

# 115/34.5kV Solar Plant & Substation

<u>Client:</u> Black & Veach: Adam Schroeder, Elymus Schaffer, Utsavee Desai <u>Faculty Advisor:</u> Venkataramana Ajjarapu





Andrew M Chizek, David W Ntako, Ben Palkovic, Mohamed A Sam, Sergio Sanchez Gomez & Dallas R Wittenburg Senior Design Team 41 12/10/2024

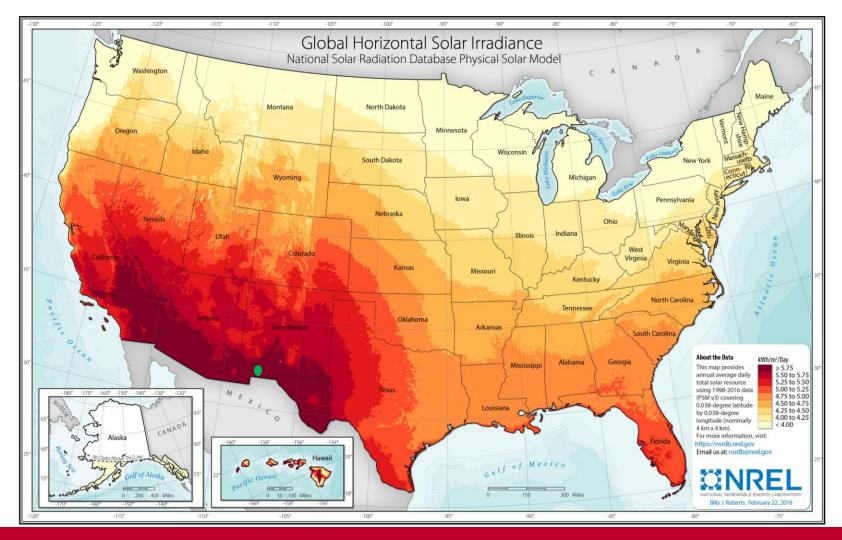


## **PROJECT OVERVIEW**

- Fully design a 60 MW solar plant and its corresponding 115/34.5 kV substation through site and component selection, modeling, and calculations to ensure our design meets all requirements
- Provide reliable, renewable energy transmission and distribution to the users of our plant

- Deming, New Mexico
- Advantages:
- Land pricing
- Solar Irradiance
- Our land plot is located near transmission lines that our substation can connect to

## LOCATION



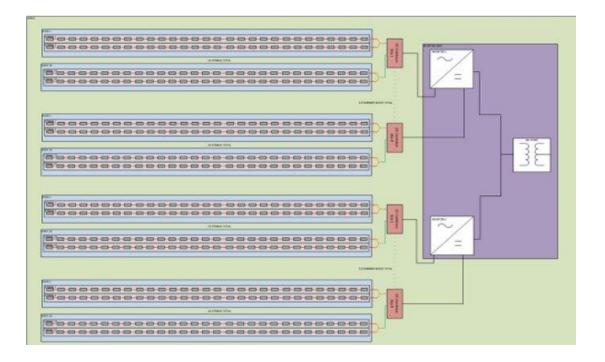
115/34.5kV Solar Plant & Substation

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## **OVERVIEW OF A 60 MW SOLAR PLANT**

- Within a string, solar panels are connected in series to combine their voltages to achieve our desired string voltage.
- Strings are connected in parallel within racks, which are then fed to a combiner box.
- The combiner box combines the strings and directs it to an inverter.
- The inverter converts the electricity from DC to AC and includes skids to step up the voltage to 34.5kV.
- The electricity is transmitted to the feeder and carried to the substation.



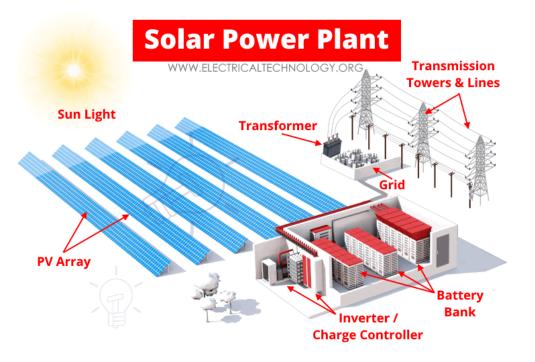
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Andrew



## **OVERVIEW OF SUBSTATION – 115/34.5 kV**

- Step-up transformer increases voltage from 34.5kV to 115kV
- The higher voltage allows integration into the local electrical grid.
- Electricity is distributed to end users, including homes and businesses.



115/34.5kV Solar Plant & Substation

## REQUIREMENTS

### **Functional**

- Solar Farm needs to provide power 24/7 without announced announcements
- Solar Panel needs to work to properly produce clean energy
- Solar Farm needs to be cost effective and help to save money

### □ Aesthetic

• Farm needs to be in calculated rows to maximize the panel efficiency and space. Panel efficiency corresponds to power output.

