EE 491 – sdmay19-26
115kV / 34.5kV SOLAR POWER PLANT/SUBSTATION DESIGN PROJECT
Week 4 Report

Monday (9/24/2018) – Sunday (9/30/2018)
Client: Black & Veatch
Advisor: Venkataramana Ajjarapu
Team Email: sdmay19-26@iastate.edu

Team Members:

Katayi Katanga – Team/Communication Leader
Nur Shuazlan – Meeting Scribe
Yao Cheah – Website Manager #1
Ahmed Sobi – Layout Designer #1
Chufu Zhou – Website Manager #2/Layout Designer #2
Tam Nguyen – Report Manager

Weekly Summary:

In this week, we had a meeting with the client, and we talked about our solar power plant cost, plant sketch, location review, single line substation diagram, justification on Hanwha 325W, and a rough draft of our Gantt chart. Then, we divided into three groups to look for exact locations in California, Texas, and New Mexico to choose the best place for our solar power plant and substation; Nur and Kat did locations in Texas, Tam and Ahmed did locations in California, and YJ and Chufu did locations in New Mexico. We also worked on our Gantt chart and justification for the combiner box.

Summary of Client Meeting:

Based on the results that we got from the Array Parameter Tool, we figured out the number of components, their prices, and the total cost of the solar plant. To build the solar plant, we'll need 237,312 panels, 252 combiner boxes, 46 inverters, and 243.8 acres of land. Then, we designed a rough layout for a single rack, a single array, and the entire power plant. We also labeled the width and height of the racks, arrays and solar plant.

Ahmed talked about the MISO North Star Solar Project that is located in Minnesota, and that they used single axis tracking to maximize production. The solar radiation that the area gets annually is three times less than what California gets. We are also considering other Southern states, like Texas, Arizona, and New Mexico because those states will most likely be cheaper than California. We decided to have one of the Southern states for our solar plant location because having a tracking rack system would significantly increase the project cost. Then, the client asked us to use Google Earth to find exact locations in each state.

Chufu did the justification for the inverter, and Ahmed did the justification for the solar panel. We are using the polycrystalline instead of the monocrystalline solar panels because the

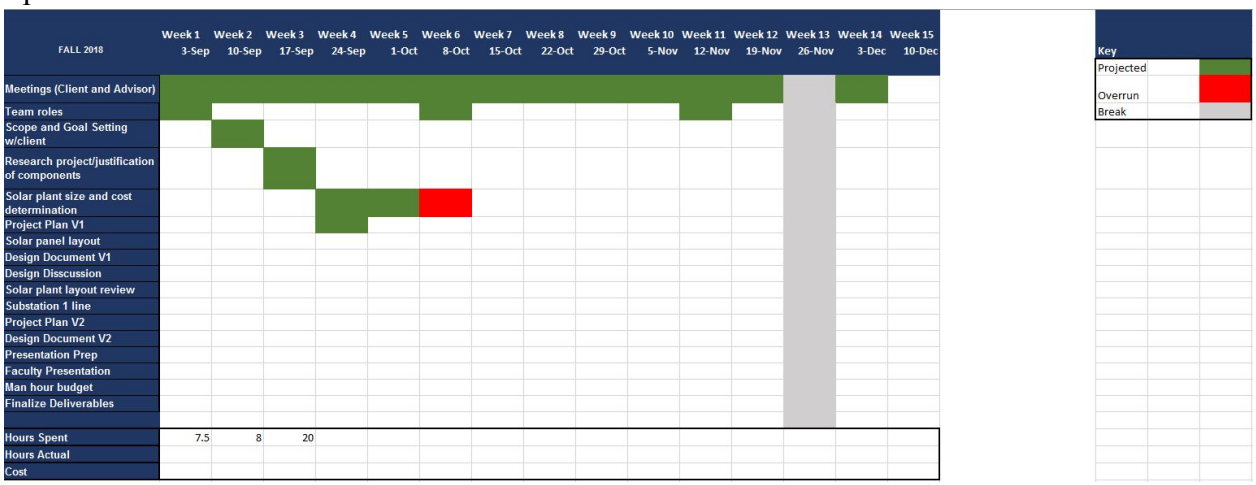
monocrystalline only have a slightly higher efficiency, but they cost almost twice as much. Also, the panels that we are using are one of the cheapest in the market. Therefore, We are going to stick with the 325W Hanwha polycrystalline panels because they are more cost-efficient.

