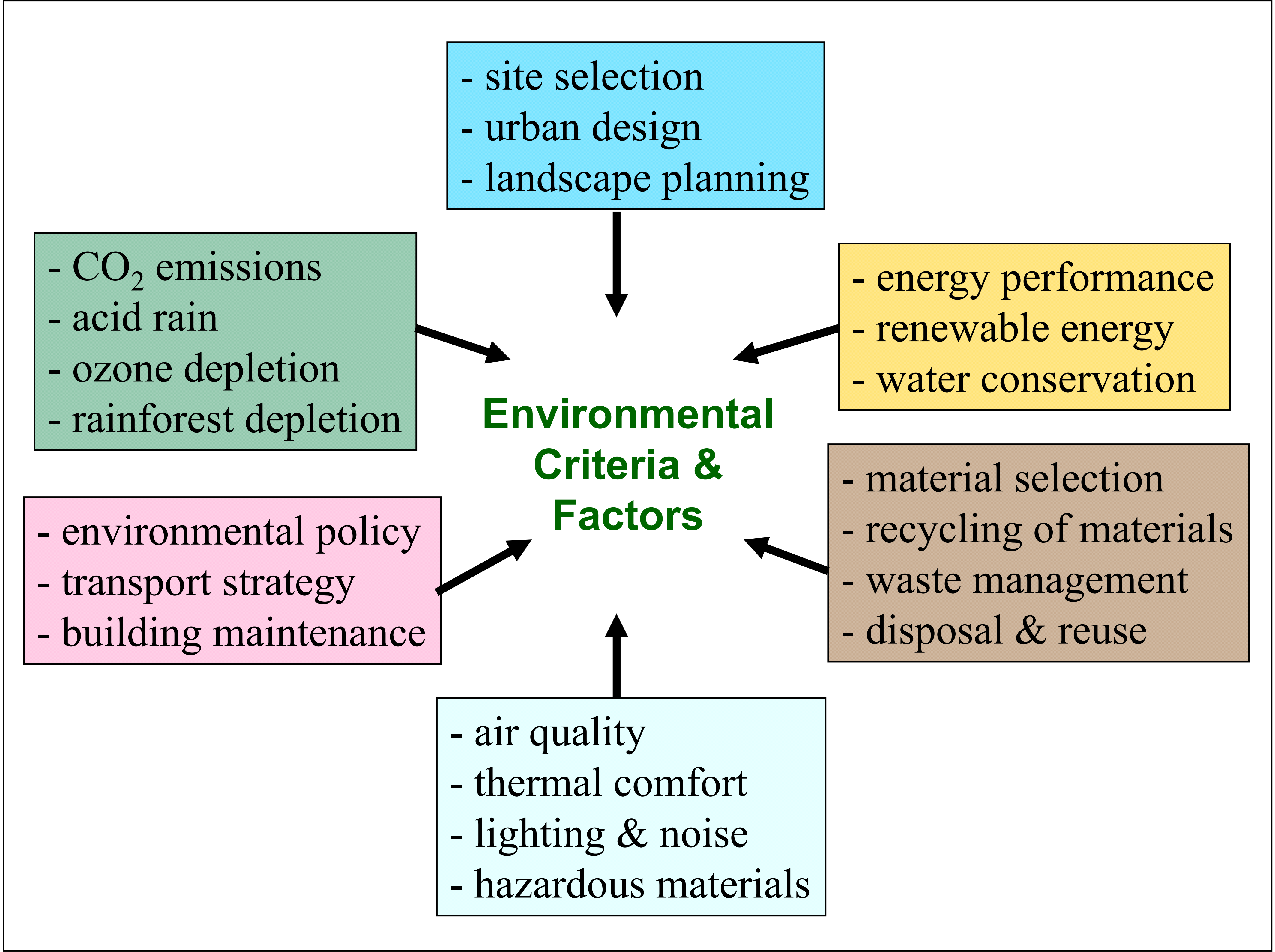


Resource and material flow in the building ecosystem

Cradle-to-Grave

Sustainable design requires life cycle thinking.

Cradle-to-grave is the full Life Cycle Assessment from resource extraction ('cradle') to use phase and disposal phase ('grave').


- site selection
- urban design
- landscape planning
- CO_2 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

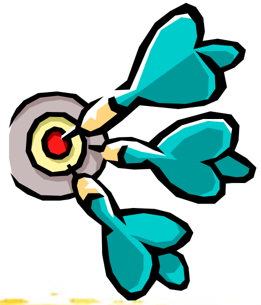
High-perform. green building

- 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

Potential benefits

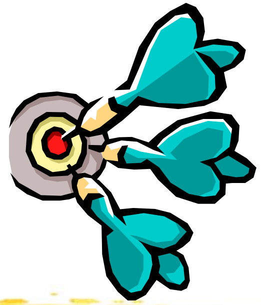
(Image source: http://www.townparkbuildcon.com/green-building.html)

Potential benefits



- 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*”

Potential benefits



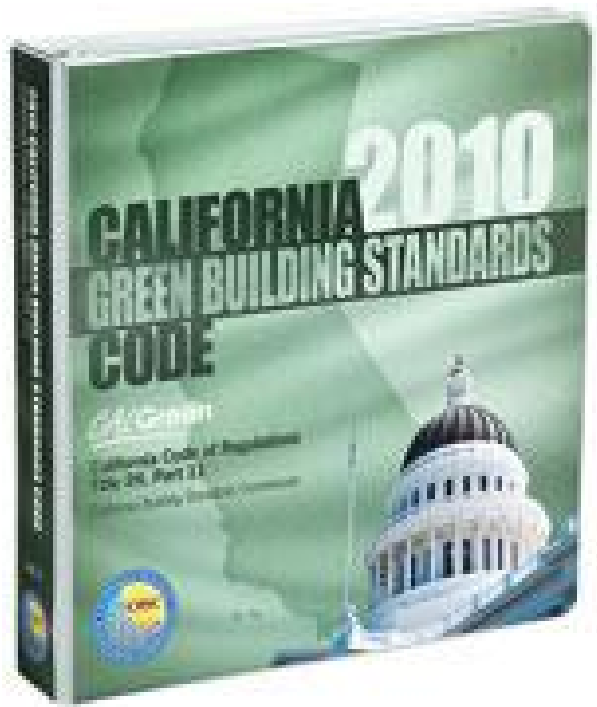
- Benefits of green/sustainable buildings:
  - They are designed to be cost effective
  - They boost employee productivity
  - They enhance health and well-being
  - They reduce liability
  - They create value for tenants
  - They increase property value
  - They benefit the community
  - They achieve more predictable results

