Smarter Cities: Smarter Buildings

Building for an Uncertain Future: Sustainable Building Products

Anthony Bernheim, FAIA, LEED Fellow

February 2012

Topics

1. Introduction
2. Integrative Design
3. Sustainable Product Selection
4. Comprehensive Product Declarations
5. Greentech + Cleantech
6. Discussion

From Top to Bottom: NASA Langley / Gundersen Lutheran Critical Care Tower, La Crosse, WI / Mary Catherine Bunting Center

Smarter Cities: Smarter Buildings

1

Introduction

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Introduction

Industry trends point towards high performance buildings that are

1. **Energy** efficient
2. **Water** efficient
3. Provide **healthy**, **comfortable** and **safe** indoor environments
4. Are constructed using **sustainable** and **intelligent building products**.

These trends are supported by

1. New green building **codes**
2. Green building **rating systems**.

This presentation will present integrative design strategies as the path to sustainable buildings (and cities) with a focus on intelligent product selection.

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More than half
the world's population
lives in Cities,

Building-related emissions will double by 2030

unless we change

how the world builds

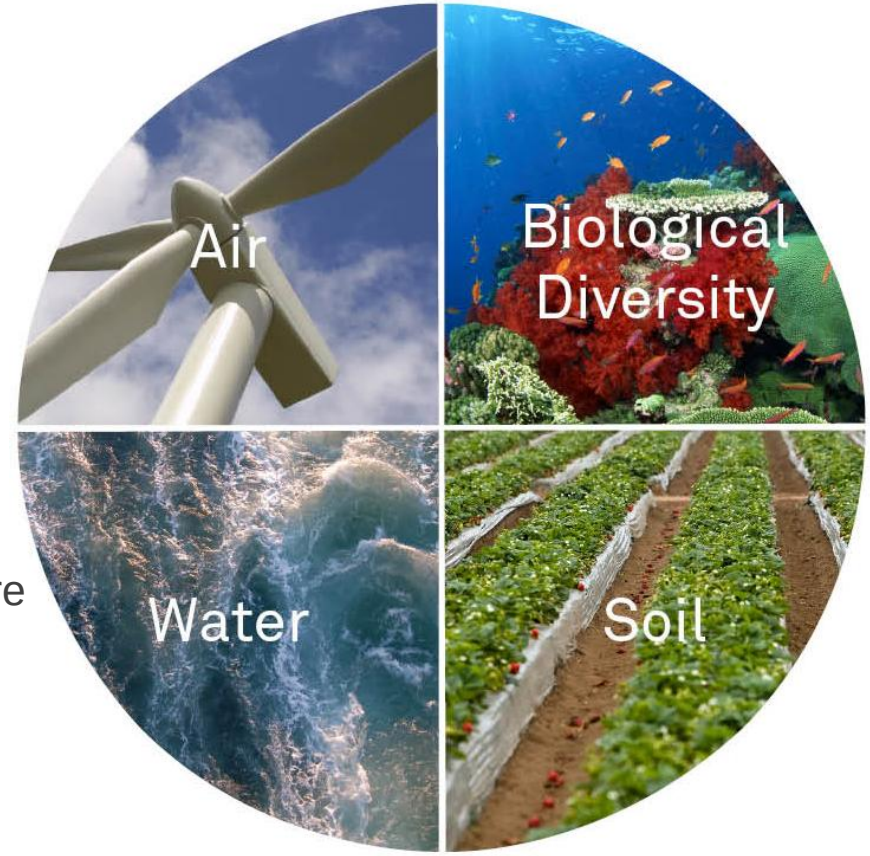
Sustainable Development

"The standard for ecological design is neither efficiency nor productivity but **health**, beginning with that of the soil and extending upward through **plants, animals, and people**. It is impossible to impair health at any level without affecting it at other levels.

The etymology of the word '**health**' reveals its connection to other words such as **healing**, wholeness, and holy.

Ecological design is an art by which we aim to restore and maintain the **wholeness** of the entire fabric of life increasingly fragmented by specialization, scientific reductionism, and bureaucratic division."

David W. Orr, Oberlin College, 2002



Smarter Cities: Smarter Buildings

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Integrative Design

Anthony Bernheim, FAIA, LEED Fellow

February 2012

Loyola Marymount University, Los Angeles, CA, USA - LEED Gold

Integrative Design

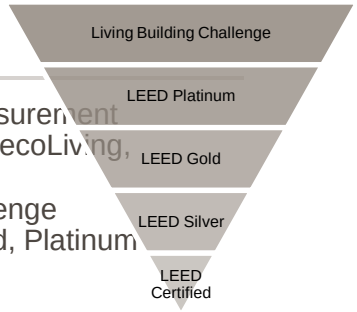
Integrative Building Process

AECOM ecoSystem Toolkit

•Framework of flexible tools organized by project phase
•Guide design professionals from pre-design through post occupancy

Metrics

•Project performance measurement
•ecoStandard, ecoCertified, ecoLiving, ecoRegenerative
•Living Building Challenge
•LEED Certified, Silver, Gold, Platinum
•BREEAM

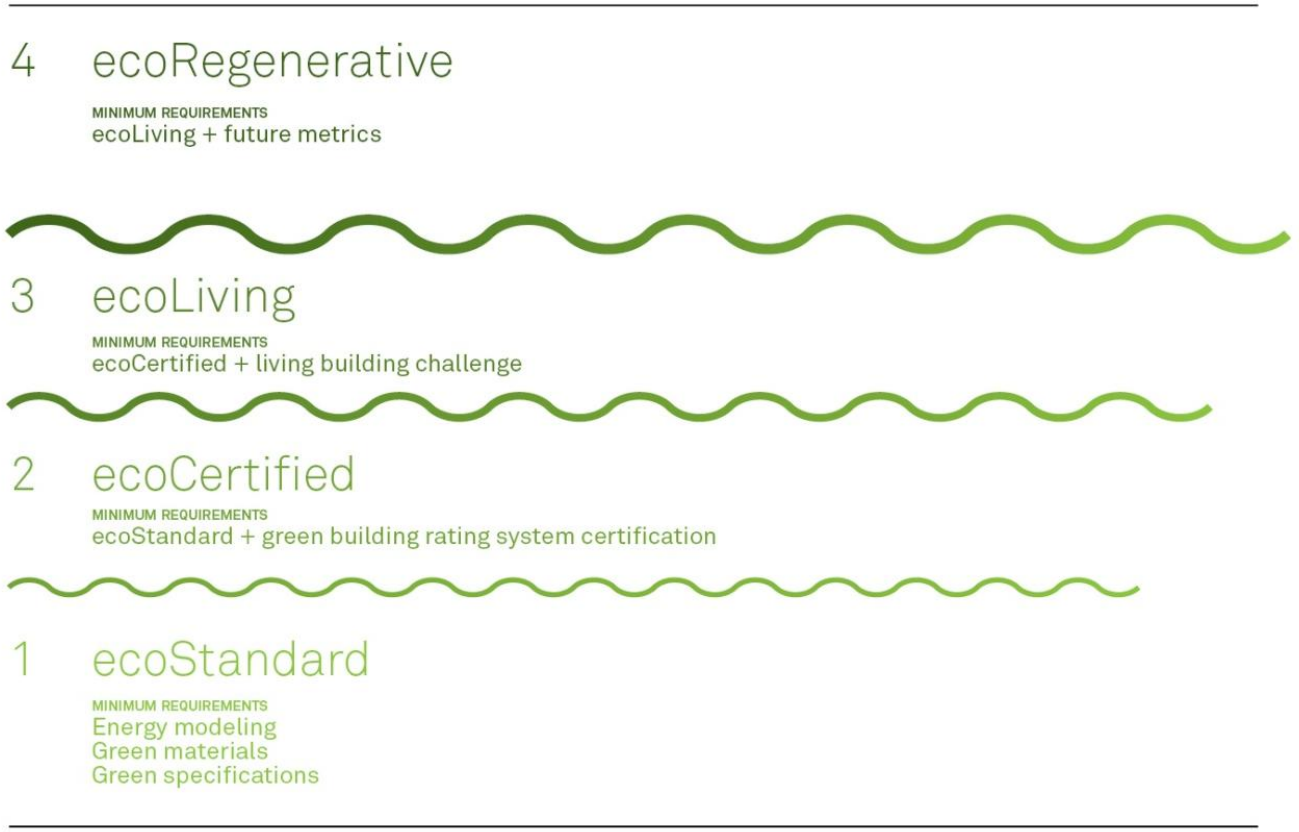


How Green?

Design Approach

Performance Levels:

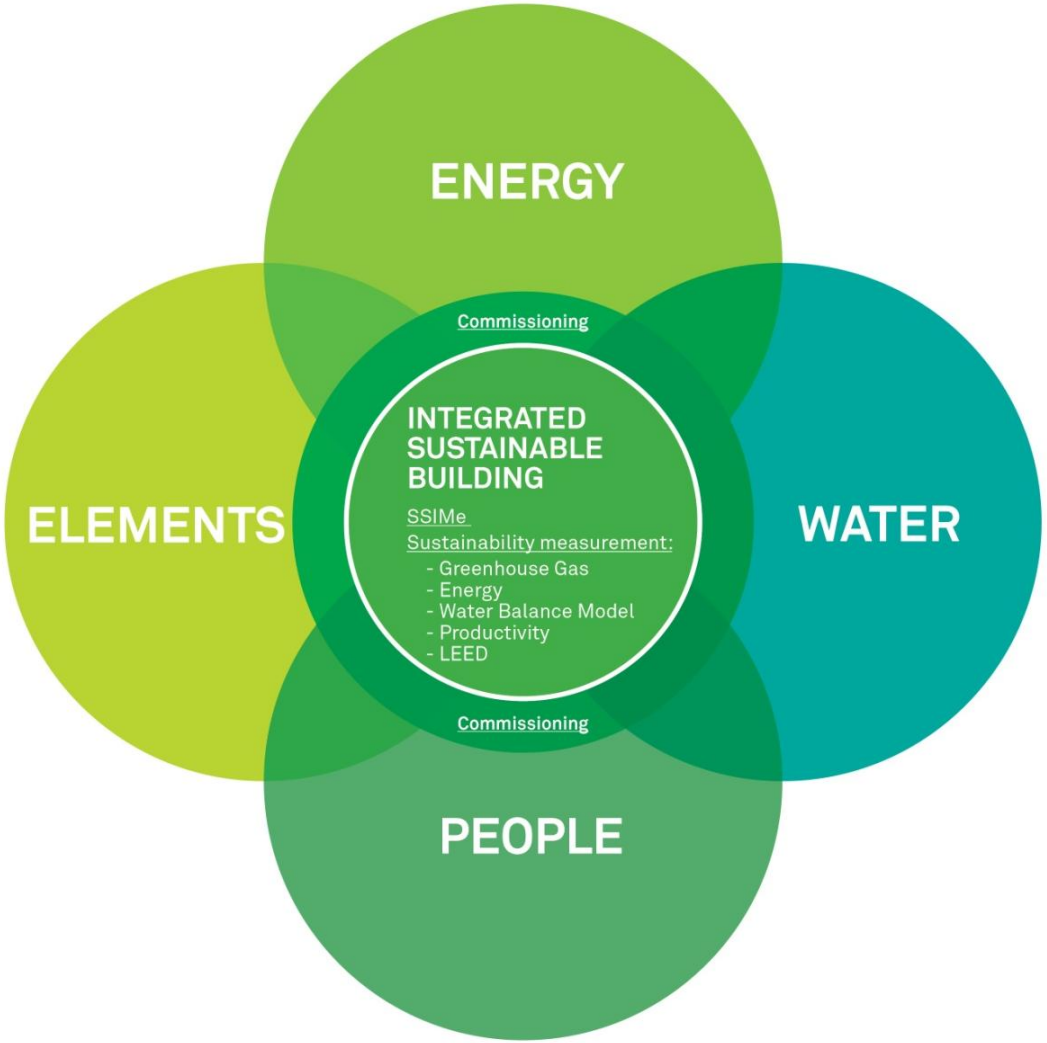
- Client
- > 50,000 ft^2 (4,645 m^2)



