La Buena Esperanza Cooperative Development

Pathways to Zero Net Energy

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1. EXECUTIVE SUMMARY

The La Buena Esperanza Pathways to Zero Net Energy project is an interdisciplinary effort to identify, analyze, and recommend methods to reduce energy use and energy costs for the La Buena Esperanza (LBE) housing community in King City, California. The project was developed and executed by UC Davis students over the course of ten weeks in Spring 2017 through the Pathways to Zero Net Energy Course[1] in collaboration with the California Center for Cooperative Development (CCCD).

Specifically, the project team analyzed on-site energy consumption, assessed several efficiency and cost mitigation measures such as lighting efficiency and on-site solar photovoltaics (PV), and developed recommendations for the client to realize feasible and cost-effective savings. The team used metering data, behavioral surveys and interview, and an in-person energy audit to collect information, and developed and integrated models of on-site energy consumption, solar potential, utility tariffs, and financing to estimate the costs and benefits of the different measures. In support of these efforts, the team researched state and federal efficiency and solar programs and incentives, utility rate policies, and other areas necessary to understand the challenge. Using these tools, the team identified approximately $3,500 in annual cost reduction opportunities through the replacement of inefficient lighting and enrollment in income-qualified rate subsidy programs.

2. BACKGROUND

LBE is a cooperative housing community in King City, CA, which only admits former or current agricultural workers into the complex. Energy costs are a considerable burden for the community, many of whom are on fixed incomes or are otherwise eligible for income-qualified government programs. The community has an aging population that utilizes some inefficient appliances that draw more energy than up-to-date products, increasing their overall energy costs.

The California Center for Cooperative Development, a non-profit organization which includes LBE as a member, contacted Dr. Kurt Kornbluth, Director of the Program for International Energy Technologies at UC Davis, to collaborate with LBE on reducing energy costs. The resulting project, memorialized in this report, consists on recommend energy use and energy cost mitigation measures to the client through the cost-benefit analysis of efficiency measures and to assess the feasibility of solar installation. This analysis took into consideration the current tiered energy rate structure established by PG&E, as well as alternative rate structures and solar rules.

3. METHODOLOGY

Project methodology consisted of three phases: data collection, modeling, and scenario analysis. Data collection consisted of an on-site energy audit, the administration and analysis of behavioral surveys and management interviews, and the retrieval and processing of hourly

[1] Applied Biological Systems Technology (ABT) 289A, Spring Quarter 2017; Professor Kurt Kornbluth.

Pacific Gas and Electric (PG&E) metering data. Modeling consisted of the development and use of modeling tools to estimate energy consumption, solar PV potential, utility billing impacts, and financial streams. Scenario analysis compared the base case (no action) to alternatives including inefficient bulb replacement, rooftop solar installation, and election into alternative rate structures. Details on these processes are provided below.

3.1 Data Collection

a) Energy Audit

On May 15, the project team conducted an on-site energy audit in the LBE housing complex with a CCCD representative. The project team observed the building envelope of the community area, outdoor areas, and five residential units. In the community area and residential units, team members catalogued end-use energy demands, including lighting, appliances, and plug-loads, as well as recording information regarding hot water, space heating, daylighting, and other relevant information regarding the built environment. The team memorialized much of this information through photography for later review.

To assess the viability of on-site solar PV, the project team also took pictures of the rooftops on the residential units and carports. They wrote observations regarding the orientation of available surfaces and potential factors for PV system losses such as tree shading to understand the LBE housing complex's potential for solar energy production.

b) PG&E bills

Meter data collection was undertaken by CCCD, who attempted to retrieve hourly billing data from five tenants and the common areas as well as aggregate energy usage data. Tenant account access and other delays resulted in challenges with receiving some account data. Ultimately, the team received usage data for two tenant units and a common area meter which serves the community room[2] and the housing for the property manager.

The team developed tools in R which would generate daily load profiles (24 hours) over seasonal and monthly averages, and compared usage data to historical weather data recorded at the Salinas Airport. The team found no correlation between electricity usage and temperature, confirming observational data indicating no portable air conditioners were used given the lack of built-in air conditioning.

The team found that usage load profiles were generally consistent across months, and ultimately aggregated the data into two representative load profiles, one for the PG&E Summer Period (June-September) and one for the PG&E Winter Period (October-May)[3]. These coincide with billing period changes that were modeled in subsequent steps.

c) Surveys

In the May 15 site visit, the project team and a CCCD representative administered five usage surveys to LBE residents and interviewed the residents and LBE property manager about

[2]There is some uncertainty regarding the specific areas covered by this meter in addition to the property manager housing. However, the load profile is consistent with a meeting space which is used for irregular evening gatherings, such as the community meeting space.

[3]PG&E TOU https://www.pge.com/tariffs/tm2/pdf/ELEC_SCHEDS_EL-TOU.pdf

their energy usage behavior throughout the year and site characteristics to identify opportunities to reduce energy costs through energy efficiency efforts. The survey asked about the lighting, temperature, water heater, kitchen, and different electronics in their home. The survey also asked about their PG&E bills, housing unit characteristics, and household size.

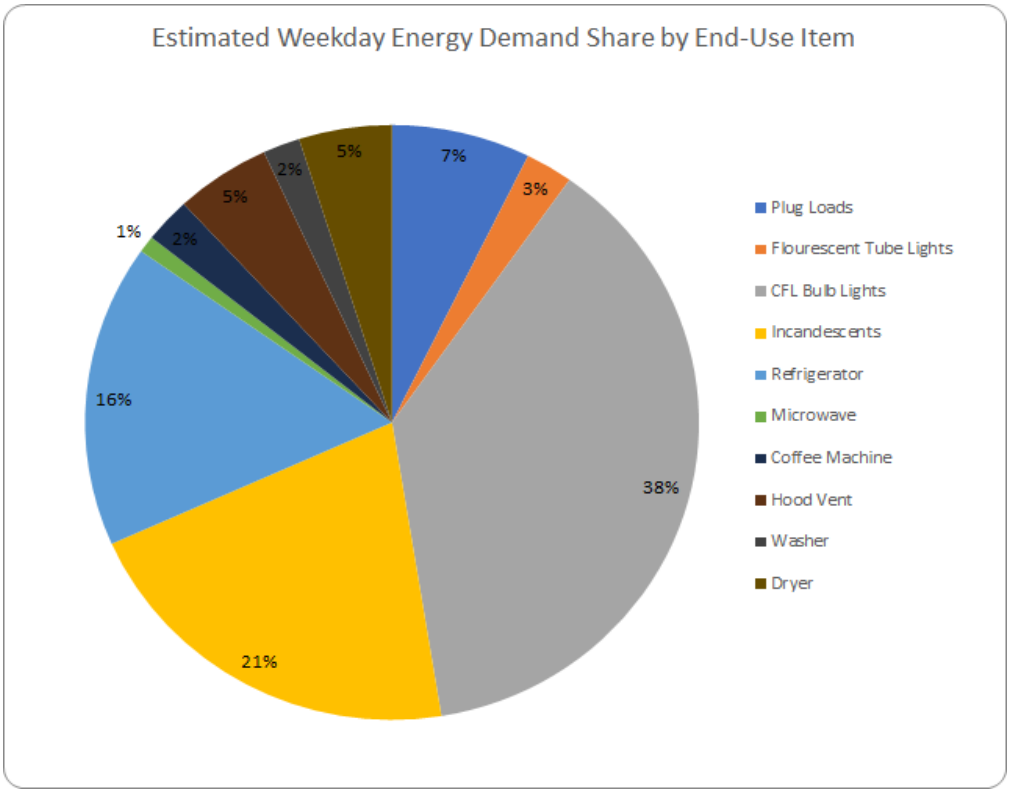
3.2 Modeling

a) Energy End-Uses

During our physical inspections of multiple units inside the complex, we took record of energy draining appliances. Consistent across the units was the presence of a refrigerator, clothes washer, lights, and some small kitchen appliances. Variance was seen in clothes drying (old machine, new machine, hang dry) and cooling methods (large fan, small AC unit, none).

