BLUM Summer Field Internship

EPIC (Electric Program Investment Charge) Synthesis Report
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Introduction

To assess the solar potential of Encanto, the EPIC team utilized multiple online resources such as Project Sunroof, Daft Logic, and Zillow. By inputting the different addresses of residential and commercial homes into these programs, we were able to gather and pool data to help determine the viability of installing more solar panels in the neighborhood. To supplement the data extracted online, our team collected sample qualitative data in Sectors 1-4 of the Chollas EcoVillage by walking around the residential neighborhoods. The following report synthesizes our data collection to provide an overview of the viability of turning Encanto into the Chollas EcoVillage—an advanced energy community.

Project Sunroof

Project Sunroof is a program owned by Google that uses data from Google Maps. It uses 3D modeling, shade calculations from nearby obstructions, historical weather trends and temperature data in order to calculate hours of usable sunlight per year, square footage on roofs, and energy savings. In order to gather data, residential addresses were searched within the Project Sunroof program. Figure 1 depicts the interface of the program:

Figure 1: Image of Project Sunroof Interface

Our measurements included hours of usable sunlight, square footage, and savings. Out of the 1750 residential homes within the Chollas EcoVillage we assessed, the average of each variable in this neighborhood lies as follows:

Residential Addresses Data Averages:

- Solar Potential: 1950 hours of usable sunlight
- Square Footage: 939 sq ft
- Savings Over 20 Years: $14,646.42

- Owner to Non-owner Ratio: 1077/675 (O/R)

The LG solar panels currently planned to be implemented in the neighborhood are 330 watts each. Sunroof data indicated that there are 1950 hours of usable sunlight in the Diamond District per year, which amounts to 5.34 hours of usable sunlight per day. Given this average, we calculated an average of approximately 54 kWh/month for each solar panel.

$$330W \times 5.34\ \frac{hours}{day} \times \frac{30\ days}{month} = 52,866\ Wh/month = 52.866\ kWh/month \quad (1)$$

Because each individual solar panel is approximately 18.435 square feet, the solar production potential or energy production per capita is 2.938 kWh/month-ft^2

$$52.866\ \frac{kWh}{month} \div 18.435\, ft^2 = 2.867\ \frac{kWh}{month{-}ft^2} \quad (2)$$

According to Project Sunroof, the average total available roof area is 939 ft^2. Solar roofs, however, only cover a certain percentage of total available roof area, thus 3 cases of true available roof area: 20%, 25%, 30% were selected. These different cases give 187.8, 234.75, 281.7 square feet available on the average roof, respectively. Given that each solar panel is approximately 18.435 square feet, the average number of solar panels per roof is 10.21 panels/roof, 12.76 panels/roof, and 15.32 panels/roof for 20%, 25%, and 30% roof coverage, respectively.

Multiplying the energy production per capita, the different square footages available, and the number of residential homes together, the total estimated energy output of the community can be calculated, as shown in Table 1 below:

Example Calculation: Calculating number of solar panels given 20% coverage and 5% participation

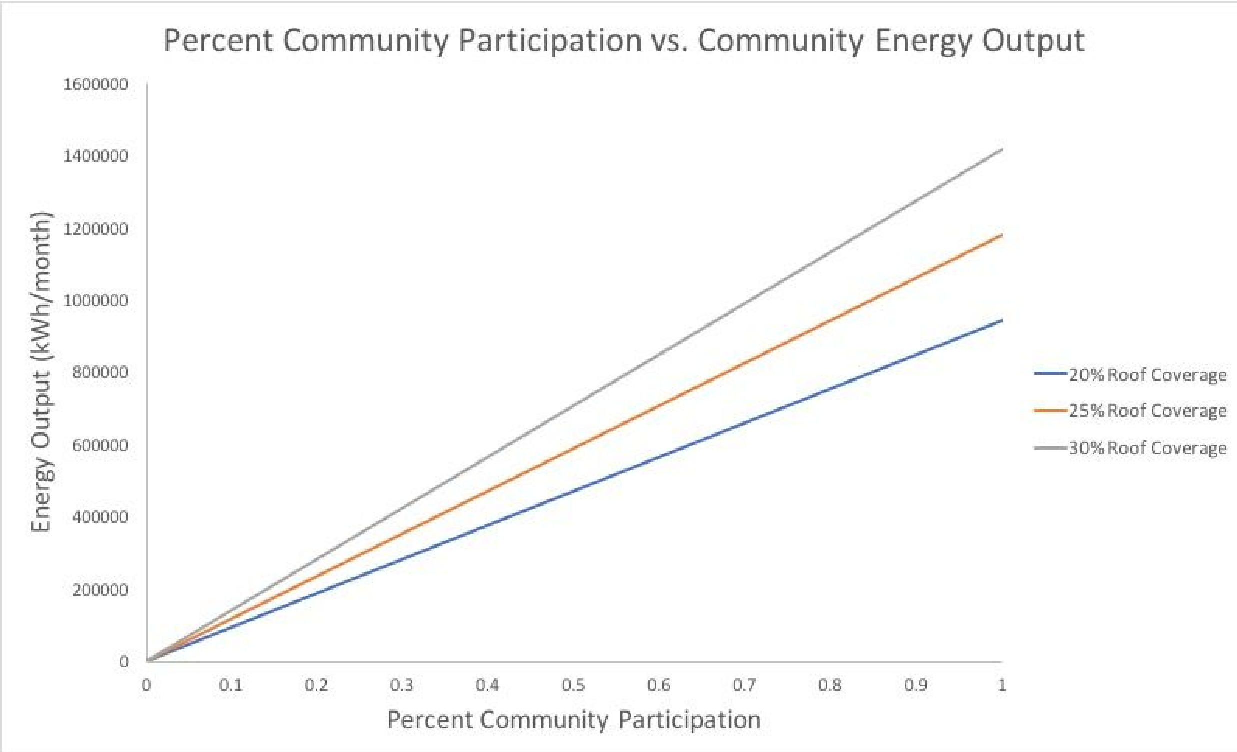
$$10.21 \, \frac{panels}{home} \times 1750 \, homes \times 5\% = 893.52 \, panels$$

