

To: Dr. David Trevas
From: Elizabeth Griffith
Date: January 24, 2020
Re: Individual Self-Directed Learning Assignment

This memo details the self-directed learning completed for learning how to create project financial models for proposed solar power systems. Learning this skill is critical to the completion of the Solar District Cup capstone because a complete financial model must be completed to determine a power purchase agreement price to report. Learning materials were gathered from the HeatSpring modules provided by the competition in addition to two youtube videos. From the learning materials I was able to create a baseline financial model to analyze the Dirt Lot design proposed in the Fall semester.

Skills Learned

For the self-directed learning assignment I have been learning how to properly construct a project financial model that can be used to create a power purchase agreement (PPA) between sellers and buyers of electricity. This skill relates directly to the Solar District Cup capstone as part of the final deliverable requirements is a detailed financial model for the system or multiple systems the team has designed. This type of model is unfamiliar to the team and the team has thus far struggled with putting the spreadsheet together.

Attributes of Design Skill is Developing

While constructing a financial model for a power purchase agreement itself does not necessarily develop any attributes of design, it is still useful in the design process. By learning the ins and outs of solar financial models, I can better help direct my team in the right direction by backing up design decisions with financial variables. These financial variables can help influence different areas of the design process by providing information on their financial feasibility. Additionally, by understanding the financial models, I can learn which aspects of design affect the financials of the project most heavily and can manipulate these areas of the design based off of their financial impact on the project.

Evidence of Training

To better understand how financial models work and how to properly construct one, I relied heavily on the videos provided to the team in the HeatSpring modules by the competition creators. Overall, there were five videos and one excel spreadsheet from the HeatSpring course that helped me break down the financial model: Solar Project Finance, Electric Bill and Details of the Property, Power Purchase Agreement, Economic Modeling & Construction Costs,

Request for Proposal, and the excel file Economic Modeling [1]. Details of these training materials are shown in Figure 1 below.

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|--|---|
| <p>✔ Lesson 4: Solar Project Finance - Travis Lowder (NREL) (27:29)</p> <p>Video</p> | <p>✔ Electric Bill and Details of the Property (3:59)</p> <p>Video</p> |
| <p>✔ Power Purchase Agreement - PPA (44:43)</p> <p>Video</p> | <p>✔ Economic Modeling & Construction Costs (9:32)</p> <p>Video</p> |
| <p>✔ Request For Proposal - RFP - Overview (10:33)</p> <p>Video</p> | <p>✔ Excel File - Economic Modeling - Construction Budget</p> <p>Download (.xlsb)</p> |

Figure 1: Heatspring resources used for learning how to create PPAs [1]

In addition to the materials provided by the competition, I was able to find 2 videos online that could help with creating the power purchase agreement: Power Purchase Agreements for Grid-Aware Renewable Energy Procurement and SAM’s Power Purchase Agreement Financial Models. Details for these videos are shown below in Figure 2 [2, 3].

Power Purchase Agreements for Grid-Aware Renewable Energy Procurement
Clean Energy Solutions Center • 3K views • 2 years ago

Power purchase agreements (PPAs) are a key mechanism that utilities use to procure variable renewable energy from ...

CC

SAM's Power Purchase Agreement Financial Models
System Advisor Model • 8K views • 6 years ago

Demonstration and presentation of the SAM PPA financial models for utility-scale projects, including the Commercial PPA, Utility ...

Figure 2: Videos specific to PPAs used for self-directed learning

Results of Training and Practice

To apply these skills I learned in creating project financial models, I made a baseline model for one of the proposed designs the team has created in the empty dirt lot located southeast of the main campus. Figure 3 below shows the assumptions and calculated inputs. Figures 4 and 5 below show the financial models created.