Miscellaneous plug loads, from TVs to phone chargers, were also too sporadic and variant to find a target for retrofit. This left us with lighting and washers.

Using PG&E data for some of the units toured, and information from the surveys distributed, we assembled a disaggregated model of a typical day. This model assumed usage of all appliances throughout the day, and was compared against real averages of hourly usage throughout a year. This average was reasonable, as the units do not have air conditioning but do have gas heating, yielding little to no correlation between temperature and usage.



Our disaggregation showed us that lighting was around 62% of usage was solely from lighting, and besides the refrigerator, the other appliances used little energy relative to this context. Lighting within the units were two-thirds somewhat dated CFL bulbs and one-third incandescent. Every kitchen had a two long tube CFL lights, and each room had 3-5 bulbs. Depending on the size of the units, this meant anywhere from 15 to 30 bulbs per unit.

b) Load Profiles

Hourly and sub-hourly usage data was made available for two residential units and one meter record which includes the common areas and the property manager's apartment was provided by the CCCD. These were synthesized into semi-annual load profiles (Summer and Winter). In order to estimate complex-wide benefits, we assumed that 60% of the apartment units had load profiles similar to the higher-usage apartment, and 40% had load profiles similar to the lower-usage apartment. In effect, the community-wide energy load profile was estimated as the sum of 24 high-usage apartments, 16 low-usage apartments, and the common area. We estimate that the community uses approximately 114,000 kWh per year.

Community Energy Load Component	**Scaling**	**Annual Energy Demand (per unit)**
Low-Usage Apartment	x16	1879 kWh
High-Usage Apartment	x24	3212 kWh
Common Area	x1	7001 kWh
Total		**114,154 kWh**

b) Solar PV Modeling

The project team used the NREL System Advisor Model (SAM)[4] to calculate the hourly output of a PV system in King City over a year. We modeled the output of a 1kW system which could be scaled to represent system output for systems of various sizes.

We developed an Excel model to integrate the solar PV output with the estimated complex-wide load profiles. The model estimated net load and returned estimated complex-wide costs with several variable parameters, including photovoltaic system size (kW), solar power purchase agreement price ($/kWh), and utility tariff (TOU, CARE TOU). Under current net metering rules, all customers adopting a net metering tariff are required to transition to a time-of-use (TOU) rate structure [5]. Net metering allows customers to import and export electricity from eligible renewable self-generation, such as an on-site solar system, and be charged only on net imports.

c) Utility Rate Modeling

Our model's functional unit was a representative 24-hour load profile for each season extrapolated to six 30-day months for simplicity. The model generated monthly total usage

[4] SAM https://sam.nrel.gov/

[5] PG&E NEM tariff https://www.pge.com/tariffs/assets/pdf/tariffbook/ELEC_SCHEDS_NEM2V.pdf

and cost data. The model explored various usage patterns, such as modified usage under the alternative LED scenario and the PV scenario, as well as alternative rate structures.

Several different utility rates and rate structures may be available to LBE residents. The five residents we interviewed on-site were enrolled in the PG&E California Alternative Rates for Energy (CARE) program, which offers eligible applicants a 20% discount on each bill; the common meter was on the standard tiered rate structure. CARE eligibility extends to households with gross annual household incomes below $32,480 for 1-2 residents, $40,840 for 3 residents, or $49,200 for 4 residents, and so on[6].

The CARE rate (EL-1) offers an increasing block, tiered rate structure with rates ranging from $.126 / kWh to $.240/ kWh[7]. As LBE is located in PG&E Baseline Territory X[8], residents are allotted 10.1 kWh of Tier 1 usage per day in the summer season and 10.9 kWh per day in the winter season. The standard tiered rate (E-1) ranges from $.200 / kWh for Tier 1 usage up to $.401 / kWh in Tier 3[9].

LBE residents are also eligible for participation in Time-of-Use rate programs. These include the standard TOU (E-TOU) and the CARE TOU (EL-TOU) rates. As discussed above, solar installation would require residents to utilize a TOU rate. TOU rates vary throughout the day and throughout the year in a pattern designed to emulate marginal cost and provide better economic and environmental signals to consumers. CARE TOU rates range from $.123 / kWh to $.222 / kWh while standard TOU rates range from $.207 / kWh to $.363 / kWh. Both structures have highest costs during the evening peak periods. Further details can be found on each of the rate structures in the appendix.

3.3 Financial Modeling

a) General assumptions

We based our financial assumptions on our site visit to the Cooperative, as well as on the energy billing information of two sample units. First of all, we interviewed five households where three of them were retirees whose energy data showed a greater usage than the other two where the heads of the households were young working parents. In this way, we assumed a proportion of 60% retirees with an average energy consumption of 267 kWh in the summer and 250 kWh in the winter while the other 40% represent young parents with an average energy usage of 157 kWh throughout the year. In addition, we assume that all the households are registered in the CARE program and paying the lowest tier rate at $0.13/kWh. Our methodology also utilized the following information:

- **Annual interest rate (i):** 15% - average interest rate for line of credits.
- **Period of time (t):** 10 years - conservative estimate of appliance lifespan.

[6] https://www.pge.com/en_US/residential/save-energy-money/help-paying-your-bill/longer-term-assistance/care/care.page?WT.mc_id=CARE_EN_adwords_20161003_search&gclid=Cj0KEQjwmv7JBRDXkMWW4_Tf8ZoBEiQA11B2fqyiTI0tcGF9ibVJpQZiBIneZYGepXactV351JNbkEsaAiKv8P8HAQ

[7] https://www.pge.com/tariffs/tm2/pdf/ELEC_SCHEDS_EL-1.pdf

[8] https://www.pge.com/en_US/residential/save-energy-money/help-paying-your-bill/longer-term-assistance/medical-condition-related/medical-baseline-allowance/understanding-baseline-quantities.page

[9] https://www.pge.com/tariffs/tm2/pdf/ELEC_SCHEDS_E-1.pdf

- **LED cost:** $4 per bulb[10]
- **Incandescent bulb wattage:** 60 W
- **LED bulb wattage:** 7-10 W

b) LED Light Bulb Replacement:

The LED replacement analysis includes the assumption of an average of 20 to 22 light bulbs per house from which 75% were compact fluorescent and 25% were incandescent, consistent with observations from our energy audit. Taking into consideration house sizes, we have estimated 848 light bulbs in the residential units. Likewise, we have estimated the light bulbs usage according to the general trend of the energy data and also the behavior of the two type of households.

c) Baseline energy costs

To calculate the light bulb energy costs, we estimated the light bulb consumption in kW and multiplied it by the first tier rate. We estimated that higher usage apartments use approximately 2.09 kWh whereas lower usage apartments consume 1.58 kWh due to the less consumption during work days. When we scaled up this energy consumption up to the apartment complex level we found that LBE residential units uses around 27,541kWh which is equivalent to $3,580.

d) Appliance renewal and investment

We assume that all residential users will change their lightbulbs from CFL and incandescents to LEDs. In this case, we have that the light bulbs energy savings in higher-usage households can save up to 1.78kWh per day, while in lower usage households they save 1.284kWh. This amount of energy can save yearly $3,002 to the whole residential community.

