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Department of Electrical and Computer Engineering


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

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| Senior Design Team 41

| 11/14/2024

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# Agenda

- Safety Moment – Heavy Machinery
- New Technology – Night Solar Panels
- AutoCAD cross sectional-view of panels and mounting
- Site Plan – Array on actual plot of land
- Updates on voltage drop calculations

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# Safety Moment

**Heavy Machinery**

Hazard: Heavy equipment as cranes used in solar farm construction pose risks of crushing injuries, accidents, and property damage if not properly operated.

Recommendations:

- Certified and Trained Personnel: Ensure only qualified operators handle machinery.
- Communication System: Establish clear communication channels for safe operations.
- Maintain a Safe Perimeter: Set boundaries to keep unauthorized personnel at a safe distance.
- Situational Awareness: Stay aware of surroundings and nearby operators.
- Visual and Audio Cues: Pay close attention to signals from operating machinery.
- Personal Protective Equipment (PPE): Verify that all required PPE is worn in and around machinery.

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# New Technology

## Night solar panels

Definition: advanced photovoltaic systems that generate electricity not only from sunlight during the day but also harness thermal or ambient energy sources at night.

Features:

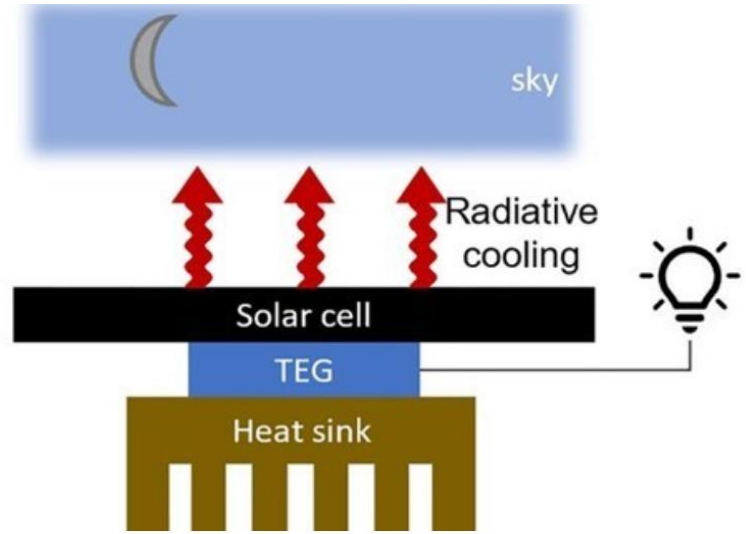
- Dual-Mode operation
- Thermoelectric Generators (TEGs)
- Low-Light Sensitivity
- Integrated Cooling for Daytime efficiency

Advantages:

- Continuous Power Generation
- Increased Energy Yield
- Greater Grid Stability
- Improved Efficiency in High-Temperature Regions
- Reduced Battery Storage Dependency

Disadvantages:

- Lower Power Output at Night
- Higher Cost and Complexity
- Efficiency Dependence on Environmental Conditions
- Limited Commercial Availability
- Potential Maintenance Issues



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# Ground Mounting Research

- Looked into Opsun Ground Mounting System
- Designed specifically for bifacial solar panels
  - All rails on the edge of the PVs, not under them. No component blocking the backside of the panels.
- Any suggestions?

