Memorandum

Subject: Camp Fogarty Regional Training Site Solar PV Technical and Economic Feasibility

Technical Feasibility

Combined Maintenance Support Shop (CSMS)

On-site Evaluation

Cadmus' on-site assessment determined that the preliminary design is feasible, with only minor modifications. Satellite images were accurate enough to reveal the large obstructions on each surface. The south-facing roof surfaces of this building are excellent options for a solar PV system. The east-facing roof surfaces are less ideal but will produce reasonably well. Table 1 documents site-specific findings.

Table 1. On-site Assessment for CSMS

Site Conditions	Cadmus accessed the roof of the CSMS building to determine the feasibility of the proposed solar design. The roof is metal standing seam, which is a good material for attaching solar racking. There are large obstructions on each of the proposed surfaces but avoiding these will be possible. Site photos are available in Appendix A.
Shading	Cadmus determined that the shading for the site would be approximately 80% TSRF. The TSRF is most likely higher than the analysis on site. Shade readings were not taken from all proposed surfaces. Shade analysis reports are available in Appendix B.
Interconnection	For a behind-the-meter installation (i.e., through the Renewable Energy Fund Program), Cadmus determined that the building's electrical system is viable for interconnecting a solar system. There are open spaces in the main switch gear—both supply and load connections are possible. The type of connection will depend on many factors that will be determined by an electrical engineer. The main PV disconnect and metering equipment needed for the solar interconnection might not fit in the electrical room. An alternate location will be needed and is most likely the wall outside the electric room. The inverters will most likely be located on the roof.

Conceptual Design

DC Capacity (kW)	550.1
AC Capacity (kW)	505.3
No. Modules	1,719
PV Module	Trina Solar 320 Watt
Inverter	SMA 24000TL-US
Est. Annual Solar Production (kWh)	696,300
Avg. Annual Energy Consumption (kWh)	874,000

Based on our preliminary analysis and incorporating on-site evaluation findings, Cadmus estimates that the CSMS building can support a PV array of approximately 550 kW DC. An array of this capacity would generate nearly 700,000 kWh annually. The PV production from this array would generate around 80% of the average annual energy consumption of the CMSM building, based on four years of consumption data for the site. Given this estimated production, and the relatively new age of the roof (9 years), **further pursuit of solar PV development on this building is recommended**.

Appendix A – Site Condition Photos

CSMS Building

C5
C3
C1

Appendix B – Shade Analysis Report

Solar Access and Shade Report

11/28/2018

For: RIANG CSMS
2841 South County Trail East Greenwich, RI 02818

By: Chris Houtz, Cadmus
100 5th Ave Waltham, MA 02451

CADMUS

Measurements made by **Solmetric SunEye™** -- www.solmetric.com

Solmetric

Estimated average is 80% TSRF

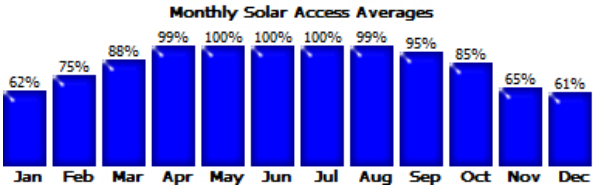
Session Properties

Name	RIANG
Creation Date	11/27/2018 11:14
Note	(none)
Location	41.7°N, 71.5°W Mag Dec: 14.3°W Time Zone: GMT-05:00

