

E 491 – sdmay19-26

115kV / 34.5kV SOLAR POWER PLANT/SUBSTATION DESIGN PROJECT

Week 7 Report

Monday (10/15/2018) – Sunday (10/21/2018)

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

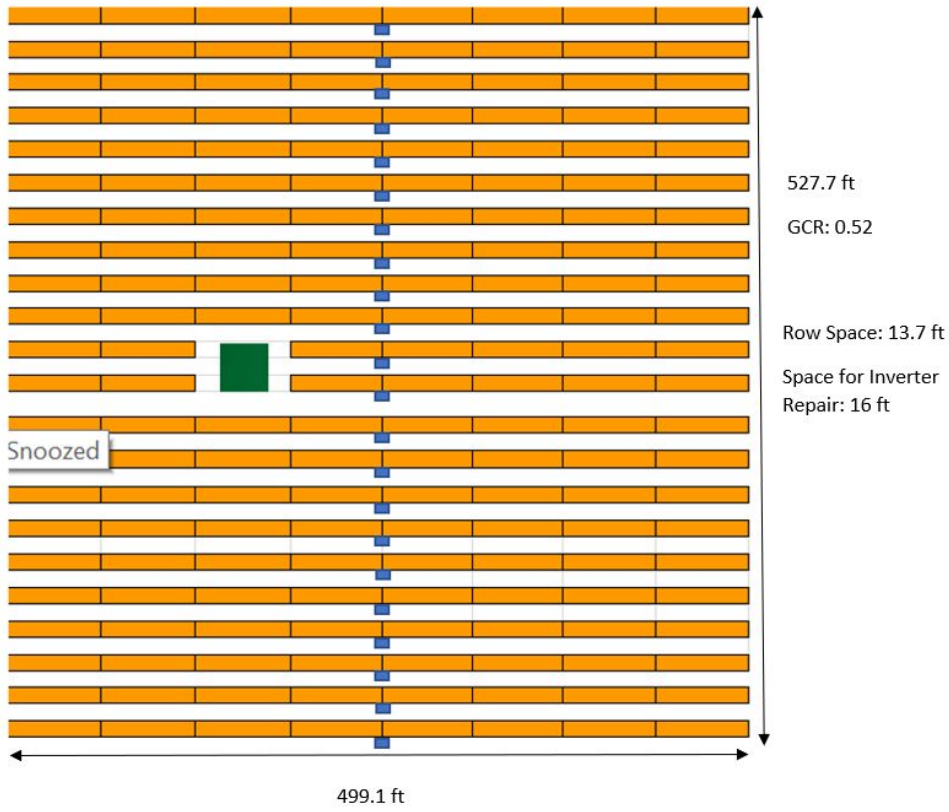
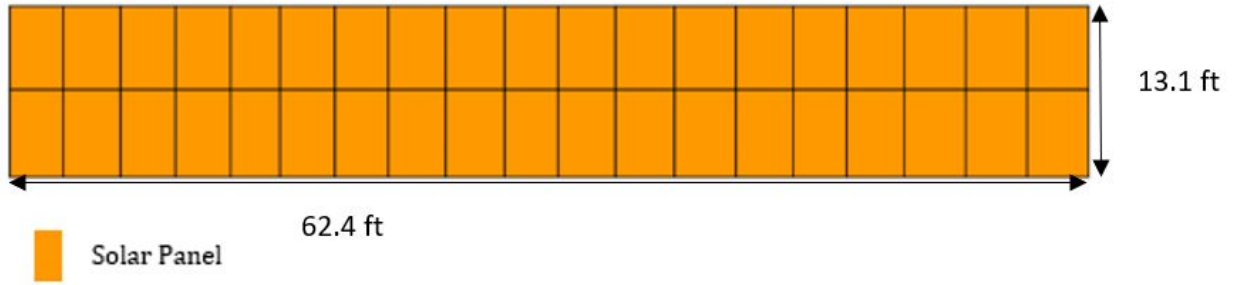
Weekly Summary:

This week we had a meeting with our client and advisor, and we talked about voltage drop calculations, ground coverage ratio, final solar layout, collector, and feeder. Then, we kept the same groups to continue to work on array wiring diagram, conductor sizing and type, voltage drop calculations, collector AutoCAD and parameters calculation, and feeder drawing.