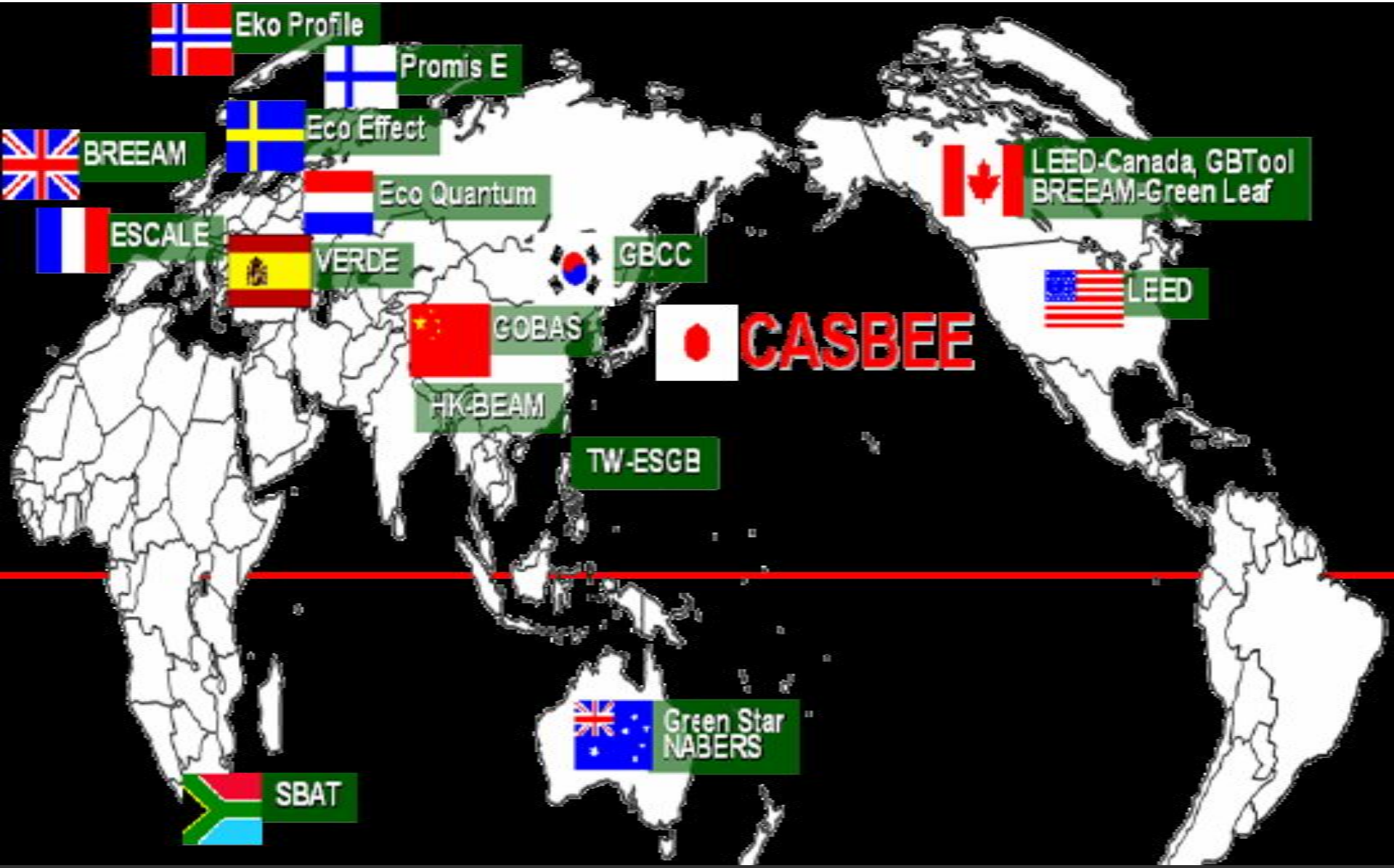
Sustainable Building Components

- **Energy**
- **Water**
- **People**
- **Elements**
  - SSIMe + SSIMw

    Green Building Rating Systems
  - Building Commissioning



Global Green Building Rating Systems



Smarter Cities: Smarter Buildings

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Sustainable Product Selection

Anthony Bernheim, FAIA, LEED Fellow

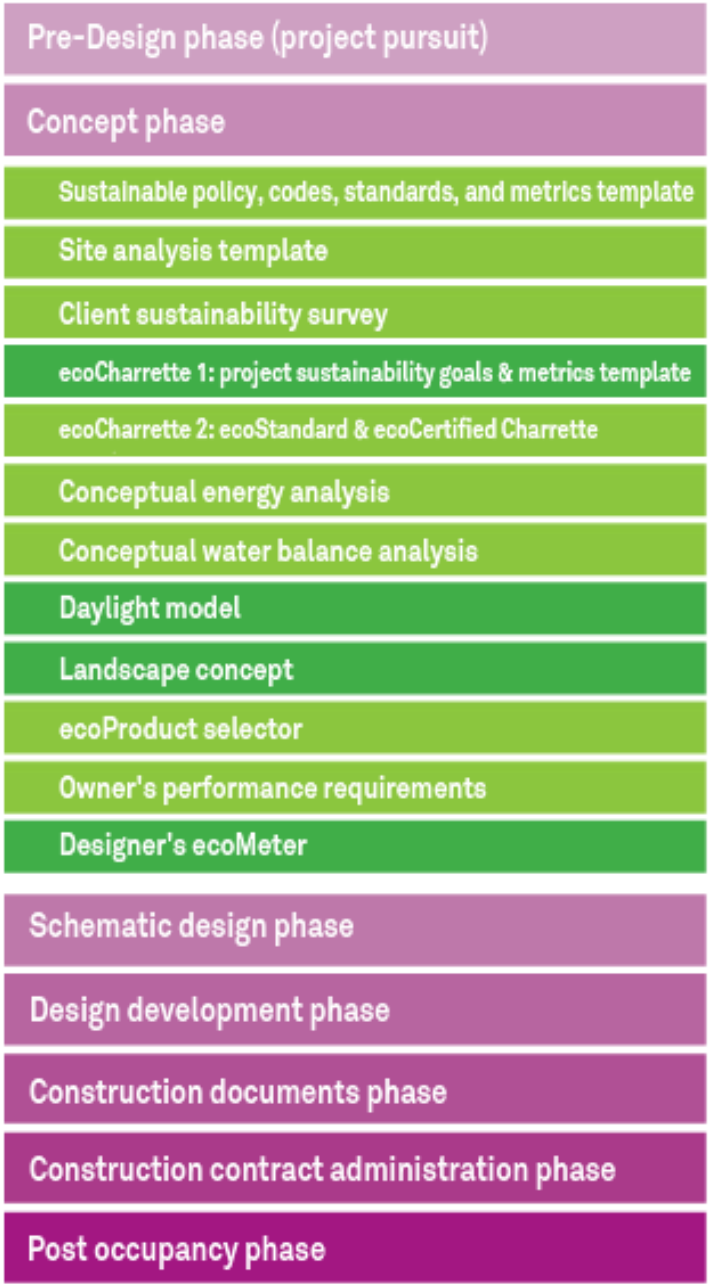
February 2012

AECOM ecoSystem Toolkit

1. **Project Phases**
2. **Obtain**
   - Download
   - Request
3. **Flexible / Adaptable**
4. **Develop by Phase**
5. **ecoStandard Tools**
   - > 50,000 sq. ft
   - Minimum Standards
   - AIA 2030 Commitment
6. **ecoCertified+ Tools**

ecoStandard

ecoCertified (and above)



Benefits

- Responsible Company
- Reputation
- Design Efficiency
- Design Excellence = Sustainability
- Client Life Cycle Cost Savings
- Client Risk Reduction
- Industry Trends
- Competitive
- AIA 2030 Commitment
- Reduced Ecological Footprint

Top: Mary Catherine Bunting Center / Bottom: Gundersen Lutheran Critical Care Tower, La Crosse, WI

Sustainability Policy, Codes, Standards, and Metrics

1. **RFQ / RFQ**
2. **Sustainability Legislation**
3. **Corporate Policy**
4. **Client Competitor Benchmarks**
5. **Codes & Standards**
6. **AECOM ecoSystem**
7. **Green Building Rating System**

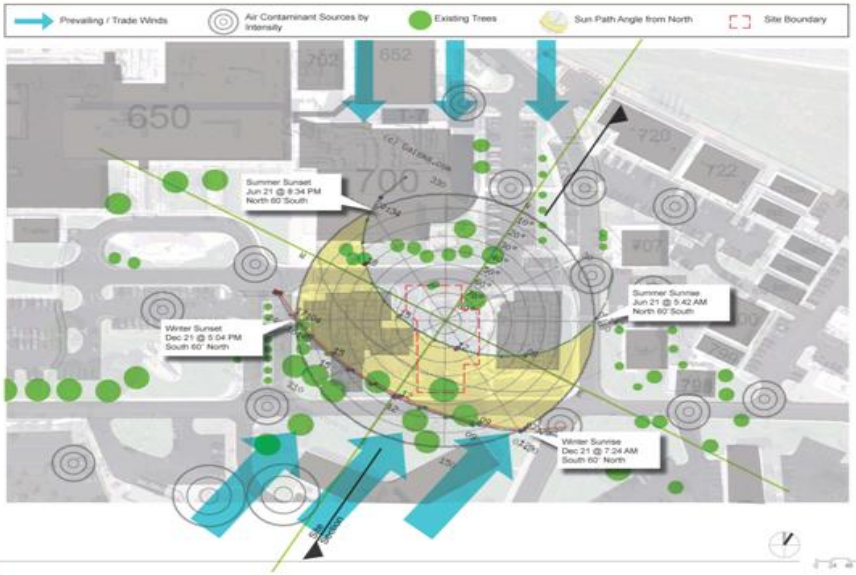
   a) **Project Approach**
   - Statement of Qualifications
   - Proposal

   b) **Team Interview**

	Pre-Design Phase Y/N	Design Phases Y/N	
RFQ/RFP Requirements			
Competition requirements			
RFQ Requirements			
RFP Requirements			
Sustainability Legislation			
International Policy			
Continental Policy			
National Policy			
State Policy			
Local (County/City Policy)			
Corporate Policy			
Client Policy			
Tenant Policy			
President's Climate Commitment (ACUPCC)			
Competitor Benchmarks			
Client/Tenant Competitors			
Neighbors			
Codes and Standards			
International Green Construction Code			
ASHRAE 189.1.2009			
State Green Building Codes			
Local Green Buildng Codes			
Other Codes			
AECOM ecoSystem			
ecoStandard			
ecoCertified			
ecoLiving			
ecoRegenerative			
Green Building Rating System/Environmental Assessment Methodology			
LEED			
New Construction			
Core and Shell			
Commerical Interiors			
Existing Buidlng O+M			
Schools			
Healthcare			
Retail			
Other			
BREEAM			
GreenStar			
CASBEE			
Other			

Site Analysis

Site Analysis

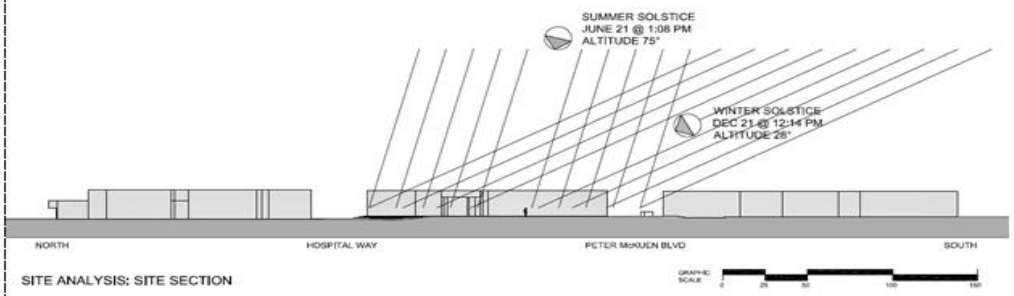


Site Analysis Plan

Location Plan

ADDITIONAL SITE DATA:
EXISTING VEGETATION IS LIMITED ON THE BUILDING SITE DUE TO AN ASPHALT COVERED PARKING LOT, ROADWAYS TO THE NORTHWEST & SOUTHEAST, AND 1-STORY BUILDINGS TO THE NORTHEAST & SOUTHWEST. THERE ARE 2 PROMINENT TREES, 1 TO THE NORTH AND 1 TO THE SOUTH.
TOPOGRAPHY RISES QUICKLY AT THE NORTHWEST THEN LEVELS OFF FOR THE MAJORITY OF THE SITE.

Landscape Data



SITE ANALYSIS: SITE SECTION

Site Analysis Section

Brownfield Status

Sensitive Species

AIR QUALITY:
ACCORDING TO THE U.S. ENVIRONMENTAL PROTECTION AGENCY SEASONAL CONTAMINANTS ARE PRESENT IN THIS AREA. OZONE LEVELS (SUBPART 2/ SEVERE 15), ALONG WITH LARGE PARTICULATE MATTER (EXCEEDS 24-HR. AQS STANDARD) & FINE PARTICULATE MATTER (EXCEEDS FEDERAL 24-HR. & ANNUAL MEANS STANDARDS BY 45-50%), REACH HIGH LEVELS PRIMARILY DURING HIGH TEMPERATURE PERIODS. CARBON MONOXIDE IS ALSO PRESENT BUT AT A MORE MODERATE LEVEL (EXCEEDS FEDERAL 8-HR. STANDARD BY 41%).

