



Green Building Assessment (I)



Ir Dr. Sam C. M. Hui

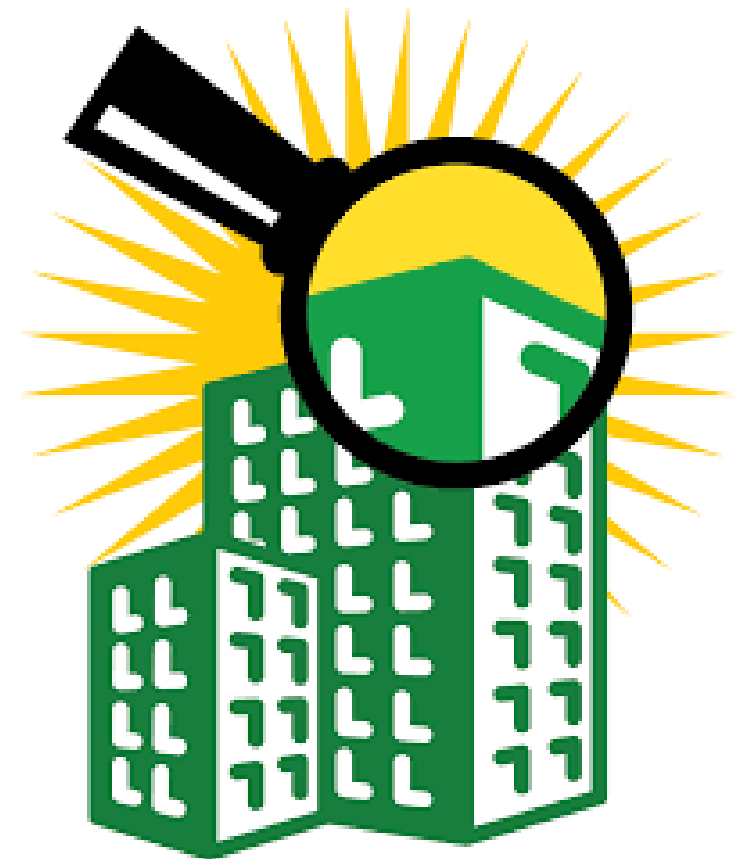
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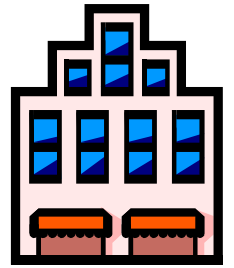
Contents



- Environmental performance
- Assessment criteria
- Assessment methods
- Current tools

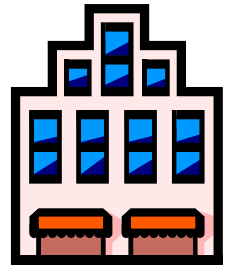


Environmental performance



- How building construction affects the **environment**
 - Energy use (e.g. electricity)
 - Greenhouse gas emissions (affect climate change)
 - Water use and drainage
 - Construction materials (resource use)
 - Waste from building construction and demolition
 - Land use and impact on the nature
 - Indoor environment and health (on human beings)

Environmental performance



- Importance of **building sector**
 - Globally, buildings account for 40% of energy use, 38% of greenhouse gas emissions, 12% of potable water and 20% of solid waste streams in developed countries
 - The Intergovernmental Panel on Climate Change (IPCC) has identified buildings as the greatest impact, least costly way to reduce greenhouse gas emissions and address climate change



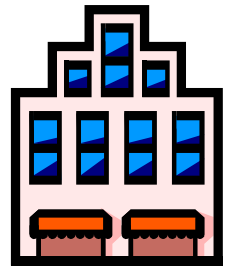
Estimate of global resources used in buildings and cities

Resource	(%)
Energy	45-50
Water	50
Materials for buildings and road (by bulk)	60
Agricultural land loss to buildings	80
Timber products for construction	60 (90% of hardwoods)
Coral reef destruction	50 (indirect)
Rainforest destruction	25 (indirect)

Estimate of global pollution that can be attributed to buildings and cities

Pollution	(%)
Air quality (cities)	23
Global warming gases	50
Drinking water pollution	60
Landfill waste	50
Ozone thinning/depletion	50

Environmental performance

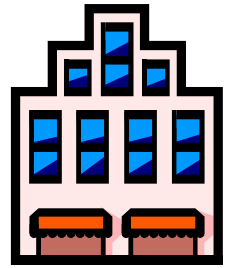


- What is “Performance” ?
 - Performance is meeting expectations
 - How well it works
- CIB definition *:
 - *“The objectively identifiable qualitative or quantitative characteristics of the building which help determine its aptitude to fulfil the different functions for which it was designed.”*



(* CIB = International Council for Research and Innovation in Building & Construction)

Environmental performance

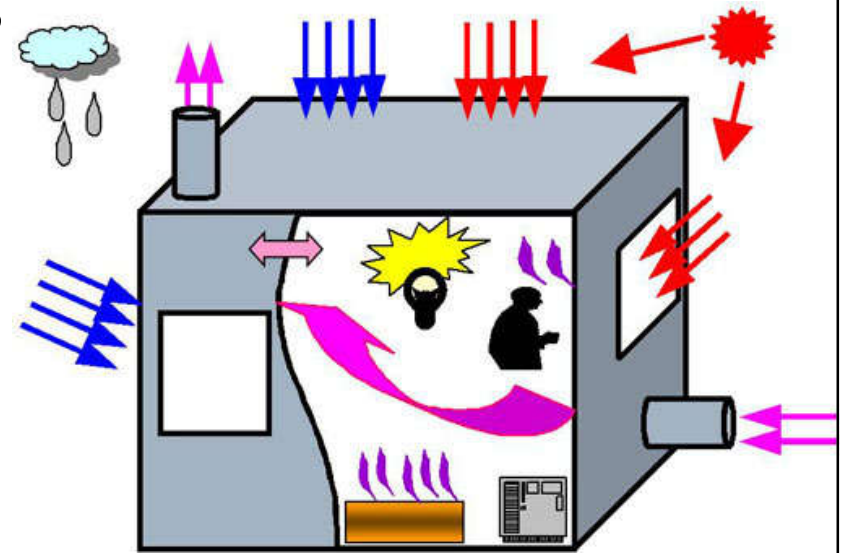


- **Building performance** issues

- Functionality
- Serviceability (usableness)
- Building-occupant comfort

- Trends

- Use it as the major criteria for building design
- Performance-based design and building codes
- The need to study, measure, and predict the level of building performance (to quantify)



Performance of a car



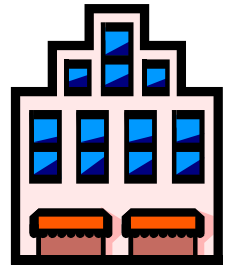
(Such as fuel efficiency)

Performance of a building/flat



Can we indicate the performance of a building, like a car?

Environmental performance



- Parameters of building performance
 - Structural
 - Fire and life safety
 - Accessibility
 - Durability
 - Sound insulation (acoustic)
 - Environmental
 - Energy efficiency



I learnt this when I was working and living in Japan in 1998.

Index of Building (Houses) Performance (Japan)

住宅性能表示のイメージ

※これはあくまでも平成11年5月現在で検討中の資料をもとに構成したものであり、今後、変更・追加される場合があります。

Structure strength

構造耐力（建築基準法の求める構造強度との比較 ○倍）

床の遮音性
（ランク○）

省エネルギー性
（ランク○）

Energy efficiency

Daylight, ventilation

採光・換気性（開口率○%）

壁の遮音性
（ランク○）

Sound insulation

Fire resistance

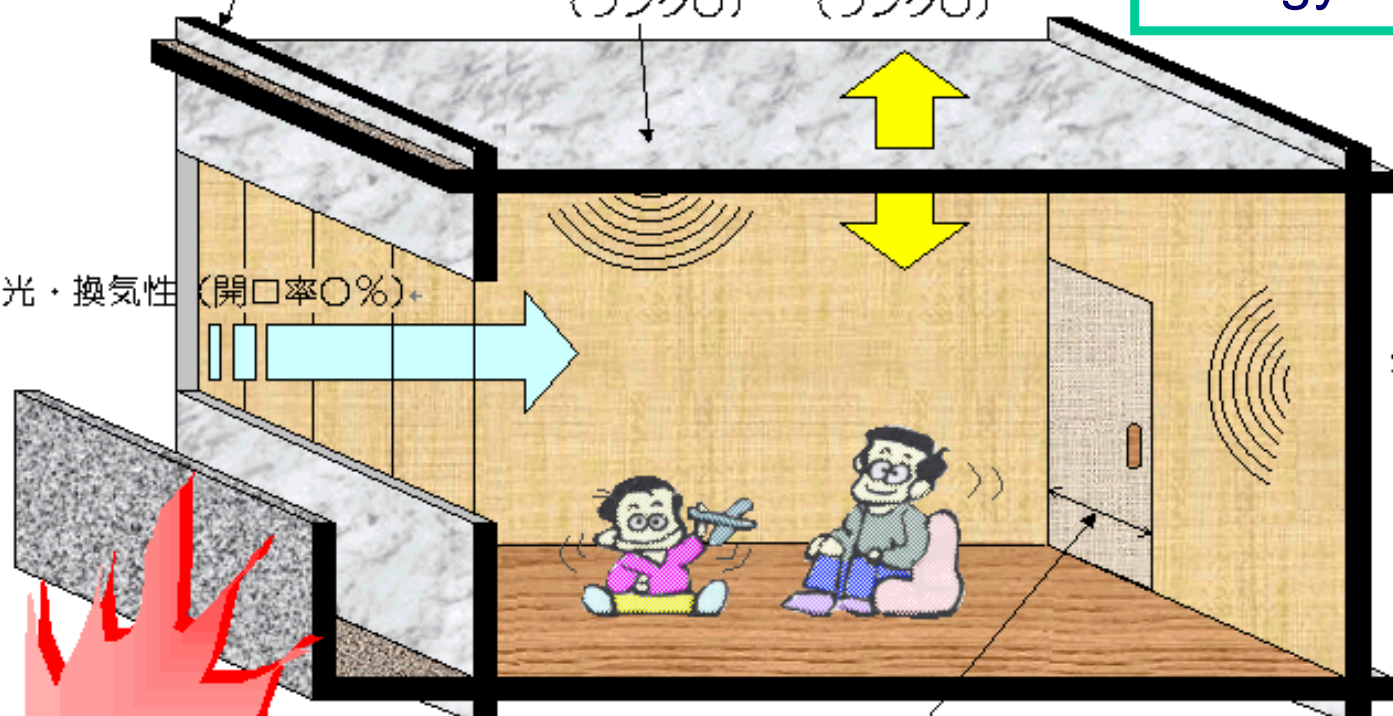
防・耐火性
（耐火時間○時間／法定耐火時間○時間）

長寿社会対応性
（ランク○）

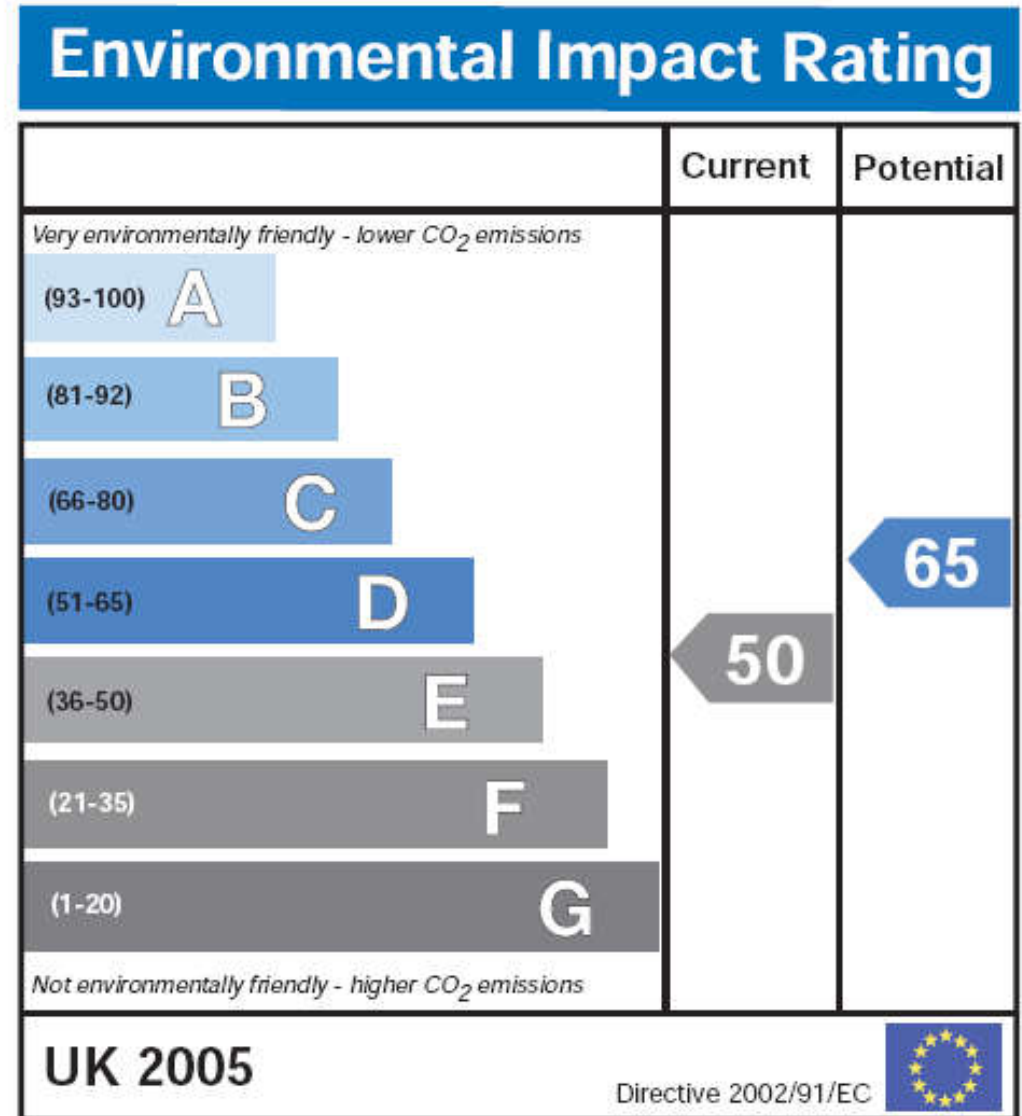
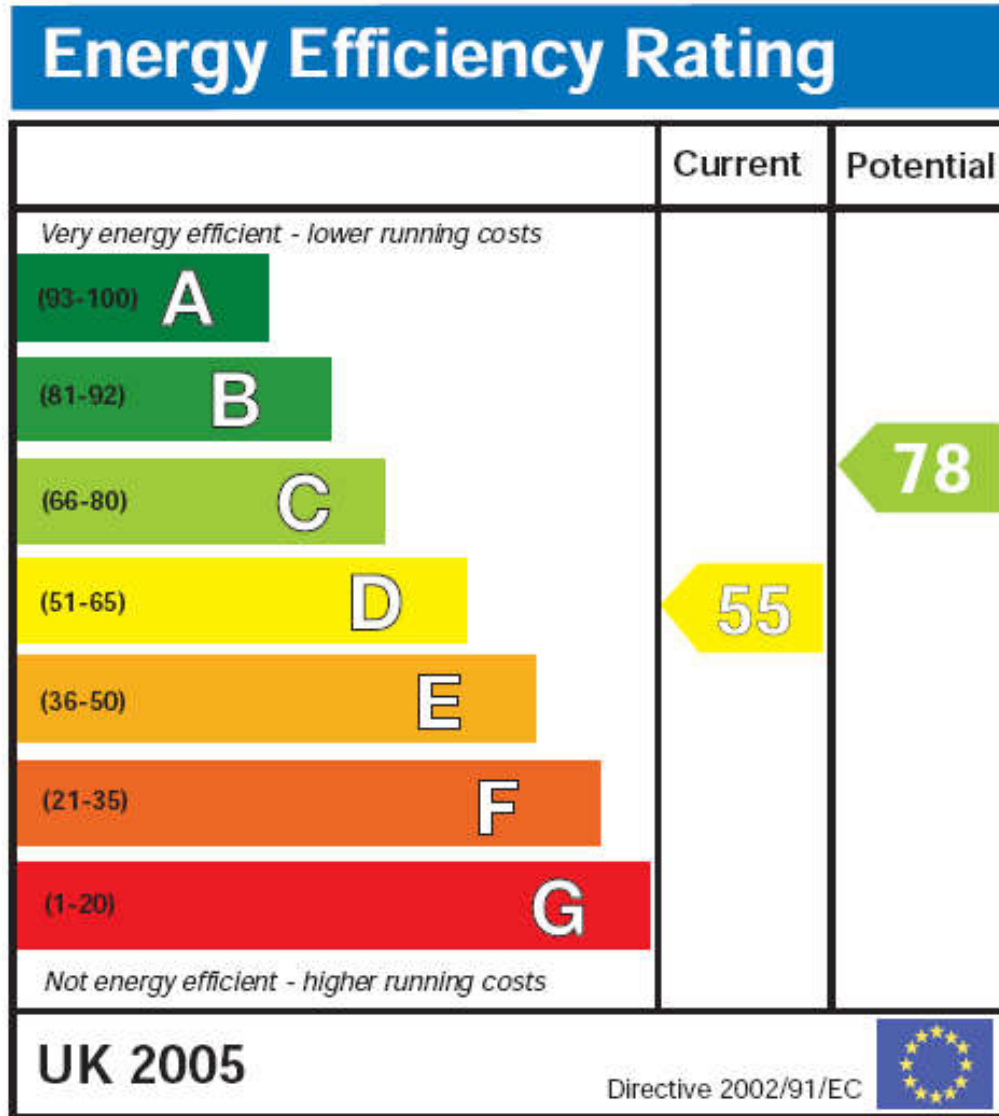
Design for the aged

耐久性（ランク○）

Durability

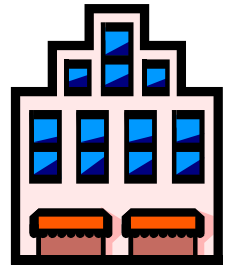


Energy efficiency rating and environmental impact rating in UK



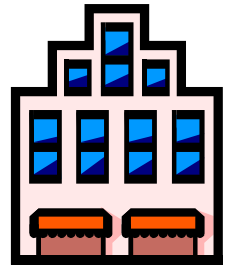
They are similar to the academic performance (grade/GPA) of students.