### □ Safety

- The solar farm construction and operation must adhere to all applicable safety code
- **Environmental** 
  - Solar Panels need to be sustainable and help reduce carbon emissions

### 1. PV Module

#### **ELECTRICAL DATA | NMOT\***

	Nominal	Opt.	Opt. Ope-	Open	Short
	Max.	Operating		Circuit	Circuit
	Power	Voltage	Current	Voltage	Current
	(Pmax)	(Vmp)	(Imp)	(Voc)	(Isc)
CS7N-685TB-AG	518 W	37.2 V	13.91 A	44.8 V	14.79 A
CS7N-690TB-AG	522 W	37.4 V	13.94 A	45.0 V	14.83 A
CS7N-695TB-AG	526 W	37.6 V	13.97 A	45.2 V	14.87 <mark>A</mark>
CS7N-700TB-AG	529 W	37.8 V	14.00 A	45.4 V	14.91 A
CS7N-705TB-AG	533 W	38.0 V	14.03 A	45.5 V	14.95 A
CS7N-710TB-AG	537 W	38.2 V	14.06 A	45.7 V	14.99 A
CS7N-715TB-AG	541 W	38.4 V	14.09 A	45.9 V	15.03 A
* Under Neminal Med	I de Onevetin	Tomore or anti-	(NIMOT) invest	linner of 00	O W/me? an o c

\* Under Nominal Module Operating Temperature (NMOT), irradiance of 800 W/m<sup>2</sup> spectrum AM 1.5, ambient temperature 20°C, wind speed 1 m/s.

## **COMPONENTS**



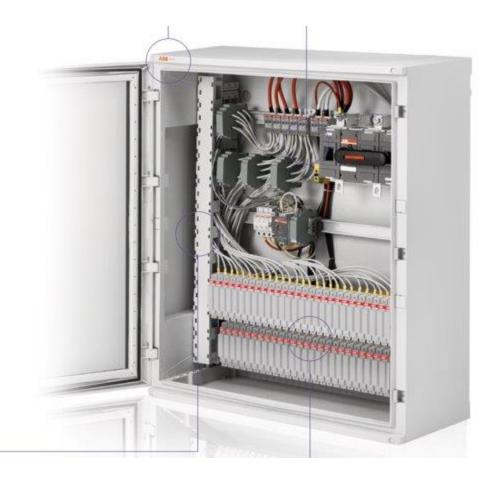
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## **COMPONENTS**

- 2. Combiner Box
- NEMA 4 outdoor-rated enclosure.
- High current ratings.
- Utility-scale.
- High protection standards.





3. Inverter

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- High efficiency.

distortion.

Large power capacity.

Low total harmonic

Versatility and scalability.

## **COMPONENTS**



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## **ARRAY PARAMETER TOOL**

		String Size			Electrical F	lack Size			CB capacity			Array Design			Array Size	
				Desig Choi		Landsc	ape									
	Location Dependent	Min Temp	4,44 C		eet Module w		.82 ft	Datasheet (STC)	mod/string lsc	18.49 A	Designer Choice		5	Designer Choice		30
				Datash	eet module he	ight 4	.27 ft	NEC secti	ic multiplier	1.25				1		
	Datasheet (STC)	Voc	47.9 V			-			nom lsc	23.1125	Designer Choice	rows per Array	26		table height proj	7.39586 ft
	Datasheet (STC)	Ref temp	25 C	Desig Choi	ner ice Rack width	i	29 module	s Irr.	multiplier	1.25						
				Desig	ner			1	max lsc	28.8906 A	Designer Choice	Racks removed	0	Designer Choice	row space	9 ft
	Datasheet	Temp Coeff of Voc	-0.0029 /C	Solar	Plant Size											
		Temp delta	-20.56	Acces	ss Road w/ S	pace for CB	50	ft	allowed current	320 A		Total Racks/Array	130		pitch	16.3959 ft
-		temp correction	1.06						s this disconnec						Space for Inverter Maintenance	ft
		V0c corrected	50.756	Heigh	nt			ft	strings per CB	11.0763		Total modules	7540		Array height	426.292 ft
									Round down:	11	-					
Confirm		string voltage	1500 V	Widt	h			ft	acks per CB	5.5	Datasheet (STC)	module capacity	700	w	Array width	1133.9 ft
possible		String size	29.5532									v - w			Ground Coverage Ratio	0.52086
with		string size	29									dc capacity	5278	kW		
Panel		Actual String Voltage	1471.9	A	of plant	1	483236	ft^2			A		<u> </u>	12		
Solar	Plant						166.35	acres			Designer		4095	Law		
Array	s in Plai	nt		15							Choice	inverter capacity	4095	MVA		
	s in Pla		113	3,100							Provided	ILR	1.28889			
Invert	ers in P	Plant		15							Industry					
CBs in	Plant			390							standard					
DC Pla	ant Out	put	7	77.33	w											
	ant Out			60		1										