Table 1: Estimated Number of Solar Panels Given Certain Percentages of Community Participation and Different Percentages of Roof Coverage of Panels

Percentage of Community Participation	20% Roof Coverage	25% Roof Coverage	30% Roof Coverage
5%	893.52 panels	1116.90 panels	1340.29 panels
10%	1787.05 panels	2233.81 panels	2680.58 panels
15%	2680.58 panels	3350.72 panels	4020.87 panels
20%	3574.10 panels	4467.63 panels	5361.16 panels
25%	4467.63 panels	5584.54 panels	6701.45 panels
30%	5361.16 panels	6701.45 panels	8041.74 panels
35%	6254.69 panels	7818.36 panels	9382.03 panels
40%	7148.21 panels	8935.27 panels	10722.32 panels
45%	8041.74 panels	10052.18 panels	12062.61 panels
50%	8935.27 panels	11169.09 panels	13402.91 panels
55%	9828.80 panels	12286.00 panels	14743.20 panels
60%	10722.32 panels	13402.91 panels	16083.49 panels
65%	11615.85 panels	14519.81 panels	17423.78 panels
70%	12509.38 panels	15636.72 panels	18764.07 panels
75%	13402.91 panels	16753.63 panels	20104.36 panels
80%	14296.43 panels	17870.54 panels	21444.65 panels
85%	15189.96 panels	18987.45 panels	22784.94 panels
90%	16083.49 panels	20104.36 panels	24125.23 panels
95%	16977.02 panels	21221.27 panels	25465.53 panels
100%	17870.54 panels	22338.18 panels	26805.82 panels

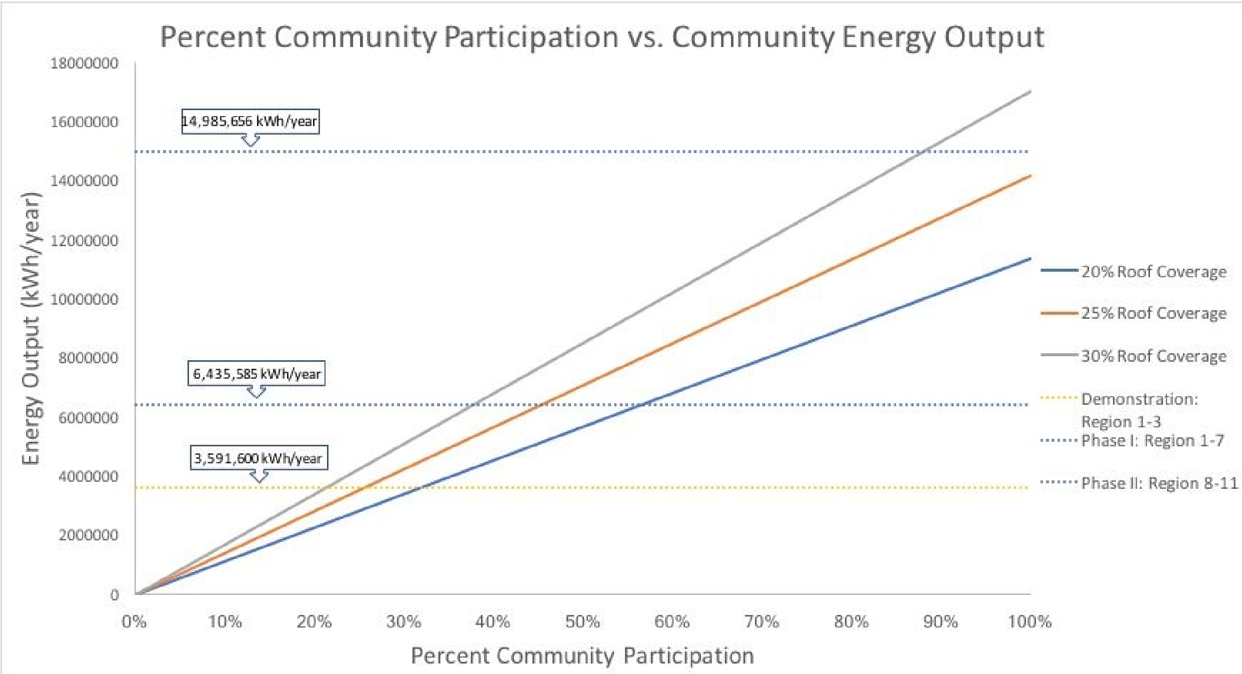
Table 2: Estimated Energy Output (kwH/month) Given Certain Percentages of Community Participation and Different Percentages of Roof Coverage of Panels

