E 491 – sdmay19-26
115kV / 34.5kV SOLAR POWER PLANT/SUBSTATION DESIGN PROJECT
Week 6 Report

Monday (10/8/2018) – Sunday (10/14/2018)
Client: Black & Veatch
Advisor: Venkataramana Ajjarapu
Team Email: sdmay19-26@iastate.edu

Team Members:

Katayi Katanga – Communication Leader
Nur Shuazlan – Meeting Scribe
Yao Cheah – Website Manager #1
Ahmed Sobi – Team Leader/Layout Designer #1
Chufu Zhou – Website Manager #2/Layout Designer #2
Tam Nguyen – Report Manager

Weekly Summary:

This week we had a meeting with our client and advisor, and we talked about why we chose Estancia, NM to be our place for our project, why we chose 5x35 to be our layout for the solar power plant, NREL SAM output, and what we found about fixed rack system design. Then, we started working on solar power plant final calculations (voltage drop, ground coverage ratio, and final solar layout), and some substation components (collector and feeder).

Summary of Client/Advisor Meeting:

- Nur did safety moment.
- Based on 9 categories: 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, we chose Estancia, NM to be out best location for our project. Then, based on ILR value, solar plant size, and total cost, we decided to choose 5x35 layout to be our layour.
- Using the supplementary software provided, students compared their system to the system created in NREL SAM. There were a few differences, such as the ILR value found using SAM which was way lower than that found using the array parameter tool. SAM suggested using almost 100,000 more panels. Katayi also compared our system to one she developed using Helioscope. The helioscope website helped us figure out what the layout would actually look like and helped with wiring. This output will be presented next week with the final array layout.
- Lastly, we talked about fixed rack system design. Students are a little lost with rack design, but they looked into common rack types and designs to see what would suit there system best. They ended up choosing a concrete pier foundation, as it was a cheaper reliable foundation method. They will be using galvanised steel rack body as it is stronger and more reliable. If they have time at the end of the semester, they will dive a little deeper into this.

Past Week Accomplishments:

Katayi and Nur:-

- They did voltage drop calculations across the cables from the solar panels to the combiner boxes using a template provided by the client. The pictures below are the results.

8 Input Disconnect Combiner Box								
Circuit	from	to	power (W)	Voltage (Vmp)	Current (Imp)	DCB Fuse (A)	Cable Size (AWG)	Cable Length (Ft)
1	ER - 1	DCB	28,674	972	29.5	30	10	200.3
2	ER - 2	DCB	28,674	972	29.5	30	10	137.9
3	ER - 3	DCB	28,674	972	29.5	30	10	75.5
4	ER - 4	DCB	28,674	972	29.5	30	10	14.1
5	ER - 5	DCB	28,674	972	29.5	30	10	14.1
6	ER - 6	DCB	28,674	972	29.5	30	10	75.5
7	ER - 7	DCB	28,674	972	29.5	30	10	137.9
8	ER - 8	DCB	28,674	972	29.5	30	10	200.3
Total:			229,392		236			

7 Input Disconnect Combiner Box								
Circuit	from	to	power (W)	Voltage (Vmp)	Current (Imp)	DCB Fuse (A)	Cable Size (AWG)	Cable Length (Ft)
1	ER - 1	DCB	28,674	972	29.5	30	10	200.3
2	ER - 2	DCB	28,674	972	29.5	30	10	137.9
3	ER - 3	DCB	28,674	972	29.5	30	10	14.1
4	ER - 4	DCB	28,674	972	29.5	30	10	14.1
5	ER - 5	DCB	28,674	972	29.5	30	10	75.5
6	ER - 6	DCB	28,674	972	29.5	30	10	137.9
7	ER - 7	DCB	28,674	972	29.5	30	10	200.3
Total:			200,718		206.5			

Strings per Harness	IMP for circuit	Rack Harness Length	Rack Harness wire size	Rack Harness resistance	Rack Harness resistance	Voltage Drop from Rack to CB	Jumper Length	Jumper wire size	Jumper resistance	Jumper resistance	Voltage Drop Across a String	DCB Whip length	DCB Whip wire size	DCB Whip resistance	DCB Whip resistance	Total resistance	Total voltage drop	Voltage drop for branch
per rack	Amp	feet	AWG	Ohm/kft	Ohm	Volts	feet	AWG	Ohm/kft	Ohm	Volts	feet	AWG	Ohm/kft	Ohm	Ohm	Volts	percent
2	29.5	200.3	10	0.9989	0.4	4.72708	62.4	12	1.588	0.198	0.3644784					0.598	5.0915584	0.52%
2	29.5	137.9	10	0.9989	0.275	2.2374275	62.4	12	1.588	0.198	0.3644784					0.473	2.6019059	0.27%
2	29.5	75.5	10	0.9989	0.151	0.6726295	62.4	12	1.588	0.198	0.3644784					0.349	1.0371079	0.11%
2	29.5	14.1	10	0.9989	0.028	0.0232932	62.4	12	1.588	0.198	0.3644784					0.226	0.3877716	0.04%
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2	29.5	75.5	10	0.9989	0.151	0.6726295	62.4	12	1.588	0.198	0.3644784					0.349	1.0371079	0.11%
2	29.5	137.9	10	0.9989	0.275	2.2374275	62.4	12	1.588	0.198	0.3644784					0.473	2.6019059	0.27%
2	29.5	200.3	10	0.9989	0.4	4.72708	62.4	12	1.588	0.198	0.3644784					0.598	5.0915584	0.52%
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2	29.5	200.3	10	0.9989	0.4	4.72708	62.4	12	1.588	0.198	0.3644784					0.598	5.0915584	0.52%

