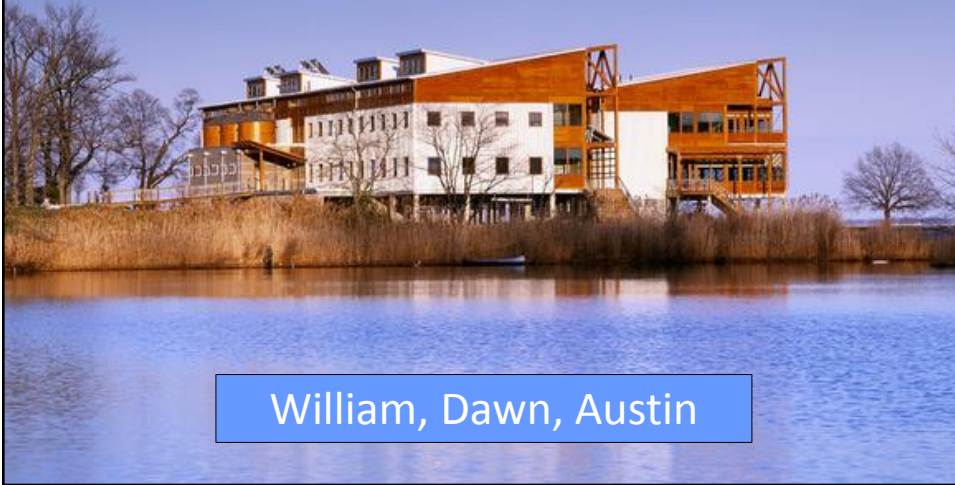
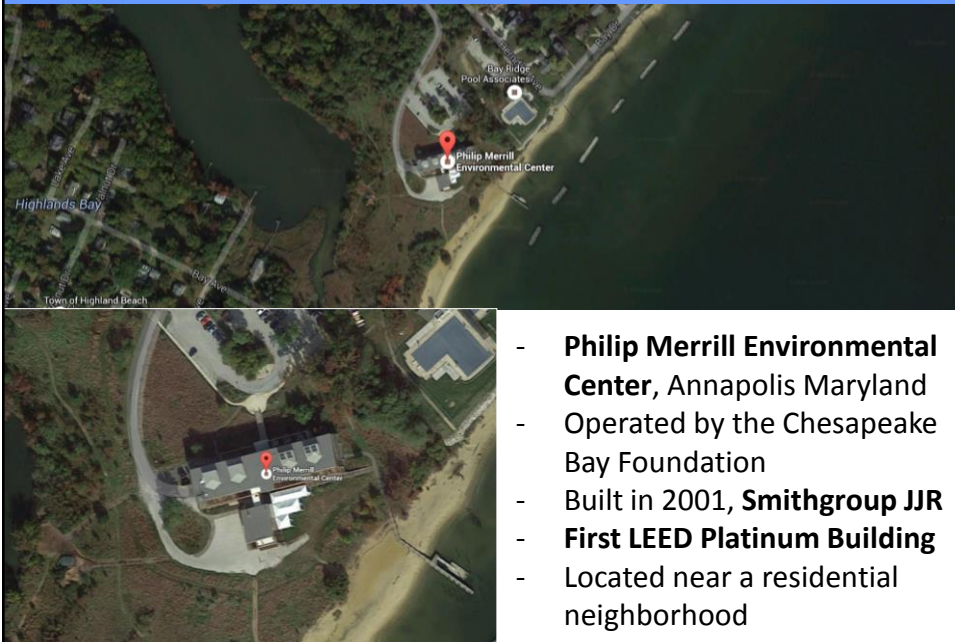


Case Study #3 Sustainable Site and Building



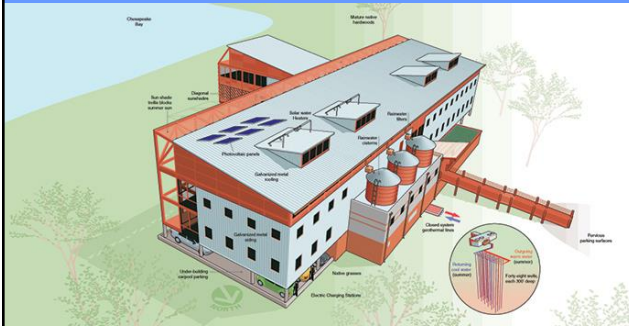
William, Dawn, Austin

Building Description



- **Philip Merrill Environmental Center**, Annapolis Maryland
- Operated by the Chesapeake Bay Foundation
- Built in 2001, **Smithgroup JJR First LEED Platinum Building**
- Located near a residential neighborhood

