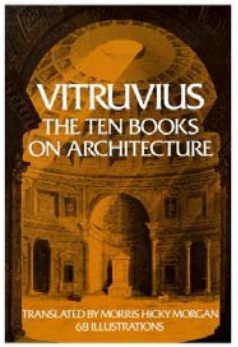
Quantifying Sustainable Design: Introduction to LEED ™

A short history on rating systems:

Architects have been attempting to arrive at a no-fail formula for “good design” for more than 2000 years:



- Vitruvius, The Ten Books of Architecture, 80 C
- Palladio, The Four Books of Architecture, c. 1
- Serlio, The Five Books of Architecture, c. 150C
- Rondelet, Dictionary of Architecture and Construction, c. 1790
- Durand, Precis de Lecons, c. 1800
- etc.

The need to “quantify” sustainable design...

- Architects are becoming increasingly aware of the need for concern about the negative impact that buildings have on our environment.
- The broad question (1987-1999) was: “What is sustainable design?”
- The more refined question (2000 -) is: “How green is it?”
- When working to both create and *market* sustainable design, it is increasingly important to be able to make definitive assessments so that proposals may be *quantified* and *compared*.
- And in 2010, “How much is your CO_2 impact?”

Different tools have been developed to assist with the ability to "quantify" and "compare" the greenness of buildings:

Assessment tools that address the WHOLE building:

BREEAM: **B**uilding **R**esearch **E**stablishment **E**nvironmental **A**ssessment **M**ethod from British Research Establishment in the UK

BREEAM/Green Leaf: variation on tool

Green Leaf™ Eco-Rating Program

Green Globes: BREEAM developed "on-line" tool that provides for an inexpensive ($250) assessment (rules similar to LEED)

GBTool: Developed in Canada by Green Building Challenge (GBC) very comprehensive, most detailed, but complicated to use

LEED™: Assessment tool developed by the USGBC

Others - more specialized, less widely utilized

ENERGY STAR® Label for Buildings

EPA United States Environmental Protection Agency

Assessment tools that address embodied energy:

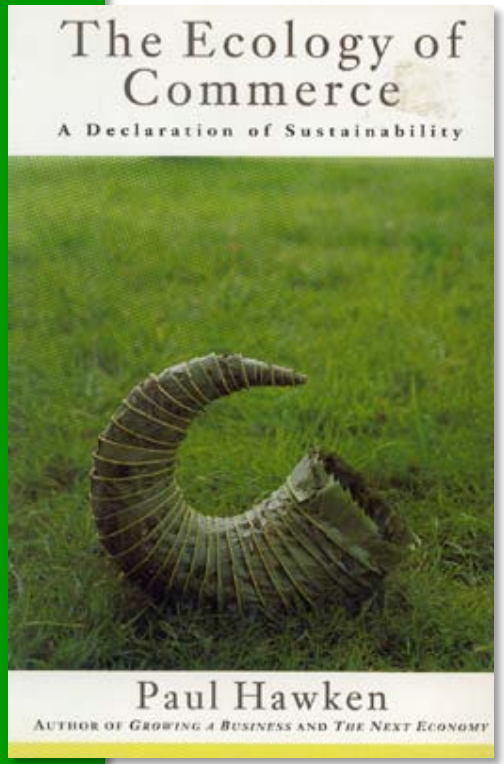
Athena: Canadian developed embodied energy assessment

http://www.athenasmi.ca/

ENVest: UK developed embodied energy assessment

http://envestv2.bre.co.uk/

Embodied energy is the energy used to mine, manufacture and transport products – take them from their "raw state" and bring them to the building site.



Paul Hawken's influential book, "*The Ecology of Commerce: A Declaration of Sustainability*" was published in 1993, where he unequivocally states that:

"Business people must either dedicate themselves to transforming commerce to a restorative undertaking, or march society to the undertaker…Quite simply, our business practices are destroying life on earth."

Therefore the Major Objectives last year *were*:

- energy efficient building
  - think use of power to heat, cool and light the building
  - think embodied energy which is the energy needed to produce the materials, transport them to the site and install them
- minimize use of non-renewable materials
- make buildings durable so that their parts last a long time to limit replacement costs (both $ and environmental)
- *minimize* CO^2 and other noxious emissions (Kyoto)
- minimize the negative impact on the site and environment

And the new objectives 2011/12 ARE:

- Design to be **CARBON NEUTRAL**
  - website of www.architecture2030.org
- Design for **ZERO WASTE** (looking at Cradle 2 Cradle concept)
  - Waste = Food
- **Design for DISASSEMBLY** (Dfd)
  - Everything should come apart for easy reuse at end of “life”
  - We have to keep moving if we are going to keep up….

Therefore the Major Objectives are:

Energy

Reduce the energy needed for the activities of the building(s) and make the highest possible use of renewable forms of energy.

Indoor Environmental Quality

Reduce (eliminate if possible) harmful substances in indoor air, introduce natural views, light and fresh air for every activity and provide adequate control of artificial light, temperature and humidity

Materials

Make the highest possible use of materials made locally from renewable or recycled resources, whenever possible re-use buildings and building components, and reduce waste during construction and afterwards.

Therefore the Major Objectives are:

Water

Reduce the amount of water needed for the activities of our projects and the surrounding landscape, and make the most efficient use of the water required.

Site Issues

Locate the building such that the energy and the pollution caused by travel to the building is reduced. Position and shape the building on the site so that soil disturbance is minimized. Manage storm water to avoid erosion.

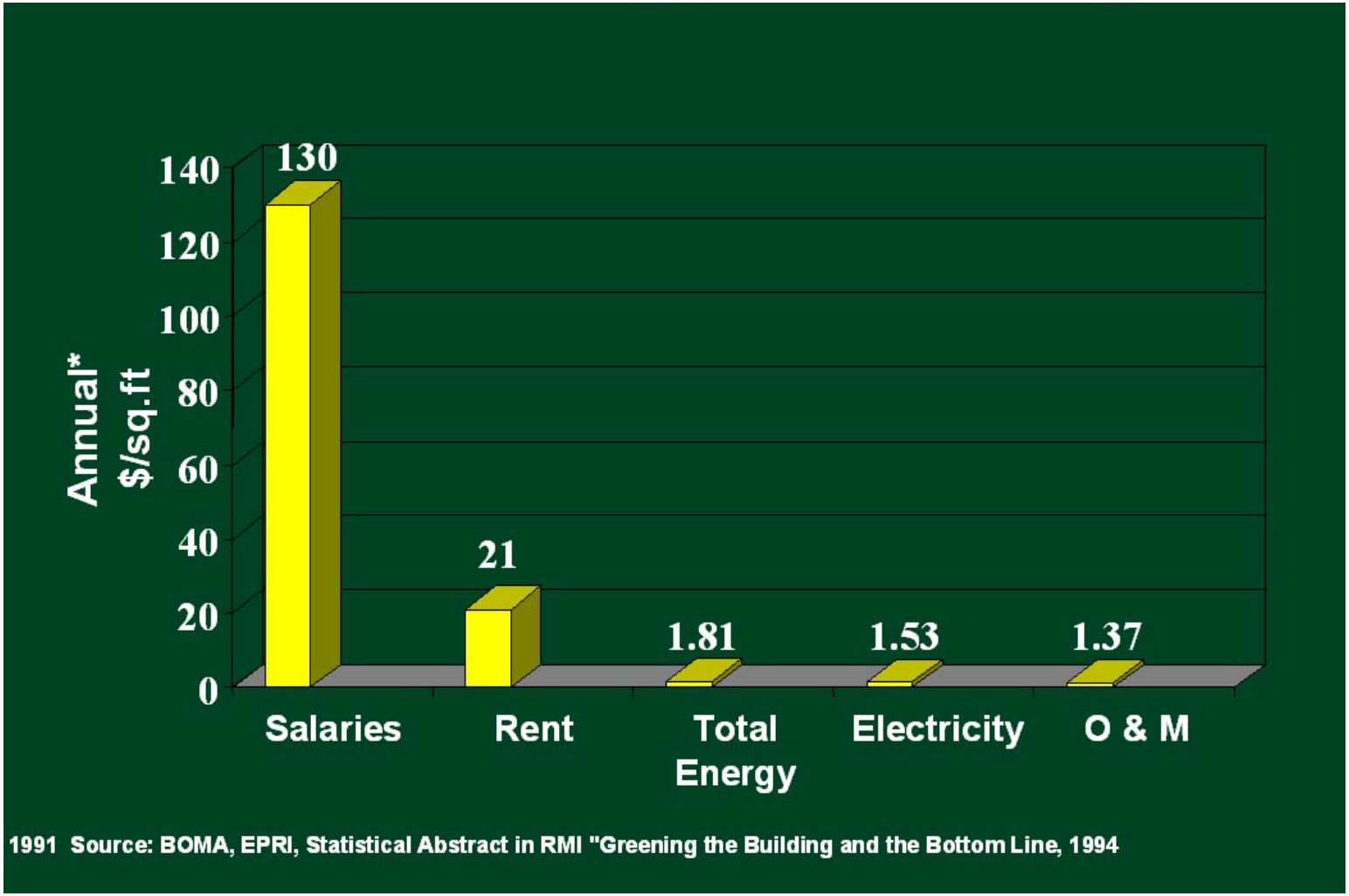
Implementation

Implement measures to ensure successful execution of the design and optimum long-term operation of the building systems.

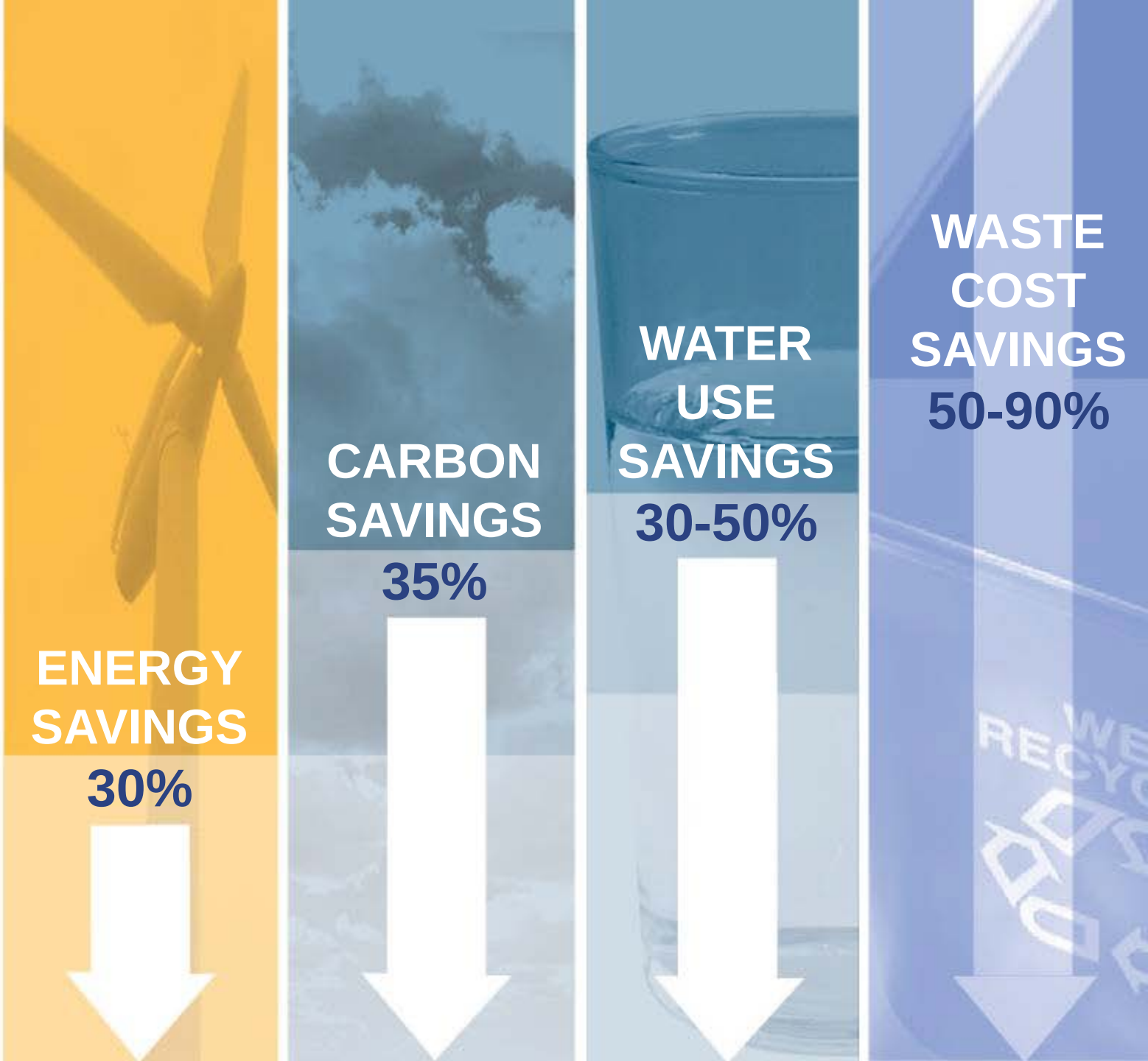
Economic Benefits - The Soft Numbers

- Reduce liability
  - Improve risk management
- Increase retail sales with daylighting
  - Studies have shown ~40% improvement[2]
- Impact on Schools and Education
- Improve productivity
  - Estimated $29 –168 billion in national productivity losses per year
- Reduce absenteeism and turnover
  - Providing a healthy workplace improves employee satisfaction

