

LEED Skins



9

Facade TecNotes Series

enclos  corp

LEED Skins:
introduction to LEED
and sustainable enclosures

Contents



Executive Summary_____1

Introduction to Enclos Technology

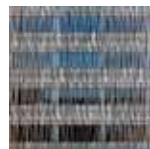
Service and Technology_____2



Green and Sustainable Facade Technology_____4

Custom Curtainwall Systems_____6

Overview of LEED



Introduction to LEED_____8

Comparative Overview of LEED v3.0_____10

Shifting Emphasis_____11

LEED Process Management_____12



LEED and the Building Facade

Sustainable Sites_____14

Water Efficiency_____14



Energy and Atmosphere_____15

Materials and Resources_____15

Indoor Environmental Quality_____15



Summary of Significant Points Changes_____16

Innovation in Design_____17

Regional Priority_____17



for Innovation Points...Structural Glass_____18

Enclos can provide complete turnkey solutions to your most challenging facade requirements, regardless of size, complexity, product or building program considerations. We are highly experienced in the varied special conditions involving commercial construction, ranging from design through site installation, and including both BIM and LEED qualifications.

LEED Skins

Executive Summary

Building energy performance is primarily influenced by enclosure systems and mechanical solutions to treat the interior space. Facade systems mitigate between the exterior climate and internal comfort, dictating what passive solutions penetrate the enclosure, and which are shielded from internal occupants. As the market continues to progress towards sustainable solutions, the evolution of the LEED green building rating system continues to force evolution in the strategies and technologies of building skins.

Enclos Corp is experienced and currently involved on numerous sustainable projects covering a wide range of LEED certifications. Several projects currently under contract striving for LEED certification include:

- Children's Hospital of Philadelphia, PA
- City Center, Las Vegas, NV
- San Diego Courthouse, CA
- 500 Fifth, Seattle, WA
- 1450 Brickell Ave, Miami, FL

Sustainability in design, fabrication and site management have long been a focus of the Enclos team. The emphasis on environmentally-conscious enclosure systems has been integral in the sustainable goals of numerous completed projects over the last decade. Examples of completed projects with LEED certification include:

- Loyola University Information Commons, Chicago, IL (Persuing LEED Silver)
- 51 Louisiana, Washington DC (Persuing LEED Silver)
- San Jose Civic Center, CA
- One River Terrace, New York, NY (Persuing LEED Silver)
- US Census Bureau, Suitland, MD (LEED Silver)
- Constitution Center, Washington, D.C. (Persuing LEED Gold)
- Comcast, Philadelphia, PA (Persuing LEED Silver)
- 301 Mission, San Francisco, CA
- Seattle Courthouse, WA

In addition to years of project experience, Enclos is committed to green solutions and sustainable education. The organization includes LEED Accredited Professionals at every level including project managers, designers, engineers, and even executives. These key personnel and knowledge are committed to supporting each projects LEED aspirations.

This document begins with a brief introduction of Enclos technology and its relationship to green building solutions. It then presents an overview of the LEED rating system and point scale. The document concludes with an evaluation of the LEED green building rating system to understand what changes have occurred from LEED NC v2.2 to the most recent release, LEED NC v3.0, and how facade engineering may be impacted.



Service and Technology

Enclos is expert in the design, engineering, fabrication, assembly and erection of custom curtainwall systems and structural glass facades, providing complete design/build services to the construction marketplace.

We specialize in innovative architecture and challenging building projects. No project is too large, no building site too difficult for our seasoned operations teams. Our work experience includes many projects with specialized materials, complex geometry, and innovative structural and mechanical system designs. Enclos curtainwall and facade systems incorporate state-of-the-art materials and performance.

The attributes most appreciated by our clients however are our site management capabilities and our track record of meeting demanding project schedules.

Custom Curtainwall Systems



Enclos offers the most innovative curtainwall systems in the marketplace, combining aesthetic, performance and economic considerations into optimum solutions to our clients' needs. Our inventive unitized systems have evolved through their application on numerous major building projects to represent the state-of-the-art in curtainwall technology and performance. Sophisticated system design features and installation methods have paralleled this evolution, resulting in improved economy as well as superior performance.

Structural Glass facade Systems



The integration of glass and structure is a predominant attribute of this expressive building form, often employed to maximize transparency in large public spaces. Enclos has played a leadership role in the development and application of this cutting-edge technology, including a range of structure types:

- cable nets
- cable trusses
- long-span truss systems
- grid shells
- spaceframes
- all-glass structures

Our glazing systems include point-fixed types in both bolted and clamped versions, as well as framed system types, all custom designed in response to specific project requirements. For more information see the section titled, Structural Glass Facades and Enclosures.

High Performance Systems



An aggressive and ongoing research and development program has resulted in systems and products designed for special applications. Among these are the following:

- hurricane products, designed and tested in conformance with the South Florida building codes
- security and blast systems
- acoustical wall systems, for those applications with acoustical performance requirements beyond those normally specified
- fire and smoke testing
- enhanced thermal efficiency
- composites, advanced materials, smart materials and systems research
- advanced facade systems, double skin facades and smart facades

Green and Sustainable Facade Technology

The building skin affects both the appearance and performance of a building like no other building system.

Facade and curtainwall systems are thus of paramount importance when considering issues of green building and sustainable design. We at Enclos understand the importance of leading the effort to improve the performance and sustainability of the building envelope, and we commit ourselves to supporting the design team in their sustainable design efforts.

We have LEED accredited professionals on staff, a mechanical engineering group with advanced CFD analysis capability, and the ability to perform whole-building energy analysis. An aggressive and ongoing research and development program assures you of state-of-the-art wall systems engineered and tested to the most demanding performance criteria. We are continuously seeking new materials and methods to further enhance this performance.

