

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

Senior Design Team 18 - May 2024

Siti Mohd Radzi, Baylor Clark, Eduardo Jimenez-Tzompaxtle,
Chicheng Tang, Eli Schaffer, Liam Gossman



BLACK & VEATCH



Agenda

- Safety Moment
- Updated AutoCAD Drawings
 - Cover Page
 - Site Plan
 - Array Drawings
- New One line drawings



Safety Moment - Chicheng

Heat Stress Prevention

- Environmental Controls
 - Install air conditioning or cooling system in plants.
 - Implement local exhaust at points of high heat production
- Personal Protection Equipment
 - Provide cooling vest or bands
 - Supply water or cooling station
- Training and Awareness
 - Training on the dangers of heat stress
 - Teach to recognize symptoms of heat-related illnesses
 - Post signs to remind to drink water and take break
- Emergency Response Plans
 - Clear plan for responding to signs of heat illness
 - Ensure easy access to cool area or emergency equipment
- Diet and Hydration
 - Make electrolyte-replenishing drinks available in addition to water
 - Encourage a balanced diet to resilience to heat



Title Sheet Update

LOVINGTON, NM SOLAR ARRAY

SPEARS RD & STATE LINE RD, LOVINGTON, NM 88260



PROJECT LOCATION MAP

| PROJECT EQUIPMENT | |
|-------------------|----------|
| TYPE | QUANTITY |
| ZNSHINE PANEL | 143,250 |
| ZRENT COMBINER | 300 |
| ABB SKID INVERTER | 15 |
| #10 AWG | 100,000' |
| 400 MCM | 50,000' |
| PRODUCT | QUAN |
| PRODUCT | QUAN |
| PRODUCT | QUAN |
| PRODUCT | QUAN |

| SHEET LIST TABLE | |
|------------------|-------------------------|
| SHEET NUMBER | SHEET TITLE |
| E100 | PROJECT TITLE |
| S100 | SITE PLAN |
| S101 | SITE KEYPLAN |
| PV100 | SOLAR KEY PLAN |
| PV101 | OVERALL ARRAY LAYOUT |
| PV102 | ARRAYS 1 - 12 LAYOUT |
| PV103 | ARRAYS 13 - 15 LAYOUT |
| PV104 | WIRING ARRAYS 1 - 12 |
| PV105 | WIRING ARRAYS 13 - 15 |
| PV106 | SOLAR DESIGN DETAILS |
| PV107 | AC ONE LINE |
| PV108 | DC ONE LINE |
| PV109 | STRING ONE LINE |
| PV110 | PANEL DATASHEET |
| PV111 | COMBINER BOX DATASHEET |
| PV112 | SKID INVERTER DATASHEET |

General Notes

SIGNATURE & SEAL

| REVISIONS | | |
|-----------|--------------------------|---------|
| NO. | DESCRIPTION | DATE |
| 1. | ISSUED FOR CLIENT REVIEW | 1/20/24 |

IOWA STATE UNIVERSITY
COLLEGE OF ENGINEERING

DESIGNED BY: [Name]
CHECKED BY: [Name]
DATE: 1/20/24
PROJECT TITLE: LOVINGTON SOLAR ARRAY

BLACK & VEATCH

LOVINGTON, NM 88260
(SUA COUNTY)

