

# Week 5 Meeting



10/1/18

Team Leader: Katayi

Other Team Members: Nur, Chufu, Tam, Ahmed, YJ

Advisor: Dr. Ajjarapu

# Topics

- Solar Plant Location and Layout in California
  - Location Information and Justification
  - Layout and Cost
- Solar Plant Location and Layout in New Mexico
  - Location Information and Justification
  - Layout and Cost
- Solar Plant Location and Layout in Texas
  - Location Information and Justification
  - Layout and Cost
- Combiner Box Justification
- Second Draft: Fall 2018 Gantt Chart

# Safety Moment

## Jump Starting A Battery:



As the cold weather starts to come upon us, many cars batteries will start to fail. The best short term way to get the motor going is to jump started therefore is important to know the proper and safer procedure.

- Makes sure the batteries are of the same voltages and position the cars so they do not touch each others
- Make sure the ignition on both vehicles is turned off. Extra precaution is to wear safety glasses and gloves
- Connect the cable according the color positive with positive and negative with negative start with the dead battery first
- Turn on the ignition on the booster car and let it run for a few minute before starting the other car.
- Remove the cables in the reverse order of connection and make sure the booster cable clamps not touch each others

# Millville, Shasta County, CA

Land price \$375,000

Land size 440 acres



# Weather and Solar Radiation

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

Month	Solar Radiation ( kWh / m <sup>2</sup> / 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
<b>Annual</b>	<b>5.67</b>	<b>90,580,119</b>	<b>\$ 12,753,681</b>

# Barstow, San Bernardino County, CA

Land price \$499,000

Land size 320 acres



# Weather and Solar Radiation

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

Month	Solar Radiation ( kWh / m <sup>2</sup> / 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
<b>Annual</b>	<b>6.76</b>	<b>108,671,155</b>	<b>\$ 12,834,063</b>

# 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 .



# Advantages and Disadvantages of Barstow

## Advantages:

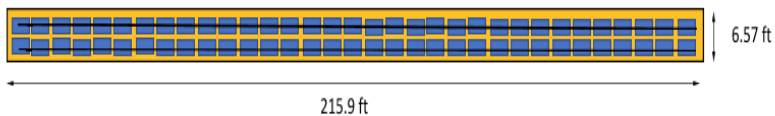
- Bigger land size, suitable weather condition
- Closer to Los Angeles and San Bernardino
- 20 miles from Mojave solar project
- Average annual precipitation-rainfall 5.25 inch
- Higher solar radiation

## Disadvantages :

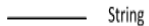
- Closer to a hilly area
- Bit expensive compared to other areas

# Single Rack and Single Array of Millville

Single Rack (2x33 panels, 2 strings)



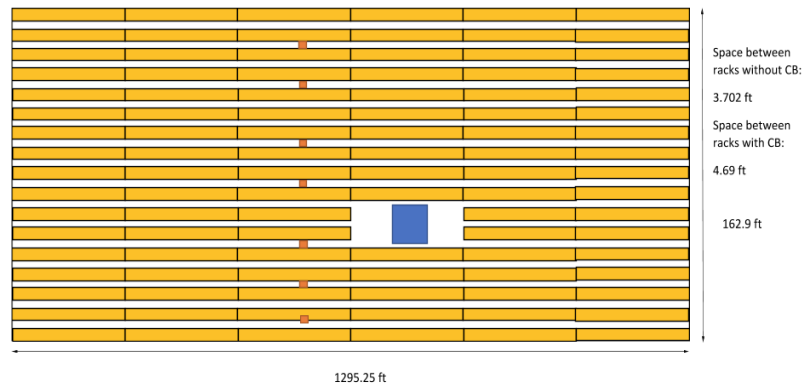
Legend (not to scale)



Rack

String

Single Array (6x17 – 2 racks, 7 CB, 1 inverters)