Percentage of Community Participation	20% Roof Coverage	25% Roof Coverage	30% Roof Coverage
5%	47237.22 kwH/month	59046.52 kwH/month	70855.83 kwH/month
10%	94474.44 kwH/month	118093.04 kwH/month	141711.65 kwH/month
15%	141711.65 kwH/month	177139.57 kwH/month	212567.48 kwH/month
20%	188948.87 kwH/month	236186.09 kwH/month	283423.31 kwH/month
25%	236186.09 kwH/month	295232.61 kwH/month	354279.13 kwH/month
30%	283423.31 kwH/month	354279.13 kwH/month	425134.96 kwH/month
35%	330660.53 kwH/month	413325.66 kwH/month	495990.79 kwH/month
40%	377897.74 kwH/month	472372.18 kwH/month	566846.62 kwH/month
45%	425134.96 kwH/month	531418.70 kwH/month	637702.44 kwH/month
50%	472372.18 kwH/month	590465.22 kwH/month	708558.27 kwH/month
55%	519609.40 kwH/month	649511.75 kwH/month	779414.10 kwH/month
60%	566846.62 kwH/month	708558.27 kwH/month	850269.92 kwH/month
65%	614083.83 kwH/month	767604.79 kwH/month	921125.75 kwH/month
70%	661321.05 kwH/month	826651.31 kwH/month	991981.58 kwH/month
75%	708558.27 kwH/month	885697.84 kwH/month	1062837.40 kwH/month
80%	755795.49 kwH/month	944744.36 kwH/month	1133693.23 kwH/month
85%	803032.71 kwH/month	1003790.88 kwH/month	1204549.06 kwH/month
90%	850269.92 kwH/month	1062837.40 kwH/month	1275404.89 kwH/month
95%	897507.14 kwH/month	1121883.93 kwH/month	1346260.71 kwH/month
100%	944744.36 kwH/month	1180930.45 kwH/month	1417116.54 kwH/month



Graph 1: Percent Community Participation vs Community Energy Output (kwH/month) Given Different Roof Coverages

According to the estimates from Bill Torre, the Program Director for Energy Storage Systems at the UC San Diego Center for Energy Research, the annual total energy usage for the Demonstration Phase (Region 1-3), Phase 1 (Region 1-7), and Phase II (Region 8-11), are 3,591,000 kWh, 6,435,585 kWh, and 14,985,656 kWh, respectively. These measurements are displayed on Graph 2 (below) as dotted lines.



