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CITY OF LIVINGSTON

October 16, 2018

TRANE®

Ingersoll Rand

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List of Facilities

Trane performed a preliminary energy study for thirty-two (32) sites for the City of Livingston, CA. The surveyed sites, include city buildings, a museum, police station, barber shop, children center, senior center, and sports complex. The remaining sites are parks, lift stations, and wells. Below is a comprehensive list of the sites.

Table 1: List of Sites Audited for Preliminary Analysis

Location Name	Location Address
2611 Barber Shop	334 Main St.
Arakelian Park	1007 J St.
City Hall	1416 C. St.
City Street Lights (Décor. Light Bridge)	C St.
Council Chambers	633 Main St.
Country Lane Lift Station	Narada Wy & Grapevine
Don Meyer Park	Natsu Rd.
East Ave Lift Station	880 East Ave./891 Olds Ave.
Fire Station	1430 C St.
Gallo Park	1201 Parkside Way
Lift Station	1007 J St.
Lil Guy's and Gal's Field	911 F St.
Livingston Historic Museum	1306 C St.
Lucero Park	Cella Dr.
Max Foster Sports Complex	2550 Walnut Ave.
Memorial Park and Alvermaz Field	1409 Main St.
Parkside Storm Lift Station	Joseph Gallo Park on Winton Parkway
Police Station	1446 C St.
Public Works	2238 Walnut
Tank Site	East end of Burgundy Drive
Walnut Child Development Center	2600 Walnut Ave.
Waste Water Treatment Plant	14960 Vinewood
Well # 08	Well#8
Well # 09	1226 or 1298 Crowell St.
Well # 11B	7206 Pacific Ave., Livingston CA NS HWY 99 E/O ROBIN
Well # 12	Well#12
Well # 13	1201 Parkside Way
Well # 14	936 Dwight Way Livingston, CA DWIGHT & WALNUT WY
Well # 15	543 Joseph Gallo Ct.
Well # 16	1168 OKHI ST
Well # 17	1780 Sun Valley Ave

Executive Summary

Trane's Comprehensive Solution (CS) Team conducted a comprehensive audit of all the sites listed in Table 1. The Team looked at a combination of Energy Conservation Measures (ECM), and Facility Improvement Measures (FIM) requested by the City of Livingston to determine the best solutions for the City. To start this process, utility data was collected for electric, water, and gas accounts for all sites in the evaluation. From the data collected, the team was able to determine a clear picture of the City's current status and evaluate the impact of the options explored and proposed.

Trane recommends a comprehensive project including:

- LED Lighting retrofits
- New HVAC replacements
- Energy Management Controls System
- Variable Frequency Drives (VFDs)
- Irrigation System Upgrades
- Solar Photovoltaic Systems

The project financials summarized below provide the City of Livingston with a comprehensive solution that will lead to significant budget reductions for utility costs which can be further reinvested into the city's infrastructure improvements or facility improvement measures (FIMs) as described in the section.

Table 2: Financial Summary of Base Option

Financial Summary Table	
Total Project Cost	$5,673,000
Cumulative 30 Year Cashflow	$16,312,780
Net Present Value	$3,396,835
Simple Payback	10.1 Years
Internal Rate of Return	10.37%

*Pre-Loan values in table, please refer to proforma for full financials

Additional Facility Improvement Measures (FIM)

Trane explored and evaluated several facility improvement measures across the city, namely:

- Additional HVAC Units & Insulation
- Additional Street Lighting
- Water Meter Upgrades

These measures do not have an energy savings impact; however, they do provide much needed infrastructure improvements while packaging the cost-heavy measures into a comprehensive, energy based contract allowing a positive cashflow. The total cost increase of implementing these measures is $3,031,000. Additional detail of each measure can be referenced in the FIM section of this report.

Utility Information

Electricity

Onsite electricity if provided by Pacific Gas & Electric (PG&E) and several sites are provided services by Modesto Irrigation District Water & Power (MID).