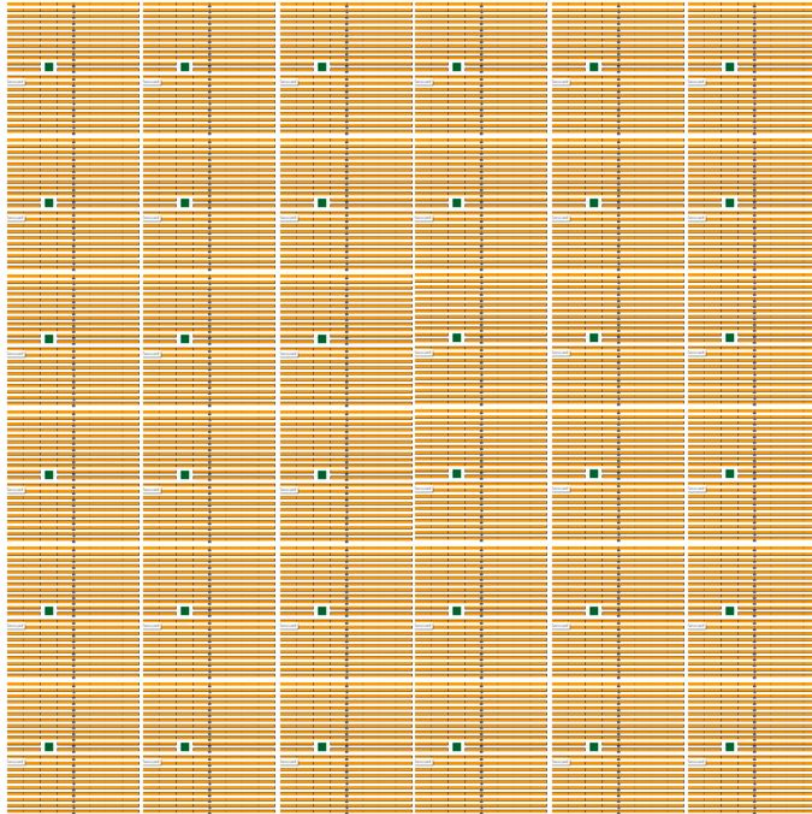
Summary of Client/Advisor Meeting:

- YJ did safety moment.
- First, we talked about voltage drop calculation. Then, we figure out the value of power per rack that we got from the template does not match the calculation from the array parameter tool. Therefore, we still need to work on final plant layout and voltage drop calculation.
- Second, we talked about ground coverage ratio
Using the supplementary software provided, students design the layout and ground Coverage ratio by given:
Row space = height of rack + tan(tilt angle) = 13.65 ft
Pitch = height of rack + row space
GCR = height of rack/pitch = 0.52

Single Array Layout: 8x22 Racks With 2 Removed, 1 Inverter, 22 CBs, ILR: 1.29



Solar Plant Layout: 36 Arrays, 36 Inverters



- Lastly, we talked about Collector and Feeder about what we researched last week. Then, the client wanted us to start working on design our own collector and feeder by AutoCAD.

Past Week Accomplishments:

Katayi and Nur:-

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

DCB	Strings per Harness	IMP for circuit	Rack Harness Length	Rack Harness wire size	Rack Harness resistance	Rack Harness resistance	Voltage Drop of Harness
DCB###	per rack	Amp	feet	AWG	Ohm/kft	Ohm	Volts
DCB1-01	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB1-02	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB1-03	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB1-04	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB1-05	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB1-06	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB1-07	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB1-08	2	29.5	62.4	14	3.1900	0.398	11.744304

Jumper Length	Jumper wire size	Jumper resistance	Jumper resistance	Voltage Drop of Jumper	DCB Whip length	DCB Whip wire size	DCB Whip resistance	DCB Whip resistance	Voltage Drop of DCB Whip	Total resistance	Total voltage drop	Voltage drop for branch
feet	AWG	Ohm/kft	Ohm	Volts	feet	AWG	Ohm/kft	Ohm	Volts	Ohm	Volts	percent
193.75	12	2.0100	0.779	22.9768125	1.23705666	7	0.4982	0.001	0.036	1.177	34.757	3.58%
131.35	12	2.0100	0.528	15.5767965	1.23705666	7	0.4982	0.001	0.036	0.926	27.357	2.81%
68.95	12	2.0100	0.277	8.1767805	1.23705666	7	0.4982	0.001	0.036	0.675	19.957	2.05%
6.55	12	2.0100	0.026	0.7767645	1.23705666	7	0.4982	0.001	0.036	0.424	12.557	1.29%
6.55	12	2.0100	0.026	0.7767645	1.23705666	7	0.4982	0.001	0.036	0.424	12.557	1.29%
68.95	12	2.0100	0.277	8.1767805	1.23705666	7	0.4982	0.001	0.036	0.675	19.957	2.05%
131.35	12	2.0100	0.528	15.5767965	1.23705666	7	0.4982	0.001	0.036	0.926	27.357	2.81%
193.75	12	2.0100	0.779	22.9768125	1.23705666	7	0.4982	0.001	0.036	1.177	34.757	3.58%

