

# MEBS6020 Sustainable Building Design

<http://www.hku.hk/bse/MEBS6020/>



## Green Building Assessment (II)



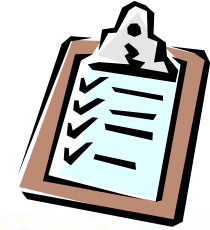
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# Contents



- LEED Certification
- LEED process
- LEED v4
- Key factors to consider
- Green building measures
- LEED technical analysis
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# LEED registered projects in international market

## Top 10 Countries (Registered + Certified)

Country	# Projects	Floor area (ft <sup>2</sup> )
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](http://www.greenbiz.com))

# Number of LEED Professionals in China (including HK and Macau)

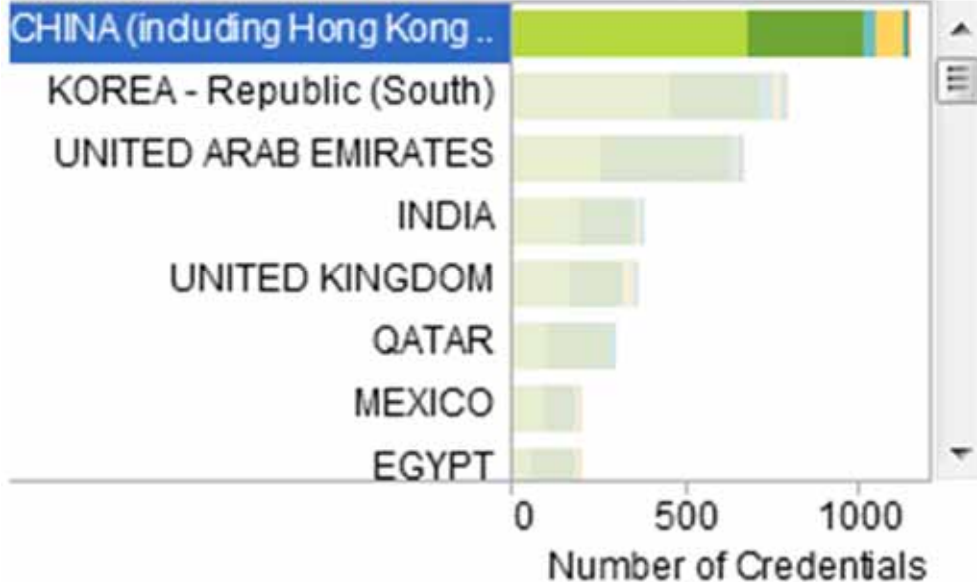
## Number of Credentials Held



### Credential

LEED AP BD+C	679
LEED Green Associate	338
LEED AP ID+C	83
LEED AP O+M	31
LEED AP ND	13
LEED AP HOMES	2
<b>Grand Total</b>	<b>1,146</b>

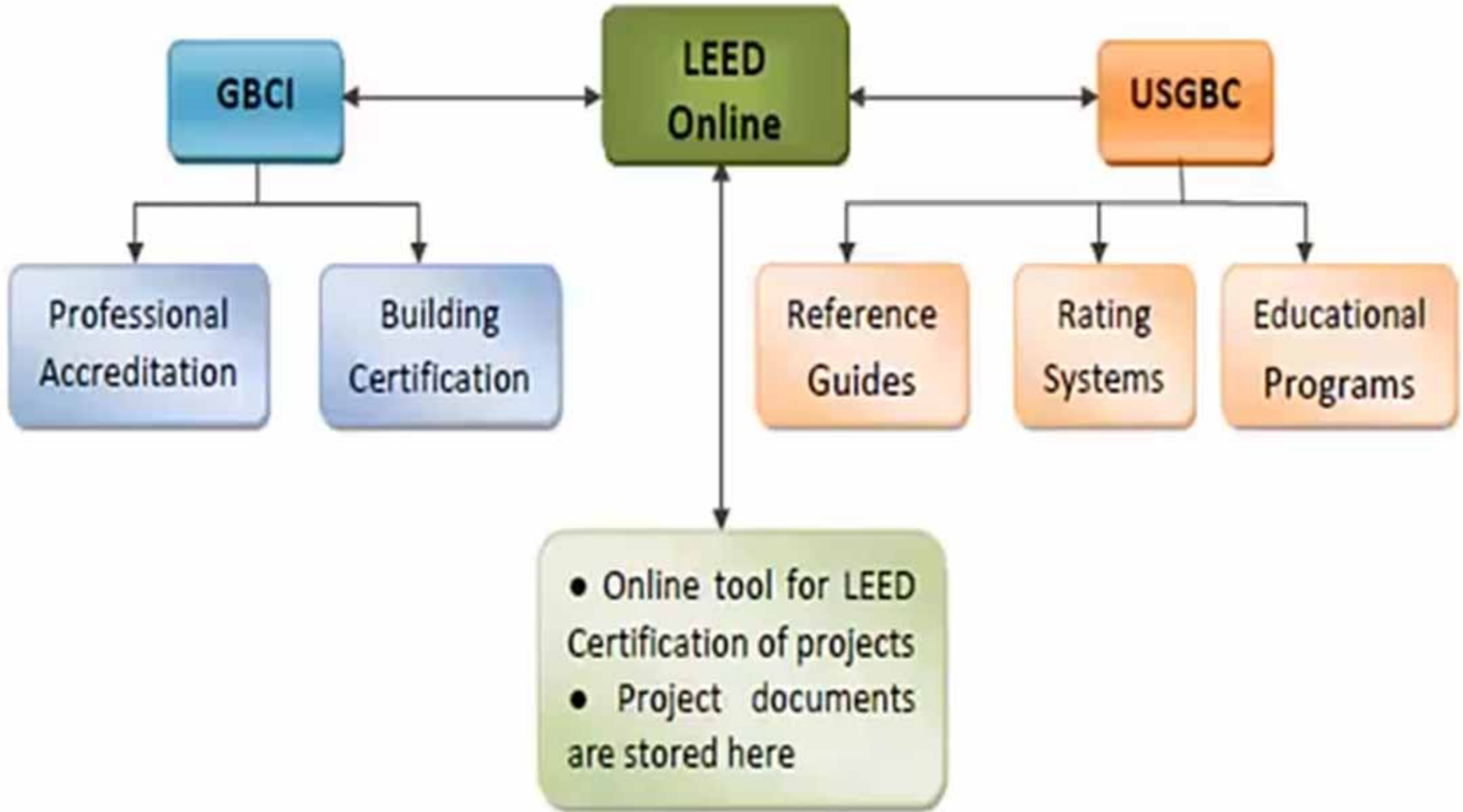
## Number of Credentials Held by Country



## Area of Practice



# USGBC, GBCI and LEED Online ([www.usgbc.org/leedonline](http://www.usgbc.org/leedonline))



GBCI = Green Building Certification Institute, [www.gbc.org](http://www.gbc.org)

USGBC = US Green Building Council, [www.usgbc.org](http://www.usgbc.org)

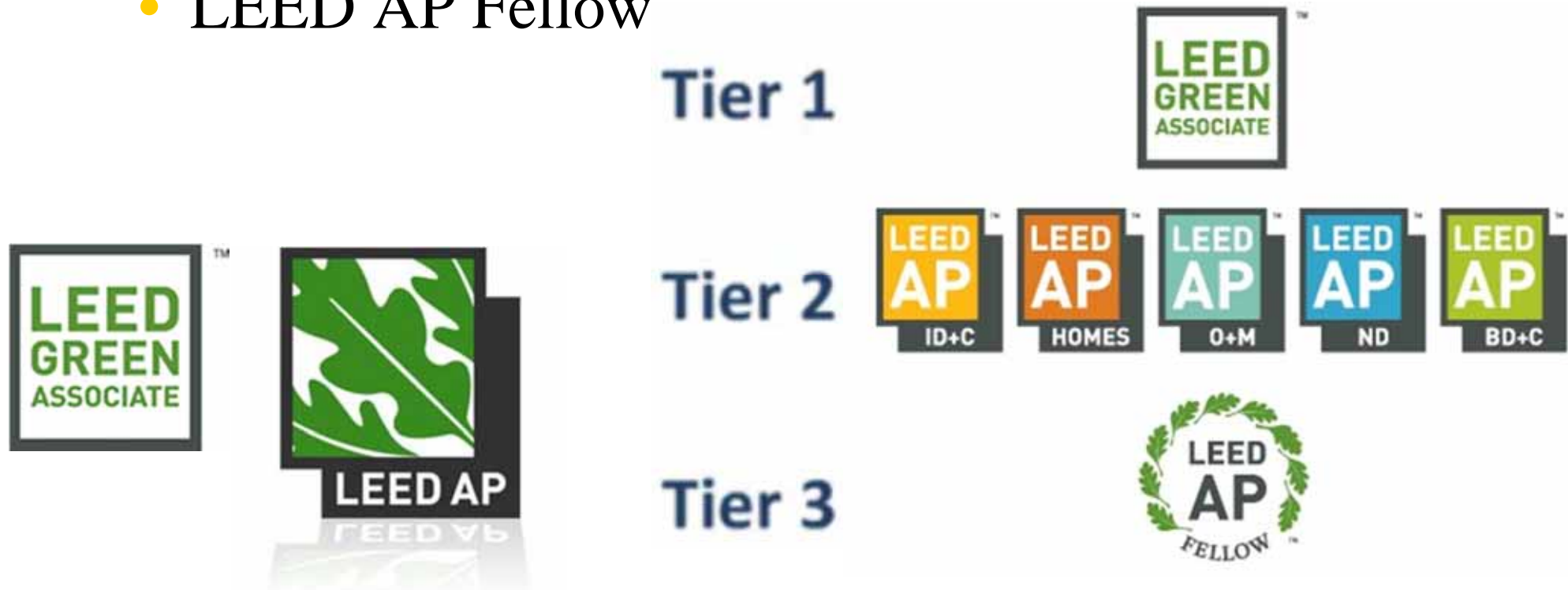


(See also: Intro To LEED Certification - GreenEDU.com (3:53)  
<http://www.youtube.com/watch?v=DTIZBFeF2Nc>)