Potential benefits

- 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

Potential benefits

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



CALGreen

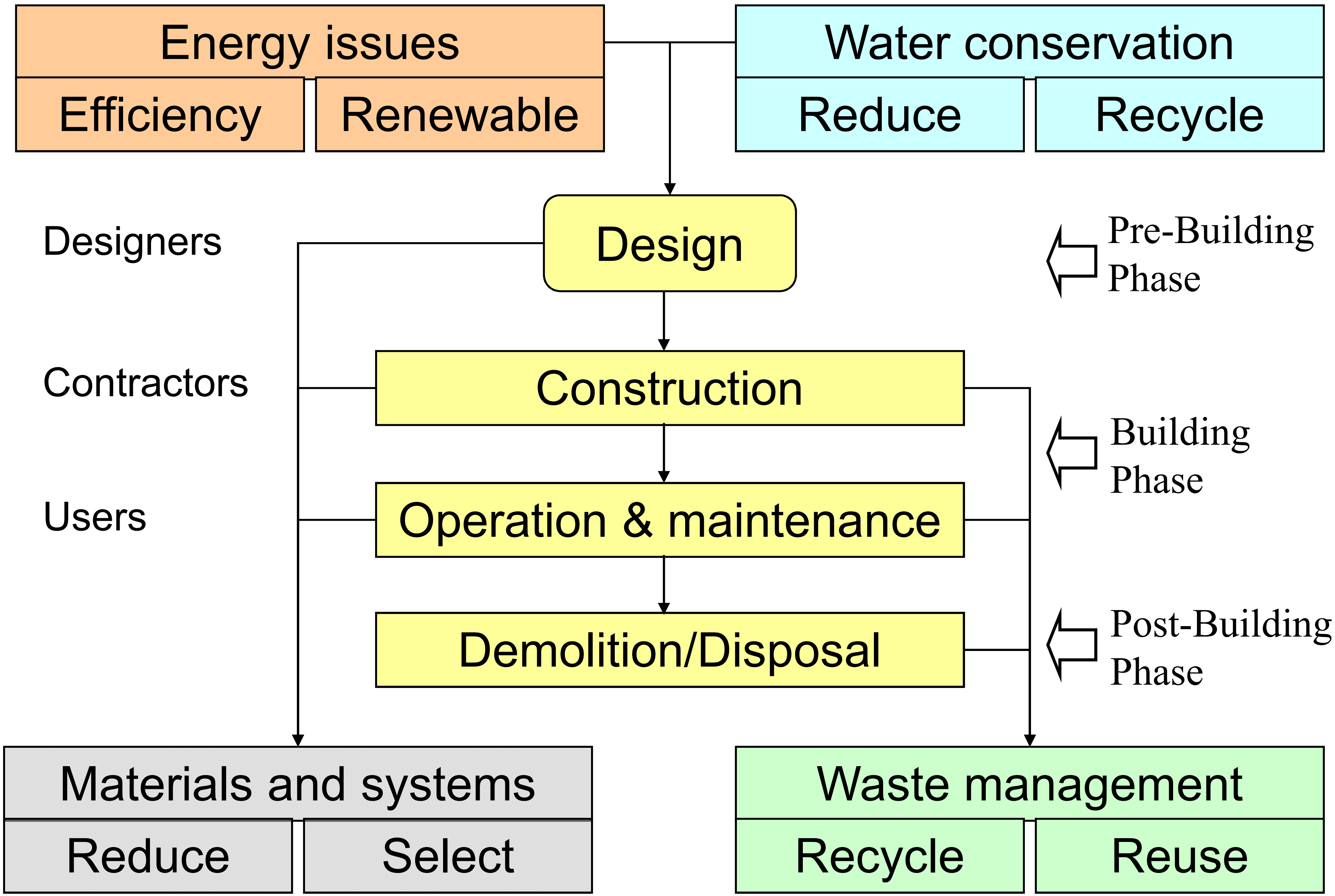
IgCC

SAFE & SUSTAINABLE BY THE BOOK

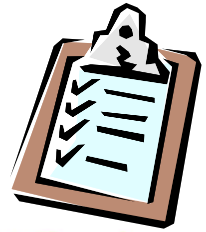
International Green Construction Code (IgCC)

Design strategies

Building life cycle and sustainable construction



Design strategies

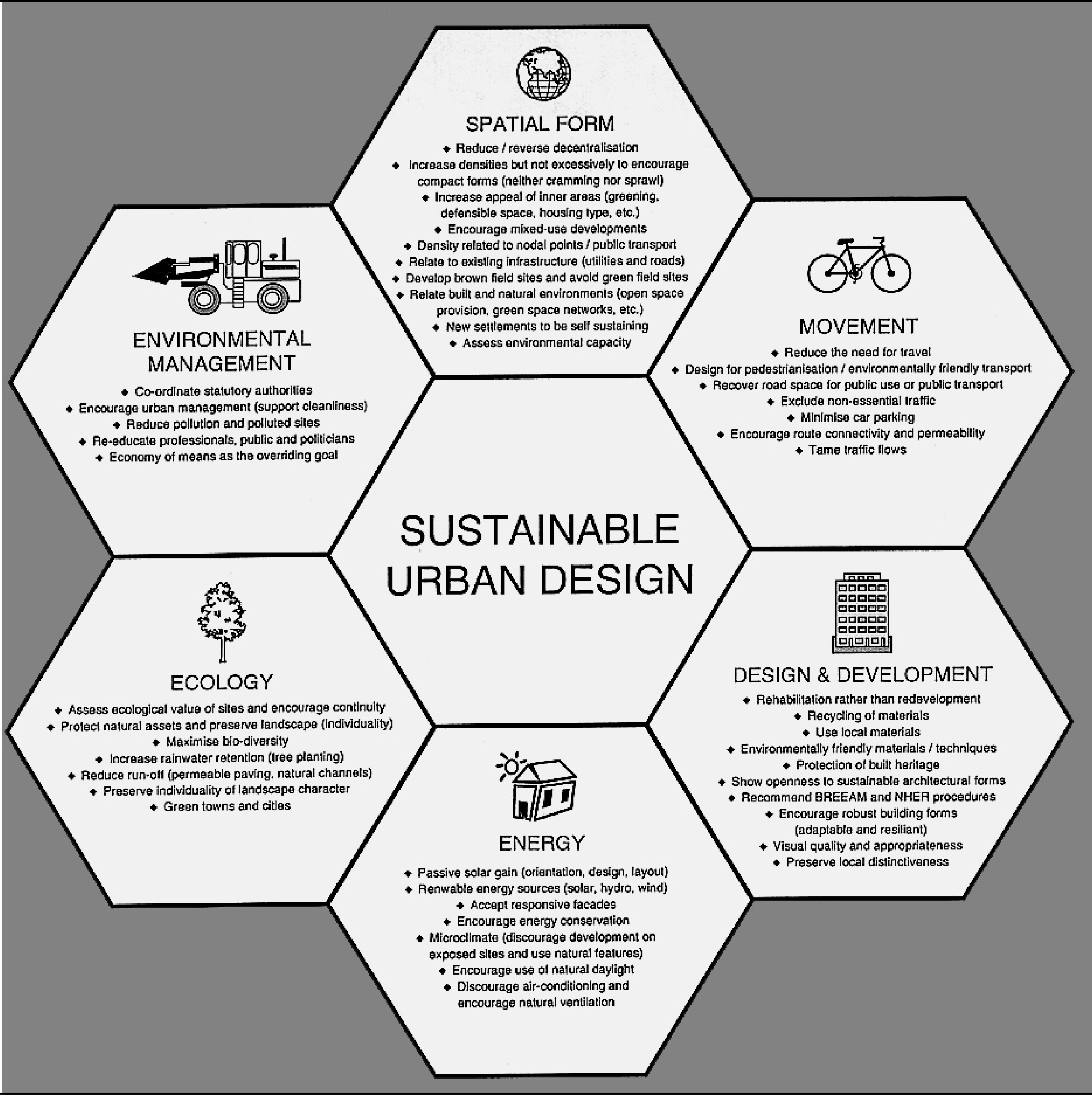


- Major aspects:
  - Urban and site design
  - Energy efficiency
  - Renewable energy
  - Building materials
  - Water issues
  - Indoor environment
  - Integrated building design

