

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
- AutoCAD Drawings
 - Solar Array
 - Horizontal
 - Vertical
 - Site Plan
 - Project Title
- Fixed vs Single Axis Tilt
- Voltage Drops + Cost calculations



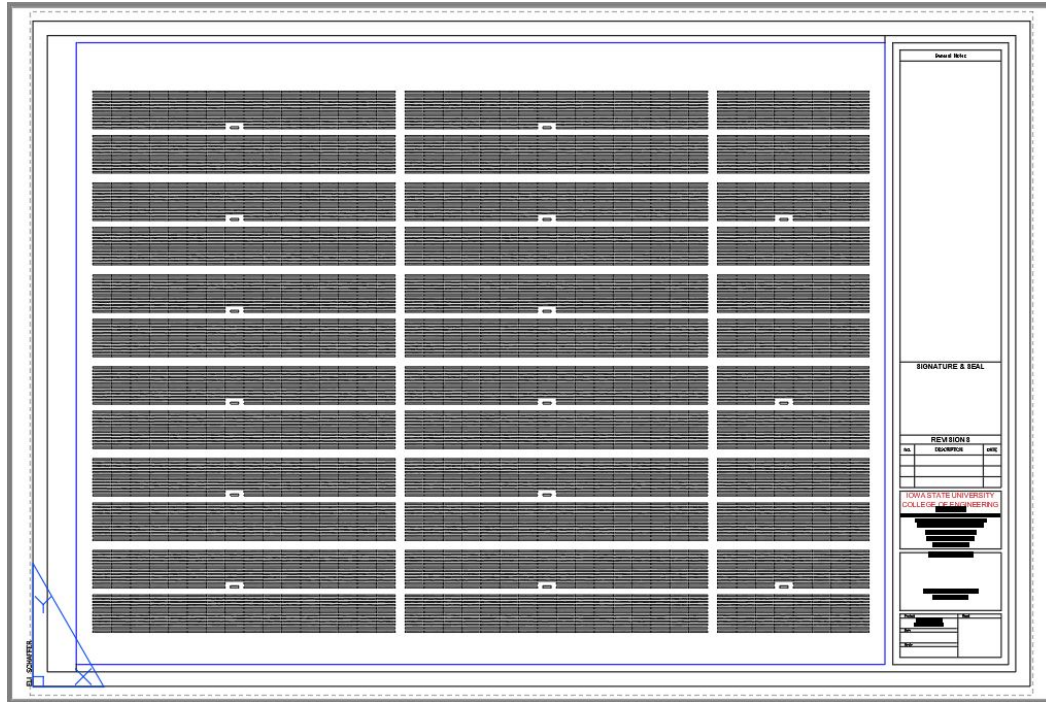
Safety Moment - Situational Awareness

SLAM Method

- S: Stop
 - Stop and consider the work and what it will involve.
- L: Look
 - Look for overhead or other objects that could be hazardous.
- A: Assess
 - Think about what PPE or other precautions need to be taken to mitigate hazards.
- M: Manage
 - Take steps needed to reduce or eliminate hazards.