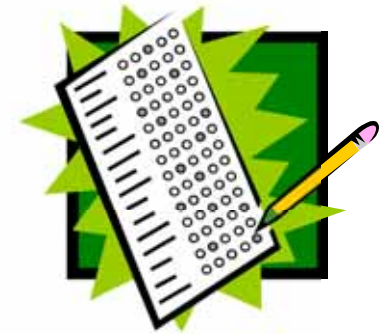
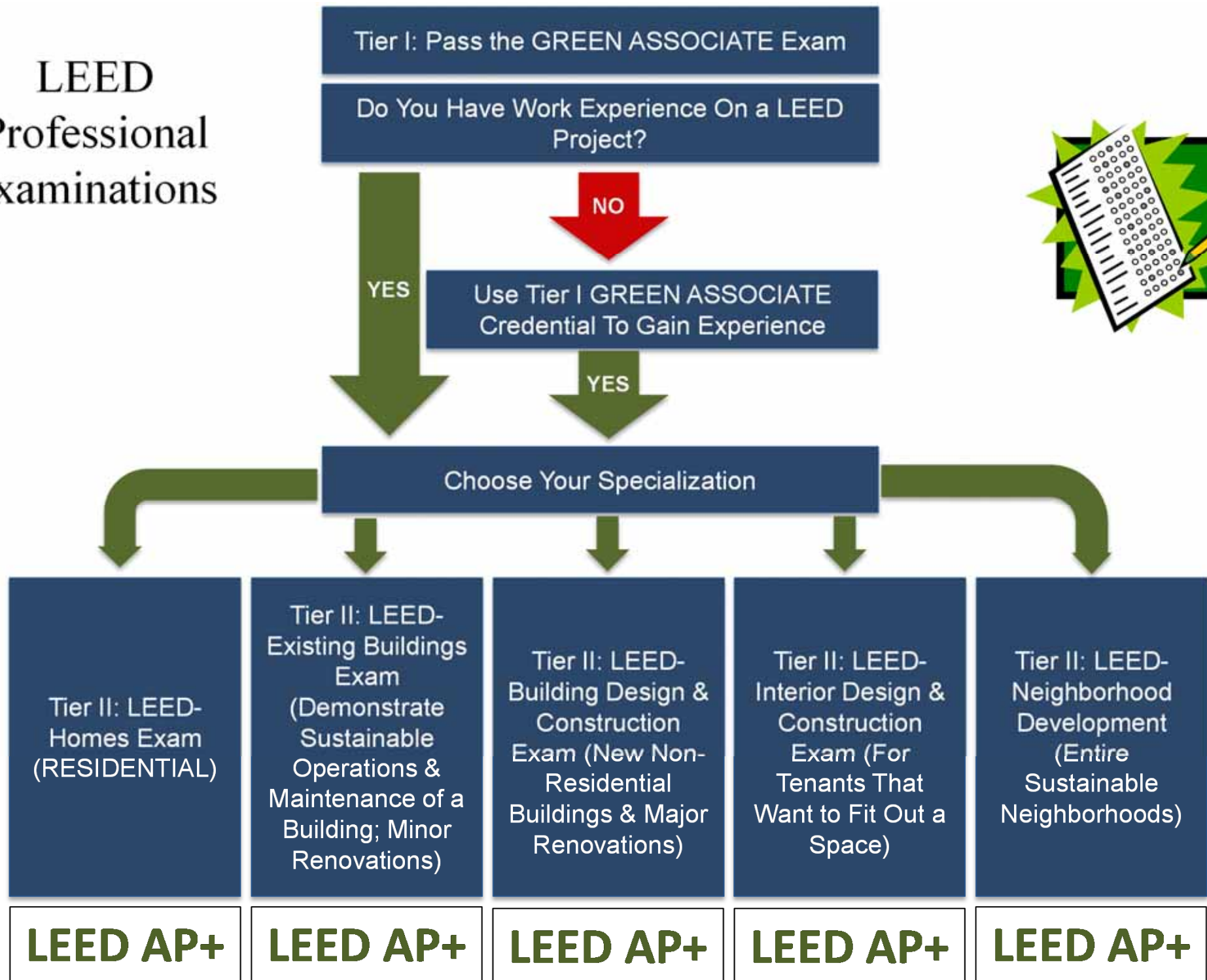


# LEED Certification

- LEED professionals system/credentials (3 tiers)
  - LEED Green Associate (GA)
  - LEED AP+ with specialty
  - LEED AP Fellow



# LEED Professional examinations





# LEED Green Associate exam: sample question

## LEED Green Associate Examination www.prometric.com

Question 1 of 100

Time remaining: 01 : 59 : 59

**Which of the following should be addressed in IAQ Management during construction? (Choose 2)**

- Protection of HVAC equipment
- Pathway interruption
- Comply with ASHRAE 62.1 2007 requirements for ventilation
- Filter replacement schedule
- Specify materials with high VOC content

Previous

Mark

Next

Calculator

Review



# LEED Certification

- Maintaining LEED credential
  - Continuing education (CE) required on a 2-year cycle (beginning on the exam date)
  - LEED GA: 15 CE hours biennially (3 must be LEED specific hours)
  - LEED AP: 30 CE hours biennially (6 must be LEED specific hours) as well as additional hours for additional specialties





# LEED process

- LEED project registration and certification
  - Submit online registration form ([www.gbc.org](http://www.gbc.org))
  - Fees vary depending on project type, size
  - LEED Platinum will receive a rebate of the fees
- LEED rating system selection:
  - Building Design and Construction (BD+C)
  - Interior Design and Construction (ID+C)
  - Building Operations and Maintenance (O+M)
  - Neighborhood Development (ND)



# LEED process

- **Building Design and Construction (BD+C)**
  - New Construction and Major Renovations
  - Core and Shell Development
  - Schools
  - Retails
  - Data Centers
  - Warehouses and Distribution Centers
  - Hospitality
  - Healthcare
  - Homes and Multifamily Lowrise
  - Multifamily Midrise



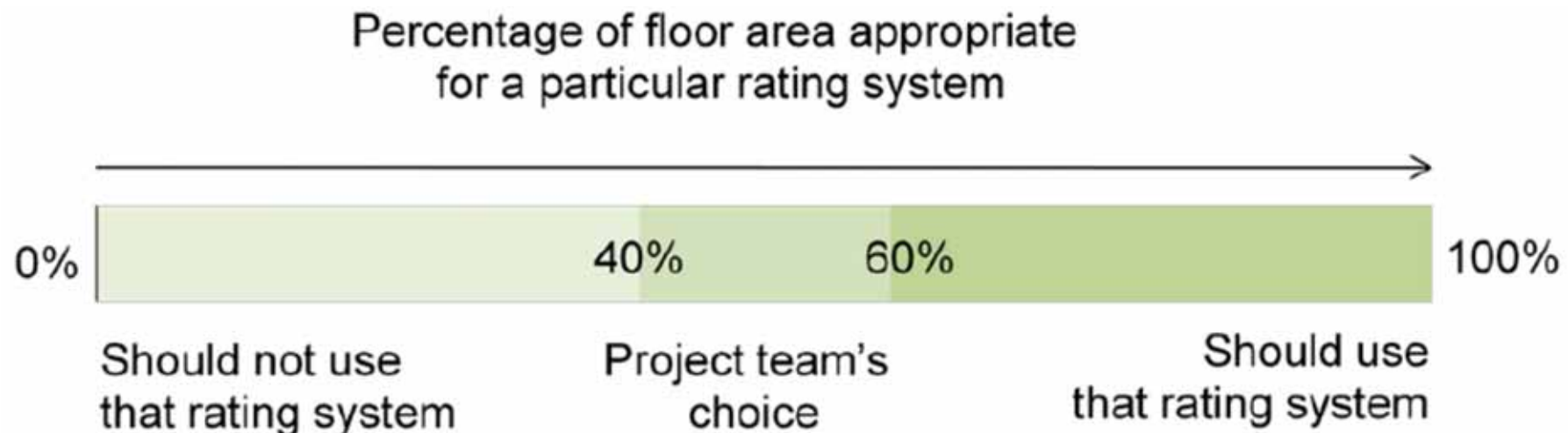
# LEED process

- Interior Design and Construction (ID+C)
  - Commercial Interiors
  - Retails
  - Hospitality
- Building Operations and Maintenance (O+M)
  - Existing Buildings
  - Retails
  - Schools
  - Hospitality
  - Data Centers
  - Warehouses & Distribution Centers



# LEED process

- **Neighborhood Development (ND)**
  - Plan (conceptual or master planning phases, or under construction)
  - Built Project
- Choosing between rating systems (**40/60 rule**)





# LEED process

- Application process
  - The project team submits LEED letter templates and other documentation for credit review and certification
  - Decision makers: the professional responsible for submitting the templates and documentation
    - Such as LEED AP, architect, building services engineer, civil engineer, commissioning authority, facility engineer, interior designer, landscape architect
  - Two phases of submission:
    - Design phase + Construction phase

