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115/34.5kV Solar Plant & Substation Senior Design Project

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| Senior Design Team 41

| 10/03/2024

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AGENDA

- Safety Moment
- New Technology
- Update on Software
- Solar Farm and Substation Location
- Selection of PV Module, Combiner Box, and Inverter
- Cost Estimation
- Model using Array Parameter Tool

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SAFETY MOMENT

Personal Protective Equipment for Solar Workers:

The use of personal protective equipment (PPE) is vital for safeguarding workers during solar installations. Key PPE items for solar workers typically include:

- Hard hats.
- Protective gloves.
- Steel-toed, rubber-soled footwear.
- Safety glasses or goggles.
- High-visibility vests
- Fall protection harnesses

Providing workers with the right PPE is essential for maintaining a safe and secure job site, reducing the risk of injury.

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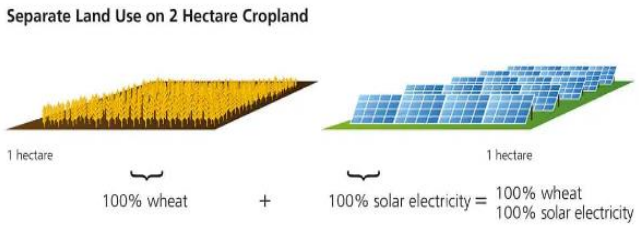
NEW TECHNOLOGY

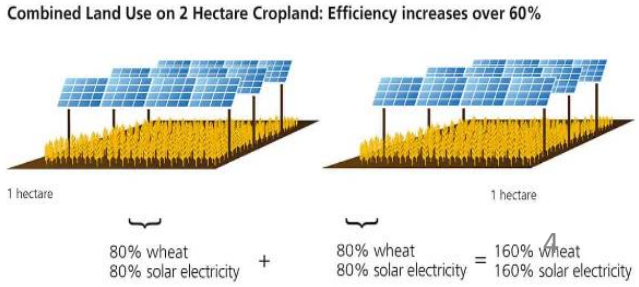
Agrivoltaics:

Agrivoltaics is an innovative approach to solar energy production that combines agricultural activities with photovoltaic (PV) power generation on the same land. This system allows for both food production and energy generation simultaneously, optimizing land use and offering several potential benefits.



Advantages of Agrivoltaics :

- Better Crop Growth
- Crop and Animal Rotation
- Energy and Water Benefits



https://earth.org/agrivoltaics/

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Software

AutoCAD

- Contacting the ETG to get access

Bluebeam

- Access to download from Iowa State

ETAP

- Access from Senior Design Lab Computers

Microsoft Access

Online Training available:

LinkedIn Learning

Microsoft Support

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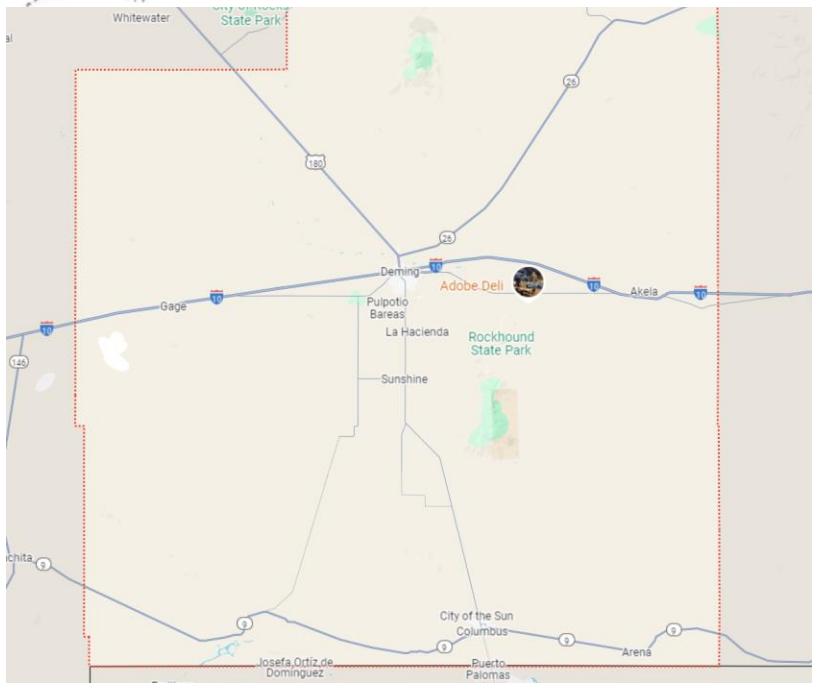
LOCATION



115/34.5kV Solar Plant & Substation

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Why Luna County?

We chose Luna County based on:

- Solar radiation.
- Land size and price.
- Sunny days per year.
- Elevation.
- State financial incentives ranking.
- Total cost of solar power plant.
- Extra land for substation and expansion.
- More cost-effective than the rest of the Nation.
- Distance to the nearest city/town.
- Proximity to transmission lines.
- Environmental and Regulatory Approvals.
- Availability of Workload.
- Logistics and infrastructure.
- Community support and social acceptance.
- Weather resilience.

