LEED™: Evaluating The Impact Potential On Building Envelope Design

Terri Meyer Boake
School of Architecture, University of Waterloo

ABSTRACT

The purpose of this research paper will be to examine the specifics of the LEED framework and requirements and to report both an assessment and a checklist of the impact of the LEED criteria on current practices in building envelope design. Within the LEED Rating System sections, there are areas that will obviously require the alignment of the building envelope – and there are also others where a building envelope design response may not be quite as obvious. How do current design practices and performance requirements of building envelope design (already) satisfy LEED, and what changes to building envelope design are either implied or necessitated by the proposed more widespread adoption of LEED.

INTRODUCTION

Background

Ever since the building science industry first became conscious of the need for energy conservation and environmentally motivated design in buildings 3 to 4 decades ago, the building envelope has borne the brunt of the change. Such change has resulted in significant increases in insulation levels, air tightness, long-term performance, and most recently, mold resistance. Most of the energy-motivated changes have resulted in modifications to the Building Code, making the various improvements in the building envelope a legally binding requirement.

The idea of energy and environmentally improved design has recently gained momentum. 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. LEED Canada Version 1.0 was approved in August 2004 for Canadian building certification. 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. In addition to creating a working definition of "green building", LEED promotes integrated, whole-building integrated design practices (IDP). This paper references the new LEED Canada Version 1.0 document.

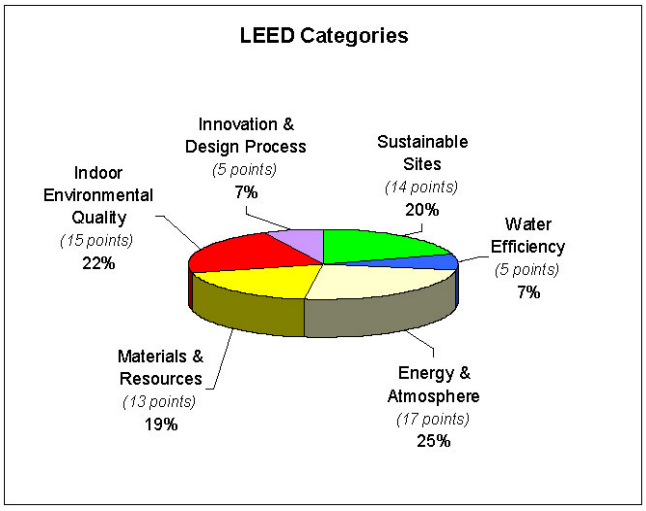

Figure 1: The LEED Pie (based on the US system of 69 points)

The structure of the LEED Rating System is segmented into sections, credits and points. The five key sections (initiatives) are identified as sustainable sites, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. In addition to these five initiatives, a sixth section is reserved for design process and innovation. This framework definition of sustainable design extends former ideas of energy efficient design to include aspects that encompass the whole building, all of its systems, and all questions related to site development. The original motivation for increased skin performance, *energy conservation*, a result of the energy crisis of the mid 1970s, only accounts for 25% of the current list of requirements for sustainable design under the LEED umbrella.

LEED is beginning to function as a "motivational" tool to those in the building industry, because of its "medal" oriented rating system. Buildings are awarded Platinum (52-70 points), Gold (39-51 points), Silver (33-38 points) or Certified (26-32 points) status based on a system of reward points. This framework definition of sustainable design extends former ideas of energy efficient design (which were envelope dominated concerns) to include aspects that encompass the whole building, all of its systems, and all questions related to site development. Most sections include one or more basic *prerequisite* items. These must be fulfilled or the balance of the points in the category will not be counted.

THE LEED CATEGORIES: RELATIONSHIP TO BUILDING ENVELOPE DESIGN

A. SUSTAINABLE SITES:

Sustainable sites deals primarily with issues of site selection, site access and site design (materials, density, drainage). Connections to the building envelope may not be obvious. 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 IDP. Although urban/brownfield sites, being denser, are highly preferred over rural or green field sites, items such as green roofs and reductions in the urban heat island effect through materials selections do raise envelope issues as they impact general roof design issues. The Heat Island Credits 7.2 gives direct preference to the use of high albedo roofing materials if a green roof is not to be used. Also included in this category could be the use of new BIPV flat roofing systems, which require different detailing to ensure proper function as both a PV element and a roofing membrane. Site selection also impacts the potential for passive solar and daylighting systems that may be part of the overall envelope strategy.

