

## APPENDIX B

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Lighting Controls Schedule

Controls Cutsheets

RETScreen© Energy Model - Photovoltaic Model Analysis

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## Lighting Controls Schedule

Location: UCSB Student Resource Building

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Label	Manf. + Catalog No.	Description	Mounting	Remarks
S-A	"Lutron EcoSystem" C-SR-M1-WH	Closed loop daylight sensor	Ceiling	-
S-B	"Lutron EcoSystem" LOS-CDT-2000R-WH	360° Dual technology occupancy sensor. 24V DC	Ceiling	-
S-C	"Lutron" Grafik Eye 4000: GRX 45XX-T-WH	"XX" zone multiple scene series control unit (XX = 2-24)	Wall	"XX" - # of zones per space usage. (Consult lighting circuit and power plans) Assoc. w/ S-1
S-D	"Lutron" Nova T: NTFV	LED low voltage dimming control	Forum Counter	IO lighting recommended control interface. (use with F9)
S-1	"Lutron" GP Dimming Panel: GP24-2774M125-20	277 V Dimming Panel	Wall	Assoc. w/ S-C

**GP Dimming Panels**  
120-127 / 277 Volt



GP3/4  
Mini  
Panels



GP8-24  
Standard-Size  
Panels



GP36  
Large-Size Panels



GP48-144  
Large-Size Panels

GP Dimming Panels provide power and dimming for up to 144 load circuits and control any light source, including full-conduction non-dim.

**Models available with:**

- 120-127 V and 277 V input power.
- 3 to 144 circuits.
- Different feed types and breakers.

**GP Dimming Panels work with:**

- GRAFIK Eye 4000 Control Units.
- GRAFIK 5000™, GRAFIK 6000®, and GRAFIK 7000® Systems.
- LP Dimming Panels.
- XP Softswitch™ Panels.
- DMX512 dimming systems via the 2LINK™ option.

<b>Job Name:</b> <input style="width: 90%; border: 1px solid black;" type="text" value="UCSB Student Resource Building"/>	<b>Model Numbers:</b> <input style="width: 60%; border: 1px solid black;" type="text" value="GP24-2774M50-20"/> <input style="width: 35%; border: 1px solid black;" type="text"/>
<b>Job Number:</b> <input style="width: 80%; border: 1px solid black;" type="text"/>	<input style="width: 30%; border: 1px solid black;" type="text"/> <input style="width: 65%; border: 1px solid black;" type="text"/>

## Specifications - 120-127 / 277 Volt

### Standards

- UL Listed (Reference: UL File 42071).
- Complies with CSA or NOM (where appropriate).

### Power

- Input power: 100-127V and 277V, 50/60Hz, phase-to-neutral.
- Branch Circuit Capacity:
  - 120-127V - up to 2000W/VA
  - 277V - 4500W/VA
- Number of Circuits: 3-144
- Branch Circuit Breakers: UL-rated thermal magnetic. AIC ratings (other ratings available):
  - 100-127V – 10,000A
  - 277V – 14,000A
- Lightning strike protection: Meets ANSI/IEEE standard 62.41-1980. Can withstand voltage surges of up to 6000V and current surges of up to 3000A.
- 10-year power failure memory: Automatically restores lighting to scene selected prior to power interruption.

### Sources/Load Types

Operates these sources with a smooth continuous Square Law dimming curve or on a full conduction non-dim basis:

- Incandescent (Tungsten)/Halogen
- Magnetic Low Voltage Transformer
- Electronic Low Voltage Transformer<sup>1</sup>
- Lutron Electronic Fluorescent Dimming Ballasts
- Magnetic Fluorescent Lamp Ballasts
- Optional modules allow for control of 0-10V, DSI, and PWM load types.
- Operates HID sources on a full conduction non-dim basis.

<sup>1</sup> Reverse-phase control transformers require an ELVI Power Interface. Check phase with transformer manufacturer.

### Wiring

- Internal: Prewired by Lutron.
- System communications: Low-voltage Class 2 (PELV) wiring connects Dimming Panels to other components.
- Line (mains) voltage: Feed, load, and control circuit wiring only. No other wiring or assembly required.

### Filter Chokes

- Load current rise time is measured at a 90 degree conduction angle.
- 10-90% of load current waveform:
  - 350µSec rise time at 50% dimmer capacity.
  - 400µSec rise time at 100% dimmer capacity.
- 0-100% of load current waveform:
  - 525µSec rise time at 50% dimmer capacity.
  - 600µSec rise time at 100% dimmer capacity.
- At no point in the waveform can the rate of current change exceed 300mA per µSec.
- Consult Lutron for higher rise time options.

### Dimming Cards

- Panel current ratings are listed for continuous operation - UL-listed specifically for each light source.
- RTISS™ filter circuit technology compensates for incoming line voltage variations: No visible flicker with +/-2% change in RMS voltage/cycle and +/-2% Hz change in frequency/second.
- Arcless-relay air gap-off switches (one per load circuit) ensure open load circuits when off function selected. Eliminate arcing at mechanical contacts when loads are switched.

