The Path to Zero Net Energy: A Hands-on Approach
TTP 298A-004
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DOS PINOS

Two Paths to Zero Net Energy

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Executive summary

Dos Pinos is a cooperative living community of about 100 members. The property consists of 60 individual units (ranging from 1-3 bedrooms), as well as a pool, spa and community room. Dos Pinos recently refinanced their mortgage, and turned to the ZNE Pathways team to explore investments to decrease their energy consumption and potentially produce onsite solar.

Prior to this project, the community had no baseline for their energy consumption. The Pathways was tasked with developing a baseline for both the individual unit meters and community meters. Additionally, the focus of the financial model was to be on community owned equipment and machinery. This included, but is not limited to, the pool and spa pumps, community laundry, outdoor lighting, all HVAC, and all water heaters. The pathways team also was responsible for determining the feasibility of install solar PV.

The team was able to create baselines for electrical and gas consumption on both individual and community meters. This required an on-site energy audit to determine how much energy the equipment uses, a survey to understand tenant behavior, and PG&E bills from both the tenants and community meters.

The baselines revealed that a major energy end-us was the outdoor lighting, contributing 76% of the community electrical demand. Upon assessment, we found that retrofitting the lighting would have an 83% return on investment. We found the rest of the equipment is relatively efficient, and should only be replaced upon the end of their life.

Project background

Dos Pinos is a cooperative living community that houses a little over 100 residents. There are 60 individual units; 6 one-bedroom units, 26 two-bedroom units, and 28 three-bedroom units. In addition to the individual units, there is also a community room, spa and pool. The members are very active in governing the community, as the each own shares of the community property. Recently, the community refinanced their mortgage and has to decide how to spend their new funds. They turned to the UC Davis Pathways to Zero-Net Energy team to consult them on how to best invest their new funds to reduce their individual and communal energy consumption, increase livability and comfort, and potential produce onsite solar.

Problem description

Prior to this report, the community had no baselines on their energy consumption. The community was able to supply PG&E bills for both the individual and communal meters, dating 3 years back. Currently, the tenants pay their individual PG&E bills. The community owns the HVAC, water-heaters, and dishwasher in the individual units. The community, as a whole, pays for the communal energy consumption. Communal consumption entails the energy consumed by the community room, pool, spa, community laundry rooms, and outdoor lighting.

The ZNE Pathways team was tasked with determining the baseline energy end-uses of both the individual and communal meters. Furthermore, the ZNE pathways team developed a financial model, outlining ways to invest new funds to reduce consumption and potentially implement solar generation.

Our deliverables:

We agreed to produce load profiles and baselines for community and individual energy consumption. For our financial model, we agreed to look at potential investments relating to that community owned property. This includes the following:

- Individual water-heaters and HVAC
- Solar tubing

- Community room plug load and HVAC
- Pool and Spa pumps; Spa heater
- Exterior Lighting
- Washers and Dryers in the community room
- Feasibility of Solar Generation

Methodology

1. Data Collection:

a) Energy audit

On April 21, a preliminary energy audit was executed in Dos Pinos housing Complex by the project team with Nancy Rowan and Luis Sierra as hostess and board members representatives.

This first visit consisted of a meeting in the community building where they presented the current state of the community. They talked about the previous investments focus on approaching being a sustainable community and their hypothesis on future investment plans according to their current needs.
After meeting and having that first conversation, Nancy and Luis took the project team to a walk through the community.

Starting with the community building, pool & spa area and laundry rooms, the project team noticed that the appliances such as water heaters in the community laundry rooms and the outdoor lighting could be an investment opportunity to be considered along the project.

Several residential units were explored. The project team took pictures of appliances and their respective name plates, wrote down observations and measured windows, while keep talking to the community members.

At the end, the project team noticed that there were several sun-exposed carports and other roof areas on the residential units with a potential use for Solar PV along the community. Pictures were taken and observations were made pointing out the orientation of the available surfaces and the constraint of tree shading.

The major observations made at this first visit are detailed in Table 1. A summary of the units explored can be found at Appendix 1 and 2.

Table 1: First visit observations summary

Item	General Description	Energy drivers
Community Building	Two store building. Includes an office, a meeting room and a bathroom. Sealed windows on one side of the roof.	Lighting (e) Space heating (g) and (e) AC space cooling (e) Office equipment (e)
Pool&Spa area	16000 gal pool, 1600 gal Spa Jacuzzi, outdoor lighting	Water heater (g) Pump (e) Outdoor lights (e)
Laundry rooms	Located at the community building	Water heaters (g) Washing machines (e) Cloth dryers (g).
Residential units	Aluminum framed double paned windows; some not-opening windows in the top part of the buildings (primarily for natural light); Stoves and dishwashers owned by the community; blind bathrooms (no natural light nor ventilation); variety of private owned appliances; variety of number of occupants.	Built-in space heaters (g) Some plug-in space heaters (e) AC (e) Refrigerators (e) Lights (e) Washing machines (e) Cloth dryers (e) Ceiling fans (e) Kitchen small appliances (e) Entertainment electronics (e)

Leyend
(g): run by gas
(e): run by electricity

b) PG&E bills

The data provided by the customer to be analyzed consisted of electrical and gas meter records from PG&E website personal accounts.

<u>Residential unit meter records</u>
A representative sample of each unit size was compiled in order to estimate the total residential energy consumption:

5 records of 3-bedrooms units (out of a total of 28 units)
3 records of 2-bedrooms units (out of a total of 26 units)
1 records of 1-bedroom units (out of a total of 6 units)

The customer provided the project team of two types of data:

A. Electrical usage
This file contains the electrical consumption of the unit in **kWh** recorded in an **hourly** time step. It also provides the start and end time of recording and the cost of the energy consumed at every time step. This file also contains the cost of every electrical usage record in **$/kWh**

B. Gas usage
This file contains the gas consumption record of the unit in **therms** recorded in a **daily** time step. It also provides the cost of energy consumed at every time step. This file also contains the cost every gas usage record in **$/therm**

<u>Common areas meter records</u>
Dos Pinos community provided also monthly records for the 6 meters in the common areas for the years of 2011, 2012 and 2013. They refer to the community circuits by the number of the building where the meter is located (See Figure 1):

- **Building 1** sits on the corner of Sycamore and Antelope. This circuit has exterior lighting. The light appears to go on at dusk and off at dawn. They think these lights are activated by photo cells. There are different types of lights - florescent, mercury vapor, and maybe sodium. Apparently, no records have been kept as the bulbs have been changed.

- **Building 4** circuit is in the northwest corner of our complex. The lighting circuit is small, but this circuit has "Bob's Shop," the building used by the maintenance man.
There is also "house current" usage on this circuit. All the circuits seem to have outlets connected to the community meters. Some are little used - one is on a lamp post in a parking lot. Others are more central and are used during repairs and the rehabbing of our

units. They noticed increased usage on this meter while the swimming pool & spa were being repaired.

- **Building 5** is a complex area that includes the Community Building and the Pool & Spa facilities. There are 2 circuits:

  1) UL (Upper Left) Acct: 4450570205-8 / Meter: 1004129555
  This circuit has the exterior lighting and the exterior pool and spa service.

  2) LR (Lower Right) Acct: 3783903581-5 / Meter: 1004129632
  This is a combined electric and gas bill. The electric service is for the clubhouse, including the office (Secretary's space heater and cooler) and the lights on the exterior of the clubhouse that light the pool deck besides the building.

  The gas service is for the clubhouse and the spa. We have a gas water heater, which serves the laundry room & clubhouse, the clubhouse stove is a gas stove, and the spa is heated by a (swimming pool) gas heater. Note the spa has one meter for electric service but the gas bill is coupled with a different electric meter.

- **Building 7** circuit stretches across the complex from Quail to Sycamore, and contains a lot of carport lighting, which is florescent tubing. It has one prominent "house current" outlet at the east end of the main parking lot.

- **Building 9** circuit is located at the far corner from Sycamore along Antelope Road and mainly contains outdoor lighting.

Figure 1: Map of common meters and outdoor lighting

c) Surveys

In order to understand how tenant behavior affects energy consumption the team created a 40 question survey. This survey was based on the survey designed by ZNE Pathways Domes Team. We adjusted the survey to accommodate for the difference in building envelope and tenants between the Domes and Dos Pinos units. Ultimately, the surveys focused on use of water heating, types of lighting, space heating and cooling, and whether the unit used personal or community washer and dryers. We distributed the survey through online, which allowed us to receive results immediately. The survey can be found in Appendix 1.

2. Data Analysis

a) Load profiles

In order to estimate the total electrical usage of each group of unit (residential), the records from the sample were averaged at every time step and then multiplied by the total of units of that specific size. For instance, for the day of August 4, 2013 at 12:00-12:59, the energy usage in kWh for the 3 bedrooms units was treated as is shown in Appendix 2.

For daily usage estimation, the quantities are added in order to estimate the total daily and monthly usage. Once the monthly electricity usage is estimated for each group of units, these are added to the common areas monthly electrical usage. These values are shown in Table 2.

Table 2: Dos Pinos Monthly Electrical Usage, 2013

YEAR 2013	3BR	2BR	1BR	TOTAL RESIDENTIAL	Bldg 1	Bldg 4	Bldg 5 LR	Bldg 5 UL	Bldg 7	Bldg 9	TOTAL COMMON	DOS PINOS TOTAL
Jan-13	5624	5785	579	11988	686	728	985	625	483	465	3972	**15960**
Feb-13	4765	4586	557	9908	621	682	611	528	431	439	3312	**13220**
Mar-13	5247	4387	516	10150	562	655	556	268	387	415	2843	**12993**
Apr-13	5137	3957	459	9553	483	578	558	242	332	362	2555	**12108**
May-13	6126	4762	760	11647	459	513	858	300	327	341	2798	**14445**
Jun-13	8763	7173	1359	17294	450	456	1025	547	323	324	3125	**20419**
Jul-13	10383	8992	2334	21709	453	459	1006	577	318	299	3112	**24821**
Aug-13	9074	8226	1503	18804	479	482	938	451	333	308	2991	**21795**
Sep-13	6776	6275	1234	14284	571	562	1131	395	392	295	3346	**17630**
Oct-13	5330	4480	490	10300	597	598	727	247	395	284	2848	**13148**
Nov-13	5329	4919	490	10738	669	695	305	468	428	310	2875	**13613**
Dec-13	6090	5735	592	12417	777	806	991	768	492	462	4295	**16712**
TOTAL	78642	69275	10875	**158792**	6806	7214	9691	5416	4641	4303	**38072**	**196863**

This analysis yielded the electrical load profile for Dos Pinos in 2013 shown in Figure 2. Individual load profiles for the different type of units can be seen in Appendix 3.