* See also: http://ibse.hk/GB_design_strategies.pdf

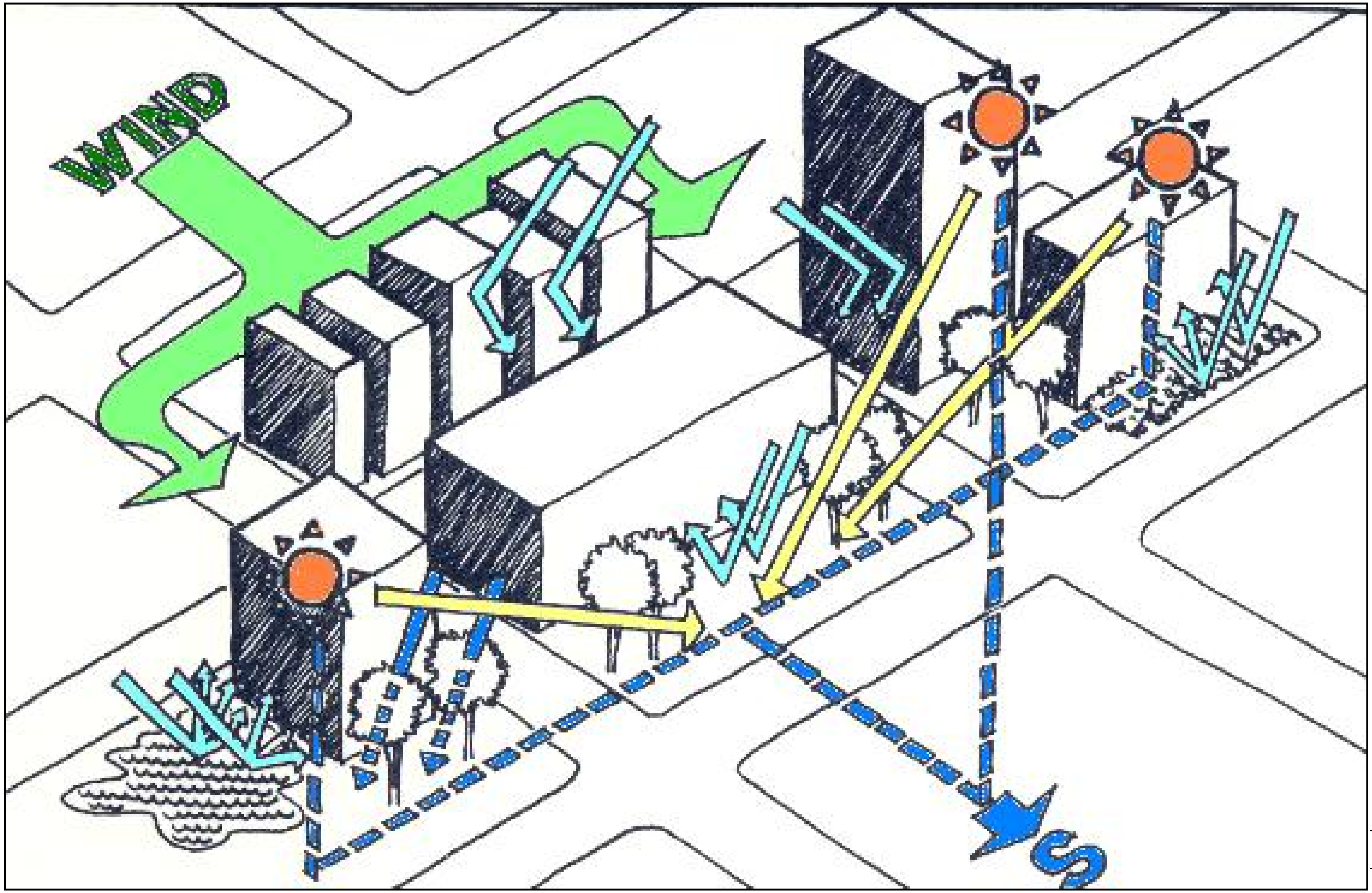
Urban and site design

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


SPATIAL FORM
◆ Reduce / reverse decentralisation
◆ Increase densities but not excessively to encourage compact forms (neither cramming nor sprawl)
◆ Increase appeal of inner areas (greening, defensible space, housing type, etc.)
◆ Encourage mixed-use developments
◆ Density related to nodal points / public transport
◆ Relate to existing infrastructure (utilities and roads)
◆ Develop brown field sites and avoid green field sites
◆ Relate built and natural environments (open space provision, green space networks, etc.)
◆ New settlements to be self sustaining
◆ Assess environmental capacity
ENVIRONMENTAL MANAGEMENT
◆ Co-ordinate statutory authorities
◆ Encourage urban management (support cleanliness)
◆ Reduce pollution and polluted sites
◆ Re-educate professionals, public and politicians
◆ Economy of means as the overriding goal
MOVEMENT
◆ Reduce the need for travel
◆ Design for pedestrianisation / environmentally friendly transport
◆ Recover road space for public use or public transport
◆ Exclude non-essential traffic
◆ Minimise car parking
◆ Encourage route connectivity and permeability
◆ Tame traffic flows
SUSTAINABLE URBAN DESIGN
ECOLOGY
◆ Assess ecological value of sites and encourage continuity
◆ Protect natural assets and preserve landscape (individuality)
◆ Maximise bio-diversity
◆ Increase rainwater retention (tree planting)
◆ Reduce run-off (permeable paving, natural channels)
◆ Preserve individuality of landscape character
◆ Green towns and cities
DESIGN & DEVELOPMENT
◆ Rehabilitation rather than redevelopment
◆ Recycling of materials
◆ Use local materials
◆ Environmentally friendly materials / techniques
◆ Protection of built heritage
◆ Show openness to sustainable architectural forms
◆ Recommend BREEAM and NHER procedures
◆ Encourage robust building forms (adaptable and resiliant)
◆ Visual quality and appropriateness
◆ Preserve local distinctiveness
ENERGY
◆ Passive solar gain (orientation, design, layout)
◆ Renwable energy sources (solar, hydro, wind)
◆ Accept responsive facades
◆ Encourage energy conservation
◆ Microclimate (discourage development on exposed sites and use natural features)
◆ Encourage use of natural daylight
◆ Discourage air-conditioning and encourage natural ventilation

風
Wind

光
Light



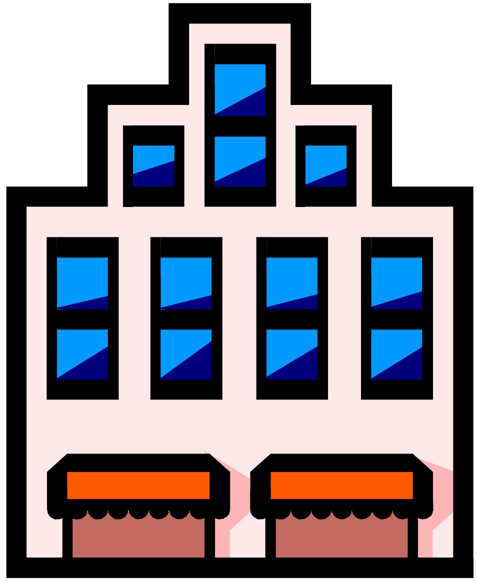
水
Water

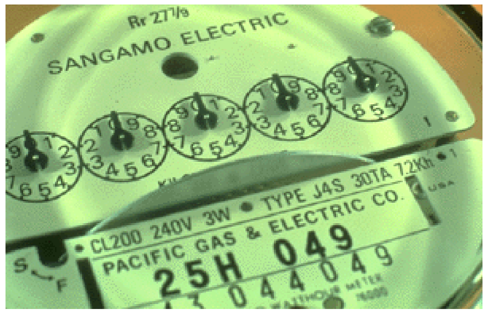
物
Matter

Site analysis and understanding of the environmental factors is important

Energy efficiency

- For new buildings
  - Designing the building
    - Design strategy
    - Control strategies
    - Commissioning
- For existing buildings
  - Operating and upgrading the building
    - Building management
    - Refurbishment/renovation/retrofitting
    - Maintenance and monitoring





Good design practices

Integrated & total energy approach

Efficient systems

Good house-keeping

User education & awareness

Efficient operation

Energy Efficiency

- High-performance HVAC*

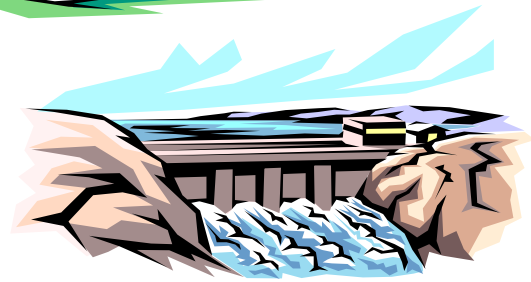
  - HVAC usually accounts for a large portion of building energy use
  - Large energy saving potential

    - Use of high performance HVAC equipment
      - Such as Next Gen chiller & unitary
    - Integrated building design with extended comfort zone
    - Consider and improve part-load performance
    - Proper commissioning and controls (e.g. on humidity)
    - Effective operations and maintenance (O&M)

(* See also: https://www.wbdg.org/resources/hvac.php)

Renewable energy

- Energy that occurs naturally and repeatedly on earth and can be harnessed for human benefit, e.g. solar, wind and biomass
- Common applications
  - Solar hot water
  - Solar photovoltaic
  - Wind energy
  - Geothermal
  - Small hydros



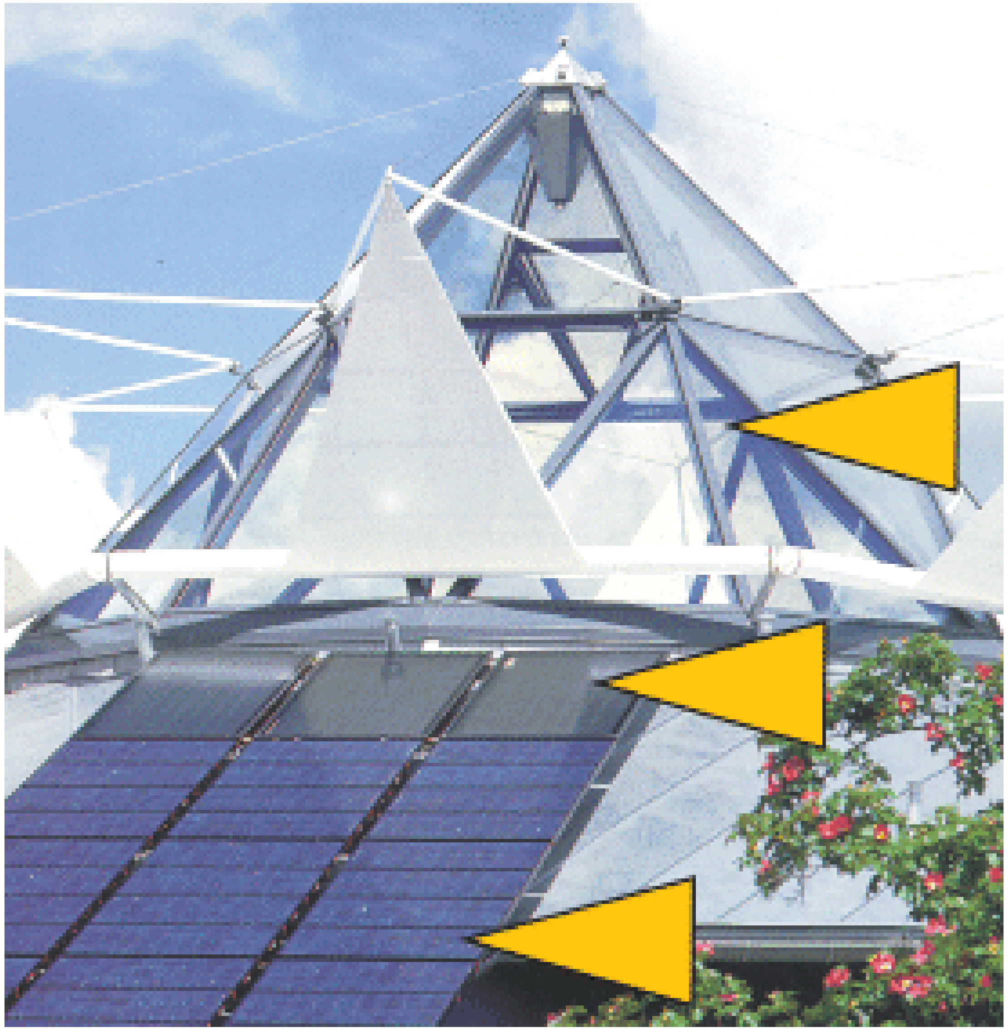
可再生能源

Renewable energy

- Renewables for buildings
  - Solar energy
    - Passive (low energy architecture)
    - Active (solar thermal)
    - Photovoltaics
  - Other renewables
    - Wind (using buildings to harvest wind energy)
    - Geothermal (e.g. hot springs)
    - Small hydros (e.g. water wheels)
  - Hybrid systems (e.g. PV + wind + diesel)