Ambient Outdoor Air Quality Summary

VERSION 1.0 8/13/2011 Page 1

Instructions | Site Analysis | Climate Analysis | Ambient Outdoor Air Quality

AECOM

Site Analysis: Ambient Outdoor Air Quality

Outdoor Air ▶ **Concentrated Indoor Air**

Pollutant	Averaging Time	Ambient Outdoor Air Quality Standards			Project Site	Notes
		Federal	California	American Lung Association	Available Data	
Ozone (O3)	1 hour		0.09 ppm (180 µg/m3)	Grade F - weighted average 9.5	0.119 ppm	Source: EPA 2008-2010 Design Value. Met NAAQS
	8 Hour	0.075 ppm (147 µg/m3)	0.070 ppm (137 µg/m3)		0.089 ppm	Source: EPA 2008-2010 Design Value. Does not meet Met NAAQS
Particulate Matter (PM10)	24 hour	150 µg/m3	50 µg/m3			No data available
	Annual Arithmetic Mean		20 µg/m3			No data available
Fine Particulate Matter (PM2.5)	24 hour	35 µg/m3				No data available
	Annual Arithmetic Mean	15.0 µg/m3	12 µg/m3		11.7 µg/m3	Source: EPA 2008-2010 Design Value. Met NAAQS
Carbon Monoxide (CO)	1 Hour	35 ppm (40 mg/m3)	20 ppm (23 mg/m3)		2.7 ppm	Source: EPA 2008-2010 Design Value
	8 Hour	9 ppm (10 mg/m3)	9.0 ppm (10mg/m3)		1.4 ppm	Source: EPA 2008-2010 Design Value. Meets NAAQS
Nitrogen Dioxide (NO2)	1 Hour	0.100 ppm	0.18 ppm (339 µg/m3)		0.052 ppm	Source: EPA 2008-2010 Design Value
	Annual Arithmetic Mean	0.053 ppm (100 µg/m3)	0.030 ppm (57 µg/m3)		0.013 ppm	Source: EPA 2008-2010 Design Value
Sulfur Dioxide (SO2)	1 Hour	75 ppb	0.25 ppm (655 µg/m3)		4.3 ppb	Source: EPA 2008-2010 Design Value
	24 Hour	0.14 ppm (365 µg/m3)	0.04 ppm (105 µg/m3)		0.007 ppm	Source: EPA 2008-2010 Design Value
	Annual Arithmetic Mean	0.03 ppm (80 µg/m3)			0.00213 ppm	Source: EPA 2008-2010 Design Value
Lead	30 Day Average		1.5 µg/m3			No data available
	Calendar Quarter	1.5 µg/m3				No data available
	Rolling 3-Month Average	0.15 µg/m3				No data available
Sulphates	24 hour		25 µg/m3			No data available
Hydrogen Sulfide	1 Hour		0.03 ppm (42 µg/m3)			No data available
Vinyl Chloride	24 Hour		0.01 ppm (26 µg/m3)			No data available
Radon	Zone 1 Highest Potential	1				
	Zone 2 Moderate Potential	2			Predicted ave. indoor radon screening level between 2 and 4pCi/L (zone 2)	Source: EPA
	Zone 3 Low Potential	3				

VERSION 1.0 9/19/2011 Page 1 of 1

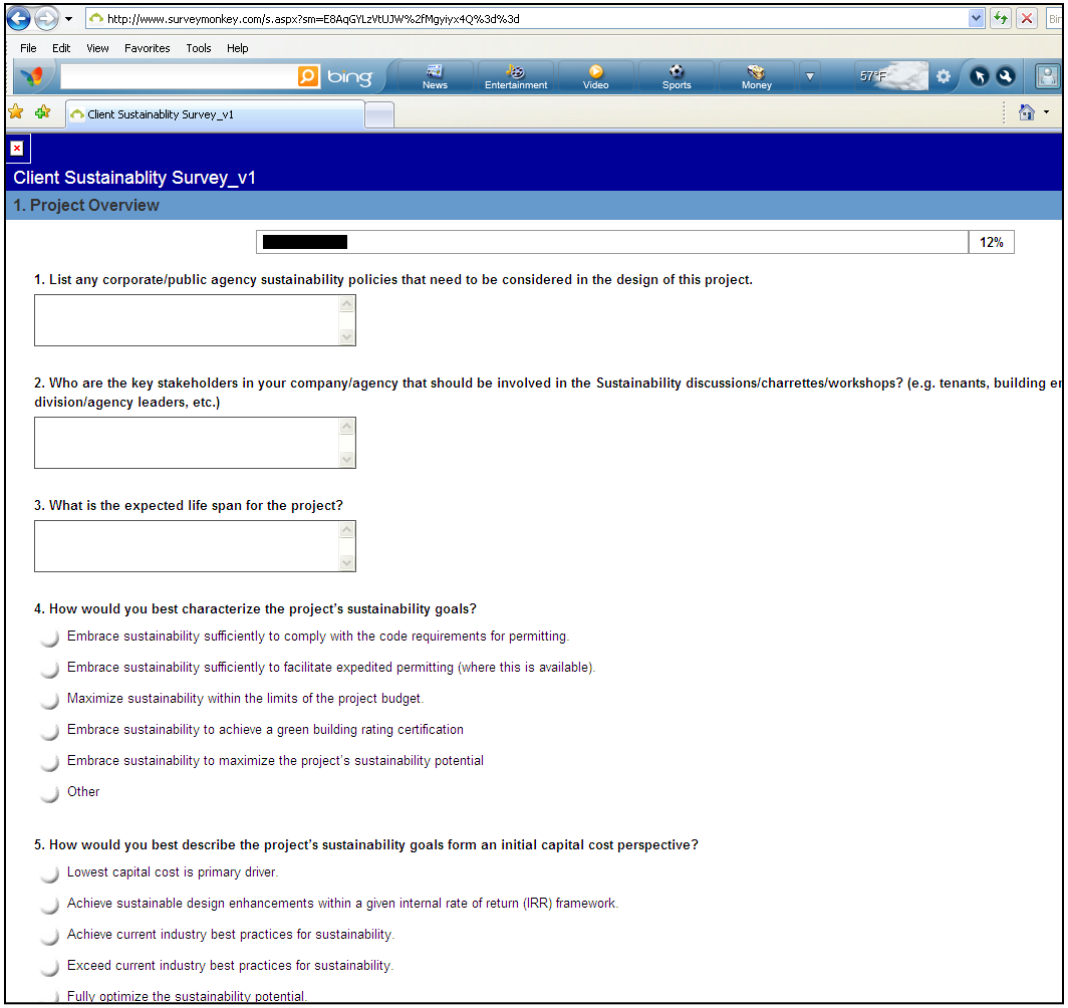
Instructions | Site Analysis | Climate Analysis | Ambient Outdoor Air Quality

AECOM

Client Sustainability Survey

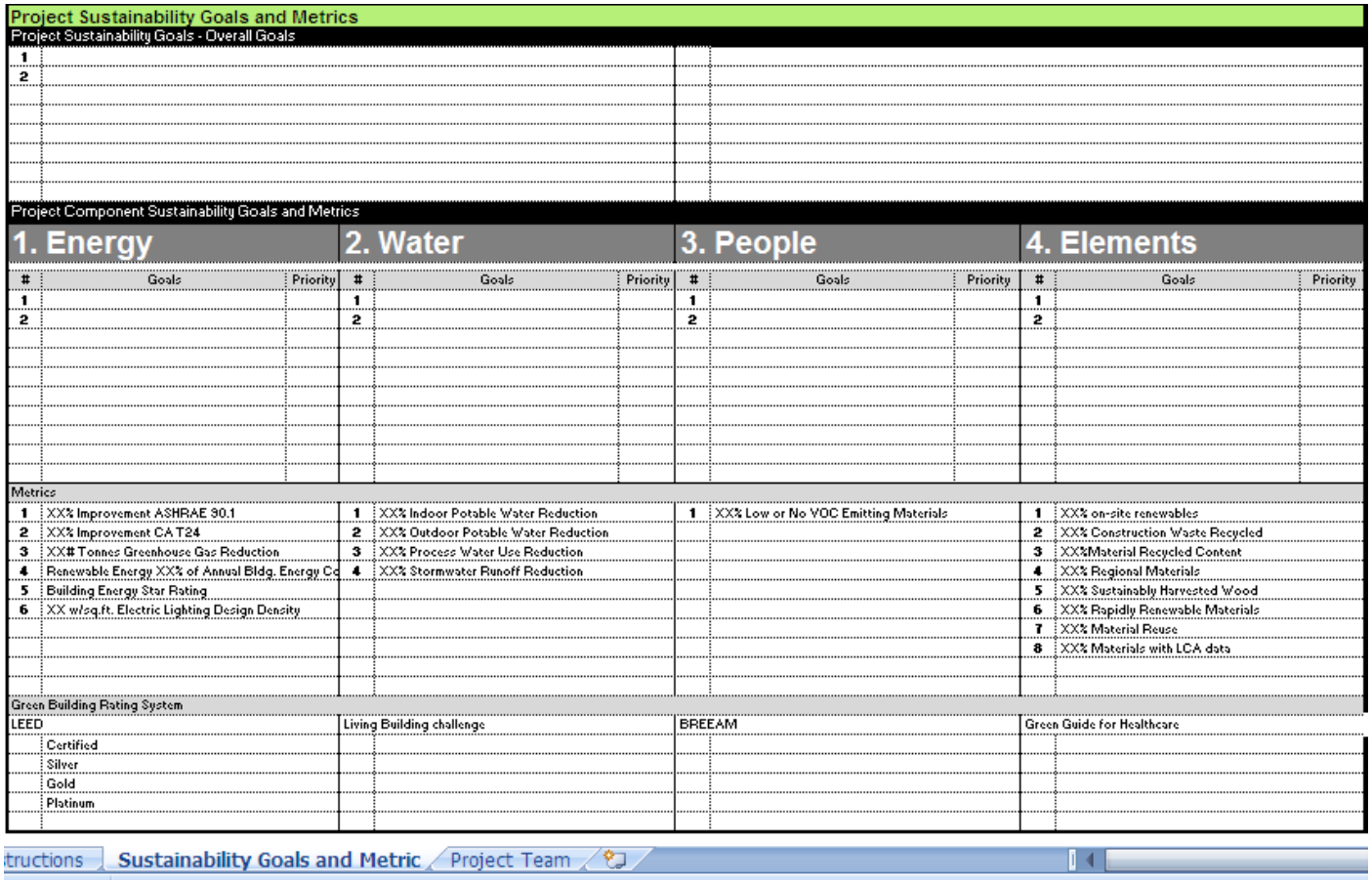
- **Captures information from project stakeholders in various focus areas, including:**
  - Energy goals
  - Water goals
  - Products
  - Operational goals

- **Results used in conjunction with goal setting Charrette 1 outcomes to inform Owner's Program Requirements**



ecoCharrette 1: Project Sustainability Goals and Metrics

- Integrate with Design Charrette
- Project Sustainability Goals
  - Overall Goals
  - Project Component Goals
    - Energy
    - Water
    - People
    - Elements
  - Metrics
  - Green Building Rating System



Project Sustainability Goals and Metrics

Project Sustainability Goals - Overall Goals

1	
2	

Project Component Sustainability Goals and Metrics

1. Energy			2. Water			3. People			4. Elements		
#	Goals	Priority	#	Goals	Priority	#	Goals	Priority	#	Goals	Priority
1			1			1			1		
2			2			2			2		

Metrics

1	XX% Improvement ASHRAE 90.1	1	XX% Indoor Potable Water Reduction	1	XX% Low or No VOC Emitting Materials	1	XX% on-site renewables
2	XX% Improvement CA T24	2	XX% Outdoor Potable Water Reduction			2	XX% Construction Waste Recycled
3	XX# Tonnes Greenhouse Gas Reduction	3	XX% Process Water Use Reduction			3	XX%Material Recycled Content
4	Renewable Energy XX% of Annual Bldg. Energy Co	4	XX% Stormwater Runoff Reduction			4	XX% Regional Materials
5	Building Energy Star Rating					5	XX% Sustainably Harvested Wood
6	XX w/sq.ft. Electric Lighting Design Density					6	XX% Rapidly Renewable Materials
						7	XX% Material Reuse
						8	XX% Materials with LCA data

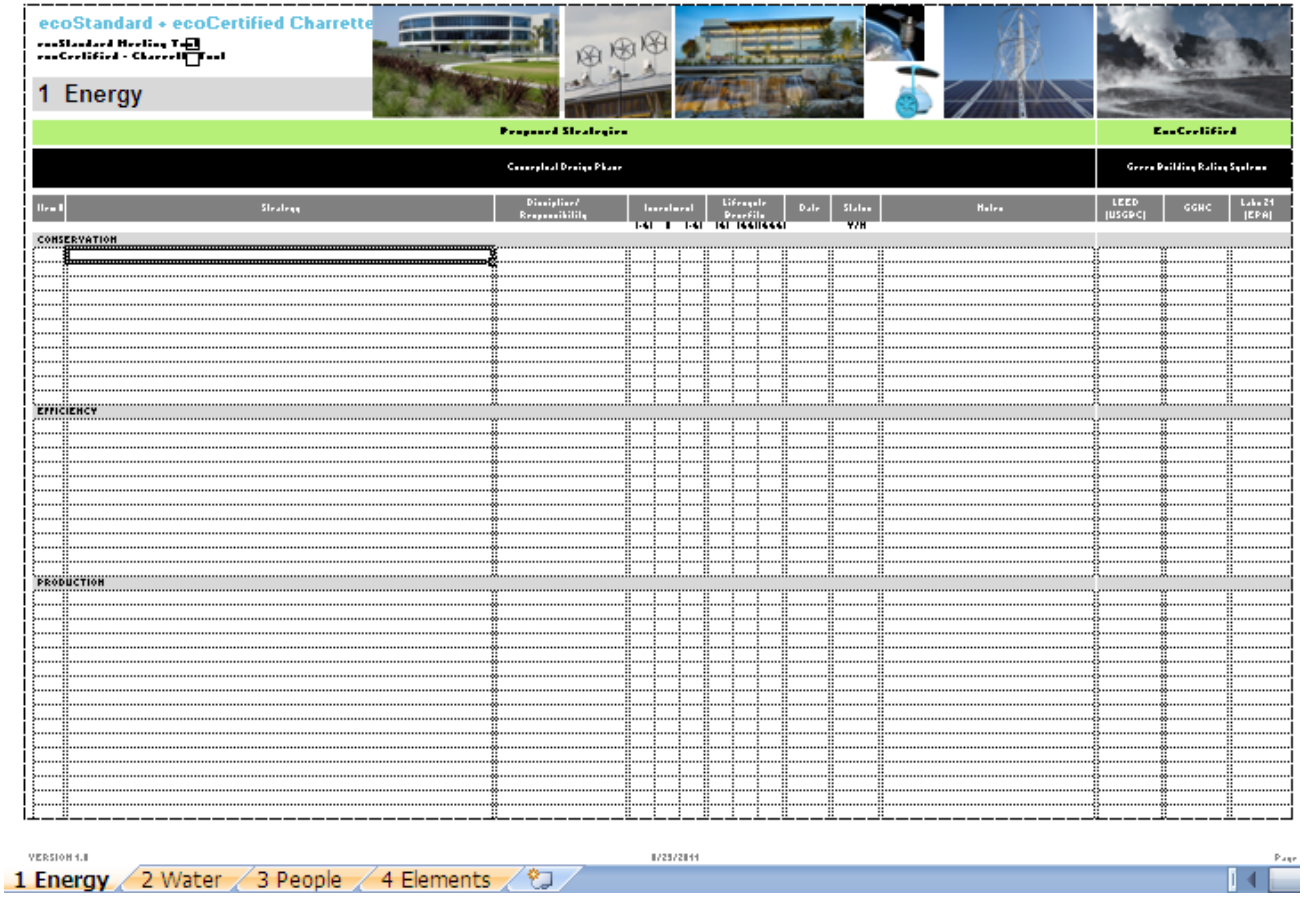
Green Building Rating System

LEED	Living Building challenge	BREEAM	Green Guide for Healthcare
Certified			
Silver			
Gold			
Platinum			