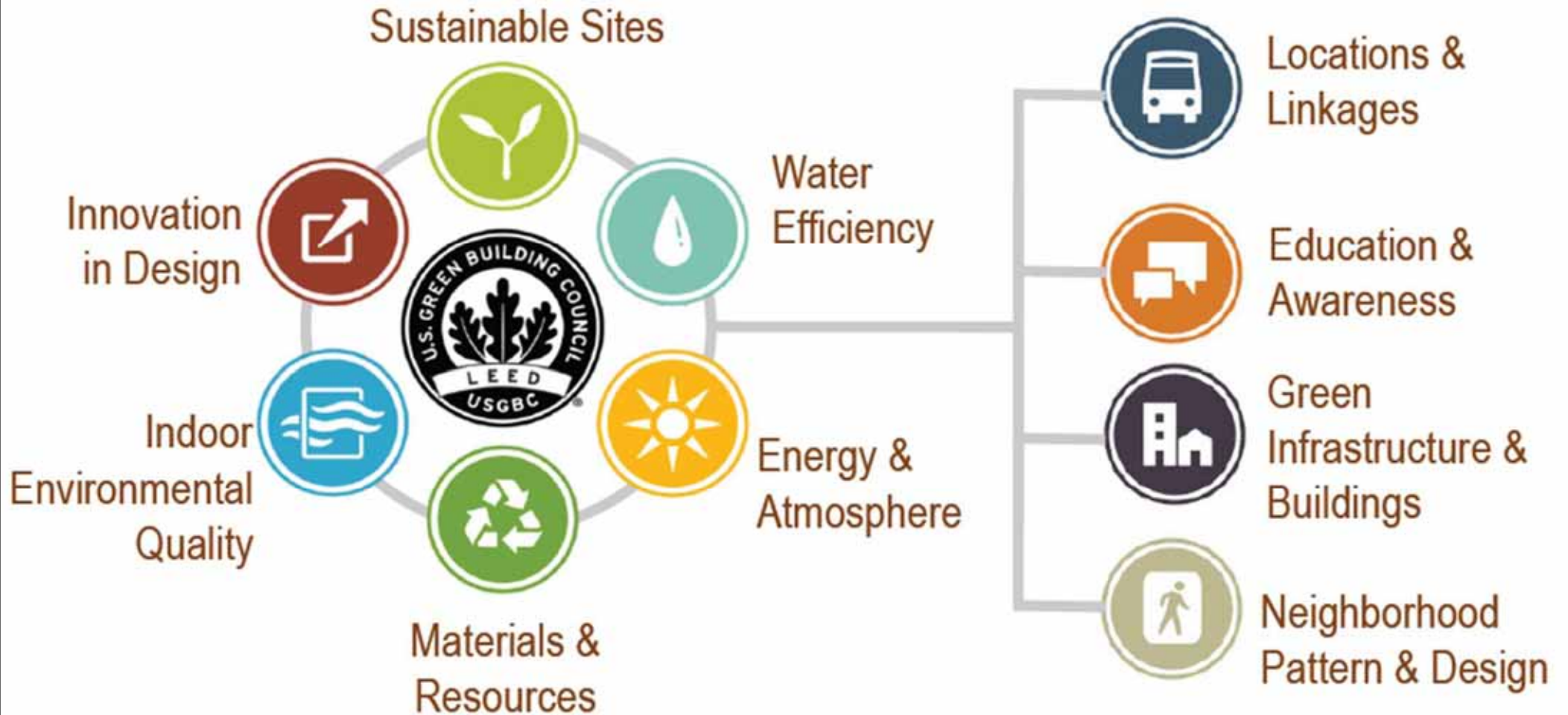


# LEED process

- **Minimum program requirements (MPRs)**
  - Define minimum characteristics that a project must possess in order to be eligible for LEED
    - Must comply with Environmental Laws
    - Must be a complete, permanent building or space
    - Must use a reasonable site boundary
    - Must comply with minimum floor area requirements
    - Must comply with minimum occupancy rates
    - Must commit to sharing whole building energy and water usage data
    - Registration & certification activity must comply with reasonable timetables



# LEED structure (LEED 2009 NC)





# LEED process

- Credits in LEED 2009 NC:
  - Sustainable Sites (**SS**)
  - Water Efficiency (**WE**)
  - Energy and Atmosphere (**EA**)
  - Materials and Resources (**MR**)
  - Indoor Environmental Quality (**IEQ**)
  - Innovation in Design (**ID**)
  - Regional Priority (**RP**)



# LEED basics – rating system example (LEED 2009-NC)

<b>Category</b>	<b>Prerequisites</b>	<b>Credits</b>	<b>Possible points</b>
Sustainable Sites (SS)	1	8	26
Water Efficiency (WE)	1	3	10
Energy & Atmosphere (EA)	3	6	35
Materials & Resources (MR)	1	7	14
Indoor Environmental Quality (EQ)	2	8	15
Innovation & Design Process (ID)	None	2	6
Regional Priority (RP)	None	1	4
<i>Totals:</i>	8	35	110



# LEED process

- Prerequisite (New Construction)
  - SSp1: Construction activity pollution prevention
  - WEp1: Water use reduction
  - EAp1: Fundamental commissioning of building energy systems
  - EAp2: Minimum energy performance
  - EAp3: Fundamental refrigerant management
  - MRp1: Storage and collection of recyclables
  - IEQp1: Minimum IAQ performance
  - IEQp2: Environmental tobacco smoke control



# LEED process

- All LEED rating systems (except LEED for homes) have 100 base points+ 6 ID+ 4RP=110 points
  - LEED for homes have 125 point scale+11ID
- LEED 2009 NC award scale:
  - Platinum 80 points and above
  - Gold 60–79 points
  - Silver 50–59 points
  - Certified 40–49 points





# LEED process

- Credit weightings
  - Based on the potential environmental impacts and human benefits of each credit with respect to a set of impact categories
- Project checklist forms
  - Determine which LEED rating system and level of certification would be best suited for the project
  - Also called LEED credit Scorecard
- Credit templates and calculators
  - Access via LEEDonline ([www.usgbc.org/leedonline](http://www.usgbc.org/leedonline))

# LEED 2009 New Construction Checklist

<b>Sustainable Sites</b>		<b>26 Possible Points</b>
<input checked="" type="checkbox"/>	Prerequisite 1 Construction Activity Pollution Prevention	Required
<input type="checkbox"/>	Credit 1 Site Selection	1
<input type="checkbox"/>	Credit 2 Development Density and Community Connectivity	5
<input type="checkbox"/>	Credit 3 Brownfield Redevelopment	1
<input type="checkbox"/>	Credit 4.1 Alternative Transportation—Public Transportation Access	6
<input type="checkbox"/>	Credit 4.2 Alternative Transportation—Bicycle Storage and Changing Rooms	1
<input type="checkbox"/>	Credit 4.3 Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
<input type="checkbox"/>	Credit 4.4 Alternative Transportation—Parking Capacity	2
<input type="checkbox"/>	Credit 5.1 Site Development—Protect or Restore Habitat	1
<input type="checkbox"/>	Credit 5.2 Site Development—Maximize Open Space	1
<input type="checkbox"/>	Credit 6.1 Stormwater Design—Quantity Control	1
<input type="checkbox"/>	Credit 6.2 Stormwater Design—Quality Control	1
<input type="checkbox"/>	Credit 7.1 Heat Island Effect—Nonroof	1
<input type="checkbox"/>	Credit 7.2 Heat Island Effect—Roof	1
<input type="checkbox"/>	Credit 8 Light Pollution Reduction	1
<b>Water Efficiency</b>		<b>10 Possible Points</b>
<input checked="" type="checkbox"/>	Prerequisite 1 Water Use Reduction	Required
<input type="checkbox"/>	Credit 1 Water Efficient Landscaping	2-4
<input type="checkbox"/>	Credit 2 Innovative Wastewater Technologies	2
<input type="checkbox"/>	Credit 3 Water Use Reduction	2-4

(Source: USGBC)

# LEED 2009 New Construction Checklist (cont'd)

## Energy and Atmosphere

35 Possible Points

<input checked="" type="checkbox"/>	Prerequisite 1	Fundamental Commissioning of Building Energy Systems	Required
<input checked="" type="checkbox"/>	Prerequisite 2	Minimum Energy Performance	Required
<input checked="" type="checkbox"/>	Prerequisite 3	Fundamental Refrigerant Management	Required
<input type="checkbox"/>	Credit 1	Optimize Energy Performance	1-19
<input type="checkbox"/>	Credit 2	On-site Renewable Energy	1-7
<input type="checkbox"/>	Credit 3	Enhanced Commissioning	2
<input type="checkbox"/>	Credit 4	Enhanced Refrigerant Management	2
<input type="checkbox"/>	Credit 5	Measurement and Verification	3
<input type="checkbox"/>	Credit 6	Green Power	2

## Materials and Resources

14 Possible Points

<input checked="" type="checkbox"/>	Prerequisite 1	Storage and Collection of Recyclables	Required
<input type="checkbox"/>	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors and Roof	1-3
<input type="checkbox"/>	Credit 1.2	Building Reuse—Maintain Existing Interior Nonstructural Elements	1
<input type="checkbox"/>	Credit 2	Construction Waste Management	1-2
<input type="checkbox"/>	Credit 3	Materials Reuse	1-2
<input type="checkbox"/>	Credit 4	Recycled Content	1-2
<input type="checkbox"/>	Credit 5	Regional Materials	1-2
<input type="checkbox"/>	Credit 6	Rapidly Renewable Materials	1
<input type="checkbox"/>	Credit 7	Certified Wood	1



