DAYLIGHT – A MANDATORY REQUIREMENT OF GREEN BUILDING

“Architecture & Daylight”
Conference – Workshop – Project Tours
29. & 30. September 09

Mario Seneviratne FI MechE, PEng.,
LEED Faculty Member
Managing Director - Green Technologies FZCO
"The objective of the Summit on Climate Change, which I am convening on 22 September, is to mobilize the political will and vision needed to reach an ambitious agreed outcome based on science at the UN climate talks in Copenhagen."

UN Secretary-General Ban Ki-moon

- The Summit marked the first UN visit for the Presidents of China and the United States (the largest GHG Emitters in the world) as well as the newly elected Prime Minister of Japan.

- **China’s commitment of 2009;**
  - “Endeavour” to cut emissions of CO₂ by “a notable margin”.
  - “Vigorously develop renewable energy and nuclear energy” to increase the share of non fossil fuels in total energy consumption to **15% by 2020.**
  - To increase forest cover by **40 million hectares (> 150,000 sq. miles) by 2020.**
  - Call to the USA to contribute more to the Climate Change solution.
HUMAN DEMAND VS EARTH’S RESOURCES

2050

Earth’s Resources : Human Demands

1 : 3
KEY ENVIRONMENTAL CHALLENGES

- Anomalous Climate Change
- Natural Resource Depletion
- Atmospheric Pollution and Acid Rain
- Contamination of Freshwater Resources
- Soil Erosion and Degradation
- Loss of Biodiversity
GREEN BUILDING
AN IMPORTANT PART OF THE SOLUTION
WORLD GREEN BUILDING COUNCIL
WORLDWIDE, BUILDINGS ACCOUNT FOR:

- 20% of fresh water consumption
- 40% of CO₂ emissions
- 40% of energy use
- 25% of wood harvest
- 30% of raw materials used

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Green Buildings Can Reduce...

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The diagram illustrates the market shift in green technologies. It shows a bell curve representing typical building practices, market leaders, and innovators & risk takers.

- **Regulations**
- **Benchmark**

**Degree of Green**:
- **Lawbreakers**: 5%
- **Market Leaders**: 20%
- **Innovators & Risk Takers**: 5%

**Typical Building Practices**: 70%
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NETT ZERO ENERGY BUILDING

Energy Consumption - Energy Recovery - 100% Renewable Energy Supply = 0

55kW Reduce

25kW

Energy Consumption

Energy Recovery

100% Renewable Energy Supply

Reduce

Reduce

Reduce
Green Strategies For Dummies

1. Improved Façade
2. Solar Hot Water Heating
3. Lower Lighting Power
4. Code Compliant HVAC System
5. Grey Water Treatment
6. Low Flow Water Fixture
USGBC membership growth reflects the expansion of green buildings in the market.

As of June 2009.

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Square Footage of Commercial LEED Certified Projects (cumulative, in millions)

* As of June 2009

385* million

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Increased Productivity through Daylighting

- Schools: 20% Better Test Performance
- Hospitals:Earlier Discharge
- Retail: Increase in Sales per Square Foot
- Factories: Increased Production
- Offices: 2-16% Productivity Increase

2007 Green Technologies FZCO – www.greentechno.com
Occupants and tenants perceive value of working in a green building to be:

- **Reduced Energy Consumption**
- **Increased Productivity**
- **Lower Operating Costs**
- **Positive Marketing and Promotion**
- **Overall Environmental Benefit**

GREEN BUILDING
AN IMPORTANT PART OF THE SOLUTION
Sesam - Green Technologies
Green Buildings Program

Solar Days
Dubai
April 20/21, 2009

Green Building

Water Days
Dubai
July 07/08, 2009

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Integrated Design For
Green Buildings
December 2009
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“Ever since the first cave people crept indoors for safety, humans have sought to bring sunlight in from the outside.”