tructions | Sustainability Goals and Metric | Project Team

ecoCharrette 2: ecoStandard and ecoCertified Charrette

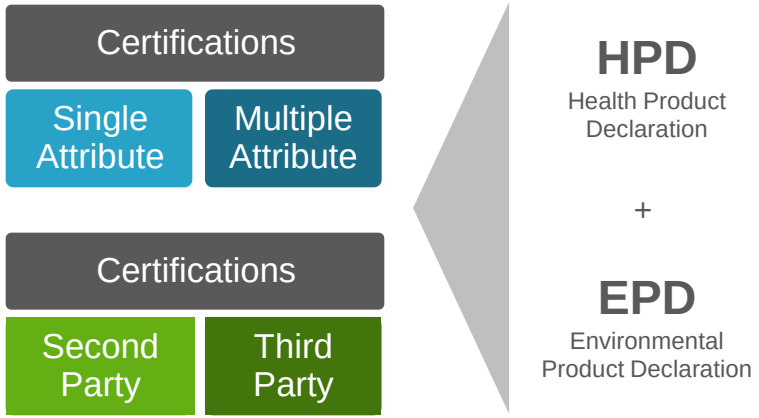
- Integrate with Design Charrette
- Four Components
  - Energy
  - Water
  - People
  - Elements
- Integrative
- Key Stakeholders
- Digital & Live
- Vote



AECOM

ecoProduct Selector

- **Goals: Select Sustainable Products**
  - Indoor Air Quality = Human Health
  - Sustainable Products = Global Health
- **Product Information**
- **Product Requirements**
  - Client
  - Code
  - AECOM Requirements
- **Product Sustainability Attributes**
  - Indoor Air Quality
  - Sustainable Products
- **Product Certifications**
  - Indoor Air Quality
  - Sustainable Products



ecoProduct Selector

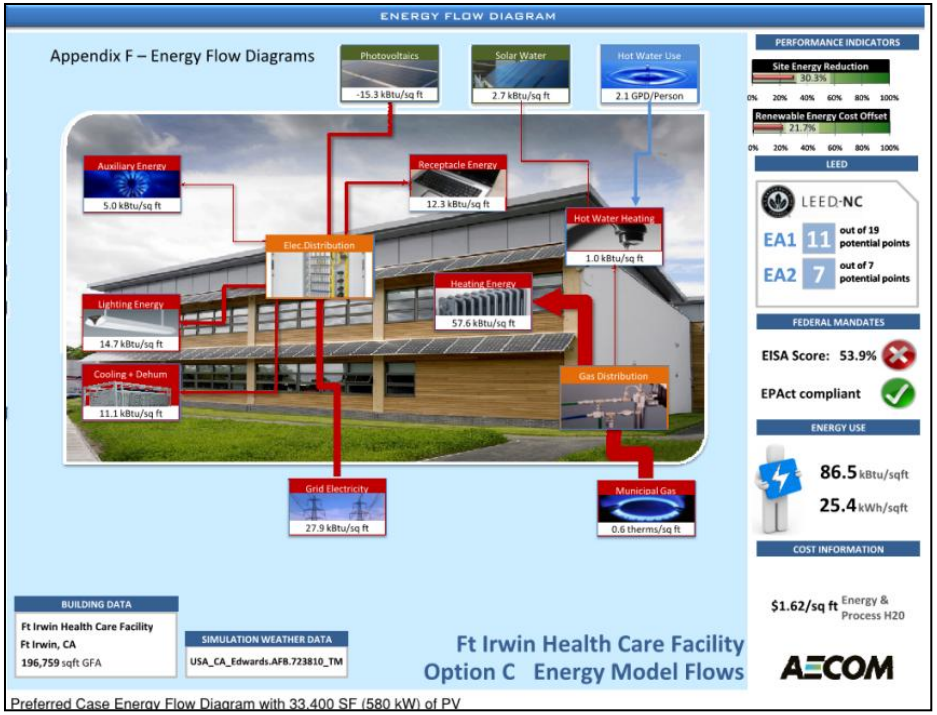
BuildingGreen.com Pharos greenwizard

1. PRODUCT INFORMATION				2. PRODUCT REQUIREMENTS				3. PRODUCT ATTRIBUTES										4. PRODUCT CERTIFICATIONS						
SPECIFICATION TITLE		PRODUCT ID		JURISDICTION REQUIREMENT	AECOM ecoSYSTEM RANKING			INDOOR AIR QUALITY			SUSTAINABLE PRODUCTS							INDOOR AIR QUALITY + SUSTAINABLE PRODUCTS						
Section Number	Section Name	Material ID	Product	Regulations / Codes / Standards	ecoStandard	ecoCertified	ecoCertified+	VOC Content	VOC Emissions	Chemical Content (Living Building	Energy (2030 Product Challenge)	Recycled Content	Recyclable	Rapidly Renewable	Sustainable Forestry	LCA	Other	Laboratory Test Data (VOC Content + VOC	Multiple Attribute 3rd Party Certifications	Single Attribute 3rd Party Certification	Single Attribute 2nd Party Certifications	Chemical Content Certifications	Life Cycle Assessment	Environmental Product Declaration (ISO
00 0000	EXAMPLE #1	CPT-1	[Mfr, product, color, pattern]	CALGreen	X	LEED-NC MR Cr4.2	Living Building	0 VOC	CA Standard Method Compliant (CALGreen-	No Red List Chemicals	50% CO2 Reduction	__% post-consumer	Mfr Reclamation	wool	GMO-Free	Primary Energy Demand	sustainable packaging	CA Standard Method V1.1 Compliant	MBDC C2C Gold	SCS Indoor Advantage Gold	Carpet & Rug Institute (CRI) Green Label Plus	LEED Pilot 1.1 Credit Chemicals		
01 0000	General Requirements																							
02 0000	Existing																							
03 0000	Concrete																							
04 0000	Masonry																							
05 0000	Metals																							
06 0000	Woods, Plastics and																							
07 0000	Thermal & Moisture																							
08 0000	Openings																							
09 0000	Finishes																							
10 0000	Specialties																							
11 0000	Equipment																							
12 0000	Furnishings																							
13 0000	Special																							
14 0000	Conveying Equipment																							
21 0000	Fire																							
22 0000	Plumbing																							
23 0000	Heating Ventilating &																							
24 0000	Reserved																							

AECOM

Energy & Water

- **Conceptual Energy Analysis**
  - Gives preliminary energy performance figures
- **Conceptual Water Balance Analysis**
  - Gives preliminary water performance figures
- **Daylight Model**
  - Analyzes pros and cons of introducing daylight



Preferred Case Energy Flow Diagram with 33,400 SF (580 kW) of PV

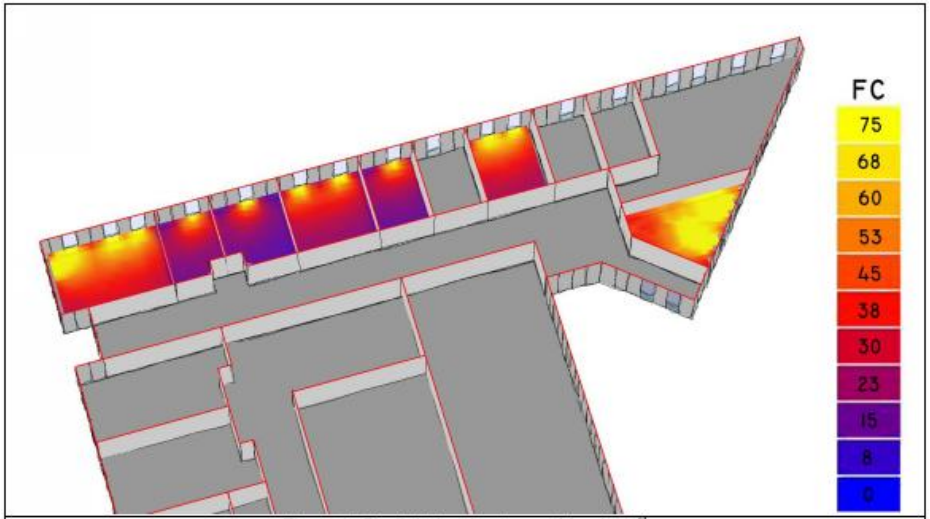


Figure 5: Daylight levels at noon March 21st

Smarter Cities: Smarter Buildings

Green Specifications

- **Green Specification Development**
- **Goals:**
  - Integrative Design
  - Recognize Green Building Codes + Standards
    - International Green Construction Code
    - ASHRAE 189.1.2009
    - CALGreen
  - Green Building Rating Systems
    - LEED - Multiple Versions + Multiple Project Types
  - Integrated Team
    - Architecture +
    - Building Engineering +
    - Landscape Architecture +
    - Interior Design