# LEED 2009 New Construction Checklist (cont'd)

Indoor Environmental Quality		15 Possible Points
<input checked="" type="checkbox"/>	Prerequisite 1 Minimum Indoor Air Quality Performance	Required
<input checked="" type="checkbox"/>	Prerequisite 2 Environmental Tobacco Smoke (ETS) Control	Required
<input type="checkbox"/>	Credit 1 Outdoor Air Delivery Monitoring	1
<input type="checkbox"/>	Credit 2 Increased Ventilation	1
<input type="checkbox"/>	Credit 3.1 Construction Indoor Air Quality Management Plan—During Construction	1
<input type="checkbox"/>	Credit 3.2 Construction Indoor Air Quality Management Plan—Before Occupancy	1
<input type="checkbox"/>	Credit 4.1 Low-Emitting Materials—Adhesives and Sealants	1
<input type="checkbox"/>	Credit 4.2 Low-Emitting Materials—Paints and Coatings	1
<input type="checkbox"/>	Credit 4.3 Low-Emitting Materials—Flooring Systems	1
<input type="checkbox"/>	Credit 4.4 Low-Emitting Materials—Composite Wood and Agrifiber Products	1
<input type="checkbox"/>	Credit 5 Indoor Chemical and Pollutant Source Control	1
<input type="checkbox"/>	Credit 6.1 Controllability of Systems—Lighting	1
<input type="checkbox"/>	Credit 6.2 Controllability of Systems—Thermal Comfort	1
<input type="checkbox"/>	Credit 7.1 Thermal Comfort—Design	1
<input type="checkbox"/>	Credit 7.2 Thermal Comfort—Verification	1
<input type="checkbox"/>	Credit 8.1 Daylight and Views—Daylight	1
<input type="checkbox"/>	Credit 8.2 Daylight and Views—Views	1
Innovation in Design		6 Possible Points
<input type="checkbox"/>	Credit 1 Innovation in Design	1-5
<input type="checkbox"/>	Credit 2 LEED Accredited Professional	1
Regional Priority		4 Possible Points
<input type="checkbox"/>	Credit 1 Regional Priority	1-4

(Source: USGBC)



# LEED process

- LEED Pilot Credit Library
  - <http://www.usgbc.org/leed/tools/pilot-credits>
  - To test new and revised LEED credit language, alternative compliance paths, and new or innovative green building technologies and concepts
  - LEED project teams may pursue an unlimited number of pilot credits, however points awarded is limited by the number of Innovation credits available (up to 5 for LEED 2009 projects)



# LEED process

- EAp2: Minimum energy performance
  - **Intent:** Establish the minimum level of energy efficiency for the proposed building and systems
  - **Requirements:** Mandatory provisions of ASHRAE 90.1 and
    - Prescriptive requirements of 90.1 **or**
    - Performance requirements of 90.1 Section 11 (Energy Cost Budget Method) **or**
    - The requirements in the local energy code, whichever is more stringent

# ASHRAE 90.1 compliance approaches

## Building System

## Compliance Options

Envelope

HVAC

SWH

Power

Lighting

Other

**Mandatory Provisions**  
(required for most compliance options)

Prescriptive Option

Trade Off Option

Energy Cost Budget

Simplified

**Energy Code Compliance**



# LEED process

- **EAc1: Optimize energy performance**
  - **Intent:** Achieve increasing levels of energy performance above the baseline in the prerequisite standard to reduce environmental impacts associated with excessive energy use
  - **Requirements:** Awards points for improving performance rating of the design building vs. baseline building as per ASHRAE Standard 90.1 (Appendix G) [1 to 19 points]

# EAc1: Optimize energy performance (Up to 19 points)

<b>New Buildings</b>	<b>Existing Building Renovations</b>	<b>Points</b>
<b>12%</b>	<b>8%</b>	<b>1</b>
<b>14%</b>	<b>10%</b>	<b>2</b>
<b>16%</b>	<b>12%</b>	<b>3</b>
<b>18%</b>	<b>14%</b>	<b>4</b>
<b>20%</b>	<b>16%</b>	<b>5</b>
<b>22%</b>	<b>18%</b>	<b>6</b>
<b>24%</b>	<b>20%</b>	<b>7</b>
<b>26%</b>	<b>22%</b>	<b>8</b>
<b>28%</b>	<b>24%</b>	<b>9</b>
<b>30%</b>	<b>26%</b>	<b>10</b>
<b>32%</b>	<b>28%</b>	<b>11</b>
<b>34%</b>	<b>30%</b>	<b>12</b>
<b>36%</b>	<b>32%</b>	<b>13</b>
<b>38%</b>	<b>34%</b>	<b>14</b>
<b>40%</b>	<b>36%</b>	<b>15</b>
<b>42%</b>	<b>38%</b>	<b>16</b>
<b>44%</b>	<b>40%</b>	<b>17</b>
<b>46%</b>	<b>42%</b>	<b>18</b>
<b>48%</b>	<b>44%</b>	<b>19</b>



# LEED process

- Guide books:\*
  - Montoya, M., 2011. *Green Building Fundamentals: A Practical Guide to Understanding and Applying Fundamental Sustainable Construction Practices and the LEED System*, 2nd ed., Prentice Hall, Upper Saddle River, N.J. [720.47 M798 g79]
  - Kubba, S., 2010. *LEED Practices, Certification, and Accreditation Handbook*, Butterworth-Heinemann/Elsevier, Burlington, MA. [720.47 K954 148](ebook)

(\* See also the References list on lecture outline)



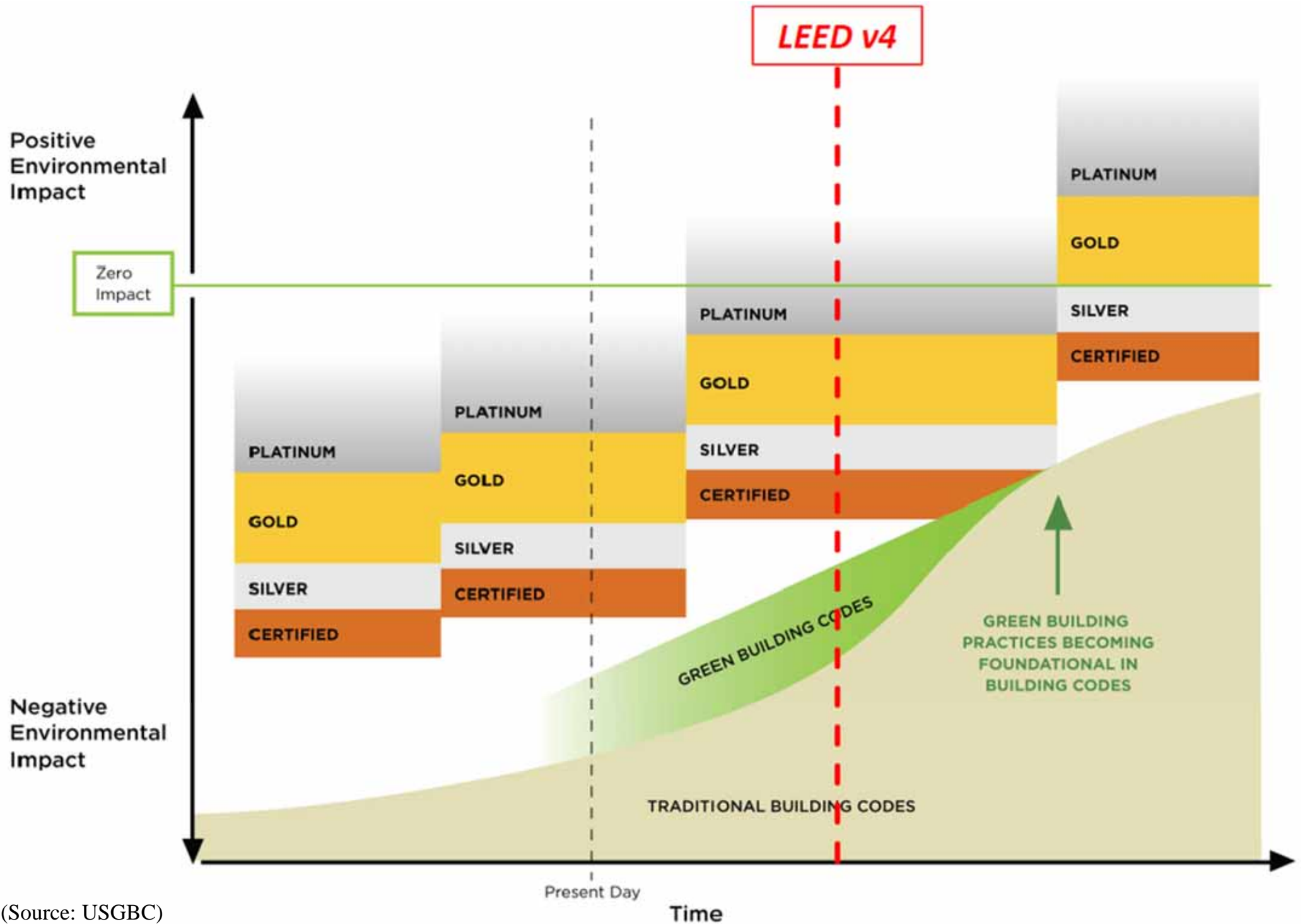


# LEED v4

- Changes in the LEED v4:
  - Global focus
    - SI units
    - Alternative compliance paths
  - New and more stringent prerequisites and credits
  - Online credit library
    - <http://www.usgbc.org/credits>
  - Market sector language
    - Different rating systems for different building types
  - Link with LEED ND




# LEED v4: A shift in focus, deeper transformation



(Source: USGBC)

# Video Presentation



- LEED® v4 Certification (3:10)
  - <http://www.youtube.com/watch?v=xHnlnXt9Td8>
  - A comprehensive update for LEED and a radical jump forward for the green building rating system
  - Major changes in LEED v4: 
    - Integrative Process
    - Location & Transportation
    - Materials & Resources (life cycle thinking, product transparency, environmental product declarations EPDs, health product declarations HPDs)
    - Other changes on Sites, Water, Energy and IEQ



# LEED v4 for BD+C: New Construction and Major Renovation

## Project Checklist

Project Name

Date

<b>Integrative Process</b>		<b>1</b>
Credit 1	Integrative Process	1

<b>Location and Transportation</b>		<b>16</b>
Credit 1	LEED for Neighborhood Development Location	16
Credit 2	Sensitive Land Protection	1
Credit 3	High Priority Site	2
Credit 4	Surrounding Density and Diverse Uses	5
Credit 5	Access to Quality Transit	5
Credit 6	Bicycle Facilities	1
Credit 7	Reduced Parking Footprint	1
Credit 8	Green Vehicles	1