Disconnect Combiner Box NUMBER	INPUT DC FUSE SIZE	NUMBER OF STRINGS	NUMBER OF INPUTS	SHORT CIRCUIT CURRENT (ISC)	MAX POWER CURRENT (IMP)	MAX POWER VOLTAGE (VMP)	DC FEEDER WIRE SIZE AND TYPE	ONE WAY DISTANCE NOT TO EXCEED (FT)
DCB#-##	AMP			AMP	AMP	VOLT		
				18.8	29.50	972		
DCB1-01	30	16	8	150	236	972	(<QUANTITY>) - <WIRE SIZE AND TYPE>	
DCB1-02	30	16	8	150	236	972		
DCB1-03	30	16	8	150	236	972		
DCB1-04	30	16	8	150	236	972		
DCB1-05	30	16	8	150	236	972		
DCB1-06	30	16	8	150	236	972		
DCB1-07	30	16	8	150	236	972		
DCB1-08	30	16	8	150	236	972		
DCB1-09	30	16	8	150	236	972		
DCB1-10	30	16	8	150	236	972		
DCB1-11	30	14	7	150	207	972		
DCB1-12	30	14	7	150	207	972		
DCB1-13	30	16	8	150	236	972		
DCB1-14	30	16	8	150	236	972		
DCB1-15	30	16	8	150	236	972		
DCB1-16	30	16	8	150	236	972		
DCB1-17	30	16	8	150	236	972		
DCB1-18	30	16	8	150	236	972		
DCB1-19	30	16	8	150	236	972		
DCB1-20	30	16	8	150	236	972		
DCB1-21	30	16	8	150	236	972		
DCB1-22	30	16	8	150	236	972		
INVERTER 1 TOTALS		348	174	3302	5133	972		

Combiner	Strings	Racks in	Per CB Output (A)
1	16	8	236
2	16	8	236
3	16	8	236
4	16	8	236
5	16	8	236
6	16	8	236
7	16	8	236
8	16	8	236
9	16	8	236
10	16	8	236
11	14	7	206.5
12	14	7	206.5
13	16	8	236
14	16	8	236
15	16	8	236
16	16	8	236
17	16	8	236
18	16	8	236
19	16	8	236
20	16	8	236
21	16	8	236
22	16	8	236
Total			5133

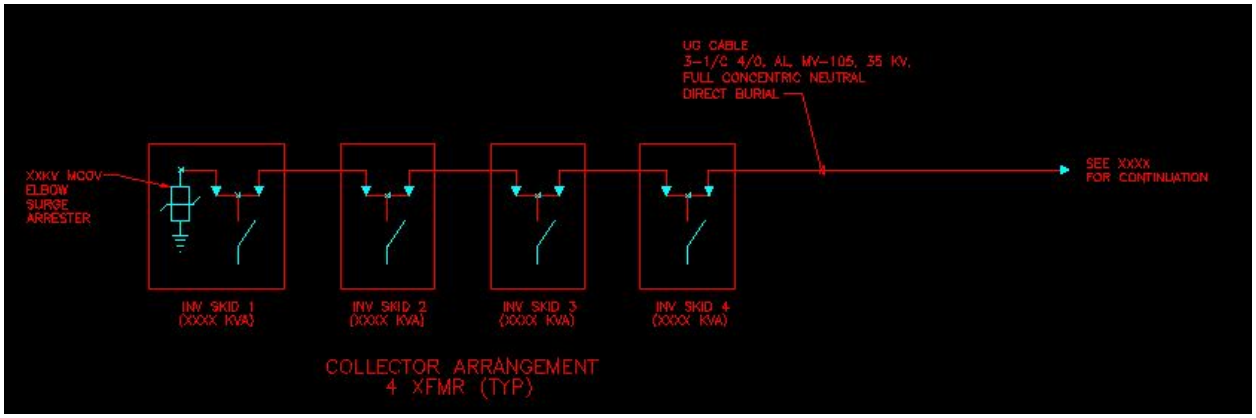
Total Voltage Drop from Panels to CBs in an Array		399.1329114	V
Percentage of Voltage Drop Per CB		1.88%	20 CBs
		1.77%	2 CBs
	Average	1.87%	