Smarter Cities: Smarter Buildings

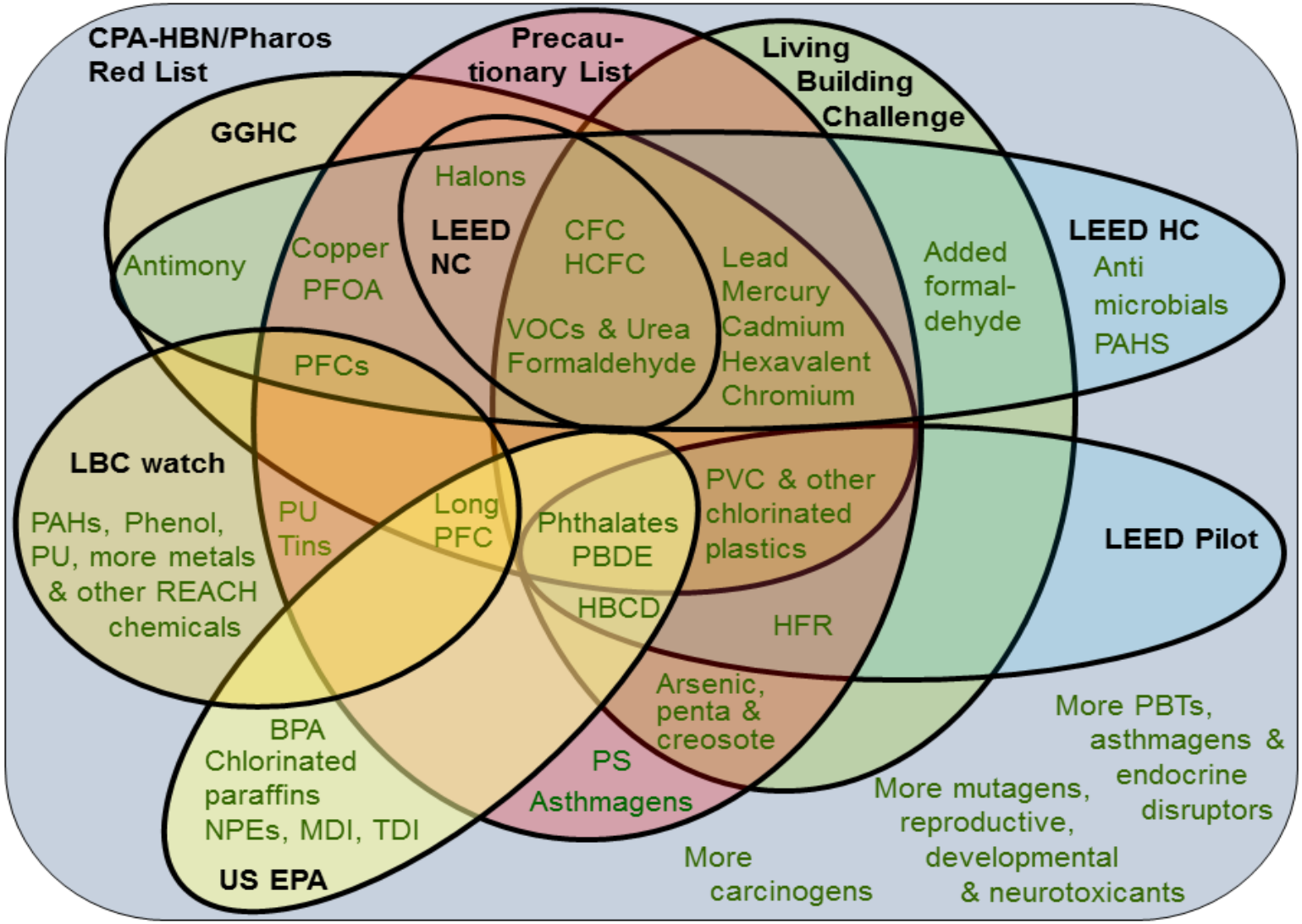
4

Comprehensive Product Declarations

Anthony Bernheim, FAIA, LEED Fellow

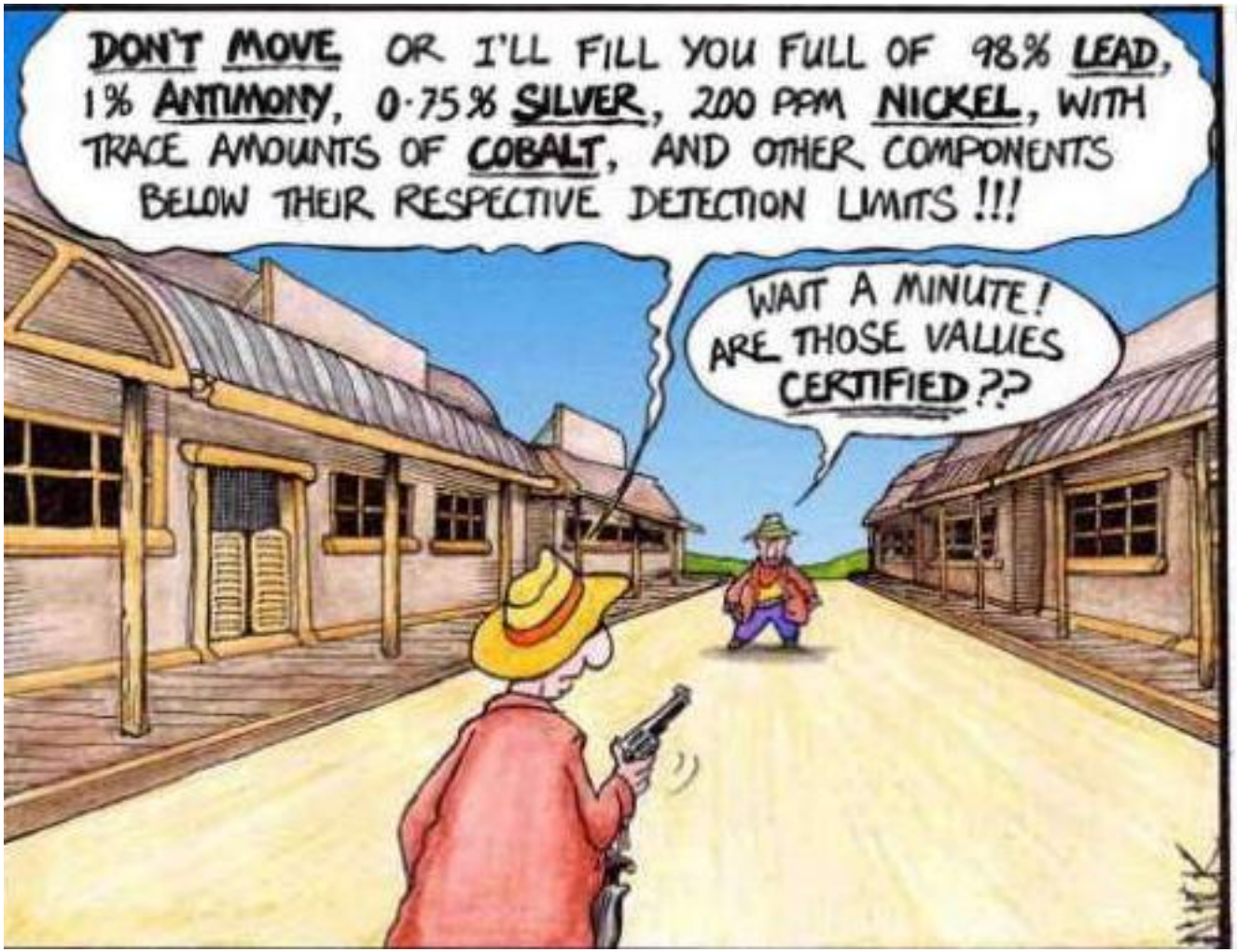
February 2012

"Red" Lists



 "Red" List Venn Diagram indicating Multiple Organizations' Chemicals of Concern (Healthy Building Network).

Sustainable Products?



Environmental Product Declaration

ENVIRONMENTAL PRODUCT DECLARATION

CARPET TILE: GLASBAC®RE, TYPE 6 NYLON

INTERFACEFLOR
MODULAR CARPET TILE WITH GLASBAC®RE BACKING &
SOLUTION DYED TYPE 6 NYLON

Modular carpet tile made with post-consumer content non-virgin backing and 100% recycled content type 6 nylon, including post-consumer and post-industrial material.

InterfaceFLOR

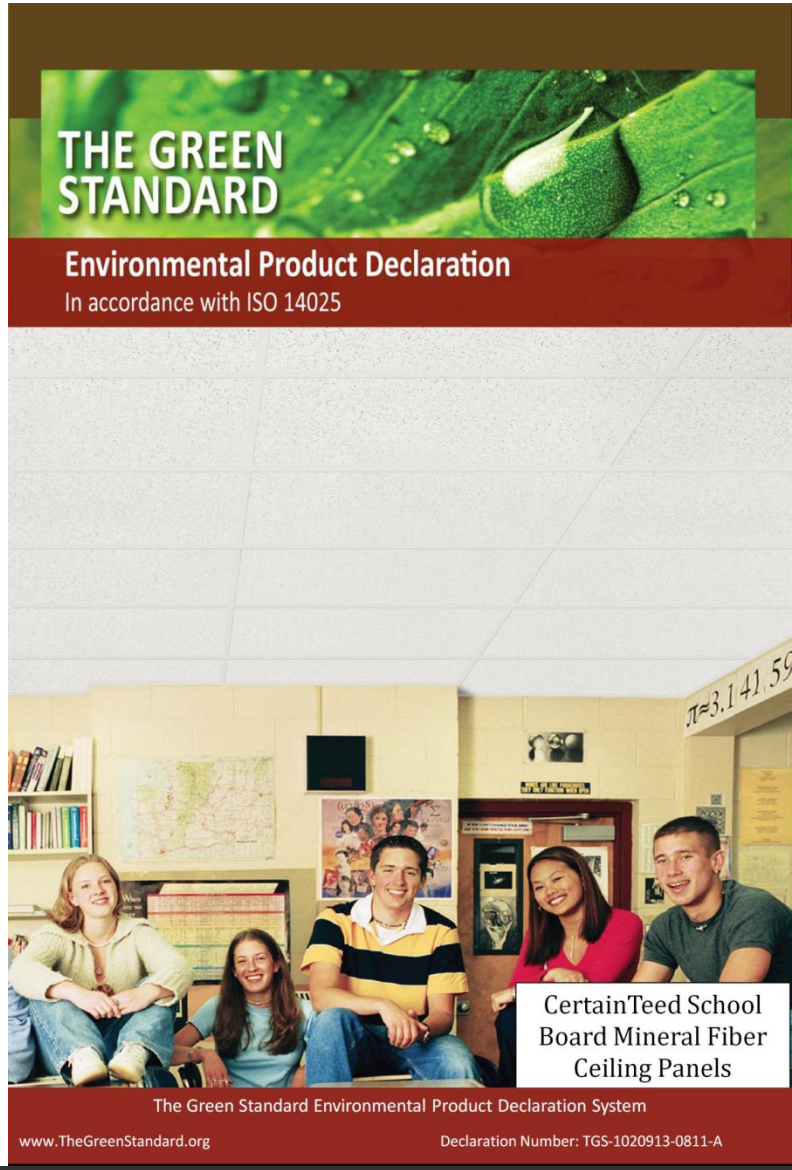
InterfaceFLOR, LLC and InterfaceFLOR Canada, Inc, are subsidiaries of Interface, Inc., the world's largest manufacturer of commercial carpet tile. For 38 years, the company has consistently led the industry through innovation and now leads the industry in environmental sustainability.

InterfaceFLOR is setting the pace for development of modular carpet using materials and processes that take less from the environment, and is well along the path to "Mission Zero®," the company's promise to eliminate any negative impact it has on the environment by the year 2020.

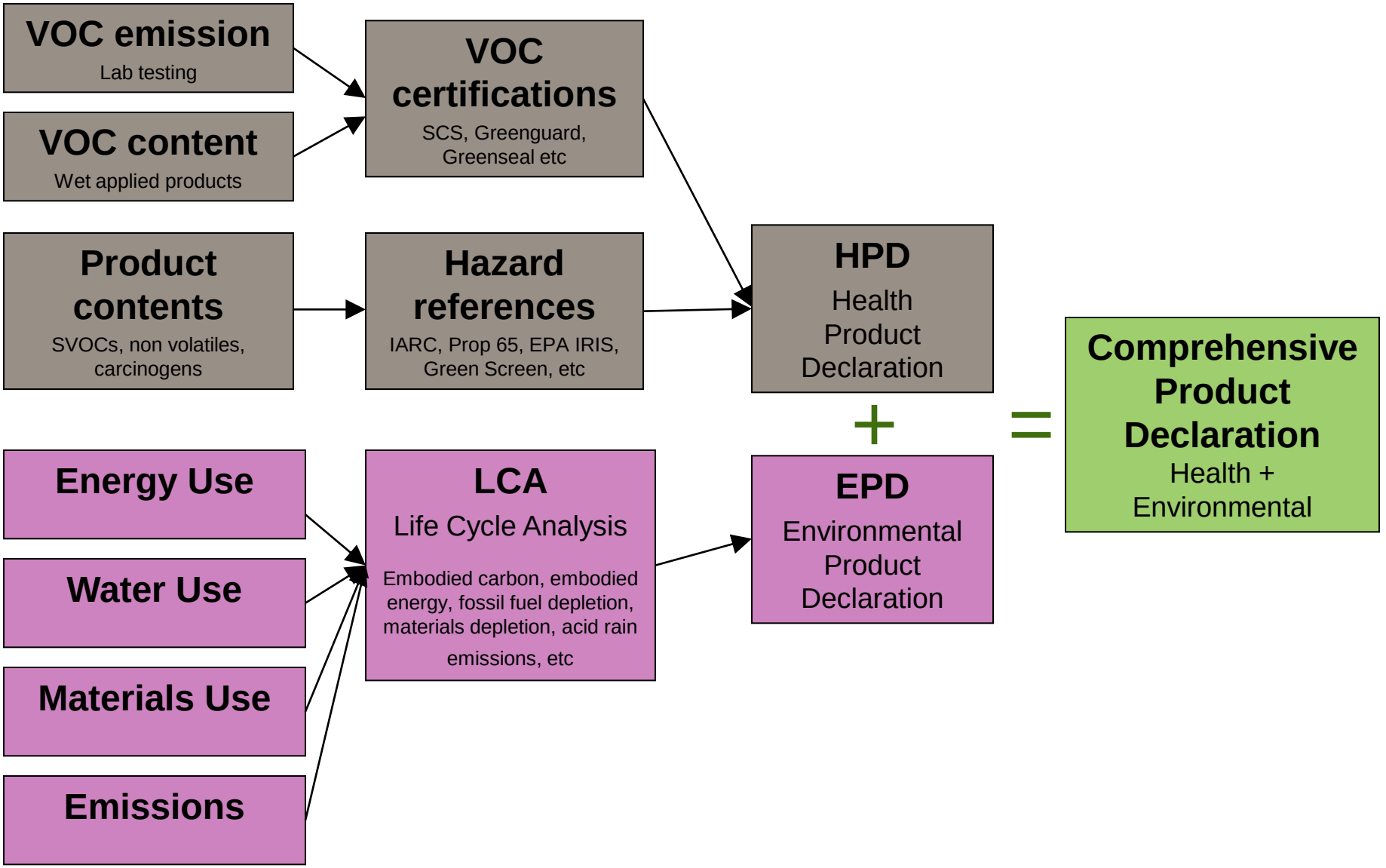
InterfaceFLOR's worldwide carpet manufacturing facilities maintain third party registration to the ISO 14001 Environmental Management System standard, and the company obtained the first-ever Environmental Product Declaration (EPD) for the commercial floor covering industry in North America. The company is recognized globally for its commitment to build environmental considerations into its business decisions.