3.4 Incentive and Rebate Research

Since the LBE housing complex had a strong interest in understanding opportunities in rooftop solar production to lower electricity costs, the project team searched for financial incentives online and used the Database of State Incentives for Renewables and Efficiency[11] to find methods to make solar installation more cost-effective. We worked on the assumption that limited funds were available to pay for the steep upfront cost of solar PV installation, and instead focused on opportunities for leasing a system rather than owning a system because most solar leases have no installation or maintenance costs. However, an important disadvantage of buying a solar lease to note was that the solar leasing company claimed the federal tax incentives and applicable state solar incentives rather than the renter.

The project team also searched for financial incentives to lower the cost of potential energy mitigation measures. The four programs we have found that the LBE housing community may qualify for will only be briefly mentioned in this paragraph. The PG&E Energy Savings Assistance Program offers CARE-eligible customers energy-saving improvements at no

[10] Standard 60w equivalent, A19 LED bulbs are available commercially for as little as $1.66 per bulb through Home Depot. We select $4 per bulb, an approximate median price, to allow for LBE to purchase quality, lasting bulbs with solid lighting quality to support a satisfactory transition for residents.

[11] DSIRE http://www.dsireusa.org/

charge[12]. The Home Energy Assistance Program (HEAP) offers income-eligible applicants an one-time calendar year credit on utilities for up to $307 and the Weatherization Assistance Program (WAP) offers HEAP-eligible applicants on-site energy assessments and installation of energy conservation and heat-loss measures such as caulking, new windows, and more efficient lighting[13]. Finally, the PG&E Multifamily Upgrade Program offers applicants $400 to $3,000 per unit for energy-efficient retrofit projects provided that building energy efficiency is improved by 10% and the retrofit measures used target two of 4 categories (envelope, HVAC, water heating, and appliances/lighting)[14].

5. RESULTS

5.1 LED Bulb Replacement Analysis

Overview

We found LED replacement to be a compelling and cost-effective mitigation measure. Due to the poor daylighting of LBE units and consequent high load factor of indoor lighting at the community, LEDs offer significant energy savings opportunities which will pay for themselves in just under one year.

Number of bulbs across complex: 848
Cost per LED replacement bulb: $4
Total cost of new bulbs: $3392
Savings per year: $3002
Payback period: 1.12 years
Bulb lifetime: 10 years

Under every financial indicator we have calculated, a LED light bulb replacement is a feasible and effective measure to save significant amount of energy. The savings obtained from this measure will allow the community to get back their investment in almost 1 year. Similarly, the IRR represents an estimation of the money returned from our investment for each year of the light bulb lifespan. Finally, the Net Present Value gauges the amount of money that is returned to the community for this investment in LED technology.

Financial Analysis

a) Payback period

Payback period = Investment /

Payback period = $3,392 / $3,002 = 1.12

[12] Energy Savings Assistance Program https://www.pge.com/en_US/residential/save-energy-money/help-paying-your-bill/energy-reduction-and-weatherization/energy-savings-assistance-program/energy-savings-assistance-program.page
[13] HEAP and WAP Application Information https://www.energyservices.org/index-afh.html
[14] Multifamily Upgrade Program https://multifamilyupgrade.com/home-page/how-to-participate/

b) IRR (Internal Rate of Return): 82%

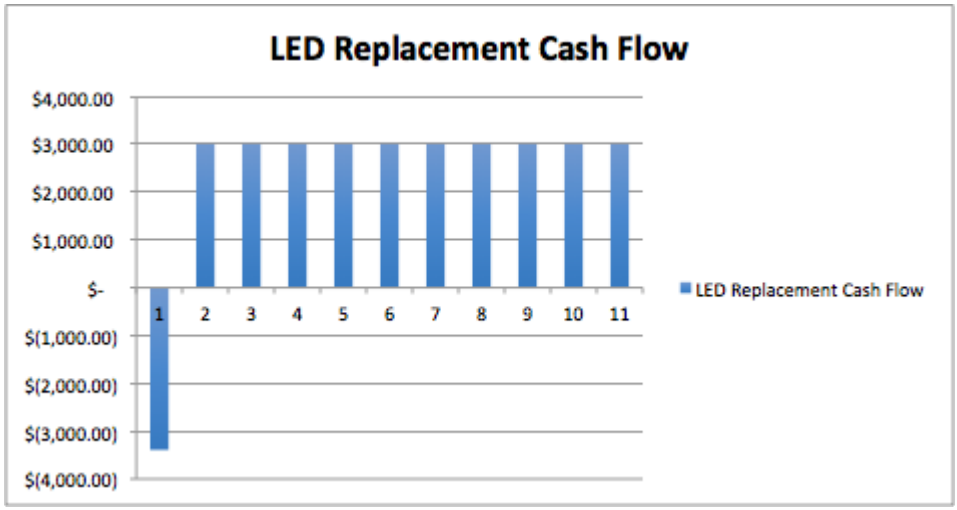
$$Investments = Savings/IRR + Savings/IRR^2 + \ldots + Savings/IRR^n$$

3,392 = 3,002/IRR +(3,002/IRR² +...+3,002/IRR¹⁰ = 82%

c) NPV(Net Present Value): $10,151

$$NPV = -Investments + Savings/t + Savings/t^2 + \ldots + Savings/t^n$$

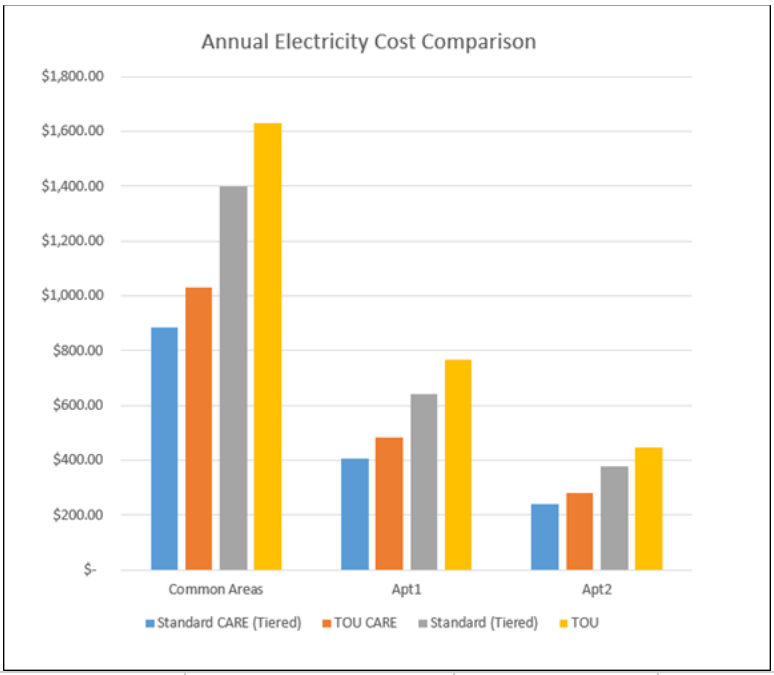
$$NPV = -3{,}392 + (3{,}002)/1.1 + (3{,}002)/1.1^2 + \ldots + 3{,}002/1.1^{10} = \$\mathbf{10,151}$$



5.2 Alternative Rate Structure Analysis

We analyzed each unit's electricity usage through our rates analysis model and determined that none of the individual units we analyzed would benefit from transitioning to Time-of-Use rates. This is due to the low energy demand - within the first tier of usage - of the LBE units we analyzed, as well as their high evening energy demand, which coincides with the higher cost peak periods.