Daylighting:

Is the controlled admission of natural light into a space to reduce or eliminate electric lighting

With or Without Solar Gain
Light and Heating Effect of Sun Light

Clear State

SageGlass IGU framed into a window

SageGlass IGU

SageGlass coating

Sunlight

Solar heat

Interior of building

Surface 4

Surface 3

Surface 2

Surface 1

Exterior of building
BENEFITS OF DAYLIGHTING

• Daylighting reduces the need for electric lighting of building resulting in decreased energy use.

• Reduces lighting energy use by 50% to 80%.

• Daylighting design involves a careful balance of heat gain and loss, glare control, visual quality, and variations in daylight availability.

• Indoor environments with sufficient natural daylight and a visual connection to outdoor environments have been proven to increase occupant productivity and comfort, leading to better employee retention.
SUCCEFUL DAYLIGHTING DESIGN

- Use of diffused light from the sky
- Integration with electric lighting system
- Daylight as primary source of illumination
- Quality visual environment
- Glare Control
- Energy savings
DAYLIGHTING TO SAVE ENERGY

- kW (peak demand)
- kWh
- Therms
- Set performance goals:
  - Lighting Power Density
  - EUI
## Green Building Design & Construction Rating System

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>AVAILABLE POINTS</th>
<th>ENVIRONMENTAL WEIGHTING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NC</td>
<td>CS</td>
</tr>
<tr>
<td>Sustainable Sites</td>
<td>26</td>
<td>28</td>
</tr>
<tr>
<td>Water Efficiency</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Energy &amp; Atmosphere</td>
<td>35</td>
<td>37</td>
</tr>
<tr>
<td>Materials &amp; Resources</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Indoor Environmental Quality</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>Daylight &amp; Views</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Innovation in Design</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Regional Priority</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>110</td>
<td>110</td>
</tr>
</tbody>
</table>
EQ Credit 8.1: Daylight & Views

Daylight

- Intent

  - To provide building occupants with a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

- Requirements

  Through 1 of the 4 options, achieve daylighting in at least the following spaces:

<table>
<thead>
<tr>
<th>Regularly Occupied Spaces</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>75%</td>
<td>1</td>
</tr>
</tbody>
</table>
Example: Building Orientation

Indoor Environmental Quality

- Control thermal comfort
- Provide daylight/views
- Consider acoustics
Strategies: Provide Daylight/Views

- North facing skylight
- Exterior shading device
- Interior light shelf
- Light fixture with sensors & dimming controls
- Daylight glazing
- Vision glazing
  - 60" max
  - 30" min

Prepared by Paladino Consulting LLC
Glare:
- is any excessively bright source of light within the visual field that creates discomfort or loss in visibility.

To control glare, use any of the following common strategies:

- Fixed exterior shading devices
  - Exterior light shelves
  - Interior light shelves
  - Interior blinds and louvers
  - Operable draperies and blinds
  - Fritted glazing
  - Electronic blackout glazing
Glare Control and Solar Control

External Shutters

Interior Shades

Electrochromatic Glass
EQ Credit 8.2: Daylight & Views

View

• **Intent**
  - To provide building occupants with a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

• **Requirements**
  - Achieve a direct line of sight to the outdoor environment via vision glazing between 30 inches and 90 inches above the finish floor for building occupants in 90% of all regularly occupied areas. Determine the area with a direct line of sight by totaling the regularly occupied square footage that meets the following criteria:
    • In plan view, the area is within sight lines drawn from perimeter vision glazing.
    • In section view, a direct sight line can be drawn from the area to perimeter vision glazing.