Environmental performance



- Environmental performance is the measurable results of an environmental management system, related to the **environmental aspects**
 - Assessment of environmental performance is based on environmental policy, environmental objectives and environmental targets
- There is a need to measure and evaluate the environmental performance of buildings in a systematic manner

Environmental performance

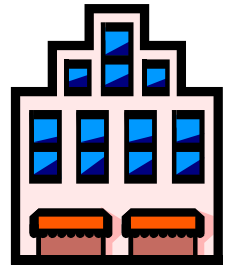


- **Building environmental assessment***
 - Identify & evaluate the environmental effects of building development or operation
 - Inform decision making and promote sustainable design & management
- An objective assessment is a useful starting point from which to make design and building improvements

For supporting decision making

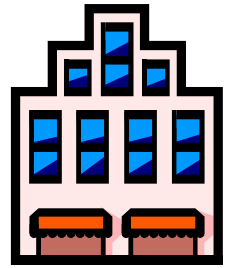
(* Also known as **green building assessment**.)

Environmental performance

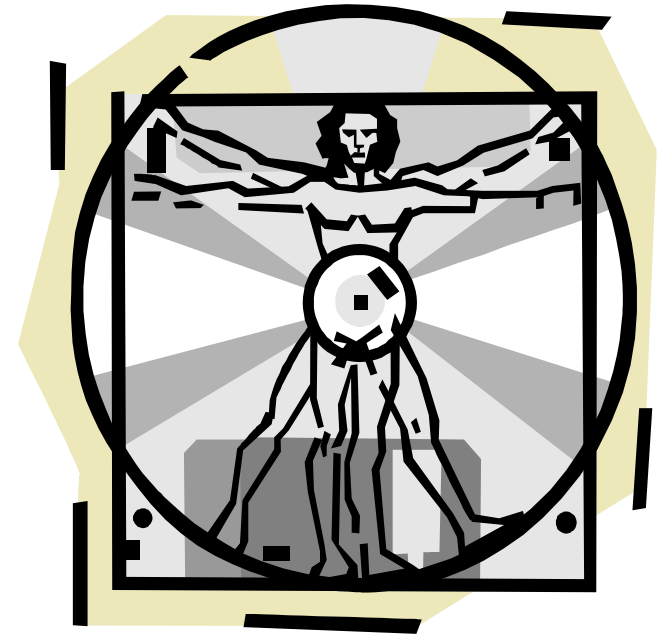


- Design guidelines provide a broader range of issues; Assessment methods give structure and priority, and provide strategic advice
 - Enhance environmental knowledge
- Enable **building performance** to be described
 - Performance-based indicators
 - Declared benchmarks
 - Prescriptive requirements (proxies for actual performance)

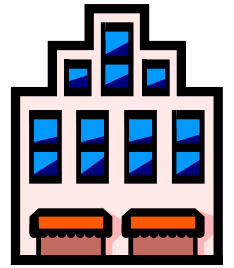
Environmental performance



- Scope/Scale of the evaluation
 - Building products
 - Building processes
 - Structural members/elements
 - Building systems
 - Single buildings
 - Groups of buildings
 - District, urban, regional & city
- Building types: new, existing & refurbished



Environmental performance



- Methods to assess the performance
 - Component by component method
 - Simple to understand and easy to implement
 - Such as HK building energy codes (prescriptive)
 - Whole building performance method
 - In kWh/m²/year or energy cost budget
 - Flexible but complicated in compliance
 - Such as HK's performance-based building energy code

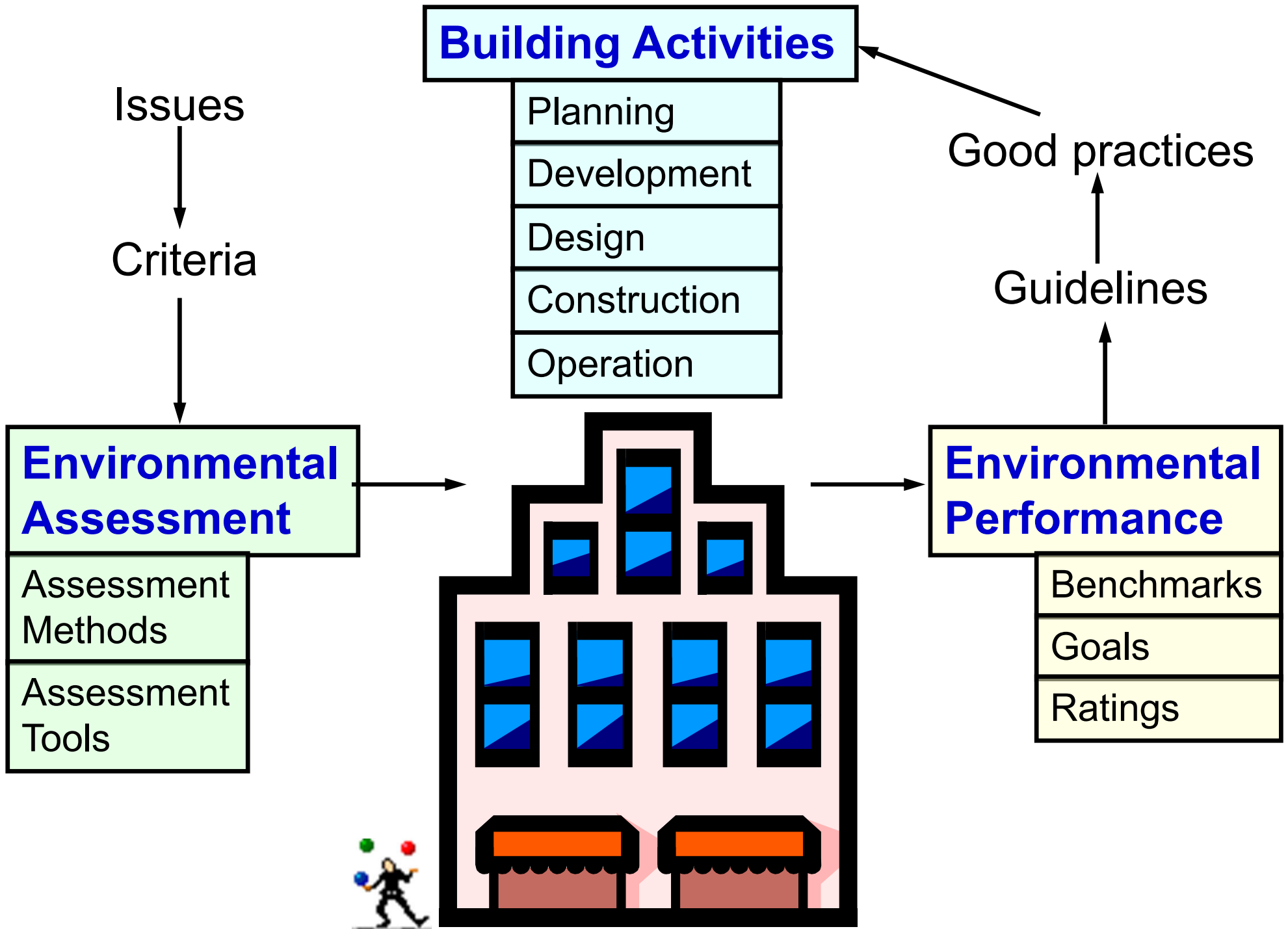




Assessment criteria

- Why environmental assessment?
 - Provide a common set of criteria & targets
 - Guide design decisions & choices
 - Raise awareness of environmental issues/standards
 - Recognise & encourage good practices
 - Stimulate the market for sustainable construction
 - Allow a verifiable method & framework
 - Enable policies & regulation (e.g. certificate/label)
 - Improve management & prioritization (incentives)

Basic principles of building environmental assessment



Assessment criteria



- A broad range of criteria
 - Qualitative issues
 - Quantitative issues
- Types of criteria
 - Ecological vs health-related
 - Direct impacts vs indirect impacts
 - Immediate vs long-term implications
 - Global vs local



How to select and evaluate the criteria?



(Source: www.moew.gov.ae)

> Apply basic principles

- site selection
- urban design
- landscape planning

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

- energy performance
- renewable energy
- water conservation

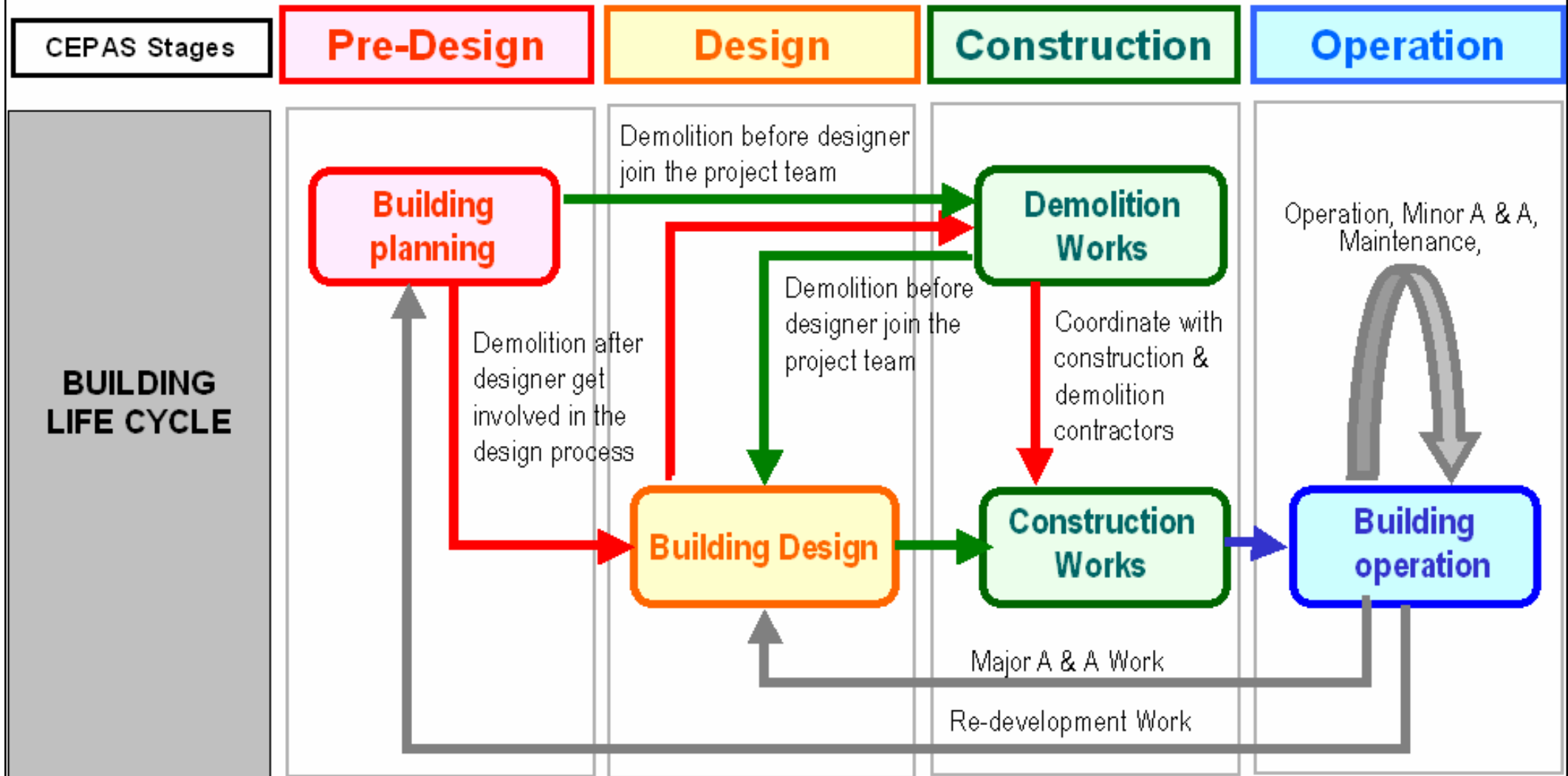
Environmental Criteria & Factors

- environmental policy
- transport strategy
- building maintenance

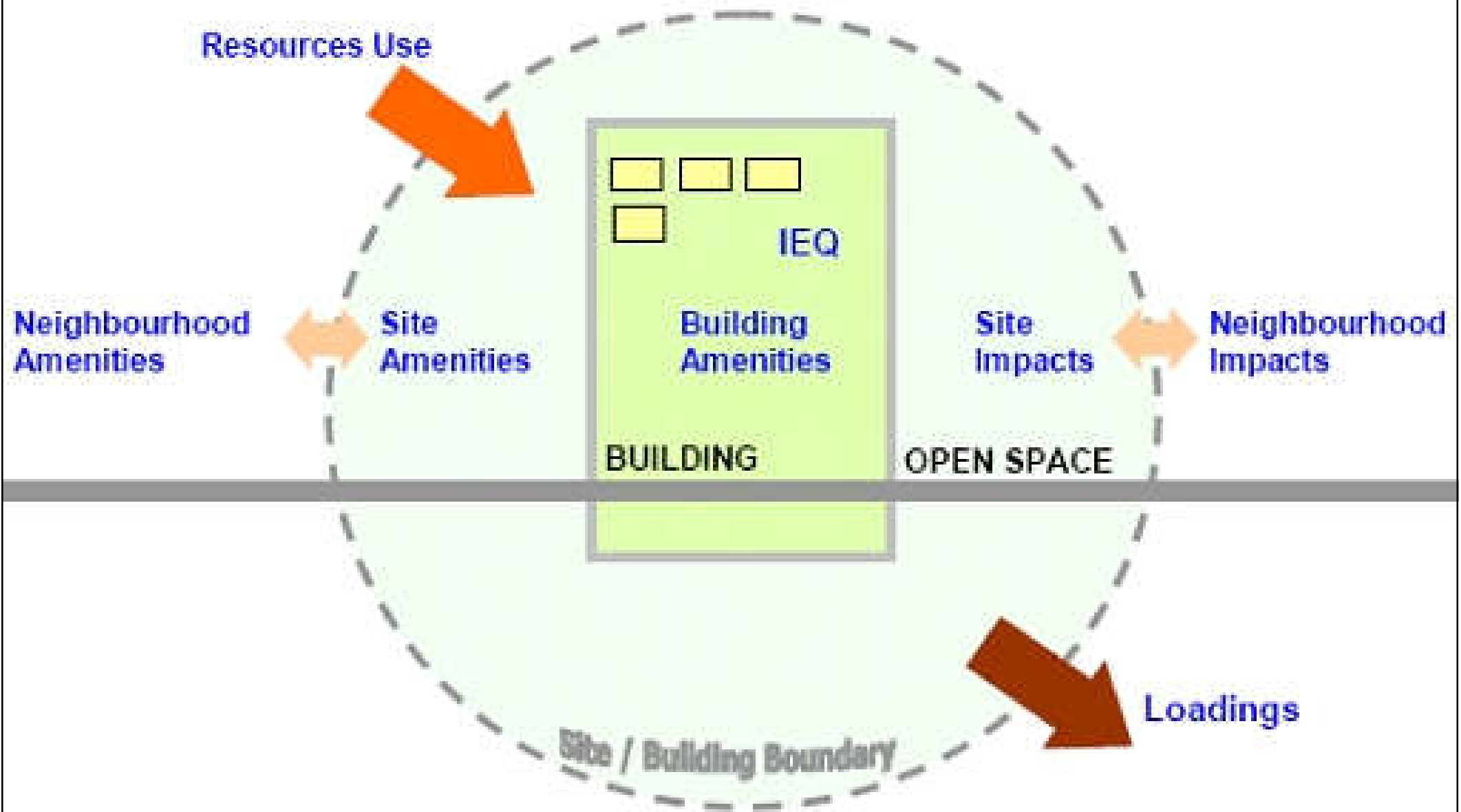
- material selection
- recycling of materials
- waste management
- disposal & reuse