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## **VOLTAGE DROP CALCULATIONS:**

#### **Department of Electrical**

DCB	Strings per Rack	IMP for String		String wire size	String Conductor resistance		Voltage Drop of String	IMP for Jumper	Jumper Length	Jumper wire size	Jumper resistance	Jumper resistance	Voltage Drop of Jumper	Voltage Drop of String	Voltage Drop of Jumper
DCB#-##	per rack	Атр	feet	AWG	Ohm/kft	Ohm	Volts	Amp	feet	AWG	Ohm/kft	Ohm	Volts	percent	percent
DCB1-01	2	14	226.87	10	1.2400	0.5448151	7.8769264	28	569	8	0.7640	0.8409313	24.344096	0.525128427	1.622939733
DCB1-02	2	14	226.87	10	1.2400	0.5448151	7.8769264	28	342	8	0.7640	0.5061071	14.632128	0.525128427	0.9754752
DCB1-03	2	14	226.87	10	1.2400	0.5448151	7.8769264	28	115	8	0.7640	0.1703152	4.92016	0.525128427	0.328010667
DCB1-04	2	14	226.87	10	1.2400	0.5448151	7.8769264	28	342	8	0.7640	0.5061071	14.632128	0.525128427	0.9754752
DCB1-05	2	14	226.87	10	1.2400	0.5448151	7.8769264	28	569	8	0.7640	0.8409313	24.344096	0.525128427	1.622939733
Combiner Name		from Array Parameter	panels in string * panel width	IMP x 1.25 AWG size above that	Table 8 NEC						Table 8 NEC				

$$V_d = \frac{I \times 2 \times d}{1000 \, ft \, / \, kft} \times \left(\frac{\Omega}{kft}\right)$$

#### Where:

- $V_{d}$
- d
- 1
- Ω//kft

- = voltage drop
- = route length of dc cable in feet (2 x adjusts for total circuit wire length)
- = dc current in amperes (commonly I<sub>mp</sub>)
- = ohms/thousand feet (resistance)

Voltage drop (in percentage) = 
$$\frac{V_d}{V_{MAX}} \times 100$$

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DCB	No. of Rack Inputs	IMP for DCB circuit	Feeder length	Feeder wire size	Feeder resistance	Feeder resistance		Voltage drop for feeder	Voltage drop for feeder	Voltage drop for circuit	VMP for circuit			Voltage drop for circuit
DCB#-##	#	Amp	feet	kcmil	Ohm/kft	Ohm		Volt	per cent	Volt	Volt			per cent
DCB1	5	140.00	780	600	0.0214	0.0323		4.67376	0.48%	42.31033333	1500.00			2.82%
DCB2	5	140.00	764	600	0.0214	0.0316		4.577888	0.47%	42.278376	1500.00			2.82%
DCB3	5	140.00	748	600	0.0214	0.0310		4.482016	0.46%	42.24641867	1500.00			2.82%
DCB4	5	140.00	732	600	0.0214	0.0303		4.386144	0.45%	42.21446133	1500.00			2.81%
DCB5	5	140.00	716	600	0.0214	0.0296		4.290272	0.44%	42.182504	1500.00			2.81%
DCB6	5	140.00	700	600	0.0214	0.0290		4.1944	0.43%	42.15054667	1500.00			2.81%
DCB7	5	140.00	684	600	0.0214	0.0284		4.098528	0.42%	42.11858933	1500.00			2.81%
DCB8	5	140.00	668	600	0.0214	0.0277		4.002656	0.41%	42.086632	1500.00			2.81%
DCB9	5	140.00	652	600	0.0214	0.0270		3.906784	0.40%	42.05467467	1500.00			2.80%
DCB10	5	140.00	636	600	0.0214	0.0263		3.810912	0.39%	42.02271733	1500.00			2.80%
DCB11	5	140.00	620	600	0.0214	0.0256		3.71504	0.38%	41.99076	1500.00			2.80%
DCB12	5	140.00	604	600	0.0214	0.0251		3.619168	0.37%	41.95880267	1500.00			2.80%
DCB13	5	140.00	588	600	0.0214	0.0244		3.523296	0.36%	41.92684533	1500.00			2.80%
DCB14	5	140.00	588	600	0.0214	0.0244		3.523296	0.36%	41.92684533	1500.00			2.80%
DCB15	5	140.00	604	600	0.0214	0.0251		3.619168	0.37%	41.95880267	1500.00			2.80%
DCB16	5	140.00	620	600	0.0214	0.0256		3.71504	0.38%	41.99076	1500.00			2.80%
DCB17	5	140.00	636	600	0.0214	0.0263		3.810912	0.39%	42.02271733	1500.00			2.80%
DCB18	5	140.00	652	600	0.0214	0.0270		3.906784	0.40%	42.05467467	1500.00			2.80%
DCB19	5	140.00	668	600	0.0214	0.0277		4.002656	0.41%	42.086632	1500.00			2.81%
DCB20	5	140.00	684	600	0.0214	0.0284		4.098528	0.05%	42.11858933	1500.00			2.81%
DCB21	5	140.00	700	600	0.0214	0.0290		4.1944	0.05%	42.15054667	1500.00			2.81%
DCB22	5	140.00	716	600	0.0214	0.0296		4.290272	0.06%	42.182504	1500.00			2.81%
DCB23	5	140.00	732	600	0.0214	0.0303		4.386144	0.06%	42.182504	1500.00			2.81%
DCB24	5	140.00	748	600	0.0214	0.0309		4.482016	0.06%	42.182504	1500.00			2.81%
DCB25	5	140.00	764	600	0.0214	0.0327		4.577888	0.06%	42.182504	1500.00			2.81%
DCB26	5	140.00	780	600 IMP x 1.25AWG size ab	0.0214	0.0334		4.67376	0.06%	42.182504	1500.00 Voltage your strings	Average of vorst-pase DCB vo	ltago drop:	2.81% 2.81%