因地制宜，多能互补。

Integration of solar energy systems in buildings

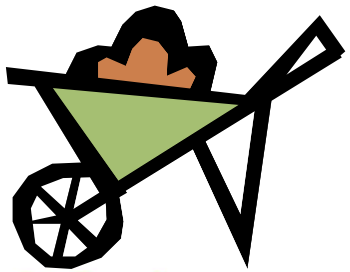


Passive solar (e.g. skylight)

Active solar (solar hot water)

Photovoltaics

Building materials

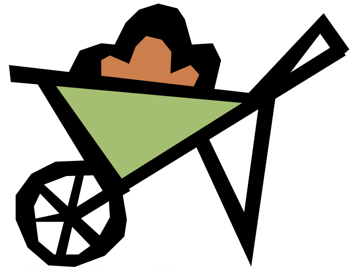


- Environmental impact of building materials
  - Through consumption of resources
  - Through production of resources (by-products, wastes, pollution, recyclables)
- Objectives
  - Make informed environmental choices about building materials and systems
  - Careful design & understanding about materials

Green Features

Manufacturing Process (MP)	Building Operations (BO)	Waste Mgmt. (WM)
Waste Reduction (**WR**)	Energy Efficiency (**EE**)	Biodegradable (**B**)
Pollution Prevention (**P2**)	Water Treatment & Conservation (**WTC**)	Recyclable (**R**)
Recycled (**RC**)	Nontoxic (**NT**)	Reusable (**RU**)
Embodied Energy Reduction (**EER**)	Renewable Energy Source (**RES**)	Others (**O**)
Natural Materials (**NM**)	Longer Life (**LL**)	

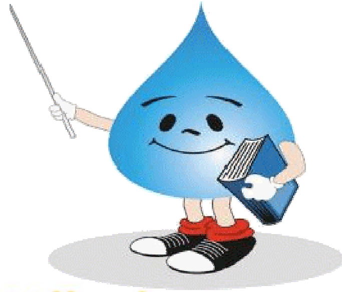
Building materials



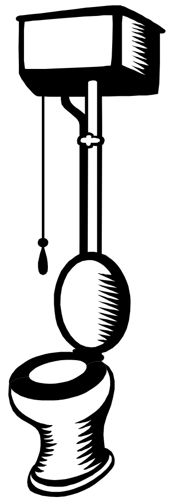
- Material conservation
  - Adapt existing buildings to new uses
  - Material conserving design & construction
  - Size buildings & systems properly
  - Incorporate reclaimed or recycled materials
  - Use environment-friendly materials & products
  - Design for deconstruction ("close the loop")

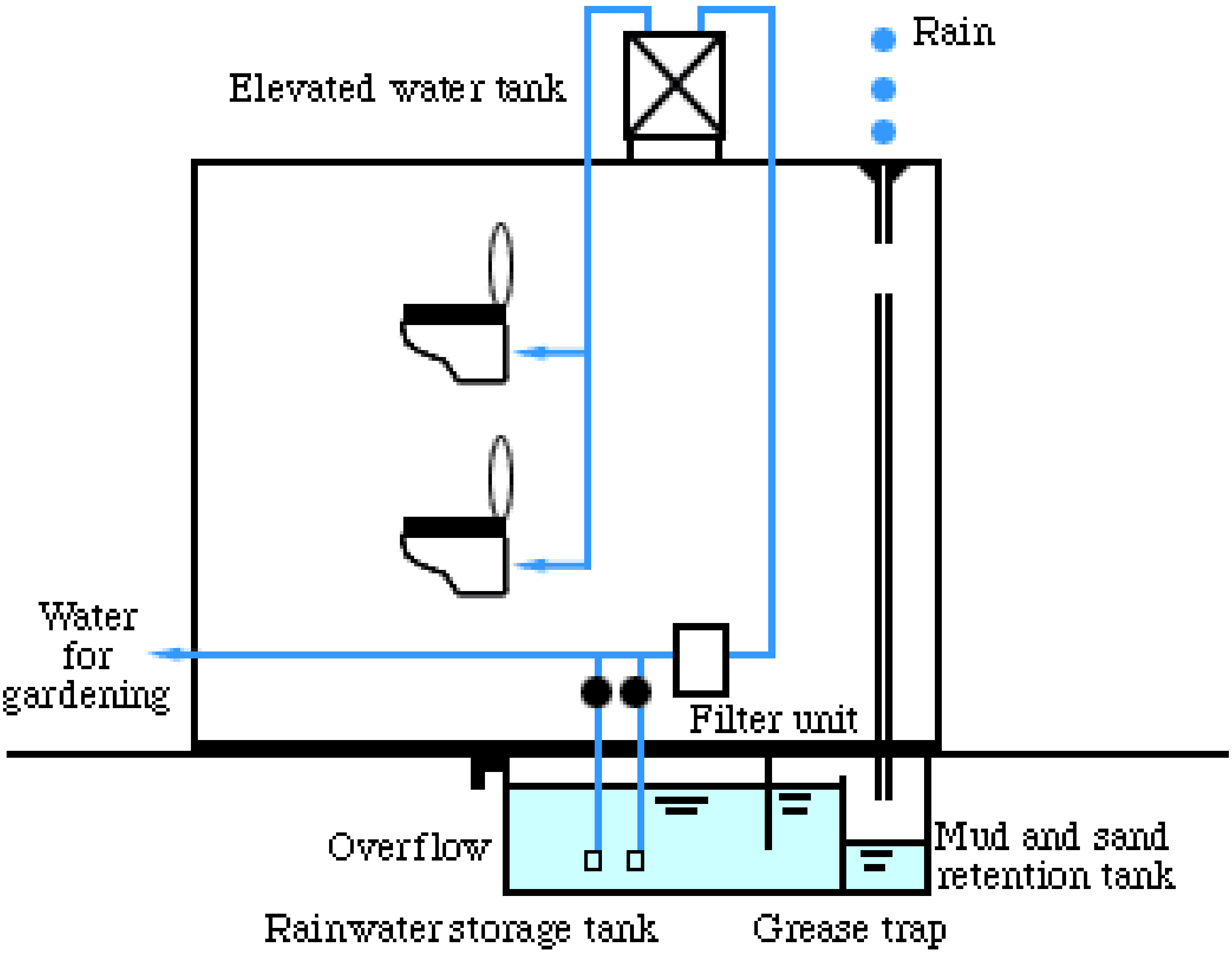
- Life cycle assessment (LCA) is often used to evaluate the environmental impact of building materials and products