### Physical Design

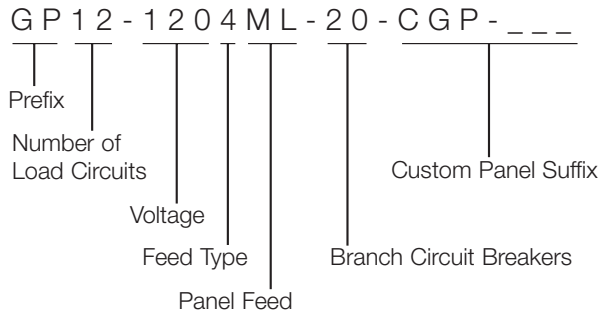
- Enclosure: NEMA-Type 1 (Type 2 available upon request), IP-20 protection; #16 U.S. Gauge Steel. Indoors only.
- Weight: 30-1300 pounds (14-590kg).
- Mounting: Surface mount only. Allow space for ventilating.

### Environment/Heat Dissipation

- Patented, ribbed aluminum heat sink base cools Panel by convection. No fans.
- 32-104°F (0-40°C). Relative humidity less than 90% non-condensing.

<b>Job Name:</b> UCSB Student Resource Building	<b>Model Numbers:</b> GP24-2774M50-20	
<b>Job Number:</b> <input type="text"/>	<input type="text"/>	<input type="text"/>

### How to Build a GP Model Number



**Prefix:**

**GP** for GP Dimming Panel

**Number of Load Circuits:**

Indicates number of load circuits in the panel

**Voltage:**

**120** for 120-127 V

**277** for 277 V

**Feed Type:**

**2** for 1 phase 2 wire

**3** for 1 phase 3 wire (split phase)

**4** for 3 phase 4 wire

**Panel Feed:**

**ML** for Main Lugs only

**Mxx** for Main Breaker with **xx** = breaker size in Amps

**Branch Circuit Breakers:**

**20** for 20A branch circuit breakers

**15** for 15A branch circuit breakers

**Custom Panel Suffix:**

Indicates panel with special options

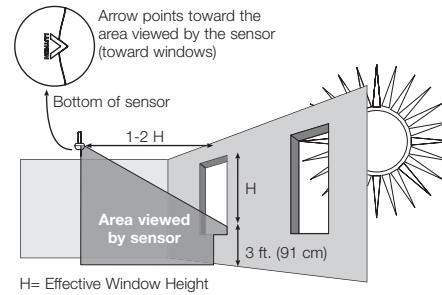
<b>Job Name:</b> <input style="width: 95%;" type="text" value="UCSB Student Resource Building"/>	<b>Model Numbers:</b> <input style="width: 60%;" type="text" value="GP24-2774M50-20"/> <input style="width: 35%;" type="text"/>
<b>Job Number:</b> <input style="width: 80%;" type="text"/>	<input style="width: 60%;" type="text"/> <input style="width: 35%;" type="text"/>

## Step 1: Determining the Daylight Sensor Mounting Location

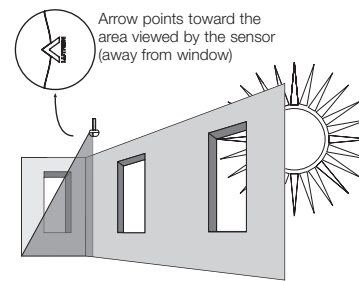
Determine the proper location of the *EcoSystem* Daylight Sensor using the adjacent diagrams.

- The arrow on the daylight sensor points toward the area viewed by the sensor.
- Place the daylight sensor so its viewing area is centered on the nearest window at a distance from the window of between one and two times the effective window height, H.
- The effective window height, H, starts at the window sill or 3 feet (91 cm) up from the floor, whichever is higher, and ends at the top of the window.
- Ensure that the view of the daylight sensor is not obstructed.
- Do not position the daylight sensor in the well of a skylight or above indirect lighting fixtures.
- For narrow areas where the daylight sensor cannot be placed 1–2 H from windows, place sensor near window facing into the space.

## C-SR-M1 location for average size areas



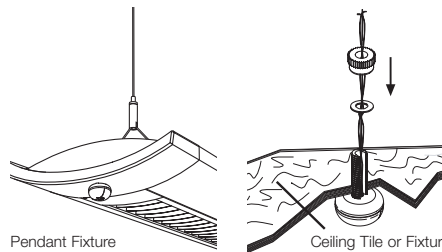
## C-SR-M1 location for narrow areas (e.g. corridors, private offices)



## Step 2: Mounting the Daylight Sensor

- Drill a 3/8" (10 mm) diameter hole in the ceiling tile or pendant fixture.
- Thread the wires through the hole.
- Install the *EcoSystem* Daylight Sensor into the hole.
- Secure the daylight sensor with the mounting hardware provided. (hand tighten only)

**Note:** If the stem of the daylight sensor must be shortened due to its location (for instance, in a pendant fixture) this should be done prior to wiring.



## Step 3: Wiring the Daylight Sensor

- Make sure that the supply breaker to the control system is OFF.
- Connect the four wires of the *EcoSystem* Daylight Sensor to the appropriate terminals of the *EcoSystem* Ballast or Ballast Module.

For additional wire between sensor and device, Lutron recommends four-conductor 22 AWG solid cable be used.