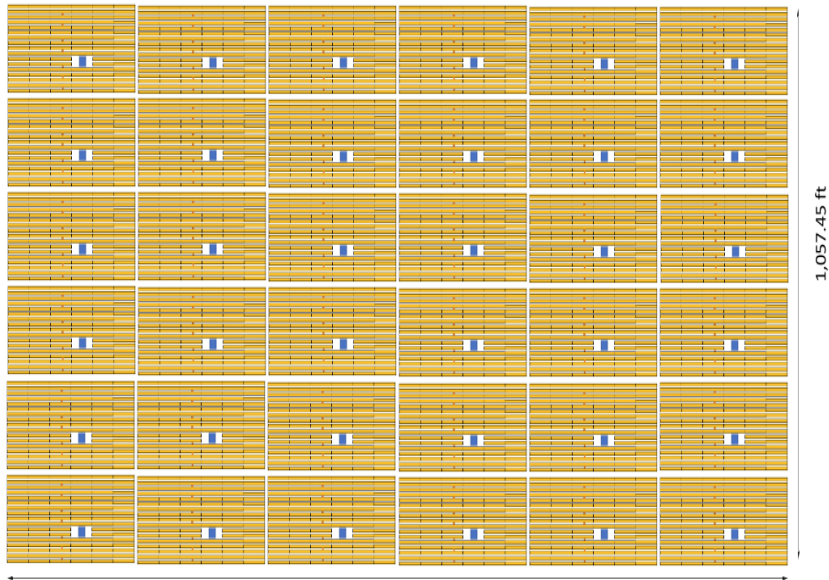
Rack

Combiner Box

Inverter

# Solar Power Plant Layout and Total Cost

Solar Power Plant Layout (36 arrays, 36 inverters)



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
	<b>Total Cost</b>	<b>64.72437612</b>	<b>million \$</b>	

# 307 Hwy 419, Sabinoso, New Mexico (307 acres)

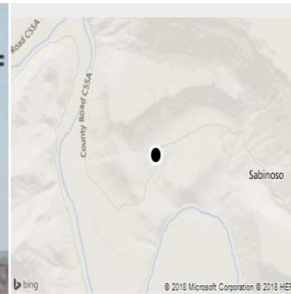
## RESULTS

# 104,500,392 kWh/Year\*

 Print Results

System output may range from 100,529,377 to 107,478,653 kWh per year near this location.  
Click [HERE](#) for more information.

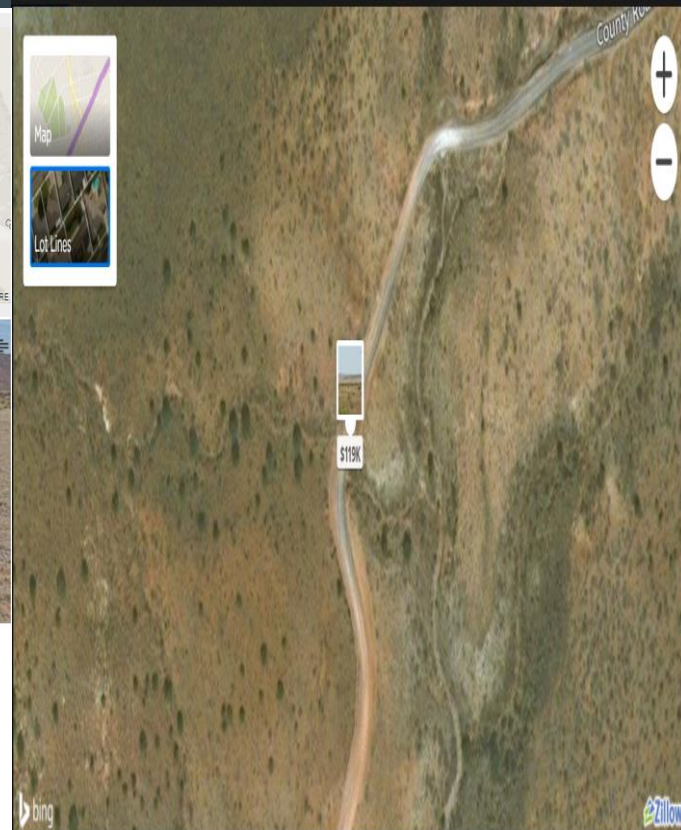
Month	Solar Radiation (kWh / m <sup>2</sup> / day)	AC Energy (kWh)	Value (\$)
January	4.91	7,380,295	1,131,399
February	5.41	7,309,796	1,120,592
March	6.57	9,457,132	1,449,778
April	7.16	9,732,121	1,491,934
May	7.37	10,261,243	1,573,049
June	7.54	9,962,183	1,527,203
July	7.39	9,924,959	1,521,496
August	7.20	9,665,547	1,481,728
September	6.67	8,898,020	1,364,066
October	5.80	8,338,648	1,278,315
November	5.00	7,071,499	1,084,061
December	4.26	6,498,933	996,286
<b>Annual</b>	<b>6.27</b>	<b>104,500,376</b>	<b>\$ 16,019,907</b>