Building Description



- Rainwater collection and reuse
- Composting toilets
- Photovoltaics
- Solar hot water

- Bio-retention filters
- Efficient envelope insulation
- Use of recycled materials
- Salvaged wood



Building Description



- Shading devices on the south face incorporate horizontal louvres to block summer sun and allow winter sun
- Timber frame construction incorporates local, recyclable, reusable, and reclaimed material

- Three cisterns capture water from the roof
- Water is filtered and reused
- Cisterns provide for sinks, gear and clothes washing



Regeneration-Based Checklist

		degeneration		sustainability			regeneration				
		-100 always	-75 usually	-50 sometimes	-25 a bit	0 balances	25 a bit	50 sometimes	75 usually	100 always	
the site	pollutes air										cleans air
	pollutes water										cleans water
	wastes rainwater										stores rainwater
	consumes food										produces food
	destroys rich soil										creates rich soil
	dumps wastes unused										consumes wastes
	destroys wildlife habitat										provides wildlife habitat
	imports energy										exports energy
	requires fuel-powered transportation										requires human-powered transportation
	intensifies local weather										moderates local weather
the building	excludes daylight										uses daylight
	uses mechanical heating										uses passive heating
	uses mechanical cooling										uses passive cooling
	needs cleaning and repair										maintains itself
	produces human discomfort										provides human comfort
	uses fuel-powered circulation										uses human-powered circulation
	pollutes indoor air										creates pure indoor air
	is built of virgin materials										is built of recycled materials
	cannot be recycled										can be recycled
	serves as an icon for the apocalypse										serves as an icon for regeneration
is a bad neighbor										is a good neighbor	
is ugly										is beautiful	

Final Score 1225

-100 points

+1325 points

Maximum score of 2200

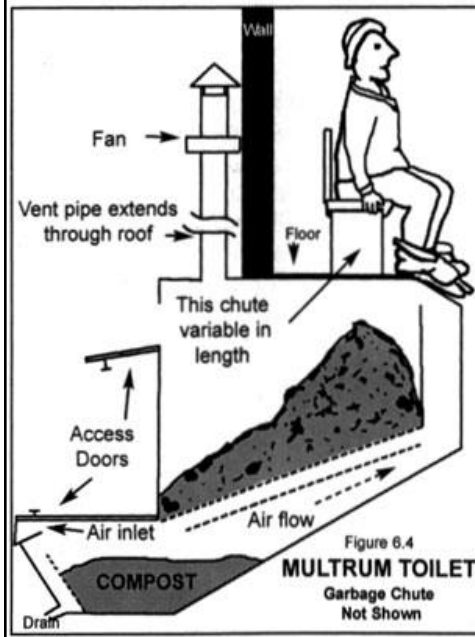
negative score 2200 possible -100	positive score 2200 possible +1325
final score: 1225	

Regeneration-Based Checklist

- **Cleans Air: +25**
 - No VOCs used in materials
 - Sensors used to monitor indoor air quality
- **Cleans Water: +100**
 - Bio retention garden acts as filter to treat all stormwater
 - Minimal impervious surfaces to allow water to seep back into water table
- **Stores Rainwater: +100**
 - Roof catchment directs rainwater to 3 cisterns
 - Rainwater treated and used in sinks and other washing



Regeneration-Based Checklist



- **Produces Food: +0**
 - Site neither produces nor consumes food, although soil is agriculturally sound
- **Creates Rich Soil: +25**
 - Combination of compost and bio-retention gardens create rich soil
- **Dumps Wastes Unused: -25**
 - Composting toilet consumes some waste, but a lot of waste isn't recycled
- **Provides Wildlife Habitat: +100**
 - Site is relatively untouched with bio-retention and several restoration projects

Regeneration-Based Checklist

- **Imports Energy: -50**
 - Despite having PVs and energy reduction devices, the building still requires 2/3 of its energy from the power grid
- **Transportation: +25**
 - Human-powered transportation (biking) isn't required, but it is very strongly encouraged
- **Moderates Local Weather: +0**
 - Neither moderates nor exacerbates local weather, although site manages stormwater well