Green Buildings & Occupants

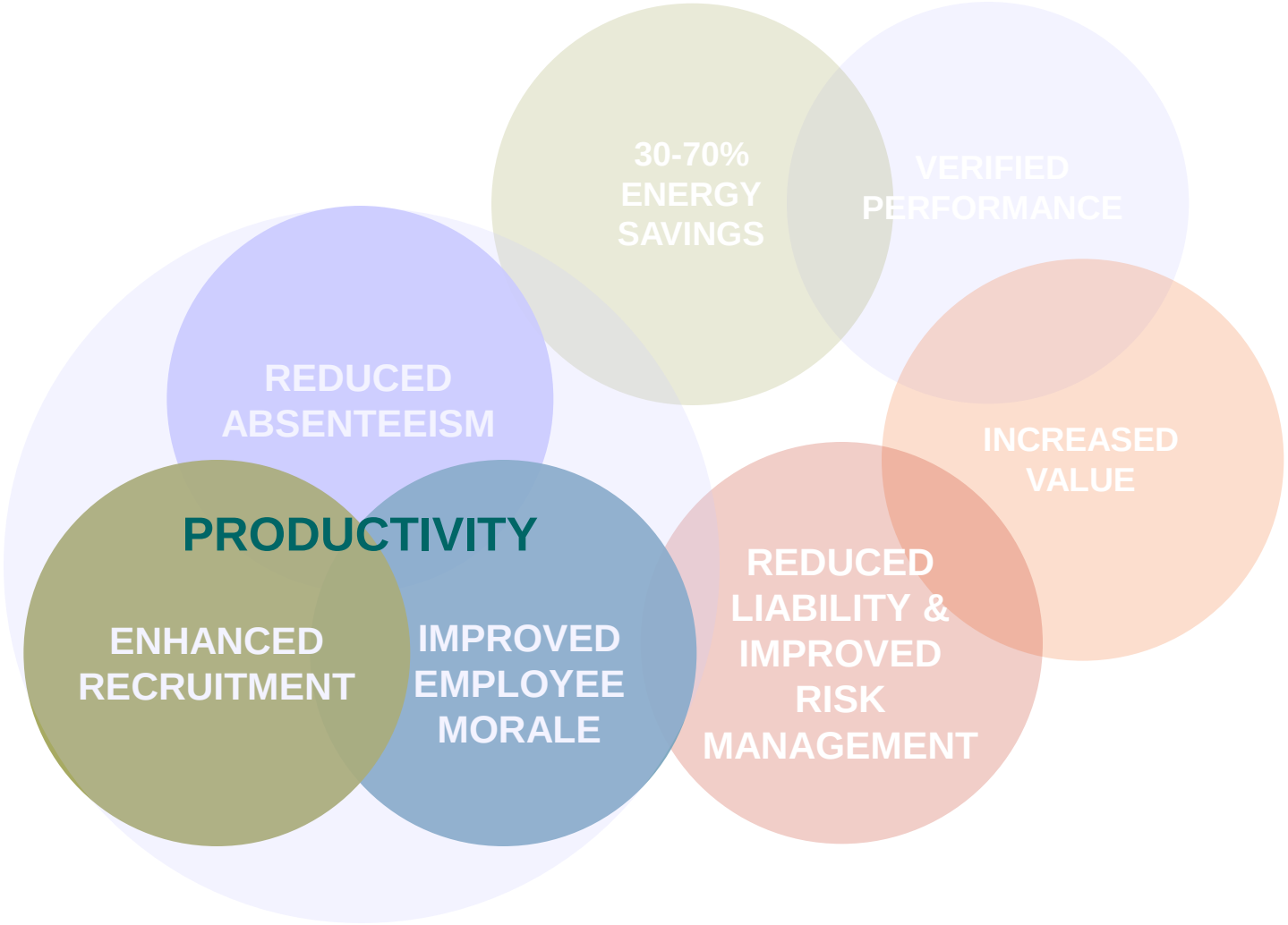


Average Savings of Green Buildings

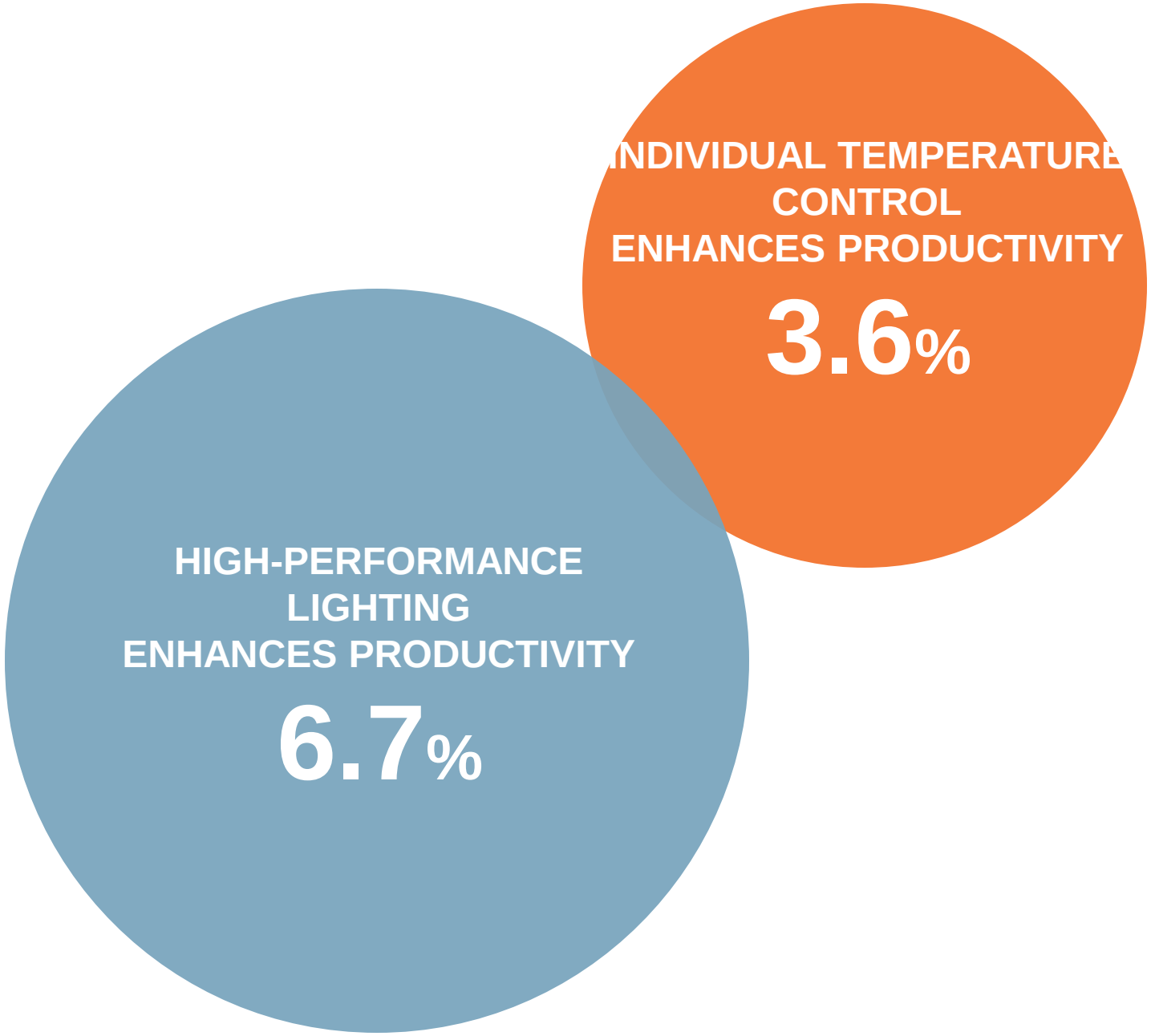


Source:
Capital E

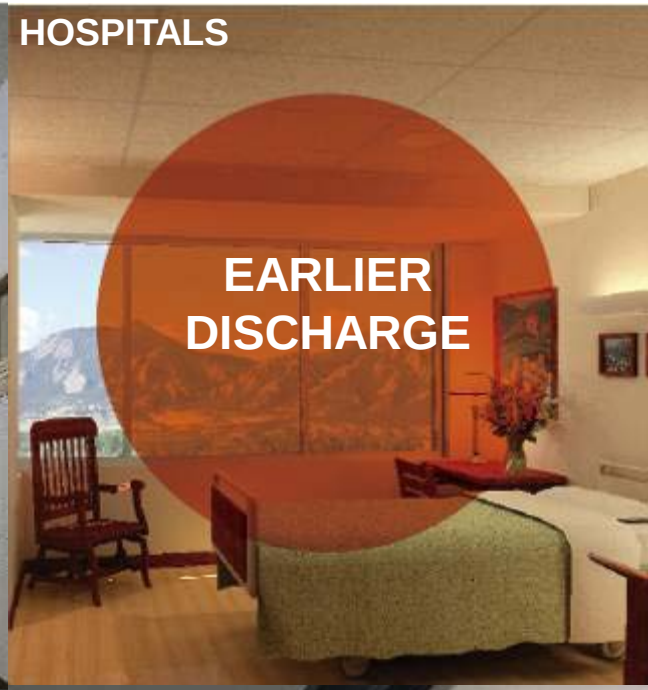
Improved Bottom Line.

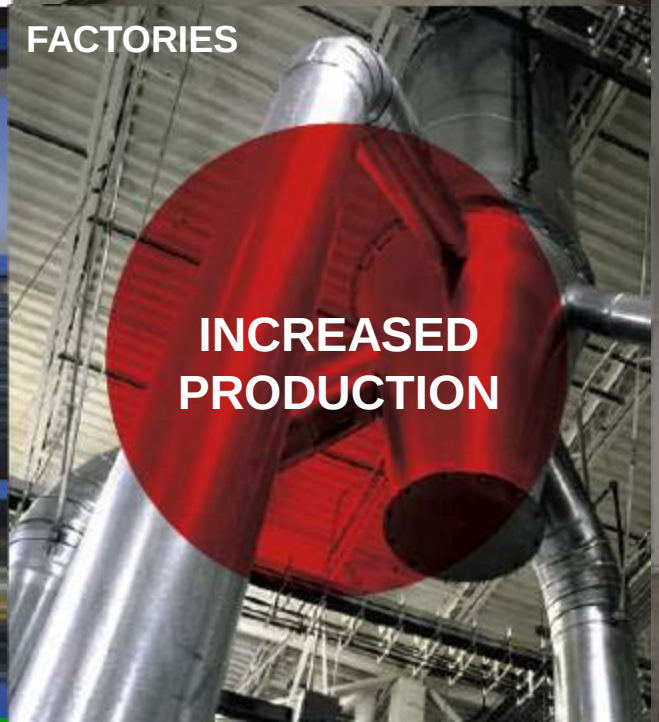


Average Productivity Gains

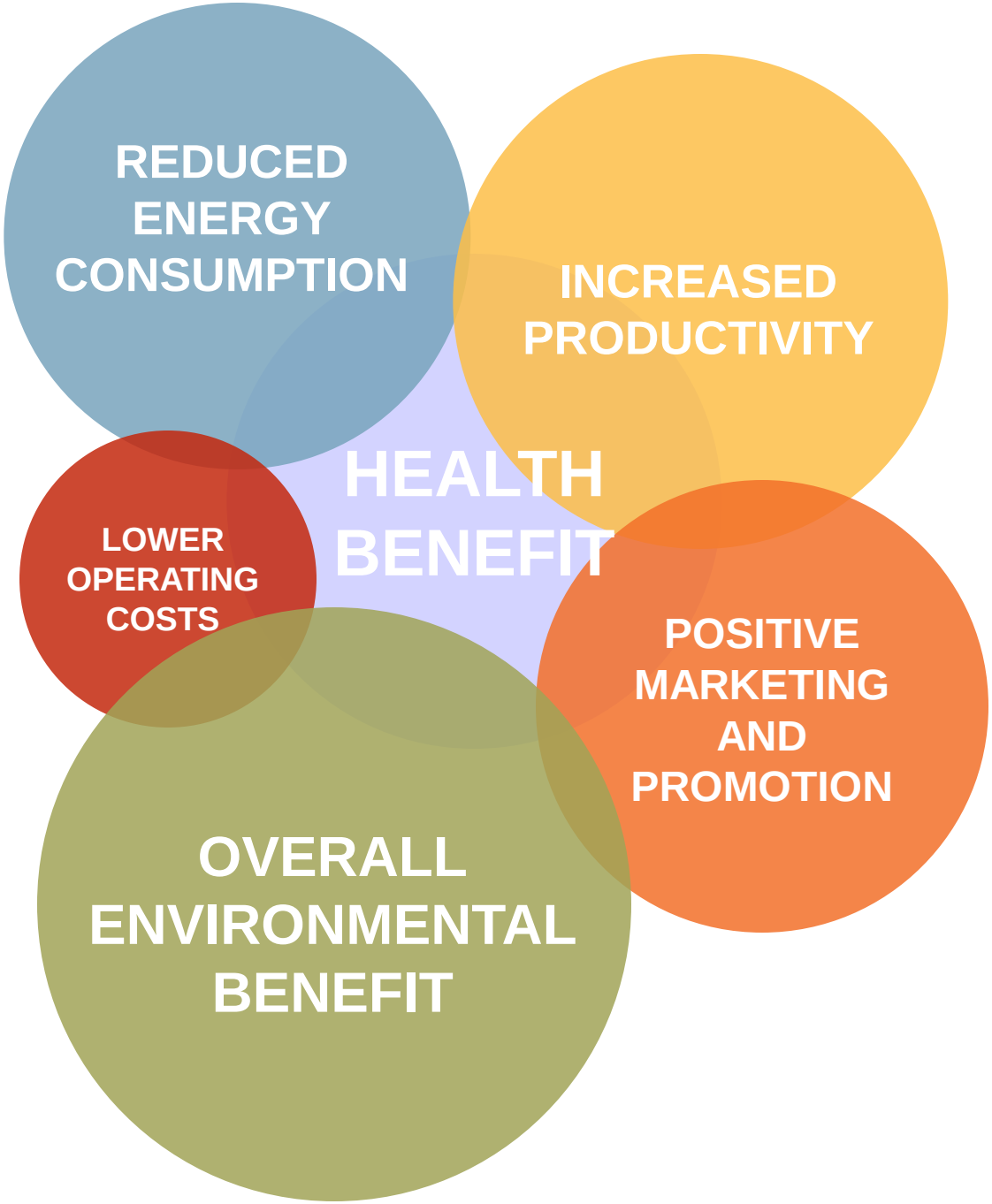


Increased Productivity.





Occupants and tenants perceive value of working in a green building to be:



Productivity Benefits

Improve occupant performance

- **Estimated $29 –168 billion in national productivity losses per year [1]**
- **Student performance is better in daylit schools**

Reduce absenteeism and turnover

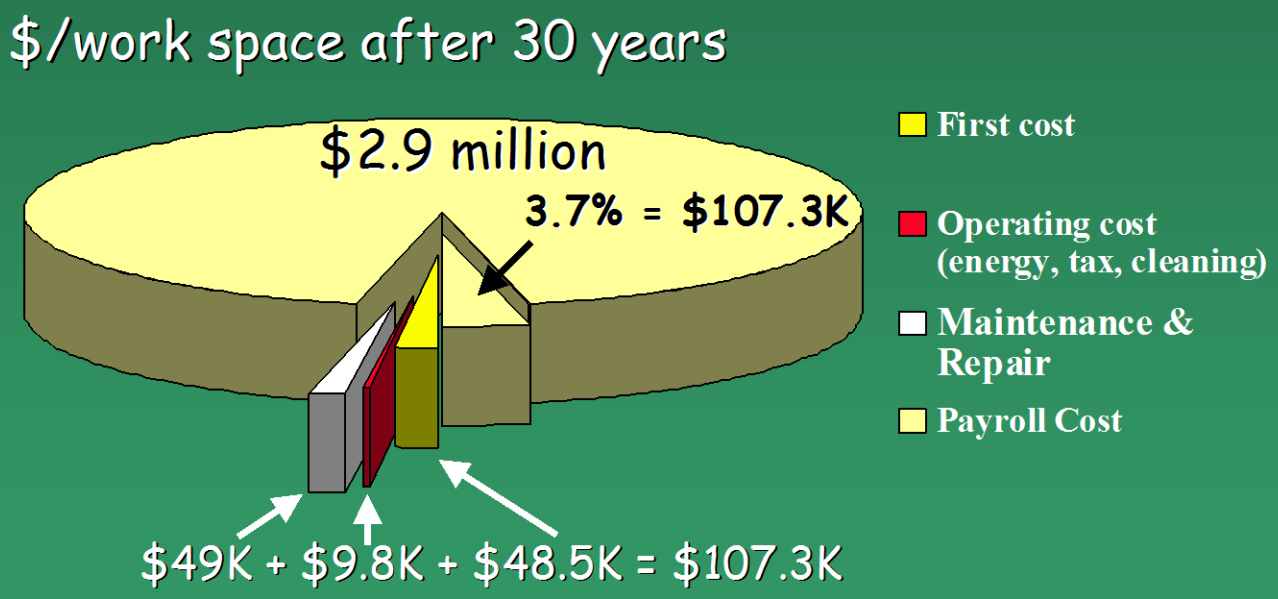
- **Providing a healthy workplace improves employee satisfaction**

Increase retail sales with daylighting

- **Studies have shown ~40% improvement**

BUILDING PERFORMANCE: Relative costs of life cycle elements

Productivity gains of only 3.7% can pay for all facility costs over a 30 year period.



Source: U.S. Secretary of Defense

The LEED Assessment system will be explored in detail in this course because it is an accessible, checklist based system that looks at all aspects of sustainable design.

The goal of this exploration of LEED will be do be able to “design to LEED”.

What is LEED?

- The **L**eadership in **E**nergy and **E**nvironmental **D**esign (LEED™) Green Building Rating System is an assessment tool that is currently being promoted throughout North America for the evaluation and promotion of sustainable design.
- The goal of LEED™ is to initiate and promote practices, which limit the negative impact of buildings on the environment and occupants. The design guideline is intended to prevent exaggerated or false claims of sustainability and to provide a standard of measurement of and between buildings. In addition to creating a working definition of "green building", LEED promotes integrated, whole-building integrated design practices (IDP).

What is the LEED System?

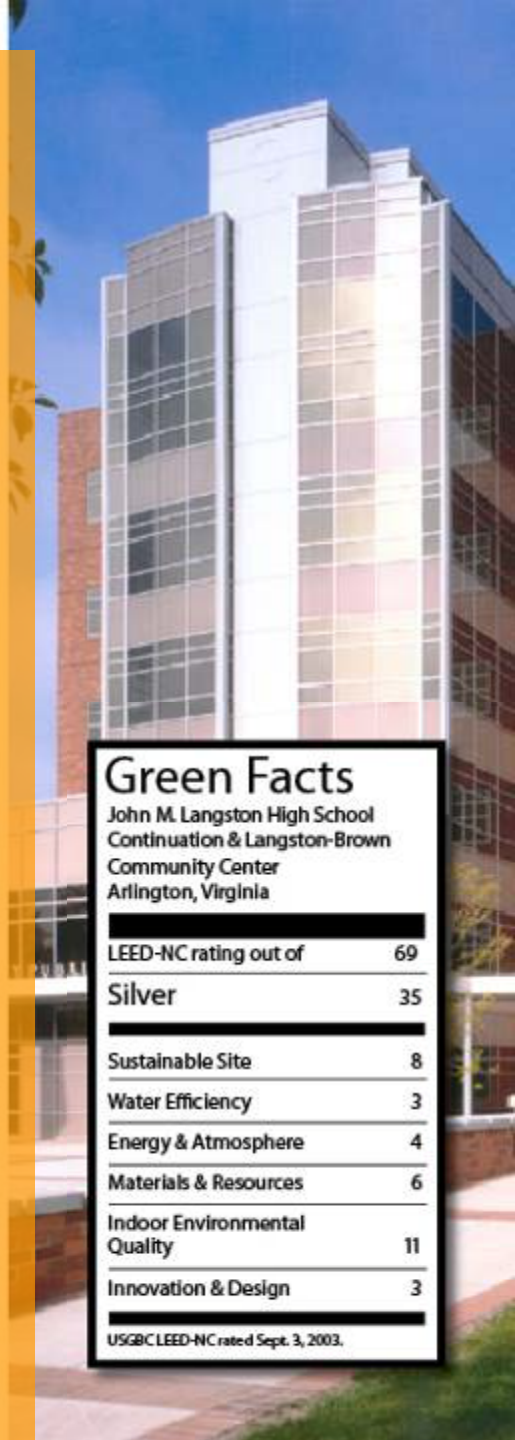
LEADERSHIP in ENERGY and ENVIRONMENTAL DESIGN

A leading-edge system for certifying **DESIGN, CONSTRUCTION, & OPERATIONS** of the greenest buildings in the world

Scores are tallied for different aspects of efficiency and design in appropriate categories.

For instance, LEED assesses in detail:

1. Site Planning
2. Water Management
3. Energy Management
4. Material Use
5. Indoor Environmental Air Quality
6. Innovation & Design Process

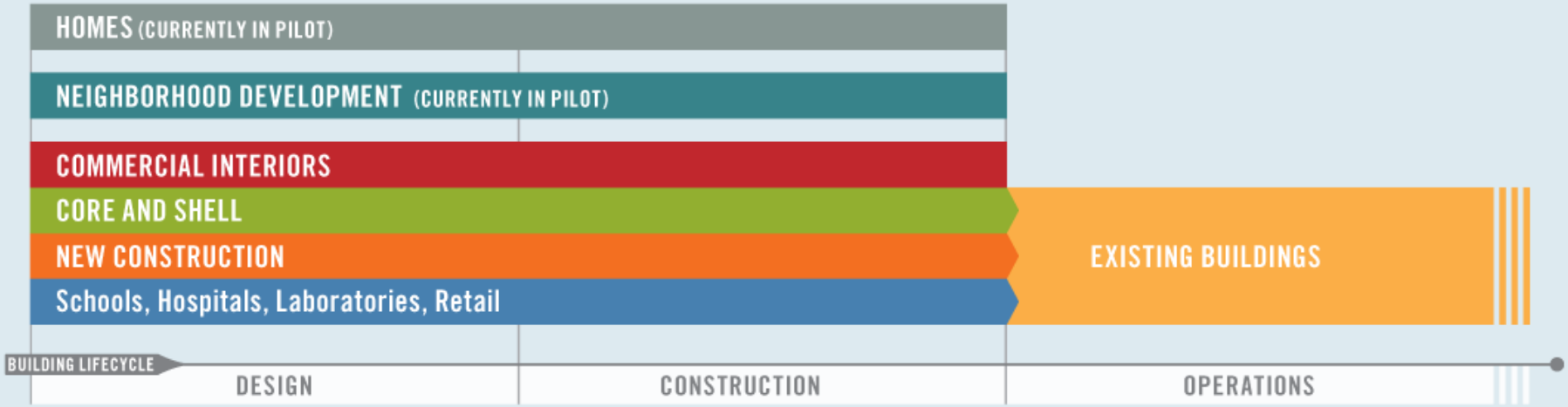


The reason architects should *(AT LEAST)* design to LEED:

- If we can't quantify, we can't compare.
- If we don't know how green it is, we can't really sell the idea convincingly to clients or the public.
- If we don't know how much environmental saving results, then we are just producing "soft" products that may or may not have any real value. If we don't understand and use sustainable design with authority, then we really don't know if what we have produced is correct or will work effectively.
- Some "green" buildings that have been designed pre-LEED have been studied and proven to be very low in LEED ratings

LEED addresses the complete lifecycle of commercial buildings.

Programs are in pilot for Homes and Neighborhoods.