Solar access averages of 2 skylines in this session

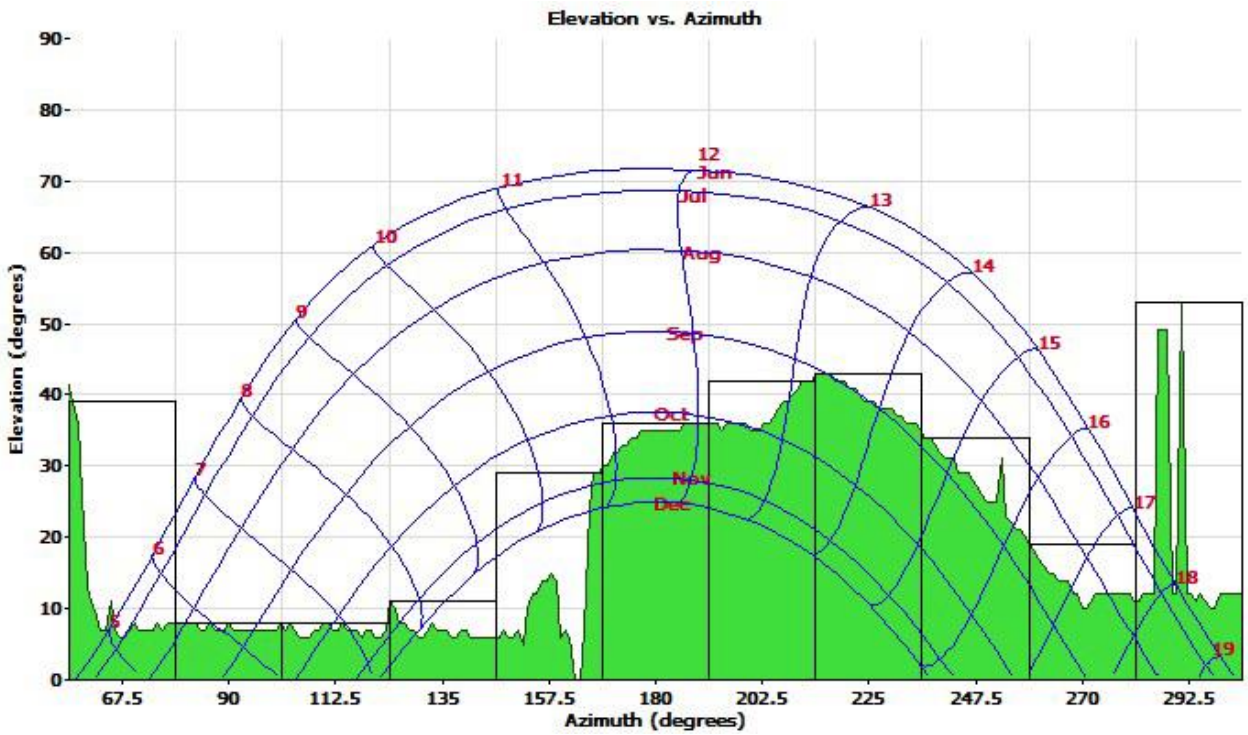
Skylines Averaged: Sky15, Sky16

Annual	May-Oct	Nov-Apr
91%	97%	80%



TSRF averages of 2 skylines in this session: 77%

Session Elevation vs. Azimuth

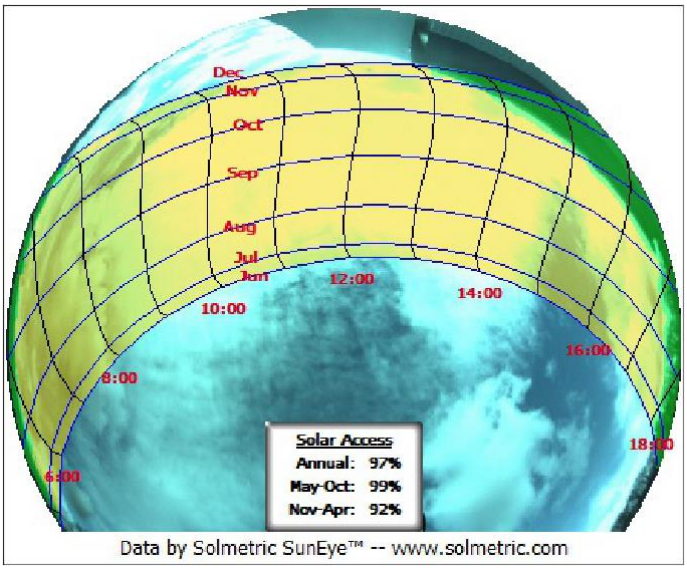


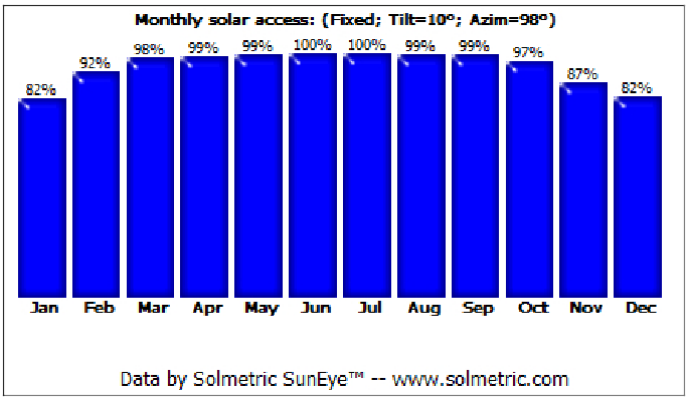