Lastly, we showed the client a rough sketch of our Fall 2018 Gantt Chart.

Past Week Accomplishments:

Katayi and Nur:-

- Justification of CB (Eaton CCB_36 vs Ingecon StringBox)
- Optimized Fall 2018 Gantt Chart



- Pros and Cons for Texas locations of solar plant

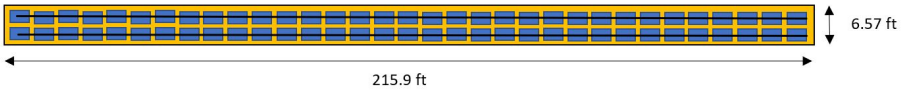
Alpine - Pros	Plains - Pros
• Brewster county has loads of solar installations (32) • $147,000 for 280 acres (35 extra acres for substation) • Good distance away from settlement area • Higher retail cost of electricity, diff of $0.011	• More land for cheaper price (385 acres of flat land selling at $231,000., 145 extra acres) • Higher annual AC Energy • No possibility of land shortage if expansion of plant and substation was considered • Less hurricanes and storms • Higher solar irradiance

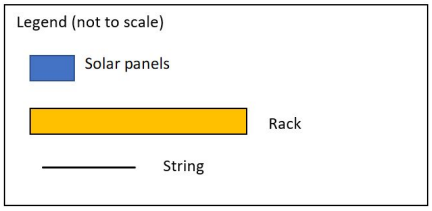
Alpine - Cons	Plains - Cons
• Lower annual AC Energy • Possibility of land shortage in expansion was ever considered	• No other installations of solar in area • Close to a settlement area • Possibility of land waste (assuming max 30 acres for substation) • Retail cost of electricity is lower compared to Alpine, difference of $0.011 • Higher chance of tornadoes

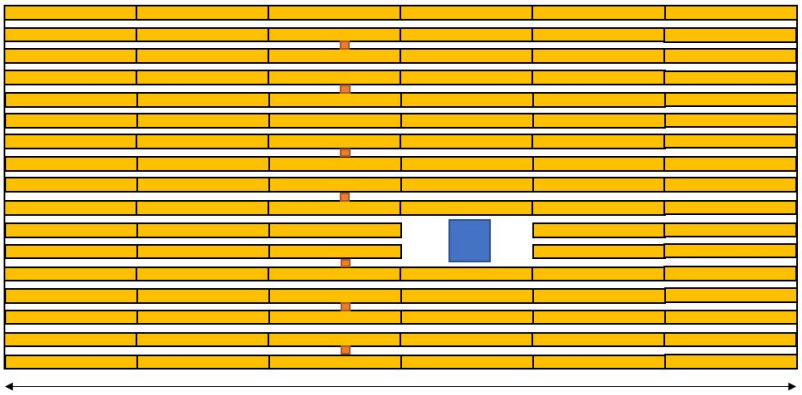
- Cost of solar plant in Alpine

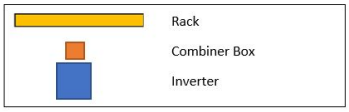
Solar Plant Cost				
Panels	237600	48.4704	million $	
CBs	252	0.32270112	million $	
Inverters	36	15.556275	million $	
Land	255.7407619	0.147	million $	280 acre
	Total Cost	64.49637612	million $	

