Conceptual Design of an 30 MW Solar Farm

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Executive Summary

This report outlines the conceptual design and performance analysis of a 30 MWdc utility-scale solar power plant at Doyline, Webster Parish, Louisiana. Using PlantPredict, the system was modeled with fixed-tilt CdTe modules, a 1.2 DC/AC ratio, and site-specific conditions. The plant is expected to generate 51.60 GWh annually, with a performance ratio of 79.95%. Financial analysis yields an LCOE of $0.02351/kWh, IRR of 7.37%, and NPV of $3.98 million, indicating strong project viability.

Assumptions

In order to conduct a preliminary design for the nominal 30 MW project in Doyline in Webster Parish, LA. The University and the Client worked together to determine the following assumptions:

1. PPA Price: $55/MWh
    a) PPA Duration: 20 years
    b) Post PPA Price: $60/MWh
2. Project Life: 35 years
3. Federal Tax Rate: 21%
4. Sales Tax Rate: 6%
5. Property Tax Cost (Year 1): $0 [Due to ITC]
6. Discount Rate for Net Present Value Calculation: 6%
7. Solar Land Lease Cost: $900/acre/year

1. Preliminary Module and Inverter Selection, considering:
    a. Domestic vs International:

The First Solar operates internationally and serves global markets, here First Solar's FS-6460A-P CdTe modules were selected as a domestic choice aligning with federal incentives and promoting local clean energy manufacturing. The SMA Sunny Central 2750-EV_V6.76 inverter was selected for this project due to its high power density, grid-friendly features, and proven reliability in utility-scale applications. Rated for 4000 kVA at 35°C, it is well-suited for the high-temperature climate of Louisiana, where derating can significantly affect performance.

b. Bifacial vs. Monofacial:

Monofacial modules were chosen due to the fixed-tilt mounting configuration and low ground albedo at the site. Since bifacial gain is minimal without high ground reflectivity or tracking systems, monofacial modules offer a more cost-effective and simpler solution without sacrificing significant energy yield.

c. Crystalline Silicon vs. Thin Film:

Thin-film CdTe modules were selected for their superior performance in high-temperature environments typical of Louisiana. These modules offer a lower temperature coefficient and better spectral response compared to crystalline silicon, resulting in higher energy output in warm, humid climates. Additionally, thin-film modules are generally less expensive per watt, providing cost savings while maintaining high system efficiency.

2. Site layout

   a. A preliminary site layout was determined as shown in Figure 1 below, considering boundaries, wetlands, and the minimal values for necessary setbacks. The dark blue lines indicate the site boundary, and the white line indicates the road inside the power plant between different organizations of table.