Figure 2: Vancouver Public Library. Moshe Safdie and Associates with Downs Archambault and Partners.
Sustainable Sites: Credit 7.2 Landscape & Exterior Design to Reduce Heat Islands (roof)

Table 1a: Sustainable Sites and the Building Envelope

Credit	Pts	Name and Description	Impact on the Building Envelope
		Sustainable Sites	
Prereq		**Erosion and Sedimentation Control**: reduce negative impacts on water and air quality	none
1	1	**Site Selection:** do not develop on land which is prime farmland, habitat for any threatened or endangered species, within 100 of water ways or wetlands, lower than 5 feet above the 100 year flood or public parkland	While urban sites pose challenges with over-shadowing from nearby neighbouring buildings, rural sites provide freedom for solar design, which may impact envelope design for some buildings.
2	1	**Development Density:** utilize sites within a density zone of 60000 s.f./acre (2-storey downtown development density)	Increased site density may require deeper floor-plates and more urban siting. Urban areas may have noise issues that need to be controlled in the envelope/window STI ratings.
3	1	**Brownfield Redevelopment:** remediate contaminated site for building use	none
4.1	1	**Alternative Transportation:** locate project near commuter rail, subway or bus lines	none
4.2	1	**Alternative Transportation:** include secure bicycle storage, showers and changerooms	none
4.3	1	**Alternative Transportation:** provide alternative-fuel vehicles or alternative-fuel refuelling stations.	none
4.4	1	**Alternative Transportation:** encourage car-pools/van-pools and limit new parking	none
5.1	1	**Reduced Site Disturbance:** limit site disturbance to conserve and restore habitats and biodiversity	Promotes greater care for the unbuilt, exterior part of a site. This may cause problems with construction staging for various exterior systems.
5.2	1	**Reduced Site Disturbance:** reduce the development footprint to exceed local zoning requirements for open space	Promotes greater care for the unbuilt, exterior part of a site. This may cause problems with construction staging for various exterior systems.
6.1	1	**Stormwater Management:** limit the rate and quantity of stormwater run-off	none
6.2	1	**Stormwater Management:** Include a stormwater treatment system on site to eliminate contaminants and increase infiltration.	none
7.1	1	**Heat-Island Effect:** provide shade within 5 years or place parking underground or use open grid paving	none
7.2	1	**Heat-Island Effect:** use high-albedo roofing or a green roof	Choice of materials may affect reflectivity of roof. BIPV roofing may be acceptable as most are mounted on white coloured membranes. High impact on the design of the roofing system.
8	1	**Light Pollution Reduction:** reduce the impact of building and site lighting on nocturnal habitats and night-sky access	May impact window design, orientation and quantity.

B. WATER EFFICIENCY:

Water efficiency 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. Although water efficiency may not present an obvious connection to envelope design, the inclusion of some systems, such as Green Walls and Living Machines can greatly increase the relative humidity of the interior environment, which in turn can impact a wall that may not be properly detailed and therefore prone to deterioration due to air leakage or vapour diffusion of the higher humidity air. Living Machines™ and Living/Breathing Walls are being used more frequently in institutional and commercial building projects.

Figure 3: YMCA Environmental Learning Centre, Charles Simon Architect
Water Efficiency: Credit 2 Innovative Wastewater Technologies: Living Machine™

Table 1b: Water Efficiency and the Building Envelope

Credit	Pts	Name and Description	Impact on the Building Envelope
		Water Efficiency	
1.1	1	**Water Efficient Landscaping:** reduce use of potable water for irrigation by 50%	none
1.2	1	**Water Efficient Landscaping:** use no potable water for irrigation or do not install a permanent irrigation system	none.
2	1	**Innovative Wastewater Technologies:** reduce building sewage by 50% or treat 100% of waste water on site	Use of systems such as Living Machines™, Breathing/Living Walls, Biofilters, may increase interior humidity and vapour pressure putting a higher than normal load on the envelope system for moisture control.
3.1	1	**Water Use Reduction:** reduce building water consumption by 20% over the calculated baseline	As above
3.2	1	**Water Use Reduction:** reduce building water consumption by 30% over the calculated baseline	As above

C. ENERGY AND ATMOSPHERE:

Energy and Atmosphere, 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. The optimization of energy performance in the building accounts for 10 potential points in this category – out of a maximum of 70 for the entire building evaluation. Energy performance issues will include overall wall design, insulation levels,

airtightness, selection of systems and materials for high thermal values, selection of glazing systems for high thermal value, and conversely, selection of glazing systems to increase passive solar gain where applicable.