USGBC LEED Rating Systems 2011

- New Construction (NC)
- Existing Buildings: Operations & Maintenance (EB: O&M)
- Commercial Interiors (CI)
- Core & Shell (CS)
- Schools (SCH)
- Retail
- Healthcare (HC)
- Homes
- Neighborhood Development (ND)

Choosing the right rating system

First, choose a rating system based on **construction type**

Complete Construction

Appropriate for:
Buildings that are undergoing new construction or *major renovation* (or *gut rehab*, for low- and mid-rise residential) and a complete *interior fit-out*.
There are five rating systems in this category:

- LEED for New Construction and Major Renovations
- LEED for Schools
- LEED for Healthcare
- LEED for Retail: New Construction and Major Renovations
- LEED for Homes

CORE AND SHELL DEVELOPMENT

Core and Shell Construction

Appropriate for:
Buildings that are undergoing new construction or *major renovation* on its exterior shell and core mechanical, electrical, and plumbing units but NOT a complete *interior fit-out*. There is only one rating system in this category:

- LEED for Core & Shell

COMMERCIAL INTERIORS

RETAIL: COMMERCIAL INTERIORS

Commercial Interior Construction

Appropriate for:
Commercial Interior spaces that are undergoing a complete *interior fit-out* of at least 60% of the certifying gross floor area. There are two rating systems in this category:

- LEED for Commercial Interiors
- LEED for Retail: Commercial Interiors

EXISTING BUILDINGS OPERATIONS AND MAINTENANCE

Existing Buildings: Limited Construction

Appropriate for:
Existing buildings undergoing improvement work or little to no construction. There is only one rating system in this category:

- LEED for Existing Buildings: Operations & Maintenance

Second, choose a rating system based on **space usage type**

NEW CONSTRUCTION AND MAJOR RENOVATIONS

Appropriate for:

- buildings that do not primarily serve K-12 educational, retail, or designated healthcare uses
- high rise (7+stories) residential buildings

SCHOOLS

Required for:

- buildings made up of *core* and *ancillary learning spaces* on K-12 school grounds

Also Appropriate for:

- buildings made up of *core* and *ancillary learning spaces on non K-12 school grounds.*
- non academic buildings on school campuses

See the Table 1 'Applying the LEED for Schools Rating System' below for more information.

HEALTHCARE

Required for (beginning January 1, 2012):

- buildings that serve individuals who seek medical treatment, including licensed and federal inpatient care facilities, licensed and federal outpatient care facilities, and licensed and federal long-term care facilities. These are considered LEED for Healthcare 'designated' uses.

Also Appropriate for:

- buildings with other kinds of medically-related uses, such as unlicensed outpatient facilities, medical, dental and veterinary offices and clinics, assisted living facilities and medical education & research centers are examples of 'non-designated' uses, and may use LEED for Healthcare at the project team's discretion.

See Table 2 'Applying the LEED for Healthcare Rating System' below for more information.

RETAIL: NEW CONSTRUCTION AND MAJOR RENOVATIONS
RETAIL: COMMERCIAL INTERIORS

Appropriate for:

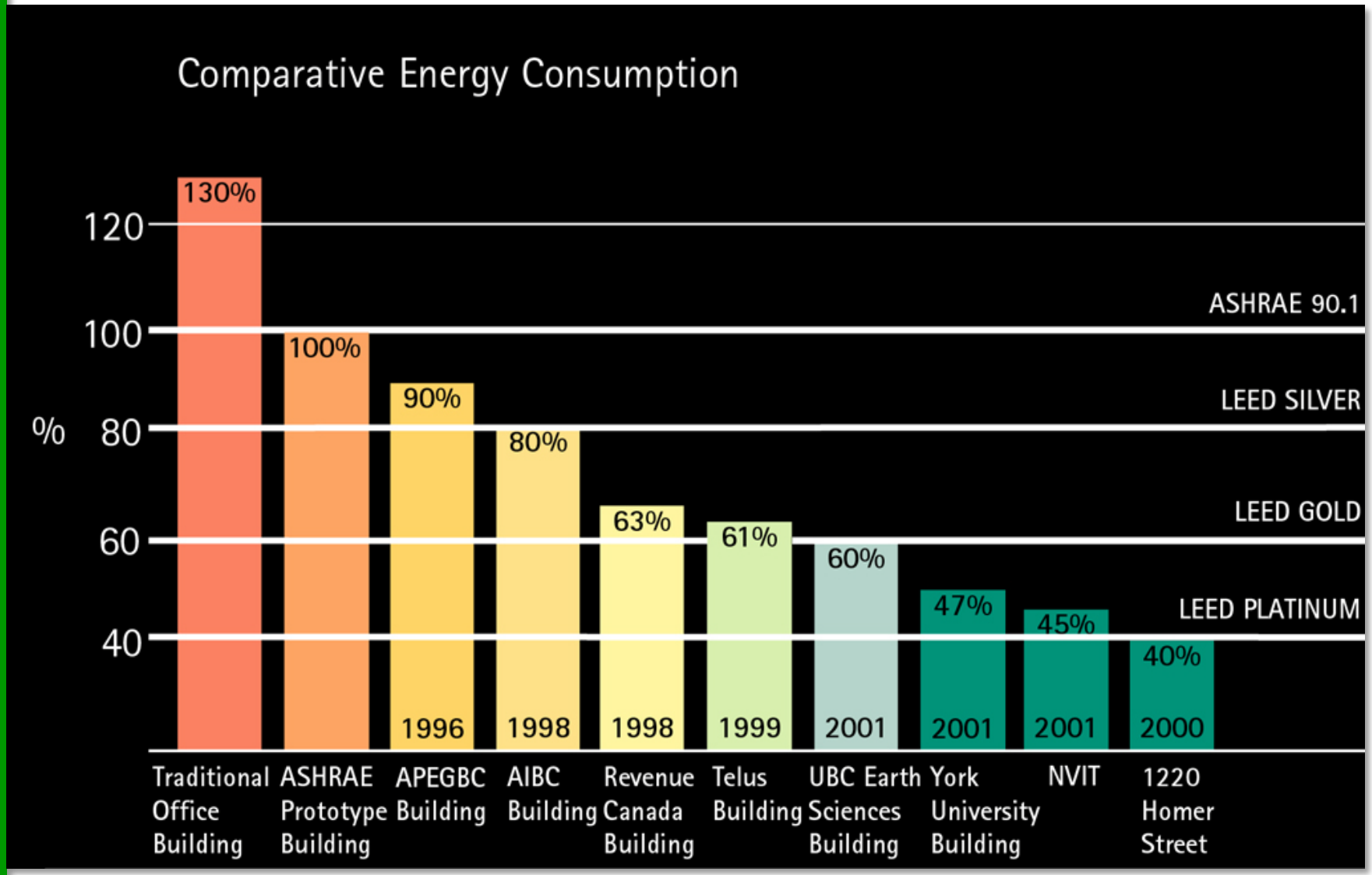
- buildings or interiors dedicated to the sale of goods or commodities directly to consumers who come onto the premise for the purpose of obtaining those goods or commodities. Includes (but is not limited to) banks, restaurants (quick and full-serve), stores of any kind, spas, etc.
- includes both direct customer service areas (showroom) and preparation or storage areas that support customer service.

HOMES

Appropriate for:

- low-rise (1-3 stories) *residential* buildings. The LEED for Homes Multi-Family Midrise rating system, located on the LEED for Homes page within usgbc.org, is appropriate for mid-rise (4-6 stories) *residential* buildings.

See Table 3 'Applying the LEED for Homes Rating System' below for more information.



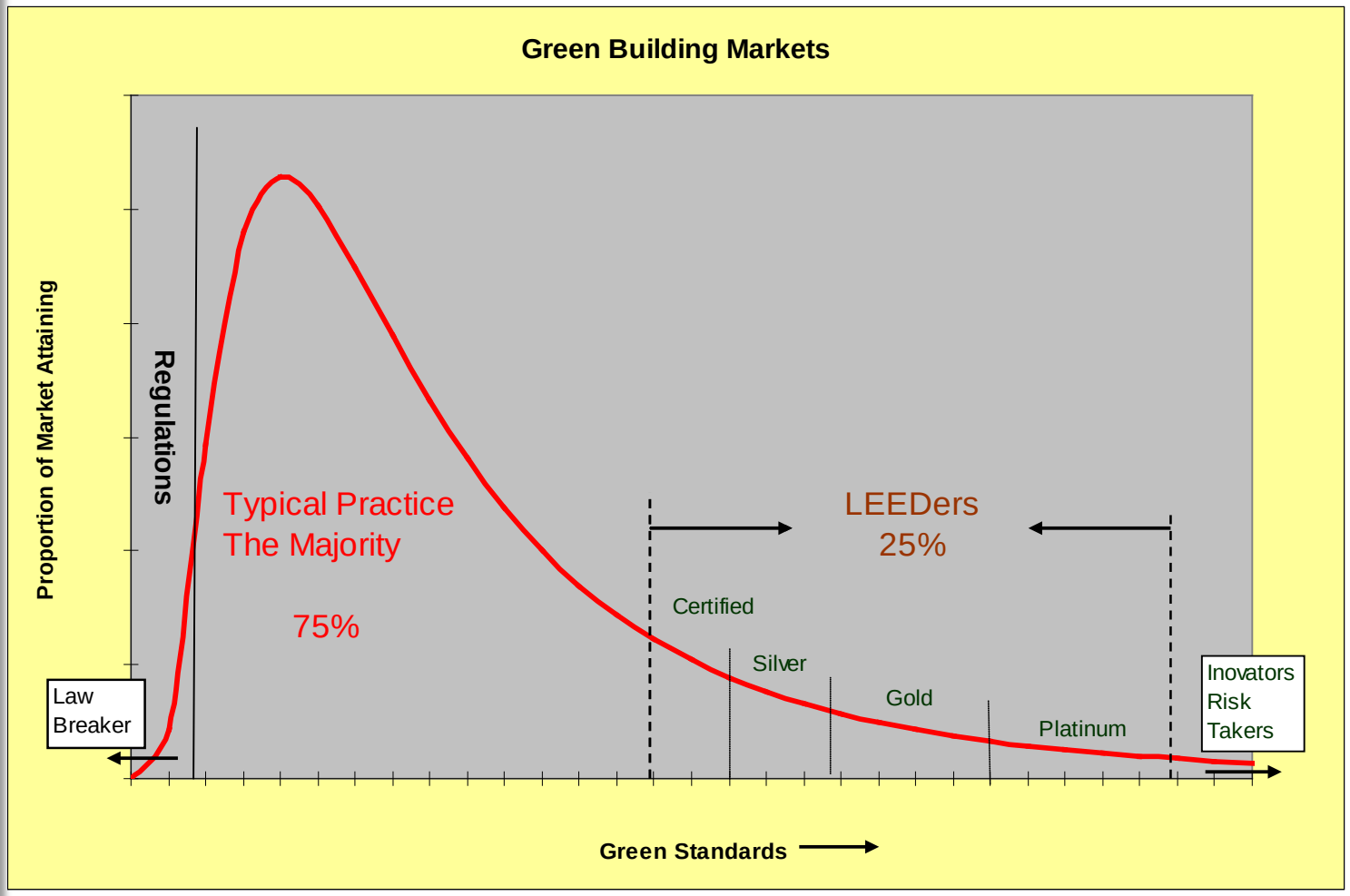
Comparisons are the key to understanding the relative effectiveness of certain design strategies.

Leadership in **E**nergy and **E**nvironmental **D**esign:

Why Was LEED® Created?

- Facilitate positive results for the environment, occupant health and financial return
- Define “green” by providing a standard for measurement
- Prevent “greenwashing” (false or exaggerated claims)
- Promote whole-building, integrated design processes
  - Use as a design guideline
  - Recognize leaders
  - Stimulate green competition
  - Establish market value with recognizable national “brand”
  - Raise consumer awareness
  - Transform the marketplace!

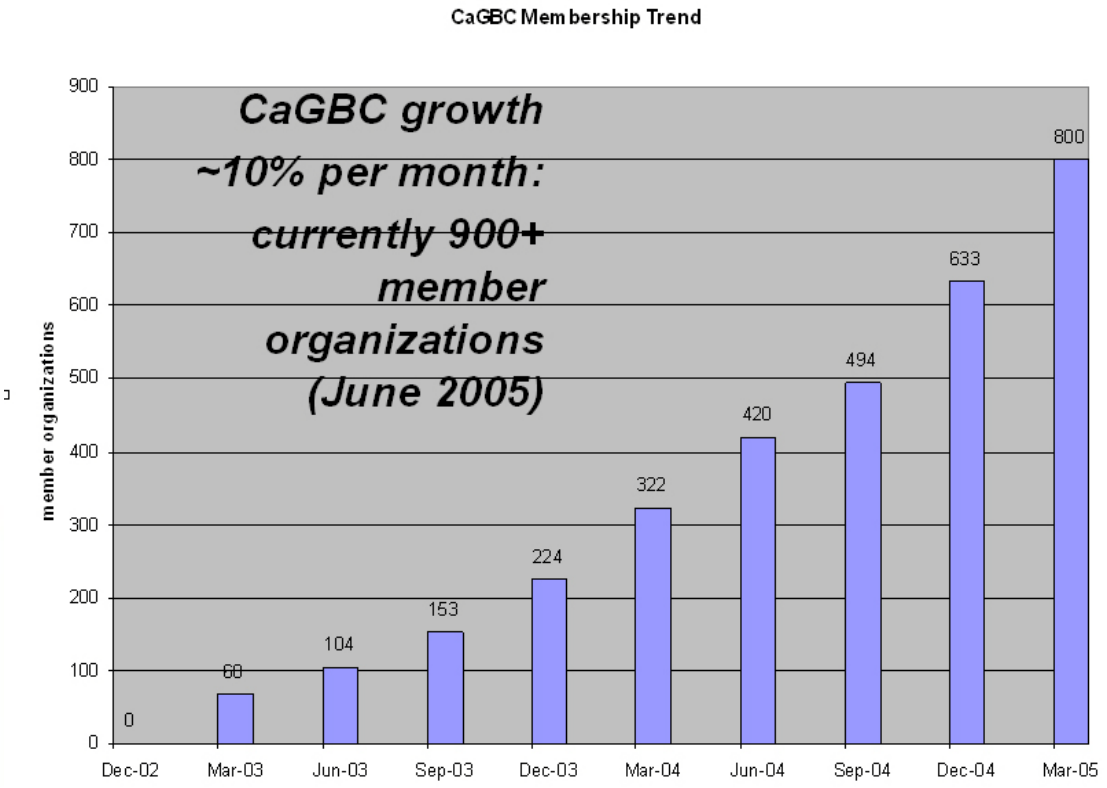
Positioning of LEED® in the Market



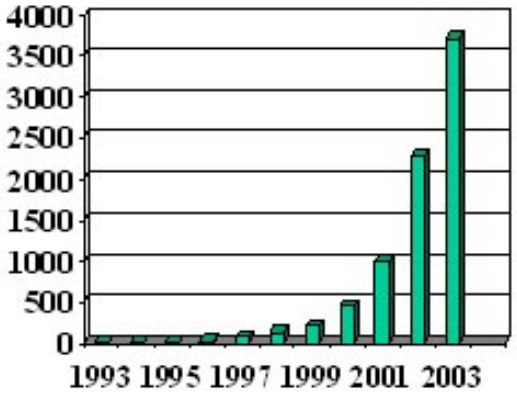
What are the Advantages of LEED® ?

- Relatively simple to implement
- Not overly prescriptive
- Can be modified for local climate and standards (LEED™ BC and LEED™ Canada)
- It has legitimacy and consistency
- Credibility of third party verification