Sky 15 -- 11/27/2018 12:58--(no skyline note)

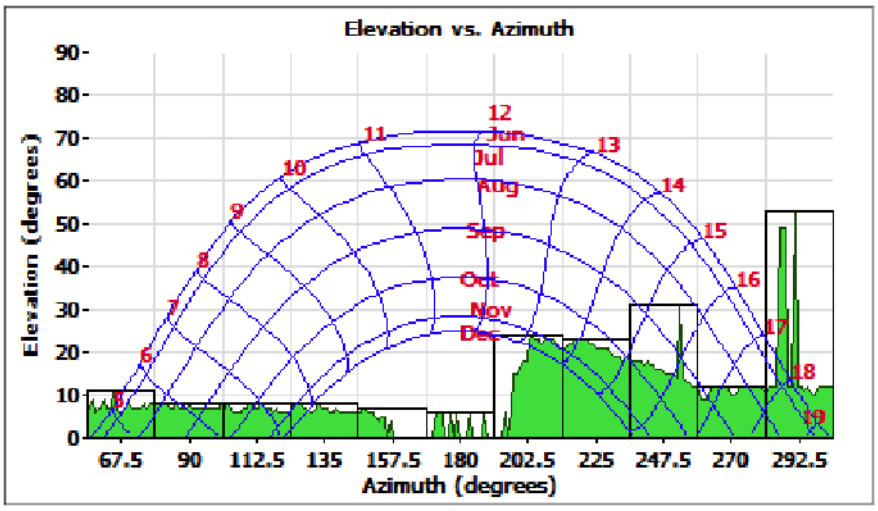
Panel Orientation: Tilt=10° -- Azimuth=98° -- **Skyline Heading=185°**

Solar Access: Annual: 97% -- Summer (May-Oct): 99% -- Winter (Nov-Apr): 92%

TSRF: 82% -- **TOF:** 84%





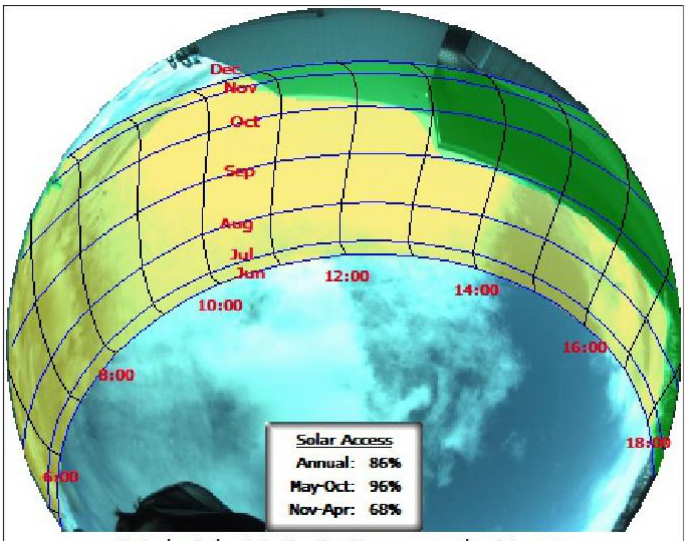


Sky16--11/27/2018 13:00--(no skyline note)