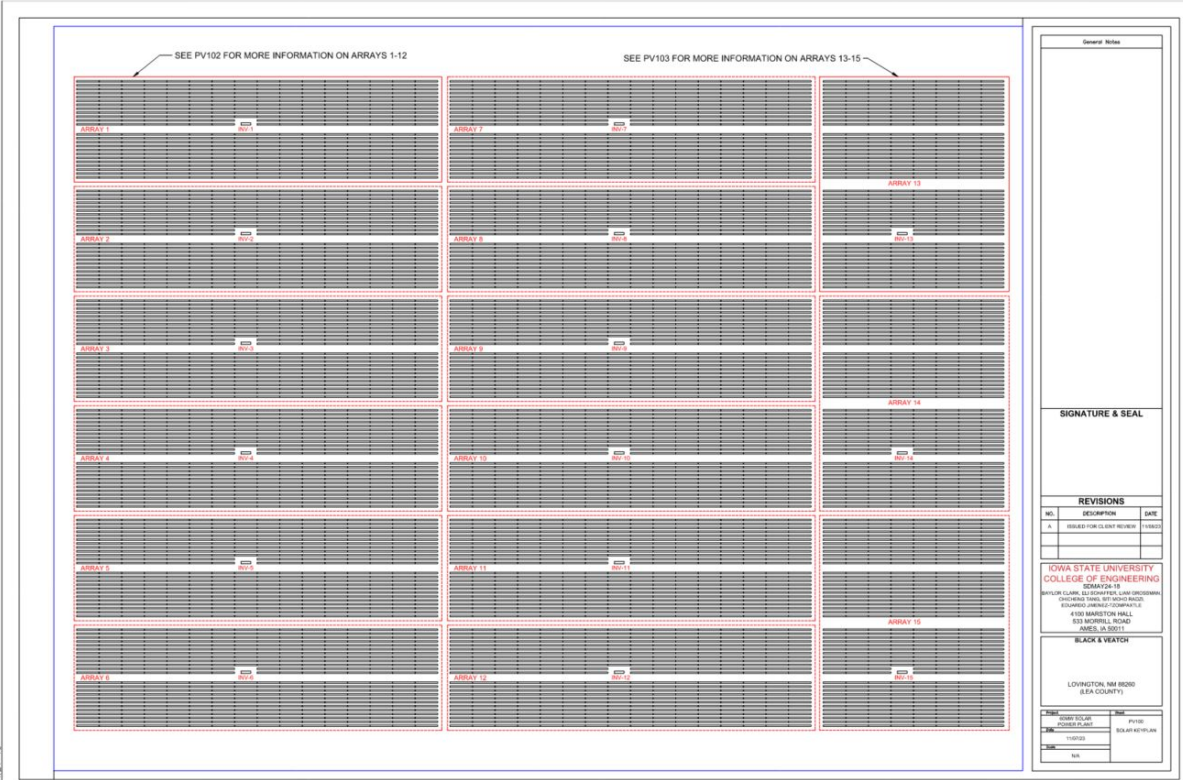
| DATE | BY | CHK |
|---------|--------|--------|
| 1/20/24 | [Name] | [Name] |
| 1/20/24 | [Name] | [Name] |

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| PV104 | WIRING ARRAYS 1 - 12 |
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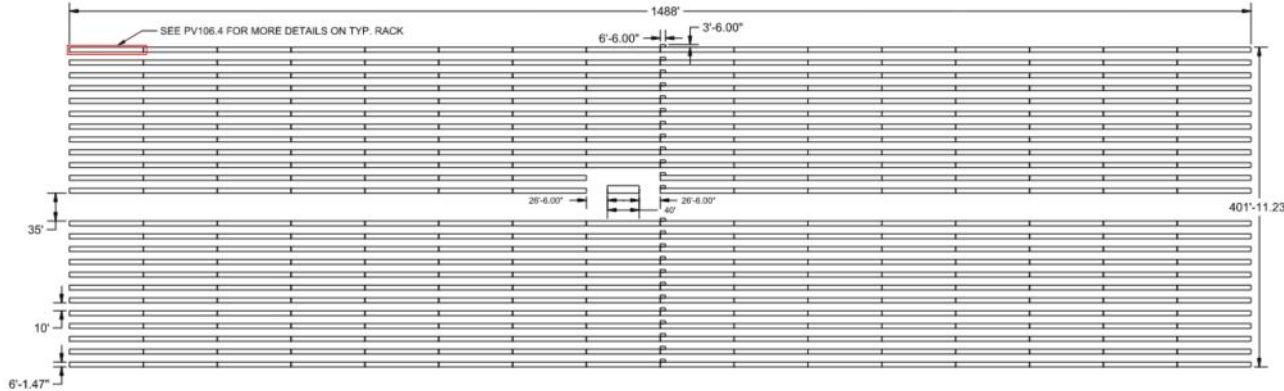
Keyplan Update



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Solar Design Details Update

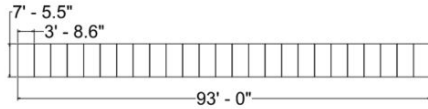


SHEET LIST TABLE

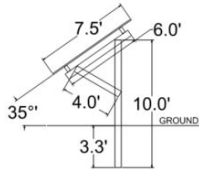
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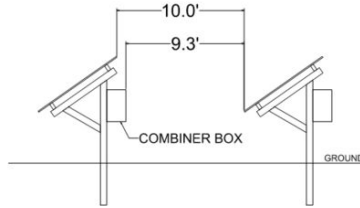
Solar Design Details Update



