

34.5/115 kV Solar Power Plant & Substation Senior Design Project

Senior Design Team 18 - May 2024

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BLACK & VEATCH



Agenda

- Safety Moment
- New Equip
- Price Discussion
- Location Discussion
- New Solar Array



Safety Moment - Importance of Regular Breaks

- Both Mental and Physical Benefits
- Breaks help boost overall productivity
 - Pushing through work can lower performance
- Prevents decision fatigue and reduces possible errors
- Neglecting breaks can lead to burnout
- Study on Duration of Breaks
 - Shorter more frequent breaks in the morning
 - Longer breaks in afternoon and evening

ARE YOU TAKING ENOUGH BREAKS DURING THE WORK DAY?

WHAT CAN HAPPEN WHEN YOU DON'T TAKE BREAKS	WHAT HAPPENS WHEN YOU DO TAKE BREAKS
<input checked="" type="checkbox"/> CHRONIC PAIN	<input checked="" type="checkbox"/> IMPROVE YOUR PRODUCTIVITY
<input checked="" type="checkbox"/> CARDIOVASCULAR DISEASE	<input checked="" type="checkbox"/> LOWERS STRESS LEVELS
<input checked="" type="checkbox"/> HIGHER STRESS LEVELS	<input checked="" type="checkbox"/> INCREASES CONCENTRATION
<input checked="" type="checkbox"/> PROBLEMS WITH CREATIVITY	<input checked="" type="checkbox"/> REDUCES ANXIETY
<input checked="" type="checkbox"/> AT RISK FOR BURNOUT	<input checked="" type="checkbox"/> IMPROVES MEMORY
<input checked="" type="checkbox"/> MORE ERRORS IN WORK	<input checked="" type="checkbox"/> INCREASE ENERGY LEVELS

[Image Link](#)

@smartbreak



What we worked on

Found a new combiner box

Found a new PV cell

Found a new inverter

Ask about junction box

Location



Updated Equipment Links

PV Cell

<https://a1solarstore.com/q-cells-480w-solar-panel-156-cells-q.peak-duo-xl-g10.d-bfg.html>

Combiner Box

<https://voltaconsolar.com/protection-monitoring/pv-combiner-boxes/zbeny-afci-combiner-box-bhsz-16-1-1500v.html>

Inverter assuming no cost

https://www.fimer.com/sites/default/files/PVS980-MWS_megawatt_station_flyer_3AXD5000042986_RevC_EN_lowres.pdf



Solar Field/Farm Cost

Solar Cells

- \$360/cell
 - 53.39 V
 - 35mm
 - 480W
- # cells/array
 - # cells/string
 - 1 string - 1 rack

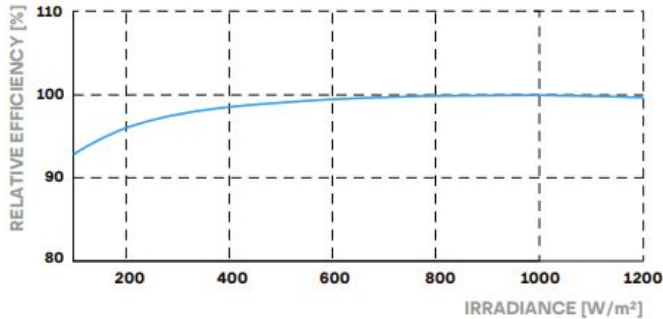
Combiner Boxes

- \$1,560/box
 - 30A/string
 - 350A OUTPUT
 - 1500 VDC
- # boxes/array
 - 16 Inputs
 - 1 Output

Skids

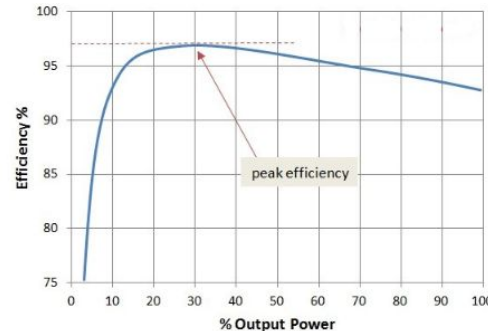
- \$690,000/skid
 - \$0.15/watt conversion
 - specs
- total # skids
 - specs

Performance at Low Irradiance



PV Cell Irradiance

Inverter Efficiency



Inverter Efficiency

[SKID - PG 4](#)

[SKID](#)

[Solar Cells](#)

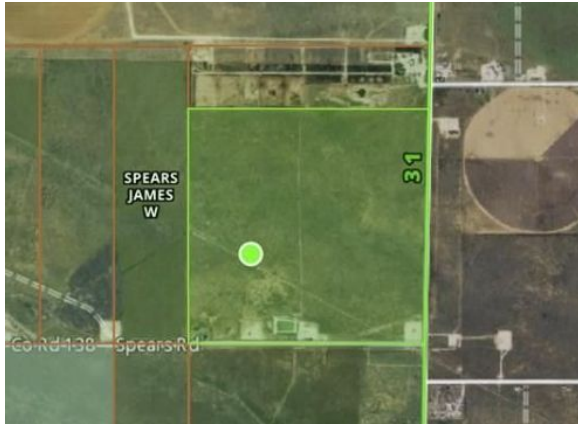
[Combiner Boxes](#)



Solar Field/Farm Cost

Land

- 406 Acres
- \$609,000
- Undeveloped
- On a road



Cables

- #10 AWG for Solar cells to combiner boxes
 - \$0.39/ft up to 1,000'
- 400 MCM for everywhere else
 - \$7/ft up to 10,000'

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Size (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum*
15	14	12
20	12	10
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0
1200	3/0	250
1600	4/0	350
2000	250	400
2500	350	600
3000	400	600
4000	500	750