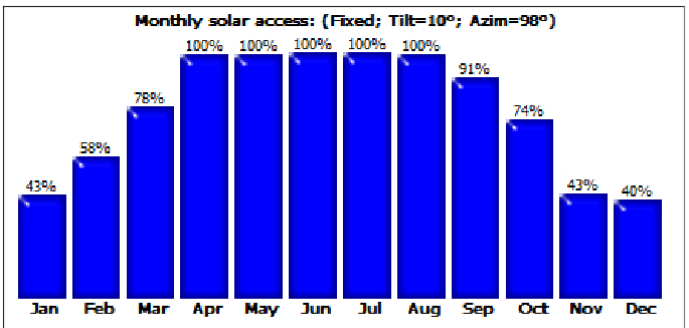
Panel Orientation: Tilt=10° -- Azimuth=98° -- **Skyline Heading=186°**

Solar Access: Annual: 86% -- Summer (May-Oct): 96% -- Winter (Nov-Apr): 68%

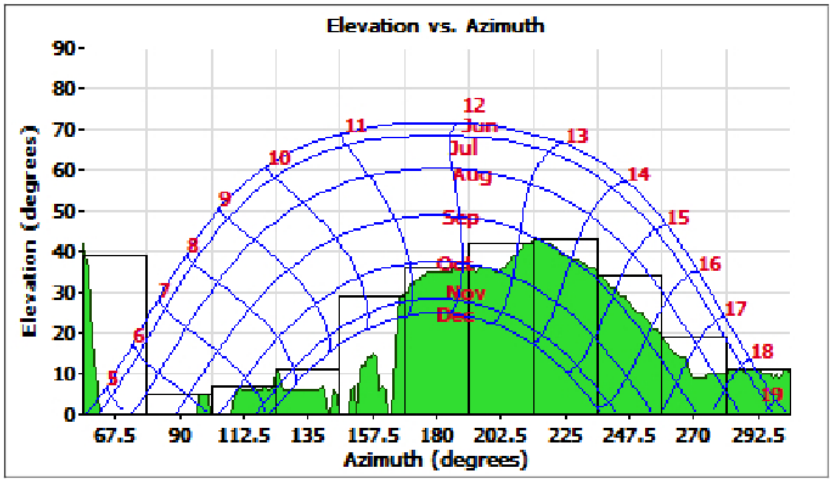
TSRF: 73% -- **TOF:** 84%



Data by Solmetric SunEye™ -- www.solmetric.com



Data by Solmetric SunEye™ -- www.solmetric.com



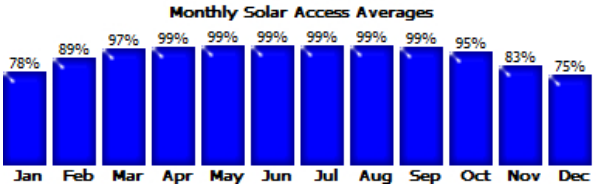
Session Properties

Name	RIANG
Creation Date	11/27/2018 11:14
Note	(none)
Location	41.7°N, 71.5°W Mag Dec: 14.3°W Time Zone: GMT-05:00