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## WIRING MATERIALS & COMPONENTS

#### CBs DCB1-01 - DCB1-26

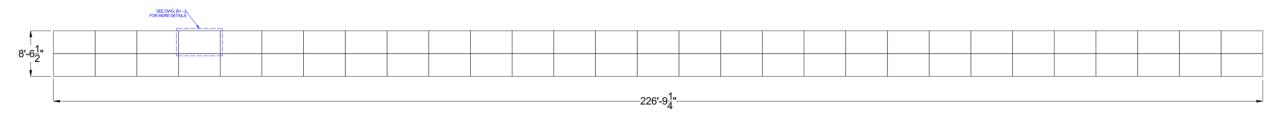
				01-01 - DCB1-20		
Department of Electrica and Computer Engineeri	Conductors	lsc(A)	IMP(A)	Туре	Conductor Material	AWG Size
and Computer Engineeri	String (Harness)	18.49	15	Underground	copper	10
	Rack to CB (Jumper)	36.98	30	Underground	copper	8
	CB to Inverter	184.9	120	Underground	copper	3/o
Property		Copper			Aluminum	
Conductivity		High			Moderate	
Weight		Heavy			Light	
Cost		Expensive			Affordable	
Strength & Durability	,	High			Moderate	
Corrosion Resistance		Excellent			<b>Requires treatment</b>	
Thermal Expansion		Low			High	



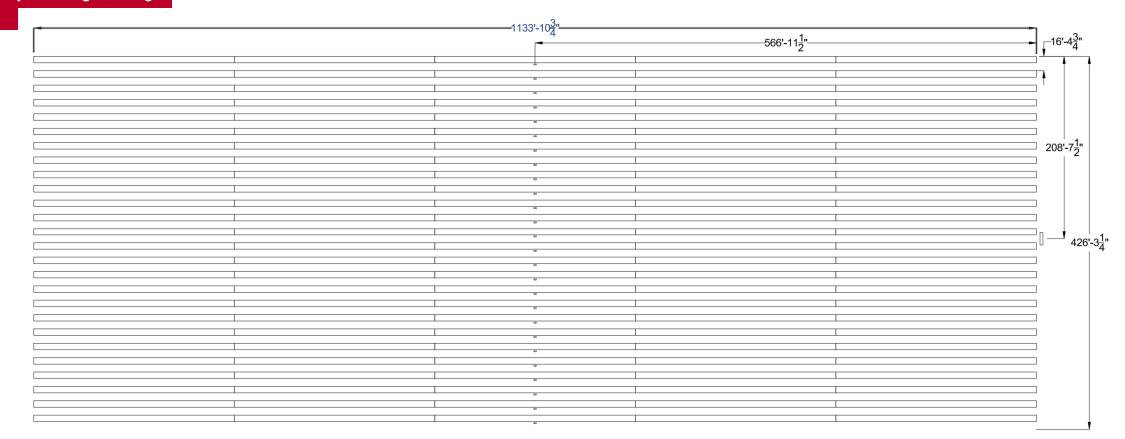
## **SYSTEM DESIGN – RACK LAYOUT**

### **Factors Effecting the Rack Layout**

- Open circuit voltage (Voc)
- Short circuit current (Isc)