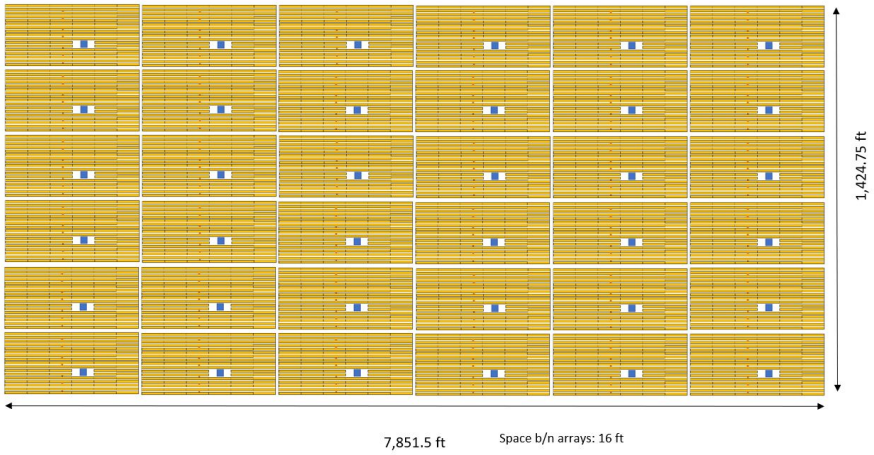
- Solar layouts





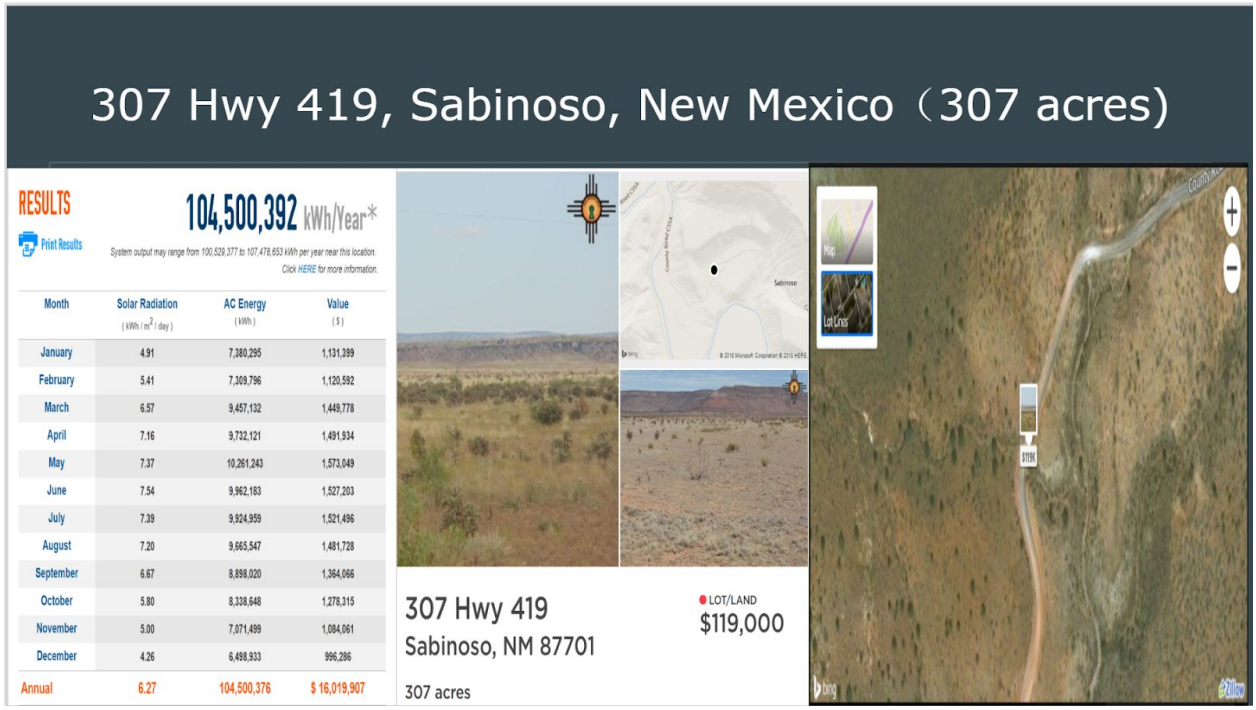

Space between racks without CB:
6.87 ft
Space between racks with CB:
7.86 ft
224.13 ft
1295.25 ft