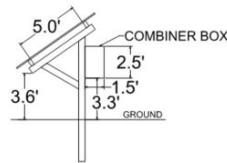
④ TYP. RACK LAYOUT
SCALE: 1" - 7.75'



② PANEL MOUNTING PROFILE
SCALE: 1" - 2.71'



③ GENERAL ARRAY MOUNTING PROFILE
SCALE: 1" - 2.71'



① COMBINER BOX MOUNTING PROFILE
SCALE: 1" - 2.71'

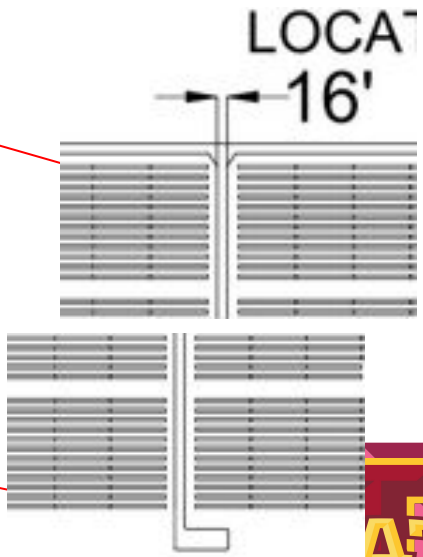
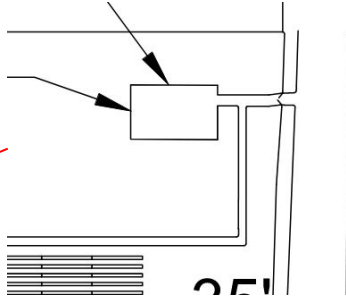
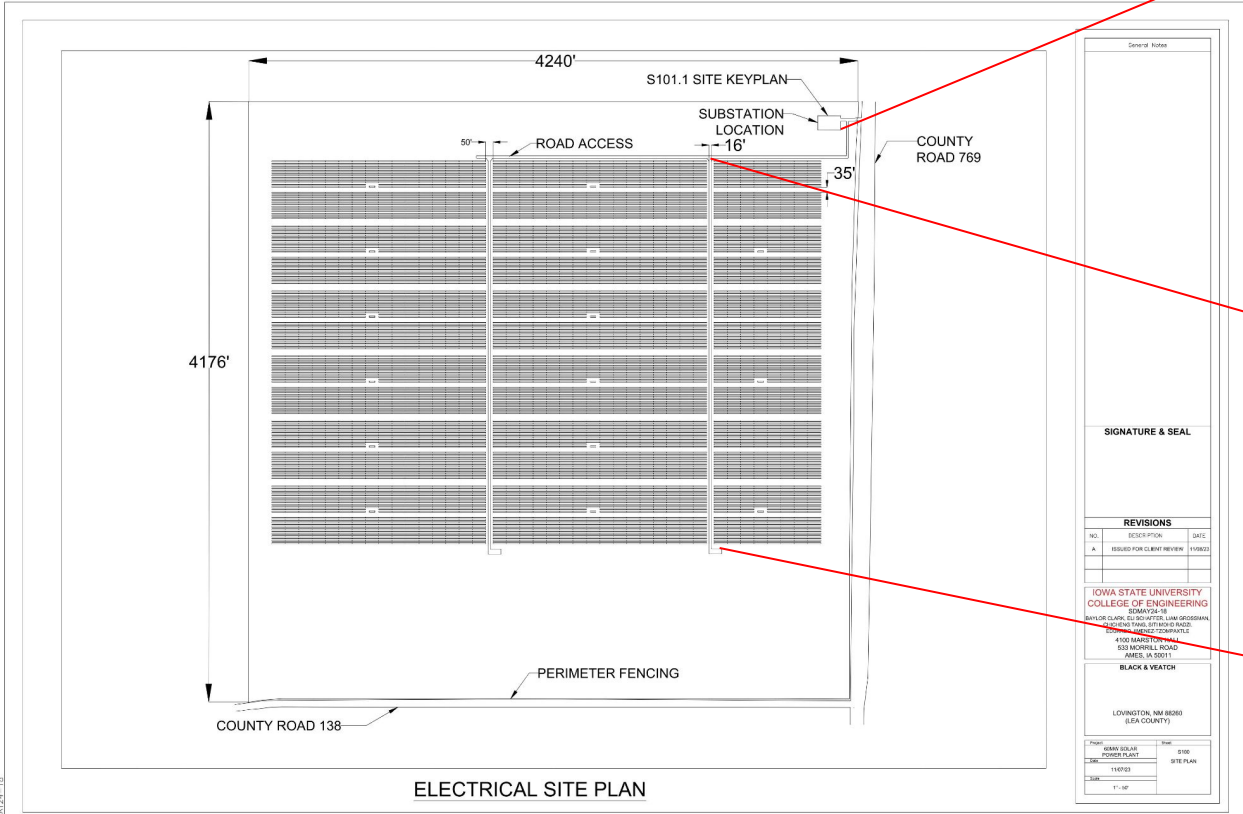
| | | |
|---|--------------------------|---------------------|
| General Notes | | |
| | | |
| SIGNATURE & SEAL | | |
| | | |
| REVISIONS | | |
| NO. | DESCRIPTION | DATE |
| A | ISSUED FOR CLIENT REVIEW | 11/05/23 |
| | | |
| | | |
| IOWA STATE UNIVERSITY COLLEGE OF ENGINEERING SCHAFFER 124 1B 1000 UNIVERSITY DRIVE, DES MOINES, IOWA 50319-1500 CONTACT: 515/281-3100 4150 MARSHALL HALL 502 MORRILL ROAD DES MOINES, IA 50319 | | |
| DRAWN BY: [REDACTED] | | |
| CHECKED BY: [REDACTED] | | |
| DATE: 11/05/23 | | |
| PROJECT: [REDACTED] | | |
| SHEET: [REDACTED] | | |
| SCALE: [REDACTED] | | |
| LOVINGTON, NM 88020 (BLA COUNTY) | | |
| DATE: 11/05/23 | BY: [REDACTED] | PROJECT: [REDACTED] |
| SCALE: [REDACTED] | BY: [REDACTED] | PROJECT: [REDACTED] |
| DATE: [REDACTED] | BY: [REDACTED] | PROJECT: [REDACTED] |
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Site Plan Updates