### SYSTEM DESIGN – ARRAY LAYOUT





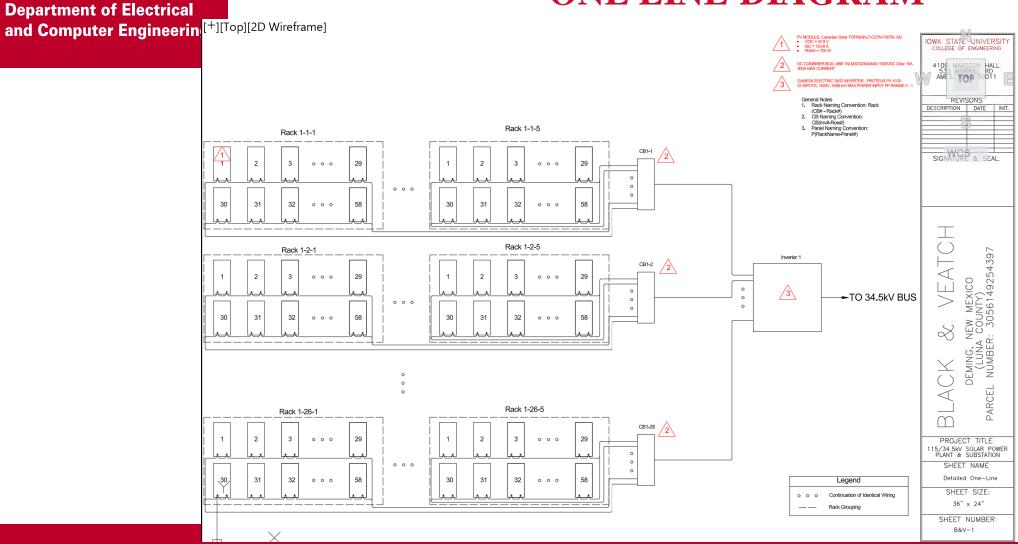
## **SYSTEM DESIGN – ARRAY LAYOUT**

### **Factors Effecting the Array Layout**

- Power generated by one rack
- Inverter capacity
  - Want DC capacity to be 1.3x the inverter capacity
- Ground coverage ratio
  - Effects how much shade is cast onto other panels
- Voltage drop
  - Effects placement of combiner boxes and inverter

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## **ONE LINE DIAGRAM**

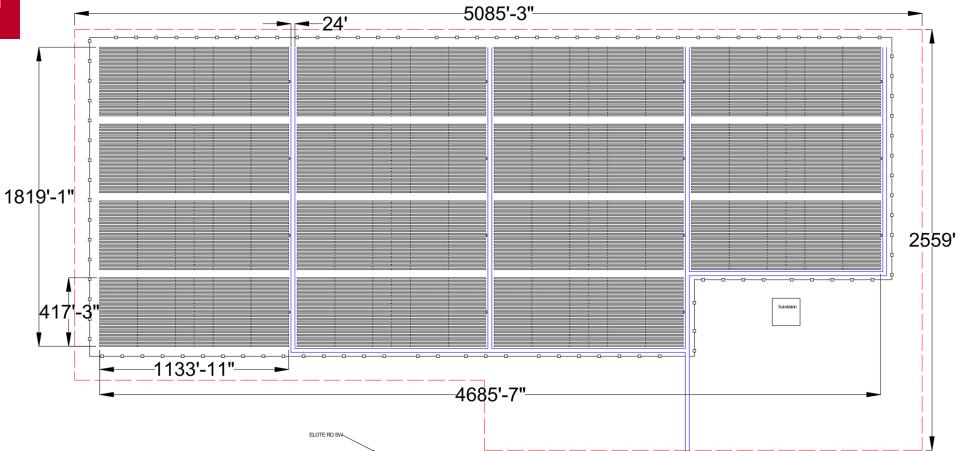


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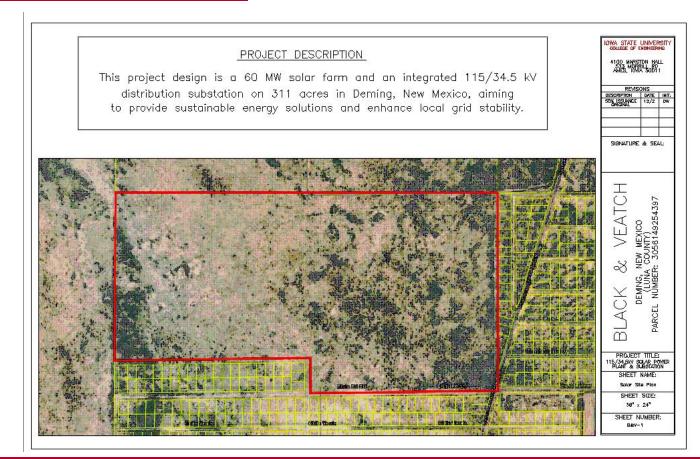
SITE PLAN

