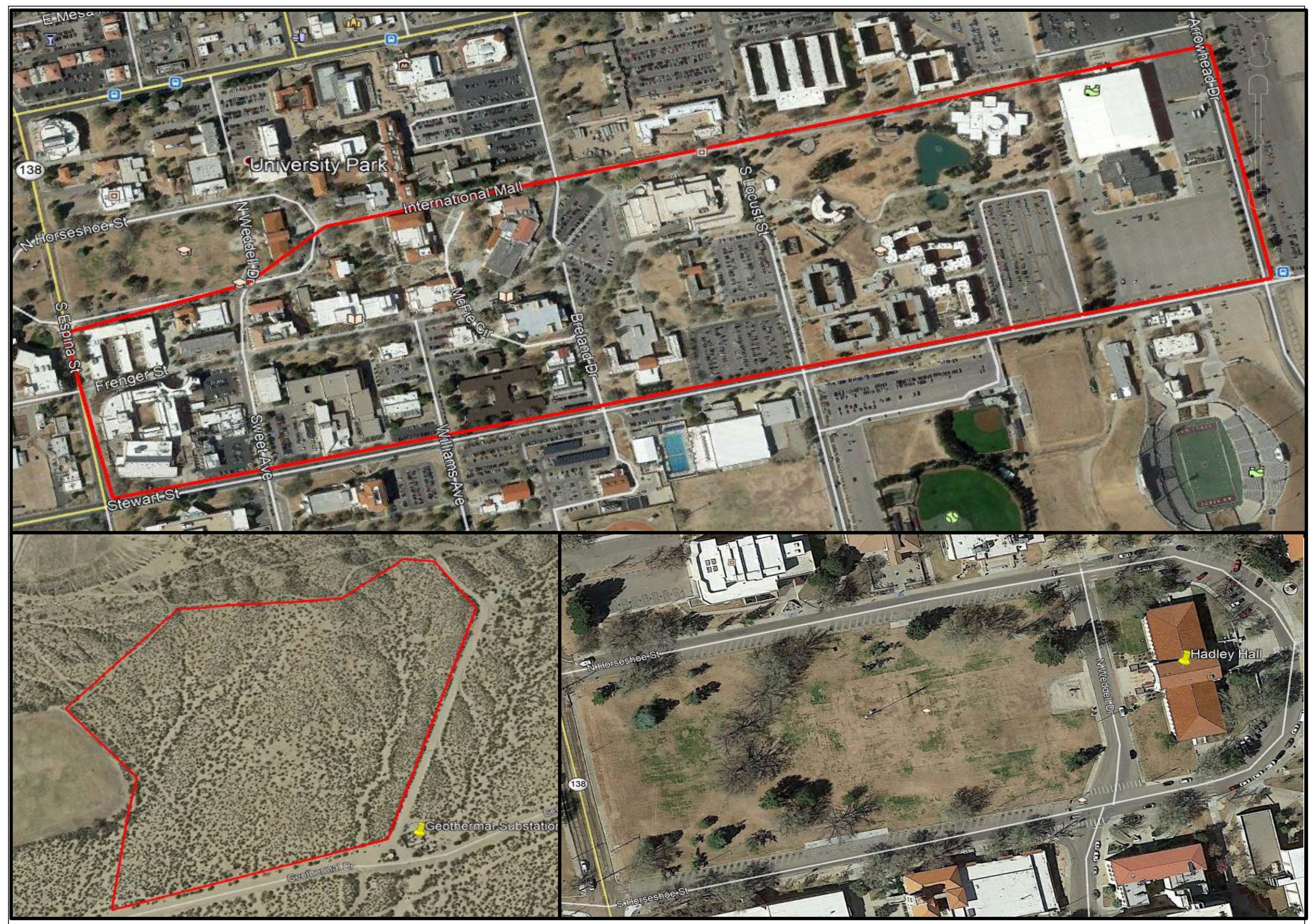
U.S. Department of Energy Competition: Solar District Cup



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Project Requirements

The U.S. Department of Energy (DOE) is challenging groups to create a photovoltaic solar energy system for a district; districts are assigned to teams of their selection. The DOE provided constraint areas, the building load profiles in 15-minute intervals for 10 buildings on the campus for the year 2018, size and length of distribution wires, electric utility rate schedule, and a master plan for the district. The above picture gives an overhead view of the project working area for New Mexico State University, along with a 29-acre open field zone for the construction of ground mounted solar panels, a block of the campus' main buildings, and a request for a creative design to be placed on or near the chancellors building are to be included in the design.

