The recommendation of the installation of PV Solar Panels to reduce the electricity costs in Schofield Barracks Commissary, Hawaii

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Abstract *— The Schofield Barracks Commissary is a supermarket that sells groceries and household goods only to military members and their families; is located in Wahiawa, Hawaii. The store experiences high electricity bills due to the oil price fluctuation in Hawaii. The Schofield Barracks Commissary annual energy consumption average is approximately 304,650 kWh. The most common solar power provided in Hawaii are the community solar and the rooftop solar PV. The rooftop solar PV installation with Customer Self-Supply is recommended due to the significant power, the Schofield Barracks Commissary utilizes. The principal contractors selected were SunPower by Eco Solar, Pacific Energy Strategies, and SolarCity. The only contractor to give a verbal quote was SunPower by Eco Solar which they estimated $6M for the whole system (installation, battery storage, inverter, warranty). Based on the current energy consumption, if the system is purchased and the store does not receive incentives, the system will pay for itself in approx. 99 months (8.25 years).*

Key Terms *— Community Solar, Customer Self-Supply, Customer Grid-Supply, Power Purchase Agreement*

INTRODUCTION

The Schofield Barracks Commissary is a supermarket that sells groceries and household goods only to military members and their families; is located in Wahiawa, Hawaii. The store's yearly electricity cost averages from $790,000 to $1M. The store's management exchanged the whole store's equipment to energy efficient systems, as a solution to reduce electricity expenses. However, their cost remains high. The management's objectives are to reduce the electricity cost by at least 25% of its monthly cost by utilizing renewable energy and to contribute in the world's reduction of greenhouse gases. The photovoltaic (PV) solar panels are recommended as an alternative to fulfill their objectives. By installing the PV solar panels, the store could reduce energy demands and gain opportunities such as protection and extension of roof life.

LITERATURE REVIEW

The Schofield Barracks Commissary experiences high electricity bills due to the oil price fluctuation in Hawaii. The Hawaii Electric Company (HECO) is their main power distributor. The HECO uses imported oil due to its geographical location. The Pacific Ocean isolates Hawaii. Hawaii "does not produce petroleum and it has no proved oil reserves" [1]. Therefore, to be able to power the state's air, ground, and water resources, they have to import the oil from Asia, the Middle East, Africa, Canada, and the Caribbean. Thus, leading Hawaii as "the most petroleum-dependent state in the nation" [1]. Of the imported oil, only about one third is used to make electricity [2]. However, Hawaii has by far the highest electricity prices in the U.S.

In 2008, to reduce the state dependency on imported oil and the electricity costs, and to promote local renewable energy production, the former state governor, Linda Lingle, approved several energy-related bills which allowed residential and commercial customers to receive rebates and incentives for renewable systems. Since then, residents and businesses have been able to lower the petroleum dependency by 15% since, 1960.

Hawaii's tropical moderated climate permits substantial renewable resources throughout the

island chain. “The solar power edged out wind power in 2015 to become the state's largest renewable source of electricity, providing 35% of renewable generation, primarily because of the growth of distributed solar generation” [1]. “The solar power projects are more cost competitive in Hawaii” [3]. In fact, “solar energy is currently the largest source of renewable energy in Hawaii, and as of 2015 Hawaii led the United States in installed solar capacity per capita” [3].

“Photovoltaic (PV) devices generate electricity directly from sunlight via an electronic process that occurs naturally in certain types of material, called semiconductors” [4]. The cost of PV has dropped dramatically, they require minimum maintenance, their life cycle last from 20 up to 30 years. Furthermore, a typical solar system in Hawaii can pay for itself in approximately four years and return a profit over four times the cost over its life. The Schofield Barracks Commissary not only will meet its objectives by installing PV, but it could also gain incentives from the state. “The state of Hawaii offers a corporate tax credit of 20 to 35% of equipment and installation costs to companies that develop the wind and solar projects” [5].

Additionally, in 2015, Hawaii became the first state in the nation to set a deadline for all electricity to be generated by renewable sources. The legislature extended the state's renewable portfolio standard (RPS), which required 40% of power to come from renewable sources by 2030, to need 100% renewable electricity by 2045 [1].