Solar access averages of1skyline inthis session

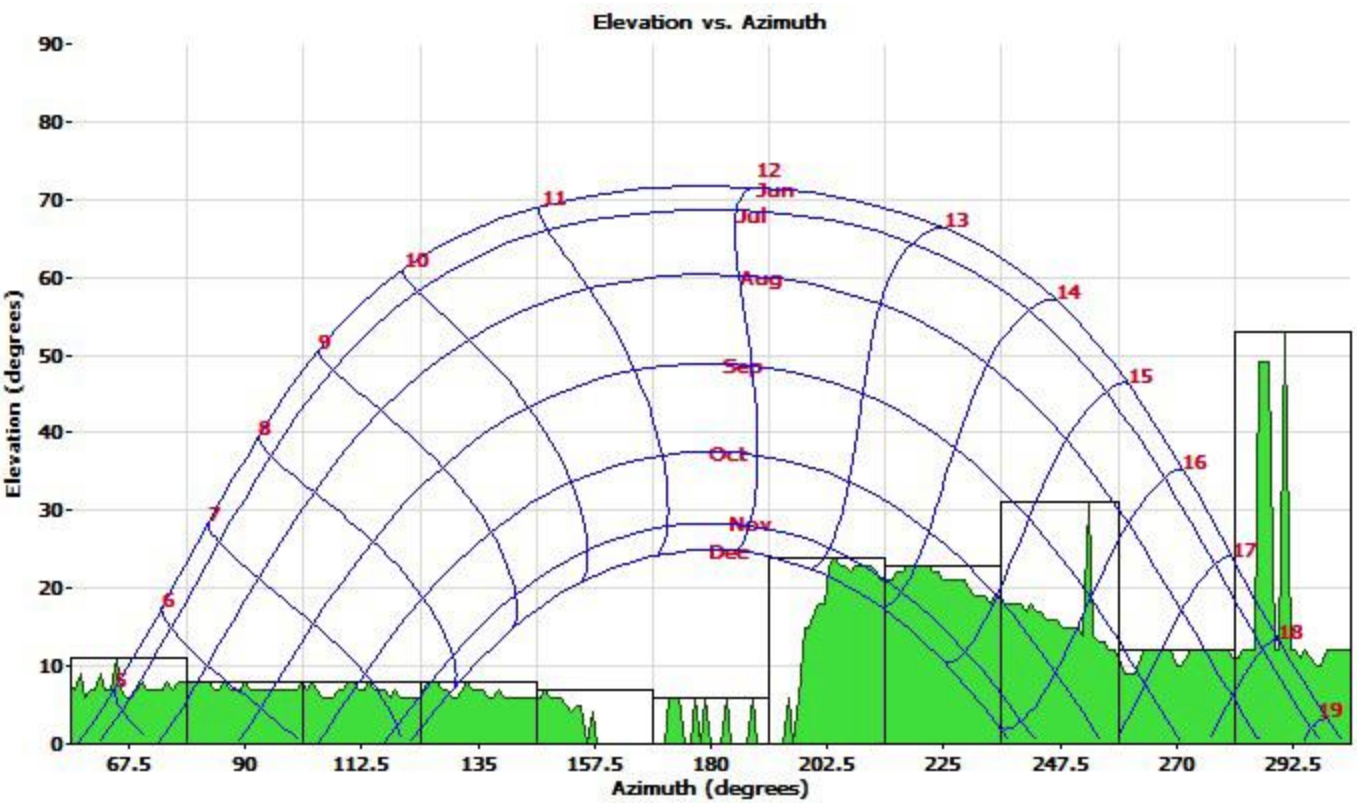
Skylines Averaged: Sky15

Annual	May-Oct	Nov-Apr
95%	98%	89%



TSRF for the skyline in this session: 87%

Session Elevation vs. Azimuth

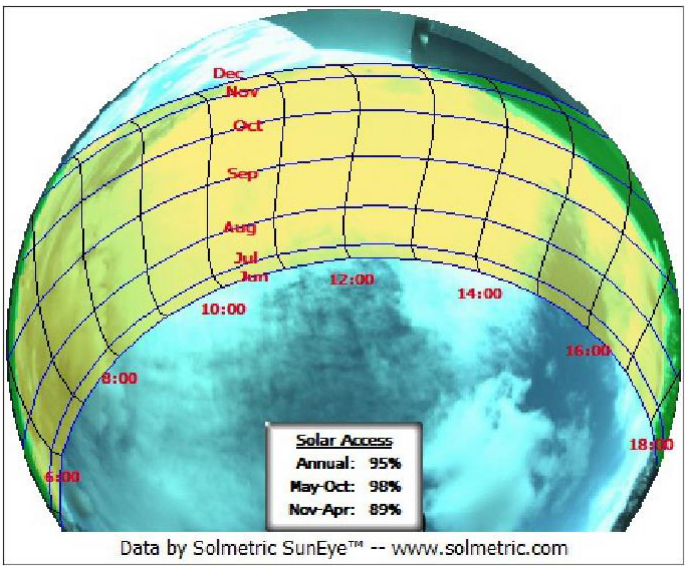


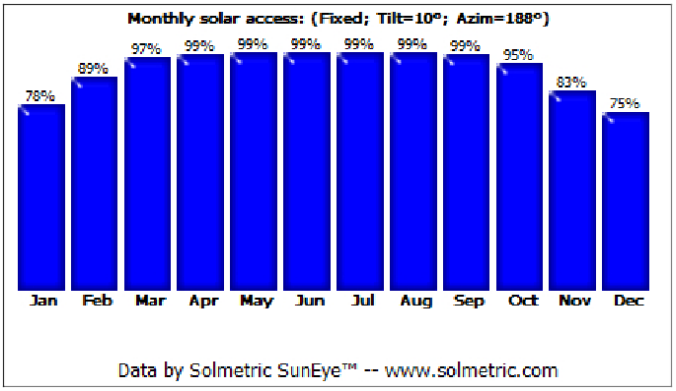
Sky15--11/27/201812:58--(no skyline note)