For more information visit
www.interfaceflor.com

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION



Comprehensive Product Declarations



Health Product Declaration

1) Product Description

1.1	**Name & IDs**	Tuff Stuff X42, product SKU SB4353	1.4	**MasterFormat**	09 96 00
1.2	**Manufacturer**	Ajax Manufacturing	1.5	**Declaration Date**	June 9, 2011
1.3	**Description**	High performance coating designed for painting bath stall walls and other wet surfaces.			

2) Product Contents Disclosure

2.1	**Intentionally added disclosure level**	**94**	percent of intentionally added content is fully disclosed (100 percent is ideal).								
2.2	**All known residuals disclosed to**	X	100 ppm		1000 ppm		As required on MSDS		Other		Not disclosed
2.3	**All ingredients are assessed against the HPD Priority lists**	X	High hazard lists	X	Precautionary lists	X	Building Certification lists				

	(A) Name	(B)Identifier	(C) %	(D) Health Hazard Warnings & Certification Lists	(E) RC	(F) Nano	(G)Role
2.5	Bisphenol A diglycidyl ether (BADGE)	1675-54-3	55%	Category 2 - Some evidence of biological activity related to endocrine disruption (EU ED)	No	No	resin
2.6	Phenyl Glycidyl Ether	122-60-1	16%	Cancer and Male reproductive toxicity (Prop 65) R37 Irritating to respiratory system, R53 May cause long-term adverse effects in the aquatic environment and H341 Suspected of causing genetic defects (EU R-Phrases)	No	No	diluent
2.7	Alkyl (C12, C14) Glycidyl Ether	68609-97-2	10%	No warnings found Green Screen Benchmark 3 (see Notes)	No	No	viscosity reducer
2.8	Not disclosed	Not disclosed	3%	Category 1 Evidence of endocrine disruption activity (EU ED) Very toxic to aquatic organisms and possible risk of impaired fertility (EU R-Phrases)	No	No	flame retardant
2.10	Silver	7440-22-4	2%	No warnings found	No	Yes	antimicrobial
2.11	Bis(2-(dimethylamino)ethyl) ether	3033-62-3	<1000 ppm	No warnings found	No	No	catalyst

2.13 All ingredients to be screened against chemicals listed on any of the Health Product Declaration Priority lists at www.hpdworkinggroup.org/prioritylists
RC = Recycled Content: PC-Post Consumer PI = Post Industrial **Nano =** comprised of nanoscale particles or nanotechnology

2.14	**Total Volatile Organic Compound Content**	**(A) Material**	30 g/l	**(B) Regulatory**	50 g/l	**(C) Total incl. EPA exempt**	60 g/l	**(D) 0 VOC tints?**	Y

3) Product Testing & Certifications

	Type	(A) Standard or Certification	(B) Certifier / Laboratory	(C) Party	(D) Test/ Cert Date	(E) Expires	(F) Certificate URL	(G) Applicable Facilities	(H) CDPH
3.1	**VOC emissions**	Indoor Advantage Gold (Residential)	Scientific Certifications Systems / Berkeley Analytic	Third	5/12/2010	6/1/2012	www.scscertified.com/products/cert_pdfs/Ajax010	Smithville TX, Jonesvile OK	Yes
3.2	**VOC content**	SCAQMD Rule 1113	Self-declared by manufacturer	First	4/11/2009	N/A	N/A	All	
3.3	**Recycled content**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
3.4	**Other certification**	Cradle to Cradle Silver	Cradle to Cradle Product Innovation Institute	Third	3/30/2010	3/30/2012	www.cradle2cradle/certs/0123456.pdf	All	

Certifying Party: First: Manufacturer's self-declaration; Second: Verification by trade association or other interested party; Third: Verification by independent certifier (ideal)
Applicable facilities: Manufacturing sites to which testing applies **CDPH**: VOC emissions certification is per CDPH Standard Method V1.1

Smarter Cities: Smarter Buildings

5

Greentech + Cleantech

Anthony Bernheim, FAIA, LEED Fellow

February 2012

N232 Collaborative Support Facility, Moffett Field, U.S.A.
Targeted LEED NC2.2 Platinum

Smarter Cities: Smarter Buildings

Next Generation Intelligent Building

SOLADIGM™

HOME
ABOUT SOLADIGM
DYNAMIC GLASS
NEWS
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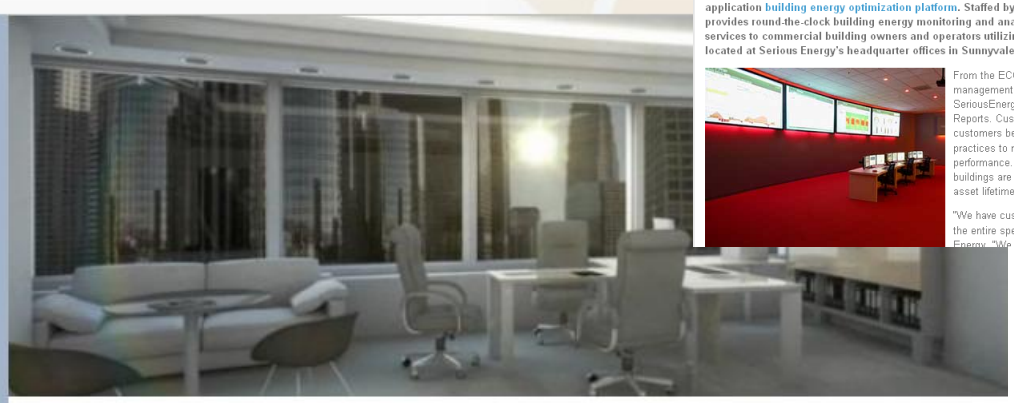

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Serious Energy Blog: Get Serious About Our Buildings

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Serious Energy Expands Next Generation Building Energy Optimization Services with Opening of Energy Control Center

by Valerie Jenkins on Sep 28 in Energy Management Software News

Provides round-the-clock support to help facility teams execute energy savings opportunities and gain peace of mind knowing their buildings and systems are constantly optimized

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Sunnyvale, CA – September 28, 2011 – Serious Energy today announced the opening of its state-of-the-art Energy Control Center (ECC) and fully managed services as a next step in its strategy to increase the value of commercial real estate via SeriousEnergy Manager, its cloud-based, multi-application building energy optimization platform. Staffed by a team of energy analysts, the Serious ECC provides round-the-clock building energy monitoring and analysis, as well as optional automated control services to commercial building owners and operators utilizing SeriousEnergy Manager. The ECC is located at Serious Energy's headquarter offices in Sunnyvale, California.

From the ECC, Serious Energy experts provide 24x7 management of energy saving opportunities identified through SeriousEnergy Manager's real-time Savings Opportunities Reports. Custom levels of managed services ensure that customers benefit from the latest in building energy best practices to maximize ongoing savings and building system performance. Customers gain peace of mind knowing their buildings are optimized every hour, every day for prolonged asset lifetime and sustained energy savings.

"We have customers whose energy management needs span the entire spectrum," explained Kevin Surace, CEO, Serious Energy. "We designed the ECC for companies that want to

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M27 bioPCmat™

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bioPCmat™ is one of our lowest cost products. Even with the lower volume of phase change material, it still packs a punch when it comes to energy savings. This product is equivalent to having a 27 Btu air conditioner or heater placed in every square foot of wall and ceiling space in which it is installed. This product aids in cooling and heating your structure while saving precious money in the process.

SCIenergy®

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Who we are
What we do
How we do it
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Nov 30, 2011 New Industry Report Sees Emerging...
Nov 22, 2011 SCIenergy, Inc. Provides First Application...
Oct 20, 2011 SCIenergy, Inc. Names Former Lieutenant...
Oct 17, 2011 SCIenergy, Inc. Receives

iRCx™

Intelligent Retro-commissioning™ (iRCx) starts with an assessment of the building, including the level of automation, tracking and control software, mechanical systems, connectivity, and energy performance. Buildings with a modern building automation system (BAS) will allow for the implementation of the world's leading fault detection & diagnostics software solution, SCIwatch®.

As a core application within the SCIenergy cloud, SCIwatch unveils data that is critical for a retro-commissioning agent to identify an expanded list of faults and validate opportunities for energy savings. With full visibility of a building's connected systems, retro-commissioning and systems engineers from SCIenergy conduct their investigations, and implement "low/no-cost" projects that have quick payback periods and verified energy savings potential.

SCIwatch's predictive diagnostics then sustains the savings and further identifies "drift". Building engineers enjoy a paradigm shift on maintenance keeping systems at optimal performance on a just-in-time basis rather than on a time-based schedule.

SCIenergy's iRCx engineers also use SCItrack™, an energy consumption tracking tool to establish a baseline for building performance, and to measure and verify energy consumption savings after specific measures are implemented.

How we do it
iRCx™
High-tech Software
High-touch Services

AECOM

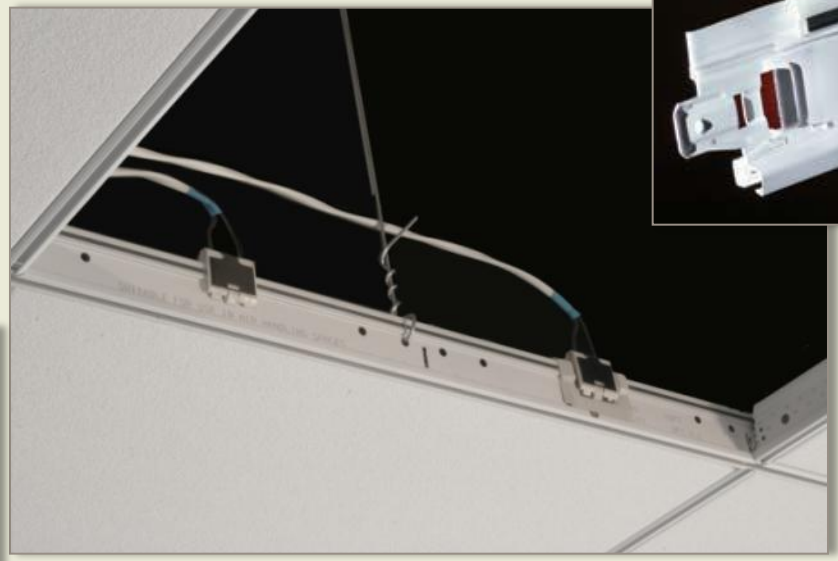
Armstrong DC FlexZone™ Grid

www.armstrong.com/dcflexzone

DC Power for DC-based Devices -LED Lighting!

Low Voltage DC “Power Outlets” in the Ceiling Plane

Safe, Low Voltage DC

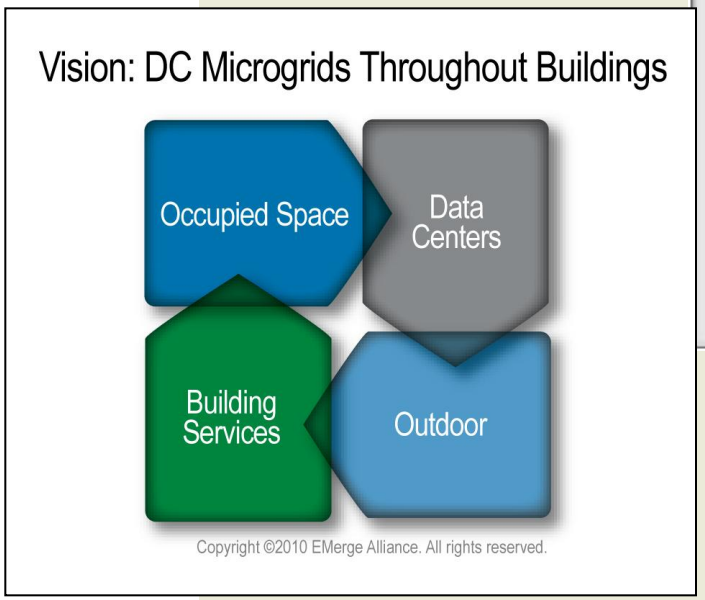


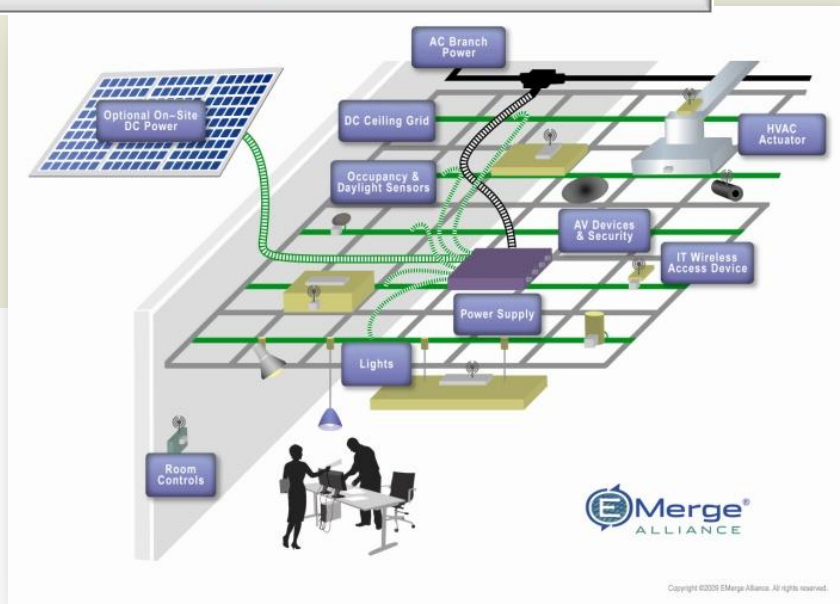
The Grid is wired, so LED Lights just “plug in” to the grid!