The majority of the electric accounts at the City of Livingston are under either A-6 Small General Time-of-Use Service, or A-10 Medium General Demand-Metered Service, or A-1 Small General Service through PGE. Monthly PGE & MID bills for all available facilities were utilized as part of the preliminary analysis. The summary of those results are tabulated below:

Table 3: Electrical Usage of all Sites Audited

Annual MID Electricity Bills

Location Name	Location Address (Livingston, CA)	Utility Company	Total kWh	Max kW	Total Cost
Don Meyer Park	Natsu Rd.	MID	2,883	18	$ 612.59
Country Lane Lift Station	Narada Way & Grapevine	MID	9,083	9	$ 1,612.09
Parkside Storm Lift Station	Joseph Gallo Park on Winton Parkway	MID	10,467	103	$ 1,397.03
City Hall	1416 C. St.	MID	92,640	62	$ 15,711.84
Walnut Child Development Center	2600 Walnut Ave.	MID	93,280	78	$ 14,711.79
Police Station	1446 C St.	MID	139,440	74	$ 19,875.22
Well # 16	1168 OKHI ST	MID	147,960	166	$ 25,214.90
Well # 8	Well # 8	MID	203,840	96	$ 37,569.61
Well # 15	543 Joseph Gallo Ct.	MID	249,068	147	$ 36,212.40
Well # 17	1780 Sun Valley Ave	MID	684,480	352	$ 93,102.40
Well # 12	Well # 12	MID	861,160	205	$ 108,474.02
Well # 9	1226 or 1298 Crowell St.	MID	921,120	243	$ 116,670.92
Total			**3,415,421**	**1,550**	**$471,164.81**

Annual PG&E Electricity Bills

Location Name	Location Address (Livingston, CA)	Utility Company	Total kWh	Max kW	Total Cost
Lil Guy's and Gal's Field	911 F St.	PG&E	7,286	35	$ 1,724.69
Lucero Park (East Ave Lift Station)	Cella Dr.	PG&E	7,426	4	$ 1,737.29
Senior Citizen's Center	420 Main St.	PG&E	9,024	11	$ 2,380.21
Council Chambers	633 Main St.	PG&E	9,764	19	$ 2,422.33
Arakelian Park (Lift Station)	1007 J St.	PG&E	12,531	10	$ 2,591.79
Livingston Historic Museum	1306 C St.	PG&E	14,147	14	$ 3,441.39
Public Works	2238 Walnut	PG&E	32,375	17	$ 7,569.66
Max Foster Sports Complex	2550 Walnut Ave.	PG&E	73,233	84	$ 16,211.05
Well # 11B	7206 Pacific Ave.	PG&E	109,104	67	$ 22,249.72
Well # 14	936 Dwight Way	PG&E	218,340	114	$ 56,403.05
Gallo Park (Well #13)	1201 Parkside Way	PG&E	459,869	113	$ 89,682.16
Waste Water Treatment Plant	14960 Vinewood	PG&E	1,386,082	250	$ 207,177.16
Total			**2,339,181**	**738**	**$413,590.50**

Natural Gas

Onsite natural gas is provided by Pacific Gas & Electric (PG&E). Monthly PG&E natural gas bills for all available facilities were utilized as part of the preliminary analysis. The summary of those results are tabulated below:

Table 4: Gas Usage of Data Available

Location Name	Location Address (Livingston, CA)	Utility Company	Therms	Cost
Memorial Park and Alvermaz Field	1409 Main St.	PG&E	19	$ 110.57
Council Chambers	633 Main St.	PG&E	36	$ 124.43
Senior Citizen Center	420 Main St.	PG&E	36	$ 124.43
Fire Station	1430 C St.	PG&E	173	$ 287.16
City Hall	1416 C. St.	PG&E	215	$ 254.93
Public Works	2238 Walnut	PG&E	467	$ 586.41
Police Station	1446 C St.	PG&E	2,042	$ 1,761.81
Walnut Child Development Center	2600 Walnut Ave.	PG&E	2,184	$ 1,813.16
Total			**5,172**	**$ 5,062.90**

Water

Domestic water use is provided by the city, Livingston Municipality. There are 12 sites with complete data sets for this analysis based on the scanned monthly bills provided to Trane. With the given information, annual water usage for the 12 facilities was tabulated and totaled below.