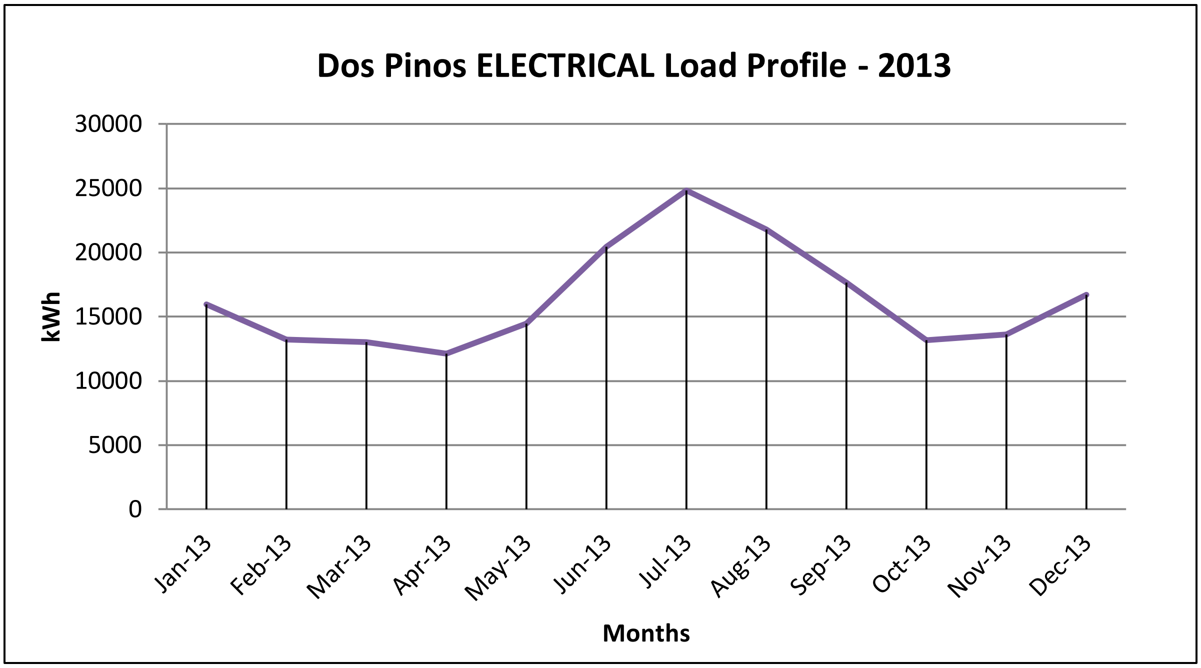

Figure 2:Dos Pinos Electrical Load Profile, 2013

Similarly, for Dos Pinos gas usage in 2013, it can be seen the following behavior in Table3 and Figure 3. Notice that for the common areas, the only gas meter is located in Building 5 LR.

Table 3: Dos Pinos Monthly Gas Usage, 2013

YEAR 2013	RESIDENTIAL			COMMON	TOTAL
	3BR	2BR	1BR	Bldg 5	
Jan-13	1645	1460	218	177	3499
Feb-13	1049	939	131	39	2158
Mar-13	610	558	62	144	1375
Apr-13	433	339	25	116	913
May-13	368	259	25	108	759
Jun-13	317	274	25	101	718
Jul-13	307	253	19	101	680
Aug-13	335	288	25	112	760
Sep-13	335	334	25	138	832
Oct-13	406	395	31	97	929
Nov-13	704	576	50	17	1347
Dec-13	1532	1268	168	21	2989
TOTAL	8041	6942	804	1171	**16958**

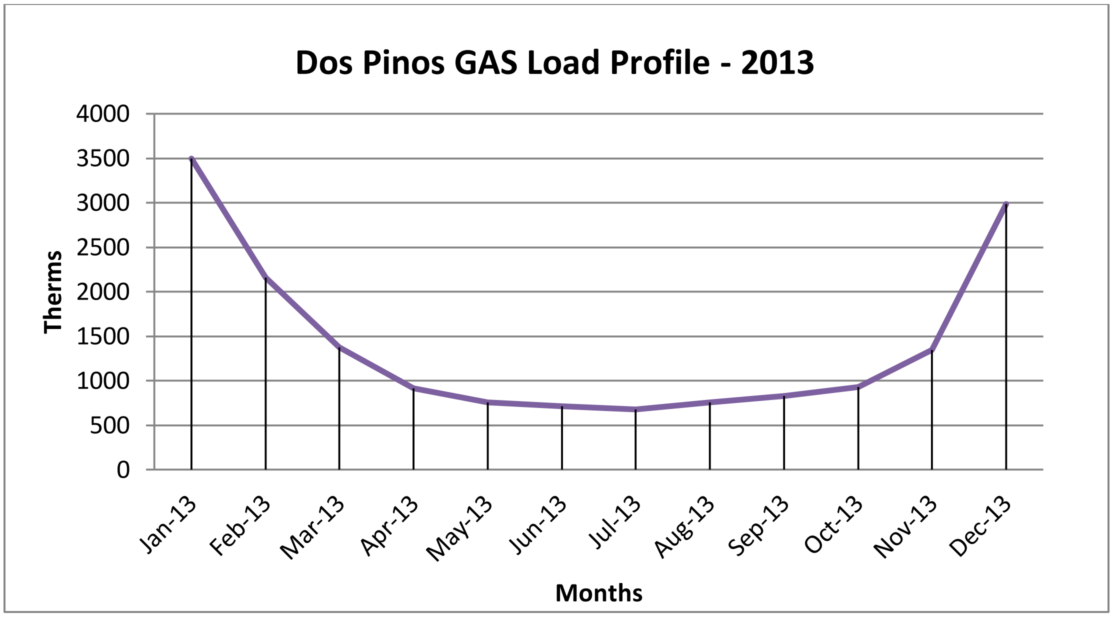

Figure 3: Dos Pinos Gas Load Profile, 2013

b) Load Breakdown by Energy End-use and Cost (Pie Charts)

In order to explore investment opportunities for Dos Pinos community, the project team designed several pie charts to see graphically the breakdown of energy consumption by the different energy drivers, electrical and gas. This approach was addressed by combining the information collected in the residential surveys, the info provided by the administration about the common areas usage and the name plates of the equipment (See Appendices 1, 4 and 5 respectively).

The pie charts yielded from this analysis show the distribution of the energy loads by end-use as well as the energy cost distribution for electrical and gas loads respectively. Figure 4 shows the breakdown for residential units.

In the case of electrical usage, the appliances, electronics and lighting were grouped into one item in order to compare with space heating (electrical), air conditioning (AC) and the refrigerator as being considered as the major electrical energy drivers in housing units.

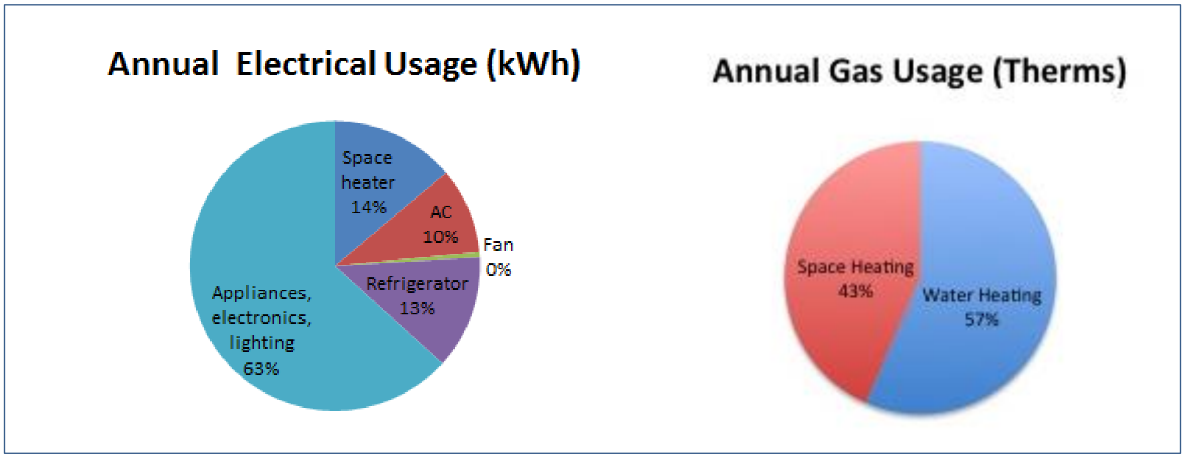

Figure 4: Breakdown on energy end-use for residential units

As part of the analysis, it was assumed that the gas consumption in each unit either went to the built in furnace or water heating. This assumption is justified when considering that the only community owned gas appliances in the individual units are the furnace and water heater, and therefore are the only two appliances that the community could use their refinanced mortgage to replace.

The project team found that 57% of the gas consumption went to water heating, while 43% of gas consumption went to space heating. (Details in the methodology can be found on Appendix 6).

For the common areas, the distribution of the energy load by end-use is shown in Figure 5.