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

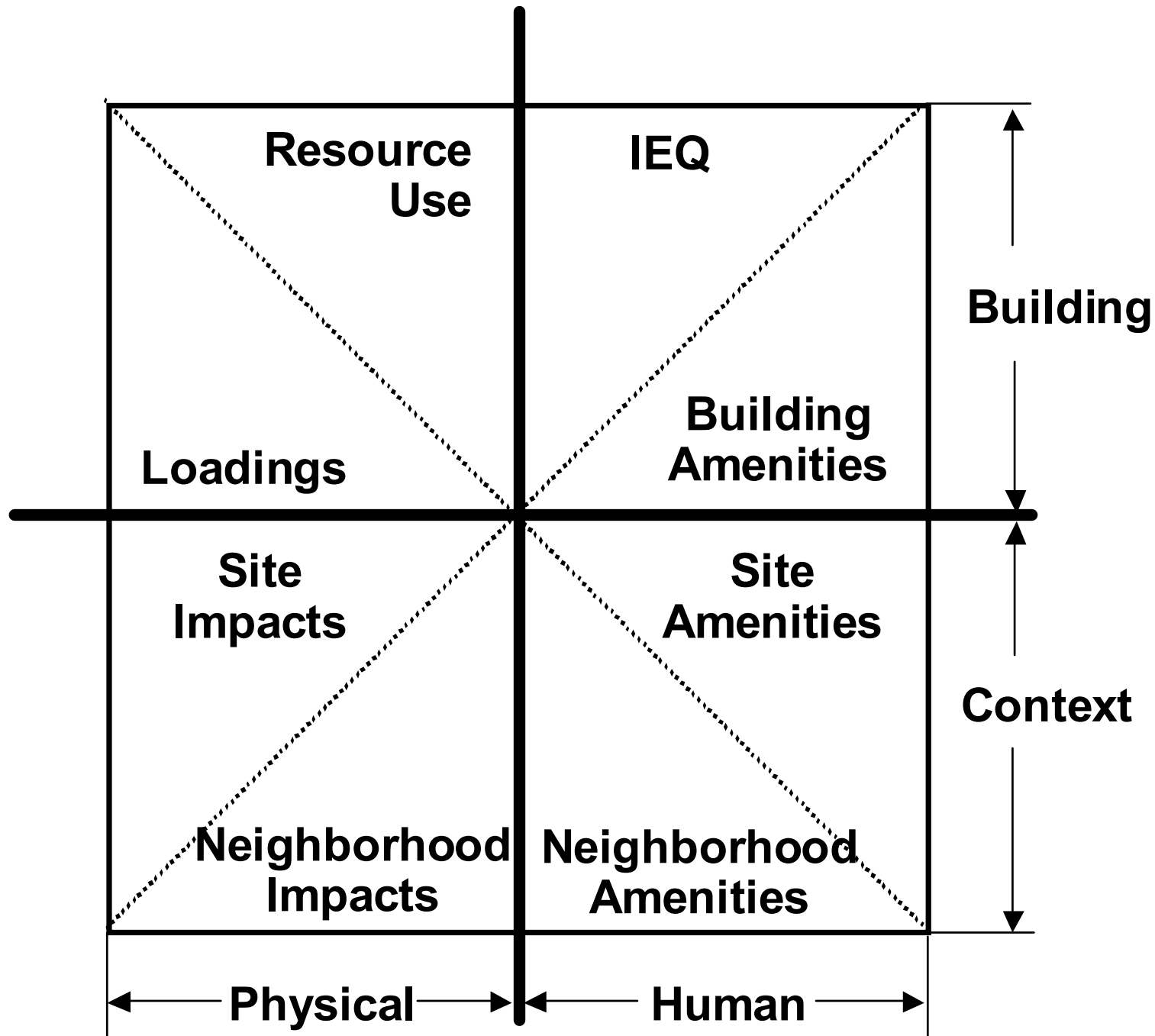
Building life cycle stages



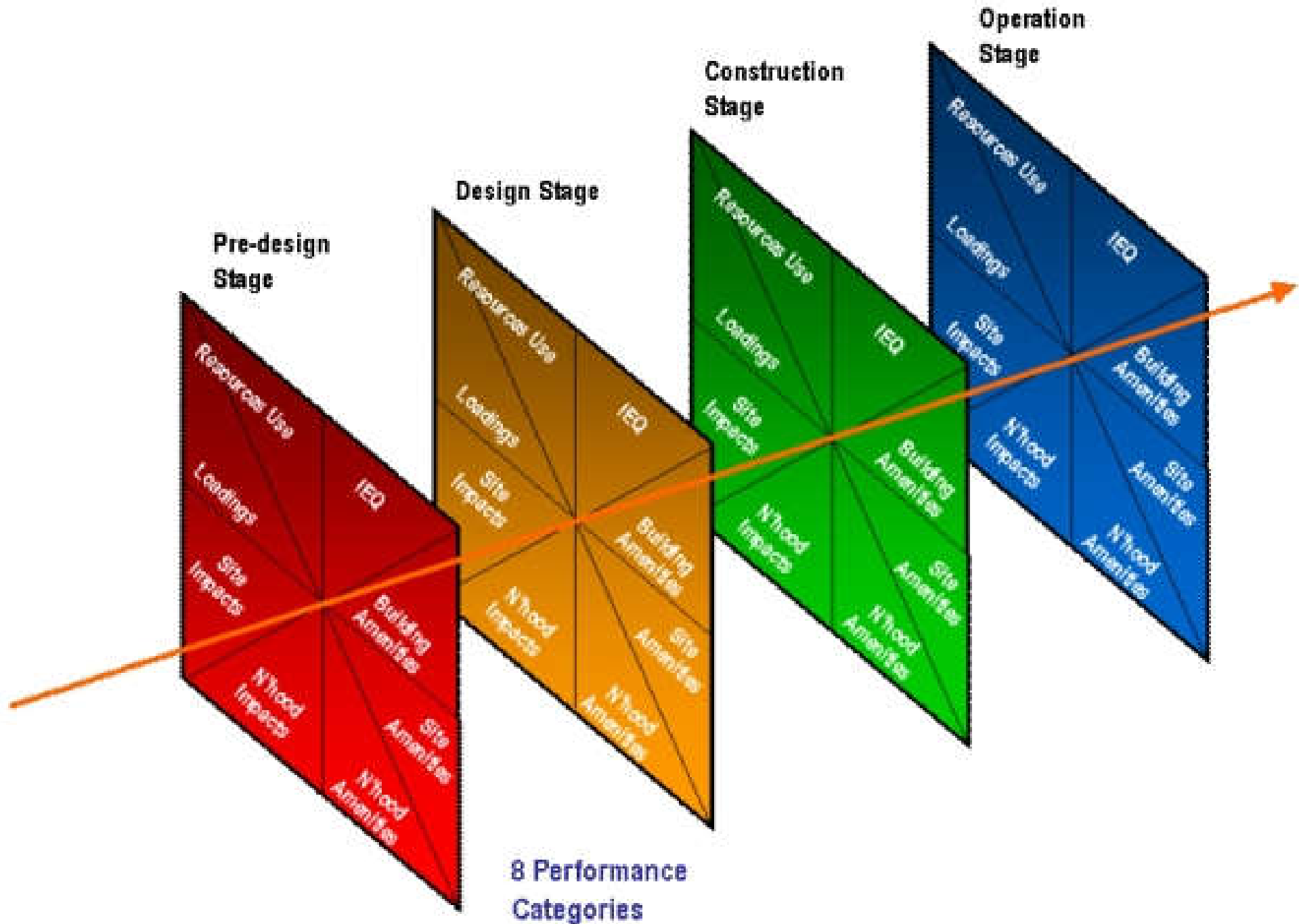
Physical relations of performance categories



Concept of environmental performance categories



Performance categories and building life cycle stages



(Source: Comprehensive Environmental Performance Assessment Scheme for Buildings (CEPAS))

https://www.bd.gov.hk/en/resources/codes-and-references/notices-and-reports/index_CEPAS.html

Aspects of assessment in green building and sustainable building

**GREEN
BUILDING**

- Consumption of non renewable fuels
- Water consumption
- Materials consumption
- Land use
- Impacts on site ecology
- Greenhouse gas emissions
- Other atmospheric emissions
- Solid waste/liquid effluents
- Indoor air quality, lighting, acoustics
- Longevity, adaptability, flexibility
- Operations and maintenance

- Social and cultural issues
- Economic considerations
- Urban planning/transportation issues

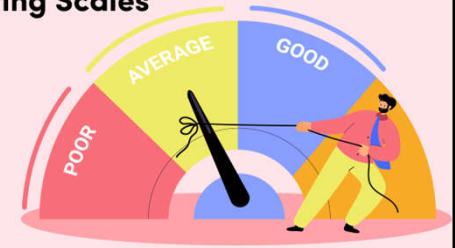
**SUSTAINABLE
BUILDING**



Assessment criteria

- Assessment process
 - Examine the performance of a building or its sub-system against a declared set of criteria
 - Usually voluntary (aim to stimulate the market)
- Scale of performance
 - Measure & assess relative performance
 - Assign 'points' or 'score' to various aspects
 - Quantitative criteria: relative to a baseline
 - Qualitative criteria: presence/absence of features

Performance
Rating Scales

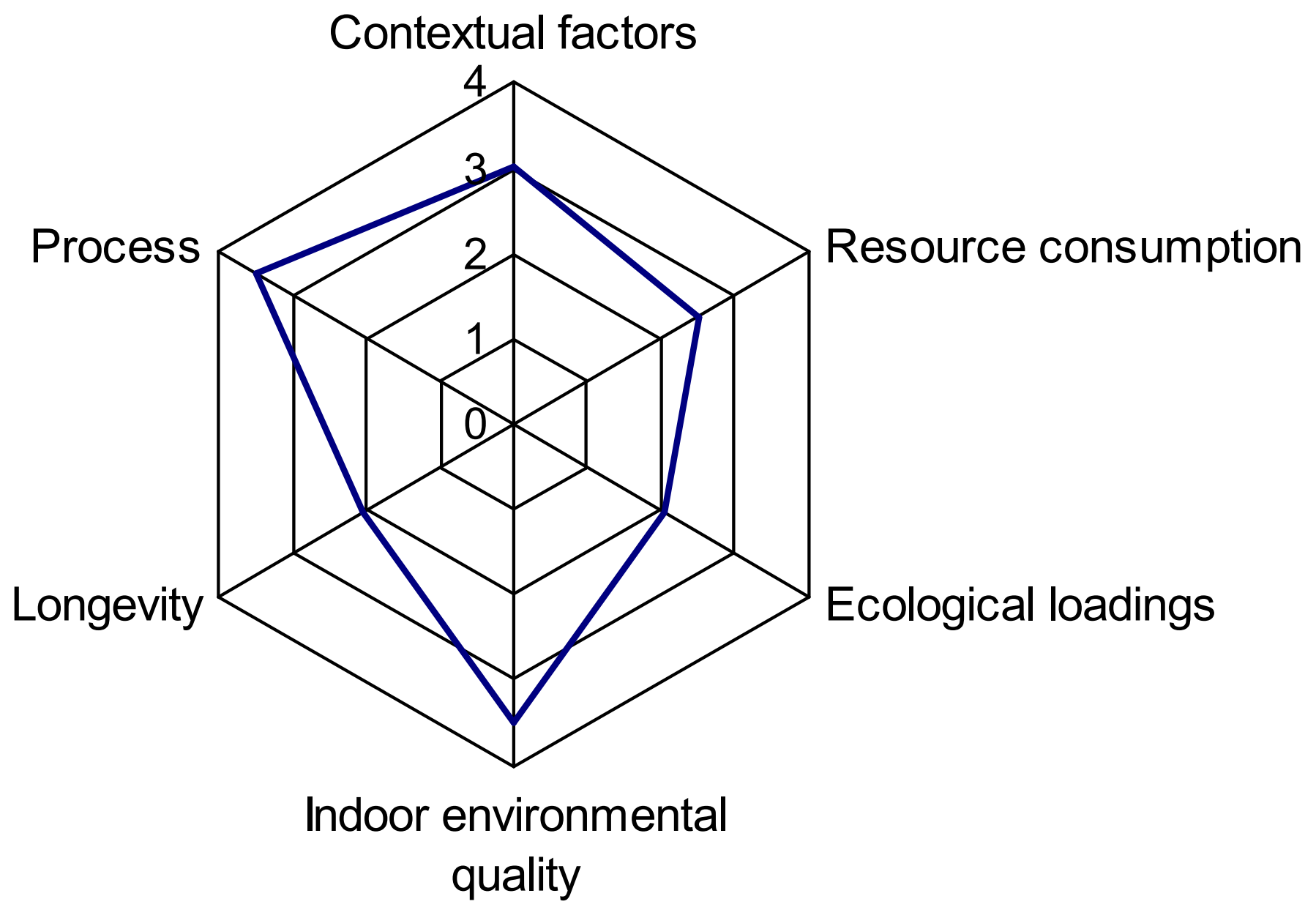




Assessment criteria

- Assessing multiple criteria
 - Indicate the ‘best’ overall performance
 - Methodology
 - Cost (or monetary value \$)
 - Equivalence method (e.g. air/water pollution index)
 - EcoCost (in common Gaia scale 0-1)
 - EcoPoint or EcoProfile
 - Weighting system
 - To show relative importance, scale and urgency

How to visualize assessment results?



Radar chart for assessing multiple criteria

How to combine different criteria?

“Ecopoint” concept in the ENVEST (environmental impact estimating) tool (UK BRE)



One “**ecopoint**” is equivalent to:

- 320 kWh electricity
- 83 m² Water: enough to fill 1,000 baths
- 65 miles by articulated truck
- landfilling 1.3 tonnes of waste
- manufacturing 3/4 tonnes brick (250 bricks)
- 540 tonne kms by sea freight
- 1.38 tonnes mineral extraction
- 300 miles of urban driving in new petrol car



(Source: UK BRE)

Assessment methods

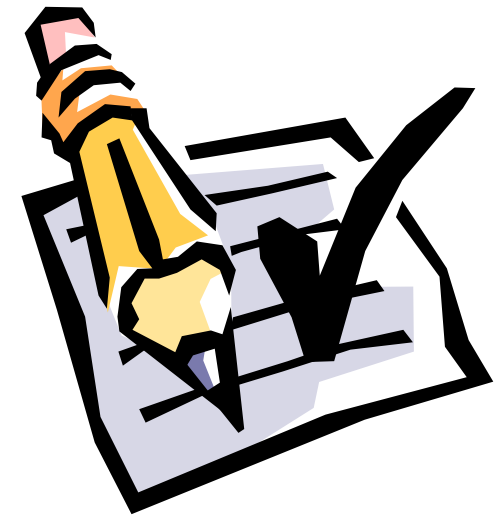


- Four major components:
 - Categories: a specific set of items relating to the environmental performance considered
 - Scoring system: performance measurement to indicate the number of possible points or credits
 - Weighting system: represents the relevance assigned to each specific category
 - Output: show the overall results of the environmental performance

Assessment methods



- Common approaches
 - Checklists or forms
 - Computer-based methods
 - Spreadsheet or computer programs
- Models used
 - Environment model
 - Product model
 - Life cycle model
- Data required: from simple to very detailed

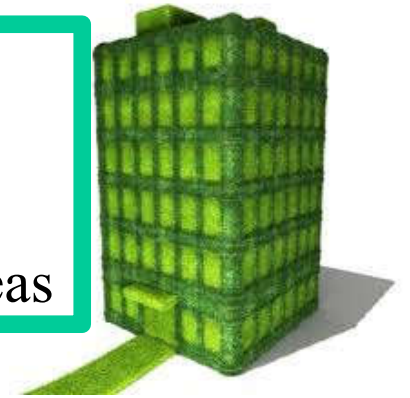


Assessment methods



- Three ways to evaluate green buildings:
 - 1. Single attribute
 - Such as energy efficiency, alternative energy, recycled green materials/products

- 2. Multiple attribute
 - Green building rating/assessment systems
 - Multi-criteria standard, points earned in various areas



- 3. Life cycle assessment (LCA)
 - Full and quantitative accounting of environmental impacts