Water issues

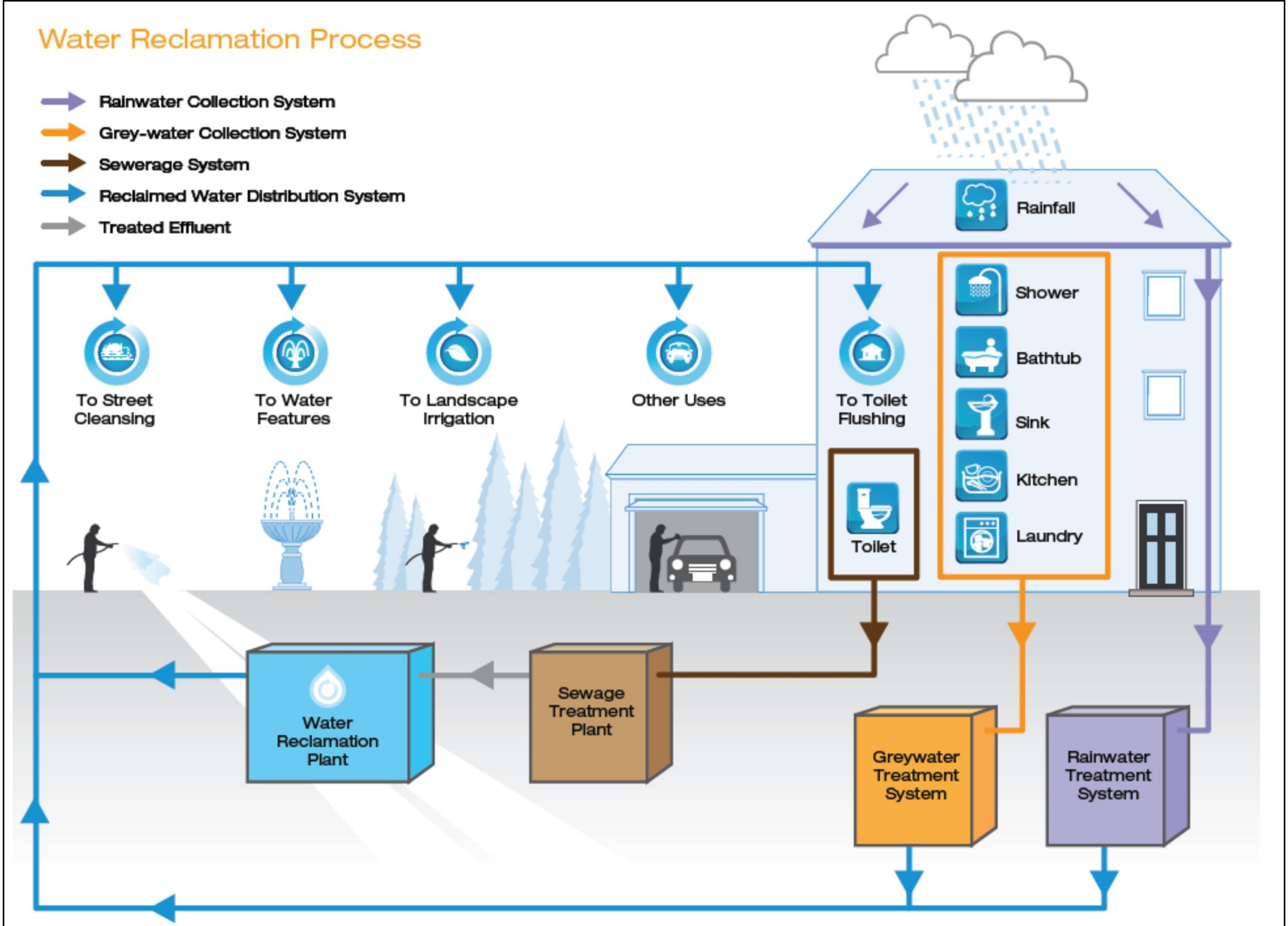


- Design strategy for water efficiency
  - Reduce water consumption
    - Low-flush toilets & showerheads
    - Leak detection & prevention
  - Correct use of appliances (e.g. washing machine)
  - Reuse and recycle water onsite
    - Rainwater collection & recycling
    - Greywater recycling (e.g. for irrigation)
  - No-/Low-water composting toilet





Rainwater recycling system

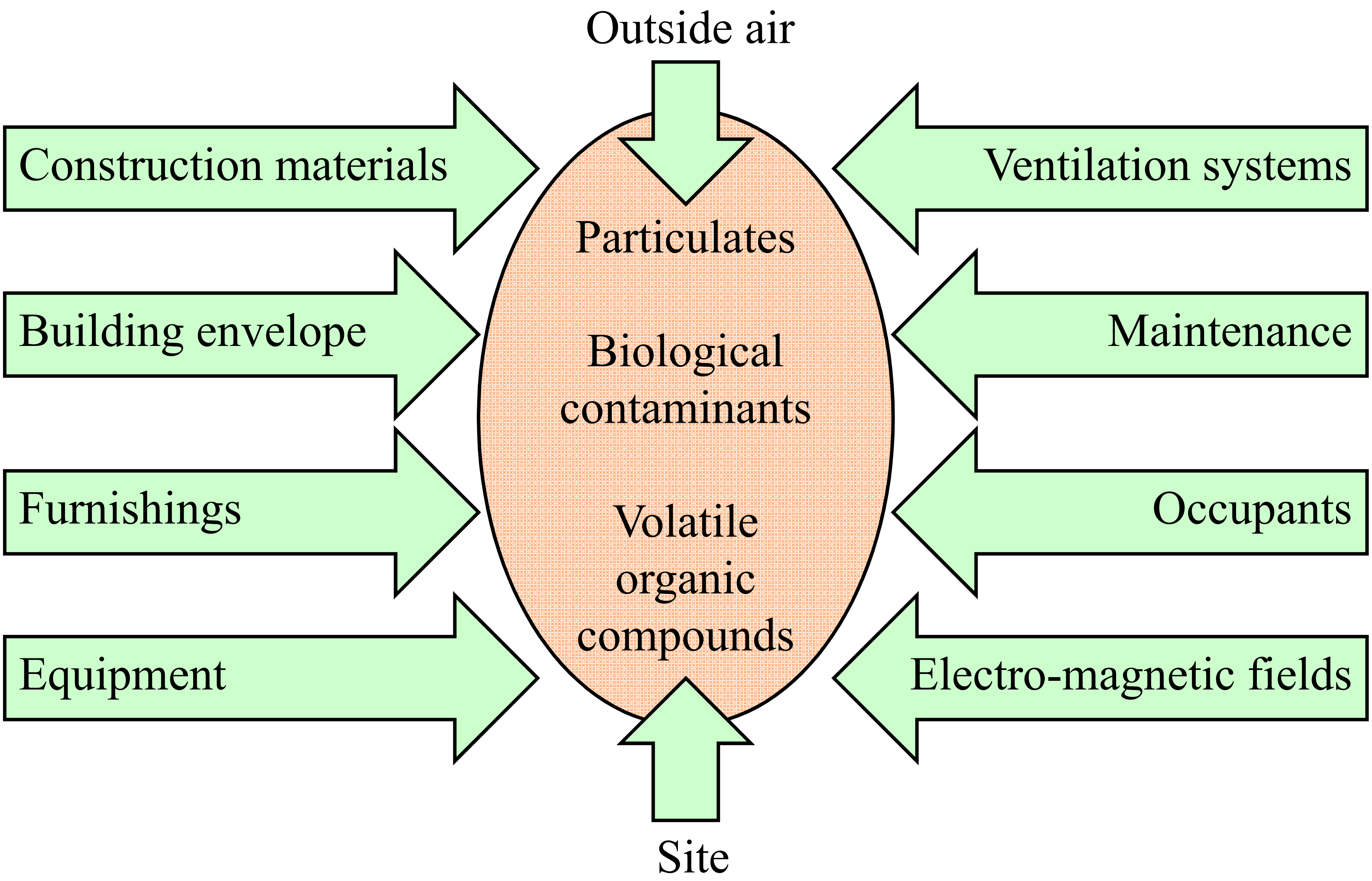


(Source: Water Supplies Department, www.wsd.gov.hk)

Indoor environment

- 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

Major factors contributing to indoor air quality (IAQ)