LEED Certified Buildings



The Leadership in Energy and Environmental Design (LEED) Green Building Rating System has proven to be a viable and effective means of reducing overall energy consumption and improving the sustainability of building practices, while at the same time bringing increased value to a building as evidenced by higher occupancy and rental rates. The building skin is a paramount consideration in any building project, but presents particular opportunities in a project where LEED certification is part of the program.

Enclos understands the nuances of the LEED rating system particularly as it relates to the building skin.

Double Skins and Active Facades



This emergent technology is finding increased application in building projects where the attributes of transparent facades are desired yet the performance of the building skin is paramount. These sophisticated facade designs can compensate for the inherently poor insulating properties of glass. In addition to providing a thermal barrier, the systems can also provide an effective means of ventilation, and often involve shading devices for the control of solar penetration and glare.

They can also provide significantly enhanced acoustical performance, and in certain applications are used for this reason alone. The Loyola Information Commons features a west facing dual skin active facade with a cable net supported outer skin. This project was one of three featured at the McGraw-Hill Innovation Conference on Net-Zero Energy Use in Buildings.

Enclos can provide complete design/build services for custom double skin unitized curtainwall systems or more complex long-span facade systems.

Building Systems Integration



Optimizing energy performance in buildings requires an integrated approach to building systems design, analysis and implementation. Building-integrated photovoltaics (BIPV) is an increasingly popular approach for using the building skin as a means to harvest solar energy. More recent technique involves systems of lighting, lighting controls, sensors, and shading devices all integrated with the building skin, and in turn integrated with the building HVAC systems. Such design strategies can reduce heat gain or loss, control direct solar penetration and glare, harvest daylight to reduce cooling load, and even provide ventilation, producing a more comfortable interior space in the process.

Enclos Corp has the ability to develop custom integrated systems in response to your particular building performance requirements.

From Net-Zero to Net-Plus



Oil prices may fluctuate in the short term, but in the long term there is little doubt that energy costs will continue to rise, as will the cost to the environment of unwise use of our energy resources in buildings. It is imperative that we improve the efficiency and sustainability of our built environment. Net-Zero energy use in buildings is a goal being increasingly embraced by forward thinking building designers and developers. An even greater opportunity presents itself in the notion of our buildings as energy producers.

Enclos sees the potential for the building skin to make a major contribution in this regard, and toward this end we are committed to continuing to play a leadership role in facade system development.

Custom Curtainwall Systems

So, just what is curtainwall?

Curtainwall is a term applied to a widely used facade technology for cladding large buildings. Curtainwall systems do not carry any dead loads imposed from the building structure. They are designed to support their self-weight and to transfer horizontal loads (wind) incident upon them to the primary building structure.

Curtainwall systems are typically “hung” from the building structure — from whence derives the “curtain” reference — and typically attached to the floor slabs. The primary functions of the curtainwall are to resist air and water infiltration and to provide a thermal barrier between inside and out. Curtainwall systems are also designed to accommodate the complexities of deflections, thermal expansion and contraction, building sway and relative movements between floors as caused by wind or seismic loads acting globally or locally on the structure.

Special design considerations can include daylighting, thermal, acoustical, security and blast-resistant performance.

Curtainwall designs for large buildings are almost always customized to individual project requirements.

Framing



Curtainwall is designed as cladding materials that are framed and fixed in place by extruded aluminum components. There are two basic types of systems:

Stick systems are built from long vertical extrusions (mullion) attached to the building structure, with horizontal extrusions spanning between the vertical mullions to create frames. Cladding materials are then installed into the frames. All assembly, installation and glazing takes place in the field.

Unitized systems are a newer adaptation of curtainwall technology that has rapidly grown in use in recent years. The vertical and horizontal framing members are figuratively split, allowing independently framed “units” to be assembled and glazed in the factory. Units can be designed to span multiple floors or multiple horizontal modules, and can incorporate multiple cladding elements including operable vents and windows. Completed units are shipped to the site and simply hung on the building. Unitized systems concentrate fabrication and assembly under controlled factory rather than in the field.

Cladding



Glass is the most common infill material used in curtainwall systems, but other cladding materials include metal panels, natural stone and terracotta. The curtainwall systems typically span across the floor slabs, creating a need for opaque cladding material over and in the vicinity of the floor slab to conceal the slab edge, fire-safing and any between-floor mechanical systems. A spandrel panel is often located between vision glass panels to conceal this area. To achieve opacity, spandrel glass is treated with a ceramic coating (called a frit), a film, or is incorporated into an assembly called a shadow box.

Glass is used extensively as a curtainwall cladding material because of its transparency and ability to provide daylight and view. Solar gain in such applications can present challenges with respect to energy performance and thermal and visual comfort, and represents an important design consideration in the development of an appropriate curtainwall facade. Enclos has worked with leading architects in the development of glass facades on many buildings pursuing LEED certification.

Facade Integration



In addressing the challenges discussed above, and in meeting the generally escalating performance demands on the building skin, curtainwall designs have become increasingly complex. Facade system requirements now frequently include daylight harvesting, daylight and glare control, artificial lighting, and even power generation. Techniques for addressing these considerations are being integrated into the curtainwall system, providing advanced functionality to the building facade. Photovoltaic systems, shade fins, light shelves, louvers, operable blinds, sensors, and multiple skins are among the things being integrated into the curtainwall system.

The building community has recognized the facade as a primary means to improve energy performance and occupant comfort, and even as a potential power source.

Anchorage



It is an exciting time for the development of advanced facade technology. At the same time, the fundamentals of sound curtainwall design have lost none of their critical import.