Costs		Incentives		Energy Bill Savings	
Cost of Panels \$/Wdc	0.47	Federal Rebate % of system	30%	Annual Energy Production (kW/year)	8817997
Cost of Inverters \$/Wdc	0.04	Tax Exemption (\$/year)	6000	Annual Bill Savings	
Racking system \$/Wdc	0.21	Production Based Incentives (\$/kWh)	0		
Electrical Components and Construction Costs	0.4				
Permits	0.09				
Total Upfront Cost \$/Wdc	\$1.21				
Cost of inverter Replacement (\$/Wdc)	\$0.04				
Operation and Maintenance (\$/kW-yr)	\$0.01				
Operation and Maintenance Escalator*	3.50%				
Cost for ITC	\$ 917,619.84				
Insurance Expense per Year per W (DC)	\$0.02				
Insurance Escalator	3.00%				

System Size	
Size (Watt)	4248240
MW	4.25

Taxes	
Federal & State Income Tax *	27%
Sales Tax *	0%
Property Tax *	0%

# of Panels	Watt size of Panel	Cost \$ per watt of Panel	Total cost of Panels
13000	335	0.46	\$ 2,003,300.00

# of Inverters	Watt size of system	Cost \$ per Watt of Inverter	Total Cost of Invertes
	4248240	0.06	\$ 254,894.40

Total Cost	
\$	2,258,194.40

Figure 3: Given assumptions and calculated inputs

Unstructured Project Economics for Dirt Lot Year	1	2	3	4	5	6	7	8	9	10
Project Revenue										
PPA Price per kWh	\$0.46	\$0.47	\$0.48	\$0.49	\$0.50	\$0.51	\$0.52	\$0.53	\$0.54	\$0.55
P50 Production (kWh)	8817997	8773907.015	8730037.48	8686387.293	8642955.356	8599740.579	8556741.876	8513958.167	8471388.376	8429031.434
P50 Revenue - Production	\$4,056,278.62	\$4,116,717.17	\$4,178,056.26	\$4,240,309.30	\$4,303,489.90	\$4,367,611.90	\$4,432,689.32	\$4,498,736.39	\$4,565,767.56	\$4,633,797.50
Gross Project Revenue	\$4,056,278.62	\$4,116,717.17	\$4,178,056.26	\$4,240,309.30	\$4,303,489.90	\$4,367,611.90	\$4,432,689.32	\$4,498,736.39	\$4,565,767.56	\$4,633,797.50
Less Sales Tax	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Total Project Revenue	\$4,056,278.62	\$4,116,717.17	\$4,178,056.26	\$4,240,309.30	\$4,303,489.90	\$4,367,611.90	\$4,432,689.32	\$4,498,736.39	\$4,565,767.56	\$4,633,797.50
Project Operating Costs										
System Components & Installation Costs	\$5,140,370.40	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
O&M Costs	\$55,227.12	\$57,160.07	\$59,160.67	\$61,231.30	\$63,374.39	\$65,592.49	\$67,888.23	\$70,264.32	\$72,723.57	\$75,268.90
Site Costs	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Site Property Tax	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Insurance	\$84,964.80	\$87,513.74	\$90,139.16	\$92,843.33	\$95,628.63	\$98,497.49	\$101,452.41	\$104,495.99	\$107,630.87	\$110,859.79
Total Project Operating Costs	\$5,280,562.32	\$144,673.81	\$149,299.83	\$154,074.63	\$159,003.02	\$164,089.98	\$169,340.65	\$174,760.31	\$180,354.44	\$186,128.69
Tax Exemption	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00
Corporate Tax										
Corporate Taxable Income	-\$1,224,283.70	\$3,972,043.36	\$4,028,756.43	\$4,086,234.67	\$4,144,486.88	\$4,203,521.92	\$4,263,348.67	\$4,323,976.09	\$4,385,413.13	\$4,447,668.81
Corporate Taxes	0	\$3,966,043.36	\$4,022,756.43	\$4,080,234.67	\$4,138,486.88	\$4,197,521.92	\$4,257,348.67	\$4,317,976.09	\$4,379,413.13	\$4,441,668.81
Net Corporate Taxes Due	0	\$3,966,043.36	\$4,022,756.43	\$4,080,234.67	\$4,138,486.88	\$4,197,521.92	\$4,257,348.67	\$4,317,976.09	\$4,379,413.13	\$4,441,668.81
Project Net Income	-\$1,224,283.70	\$150,673.81	\$155,299.83	\$160,074.63	\$165,003.02	\$170,089.98	\$175,340.65	\$180,760.31	\$186,354.44	\$192,128.69