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## **PROJECT PLAN**



- Project site in Deming, New Mexico
- 311 acres
- Array design fits the plot dimensions

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## **BILL OF MATERIALS**

A	B	C	D	E	F	G
1 60 MW Solar Farm Compone	ints					
2 Component Type	SKU/Model Number	Quantity	Price	Datasheet	Total Quantity Price	Pricing
3 Canadian Solar PV Modules	TOPBiHiKu7 CS7N-700TB-AG	113,100	\$223	Link	\$25,221,300	Link
4 DC Combiner Boxes	CA1500-24-20S	390	\$2,156.00	Link	\$840,840	Link
5 Inverters	SLG-330-0279	15	\$119,210.14	Link	\$1,788,152	Link
6 600 kcmil			10-2030-21121-00		\$0	
7 Land		311 Acres			\$217,700	Link
8 Fencing	S				\$0	
9 Labor	8	6+ Months @ \$24/hr., 50 Workers			\$0	Link
0					\$0	
1		1			\$0	
2					\$0	
3					\$0	
4					\$0	
5	-				\$0	
6					\$0	
7				N	\$0	1
8				Total Cost	\$28,067,992	

Dallas

1	Documentation		
	Weekly Agenda	A11	9/12/2024
	Meeting Minutes	A11	9/12/2024
	Weekly Report	A11	9/12/2024
	Presentation Slides	A11	9/12/2024
	Project Design Document	A11	9/12/2024
	Final Report	A11	9/12/2024
	Final Presentation	A11	9/19/2024
2	Research		
	Utility-Grade Solar Panels	Sergio	9/12/2024
	Combiner Boxes	Mohamed	9/12/2024
	Utility-Grade Solar Inverters (skids)	Andrew	9/12/2024
	Safety Moment	Ben	9/12/2024
	Substation Design Overview	Sergio	9/12/2024
	Land Comparison	David	9/12/2024
3	Component Selection		
	Solar Component	David	9/19/2024
	Substation Component	A11	9/19/2024
	Solar Farm and Substation Location	Sergio	9/19/2024
	Cost Estimation	A11	9/19/2024
	Cost Analysis	Dallas	10/3/2024

## FALL GANTT CHART

Project:	115/34.5 kV Solar Power Plant & Substation	Company	Name		Black & Veatch																											
Project man	g Adam Schroeder, Eli Schaffer, Utsavee Desai																	CAI	NTT	СН	AD'	г										
			START	DUE				ek l	Week		Week 3		eek 4	Wee		Week (			We				Week		Week 1		Week 12		ek 13		ek 14	
	TASK TITLE	TASK OWNER	DATE	DATE	DURATION	TASK COMPLET					/19/2024		3/2024			10/17/20			10/3			024	11/14/20	24 1								12/19/20. H T W B F
	SOLAR PLANT						HITW	R F 5 S	- H T V R I	F 5 5 H T	WRFS	5. H T W	R F 5 5	HTWR	F 5 5 H	TWRF	5 5 8 1	WRFS	SHIT	RFSS	HIVE	1 8 5	4 TV BF	8 s. H	TVRF	2 s. H	TVBFS	5. H T V	RISS		81 2 5	TWRF
1	Documentation																															
•	Weekly Agenda	A11	9/12/2024	12/20/2024	99		m																ТПТ				TTT	Ш			TTT	ΠF
	Meeting Minutes	All	9/12/2024	12/20/2024	99		HH		+++++																						++++	Æ
	Weekly Report	All	9/12/2024	12/20/2024	99		HH		+++++																						++++	Æ
	Presentation Slides	All	9/12/2024	12/20/2024	99		HH																								++++	/III/
	Project Design Document	All	9/12/2024	12/20/2024	99				+++++																						++++	/##P
	Final Report	Att	9/12/2024	12/20/2024	99																									ш	++++	/////
	Final Presentation	All	9/19/2024	12/20/2024	92																										1117	an P
2	Research																															
	Utility-Grade Solar Panels	Sergio	9/12/2024	9/19/2024	7																											
	Combiner Boxes	Mohamed	9/12/2024	9/19/2024	7																											
	Utility-Grade Solar Inverters (skids)	Andrew	9/12/2024	9/19/2024	7																											
	Safety Moment	Ben	9/12/2024	9/19/2024	7																											
	Substation Design Overview	Sergio	9/12/2024	9/19/2024	7																											
	Land Comparison	David	9/12/2024	9/19/2024	7																											
3	Component Selection						_						_																			
	Solar Component	David	9/19/2024	9/26/2024	7																											
	Substation Component	All	9/19/2024	9/26/2024	7																											
	Solar Farm and Substation Location	Sergio	9/19/2024	9/26/2024	7																											
	Cost Estimation	A11	9/19/2024	9/26/2024	7																					_					_	
	Cost Analysis	Dallas	10/3/2024	12/20/2024	78																										ш	ΔШИ
4	Array Parameter Calculations (Array parameter t																															
	String Size	A11	9/19/2024	10/18/2024	30																											
	Electrical Rack Size	A11	9/19/2024	10/18/2024	30																											
	CB Capacity	A11	9/19/2024	10/18/2024	30							++++							_	-												
	Array Design	Ben	9/19/2024	11/1/2024	53							++++					++++	++++														
	Array Size	Ben David	9/19/2024 9/19/2024	11/1/2024 11/1/2024	43							++++					++++	++++														
	Total Equipment Total Cost and Budget	Andrew	9/19/2024	11/1/2024	43												++++	++++		++												
	Total Power (AC & DC)	Andrew	10/10/2024	10/18/2024	8																											
	Voltage Drop Calculation	All	10/10/2024	11/1/2024	22	i ii																										
5	Solar Farm Design & AutoCAD Drawings	Au	10/10/2024	11/1/2024	22																											
	Solar Panel Model	Dallas	10/10/2024	11/1/2024	22													ш														
	Array	Ben	10/10/2024	11/1/2024	22																											
	Rack	Ben	10/10/2024	11/1/2024	22																											
	Solar Layout	Ben & Dallas	10/10/2024	11/1/2024	22																											
	One Line Diagram	Ben	10/10/2024	11/1/2024	22													+++														
	Mounting Structure	Dallas & Servio	11/2/2024	11/15/2024	13													_														
	Site Plan w/ Measurements	Ben	11/2/2024	11/15/2024	13																											
	Solar Panel Side View	Dallas & Servio	11/2/2024	11/15/2024	13																											
6	Simulation																															
	Requirements	A11																														
	Simulation	A11																														
7	Presentation																														TP	ΔTF
	Presentation	All																														