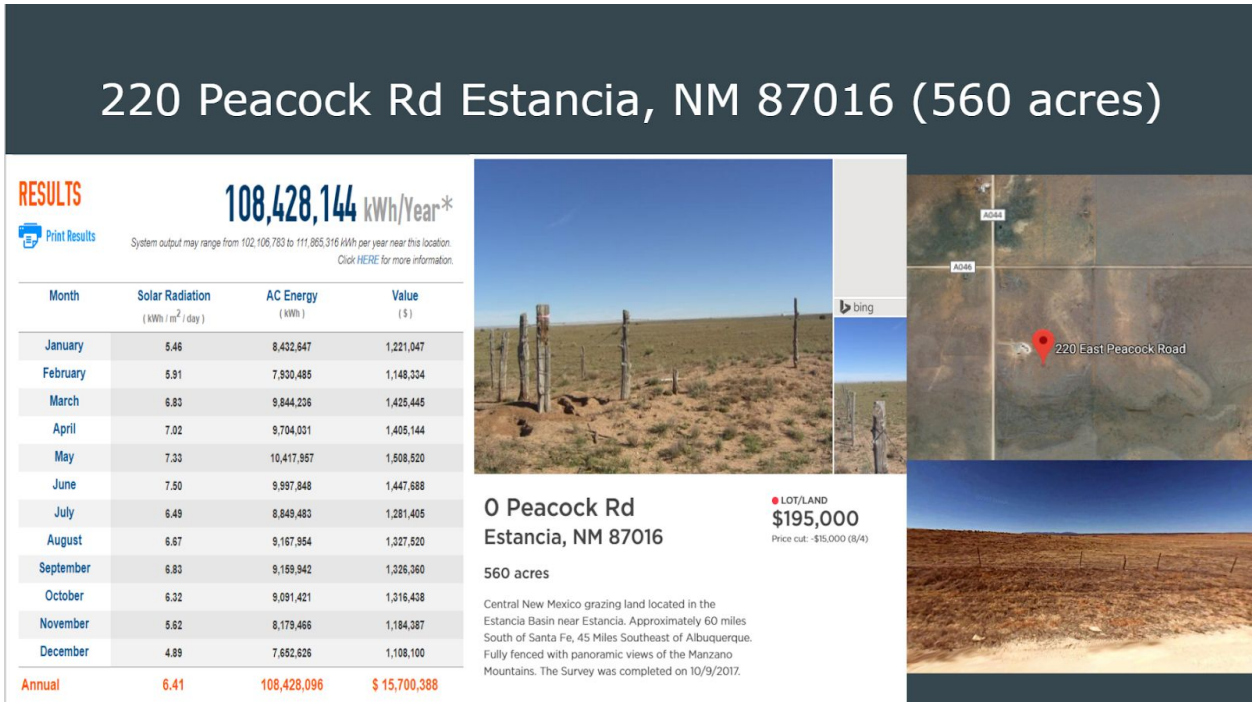

Rack
Combiner Box
Inverter


1,424.75 ft
7,851.5 ft
Space b/n arrays: 16 ft

YJ and Chufu:-

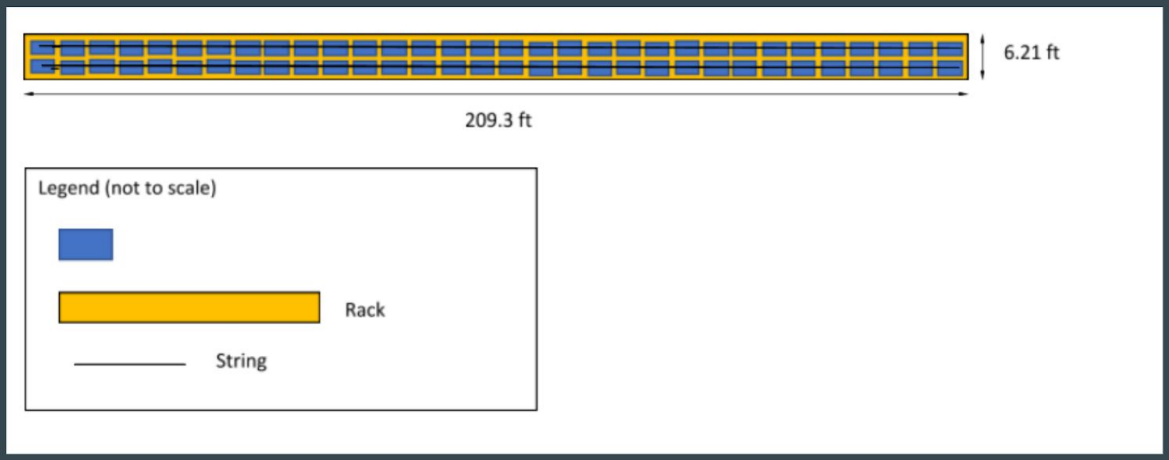
- We found two locations for New Mexico from Zillow.com that is suitable to allocate our solar power plant.