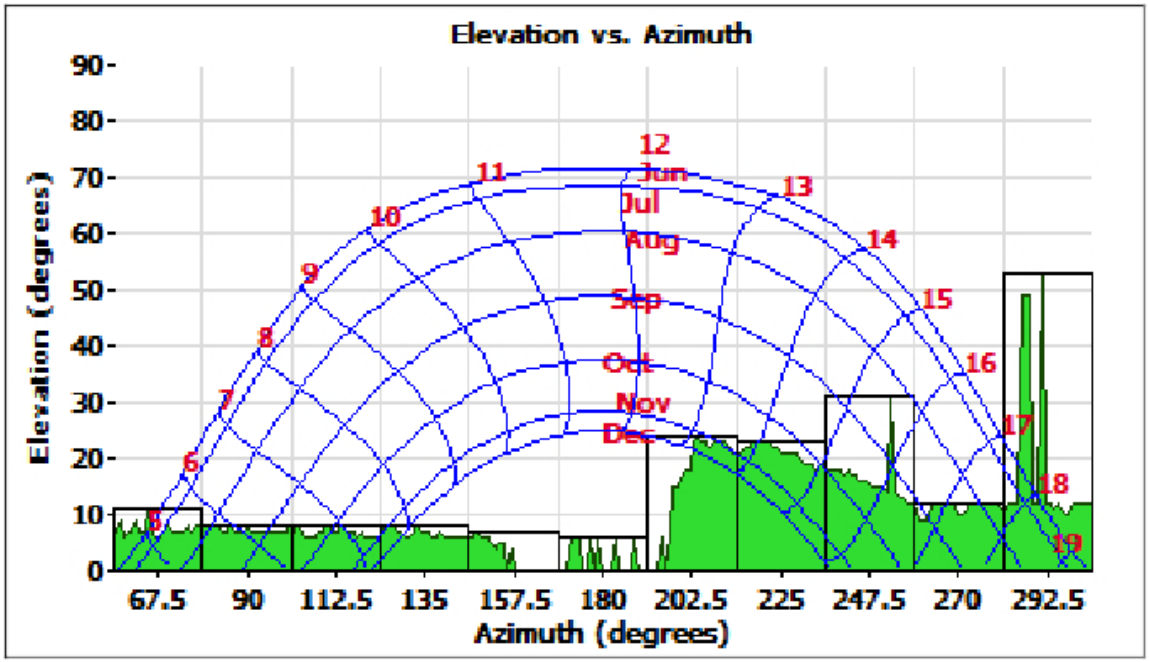
Panel Orientation: Tilt=10° -- Azimuth=188° -- **Skyline Heading=185°**

Solar Access: Annual: 95% -- Summer (May-Oct): 98% -- Winter (Nov-Apr): 89%

TSRF: 87% -- **TOF:** 91%







Appendix C – HelioScope Reports

CSMS RI Camp Fogarty Armory, 41.617195, -71.493209

Report

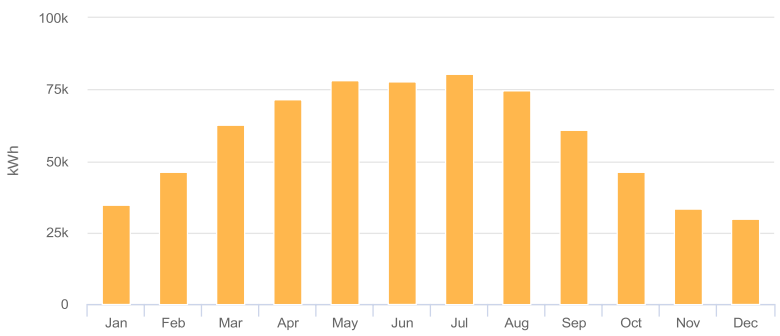
	RI Camp Fogarty Armory
	Roof Array
	41.617195, -71.493209
	Ryan Fahey ryan.fahey@cadmusgroup.com