Armstrong

DC FlexZone Part of "Delivery Infrastructure"

in Open Standards-Based DC Power Distribution

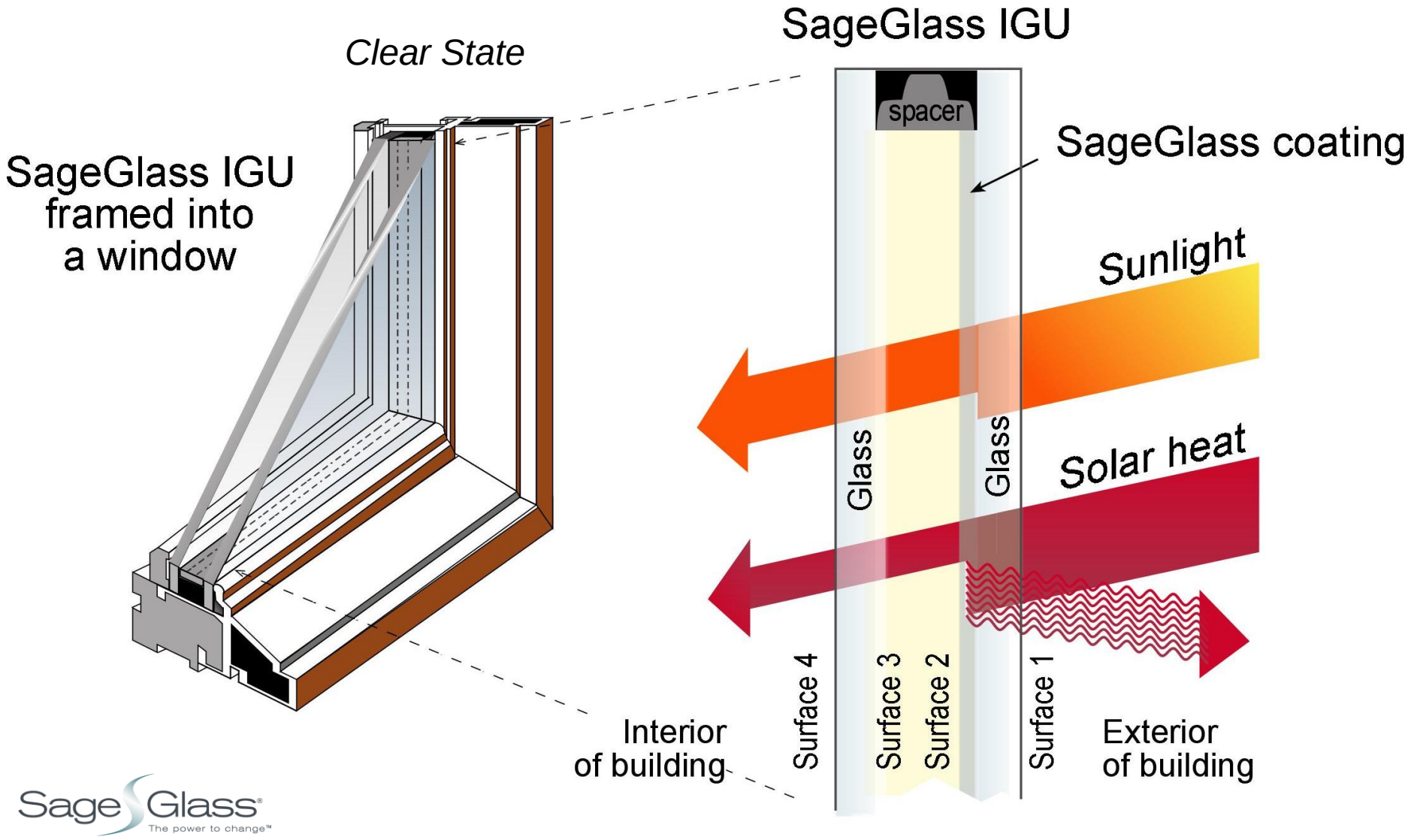




Armstrong is a Founding Member of the 80+ members in EMerge Alliance

www.EMergeAlliance.org

Electro-Chromatic Glazing: Phase Change Tintable



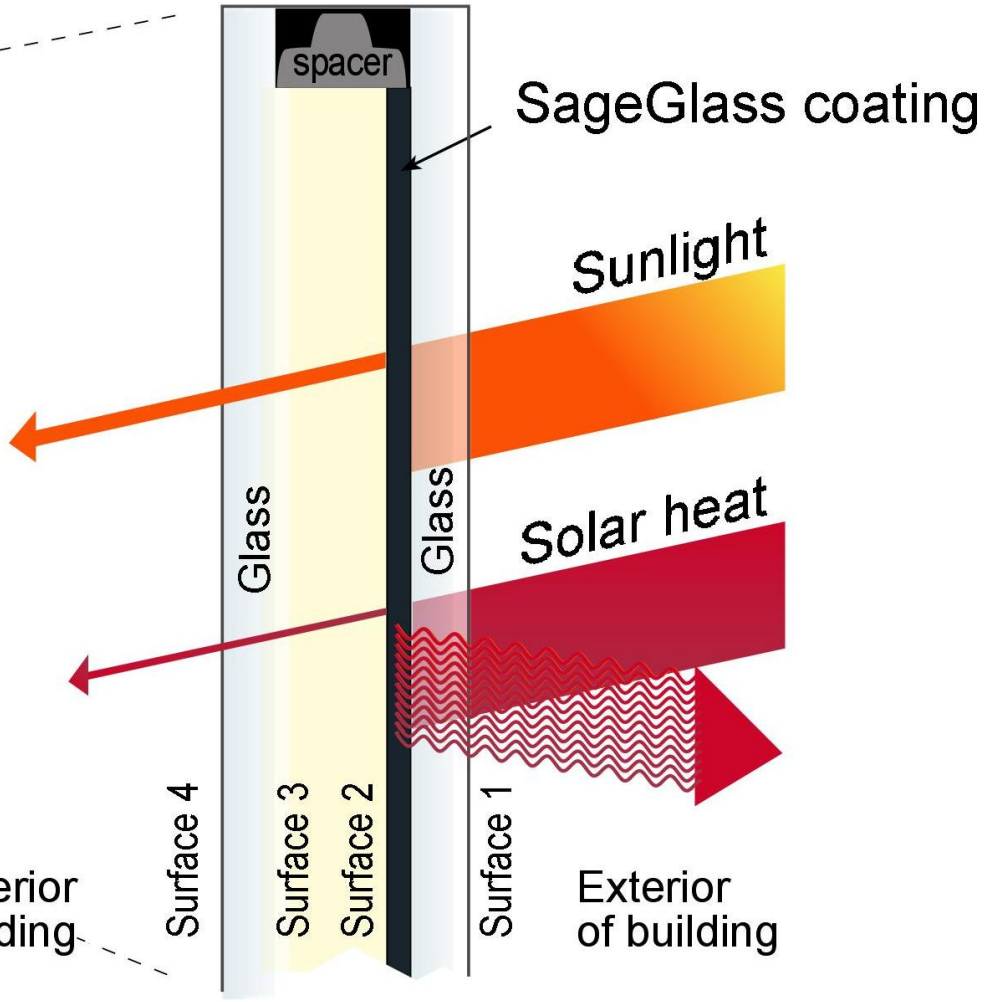
SageGlass
The power to change™

Electro-Chromatic Glazing: Phase Change Tintable

Tinted State

SageGlass IGU framed into a window

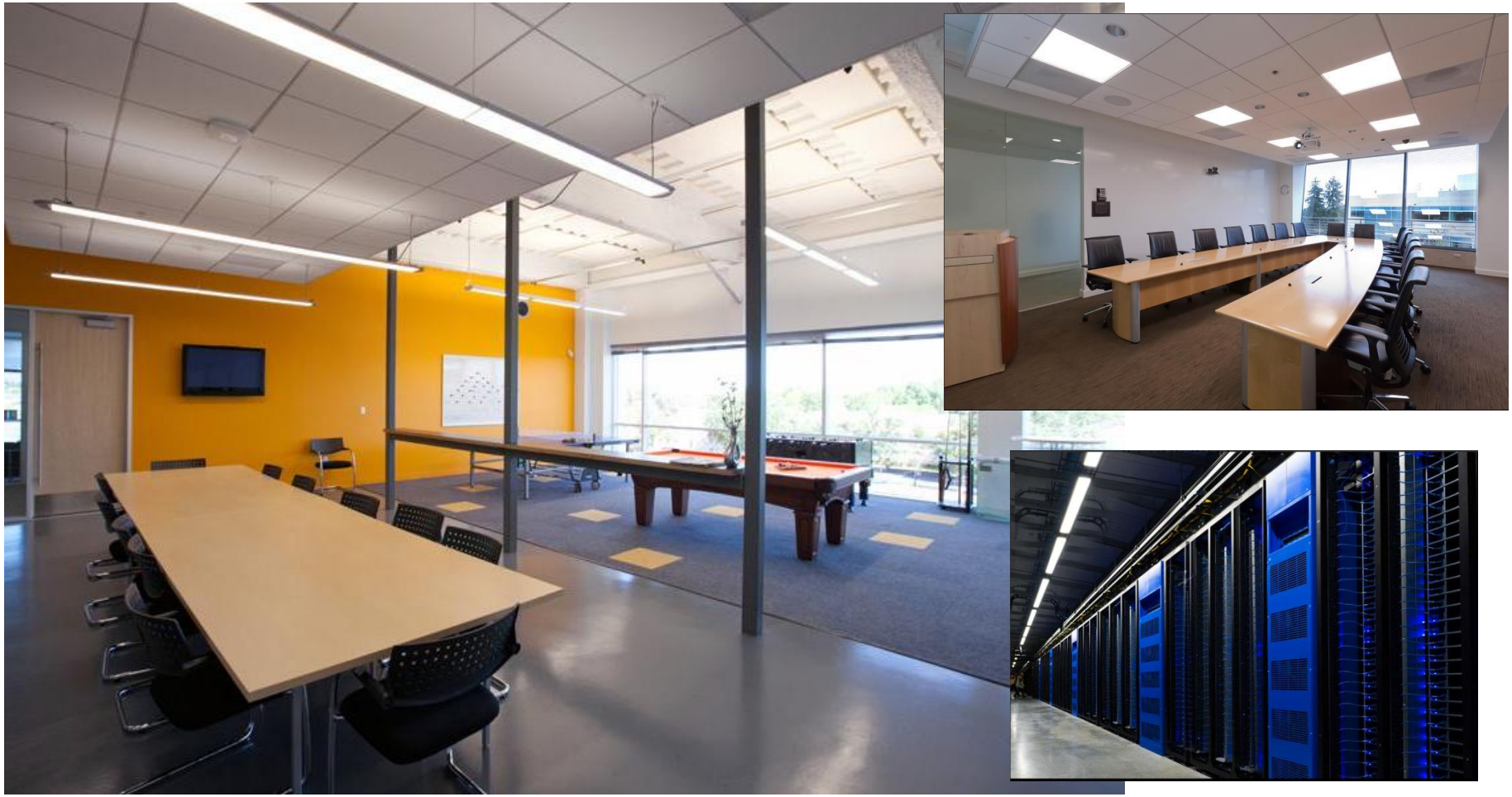
SageGlass IGU



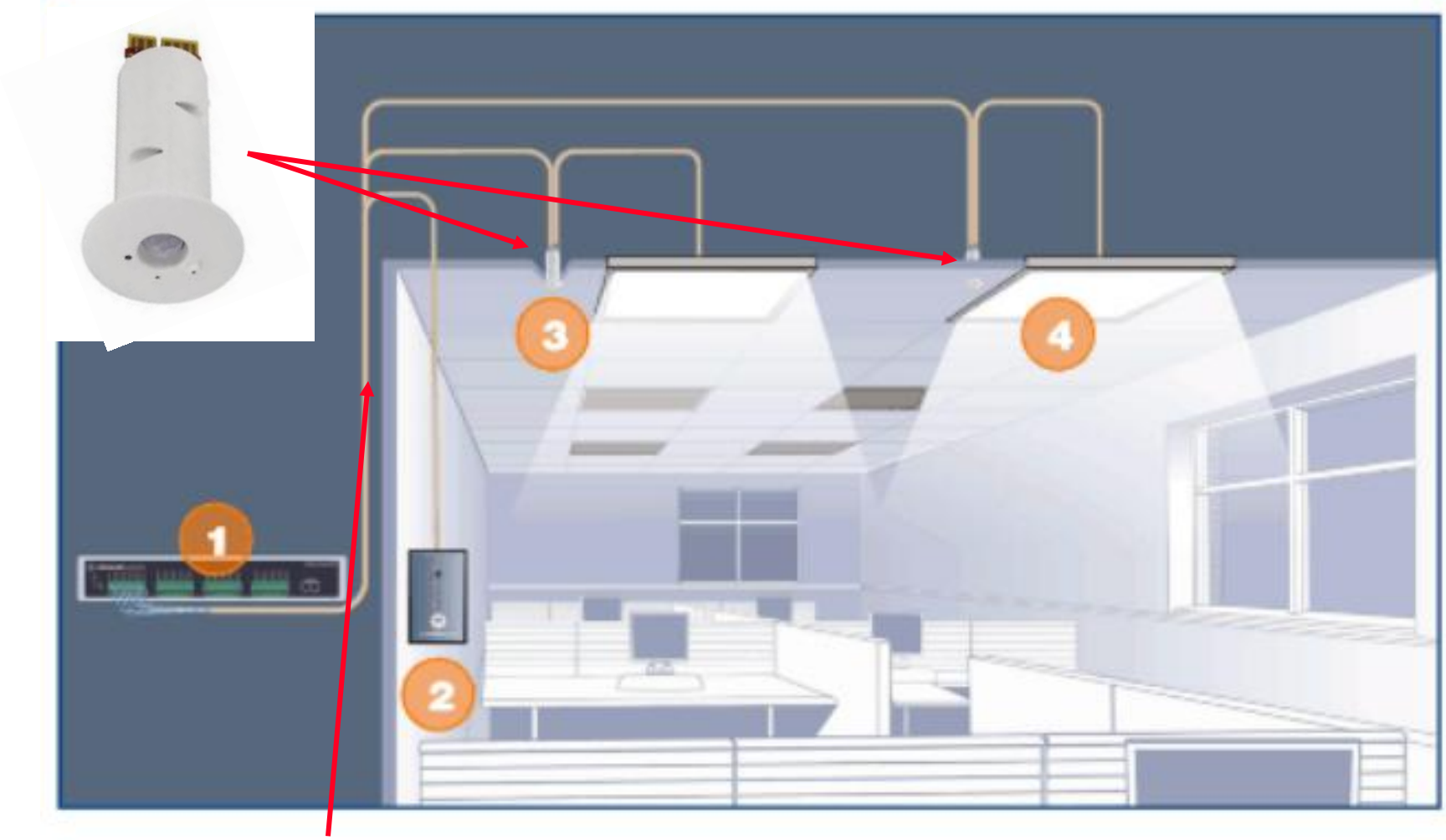
SageGlass® The power to change™

Building Integrated Solar & Micro Wind Turbines

Integrated Lighting Solutions



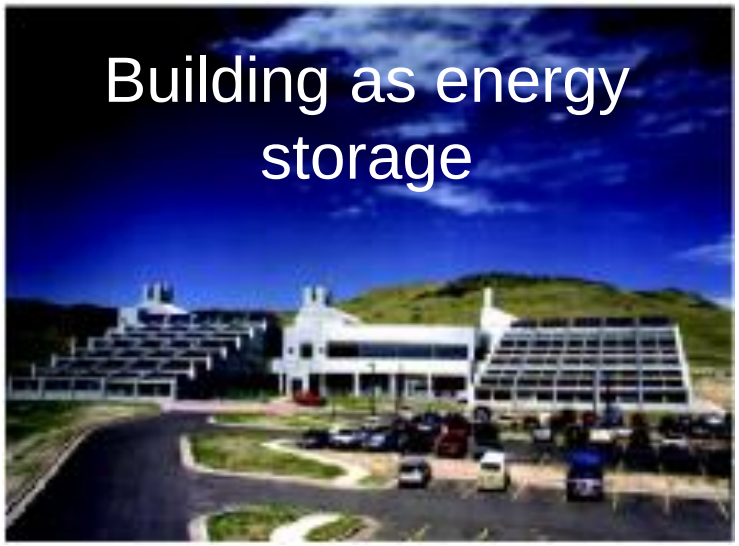
Integrated Lighting Solutions



Net Zero Energy Buildings

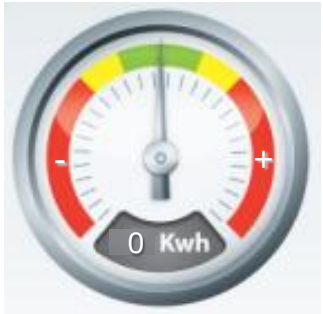
By load shifting and intelligently adjusting interior temperatures, BuildingIQ optimizes HVAC operations, balancing :

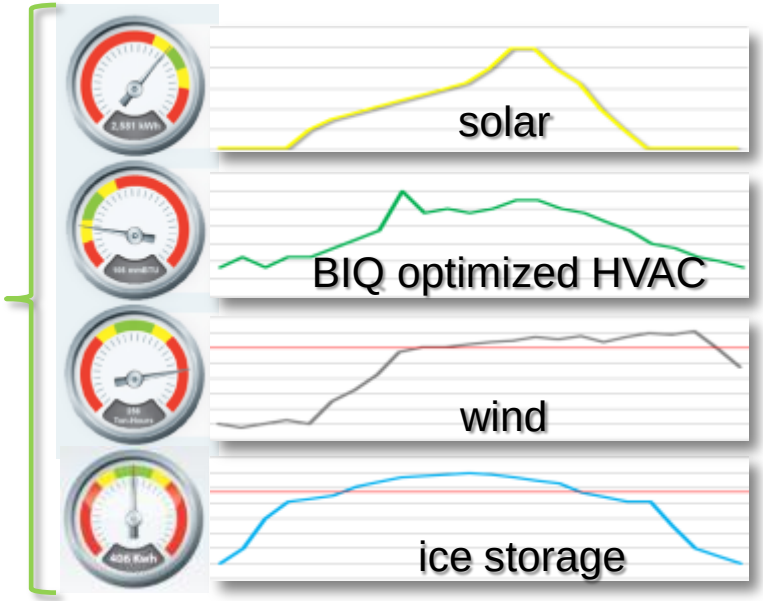
- reduced energy usage/cost
- maintained or improved occupant comfort
- maximized DR event performance



In net zero buildings this strategy:

- uses the building's thermal mass as energy storage to balance volatile renewable sources
- forecasts and adjusts timing of peak HVAC loads to match renewable power supply



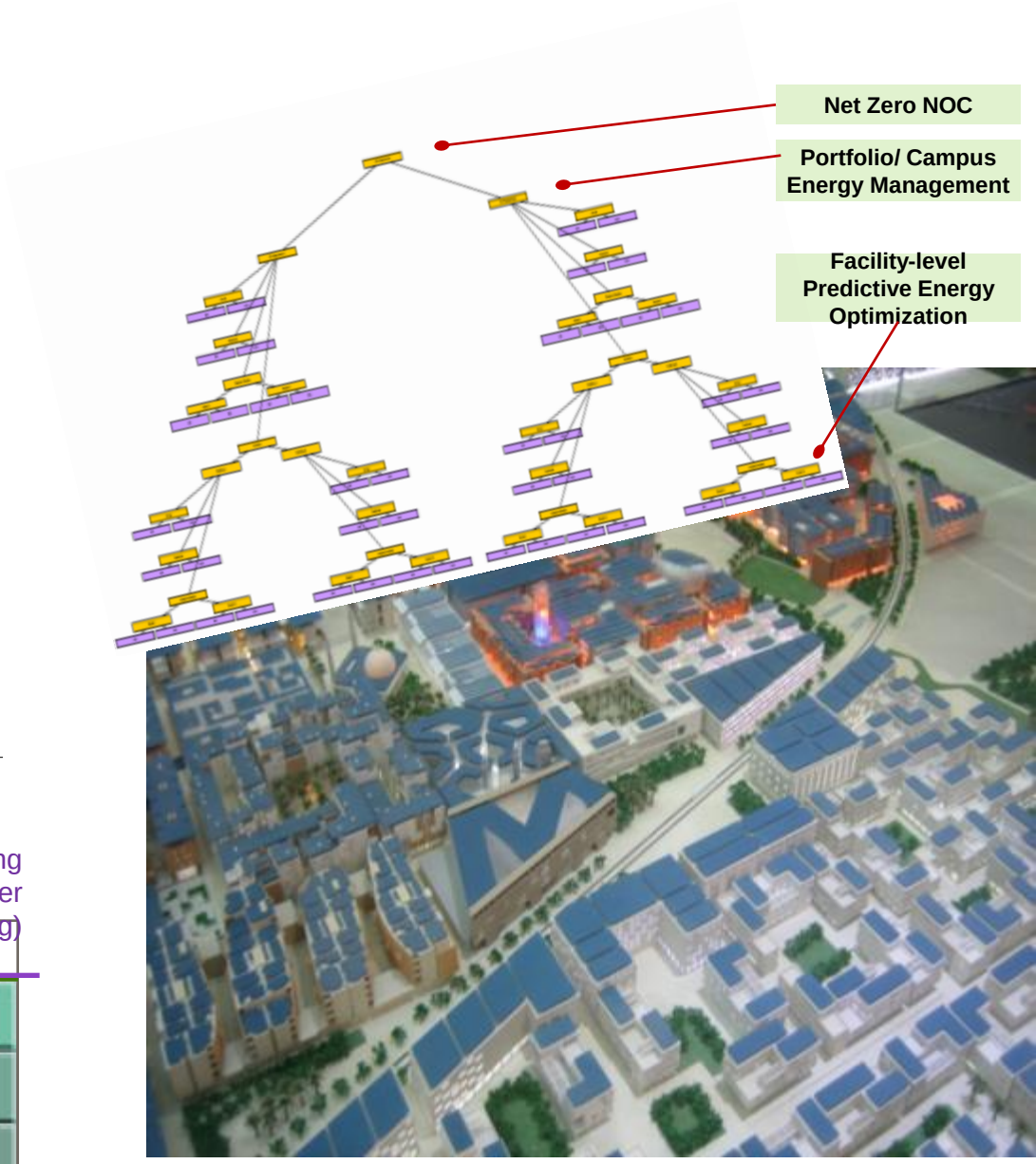


BuildingIQ

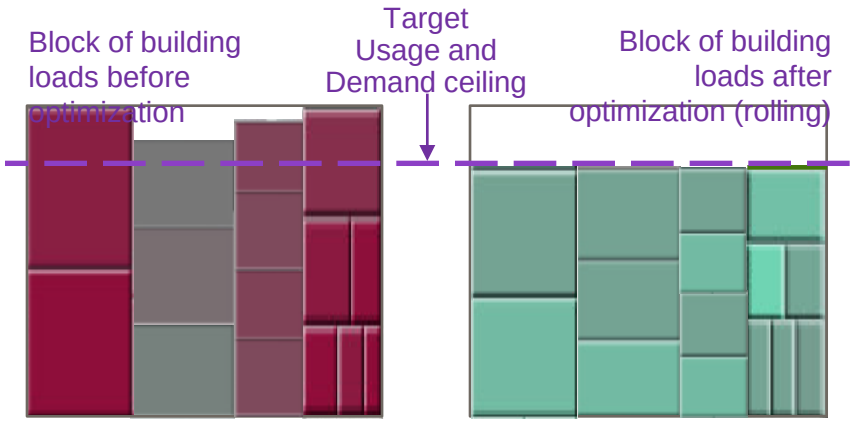
Levelized District Optimization for Net Zero Energy Cities