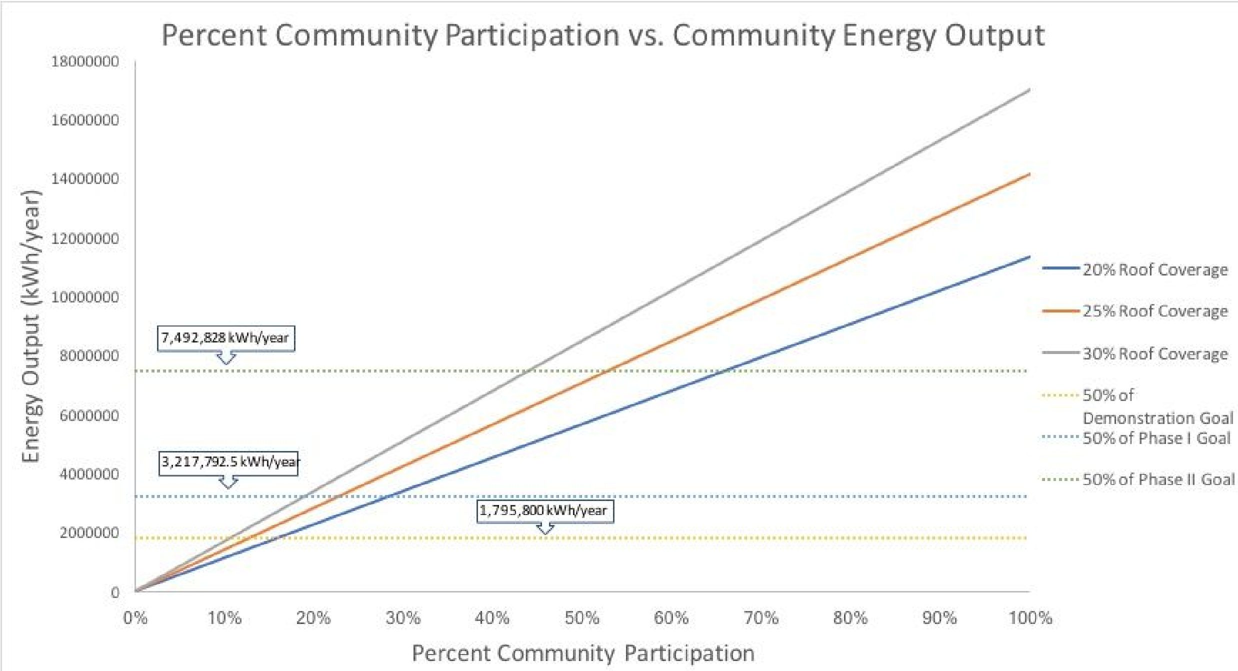
Graph 2: Percent Community Participation vs Community Energy Output (kwH/year) Given Different Roof Coverages and Energy Usage for Demonstration, Phase 1 and 2.

As evident in the table 3 below, the total energy consumption of the community could be matched using residential solar at high participation rates at 30% roof coverage. For example, it would require 21% community participation with 30% roof coverage to match the energy usage for Regions 1-3. The energy goal for Phase 2 (Regions 8-11) can only be achieved with 30% roof coverage and 88% community participation.

Table 3: Necessary Community Participation Percentages to Meet Energy Usages in Demonstration, Phase 1, and Phase 2

Phase	Necessary community participation to match energy usage @ 20% roof coverage	Necessary community participation to match energy usage @ 25% roof coverage	Necessary community participation to match energy usage @ 30% roof coverage
Demonstration: Region 1-3	31%	25%	21%
Phase 1: Region 1-7	56%	45%	38%
Phase 2: Region 8-11	Not possible	Not possible	88%

Residential solar is not expected to account for 100% of the community's energy usage; however, Graph 3 shows the expected community output given different percentages of community participation, along with markers indicating 50% of the goal production for the Demonstration Phase, Phase I, and Phase II.



Graph 3: Percent Community Participation vs Community Energy Output (kwH/year) Given Different Roof Coverages and Energy Usage for Demonstration, Phase 1 and 2. (Assuming only 50% of Energy Demand is Met by Solar)

Table 4 depicts the necessary community participation percentages to meet 50% of the energy production goals for The Demonstration Phase, Phase I, and Phase II, given 20% roof coverage, 25% roof coverage, and 30% roof coverage.

Table 4: Necessary Community Participation Percentages to Meet Energy Usages in Demonstration, Phase 1, and Phase 2 (Assuming Solar Accounts for 50% of Energy Usage)

Phase	Necessary community participation to match energy usage @ 20% roof coverage	Necessary community participation to match energy usage @ 25% roof coverage	Necessary community participation to match energy usage @ 30% roof coverage
50% of Demonstration Goal	16%	12%	10%
50% of Phase I	28%	24%	20%

Goal			
50% of Phase II Goal	66%	54%	45%

The same measures from Project Sunroof were also assessed for commercial addresses in the surrounding area.

Commercial Addresses Data Averages:

- Solar Potential: 1911 hours of usable sunlight
- Square Footage: 2009 sq ft
- Savings: $14348.84
- Owner to Non-owner ratio: 8/37 (O/R)

Neighborhood Walkthrough

In order to further investigate the solar potential of the residential homes, the team also walked through the neighborhood, examining rooftop potential in Gompers Preparatory Academy's surrounding area, and gathered sampling data from 116 houses from sectors 1-4. These samples were chosen as representative because they were in the nearby vicinity of the EarthLab. To supplement our research from Project Sunroof, the team went into the field to perform additional assessment on roof condition, roof type, angle, physical obstruction, and potential areas for solar. Sample data was collected in hopes of providing a representation of the feasibility of solar potential in the larger Encanto region.