Specifically, the low-usage apartment has an average monthly electric bill of $19.80 under the tiered CARE program, but would pay $23.47 under CARE TOU, $31.28, while the higher-usage apartment would have an average bill of $40.23 instead of $33.84 under a TOU rate.



Rate Structure	Complex (Estimated)	Common Areas	Apt1	Apt2
Standard CARE (Tiered)	$ 14,432.56	$ 73.76	$ 33.84	$ 19.80
TOU CARE	$ 17,121.89	$ 85.83	$ 40.23	$ 23.47
Standard (Tiered)	$ 22,806.94	$ 116.57	$ 53.48	$ 31.28
TOU	$ 27,220.01	$ 135.71	$ 63.99	$ 37.30

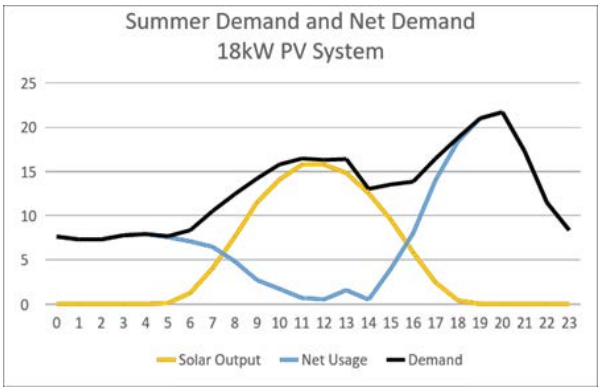
However, the common area meter is not currently enrolled on the CARE rate. After discussing this issue with the PG&E CARE call center, it is our understanding that this utility account is eligible for the CARE program so long as the property manager, whose home is served by the common meter, is eligible for the program. This could provide an average of over $40 per month for the LBE community.

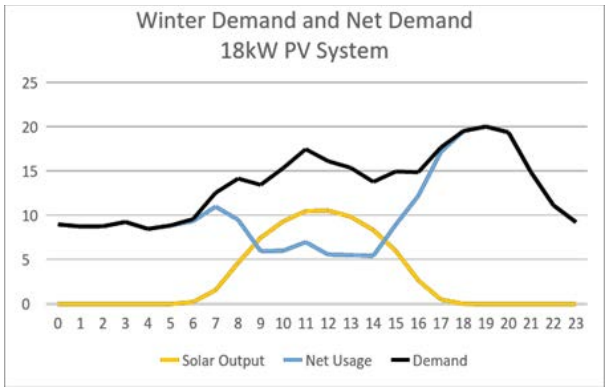
5.3 Solar PV Analysis

We analyzed several scenarios related to the installation of on-site solar PV. Given available roof and carport space, PV installation would likely be relatively simple from an engineering perspective. Additionally, PV installation was a key area of interest for the client and community. However, economic and policy drivers present considerable barriers to PV adoption. Specifically, the mandatory transition to TOU electricity rates, coupled with the very low cost of electricity offered through the CARE program, make solar PV unattractive for LBE at this time.

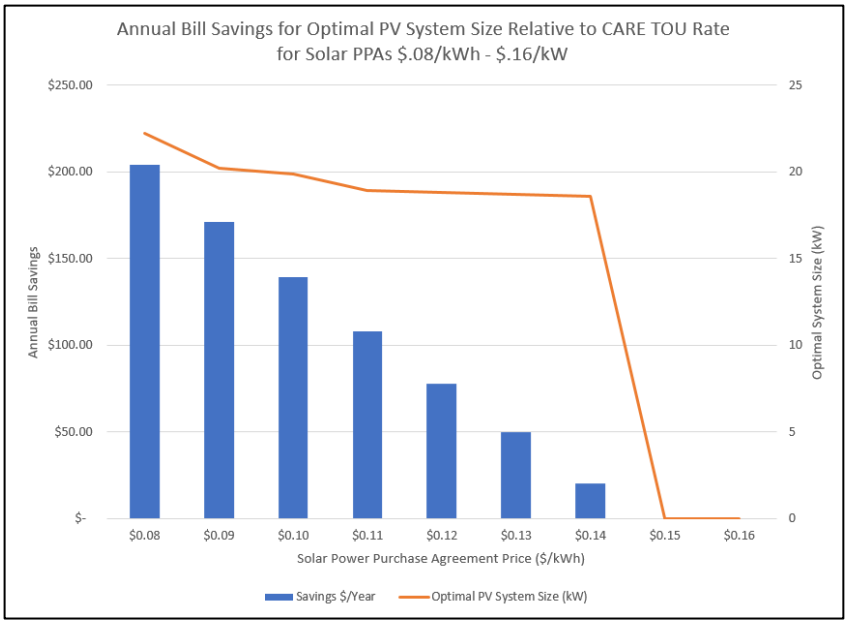
Using the NREL System Advisor Model, we found the mean hourly solar output of a 1kW system by month and grouped the information to find the mean hourly solar output by season. Using the Excel Solver tool, we determined that the break-even solar lease price in-light of the tariff change would need to be below $.06 / kWh. This is considerably below the reasonable range for a solar lease with current prices, which is likely in the range of $.10-$.15 / kWh.

However, we also modeled an alternative scenario which compares solar adoption against other





TOU rates (above). This scenario assumes LBE would otherwise be served on the CARE TOU rate described above, and is plausible considering upcoming rate changes and potential future pressure for customers to adopt TOU rates in 2019. Again using the Excel Solver software, we optimize system size under a variety of solar lease prices and determine a break-even price of approximately $.14 / kWh, with an optimal PV system in the 18-20 kW range. However, potential savings are quite low, even at the unlikely low solar lease price of $.08 / kWh, in which case the entire community might enjoy approximately $200 / year in cost savings.



7. CONCLUSIONS AND RECOMMENDATIONS

Through the replacement of inefficient lighting and election of the common area meter into the CARE program, we estimate LBE residents and management could capture $3,000-$3,500 per year in annual savings.

Specifically, we recommend replacing the compact fluorescent and incandescent lightbulbs with LED lightbulbs immediately to save 1.3 - 2.2 kWh per day per unit. These savings yield up to 800 kWh of energy a year, or $100 per unit. The payback period is less than 1 year (0.97 years).

Replacing common areas lighting can also save $370 for the entire complex. A conservative approach to bulb replacement could focus on providing 2-4 bulbs for LBE residents to install in their highest-usage lighting fixtures, such as an outdoor light which is left on overnight.

Further, we recommend all eligible LBE residents to sign up for the PG&E CARE program immediately if they had not done so already. Tiered CARE rates can save LBE residents approximately $20 per month as long as their usage remains relatively low. We also recommend enrolling the property manager unit and common area meter in the CARE program to save $40-50 per month.