<b>Sustainable Sites</b>		<b>10</b>
Y	Prereq 1 Construction Activity Pollution Prevention	Required
	Credit 1 Site Assessment	1
	Credit 2 Site Development--Protect or Restore Habitat	2
	Credit 3 Open Space	1
	Credit 4 Rainwater Management	3
	Credit 5 Heat Island Reduction	2
	Credit 6 Light Pollution Reduction	1

<b>Water Efficiency</b>		<b>11</b>
Y	Prereq 1 Outdoor Water Use Reduction	Required
Y	Prereq 2 Indoor Water Use Reduction	Required
Y	Prereq 3 Building-Level Water Metering	Required
	Credit 1 Outdoor Water Use Reduction	2
	Credit 2 Indoor Water Use Reduction	6
	Credit 3 Cooling Tower Water Use	2
	Credit 4 Water Metering	1

<b>Energy and Atmosphere</b>		<b>33</b>
Y	Prereq 1 Fundamental Commissioning and Verification	Required
Y	Prereq 2 Minimum Energy Performance	Required
Y	Prereq 3 Building-Level Energy Metering	Required
Y	Prereq 4 Fundamental Refrigerant Management	Required
	Credit 1 Enhanced Commissioning	6
	Credit 2 Optimize Energy Performance	18
	Credit 3 Advanced Energy Metering	1
	Credit 4 Demand Response	2
	Credit 5 Renewable Energy Production	3

<b>Energy and Atmosphere Continued</b>		
	Credit 6 Enhanced Refrigerant Management	1
	Credit 7 Green Power and Carbon Offsets	2

<b>Materials and Resources</b>		<b>13</b>
Y	Prereq 1 Storage and Collection of Recyclables	Required
Y	Prereq 2 Construction and Demolition Waste Management Planning	Required
	Credit 1 Building Life-Cycle Impact Reduction	5
	Credit 2 Building Product Disclosure and Optimization - Environmental Product Declarations	2
	Credit 3 Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
	Credit 4 Building Product Disclosure and Optimization - Material Ingredients	2
	Credit 5 Construction and Demolition Waste Management	2

<b>Indoor Environmental Quality</b>		<b>16</b>
Y	Prereq 1 Minimum Indoor Air Quality Performance	Required
Y	Prereq 2 Environmental Tobacco Smoke Control	Required
	Credit 1 Enhanced Indoor Air Quality Strategies	2
	Credit 2 Low-Emitting Materials	3
	Credit 3 Construction Indoor Air Quality Management Plan	1
	Credit 4 Indoor Air Quality Assessment	2
	Credit 5 Thermal Comfort	1
	Credit 6 Interior Lighting	2
	Credit 7 Daylight	3
	Credit 8 Quality Views	1
	Credit 9 Acoustic Performance	1

<b>Innovation</b>		<b>6</b>
	Credit 1.1 Innovation	1
	Credit 1.2 Innovation	1
	Credit 1.3 Innovation	1
	Credit 1.4 Innovation	1
	Credit 1.5 Innovation	1
	Credit 2 LEED Accredited Professional	1



<b>Regional Priority</b>		<b>4</b>
	Credit 1 Regional Priority: Specific Credit	1
	Credit 2 Regional Priority: Specific Credit	1
	Credit 3 Regional Priority: Specific Credit	1
	Credit 4 Regional Priority: Specific Credit	1

<b>Total</b>		<b>110</b>
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(Source: USGBC)

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

# LEED 2009 vs. LEED v4

Category	LEED 2009	%	Category	LEED v4	%
N/A	0	0%	Integrative Design 	1	1%
Sustainable Sites	26	24%	Location & Transport 	16	15%
			Sustainable Sites	10	9%
Water Efficiency	10	9%	Water Efficiency	11	10%
Energy & Atmosphere	35	32%	Energy & Atmosphere	33	30%
Materials & Resources	14	13%	Materials & Resources	13	12%
Indoor Environmental Quality	15	14%	Indoor Environmental Quality	16	15%
Innovation	6	5%	Innovation	6	5%
Regional Priority	4	4%	Regional Priority	4	4%
<b>Total</b>	<b>110</b>			<b>110</b>	



# LEED v4

- Integrative Process



- Requires team to analyse opportunities for water and energy savings early in design (1 pt)
- Requires iterative energy modelling
- Requires water budget

- Location & Transportation



- Changes Sustainable Site credit points and introduce new credits, e.g.
  - Select a LEED ND certified site (1 pt)
  - Access to quality transit (5 pts)
  - Green vehicles (1 pt)



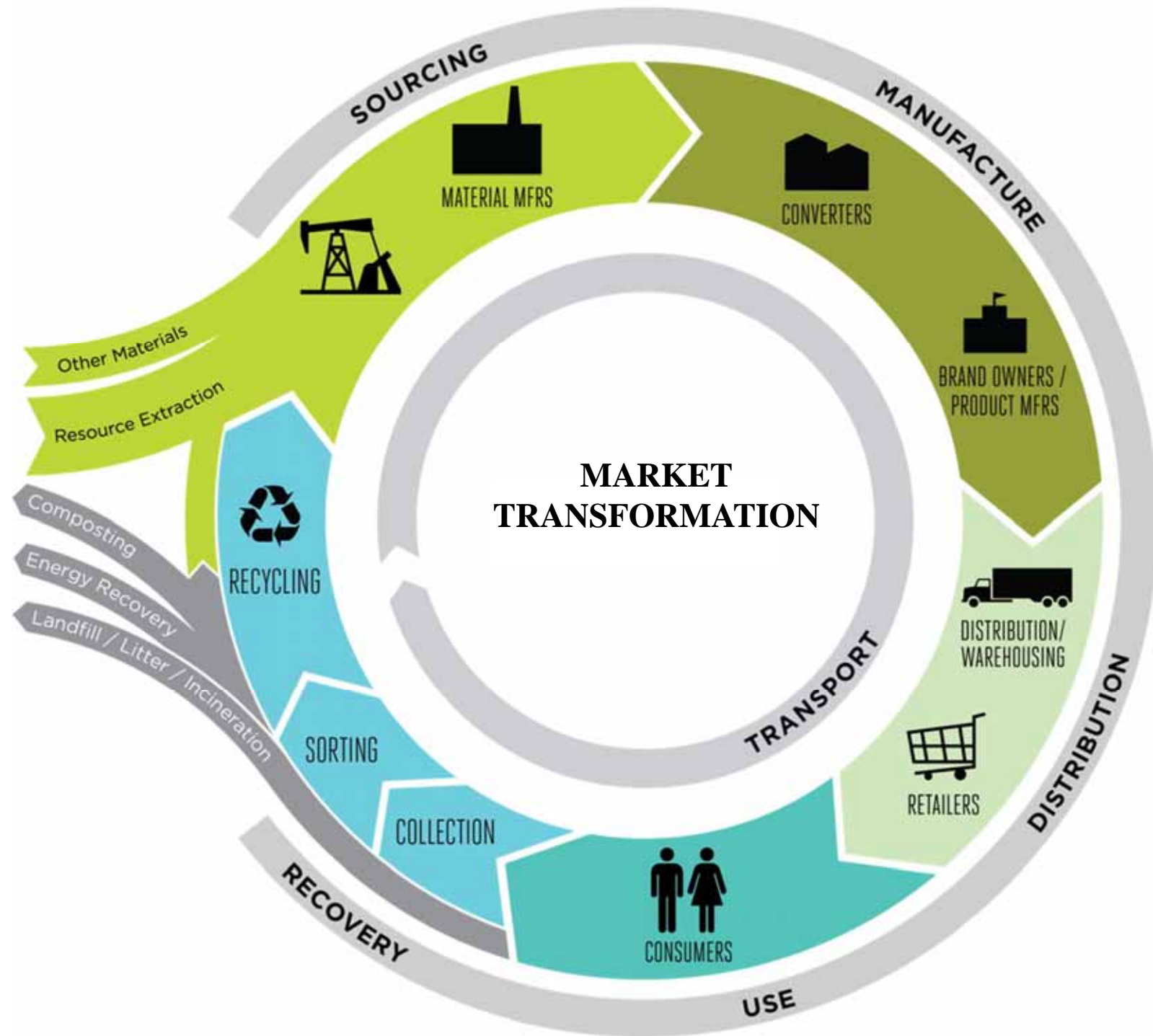
# LEED v4

- Materials & Resources



- New prerequisite:
  - Construction & demolition waste management planning
- New credits:
  - Building life-cycle impact reduction (5 pts)
  - Building product disclosure and optimization – environmental product declarations (2 pts)
  - Building product disclosure and optimization – sources of raw materials (2 pts)
  - Building product disclosure and optimization – material ingredients (2 pts)

# LEED v4 focuses on market transformation of the manufacturing industry





# LEED v4

- Sustainable Sites



- New credits, e.g.
  - Site assessment (1 pt)
  - Rainwater management (3 pts)

- Water Efficiency



- New prerequisites:
  - Outdoor water use reduction
  - Building-level water metering
- New credits:
  - Cooling tower water use (2 pts)
  - Water metering (1 pt)





# LEED v4

- Energy and Atmosphere



- New prerequisites:

- Building-level energy metering

- New credits:

- Advanced energy metering (1 pt)
- Demand response (2 pts)

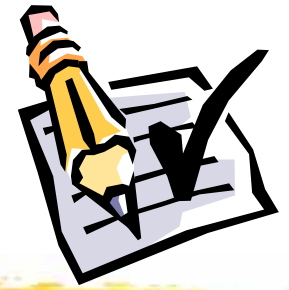
- Indoor Environmental Quality



- New credit:

- Acoustic performance (1 pt)