DCB11-01	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB11-02	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB11-00							
DCB11-03	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB11-04	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB11-05	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB11-06	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB11-07	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB12-01	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB12-02	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB12-00							
DCB12-03	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB12-04	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB12-05	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB12-06	2	29.5	62.4	14	3.1900	0.398	11.744304
DCB12-07	2	29.5	62.4	14	3.1900	0.398	11.744304

198.842	12	2.0100	0.799	23.58067278	1.23705666	7	0.4982	0.001	0.036	1.197	35.361	3.64%
136.442	12	2.0100	0.548	16.18065678	1.23705666	7	0.4982	0.001	0.036	0.946	27.961	2.88%
6.55	12	2.0100	0.026	0.7767645	1.23705666	7	0.4982	0.001	0.036	0.424	12.557	1.29%
6.55	12	2.0100	0.026	0.7767645	1.23705666	7	0.4982	0.001	0.036	0.424	12.557	1.29%
68.95	12	2.0100	0.277	8.1767805	1.23705666	7	0.4982	0.001	0.036	0.675	19.957	2.05%
131.35	12	2.0100	0.528	15.5767965	1.23705666	7	0.4982	0.001	0.036	0.926	27.357	2.81%
193.75	12	2.0100	0.779	22.9768125	1.23705666	7	0.4982	0.001	0.036	1.177	34.757	3.58%
203.934	12	2.0100	0.82	24.18453306	1.23705666	7	0.4982	0.001	0.036	1.218	35.965	3.70%
141.534	12	2.0100	0.569	16.78451706	1.23705666	7	0.4982	0.001	0.036	0.967	28.565	2.94%
6.55	12	2.0100	0.026	0.7767645	1.23705666	7	0.4982	0.001	0.036	0.424	12.557	1.29%
6.55	12	2.0100	0.026	0.7767645	1.23705666	7	0.4982	0.001	0.036	0.424	12.557	1.29%
131.35	12	2.0100	0.528	15.5767965	1.23705666	7	0.4982	0.001	0.036	0.926	27.357	2.81%
193.75	12	2.0100	0.779	22.9768125	1.23705666	7	0.4982	0.001	0.036	1.177	34.757	3.58%
131.35	12	2.0100	0.528	15.5767965	1.23705666	7	0.4982	0.001	0.036	0.926	27.357	2.81%