**307 Hwy 419**  
**Sabinoso, NM 87701**

307 acres

● LOT/LAND  
**\$119,000**



# 0 Peacock Rd Estancia, NM 87016 (560 acres)

## RESULTS

 Print Results

# 108,428,144 kWh/Year\*

System output may range from 102,106,783 to 111,865,316 kWh per year near this location.  
Click [HERE](#) for more information.

Month	Solar Radiation (kWh / m <sup>2</sup> / day)	AC Energy (kWh)	Value (\$)
January	5.46	8,432,647	1,221,047
February	5.91	7,930,485	1,148,334
March	6.83	9,844,236	1,425,445
April	7.02	9,704,031	1,405,144
May	7.33	10,417,957	1,508,520
June	7.50	9,997,848	1,447,688
July	6.49	8,849,483	1,281,405
August	6.67	9,167,954	1,327,520
September	6.83	9,159,942	1,326,360
October	6.32	9,091,421	1,316,438
November	5.62	8,179,466	1,184,387
December	4.89	7,652,626	1,108,100
<b>Annual</b>	<b>6.41</b>	<b>108,428,096</b>	<b>\$ 15,700,388</b>



 bing



## 0 Peacock Rd Estancia, NM 87016

● LOT/LAND  
**\$195,000**

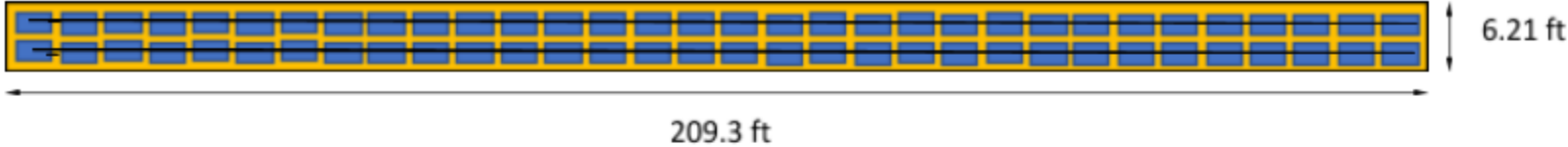
Price cut: -\$15,000 (8/4)

560 acres

Central New Mexico grazing land located in the Estancia Basin near Estancia. Approximately 60 miles South of Santa Fe, 45 Miles Southeast of Albuquerque. Fully fenced with panoramic views of the Manzano Mountains. The Survey was completed on 10/9/2017.