System Metrics

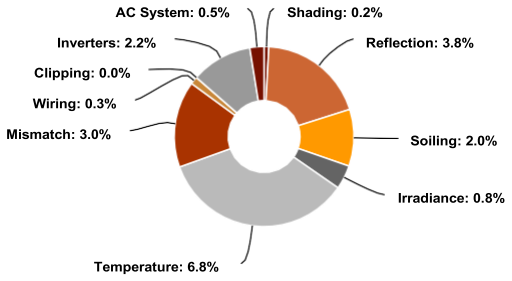
Design	CSMS
	550.1 kW
	505.3 kW Load Ratio: 1.09
	696.3 MWh
	81.9%
	1,265.9
	TMY, 10km grid (41.65,-71.45), NREL (prospector)
	1f01512ceb-3a521c1ab2-f54d0035ec-1f4250ba9b

Project Location

Monthly Production



Sources of System Loss



Annual Production

Energy (kWh)	Annual Global Horizontal Irradiance	1,456.8	
	POA Irradiance	1,545.0	
	Shaded Irradiance	1,542.4	-0.2%
	Irradiance after Reflection	1,484.3	
	Irradiance after Soiling	1,454.6	-2.0%
	Total Collector Irradiance		
	Nameplate	800,569.3	
	Output at Irradiance Levels	793,818.2	
	Output at Cell Temperature Derate	739,654.0	-6.8%
	Constrained DC Output	715,269.3	0.0%
	Inverter Output	699,829.0	-2.2%
	Energy to Grid	696,330.0	-0.5%
Temperature Metrics			
	Avg. Operating Ambient Temp		
	Avg. Operating Cell Temp		27.5 °C
Simulation Metrics			
	Solved Hours		4686

Condition Set

	Condition Set 1			
	TMY, 10km grid (41.65,-71.45), NREL (prospector)			
Solar Angle Location	Meteo Lat/Lng			
Transposition Model	Perez Model			
Temperature Model	Sandia Model			
Temperature Model Parameters				Temperature Delta
	Fixed Tilt	-3.56	-0.075	3°C
	Flush Mount	-2.81	-0.0455	0°C
Soiling (%)	J		S	
	2 2 2 2 2	2 2 2 2	2 2 2 2	
Irradiation Variance	5%			
Cell Temperature Spread	4° C			
Module Binning Range	-2.5% to 2.5%			
AC System Derate	0.50%			
Module Characterizations			Characterization	
	TSM-PD14 320 (May16) (Trina Solar)		Spec Sheet Characterization, PAN	
Component Characterizations				Characterization
	Sunny Tripower 24000TL-US (SMA)			Modified CEC

Components

Component	Name	Count
Inverters	Sunny Tripower 24000TL-US (SMA)	21 (505.3 kW)
Strings	10 AWG (Copper)	102 (10,240.3 ft)
Module	Trina Solar, TSM-PD14 320 (May16) (320W)	1,719 (550.1 kW)

Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	12	5-19	Along Racking
Wiring Zone 2	12	5-19	Along Racking
Wiring Zone 3	12	5-19	Along Racking
Wiring Zone 4	12	5-19	Along Racking
Wiring Zone 5	12	5-19	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Flush Mount	Landscape (Horizontal)	10°	189.445°	2.0 ft	1x1	292	289	92.5 kW
Field Segment 2	Flush Mount	Landscape (Horizontal)	10°	189.445°	2.0 ft	1x1	498	495	158.4 kW
Field Segment 3	Flush Mount	Landscape (Horizontal)	10°	98.6576°	2.0 ft	1x1	310	309	98.9 kW
Field Segment 4	Flush Mount	Landscape (Horizontal)	10°	98.6576°	2.0 ft	1x1	71	69	22.1 kW
Field Segment 5	Flush Mount	Landscape (Horizontal)	10°	98.6576°	2.0 ft	1x1	185	182	58.2 kW
Field Segment 6	Flush Mount	Landscape (Horizontal)	10°	189.114°	2.0 ft	1x1	379	375	120.0 kW

Detailed Layout