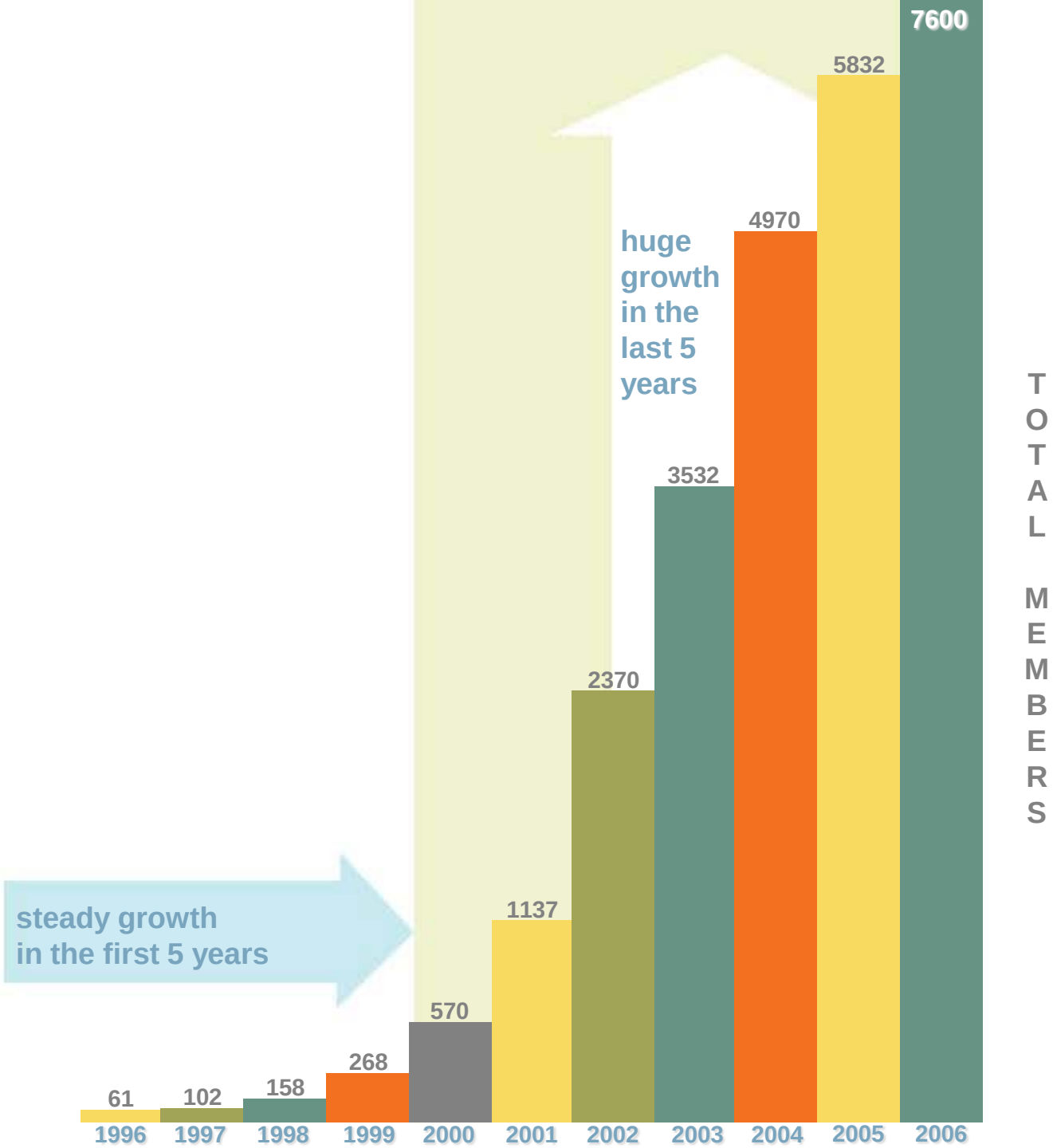
LEED® Uptake – USGBC & CaGBC Membership



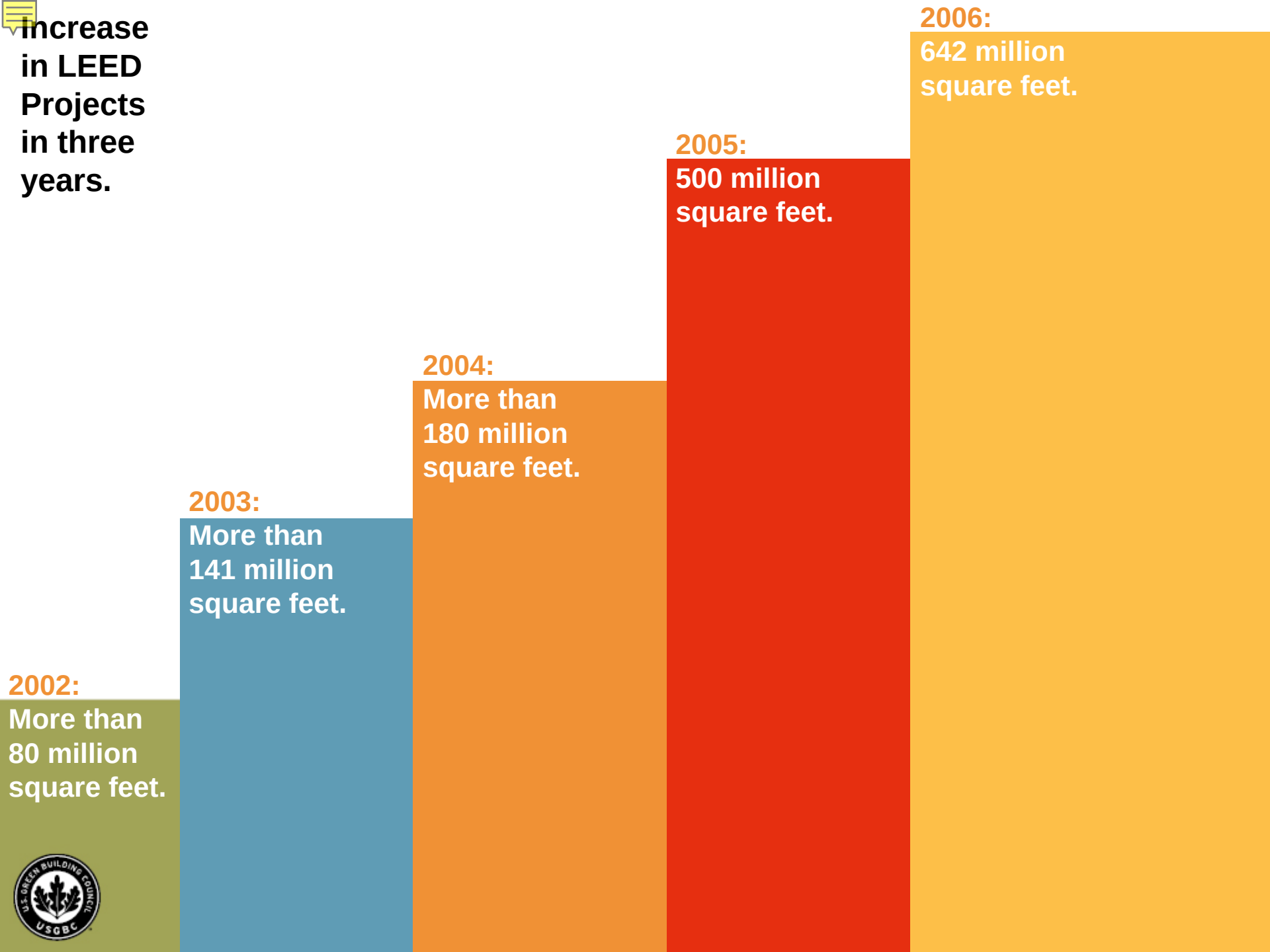
USGBC: Dec. 2003



USGBC membership growth reflects the expansion of green buildings in the market

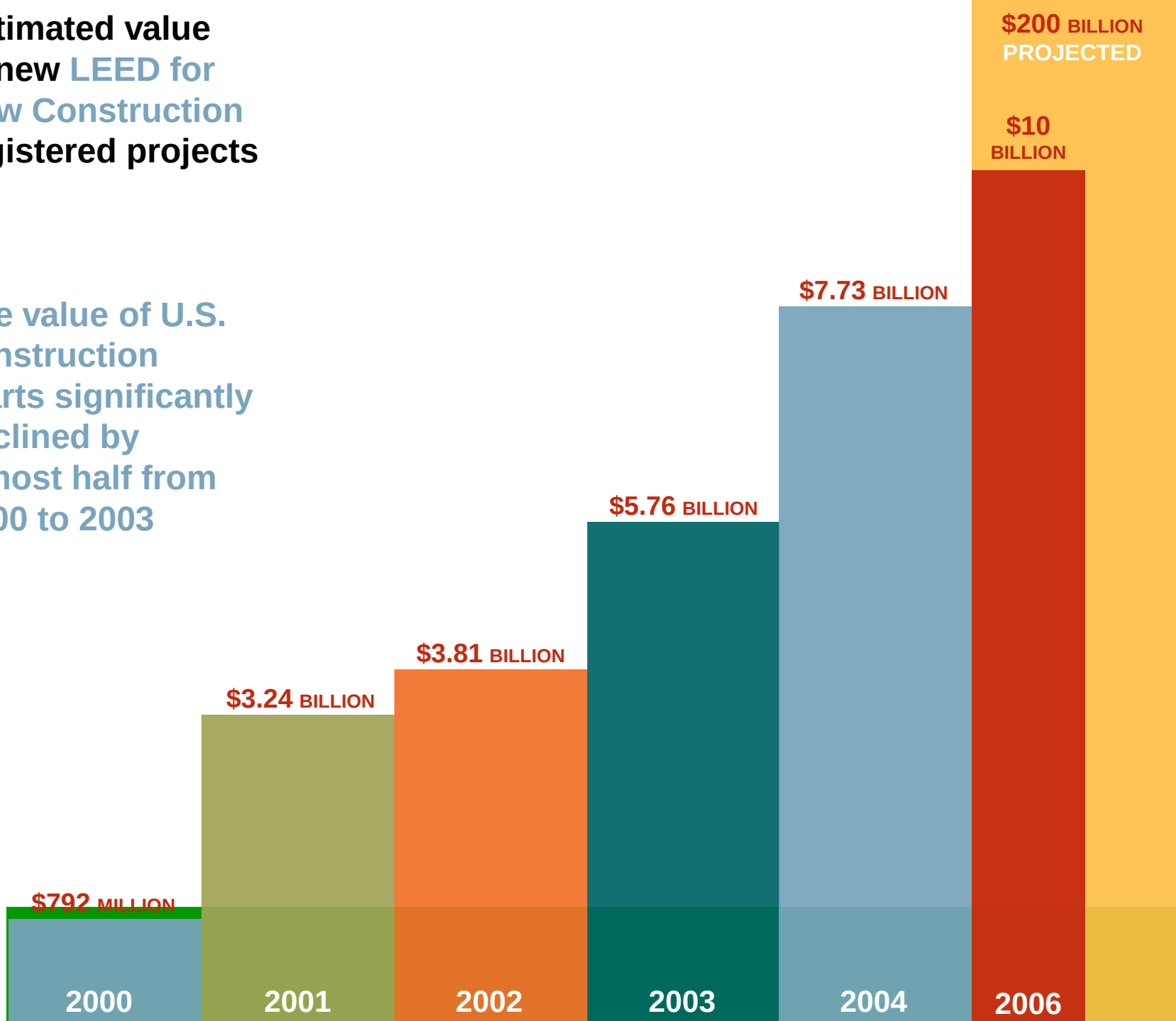


Increase in LEED Projects in three years.



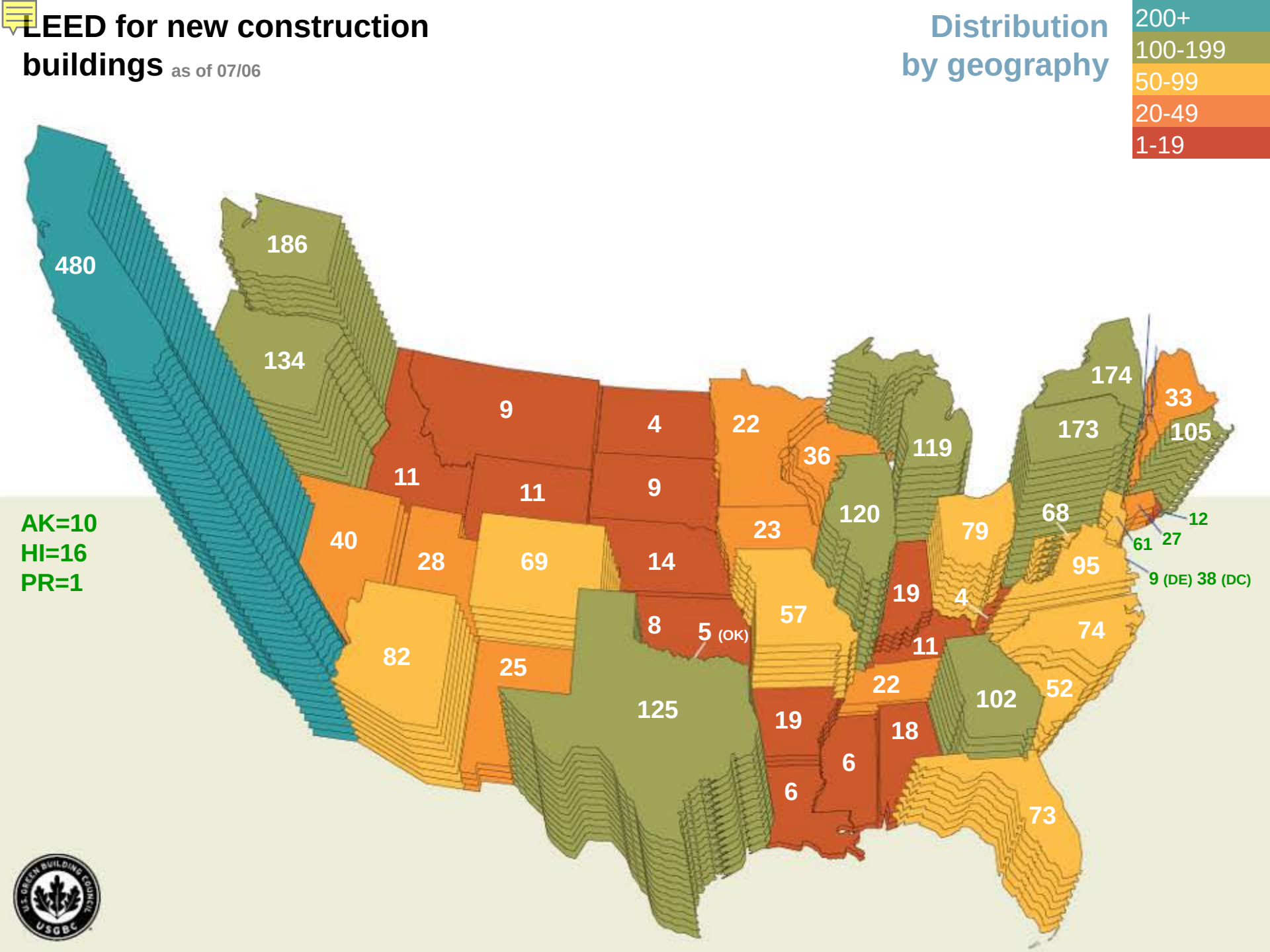
Estimated value of new LEED for New Construction registered projects

The value of U.S. construction starts significantly declined by almost half from 2000 to 2003



LEED for new construction buildings as of 07/06

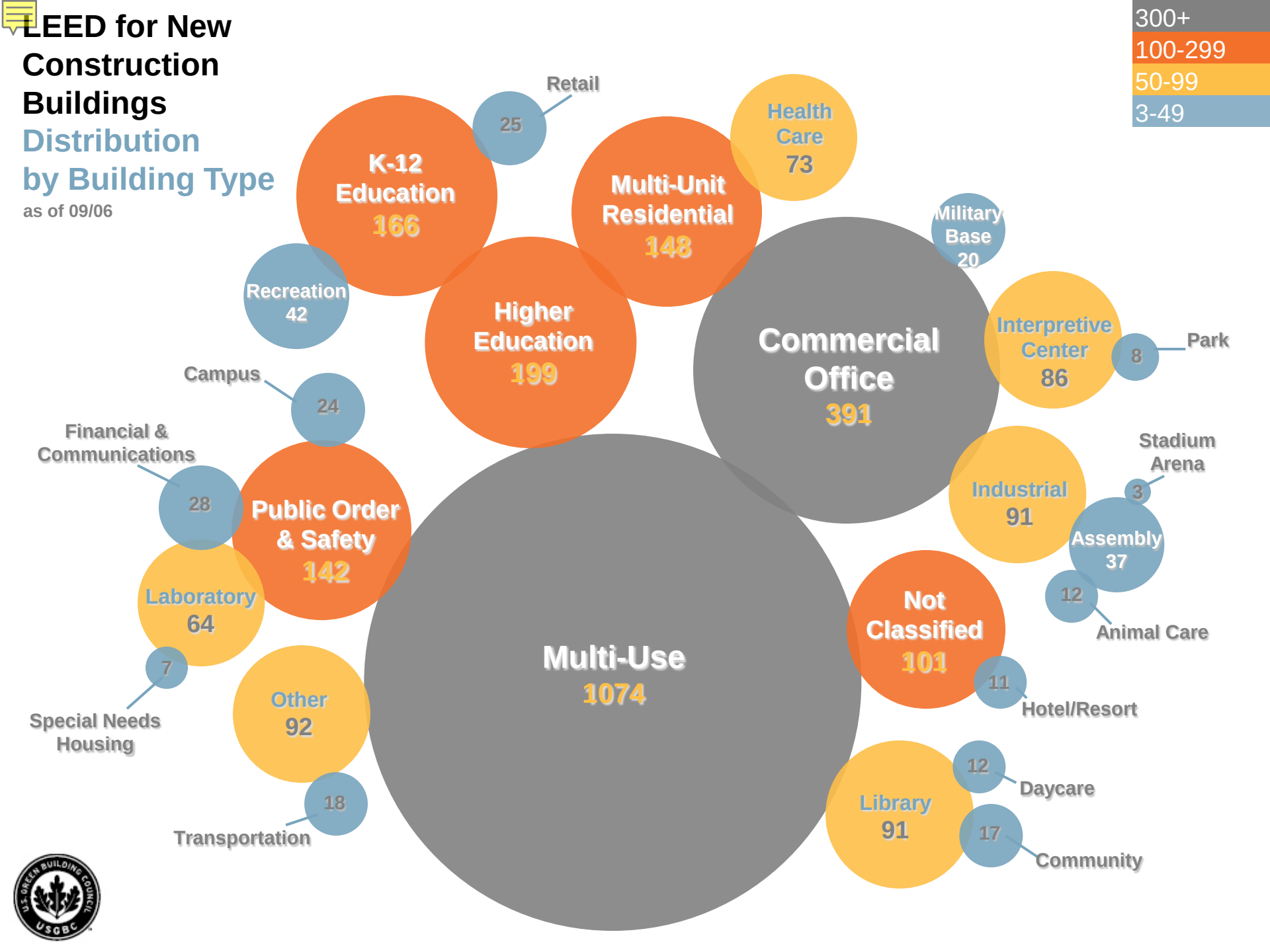
Distribution by geography



LEED for New Construction Buildings

Distribution by Building Type

as of 09/06



Reasons for LEED Momentum

- Works well for institutional & commercial buildings
- Capital Cost effective (LEED Silver 0-2% premium) if IDP used
- Very rapid paybacks
- Third party credibility and independent verification process
- Key to meeting Kyoto commitments