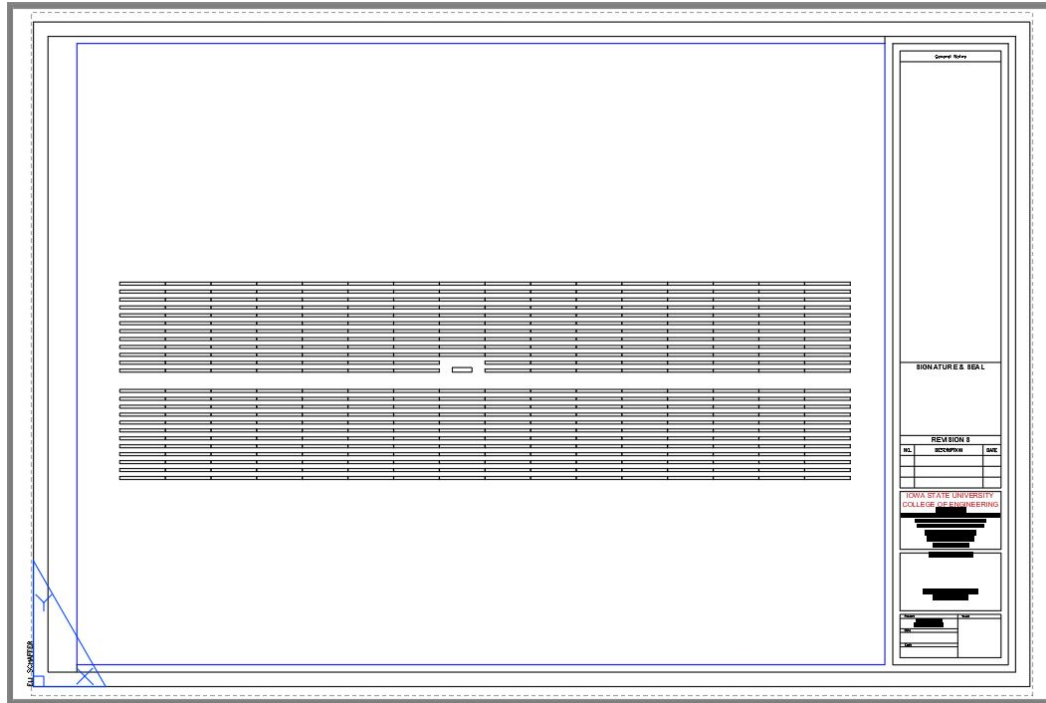
Array Plan - Total Farm



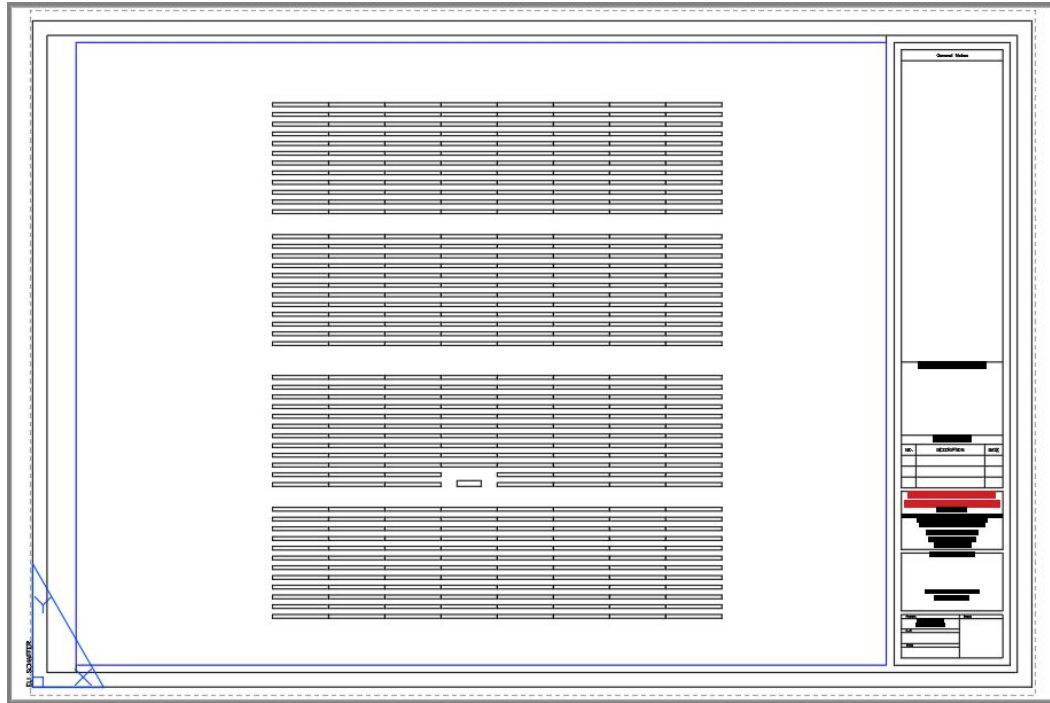
- Added 50 foot access roads between each array for easy access