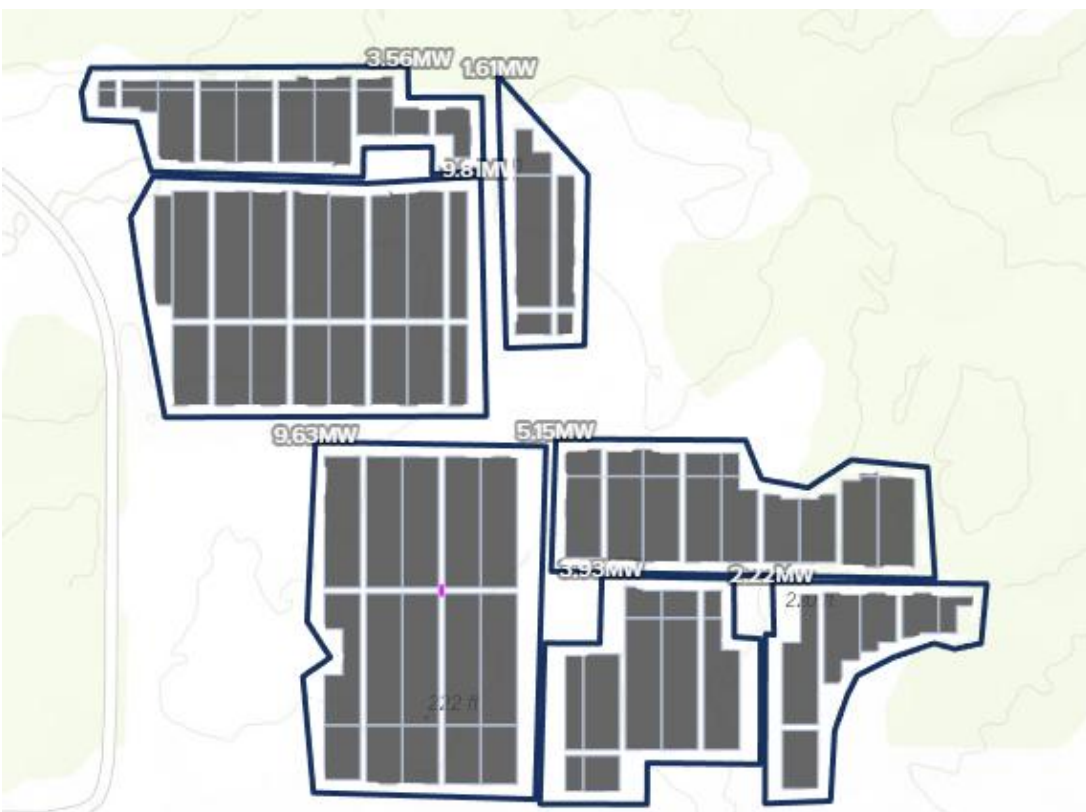

Figure 1 – Site Layout

3. Optimized Design:

The design was optimized for maximum financial return using multiple financial factors, including LCOE, Internal Rate of Return, and Net Present Value. Based on that study and customer feedback, the final choices were:

a. Mounting type: Fixed Tilt

Fixed tilt was selected due to its lower capital cost and ease of installation. Simulation results showed that while single-axis tracking increased annual energy yield, it also significantly raised installation and O&M costs, lowering the IRR. For this project in flat terrain, fixed tilt offered the best tradeoff between performance and cost.

b. DC/AC ratio: 1.2

A DC/AC ratio of 1.21 was chosen based on optimization runs in PlantPredict. Increasing the ratio slightly above 1.0 allowed for better inverter utilization and reduced LCOE, while avoiding excessive energy clipping. The final choice balanced CAPEX with financial returns.

c. Azimuth and tilt angle: 25

The panels are oriented due south (180°) to maximize solar exposure. A 20° tilt was chosen because it is close to the site's latitude (~32.5°) and provides strong performance year-round. PlantPredict simulations showed this setup delivers a high specific yield and performance ratio.

d. Ground coverage ratio: 85

A GCR of 85% was selected to maximize module density per acre, improving site capacity without significant shading loss. Simulations confirmed that this GCR level provided the best financial return given the land constraints and spacing requirements.

4. Calculate Overall Site Information

a. Estimated land area used: 106.36 acres. Note this was based on a visual estimate of site boundary on a map. It is not the result of an actual site survey.
b. Buildable area: 72.52 acres
c. Site capacity: 35.92 MW
d. Array area: 58.15 acres
e. MWac: 29.83 MWac
f. MWdc: 35.92 MWdc
g. DC/AC ratio: 1.204

5. Calculate P50 First Year Energy Production

a. First Year Plant Net Energy: 51.60 GWh/year

b. Plant Auxiliary Losses: 312.12 MWh
c. Specific Yield DC: 1436.39 kWh/kWdc
d. Performance Ratio: 79.95%
e. AC Capacity Factor: 19.74%
f. Loss Factors