One of the basic considerations that impacts every building project without exception is the means by which the curtainwall is anchored to the building. Anchor design can affect many things beyond the immediate curtainwall design, including the work of other trades and the design of the building interior. As with so many other aspects of the building skin, Enclos continues to lead the way with anchor design. Enclos anchor designs can be positioned on the face, top or bottom of slab, or recessed in any of these positions. The Enclos anchoring method is highly efficient, speeds field installation of the curtainwall and provides optimum economy to the building developer.

Curtainwall anchors are set prior to the commencement of unit installation. If the anchors are to be recessed, they are sometimes set prior to the concrete floor slabs being poured.

Installation



Installation strategy is highly sensitive to specific site, schedule, and coordination requirements. All Enclos operations are driven by the requirements of the building site.

Unitized curtainwall systems provide optimum flexibility in this regard. Materials can be fabricated, assembled and stored offsite, and be delivered on a just-in-time basis as required to support installation crews, thus minimizing on-site storage and staging requirements on highly congested building sites. Assembled units are delivered to the site on open flatbed trailers. Units can be lifted by crane from the trailer and directly set in place on the building facade. Alternately, units can be designed to be installed from inside the building. Installation crews working from a floor above use a small jib crane to lower units to a setting crew below.

Installation strategy, site logistics and operations are among the greatest strengths of Enclos, and represent the capabilities most valued by our general contracting clients.

Introduction to LEED

In the United States, buildings consume 39% of all energy and 71% of the total electricity consumed (United States Department of Energy, 2004). Escalating energy consumption and CO₂ emissions expose the global need for smarter design and systems to optimize energy use for smarter buildings in a more sustainable future. In order to change building performance and design practices, new standards have to be developed, information monitored, and evolving metric standards to continually seek optimal harmony between the built and natural environments.

The U.S. Green Building Council (USGBC) developed the LEED (Leadership in Energy and Environmental Design) green building rating system as a common standard for the entire architectural/engineering/construction industry to assess the environmental sustainability of building designs. The system measures building attributes which are considered environmentally beneficial using a point system. Buildings can then achieve different levels of certification for the sustainable efforts and integrations in the design.

Certain organizations mandate particular LEED certification levels for their designs, while others see it as a marketability strategy to align themselves within the sustainable movement. In addition to different tiers of certification, there are several different certification standards for different types of construction; the traditional LEED-NC (New Construction), LEED-EBOM (Existing Buildings), LEED-ND (Neighborhood Development), LEED-CI (Commercial Interiors), and LEED-CS (Core and Shell).



The USGBC's LEED rating system differentiates itself from other previous United States rating systems by utilizing quantified levels to attain points, or green credits. Similar metrics are integral in European building codes, but until recently were previously not addressed in the American building codes and standards. For example, daylight must be provided for building occupants in 75% of all "regularly occupied areas" to obtain Indoor Environmental Quality Credit 8.1. Another example is reusing 5% of the building materials in efforts to reduce waste can earn a project a point for Materials and Resources Credit 3. LEED-NC v3.0 includes 110 possible points subdivided into seven topic categories. An overview of each topic area is presented below:

- *Site Development*

minimize storm water run-off, encourage car pooling and bicycling, increase urban density and green space

- *Water Efficiency*

eliminate site irrigation, reduce water consumption, minimize or treat wastewater

- *Energy Efficiency*

reduce building energy consumption, use renewable energy, eliminate ozone-depleting chemicals, commission building systems

- *Material Selection*

minimize construction waste, re-use existing building facade, use recycled and salvaged materials, use renewable construction materials, design and build more durable buildings

- *Indoor Environmental Quality*

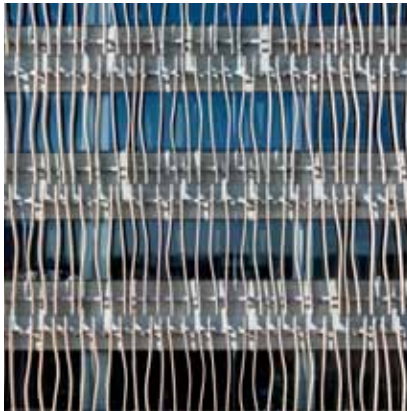
incorporate daylighting, use low off-emitting materials, provide operable windows and occupant control of work space, improve delivery of ventilation air

- *Innovation in Design*

use a LEED Accredited Professional, greatly exceed the requirements of a credit, incorporate innovative environmental features not covered in other areas

- *Regional Priority*

provide incentive to address geographically specific environmental issues



The number of LEED certified new and existing buildings has more than doubled since 2006. As of July 2008, 1,585 commercial projects had been certified under LEED ratings systems and 12,706 projects were registered with the intent of obtaining certification when completed. Many developers, especially those working on federal government and cutting-edge private sector buildings, are requiring that building designs meet LEED Silver performance. Given that most conventional new buildings would struggle to achieve a few LEED points, the ratings system represents a significant reduction in building environmental impact and improvement of indoor environment.

The LEED rating system achieves sustainable building design in three primary ways:

1. LEED can serve as a design guide for the design team with the credit system ensuring significant environmental issues are considered during the design of a building.

2. LEED reports documentation allows

for clear communication to the client that the design has effectively addressed environmental issues.

3. A building design can be certified by the USGBC.

The larger benefit of LEED buildings is an improved indoor environment which can yield reduced absenteeism, increased productivity, and improved thermal comfort. Additionally, LEED designs can lower maintenance costs by providing a commissioned building, more durable materials, and the use of smaller or eliminated building systems. Such designs can reduced risk of remedial measures such as environmental contaminants or the commonly referred to sick building syndrome. Beyond the physical and performative advantages of a sustainable, LEED certified project are the marketing advantage, higher corporate profile, improved employee morale, and potential increased product sales as a result of investment in the building.