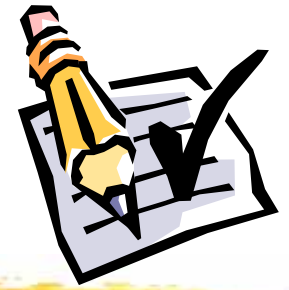
# Key factors to consider



- Passive design
  - Taking advantage of the sun and wind
- Regenerative Projects
  - Support the health, generate electricity and send back to the grid. Its goal to achieve “net zero”
- The triple bottom line
  - People (Social)
  - Planet (Environmental)
  - Profit (Economic)



# Key factors to consider

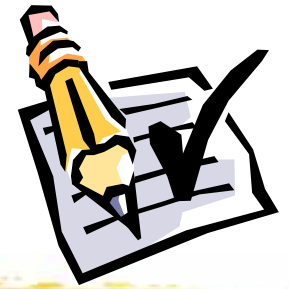


- Sustainable sites



- Develop only on appropriate sites
- Provide for non-auto access
- Preserve open space
- Manage stormwater
- Reduce urban heat island effect
- Reduce light pollution of the night sky

# Key factors to consider



- Water conservation



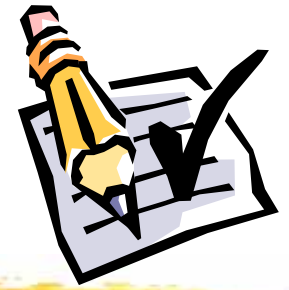
- Reduce use of potable water for irrigation and for building water use and sewage conveyance

- Energy efficiency and atmosphere protection



- Reduce building energy use
- Use less harmful chemicals for refrigerants
- Generate renewable energy on-site
- Provide for ongoing energy savings
- Purchase green power for project use

# Key factors to consider

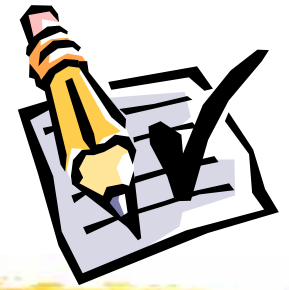



- Materials and resource conservation



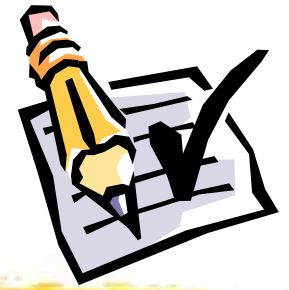
- Provide for recycling
- Reuse existing buildings
- Reduce construction waste generation
- Use salvaged and recycled content materials
- Source materials regionally
- Use rapidly renewable (agricultural) materials and certified wood products


# Key factors to consider



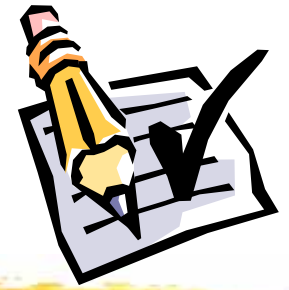
- Indoor environmental quality 
  - Improve indoor air quality
  - Increase outside air ventilation
  - Manage air quality during construction
  - Use only nontoxic quality finishes, carpets, and composite wood products
  - Reduce exposure to toxic chemicals during building operations
  - Provide for individual comfort control
  - Maintain thermal comfort standards

# Key factors to consider



- Indoor environmental quality (cont'd)
  - Provide daylighting and views to the outdoors
- Encourage innovation and integrated design 
  - Provide for exemplary performance above LEED standards and encourage other innovations
  - Use accredited professionals on the design team

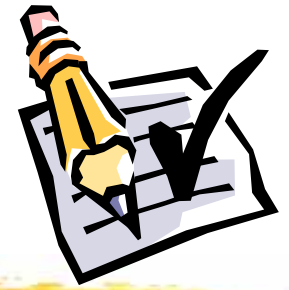
# Key factors to consider



- Disadvantages of LEED:
  - It is expensive (add 4-7% to construction cost)
  - The process is driven by scoring points and not designing sustainable buildings for a particular site and use
  - LEED stifles the creative process by providing strict guidelines on what to build
  - There is a lot of discrepancy about the weight of certain credits (e.g. bike rack)
  - It promotes green building that, in some cases is not actually 'green'

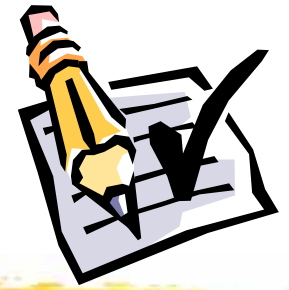


# Key factors to consider



- LEED criticism:
  - Benefits
    - Raises consciousness of owners
    - Encourages integrated design
    - Facilitates discussions about the benefit of environmentally preferable building design strategies
    - Easily navigated; accessible to all building professionals
    - Constantly re-examined and updated

# Key factors to consider



- LEED criticism: (cont'd)
  - Limitations
    - Equivalent point values are given to non-equivalent design strategies and improvements
    - Often reduced to a point optimization process
    - Evaluation mechanisms are often overly simplified and therefore misleading
    - Can only gain points for doing good, never lose points for inflicting harm
    - Chasing a high performance score may constrain green design

# Green building measures



- Typical green building measures
  - Solar photovoltaic systems
  - High-efficiency ventilation and underfloor air distribution systems
  - Operable windows and greater control over thermal comfort by occupants
  - Native plants to restore sites
  - Certified wood products
  - Rapidly renewable materials such as cork and bamboo flooring

# Green building measures



- Most commonly used measures
  - Low-VOC-content paints, coatings, adhesives, sealants
  - Low-VOC-emitting carpeting
  - 10% or more recycled-content materials
  - Views to the outdoors from 90% or more of spaces
  - Two innovation points such as public education, extra water conservation, or higher levels of construction waste recycling

# Green building measures



- Commonly used measures
  - Two-week building flushout prior to occupancy
  - CO<sub>2</sub> monitoring to improve outside air ventilation
  - Bioswales, detention/retention ponds, and other stormwater control measures
  - Green roofs or reflective roofs
  - Construction-period indoor air quality best management practices
  - Permanent temp. and humidity monitoring system
  - Daylighting for at least 75% of spaces

# Green building measures



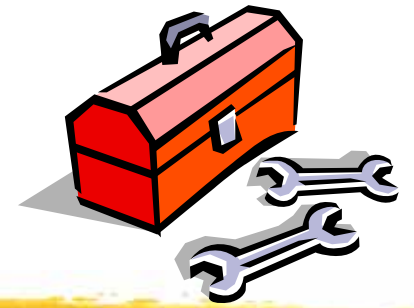
- Commonly used measures (cont'd)
  - Cutoff light fixtures and lower outdoor ambient lighting levels to control light trespass from site
  - Water-conserving fixtures and waterfree urinals
  - At least a 35% energy use reduction over conventional buildings
  - Additional building commissioning, with peer review of design documents
  - Purchased green power for at least two years
  - No added urea-formaldehyde in composite wood or agri-fiber products

# Green building measures



- Cost impacts of the measures depend on:
  - Level of LEED certification sought
  - Stage of the project when seek certification
  - Project type
  - Experience of the design and construction teams in sustainable design and green buildings
  - Types of green technologies involved
  - Level of direction from the owner
  - Geographic location and climate

# LEED technical analysis

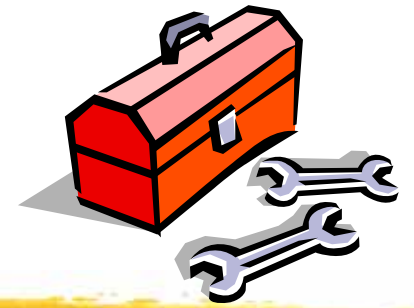


- Standards referenced by LEED, such as
  - ASHRAE Standards
    - 90.1: Building energy conservation
    - 62.1: Indoor air quality
    - 55: Thermal comfort
    - 52: Testing of air-cleaning devices
  - ANSI Standards (e.g. E779-03 for air leakage rate)
  - IESNA (lighting credits for ASHRAE 90.1)
  - ASTM Standards
  - U.S. Code of Federal Regulations (CFR)



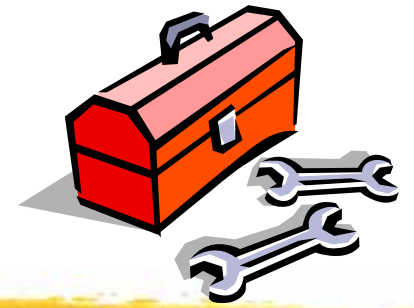


# LEED technical analysis



- Related agencies:
  - U.S. Department of Energy ([www.doe.gov](http://www.doe.gov))
  - U.S. Environmental Protection Agency ([www.epa.gov](http://www.epa.gov))
- Modelling, simulation and calculation are needed and they are quite complex
- Some calculations are built in the LEED letter templates