Prior to the adoption of LEED, energy efficiency might have been the only motivation to improving envelope related design strategies. Within the holistic sustainable design framework provided by LEED, the *apparent* importance of these issues has been revised to represent only 25% of the potential credits. This is likely the area where interests of envelope design can be seen as most important.

Energy efficient building envelope design may also include passive solar strategies, differentiated façade design, shading devices, etc. Such envelope design strategies will be able to positively impact potential LEED credits under energy optimization, as well as crossing over into areas of Indoor Environmental Quality.

The emergence of Building Integrated Photovoltaic systems (BIPV) presents new considerations in envelope design and can create an even more efficient envelope if it is capable of also producing electricity. PV that is incorporated into skylight and curtainwall systems, can also be used to effect shading, thereby reducing cooling loads.

Figure 4: BC Gas (Terasan Gas) Musson, Cattell Mackey Partnership
Energy Efficiency: Prereq 2: Minimum Energy Performance: Solar shading to reduce energy consumption. Differentiated façade strategies as a function of orientation.

Table 1c: Energy and Atmosphere and the Building Envelope

Credit	Pts	Name and Description	Impact on the Building Envelope
		Energy & Atmosphere	
Prereq		**Fundamental Building Systems Commissioning:** verify design, installation and calibration of the fundamental building systems	Although not directly linked to the envelope, certain choices in envelope design can be validated with commissioning as a requirement.
Prereq		**Minimum Energy Performance:** ensure a minimum energy efficiency to comply with ASHRAE 90.1-1999[1]	Requires the design of an efficient, well-insulated building envelope to meet the minimum level – good since a permit can be purchased without meeting this base criteria!
Prereq		**CFC Reduction in HVAC&R Equipment**: base building HVAC&R equipment is to use no CFC-based refrigerants	none
1	**1 - 10**	**Optimize Energy Performance:** exceed the ASHRAE 90.1-1999 energy performance standard for	Many of these points drive decisions in envelope design: super insulation, high quality roofing, wall, window and curtain wall systems. This area

		regulated systems	can also encourage passive solar design strategies for heating, which can impact envelope design strategies.
2.1	1	**Renewable Energy:** include on-site renewable energy systems to provide at least **5%** of the total energy use of the building	Some envelope implications, as a good envelope that reduces heating and cooling requirements can lower all energy requirements and possibly make 100% use of renewables more achievable. Encourages use of PV and BIPV, which must be incorporated into envelope systems (windows, skylights and roofs).
2.2	1	**Renewable Energy:** include on-site renewable energy systems to provide at least **10%** of the total energy use of the building	
2.3	1	**Renewable Energy:** include on-site renewable energy systems to provide at least **20%** of the total energy use of the building	
3	1	**Best Practice Commissioning:** complete additional verification of systems design, construction and calibration	Post occupancy evaluations can help to ensure that occupants have been properly educated to prevent improper functioning of building. This can reinforce the effectiveness of decisions made on the building envelope if extra costs were involved to predict the generation of energy savings.
4	1	**Ozone Protection:** ensure that base building HVAC&R and fire suppression systems do not use HCFCs or Halons	No significant impact.
5	1	**Measurement and Verification:** install metering equipment for key efficiency issues including lighting systems, motor loads, chiller efficiency, cooling load, and several others	This can help to ensure that occupants have been properly educated to prevent improper functioning of building. This can reinforce the effectiveness of decisions made on the building envelope if extra costs were involved to predict the generation of energy savings.
6	1	**Green Power:** engage in a minimum two-year contract for renewable energy to supply at least 50% of the building's electricity	none

D. MATERIALS AND RESOURCES:

Materials and resources, with 13 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. This portion of the LEED requirements has a high impact on issues of building envelope – and inversely, the particular design and materials selection/specification of the building envelope has extreme impact potential on the award of these points.