The most difficult element to quantify, but most important to the client, is the typical payback period on the invest-

ment to achieve a LEED rating. It becomes clear that an investment to achieve a LEED rating that takes 10 or more years to pay off is more likely to be taken on by a developer likely to hold onto the building for a long duration, such as the U.S. General Services Administration (GSA) who build and manage federal structures including courthouses. Other building types that may remain with the developer long after construction include schools, museums, infrastructural facilities, and hospitals. Unfortunately, for the last several decades the American development strategy has been built with a build-to-sell approach. Therefore, until now, the initial investment to achieve LEED would have been unattractive or not considered in the private sector. Fortunately for a more sustainable future, declining markets and limited private development has made LEED a way for designers, contractors, and developers to differentiate in an extremely competitive market.

Comparative Overview of LEED v3.0

The primary difference between the LEED-NC v2.2 and LEED-NC v3.0 is that the point scale has been modified from 69 possible points in the previous to 110 possible points in the recently adopted version. The later allows for more bonus points to be earned as part of a new Regional Priority component. The point scale modification allows for nice even numbers to define the different rating levels, but each level can be achieved with gaining a smaller overall percentage of the Base Points. For example, to achieve LEED Silver in v2.2 required 33 out of 64 possible points (51.56%) compared to LEED Silver in v3.0 requires 50 out of 100 possible points (50%). Such a minor difference exists at each of the four certification levels. The benefit of the revised scale is it is easier to remember the equal increments based on 100 point scale.

Table 1 – Comparative Certification Levels

Rating Level	v2.2	v3.0
Certified	26 – 32	40 - 49
Silver	33 - 38	50 - 59
Gold	39 – 51	60 - 79
Platinum	52 – 69	80 +
Base Points	64	100
Bonus Points	5	10
Total Points	69	110

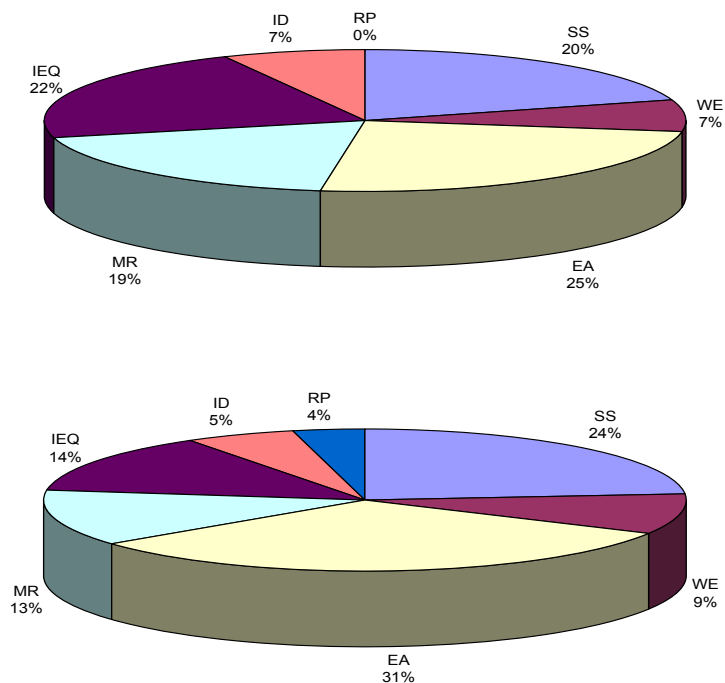


Figure 1 – Comparative Distributions; v2.2 (top), v3.0 (bottom).

The USGBC conducted these modifications using a common assessment tool developed by the United States Environmental Protection Agency (EPA), committing to a consistent set of metrics and decision making framework. The tool is known as TRACI, the Tool for the Reduction and Assessment of Chemical and other environmental Impacts to assist in impact assessment for Sustainability Metrics, Life Cycle Assessment, Industrial Ecology, Process Design, and Pollution Prevention. TRACI is versatile and can be used to compare the environmental and human health

preferability of two or more products or processes. TRACI utilizes one impact assessment methodology which was developed to reflect the current impact of each category relevant for the United States. It accounts for market changes, state-of-the art technologies, and will result in different ratios of importance over time. The application of TRACI to the LEED rating system has resulted in an increase emphasis on credit categories such as Energy and Atmosphere, and the introduction of a Regional Priority credit category.