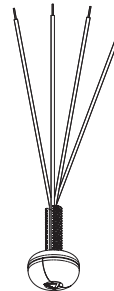


Daylight sensor circuits are Class 2 only. Unless otherwise specified, the voltages do not exceed 35 V $\overline{\text{---}}$ . These circuits comply with the requirements of NFPA 70, National Electrical Code® (NEC®). When installing the sensors, follow all applicable national and/or local wiring regulations.

**Note:** Only one daylight sensor can be wired to an individual ballast or ballast module. A sensor cannot be wired to more than one ballast or ballast module. Control of multiple ballasts or ballast modules may be achieved through programming.

**Note:** If IR Output is not required for device, white wire should be capped.

Red Black Yellow White



Red = 20 V $\overline{\text{---}}$   
 Black = Common  
 Yellow = Daylight Output  
 White = IR Output

**Note:** Wire length between sensor and device must not exceed 100 ft.

## Dual Technology Ceiling Mount Sensor



The LOS-CDT Series ceiling-mount dual-technology sensors can integrate into Lutron systems or function as stand-alone controls using a Lutron power pack. The technology eliminates manual sensitivity and timer adjustments during installation and over the life of the product.

### Features

- Intelligent, continually adapting sensor
- Ultrasonic (US) combined with passive infrared (PIR) sensing provide high sensitivity, high noise immunity, and excellent false tripping immunity
- Suited for complex environments that are difficult to control with single-technology sensors
- Snap-locks to ceiling-mounted cover plate
- Non-Volatile Memory: settings saved in protected memory are not lost during power outages
- 500 to 2,000 sq.ft. coverage mounted on 8 ft. ceiling; 180° and 360° field of view
- Affords choice of turning lights off or dimming to a preset level in the unoccupied state when integrated with a Lutron system.

### Models Available

Cat. No.	Color	Coverage (sq.ft.)	Field of View
LOS-CDT-500-WH	White	500	180°
LOS-CDT-500R-WH	White	500	180°
LOS-CDT-1000-WH	White	1,000	180°
LOS-CDT-1000R-WH	White	1,000	180°
LOS-CDT-2000-WH	White	2,000	360°
LOS-CDT-2000R-WH	White	2,000	360°

### Self-Adaptive Feature

The LOS-CDT Series ceiling-mount occupant sensors combine both (US) motion detection for maximum sensitivity and passive infrared (PIR) motion detection for false triggering immunity. The self-adapting internal microprocessor analyzes the composite sum of both signals to eliminate time-consuming adjustments and callbacks found in non-intelligent sensors.

Job Name: <input type="text"/>	Model Numbers: <input type="text" value="LOS-CDT-2000R-WH"/>	<input type="text"/>
Job Number: <input type="text"/>	<input type="text"/>	<input type="text"/>

## Specifications

### Timer Adjustment

- Automatic mode: Continually adapting sensor automatically adjusts settings to the space
- Manual mode: 8 to 32 minutes
- Test mode: 8 seconds

### LED Lamp

- Red: infrared motion detected
- Green: ultrasonic motion detected

### Housing

- Rugged, high-impact, injection-molded plastic
- Color-coded leads 6" (16.24cm)

### Power

- Operating voltage: 20-24 V $\overline{\text{---}}$ , Class 2 (PELV) low-voltage
- Operating current: 33 mA nominal
- Control output: 20-24 V $\overline{\text{---}}$  active high logic control signal with short-circuit protection, open collector when unoccupied

### Operating Environment

- Temperature: 32°F to 104°F (0°C to 40°C)
- Relative humidity: less than 95%, non-condensing
- For indoor use only

### Adaptive Functions

- Installation: 60 minutes
- Learning: 4 weeks for response to error conditions, air current adaptation, and timer optimization
- Post-learning occupancy periods
  - 24-hour circadian occupancy periods learned
  - Weekly occupancy periods learned
- Adjustments in post-learning period
  - Generally occupied periods (threshold = high-sensitivity mode)
  - Generally unoccupied periods (threshold = miser mode)

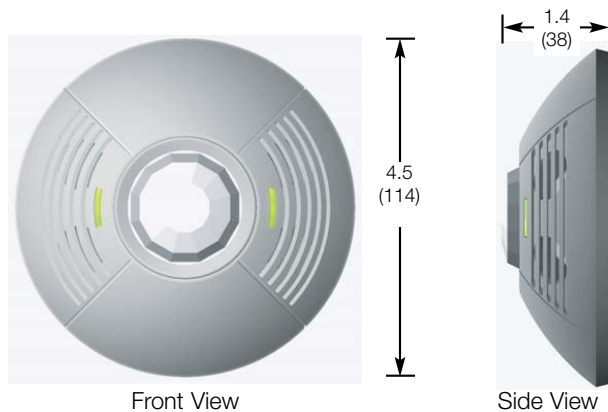
### Contact Rating (R Models only)

- SPDT 500 mA rated at 24 V $\overline{\text{---}}$  isolated relay

### Photo Cell (R Models only)

- Prevents light from turning on when there is sufficient natural light
- Sensitivity: 0-1,000 LUX adjustable

## Dimensions



Measurements are in inches (mm)

 **LUTRON** SPECIFICATION SUBMITTAL

Page 2

Job Name: <input type="text"/>	Model Numbers: LOS-CDT-2000R-WH	<input type="text"/>
Job Number: <input type="text"/>	<input type="text"/>	<input type="text"/>

**UCSB Student Resource Building**

Controls Cutsheet

**Type: S-B**

Issue: 4.12.07

2 of 2



**GRAFIK Eye 4000 Series Control Unit**

Cover (shown open)



**Description**

- Provides pushbutton recall of four preset lighting scenes, plus Off.
- Allows setup of lighting scenes using buttons on the Control Unit.
- Controls virtually any light source via dimming and switching panels.
- Provides lockout options to prevent accidental changes.
- Includes built-in infrared receiver for operation with an optional remote control.