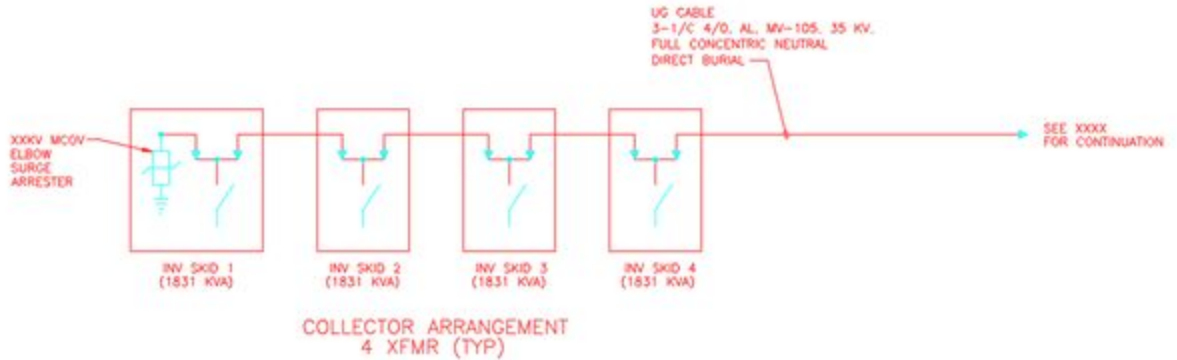
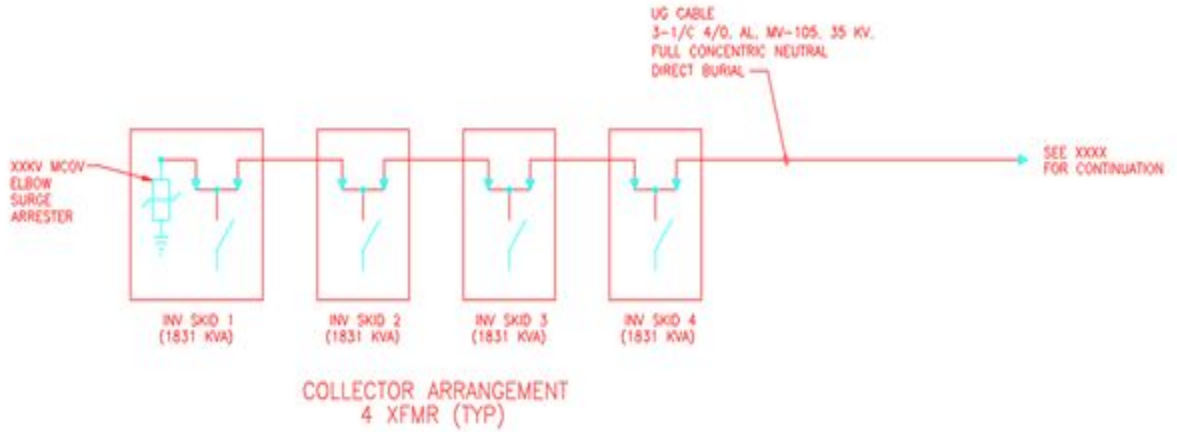
8 Input Disconnect Combiner Box (CBs 1 - 10 & 13 - 22)								
Circuit	from	to	power (W)	Voltage (Vmp)	Current (Imp)	DCB Fuse (A)	Cable Size (AWG)	Cable Length (Ft)
1	ER - 1	DCB	28,674	972	29.5	30	12	193.75
2	ER - 2	DCB	28,674	972	29.5	30	12	131.35
3	ER - 3	DCB	28,674	972	29.5	30	12	68.95
4	ER - 4	DCB	28,674	972	29.5	30	12	6.55
5	ER - 5	DCB	28,674	972	29.5	30	12	6.55
6	ER - 6	DCB	28,674	972	29.5	30	12	68.95
7	ER - 7	DCB	28,674	972	29.5	30	12	131.35
8	ER - 8	DCB	28,674	972	29.5	30	12	193.75
Total:			229,392		236			

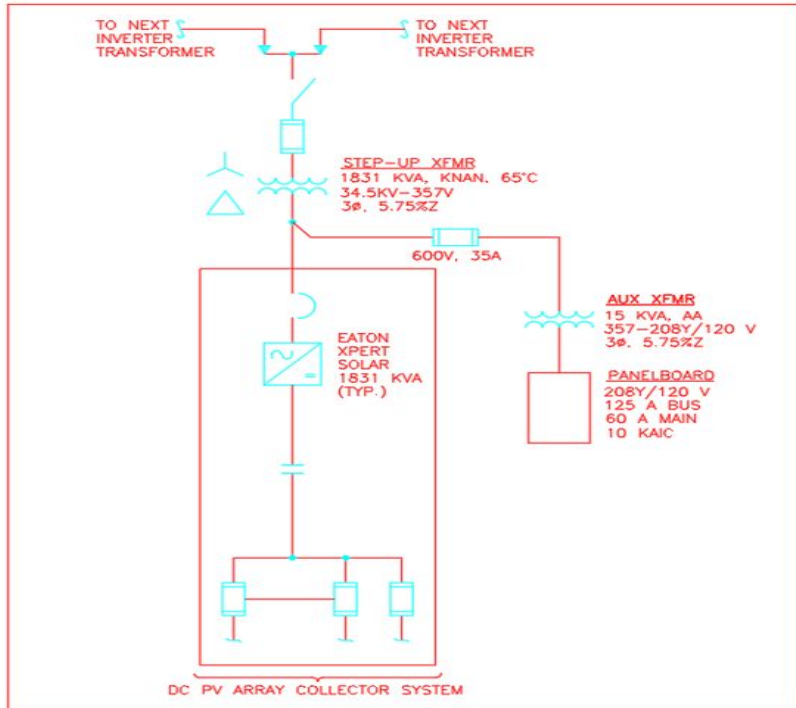
7 Input Disconnect Combiner Box (CB 11)								
Circuit	from	to	power (W)	Voltage (Vmp)	Current (Imp)	DCB Fuse (A)	Cable Size (AWG)	Cable Length (Ft)
1	ER - 1	DCB	28,674	972	29.5	30	12	198.842
2	ER - 2	DCB	28,674	972	29.5	30	12	136.442
3	ER - 3	DCB	28,674	972	29.5	30	12	6.55
4	ER - 4	DCB	28,674	972	29.5	30	12	6.55
5	ER - 5	DCB	28,674	972	29.5	30	12	68.95
6	ER - 6	DCB	28,674	972	29.5	30	12	131.35
7	ER - 7	DCB	28,674	972	29.5	30	12	193.75
Total:			200,718		206.5			