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



Legend (not to scale)

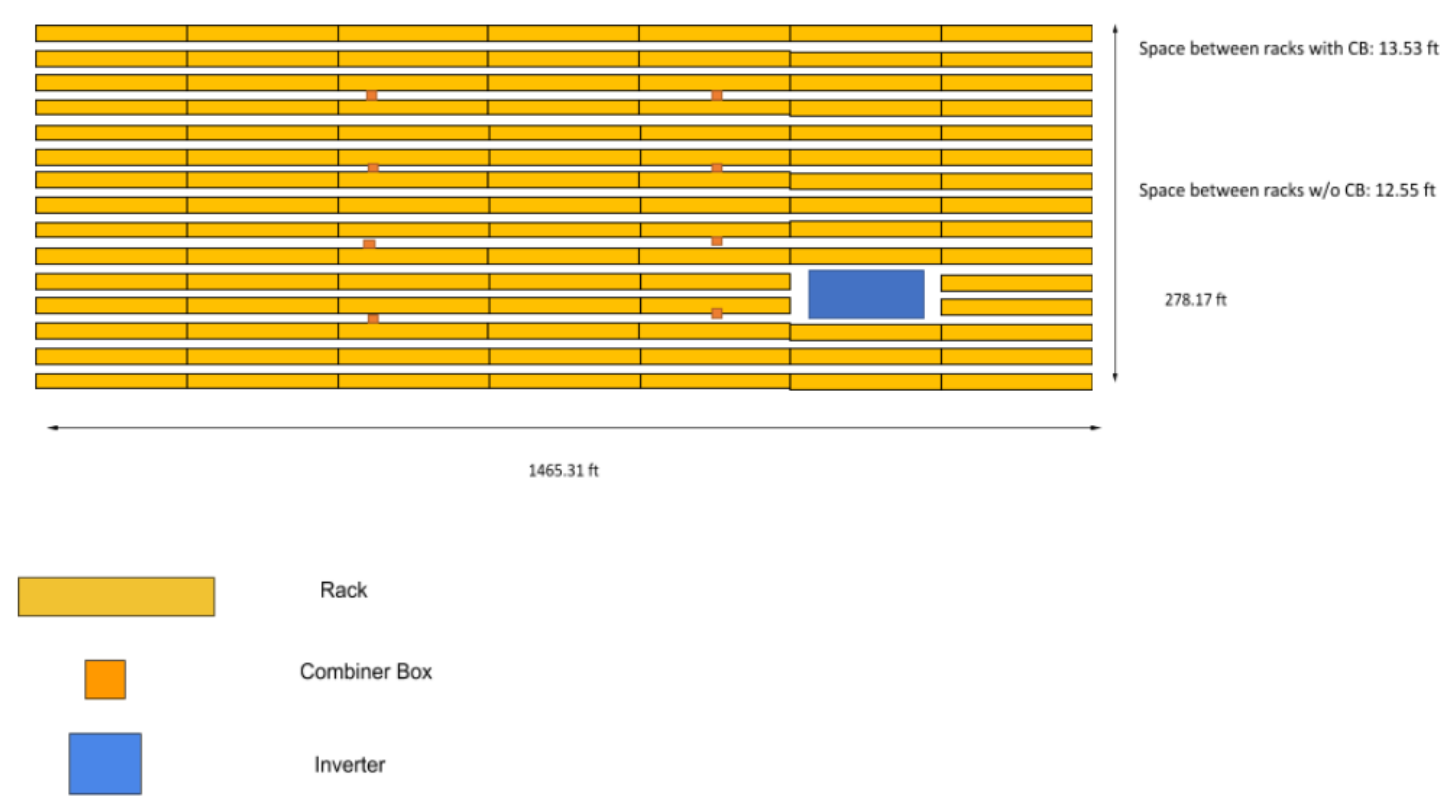


Rack

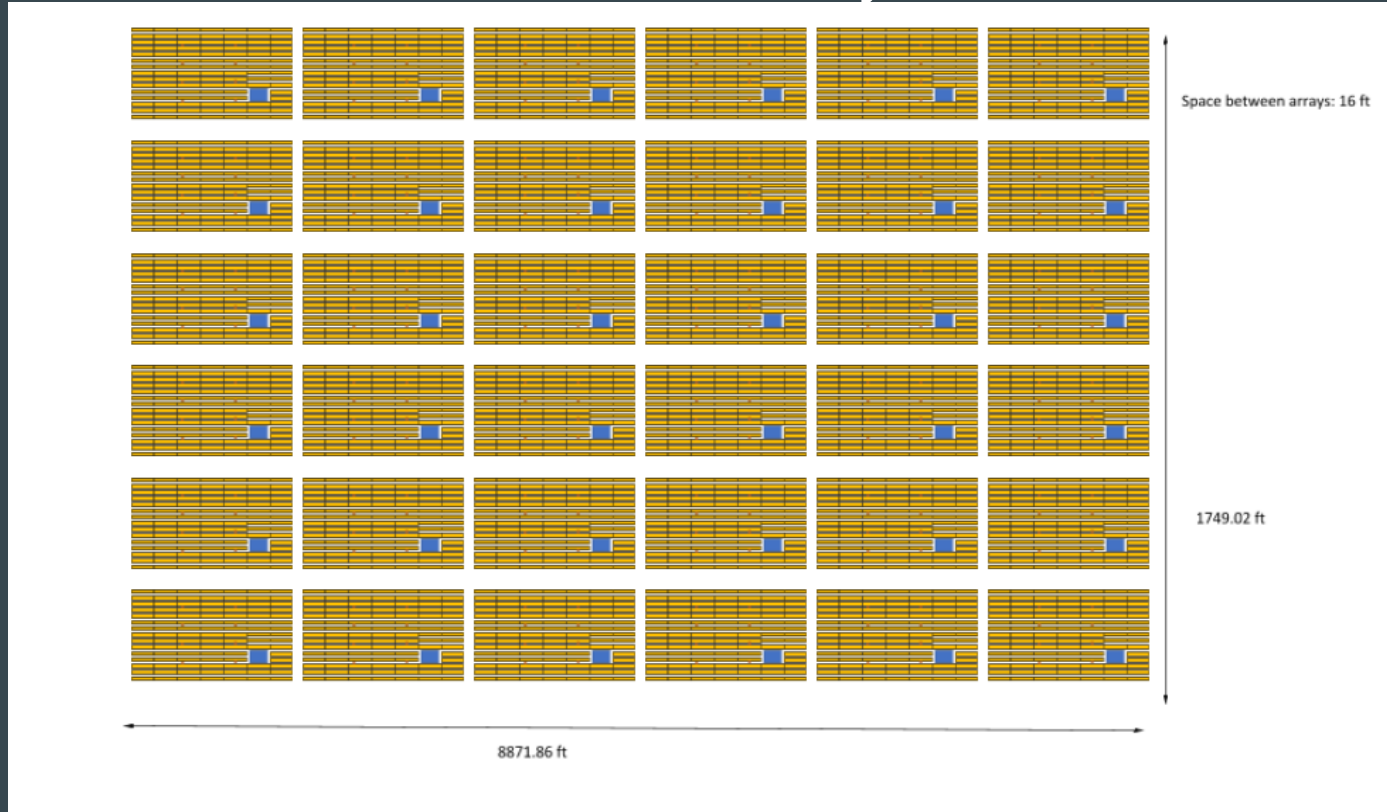


String

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



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





# New Mexico Power Plant Cost

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

# Plains, Yoakum County, Texas

## RESULTS

 Print Results

# 106,840,256 kWh/Year\*

System output may range from 103,090,163 to 109,030,481 kWh per year near this location.  
Click [HERE](#) for more information.