Regeneration-Based Checklist




- **Needs Cleaning and Repair: -25**
 - Building maintained well but still requires maintenance
- **Provides Human Comfort: +100**
 - Sensors, ventilation, daylight, manual operation
- **Uses Daylight: +100**
 - South-facing façade uses horizontal louvres as shading devices
 - Summer sun blocked, winter sun penetrates
- **Uses Passive Heating: +100**
 - Sun absorption acts as passive heating during cooler months
- **Uses Passive Cooling: +100**
 - Automatic and manual operation of ventilation
 - Conditions monitored to notify occupants when ventilation is optimal

Regeneration-Based Checklist

- **Circulation: +75**
 - Circulation on site and in the building is human-powered
 - Couldn't find an elevator
- **Creates Pure Indoor Air: +100**
 - Indoor air sensors provide occupants with notifications
 - Building ventilates well and filters air
- **Used Recycled Materials: +50**
 - Wood sun shades and some trim are recycled from salvaged wood
 - Recycled steel, concrete, tile, fabric, rubber



Regeneration-Based Checklist



- **Can be Recycled: +50**
 - Recycled materials can be recycled again
 - No VOCs used
 - Large amount of wood
- **Regeneration Icon: +75**
 - The first LEED Platinum building (2001)
 - Large amount of exposed wood used
- **Is a Good Neighbor: +100**
 - Shares area with nearby residential neighborhood
 - Responds well to surrounding density
- **Is Beautiful: +100**
 - Exposed wood, curtain walls, great aesthetics
 - We like it