Table 5: Water Usage from local Water Utility Company

Annual Local Water Bills				
Site	Meter	Address	Water Consumption (kGal)	Annual Charge
Senior Citizen's Center	101072-015	420 Main Street	22	$2,044.77
Don Meyer Park	101072-021	Z21 Don Meyer Park (Natsu Rd)	4,102	$7,985.71
Arakelian Park	101072-022	Z22 Arakalian Park-I Street	9,269	$14,493.97
Fire Station	101072-023	Z23 Fire Department	54	$327.91
Police Station	101072-024	1446 C Street	1,163	$2,992.15
City Hall	101072-026	1416 C Street	543	$3,453.23
Lucero Park	101072-027	Z25 Lucero Park	3,362	$5,538.01
Memorial Park and Alvermaz Field	101072-028	Z26 Memorial Park	5,909	$10,658.89
Gallo Park	101072-029	Z27 Joseph Gallo Park	16,228	$27,903.17
Public Works	101072-030	2238 Walnut Ave	152	$1,682.84
Max Foster Sports Complex	101072-031	2600 Walnut Avenue	17,967	$30,306.52
Walnut Child Development Center	101072-032	2600A Walnut Avenue	542	$2,230.22
TOTAL			**68,743**	**$109,617.39**

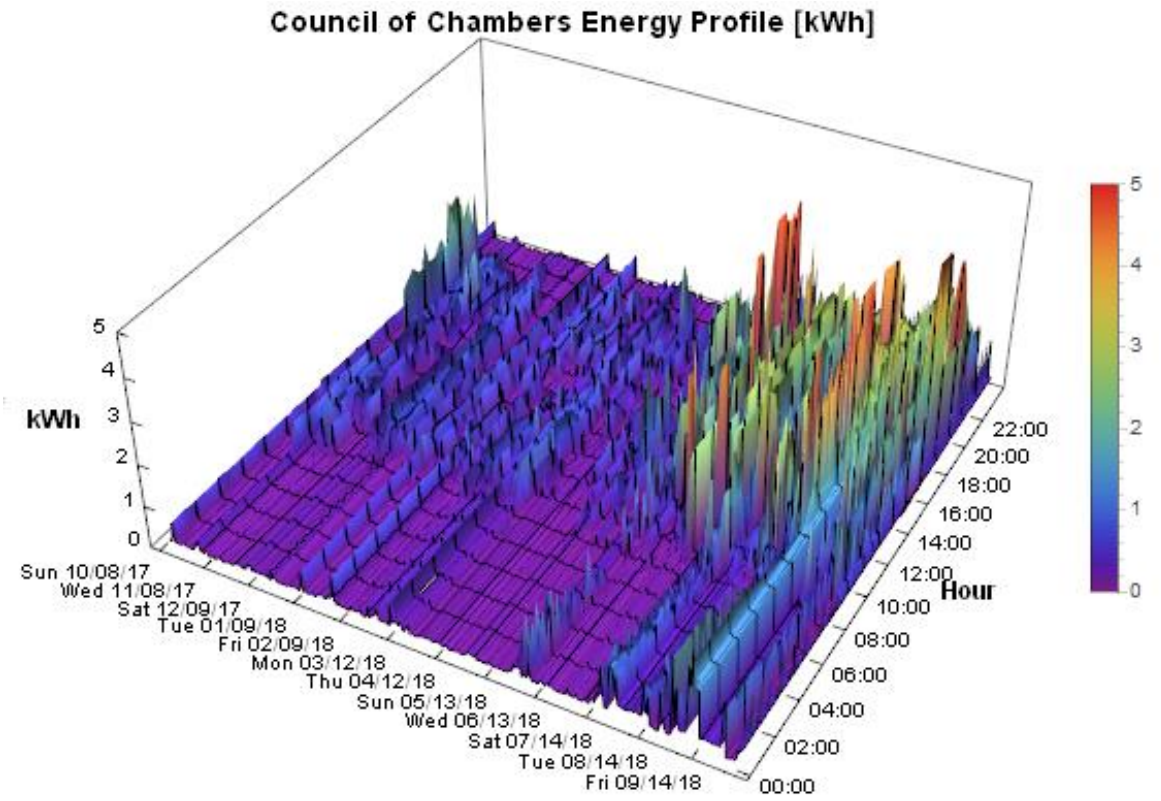
Interval Data Analysis

Trane collected and plotted the city's 15 minute interval data per site in the graphs below. This gives a 3D representation of each sites' electric utility usage for a year. Trane then uses these plots to glean valuable insights into a buildings usage patterns, high demand areas, and non-typical operations as compared to similar building types. The data can then be used to help evaluate potential savings opportunities and optimization of the sites utility profile.