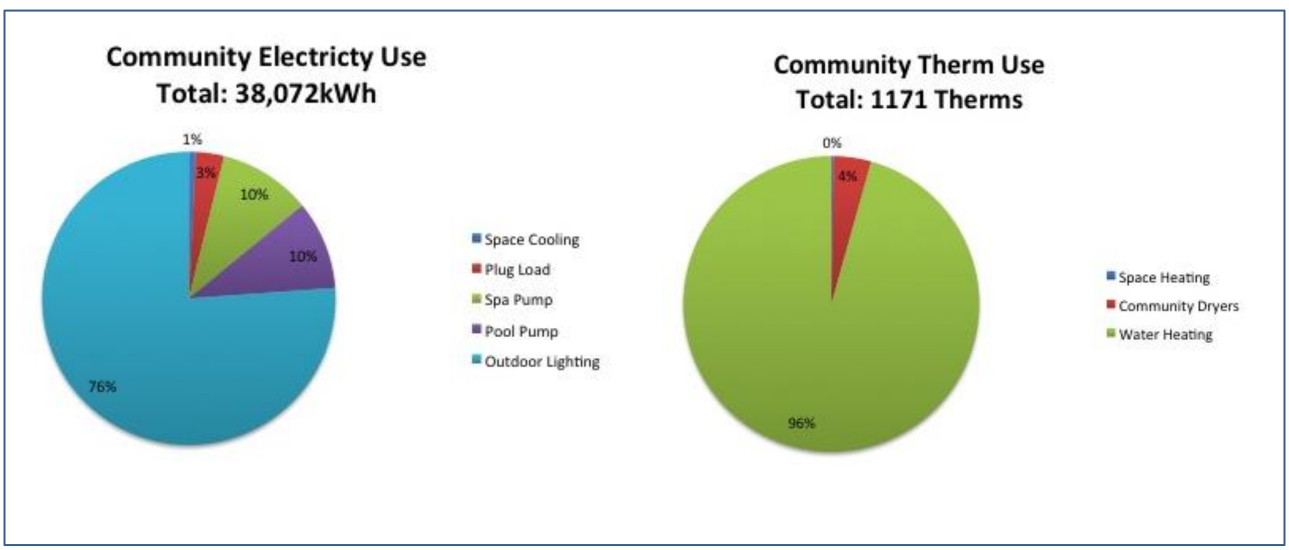

Figure 5: Breakdown on energy end-use for Common areas

In order to compare gas and electricity consumption, percentages of energy cost were calculated. This is in part because comparing therms and kWh is not an accurate means of comparison. Using cost as a comparison allowed the team to account for the difference in gas and electricity prices in analyzing end-use energy. Thus, it was found that 80% of energy costs went to electricity consumption, and 20% of energy costs went gas consumption as it is shown in Figure 6.a. An additional segregation of cost energy by end-use in Figure 6.b shows that the outdoor lighting is the main energy cost driving in the common areas.

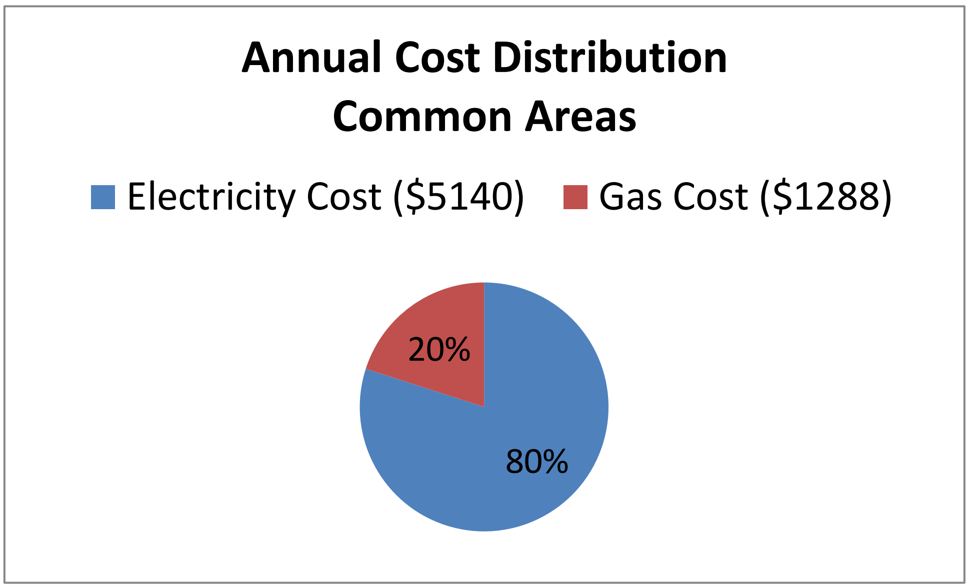

Figure 6.a: Annual Cost Distribution for common areas meters

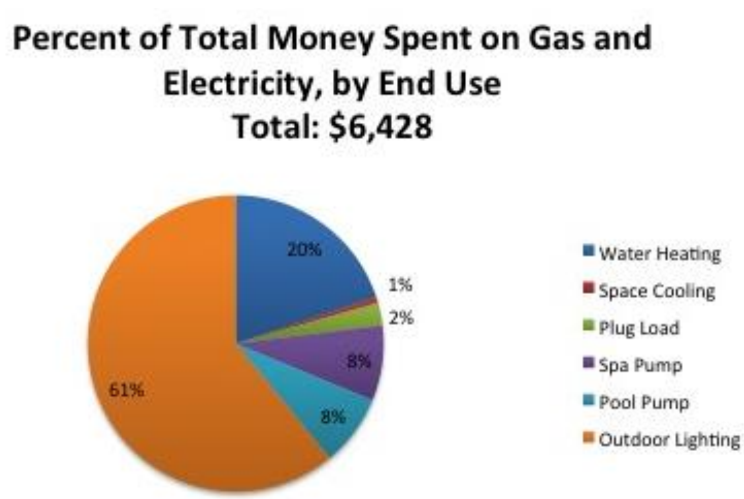

Figure 6.b: Percent of Total Money Spent on Gas and Electricity by end-use

Financial Model and Retrofit Recommendations

Dos Pinos Financial Model

Design:

- Discounted Cash Flows were modeled 2015-2030
- Discount rate = 1%, based upon current savings account rate and opportunity costs
    - Discount rate is likely to rise in time period, so a more sophisticated model would factor this in
- Cost of electricity modeled to rise 3% YoY, based upon 2013 UCD Energy Efficiency Center study (conservative estimate)
- Cost of gas modeled to rise 5% YoY, based upon 2013 DOE study (conservative estimate)
- Model uses 2013 actual Dos Pinos expenditures on electricity and gas combined with our baseline estimates form above

  The details of this modelation can be found in Appendix 7.

Our Findings:

In Part B, Investments, three potential investments are analyzed: CMH Dimming (outdoor lighting), Solar Tubes, and PV (full load 38 MWh)

- **CMH Dimming** is a strong investment option, with NPV = $20.5k (over 15 yrs) and ROI of 83%
    - Lifespan of this investment is likely to be longer than 15 yrs, thus this is a very conservative estimate and benefits could be much larger

- **Solar Tubes** did not yield a positive NPV or ROI – do not invest in these for energy savings, however they do provide beneficial natural light during daytime

- **Solar PV** is a positive investment option, with NPV = $2418 and ROI of 3% (roughly breakeven over 15 yrs)

    - Lifespan of this investment is likely to be longer than 15 yrs, thus this is a conservative estimate and benefits could be slightly larger

    - This investment, while not very attractive financially, allows DP to become Zero Net Energy on its Common Meters, a stated goal of this project, reducing GHG emissions

    - Our model is based upon the assumption that DP would be able to reap the Federal and State Investment Tax Credits associated with Solar PV, something not guaranteed and requiring further investigation

    - A possible solution to the tax credit issue is for a third party to buy and own the array, reap the tax benefits, and sell the electricity back to DP in a Power Purchasing Agreement

Outdoor Lighting Retrofit & Solar Energy Production

Assessement:

We have assessed the luminaire at the DOS PINOS community to see if there are opportunities to reduce the energy usage by retrofit ting to sustainable lamps and fixtures. By reviewing the PGE energy bills, we noticed that the community have already taken steps to conserve energy by best practices and replacing their incandescent light and high wattage light bulbs with energy saving lights such CFL, or neon lamps. From the PGE bills, we noticed that the biggest energy usage was coming from the outdoor/parking, street and area luminaires (see figure 1). We visited the area and parking luminaire on Saturday, May 24th, night to see visualized the light intensity and coverage.

The Problem:

Most of the luminaire at Dos Pinos parking and area utilize high-intensity discharge (HID) light source such as HPS (high pressure sodium) and metal halid (MH) lamps. They in general provide constant level of illumination throughout the night, regardless of occupancy and actual usage patterns. Though, the area luminaires are on timer day control that triggers the light to come on at night, they waste considerable amounts of energy and may contributes to light pollution. These lights sources consume more electricity and have a shorter average lamp life but do offer a poor color rendering than emerging light sources available today.

Two Solutions:

1. Use Solar PV systems to power the area luminaires.

Advantages of Solar PV:

Opportunities: the main opportunity is the common building which is suitable for the solar installation.

- Rooftop solar PV can reduce your energy bill and they can pay out on a long run
- The cost of solar PV is coming down fast because of advance in the technology
- Cut Your Electricity By Up to 70%
- The solar PV is subsidized by about 30-50% Off With Government Rebates & Incentives
- The solar PV can also be leased. Some installer offer $0 down payment
- The PV Solar shield the consumer against Rising Electricity Prices

Disadvantages:

- As per the PGE bills, IT is neither necessary nor beneficial to tap the common meter to the solar PV. The roof top does not provide adequate platform to install PV solar because of the space restriction and trees shading. The other option is the roof top of the parking but we've been told the roof cannot support the solar PV system weight: Another obstacle to consider is the distance from the parking's roof top to the common meter: we will experience a lot of waste because of the heat dissipation in the wire.

- The installation will require breaking the ground to get the electrical wire through, thus modifying the landscape of the community
- To optimize the PV solar efficiency, we must free the right of view of any shade or tree. The community is not willing to cut their trees
- We need to have a maintenance crew on site to mitigate any issue arising from the solar, such as cleaning the panel, replacing a broken panel.

2. Retrofitting

Nowadays there are many effective emerging light sources for exterior lighting and area luminaires. LED, and advanced CMH (Ceramic Metal Halide). These lamps provide full-range dimming. Although Occupancy sensors which have provided adaptive lighting controls in exterior parking and area lighting applications, but some applications are not compatible with sensor coverage patterns.

What we propose to achieve comparable energy savings (as PV solar), cut the energy usage, and protect the community with constant lighting during the dark time, is to combine dimmable sources with a controller that dims based on time of day and occupancy sensors. In these scenarios light level reductions can be programmed to achieve as modest as 10% or as extensive as 90% depending of the various needs of the lighting applications.

Advantages of retrofitting with RE lamps:

- Reducing maintenance and operation costs: no need to monthly maintenance
- Pre-programmable and adjustable to seasonal changes and light outputs
- High – quality light source

The cost benefit:

The major expenses associated with this retrofit derived from 2 factors:

1. Upgrading from the standard lighting systems to advanced light sources that are dimmable. In our case it is the HID light sources and some of neon lamps. Indeed the cost of advanced light sources that are dimmable cost approximately twice as much as standard HID light sources
2. Inclusion of the curfew dimming module an option which is approximately $100 more.

3. In average retrofitting in this scenario cost about $3,180 but can be also offset by maintenance savings and utility savings.
    a. Indeed currently utilities offer one-time rebates for energy-efficient exterior lighting retrofits, depending on energy savings. Retrofit projects receive $0.05/kWh saved and $100/kW demand reduced. Some utilities avoid the need to do energy savings calculations by offering categorized rebates based on application, lighter source and controls type.
    b. At DOS PINOS we counted about 16 area luminaires: each luminaire is approximately $150W (189W system wattage) MH luminaire. For example, If we replace the incumbent light source with 60W (67W system wattage) Phillips Gardco Pyramid luminaires utilizing CMH lamps we get the following: see table.