We do not recommend installing solar under current circumstances since Solar TOU CARE rates cost more than Tiered CARE rates, or an estimated $2,400 increase in electricity bills per year. However, as rates transition to default TOU in 2019, tiered rates may be less attractive and solar may be more cost-effective. If TOU is mandatory, usage increases, or tiered rates exceed TOU rates, solar may be cost-effective relative to CARE TOU rates at solar rates below $.14/kWh. However, benefits are low, with net savings unlikely to exceed $200/year for the community.

Uncertainty and Risk

While the project team believes considerable savings are easily achievable by LBE, we caution that our analysis was built on a very small sample of data from the community. Our information comes almost exclusively from a sample of five residents of a community of forty and is comprised of individuals who may not be representative of broader energy usage patterns. Further, utility demand information was collected for only two specific apartment units. To the extent the occupants of these apartments have considerably different usage patterns than others, the proposed mitigation measures may be more or less effective. Further research and surveying is necessary to confirm our findings prior to significant capital expense, such as the proposed LED bulb replacement program. However, risk associated the recommendation that all eligible accounts participate in the CARE program is very low - we offer no reservations regarding this recommendation.

Further Work

Our client has indicated that at some point in the next 10-20 years LBE will undergo a considerable retrofit. Given considerably lower costs for solar installation during other construction, LBE could revisit the question of solar viability at this time and finalize the process to receive aggregate energy usage data for the complex for this analysis. Further, incentive programs which are currently on hold may be available at that time to cover some or all of the capital costs of rooftop solar.

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APPENDIX

Appendix 1: PG&E Rates Information

Tiered Rates (E-1 and EL-1):

	E-1		Standard Residential	https://www.pge.com/tariffs/tm2/pdf/ELEC_SCHEDS_E-1.pdf
	Price		Summer Quantity (kWh)	Winter Quantity (kWh)
Tier 1	$ 0.20	Up to	10.10	10.90
Tier 2	$ 0.28	Up to	40.40	43.60
Tier 3	$ 0.40	All above		
	EL-1		CARE Residential	https://www.pge.com/tariffs/tm2/pdf/ELEC_SCHEDS_EL-1.pdf
	Price		Summer Quantity (kWh)	Winter Quantity (kWh)
Tier 1	$ 0.13	Up to	10.10	10.90
Tier 2	$ 0.17	Up to	40.40	43.60
Tier 3	$ 0.24	All above		

Time-of-Use Rates (E-TOU and EL-TOU):

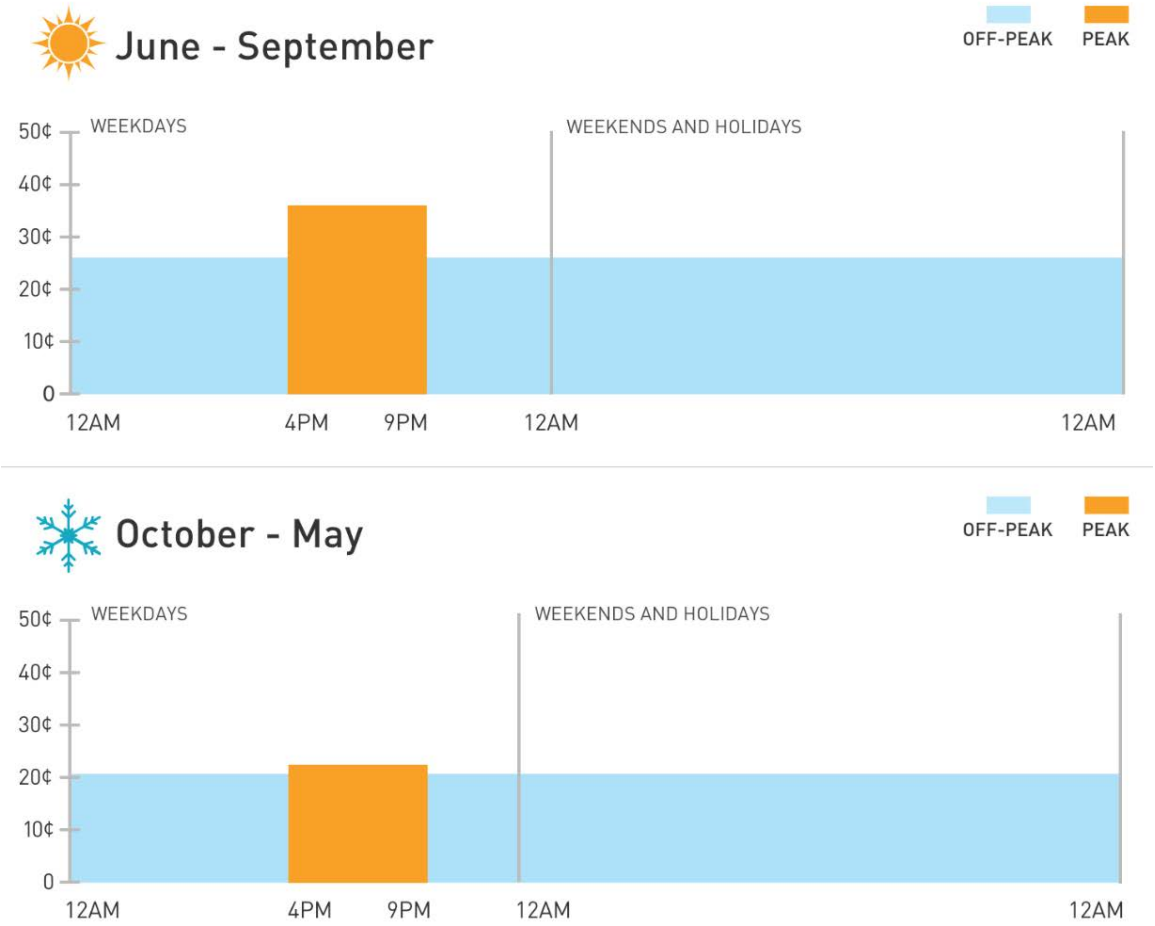
Standard TOU:

Total Energy Rates ($ per kWh)	PEAK	OFF-PEAK
Summer (all usage)	$0.36335 (I)	$0.26029 (I)
Winter (all usage)	$0.22588 (I)	$0.20708 (I)

CARE TOU:

Total Energy Rates ($ per kWh)	PEAK	OFF-PEAK
Summer (all usage)	$0.22163 (I)	$0.15670 (I)
Winter (all usage)	$0.13502 (I)	$0.12317 (I)

TOU Periods:



Periods are the same for both CARE and standard TOU. The prices referenced above are per kWh and are for the standard TOU rate.