**Models available to:**

- Control 2 to 24 zones of lighting.

**4000 Series Control Units work with:**

- GRAFIK Eye Wallstations
- GP and LP Dimming Panels
- XP Softswitch™ Panels

**GRX-4100 Control Units**

Provide setup using buttons on the Control Unit.

**GRX-4500 Control Units**

Provide optional setup using a PC, including setting lighting levels in 1% increments.

<b>Job Name:</b> UCSB Student Resource Building	<b>Model Numbers:</b> GRX-45XX-T-WH	
<b>Job Number:</b>		

**Specifications**

**Power**

- Low-voltage type Class 2 (PELV)  
Operating voltage: 24 V Direct Current.

**Lighting Sources/Load Types**

Controls lighting sources with a smooth, continuous Square Law dimming curve or on a full conduction non-dim basis via GP and LP Dimming Panels and XP Softswitch™ Panels.

**Preset Control**

- 4 preset lighting scenes and off are accessible from the Control Unit front panel.
- 12 additional scenes are stored in the Control Unit. These scenes are accessible via Wallstations and/or Control Interfaces.
- Light levels fade smoothly between scenes. Fade time can be set differently for each scene, between 0-59 sec. or 1-60 min. Fade time from Off is capped at 5 sec.

**Key Design Features**

- Meets IEC 801-2. Tested to withstand 15kV electrostatic discharge without damage or memory loss.
- Power failure memory automatically restores lighting to the scene selected prior to power interruption.
- Faceplate snaps on with no visible means of attachment.

**System Communications and Capacities**

- Low-voltage type Class 2 (PELV) wiring connects Control Units, Wallstations, and Control Interfaces.
- Up to 8 Control Units may be linked to control up to 64 zones.
- Up to 16 total Wallstations and Control Interfaces may be added for a total of 24 control points.

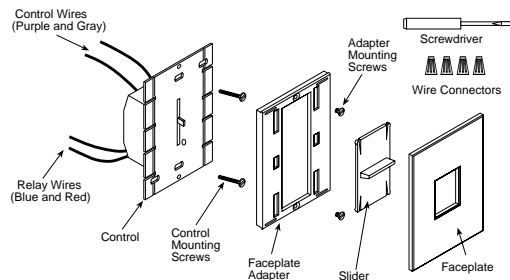
**Environment**

- 32-104°F (0-40°C). Relative humidity less than 90% non-condensing.

<b>Job Name:</b> UCSB Student Resource Building	<b>Model Numbers:</b> GRX-45XX-T-WH	
<b>Job Number:</b>		



**Package Contents and Parts Identification**



**Pre-Installation**

Determine whether this will be a single-gang installation or a multigang installation.

**If a single-gang installation:** Install unit as outlined in the "Installation" section below.

**If a multigang installation:** Before proceeding to the "Installation" section, follow the multigang installation procedure on pages 3-4 of this sheet and refer to the instruction sheet supplied with multigang faceplates.

**Operation**

The Low-Voltage Ballast Control provides dimming control for Lutron Eco-10 10 Volt Option Ballasts. The control allows dimming to 10% when used with these 10% dimming ballasts. Use this product only as intended with recommended accessories.

**Important Notes**  
**Please Read Before Installation**

**Wallbox Dimensions:** A single-gang wallbox (3" high x 2" wide x 2 1/2" deep) will service all individual controls.

**Wiring Note:** Always turn off AC power before installation. Install in accordance with all local and national electrical codes.

**Lamps:** For proper dimming performance new lamps must be operated at full intensity for 100 hours, prior to dimming.

**Ballasts:** A single Low-Voltage Ballast Control can be used with a maximum of 60 Lutron Eco-10 10 Volt Option Ballasts.

**Do not** connect this control to line voltage.

**Relays:** If wiring for ON/OFF and dimming, the Low-Voltage Ballast Control **must** be used with the Lutron PP-20 Power Pack.

**Compatible Ballasts:** Lutron Eco-10 10 Volt Option Ballasts have the following model number format: Eco-10 TVE-XXXX-XXX-X. For a complete list of ballast models refer to catalog sheet P/N 360-489.

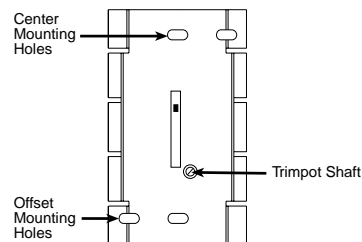
This control is not compatible with Lutron Eco-10 Phase Control Option Ballasts. These ballasts have the following model number format: ECO-XXXX-XXX-X.