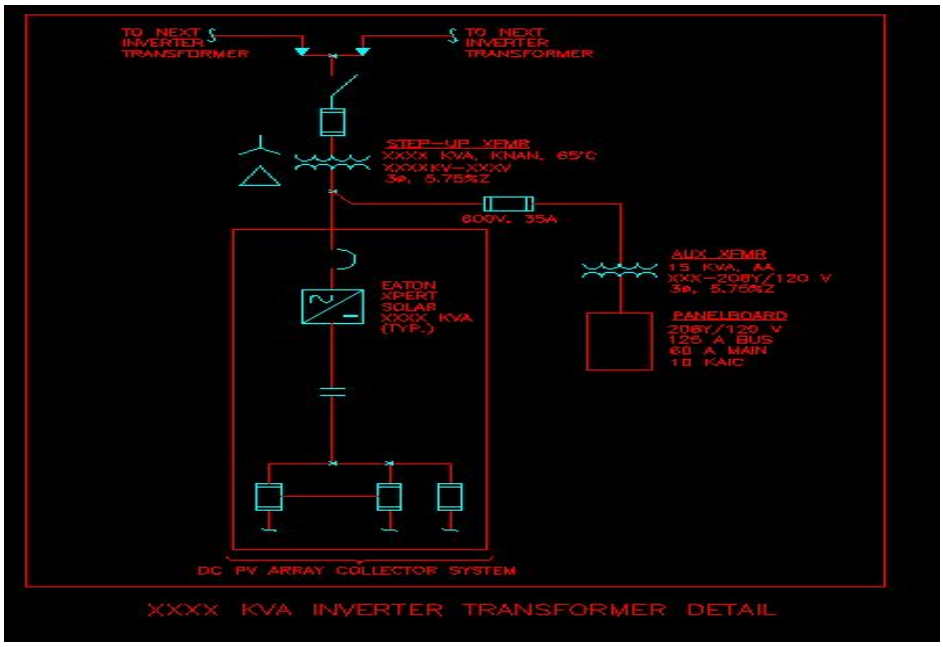
Conductors	Max Isc(A)	Type	Material	AWG
String	14.75	free air	Copper	12
Rack to CB	29.5	free air	Copper	10
CB to Inverter	236	Underground	Aluminum	
Inverter to Transformer	5133	Underground	Aluminum	

--They also made a layout of the solar plant and determined its total cost

Ahmed and Chufu:

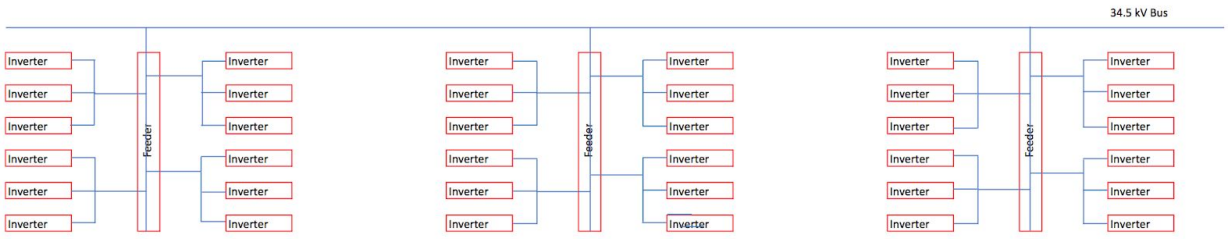
- collector specification and explanation





Tam and YJ: -

- Feeder is output of collector and input to 34.5 kV bus.
- We will use 4 terminal feeders, each terminal has a 22kV surge arrester, a switch, and connect to a collector.
- We will use 3 feeders in total.



Pending Issues:

- The value of power per rack that we got from the voltage drop calculation does not match the calculation from the array parameter tool, did we input the values wrong for vmp and imp?
- What is DCB whip wire referring to?
- Why did you use 500 to calculate the rack harness resistance?
- Are the collector arrangements 4 per collector or we have to figure out our own arrangement?
- The feeder drawings explanation.

Plans For Next Week:

Kat and Nur:

- Redo the solar layout and produce the final system layout.
- Redo voltage drop calculations

Tam and YJ: -

- Do AutoCAD for feeders

Amed and Chufu: -

- Do AutoCAD for collectors

Individual Contributions

Team Member	Individual Contributions	Hours	Cumulative Hours
Katayi Katanga	Did research on: - Voltage drop calculations - NEC Created/Performed: - Solar plant layout - Total cost of solar plant - Design document - Attend all meetings	17.5	77
Nur Shuazlan	Did research on: - Voltage drop calculations - NEC Created/Performed: - Solar plant layout - Total cost of solar plant - Design document	19	79

	- Attend all meetings		
Yao Cheah (YJ)	Did research on: - What is the feeder system for substation - Feeder components Created/Performed: - Upload weekly report - Attend all meeting	12	53.5
Ahmed Sobi	Did research on: - What is the collector system for substation - Collector components - Inverter skid Created/Performed: - Drawing modification - Inverter skid block diagram - Attend all meeting	15.5	62.5
Tam Nguyen	Did research on: - What is the feeder system for substation - Feeder components Created/Performed: - Feeder diagram - Weekly report - Meeting agenda - Design document - Attend all meeting	16	58.5
Chufu Zhou	Did research on: - What is the collector for substation - Collector components Created/Performed: - Collector Parameter - Weekly report - Attend all meeting	14	47

Team Hours: 94
Cumulative Team Hours: 377.5