Appendix 2: Mean Hourly Load Profiles

Summer (June-September):

Hour and Season		Usage (kWh)			
Hour	Season	Common	Apt1	Apt2	Complex Estimate
0	summer	0.58	0.19	0.16	7.63
1	summer	0.57	0.18	0.15	7.31
2	summer	0.56	0.18	0.15	7.30
3	summer	0.56	0.18	0.18	7.78
4	summer	0.56	0.21	0.14	7.92
5	summer	0.57	0.20	0.14	7.68
6	summer	0.64	0.23	0.14	8.36
7	summer	0.67	0.31	0.16	10.53
8	summer	0.63	0.37	0.19	12.45
9	summer	0.69	0.43	0.20	14.22
10	summer	0.69	0.46	0.25	15.80
11	summer	0.73	0.50	0.23	16.46
12	summer	0.71	0.52	0.19	16.31
13	summer	0.71	0.52	0.20	16.40
14	summer	0.73	0.39	0.18	13.03
15	summer	0.79	0.39	0.22	13.53
16	summer	0.77	0.38	0.24	13.85
17	summer	0.79	0.46	0.30	16.46
18	summer	0.92	0.50	0.36	18.80
19	summer	1.10	0.59	0.35	21.01
20	summer	1.09	0.67	0.29	21.72
21	summer	0.91	0.51	0.26	17.28
22	summer	0.70	0.32	0.19	11.48
23	summer	0.63	0.21	0.16	8.35

Winter (October-May):

Hour and Season		Usage (kWh)			
Hour	Season	Common	Apt1	Apt2	Complex Estimate
0	Winter	0.69	0.24	0.16	8.98
1	Winter	0.68	0.22	0.17	8.75
2	Winter	0.68	0.23	0.16	8.77
3	Winter	0.68	0.23	0.19	9.25
4	Winter	0.69	0.22	0.15	8.47
5	Winter	0.72	0.24	0.16	8.86
6	Winter	0.92	0.25	0.17	9.59
7	Winter	0.98	0.35	0.20	12.55
8	Winter	0.89	0.39	0.25	14.15
9	Winter	0.90	0.37	0.24	13.45
10	Winter	0.87	0.43	0.26	15.33
11	Winter	0.83	0.51	0.27	17.47
12	Winter	0.87	0.50	0.20	16.11
13	Winter	0.82	0.47	0.20	15.37
14	Winter	0.80	0.40	0.22	13.78
15	Winter	0.87	0.41	0.26	14.95
16	Winter	0.90	0.38	0.30	14.87
17	Winter	1.10	0.46	0.35	17.66
18	Winter	1.35	0.54	0.32	19.52
19	Winter	1.45	0.58	0.29	20.02
20	Winter	1.32	0.55	0.30	19.37
21	Winter	1.03	0.42	0.24	14.87
22	Winter	0.82	0.30	0.20	11.13
23	Winter	0.72	0.24	0.17	9.23

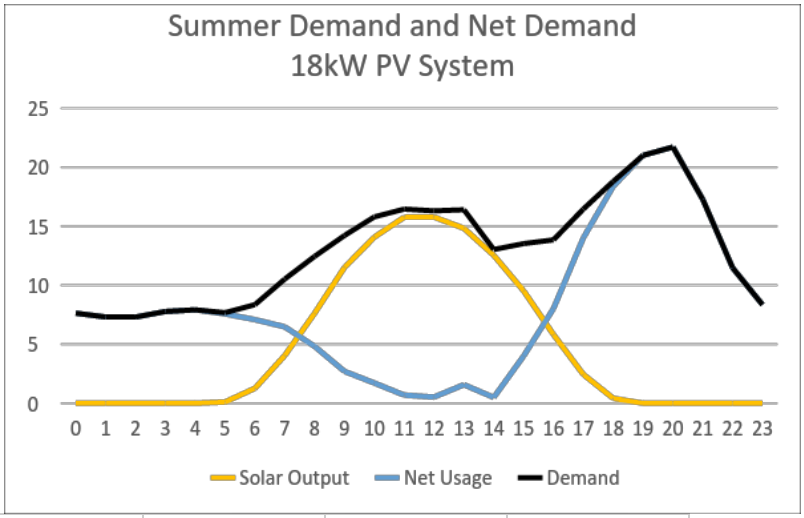
Appendix 3: Mean Hourly Solar Generation Profiles

Mean hourly solar generation profiles for King City, CA, scaled to approximate larger systems:

Hour	1kW Solar System Output (kWh)		18kW Solar System Output (kWh)	
	Summer	Winter	Summer	Winter
0	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
5	0.01	0.01	0.10	0.00
6	0.07	0.09	1.27	0.23
7	0.22	0.26	4.05	1.57
8	0.42	0.42	7.63	4.65
9	0.64	0.52	11.52	7.48
10	0.78	0.58	14.08	9.32
11	0.88	0.59	15.77	10.48
12	0.88	0.55	15.79	10.53
13	0.82	0.46	14.83	9.85
14	0.70	0.33	12.54	8.35
15	0.53	0.15	9.53	5.99
16	0.32	0.03	5.82	2.66
17	0.14	0.00	2.44	0.51
18	0.02	0.00	0.42	0.02
19	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00

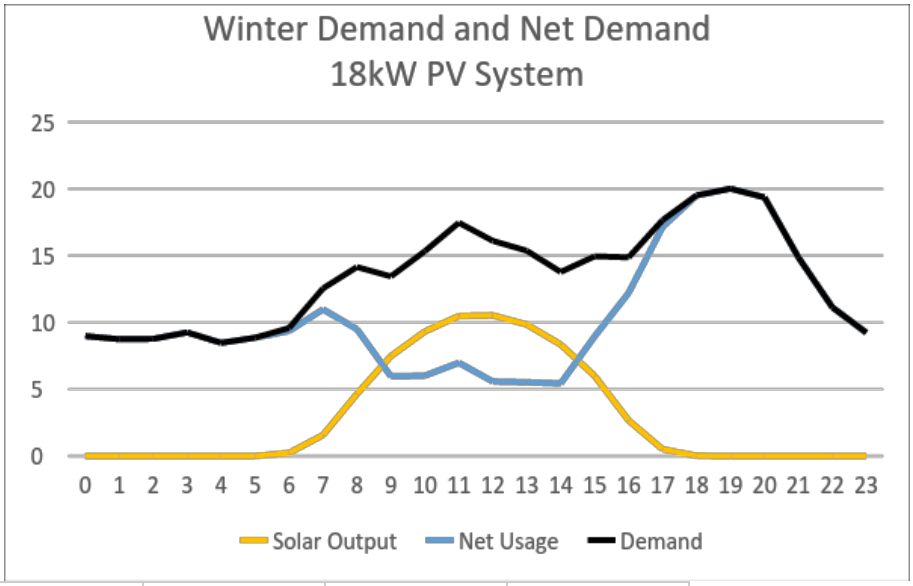
Appendix 4: Mean Hourly Net Load (18kW System)

Summer:



Hour	Solar Output	Net Usage	Demand
0	0.00	7.63	7.63
1	0.00	7.31	7.31
2	0.00	7.30	7.30
3	0.00	7.78	7.78
4	0.00	7.92	7.92
5	0.10	7.57	7.68
6	1.27	7.09	8.36
7	4.05	6.48	10.53
8	7.63	4.82	12.45
9	11.52	2.70	14.22
10	14.08	1.72	15.80
11	15.77	0.69	16.46
12	15.79	0.53	16.31
13	14.83	1.57	16.40
14	12.54	0.49	13.03
15	9.53	4.00	13.53
16	5.82	8.03	13.85
17	2.44	14.02	16.46
18	0.42	18.38	18.80
19	0.00	21.01	21.01
20	0.00	21.72	21.72
21	0.00	17.28	17.28
22	0.00	11.48	11.48
23	0.00	8.35	8.35

Winter:



Hour	Solar Output	Net Usage	Demand
0	0.00	8.98	8.98
1	0.00	8.75	8.75
2	0.00	8.77	8.77
3	0.00	9.25	9.25
4	0.00	8.47	8.47
5	0.00	8.85	8.86
6	0.23	9.36	9.59
7	1.57	10.98	12.55
8	4.65	9.50	14.15
9	7.48	5.97	13.45
10	9.32	6.01	15.33
11	10.48	6.98	17.47
12	10.53	5.58	16.11
13	9.85	5.52	15.37
14	8.35	5.43	13.78
15	5.99	8.96	14.95
16	2.66	12.21	14.87
17	0.51	17.15	17.66
18	0.02	19.50	19.52
19	0.00	20.02	20.02
20	0.00	19.37	19.37
21	0.00	14.87	14.87
22	0.00	11.13	11.13
23	0.00	9.23	9.23

Appendix 5: Survey

La Buena Esperanza Community Energy Use Survey / Encuesta sobre el uso de energía en la comunidad La Buena Esperanza

This survey, conducted by student-volunteers from the University of California Davis, is intended to collect information on energy usage from residents of La Buena Esperanza. The intent of the survey and subsequent research project is to identify opportunities to reduce residents' energy bills through energy efficiency efforts.