Building Re-use (Credits 1.1, 1.2 and 1.3) The first 3 credits that pertain to the reuse of buildings will impact both the overall design of the envelope as they will infer the inclusion of elements that may or may not be ultimately desirable when trying to achieve an energy efficient envelope. It is important to note when reviewing the envelope reuse credits that it is expected that "degraded" or "non-energy efficient" elements such as roofing materials are expected to be directed to the waste stream.

Materials Re-use may require additional effort in sourcing components. Care must be taken to ensure that the materials chosen meet with local code requirements for reuse as some authorities limit wood reuse depending on its ultimate role in the building.

Recycled Content credits also require additional investigation when sourcing and specifying materials. It is also important to consider whether or not the materials used in the building envelope have potential for recycling when they are no longer useful in the building: the Cradle to Cradle concept.

The idea behind the *Regional Materials* credits focuses on embodied energy issues as a function of transportation costs. The requirements for this credit have been eased from the USGBC version due to the larger travel distances inherent to Canada. The limiting distance as within a 500-mile (800 km) radius and refers to the location of final assembly of the materials into the manufactured product – the materials themselves may come from further afield.

One of the most significant additions to the Canadian Version of LEED is the inclusion of the new Durable Building Credit. Durability of components and assemblies is a critical part of high quality envelope design. It is the envelope that takes the highest amount of abuse as a result of environmental pressures. The intent of the Durable Building Credit is to "Minimize materials use and construction waste over a building's life resulting from premature failure of the building and its constituent components and assemblies". This credit promotes the incorporation of materials based upon a Life Cycle Assessment viewpoint. This can lead to support for the use of higher quality window and curtain wall systems, roofing membranes, and longer lasting components in general. The 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. This will also impact envelope design practices and specific materials specifications. The submittals also require documentation of the Building Science training and qualifications of the envelope designers. While this may on the surface be good news for this community, it is still quite possible to certify a building without applying for this key credit. The Durability credit may also make it more difficult to use some recycled materials in cladding (for example brick, as illustrated below) as such materials will not come with any quality testing assurance from their manufacturers.

Figure 5: C.K. Choi Institute for Asian Studies, UBC, Matsuaki Wright Architects
Materials and Resources: Credit 4 Recycled Content (both the timber frame and brick veneer cladding)

Table 1d: Materials and Resources and the Building Envelope

Credit	Pts	Name and Description	Impact on the Building Envelope
		Materials & Resources	
Prereq		**Storage and Collection of Recyclables:** provide facilities for storage and separation.	No significant impact.
1.1	1	**Building Reuse:** retain **75%** of walls, floors and roof of existing building on site	Large impact on envelope design. Envelope must be able to accommodate existing conditions and limitations of materials and orientation previously chosen.
1.2	1	**Building Reuse:** retain **95%** of walls, floors and roof of existing building on site	As above
1.3	1	**Building Reuse:** retain **50%** of interior non-shell/non-structure portions of existing building on site	Little impact on envelope.