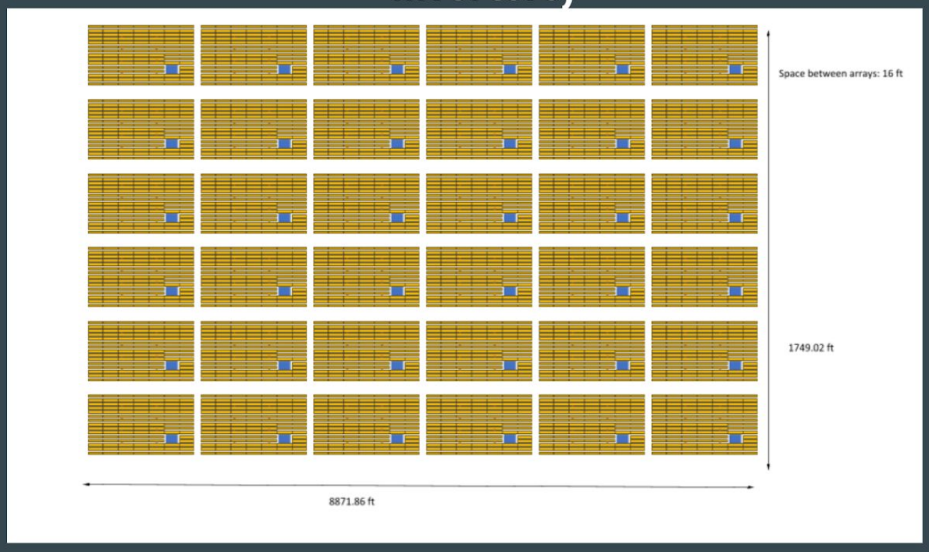
- Based on the first location at Sabinoso, New Mexico, we created a layout based on the array parameter tool. Below shown are the single rack, single array and overall layout of our solar power plant.

New Mexico: Single Rack Layout (2x32 Panels, 2 Strings)



New Mexico: Single Array Layout (15x7 - 2 Racks, 8 CB, 1 Inverter)

New Mexico: Solar Power Plant Layout (36 Arrays, 36 Inverters)



- The cost expected are as below:

New Mexico Power Plant Cost

Solar Plant Cost				
Panels	241920	49.35168	Million$	
CBs	288	0.36880128	Million$	
Inverters	36	15.556275	Million$	
Land	360.4482785	0.195	Million$	560 acres
	Total Cost	65.4717563	Million$	

Ahmed and Tam:-

- Chose exact location for solar plant advantages and disadvantages of the places

Advantages and Disadvantages of Millville

Advantages :

- California is considered to be the number one state for solar power
- The land is cheap and level
- The only precipitation is rainfall
- Extra land for future expansion

Disadvantages:

- Far from highly populated areas.
- Higher precipitation days.
- Lower solar radiation .

Weather and Solar Radiation

CLIMATE	Millville, California	United States
Rainfall (in.)	34.1	39.2
Snowfall (in.)	2.4	25.8
Precipitation Days	55.9	102.0
Sunny Days	249	205
Avg. July High	98.5	86.1
Avg. Jan. Low	36.7	22.6
Comfort Index (higher=better)	82	54
UV Index	4.8	4.3
Elevation ft.	600	1443

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	3.29	4,851,858	683,142
February	4.10	5,374,672	756,754
March	4.90	6,975,374	982,133
April	6.34	8,509,150	1,198,088
May	7.08	9,613,502	1,353,581
June	7.31	9,156,600	1,289,249
July	7.75	9,815,469	1,382,018
August	7.59	9,757,208	1,373,815
September	7.11	8,871,938	1,249,169
October	5.60	7,630,851	1,074,424
November	3.99	5,475,725	770,982
December	3.03	4,547,772	640,326
Annual	5.67	90,580,119	$ 12,753,681

Advantages and Disadvantages of Barstow

Advantages:

- Bigger land size, suitable weather condition
- Closer to Los Angeles and San Bernardino
- 20 miles from Mojave solar project
- Average annual precipitation-rainfall 5.25 inch
- Higher solar radiation

Disadvantages :