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4	Array Parameter Calculations (Array p	arameter tool)	
	String Size	A11	9/19/2024
	Electrical Rack Size	A11	9/19/2024
	CB Capacity	A11	9/19/2024
	Array Design	Ben	9/19/2024
	Array Size	Ben	9/19/2024
	Total Equipment	David	9/19/2024
	Total Cost and Budget	Andrew	10/10/2024
	Total Power (AC & DC)	A11	10/10/2024
	Voltage Drop Calculation	A11	10/10/2024
5	Solar Farm Design & AutoCAD Drawing	gs	
	Solar Panel Model	Dallas	10/10/2024
	Array	Ben	10/10/2024
	Rack	Ben	10/10/2024
	Solar Layout	Ben & Dallas	10/10/2024
	One Line Diagram	Ben	10/10/2024
	Mounting Structure	Dallas & Sergio	11/2/2024
	Site Plan w/ Measurements	Ben	11/2/2024
	Solar Panel Side View	Dallas & Sergio	11/2/2024
6	Simulation		
	Requirements	A11	
	Simulation	A11	
7	Presentation		
	Presentation	A11	

	115/34.5 kV Solar Power Plant & Substation	Company	Name		Black & Veatch																										
roject manag	Adam Schroeder, Eli Schaffer, Utsavee Desai															GΔ	NTT	CH	<b>IAR</b>	Г											
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2	Research																														۴
	Utility-Grade Solar Panels	Sergio	9/12/2024	9/19/2024	7			F	TIT	Ш																					
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	Utility-Grade Solar Inverters (skids)	Andrew	9/12/2024	9/19/2024	7																										
	Safety Moment	Ben	9/12/2024	9/19/2024	7																										
	Substation Design Overview	Sergio	9/12/2024	9/19/2024	7																										
	Land Comparison	David	9/12/2024	9/19/2024	7																										
	Component Selection	20000	311212024	311312024																											
	Solar Component	David	9/19/2024	9/26/2024	7																										
	Substation Component	All	9/19/2024	9/26/2024	7																										
	Solar Farm and Substation Location	Sergio	9/19/2024	9/26/2024	7																										
	Cost Estimation	All	9/19/2024	9/26/2024	7																										
	Cost Analysis	Dallas	10/3/2024	12/20/2024	78																										t
	Array Parameter Calculations (Array parameter to		10/5/2024	12/20/2024	10																										-
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	Electrical Rack Size	All	9/19/2024	10/18/2024	30									++++																	
	CB Capacity	All	9/19/2024	10/18/2024	30																										
	Array Design	Ben	9/19/2024	11/1/2024	53											*****	1111	TTI -													
	Array Size	Ben	9/19/2024	11/1/2024	53																										
	Total Equipment	David	9/19/2024	11/1/2024	43																										
	Total Cost and Budget	Andrew	10/10/2024	11/1/2024	22																										
	Total Power (AC & DC)	All	10/10/2024	10/18/2024	8									+++++																	
	Voltage Drop Calculation	All	10/10/2024		22												1111														
	Solar Farm Design & AutoCAD Drawings		10/10/2024	11/1/2024																											
	Solar Panel Model	Dallas	10/10/2024	11/1/2024	22								TTTT	TITT	TIT	TITT	TIT														
	Array	Ben	10/10/2024	11/1/2024	22																										
	Rack	Ben	10/10/2024	11/1/2024	22																										
	Solar Layout	Ben & Dallas	10/10/2024	11/1/2024	22																										
	One Line Diagram	Ben	10/10/2024	11/1/2024	22																										
	Mounting Structure	Dallas & Servio	11/2/2024	11/15/2024	13																										
	Site Plan w/ Measurements	Ben	11/2/2024	11/15/2024	13																										
	Solar Panel Side View	Dallas & Servio	11/2/2024	11/15/2024	13																										
6	Simulation	manue er ogi Ern	100000	1010024																											
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| Sergio | 12/10/2024 115/34.5kV Solar Plant & Substation Senior Design Project | 22