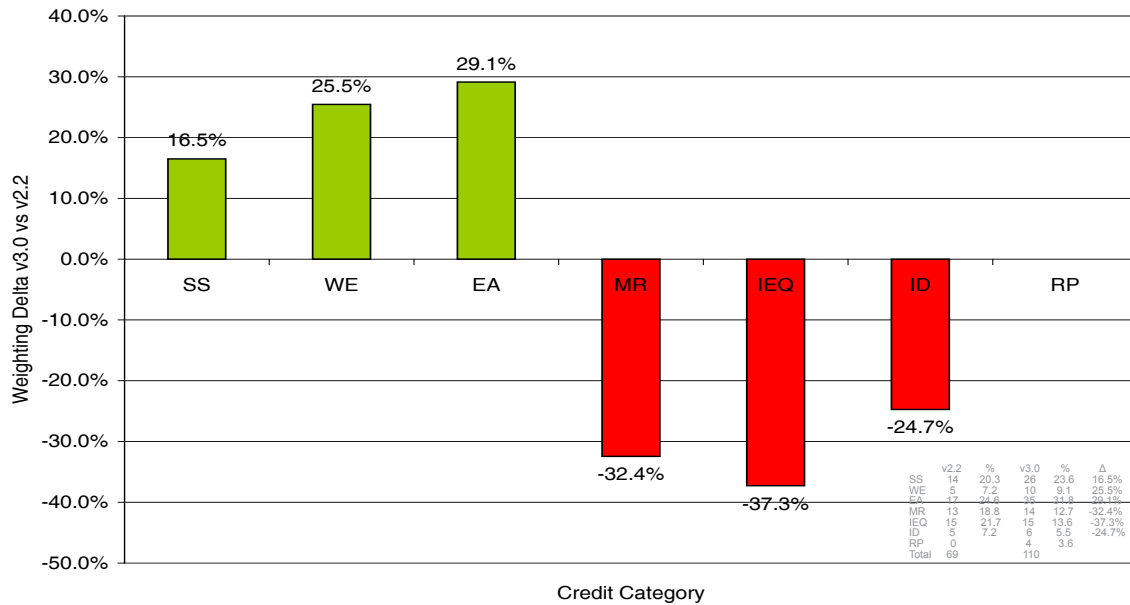


Figure 2 – Relative Credit Category Change as a Component of Overall Possible Points.

The re-distribution of credits in LEED-NC version 3.0 has placed a greater emphasis on Sustainable Sites, Water Efficiency, and Energy & Atmosphere. There is a reduced priority on Materials & Resources, Indoor Environmental Quality, and Innovation in Design. Additionally, a new category containing a possible four bonus points has been introduced, known as Regional Priority. The re-distribution of credits is summarized in Figure 2 where the relative weighting delta of LEED-NC v3.0 compared to v2.2 is a comparison of each category overall percentage

The introduction of Regional Priority credits is a positive addition which provides incentives to address geographically specific environmental issues. Each USGBC regional council has identified 6 credits that are particularly important, and of which up to 4 regional priority points may be earned. For the San Francisco zip code of 94107 (and many other San Francisco zip codes) the following credits are identified as regional priority credits; SS 5.2 Site Developments – Maximize Open Space, WE 2 Innovative Wastewater Technologies, WE 3 Water Use Reduction (40%), EA 2 On-Site Renewable Energy (1%), MR 1.1 Building Reuse – Maintain Exist-

ing Walls, Floors and Roof (55%), IEQ 8.1 Daylight and Views – Daylight. The regional priorities clearly emphasize the water efficiency credit category the most.

The latest LEED-NC v3.0 has made ambitious strides which will continue to challenge designers and developers to achieve. The changes will also create more discussion, criticism, and praise of the USGBC's priorities and expectations. This discussion in itself, positive or negative, is powerful because it keeps sustainability and striving towards more efficient building constructions integrated into the a/e/c industry routine.

The restructuring of the credit category ratings has placed more emphasis in areas of Sustainable Sites, Water Efficiency, and Energy & Atmosphere than the others. This is a big adjustment, but such weightings will have to continually adjust over time as markets shift, technology advances, and expectations expand. Another opportunity to accelerate the sustainable standards metrics and expectations is for there to be standards in competition, or complementary, to the LEED rating system. More standards such as California's Title 24 should occur at regional levels to respond to

regional issues, and mandate higher performance from new construction in their area.

Overall LEED has matured a great deal from its inception and continues to challenge designers to create more efficient, intelligent, and sensible buildings. As the standards and priorities continue to shift, the building enclosure will transform too. Facade engineering is in a position of pressure and leadership to adopt creative solutions, interact with new technologies and trades, and preserve the aesthetic and comfort we have come to know from beautiful buildings.

References:

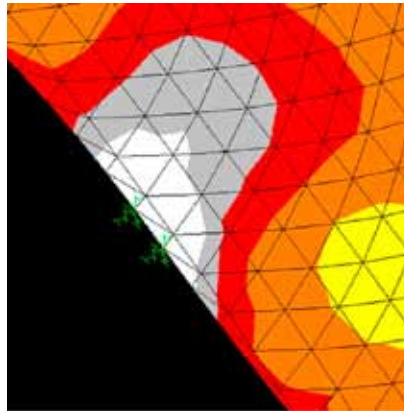
California Energy Code: California Code of Regulation. Title 24, Part 6. California Building Standards Commission, 2005.
 United States Department of Energy . 24 April 2009. <<http://www.energy.gov/>>.
 United States Environmental Protection Agency . 8 May 2009. <<http://www.epa.gov/>>.
 USGBC. LEED 2009 for New Construction and Major Renovations. United States Green Building Council. 2008.
 USGBC. LEED for New Construction and Major Renovations, v2.2. United States Green Building Council. 2005.

LEED Process Management

Managing the project delivery process is the core strength of Enclos, something at which we excel beyond all our competition. This capability provides us consistent control over the vital requirements of schedule, quality and cost, and allows us to consistently deliver top quality economically and on time. This capability is the basis for our many long term relationships with developers, general contractors and architects.

Each new project undertaken by Enclos is treated as unique, and a custom delivery strategy is developed in direct response to the singular set of considerations presented by the project. This custom strategy however, is developed through a uniform process unique to Enclos that embraces the spectrum of activities from preconstruction through design, engineering, procurement, fabrication, assembly, and erection. This process, developed and refined through the successful completion of hundreds of remarkably diverse facade and curtain-wall installations, serves to mitigate the inherent risk of a challenging building project by enhancing the predictability of performance, schedule and cost.

Design and Engineering



The foundation of a successful facade or curtainwall project is innovative system design and engineering. Our D&E group develops custom solutions to each new project, derived from a robust framework of Enclos technology and know-how. Design considerations range from the aesthetic and performance requirements determined in collaboration with the architect, to the fabrication and installation requirements that must be anticipated by the system design to assure a successful project completion.