Table 4 was estimated based on demonstration results done by CLTC at CSULB on the summer of 2011. The luminaire were preprogrammed with a curfew dimming system at 75% for 10 hrs o f the night . the lowest output consume 51W and the highest output consume 67W. In average the fixture consumes 54W.

- Annual hours of use=$4380; Lifespan=7 years ; MH lifespan=12000hrs ;
- Nightly hours on total in low mode: 10hr/12hrs; Total maintenance cost: $140;
- CMH Lifespan: 30,000hrs
- Number of fixtures: 24
- Cost of labor: $100/hr; Time to replace a lamp: 0.5hr;
- MH lamp cost: $20
- Energy cost: $0.14/kWh at PG&E
- Upfront cost of installation: $1050* x 24=$25200 without federal and state incentive **

*$1050 include lamp+controllers.

Table 4: Cost benefits of retrofitting

Technology	System size (W)	Annual energy consumption (kWh). Annual hours of use: 4380 hrs	Annual Energy cost ($)	Annual Maintenance cost($)	Total annual cost ($)	Total Life cycle cost (7 yrs)
MH (1fixture)	189	828	$ 111.76	$ 20.00	$ 131.76	$ 922.29
MH (total=15+9=24)	4536	19867.68	$ 2,682.14	$ 480.00	$ 3,162.14	$ 22,134.96
CMH Curfew dimming	51(Low) 67(High)	237	$ 31.93	$ -	$ 31.93	$ 376.00
CMH Curfew dimming(24 fixtures)	1296	$ 5,676.48	$ 766.32	$ -	$ 766.32	$ 9,024.00
Total Savings	3240	14191.2	$ 1,915.81	$ 480.00	$ 2,395.81	$ 13,110.96
	NPV	ROI	Investments	Incremental Maintenance (annual)		
CMH dimming	$ 20,595	83%	$ (24,876)	$ (480)		

We considered two options: the first option is to power the common building with PV solar system alone, and the second option is to combine the retrofit with the PV solar

Option 1: Dos Pinos PV Solar without adding Luminaires retrofit Common building

Assumptions:

- 100% electricity provided by PV solar
- Electricity rate: $0.14/kWh
- Utility Inflation rate: 3%
- Utility savings method: Netmetering
- Federal Tax Credit (30% of Net Cost at Installation) :$40770 *

ESTIMATED COST

- Total load: 38,071 kwh
- Size system required: 27.18kW (DC PEAK POWER WATT)
- Roof area needed: 2718sq-ft
- Average electricity cost: $5/w
- Upfront Gross cost: 27.18 * 5 = $135000
- Federal Tax Credit (30% of Net Cost at Installation) :$40770 *

*check with a tax professional to see if credit applies

- **FINAL ESTIMATED NET COST:$ 95130**

SAVINGS AND BENEFITS: (see table below for details)

Based our research and simulation,

Breaks even: in 10 years

ROI (Reverse On Investment) : $204 to 676%

25-years Utility Saving: $198318-$515626

Table 5: Cash flow Option 1

Option 2: PV Solar + Retrofit of luminaires

Assumptions:

- 100% electricity provided by PV solar
- Electricity rate: $0.14/kWh
- Utility Inflation rate: 3%
- Utility savings method: Netmetering
- Federal Tax Credit (30% of Net Cost at Installation)

ESTIMATION COST:

- Total Load: 38071 kWh – 14191kWh*** =23980kWh
- Size system required=17.04kW (DC WATT)
- Roof area needed: 1704sq-ft
- Average: $5/w in California
- Upfront gross cost: 17.04kWh * 5 = $85200 + $25640 (cost of retrofit) = $85280
- Federal Tax Credit (30% of Net Cost at Installation)** :$25560
- **ESTIMATED NET COST:$ 59,720**

**check with a tax professional to see if credit applies

*** Load reduced from the retrofit CMH lamps

SAVINGS AND BENEFITS: (see table below for details)

Based our research and simulation,

Breaks even: in 10 years

ROI (Reverse On Investment) : $202 to 672%

Table 6: Cash Flow Option 2

Table 7: Savings & Benefits

SAVINGS & BENEFITS	
First-year Utility Savings: Your utility offers Tiered rates and/or TOU metering. Therefore, the electricity savings you realize may exceed the annual electricity needs of your building. See the Notes, below, about why you may want to choose a smaller system.	$3,293 to $8,562
Average Monthly Utility Savings: *over 25-year expected life of system*	$412 to $1,072
Average Annual Utility Savings: *over 25-year expected life of system*	$4,946 to $12,861
25-year Utility Savings:	$123,662 to $321,522
Levelized Cost of your Solar Energy: $59,640 cost / 596,825 KWh electricity replaced by solar	$0.1 per kWh
Utility savings shown above do not take income tax effects into account (they use "Post-Tax" dollars). The financial ratios shown below are based upon the cash flow values shown in the Cash Flow table, below, which include income tax effects, as noted.	
Appreciation (Increase) in Property Value:	$65,860 to $171,236
Return on Investment (ROI):	202% - 672%
Internal Rate of Return (IRR):	9.7% - 25.7%
Net Present Value (NPV):	$35,296 - $188,140
Profitability Index:	1.6 - 4.2
Greenhouse Gas (CO2) Saved: *over 25-year system life*	490 tons 980,000 auto miles

Other End-Use Retrofits

Aside from outdoor lighting, the other community owned property are very energy efficient. We realized that our recommendation for all the equipment would be to replace at the end of life. We decided running an NPV analysis for an equally efficient vs less efficient machine, to see if the efficient machines ultimately save them enough to payback the higher cost.

Design

- Considered equally and less efficient equipment
- Used similar NPV analysis as above, the only difference is that this calculates to the total cost incurred of the life of the equipment.
- 15-year lifespan; 5% increase in gas price; 3% increase in electricity price; 1% discount rate

Table 8: Other retrofits recommendations

Machine	Less efficiency/ Equally efficient?	Cost ($)	Yearly Consumption	NPV (total cost over life cycle)
Whirlpool Washing Machine	**Less Efficient than current Machine (MEF: 1.42)**	719	432.6kWh	**$1828**
Speed Queen Washing Machine	Equally as Efficient (MEF: 2.4)	2200	220 kWh	$2766
Whirl Pool Dryer	**More Efficient (22,000 btu/hr)**	764	42.42 Therms	**$2030**
Speed Queen Dryer	Equally as Efficient (25,000 btu/hr)	1638	48 Therms	**$2830**
Single Speed Pool Pump	Less Efficient	1026	6285kWh	$17,129
Variable speed Speed pool pump	**Equally Efficient**	979	3747kWh	**$10580**
Rheem 40* Water Heater	More Efficient (.80EF)	1699	113 therms	$5427
Rheen 42VR Water Heater	**Less Efficient (.62 EF)**	429	147 therms	**$4078**
Winchester HVAC	**More Efficient (.95 AFUE)**	1099	92 therms	**$3385**
Winchester HVAC	Equally Efficient Equal (.78AFUE)	699	110 therms	$3428

Recommendations

Invest in a more efficient machine: We recommend getting a more efficient HVAC at the end of your current HVAC cycle. Your current HVAC is rated at .78 AFUE, the more efficient HVAC we used in our analysis had an AFUE of .95. While a more efficient HVAC costs more, you will ultimately save enough on your annual energy bills that a more efficient HVAC will cost you less over the course of its life.

Invest in an equally efficient machine: We recommend replacing your pool pump with an equally efficient variable speed pool pump. In our analysis, one will find that the single speed pool pump was both less efficient and more expensive. This is due to the large amount of variable speed pool pumps currently available, which are notoriously more efficient. We recommend replacing the current pool pump with a variable speed pump at the end of its cycle, because it is both efficient and affordable.

Invest in a less efficient machine: Dos Pinos current washer and dryers are very efficient. Given how little they are used, don't make back the extra costs associated with the more efficient equipment. As mentioned before, the Dos Pinos members thought that we underestimated the annual dryer use. If the Dos Pinos members send more accurate estimations, the ZNE team can adjust the model to determine whether an equally efficient washer and dyer would pay off.

The current water heaters are not very efficient. However, we noticed that the community as a whole uses the water heaters less than an average person. This, paired with the cheap price of gas, means that the cost of a more efficient water heater would not pay back. For these reasons, we recommend Dos Pinos buy relatively low efficient water heaters, should it be significantly cheaper. If, in the future, the price of more efficient water heaters decreases, we recommend doing another NPV analysis to determine if the more efficient water heaters will pay off.

Final Remarks

Going forward, the Dos Pinos community now has a baseline for their energy consumption. We recommend they invest in retrofitting their outdoor lighting immediately, as they will see profound energy savings. As for the other end uses explored, our team recommends holding off on retrofits until the other equipment reaches their end of life. When these retrofits do occur, we recommend the community reaches out to professional contractors. We also recommend the community conducts a similar NPV analysis on high and low efficient equipment using the baseline energy consumption we provided.

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Other resources

Solar Incentives Resources:

- List of incentives:
  http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/Business_Rebates_List.pdf

State Loan Program

- Energy Efficiency Financing Program

State Rebate Program

- California Solar Initiative
- California Solar Initiative - Multi-Family Affordable Solar Housing (MASH) Program
- California Solar Initiative - Pilot Solar Water Heating Program
- Emerging Renewables Program
- Self-Generation Incentive Program
- PG&E - Non-Residential Energy Efficiency Rebates
- http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/Business_Rebates_List.pdf
- SCE - Non-Residential Energy Efficiency Programs

Appendices

Appendix 1: Online Survey

Sample Survey Responses

2) During the winter months I generally feel...

- [ ] Cold
- [x] Somewhat Cold
- [ ] Just Right
- [ ] Somewhat Hot
- [ ] Hot

3) Which of the following heating systems do you have?

- [x] Built in Heater
- [ ] Space Heater
- [ ] Other

Other (Please Specify)

4) In the winter, I use the built in heater

- [ ] 5-7 Days a week
- [x] 3-5 Days a week
- [ ] 1-2 Days a week
- [ ] Never

5) In the Winter, I use a space heater

- [ ] 5-7 Days a week
- [ ] 3-5 Days a week
- [ ] 1-2 Days a week
- [x] Never

6) When I use the built in heater on a weekday, I generally use it in the morning for ___ minutes

16

7) When I use the built in heater on a weekday, I generally use it in the evening for ___ minutes

16

8) When I use the built in heater on the weekend, I use it for ____ minutes a day

32

9) During the Summer months, I generally feel ...