Trend to include more LCA elements

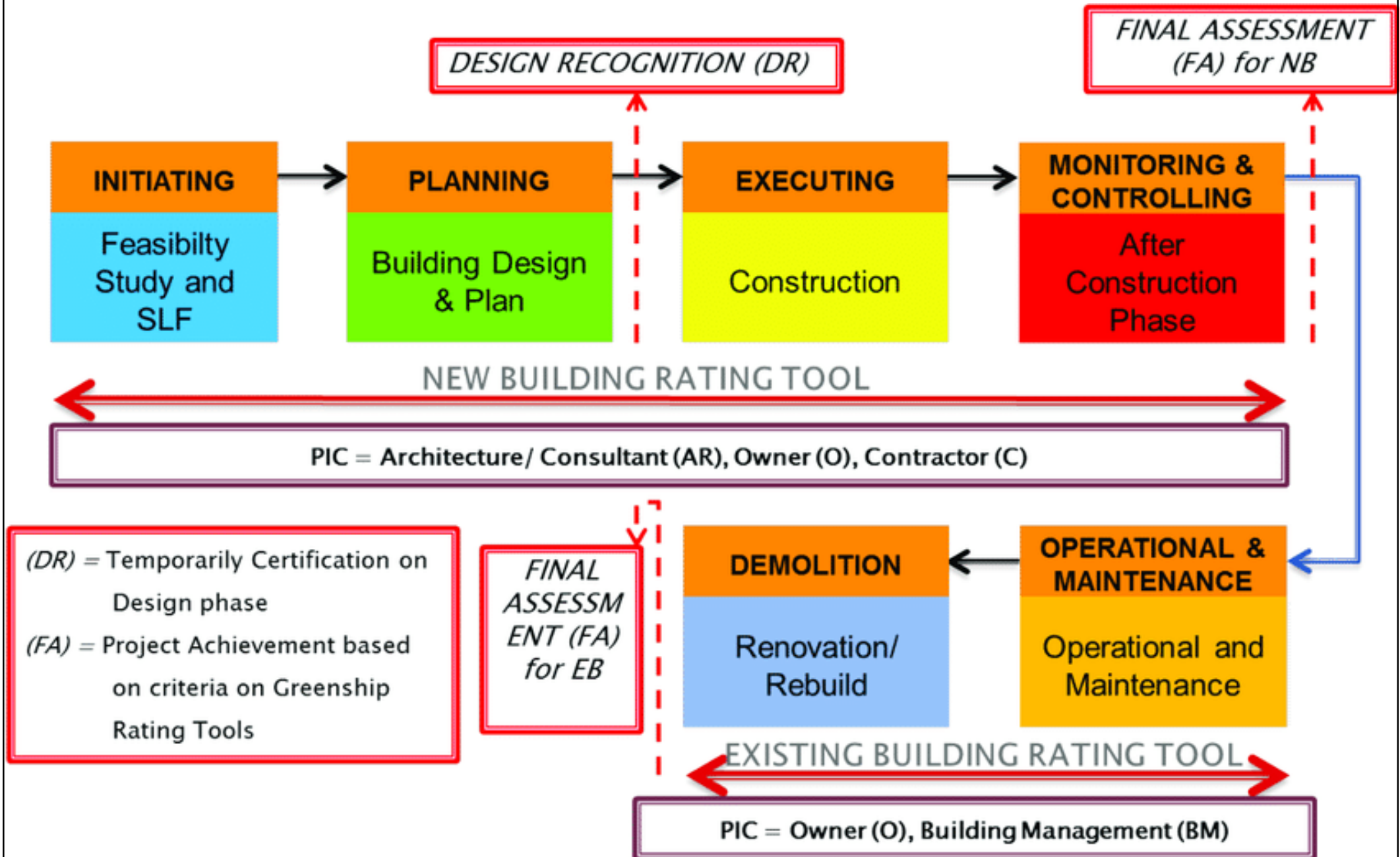
Assessment methods



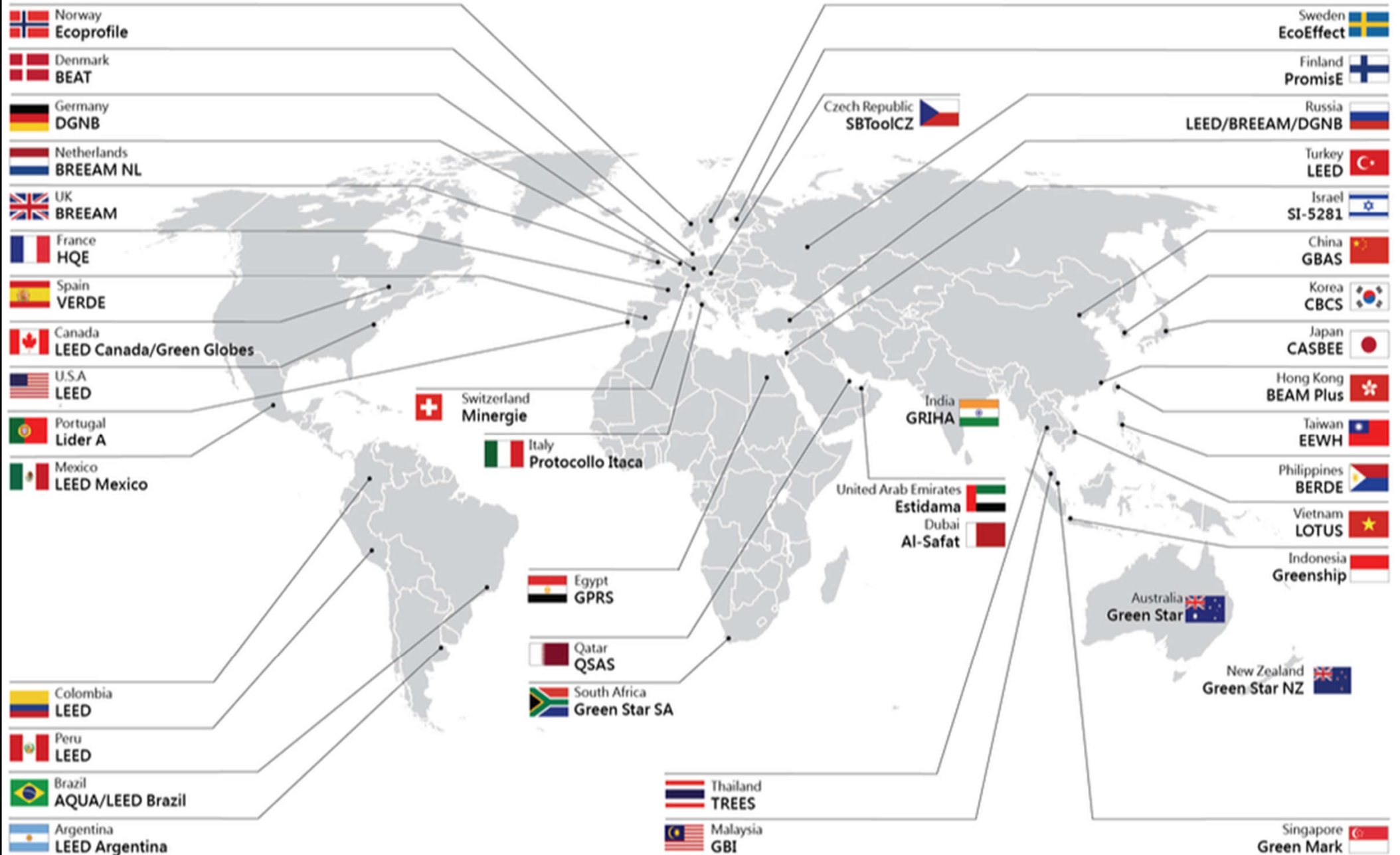
- A **green building assessment method** is a tool for evaluating whether a building is green or not, and rank is given to the building after detailed assessment
- Assessment methods & tools:
 - Building environmental assessment
 - Green building rating
 - Green building certification & label
 - Sustainability assessment



Flow process of green building assessment and rating tools



Global green building assessment systems



Assessment methods



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

- Examples

- Europe:

- BREEAM (UK)
- CEPHEUS & DGNB (Germany)
- ECO-PRO (Germany)
- EcoProP & PIMWAQ (Finland)
- EQUER & HQE (France)
- ECO QUANTUM (Netherlands)
- MINERGIE (Switzerland)
- BREEAM-NL (Netherlands)
- VERDE (Spain)



Assessment methods



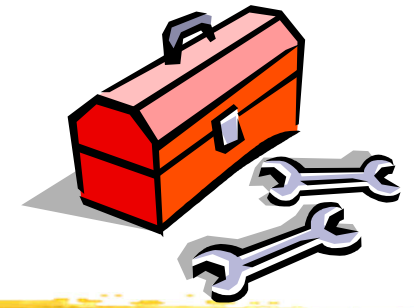
- Examples (cont'd)
 - Canada & USA:
 - BREEAM-Canada & BEPAC-Canada
 - LEED Canada
 - LEED (USA)
 - BEES (USA) (for building products)
 - GreenGlobes (Canada & USA)
 - Australia & New Zealand
 - Green Star (Australia)
 - Green Office Scheme (New Zealand)

Assessment methods



- Asian countries:
 - Japan Green Building Guide & CASBEE
 - Korea Green Building Rating System
 - GB/T 50378-2019 and GOBAS (Mainland China)
 - Taiwan Green Building Label (EEWH)
 - HK-BEAM/BEAM Plus and CEPAS (HK)
 - Green Mark Scheme (Singapore)
 - Green Building Index (Malaysia)
 - TGBRS, GRIHA, LEED India (India)

Current tools

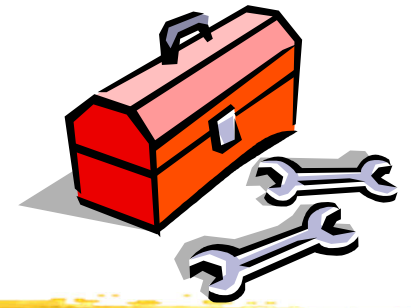


- BREEAM – UK (since 1990)
 - **B**uilding **R**esearch **E**stablishment **E**nvironmental **A**ssessment **M**ethod
 - Used as a reference in many countries
 - BREAM family of assessment methods & tools
 - Any types of buildings (new and existing)
 - BREEAM International (outside of UK)
 - BREEAM In-Use (building management)
 - BREEAM Communities (planning stage)
 - Website: www.breeam.org/

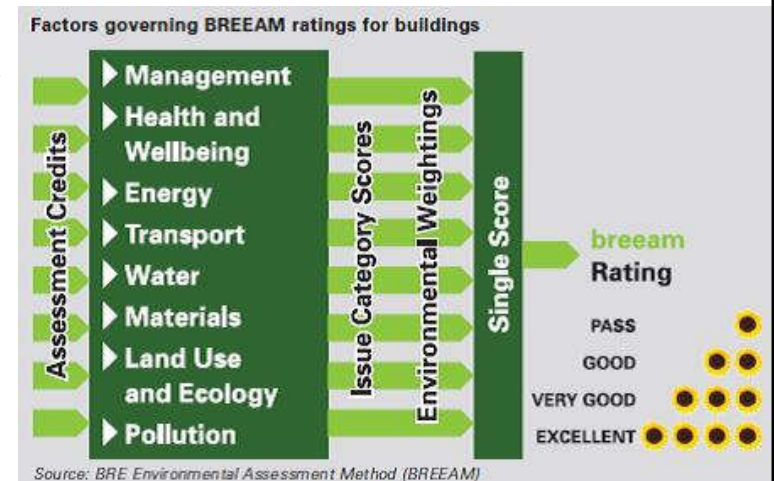
breeam



Current tools



- BREEAM – UK (cont'd)
 - Credits awarded for a set of performance criteria
 - Energy, water, pollution, materials, transport, ecology and land use, health and well being
 - Construction & building operational management
 - A weighting system is applied to determine final rating
 - Stages of building development
 - Design & procurement
 - Management & operation
 - Post construction review



Assessment areas of BREEAM-UK

Minimum Standards

- Energy
- Management
- Health & Well-being
- Water
- Waste
- Land Use & Ecology

Tradable Credits

- Energy
- Water
- Materials
- Transport
- Waste
- Pollution
- Health & Well-being
- Management
- Land Use & Ecology

Innovation Credits

- Exemplary Performance Requirements
- Approved Innovation Credits

Category Scores

Environmental Weighting

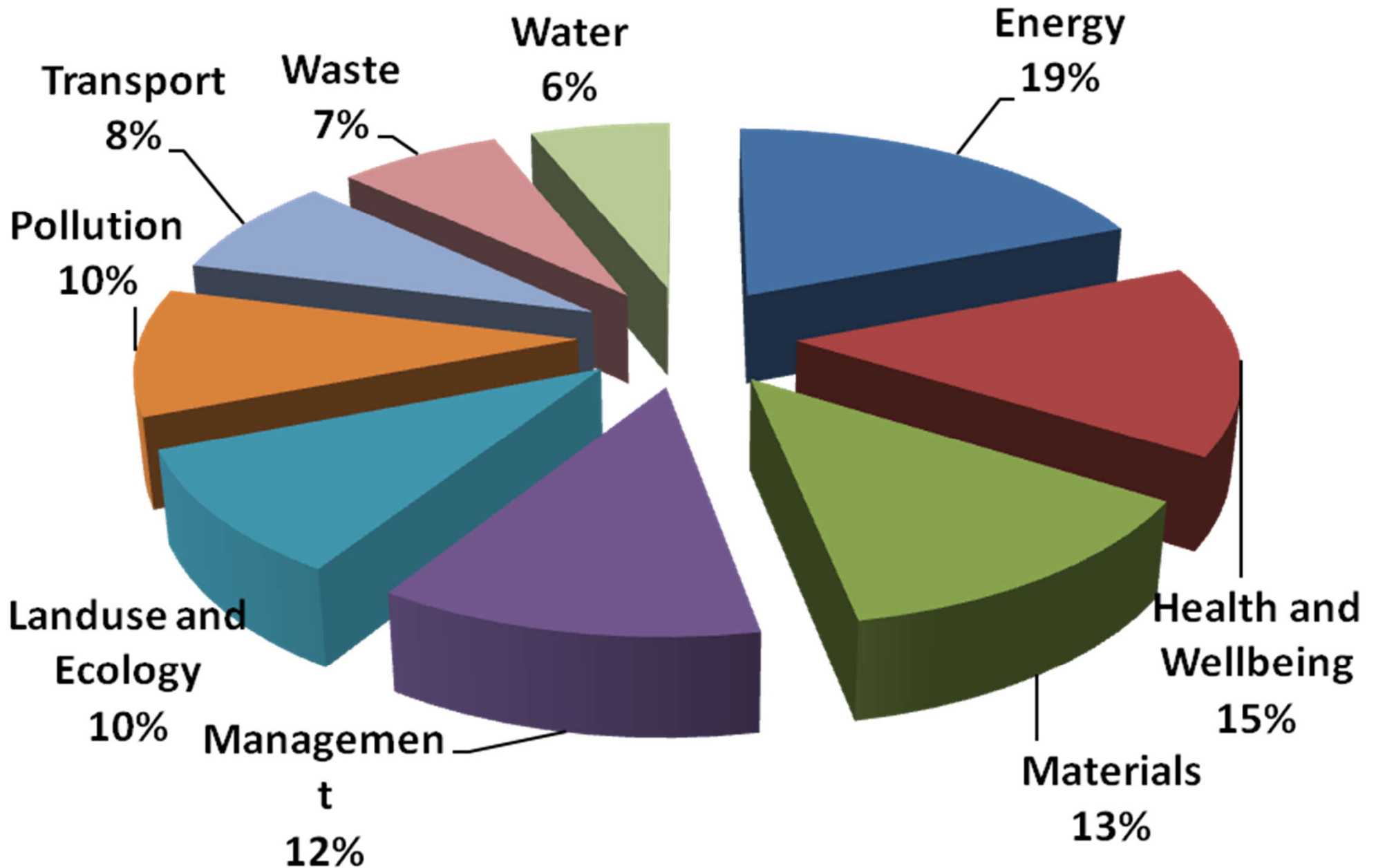
Final Score

Pass	≥ 30
Good	≥ 45
Very Good	≥ 55
Excellent	≥ 70
Outstanding	≥ 85

breeam

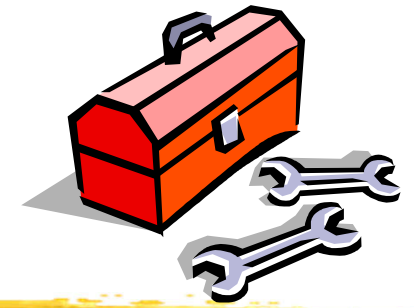


Assessment weightings of BREEAM-UK



Which are the most important aspects?