LEED Checklist

Sustainable Sites		26 Possible Points		Materials and Resources		14 Possible Points	
<input checked="" type="checkbox"/>	Prerequisite 1	Construction Activity Pollution Prevention	Required	<input checked="" type="checkbox"/>	Prerequisite 1	Storage and Collection of Recyclables	Required
<input checked="" type="checkbox"/>	Credit 1	Site Selection	1	<input type="checkbox"/>	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors and Roof	1-3
<input checked="" type="checkbox"/>	Credit 2	Development Density and Community Connectivity	5	<input type="checkbox"/>	Credit 1.2	Building Reuse—Maintain Existing Interior Nonstructural Elements	1
<input checked="" type="checkbox"/>	Credit 3	Brownfield Redevelopment	1	<input checked="" type="checkbox"/>	Credit 2	Construction Waste Management	1-2
<input type="checkbox"/>	Credit 4.1	Alternative Transportation—Public Transportation Access	6	<input checked="" type="checkbox"/>	Credit 3	Materials Reuse	1-2
<input checked="" type="checkbox"/>	Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1	<input checked="" type="checkbox"/>	Credit 4	Recycled Content	1-2
<input checked="" type="checkbox"/>	Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3	<input checked="" type="checkbox"/>	Credit 5	Regional Materials	1-2
<input checked="" type="checkbox"/>	Credit 4.4	Alternative Transportation—Parking Capacity	2	<input checked="" type="checkbox"/>	Credit 6	Rapidly Renewable Materials	1
<input checked="" type="checkbox"/>	Credit 5.1	Site Development—Protect or Restore Habitat	1	<input checked="" type="checkbox"/>	Credit 7	Certified Wood	1
<input checked="" type="checkbox"/>	Credit 5.2	Site Development—Maximize Open Space	1	Indoor Environmental Quality			
<input checked="" type="checkbox"/>	Credit 6.1	Stormwater Design—Quantity Control	1	<input checked="" type="checkbox"/>	Prerequisite 1	Minimum Indoor Air Quality Performance	Required
<input checked="" type="checkbox"/>	Credit 6.2	Stormwater Design—Quality Control	1	<input checked="" type="checkbox"/>	Prerequisite 2	Environmental Tobacco Smoke (ETS) Control	Required
<input type="checkbox"/>	Credit 7.1	Heat Island Effect—Nonroof	1	<input checked="" type="checkbox"/>	Credit 1	Outdoor Air Delivery Monitoring	1
<input checked="" type="checkbox"/>	Credit 7.2	Heat Island Effect—Roof	1	<input checked="" type="checkbox"/>	Credit 2	Increased Ventilation	1
<input checked="" type="checkbox"/>	Credit 8	Light Pollution Reduction	1	<input checked="" type="checkbox"/>	Credit 3.1	Construction Indoor Air Quality Management Plan—During Construction	1
Water Efficiency				10 Possible Points			
<input checked="" type="checkbox"/>	Prerequisite 1	Water Use Reduction	Required	<input checked="" type="checkbox"/>	Credit 3.2	Construction Indoor Air Quality Management Plan—Before Occupancy	1
<input checked="" type="checkbox"/>	Credit 1	Water Efficient Landscaping	2-4	<input checked="" type="checkbox"/>	Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
<input checked="" type="checkbox"/>	Credit 2	Innovative Wastewater Technologies	2	<input checked="" type="checkbox"/>	Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
<input checked="" type="checkbox"/>	Credit 3	Water Use Reduction	2-4	<input checked="" type="checkbox"/>	Credit 4.3	Low-Emitting Materials—Flooring Systems	1
Energy and Atmosphere				35 Possible Points			
<input checked="" type="checkbox"/>	Prerequisite 1	Fundamental Commissioning of Building Energy Systems	Required	<input checked="" type="checkbox"/>	Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
<input checked="" type="checkbox"/>	Prerequisite 2	Minimum Energy Performance	Required	<input checked="" type="checkbox"/>	Credit 5	Indoor Chemical and Pollutant Source Control	1
<input checked="" type="checkbox"/>	Prerequisite 3	Fundamental Refrigerant Management	Required	<input checked="" type="checkbox"/>	Credit 6.1	Controllability of Systems—Lighting	1
<input checked="" type="checkbox"/>	Credit 1	Optimize Energy Performance	1-19	<input checked="" type="checkbox"/>	Credit 6.2	Controllability of Systems—Thermal Comfort	1
<input checked="" type="checkbox"/>	Credit 2	On-site Renewable Energy	1-7	<input checked="" type="checkbox"/>	Credit 7.1	Thermal Comfort—Design	1
<input checked="" type="checkbox"/>	Credit 3	Enhanced Commissioning	2	<input checked="" type="checkbox"/>	Credit 7.2	Thermal Comfort—Verification	1
<input checked="" type="checkbox"/>	Credit 4	Enhanced Refrigerant Management	2	<input checked="" type="checkbox"/>	Credit 8.1	Daylight and Views—Daylight	1
<input checked="" type="checkbox"/>	Credit 5	Measurement and Verification	3	<input checked="" type="checkbox"/>	Credit 8.2	Daylight and Views—Views	1
<input checked="" type="checkbox"/>	Credit 6	Green Power	2	Innovation in Design			
				<input checked="" type="checkbox"/> Credit 1 Innovation in Design 1-5			
				<input checked="" type="checkbox"/> Credit 2 LEED Accredited Professional 1			
				Regional Priority			
				<input checked="" type="checkbox"/> Credit 1 Regional Priority 1-4			
LEED 2009 for New Construction and Major Renovations							
100 base points; 6 possible Innovation in Design and 4 Regional Priority points							
Certified		40-49 points		Silver		50-59 points	
Gold		60-79 points		Platinum		80 points and above	

- 78 points total; 2 shy of Platinum
- Most points lost in Optimizing Energy Performance and On-site Renewable Energy
- No public transportation access

Conclusions and Improvements

- **Too much power consumption**
 - Add additional array of PVs on roof
 - Add wind power
- **No food production**
 - Add gardens for on-site food production
- **Transportation issues**
 - Facilitate bus stop and bus loop on site
 - Facilitate electric car charging stations on site
- **Add outdoor bicycle parking**
- **Improve recycling initiatives**



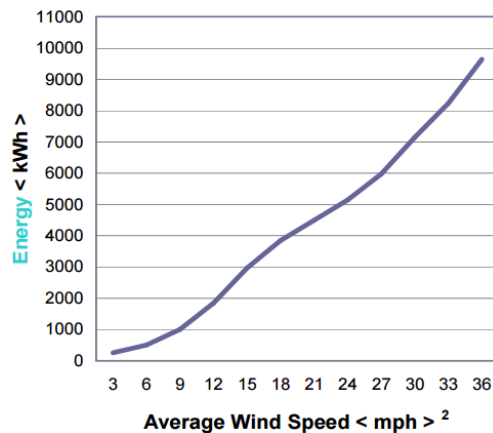
Wind Turbine Calculations

610V AEROTURBINE

Cage Height	10 ft
Cage Diameter	6 ft
Rotor Height	109 in
Rotor Diameter	57 in
Rotor Area	43.15 sq ft
Rotor Weight	86 lbs