https://opsun.com/en/commercial/ground-mount-c/sungroundu2122-seasonal/

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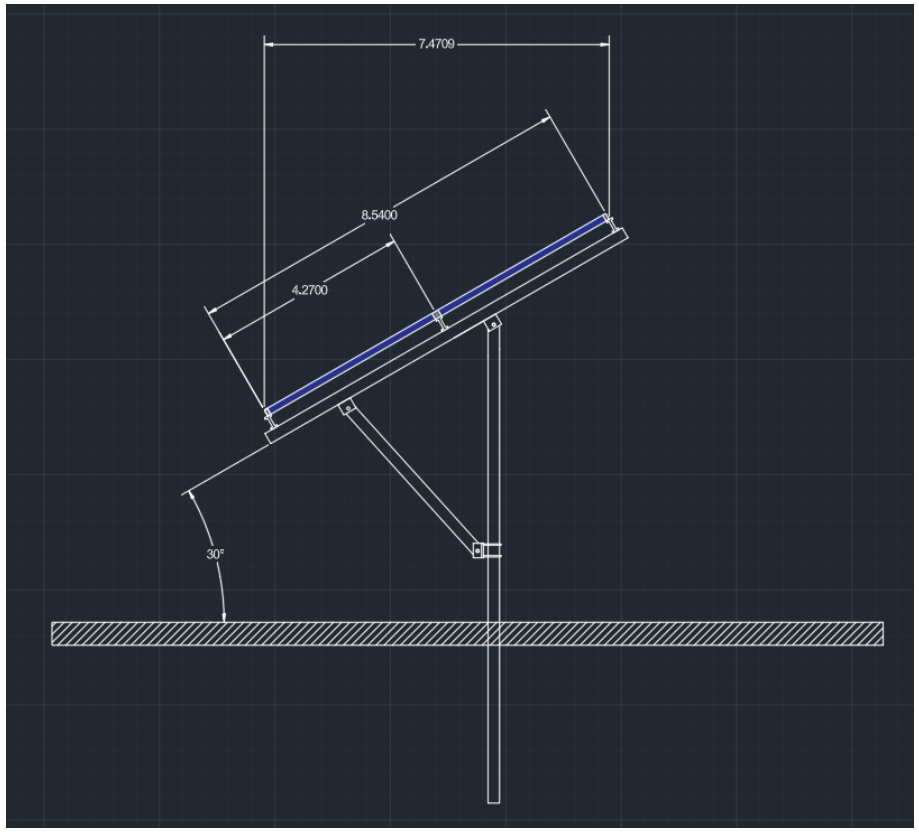
# Side View of Panels & Ground Mounting

- Initial AutoCAD drawings created
- 30 Degree Tilt
- Will have to change height from ground, etc.
- Will have to add combiner box in other drawings