2.1	1	**Construction Waste Management:** recycle and/or salvage 50% of site waste (construction, demolition and land clearing) to limit material going to landfill	This does not necessarily impact envelope design, but if construction strategies for envelopes generate waste, this must be directed to recycling or salvaging operations. This would include cut-offs of wall studs and sheathing components and gypsum board, for example. Therefore design systems to limit waste from initial principles. Preference for use of prefabricated components on site. Reuse of concrete and other forms.
2.2	1	**Construction Waste Management:** recycle and/or salvage 75% of site waste (construction, demolition and land clearing) to limit material going to landfill	
3.1	1	**Resource Reuse:** source 5% of building materials as salvaged, refurbished or reused	Source such materials and include them in assemblies where applicable and where the use of such materials upholds energy and durability criteria of envelope systems. This would include the use of recycled wood products for cladding and floor finishing, for example.
3.2	1	**Resource Reuse:** source 10% of building materials as salvaged, refurbished or reused	
4.1	1	**Recycled Content:** source 7.5% of building materials: (post-consumer product + ½ post industrial).	Requires consideration when sourcing systems and products to verify their recycled content as this must be entered into a calculation of recycled content for all materials in the building project.
4.2	1	**Recycled Content:** source 15% of building materials: (post-consumer product + ½ post industrial)	
5.1	1	**Regional Materials:** ensure that at least **10%** of building materials and products are manufactured within a 500mi radius of the site, or up to 1500 mi if shipped by rail or water.	When specifying any envelope components, check to see that the location of material source and manufacturing meets this requirement. This may be of concern for specialty systems such as glazing, curtain wall, etc.
5.2	1	**Regional Materials:** ensure that at least **20%** of the building materials and products are harvested, extracted or recovered within a 500mi radius of the site. or up to 1500 mi if shipped by rail or water.	As above.
6	1	**Rapidly Renewable Materials:** ensure that at least 5% of the building materials are made from plants harvested within a ten-year cycle)	This may impact materials selection for components: use of wheat board, strawbale, bamboo and generally plants that are harvested within a 10 year cycle. Durability of such materials if used as an interior wall/ceiling finish, cladding system or main support system as in strawbale construction.
7	1	**Certified Wood:** specify at least 50% of building materials to be wood-based and certified from environmentally responsible forestry operations.	Important in specification of wood framed wall systems, wood window frame systems and exterior deck and screen elements that are wood based, as well as formwork and temporary structures on site.

8 ***NEW***	1	**Durable Building:** Minimize material use and construction waste over a building's life resulting from premature failing of the building and its constituent components and assemblies	This credit is new to the Canadian Version of LEED and has potentially a great impact when specifying higher quality components for all envelope assemblies (walls and roofs) as well as all glazing and window systems. The credit is more difficult than many to document and prove in order to gain the credit points.

E. INDOOR ENVIRONMENTAL QUALITY:

Indoor environmental quality 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, thermal comfort and daylight 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.

Maintaining a high ventilation rate, combined with reduced toxicity as a result of specified components or processes within the building, is the primary goal. Secondly, in the interest of occupant comfort and satisfaction, the section promotes *perimeter control* of "systems" by the occupant. This would include level of heating, cooling, direct sunlight or daylight.

Occupant control of perimeter systems, as well as ventilation requirements (i.e. operable windows) has a large potential impact on the design of envelope systems. These criteria will affect the selection and design of window systems to include a higher than normal percentage of operable units. Control of the operation of windows outside of occupancy hours may require computerized override systems to prevent unnecessary losses during unoccupied hours from windows that have been accidentally left open. It will also increase the inclusion of operable shades in the building perimeter, which may be incorporated into envelope systems. These may be located on the interior or exterior of the building, or integrated into the wall system itself.

Issues of mold in the building envelope (migrating to the interior) or building itself due to improper ventilation practices are dealt with in the IEQ credit categories. Detailing of the envelope system to prevent mold, although not directly stated, is inferred in this category.

Figure 6: C.K. Choi Institute for Asian Studies, UBC, Matsuaki Wright Architects
Indoor Environmental Quality: Ventilation Effectiveness + Control of Perimeter systems

Post occupancy assessment of systems is always important. The operable windows on the C.K. Choi Building may provide user control and ventilation, but feedback indicated that the style of window and its method of opening were uncomfortable for the users. The extreme height and inward tilt was found to feel "threatening", and the upward flow of air was not immediately felt.