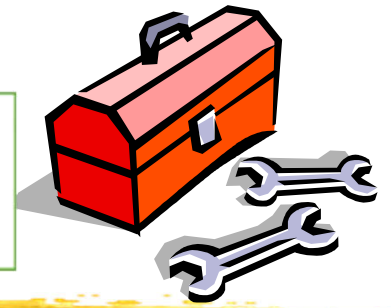
Current tools



- BREEAM – UK (cont'd)
 - Overall score rating:
 - Pass, Good, Very Good, Excellent, Outstanding
 - BREEAM Assessors
 - BREEAM Accredited Professional (**BREEAM AP**) and examination/training
 - Up to 3 credits if a BREEAM AP is engaged (BREEAM 2011)

To encourage using green building professionals

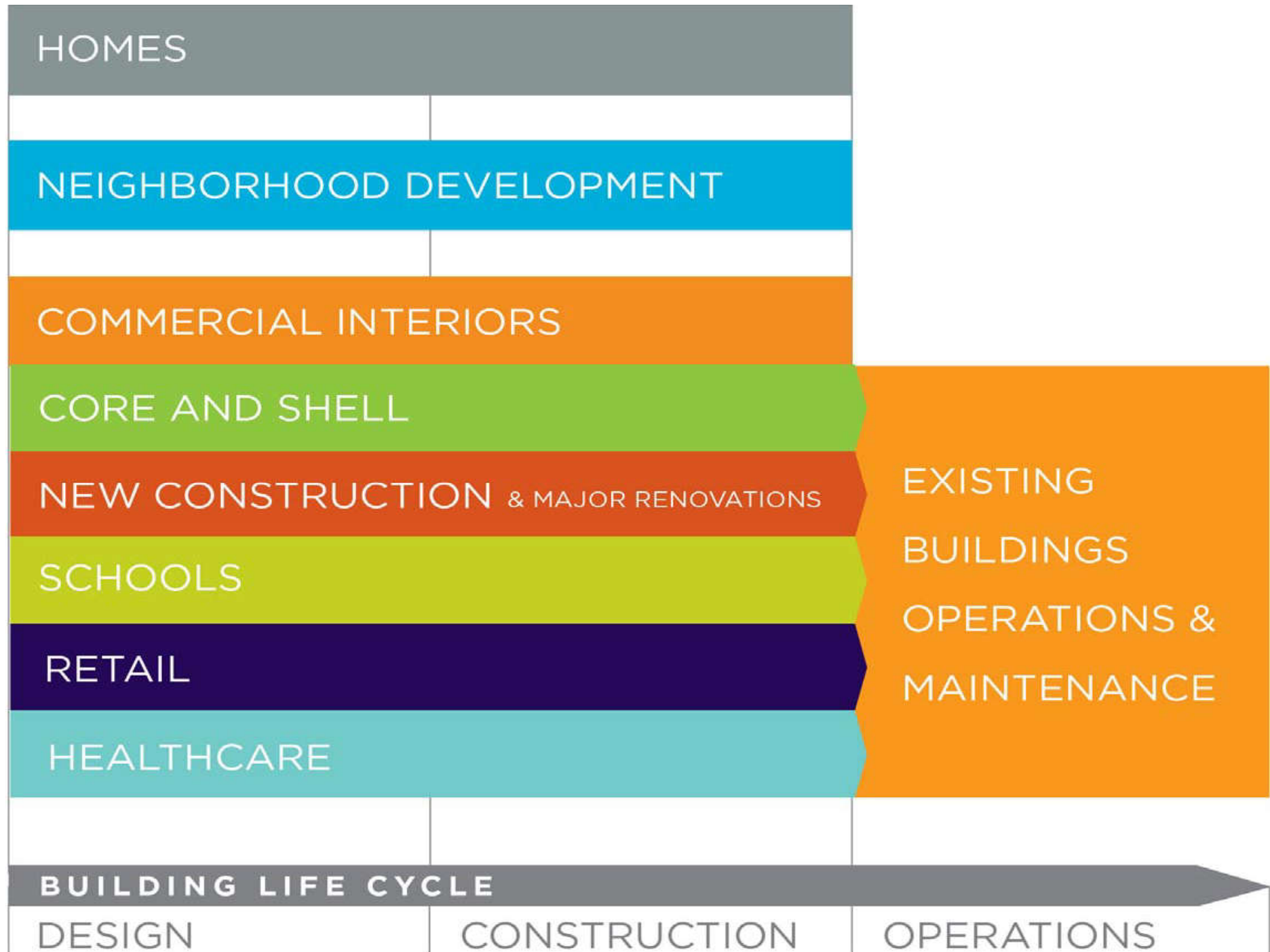
Current tools



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



LEED Green Building Rating



(Source: USGBC <http://www.usgbc.org/leed>; <http://leed.usgbc.org/>)

LEED Rating System



```
graph TD; A[LEED Rating System] --> B[Credit Categories]; B --> C[Prerequisites + Credits]; C --> D[Satisfy mandatory requirements + earn points]; D --> E[Certified, Silver, Gold or Platinum]
```

The diagram is a vertical flowchart with five main stages. The first stage is 'LEED Rating System'. An arrow points down to the second stage, 'Credit Categories'. From 'Credit Categories', an arrow points down to a third stage consisting of two boxes: 'Prerequisites' on the left and 'Credits' on the right, with a plus sign between them. An arrow points down from this third stage to the fourth stage, 'Satisfy mandatory requirements + earn points'. Finally, an arrow points down from the fourth stage to the fifth and final stage, 'Certified, Silver, Gold or Platinum'.

Credit Categories

Prerequisites

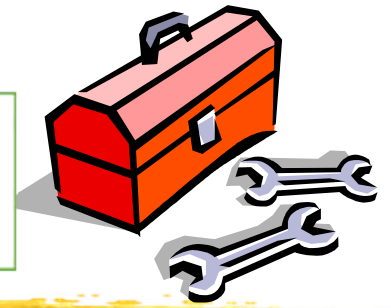
+

Credits

**Satisfy mandatory requirements + earn
points**

Certified, Silver, Gold or Platinum

Current tools



- 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

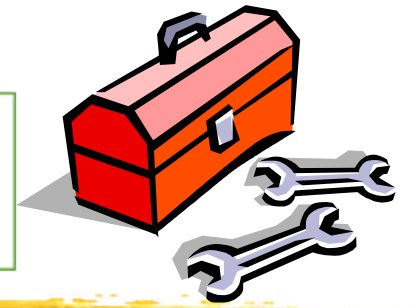
- Innovation credits



- Website: <http://www.usgbc.org/leed>

Different versions
of LEED NC:
v.1.0, v.2, v.2.1,
v.3, v.4

Current tools

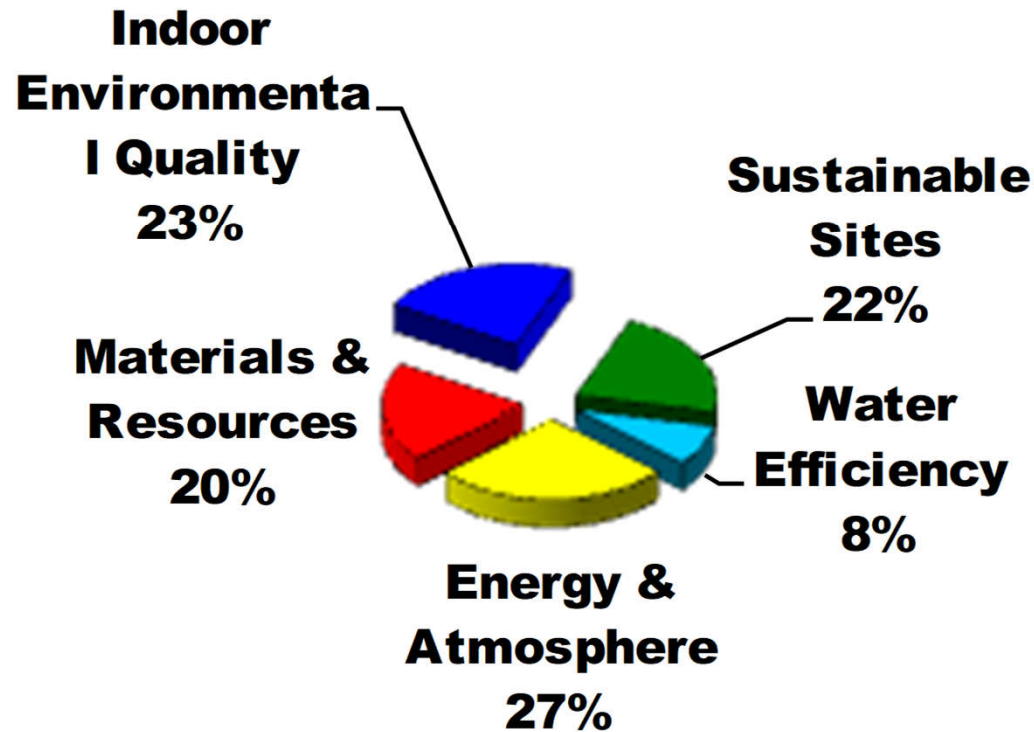


- LEED Green Building Rating System
 - Whole-building approach encourages & guides a collaborative, integrated design & construction process
 - Optimizes environmental and economic factors
- Four levels of certification (for version 2 or before)
 - LEED Certified 26 - 32 points
 - Silver Level 33 - 38 points
 - Gold Level 39 - 51 points
 - Platinum Level 52+ points (69 possible)
- LEED Accredited Professional



Which are the most important criteria?

LEED Point Distribution (version 2)



(Source: USGBC)

The relative importance of the criteria may change from one society to another one.

Phillip Merrill Environmental Center Headquarters Annapolis, Maryland



LEED™ 1.0 Certification:
PLATINUM

Notes from the Project Team: *LEED™ was instrumental in conveying the importance of the sustainable elements of the design to CBF's Board of Trustees.*

Sustainable Sites

- **Site Selection:** *Erected in Smart Growth Funding Area on footprint of existing structure. 26.6 acres remain undisturbed in Land Trust.*
- **Educational Model:** *Interpretive trails & demonstrations for public visitors*
- **Storm/Waste Water:** *All Composting Toilets & Bioretention/Wetland*
- **Resource Protection:** *Woodland, Wetland, & Tidal Water Restoration*

Water Efficiency

- **Water:** *Rainwater Catchment & Reuse for Hand Washing & Irrigation*

Energy and Atmosphere

- **Domestic Hot Water:** *Thermomax-Solar Technology*
- **Energy:** *Exceeds ASHRAE/IES Standard 90.1-1989 by 50%*
- **HVAC:** *Natural Ventilation and Desiccant Dehumidification & Heat Recovery*
- **Controls/Monitoring:** *Building Energy management System, "Green Light" notifies staff to open windows when outside conditions comply*
- **Power Source:** *30% Renewable with Geo-Exchange & Photovoltaics*
- **Lighting:** *Daylight Harvesting and time clock lighting controls*
- **Rapidly Renewable:** *Bamboo, cork and linoleum floorings*
- **Recycled Content:** *Metal roofing and siding, acoustic ceiling, ceramic tile, and MDF cabinetry*

Materials and Resources

- **Structure:** *Rapidly Renewable-Paralam Post, Beam, and Truss system*
- **Envelope:** *Structural Insulated Panels (SIP) R-20 walls, R-30 roof*

Indoor Environmental Quality

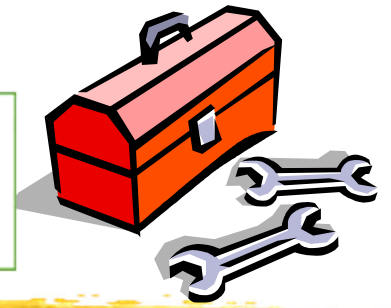
- **Indoor Environmental Quality:** *CO₂ and VOC monitors.*
- **Furniture:** *Small, open offices allow for communal space. Systems furniture allows flexible layout to accommodate "churn"*






Owner:	Chesapeake Bay Foundation
Project Team:	Architect: <i>SmithGroup, Inc.</i>
	Engineer: <i>SmithGroup, Inc.</i>
	P.Manager: <i>Synthesis, Inc.</i>
	Contractor: <i>Clark Construction Group</i>
	Consultant: <i>Janet Harrison, Architect</i>
Building Statistics:	
Completion Date:	<i>November, 2000</i>
Cost:	<i>\$6.36 M</i>
Size:	<i>30,600 gross square feet</i>
Footprint:	<i>12,000 square feet</i>
Construction Type:	<i>3B, Two Stories over Open Parking</i>
Use Group:	<i>Business(B), Assembly(A-3), Storage(S-2)</i>
Lot Size:	<i>33 acres</i>
Annual Energy Use:	<i>23 kBtu/sf/year</i>
Occupancy:	<i>90 Staff</i>

(Source: USGBC)

Current tools



- LEED version 3 and new schemes
 - Include other criteria
 -  • Locations & linkages
 - Awareness & education 
 -  • Regional priority
 - LEED Professionals
 - LEED Green Associate
 - LEED AP (different types)
 - Bldg design & construction, O&M, Homes, Interior design, Neighborhood development

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

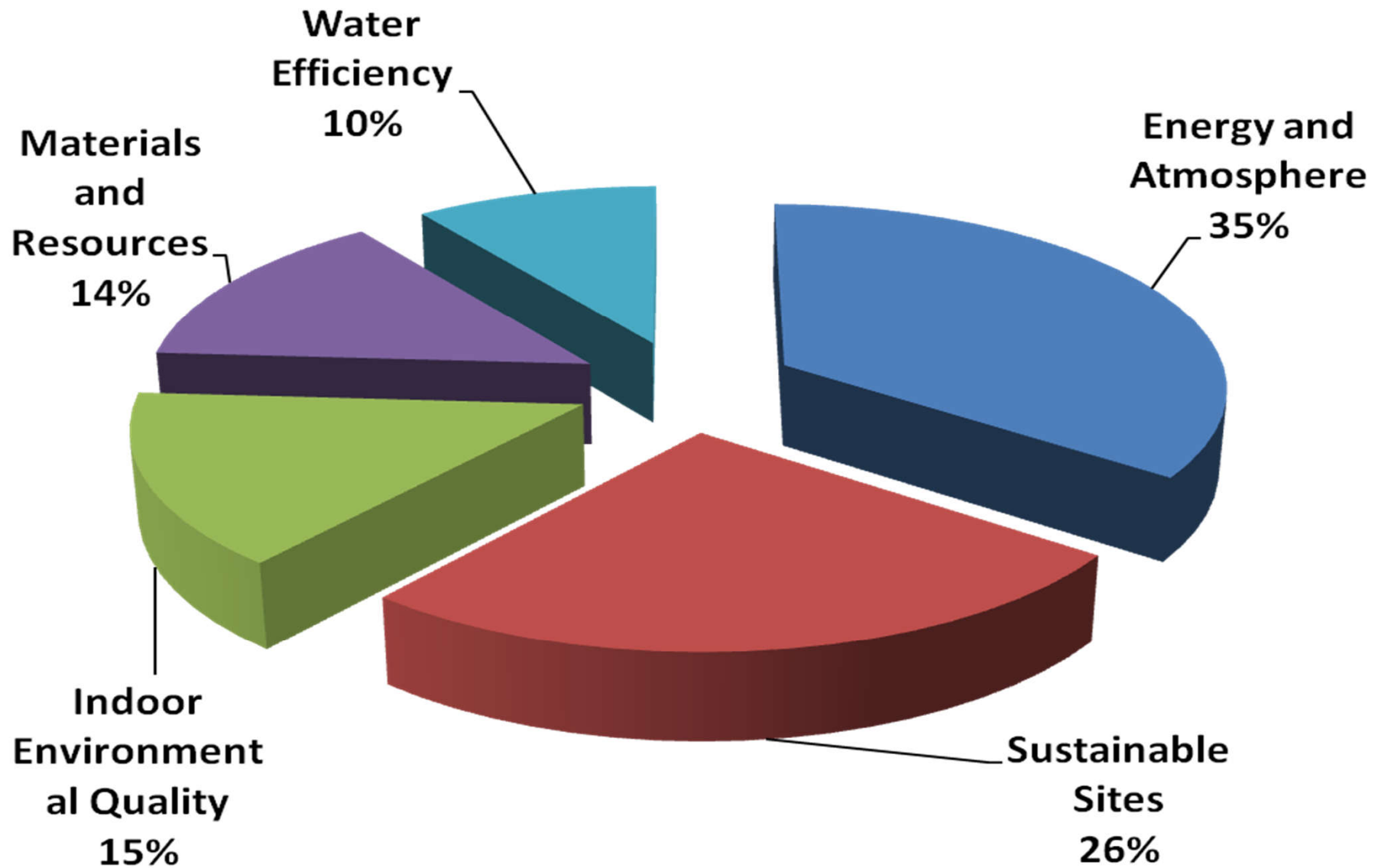
** Certified 40+ points, Silver 50+ points, Gold 60+ points, Platinum 80+ points

	Innovation in Operations	6
	Regional Priority	4

(Source: USGBC)

For LEED version 3

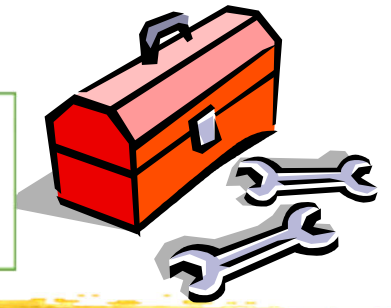
LEED NC point distribution (version 3, 2009)



(Source: USGBC)

Which are the most important aspects?

