34.5/115 kV Solar Power Plant & Substation Senior Design Project

Senior Design Team 18 - May 2024

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Agenda

- Safety Moment
- AutoCAD Drawings
  ○
- Voltage Drops + Cost calculations
- ETAP

Eli

Safety Moment - Cyber Security

Why it is important:
- Protect sensitive information
- Protect company equipment
- Prevent potential cyber attacks and various network issues

How to practice it:
- Keep login information private
- Ensure login details are complex
- Keep an eye out for phishing attempts
- Do not access sensitive information on vulnerable networks
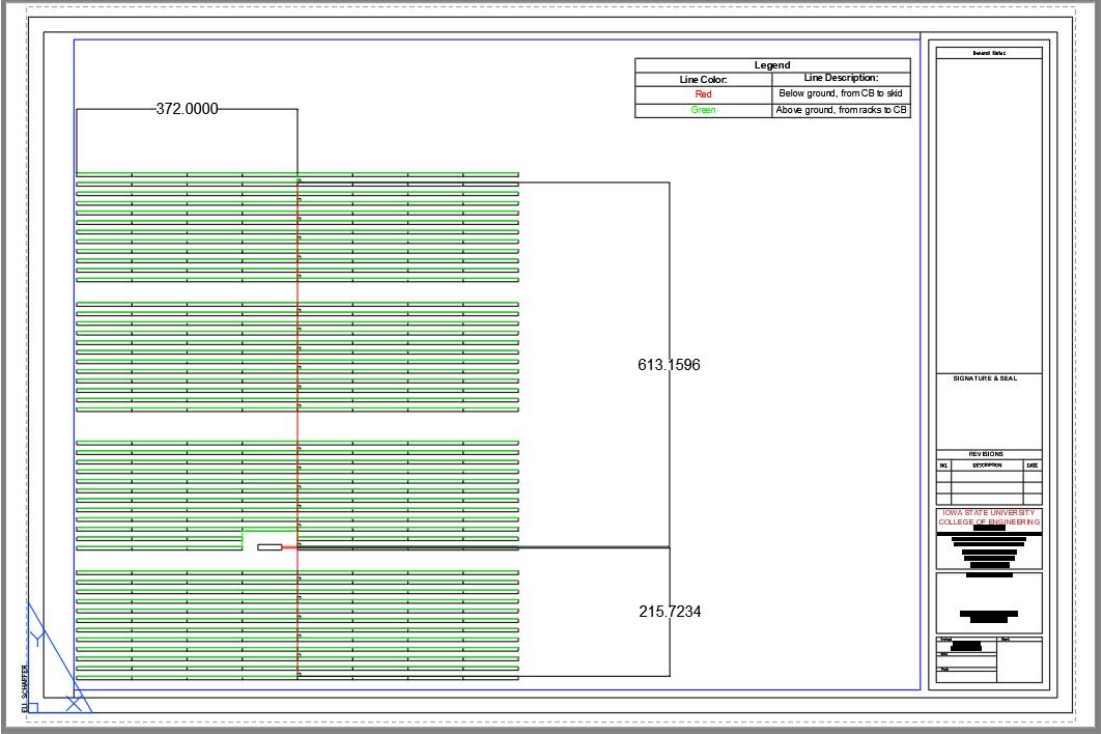- Deny access to unauthorized personnel
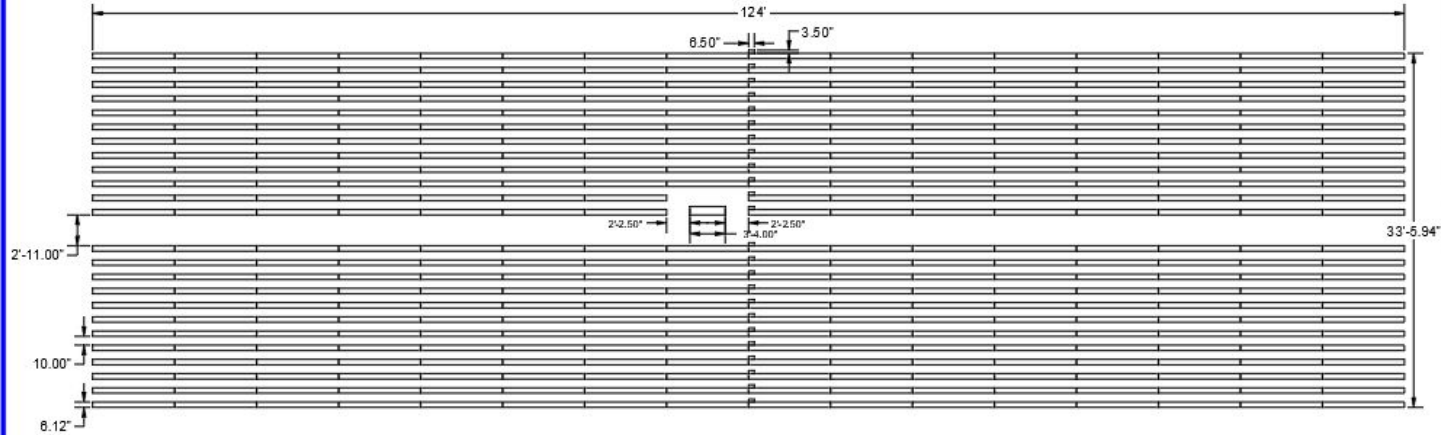
PV104 - Horizontal Wiring Layout
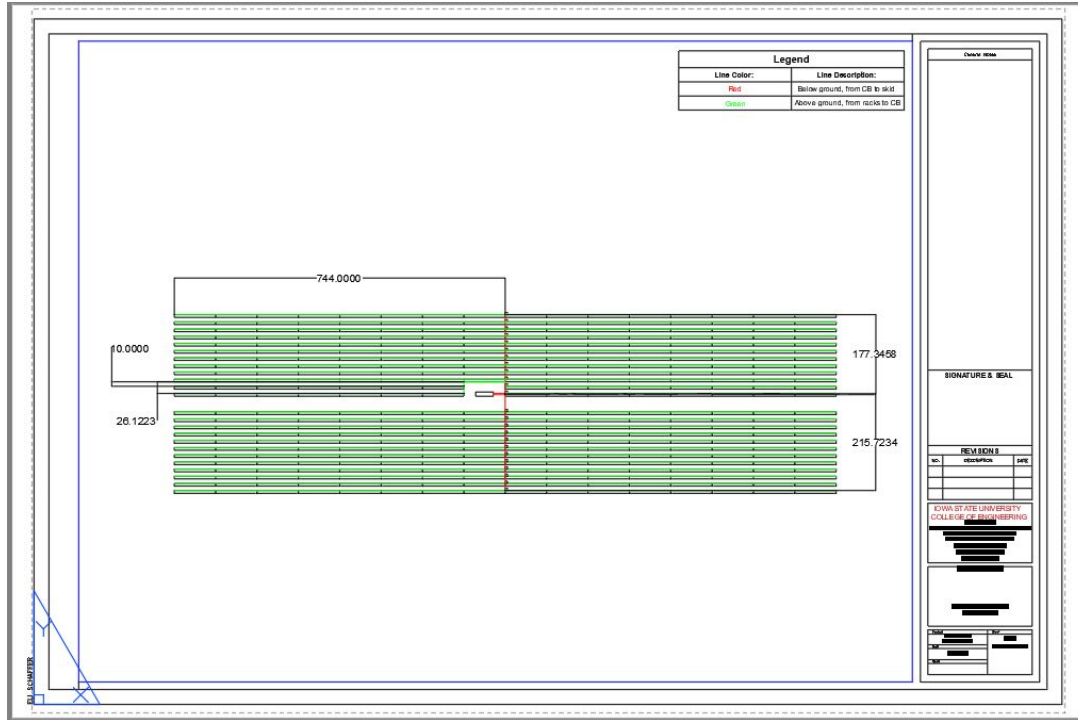
- Added dimensions for wire distances
- Color coordinated wire types

PV105 - Vertical Wiring Layout

Array Plan - Horizontal - UPDATED

Array Plan - Vertical - UPDATED

Site Plan - UPDATED

- Brought in overall solar array layout
- Added additional dimensions
- Detailed view for substation
- Add another details for road access to solar field

Site Plan Detailed Views

- Call out detailed plan for the substation location
- Will add more dimensioning and line work details