An in-house team of engineers, architects and designers over 100 strong comprise the Design and Engineering Group at Enclos Corp, representing a unique talent pool that has consistently delivered innovative, effective and elegant solutions to the most demanding building facade requirements. Autocad, Inventor, Revit, Space Gass, Strand 7, FloVENT CFD, are among the many tools that comprise our design development process. Building Information Modeling (BIM) is another service we provide our clients.

Project Management



Project management is an empowered function at Enclos Corp, and key to our success. Personnel skilled and experienced in project management are vital to the success of any construction project. Our project management teams lead design development, production engineering, fabrication and assembly, and field operations, bridging these various activities to form an organized, unified continuum of project development throughout the design and build process. Enclos project management personnel receive extensive training and years of on the job experience before being appointed to the position and entrusted with the responsibility of running their own projects.

Our people understand the critical importance to a building project of on-time, on-budget performance, a fact which our past clients can best attest to. We will happily provide you with such references.

Fabrication



Curtainwall fabrication and assembly is a critically important part of the project development process. Enclos Corp maintains dedicated manufacturing operations in key geographic locations capable of providing fabrication services for the most complex designs and the most challenging project schedules. Our facilities incorporate state-of-the-art equipment and processes for curtainwall unit fabrication and assembly. In addition, to provide adequate capacity for the fluctuating demands typical of the building marketplace, we have developed a network of outside fabrication sources, all of whom have been rigorously trained and qualified in all aspects of Enclos systems materials, fabrication and assembly, and all of whom have successfully provided services on prior Enclos projects.

Supply Chain Management



Our global supply chain is a significant corporate asset that we provide to our clients, who receive the benefit of the most competitive possible cost independent of the fluctuations of local market conditions. Global economies, currencies and markets are shifting faster and more dramatically than ever before. In order for domestic firms to provide optimum solutions to their client's needs, it is mandatory that they be able to procure materials and services from any global market providing the best combination of quality, lead time and cost.

Recognizing this, Enclos Corp launched an initiative in 2002 to develop its nascent network of key suppliers into a world class global procurement machine. Enclos has successfully provided project materials and services from diverse areas of Europe and Asia on dozens of domestic projects, saving our clients many millions of dollars in the process. In circumstances where domestic supply is a requirement Enclos has both its own dedicated manufacturing facilities and qualified domestic suppliers.

Quality Assurance



Design or material supply problems surfacing in manufacturing are a frustrating and costly annoyance; design or manufacturing problems surfacing on the building site are a disaster. There is far too much at stake in the building process to settle for anything less than top quality and the programs that consistently deliver it. Effective quality programs garner the participation of everyone in the organization from top to bottom while reaching throughout the web of company operations and activities. We have developed and refined our quality assurance and quality control programs over the span of many years and hundreds of diverse project experiences, another way that our deep experience works for you. These programs are robust and all embracing, ranging from management systems and procedures to the minutia of in-line quality verification processes. In addition, we develop a specific quality plan for each new project based on an analysis that identifies and accounts for any unique aspect of the project whether it be material type, location, site condition, performance requirement or design detail.

LEED and the Building Facade

The dramatic change in relative emphasis on Energy & Atmosphere credits reflects the significance of the envelope and mechanical systems on the sustainable performance of buildings. The building envelope must integrate basic passive strategies, as well as integrating technological intelligent control systems to create an energy efficient solution while preserving the desirable transparent aesthetic of glass. This balance must be founded on intelligent design, but more importantly, quality execution during the fabrication and installation processes. David White, a climate engineer with the German firm Transsolar says, “Unfortunately, the exuberant creative stuff--the expensive buzz words such as ‘geothermal,’ ‘photovoltaic,’ ‘double facade,’ and ‘absorption chiller’--only makes sense when the basic requirements, such as a well-insulated, airtight facade with good solar control, are satisfied.” (Kamenetz, 2007). The desire from clients to integrate the most sustainable technologies and systems so they have a feature to point at often overshadows the actual sustainable strategies which are rooted in intelligent, fundamental decisions early in the design process. The facades role in the energy consumption, efficiency, and performance is fundamental and will continue to grow in importance as LEED continues to increase the metrics (higher mandatory percentage improvement compared to ANSI/ASHRAE/IESNA Standards). The EA Prerequisites and Credits are the most reliant on the performative-nature of the building enclosure.

In the following section, each of the 7 LEED credit categories is overviewed for significant changes in the most recent version, as well as the potential relationships to facade engineering.

Sustainable Sites (SS)



The Sustainable Sites (SS) credit category in v3.0 is one prerequisite and a total of 26 possible points (14 points in v2.2). The increase in points is primarily due to an increased emphasis on density, connectivity, and alternative transportation credits.

The Sustainable Sites credits do not have an immediate effect on facade engineering, but there are several potential indirect effects. Credits in this category reward construction in what tend to be urban, dense, or brownfield sites. Such sites may have shading issues from adjacent buildings, orientation constraints, increased dirt on the facade, potential glare on other buildings, and application of advertisement on the building enclosure.

Water Efficiency (WE)



The Water Efficiency (WE) credit category in v3.0 is one new prerequisite and a total of 10 possible points (5 points in v2.2). The increase in points is due to doubling of the possible points for each credit.

The Water Efficiency credits do not have an immediate effect on facade engineering. Credits 1.1 and 1.2, and Credits 3.1 and 3.2 (from v2.2), have been consolidated into single credits in the latest rating system.