Table 1g: Indoor Environmental Quality and the Building Envelope

Credit	Pts	Name and Description	Impact on Building Envelope
		Indoor Environment Quality	
Prereq		**Minimum IAQ Performanc**e: establish indoor air quality performance to meet the ASHRAE 62-999 voluntary ventilation standard	Operable windows provide fresh air and significant air exchange and also promote passive heating and daylighting. Building envelope must incorporate ventilation strategies. Tightly sealed envelope systems are not encouraged except in specialized uses where adequate air quality is provided in total by the HVAC systems.
Prereq		**Environmental Tobacco Smoke Control:** ensure non-smokers experience no exposure to environmental tobacco smoke	Operable windows pose a difficulty if they are near areas where smokers congregate. Check building layout.
1	1	**Carbon Dioxide Monitoring:** install a CO_2 monitoring system which reports on ventilation performance and allows operational adjustments	Use of operable windows or trickle vents in envelope systems can provide natural ventilation to reduce CO_2 levels. This can impact overall envelope design, materiality and operable glazing ratios.
2	1	**Ventilation Effectiveness:** provide effective delivery and mixing of fresh air to meet ASHRAE 129-1997 standard for mechanically ventilated buildings OR demonstrate suitable air flow patterns for naturally ventilated buildings.	Well-designed window layout will provide cross-ventilation and a means to free air-conditioning during shoulder seasons. Use of windows promotes potential for passive solar. Rolls into other envelope concerns.
3.1	1	**Construction IAQ Management Plan:** maintain indoor air quality during construction and pre-occupancy phases	No significant impact.
3.2	1	**Construction IAQ Management Plan:** conduct an appropriate building flush-out to eliminate any air problems resulting from construction/renovation processes	No significant impact.
4.1	1	**Low-Emitting Materials:** specify **adhesives and sealants** which are low in volatile organic compounds (VOCs)	Check specs to see that low VOC adhesives and sealants are used in the envelope assemblies.
4.2	1	**Low-Emitting Materials:** specify **paints and coatings** which are low in VOCs	Check specs to see that low VOC paints and coatings are used in the envelope assemblies.
4.3	1	**Low-Emitting Materials:** specify **carpets** which are low in VOCs	No significant impact.
4.4	1	**Low-Emitting Materials:** specify **composite wood products** which are low in VOCs	Check specs to see that low VOC wood products and glues are used in the envelope assemblies.
5	1	**Indoor Chemical and Pollutant Source Control:** employ floor grills at entries and appropriate exhaust and plumbing in areas where water and chemical concentrate mixing occurs	No significant impact.

6.1	1	**Controllability of Systems:** provide at least one operable window and one lighting control zone per 200 s.f. within 15 feet of the perimeter wall	Operable windows and skylights with blinds can provide airflow, temperature control and lighting control for perimeter areas. This must be incorporated into the envelope assembly.
6.2	1	**Controllability of Systems:** provide airflow, temperature and lighting controls for at least 50% of occupants in non-perimeter areas	Non-perimeter occupants can still rely on diffuse natural light if care is taken to bounce light deeper into the building, such as with light-shelves, skylights or roof monitors. These systems are integral with the envelope design.
7.1	1	**Thermal Comfort:** ensure compliance with ASHRAE 55-1992 for thermal comfort to include humidity control	Designing daylight systems to avoid direct beam light will prevent thermal discomfort from intense solar heat gain. If thermal mass is being used, it will likely have a noticeable effect on the temperature control in the buildings. Diffuse light can provide illumination without undue heat gain. Daylighting design impacts envelope design.
7.2	1	**Thermal Comfort:** install a permanent monitoring system for temperature and humidity and provide operator control over humidification/dehumidification	No significant impact.
8.1	1	**Daylight and Views:** ensure a minimum of 2% daylight factor to 75% of occupied spaces	The envelope must be designed to promote daylighting and provide adequate and properly placed windows to achieve the daylight factor required. Windows must be selected that do not compromise the insulation integrity of the envelope. May require spectrally selective glass to be considered. May require light shelves, shading devices, deflectors or other envelope modifications.
8.2	1	**Daylight and Views:** ensure direct line of site to vision glazing for 90% of regularly occupied areas	

F. INNOVATION AND DESIGN PROCESS:

Innovation and design process 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. So for example if adequate passive and active systems were incorporated into the design as to allow the building to function independent of the grid, this would qualify for an innovation point. If the energy performance optomization exceeds the maximum permitted by point EA #1, 64% of MNECB or 60% of ASHRAE 90.1, an extra point may be awarded. A point is also given for the involvement of a LEED Accredited Professional, which may be somewhat self-serving to the system, but does encourage a higher level of sustainable design education of the profession to pass through the accreditation exam process.

Increased interest in innovative sustainable design construction methods that have more recently been imported from European models, such as double skin wall façade systems, can also qualify for an innovation point. These buildings are normally more sustainable motivated, and the double skin wall system will also impact issues of perimeter control, access to natural ventilation, indoor air quality, thermal quality, envelope performance as well as protection of shading devices in harsh climates. Such systems can now be seen in the Telus/William Farrell Building designed by Busby and Associates in Vancouver, the Caisse de Depots et Placement, in Montreal and currently under construction, the Centre for Cellular and Biomolecular Research at the University of Toronto, by Benisch, Benisch with Architects Alliance.

