Northern Arizona University
NAU Capstone Team
New Mexico State University
3A. Financial Analysis—Financial Narrative

1 Summary of Approach to Financial Modeling

The team used the provided HeatSpring Solar MBA template to create all financial models. In total there are three models to represent the three different PV systems: the Geothermal Substation Ground Mount system (GSGM), the Pan American Center Solar Parking Awnings (PACSPA), and the Hadley Hall Spanish Solar Tiles (HHSST). The battery storage financial model was exported as an excel file from REopt lite and then modified.

The team decided to model the three PV systems separately because of the substantial differences in their sizes—2.9 MW for GSGM, 1.9 MW for PACSPA, and 164 kW for the HHSST. The differences in sizes are important distinctions because they are classified differently and the inputs to the financial model change with each classification. The GSGM was classified as a utility scale system because it was larger than 2 MW, while the PACSPA and HHSST were determined to be commercial systems because they were less than 2 MW but greater than 10 kW [1].

While the PACSPA and HHSST are both commercial sized systems, the two systems were modeled separately because of the potential for the university getting money back with the solar parking awnings. The team found that in general, across universities, passes for covered parking spots cost more than passes for uncovered spots. This increase in price for the passes could go towards paying off the initial costs for the solar awnings' installation. For the 2019-2020 year New Mexico State University (NMSU) charged $71 for commuter and resident student parking passes [2]. Table 1 shows comparisons of parking pass prices for three universities of either similar sizes or similar weather.

Table 1: 2019-2020 parking permit prices for covered and uncovered parking passes

University	Relation	Uncovered Parking Pass ($)	Covered Parking Structure Pass ($)	Difference ($)
University of New Mexico [3]	Similar weather	$240	$504	$264
University of Texas El Paso [4]	Similar weather	$151.50	$273	$121.50
Baylor University [5]	Similar weather/similar size	$360	$435	$75

Using the differences in prices and considering that the universities used for comparison have parking structures and not just covered parking spots, the team decided an increase in price of $78 per parking spot was a conservative value. In total, there would be 577 parking spots covered with the solar parking awnings. The team chose an inflation rate of 2% for the parking spots each year to match the given inflation rate from the competition. These values were incorporated into the Pan American Center Solar Parking Awnings financial model in the unstructured section and helped substantially in the project savings. In total, after the 20 years the increase in price offsets the initial cost by roughly 1.1 million dollars.

Several sources were used to find the appropriate inputs for each model. The assumptions given by the competition holders remained constant for each financial model. These values are displayed in Table 2.

Table 2: Inputs used from competition given assumptions

Input	Value
Roof Upgrade & Warranty	$0.00
Developer Margin	$0.00
Annual Panel Degradation Rate	0.50%
Construction Loan Term	6 months
PPA Annual Price Escalator	2%
Site Purchase or Lease	Purchase
Site Purchase Price	$0.00
Depreciation Method	MACRS
Depreciation Bonus Rate	0%
Taxpayer’s Federal Marginal Tax Rate	27%
Taxpayers State Income Tax	0%
State Sales Tax on Electricity	0%

The inputs used for the Customer Conventional Power section of the financial models were determined using the El Paso Electric Utility Bill provided by the competition and other outside resources.

The utility charge per kWh for the campus is made up of two numbers, an on-peak cost and off-peak cost. To find a single value to input into the financial model, the team used the equation below.

$$\left(\frac{\#\ of\ on\ peak\ hours\ per\ year}{total\ \#\ of\ hours\ per\ year} * on\ peak\ cost\right) + \left(\frac{\#\ of\ off\ peak\ hours\ per\ year}{total\ \#\ of\ hours\ per\ year} * off\ peak\ cost\right) = average\ cost \quad (1)$$

Equation 1 outputs the average utility charge per kWh for the campus, using 732 hours for the “# of on peak hours per year,” 8028 hours for the “# of off peak hours per year,” 8760 hours for the “total # of hours per year,” 0.09124 $/kWh for the “on peak cost,” and 0.00428 $/kWh for the “off peak cost.” The demand charge rate was found by taking the maximum energy usage in kW for a 30 minute period, in the month of January and plugging it into the equation below.