**Ballast Functionality Check:** With power OFF, check new ballast for functionality prior to installation of control by connecting the ballast's purple and gray wires together at the control. Turn power on. The lights should now be at minimum brightness. With power OFF, disconnect the wires. Turn power ON. The lights should now be at maximum brightness.

**Installation**

1. **TURN POWER OFF** to disable the 0-10 volt electronic ballast(s) to be dimmed.
2. Remove faceplate and slider from control to prevent surface damage and to access mounting holes. Pull on faceplate at top and bottom edges to snap off plate.
3. Strip wallbox wires to the following lengths:  
 $\frac{5}{8}$ " for No. 16, 18 and 20 gauge  
 $\frac{1}{2}$ " for No. 10, 12 and 14 gauge
4. Wire controls according to the appropriate wiring diagram shown in the "Wiring" section on pages 2-3 of this sheet and on the ballast.
5. Carefully push wires into wallbox allowing room for the dimmer back cover.
6. Mount control into wallbox using screws provided. Units must be mounted vertically. See Figure A.

**Figure A: Front View - Mounting Control Unit**



Site Conditions		Estimate	Notes/Range
Project name		<b>Student Resource Building</b>	<a href="#">See Online Manual</a>
Project location		<b>UC Santa Barbara</b>	
Nearest location for weather data	-	Los Angeles, CA	→ <a href="#">Complete SR&amp;SL sheet</a>
Latitude of project location	°N	34.4	-90.0 to 90.0
Annual solar radiation (tilted surface)	MWh/m <sup>2</sup>	1.81	
Annual average temperature	°C	16.7	-20.0 to 30.0

System Characteristics		Estimate	Notes/Range
Application type	-	<b>On-grid</b>	
Grid type	-	Central-grid	
PV energy absorption rate	%	100.0%	
<b>PV Array</b>			
PV module type	-	User-defined	
PV module manufacturer / model #		Solar Integrated/ SI816G1	<a href="#">See Product Database</a>
Nominal PV module efficiency	%	4.4%	4.0% to 15.0%
NOCT	°C	48	40 to 55
PV temperature coefficient	% / °C	0.35%	0.10% to 0.50%
Miscellaneous PV array losses	%	5.0%	0.0% to 20.0%
Nominal PV array power	kWp	<b>58.80</b>	
PV array area	m <sup>2</sup>	1,336.4	
<b>Power Conditioning</b>			
Average inverter efficiency	%	90%	80% to 95%
Suggested inverter (DC to AC) capacity	kW (AC)	52.9	
Inverter capacity	kW (AC)	60.0	
Miscellaneous power conditioning losses	%	0%	0% to 10%

Annual Energy Production (12.00 months analysed)		Estimate	Notes/Range
Specific yield	kWh/m <sup>2</sup>	64.6	
Overall PV system efficiency	%	3.6%	
PV system capacity factor	%	16.8%	
Renewable energy collected	MWh	95.910	
Renewable energy delivered	MWh	<b>86.319</b>	
	kWh	86,319	
Excess RE available	MWh	<b>0.000</b>	<a href="#">Complete Cost Analysis sheet</a>

# RETScreen® Solar Resource and System Load Calculation - Photovoltaic Project

Site Latitude and PV Array Orientation		Estimate	Notes/Range
Nearest location for weather data		Los Angeles, CA	<a href="#">See Weather Database</a>
Latitude of project location	°N	34.4	-90.0 to 90.0
PV array tracking mode	-	Fixed	
Slope of PV array	°	0.0	0.0 to 90.0
Azimuth of PV array	°	0.0	0.0 to 180.0

Monthly Inputs					
	Fraction of month used	Monthly average daily radiation on horizontal surface (kWh/m <sup>2</sup> /d)	Monthly average temperature (°C)	Monthly average daily radiation in plane of PV array (kWh/m <sup>2</sup> /d)	Monthly solar fraction (%)
Month	(0 - 1)				
January	1.00	2.81	13.4	2.81	-
February	1.00	3.65	13.9	3.65	-
March	1.00	4.80	14.1	4.80	-
April	1.00	6.06	15.3	6.06	-
May	1.00	6.41	16.5	6.41	-
June	1.00	6.61	18.2	6.61	-
July	1.00	7.14	20.0	7.14	-
August	1.00	6.54	20.7	6.54	-
September	1.00	5.30	20.3	5.30	-
October	1.00	4.19	18.8	4.19	-
November	1.00	3.16	16.0	3.16	-
December	1.00	2.62	13.5	2.62	-
			<b>Annual</b>	<b>Season of use</b>	
Solar radiation (horizontal)		MWh/m <sup>2</sup>	1.81	1.81	
Solar radiation (tilted surface)		MWh/m <sup>2</sup>	1.81	1.81	
Average temperature		°C	16.7	16.7	

Load Characteristics	Estimate
Application type	On-grid

[Return to Energy Model sheet](#)