Average wind speed 11mph annually
 ~2000 kWh per unit @ 10 feet
 Building length 150 feet = 15 units
 30,000 kWh = 30 mWh
 1 on each ridgeline (3)
 90,000 kWh = 90 mWh
 3 mWh PV array = 1% of current energy needs
 90/3 = 30% of energy needs

Estimated Energy per Year¹



90 mWh
Amounts to 30% of
annual energy needs

Solar Panel Calculations

3,750 sq. feet of PVs
 25 foot array along entire building length
 15 panels = 5kW capable of producing
 6000 kWh x 10 sets of 15 panels = 60,000
 kWh = 60 mWh
 3 mWh PV array = 1% of current building
 energy needs
 60/3 = 20% of current energy needs

"...a 5kW system may produce 6,000 kWh (kilowatt hours) of electricity every year in Boston, while it will produce 8,000 kWh every year in Los Angeles because of the amount of sun each location gets each year." – energysage.com

60 mWh; 20% of annual energy needs

OPTIMUS SERIES: OPT 72 CELL MODULES

ELECTRICAL DATA (NOMINAL)

The above information is only valid for the electrical data of other electrical parameters (p. 4) 2%

Module Type	OPT335-72-4-100	OPT330-72-4-100	OPT335-72-4-100	OPT340-72-4-100
Power Classification (Pmax)	325 W	330 W	335 W	340 W
Module Efficiency (%)	16.66%	16.92%	17.18%	17.43%
Voltage at Max. Power Point (Vmp)	37.5 V	37.6 V	37.7 V	37.8 V
Current at Max. Power Point (Imp)	8.67 A	8.78 A	8.89 A	8.99 A
Open Circuit Voltage (Voc)	45.8 V	45.9 V	45.9 V	46.0 V
Short Circuit Current (Isc)	9.42 A	9.54 A	9.66 A	9.78 A

The electrical data apply to standard test conditions (STC): Irradiance of 1000 W/m² with AM 1.5 spectrum at 25°C.

CHARACTERISTIC DATA

Type of Solar Cell	High-efficiency AR/Tsun Select cells, 3 and 5 busbar options available
Frame	Silver anodized aluminum alloy
Glass	Tempered (low-iron), anti-reflective coating
Junction Box	NEMA IP67 rated, 6 internal diodes
Cable & Connectors	12 AWG (4 mm²) PV Wire with multiple connector options available; cable length 1500 mm

MECHANICALS

Cells / Module	72 (6 x 12)
Module Dimensions	1975 x 990 mm (77.8 x 39 in.)
Module Thickness (Depth)	38 mm (1.5 in.)
Approximate Weight	23 kg (50.7 lbs.)

TEMPERATURE COEFFICIENTS

Voltage	β, Voc (%/°C)	-0.335
Current	α, Isc (%/°C)	+0.047
Power	γ, Pmax (%/°C)	-0.420
MOCT Avg	(α+β-γ)	46.9