$$\frac{DC}{year} = \mathrm{U} * \text{on peak DC cost} * 4 + \mathrm{U} * off\ peak\ DC\ cost * 8 \quad (2)$$

Where “DC” represents the demand charge and U represents the max 30 minute usage in January. With the DC/year the team then input this into equation 3 below.

$$\frac{\frac{DC}{year}}{\frac{DC}{year}+average\ cost*yearly\ energy\ consumption} = Demand\ charge\ rate \quad (3)$$

Using the values given from the utility agreement and energy usage data provided by the competition. The estimated utility charge escalation was found using the Energy Escalation Rate Calculator (EERC) [6]. The kWh Consumption (Avg. Monthly) was found by summing the monthly usage data for each given building and taking the average of those 12 months. The customer (NPV) discount rate was taken from the “2019 Discount Rates” document from the Department of Energy (DOE) [6]. All the final values calculated for the customer conventional power inputs are shown in table 3 below.

Table 3: Customer conventional power inputs

Input	Value
Utility Charge per kWh	$0.01
Demand Charge Rate (% of utility $/kWh)	74%
Estimated Utility Charge Escalation	1.84%
kWh Consumption (Avg. Monthly)	2,945,376
Customer (NPV) Discount Rate	1.50%

Several inputs were determined using the National Renewable Energy Laboratory’s U.S. Solar Photovoltaic System Cost Benchmark: Q1 2018 PDF [1]. The values obtained from the document are displayed in Table 4.

Table 4: Inputs obtained from NREL’s U.S. Solar Photovoltaic System Cost Benchmark: Q1 2018 PDF

Input	GSGM	PACSPA	HHSST	Page/Table
Construction Loan Rate	4.5%	4.5%	4.5%	p. 22
Annual Operations & Maintenance Cost per W (DC)	$0.013	$0.018	$0.018	Tables 5, 8
Construction Loan Fee & Closing Cost	$29,353	$22,455	$1,815	1% construction loan: p. 31, Table 6

Several more financial model inputs were values obtained as outputs from the System Advisor Model simulations. These values are displayed in Table 5.

Table 5: Values obtained from System Advisor Model simulations

Input	GSGM	PACSPA	HHSST
Size of System in W (DC)	2,999,000	1,950,000	164,000
Panel and Hard Eq. Cost per W (DC)	$0.74	$0.82	$0.79

Estimated P50 Annual Production (kWh per kW AC)	2,216	2,034	2,355
Est. Delta P90/P50 (AC)	96.69%	96.93%	97.88%
AC to DC Conversion Factor	113%	110%	135%
Construction Loan Amount	$2,935,266	$2,245,477	$181,457

The final inputs and their sources are documented in Table 6.

Table 6: Miscellaneous inputs and their sources

Input	GSGM	PACSPA	HHSST	Source
Construction Cost/Watt (DC)	$0.98	$1.15	$1.11	Construction Loan Amount/Size of System in W
Closing Costs and Fees	$102,734	$78,592	$6,351	3.5%*Project Loan Amount [7]
Project Sale Price	$3,133,400	$2,397,100	$193,800	Rounded up value from Aggregate Project Cost
Project Loan Term	10 years	10 years	10 years	[7]
Project Loan Rate	2.25%	2.25%	2.25%	[7]
Project Loan Amount	$2,935,266	$2,245,477	$181,457	-
Project Loan Coverage Ratio	100%	100%	100%	Assuming breakeven
Tax Equity Partner, Pre-Flip Share	95%	95%	95%	[8]
Tax Equity Partner, Post-Flip Share	5%	5%	5%	[8]
Tax Equity, % of Equity Investment	60%	60%	60%	[8]
Annual Site Property Tax Rate	0%	0%	0%	-
Site Property Annual Adjustment Rate	0%	0%	0%	-
Annual Equipment Tax Rate	0%	0%	0%	-
Personal Property Equipment Book Depreciation Rate	3.33%	3.33%	3.33%	Rate for a lifespan of 30 years
Annual O&M Escalator	2%	2%	2%	[9]
Insurance Expense per Year per W (DC)	$0.002	$0.003	$0.003	0.25%*Construction Cost/Watt [10]
Insurance Escalator	2%	2%	2%	Inflation Rate