PV106 - PV Details

Existing Transmission Lines
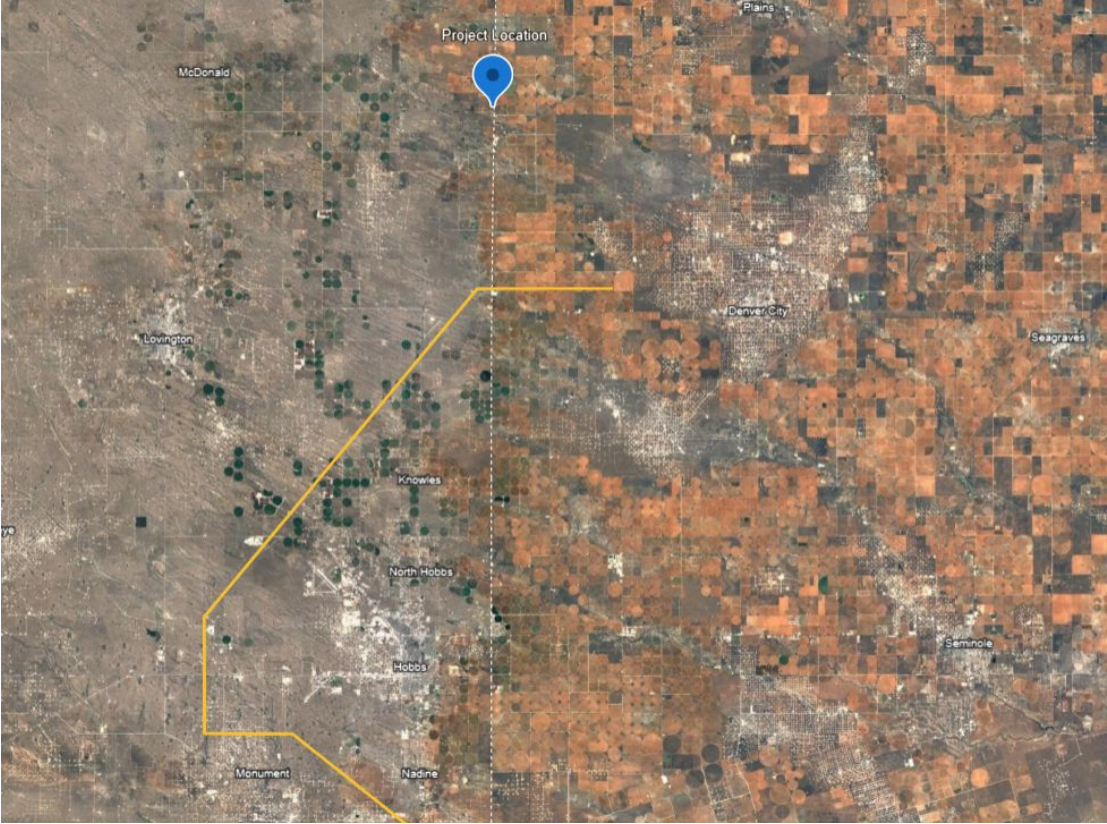
From project location it is about 10 miles.

Voltage Drop calculation

Horizontal array

Met the NEC requirement Vd < 3%

Voltage-Drop Calculation = <3%

16 racks Combiner box (Horizontal Array)