Figure 4: Financial Model of years 1-10

Unstructured Project Economics for Dirt Lot Year	11	12	13	14	15	16	17	18	19	20
Project Revenue										
PPA Price per kWh	\$0.56	\$0.57	\$0.58	\$0.60	\$0.61	\$0.62	\$0.63	\$0.64	\$0.66	\$0.67
P50 Production (kWh)	8386886.277	8344951.846	8303227.087	8261710.951	8220402.396	8179300.384	8138403.882	8097711.863	8057223.304	8016937.187
P50 Revenue - Production	\$4,702,841.08	\$4,772,913.42	\$4,844,029.83	\$4,916,205.87	\$4,989,457.34	\$5,063,800.25	\$5,139,250.88	\$5,215,825.71	\$5,293,541.52	\$5,372,415.29
Gross Project Revenue	\$4,702,841.08	\$4,772,913.42	\$4,844,029.83	\$4,916,205.87	\$4,989,457.34	\$5,063,800.25	\$5,139,250.88	\$5,215,825.71	\$5,293,541.52	\$5,372,415.29
Less Sales Tax	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Total Project Revenue	\$4,702,841.08	\$4,772,913.42	\$4,844,029.83	\$4,916,205.87	\$4,989,457.34	\$5,063,800.25	\$5,139,250.88	\$5,215,825.71	\$5,293,541.52	\$5,372,415.29
Project Operating Costs										
System Components & Installation Costs	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
O&M Costs	\$77,903.31	\$80,629.92	\$83,451.97	\$86,372.79	\$89,395.84	\$92,524.69	\$95,763.06	\$99,114.76	\$102,583.78	\$106,174.21
Site Costs	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Site Property Tax	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Insurance	\$114,185.59	\$117,611.15	\$121,139.49	\$124,773.67	\$128,516.88	\$132,372.39	\$136,343.56	\$140,433.87	\$144,646.88	\$148,986.29
Total Project Operating Costs	\$192,088.89	\$198,241.08	\$204,591.46	\$211,146.46	\$217,912.72	\$224,897.08	\$232,106.62	\$239,548.63	\$247,230.66	\$255,160.50
Tax Exemption	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00	\$ 6,000.00
Corporate Tax										
Corporate Taxable Income	\$4,510,752.19	\$4,574,672.34	\$4,639,438.37	\$4,705,059.41	\$4,771,544.62	\$4,838,903.17	\$4,907,144.26	\$4,976,277.08	\$5,046,310.85	\$5,117,254.78
Corporate Taxes	\$4,504,752.19	\$4,568,672.34	\$4,633,438.37	\$4,699,059.41	\$4,765,544.62	\$4,832,903.17	\$4,901,144.26	\$4,970,277.08	\$5,040,310.85	\$5,111,254.78
Net Corporate Taxes Due	\$4,504,752.19	\$4,568,672.34	\$4,633,438.37	\$4,699,059.41	\$4,765,544.62	\$4,832,903.17	\$4,901,144.26	\$4,970,277.08	\$5,040,310.85	\$5,111,254.78
Project Net Income	\$198,088.89	\$204,241.08	\$210,591.46	\$217,146.46	\$223,912.72	\$230,897.08	\$238,106.62	\$245,548.63	\$253,230.66	\$261,160.50

Figure 5: Financial model of years 11-20

References:

C. Lord and K. Cronin, "Solar District Cup - 8 Module Online Course," *HeatSpring*. [Online]. Available: <https://www.heatspring.com/events/2689/active>. [Accessed: 23-Jan-2020].

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