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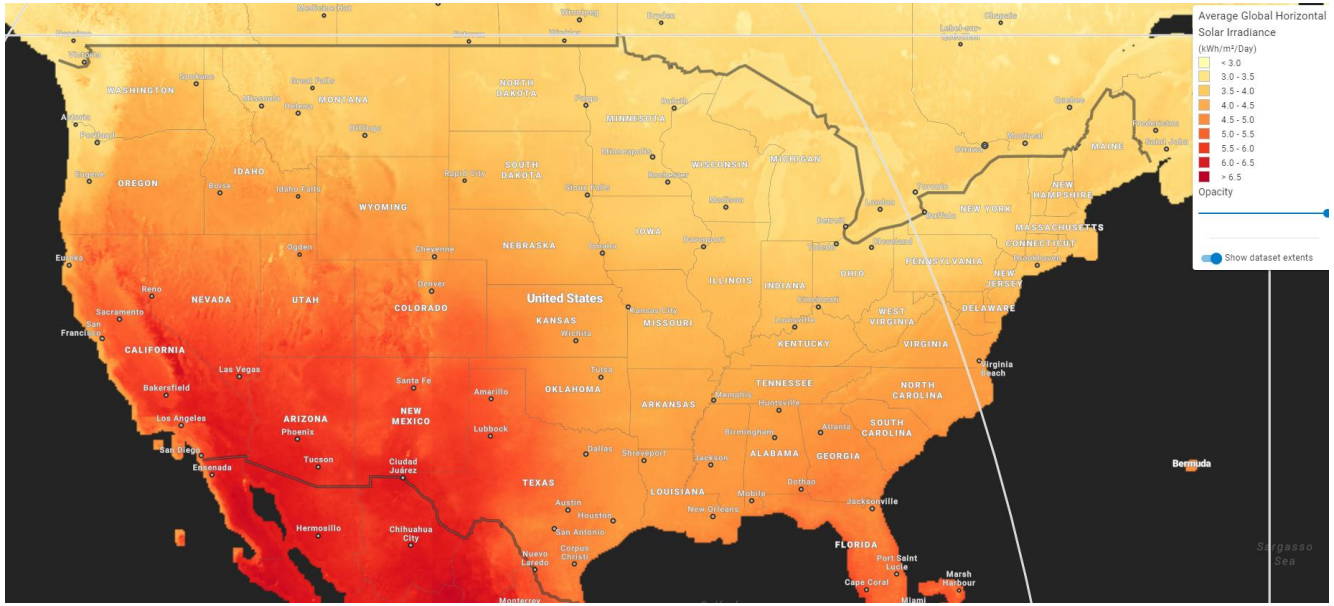
Solar Irradiation



- New Mexico: 5.50 to 6.50 kWh/m² per day
- Luna County: Southwest part of the state, 5.75 to 6.50 kWh/m² per day

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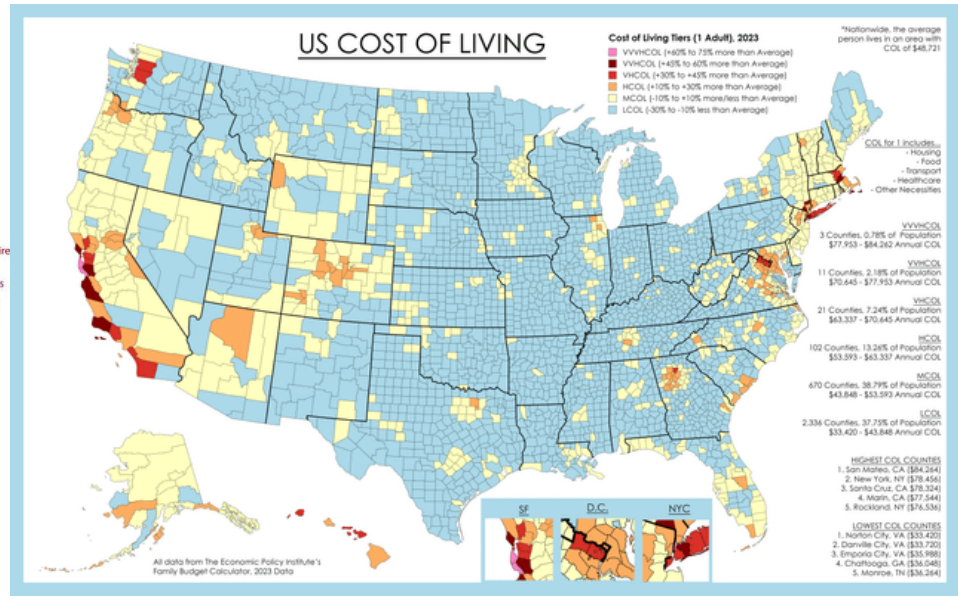
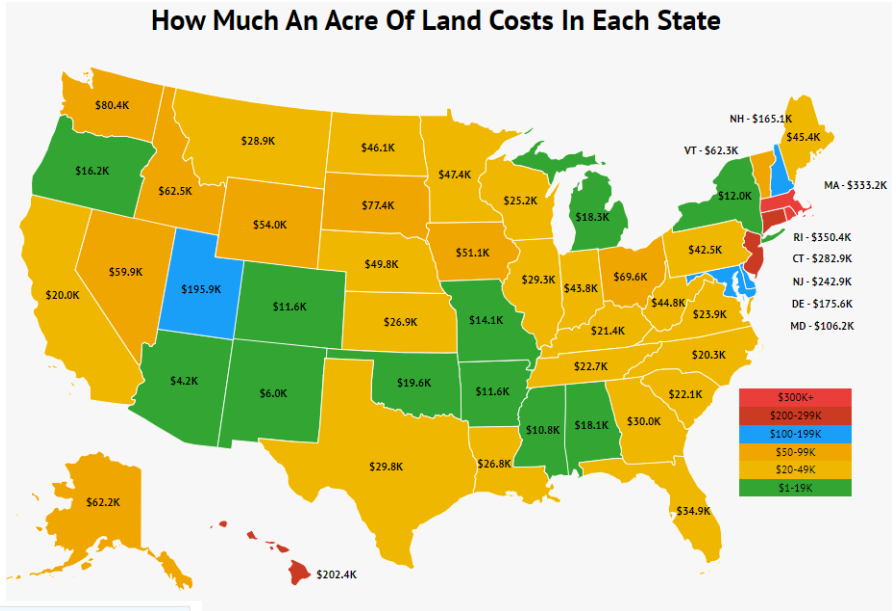
Land size and price