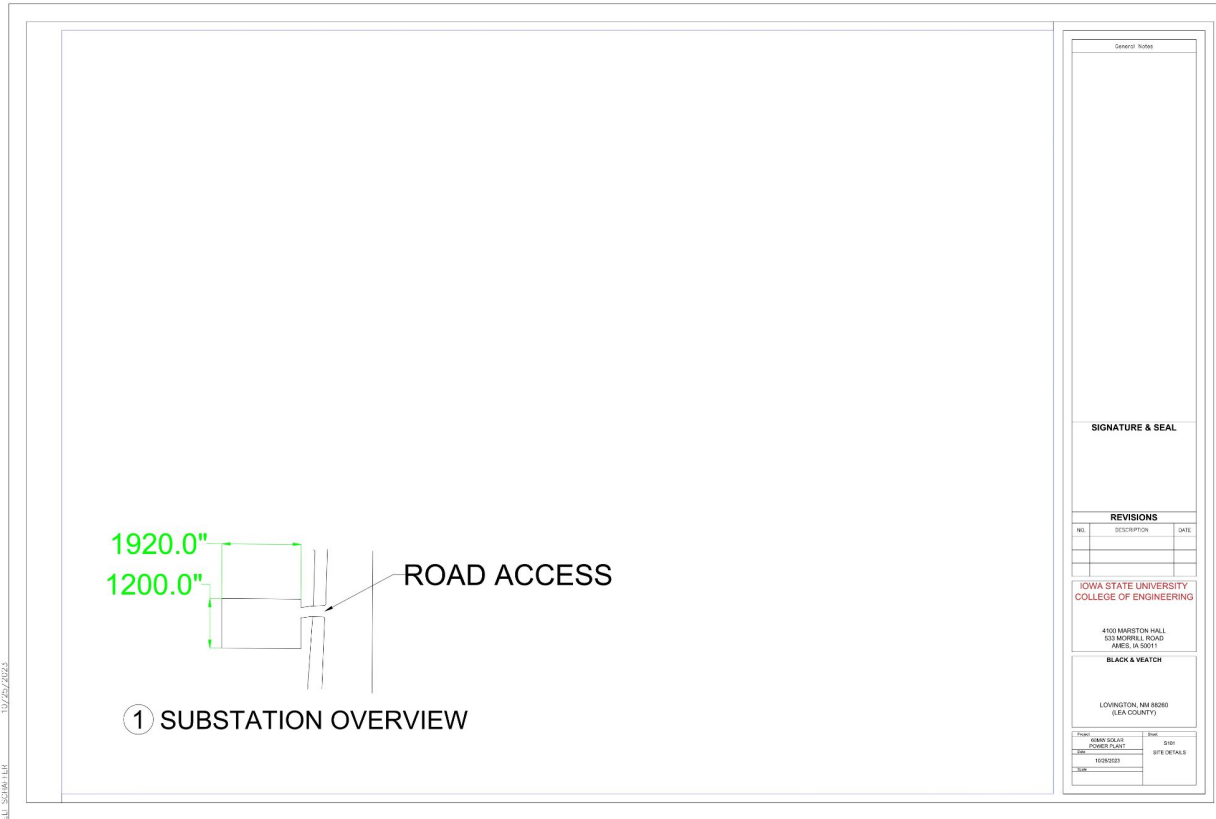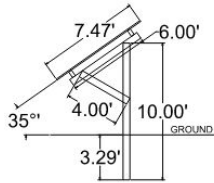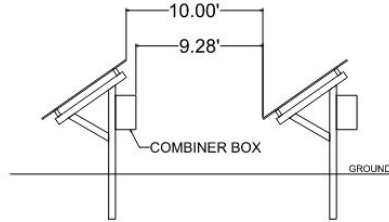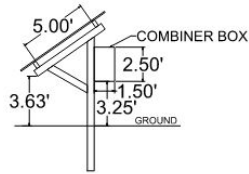| DCB	Strings per rack	ISC for string	String length	String wire size	String conductor resistance	String resistance	Voltage drop of string(AWG #12)	Voltage drop of string
DCB#-##	per rack	Amp	feet	AWG	ohm/kft	ohm	Volts	%
DCB1-01	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-02	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-03	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-04	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-05	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-06	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-07	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-08	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-09	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-10	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-11	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-12	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-13	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-14	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-15	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-16	1	13.89	93	12	1.98	0.18414	5.115	0.341