General Notes

SIGNATURE & SEAL

REVISIONS

| NO. | DESCRIPTION | DATE |
|-----|--------------------------|----------|
| A | ISSUED FOR CLIENT REVIEW | 11/08/23 |

IOWA STATE UNIVERSITY
 COLLEGE OF ENGINEERING
 SEMA 472-38
 8610 CLARK BUILDING, IAWA GROUNDS
 2025 END TIME, 877 408 0 8022
 2025 11/08/23

4100 MARGIE TERPAGAL
 525 MONROE ROAD
 JAMES, IA 52011

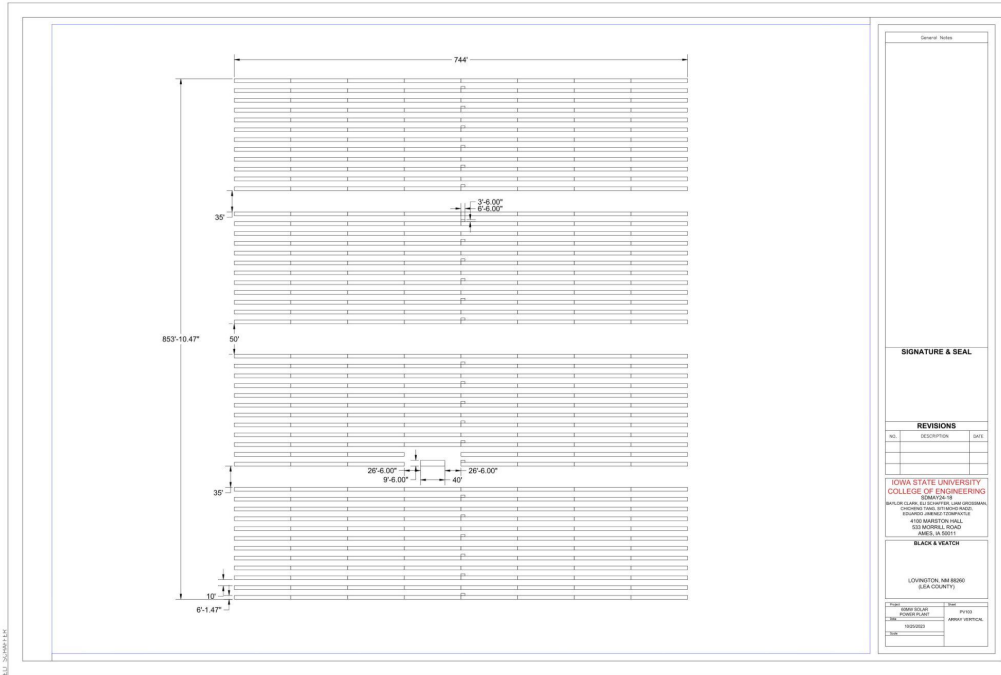
BLACK & VEATCH

LIVINGSTON, MN 56000
 (JEA COUNTY)

Project: 0888 0814 01
 SHEET: 0102
 DATE: 11/08/23
 Scale: 1" = 30'

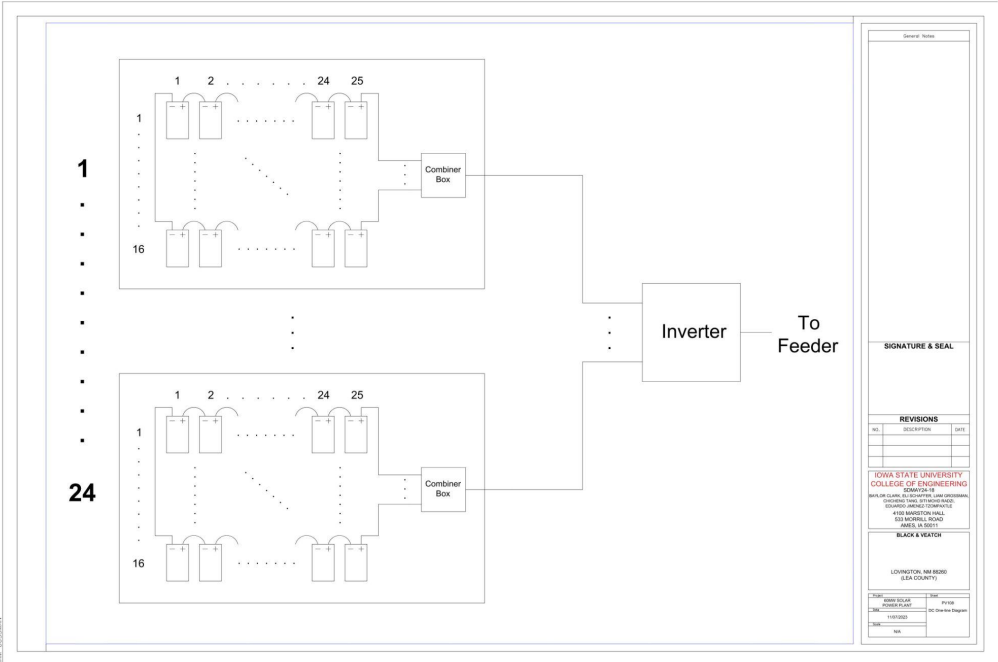


Updated Units for Drawings

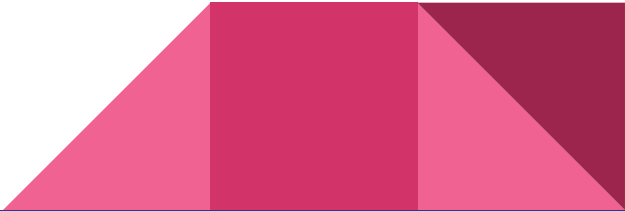


- Converted units to Engineering Standard XX'-XX"
- Fixed unit scaling to show accurate measurements