Labor

- Design Work
 - 6hrs/person/week
 - 15 weeks
 - \$20–25/hr

[Location Link](#)

[#10 AWG](#)

[400 MCM Wire](#)

[Cable Size Link](#)



Array Tool

Old Design:

- 10 modules per string, 2 strings per rack
- 10 racks per row, 33 rows per array, 2 combiner boxes per 3 rows (401 total)
- 18.2 arrays total with possibly 19 inverter skids

New Design:

- 23 modules per string, 1 string per rack
- 16 racks per row, 30 rows per array, 1 combiner box per row (450 total)
- 15 arrays total with 15 inverter skids



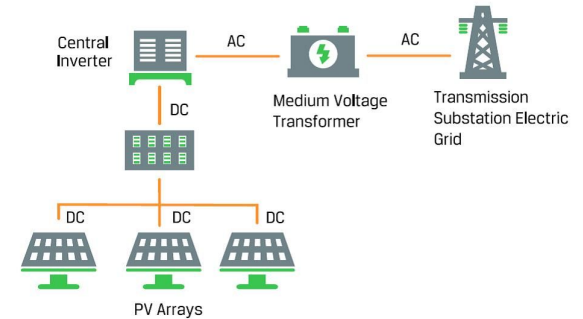
Outputs

Option 1

- DC combiner box to the inverter
- Each AC circuit output connects to a transformer connecting to grid
- Ended with the first option
- String inverters are more common in residential places

[Option 1 link](#)

FIGURE 1: CENTRAL INVERTER ARCHITECTURE



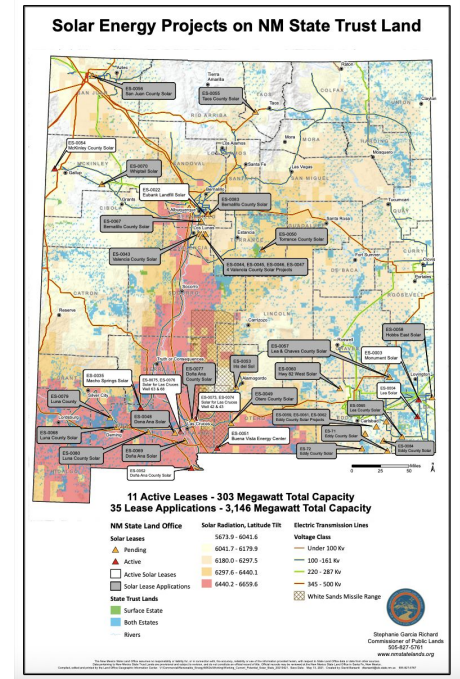
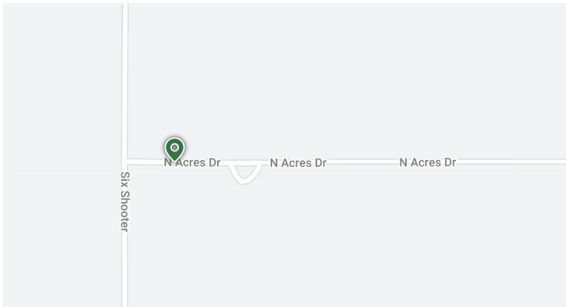
Location - Lovington, NM



406 Acres in Lovington, NM - \$609,000

Acres - Lovington, NM

406 Acres Of Ranch Land On State Line Rd. Easy Access To Plains Hwy. Small Farm House At Sw Corner Of Property. Native Terrain And Mostly Flat. Possibilities Are Great!!



There are numbers of solar energy projects around Lovington, New Mexico, shows that the area/location is a strategic location, whereas the solar radiation, access to water supply, labor and maintenance resources, and grid connection are reliable.

<https://www.landandfarm.com/property/acres-lovington-nm-14522503/>



Why the location is strategic for Solar farm project?

1. Solar irradiation

- Solar radiation/latitude tilt = 6041.7 - 6179.9

Realistic average daily solar insolation by month (kWh/m ² /day)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2.835	3.592	4.645	5.587	5.932	6.321	5.954	5.503	4.460	3.792	2.885	2.410

Source: <https://www.fabhabs.com/solar-insolation-calculator>

2. Land size

- 406 acres size
- Estimated use of land = 250 acres
- Margin for future expansion

3. Land availability and ownership

Real estate property- Robinson & Associates Real Estate : <https://www.landandfarm.com/property/acreage-lovington-nm-14522503/>

- \$609,000 or \$ 4582

4. Infrastructure (Soil/Land Preparation)

- Undeveloped ranch land provides a relatively blank canvas for the construction of a solar power plant. There may be minimal need for land clearing or demolition, reducing project costs and timelines.
- The site's native terrain can be suitable for solar panel installation, and the region's relatively flat topography may require less grading and earthwork

5. Accessibility (Water, Labor or Maintenance)

- Near the main road, access to labor and maintenance

6. Proximity to Grid and Demand



Solar Site Preparation

1. Solar Power Purchase Agreement (PPA)
 - Solar PPAs are an agreement where development aspects such as environmental permitting and solar installation are facilitated by a developer on a customer's land.

<https://www.transect.com/resources/commercial-solar-financing>

2. Site preparation

<https://go.yakaccess.com/complete-guide-to-site-preparation-for-solar-energy-projects#:~:text=Installation%20of%20ground%2Dmounted%20solar.safely%20and%20efficiently%20install%20panels.>



Feedback and Updates

- Array Layout in Excel - Liam
- Transition into ACAD - Eduardo
- Title Blocks - Baylor & Eli
- Understand ETAP&ACAD - ALL
- Try to start on voltage drops - Bell/Chicheng/Eli
- File control - Bell/Chicheng
- Send over
 - IP and other agreements
 - Costs
 - MMs