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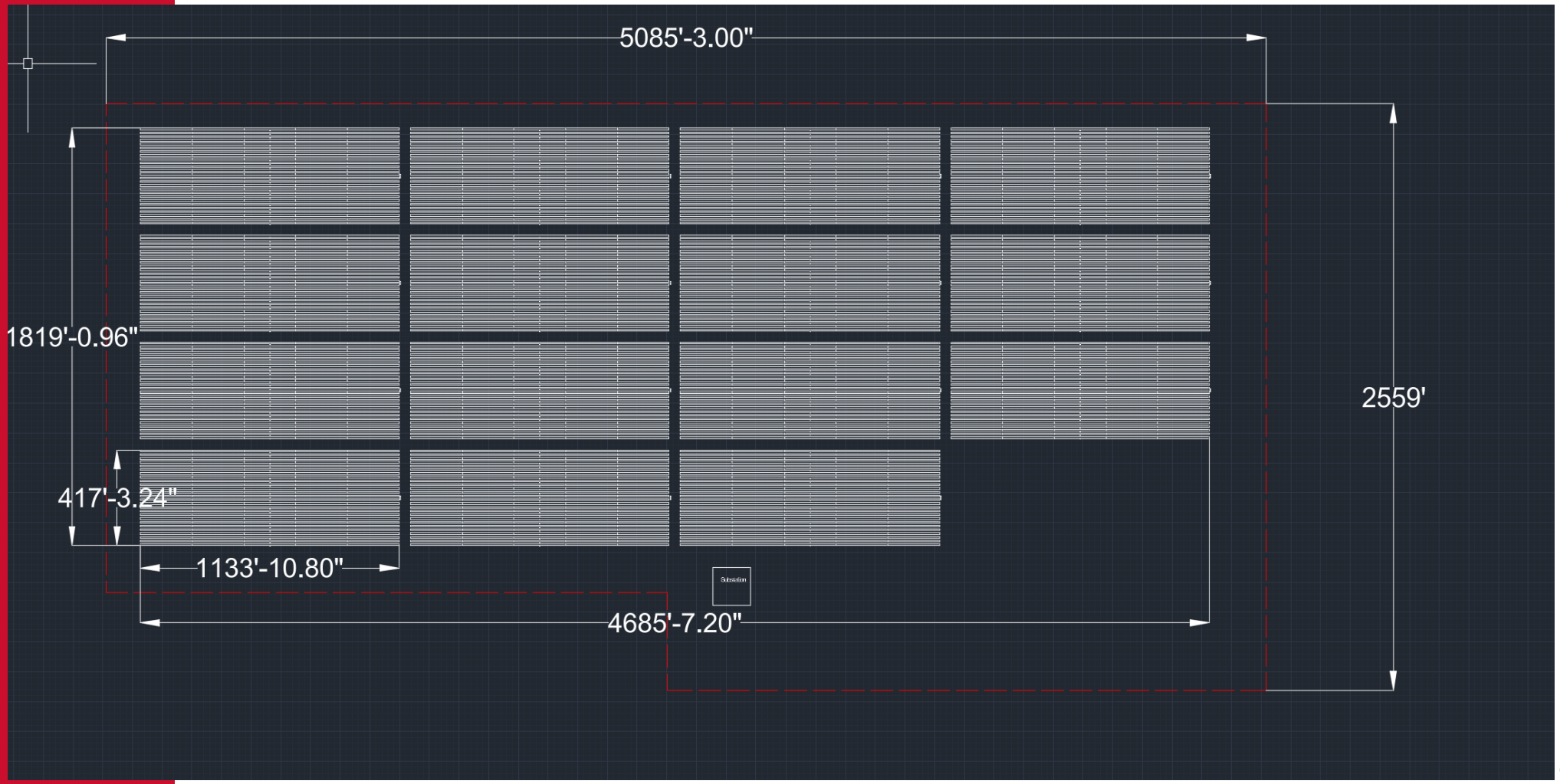
# Full Array on Plot of Land



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# String voltage drop

| DCB | Strings per Rack | IMP for String | String Length | String wire size | String Conductor resistance | String 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 | Amp | 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 | 7.876926 | 28 | 569 | 8 | 0.7640 | 0.8409313 | 24.344096 | 0.525128427 | 1.622939733 |
| DCB1-02 | 2 | 14 | 226.87 | 10 | 1.2400 | 0.5448151 | 7.876926 | 28 | 342 | 8 | 0.7640 | 0.5061071 | 14.632128 | 0.525128427 | 0.9754752 |
| DCB1-03 | 2 | 14 | 226.87 | 10 | 1.2400 | 0.5448151 | 7.876926 | 28 | 115 | 8 | 0.7640 | 0.1703152 | 4.92016 | 0.525128427 | 0.328010667 |
| DCB1-04 | 2 | 14 | 226.87 | 10 | 1.2400 | 0.5448151 | 7.876926 | 28 | 342 | 8 | 0.7640 | 0.5061071 | 14.632128 | 0.525128427 | 0.9754752 |
| DCB1-05 | 2 | 14 | 226.87 | 10 | 1.2400 | 0.5448151 | 7.876926 | 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 | | | | |

CBs DCB1-01 - DCB1-26

| Conductors | Isc(A) | IMP(A) | Type | Conductor Material | AWG Size |
|---|---|---|---|---|---|
| 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 |

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# Feeder voltage drop (Horizontal array+ vertical)

| 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 | 0.0214 | 0.0334 | | | 4.67376 | 0.06% | 42.182504 | 1500.00 | | | 2.81% |
| | | sum total of combiner box c | | IMP x 1.25AWG size ab | Table 8 NEC | | | | | | | Voltage your strings/ | Average of worst-case DCB voltage drop: | | 2.81% |

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