Second cheapest in the US: $6000 per acre (2023).
https://www.zippia.com/advice/acre-land-costs-each-state/

State	Overall Price per Acre 2024 (USD)		Farmland Price per Acre 2024 (USD)		Overall PPA ($) 2019		Farmland PPA ($) 2019	
New Mexico	Min	Max	Min	Max	Min	Max	Min	Max
New Mexico	$6,000		$671		$1,931		$610	

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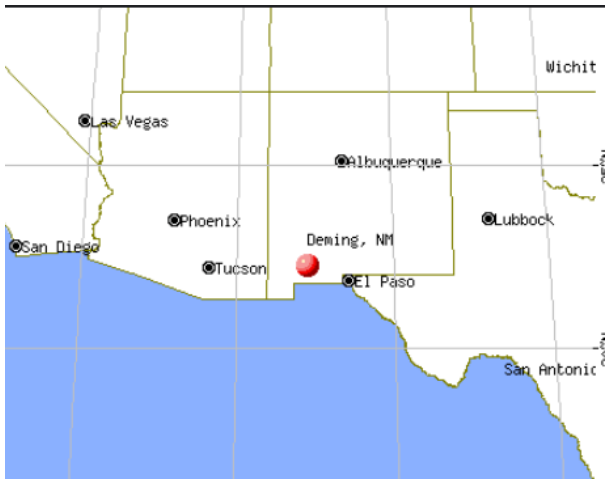
Land in New Mexico

Good location and size for solar farm + substation
5 acres/MW

https://www.zillow.com/homedetails/0-Hermanas-Grade-Rd-SW-Deming-NM-88030/346215623_zpid/



Luna County, NM

115/34.5kV Solar Plant & Substation

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Elevation

- Elevation => Solar energy production
- Less atmosphere to absorb ultraviolet (UV) radiation.
- Efficiency of the solar panels.

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New Mexico Tax Credits and Incentives

Federal Investment Tax Credit (ITC):

- Can reduce the cost of your solar panel system by 30%.
- This credit applies to the total system cost, including equipment, labor, and other associated costs (EnergySage).

New Mexico Solar Market Development Tax Credit (SMDTC):

- State-level tax credit offers up to 10% of the cost of installing solar energy systems, with a cap of $6,000.
- This incentive is applicable to residential, commercial, industrial, and agricultural installations. You need to ensure that the systems are certified by the New Mexico Energy, Minerals and Natural Resources Department (EMNRD) (Solar Place) (Comparing Solar Companies).

Property Tax Exemption for Residential Solar Systems: If your project increases the property value, the additional value due to the solar installation will not be taxed, which can lead to significant savings depending on the local property tax rates (Solar Place).

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State financial incentives ranking

https://www.tax.newmexico.gov/wp-content/uploads/2024/01/ITEP-rankings-release.pdf
https://www.abq.org/incentives/
https://www.emnrd.nm.gov/ecmd/tax-incentives/
https://www.emnrd.nm.gov/ecmd/tax-incentives/solar-market-development-tax-credit-smdtc/

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Environmental and regulatory approvals

- Luna County has vast expanses of desert and scrubland
- Fewer environmental obstacles.

https://programs.dsireusa.org/system/program/detail/3841/el-paso-electric-company-commercial-efficiency-program

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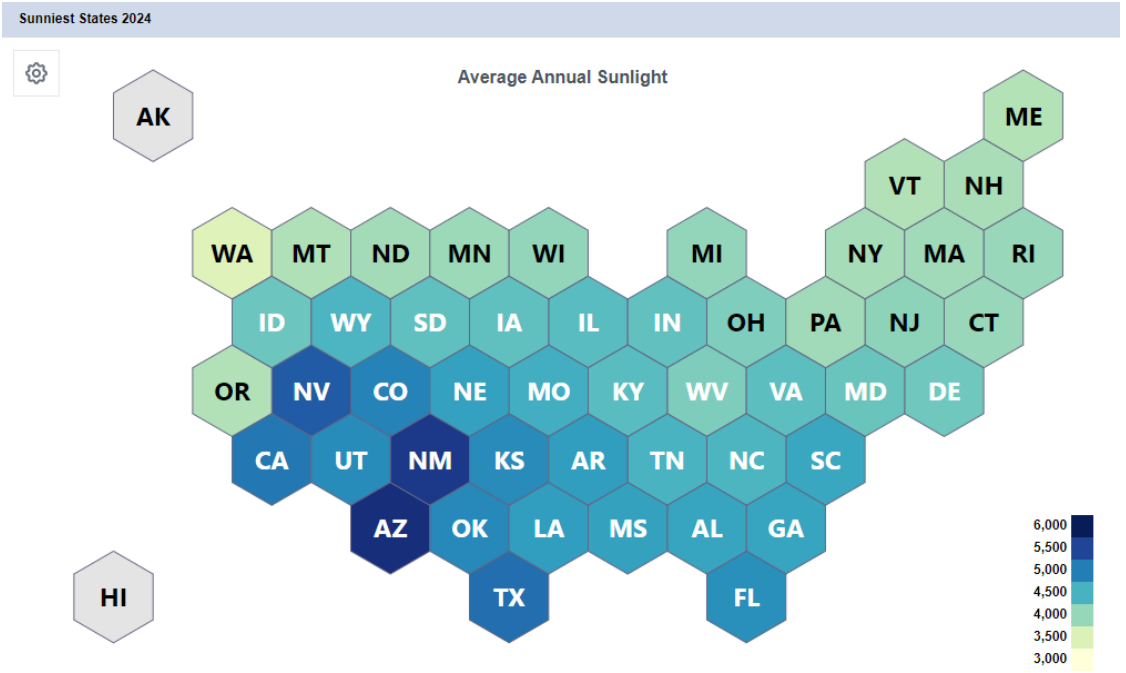
Sunny days per year