# LEED technical analysis

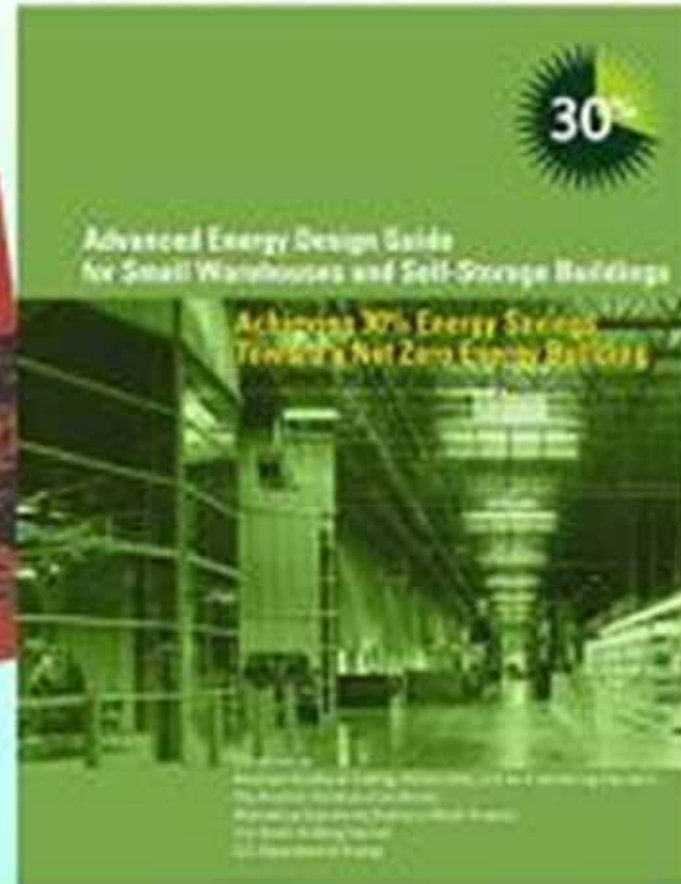
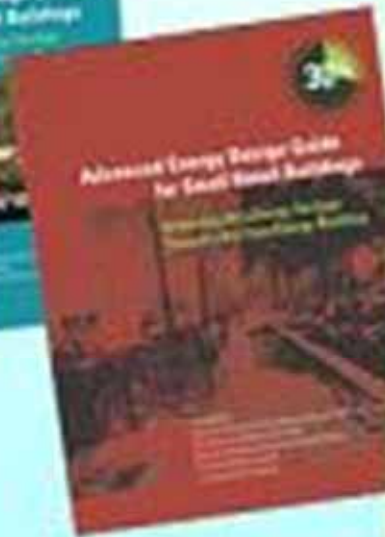
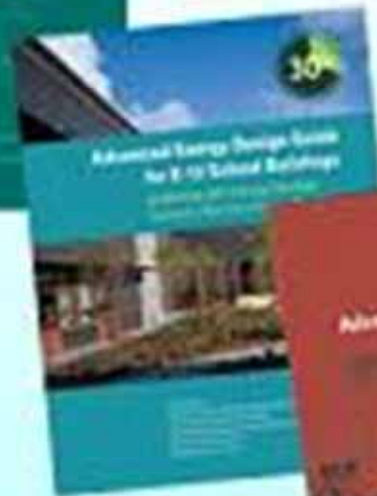


- Advanced Energy Design Guides
  - Developed by ASHRAE, USGBC, AIA
  - Free for download at [www.ashrae.org/freeaedg](http://www.ashrae.org/freeaedg)
    - Small warehouses and self-storage buildings
    - Small office buildings
    - Small retail buildings
    - K-12 school buildings
  - Energy savings target of 30% (the first step in the process toward achieving a ZEB)

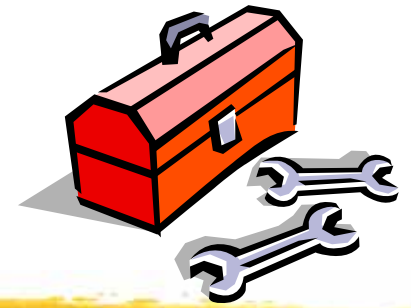
# Advanced Energy Design Guides

[www.ashrae.org/freeaedg](http://www.ashrae.org/freeaedg)

**Now Available for Free  
Download from ASHRAE**



# LEED technical analysis



- New ASHRAE Standard 189.1: Design of High-Performance Green Buildings
  - Developed by ASHRAE, USGBC and IESNA
  - A total building sustainability package
  - The first code-intended commercial green building standard in USA
  - It covers key topic areas similar to LEED
  - Further information:
    - [www.ashrae.org/greenstandard](http://www.ashrae.org/greenstandard)





# ASHRAE 189.1

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- 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 Preview

[www.ashrae.org/greenstandard](http://www.ashrae.org/greenstandard)



Knowledge is power.  
Understanding is power<sup>2</sup>.





# ASHRAE Standard 189.1

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- 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)



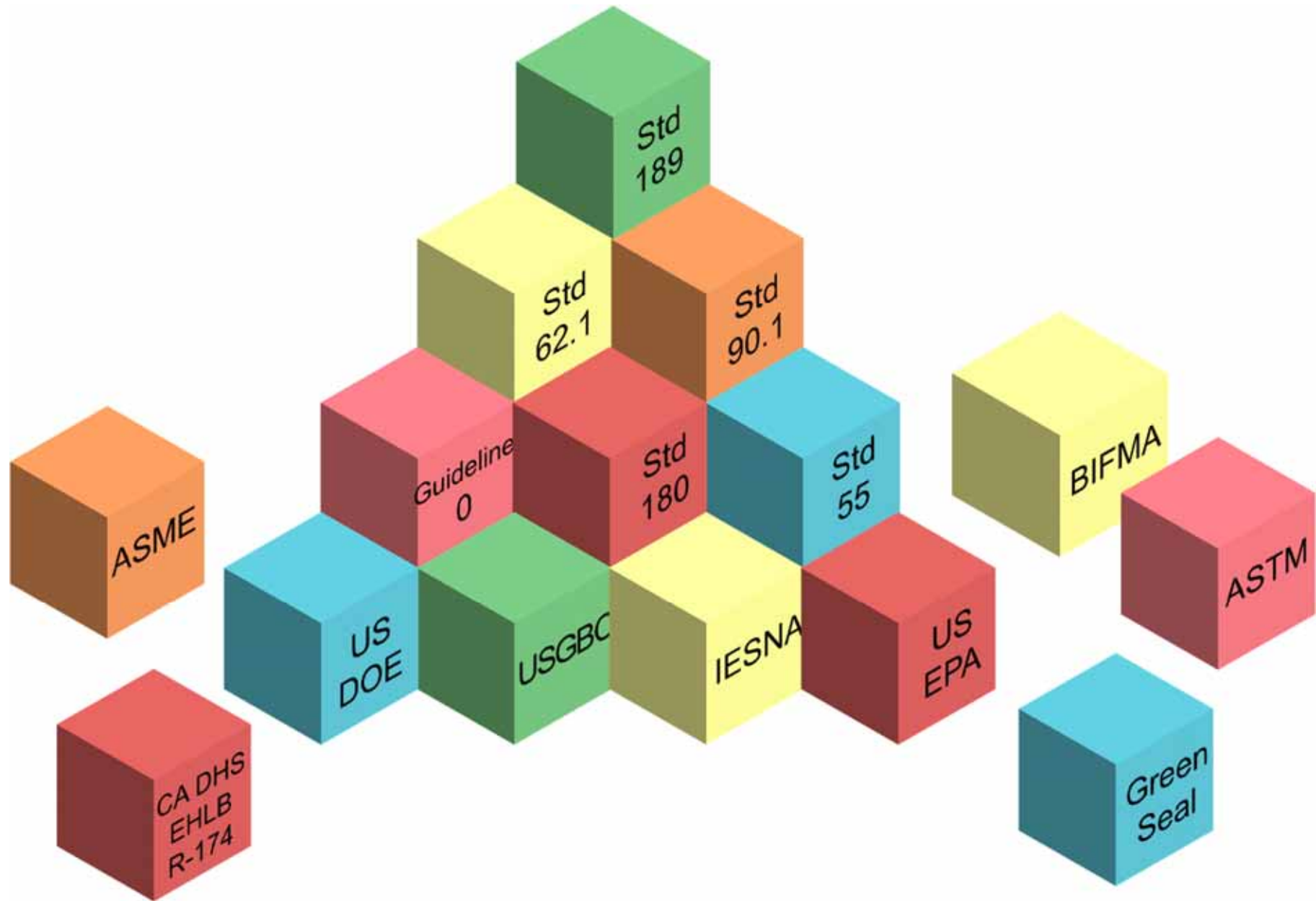
# ASHRAE Standard 189.1

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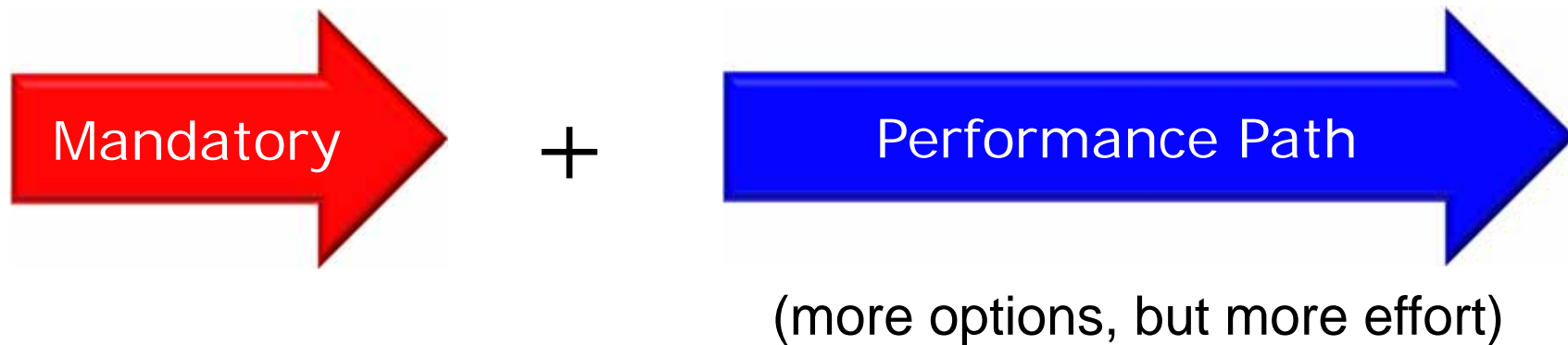
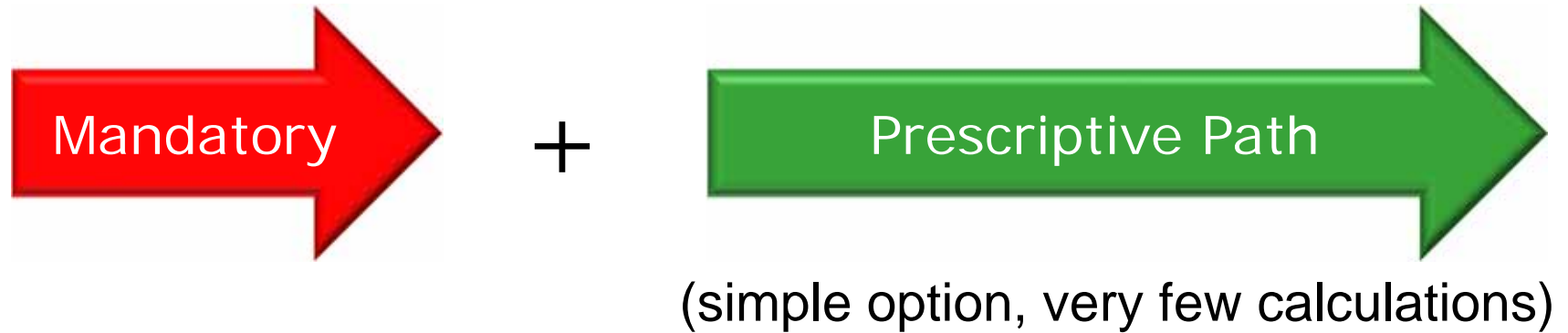
- Goals for Standard 189.1
  - Establish mandatory criteria in all topic areas
    - One “challenge” is existing green building rating systems contain few mandatory provisions
  - Provide simple prescriptive compliance options
  - Provide flexible performance compliance options
  - Complement green building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