ANALYSIS

This section demonstrates the data collected to understand the Schofield Barracks Commissary electricity usage and the solar technology research.

Data Collection

The Schofield Barracks Commissary annual energy consumption average is approximately 304, 650 kWh. The store’s daily approximately kilo-Watt per hour (kWh) usage for six months during 2015 was an average of 11,933 kWh, highlighted in Figure 1. During 2016 the daily average reduced to an approximate usage of 9030 kWh, highlighted in Figure 2. However, Figure 3 shows that the rate per kWh increased 25% in May 2017 compared to May 2016 rate/kWh, which it changed from $0.18 to $0.22.

Usage History - Meter #6679

Date	Read	Units	kWh	Days	kWh/Day
5/4/2015	163661	697	278800		
5/27/2015	164267	606	242400	23	10539
7/8/2015	165355	1088	435200	42	10362
8/6/2015	166245	890	356000	29	12276
8/31/2015	166985	740	296000	25	11840
10/5/2015	168160	1175	470000	35	13429
11/2/2015	168995	835	334000	28	11929
12/1/2015	169848	853	341200	29	11766
1/8/2016	170808	960	384000	38	10105
2/1/2016	171375	567	226800	24	9450
3/2/2016	172100	725	290000	30	9667
3/28/2016	172733	633	253200	26	9738
5/4/2016	173671	938	375200	37	10141
6/1/2016	174253	582	232800	28	8314

Figure 1
2015 Usage History

Usage History - Meter #6679

Date	Read	Units	kWh	Days	kWh/Day
5/4/2016	173671	938	375200		
6/1/2016	174253	582	232800	28	8314
7/7/2016	175070	817	326800	36	9078
8/4/2016	175729	659	263600	28	9414
8/29/2016	176303	574	229600	25	9184
9/30/2016	177039	736	294400	32	9200
11/1/2016	177756	717	286800	32	8963
12/5/2016	178504	748	299200	34	8800
12/30/2016	179040	536	214400	25	8576
2/2/2017	179757	717	286800	34	8435
3/2/2017	180359	602	240800	28	8600
3/31/2017	181002	643	257200	29	8869
5/1/2017	181716	714	285600	31	9213
6/5/2017	182497	781	312400	35	8926

Figure 2
2016 Usage History

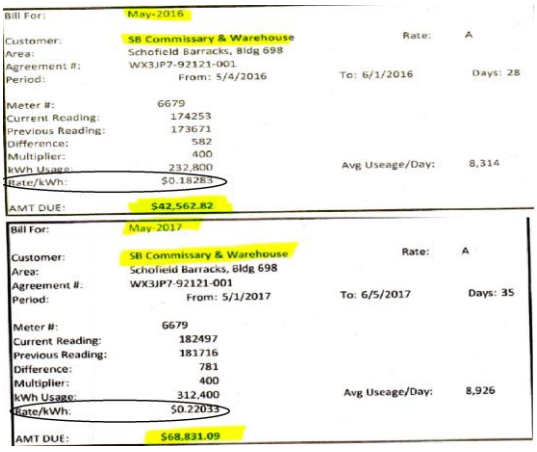

Figure 3
Comparison between May 2016/2017

Technology Research

“Solar or photovoltaic (PV) cells are electronic devices that essentially convert the solar energy of sunlight into electric energy or electricity. Solar cell technologies at present fall into three main

categories: monocrystalline (single-crystal construction), polycrystalline (semicrystalline), and amorphous silicon thin film" [6]. However, companies such as Amonix and SunPower have adapted concentrator PV (CPV) solar technologies which convert the sunlight into electrical energy in the same way than conventional solar systems, except that they use optics to focus the solar radiation before the light is absorbed by solar cells. This type of technology is the most efficient solar energy and produces more energy per megawatt (MW) installed than traditional PV systems.