- **Iowa – New Mexico**

State	Average Annual Sunlight (kJ/m²)
Arizona	5,755
New Mexico	5,642
Nevada	5,296
Texas	5,137
California	5,050
Colorado	4,960
Oklahoma	4,912
Iowa	4,331



- **Cities in New Mexico**

Annual days of sunshine			
City	Sunny	Partly Sunny	Total Days with Sun
Alburquerque	167	111	278
Clayton	162	99	261
Rio Rancho	163	110	273
Roswell	168	113	281
Luna County	170	112	282

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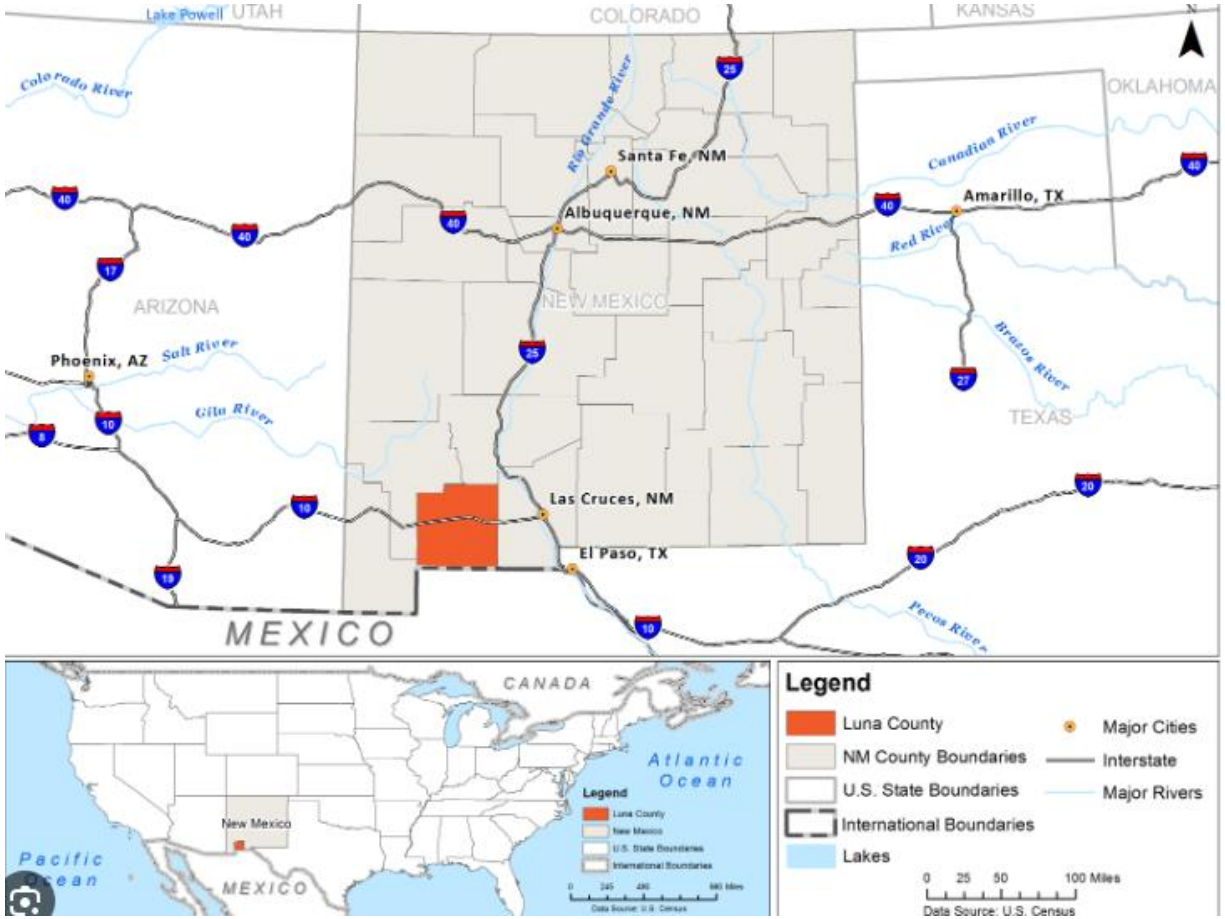
Distance to the nearest city/town

- Luna County is reasonably accessible to Santa Fe and Albuquerque, which are key economic and administrative centers in New Mexico.
- Infrastructure support.
- Lower transmission costs
- Access for logistics and workforce deployment.