# Standard 189.1 building blocks



# Compliance paths of Standard 189.1





# ASHRAE Standard 189.1

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- 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 trespass limits





# ASHRAE Standard 189.1

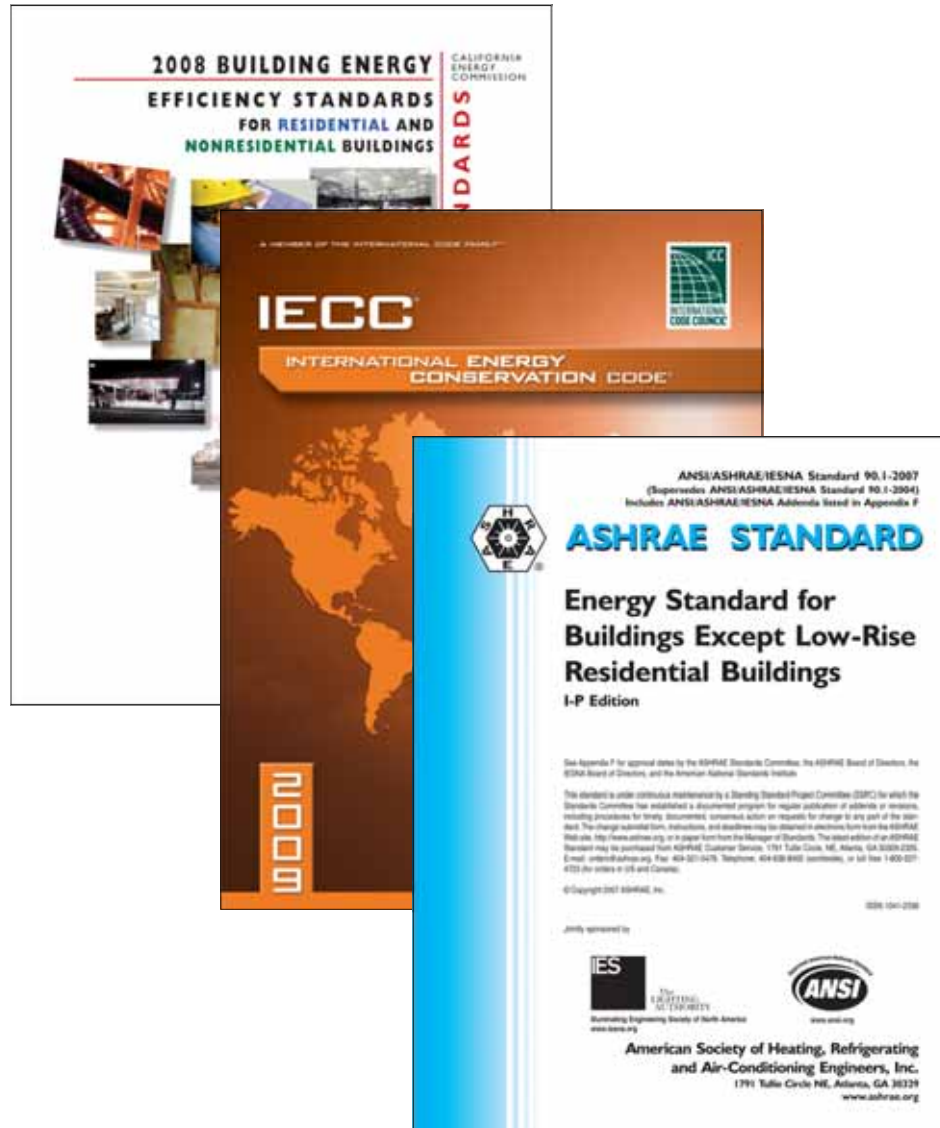
## • Water Use Efficiency Highlights

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
- HVAC Systems, equipment
- Water consumption management



# Building Energy Codes (e.g. ASHRAE 90.1)



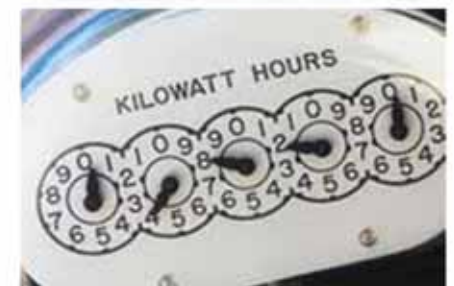


# ASHRAE Standard 189.1

- 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
  - Remote or automatic reading meters





# 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







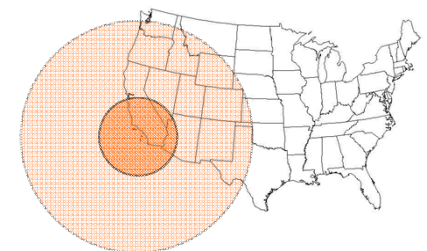
# ASHRAE Standard 189.1

- The Building's Impact on the Atmosphere

MR

## Highlights

- Construction waste management
- Reduced impact materials
- Wood products
- Refrigerants (no CFC)
- Storage and collection of recyclables and discarded goods



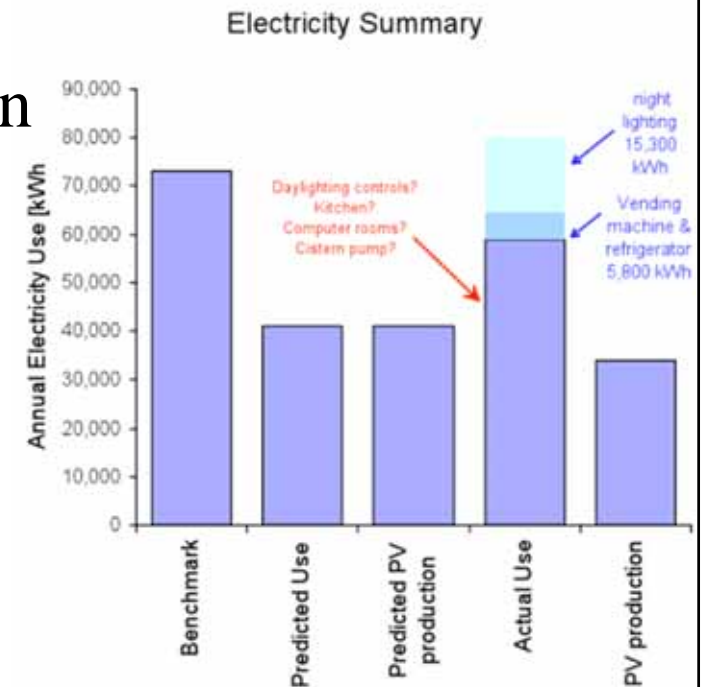


# ASHRAE Standard 189.1

- Construction and Operation Highlights

CO

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





# Further Reading

- Hong Kong Green Building City Market Brief
  - <http://www.usgbc.org/resources/hong-kong-green-building-city-market-brief>
- Review and Critique of LEED
  - <http://ecobrooklyn.com/review-critique-lead/>
- USGBC, 2014. *LEED v4 for Building Design and Construction*, Updated July 1, 2014, U.S. Green Building Council (USGBC), Washington, DC. [[PDF](#)]



# Useful Websites

- US Green Building Council (GBC)

<http://www.usgbc.org>

- Guide to LEED Certification: Commercial  
<http://www.usgbc.org/cert-guide/commercial>
- LEED <http://www.usgbc.org/leed>
- LEED v4 <http://www.usgbc.org/leed/v4>
- LEED Online [www.usgbc.org/leedonline](http://www.usgbc.org/leedonline)
- LEED Projects <http://www.usgbc.org/projects>
- LEED People <http://www.usgbc.org/people>
- LEED Pilot credits <http://www.usgbc.org/leed/tools/pilot-credits>



# Useful Websites

- LEED projects -- examples:
  - Patagonia's Reno Service Center (5.8 min.)
    - <http://www.youtube.com/watch?v=-3KPlk34DZ0>
  - PBS&J University of Texas LEED Certified Building (2.8 min.)
    - <http://www.youtube.com/watch?v=e7OoVhRMnS0>
  - Honda's Green Buildings (10.4 min.)
    - <http://www.youtube.com/watch?v=pNOB4LS8W7Y>