- [ ] Cold
- [ ] Somewhat Cold
- [ ] Just right
- [x] Somewhat Hot
- [ ] Hot

10) Which of the following cooling systems do you use?

- [x] Fan
- [x] Central Air Conditioning
- [ ] Portable Air Conditioner
- [x] Opening the Windows/ Doors
- [ ] None
- [ ] other

Other (Please Specify)

11) I use central air in the summer

- ( ) 5-7 Days a week
- (•) 3-5 Days a week
- ( ) 1-2 Days a week
- ( ) Never

12) When I use cental air on a week day, I typically use it for ____ minutes in the morning

0

13) When I use the central air conditioning on a weekday, I use it for ___ minutes in the evening

16

15) I would rate the circulation in my house as...

- ( ) Good
- (•) Okay
- ( ) Poor
- ( ) Stagnant

16) In my kitchen I have a

- [x] Toaster
- [x] Microwave
- [ ] Coffee Maker
- [ ] Other

Other (Please Specify)

17) I have the following electronics (please list any additional electronics that you think may use a significant amount of energy)

- [x] Television
- [x] Audio System
- [ ] Humidifier
- [ ] Desktop Computer
- [x] Lap Top
- [ ] Other

Other (Please Specify)

Question: 2. I do ____ loads of dishes in my dish washer a week?

Question: 3. I manually wash my dishes in hot water

Question: 4. When I wash my dishes manually, I run the hot water for approximately ____ minutes

Question: 5. I use my own personal washing machine

Question: 6. I use my own personal dryer

Question: 7. I use the community washers

Question: 8. I use the community dryers

Question: 9. During the winter, I take a hot shower

Question: 10. On average, during the winter my hot shower lasts ____ minutes

Question: 11. During the summer, I take a hot shower

Question: 12. On average, during the summer my hot showers last ____ minutes

Question: 13. How many lights do you use in the evening?

Question: 14. During the week, my lights are on for ____ hours each evening/ night

Question: 15. During the weekend, my lights are on for ____ hours each evening/night?

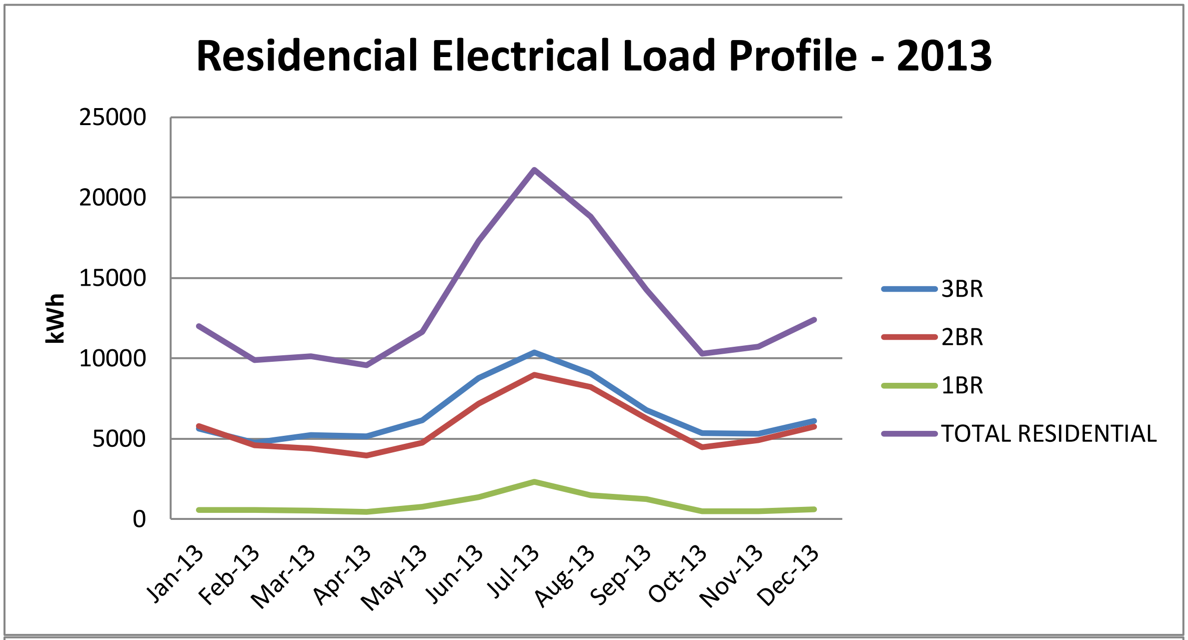
Question: 16. Lighting approximations

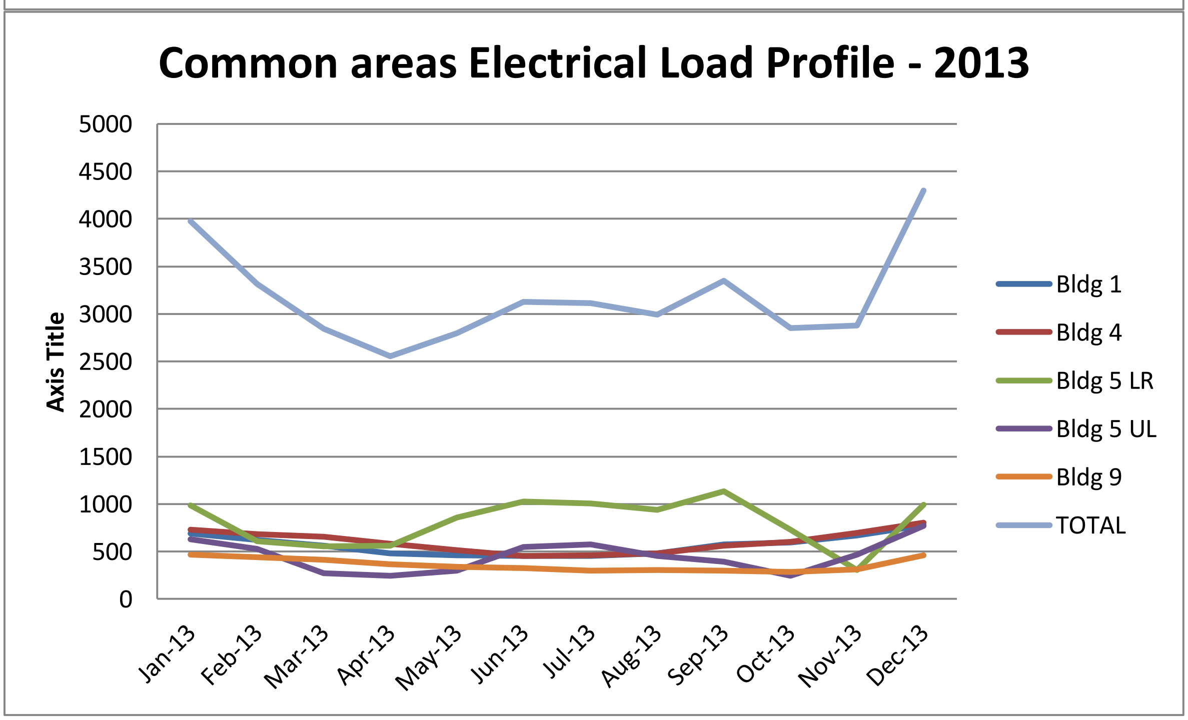
Leyend
USAGE in kWh
COST in US$
Dots were replaced by commas

Appendix 2: Example* of data consolidation for electrical usage in 3 bedrooms units
*The complete spreadsheet can be provided to the client upon request

TIME STEP			UNIT 5C		UNIT 3C		UNIT 6G		UNIT 2D		UNIT 8C		HOURLY	
DATE	START TIME	END TIME	USAGE	COST	USAGE	COST	USAGE	COST	USAGE	COST	USAGE	COST	USAGE AVERAGE	USAGE TOTAL ESTIMATION
04/08/2013	0:00	0:59	0,3	$0,04	0,08	$0,01	0,08	$0,01	0,08	$0,01	0,53	$0,07	0,214	5,992
04/08/2013	1:00	1:59	0,1	$0,01	0,08	$0,01	0,06	$0,01	0,07	$0,01	0,47	$0,06	0,156	4,368
04/08/2013	2:00	2:59	0,1	$0,01	0,14	$0,02	0,06	$0,01	0,09	$0,01	0,16	$0,02	0,11	3,08
04/08/2013	3:00	3:59	0,09	$0,01	0,12	$0,02	0,08	$0,01	0,06	$0,01	0,14	$0,02	0,098	2,744
04/08/2013	4:00	4:59	0,11	$0,01	0,08	$0,01	0,05	$0,01	0,09	$0,01	0,18	$0,02	0,102	2,856
04/08/2013	5:00	5:59	0,08	$0,01	0,07	$0,01	0,08	$0,01	0,06	$0,01	0,17	$0,02	0,092	2,576
04/08/2013	6:00	6:59	0,11	$0,01	0,07	$0,01	0,11	$0,02	0,09	$0,01	0,3	$0,04	0,136	3,808
04/08/2013	7:00	7:59	0,18	$0,02	0,08	$0,01	0,65	$0,09	0,07	$0,01	0,53	$0,07	0,302	8,456
04/08/2013	8:00	8:59	0,32	$0,04	0,23	$0,03	0,61	$0,08	0,08	$0,01	0,3	$0,04	0,308	8,624
04/08/2013	9:00	9:59	0,41	$0,05	0,32	$0,04	0,18	$0,02	0,06	$0,01	0,43	$0,06	0,28	7,84
04/08/2013	10:00	10:59	0,33	$0,04	0,35	$0,05	0,06	$0,01	0,38	$0,05	0,35	$0,05	0,294	8,232
04/08/2013	11:00	11:59	0,09	$0,01	0,51	$0,07	0,09	$0,01	0,31	$0,04	0,37	$0,05	0,274	7,672
04/08/2013	12:00	12:59	0,87	$0,12	2,6	$0,34	0,09	$0,01	0,08	$0,01	0,62	$0,08	0,852	23,856
04/08/2013	13:00	13:59	1,21	$0,16	2,11	$0,28	0,11	$0,01	0,13	$0,02	0,54	$0,07	0,82	22,96
04/08/2013	14:00	14:59	0,78	$0,10	0,34	$0,05	0,15	$0,02	0,33	$0,04	0,91	$0,12	0,502	14,056
04/08/2013	15:00	15:59	1,14	$0,15	0,4	$0,05	0,08	$0,01	0,14	$0,02	0,86	$0,11	0,524	14,672
04/08/2013	16:00	16:59	1,25	$0,17	0,32	$0,04	0,23	$0,03	0,21	$0,03	0,81	$0,11	0,564	15,792
04/08/2013	17:00	17:59	1,24	$0,16	0,34	$0,05	0,23	$0,03	0,34	$0,04	0,72	$0,10	0,574	16,072
04/08/2013	18:00	18:59	1,14	$0,15	0,33	$0,04	0,3	$0,04	0,37	$0,05	0,66	$0,09	0,56	15,68
04/08/2013	19:00	19:59	1,18	$0,16	0,36	$0,05	0,21	$0,03	0,36	$0,05	0,42	$0,06	0,506	14,168
04/08/2013	20:00	20:59	0,63	$0,08	0,38	$0,05	0,24	$0,03	0,43	$0,06	0,28	$0,04	0,392	10,976
04/08/2013	21:00	21:59	0,61	$0,08	0,31	$0,04	0,22	$0,03	0,53	$0,07	0,31	$0,04	0,396	11,088
04/08/2013	22:00	22:59	0,37	$0,05	0,2	$0,03	0,16	$0,02	0,27	$0,04	0,18	$0,02	0,236	6,608
04/08/2013	23:00	23:59	0,35	$0,05	0,09	$0,01	0,07	$0,01	0,09	$0,01	0,18	$0,02	0,156	4,368