LIDAR (Terrain) **Irradiance Model**

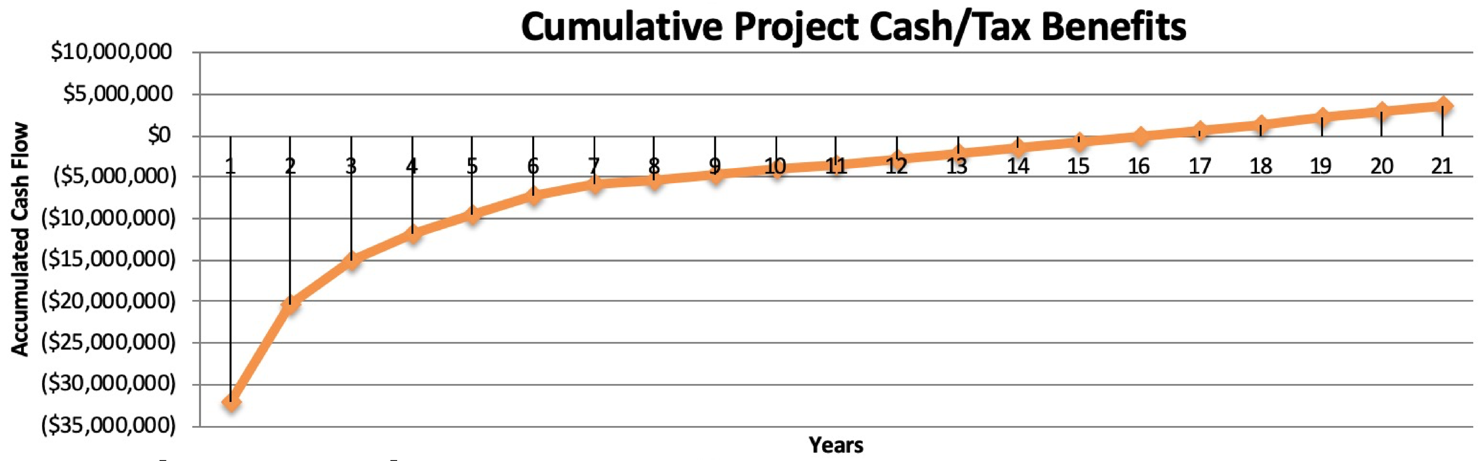
Aurora solar is the software design utilized for the project as there are many factors into creating a photovoltaic solar energy system. Referring to the picture on the left, the software has a function to model the height of the buildings and the location of obstructions such as trees and other buildings. The Lidar function influences the shading model of the rooftops where solar cells planned to be located. Leading to the function, Irradiance Model, demonstrates areas where solar panels will be effective and areas receiving less than ideal sunlight throughout the year. Referencing the Irradiance Model figure, the darker the area is on the rooftop results in loss of effectiveness due to the solar panel being unable to receive sunlight throughout portions of the day and year.

Abstract

The Solar District Cup is a two-semester design competition sponsored by the U.S. Dept. of Energy in which teams from across the nation compete to design the most efficient and cost effective solar plus storage system for a unique district case. The Embry Riddle team was tasked with designing such a system for New Mexico State University in Las Cruses, NM.

Finance

SAM Financial Analysis Model and Excel that is provided by NREL were used to analyze the cost and payback period
•Payback of the system complete in 16 years
•The capital cost of the photovoltaic system is $29,597,200
•Utilizes a 20 year Power Purchase Agreement
•NMSU is tax exempt
•System inflation is 2% per year and degradation is 0.5% per year