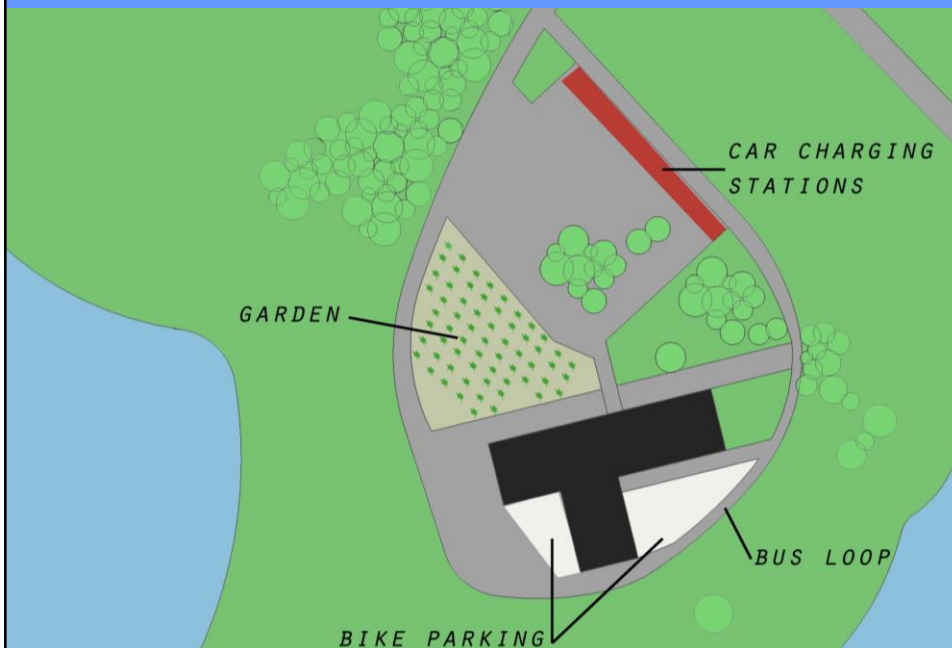
LIMITS

Max. System Voltage	1000 VDC for IEC, 1000 VDC for UL
Max Series Fuse Rating	15 Amps
Operating Module Temperature	-40°C to +85°C (-40°F to +185°F)
Storm Resistance/Static Load	Tested to IEC 61215 for loads of 2400 Pa (90 psf), hail and wind resistant

Manufacturer reserves the right to change the data at any time. Please contact us at www.suniva.com. *UL 60361, TC 400, DIN 2000. *Tests were conducted on module type OPT 60 other frame.

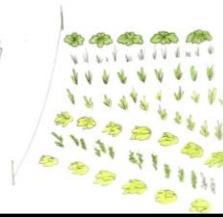
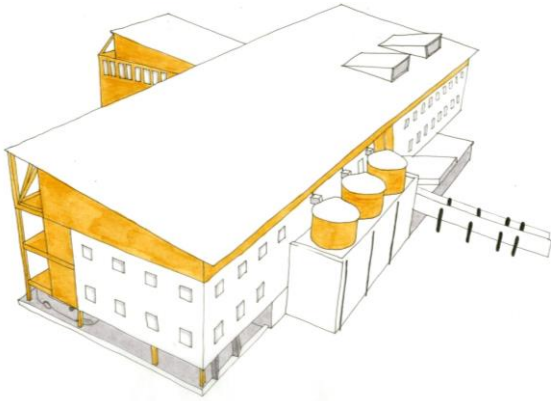
Model	Part No.	Watts	Amps	Volts	Weight	Size
Suniva OPT335-72-4-100 Silver Mono Solar Panel	1524530	335W	8.89A	37.7VDC	50.7lbs	77.6" x 39" x 1.5"

New Site Plan



Additional Improvements

- Recycling Initiatives
- Charging Stations
- Bike Parking
- On-site Garden(s)



Regeneration Checklist Re-evaluation

		degeneration			sustainability			regeneration			
		-100 always	-75 usually	-50 sometimes	-25 a bit	0 balances	25 a bit	50 sometimes	75 usually	100 always	
the site	pollutes air										cleans air
	pollutes water										cleans water
	wastes rainwater										stores rainwater
	consumes food										produces food
	destroys rich soil										creates rich soil
	dumps wastes unused										consumes wastes
	destroys wildlife habitat										provides wildlife habitat
	imports energy										exports energy
	requires fuel-powered transportation										requires human-powered transportation
	intensifies local weather										moderates local weather
the building	excludes daylight										uses daylight
	uses mechanical heating										uses passive heating
	uses mechanical cooling										uses passive cooling
	needs cleaning and repair										maintains itself
	produces human discomfort										provides human comfort
	uses fuel-powered circulation										uses human-powered circulation
	pollutes indoor air										creates pure indoor air
	is built of virgin materials										is built of recycled materials
	cannot be recycled										can be recycled
	serves as an icon for the apocalypse										serves as an icon for regeneration
is a bad neighbor										is a good neighbor	
is ugly										is beautiful	