Company Research

Hawaii has several contractors to be selected to offset the customer's monthly bills. However, when selecting a contractor, it should be chosen wisely. The contractor to be selected should be an experienced solar contractor with an electrical contractor's license. For this project, several contractors were researched to collect bids, compare the generation capacity of each system and the estimated amount of energy it will produce annually based on sunlight conditions in the Schofield Barracks Commissary's area. The principal contractors selected were SunPower by Eco Solar, Pacific Energy Strategies, and SolarCity. The other contractors were American Electric, Solar World, and Mercury Solar Hawaii. These contractors presented a vast experience in the PV installation in government facilities.

Programs offered

The most common solar power provided in Hawaii are the community solar, and the rooftop solar PV installation with options such as Customer Self-Supply (CSS), Customer Grid-Supply (CGS), and Power Purchase Agreement (PPA). The community solar is where "customers who wish to participate will purchase an interest in the energy from the community solar facility to offset their monthly bills without installing solar panels on their property. The rooftop solar PV installation in Hawaii with the CSS option is "intended only for solar PV installations that are designed not to export any electricity to the grid. Customers are not compensated for any export of energy and they need a storage battery. The rooftop solar PV CGS option is for customers who receive a Public Utilities Commission (PUC) approved credit for electricity sent to the grid and are billed at the retail rate for electricity they use from the grid" [7]. A PPA is when a customer agrees to purchase with a contractor. The systems get installed and connected to the utility grid at no upfront cost, and the customer pays for the power consumed, typically less than the utility company. After the time specified in the agreement, the customer can sign a new deal or remove the system at no cost.

RESULTS

This section answers which company and technology should be selected to reduce the Schofield Barracks Commissary electricity bill.

Technology Selection

The technology recommended to be selected for this project is the CPV. CPV produces 25% - 30% more power compared to conventional cells; they are 15% efficient. The energy produced by a solar system will depend on the manufacturer's material production.

The attractiveness of the PV Solar panels is its durability. The lifespan of a solar power system is typically the standard 25-year warranty a manufacturer offers. However, the power output should not be less than 80% of rated power after 25-years. Hence, the system could last for an extended period after the warranty expires.

Company Selection

The only contractor to give a verbal quote was SunPower by Eco Solar which they estimated $6M for the whole system (installation, battery storage, inverter, warranty). Unfortunately, all the contractors selected for this project shared the same lack of response when requesting a quote. There is no quote available to collect bids. There are no product specification sheets to compare the generation capacity of each system and the

estimated amount of energy it will produce annually based on sunlight conditions in the Schofield Barracks Commissary's area. Therefore, there is no company to be selected.

DISCUSSION

To meet the objectives of the project, it is recommended to select the rooftop PV installation with CSS. This option will reduce the electricity cost and lower the demand of energy. Thus, it will contribute with the reduction of greenhouse gases. Based on the only verbal quote ($6M by SunPower), by buying the system, the store could gain incentives; however, this benefit was in doubt because SunPower did not know if the store could benefit from it since it is a government facility. Assuming the current energy consumption will remain constant for the next 25 years, if the system is purchased and the store does not receive incentives, the system will pay for itself in approx. 99 months (8.25 years). The other 17 years (based on the standard warranty) will be returned in profit.

In Hawaii, the community solar is a pilot program proposed by the HECO to give options to about 50 Oahu customers. This plan is not feasible for the store due to its energy consumption. The PPA is not recommended because the current rate is $0.19, even though is a flat rate, the oil price fluctuates; hence it could cause money loss.

CONCLUSION

Finally, the Schofield Barracks Commissary is located in an area where there is abundant sun and no shade to obstruct the sunlight to reach the PV solar panels installed. The store's roof is 79,481 sq. Ft. which allows at least an installation of 239-panel on it, maybe more. The average sunny days for this area is 271 days with an approx. 6 hours of sun per day. Unfortunately, accurate data could not be acquired due to the contractor's lack of response. The results did not contribute to the knowledge of the field. However, for future works it was found that when selecting a contractor, it is essential to have more than the minimum data of the project to be able to pressure the contractor to receive a quote to provide concurrent data.

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