7 Input Disconnect Combiner Box (CB 12)								
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	12	203.934
2	ER - 2	DCB	28,674	972	29.5	30	12	141.534
3	ER - 3	DCB	28,674	972	29.5	30	12	6.55
4	ER - 4	DCB	28,674	972	29.5	30	12	6.55
5	ER - 5	DCB	28,674	972	29.5	30	12	131.35
6	ER - 6	DCB	28,674	972	29.5	30	12	131.35
7	ER - 7	DCB	28,674	972	29.5	30	12	193.75
Total:			200,718		206.5			

Ahmed and Chufu:

- Transformer rating calculation
- output collector current calculation
- AutoCAD drawing
- Modifying the collector parameters bases on the calculations





1831 KVA INVERTER TRANSFORMER DETAIL

The max current output of 1 skid (inverter and transformer)

Using the AUX XFNR 15 KVA

$$I = 15000 \text{ VA} / (208 \times 1.732) = 41 \text{ A}$$

Each collector is attached to 3 inverter skid the total Amp is 123 A

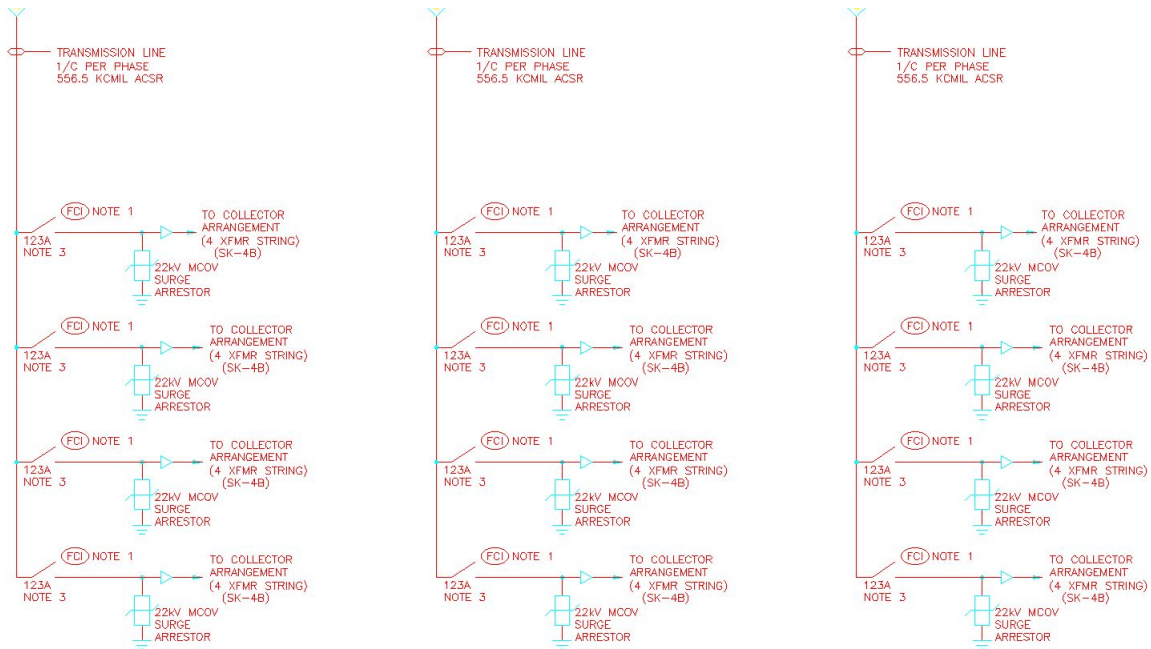
3 Phase Transformer

Max current = 3000 A

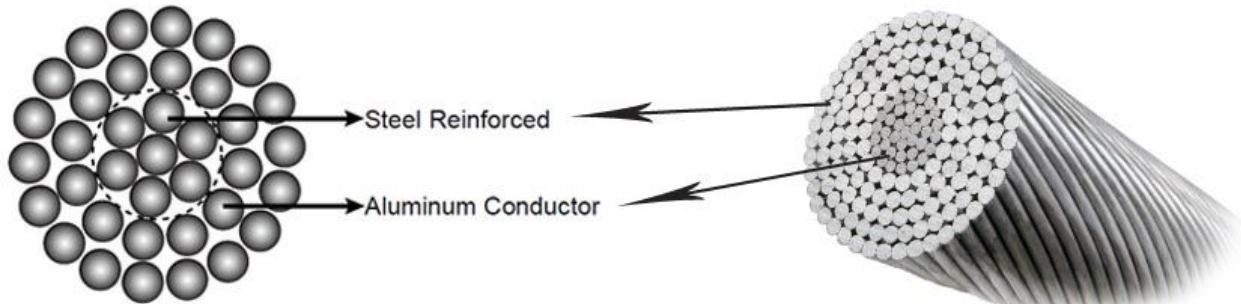
Rated Voltage = 357

$$\text{Transformer rating} = (3000 \times 357 \times 1.732) = 1854 \text{ KVA}$$

Tam and YJ: -



- Conductor for Feeder Line
 Aluminum Conductor Steel Reinforced (ACSR)
 High-purity aluminum for good conductivity, low weight, and cost
 Zinc coated steel core wire is for strength to support the weight of the conductor (lower elasticity from deformity)



- About ACSR
 Given from the AutoCAD, the size that we are choosing for ACSR is 556.5KCM.
 Which one of these should we choose?
 Current per feeder = $4 \times 123 \text{ A}$
 = 492 A

Code Word	Size (AWG or komil)	Strand- ing (Al/Stl)	Rated Strength (lbs.)	Resistance OHMS/1000 ft.		Allowable Ampacity* (Amps)
				DC @ 20°C	AC @ 75°C	
Osprey	556.5	18/1	13700	0308	0379	711
Parakeet	556.5	24/7	19800	0307	0378	721
Dove	556.5	26/7	22600	0306	0375	726
Eagle	556.5	30/7	27800	0303	0372	734
Ostrich	300	26/7	12700	0587	0693	492
Merlin	336.4	18/1	8680	0510	0625	519
Linnet	336.4	26/7	14100	0505	0618	529
Orion	336.4	30/7	17300	0502	0613	535

Pending Issues:

- In the voltage drop calc template, what is “one way distance not to exceed” referring to?