Month	Solar Radiation ( kWh / m <sup>2</sup> / day )	AC Energy ( kWh )	Value ( \$ )
January	5.58	8,251,613	816,910
February	6.24	8,104,409	802,336
March	6.99	9,782,323	968,450
April	7.32	9,734,554	963,721
May	7.25	9,939,141	983,975
June	7.27	9,298,082	920,510
July	7.01	9,243,728	915,129
August	7.02	9,272,075	917,935
September	6.64	8,640,301	855,390
October	6.43	8,920,405	883,120
November	5.78	8,215,649	813,349
December	4.94	7,437,948	736,357

**Annual**                      **6.54**                      **106,840,228**                      **\$ 10,577,182**



# Alpine, Brewster County, Texas

## RESULTS

 Print Results

# 105,872,800 kWh/Year\*

System output may range from 101,373,206 to 108,297,287 kWh per year near this location.  
Click [HERE](#) for more information.

Month	Solar Radiation ( kWh / m <sup>2</sup> / day )	AC Energy ( kWh )	Value ( \$ )
January	5.73	8,454,200	928,271
February	6.50	8,442,383	926,974
March	7.22	9,989,839	1,096,884
April	7.41	9,795,694	1,075,567
May	7.32	9,875,375	1,084,316
June	6.76	8,720,426	957,503
July	6.35	8,643,113	949,014
August	6.44	8,629,138	947,479
September	6.39	8,250,364	905,890
October	6.41	8,847,852	971,494
November	5.76	8,017,566	880,329
December	5.58	8,206,834	901,110
<b>Annual</b>	<b>6.49</b>	<b>105,872,784</b>	<b>\$ 11,624,831</b>



# Texas Location and Justification

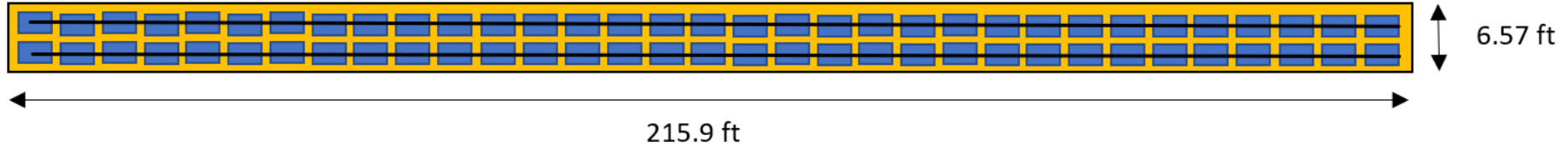
Alpine - Pros	Alpine - Cons
<ul style="list-style-type: none"><li>• Brewster county has loads of solar installations (32 in area)</li><li>• Good distance away from settlement area</li></ul>	<ul style="list-style-type: none"><li>• Lower solar radiation (diff of 0.14)</li><li>• Possibility of land shortage in expansion was ever considered</li></ul>

Plains - Pros	Plains - Cons
<ul style="list-style-type: none"><li>• More land for cheaper price (385 acres of flat land selling at \$231,000., 145 extra acres)</li><li>• No possibility of land shortage if expansion of plant and substation was considered</li><li>• Less hurricanes and storms</li><li>• Higher solar radiation</li></ul>	<ul style="list-style-type: none"><li>• No other installations of solar in area</li><li>• Close to a settlement area</li><li>• Possibility of land waste (assuming max 30 acres for substation)</li><li>• Retail cost of electricity is lower compared to Alpine, difference of \$0.011</li><li>• Higher chance of tornadoes</li></ul>


# Best Choice For Texas - Alpine

CLIMATE	Alpine, Texas	United States
<a href="#">Rainfall (in.)</a>	17.2	39.2
<a href="#">Snowfall (in.)</a>	1.3	25.8
<a href="#">Precipitation Days</a>	35.5	102.0
<a href="#">Sunny Days</a>	247	205
<a href="#">Avg. July High</a>	88.5	86.1
<a href="#">Avg. Jan. Low</a>	30.3	22.6
<a href="#">Comfort Index (higher=better)</a>	66	54
<a href="#">UV Index</a>	6.5	4.3
<a href="#">Elevation ft.</a>	4514	1443