RETScreen® Cost Analysis - Photovoltaic Project

Type of analysis: Feasibility

Currency: \$

Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
<b>Feasibility Study</b>							
Site investigation	p-h	8	\$ -	\$ -	-	-	-
Preliminary design	p-h	20	\$ -	\$ -	-	-	-
Report preparation	p-h	10	\$ -	\$ -	-	-	-
Travel and accommodation	p-trip	1	\$ -	\$ -	-	-	-
Other - Feasibility study	Cost	1	\$ -	\$ -	-	-	-
Credit - Base case system	Credit	1	\$ -	\$ -	-	-	-
Sub-total :				\$ -	0.0%		
<b>Development</b>							
Permits and approvals	p-h	4	\$ -	\$ -	-	-	-
Project management	p-h	50	\$ -	\$ -	-	-	-
Travel and accommodation	p-trip	1	\$ -	\$ -	-	-	-
Other - Development	Cost	1	\$ -	\$ -	-	-	-
Credit - Base case system	Credit	1	\$ -	\$ -	-	-	-
Sub-total :				\$ -	0.0%		
<b>Engineering</b>							
PV system design	p-h	15	\$ -	\$ -	-	-	-
Structural design	p-h	20	\$ -	\$ -	-	-	-
Electrical design	p-h	32	\$ -	\$ -	-	-	-
Tenders and contracting	p-h	11	\$ -	\$ -	-	-	-
Construction supervision	p-h	15	\$ -	\$ -	-	-	-
Other - Engineering	Cost	1	\$ -	\$ -	-	-	-
Credit - Base case system	Credit	1	\$ -	\$ -	-	-	-
Sub-total :				\$ -	0.0%		
<b>Energy Equipment</b>							
PV module(s)	kWp	58.80	\$ 8,490	\$ 499,236	-	-	-
Transportation	project	0	\$ -	\$ -	-	-	-
Other - Energy equipment	Cost	0	\$ -	\$ -	-	-	-
Credit - Energy equipment	Credit	0	\$ -	\$ -	-	-	-
Sub-total :				\$ 499,236	95.2%		
<b>Balance of Equipment</b>							
Module support structure	m <sup>2</sup>	1,336.4	\$ -	\$ -	-	-	-
Inverter	kW AC	60.0	\$ -	\$ -	-	-	-
Other electrical equipment	kWp	58.80	\$ -	\$ -	-	-	-
System installation	kWp	58.80	\$ -	\$ -	-	-	-
Transportation	project	0	\$ -	\$ -	-	-	-
Other - Balance of equipment	Cost	0	\$ -	\$ -	-	-	-
Credit - Balance of equipment	Credit	0	\$ -	\$ -	-	-	-
Sub-total :				\$ -	0.0%		
<b>Miscellaneous</b>							
Training	p-h	6	\$ 65	\$ 390	-	-	-
Contingencies	%	5%	\$ 499,626	\$ 24,981	-	-	-
Sub-total :				\$ 25,371	4.8%		
<b>Initial Costs - Total</b>				\$ 524,607	100.0%		
Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
<b>O&amp;M</b>							
Property taxes/Insurance	project	0	\$ -	\$ -	-	-	-
O&M labour	p-h	16	\$ 55	\$ 880	-	-	-
Other - O&M	Cost	0	\$ -	\$ -	-	-	-
Credit - O&M	Credit	0	\$ -	\$ -	-	-	-
Contingencies	%	0%	\$ 880	\$ -	-	-	-
Sub-total :				\$ 880	100.0%		
<b>Annual Costs - Total</b>				\$ 880	100.0%		
Periodic Costs (Credits)	Period	Unit Cost	Amount	Interval Range	Unit Cost Range		
Inverter Repair/Replacement	Cost	12 yr	\$ 60,000	\$ 60,000	-	-	
			\$ -	\$ -	-	-	
			\$ -	\$ -	-	-	
End of project life			\$ -	\$ -	-	-	<a href="#">Go to GHG Analysis sheet</a>

**RETScreen® Financial Summary - Photovoltaic Project**

Annual Energy Balance		Student Resource Building	Nominal PV array power	kWp	58.80
Project name		UC Santa Barbara			
Project location		86.319			
Renewable energy delivered	MWh	-			
Firm RE capacity	kW	On-grid			
Application type					

Financial Parameters		Debt ratio	%	0.0%
Avoided cost of energy	\$/kWh	0.183		
RE production credit	\$/kWh	0.015		
RE production credit duration	yr	10		
RE credit escalation rate	%	2.0%		
Energy cost escalation rate	%	5.0%		
Inflation	%	2.5%		
Discount rate	%	9.0%		
Project life	yr	20		
Income tax analysis?	yes/no			NO

Project Costs and Savings		Annual Costs and Debt	\$	880
<b>Initial Costs</b>		O&M	\$	-
Feasibility study	0.0%	Fuel	\$	-
Development	0.0%			
Engineering	0.0%			
Energy equipment	95.2%	<b>Annual Costs and Debt - Total</b>	<b>\$</b>	<b>880</b>
Balance of equipment	0.0%	<b>Annual Savings or Income</b>	<b>\$</b>	<b>15,814</b>
Miscellaneous	4.8%	Energy savings/income		
<b>Initial Costs - Total</b>	<b>100.0%</b>	RE production credit income - 10 yr	\$	1,295
Incentives/Grants		<b>Annual Savings - Total</b>	<b>\$</b>	<b>17,109</b>
		Schedule yr # 12		
<b>Periodic Costs (Credits)</b>				
Inverter Repair/Replacement				
End of project life -				