Appendix 3: Electrical Load profiles for different type of units at Dos Pinos. Residential and Common areas.





Appendix 4: Common areas information provided by Dos Pinos Administration.

- Spa:

  Heater: RayPak, model no.: C-R266A-EN-C ASME

  This is an old work horse. It was bought years ago, and still chugs away. It is a gas heater. It is really a swimming pool heater.

  There seem to be 2 motors for the spa:

  Motors US, 1081 Pool Motor
  Cat. # ESQ1052
  Model C55CXKLL-5001

  StaRite Motor # K48L2PA105C3
  H.P. 1.65
  Pump Motor P6E6E-206L

  The Blower is:

  Polaris
  Model 1-460-02
  Serial # 08 09 28

  Swimming Pool:

  Pentair Swimming Pool Pump
  227T
  354606 REV. C

  3HP
  1.32 SF
  3.96 SFHP

  The equipment should be new. We just replaced the pool deck and resurfaced the pool and spa. Most of the spa equipment was replaced at that time.

  Size of pool and spa: A member did calculate he volume of the pool recently, but I cannot find that information. The documents have not been filed. Perhaps Nan, a board member, has saved them. (Jean Malamud did the calculation.)

  The spa seats 6.

The swimming pool is unheated.

The spa is now turns on 4:00 p.m. to late evening. (11:00 p.m.?) Temperature is usually 101 - 102 degrees when fully heated, about 5:00 p.m. I was told this temperature is required by law.

When the swimming pool is officially open, I am told the spa must be open also. Then the spa heater timer will be reset to operate when the pool is open. This usually happens after May 31. Official hours are listed as Sun - Thurs. 8:00 a.m. to 10:00 p.m.: Fri. & Sat. - 8:00 a.m. to midnight. I am not sure how flexible the pool timer is. Seems to me last year the pool and spa were open 8:00 a.m. to 10:00 p.m. all days.

There is a timer on the outside of the community room that can be set by hand to operate the spa blower. It has a dial that goes up to 15 minutes, but the cycle may run for 20 minutes if fully turned. I have noted this as a concern for some of our senior spa users. Sometimes therapy use is limited, and timed. Suspect this timer is on the community room circuit. (not 37, which has most of the energy use for the spa.) Have no proof for this assumption.

- Thanks to Gretchen, Joyce and the Yolo County Health Dept. Reports we have:

  Pool volume: 16,000 gal.

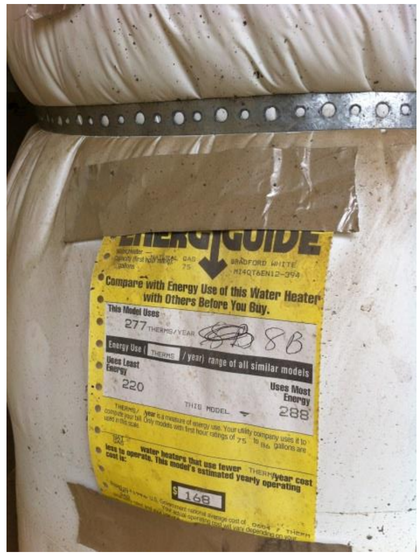
  Spa volume: 1,600 gal.

Appendix 5: Photos from Audit (name plates and map)

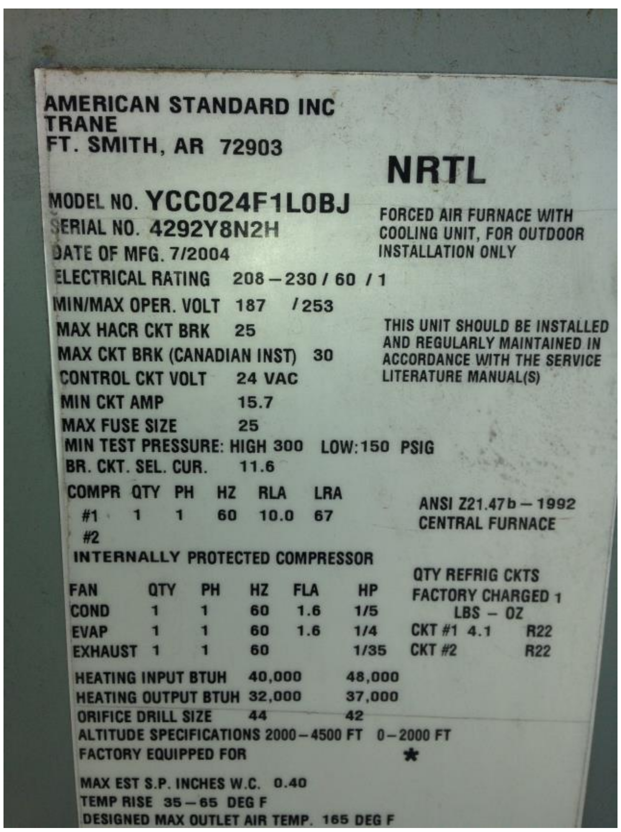
Washer

Dryer

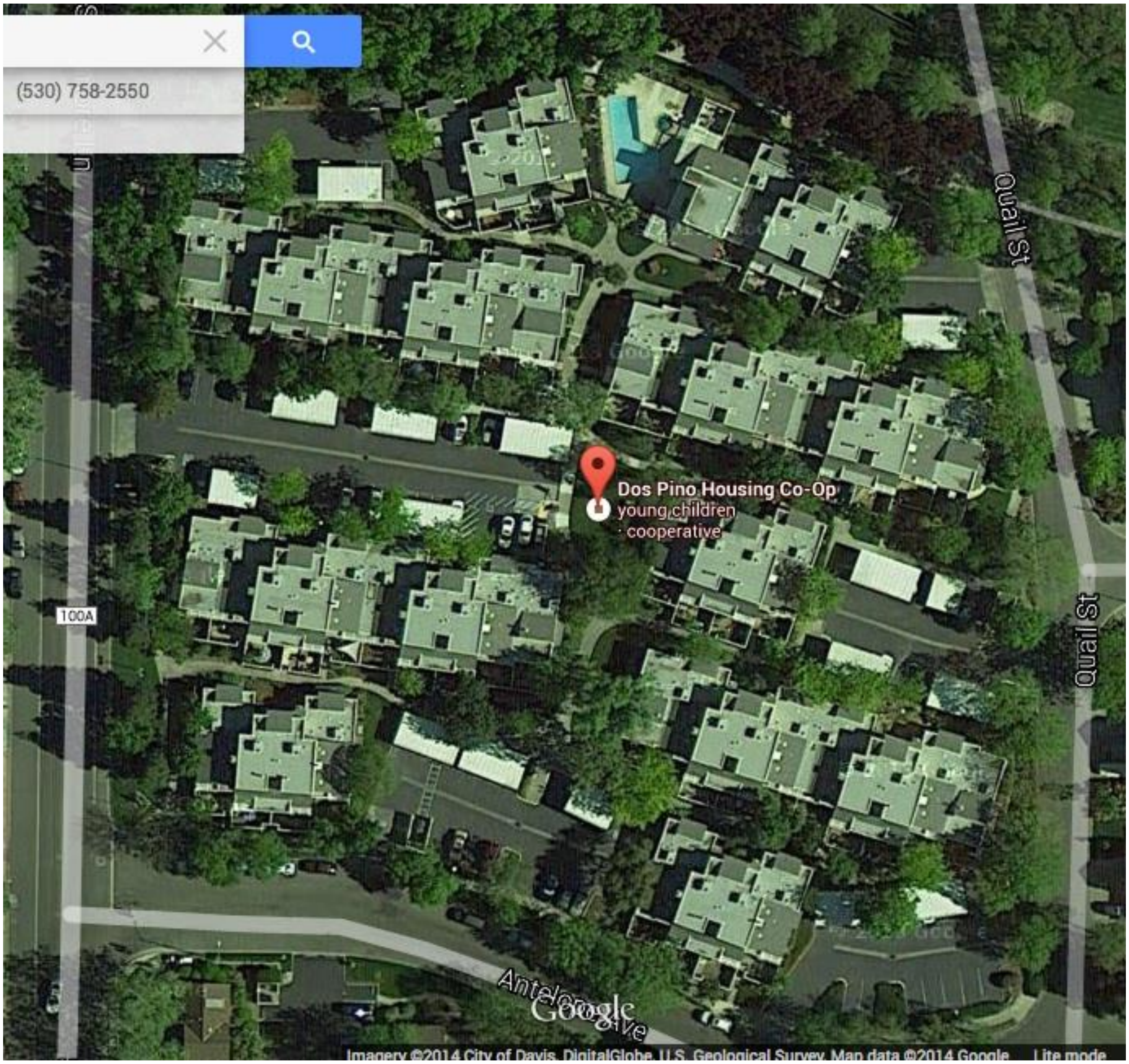
Water Heaters



HVAC



Dos Pinos Map



Appendix 6: Breakdown energy end-use methodology details

Individual units

a) Electrical usage breakdown

Space heater					
	Frecuency	Population	Days/week	hours/day	7
5-7 days a week	3	11	74	weeks/year	18
3-5 days a week	2	7	35	hours/year	14675
1-2 days a week	1	4	7	Power* (kW)	2
Never	11	39	0		
Total	17	60	116	Usage (kWh)	22013
AC (Trane 10 SEER unit)**					
	Frecuency	Pop	Days/week	hours/day	8
5-7 days a week	7	25	173	weeks/year	18
3-5 days a week	3	11	53	hour/year	30494
1-2 days a week	6	21	42	Av Power (W)	500
Never	1	4	0		
Total	17	60	212	Usage (kWh)	15247
Fan***					
14 out of 17 (82%)use the fan for ventilation=49,411 units Assuming an use of 3 hours/day=21 hours/week =21h/week*18week/year= 378 hours/year				Total hours/year	18677
				Av Power (W)	50
				Usage (kWh)	934
Refrigerator					
Av Power (VAC)					115
hours/year****					2920
Total hours/year					175200
Usage (kWh)					20148
Appliances, electronics and lighting					
Total load - space heater- AC-Fan-Refrigerator 158792 kWh - 22013kWh - 15247kWh - 934kWh - 20148kWh					
				Usage (kWh)	100450