Current tools



- 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)





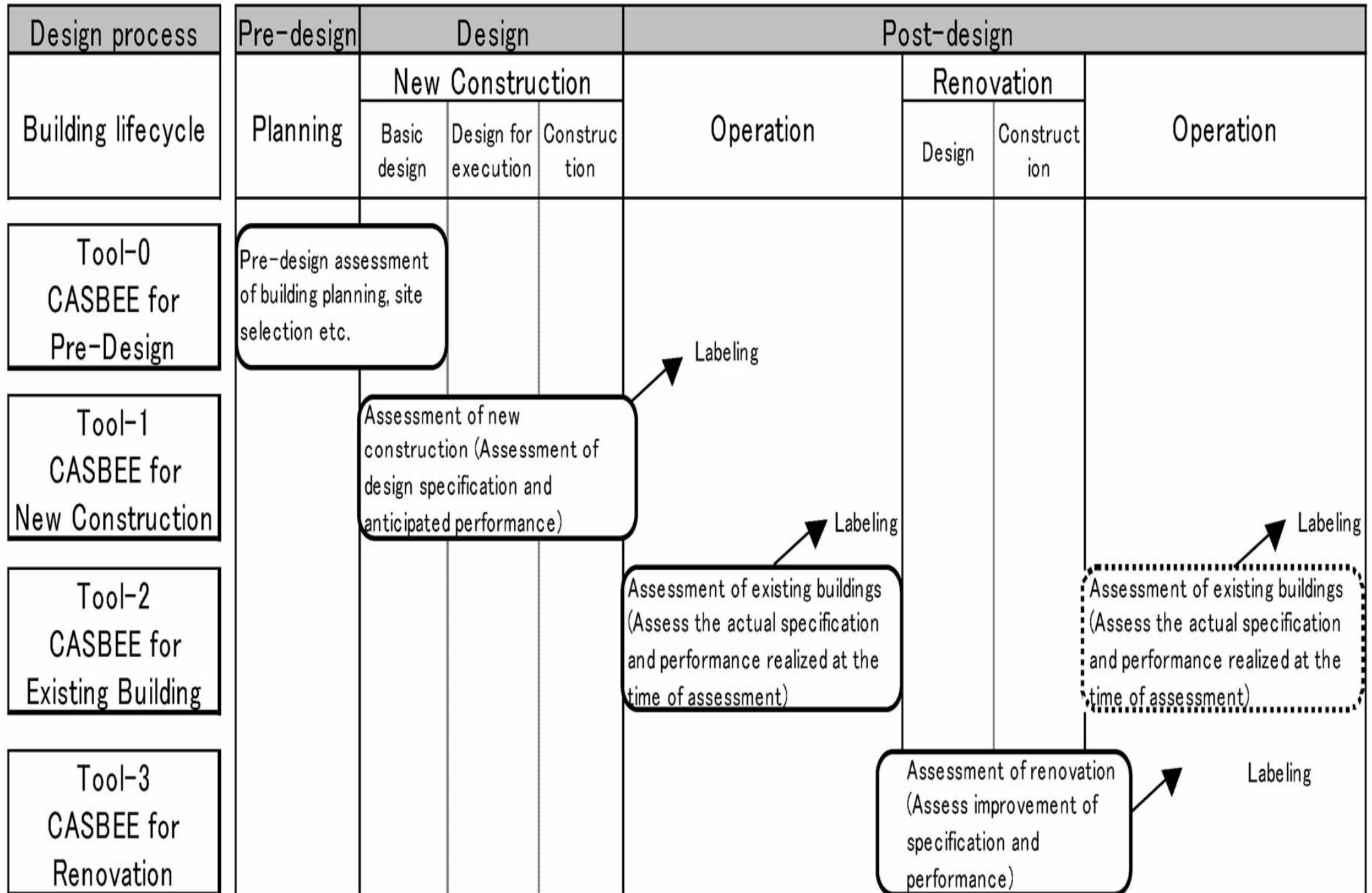
Current tools

- CASBEE (Comprehensive Assessment System for Building Environmental Efficiency), Japan
 - Tool-0: Pre-design
 - Tool-1: New Construction
 - Tool-2: Existing Buildings
 - Tool-3: Renovation
 - Website: www.ibec.or.jp/CASBEE/

CASBEE[®] 建築環境総合性能評価システム

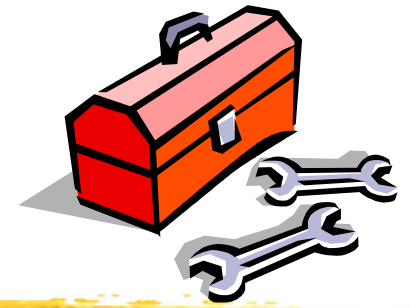
Comprehensive Assessment System for Built Environment Efficiency

CASBEE Building Lifecycle and Four Assessment Tools



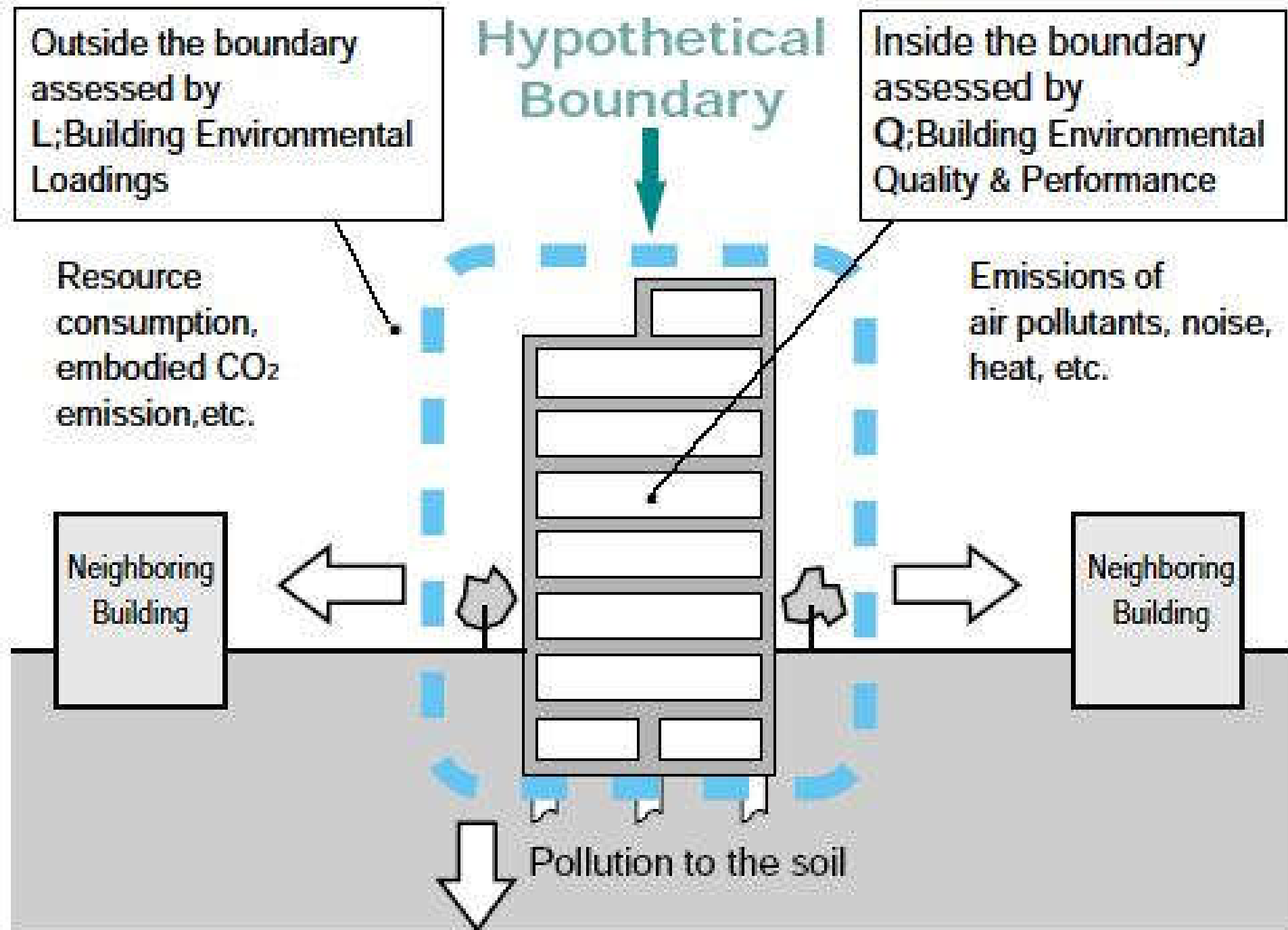
(Source: IBEC, Japan)

Current tools



- CASBEE systems:
 - CASBEE for New Construction
 - CASBEE for Interior Space
 - CASBEE for Existing Building
 - CASBEE for Renovation
 - CASBEE for Heat Island (HI)
 - CASBEE for Home (Detached House)
 - CASBEE for Housing Unit
 - CASBEE for Urban Development (UD)
 - CASBEE for City

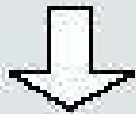




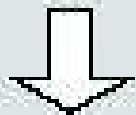
(Source: IBEC, Japan)

From Eco-efficiency of a building to BEE

Original definition:
(WBCSD)

$$\frac{\text{Values of products or services}}{\text{Environmental load unit}}$$


Modeled definition:

$$\frac{\text{Beneficial output}}{\text{Input} + \text{Non-beneficial output}}$$


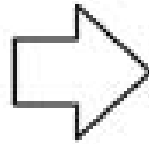
Definition of BEE
in CASBEE:

$$\frac{\text{Building Environmental Quality \& Performance}}{\text{Building Environmental Loadings}}$$

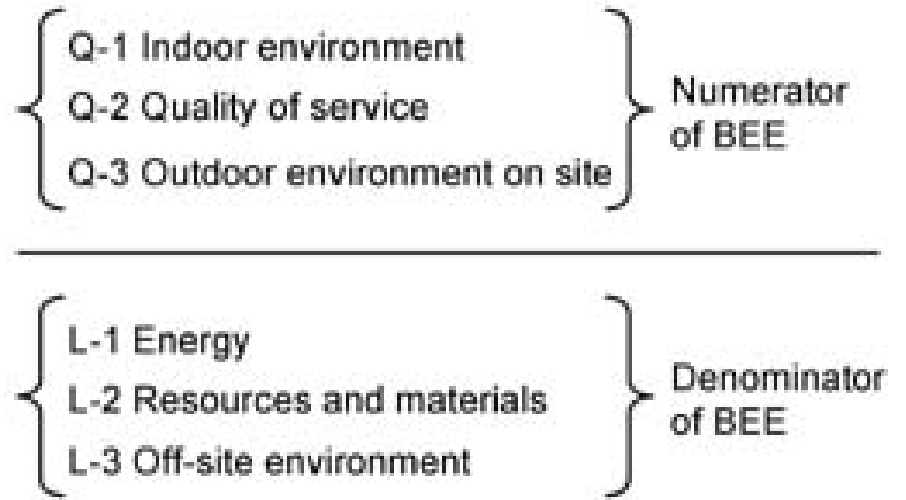
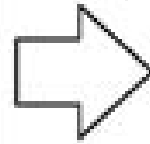
Building Environmental Efficiency (BEE)

$$= \frac{\text{Building Environmental Quality \& Performance}}{\text{Building Environmental Loadings}}$$

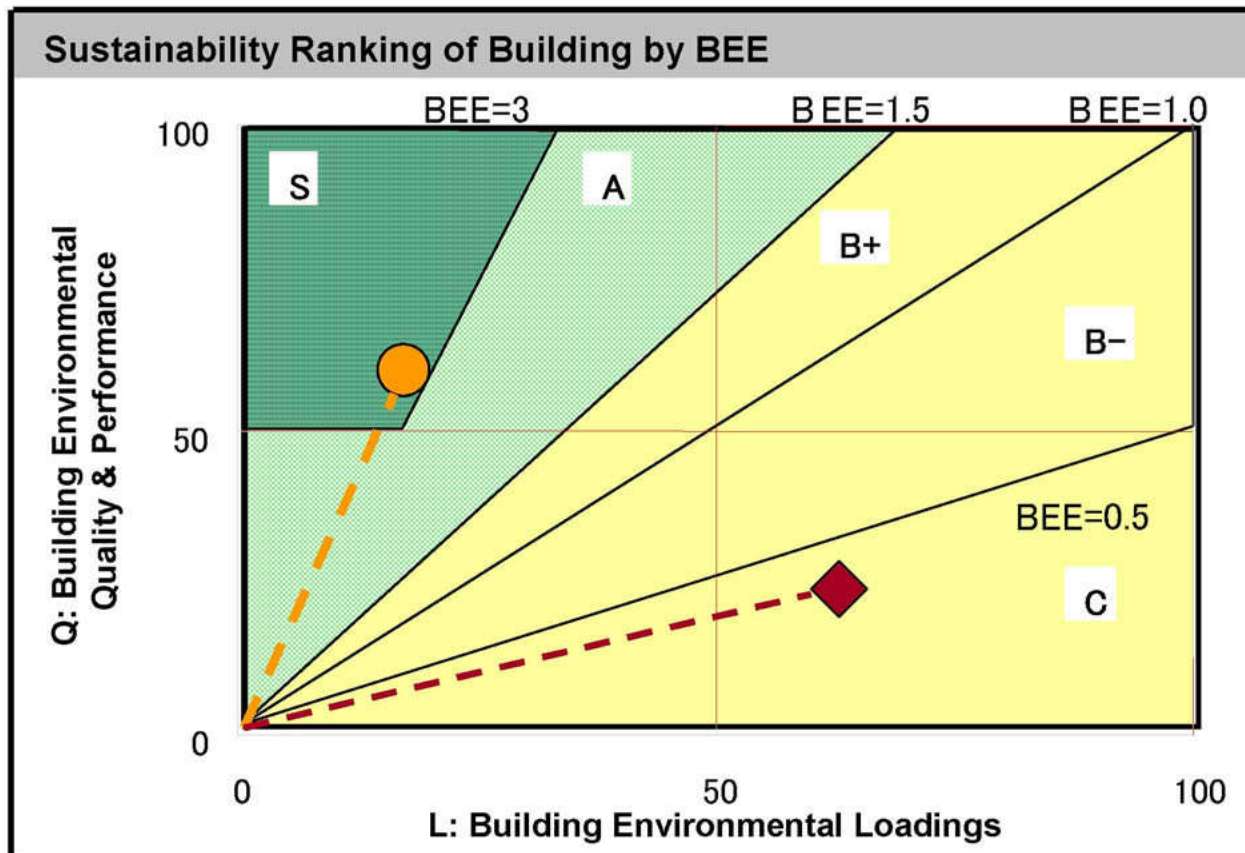
- (1) Energy efficiency
- (2) Resource efficiency
- (3) Local environment
- (4) Indoor environment



Recategorized into
Q (Quality)
and
L (Loadings)



(Approx. 80 sub-items in total)



- : Ordinary Building
- : Sustainable building (Sample)

CASBEE Ranking:

- S = ★ ★ ★ ★ ★
- A = ★ ★ ★ ★
- B+ = ★ ★ ★
- B- = ★ ★
- C = ★

(Source: IBEC, Japan)

CASBEE® 評価内容

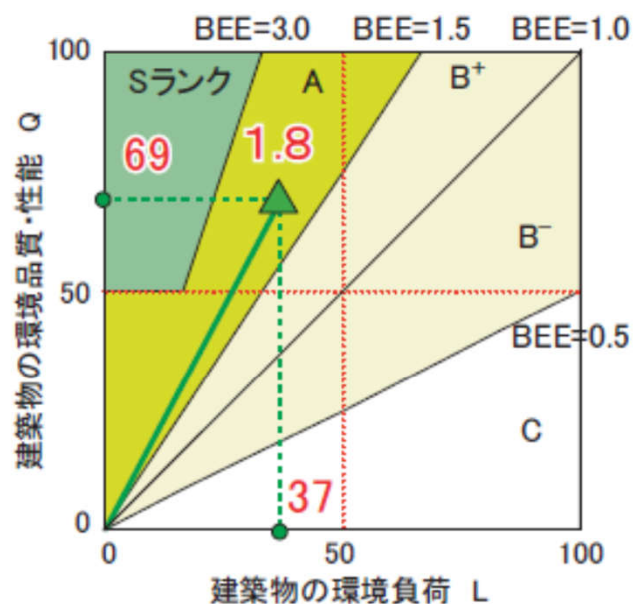
CASBEE-新築(簡易版)

評価ツール CASBEE-NCb_2006v1.2
 認証番号 IBEC-C0046-NCb(c)
 交付日 2009年3月10日

建物名称	NBF豊洲ガーデンフロント	敷地面積	12,551.33㎡
建物用途	事務所	建築面積	5,092.29㎡
建設地	東京都江東区豊洲5丁目6-7	延床面積	36,310.82㎡
気候区分	—	階数	地上10階
地域・地区	準工業地域、準防火地域、第三種高度地区	構造	S造
竣工日	2007年9月30日	平均居住人員	5,660人
		年間使用時間	2,500時間/年

建築物の環境性能効率 (BEE: Building Environmental Efficiency)

BEEによる建築物のサステナビリティランキング

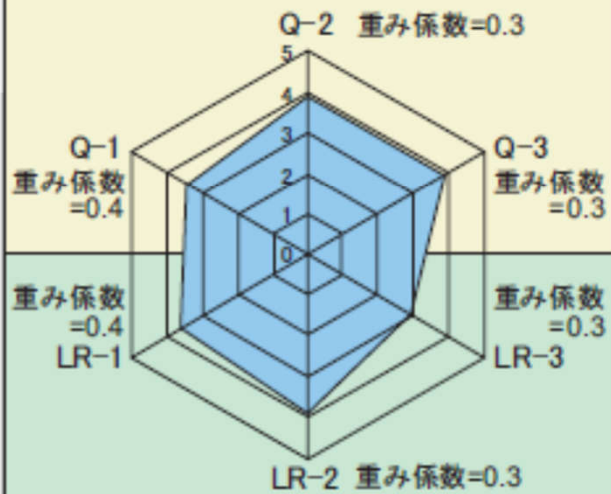


$$BEE = \frac{\text{建築物の環境品質・性能 } Q}{\text{建築物の環境負荷 } L} = \frac{25 \times (S_Q - 1)}{25 \times (5 - S_{LR})} = \frac{69.0}{37.0} = 1.8$$

(Source: IBEC, Japan)