CaGBC | Member List - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://www.cagbc.org/membership_information/statistics.php
banning laptops david
University of Waterlo... Quest login | Quest S... Yahoo! Groups Calendars, courses a... Kentico CMS Desk deviantART: Boogie's... EasyWeb Technology and Iden...
U.S. Green Building Council
CaGBC | Member List
Canada Green Building Council
Professional Accreditation
Register Your Project
Green Building Projects
Join Now
Sitemap :: En Français :: Contact
search
:: CaGBC PROFILE
:: NEWS & EVENTS
:: GREEN BUILDING PROJECTS
:: MEMBERSHIP
Overview
Join CaGBC
FAQ
Statistics
:: CHAPTERS
:: OTHER GREEN BUILDING COUNCILS
:: EMERGING GREEN BUILDERS (EGB)
:: LEED® AND OTHER BUILDING RATING SYSTEMS
:: LEED® AP
:: GREEN RESOURCES
:: JOB POSTINGS
:: MY CaGBC
:: LINKS
Statistics
Members by Type
Retail, Construction and Products 300
Academia, Research and Policy 50
Financial and Support Services 1
Professional Firms 1034
Non-Profit Organizations and Industry Associations 33
Utilities 8
Real Estate, Managers, Owners & Tenants 119
Total: 1545
Members by Province
Alberta 168
British Columbia 333
Manitoba 63
New Brunswick 22
Newfoundland and Labrador 4
Nova Scotia 31
Northwest Territories 3
Ontario 638
Prince Edward Island 5
Quebec 249
Saskatchewan 18
Yukon 1
US 10
Done
start
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usgbc-leed
CaGBC | Member List ...
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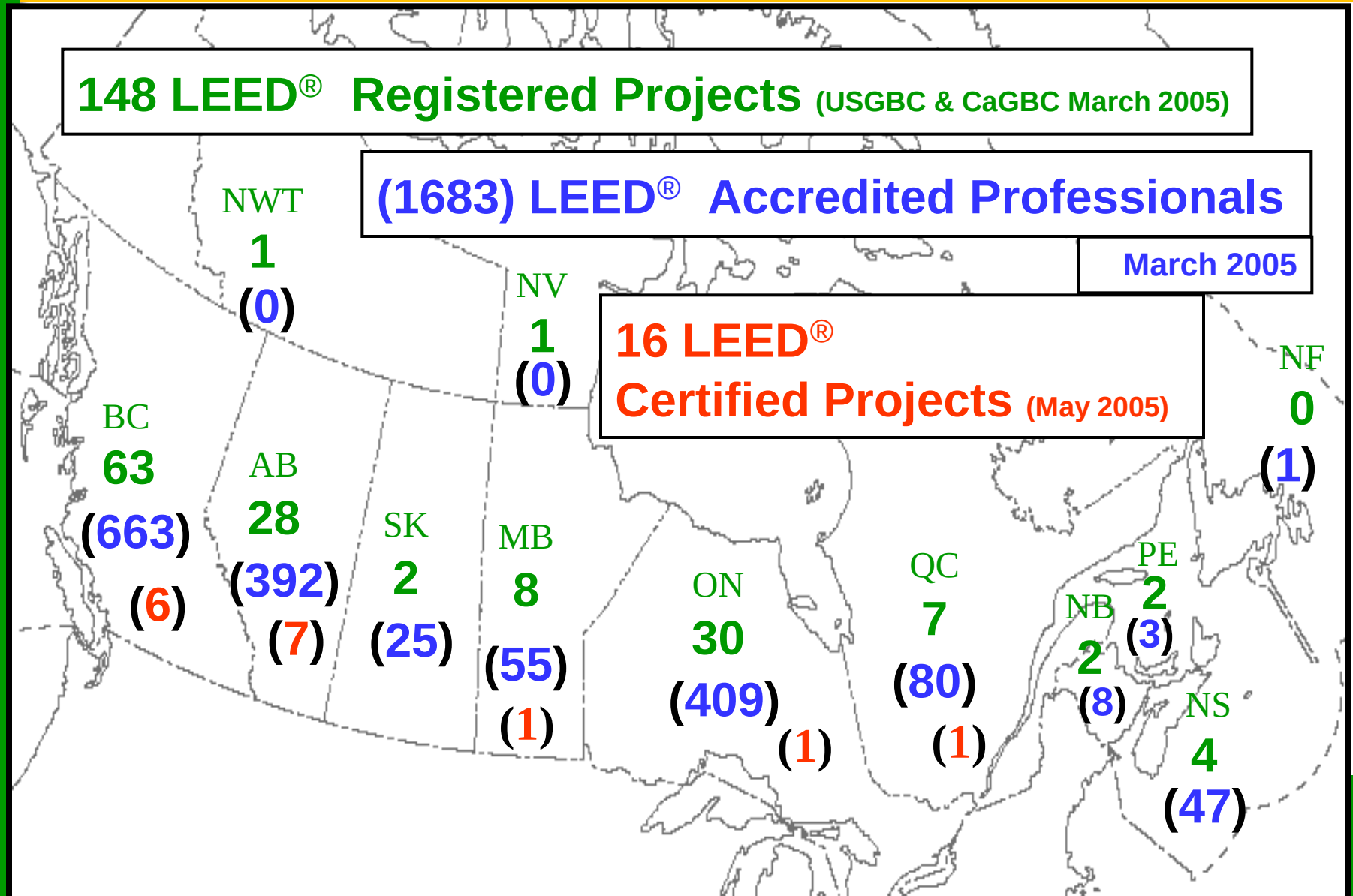
LEED Endorsement in Canada

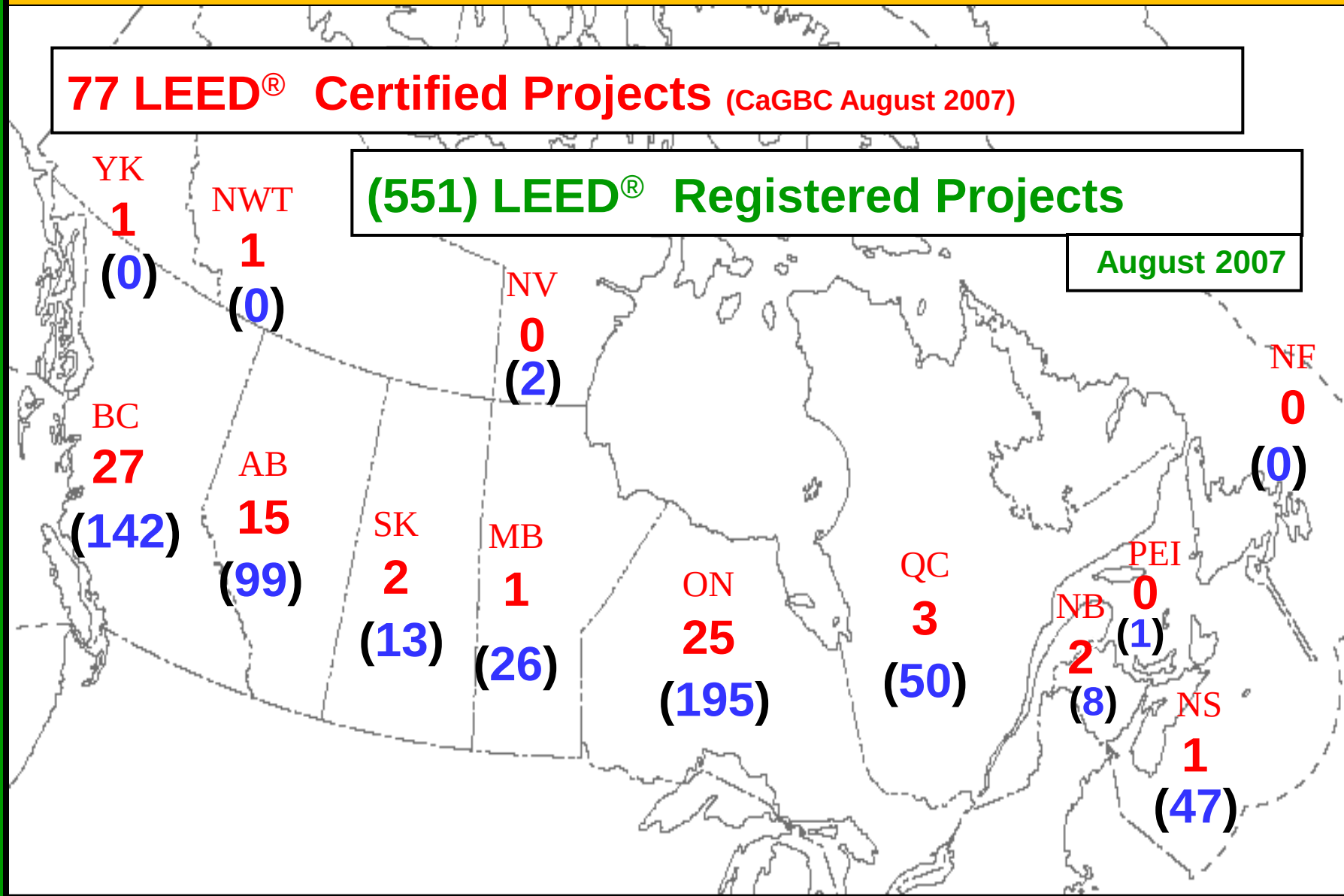
- APEG BC
- GVRD
- University of BC
- BC Buildings Corporation
- Vancouver 2010 Olympics: *Silver*
- City of Vancouver facilities: *Gold*
- City of Victoria Dockside Lands: *Platinum*

- Alberta Infrastructure Schools Pilot
- City of Calgary Sustainable Buildings Policy
- Manitoba Hydro $150 million building
- Public Works & Government Services Canada, Capital Projects > $10 million = LEED Gold
- La Société Immobillière du Québec, New Construction & Renovations
- Toronto Waterfront Rehabilitation Corporation: LEED Gold
- TCHC – Regent Park Revitalization: LEED Gold Region of Waterloo: LEED Silver

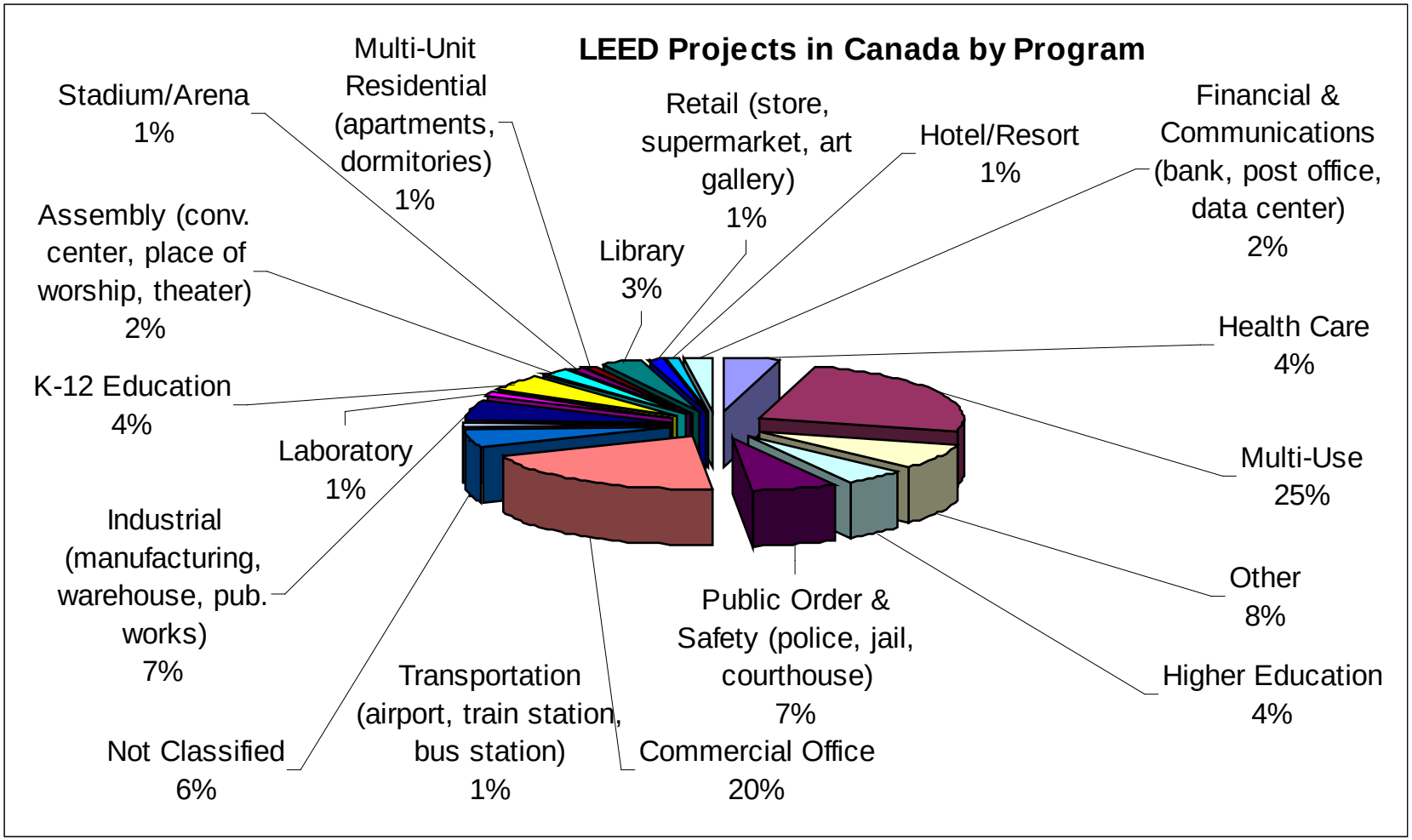
LEED Projects
& LEED Accredited Professionals in Canada 2005



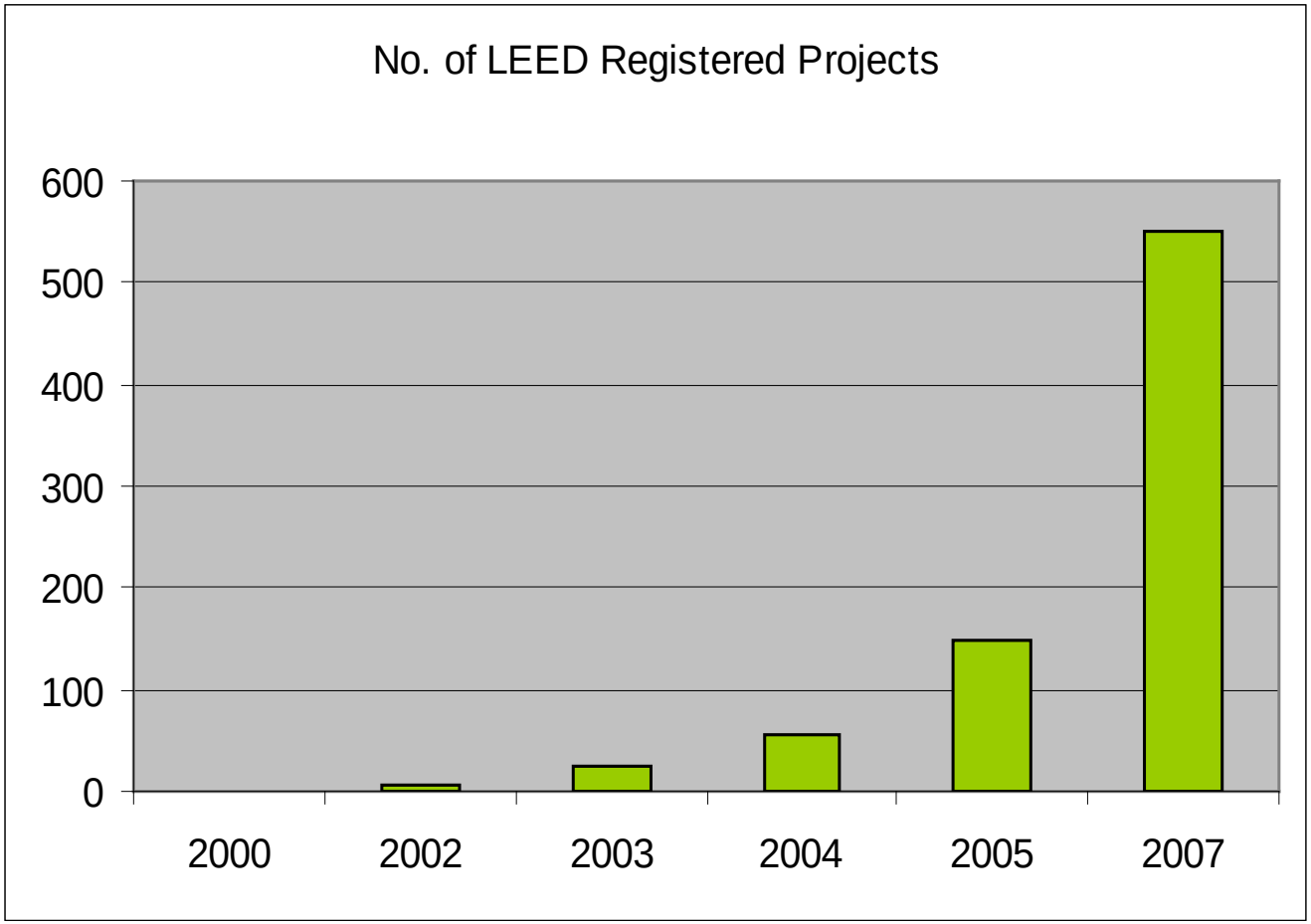
LEED Projects in Canada 2007



LEED Projects in Canada by Program Type



Growth in LEED Registered Projects in Canada



LEED is not perfect...

- has been criticized *because* it is a *checklist* system
- many points are equally weighted as if they are of equal importance (which they may not be…) although this is changing
- some issues are not addressed at all (ie. Carbon Neutral, Design for Disassembly, climate differences in Regions)
- there are mandatory credits but not subtractive ones (many students have suggested that you should be penalized for having some systems or items in your buildings)
- present LEED Canada does not have as many versions as USGBC
- it is quite expensive to take your building through certification

I like LEED....

✓because it is an accessible checklist system (you can find out much online for free)

✓realizing it is not perfect, but you have to start changing attitudes somewhere

✓students that I have asked to design to LEED standards thus far, seem to have been able to work with the basic requirements without problem

✓student project work that has been produced with LEED in mind has been much more rigorous than “greenish” design in the past

✓because I am going to tell you that like the Building Code, this should be considered a set of MINIMUM requirements!

✓because they DO revise and upgrade and add new evaluation systems quite regularly

This section is based on LEED 1.0 for Canada!

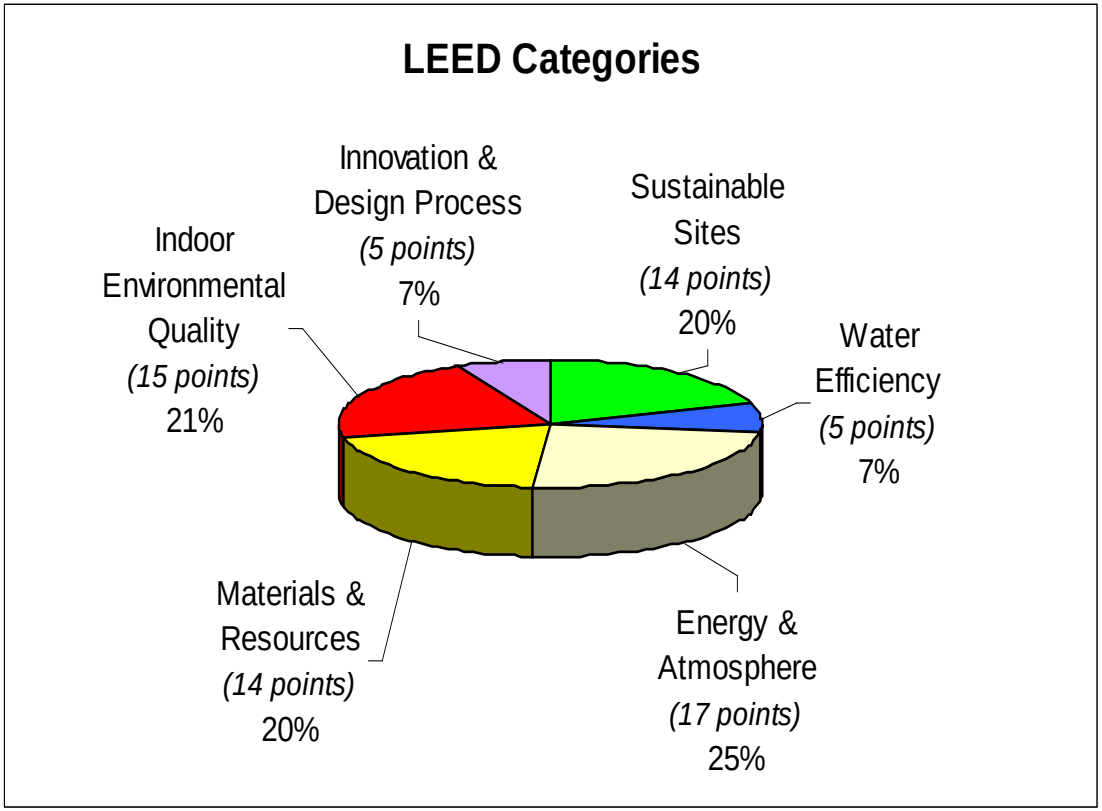


Chart based on LEED Canada 70 points

In the early days of energy consciousness, the primary focus was on energy efficiency, insulation levels and air tightness. With the introduction of a more comprehensive rating system, the role of envelope efficiency might be seen to comprise only 25% of the points available...