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

Four principles of indoor air quality design

1. Source Control

+

2. Ventilation Control

+

3. Occupant Activity Control

+

4. Building Maintenance

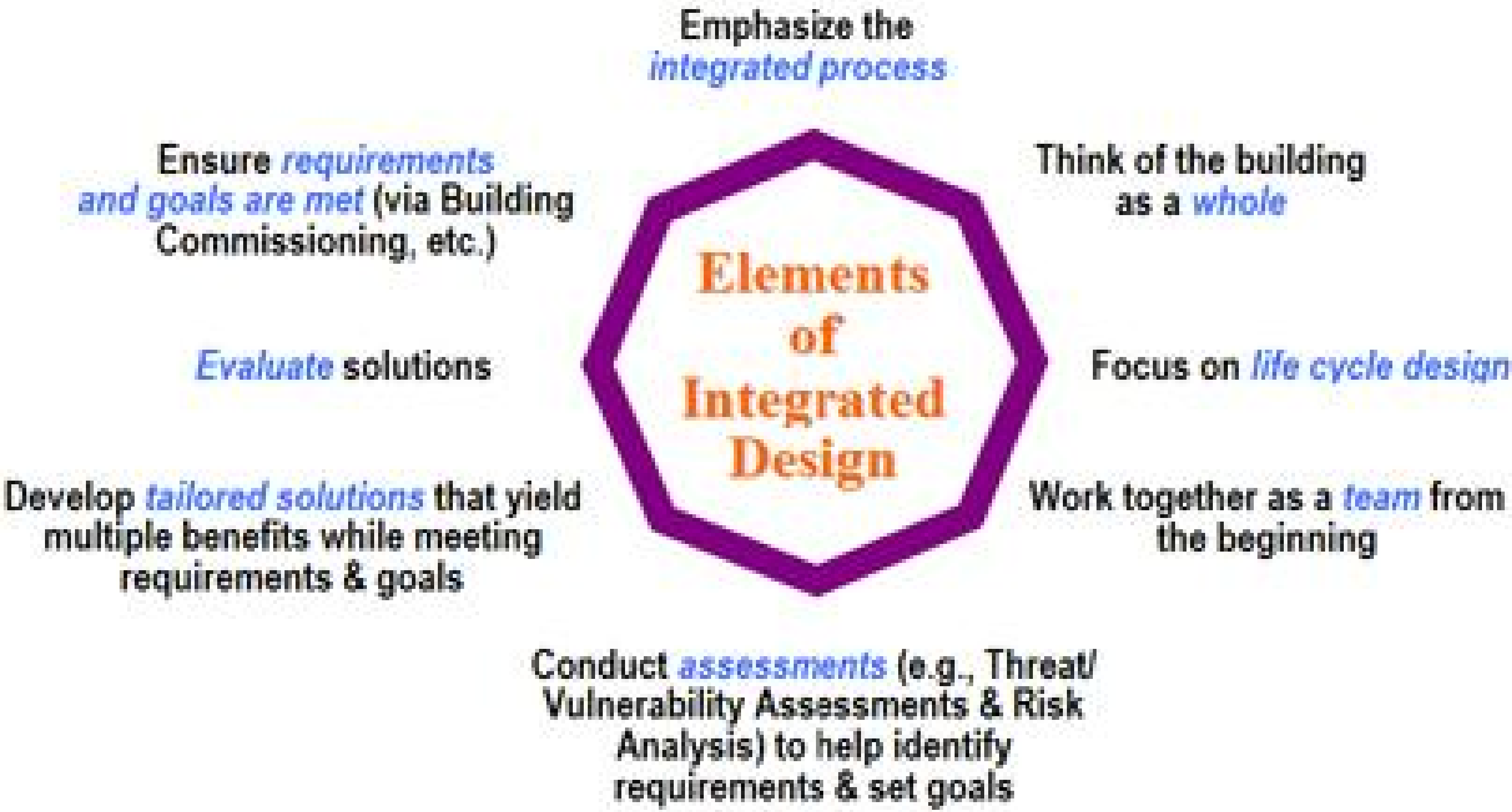
= *Total Indoor Air Quality*

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

Integrated building design

- Typical integrated design process
  - Preparation
  - Design development
  - Contract documents
  - Construction phase
  - Commissioning
  - Post-occupancy evaluation

- Usually more efforts in preparation and pre-design phases



(Source: www.wbdg.org)

Integrated building design

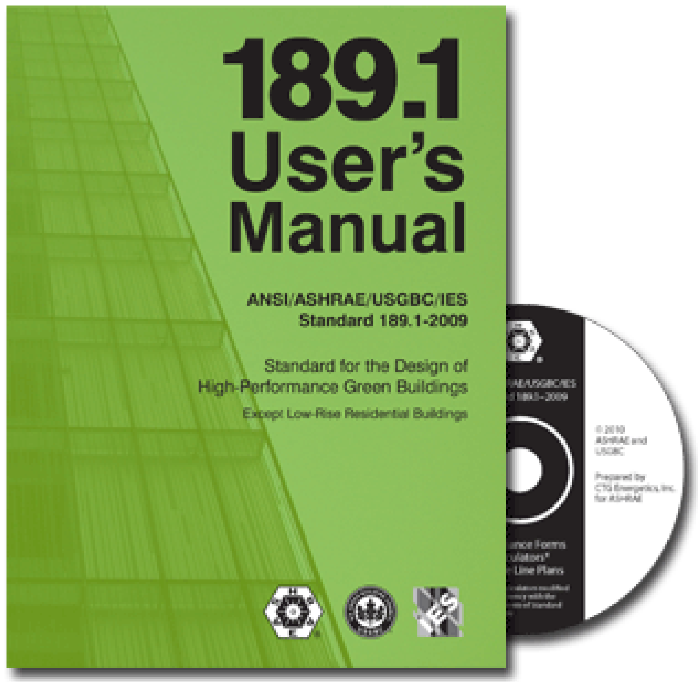
- Integrated, multidisciplinary project team
  - Owner's representative
  - Architect
  - Building Services Engineer
  - Civil/Structural Engineer
  - Construction Manager
  - Landscape Architect
  - Specialized Consultants

ASHRAE Standard 189.1

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)