Neighborhood Sampling Data:

- Roof Angle: 59 Slant, 57 Flat
- Roof Type: 5 Tile, 111 Shingle
- Roof Condition: 52 Good, 5 Poor
- Other notes: Many houses had installed additional structures, such as shade structures and large sheds. Our limited expertise prevents us from concluding whether or not these structures are stable for solar panels; however, it allows for discovery of areas for potential solar. Furthermore, walking through the neighborhood allowed us to search for environmental factors that can hinder full solar potential; multiple houses had large trees or other physical infrastructures that obstructed rooftop sunlight exposure.

Daft Logic

In addition to Project Sunroof, we used Daft Logic to estimate the potential lot space available near these commercial buildings (45 addresses total). Daft Logic is a platform that allows one to see the distance between any given points on Google Maps. The goal is to examine the viability of using parking lots and estimate footage for other solar potential locations. The interface of the program is as seen below:

Figure 2: Image of Daft Logic Interface

In the future, parking lots could encourage the transition to electric vehicles in the Encanto region. Overhanging solar structures could be created in parking lots to provide shade to vehicles, in addition to providing electricity needed for charging stations that electric vehicles could use.

From Daft Logic, ***we estimated that the vacant/potential lot space for solar for the commercial addresses is, on average, 18574 sq ft/commercial-address.***

Average Lot Space per Commercial Address	18574 ft^2

From our observations, we realized that none of the commercial lots currently house or support any type of structures for the placement of solar panels (ie. roofs of parking structures). Most of the vacant spaces appear to be either parking lots or dirt pavement. Many of these plots, however, do contain large potential lots that could provide available space needed for solar PV: The top 10 addresses with the most commercial lot space are shown in Table 5 below. The total energy output (kWH/year) from just these top 10 addresses is ***6,842,125.86 kwH/year.***

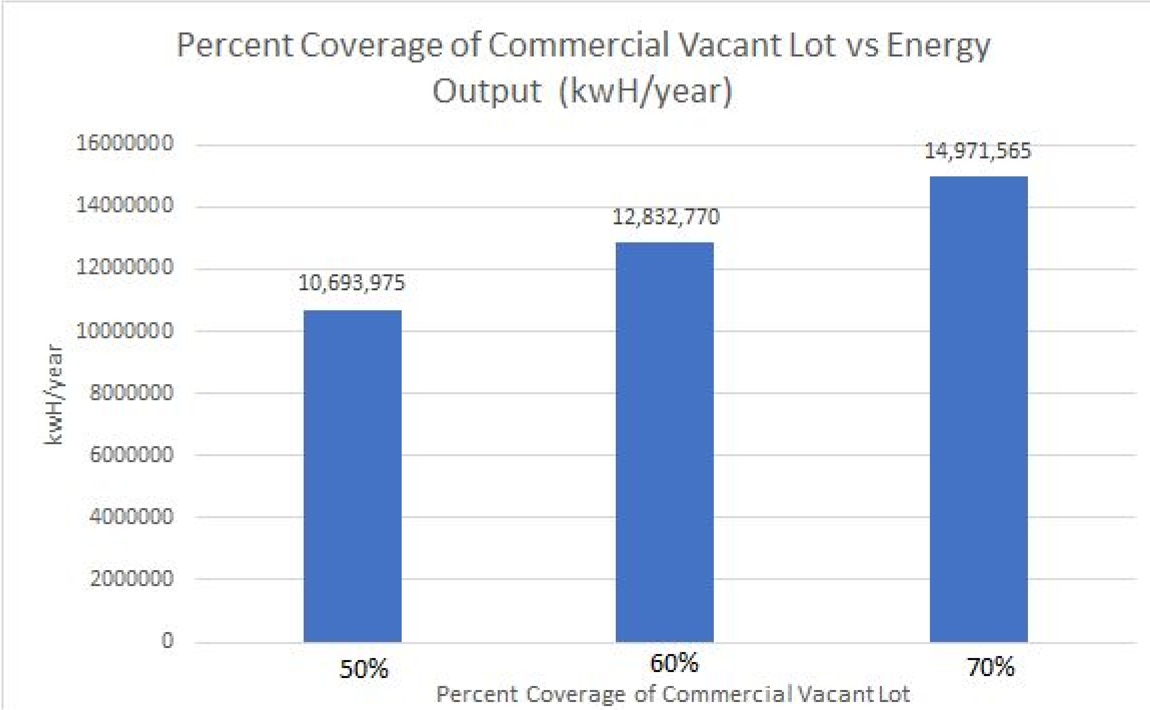
Table 5: Top 10 Commercial Addresses with the Largest Vacant/Potential Lot Space