Resources — NEC Table 8 Conductor Properties / NEC AWG Chart

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/kft	Ohm	Volt	per cent	Volt	Volt	per cent
DCB1	16	222.24	161	600	0.0241	0.004	1.725	0.11	11.96	1500	0.80
DCB2	16	222.24	151	600	0.0241	0.004	1.618	0.11	11.85	1500	0.79
DCB3	16	222.24	141	600	0.0241	0.003	1.510	0.10	11.74	1500	0.78
DCB4	16	222.24	131	600	0.0241	0.003	1.403	0.09	11.63	1500	0.78
DCB5	16	222.24	121	600	0.0241	0.003	1.296	0.09	11.53	1500	0.77
DCB6	16	222.24	111	600	0.0241	0.003	1.189	0.08	11.42	1500	0.76
DCB7	16	222.24	101	600	0.0241	0.002	1.082	0.07	11.31	1500	0.75
DCB8	16	222.24	91	600	0.0241	0.002	0.975	0.06	11.21	1500	0.75
DCB9	16	222.24	81	600	0.0241	0.002	0.868	0.06	11.10	1500	0.74
DCB10	16	222.24	71	600	0.0241	0.002	0.761	0.05	10.99	1500	0.73
DCB11	16	222.24	61	600	0.0241	0.001	0.653	0.04	10.88	1500	0.73
DCB12	14	222.24	51	600	0.0241	0.001	0.546	0.04	10.78	1500	0.72
DCB13	14	222.24	41	600	0.0241	0.001	0.439	0.03	10.67	1500	0.71
DCB14	16	222.24	82	600	0.0241	0.002	0.878	0.06	11.11	1500	0.74
DCB15	16	222.24	92	600	0.0241	0.002	0.986	0.07	11.22	1500	0.75
DCB16	16	222.24	102	600	0.0241	0.002	1.093	0.07	11.32	1500	0.75
DCB17	16	222.24	112	600	0.0241	0.003	1.200	0.08	11.43	1500	0.76
DCB18	16	222.24	122	600	0.0241	0.003	1.307	0.09	11.54	1500	0.77
DCB19	16	222.24	132	600	0.0241	0.003	1.414	0.09	11.64	1500	0.78
DCB20	16	222.24	142	600	0.0241	0.003	1.521	0.10	11.75	1500	0.78
DCB21	16	222.24	152	600	0.0241	0.004	1.628	0.11	11.86	1500	0.79
DCB22	16	222.24	162	600	0.0241	0.004	1.735	0.12	11.97	1500	0.80
DCB23	16	222.24	172	600	0.0241	0.004	1.842	0.12	12.07	1500	0.80
DCB24	16	222.24	182	600	0.0241	0.004	1.950	0.13	12.18	1500	0.81

Average of worst-case DCB Voltage drop (%) — 0.76

Voltage Drop Calculation

Vertical array

Voltage-Drop Calculation = <3%

Met the NEC requirement Vd < 3%

Resources	NEC Table 8 Conductor Properties
	NEC AWG Chart

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)	Voltage drop of string
DCB#-##	per rack	Amp	feet	AWG	ohm/kft	ohm	Volts	%
DCB1-01	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-02	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-03	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-04	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-05	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-06	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-07	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-08	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-09	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-10	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-11	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-12	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-13	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-14	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-15	1	13.89	93	12	1.98	0.18414	5.115	0.341
DCB1-16	1	13.89	93	12	1.98	0.18414	5.115	0.341

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/kft	Ohm	Volt	per cent	Volt	Volt	per cent
DCB1	16	222.24	607	600	0.0214	0.013	5.774	0.38	16.005	1500	1.07
DCB2	16	222.24	585	600	0.0214	0.013	5.564	0.37	15.795	1500	1.05
DCB3	16	222.24	563	600	0.0214	0.012	5.355	0.36	15.586	1500	1.04
DCB4	16	222.24	541	600	0.0214	0.012	5.146	0.34	15.377	1500	1.03
DCB5	16	222.24	519	600	0.0214	0.011	4.937	0.33	15.167	1500	1.01
DCB6	16	222.24	497	600	0.0214	0.011	4.727	0.32	14.958	1500	1.00
DCB7	16	222.24	440	600	0.0214	0.009	4.185	0.28	14.416	1500	0.96
DCB8	16	222.24	418	600	0.0214	0.009	3.976	0.27	14.207	1500	0.95
DCB9	16	222.24	396	600	0.0214	0.008	3.767	0.25	13.998	1500	0.93
DCB10	16	222.24	374	600	0.0214	0.008	3.557	0.24	13.788	1500	0.92
DCB11	16	222.24	352	600	0.0214	0.008	3.348	0.22	13.579	1500	0.91
DCB12	14	222.24	330	600	0.0214	0.007	3.139	0.21	13.370	1500	0.89
DCB13	14	222.24	258	600	0.0214	0.006	2.454	0.16	12.685	1500	0.85
DCB14	16	222.24	236	600	0.0214	0.005	2.245	0.15	12.476	1500	0.83
DCB15	16	222.24	214	600	0.0214	0.005	2.036	0.14	12.266	1500	0.82
DCB16	16	222.24	192	600	0.0214	0.004	1.826	0.12	12.057	1500	0.80
DCB17	16	222.24	170	600	0.0214	0.004	1.617	0.11	11.848	1500	0.79
DCB18	16	222.24	148	600	0.0214	0.003	1.408	0.09	11.639	1500	0.78
DCB19	16	222.24	91	600	0.0214	0.002	0.866	0.06	11.096	1500	0.74
DCB20	16	222.24	113	600	0.0214	0.002	1.075	0.07	11.306	1500	0.75
DCB21	16	222.24	135	600	0.0214	0.003	1.284	0.09	11.515	1500	0.77
DCB22	16	222.24	157	600	0.0214	0.003	1.493	0.10	11.724	1500	0.78
DCB23	16	222.24	179	600	0.0214	0.004	1.703	0.11	11.933	1500	0.80
DCB24	16	222.24	201	600	0.0214	0.004	1.912	0.13	12.143	1500	0.81
									Average of worst-case DCB Voltage drop		0.89