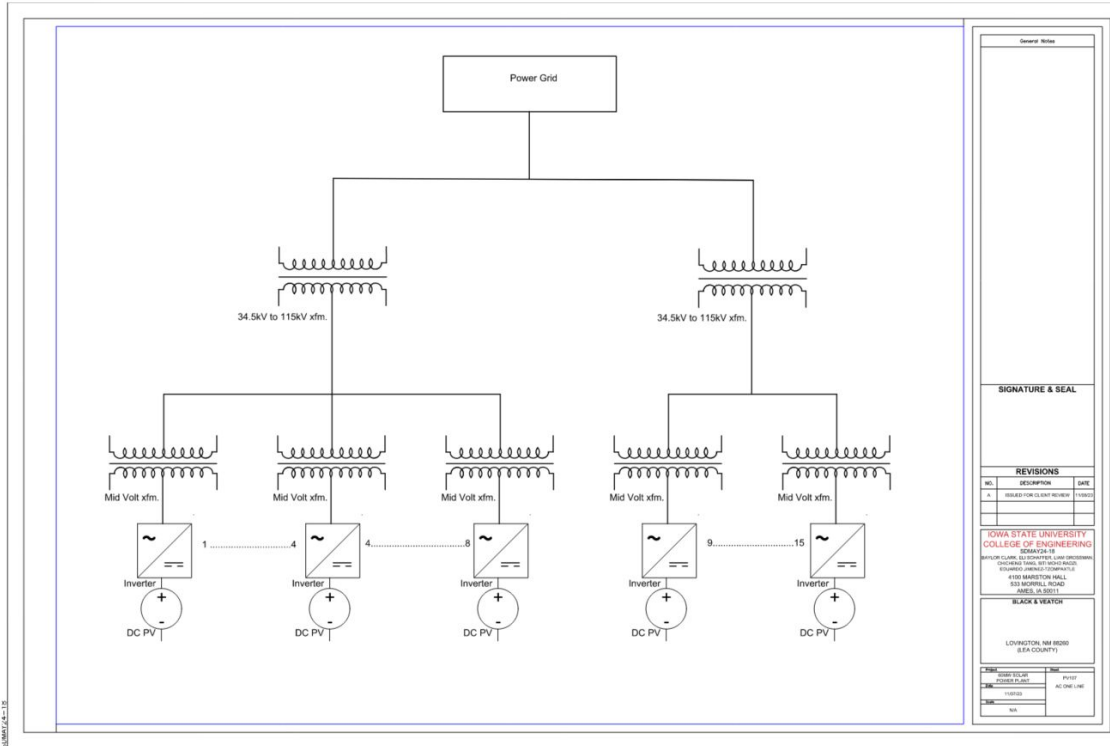
DC One-line



- Created DC one-line for both arrays

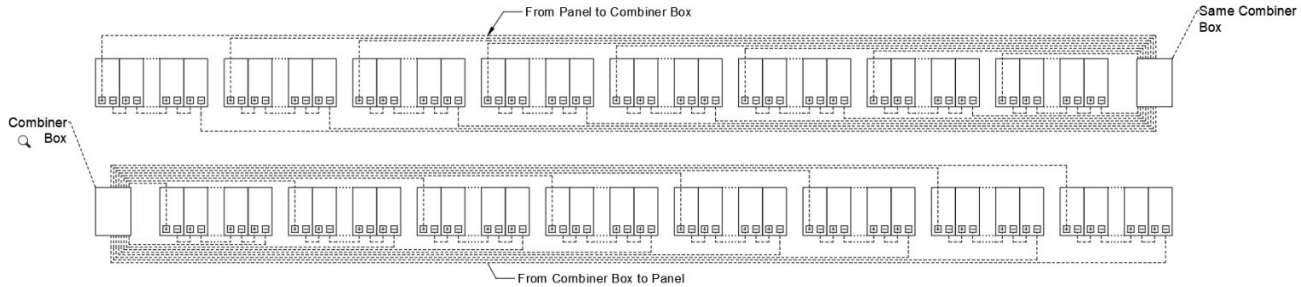


AC One-line



- Created AC one-line for both Feeders

String Connection Diagram



Not to Scale



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| | | |
| | | |

IOWA STATE UNIVERSITY
COLLEGE OF ENGINEERING
 SD MAY 24-18
 BAYLOR CLARK, ELSCHOFFER, LIAM GROSSMAN,
 CHICHEN TANG, SHIMOH RADZI,
 EDUARDO JIMENEZ-TEJAPALSTE
 4100 MARSTON HALL
 533 MORRILL ROAD
 AMES, IA 50011