- Closer to a hilly area
- Bit expensive compared to other areas

Weather and Solar Radiation

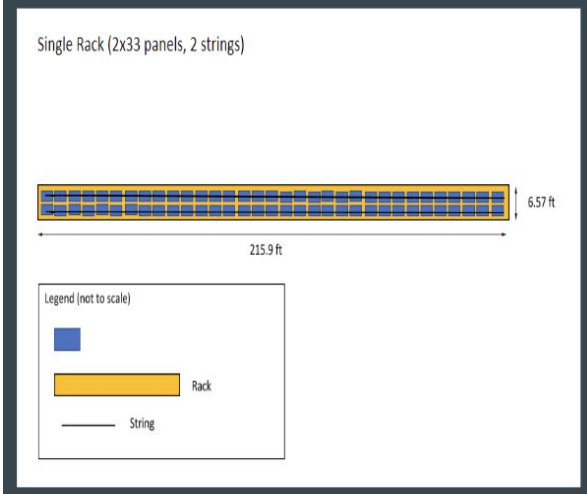
CLIMATE	Barstow, California	United States
Rainfall (in.)	5.2	39.2
Snowfall (in.)	0.3	25.8
Precipitation Days	20.7	102.0
Sunny Days	281	205
Avg. July High	101.6	86.1
Avg. Jan. Low	33.6	22.6
Comfort Index (higher=better)	83	54
UV Index	5.7	4.3
Elevation ft.	2287	1443

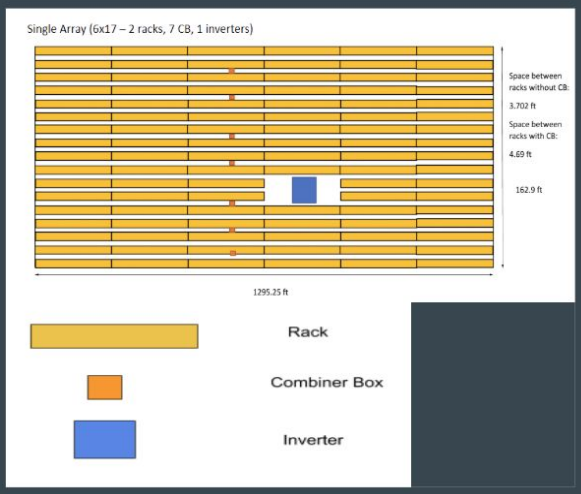
Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	4.91	7,097,904	838,262
February	5.67	7,500,423	885,800
March	6.99	9,690,316	1,144,426
April	7.68	10,359,472	1,223,454
May	8.06	10,854,618	1,281,930
June	8.33	10,468,167	1,236,291
July	7.89	10,009,052	1,182,069
August	7.79	10,059,745	1,188,056
September	7.40	9,373,478	1,107,008
October	6.54	9,161,463	1,081,969
November	5.31	7,413,516	875,536
December	4.51	6,683,001	789,262
Annual	6.76	108,671,155	$ 12,834,063

- Worked with array parameter tool to find the number of components to be used in solar plant