Plot Descriptions

Electricity consumption (kWh) data is shown for each 24 hour period, in 15 minute intervals, for the previous 12 month period. The greatest (highest) consumption is shown in red and the lowest is in purple. The color intensity scale can be referenced to the right of each chart. Trane has provided comments and insights below each chart for the particular building or site being analyzed.

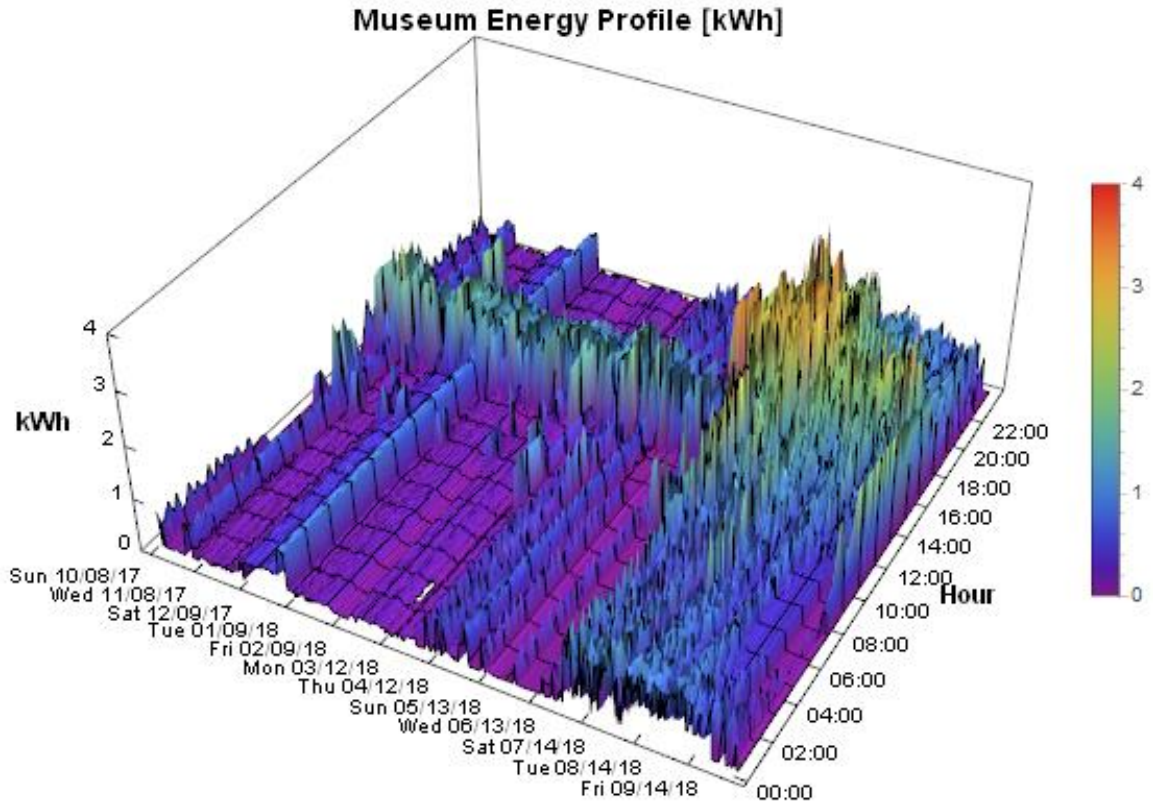
Council of Chambers



Comments on Site Load Profile:

- Data is shown from October 8 2017 to October 7 2018. The facility's highest recorded consumption peaked at 5 kWh on September 5 2018 at 2:45pm. The site's total annual consumption between the two dates analyzed was 12,063 kWh.
- Daytime operation appears to start at 8 am and lasts until 8pm during non-summer months. Energy usage increases greatly in Summer months, with starting times remaining at 8am but staying higher as late as 10 pm at night.
- There is minimal weekend operation seen showing good setback control. Major energy usage comes from summer usage with no morning warmup/drift schedules observed to be in operation.