Financial Feasibility		Calculate energy production cost?	yes/no	Yes
Pre-tax IRR and ROI	%	Energy production cost	\$/kWh	0.17
After-tax IRR and ROI	%			
Simple Payback	yr	Project equity	\$	524,607
Year-to-positive cash flow	yr			
Net Present Value - NPV	\$			
Annual Life Cycle Savings	\$			
Benefit-Cost (B-C) ratio	-			

Yearly Cash Flows		Pre-tax	After-tax	Cumulative
Year #		\$	\$	\$
0		(169,884)	(169,884)	(169,884)
1		17,024	17,024	(152,860)
2		17,858	17,858	(135,002)
3		18,734	18,734	(116,268)
4		19,653	19,653	(96,616)
5		20,618	20,618	(75,998)
6		21,631	21,631	(54,367)
7		22,694	22,694	(31,674)
8		23,810	23,810	(7,864)
9		24,982	24,982	17,118
10		26,212	26,212	43,330
11		25,893	25,893	69,224
12		(53,476)	(53,476)	15,747
13		28,607	28,607	44,355
14		30,068	30,068	74,423
15		31,603	31,603	106,026
16		33,215	33,215	139,240
17		34,908	34,908	174,148
18		36,687	36,687	210,835
19		38,556	38,556	249,391
20		40,519	40,519	289,909