The collected LEED base sections amount to 65 points in 32 credit categories. Adding the 5 points for Innovation & Design Process results in a potential of 70 points. Buildings are accredited by the number of points gained:
26 to 32 point is LEED certified;
33 to 38 points is LEED Silver;
39 to 51 is LEED Gold, and;
LEED Platinum is awarded to projects with 52 or more points.
By awarding a medal to successful buildings, LEED is an incentive-based system, which can be easily understood by designers and clients alike. It can also be used as a forceful marketing tool, by "brand naming" buildings with the LEED award label. Several cities in the United States and Canada have adopted LEED Silver, for instance, as the minimum standard for all new municipal construction.

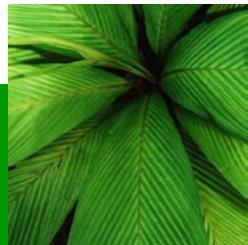
Pre-requisite credits:

- in the LEED system, many of the categories include pre-requisite points/credits
- you MUST achieve these credits or none of the other credits in the category count
- the intent of the pre-requisite points is to set up basic criteria for sustainable building for the category
- Sustainable Sites: erosion and sedimentation control
- Energy & Atmosphere: Fundamental Building Systems Commissioning, Minimum Energy Performance, CFC Reduction
- Materials and Resources: Storage and Collection of Recyclables
- Indoor Environmental Quality: Minimum IAQ, No Tobacco Smoke

Sustainable Sites: 20% : 14/70 points

deals primarily with issues of site selection, site access and site design (materials, density, drainage). The prerequisite concerns erosion and sedimentation control on site. There are eight credits offering a total of 14 potential points. The development of sustainable site design is seen as a critical starting point for an attitude towards the entire building design in the Integrated Design Process.

Sustainable Sites	**14 Possible Points**	
Prerequisite 1	Erosion & Sedimentation Control	Required
Credit 1	Site Selection	1
Credit 2	Development Density	1
Credit 3	Brownfield Redevelopment	1
Credit 4.1	Alternative Transportation, Public Transportation Access	1
Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1
Credit 4.3	Alternative Transportation, Alternative Fuel Vehicles	1
Credit 4.4	Alternative Transportation, Parking Capacity	1
Credit 5.1	Reduced Site Disturbance, Protect or Restore Open Space	1
Credit 5.2	Reduced Site Disturbance, Development Footprint	1
Credit 6.1	Stormwater Management, Rate and Quantity	1
Credit 6.2	Stormwater Management, Treatment	1
Credit 7.1	Landscape & Exterior Design to Reduce Heat Islands, Non-Roof	1
Credit 7.2	Landscape & Exterior Design to Reduce Heat Islands, Roof	1
Credit 8	Light Pollution Reduction	1



Sustainable Sites: Examples

Vancouver Public Library

- green roof
- controls site water
- offsets urban heat island effect

Sustainable Sites: Examples

Green on the Grand,
Kitchener, Ontario

- storm water retention pond
- controls site water
- offsets urban heat island effect
- also used with heating/AC system

Water Efficiency: 7% : 5/70 points

is the smallest section comprising only three credits, worth 5 points. This section deals with landscaping, wastewater treatment and water use reduction. Items such as Living Machines™, use of the Waterloo Biofilter™, waterless urinals and composting toilets can be rewarded with points in this category.

Water Efficiency	5 Possible Points	
Credit 1.1	Water Efficient Landscaping, Reduce by 50%	1
Credit 1.2	Water Efficient Landscaping, No Potable Use or No Irrigation	1
Credit 2	Innovative Wastewater Technologies	1
Credit 3.1	Water Use Reduction, 20% Reduction	1
Credit 3.2	Water Use Reduction, 30% Reduction	1

Water Efficiency: Examples

YMCA Environmental Learning Centre: Living Machine

CMHC Healthy House: Waterloo Biofilter

Water Efficiency: Examples

The White Rock Operations Centre uses 100% reclaimed water for both vehicle washing and landscape watering.

Energy and Atmosphere: 25% : 17/70 points

includes three prerequisites – fundamental building systems commissioning, minimum energy performance, and CFC reduction in HVAC&R equipment. The prerequisites are followed by six credits for energy performance, renewable energy and additional building monitoring, with a potential value of eight points.

Energy & Atmosphere	17 Possible Points	
Prerequisite 1	Fundamental Building Systems Commissioning	Required
Prerequisite 2	Minimum Energy Performance	Required
Prerequisite 3	CFC Reduction in HVAC&R Equipment	Required
Credit 1	Optimize Energy Performance	1 to 10
Credit 2.1	Renewable Energy, 5%	1
Credit 2.2	Renewable Energy, 10%	1
Credit 2.3	Renewable Energy, 20%	1
Credit 3	Additional Commissioning	1
Credit 4	Ozone Depletion	1
Credit 5	Measurement & Verification	1
Credit 6	Green Power	1

Energy and Atmosphere: 25% : 17/70 points cont'd

Prior to the adoption of LEED, energy efficiency was the only motivation to improving design strategies! It did succeed in effecting:

- increased levels of insulation,
- higher efficiency ratings on appliances and heating/cooling systems
- tighter building envelopes

Within the holistic sustainable design framework provided by LEED, the relative importance of these issues has been revised to represent only 25% of the potential credits.

Energy and Atmosphere: Examples

BC Gas, Surrey, BC.

- orientation differentiation
- shading devices
- natural ventilation
- passive gain

Energy and Atmosphere: Examples

- orientation differentiation
- shading devices
- natural ventilation
- passive gain

Revenue Canada,
Surrey, BC.

Materials and Resources: 20% : 14/70 points

with 14 points generated in seven credits, this section has only one prerequisite: storage and collection of recyclables. The credits focus on building reuse; waste management; reused, recycled or certified materials; as well as local or regional materials.

LEED Canada has introduced a new credit in this category to recognize the importance of building durably.

Credit 8: Durable Building

- "Minimize materials use and construction waste over a building's life resulting from premature failure of the building and its constituent components and assemblies"
- promotes the incorporation of materials based upon a Life Cycle Assessment viewpoint
- credit references the *Guideline on Durability in Buildings CSA S478-95 (R2001)*
- If components cannot be proven to last for the design service life of the building, then they are to be specified and constructed with disassembly in mind
- demonstrate the predicted service life of chosen components or assemblies by documenting demonstrated effectiveness or modelling deterioration
- submittals require documentation of the training of the building envelope designer in the area of building science

Materials & Resources	**14 Possible Points**	
Prerequisite 1	Storage & Collection of Recyclables	Required
Credit 1.1	Building Reuse, Maintain 75% of Existing Shell	1
Credit 1.2	Building Reuse, Maintain 100% of Shell	1
Credit 1.3	Building Reuse, Maintain 100% of Shell & 50% Non-Shell	1
Credit 2.1	Construction Waste Management, Divert 50%	1
Credit 2.2	Construction Waste Management, Divert 75%	1
Credit 3.1	Resource Reuse, Specify 5%	1
Credit 3.2	Resource Reuse, Specify 10%	1
Credit 4.1	Recycled Content, Specify 5% p.c. or 10% p.c. + 1/2 p.i.	1
Credit 4.2	Recycled Content, Specify 5% p.c. or 20% p.c. + 1/2 p.i.	1
Credit 5.1	Local/Regional Materials, 20% Manufactured Locally	1
Credit 5.2	Local/Regional Materials, of 20% in MRc5.1, 50% Harvested Loc	1
Credit 6	Rapidly Renewable Materials	1
Credit 7	Certified Wood	1
Credit 8	Durable Building	1

Just added in LEED Canada V1, Credit 8: Durability, making the total a score out of 70.

Materials and Resources: Examples

- low energy/durable materials
- re-used large timbers in roof structure
- also low site impact - no destruction of local trees, retained site vegetation
- flyash concrete

Liu Centre for Asian Studies, UBC

Materials and Resources: Examples

Telus Building,
Vancouver, BC

- avoided demolition of building
- re-used concrete structure
- energy efficient double skin façade (EA)
- exposed concrete for passive gain (EA)

Materials and Resources: Examples

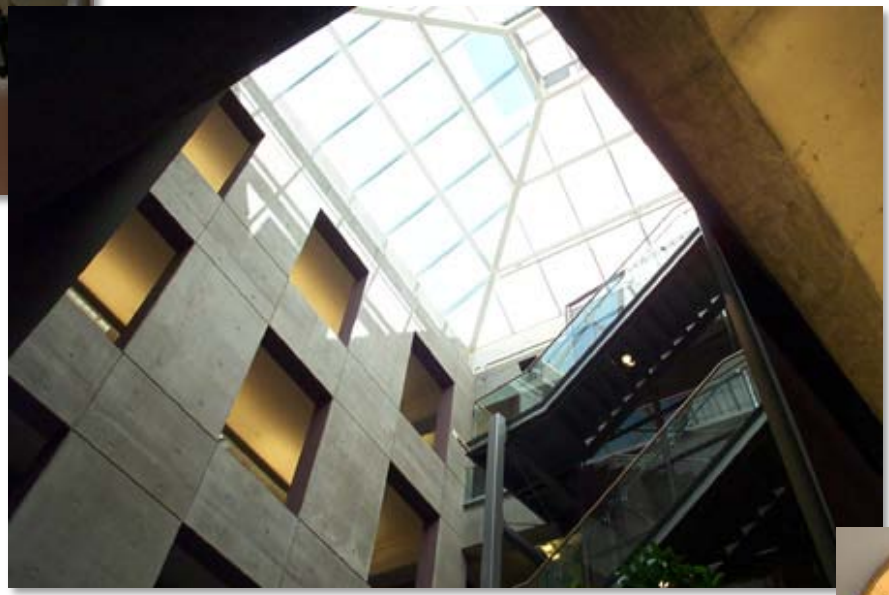
- re-used brick on exterior
- re-used large timber structures on interior
- composting toilets (WE)
- natural ventilation (IEQ)

C.K. Choi Institute, UBC

Materials and Resources: Flyash Concrete

York University, Computer Science Building, Toronto

BC Gas, Surrey, BC



Flyash is a waste product from the production of steel that can be used to replace a significant portion of the cement in the concrete mix. Cement is environmentally bad because of its high embodied energy.

Indoor Environmental Quality: 22% : 15/70 points

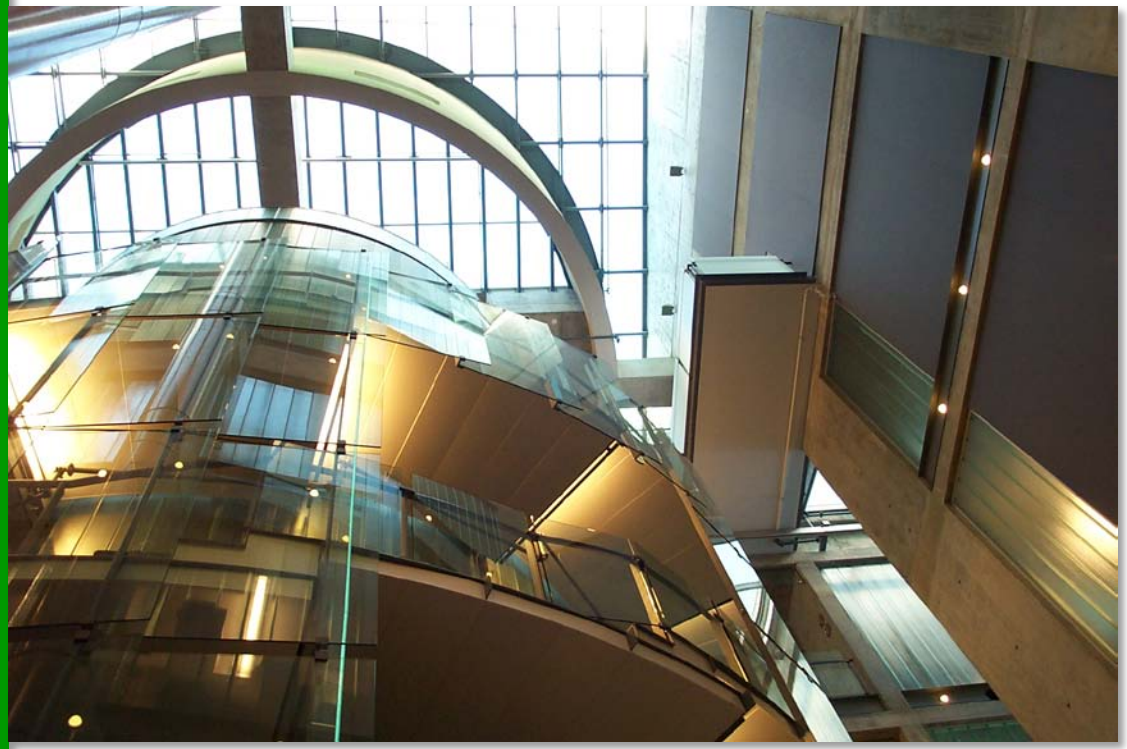
is the largest category with two prerequisites, IAQ performance and environmental tobacco smoke control, eight credits and a total of 15 points. The credits in the indoor environment quality cover many issues of air quality, including ventilation and carbon dioxide monitoring, low-emitting materials, construction IAQ, controllability of systems, operable windows, thermal comfort and daylight and view access. This category places high emphasis on occupant comfort and well-being – issues that are not addressed in other mandatory code requirements – this category falling outside issues of life safety, structural integrity and minimum energy requirements.

(Indoor Environmental Quality is not addressed in the Building Code to any extent, so many commercial and institutional buildings ignore this requirement completely)

Indoor Environment Quality	15 Possible Points	
Prerequisite 1	Minimum IAQ Performance	Required
Prerequisite 2	Environmental Tobacco Smoke (ETS) Control	Required
Credit 1	Carbon Dioxide (CO_2) Monitoring	1
Credit 2	Ventilation Effectiveness	1
Credit 3.1	Construction IAQ Management Plan, During Construction	1
Credit 3.2	Construction IAQ Management Plan, Before Occupancy	1
Credit 4.1	Low-Emitting Materials, Adhesives & Sealants	1
Credit 4.2	Low-Emitting Materials, Paints	1
Credit 4.3	Low-Emitting Materials, Carpet	1
Credit 4.4	Low-Emitting Materials, Composite Wood	1
Credit 5	Indoor Chemical & Pollutant Source Control	1
Credit 6.1	Controllability of Systems, Perimeter	1
Credit 6.2	Controllability of Systems, Non-Perimeter	1
Credit 7.1	Thermal Comfort, Comply with ASHRAE 55-1992	1
Credit 7.2	Thermal Comfort, Permanent Monitoring System	1
Credit 8.1	Daylight & Views, Daylight 75% of Spaces	1
Credit 8.2	Daylight & Views, Views for 90% of Spaces	1

Indoor Environmental Quality: Examples

Bahen Centre, UofT



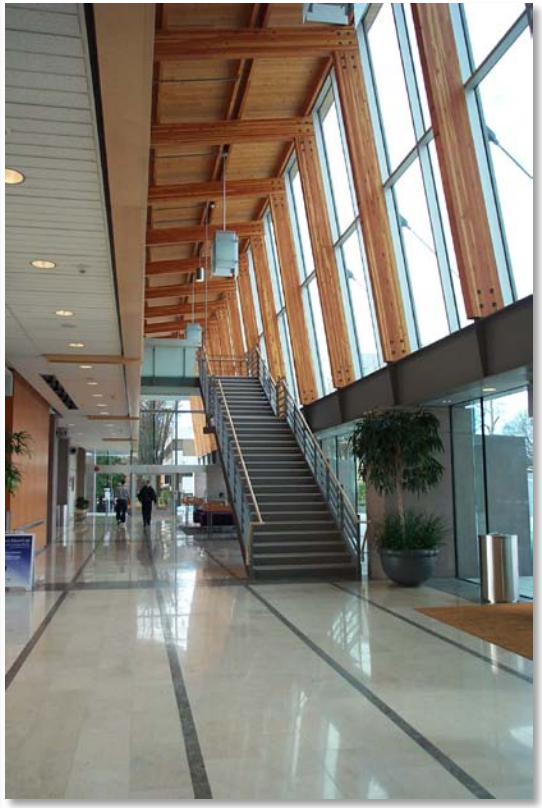
- daylighting

Indoor Environmental Quality: Examples

Jackson-Triggs Estate Winery,
Niagara-on-the-Lake, Ontario

- daylighting

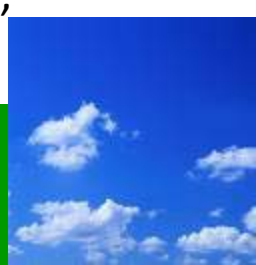
Indoor Environmental Quality: Daylighting and Views



Richmond City Hall, Richmond, BC

Mountain Equipment Coop, Ottawa

Information Technology Building, UofO, Ottawa



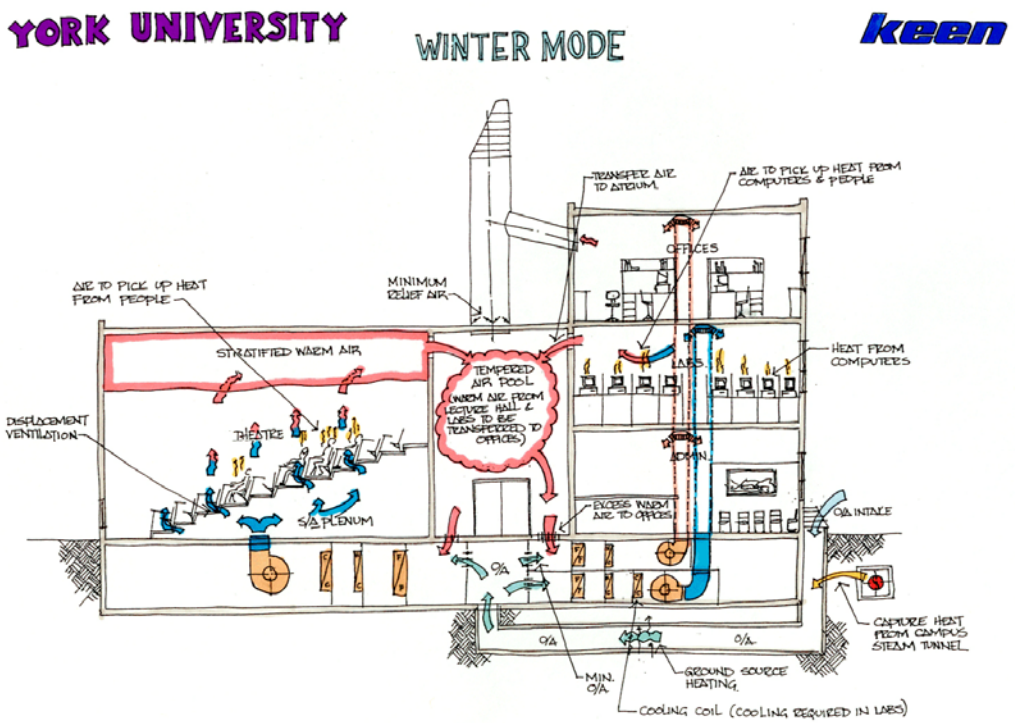
Innovation and Design Process: 7% : 5/70 points

allows a building to obtain as many as four design innovation points, as well as one additional point for including a LEED accredited professional in the design process. The design innovation points may be awarded for achievements such as lifecycle analysis, community development or education of occupants. Substantially exceeding one of the earlier credits, may also merit an innovation point.