The line of sight may be drawn through interior glazing. For private offices, the entire square footage of the office may be counted if 75% or more of the area has a direct line of sight to perimeter vision glazing. For multi-occupant spaces, the actual square footage with a direct line of sight to perimeter vision glazing is counted.
Metric: Horizontal View to Confirm View Access
<table>
<thead>
<tr>
<th>Prerequisite 1</th>
<th>Fundamental Building Commissioning</th>
<th>Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite 2</td>
<td>Minimum Energy Performance</td>
<td>Required</td>
</tr>
<tr>
<td>Prerequisite 3</td>
<td>Fundamental Refrigerant Management</td>
<td>Required</td>
</tr>
<tr>
<td>Credit 1</td>
<td>Optimize Energy Performance</td>
<td>3 -19</td>
</tr>
<tr>
<td>Credit 2</td>
<td>On – Site Renewable Energy</td>
<td>1 - 7</td>
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<td>Credit 3</td>
<td>Enhanced Commissioning</td>
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<tr>
<td>Credit 4</td>
<td>Enhanced Refrigerant Management</td>
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</tr>
<tr>
<td>Credit 5</td>
<td>Measurement &amp; Verification</td>
<td>3</td>
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<tr>
<td>Credit 6</td>
<td>Green Power</td>
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<tr>
<td><strong>Total Possible Points</strong></td>
<td></td>
<td><strong>35</strong></td>
</tr>
</tbody>
</table>
Strategies: Reduce Energy Demand

- Reduce demand for artificial heating, cooling, ventilation and lighting
- Use efficient equipment with controls and feedback

Creekside Village Community Center Photo by K.C. Kratt
EA Prerequisite 2: MINIMUM ENERGY PERFORMANCE

• **Intent**
  - Establish minimum level of efficiency for the proposed building and systems to reduce environmental and economic impacts associated with excessive energy use.

• **Requirements**
  - OPTION 1. Whole Building Energy Simulation
EA Credit 1: OPTIMIZE ENERGY PERFORMANCE

• **Intent**
  - Achieve increasing levels of energy consumption below the prerequisite standard to reduce environmental impacts associated with excessive energy use

• **Requirements**
  - Select 1 of the 3 compliance path options described below. Project teams documenting achievement using any of the 3 options are assumed to be in compliance with EA Prerequisite 2: Minimum Energy Performance.

**Option 1:** Whole Building Energy Simulation

**Option 2:** Prescriptive Compliance Path: ASHRAE Advanced Energy Design Guide

**Option 3:** Prescriptive Compliance Path: Advanced Buildings™ Core Performance™ Guide
THE KANDALAMA HOTEL, Dambulla – LEED Bronze; 2000
The First LEED Green Building outside USA & the First LEED Green Hotel in the World
TECOM MANAGEMENT OFFICE INTERIORS, DUBAI – LEED Platinum; 2009
The First LEED Platinum Commercial Interiors in the Middle East
SUMMERTOWN INTERIORS,
DUBAI
Pursuing LEED Gold
JEHAN GREEN WALLS,
SHARJAH
Pursuing LEED Platinum
Lighting-Daylighting System Concepts

Artificial Lighting Photometrics Summary

Ground Floor
Lighting-Daylighting System Concepts

Lighting Raytrace Preview
Ground Floor
Sage Electrochromics

- Clear: 62% visible light and 0.48 SHGC
- Tinted: 3.5% visible light and 0.09 SHGC
- Uses less electricity per 1,500sf glass than 60w bulb
- Documented energy savings of 10-25%
One Option - SAGE ELECTROCHROMIC GLASS

1. Application of Low Voltage (less than 5V DC) to Sage Glass coating of glass in the “clear” state.
2. Ion exchange from counter electrode to electrochromic electrode layer.
3. Glass darkens. Sun’s light and heat are absorbed. (0.09 SHGC)
4. Reverse of voltage polarity by “switching off”.
5. Ion exchange to original layer, the counter electrode.
Energy Simulation Results
Summary in Graphs
Building Peak Cooling Load

![Graph showing Energy Simulation Results](image-url)
Energy Simulation Results
Summary in Graphs

Building Annual Energy Cost

58.1% Energy Cost Improvement

19 POINTS out of 19
points for LEED NC Energy and Atmosphere Credit 1 +
1 POINT for Innovation in Design Credit
Mandatory Day lighting Will

1 - Reduce Energy Consumption

2 - Improve Indoor Environment Quality, Occupant Comfort and Productivity

3 - Lowers Requirement for Artificial Lighting
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