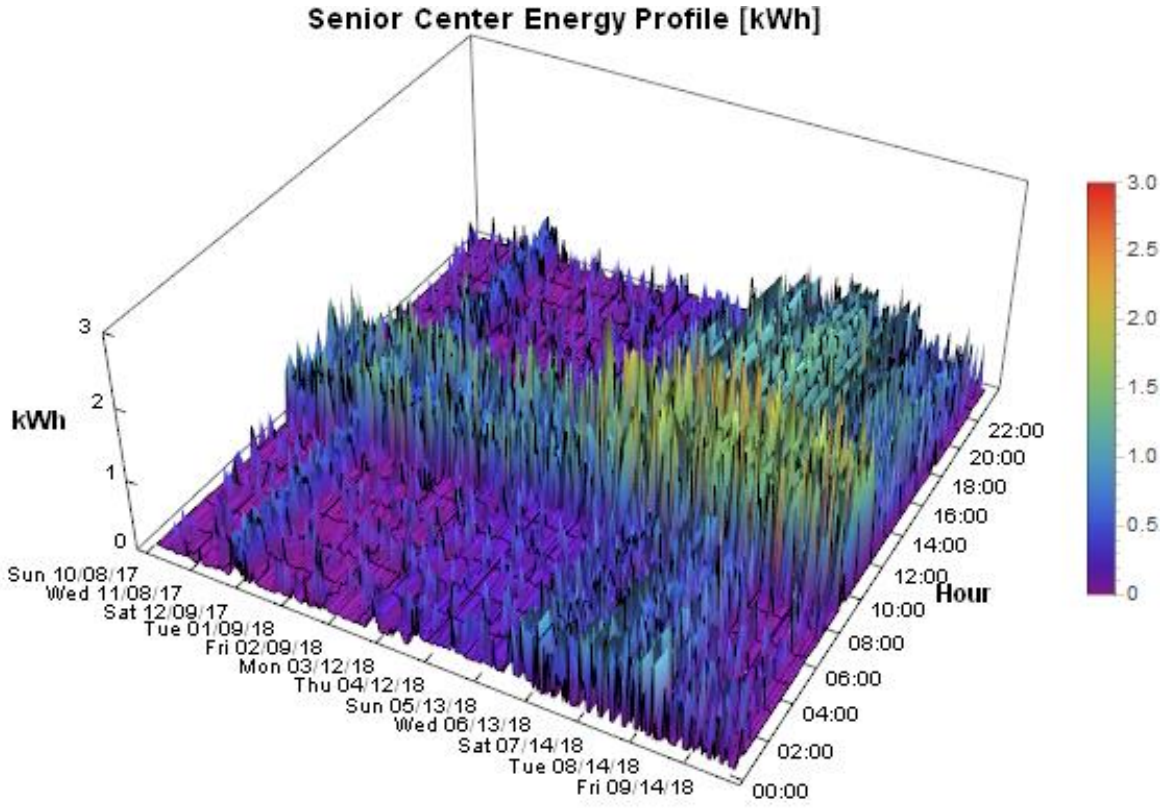
Museum



Comments on Site Load Profile:

- Data is shown from October 8 2017 to October 7 2018. The facility's highest recorded consumption peaked at 3.5 kWh on July 6 2018 at 6:45pm. The site's total annual consumption between the two dates analyzed was 13,962 kWh.
- Typical operation schedules are from 2pm to 5pm on weekdays and weekends.
- Consumption shows good correlation with ambient temperature, as can be seen by the higher energy consumption in the cooling season especially during afternoon periods.
- Twenty four hour operation can be seen intermittently during the year.
- No morning warmup are observed to be in operation at this facility.