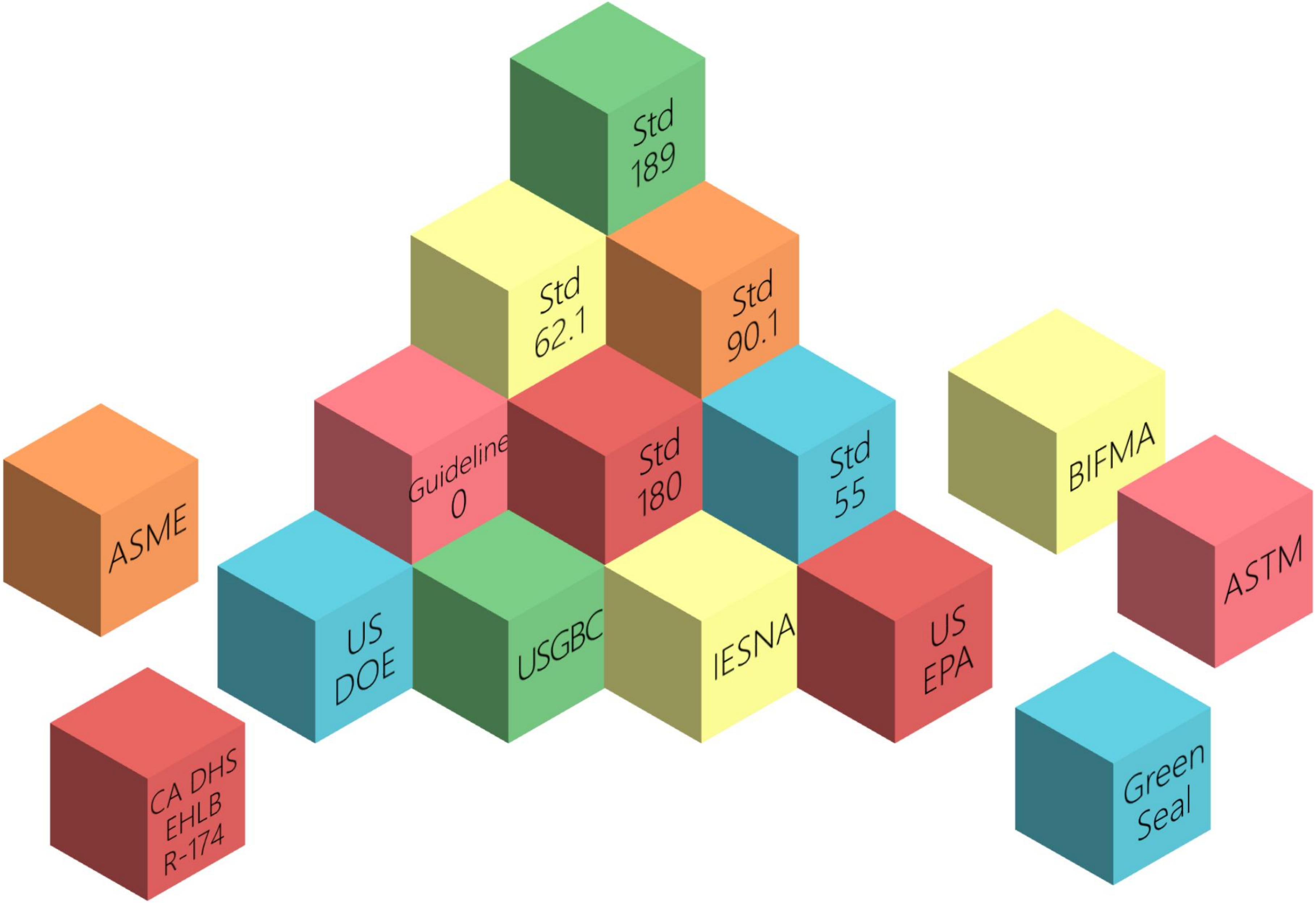
ASHRAE Standard 189.1

- 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

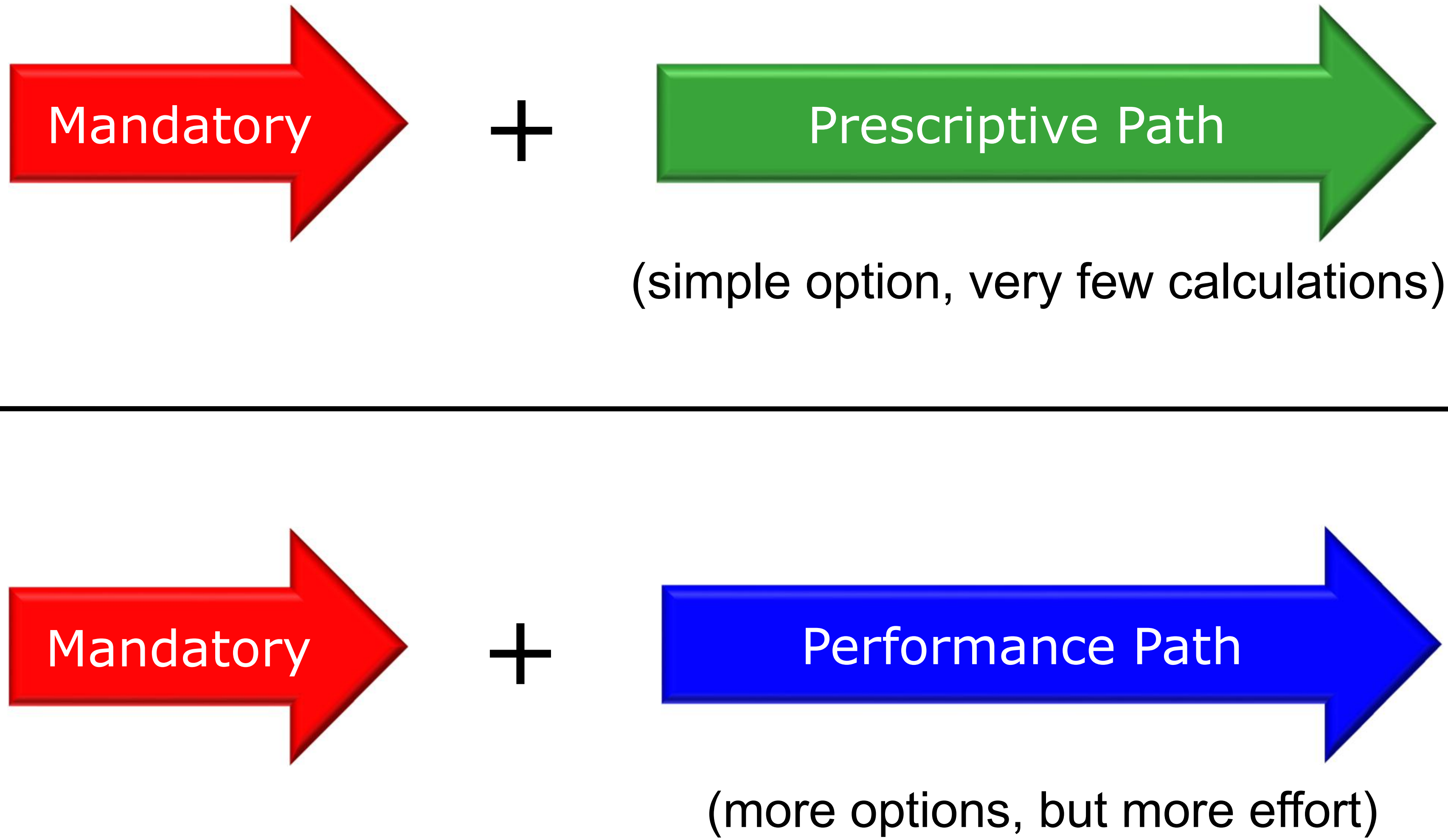
- Goals for Standard 189.1
  - Establish mandatory criteria in all topic areas
    - One “challenge” is existing green building rating systems contain few mandatory provisions
  - Provide simple prescriptive compliance options
  - Provide flexible performance compliance options
  - Complement green building 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



(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®

Certified

Energy Assessment

Energy Modeling

Commissioning

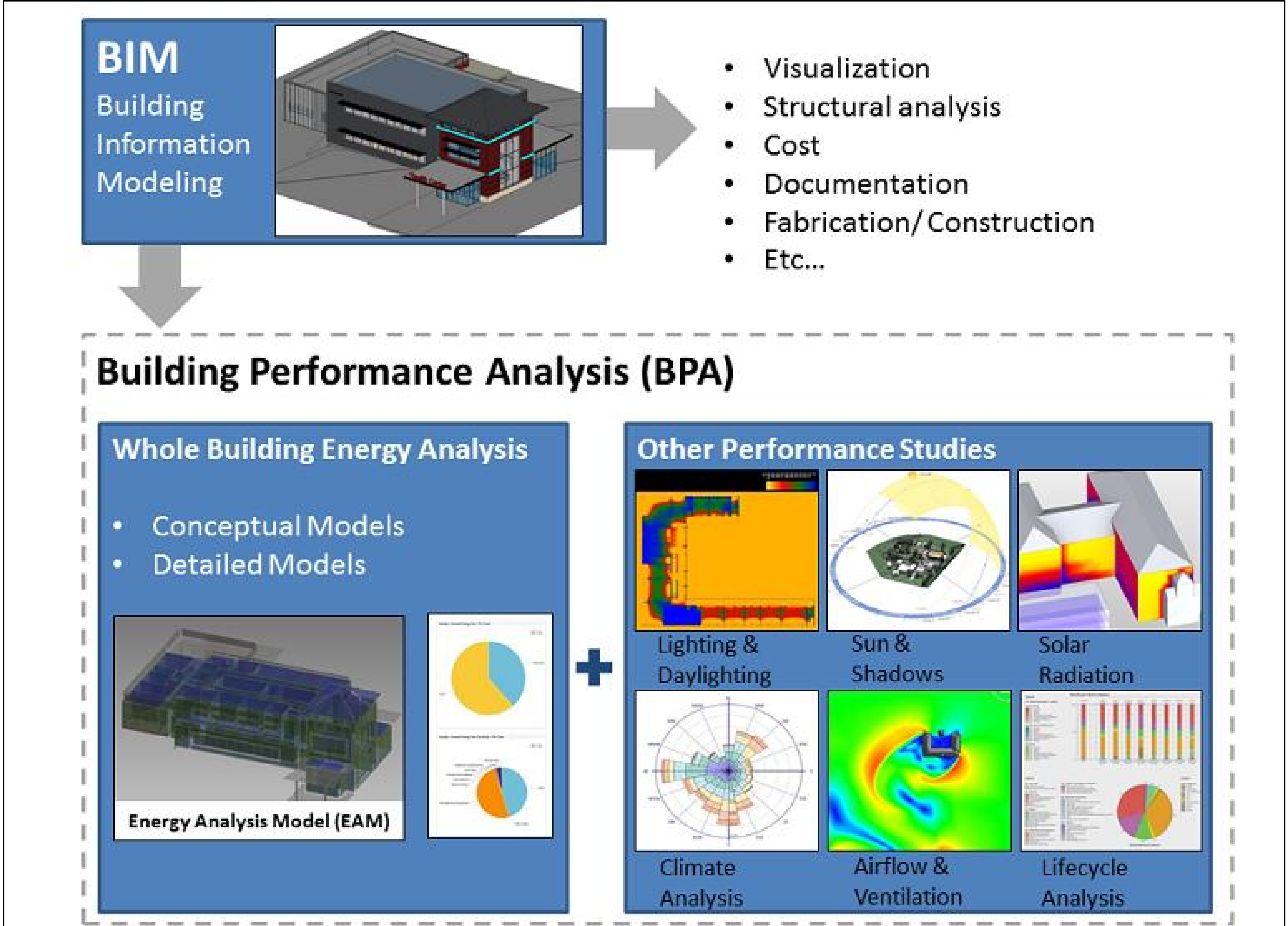
Healthcare Facility Design

High-Performance Building Design

Building Operations

www.ashrae.org/certification

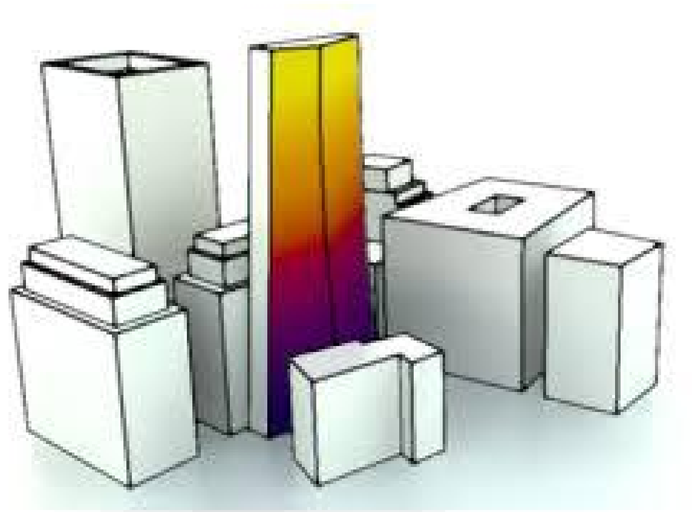
Certification Program	Relevant Experience and Knowledge
Building Energy Assessment Professional (BEAP)	Building energy audit, building energy management, building services systems (design, installation, and/or management)
Building Energy Modeling Professional (BEMP)	Building energy simulation, energy modeling software, building energy analysis, building services systems (design and/or installation)
Commissioning Process Management Professional (CPMP)	Building testing and commissioning, facilities operations/management, construction, design, or consulting
Healthcare Facility Design Professional (HFDP)	Healthcare HVAC&R design, medical equipment & procedures, healthcare facilities operation & maintenance
High-Performance Building Design Professional (HBDP)	HVAC&R design, sustainability concepts, energy analysis, indoor environment, controls, energy and environmental performance, water conservation, commissioning, building operation & maintenance
Operations & Performance Management Professional (OPMP)	Facility operations/management, construction, design, or consulting, Facility life cycle, O&M program, building performance management, communications, environmental, health & safety



(Source: Autodesk http://sustainabilityworkshop.autodesk.com/high-performance-building-design)