Federal ITC Payment Program	Credit	Credit	Credit	[11]
Federal Investment Tax Credit (ITC)	26%	26%	26%	[11]

2 Expected System Operation within Utility Rate Structure

The resulting NPV of all the systems and battery storage are shown in Table 7. The team fluctuated the increase in cost for the parking passes and the power purchase agreement price to have a final NPV as close to zero as possible.

Table 7: NPV of each system plus battery storage

System	Net Present Value (NPV)
Geothermal Substation Ground Mount	($100,433)
PanAmerican Center Solar Parking Awnings	$194,079
Hadley Hall Spanish Solar Tiles	($26,689)
Battery Storage using REopt Lite	($65,048)
Summary NPV	**$1,909**

In total, the three proposed systems offset 31% of the given university usage. The determined PPA price is $0.023/kWhac with the inflation rate of 2% set by the competition. The IRR values for each system are displayed in Table 8.

Table 8: Summary of IRR values

System	Internal Rate of Return (IRR)
Geothermal Substation Ground Mount	19.65%
PanAmerican Center Solar Parking Awnings	270.15%
Hadley Hall Spanish Solar Tiles	25.40%
Battery Storage using REopt Lite	-4.67%

The summary and net customer savings are shown in Table 9:

Table 9: Summary of net customer savings

System	Customer Net Present Value (NPV)
Geothermal Substation Ground Mount	($3,531,408)
PanAmerican Center Solar Parking Awnings	($2,107,310)
Hadley Hall Spanish Solar Tiles	($203,486)
Summary NPV	**($5,842,204)**

3 Explanation of Value Stacking of Battery Use Cases

With implementing battery storage, value stacking becomes a way to maximize the value of the storage. The different ways the battery storage can and will be used for this project are, demand charge reduction, PV utilization, ITC, backup power, and carbon offset. The demand charge reduction cost and PV utilization are outputs from REopt lite, they are estimated to be $337,856, and $63,925 respectively. The ITC value is the 26% of the cost of the implementation of the battery storage because it is being charged completely by the solar panels for their lifetime, this value is $130,206. The backup power value is estimated using a calculator online that will be discussed in further detail in the resilience premium section below, this value comes to a total of $114,516 for the battery storage system. Lastly, the carbon offset value was set just higher than the total cost of the system after 20 years which is $6,000,000 for the entire system that means that the carbon offset value is about 0.028 $/kW. The carbon offset value would be so high because the campus has a goal of being carbon neutral by 2050. The carbon offset value covers the entire design so for the battery value stacking the team took the total kW discharged by the battery over the 20 years and multiplied it by the 0.028 $/kW getting a value of $1,591. In total, stacking all these values together the project has a value of $648,094. This helps make the battery storage more financially viable, and with the carbon offset value for the other designs the system is worth implementing in order to further the goal of carbon neutrality.

4 Explanation of Valuation of Resilience Premium

The resilience premium was found using the ICE calculator linked in REopt lite [12]. The inputs used for the calculator are New Mexico for the state 14,000 non-residential customers, 2000 residential customers, a SAIFI index of 0.99, and a SAIDI of 84.49. This outputs a resilience value of 75.24($2016/kWh) applying inflation rates, this value comes to 81.92 ($2020/kWh), this was rounded to 82 ($2020/kWh) to be used in REopt lite [13] . The 14,000 non-residential customers come from a rounded value 2019 student head count for the Las Cruses campus of New Mexico State University, the original value is 14,296 students and it was rounded down to 14,000 to be conservative [14]. The residential customers was taken as the number of first time freshman for the Las Cruces campus in 2019, rounded down again to be conservative [14]. The SAIFI and SAIDI values were taken from New Mexico State’s utility references [15].

5 Works Cited

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