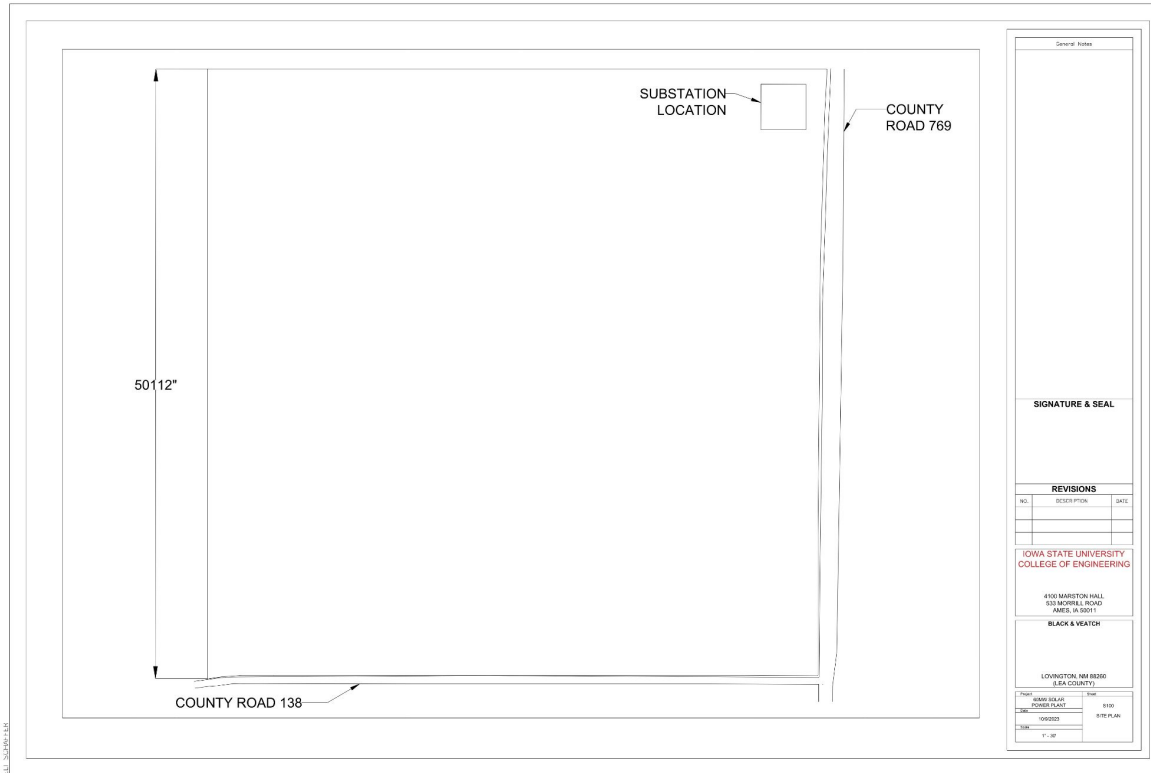
Array Plan - Horizontal



Array Plan - Vertical



Updated Site Plan



- Added a few dimensions and tags
- Going to add more dimensions and annotations this week
- Looking to show array layout in some capacity on site plan



Updated Project Title

LOVINGTON, NM SOLAR ARRAY

SPEARS RD & STATE LINE RD, LOVINGTON, NM 88260

PROJECT LOCATION MAP

GENERAL NOTES

1. NOTES

SHEET LIST TABLE	
SHEET NUMBER	SHEET TITLE
E100	PROJECT TITLE
S100	SITE PLAN
S101	SITE DETAILS
PV100	SOLAR DESIGN PLAN
PV101	OVERALL ARRAY LAYOUT
PV102	ARRAY HORIZONTAL
PV103	ARRAY VERTICAL
FUTURE	FUTURE
PV106	SOLAR DESIGN DETAILS
PV110	PANEL DATASHEET
PV111	COMBNER BOX DATASHEET
PV112	SKID INVERTER DATASHEET
FUTURE	FUTURE
FUTURE	FUTURE

PROJECT EQUIPMENT	
TYPE	QUANTITY
ZSUNSHINE PANEL	143,250
ZSENY COMBNER	300
ABB SKID INVERTER	15
8" X 8" ANGLE	100,000'
400 MCM	50,000'
PRODUCT	QUAN
PRODUCT	QUAN
PRODUCT	QUAN
PRODUCT	QUAN
PRODUCT	QUAN

General Notes

SIGNATURE & SEAL

REVISIONS

NO.	DESCRIPTION	DATE

IOWA STATE UNIVERSITY
COLLEGE OF ENGINEERING

4100 MARSTON HALL
153 MARSHALL ROAD
AMES, IA 50011

BLACK & VEATCH

LOVINGTON, NM 88260
(SEA COUNTY)

DATE	REV	BY	DATE
DRAWN BY	CHECKED BY	DATE	PROJECT TITLE

- Updated location Map
- Added more sheets to correspond with work done
- Added project equipment



Single Axis Tilt VS Fixed Axis

	Single Axis Tilt	Fixed Axis Tilt
Installation Cost(\$/MW,DC)	1,010,000	950,000
O&M Cost(\$/MW,DC)	11,000	10,800
Space Cost(Acre/MW)	7	5
Production	Single Axis Tilt 15%-25%higher than Fixed Axis Tilt	

Extreme weather situation at Lea County (Number of Occurrences 4 - 5)

- Tornado
- Thunderstorms
- Winter Storm

We are not going to use axis tracking technology because there were many additional factors that come with axis tracking that would complicate our calculations, but for now, we would compare in terms of cost analysis.