Building performance analysis

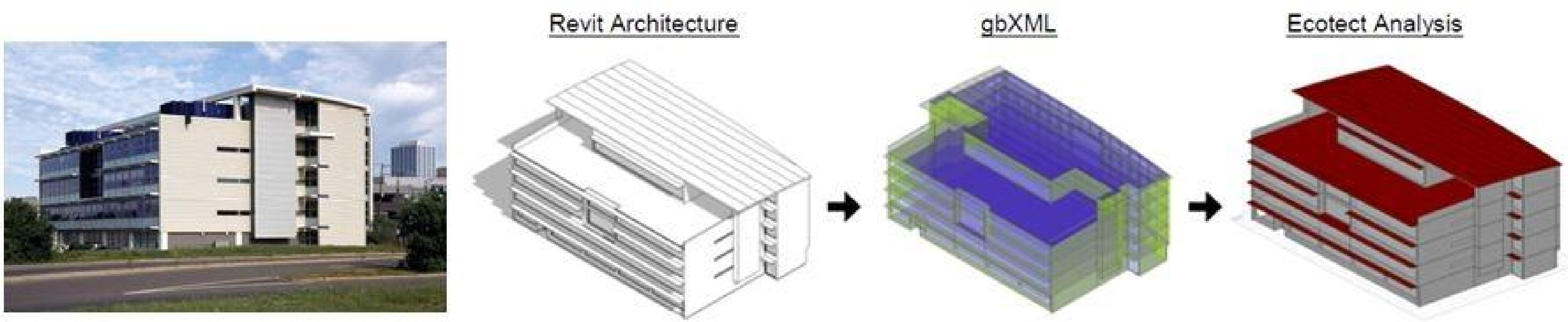
- Sustainable Building Projects
  - Require evaluation of building performance
- Typical analyses for sustainable buildings:
  - Climate analysis
  - Solar analysis
  - Building energy analysis
  - Air flow analysis
  - Life cycle analysis
  - Carbon analysis

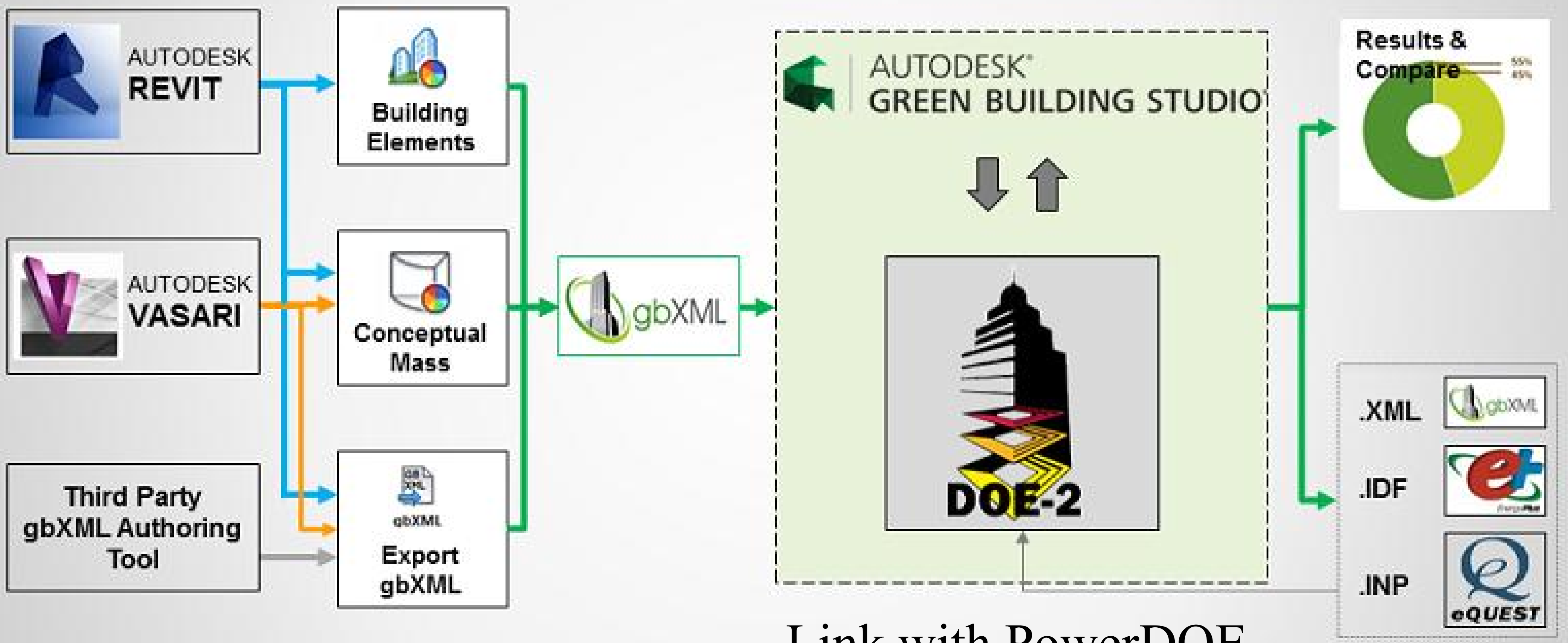


Building performance analysis

- Building Information Modeling (BIM)
  - An approach to design that uses intelligent 3D computer models to create, modify, share, and coordinate information throughout the design process
  - BIM is useful for sustainable design
    - It can help people iteratively test, analyze, and improve the building design
    - It can be used for building performance analysis (BPA)

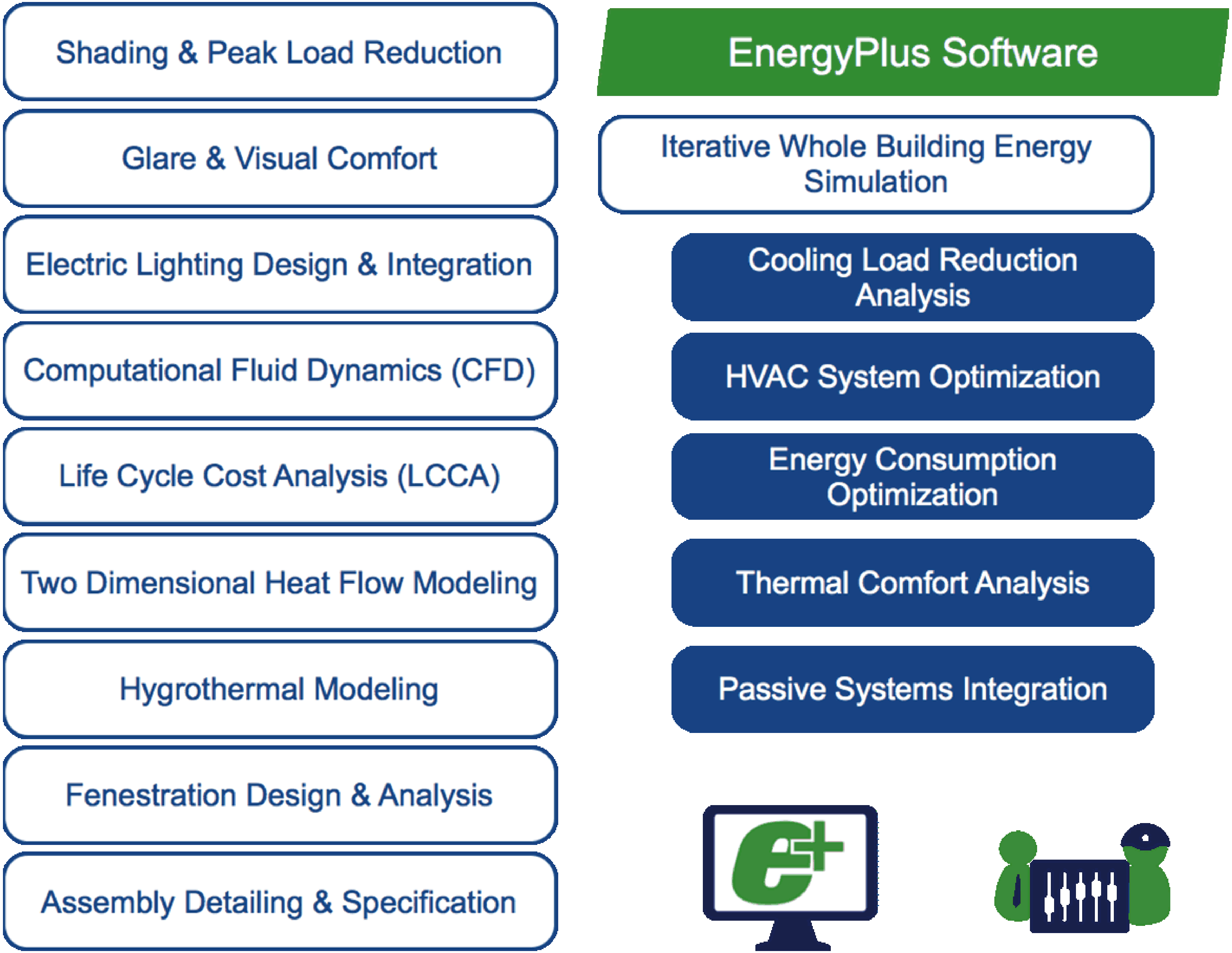
(See also: http://en.wikipedia.org/wiki/Building_information_modeling)





Link with PowerDOE, eQUEST or EnergyPlus

(Source: Autodesk)



(Source: www.synergyefficiency.solutions)

THANK YOU 謝謝 !!

(Further information: http://ibse.hk/cmhui/)