Energy and Atmosphere (EA)



The Energy and Atmosphere (EA) credit category in v3.0 remains 3 prerequisites, 6 base credits, and a total of 35 possible points (17 points in v2.2).

EA Credit 1 Optimize Energy Performance has the greatest weight of any credit with 1-19 points possible. The awarded point value is determined by the percentage improvement of energy consumption above the minimum energy performance baseline of EA Prerequisite 2. The baseline can be determined by one of three options: Whole Building Energy Simulation (1-19 points), Prescriptive Compliance Path: ASHRAE Energy Design Guide (1 point), and Prescriptive Compliance Path: Advanced Building Core Performance Guide (1-3 points). The Whole Building Energy Simulation is according to Appendix G of ASHRAE Standard 90.1-2007. The greatest change amongst these credits is the revised whole building energy performance levels for each point level.

Other opportunities, such as integration of photovoltaic systems into facade elements, can significantly contribute to the second largest weighted credit, EA 2 On-site Renewable Energy.

Materials and Resources (MR)



The Materials and Resources (MR) credit category in v3.0 is one prerequisite and a total of 14 possible points (13 points in v2.2). The increase of one point is due to an additional point possible for Credit 1.1 Building Reuse-Maintaining Existing Walls, Floors and Roofs.

These credits tend to affect all materials on the project – facade elements included. Most of these credits would apply to the material content and fabrication/installation methods adapted by the building enclosure on the project. The recycled content in the facade enclosure may be applied towards MR Credit 4 Recycled Content including a percentage of recycled glass content. Portions of the facade system may be considered for MR Credit 5 Regional Materials which includes materials which have been extracted, harvested or recovered, as well as manufactured within 500 miles of the project site.

Indoor Environmental Quality (EQ)



The Indoor Environmental Quality (IEQ) credit category in v3.0 is two prerequisites and a total of 15 possible points (same as v2.2). The general application of all credits remains minimally changed, with the exception of expanded detail discussion of determination of calculations for Credit 8.1 Daylight and Views – Daylight.

The building enclosure is integral to the thermal comfort of all designs (Credit 6.2, 7.1, and 7.2), but Credits 8.1 and 8.2 for Daylight and Views are the most directly related to the facade design. The revised Credit 8.1 includes expanded discussion and new illustrative diagrams which communicate the four options for fulfilling the requirements; simulation, prescriptive (new), measurement, and combination (new). To earn EQ Credit 8.1 Daylight and Views requires 75% of spaces to be daylight as determined by any one of the four calculation methods. The visible light transmittance (VLT) and the window-to-floor area ratio (WFR) of the glazing system are integral to the calculations and simulations for daylight.

LEED and the Building Facade

Summary of Significant Points Changes

Credit	Title	v2.2	v3.0
Sustainable Sites (SS)			
Credit 2	Development Density and Community Connectivity	1	5
Credit 4.1	Alt. Transportation – Public Transportation Access	1	6
Credit 4.3	Alt. Transportation – Low-Emitting & Fuel Eff. Vehicles	1	3
Credit 4.4	Alt. Transportation – Parking Capacity	1	2
Water Efficiency (WE)			
Credit 1	Water Efficient Landscaping	1 + 1	2-4
Credit 2	Innovative Wastewater Technologies	1	2
Credit 3	Water Use Reduction	1 + 1	2-4
Energy and Atmosphere (EA)			
Credit 1	Optimize Energy Performance	1-10	1-19
Credit 2	On-site Renewable Energy	1-3	1-7
Credit 3	Enhance Commissioning	1	2
Credit 4	Enhanced Refrigerant Management	1	2
Credit 5	Measurement and Verification	1	3
Credit 6	Green Power	1	2
Materials and Resources (MR)			
Credit 1.1	Building Reuse–Maintain Existing Walls, Floors and Roofs	1 + 1	1-3
Credit 2	Construction Waste Management	1 + 1	1-2
Credit 3	Materials Reuse	1 + 1	1-2
Credit 4	Recycled Content	1 + 1	1-2
Credit 5	Regional Materials	1 + 1	1-2
Indoor Environmental Quality (IEQ)	NO CHANGES		
Innovation in Design (ID)	NO CHANGES		
Regional Priority (RP)			
SS Credit 5.2	Site Development – Maximize Open Space		
WE Credit 2	Innovative Wastewater Technologies		
WE Credit 3	Water Use Reduction (40%)		
EA Credit 2	On-site Renewable Energy (1%)		
MR Credit 1.1	Building Reuse – Maintain Existing Walls, Floors and Roof (55%)		
IEQ Credit 8.1	Daylight and Views – Daylight		

Innovation in Design (ID)



The Innovation in Design (ID) credit category in v3.0 is a total of 6 possible points (5 points in v2.2), with an additional possible point in Credit 1 Innovation in Design.

The credit can be achieved through two paths: Innovation in Design (1-5 points), or Exemplary Performance (1-3 points). To earn credits using the Innovation in Design path requires a significant, measurable, environmental performance using a strategy not addressed in the LEED v3.0 standard. To earn credits using the Exemplary Performance path requires performance that achieves double (or the next incremental percentage) of the stated metric in LEED v3.0.

Regional Priority



Regional Priority credits are a completely new category in v3.0 and includes up to 4 possible bonus points to be earned for achieving credits “that address geographically-specific environmental priorities,” (LEED v3.0, p. 85). Based on information derived from the USGBC website for the San Francisco zip code 94107, the following (see right) are credits eligible for bonus points under the Regional Priority:

The potential to earn bonus points for achieving IEQ Credit 8.1 Daylight and Views – Daylight is evidence of the significant role the Green Building Council realizes the building enclosure plays in the comfort, performance, and aesthetic of sustainable architecture in San Francisco, California.