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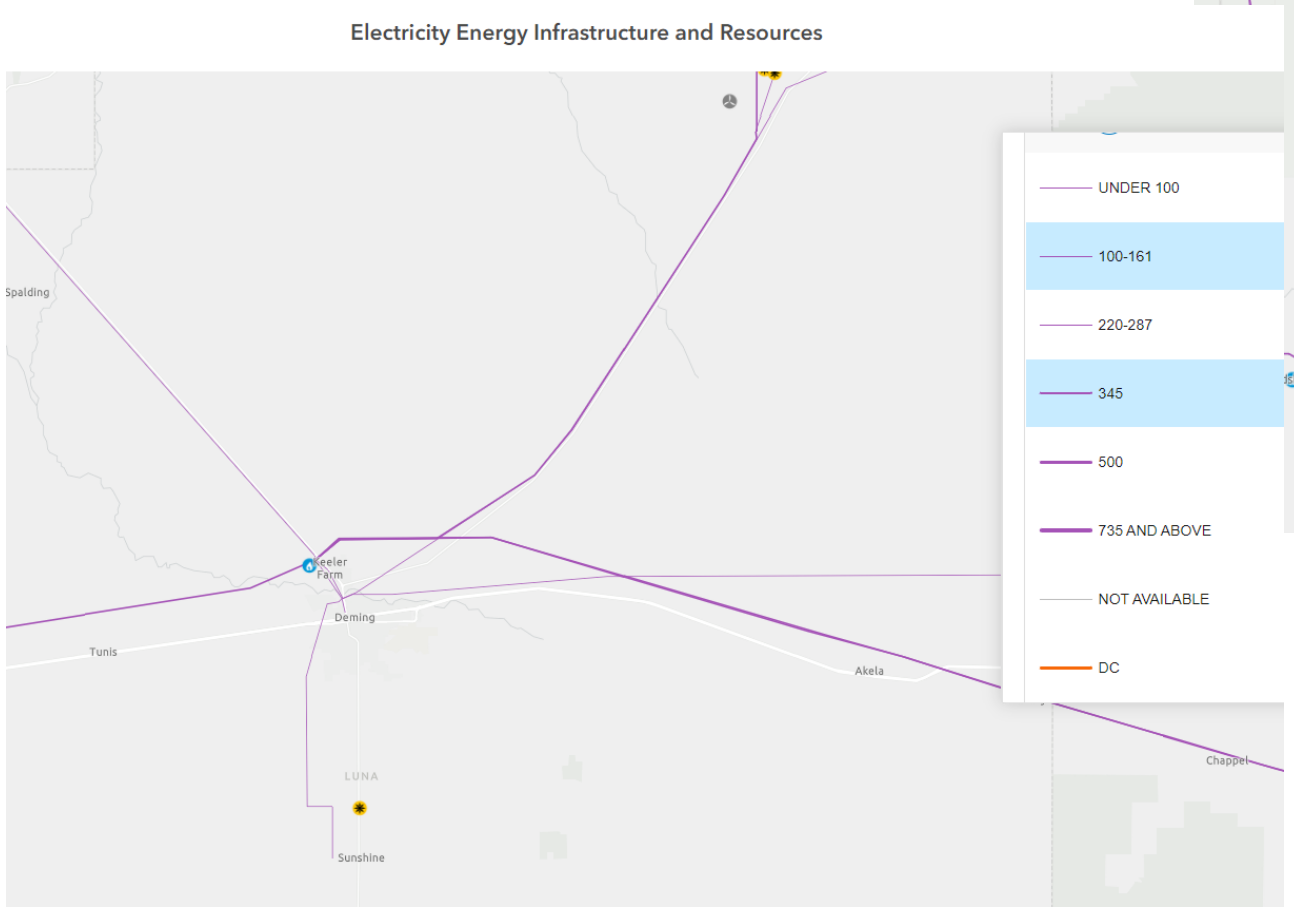
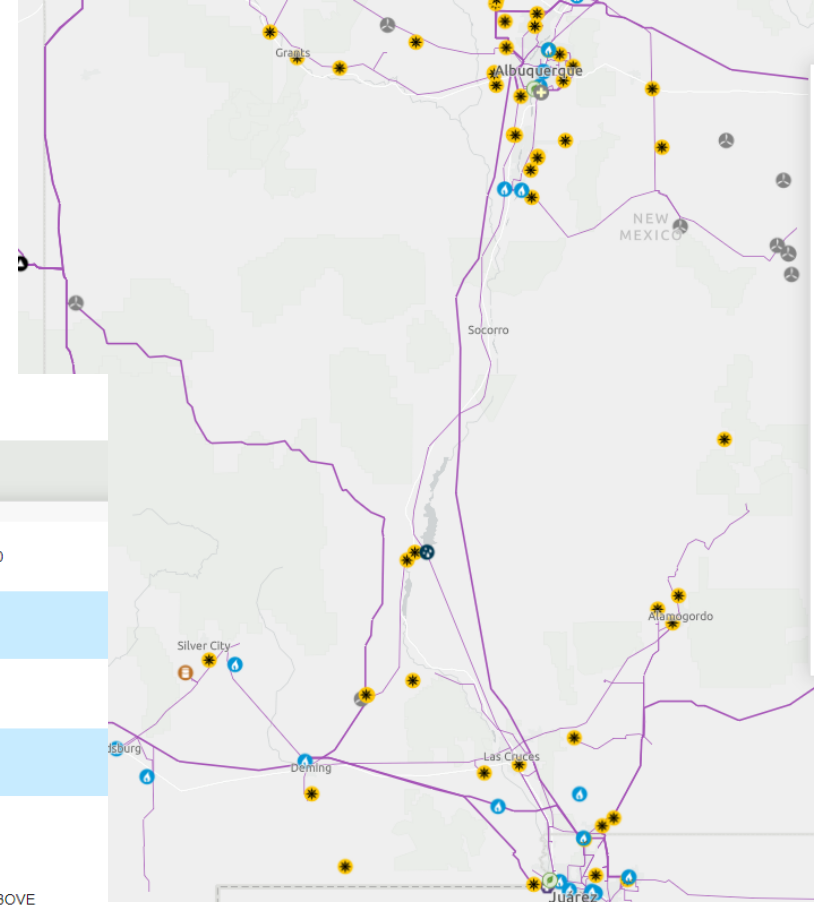
Proximity to transmission lines





The location is close to existing high-voltage transmission lines (115 kV or higher).