# Texas: Single Rack Layout (2x33 Panels, 2 Strings)



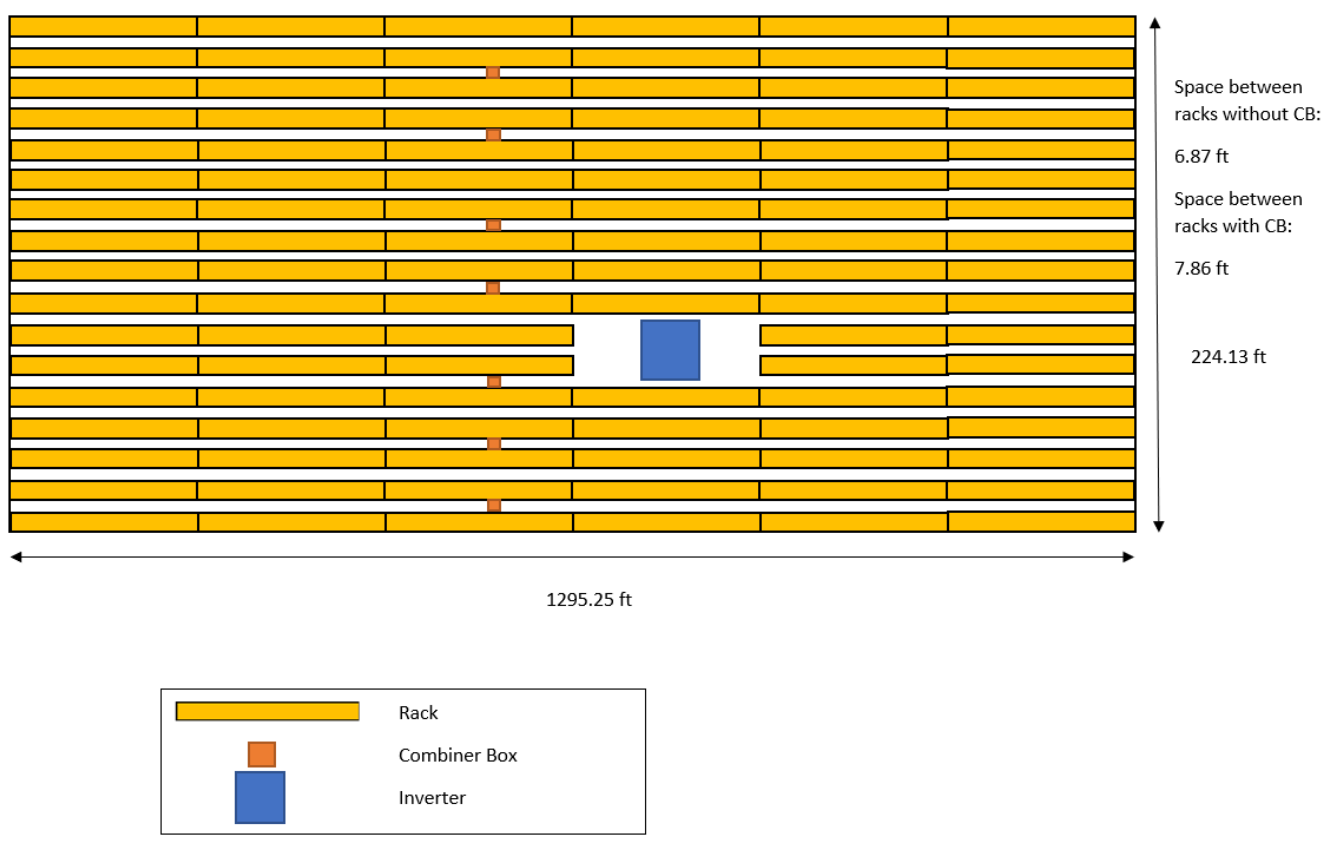
Legend (not to scale)