Use predictive energy optimization in 2 ways:

- **At District Level: DemandCenterIQ and ManagerIQ form a *Net Zero NOC* that:**
  - predicts and analyzes DR capacity and energy storage capacity to aggregate
  - electronically dispatches DR using OpenADR.
- **At Facilities level: BuildingIQ:**
  provide operational and analytical oversight on entire portfolio and campus – from predictive, real-time, historical perspectives.



Rolling Optimized Reserves



BuildingIQ

Intelligent Building Technology Adoption

- **Visionaries + Technology Enthusiasts**
- **Pause for Disruptive Technology**
- **Very Specific Customers**

  (Niche Market)
- **Mass Market**

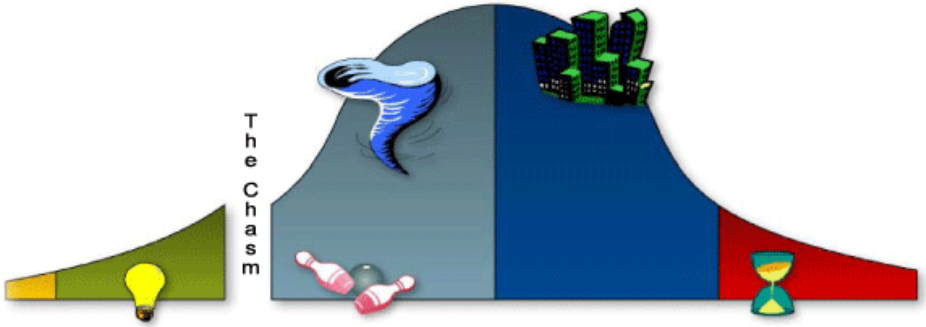
  =

Next Generation Intelligent Buildings

- **Dynamic**
- **Efficient**
- **Environmentally Responsive**
- **Highly skilled**

  Design/Construct/Operation

Technology Adoption Lifecycle (TALC)



Customer Mindset:	Techie "it's cool"	Visionaries "let's be ahead"	Pragmatists with a problem	Mid-majority - Move with herd (e.g. IT)	Conservatives	Skeptics
Product Type:	Generic New Category	Incomplete	Expected Whole Product	Easy Plug-in Solution	Augmented	Assimilated

"Inside the Tornado" Geoffrey A. Moore and "The Chasm Companion" Paul Wiefels

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Thank you.

Smarter Cities: Smarter Buildings

7

Discussion

Anthony Bernheim, FAIA, LEED Fellow

February 2012