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Logistics and infrastructure

- Key routes include Interstate 10 (I-10) and U.S. Route 180.
- Close to Deming, and not very far from Alburquerque and Santa Fe.
- Luna County benefits from relatively easy access to high-voltage transmission lines. Public Service Company of New Mexico (PNM).
- Union Pacific Railroad.

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Community support and social acceptance

- Local community is highly supportive of renewable energy initiatives
- Community Solar Act

https://www.aes.com/community-solar-new-mexico

- No significant local objections or legal hurdles that could delay the project

https://energycentral.com/news/nm-supreme-court-denies-pause-community-solar-rules

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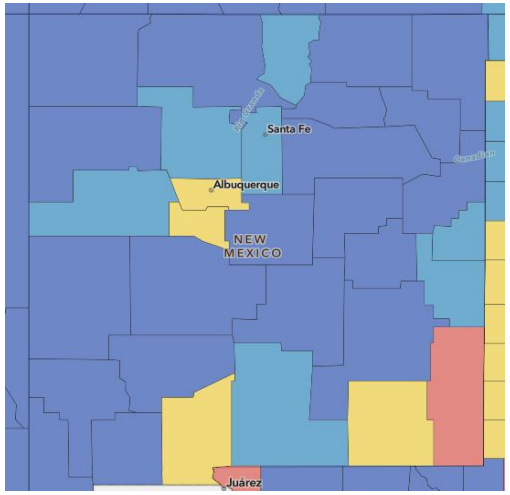
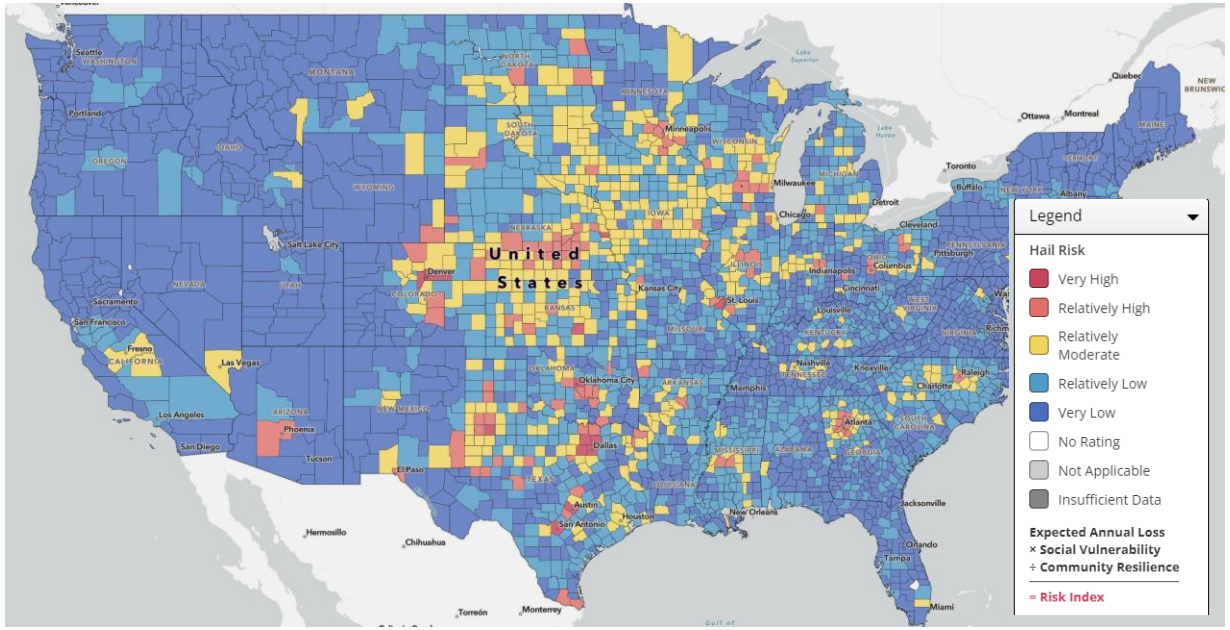
Weather resilience





- Relative Low Hail risk.
- Long-term safety and reliability of the solar plant.

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Availability of Workload

- Skilled workforce.
- Contractor and Supplier Network.
- Local Government Support.