Voltage drop Calculations

String voltage drop

Voltage-Drop Calculation = <3%

Resources	NEC Table 8 Conductor Properties NEC AWG Chart
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16 racks Combiner box (Horizontal Array)

DCB	Strings per rack	ISC for string	String length	String wire size	String conductor resistance	String resistance	Voltage drop of string (AWG-12)
DCB#-##	per rack	Amp	feet	AWG	ohm/ft	ohm	Volts
DCB1-01	1	13.89	93	12	1.98	0.18414	5.115
DCB1-02	1	13.89	93	12	1.98	0.18414	5.115
DCB1-03	1	13.89	93	12	1.98	0.18414	5.115
DCB1-04	1	13.89	93	12	1.98	0.18414	5.115
DCB1-05	1	13.89	93	12	1.98	0.18414	5.115
DCB1-06	1	13.89	93	12	1.98	0.18414	5.115
DCB1-07	1	13.89	93	12	1.98	0.18414	5.115
DCB1-08	1	13.89	93	12	1.98	0.18414	5.115
DCB1-09	1	13.89	93	12	1.98	0.18414	5.115
DCB1-10	1	13.89	93	12	1.98	0.18414	5.115
DCB1-11	1	13.89	93	12	1.98	0.18414	5.115
DCB1-12	1	13.89	93	12	1.98	0.18414	5.115
DCB1-13	1	13.89	93	12	1.98	0.18414	5.115
DCB1-14	1	13.89	93	12	1.98	0.18414	5.115
DCB1-15	1	13.89	93	12	1.98	0.18414	5.115
DCB1-16	1	13.89	93	12	1.98	0.18414	5.115

Need to recheck the wire diameter, connectors, adaptors used.

Feeder voltage drop (Horizontal array)

AWG=600

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/ft	Ohm	Volt	per cent	Volt	Volt	per cent
DCB1	16	222.24	161	600	0.0241	0.004	1.725			1500	0
DCB2	16	222.24	151	600	0.0241	0.004	1.618			1500	0
DCB3	16	222.24	141	600	0.0241	0.003	1.510			1500	0
DCB4	16	222.24	131	600	0.0241	0.003	1.403			1500	0
DCB5	16	222.24	121	600	0.0241	0.003	1.296			1500	0
DCB6	16	222.24	111	600	0.0241	0.003	1.189			1500	0
DCB7	16	222.24	101	600	0.0241	0.002	1.082			1500	0
DCB8	16	222.24	91	600	0.0241	0.002	0.975			1500	0
DCB9	16	222.24	81	600	0.0241	0.002	0.868			1500	0
DCB10	16	222.24	71	600	0.0241	0.002	0.761			1500	0
DCB11	16	222.24	61	600	0.0241	0.001	0.653			1500	0
DCB12	14	222.24	51	600	0.0241	0.001	0.546			1500	0
DCB13	14	222.24	41	600	0.0241	0.001	0.439			1500	0
DCB14	16	222.24	82	600	0.0241	0.002	0.878			1500	0
DCB15	16	222.24	92	600	0.0241	0.002	0.986			1500	0
DCB16	16	222.24	102	600	0.0241	0.002	1.093			1500	0
DCB17	16	222.24	112	600	0.0241	0.003	1.200			1500	0
DCB18	16	222.24	122	600	0.0241	0.003	1.307			1500	0
DCB19	16	222.24	132	600	0.0241	0.003	1.414			1500	0
DCB20	16	222.24	142	600	0.0241	0.003	1.521			1500	0
DCB21	16	222.24	152	600	0.0241	0.004	1.628			1500	0
DCB22	16	222.24	162	600	0.0241	0.004	1.735			1500	0
DCB23	16	222.24	172	600	0.0241	0.004	1.842			1500	0
DCB24	16	222.24	182	600	0.0241	0.004	1.950			1500	0