***http://www.absak.com/library/power-consumption-table

****Note: To estimate the number of hours that a refrigerator actually operates at its maximum wattage, divide the total time the refrigerator is plugged in by three. Refrigerators, although turned "on" all the time, actually cycle on and off as needed to maintain interior temperatures.
http://energy.gov/energysaver/articles/estimating-appliance-and-home-electronic-energy-use

b) Gas usage breakdown

- The team broke down gas usage by month for each individual unit.

- It was estimated water-heating consumption by averaging the gas usage of April and September, then multiplying the average by 12 months. These two months were chosen for 2 reasons:

1. We assumed there would be no gas use for space heating in these months, given the mild climate in Davis during spring and fall.

2. We assumed there would be above-average water heating use in winter months, and below-average water heating use in summer months. Using this methodology, we found the average (among the 8 units) to be 146 therms.

- Accuracy test
  - We evaluated a unit that consumed more than this average.
  - The unit's average water heating therm usage was 366.48 therms, more than twice the community average of 146.
  - We looked at the individual survey for this unit, and found that there are 5 people living in the unit, which more than double the other units.
  - This supports our methodology, because one would expect water-heating usage to grow with the number of people living in the unit.

- Therefore, we concluded that **146 therms** was an accurate average for annual therm for water heating use by each unit.

- Total 258 therms – 146 therms (water-heat) = **112 terms went to space heating**.

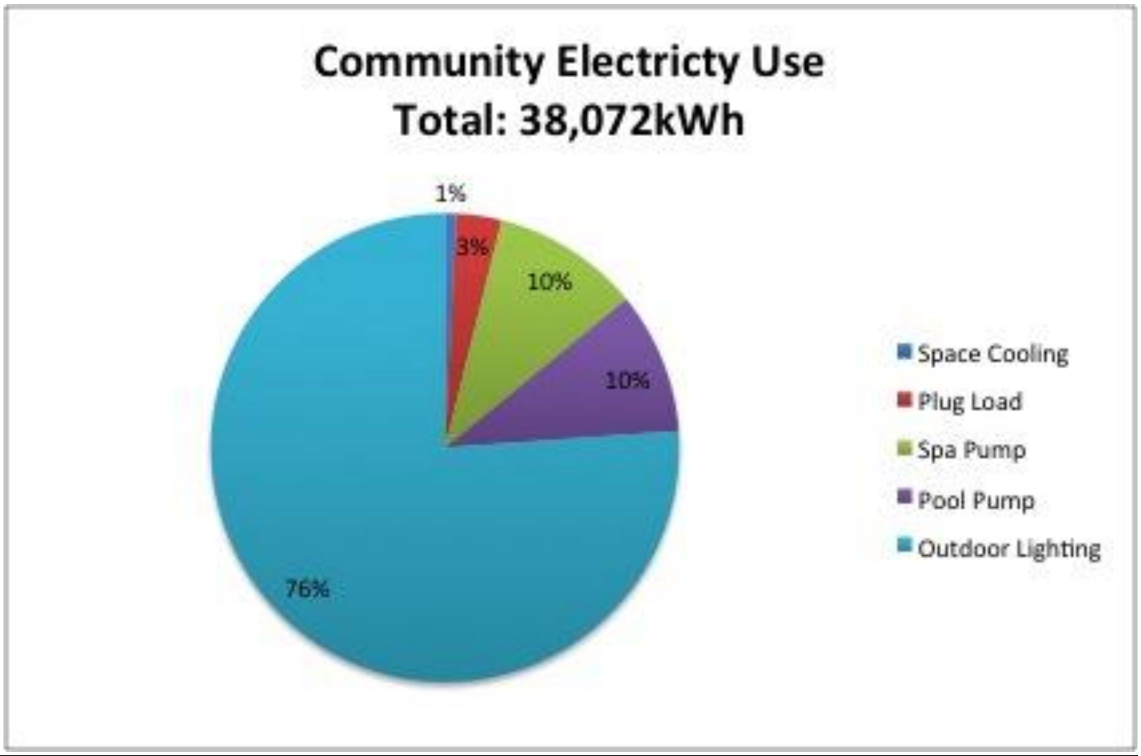
Common meters

- Space heat: We knew the client rarely used the built in heater, and instead use a space heater. Therefore, gas usage that would typically be used for space heating was transferred to electrical use.
- Dryer: 4%= 48/1171
    - .25 therms cycle * 18 uses a month * 12 months= 48 therms/yr
- Water heating: 96%
    - We assumed the rest of the gas went to water heating. We didn't have sufficient information on all potential water heating end loads to break this section down.

Limitations and recommendations:

- When the ZNE team presented our findings to Dos Pinos, many of the members felt that the dryer usage was underestimated. We were limited to using our survey results.
    - Some members suggested looking at the money collected by the machines to get an exact number of usages. This financial information was not available in time for to this report. If the information can be sent to the ZNE team, it would be easy to adjust our model to account for any underestimations—ultimately giving us a more accurate pie chart.
- Potential savings could be analyzed by water-heating end use, primarily concerning the spa heater, but more information regarding water-heating devices will be necessary.

Community Electrical Use



- Determining Electrical End Use was much more laborious than determining gas usage. This is in part due to how the community meters are set up.

- The Community electrical meters account for all the outdoor lighting, spa and pool pumps, plug load in the office, and community washers and dryers.

- There are 6 community meters:

  - 4 meters measure just outdoor lighting on the individual units.

  - "Building 5 Lower Right" meter measures out door lighting and the pool pump.

  - "Building 5 Upper Left" meter measures the plug load of the community room, office plug load, spa pump, and community laundry room.

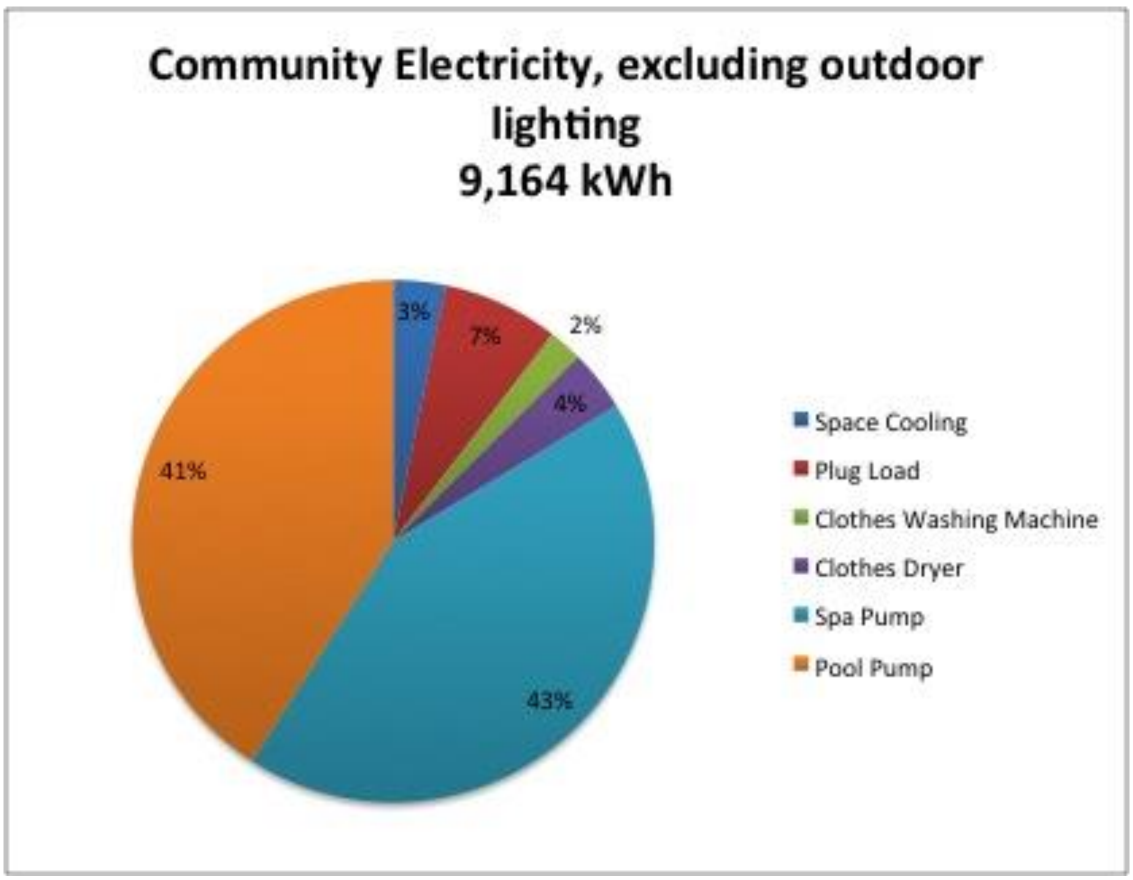
Outdoor Lighting and other end-uses

- We first determined the total electricity usage of the outdoor lighting, considering it clearly accounted for a majority of the electricity consumption.
- Task: aggregate 4 meters that measured just outdoor lighting and determining the amount of electricity that went to out door lighting on the "building 5 LR" meter.
- Outdoor lighting= Total "building 5 LR" energy – pool pump energy
    - Pool pump rating: 3.2 kW * 14hrs *356 days = 3747.84 kWh a year.
    - Total energy at "building 5 LLR" meter 9691 kWh – 3747.84 = **5943kWh**.
- Check this figure: we averaged the 4 outdoor lighting meters to find an average outdoor lighting kWh use per meter.
    - Ave of 4 outdoor lighting meters= 5,826 kWh
    - This supports our finding that the "building 5 LR" meter uses 5943kWh/yr for outdoor lighting.
- Aggregate all 5 meter readings to find that **outdoor lighting** accounts **for 29,245 kWh/ year.** This ultimately accounts for **76% o**f community electrical consumption.
- Also, this revealed that **the pool pump** accounted for about **10% of the total electricity consumption**.