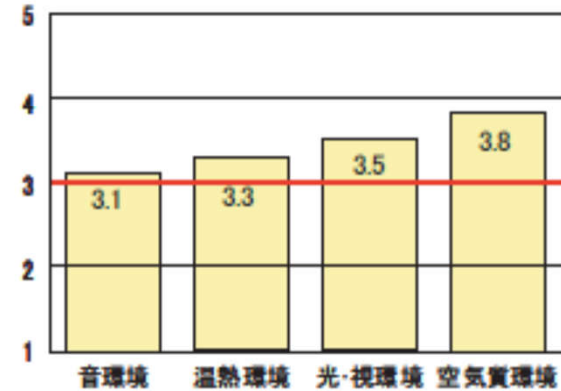
建築物の環境品質・性能と環境負荷低減性

レーダーチャート

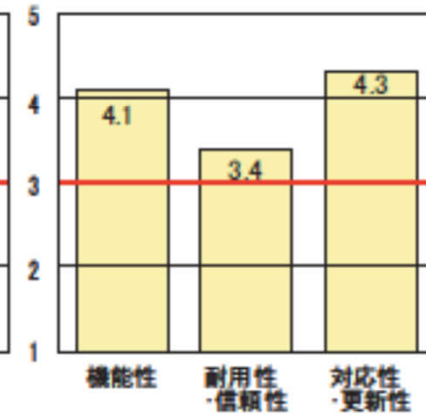


Q 建築物の環境品質・性能 (建築物の居住環境のアメニティを向上させる性能評価) $S_Q = 3.7$

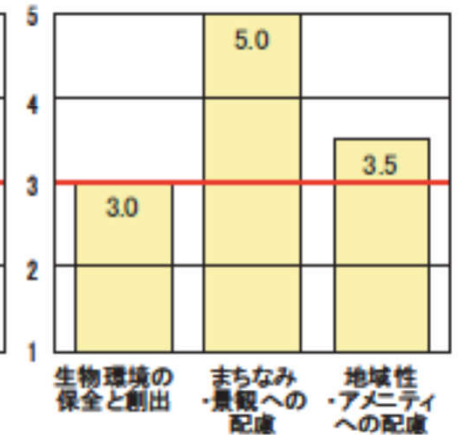
Q-1:室内環境 $S_{Q1} = 3.4$



Q-2:サービス性能 $S_{Q2} = 3.9$



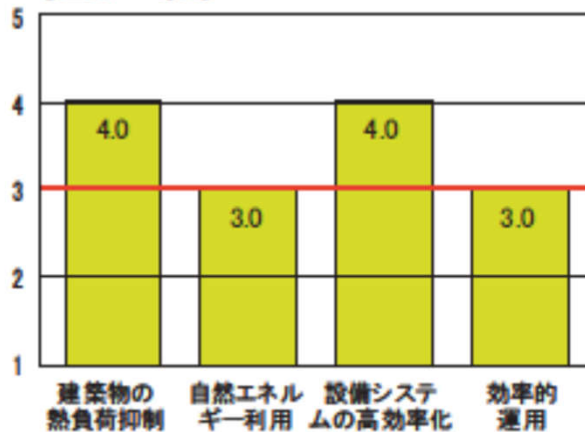
Q-3:室外環境(敷地内) $S_{Q3} = 3.9$



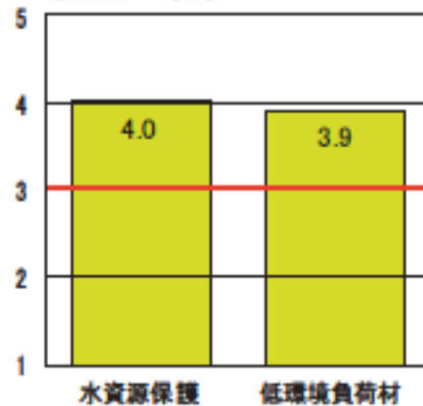
LR 建築物の環境負荷低減性 (建築物の環境負荷を低減させる性能評価)

$SLR = 3.5$

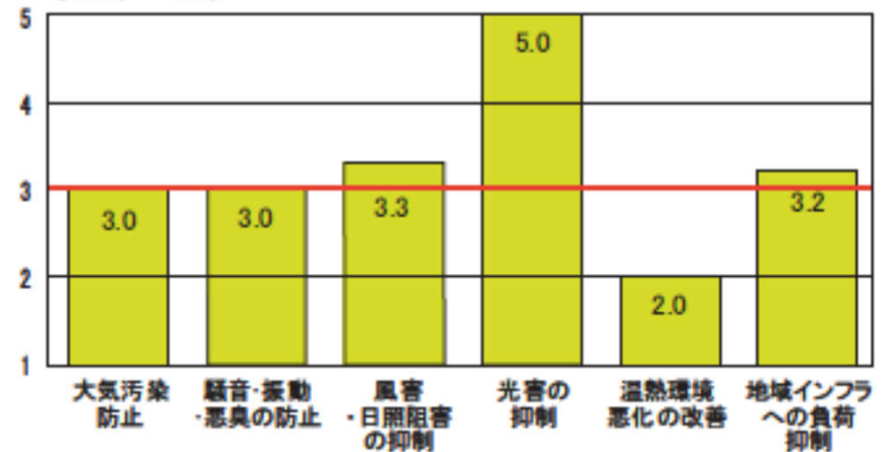
LR-1:エネルギー $SLR1 = 3.6$



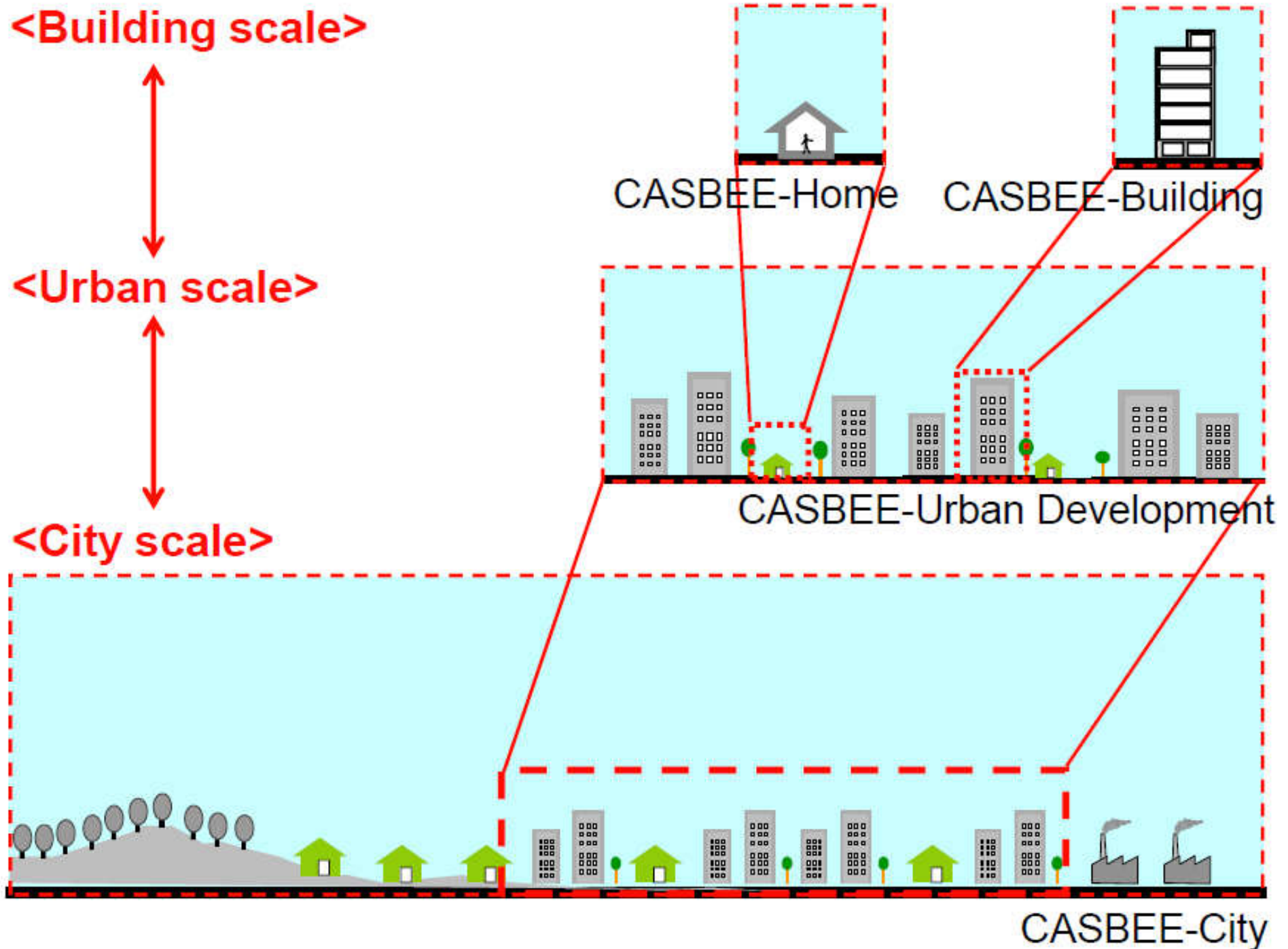
LR-2:資源・マテリアル $SLR2 = 3.9$



LR-3:敷地外環境 $SLR3 = 2.9$

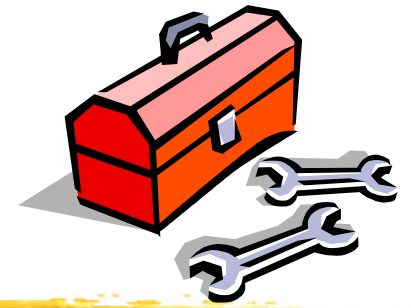


CASBEE from Home/Building to City Scale



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

Current tools



- **Green Mark (GM) Scheme, Singapore**

- Started 2005 (mandatory)

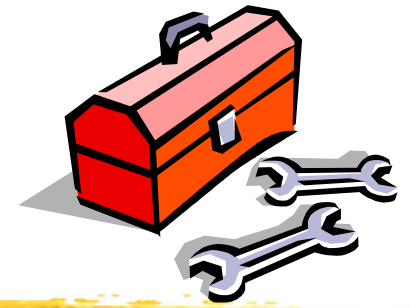
- <https://www1.bca.gov.sg/buildsg/sustainability/green-mark-certification-scheme>

- Categories:

- Non-residential buildings (new & existing)
 - Residential buildings (new & existing)
 - Super low energy buildings
 - Existing schools, healthcare facilities
 - Healthier workplaces [office interior] (new office fit-outs existing offices in operation)
 - Landed houses, restaurants, supermarket, retail
 - Infrastructure, district, data centres, laboratories, parks



Current tools



- **Green Mark (GM) Scheme, Singapore**
 - Assessment criteria (new non-residential)
 - Energy Efficiency [79]
 - Water Efficiency [14]
 - Environmental Protection [32]
 - Indoor Environmental Quality [8]
 - Other Green Features and Innovation [7]
 - GM ratings: max 140 + 20 bonus points
 - Platinum (90+), GoldPlus (85-90), Gold (75-85) or Certified (50-75)
 - Re-assess every 3 years to maintain GM status

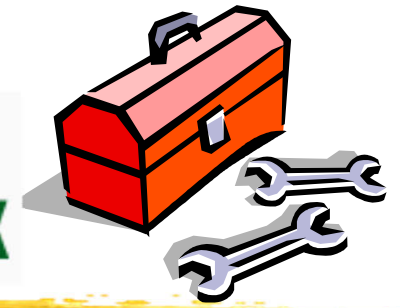


Green Mark: 2021 (GM: 2021) has 2 key shifts:

- (a) Aggressively raising energy efficiency standard with the aim of mainstream delivery of Super Low Energy (SLE) buildings;
- (b) Aligning with the United Nation (UN) Sustainable Development Goals (SDGs) to cover key sustainability outcomes



Current tools



- **Green Building Index (GBI), Malaysia**
 - Started 2009 (www.greenbuildingindex.org)
 - GBI Tools:
 - New Construction (NC)
 - Non-residential (NRNC) and residential (RNC)
 - Non-Residential Existing Building (NREB)
 - Data Centre, Retail, Hotel, Resort, Hospital
 - Township
 - Industrial New Construction (INC) & Industrial Existing Building (IEB)
 - Interiors (ID)

Current tools

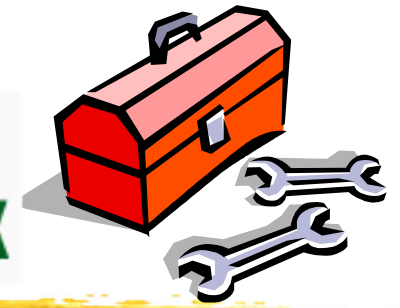


- **Green Building Index (GBI), Malaysia**
 - Six main criteria: [max. point for new construction]
 - Energy Efficiency (**EE**) [35]
 - Indoor Environment Quality (**EQ**) [21]
 - Sustainable Site Planning & Management (**SM**) [16]
 - Materials & Resources (**MR**) [11]
 - Water Efficiency (**WE**) [10]
 - Innovation (**IN**) [7]
 - Total score = 100
 - GBI ratings: Certified (50-65), Silver (66-75), Gold (76-85) and Platinum (86+)

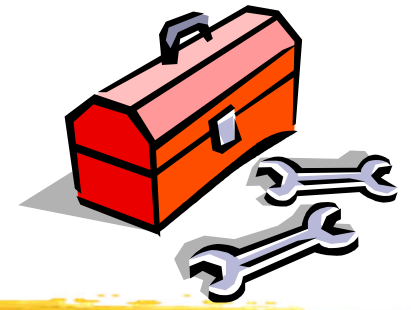
Three tiers of GBI accreditation for buildings



Current tools



- **Green Building Index (GBI), Malaysia**
 - Assessment process:
 - Stage 1. Application & Registration
 - Stage 2. Design Assessment
 - Stage 3. Completion & Verification Assessment
 - Professionals:
 - GBI Accreditation Panel (GBIAP)
 - GBI Certifiers [assessment]
 - GBI Facilitators [consultancy]
 - GBI Commissioning Specialists (CXS)



Current tools

- Mainland China

- Green Olympic Building Assessment System (GOBAS) (綠色奧運建築評核系統) (2006)

- Developed from the Japan's CASBEE method
 - Applied mainly in Beijing

- GB/T 50378-2019, Assessment Standard for Green Building (綠色建築評價標準)

- Similar to LEED in structure and rating process
 - A three-star Green Building certificate will be awarded to the qualified buildings





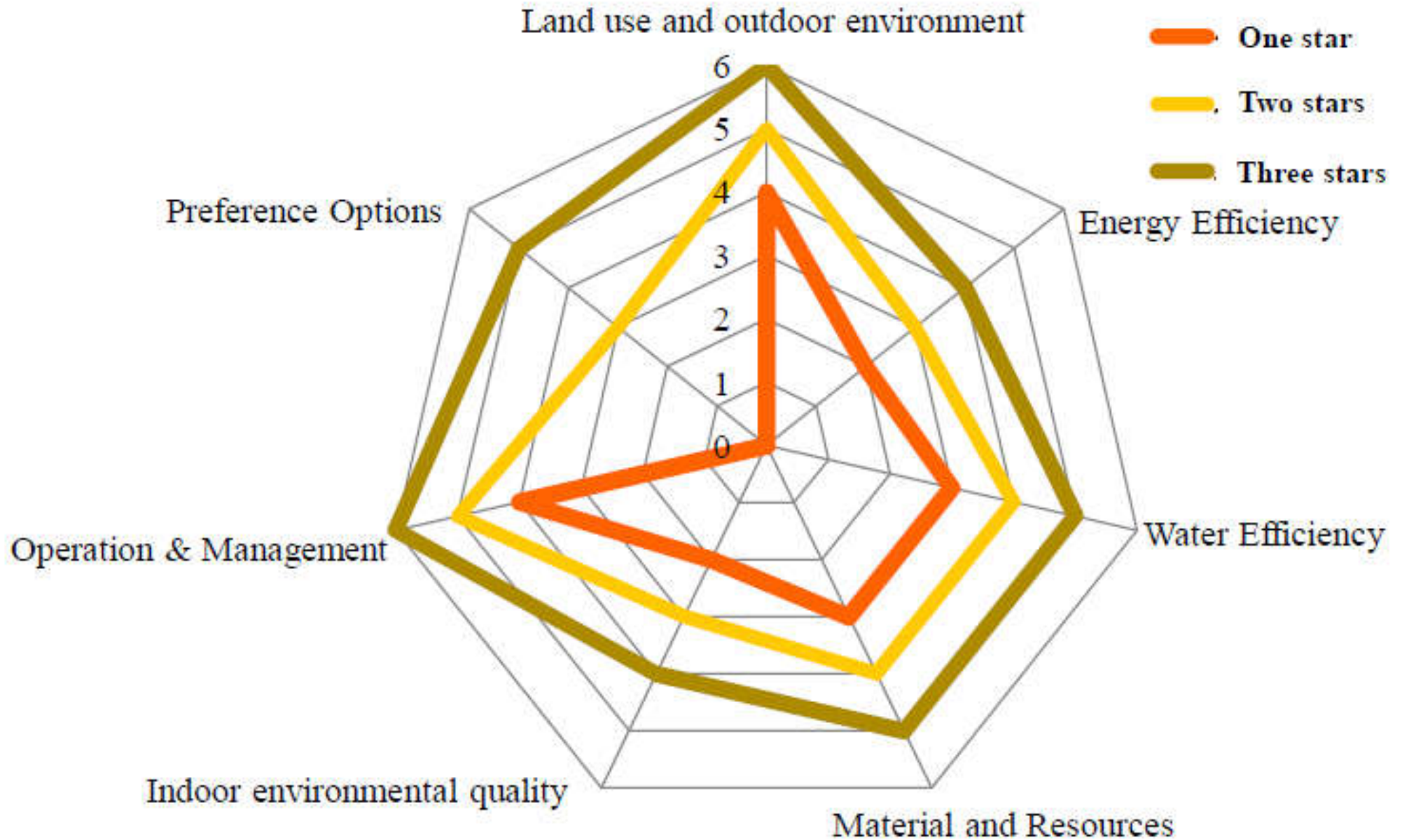
Evaluation Standard for Green Building – China (Three Star System)

		General Items (40)						Preference Options
Grade	Land Use and Outdoor Environment (8)	Energy Efficiency (6)	Water Efficiency (6)	Material and Resources (7)	Indoor Environmental Quality (6)	Operation & Management (7)	(9)	
Residential Building	★	4	2	3	3	2	4	-
	★★	5	3	4	4	3	5	3
	★★★	6	4	5	5	4	6	5
		General Items (43)						Preference Options
Grade	Land use and outdoor environment (8)	Energy Efficiency (6)	Water Efficiency (6)	Material and Resources (8)	Indoor Environment Quality (6)	Operation & Management (7)	(14)	
Public Building	★	3	4	3	5	3	4	-
	★★	4	6	4	6	4	5	6
	★★★	5	8	5	7	5	6	10

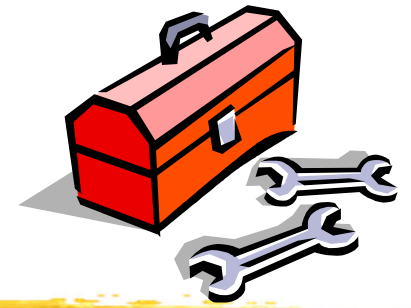


Evaluation Standard for Green Building – China

Assessment categories and weighting



Current tools



- Mainland China

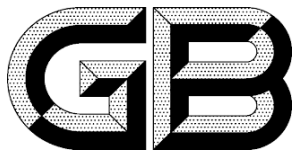
- Green building standard system

- Design stage (technical standards)



- JGJ/T 229-2010 Green design standard of civil buildings
 - JGJ/T 449-2018 Civil building green performance calculation standard

- Construction stage (national standards)



- GB/T 50640-2010 Assessment standard for green construction of building
 - GB/T 50905-2014 Construction Code for green building

- Operation stage (technical standard)



- JGJ/T 391-2016 Technical standard for green building operation and maintenance

- Assessment standards (10 nos.)