Plans For Next Week:

Kat and Nur:

- Rearrange solar plant components in array rows 11 and 12
- Produce final versions of solar layout and voltage drop calculations based on client’s feedback

Tam and YJ: -

- Finalize everything about feeder.

Amed and Chufu: -

- Finalize everything about collector.

Individual Contributions

Team Member	Individual Contributions	Hours	Cumulative Hours
Katayi Katanga	Did research on: <ul style="list-style-type: none">- Voltage drop- NEC Created/Performed: <ul style="list-style-type: none">- Voltage drop calculations- Conductor Sizing- Plan for wiring- Attend all meetings	10	87
Nur Shuazlan	Did research on: <ul style="list-style-type: none">- Voltage drop- NEC Created/Performed: <ul style="list-style-type: none">- Voltage drop calculations- Conductor Sizing- Plan for wiring- Attend all meetings	10	89

Yao Cheah (YJ)	<p>Did research on:</p> <ul style="list-style-type: none"> - Conductor for feeder - Surge arrestor properties <p>Created/Performed:</p> <ul style="list-style-type: none"> - Attended all meetings - Did safety moment 	8.5	62
Ahmed Sobi	<p>Did research on:</p> <ul style="list-style-type: none"> - 3 phase transformer rating - Inverter specification - Inverter skid layout - Output current of the transformer <p>Created/Performed:</p> <ul style="list-style-type: none"> - Skid parameters - AutoCAD pdf version - calculation for collector parameters - Attended all meetings 	17.5	80
Tam Nguyen	<p>Did research on:</p> <ul style="list-style-type: none"> - Conductor for feeder - Price of surge arrester <p>Created/Performed:</p> <ul style="list-style-type: none"> - Weekly report - Meeting agenda - Attend one meeting 	6	64.5
Chufu Zhou	<p>Did research on:</p> <ul style="list-style-type: none"> - 3 phase transformer rating - Inverter specification - Inverter skid layout - Output current of the transformer <p>Created/Performed:</p> <ul style="list-style-type: none"> - Wiring diagram of array layout 	12	59

Team Hours: 64

Cumulative Team Hours: 441.5