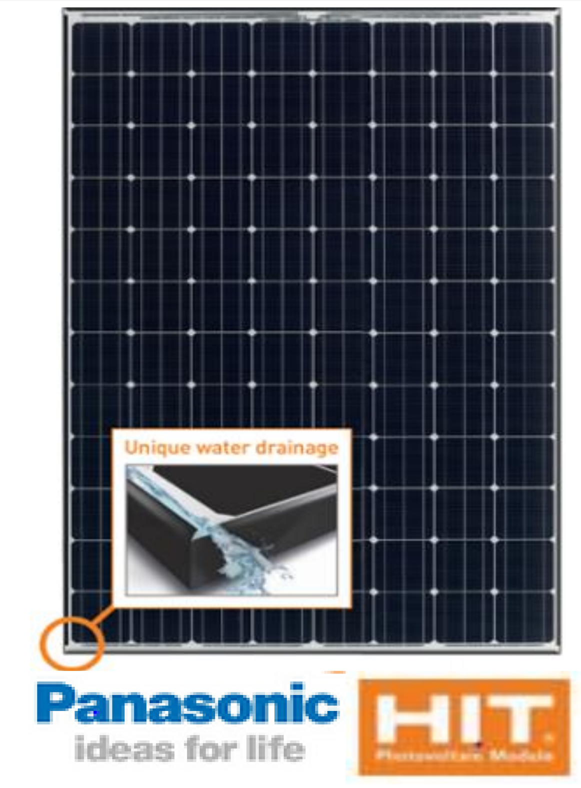


Development Plan

- State Building and Reroof Permit
- Special Permit
- Valid license issued by CID (Construction Industries Division)

Building Roof Area Selection

- Available Roof Area
- Distance to Energy Receiving Building
- Minimal shadowing area
- Satisfy the electrical loads requirement



ELECTRICAL SPECIFICATIONS

Model	VBHN330SA17	VBHN325SA17
Rated Power (Pmax)[1]	330W	325W
Maximum Power Voltage (Vpm)	58.0V	57.6V
Maximum Power Current (Ipm)	5.70A	5.65A
Open Circuit Voltage (Voc)	69.7V	69.6V
Short Circuit Current (Isc)	6.07A	6.03A
Temperature Coefficient (Pmax)	-0.258%/°C	-0.258%/°C
Temperature Coefficient (Voc)	-0.16V/°C	-0.16V/°C
Temperature Coefficient (Isc)	3.34mA/°C	3.32mA/°C
NOCT	44.0°C	44.0°C
CEC PTC Rating	311.7W	306.8W
Cell Efficiency	22.09%	21.76%
Module Efficiency	19.7%	19.4%
Watts per Ft.[2]	18.3W	18.0W
Maximum System Voltage	600V	600V
Series Fuse Rating	15A	15A
Warranted Tolerance (-/+)	+10%/-0%*	+10%/-0%*

Equipment Selection

Prioritizing different factors contributing to the efficiency, cost, and performance of the PV system the Panasonic HIT N330 is selected throughout the design. The high panel efficiency and low degradation would provide a high energy output for the lifetime of the system as there is an expected useful life of 30 years. The goal of this system is to be efficient and have a low difference between performance in the first year and the final year of the PV system; end of useful life. Inverters used on a University of Massachusetts project, designed by Borrego Solar Systems Inc., were the string inverters chosen for this system due to the similar circumstances in providing power to a college campus, Solectria XGI 1500-166/166.

DC Input	
Absolute Maximum Input Voltage	1500 VDC
Maximum Power Input Voltage Range (MPPT)	860-1250 VDC
Operating Voltage Range (MPPT)	860-1450 VDC
Number of MPP Trackers	1 MPPT
Maximum Operating Input Current	197.7 A
Maximum Operating PV Power	170 kW
Maximum DC/AC Ratio | Max Rated PV Power	1.5 | 250 kW
Max Rated PV Short-Circuit Current (∑Isc x 1.25)	320 A
AC Output	
Nominal Output Voltage	600 VAC, 3-Ph
AC Voltage Range	-12% to +10%
Continuous Real Output Power	166 kW
Continuous Apparent Output Power	166 kVA
Maximum Output Current	160 A
Nominal Output Frequency	60 Hz
Power Factor (Unity default)	+/- 0.85 Adjustable
Total Harmonic Distortion (THD) @ Rated Load	<3%
Grid Connection Type	3-Ph + N/GND
Fault Current Contribution (1 cycle RMS)	192 A

System Evaluation

OpenDSS is a simulation tool used to estimate the impacts of the PV system connected to an electric utility power distribution system in terms of voltage, power and current. In order to verify if the system can receive such loads in specified areas, the simulation tool incorporates elements such as are wires, transformers, and solar panels in its calculation. The overall purpose is to demonstrate if there are system overloads on the grid from designing a PV system along with the predefined substation system. The below graph shows the power production of the designed PV system for 8 months.