Green building standard system in Mainland China

Green Building Standard System covers the whole building life cycle

Assessment Stage

- Assessment standard for green building (GB/T 50378)
- Assessment standard for green eco-district(GB/T 51255)
- Assessment standard for green campus(GB/T 51356)

Design Stage

- Code for green design of civil buildings(JGJ/T 229)
- Standard for green performance calculation of civil buildings(JGJ/T 449)

Construction Stage

- Evaluation standard for green construction of building(GB/T 50640)
- Code for green construction of building(GB/T 50905)

Retrofitting Stage

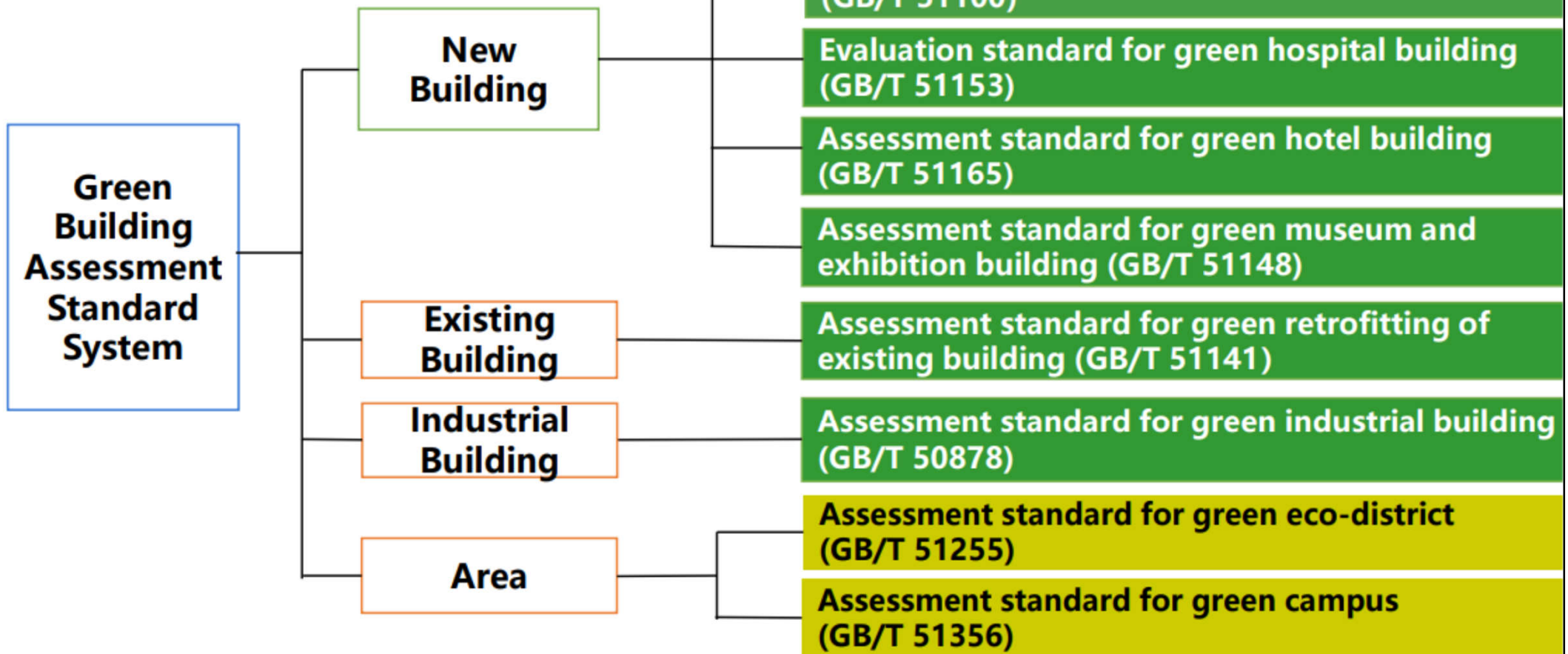
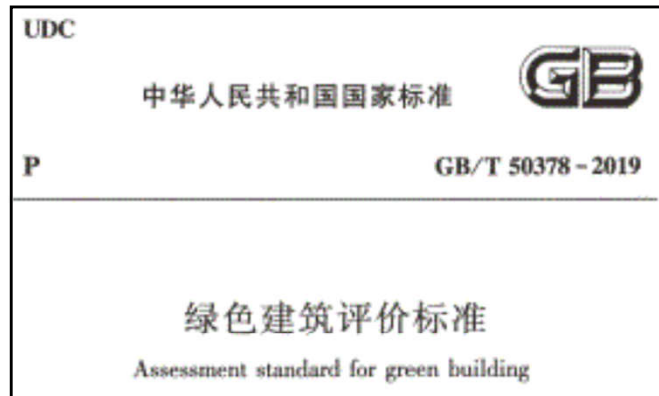
- Assessment standard for green retrofitting of existing building(GB/T 51141)
- Technical standard for green retrofitting of existing community(JGJ/T 425)

Operation Stage

- Technical code for operation and maintenance of green building(JGJ/T 391)
- Standard for test and assessment of green lights(GB/T 51268)

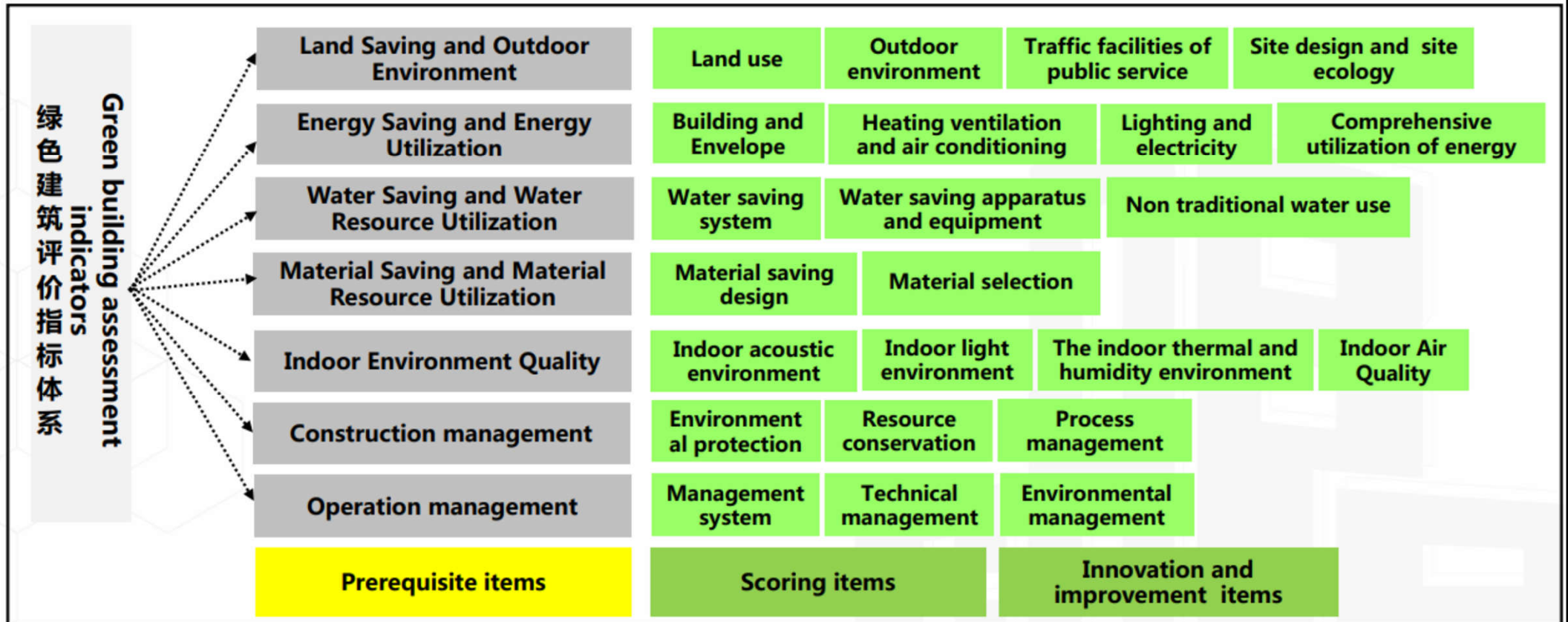


Green building assessment standard system in Mainland China



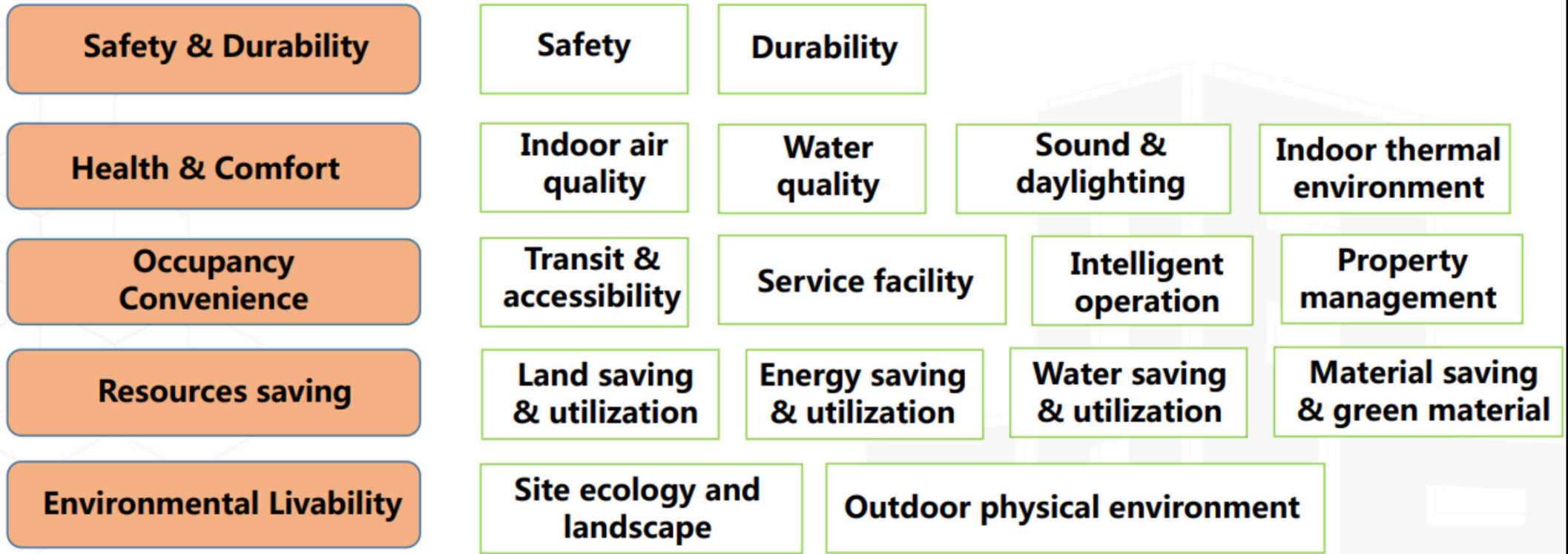
Assessment criteria of GB/T 50378-2014 Assessment Standard for Green Building (2nd edition)

Assessment standard for green building GB/T 50378-2014 (2nd edition)



Assessment criteria of GB/T 50378-2019 Assessment Standard for Green Building (3rd edition)

Assessment standard for green building GB/T 50378-2019 (3rd edition)



Five new performance assessment criteria

- 安全耐久 Safety and Durability
- 健康舒适 Health and Comfort
- 生活便利 Occupancy Convenience
- 资源节约 Resource Saving
- 环境宜居 Environment Livability

Revised requirements in GB/T 50378-2019 Assessment Standard for Green Building (3rd edition)

提出了绿色建筑星级评价特殊要求

For 1~3 star green building, more high requirements shall be met.

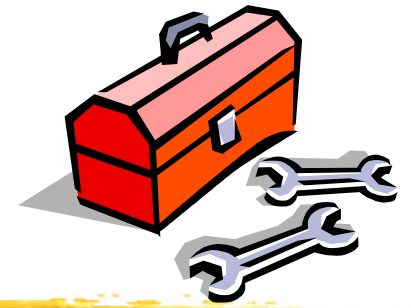
总得分 Scores : $Q = (Q_0 + Q_1 + Q_2 + Q_3 + Q_4 + Q_5 + Q_A) / 10$

	控制项 基础分值 Basic score of control term	评价指标体系评分项满分值 Full score of scoring items in evaluation index system					提高与创新项加分值 Bonus point of improvement & innovation
		安全耐久 Safety and Durability	健康舒适 Health and Comfort	生活便利 Occupancy Convenience	资源节约 Resource Saving	环境宜居 Environment Livability	
预评价分值 Pre-evaluation score	400	100	100	80	200	100	100
评价分值 Evaluation score	400	100	100	100	200	100	100

星级确定：最低得分（每类指标满分值的30%）+全装修+总得分（60、70、85）

The lowest score for 1-star, 2-star and 3-star is 60, 70 and 85 respectively.

Current tools



- Taiwan Green Building Label (EEWH)
 - Nine sets of assessment criteria/indicators:

- E**cology 生態
 - 1. Biodiversity 生物多樣性
 - 2. Greenery 綠化量
 - 3. Water retention 基地保水
- E**nergy 節能
 - 4. Energy efficiency 日常節能
- W**aste reduction 減廢
 - 5. Carbon dioxide reduction CO₂減量
 - 6. Waste reduction 廢棄物減量
- H**ealth 健康
 - 7. Indoor environment 室內環境
 - 8. Water resources 水資源
 - 9. Wastewater and garbage 污水拉圾改善



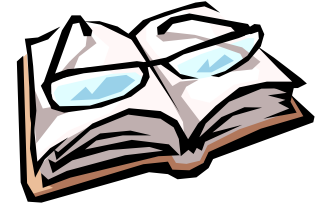
Taiwan Green Building Label (EEWH) evaluation manuals



Nine indicators & score for Taiwan Green Building Label (EEWH)

Four categories	Nine Indicators		New Grading Score		
			Benchmark Score	Highest Score	Subtotal
Ecology	1.Biodiversity		2	9	27
	2.Greenery		2	9	
	3.On-site Water Retention		2	9	
Energy Saving	4.Daily Energy Saving	Envelope	2	12	28
		AC	2	10	
		Lighting	2	6	
Waste Reduction	5.CO ₂ Reduction		2	9	18
	6.Construction Waste Reduction		2	9	
Health	7.Indoor Environment		2	12	27
	8.Water Resource		2	9	
	9.Sewage & Garbage Improvement		2	6	

Further Reading



- Building Environmental Assessment Tools: Current and Future Roles
 - http://www.sb05.com/academic/4&5_IssuePaper.pdf
- Green building rating tools [WGBC]
<https://www.worldgbc.org/rating-tools>
- Green Building Standards and Certification Systems [WBDG]
 - <http://www.wbdg.org/resources/gbs.php>