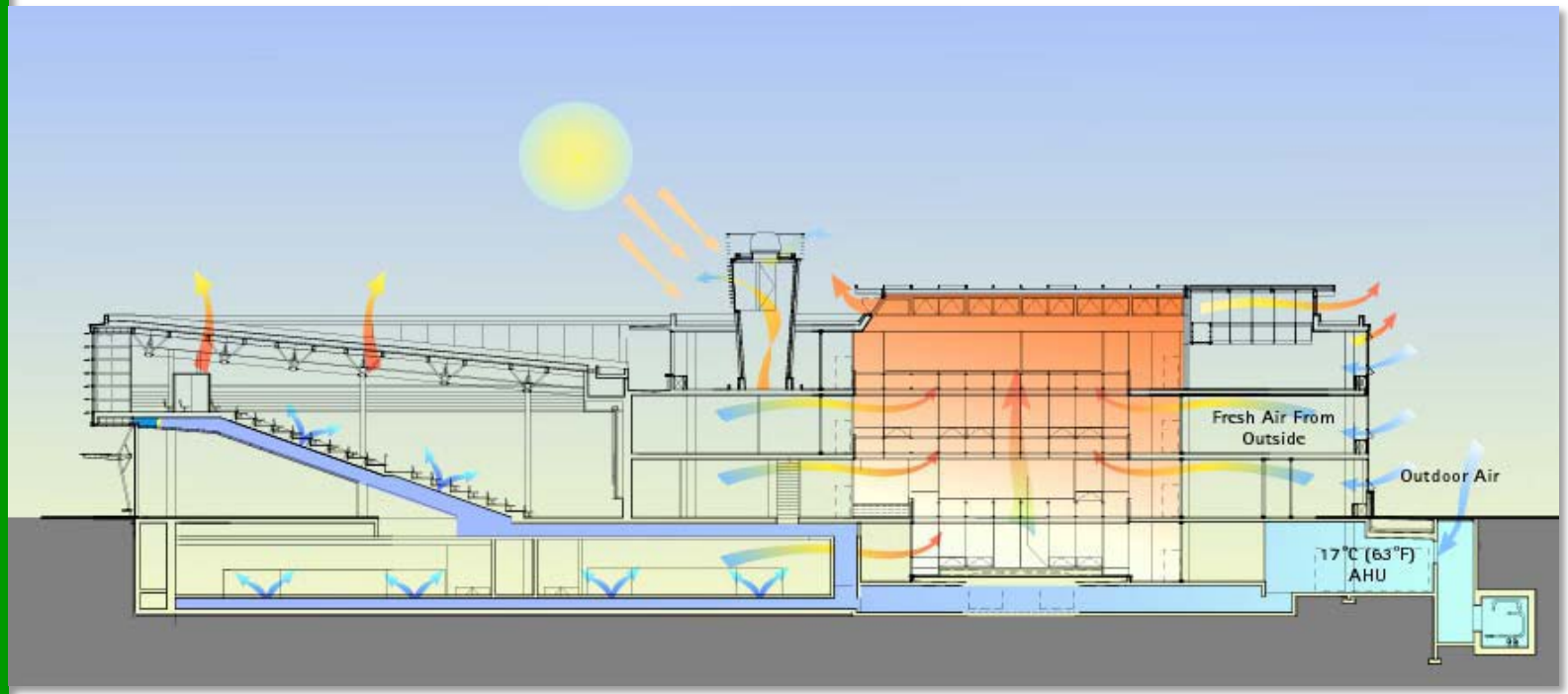
Innovation & Design Process	5 Possible Points	
Credit 1.1	Innovation in design	1
Credit 1.2	Innovation in design	1
Credit 1.3	Innovation in design	1
Credit 1.4	Innovation in design	1
Credit 2	LEED™ Accredited Professional	1

This is likely the trickiest set of credits to get… and the ones that involve the greatest commitment of effort (aside from Credit 2 which is a no-brainer!)

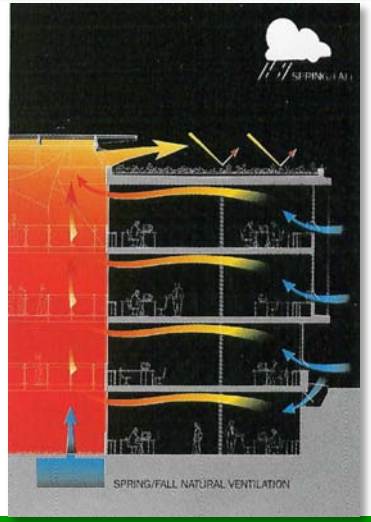
Innovation and Design Process: Examples



York University Computer Science Building: A critical part of the success of this project was the involvement of the ENTIRE design team from the outset of the project. Working with the mechanical engineer allowed the Architects to lay out the building to properly zone the uses so to have heat generating process on the cool side of the building, etc.



The realization of the shape of the building and the relationships between the spaces was not remarkably dissimilar from the early IDP sketches generated by the team.



LEED-NC® Certification Process

A three step process:

- Step 1: Project Registration
  - LEED Letter Templates, CIR access, and on-line project listing
- Step 2: Technical Support
  - Reference Package
  - Credit Inquiries and Rulings (CIR)
- Step 3: Building Certification
  - Upon documentation submittal and USGBC review

Cost of LEED Certified Buildings

Figure III-1. Level of Green Standard and Average Green Cost Premium

Level of Green Standard	Average Green Cost Premium
Level 1 – Certified	0.66%
Level 2 – Silver	2.11%
Level 3 – Gold	1.82%
Level 4 – Platinum	6.50%
Average of 33 Buildings	1.84%

Source: USGBC, Capital E Analysis

Cost of LEED Certified Buildings

- Average cost for for a green building is around 2% cost premium, which is $3-5/s.f.

- The financial benefits of green design run from $50 (Certified & Silver) to $75 (Gold & Platinum) per s.f. in a LEED™ building – more than 10 times the additional cost associated with building green up to LEED™ Gold level makes financial sense today sustainable buildings are a cost-effective investment.

LEED Canada-NC 1.0 Changes from USGBC LEED 2.1: Highlights of Major Changes

- Substitution of applicable base Canadian codes, standards, regulations where possible
- Some increases in performance targets
- Clearer definitions of requirements
- Added flexibility in many credits
- One new additional credit, Durability, exclusive to Canada

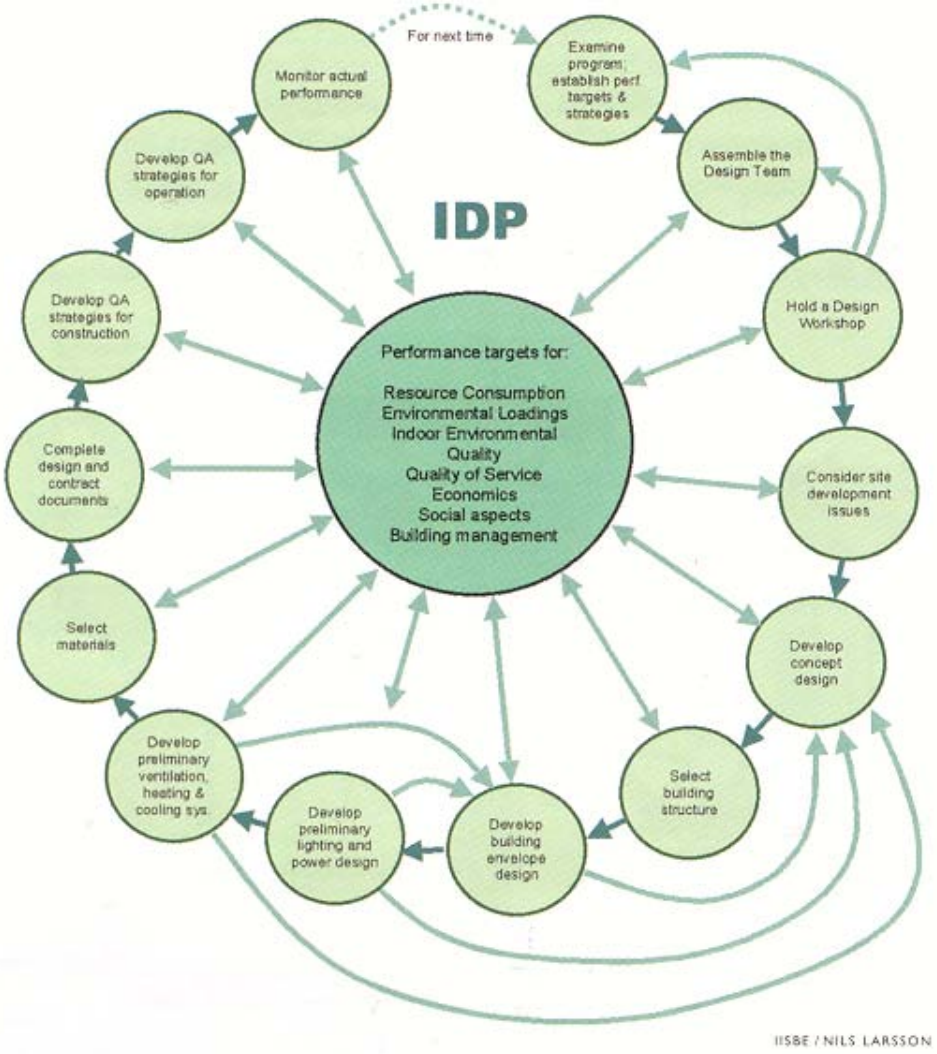
Integrated Design Process (IDP)

Conventional Design Process: the architect (or designer) and the client agree on a design concept consisting of a general massing scheme, orientation, fenestration and the general exterior appearance of the building. Then the mechanical, electrical and structural engineers are asked to implement the design and to suggest appropriate systems.

The problem with conventional practice is that this design process is too quick and simple, often resulting in high operating costs, poor comfort performance and very few sustainable gestures that fall within the client's restrained budget.

This is often a surprise to the owners, operators and users, since the conventional design process usually does not involve computer simulations of predicted energy performance and cost. In fact, engineers have little or no enthusiasm in this context as their role is limited to applying code requirements, cost-benefit analysis and, at times, satisfying the whimsical desires of traditional designers.

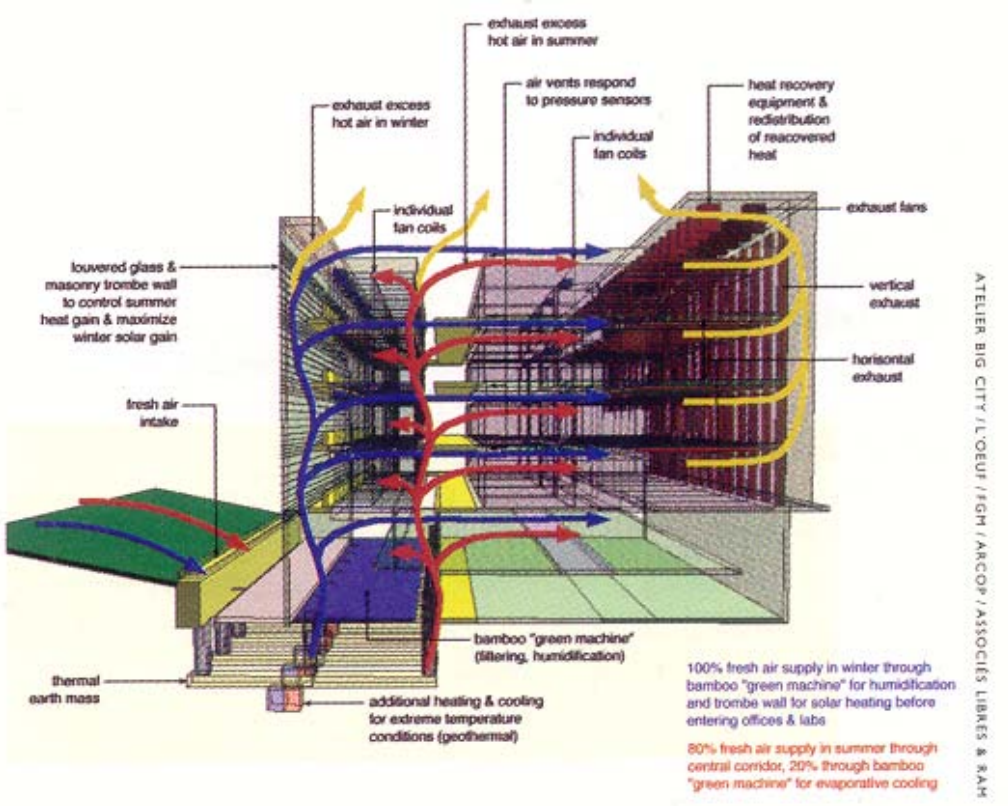
Integrated Design Process (IDP)



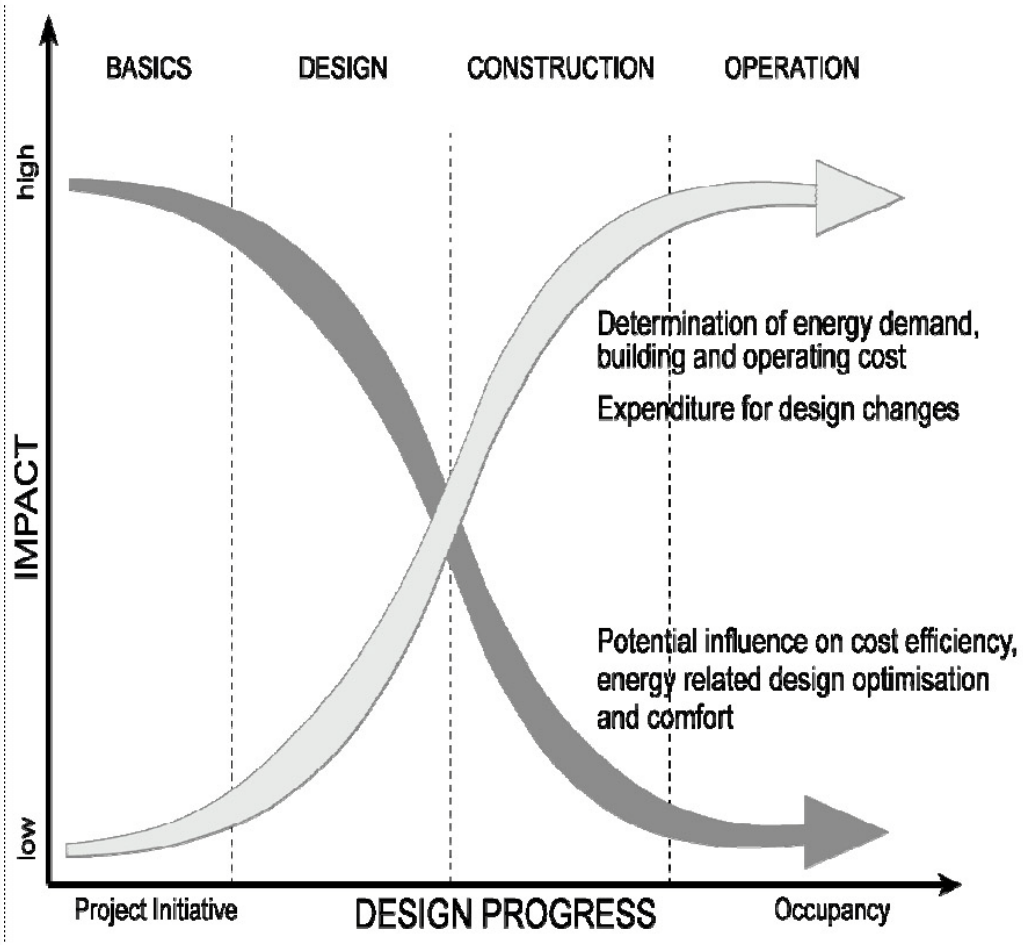
In professional practice, IDP has a significant impact on the makeup and role-playing of the initial design team. The client takes a more active role than usual, the architect becomes a team leader rather than the sole form-giver, and the structural, mechanical and electrical engineers take on active roles at early design stages. The team includes an energy specialist (simulator) and hopefully, a bio-climatic engineer.

Integrated Design Process (IDP)

IDP is not a mechanized design approach that stunts creative iterations; in fact it can help evaluate the potential of numerous schematic design approaches with corresponding bio-climatic strategies at the earliest design stage possible. More specifically, it is the realization that more than 80% of the poetic, economic and ecological potential of a design approach is defined at the earliest stage, and thus it is crucial to have as much input from as wide a cross section of disciplines as possible, involved even at the most embryonic design stage.

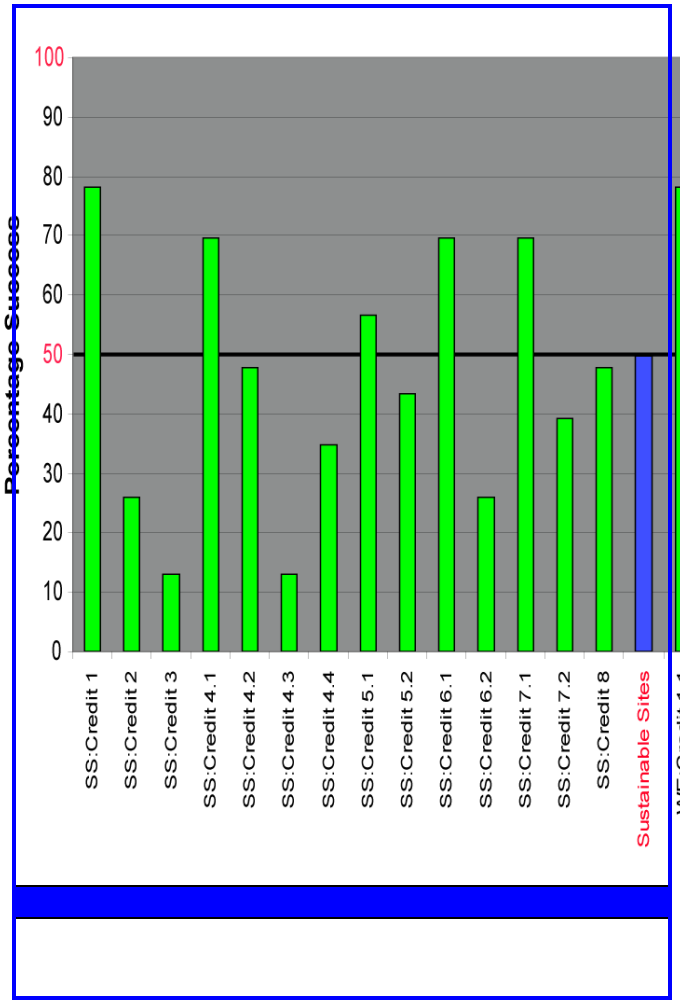


Integrated Design Process (IDP)



It is generally accepted that the impact of decisions varies inversely with the time in the process the decision is made, while the direct cost of such decisions vary directly with time. In other words, early decisions are usually cheap and have a major impact on the ultimate performance of the building, while later changes are expensive and have little hope of improving performance .