Voltage drop Calculations

String voltage drop

Voltage-Drop Calculation = <3%

Resources	NEC Table 8 Conductor Properties NEC AWG Chart
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DCB	Strings per rack	ISC for string	String length	String wire size	String conductor resistance	String resistance	Voltage drop of string (AWG=12)
DCB#-##	per rack	Amp	feet	AWG	ohm/ft	ohm	Volts
DCB1-01	1	13.89	93	12	1.98	0.18414	5.115
DCB1-02	1	13.89	93	12	1.98	0.18414	5.115
DCB1-03	1	13.89	93	12	1.98	0.18414	5.115
DCB1-04	1	13.89	93	12	1.98	0.18414	5.115
DCB1-05	1	13.89	93	12	1.98	0.18414	5.115
DCB1-06	1	13.89	93	12	1.98	0.18414	5.115
DCB1-07	1	13.89	93	12	1.98	0.18414	5.115
DCB1-08	1	13.89	93	12	1.98	0.18414	5.115
DCB1-09	1	13.89	93	12	1.98	0.18414	5.115
DCB1-10	1	13.89	93	12	1.98	0.18414	5.115
DCB1-11	1	13.89	93	12	1.98	0.18414	5.115
DCB1-12	1	13.89	93	12	1.98	0.18414	5.115
DCB1-13	1	13.89	93	12	1.98	0.18414	5.115
DCB1-14	1	13.89	93	12	1.98	0.18414	5.115
DCB1-15	1	13.89	93	12	1.98	0.18414	5.115
DCB1-16	1	13.89	93	12	1.98	0.18414	5.115

Need to recheck the wire diameter, connectors, adaptors used.

Feeder voltage drop (Vertical array)

AWG= 600, diameter = 22-32mm

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/ft	Ohm	Volt	per cent	Volt	Volt	per cent
DCB1	16	222.24	607	600	0.0214	0.013	5.774			1500	0
DCB2	16	222.24	585	600	0.0214	0.013	5.564			1500	0
DCB3	16	222.24	563	600	0.0214	0.012	5.355			1500	0
DCB4	16	222.24	541	600	0.0214	0.012	5.146			1500	0
DCB5	16	222.24	519	600	0.0214	0.011	4.937			1500	0
DCB6	16	222.24	497	600	0.0214	0.011	4.727			1500	0
DCB7	16	222.24	440	600	0.0214	0.009	4.185			1500	0
DCB8	16	222.24	418	600	0.0214	0.009	3.976			1500	0
DCB9	16	222.24	396	600	0.0214	0.008	3.767			1500	0
DCB10	16	222.24	374	600	0.0214	0.008	3.557			1500	0
DCB11	16	222.24	352	600	0.0214	0.008	3.348			1500	0
DCB12	14	222.24	330	600	0.0214	0.007	3.139			1500	0
DCB13	14	222.24	258	600	0.0214	0.006	2.454			1500	0
DCB14	16	222.24	236	600	0.0214	0.005	2.245			1500	0
DCB15	16	222.24	214	600	0.0214	0.005	2.036			1500	0
DCB16	16	222.24	192	600	0.0214	0.004	1.828			1500	0
DCB17	16	222.24	170	600	0.0214	0.004	1.617			1500	0
DCB18	16	222.24	148	600	0.0214	0.003	1.408			1500	0
DCB19	16	222.24	91	600	0.0214	0.002	0.866			1500	0
DCB20	16	222.24	113	600	0.0214	0.002	1.075			1500	0
DCB21	16	222.24	135	600	0.0214	0.003	1.284			1500	0
DCB22	16	222.24	157	600	0.0214	0.003	1.493			1500	0
DCB23	16	222.24	179	600	0.0214	0.004	1.703			1500	0
DCB24	16	222.24	201	600	0.0214	0.004	1.912			1500	0

Average of worst-case DCB Voltage drop



Feedback and Updates

- PDF Full set
- 160'x100' rough guess
- BV pres 11/29
- Liam - PV104 (Wiring Layout)
- Eli - PV106 (Details (grounding, cross sectional))
- Baylor - Site Layout/Details
- Eduardo - Further dimensions and combiner boxes
- Bell - Voltage & Cost (help Chicheng)
- Chicheng - ETAP "Simulation"