negative score 2200 possible
-50

positive score 2200 possible
+1400

final score: 1350

Final Score 1350

**-50 points
+1400 points**

**Realistic score is
1400
(disregarding
beauty)**

**Improvement of
125 (175)**

LEED Checklist Re-evaluation

Category	Item	Points	Notes	
Sustainable Sites	Prerequisite 1	Construction Activity Pollution Prevention	Required	
	Credit 1	Site Selection	1	
	Credit 2	Development Density and Community Connectivity	5	
	Credit 3	Brownfield Redevelopment	1	
	Credit 4.1	Alternative Transportation—Public Transportation Access	6	
	Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1	
	Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3	
	Credit 4.4	Alternative Transportation—Parking Capacity	2	
	Credit 5.1	Site Development—Protect or Restore Habitat	1	
	Credit 5.2	Site Development—Maximize Open Space	1	
	Credit 6.1	Stormwater Design—Quantity Control	1	
	Credit 6.2	Stormwater Design—Quality Control	1	
	Credit 7.1	Heat Island Effect—Nonroof	1	
	Credit 7.2	Heat Island Effect—Roof	1	
Credit 8	Light Pollution Reduction	1		
Water Efficiency	Prerequisite 1	Water Use Reduction	Required	
	Credit 1	Water Efficient Landscaping	2-4	
	Credit 2	Innovative Wastewater Technologies	2	
	Credit 3	Water Use Reduction	2-4	
Energy and Atmosphere	Prerequisite 1	Fundamental Commissioning of Building Energy Systems	Required	
	Prerequisite 2	Minimum Energy Performance	Required	
	Prerequisite 3	Fundamental Refrigerant Management	Required	
	Credit 1	Optimize Energy Performance	1-19	
	Credit 2	On-site Renewable Energy	1-7	
	Credit 3	Enhanced Commissioning	2	
Credit 4	Enhanced Refrigerant Management	2		
Credit 5	Measurement and Verification	3		
Credit 6	Green Power	2		
Materials and Resources	Prerequisite 1	Storage and Collection of Recyclables	Required	
	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors and Roof	1-3	
	Credit 1.2	Building Reuse—Maintain Existing Interior Nonstructural Elements	1	
	Credit 2	Construction Waste Management	1-2	
	Credit 3	Materials Reuse	1-2	
	Credit 4	Recycled Content	1-2	
	Credit 5	Regional Materials	1-2	
	Credit 6	Rapidly Renewable Materials	1	
	Credit 7	Certified Wood	1	
	Indoor Environmental Quality	Prerequisite 1	Minimum Indoor Air Quality Performance	Required
		Prerequisite 2	Environmental Tobacco Smoke (ETS) Control	Required
		Credit 1	Outdoor Air Delivery Monitoring	1
		Credit 2	Increased Ventilation	1
		Credit 3.1	Construction Indoor Air Quality Management Plan—During Construction	1
Credit 3.2		Construction Indoor Air Quality Management Plan—Before Occupancy	1	
Credit 4.1		Low-Emitting Materials—Adhesives and Sealants	1	
Credit 4.2		Low-Emitting Materials—Paints and Coatings	1	
Credit 4.3		Low-Emitting Materials—Flooring Systems	1	
Credit 4.4		Low-Emitting Materials—Composite Wood and Agrifiber Products	1	
Credit 5	Indoor Chemical and Pollutant Source Control	1		
Credit 6.1	Controllability of Systems—Lighting	1		
Credit 6.2	Controllability of Systems—Thermal Comfort	1		
Credit 7.1	Thermal Comfort—Design	1		
Credit 7.2	Thermal Comfort—Verification	1		
Credit 8.1	Daylight and Views—Daylight	1		
Credit 8.2	Daylight and Views—Views	1		
Innovation in Design	Credit 1	Innovation in Design	1-5	
	Credit 2	LEED Accredited Professional	1	
Regional Priority	Credit 1	Regional Priority	1-4	

- 94 points total
- Improvements in energy performance, production, and public transportation access

LEED 2009 for New Construction and Major Renovations
 100 base points; 6 possible Innovation in Design and 4 Regional Priority points

Certified	40-49 points	94 Points Total
Silver	50-59 points	
Gold	60-79 points	
Platinum	80 points and above	

Conclusion



dreamstime.com

- Initial building and site already incredibly sustainable
- Little left to improve
- Site lacked food production, public transportation
- Building imported too much energy from grid
- Improvements like gardens and wind power increased scores and both checklists
- **1225 to 1400; 78 to 94**
- Sustainability goals met further