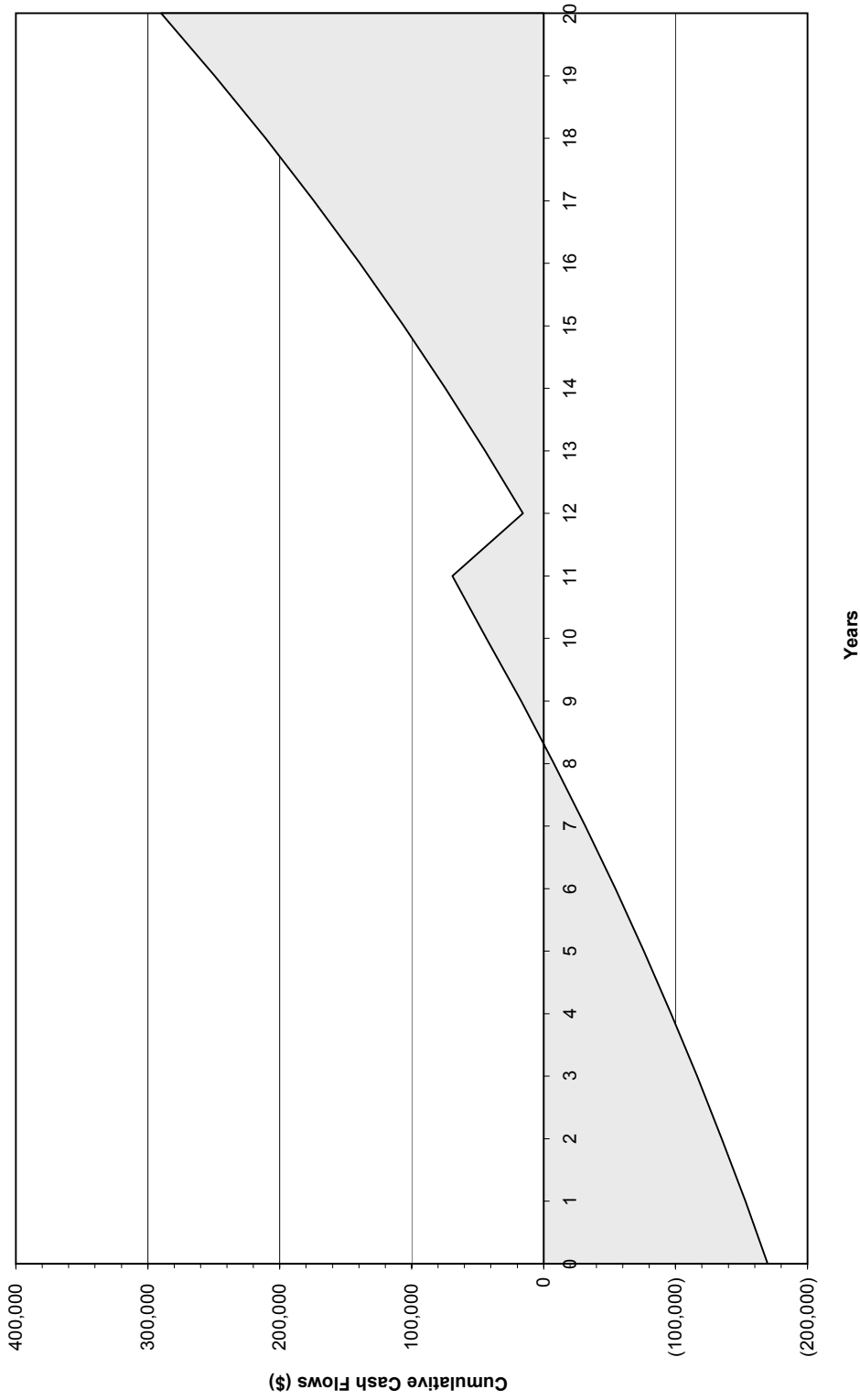


Cumulative Cash Flows Graph

**Photovoltaic Project Cumulative Cash Flows  
Student Resource Building, UC Santa Barbara**

Renewable energy delivered (MWh/yr): 86.319

Total Initial Costs: \$ 524,607



IRR and ROI: 10.4%

Year-to-positive cash flow: 8.3 yr

Net Present Value: \$ 19,354

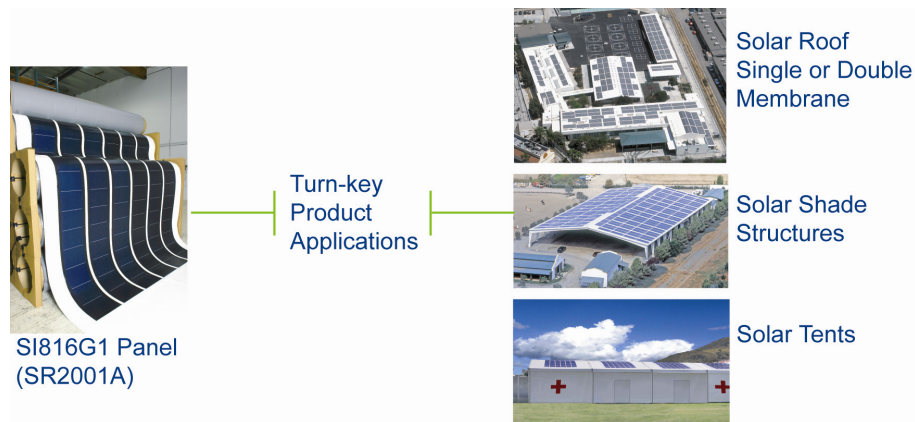
## SI816G1 (SR2001A) Product Information

### Solar Panels: Built to Last and Generate Reliable Power

#### Overview

Ideal for new construction or rooftop replacements, shade structures and solar tents, Solar Integrated's building integrated photovoltaic (BIPV) solar panel is a unique product designed for multiple solar applications. The SI816G1 (SR2001A), engineered as a weather-tight solar panel, combines low maintenance industrial fabrics with UNI-SOLAR lightweight, amorphous PV cells. The result is a flexible durable solar panel that can be installed on virtually any low slope surface.

Until the introduction of Solar Integrated's BIPV products, the installation of solar panels on industrial rooftops, shade structures or tents was limited due to the heavy weight of rigid crystalline panels. The lightweight Solar Integrated products eliminate this issue and allow virtually any structure to generate electricity.



#### Key Product Features

- **Lightweight** - The solar panel is the lightest in the industry, weighing only 12 ounces per square foot.
- **Rugged and durable** - Durability to cope with challenging weather conditions and stability to handle changing light and shade conditions are built into our BIPV products. In addition, unlike crystalline panels, our systems incorporate bypass technology enabling power production even when damaged.
- **Powerful** – Amorphous silicon panels enable maximum kilowatt-hour output, producing electricity using a wider spectrum of light than traditional crystalline technology. This feature enables optimum electricity production, even when it is cloudy.
- **Reduced Silicon** - While 94% of all solar panels require silicon as a raw ingredient, amorphous silicon uses silane gas and not purified silicon. Therefore, the technology is not effected by the raw silicon shortages.

## SI816G1 (SR2001A) Electrical Specifications

Power (Pmax) (Watts)	816.0
PTC Power (Pmax PTC) (Watts) <sup>1</sup>	772.4
Operating Voltage (Vmax) (Volts)	198.0
Operating Current (Imax) (Amp)	4.13
Open Circuit Voltage (Voc) (Volts)	277.2
Short Circuit Current (Isc) (Amp)	5.1
Maximum System Voltage (Volts)	600.0
Voc (-10C CellT @ 1.25 sun) (Volts)	316.2
Isc (75C CellT @ 1.25 sun) (Amp)	6.7
Series Fuse Rating (Amp)	8.0
Blocking Diode Rating (Amp)	8.0

## SI816G1 (SR2001A) Physical Specifications

Length (ft)	20.0
Length (mm)	6096.0
Width (ft)	10.0
Width (mm)	3050.0
Thickness (in)	0.12
Thickness (mm)	3.05
Weight (lb)	147.73
Weight (kg)	67.0

<sup>1</sup> Also available in double panels (1632 watts). Multiple single and double panels are configurable to virtually any output requirements.

## Electrical and Safety Certifications and Listings

The Solar Integrated SI816G1 (SR2001A) solar panel is certified to the following standards:



- Certified to UL 1703 standard
- IEC61215 CB-FCS
- Class A Fire Rating

## Endurance Tested

Solar Integrated's BIPV products have passed UL, IEC and TUV tests for accelerated aging, electrical safety, weather resistance, thermal shock, hail impact and humidity and freeze cycling.

## Leveraging Over 80 Years of Roofing Experience, We've Got You Covered!

Solar Integrated is a leading provider of BIPV products for multiple applications. Contact us for a free layout design of a solar rooftop or shade structure or get a quote for a solar tent. Our team will design a customized system using multiple panels, configured for maximum coverage and electricity output. Go to our website at [www.solarintegrated.com](http://www.solarintegrated.com) and fill in our Is Solar Right for You? on-line questionnaire.



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