Ranking #	Address	Zip Code	Vacant/Potential Lot Space (sq ft)	Expected kWh/year @50% Coverage
1	404 EUCLID Ave San Diego CA	92114-2221	122,239.59	1,636,696.35
2	4902 MARKET St San Diego CA	92102-4719	80,924.2	1,083,514.29
3	5053 CHURCHWARD Plz San Diego CA	92113-2045	50,693.56	678,748.15
4	5065 LOGAN Ave San Diego CA	92113-4490	49,068.38	656,988.77
5	292 EUCLID Ave San Diego CA	92114-3643	48,248.26	646,007.99
6	4637 MARKET St San Diego CA	92102-4709	47,279.18	633,032.73
7	5039 CHURCHWARD Ave San Diego CA	92113-2045	33,442.75	447,773.32
8	4931 LOGAN Ave San Diego CA	92113-4471	29,128.4	390,007.41
9	602 EUCLID Ave San Diego CA	92102	27,462.73	367,705.34

10	212 EUCLID Ave San Diego CA	92114-36 09	22,536.85	301,651.505

In order to calculate the total solar potential of vacant parking lots in commercial areas, we made the assumption that commercial address vacant lots had the same usable sunlight hours per day as their commercial building counterparts from Project Sunroof. The data for the power and square footage of each solar panel used in this calculation were borrowed from Lumos, a solar PV company that specializes in creating solar panels and support structures in parking lot areas.

Calculations for solar potential in commercial areas were identical to calculations used to determine the solar potential in residential areas, using equations (1) and (2) from above. Instead commercial areas would use 265W panels that were 18.65 square feet (from Lumos Solar), and each lot had 5.235 usable hours of sunlight (from Project Sunroof). Realistically solar panels cannot cover all of the parking lots, so the assumption was made that commercial lots would have 50%, 60%, and 70% . The following graph shows the solar potential of total commercial vacant lots at these different coverages:



Graph 4: Solar Potential (kWh/year) of Commercial Vacant Lots At Different Coverages

According to Graph 4 above, commercial lots could provide 14,715,565 kWh per year when 70% of their square footage is covered by solar panels. This could help meet the energy demand for each phase substantially if solar in commercial lots could be used in conjunction with solar in residential areas.

Zillow

In addition to Project Sunroof, the real estate app Zillow was used to further assess 704 residential homes from sectors 1-4 in the Encanto Region. Zillow extracts data from public records and publishes them in an electronic format online. An image of the Zillow interface is provided below:

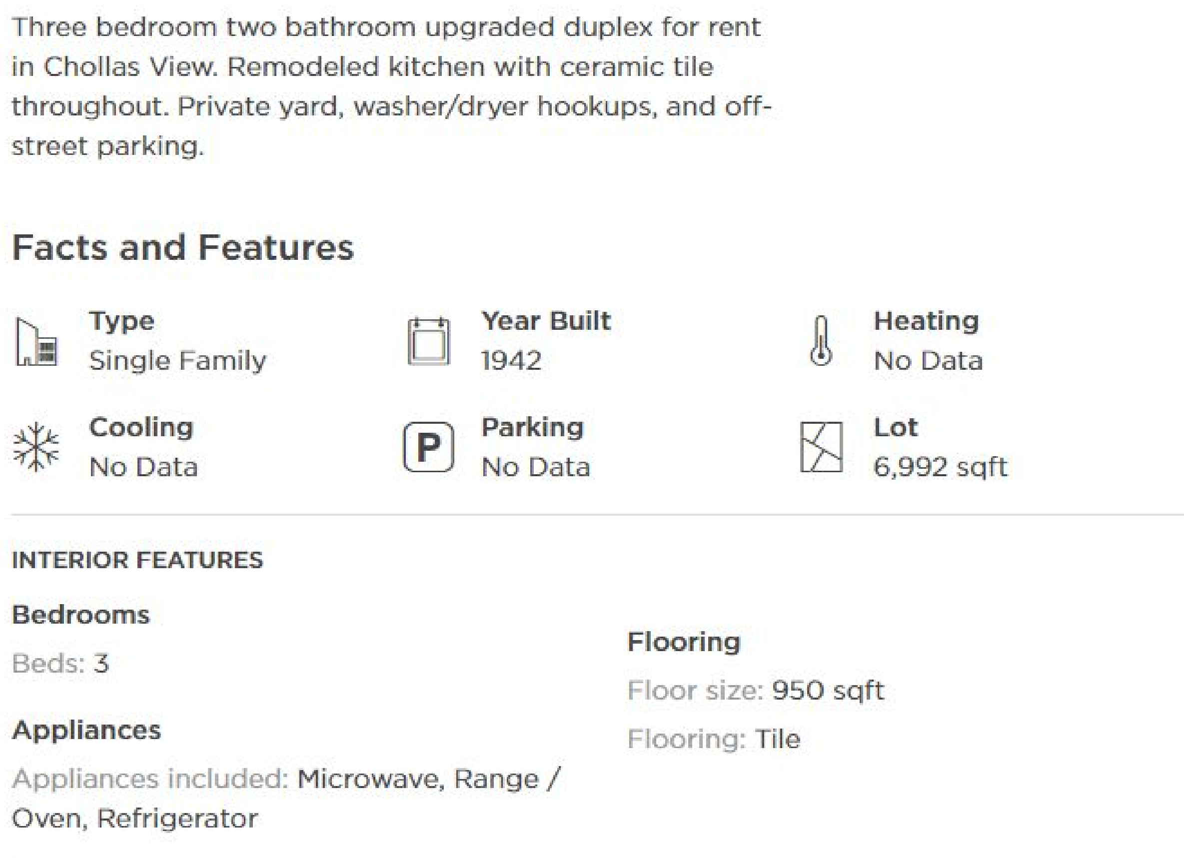


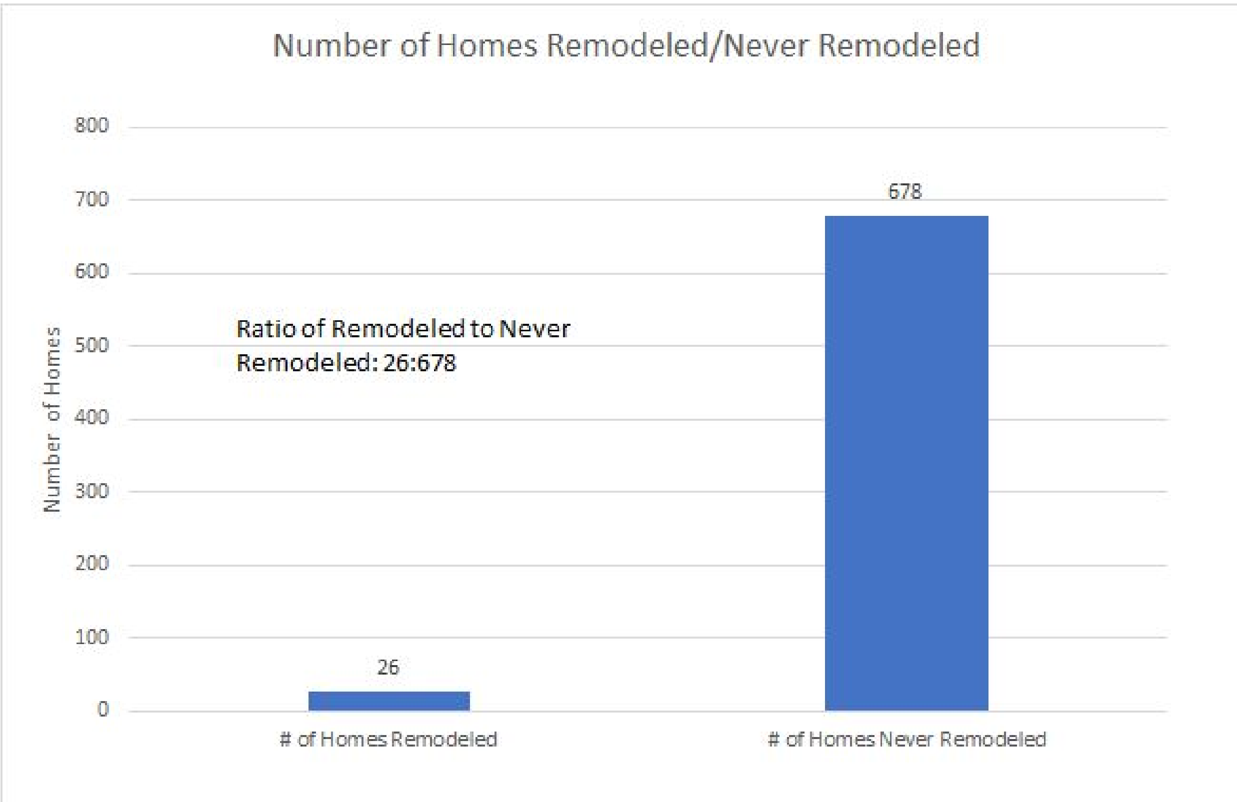
Figure 3: Image of Zillow Interface

The following parameters were assessed and data was averaged from Zillow:

- Year Built: 1955
- Floor Square Footage: 1334 sq ft
- Lot Size: 7679 sq ft
- Sun Number: 86.8[1]
- Number of remodeled homes: 26

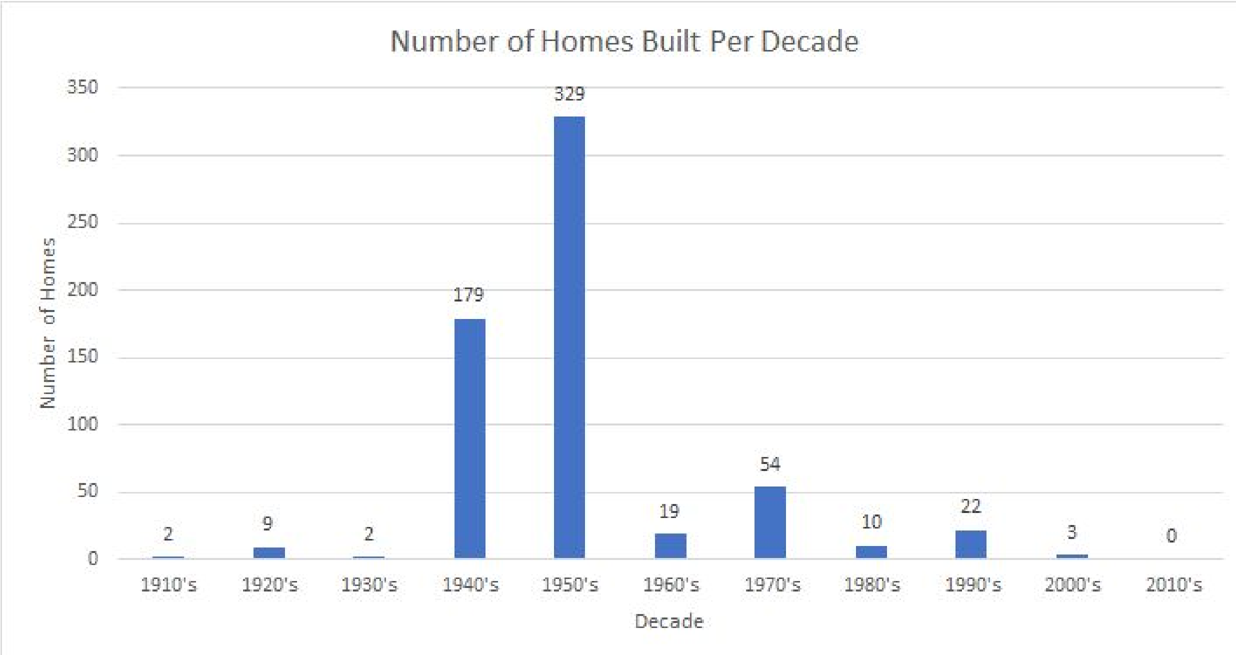
[1] The Sun Number Score is a comprehensive scale that gauges a home's suitability for solar on a scale from 0-100. It implements a detailed roof analysis to determine how much roof area is available for solar based on the pitch, orientation, and size of each roof, as well as the amount of sunlight the roof receives considering surrounding obstructions like trees. Other factors that determine Sun Number include the local cost of electricity (in this case through SDGE), the local cost of solar, and climate of the surrounding area. Based on the data given by Zillow, it appears that the residential homes (from sectors 1-4), on average, have great potential for solar.

From Zillow data, it was determined that a majority of homes have not been remodeled since being built (96.3% never remodeled) as seen in Graph 5 below. This raises concern in regards to the structural integrity of homes that have not been remodeled as their roofs may not be able to sustain the weight of solar PV.



Graph 5: Number of Homes Remodeled/Not Remodeled In Sectors 1-4

In addition, our Zillow data determined that a majority of homes (80.7%) have been built between the 1940s and the 1950s.



Graph 6: Number of Homes Built per Decade In Sectors 1-4

Notes for Further Action

Further investigation could be done towards inspecting the condition of roofs on residential homes. The installation of solar panels requires stable roofs that can account for the weight of solar photovoltaic panels. According to our sample data, a majority of homes contained roofs with shingles. Compared to their heavier, tile counterparts, shingle roofs raise concerns as to whether or not homes can sustain solar panels as shingles are very light and the roofs that support shingles may or may not be able to sustain the weight of solar panels.

In addition, our sample data on roofs and lawns were only limited to a small portion of the Encanto region. In the future, more residential addresses in the community should be sampled to gather more comprehensive data on the roof structures in the Encanto region.