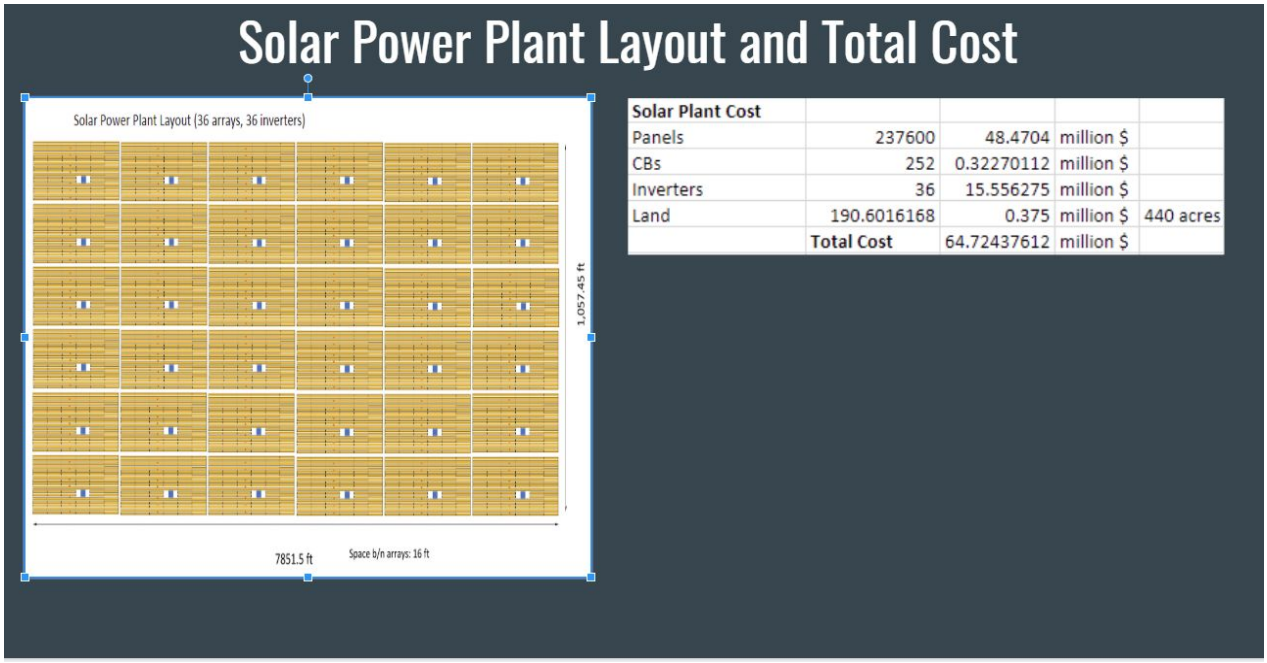
the following parameter tools are for Millville, CA because it was determined the best location in California.

Single Rack and Single Array of Millville





- Plant cost and Solar plant layout



Solar Plant Cost				
Panels	237600	48.4704	million $	
CBs	252	0.32270112	million $	
Inverters	36	15.556275	million $	
Land	190.6016168	0.375	million $	440 acres
	Total Cost	64.72437612	million $	

Pending Issues:

None.

Plans For Next Week:

Everyone:-

- Write up the reasons why we choose Estancia, NM is the best location for our solar power plant and substation.
- Choose the best layout for the plant.

Katayi and Nur:-

- Design the 5x35 version layout for Estancia, NM.

YJ and Chufu:-

- Design the 8x22 version layout for Estancia, NM.

Ahmed and Tam:-

- Design the 6x30 version layout for Estancia, NM.

Individual Contributions:

Team Member	Individual Contributions	Hours	Cumulative Hours
Katayi Katanga	Did research on: - Justification of CB used. - Fall 2018 Gantt Chart. - Chose the exact locations for the solar plant. - Worked with array parameter tool to find the number of components to be used in the solar plant. - Determined plant cost. Created/Performed: - Solar layouts. - Project plan. - Attend all meetings.	17.5	47
Nur Shuazlan	Did research on: - Justification of CB used. - Fall 2018 Gantt Chart. - Chose the exact locations for the solar plant. - Worked with array parameter tool to find the number of components to be used in the solar plant. - Determined plant cost. Created/Performed: - Solar layouts. - Project plan. - Attend all meetings.	17.5	48.5
Yao Cheah (YJ)	Did research on: - Researching location at New Mexico for building the solar power plant - Using the array parameter tool to get the design parameters - Draw the design draft	14	33.5

	Created/Performed: - Solar layouts - Project plan. - Attend all meetings		
Ahmed Sobi	Did research on: - Choose an exact location for the solar plant. - Worked with array parameter tool to find the number of components to be used in the solar plant. - Determined plant cost Solar projects in California. Created/Performed: - Solar layouts. - Project plan.	14.5	34.5
Tam Nguyen	Did research on: - Choose an exact location for the solar plant. - Worked with array parameter tool to find the number of components to be used in the solar plant. - Determined plant cost for Solar projects in California. Created/Performed: - Solar layouts. - Project plan. - Weekly report. - Meeting agenda. - Attend all meetings.	15	33.5
Chufu Zhou	Did research on: - Choose an exact location for the solar plant in New Mexico - Worked with array parameter tool to find the number of components to be used in the solar plant.	11	29

	- Determined plant cost for Solar projects in New Mexico. - Layout in AutoCAD Created/Performed: - Project plan. - Attend all meetings.		

Team Hours: 89.5
Cumulative Team Hours: 226.0