BLACK & VEATCH

LOVINGTON, NM 88260
 (LEA COUNTY)

| Project | Sheet |
|---------------------------|-----------------|
| 60MW SOLAR POWER PLANT | PI109 |
| Site | STRING ONE LINE |
| Date | 11/07/23 |
| State | N/A |

Simple Cost Analysis

Economic Cost Analysis

| | | | | | | | | | | | |
|--|--|------------------------|--|---|--|---------------------------------------|--|---|--|---|--|
| Solar Field Rating (MW) (Fixed Axis) | | Hours of sunshine/year | | Average Monthly Electricity Cost (cents/kwh) | | Assumed Efficiency | | Hours of sunshine.com/blog/peak-sun-hours-explained | | Average monthly.com/resources/electricity-bills-by-state/ | |
| 60MW | | 6.6/day = 2400/year | | 14.71 | | Inverter 0.8 Indirect sunlight 0.7 | | ninvertersun | | North American Solar and Wind PPA Prices Increased 5.6 - LevelTen Energyhttps://www.leveltenenergy.com/post | |
| Solar Field Rating (MW) (Axis Tracking) | | PPA | | Axis Tracking Efficiency | | | | Payback period | | ADFn0ECC4QAQ&url=https://www.energysage.com/%2Folar-panels/%2Fnm/%2F&usq=ACvWaw36C5dbAH2vRAjoVUx0ht&op | |
| 74.85MW | | \$49/MWh | | 0.2475 | | | | CF | | i.com/%2Fmarketintelligence/%2Fen/%2Fnews-insights/%2Fresearch/%2Fusual-sun-states-shine-bright-at-top-of-us-solar-capacity-factor-lead | |
| Fixed Tilt (No axis tracking) | | 5.8 kw | | Annual Revenue | | | | Price | | 0.16/kwh | |
| Installation cost (\$) | | O+M/year | | Inflation rate (%) | | Space Cost (Acre/MW) | | Tracking Cost | | cker-cost-%2F%23%3A-%3Atext%3DHigh%252Dperformance%252Dangle%252Daxis%252DGPS%2C%253A%2520%25240.08%2520%25 | |
| 63,912,000 | | 348,000 | | 3.7 | | 15,277,467 | | 4-5 | | | |
| Cash flow | | Year 1 | | Year 2 | | Year 3 | | Year 4 | | Year 5 | |
| 63,912,000 | | 14,929,467 | | 14,941,884 | | 14,953,857 | | 14,965,404 | | 14,976,538 | |
| Year 6 | | Year 7 | | Year 8 | | Year 9 | | Year 10 | | | |
| 14,987,275 | | 14,997,629 | | 15,007,614 | | 15,017,242 | | 15,035,481 | | | |
| Present Value | | Year | | Installation cost | | O+M | | Revenue | | Profit | |
| 10 | | 63,912,000 | | 2419868.02 | | 149,812,392 | | 147,392,524 | | | |
| 1-axis tracking) | | 6.96 kw | | Annual Revenue | | Space Cost (Acre/MW) | | | | | |
| Installation cost (\$/MW) | | O+M/year | | Inflation rate (%) | | 4-7 | | | | | |
| 71,712,000 | | 417,800 | | 3.7 | | 22,822,400 | | | | | |
| Cash flow | | Year 1 | | Year 2 | | Year 3 | | Year 4 | | Year 5 | |
| 71,712,000 | | 22,204,800 | | 22,189,349 | | 22,173,326 | | 22,156,710 | | 22,139,480 | |
| Year 6 | | Year 7 | | Year 8 | | Year 9 | | Year 10 | | | |
| 22,121,612 | | 22,103,082 | | 22,083,868 | | 22,063,942 | | 22,043,279 | | | |
| Present Value | | Year | | Installation cost | | O+M | | Revenue | | Profit | |
| 10 | | 71,712,000 | | 2903841.623 | | 221,279,447 | | 218,375,606 | | | |

To be updated with additional cost



Feedback and Updates

- Tasks
 - Bell: Design Doc
 - Liam: Fuses + Units
 - Eli: Cover Page/Details - Website Update
 - Baylor: Site Stuff
 - Eduardo: Presentation
 - Chicheng: Fuses
 - S102 - Site Wiring