 Solar panels

 Rack

 String

# Texas: Single Array Layout (17x6 - 2 Racks, 7 CB, 1 Inverter)



# Texas: Solar Power Plant Layout (36 Arrays, 36





# Texas Solar Power Plant Cost

<b>Solar Plant Cost</b>				
Panels	237600	48.4704	million \$	
CBs	252	0.32270112	million \$	
Inverters	36	15.556275	million \$	
Land	256.8052046	0.147	million \$	280 acres
	<b>Total Cost</b>	64.49637612	million \$	

# Final Choice

- Based on the following factors:
  - Solar radiation
  - Total cost of project + land cost
  - Sunny days in a year
  - Distance to human settlement
  - Space for expansion
  
- Final choice: Estancia New Mexico

# Combiner Box: Eaton CCB\_36 DS vs Ingecon StringBox

- Has the larger max current (433 A) compared to Ingecon StringBox (360 A)
- Can handle more strings
- We would need less CBs
- Surge protection: Used to limit voltage in the event of electrical surge, lightning strike, etc

## Solar Combiner CCB 1500V Technical Information

Standard Design:		Tech Spec					Mech Spec**				
CCB Series	Description	Voltage	Max Ambient	Max Fuse Size	Max Current for Greatest Number of Strings	Max PV Module Short Circuit Current	Input Conductors (Cu Only)		Output Conductors (Cu/Al)		NEMA Rating
		(VDC)	(°C)	(A)	(A)	(A)	Wire Gauge	Torque (in-lbs)	Wire Gauge	Torque (in-lbs)	Type
CCB_06	6 String Combiner Box (02-06 Strings)	600/1000/1500	50	15	72	9.6	#14 - #8	25	250 MCM or 350 MCM	325	4X/4/3R
CCB_12	12 String Combiner Box (07-12 Strings)	600/1000/1500	50	15	144	9.6	#14 - #8	25	250 MCM or 350 MCM	325	4X/4/3R
CCB_18	18 String Combiner Box (13-18 Strings)	600/1000/1500	50	15	216	9.6	#14 - #8	25	350 MCM	325	4X/4/3R
CCB_24	24 String Combiner Box (19-24 Strings)	600/1000/1500	50	15	288	9.6	#14 - #8	25	500 MCM	375	4X/4/3R
CCB_36	36 String Combiner Box (25-36 Strings)	600/1000/1500	50	15	433	9.6	#14 - #8	25	500 MCM	375	4X/4/3R
CCB_06 DS	6 String Combiner Box w/ Integral Disconnect Switch (02-06 Strings)	600/1000/1500	50	15	72	9.6	#14 - #8	25	250 MCM or 350 MCM	325	4X/4/3R
CCB_12 DS	12 String Combiner Box w/ Integral Disconnect Switch (07-12 Strings)	600/1000/1500	50	15	144	9.6	#14 - #8	25	250 MCM or 350 MCM	325	4X/4/3R
CCB_18 DS	18 String Combiner Box w/ Integral Disconnect Switch (13-18 Strings)	600/1000/1500	50	15	216	9.6	#14 - #8	25	350 MCM	325	4X/4/3R
CCB_24 DS	24 String Combiner Box w/ Integral Disconnect Switch (19-24 Strings)	600/1000/1500	50	15	288	9.6	#14 - #8	25	500 MCM	375	4X/4/3R
CCB_36 DS	36 String Combiner Box w/ Integral Disconnect Switch (25-36 Strings)	600/1000/1500	50	15	433	9.6	#14 - #8	25	500 MCM	375	4X/4/3R



# Questions That We Have

- What is the price of inverter?
- Will we design the rack system or buy it?
- What is the ground coverage ratio?
- Will you choose high solar radiation land but expensive or good solar radiation land but cheaper?