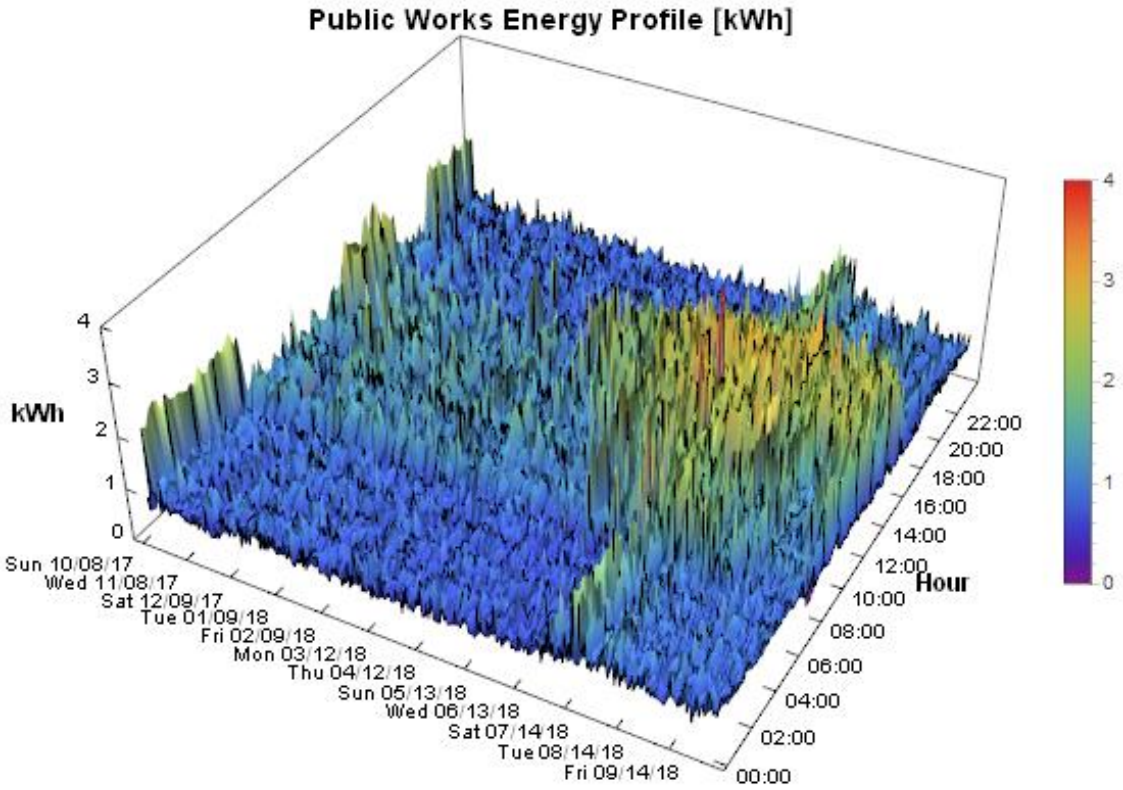
Senior Center



Comments on Site Load Profile:

- Data is shown from October 8 2017 to October 7 2018. The facility's highest recorded consumption peaked at 2.5 kWh on September 24 2018 at 8:45 am. The site's total annual consumption between the two dates analyzed was 8,926 kWh.
- Typical operation noted by higher energy usage occurs from 9am to 1pm on weekdays at the Senior Center.
- Peak consumption is correlated with ambient air temperature during the cooling (Summer) season, shown by the higher spikes during the summer morning periods and consistently higher energy draw throughout the afternoon and night.
- No morning warmup control can be seen in operation at this facility.