Figure 7: *Innovation and Design Process:* Caisse de Depots et Placements, Montreal Double skin wall construction.

Table 1f: Innovation and Design Process and the Building Envelope

Credit	Pts	Name and Description	Impact on the Building Envelope
		Innovation & Design Process	
1	1 - 4	Innovation in Design: extra credits are awarded for substantially exceeding a LEED performance credit, OR for significant performance in other categories, such as acoustic performance, life-cycle costing or education of occupants.	A well designed energy efficient building, if shown to perform better than its benchmark due to the inherent superior envelope strategies may be eligible for one or more innovation credits as a function of the areas incorporated. Innovative wall systems, double skin façade systems, passive solar systems, can potentially earn these credits.
2	1	LEED Accredited Professional: include a LEED accredited professional in the project team	No inherent link to building envelopes, but inclusion of such an individual would be helpful in working with trade-offs and synergies in the envelope design.

CONCLUSION

It is not difficult to see how intrinsically connected are the interests of building envelope design and the LEED Credit system. It is evident that, given the pervasiveness of the need well designed, durable, energy efficient envelopes in both the Energy and Atmosphere as well as Materials and Resource sections of the LEED Credit System, that it would be difficult to attain even a Certified Label without significant incorporation of good envelope design. The added incorporation of concerns regarding Indoor Environmental Quality (mold issues) can easily assist in taking the project to a Platinum level.

As growing number of jurisdictions, governments and organizations look to adopt LEED Standards for their new and renovated construction, it becomes increasingly important for designers to understand the system and the impact of the tool on their areas of expertise. As LEED itself has been designed as an effective environmental marketing tool, so can it be used to more effectively ensure high quality envelope design to our clients.

POST SCRIPT: TO LEED OR NOT TO LEED?

Although this paper has based its suggestions upon the LEED system of evaluation, it is not intended to sanction LEED as a flawless system, nor the only system that could or should be referenced. Indeed the points based system, one that awards the same number of points for being near a bus stop as it does the creation of a durable building, can create an atmosphere that favours point-grabbing over thorough integrated design – a process that the system is meant to favour. For some budgets, a true LEED evaluation is simply too expensive to pursue. Depending upon the size of the building, as well as the engineering expertise and calculations required, a LEED certification may run into the $10,000+ range.

Green Globes is an online evaluation system that has a similar structure, is used as the assessment system of choice by Public Works Canada and BOMA. Its fee structure is more affordable. For information, please go to: http://www.greenglobes.com/

In the end, any tool should be used foremost as a "*design* tool". If used as an after the fact "*evaluation* tool", sustainable design and the integrated process is likely to be shortchanged. The "branding" associated with the award system of any tool seems to be required to get the ball rolling.

REFERENCES

The general description of the LEED credit system was taken from an article that I co-authored with Caroline Prochazka, a Masters Candidate at the School of Architecture, University of Waterloo.

LEED: A Primer. Canadian Architect Magazine. January 2004.

The online version is available at:

http://www.canadianarchitect.com/issues/ISarticle.asp?id=145884&story_id=209449105534&issue=01012004&PC=

LEED NC VERSION 2.1 USGBC http://www.usgbc.org

LEED NC VERSION 1.0 CaGBC, http://www.cagbc.ca

GREEN GLOBES ASSESSMENT SYSTEM: Design Summary:

http://www.architecture.uwaterloo.ca/faculty_projects/terri/sustain_casestudies/Green_Globes_Design_Summary.pdf

For additional information, case studies, images, spreadsheets and comparative data on Canadian sustainable buildings, please visit:

http://www.architecture.uwaterloo.ca/faculty_projects/terri/684_sust.html

FIGURES

All photographic images included in this paper were taken by the author.

ENDNOTES:

[1] *New Building:* Reduce design energy consumption to comply with NRC's CBIP requirement for a **25%** energy reduction compared to the reference building designed to meet the Model National Energy Code of Canada for Buildings 1997.
Major Renovations to Existing Buildings: Reduce design energy consumption to comply with NRC's CBIP requirement for a **10%** reduction compared to the reference building designed to MNECB 1997.