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Array Parameter Tool

		String Size				Electrical Rack Size				CB capacity				Array Design				Array Size		
					Designer Choice		portrait or Landscape													
	Location Dependent	Min Temp	4.44	C	Datasheet	Module width	3.98	ft	Datasheet (STC)	mod/string Isc	3.04	A	Designer Choice	Racks per row	85	Designer Choice	tilt	0	
					Datasheet	module height	7.54	ft	NEC sectic	multiplier	1.25								
	Datasheet (STC)	Voc	226.1	V						nom Isc	3.8		Designer Choice	rows per Array	10		table height proj	45.24	ft
	Datasheet (STC)	Ref temp	25	C	Designer Choice	Rack width	2	modules	Irr.	multiplier	1.25								
					Designer Choice	Rack height	6	modules		max Isc	4.75	A	Designer Choice	Racks removed	2	Designer Choice	row space	45	ft
	Datasheet	Temp Coeff of Voc	-0.0028	/C		Modules per rack													
		Temp delta	-20.56			Rack width	7.96	ft	Designer	allowed current	200	A		Total Racks/Array	848		pitch	90.24	ft
		temp correction	1.06			Rack height	45.24	ft	Choice:	is this disconnect A?							Space for Inverter Maintenance		ft
		V0c corrected	239.1161						200,	strings per CB	42.10526			Total modules	10176		Array height	902.4	ft
									400A etc.	Round down:	42								
Confirm possible with Panel type chosen		string voltage	1500	V						racks per CB	21		Datasheet (STC)	module capacity	525	W	Array width	676.6	ft
	Designer Choice: 600, 1000, 1500, 2000V	String size	6.273103							**CB can only have 20 inputs							Ground Coverage Ratio	0.50133	
		string size	6											dc capacity	5342.4	kW			
		Actual String Voltage	1434.7																
													Designer Choice	inverter capacity	4095	kW			
																MVA			
													Provided: Industry standard 1.3	ILR	1.304615				
		Input Information =																	

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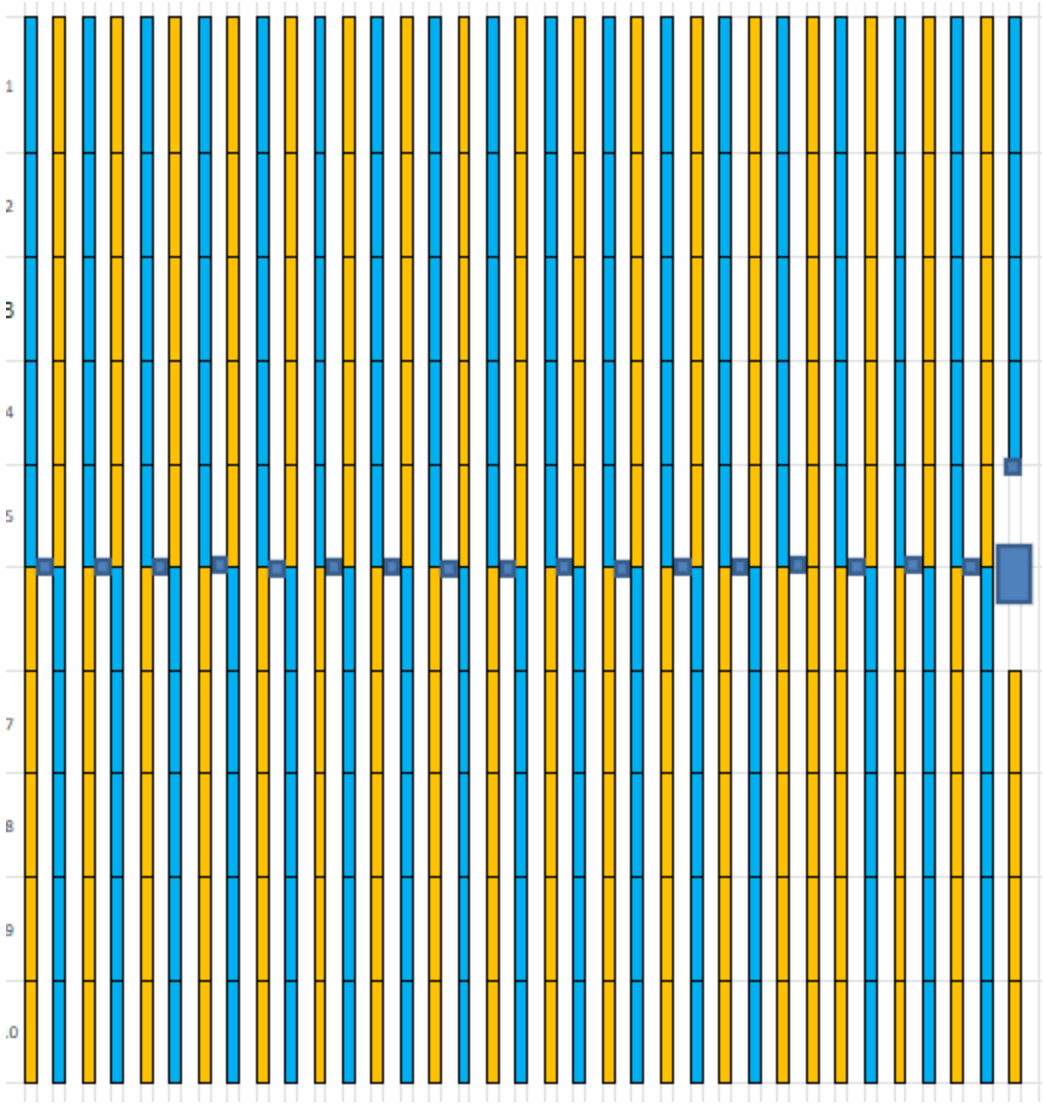
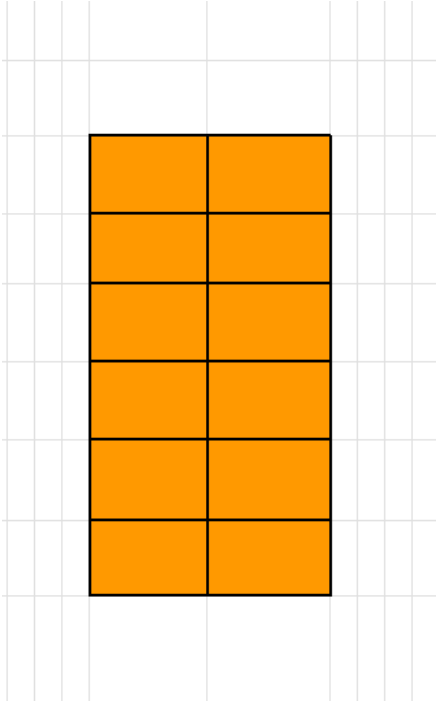
Array Model





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Array Model

- 1 array takes up around 14 acres of land
- Need 14.65 arrays in order to reach 60 MW of production
- Need around 205 acres in total for the solar field

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Selection of PV Module, Combiner Box, and Inverter

1. PV Module

COMPONENT SELECTION ANALYSIS FOR 115/34.5 kV SOLAR PLANT & SUBSTATION

PV MODULE

1 **FIRST SOLAR**

Thin-film technology for high-temp environment

Series 7 TR1.