Other end uses:

In order to determine other electrical end uses, the team looked at the energy consumption measured by the "building 5 upper left" meter. As previously stated, this meter accounts of office & community room plug load, community laundry, and the spa pump. Table 2 and chart 5 outline these findings:

End Use	kW	Yearly kWh	% Total	% total (excluding Outdoor Lighting)
Office Plug Load	Space heater: 2kW Misc: .160kW **2.160kWh**	320 kWH 307 kWh **Total: 627**	1.5%	7%
Space Cooling	AC: 18kW Fan: .13kW **18.13kW**	252 kWh 47kWh **Total: 298**	.8%	3%
Washing Machine	**1.150 kW**/ cycle	**193.2** (14 cycles/month.)	.5%	2%
Dryer	**1.8kW**/ Cycle	**345** (16 cycles/ month)	.9%	4%
Indoor Lighting	**.2kW**	**78kWh**	.2%	0%
Spa Pump	Unknown	**3,920 kWh** (5416kWh-1495kWh) (Meter total-estimations)	10.2%	43%
Pool Pump	**3.2 kW**	**3747kWh**	9.8%	43%



End Use Calculations

- Plug load: 627 kWh a year
    - Estimated: .160 kW at any time
    - This estimation accounts for appliances that are regularly consume power, such as the refrigerator and desktop computer, and any other appliances that are likely rarely used—i.e. microwave.
    - Space heater all day during the winter: we assumed the space heaters uses 2kW an hour, is on for 8 hours a day, for 4 winter months.
- Space Cooling:
    - Estimated fun uses 45.7 kWh a year
    - SEER 13 Air Conditioning, 2 hrs a day, June – August: 252 kWh/year
- Washer and Dryer: 193kWh/y Washer; 345.5kWh a year Dryer
    - Name plate data + Survey for use estimates
- Lighting: 78 kWh year
    - We estimated that lights inside the laundry room and common area are four 100-watt bulbs used for 2 hours a day, accounting for 78 kWh year.
- Spa pump: 3920 kWh/ year
    - We aggregated these numbers, and subtracted it from the total to determine how much electricity the spa pump used. We found that the spa pump 3,920 kWh a year.

Outdoor Lighting Estimation:

Our outdoor lighting estimation depended on nameplate data from the pool pump. We have learned through the ZNE class that nameplate data does not always accurately depict energy consumption by an appliance. Therefore, if one desired a more accurate estimation, we recommend measuring the outdoor lighting specifically.

Other plug load Estimations:

As for the spa pump, we were unable to find nameplate data based on the information given to us. Therefore, our estimation is dependent on our total end use estimations, diminishing the accuracy of this estimation. In order to get a more accurate estimation, the team suggests finding name- plate data on that spa pump. Additionally, metering the dryers and washers individual will give the exact energy consumption, making our estimations more accurate. While metering individual plug loads in the office would give more accurate estimations, this likely won't have a profound effect on total energy consumption, considering office plug load energy demand is much smaller then the other end uses.

Appendix 7: Financial model

Financial model

2013 kWh usage total				
3BR	**2BR**	**1BR**	**Common**	**Total**
78642	69232	10318	38072	196264
$ 10,617	$ 9,346	$ 1,393	$ 5,140	$ 26,496

2013 therms (gas) usage total				
3BR	**2BR**	**1BR**	**Common**	**Total**
7784	6915	798	1171	16668
$8,563	$7,606	$878	$1,288	$18,335

	Common		Individual	
e-	$5,140	80%	$21,356	56%
Gas	$1,288	20%	$17,047	44%
Total	$6,428	100%	$38,403	100%

References & Assumptions	Price of gas ($/therm)	Price of electricity ($/kWh)	Discount Rate	e- annual $ growth rate[1]	gas annual $ growth rate
	$1.10	**$0.14**	**1%**	**3%**	**5%**

[1] UC Davis, Energy Efficiency Center study, 2013

Status Quo - Common Meters	Buildings 1-5, inc. pool & jacuzzi, outdoor lighting, laundry room, community center & office								
Energy Load Liabilities	**Present Value**	**Present %**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Gas	**$25,336**	**20%**	$1,316	$1,347	$1,380	$1,413	$1,447	$1,482	$1,517
Space Heating	$311	0%	$3	$17	$18	$18	$19	$19	$19
Community Dryers	$4,977	**4%**	*$54*	*$276*	*$283*	*$290*	*$296*	*$304*	*$311*
Water Heating	$24,233	**96%**	*$1,259*	*$1,289*	*$1,320*	*$1,351*	*$1,384*	*$1,417*	*$1,451*
Electricity	**$101,344**	**80%**	$5,264	$5,390	$5,519	$5,651	$5,787	$5,926	$6,069
Space Cooling	**$786**	1%	*$41*	*$42*	*$43*	*$44*	*$45*	*$46*	*$47*
Central AC	$665	1%	*$35*	*$35*	*$36*	*$37*	*$38*	*$39*	*$40*
Fans	**$121**	0%	$6	$6	$7	$7	$7	$7	$7
Plug Load	$3,161	3%	*$164*	*$168*	*$172*	*$176*	*$181*	*$185*	*$189*
Misc plugload	$690	1%	*$36*	*$37*	*$38*	*$38*	*$39*	*$40*	*$41*
Clothes Washing Machine	**$510**	1%	*$26*	*$27*	*$28*	*$28*	*$29*	*$30*	*$31*
Clothes Dryer	$912	1%	*$47*	*$48*	*$50*	*$51*	*$52*	*$53*	*$55*
Indoor lighting	$205	0%	*$11*	*$11*	*$11*	*$11*	*$12*	*$12*	*$12*
Space Heater	$844	1%	*$44*	*$45*	*$46*	*$47*	*$48*	*$49*	*$51*
Spa Pump									
Pool Pump									
Outdoor Lighting									
Total									

End

Energy Load F	NPV of Liabili	Percent	Present Cost	2015	2016	2017	2018	2019	2020	2021
Washing Machine										
Whirlpool CAI	**1828**		719	60	61	62	63	64	66	67
Speed Quee	2766		2200	30	31	32	32	33	34	34
Saving:	938									
Dryers										
Whirl	**1808.90766**		764	48.029703	49.9318694	51.9093692	53.9651858	56.1024209	58.3242989	60.6341722
Speed Queen	2830.18018		1636	54.8910891	57.0649936	59.3249934	61.6744981	64.1170524	66.6563416	69.2961968
Saving:	1021.27252									
Pool Pump										
Single speed	17129.3599		1026	865.276485	882.410673	899.884152	917.70364	935.875989	954.408187	973.307359
Variable spee	**10579.5234**		979	515.861733	526.076816	536.494179	547.117826	557.951843	569.000394	580.267729
Saving	6549.83651									
Water Heater										
Rheem 40*	4526.96794		1699	129.98896	135.137038	140.489	146.052921	151.837195	157.850549	164.102056
Rheem 42VR	**4077.96681**		429	167.726584	174.369221	181.274933	188.454138	195.917668	203.676784	211.743191
Saving:	449.001126									
HVAC										
Winchester Hi	**3384.8599**		1099	105.070693	109.231909	113.557925	118.055268	122.730725	127.591347	132.64447
Winchester Lc	3427.70171		699	125.426139	130.39351	135.55761	140.926228	146.507465	152.309741	158.34181

2021	2022								
$1,517	$1,554								
$19	$20								
$311	*$319*								
$1,451	*$1,486*								
$6,069	$6,216								
$47	*$48*								
$40	*$41*								
$7	$7								
$189	*$194*								
$41	*$42*								
$31	*$31*								
$55	*$56*	*$57*	*$59*	*$60*	*$62*	*$63*	*$65*	*$66*	*$68*
$12	*$13*	*$13*	*$13*	*$14*	*$14*	*$14*	*$15*	*$15*	*$15*
$51	*$52*	*$53*	*$54*	*$56*	*$57*	*$58*	*$60*	*$61*	*$63*
$619	$634	$650	$666	$682	$699	$716	$733	$751	$770
$592	$607	$621	$636	$652	$668	$684	$701	$718	$736
$4,621	$4,733	$4,848	$4,966	$5,087	$5,212	$5,340	$5,471	$5,606	$5,745
$7,586	$7,770	$7,959	$8,153	$8,352	$8,556	$8,766	$8,982	$9,204	$9,432

of life cycle Analysis

2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
63	64	66	67	68	70	71	72	74	75	77	78	80
32	33	34	34	35	36	36	37	38	38	39	40	41
53.9651858	56.1024209	58.3242989	60.6341722	63.0355255	65.531982	68.127308	70.8254192	73.6303863	76.5464412	79.5779834	82.7295867	86.006006
61.6744981	64.1170524	66.6563416	69.2961968	72.0406006	74.8936937	77.8597806	80.9433362	84.1490129	87.4816471	90.9462668	94.5480991	98.2925783
917.70364	935.875989	954.408187	973.307359	992.580772	1012.23584	1032.28011	1052.7213	1073.56727	1094.82603	1116.50575	1138.61477	1161.1616
547.117826	557.951843	569.000394	580.267729	591.758179	603.476162	615.426185	627.612842	640.04082	652.714895	665.639943	678.820932	692.26293
146.052921	151.837195	157.850549	164.102056	170.601147	177.357628	184.381693	191.683938	199.275381	207.167476	215.372128	223.901717	232.769112
188.454138	195.917668	203.676784	211.743191	220.12906	228.847043	237.910292	247.332482	257.127828	267.311108	277.897686	288.903535	300.34526
118.055268	122.730725	127.591347	132.64447	137.897716	143.359012	149.036597	154.939036	161.075236	167.454453	174.086312	180.98082	188.148377
140.926228	146.507465	152.309741	158.34181	164.612772	171.13209	177.909599	184.955523	192.280495	199.895564	207.81222	216.042406	224.598541

Appendix 8: Specifications of sample equipment used in NPV analysis

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