This survey is expected to take approximately 15 minutes. The survey is voluntary and responses to the survey will not be shared with third-parties. Please answer the following questions to the best of your ability. If you are unsure of any of the answers, you are free to leave the question blank or to ask for assistance.

Esta encuesta, realizada por estudiantes-voluntarios de la Universidad de California Davis, tiene como objetivo recolectar informacion sobre el uso de energía de los residentes de La Buena Esperanza. El propósito de la encuesta y del proyecto de investigación es identificar las oportunidades para reducir los costos en los recibos de energía (energy bills) a través de propuestas de energía eficiente.

La encuesta tomará aproximadamente 15 minutos. Esta encuesta es voluntaria y las respuestas serán completamente confidenciales. Por favor responsa a las siguiente preguntas con la mayor precisión posible. Si no está seguro de alguna pregunta, siéntase tranquilo de dejarla en blanco o solicite asistencia.

Lighting / Iluminación

This section will ask you about the lighting in your home and how you use your lights.

Esta seccion les probara uds sobre el uso de la iluminacion en su casa y como uds. usen las luces.

1. **Do you feel that your home is sufficiently well-lit? / Siente ud. que su casa está suficientemente iluminada?**
   Mark only one oval.
   - ◯ Yes / Si
   - ◯ No / No
   - ◯ I don't know / No sé

2. **Do you leave an indoor light on overnight? Deja ud. alguna luz interior durante la noche?**
   Mark only one oval.
   - ◯ Always / Siempre
   - ◯ Most of the time / A menudo
   - ◯ Sometimes / A veces
   - ◯ Never / Nunca

3. **Do you leave an outdoor light on overnight? Deja alguna luz exterior prendida durante la noche?**
   Mark only one oval.
   - ◯ Always / Siempre
   - ◯ Most of the time / A menudo
   - ◯ Sometimes / A veces
   - ◯ Never / Nunca

4. **Do you turn off lights when you are in another room or not at home? Apaga las luces cuando deja de usar alguna habitación o cuando sale de casa?**

Mark only one oval.

- Always / Siempre
- Most of the time / A menudo
- Sometimes / A veces
- Never / Nunca

5. **Are you familiar with the difference between traditional incandescent light bulbs and modern LED and CFL light bulbs? // Está familiarizado con la diferencia entre los focos de luz incandescentes, fluorescentes y LED?**

		
Incandescent Bulb	Compact Fluorescent Lamp (CFL) Bulb	Light Emitting Diode (LED) Bulb

Mark only one oval.

- Yes / Si
- No / No
- I don't know / No sé

6. **If so, have you or do you plan to replace your light bulbs with LED or CFL bulbs?**

Mark only one oval.

- Yes - I have or plan to replace my incandescent light bulbs with LED bulbs. // Sí - Yo tengo o planeo reemplazar mis focos incandescentes con focos LED.
- Yes - I have or plan to replace my incandescent light bulbs with CFL bulbs. // Sí - Yo tengo o planeo cambiar mis focos incandescentes con focos fluorescentes
- No - I do not plan to replace my incandescent light bulbs. // No planeo reemplazar mis focos incandescentes
- I don't know // No sé

Temperature and Comfort // Temperatura y comfort

This section will ask you about the temperature in your home and how you use your heater.

7. **How often would you say that you are satisfied with the temperature in your home? // Cuan frecuenta diría que está satisfecho(a) con la temperatura de su hogar?**

Mark only one oval.

- Always // Siempre
- Most of the time // A menudo
- Sometimes // A veces
- Never // Nunca

8. **How often would you say that you are too hot in the summer? // Cuan frecuenta usted diría que padece de calor durante el verano?**

Mark only one oval.

- Always // Siempre
- Most of the time // Frecuentemente
- Sometimes // A veces
- Never // Nunca

9. **How often would you say that you are too cold in the winter? // Cuan frecuente diría que siente mucho frio en el verano?**
Mark only one oval.

- ◯ Always // Siempre
- ◯ Most of the time // A menudo
- ◯ Sometimes // A veces
- ◯ Never // Nunca

10. **Does your home have a thermostat to control the temperature? // Su hogar cuenta con un termostato para controlar la temperatura?**
Mark only one oval.

- ◯ Yes // Sí
- ◯ Yes, but it does not work // Sí, pero no trabaja
- ◯ No
- ◯ I don't know // No sé

11. **If yes, do you use your thermostat to control the temperature? // Si la respuesta anterior es sí, usa el termostato para controlar la temperatura?**
Mark only one oval.

- ◯ Yes - I turn the thermostat on when I am cold and off when I am comfortable // Sí, lo prendo cuando tengo frío y lo apago cuando ya me siento cómodo
- ◯ Yes - I set the thermostat at a specific temperature // Sí yo deja la temperatura predeterminada en el termostato
- ◯ No - I don't use the thermostat // No uso el termostato
- ◯ I don't know // No sé

12. **Do you turn off your heater when you are not home? // Apaga su calefacción cuando no está en casa?**
Mark only one oval.

- ◯ Always // Siempre
- ◯ Most of the time // A menudo
- ◯ Sometimes // A veces
- ◯ Never // Nunca

13. **Do you use a portable electric heater (space heater)? // Usa calefacción portátil eléctrica?**
Mark only one oval.

- ◯ Always // Siempre
- ◯ Most of the time // A menudo
- ◯ Sometimes // A veces
- ◯ Never // Nunca

Water Heater // Calentador de agua

This section will ask you questions about your hot water and how you use hot water.

14. **Do you believe the hot water in your home to be the right temperature? // Considera la temperatura del agua muy caliente?**
Mark only one oval.

- ◯ My hot water is too hot // Mi agua caliente es muy caliente
- ◯ My hot water is just right // Mi agua caliente es como la quiero
- ◯ My hot water is not hot enough // Mi agua no calienta lo suficiente

15. **Approximately how many showers does your household take each day? // Aproximadamente cuántas veces se bañan en su hogar al día?**
Mark only one oval.

- ◯ 1-2
- ◯ 3-4
- ◯ 5-6
- ◯ Other: _____

16. **Do you try to limit the length of showers to a specific amount of time to reduce bills and conserve water and energy? // Intenta limitar la duración de sus baños a un monto específico de tiempo para reducir sus gastos de energía y conservar el agua?**
Mark only one oval.

- ◯ Yes, I limit my showers to five minutes or less // Sí, limito mis baños a 5 minutos o menos
- ◯ Yes, I limit my showers to ten minutes or less // Sí, limito mis baños a 10 minutos o menos
- ◯ No, but I try to take short showers // No, pero trato de que sean cortos
- ◯ I prefer longer showers // Prefiero los baños largos
- ◯ I don't know // No sé

17. **How do you wash clothes? // Como lava su ropa?**
Mark only one oval.