### **SPRING GANTT CHART**

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	SUBSTATION		<b>_</b>
1	Documentation		
	Weekly Agenda	A11	1/20/2025
	Meeting Minutes	A11	1/20/2025
	Weekly Report	A11	1/20/2025
	Presentation Slides	A11	1/20/2025
	Project Design Document	A11	1/20/2025
	Final Report	A11	1/20/2025
	Final Presentation	A11	1/20/2025
2	Research		
	Substation Components	A11	1/20/2025
	Safety Moment	A11	1/20/2025
	One Line	A11	1/20/2025
	Bus Layouts	A11	1/20/2025
	Design Standards	A11	1/20/2025
3	Component Selection		
	Circuit Breakers	A11	2/3/2025
	Transformer	A11	2/3/2025
	Switches	A11	2/3/2025
	Control Building	A11	2/3/2025
	Cables	A11	2/3/2025
	Panels	A11	2/3/2025
	Relays	A11	2/3/2025
	Backup Service Batteries	A11	2/3/2025

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		Switches	A11	2/3/2025	2/14/2025	11																								
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0/2025		Relays	A11	2/3/2025	2/14/2025	11																								
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/2025	5	Substation AutoCAD Drawings														(TTTT								-						
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115/34.5kV Solar Plant & Substation

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| Sergio | 12/10/2024

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	Electrical Layout Drawings (Substation Equipment)	A11	2/16/2025	rinal Presentation All Research	1	1/20/2023 5/2/2023	102																	шшш	
	Load Flow Analysis / AC Arc Flash Study / Protection Element Analysis	A11	2/16/2025	Substation Components All	1	1/20/2025 1/31/2025	11				1														1111
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5	Substation AutoCAD Drawings			Bus Layouts All	1	1/20/2025 1/31/2025	11																		
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				Component Selection Circuit Breakers All	1	2/3/2025 2/14/2025	11																		
	Three Line	A11	3/3/2025	Transformer All	1	2/3/2025 2/14/2025	11																		
	AC Schematics	A11	3/3/2025	Switches All	1	2/3/2025 2/14/2025	11																		
	DC Schematics	A11	3/3/2025	Control Building All	1	2/3/2025 2/14/2025	11																		
				Cables All	1	2/3/2025 2/14/2025	11																		
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	Conduit Layout	A11	3/3/2025	Relays All Backup Service Batteries All	1	2/3/2025 2/14/2025 2/3/2025 2/14/2025	11					+++++													
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	General Arrangement	A11	3/3/2025	Additional Calculations (AC, DC, lightning protection, etc.) All	1	2/16/2025 2/28/2025	12								TTTT 1										1111
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### **TEST PLAN**



#### ΕΤΑΡ

- Design
- Analysis
- Optimization

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## CONCLUSIONS

- Schedule Progress
- Group Member Contributions
  - o Andrew: Bill of Materials, AutoCAD, Component Research
  - o Ben: AutoCAD, Array Parameter Tool, PV Module Research
  - o Dallas: PV Module Cost Analysis, Ground Mounting System
  - David: Solar Plant Components Selection, Voltage Drop Calculation
  - Mohamed: Voltage Drop Calculation, Combiner Box Research
  - Sergio: Gantt Chart, AutoCAD, Ground Mounting
- Plans for next semester



## **Q&A Session**

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### IOWA STATE UNIVERSITY

**Department of Electrical and Computer Engineering** 

# **THANK YOU**

Senior Design Team 41 12/10/2024