ETAP Simulation
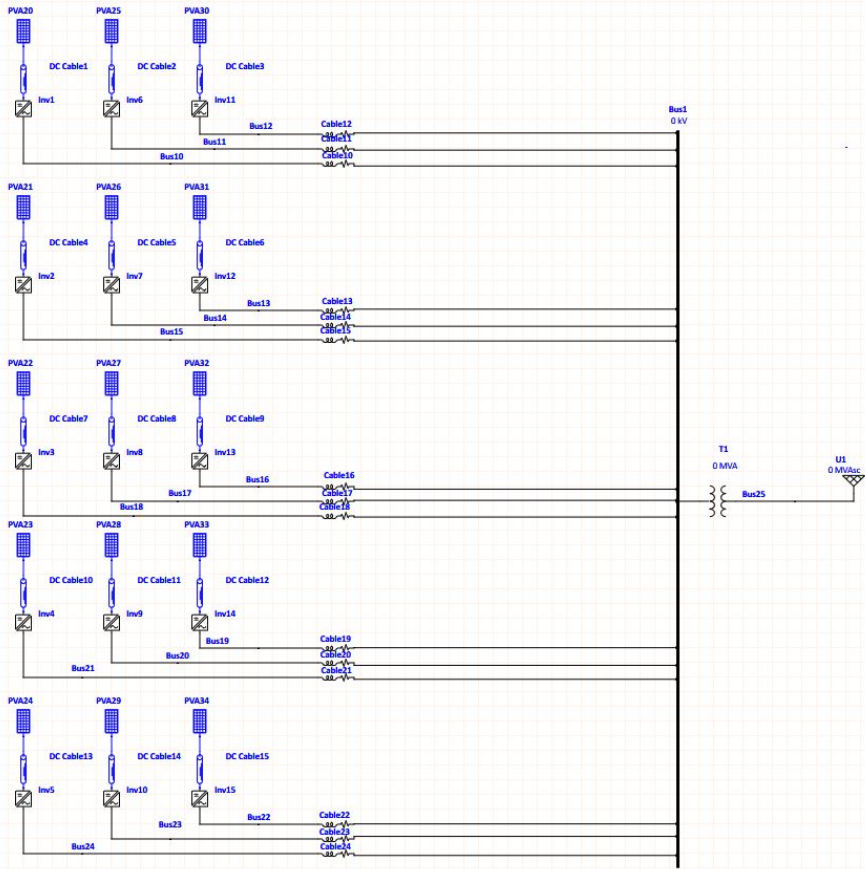
Feedback and Updates

- Saw the comments back
- Advisor presentations on 12/6
- Tasks: Pick up comments
    - Chicheng - ETAP, AC One Line
    - Liam - DC One Line
    - Baylor - Site Plans (Roads/feeders etc)
    - Bell - Has stuff
    - Eduardo - String Connection Diagram
    - Eli - Title Block Updates, Details,