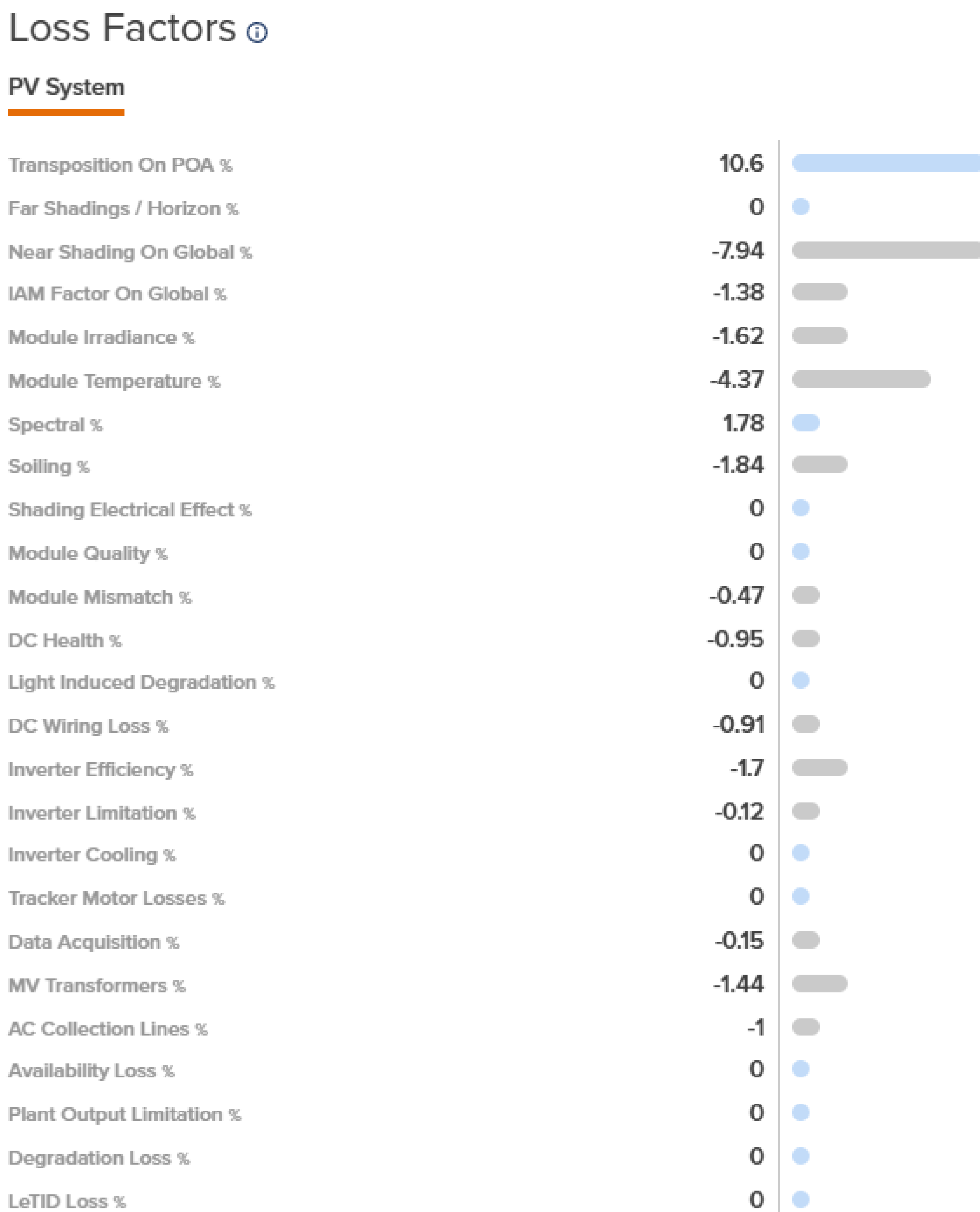

Figure 2 – Loss Factors

6. Financial Analysis
    a. Capital Costs and ITC
        i. EPC Capital Cost: $17.96 M
        ii. Development Cost: $2.98 M
        iii. Module Cost: $10.78 M
        iv. Capital Cost total Pre-ITC: $31.72 M
        v. Capital Cost Post ITC: $23.47M
        vi. ITC: $8.247M
        vii. Salvage Value: $1.586016M
    b. Total Project Lifetime Cost (EPC + O&M): $40291480.2 M
    c. Total Lifetime Energy Produced: 1713.8 GWh
    d. Simple LCOE: $0.02351/kWh
    e. Indicative IRR: 7.37%
    f. Indicative Comparative Net Present Value: $3988805.05
    g. Energy and Operations Cash Flow