- ◯ Using a home washing machine // Uso
- ◯ By hand at home // A mano
- ◯ At a laundromat or other location // En una lavandería pública (laundromat) u otro lugar

18. **How do you dry clothes? // Cómo seca su ropa?**
Mark only one oval.

- ◯ Using a home dryer // Usa una secadora de ropa
- ◯ Using a clothesline / hanging clothes // Uso gancho de ropa y/o cuelgo mi ropa
- ◯ At a laundromat or other location // En una lavandería pública (laundromat) u otro lugar

19. **How many loads of laundry does your household do per week? // Cuántas cargas de lavado su hogar realizar a la semana?**
Mark only one oval.

- ◯ 1-2
- ◯ 2-3
- ◯ 3-4
- ◯ 5-6
- ◯ Other: _____

Kitchen // Cocina

This section will ask you about your kitchen and how you use kitchen appliances.

20. **Which appliances do you use to cook? // Qué electrodomésticos usa para cocinar?**
Check all that apply.

- [ ] Gas stove // Estufa a gas
- [ ] Gas oven // Horno a gas
- [ ] Electric stove // Cocina eléctrica
- [ ] Electric oven // Horno eléctrico
- [ ] Microwave // Horno microondas
- [ ] Toaster/toaster oven // Tostadora/horno tostador
- [ ] Slow cooker // Olla de cocción lenta
- [ ] Barbecue // parrilla
- [ ] Other: _____

21. **Of the above appliances, which do you use most for cooking? // De los artículo de la pregunta anterior, cuál usa más?**
Mark only one oval.

- ◯ Gas stove // Estufa a gas
- ◯ Gas oven // Horno a gas
- ◯ Electric stove // Estufa eléctrica
- ◯ Electric oven // Horno eléctrico
- ◯ Microwave // Horno microondas
- ◯ Toaster/toaster oven // Tostadora/horno tostador
- ◯ Slow cooker // Olla de cocción lenta
- ◯ Barbecue // Parrilla
- ◯ Other: _____

22. **How many refrigerators are plugged-in your household? // Cuántos refrigeradores están enchufados en su hogar?**
Mark only one oval.

- ◯ One full-size refrigerator // Un refrigerador grande
- ◯ One full-size refrigerator and one or more miniature refrigerators (mini-fridge) or stand-alone freezers // Un refrigerador grande y uno mas de tamaño regular o mediano
- ◯ Two or more full-size refrigerator or more than two miniature refrigerators // Dos o más refrigeradoras de tamaño grande más dos o más refrigeradores pequeños

23. **When washing dishes, how often do you leave the hot water running? Cuándo lava platos, qué tan seguido deja el agua caliente correr?**
Mark only one oval.

- ◯ Always // Siempre
- ◯ Often // A menudo
- ◯ Sometimes // A veces
- ◯ Rarely // Raramente

Other Electronics // Otros electrodomésticos

This section will ask you about other electronics in your home, such as televisions and computers.

24. **How many televisions are in your home? // Cuántas televisiones están en tu casa?**
Mark only one oval.

- ◯ 0
- ◯ 1
- ◯ 2
- ◯ More than 2 // Más de 2

25. **Do you leave a television on overnight or when you are not home? // Deja la televisión prendida en la noche o cuando no está en casa?**
Mark only one oval.

- ◯ Yes // Sí
- ◯ No
- ◯ I don't know // No sé

26. **Do you own a computer? // Tiene computadora?**
Mark only one oval.

- ◯ Yes - I leave it in standby mode // Si, cuando no la uso la dejo en modo dormir
- ◯ Yes - I power it off when not in use // Si, cuando no la uso la apago
- ◯ No

Energy Bill // Recibo de luz

This section will ask you questions about your electricity and gas bills.

27. **Do you receive an energy bill from (Pacific Gas and Electric) PG&E? // Usted recibe los recibos de luz de PG&E?**
Mark only one oval.

- ◯ Yes - I receive a paper bill through the mail // Sí, los recibo a través del correo regular
- ◯ Yes - I receive an electronic bill by e-mail // Sí, los recibo electrónicamente
- ◯ No - I don't receive a bill from PG&E // No, no recibo los recibos de PG&E
- ◯ I don't know // No sé

28. **On average, approximately how much was your PG&E bill last month? // En promedio, aproximadamente cuánto fue su último recibo de PG&E?**
Mark only one oval.

- ◯ $0-$20
- ◯ $20-$40
- ◯ $40-$60
- ◯ $60-$80
- ◯ $80-$100
- ◯ $100-$120
- ◯ More than $120
- ◯ I don't know

29. **Approximately how much was the highest PG&E bill you recall receiving in your current home? // De lo que usted recuerda, aproximadamente cuál fue la cantidad máxima que usted haya tenido que pagar a PG&E en su actual hogar?**

Mark only one oval.

- $0-$20
- $20-$40
- $40-$60
- $60-$80
- $80-$100
- $100-$120
- More than $120 // Más de 120
- I don't know // No sé

30. **Approximately how much was the lowest PG&E bill you recall receiving in your current home? // Aproximadamente cuánto fue la cantidad mínima que haya tenido que pagar en un recibo de PG&E en su actual hogar?**

Mark only one oval.

- $0-$20
- $20-$40
- $40-$60
- $60-$80
- $80-$100
- $100-$120
- More than $120 // Más de 120
- I don't know // No sé

31. **Are your PG&E bills typically higher in the summer or winter? // Sus recibos de PG&E son más altos en el invierno o verano?**

Mark only one oval.

- Summer // Verano
- Winter // Invierno
- I don't know // No sé

32. **Are you aware of PG&E discounts for low-income customers? If so, is your household signed up for CARE or another energy bill discount program? // Sabe usted de los descuentos de PG&E para clientes de bajos recursos? Si así fuese, su hogar se ha registrado a CARE o otro programa de descuento de recibos de energia?**

Mark only one oval.

- Yes, my household is signed up for discounted bills through PG&E's low-income programs. // Sí, mi hogar está registrado para descuentos en los recibos a través de los programa de PG&E
- Yes, but my household does not qualify for discounted bills through PG&E's low-income programs. // Sí, pero mi hogar no califica para los descuentos de los
- Yes, but my household is not signed up for another reason. // Sí, pero mi hogar no está registrado por otro motivo
- No, I am not aware of PG&E billing discounts. // No, no sé de estos descuentos
- I don't know // No sé

33. **How many people live in your household? // Cuántas personas viven en su hogar?**

Mark only one oval.

- 1
- 2
- 3
- 4
- 5
- More than 5 // Más de 5

34. **How many people are in your household during the day? // Cuántas personas están en su hogar durante el día?**

Mark only one oval.

- 0
- 1
- 2
- 3
- 4
- 5
- More than 5 // Más de 5

35. **How many people are in your household during the weekend and at night? // Cuántas personas hay en su hogar durante los fines semanas y en las noches?**

Mark only one oval.

- 0
- 1
- 2
- 3
- 4
- 5
- More than 5 // Más de 5

36. **Which type of apartment do you live in? // En qué tipo de departamento vive?**

Mark only one oval.

- 1 Bedroom // 1 cuarto
- 2 Bedroom // 2 cuartos
- 3 Bedroom // 3 cuartos
- 4 Bedroom // 4 cuartos
- Other // Otros