USGBC Regional Priority Credits

San Francisco, California
Zip Code: 94107

SS Credit 5.2
Site Development – Maximize Open Space

WE Credit 2
Innovative Wastewater Technologies

WE Credit 3
Water Use Reduction (40%)

EA Credit 2
On-site Renewable Energy (1%)

MR Credit 1.1
Building Reuse – Maintain Existing Walls, Floors and Roof (55%)

IEQ Credit 8.1
Daylight and Views – Daylight

for Innovation Points...

Structural Glass Facades and Enclosures

A new facade technology has emerged over the past three decades driven by the pursuit of transparency in architecture among leading international building designers.

This new technology has evolved primarily in long-span applications of approximately 20 feet and over, and can be categorized by the various structural systems employed as support. New glazing systems are also a part of this emergent technology, with the various point-fixed systems finding most frequent use.

Recognizing the importance of structural glass facade technology, Enclos took action to acquire the technology and expertise required to play a leadership role in implementing and further developing this innovative technology in the US marketplace. As a result, we are now providing complete in-house services for both the curtainwall and structural glass facade areas of the building skin, all as a single-source package backed by the deep technical and financial resources of a national specialty contractor.

Characteristics of structural glass facade technology include: highly crafted and exposed structural systems with long-spanning capacity, integration of structure and form, simultaneous dematerialization and celebration of structure, complex geometries, extensive use of tensile elements, specialized materials and processes, an integration of structure and cladding system, and a complex array of design variables.

Cable Nets



Frei Otto developed and popularized cable nets as a structural system in the 1960s and 70s. Architect Helmut Jahn with engineering firm Schlaich Bergermann applied the technology in a most innovative manner as a flat cable net supported glass facade for the Kempinski Hotel in Munich, circa 1992, fueling widespread interest in this structural form in glass facade applications.

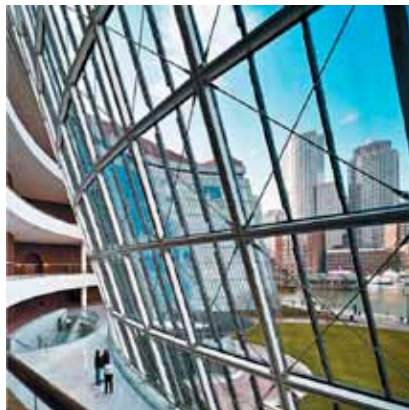
Cable nets represent the ultimate in elegant minimalist structural systems and can provide optimum transparency when the effect of a sheer glass membrane is desired. The glass is supported by a net geometry of pre-tensioned cables. Designs can be flat, or the net can be pulled into double-curvature. A clamping component locks the cables together at their vertices and fixes the glass to the net. Large pre-stress loads in the net structures require the early involvement of the facade design/build team with the building engineer.

Cable Trusses



Another minimalist structural system is that of cable trusses. While cable trusses can vary widely in both truss design and configuration with vertical, overhead, vaulted and domed forms easily achieved, the trusses themselves are most often characterized by spreader strut elements representing the only compression members in the structural system. As with cable nets, these systems rely on the pre-tensioning of truss elements to provide stability, and thus benefit significantly from the early involvement of the facade design/build team.

Grid Shells



Grid Shell structural systems are another means to minimize the visual mass of structure. Configurations can be vaulted, domed and double-curved. Systems can be welded, bolt-up, or some combination of each. Grid shell structures with integrated cable bracing can produce a highly efficient structure with a refined aesthetic. Cable pre-tensioning may be required on such systems. Grid shells can be used in vertical and overhead applications, as well as to form complete building enclosures.

Glass Fin Systems



This is the earliest form of structural glass facade dating back to the 1950s and the French Hahn system used at the Maison de la Radio in Paris in 1953. Here 2-story glass plates were suspended and laterally stiffened by the use of glass fins set perpendicular to the plates at the vertical joints between them. This technology was popularized by the Willis Faber & Dumas Building, Ipswich, England circa 1972. In this curving facade designed by Foster Associates, multiple plates of reflective glass are suspended to provide one of the first examples of an entire building facade in frameless glass. This project inspired a diffusion of glass fin technology in numerous applications throughout Europe and America starting in the 1970s and continuing today. Glass fin-supported facades still represent one of the most transparent forms of structural glass facades and an economical solution especially at lower spans.

Enclos provides custom fin-supported facade designs for any application.

All-Glass Systems



Glass facades are comprised of a glass system supported by some form of structural system (except glass fin-supported walls in which the glass is hung and braced laterally with fins). As the pursuit of transparency is a frequent reason for the use of structural glass facade technology, point-fixed (frameless) glass systems are most often integrated into the facade design. These can be systems where the glass is perforated and bolted or non-perforated and clamped. Such systems typically provide optimum transparency and design elegance. However, the structural systems employed in structural glass facades can easily be designed to accommodate any type of glass system. In some applications framed systems can provide certain practical or economical advantage.

Enclos is capable of developing and providing any type of custom glazing system for structural glass facade applications.

Enclos Press Publications

*Inter-Story Acoustical Evaluation of
Unitized Curtainwall Systems - 2008*

*Analysis and Design of Spandrel and
Shadowbox Panels in Unitized Curtain
Walls - 2009*

Enclos: Collective Works - 2009

Facade TecNotes Series:

1 Skylight

2 Double Skin

*3 Architecturally Exposed Structural
Steel (AESS)*

4 Airports

5 Healthcare

6 BIM and the Building Facade

7 Cable Nets

8 Security

9 LEED Skins



enclos  corp

© Enclos Corp 2009 | www.enclos.com | 888.234.2966 | curtainwall@enclos.com