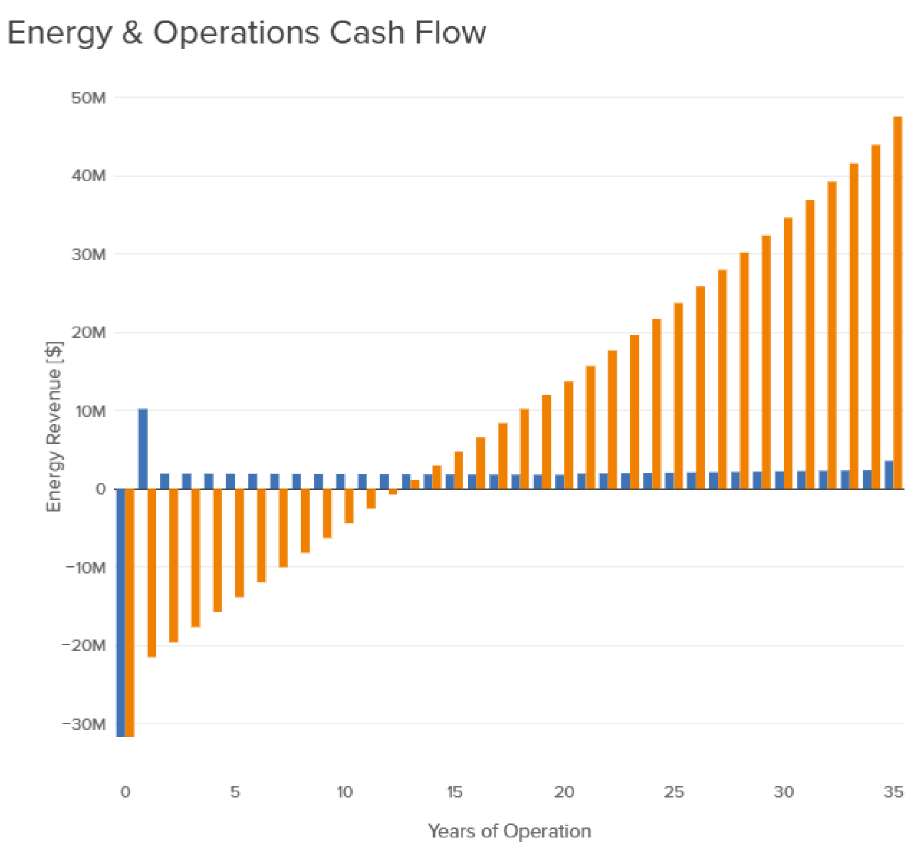

Figure 3 – Energy and Cash Flow

Appendix A – PlantPredict Input Values for Financial Analysis

Prediction Data

Prediction Name
30mw

Location	Status
Doyline, LA	Draft-Private
MWdc	**MWac**
35.9	29.8
DC:AC at POI	**DC:AC at Inverter**
1.2	1.2
Average GCR %	**Modules**
85 %	FS-6460A-P CdTe October20

Mounting
Fixed Tilt

Capital Costs and ITC

BOS Cost	0.5	$/W
Development Cost	0.1	$/Wac
Module Cost	0.3	$/W
ITC%	26	%
ITC Eligibility	100	%
Solar Salvage Value %	5	%

Totals

EPC Capital Cost	17.96	$M
Development Cost	2.98	$M
Module Cost	10.78	$M
Capital Cost Total Pre ITC	31.72	$M
Capital Cost Total Post ITC	23.47	$M
ITC	8.247	$M
Salvage Value	1.586016	$M

Results

Total Project Lifetime Cost (EPC + O&M)
40,291,480.2 $M

Year 1 Energy Produced
51.6 GWh

Total Liftetime Energy Produced
1713.8 GWh

Simple LCOE
0.02351 $/kWh

Indicative Comparitive IRR
7.37 %

Indicative Comparitive NPV
3,988,805.05 $

Energy and Degradation

First Year Energy
51.60 GWh

Specific Yield DC used in Analysis
1436.39 kWh/kWpDC

Year 1 Energy Adjustment	0	%
Annual Solar Degradation	0.3	%

PPA + OPEX + Project Life

PPA Price	55	$/MWh
PPA Escalator	0	%
PPA Duration	20	years
Project Life	35	years
Post PPA Price	60	$/MWh
Post PPA Price Escalation	2	%
O&M Year 1	3.5	$/kWdc
O&M Yearly Escalator	2.5	%
Insurance Year 1 (% of Capital Co...	0.15	%
Insurance Escalator Per Year	0	%
Solar Land Lease Cost Year 1	0	$
Solar Land Lease Escalation	0	%

Tax and Depreciation

Federal Tax Rate
21 %

State Tax Rate
6 %

Solar Property Tax Cost Year 1
0 $

Solar Property Tax Escalation
0 %

Bonus Deprecation Rate
0 %

Totals

Basis for Depreciation
26.01 $M

Bonus Depreciation
0 $M

Basis for MACRS
26.01 $M

NPV and LCOE Calculation

Discount Rate for NPV Calculation
6 %