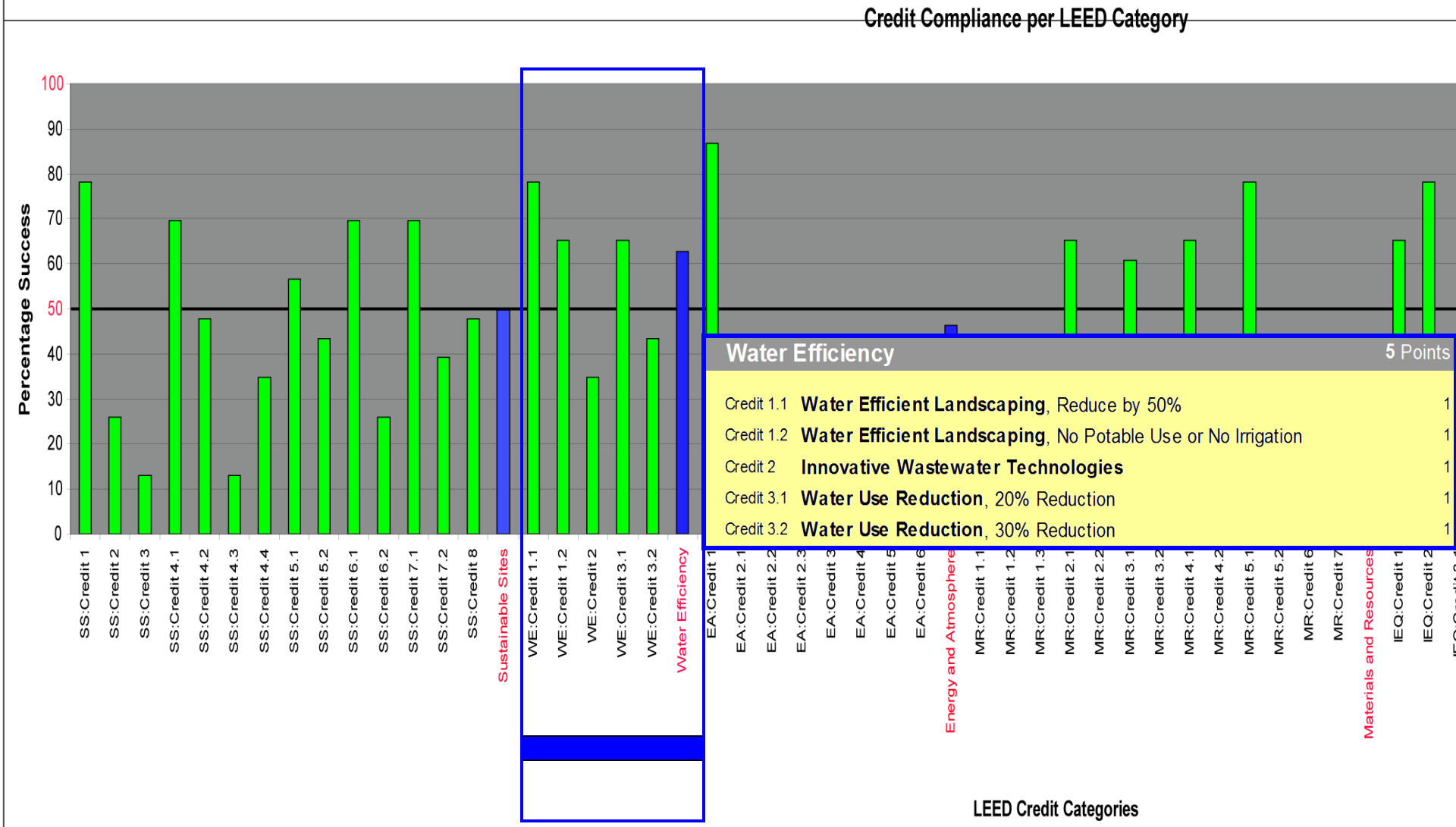
Credit Compliance per LEED Category



Sustainable Sites — 14 Points

Prereq 1	**Erosion & Sedimentation Control**	Required
Credit 1	**Site Selection**	1
Credit 2	**Development Density**	1
Credit 3	**Brownfield Redevelopment**	1
Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling	1
Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
Credit 6.1	**Stormwater Management**, Rate and Quantity	1
Credit 6.2	**Stormwater Management**, Treatment	1
Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
Credit 8	**Light Pollution Reduction**	1

This chart summarizes the successes of the full database of 25 projects studied to see which points are being achieved and which are being missed *(all pre-requisites MUST be satisfied to be certified).*



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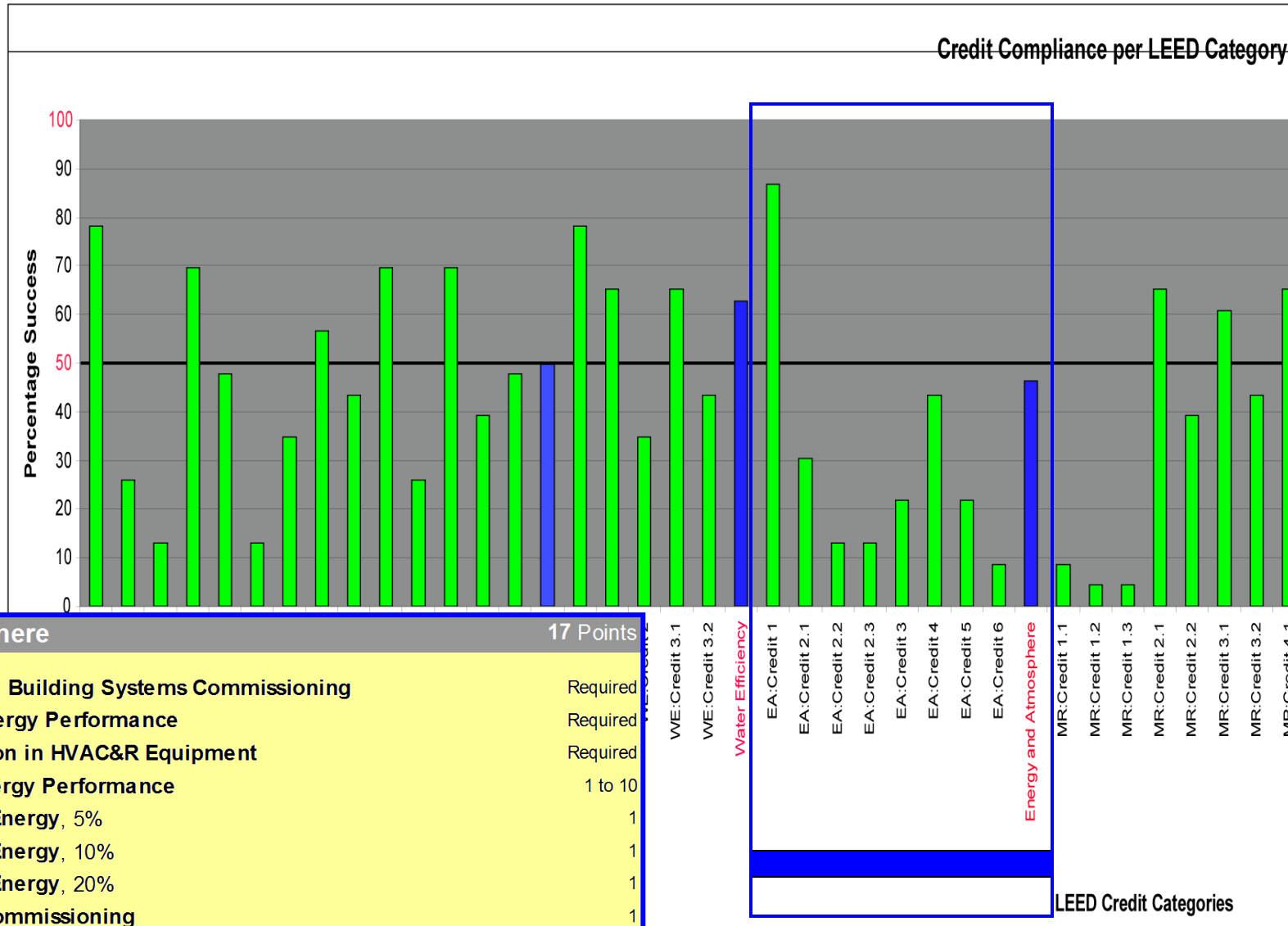

Energy & Atmosphere		17 Points
Prereq 1	**Fundamental Building Systems Commissioning**	Required
Prereq 2	**Minimum Energy Performance**	Required
Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
Credit 1	**Optimize Energy Performance**	1 to 10
Credit 2.1	**Renewable Energy**, 5%	1
Credit 2.2	**Renewable Energy**, 10%	1
Credit 2.3	**Renewable Energy**, 20%	1
Credit 3	**Additional Commissioning**	1
Credit 4	**Ozone Depletion**	1
Credit 5	**Measurement & Verification**	1
Credit 6	**Green Power**	1

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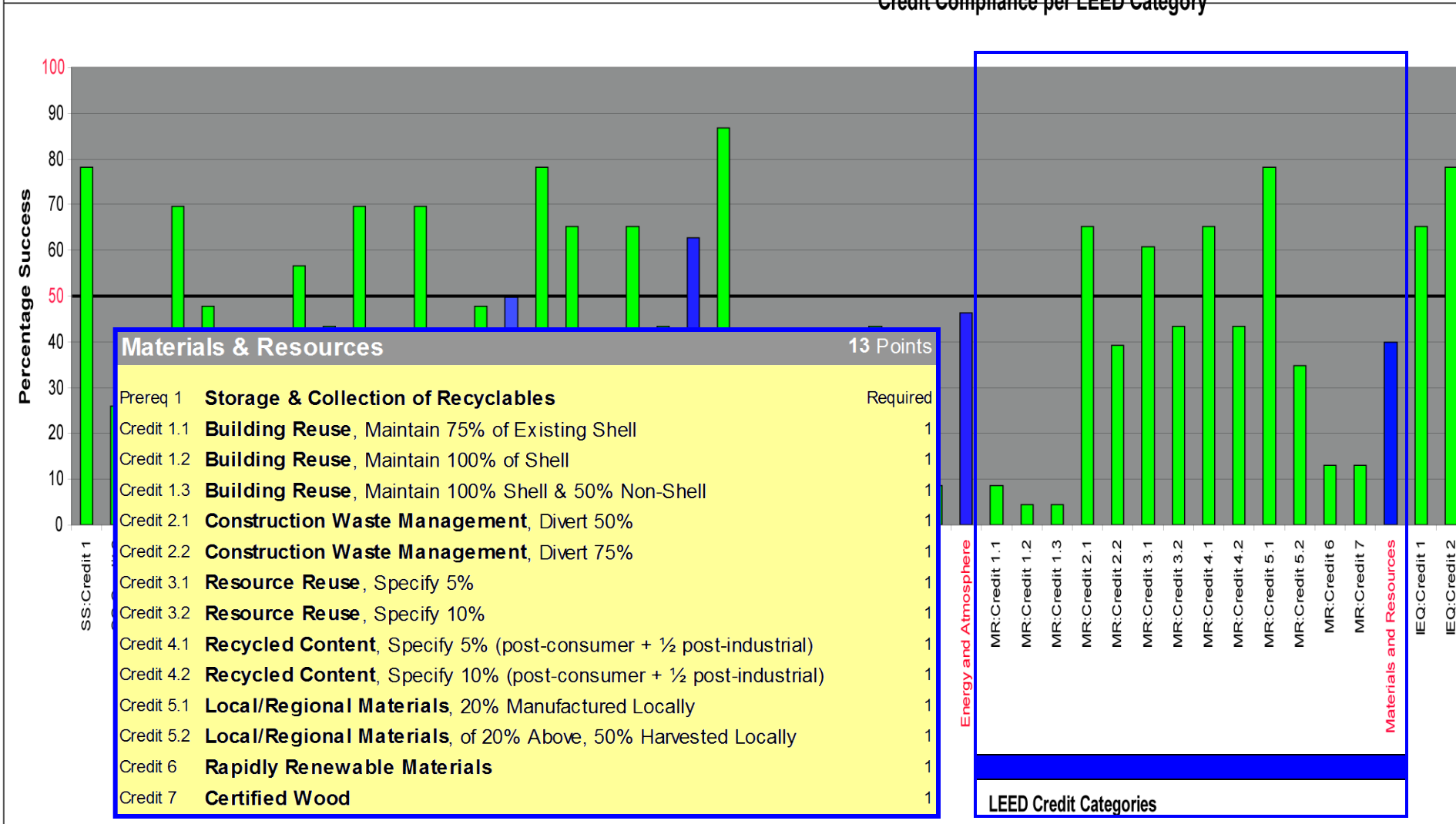
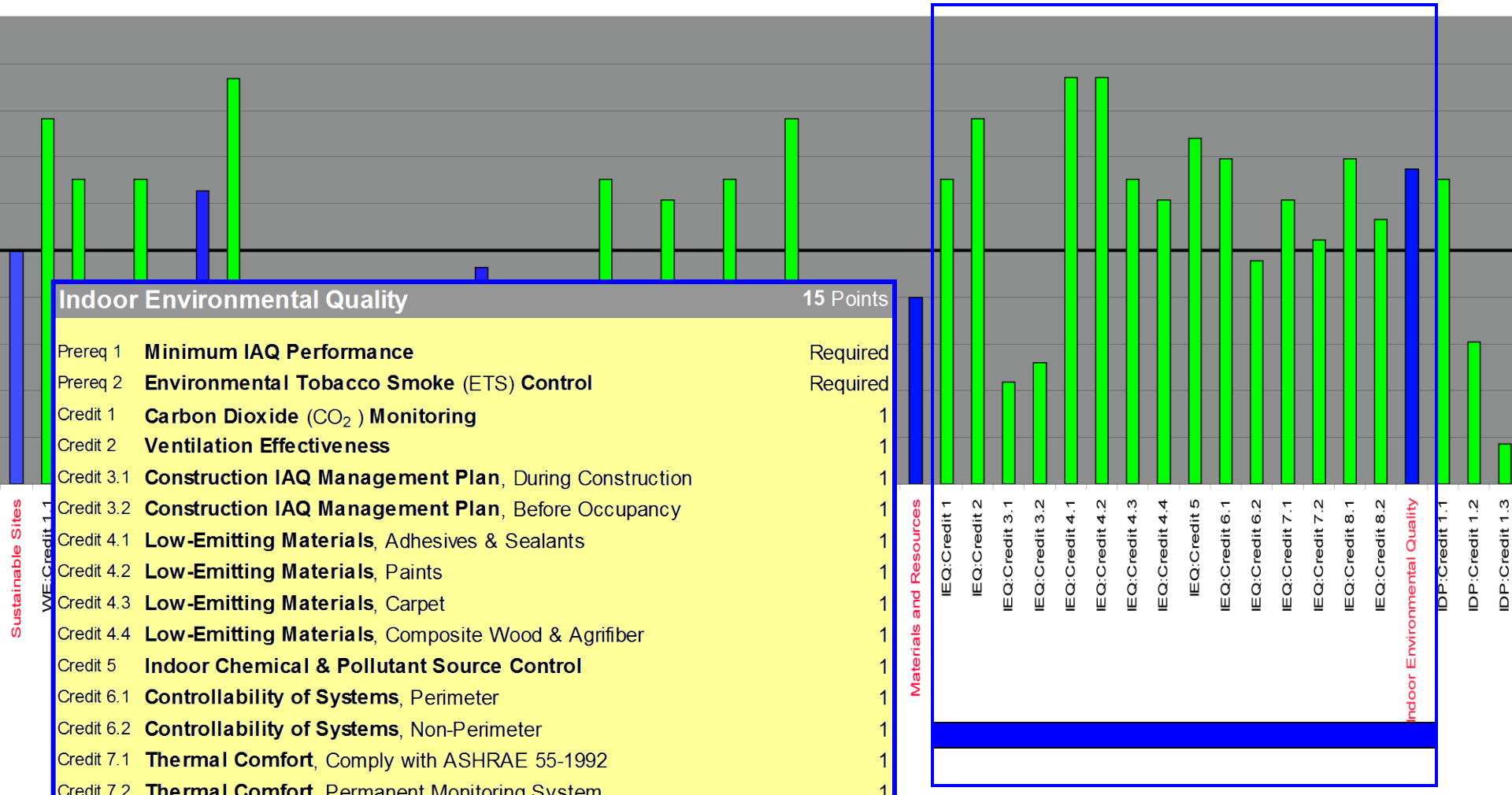


Materials & Resources — 13 Points

Prereq 1	**Storage & Collection of Recyclables**	Required
Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1
Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
Credit 2.1	**Construction Waste Management**, Divert 50%	1
Credit 2.2	**Construction Waste Management**, Divert 75%	1
Credit 3.1	**Resource Reuse**, Specify 5%	1
Credit 3.2	**Resource Reuse**, Specify 10%	1
Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	1
Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	1
Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
Credit 6	**Rapidly Renewable Materials**	1
Credit 7	**Certified Wood**	1

This chart summarizes the successes of the full database of 25 projects studied to see which points are being achieved and which are being missed *(all pre-requisites MUST be satisfied to be certified).*

Credit Compliance per LEED Category



Indoor Environmental Quality — 15 Points

Prereq 1	**Minimum IAQ Performance**	Required
Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
Credit 2	**Ventilation Effectiveness**	1
Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
Credit 4.2	**Low-Emitting Materials**, Paints	1
Credit 4.3	**Low-Emitting Materials**, Carpet	1
Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber	1
Credit 5	**Indoor Chemical & Pollutant Source Control**	1
Credit 6.1	**Controllability of Systems**, Perimeter	1
Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

This chart summarizes the successes of the full database of 25 projects studied to see which points are being achieved and which are being missed *(all pre-requisites MUST be satisfied to be certified).*