Electrical Specifications

TEMPERATURE CHARACTERISTICS		
Module Operating Temperature Range	(°C)	-40 to +85
Temperature Coefficient of P_{MAX}	$T_K(P_{MAX})$	-0.32%/°C (Temperature Range: 25°C to 70°C)
Temperature Coefficient of V_{OC}	$T_K(V_{OC})$	-0.28%/°C
Temperature Coefficient of I_{SC}	$T_K(I_{SC})$	+0.04%/°C
Nominal Operating Cell Temperature	(°C)	45

MECHANICAL DESCRIPTION	
Length	2300mm
Width	1216mm
Area	2.80m²
Module Weight	38.4[7] / 39.7 kg
Leadwire[8]	2.5mm², 650mm (+) & Bulkhead (-)
Connectors	TE Connectivity PV4-S or alternate
Junction Box	IP68 Rated
Bypass Diode	N/A
Cell Type	Thin film CdTe semiconductor, up to 268 cells
Back Rail Material	Galvanized steel
Front Glass	Heat strengthened
Back Glass	Heat strengthened
Encapsulation	Laminate material with edge seal
Frame to Glass Adhesive	Silicone
Load Rating	2400Pa

https://www.firstsolar.com/-/media/First-Solar/Technical-Documents/Series-7/Series-7-TR1-High-Bin-Datasheet.ashx?la=en

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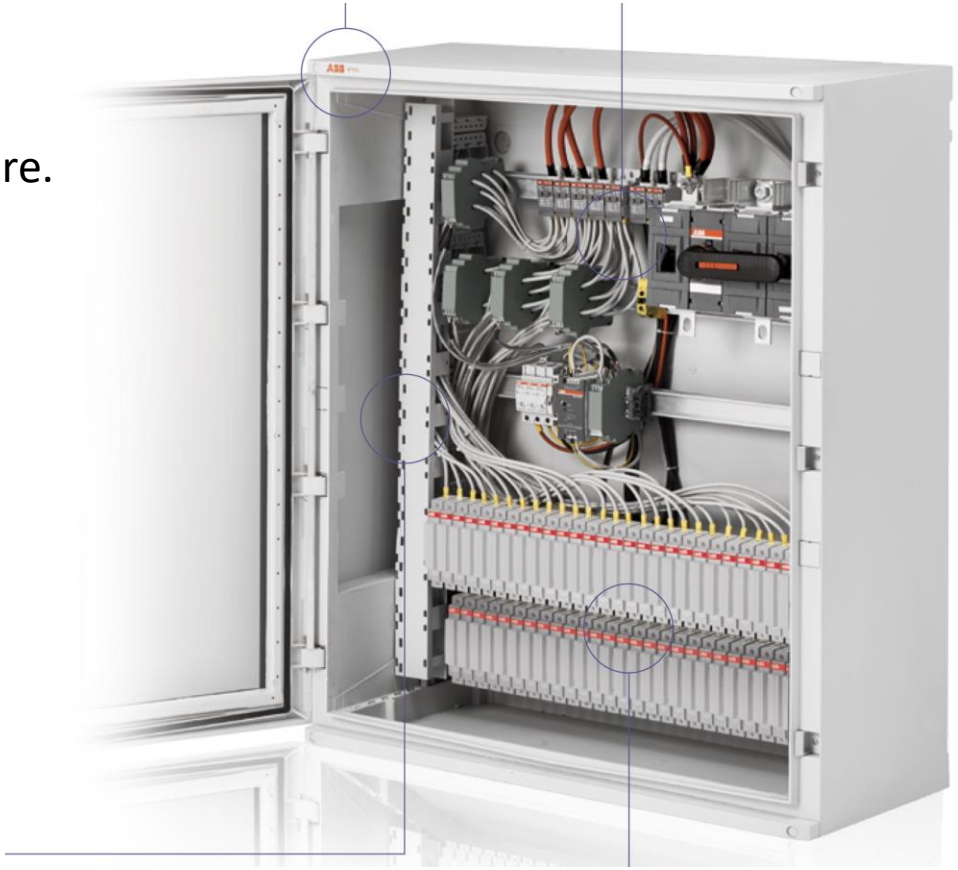
Selection of PV Module, Combiner Box, and Inverter

2. Combiner Box

- NEMA 4 outdoor-rated enclosure.
- High Current ratings.
- Utility-scale.
- High Protection Standards.



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Selection of PV Module, Combiner Box, and Inverter

3. Inverter

- High Efficiency.
- Large Power Capacity.
- Low total Harmonic Distortion.
- Versatility and Scalability.

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COST ESTIMATION

- Solar cells
- Combiner boxes
- Skids
- Land: 281 Acres, $ 2,000 per acre
- Cables
- Labor

• Average Salary in New Mexico: $ 18-24 per hour per worker
• Workday: 8 hours
• 3-4 months for labor

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THANK YOU

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