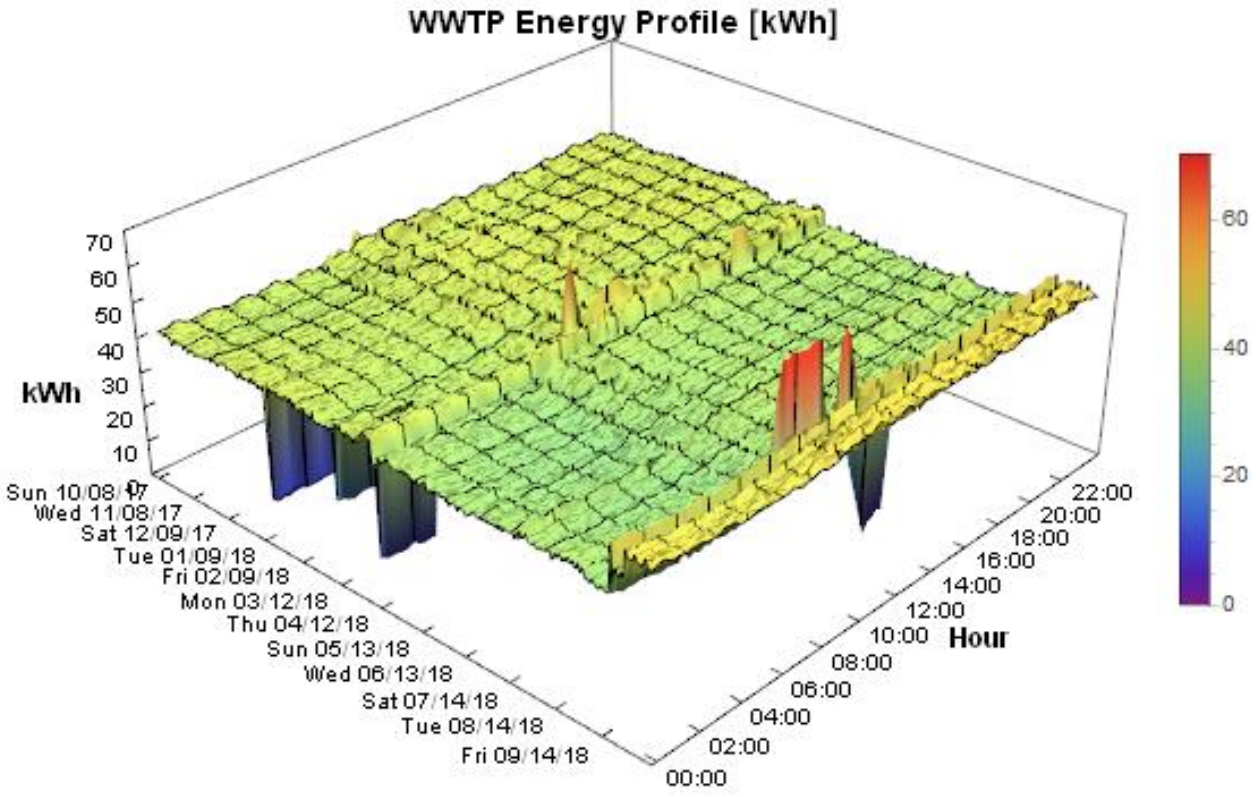
Public Works Load Analysis



Comments on Site Load Profile:

- Data is shown from October 8 2017 to October 7 2018. The facility's highest recorded consumption peaked at 4.7 kWh on July 16 2018 at 9 am. The site's total annual consumption between the two dates analyzed was 32,293 kWh.
- Energy usage is highly correlated with ambient air temperature, shown by higher consumption during the cooling (Summer) season.
- The facility ramps up at around 6 am and shuts down at approximately 5 pm every day. A consistent energy load is observed during the night and weekends.

Waste Water Treatment Plant Load Analysis



Comments on Site Load Profile:

- Data is shown from October 8 2017 to October 7 2018.
- Due to consistant, 24/7 plant operation throughout the year, the energy consumption at the plant is relatively weather independent.
- There are a few atypical days, potentially showing maintenance or other short term increases in consumption. This can be seen as the large red “fins” in the plot.
- Increases in overall energy usage starting in September 2018 can be seen which potentially elude to a change in plant operation or connected load.

Time of Use Schedule & Rate Change

As a result of Time of Use schedule and rate changes in California, the Trane CS team used the interval data collected to project what the future utility expenditures would be for the City of Livingston, as well as to analyze future impacts on the proposed ECMs such as Solar PV. The projected utility cost can be referenced in the next section, Utility Charges Post-Rate Redesign.

A Time of Use (TOU) Schedule is used for every electricity utility user. In short, the schedule defines at what times the electricity prices are applied. Typically, there is a peak price, mid-peak price, and an off-peak price, decreasing in value respectively. For decades, the highest peak price times have been during the middle of the day, most peak times occurred during 12pm to 6pm. Therefore, energy companies, specifically solar companies, had a great advantage to save customers energy and money during this time and there has been a dramatic increase in solar installations.

Due to the increase in solar installations the electrical grid and the requirement to manage it are changing significantly. High solar adoption creates a challenge for utilities to balance supply and demand on the grid. When the sun is shining, solar floods the market and then drops off as electricity demand peaks in the evening. Another challenge with high solar adoption is over-generation as it leads to curtailment of solar generation, which reduces its economic and environmental benefits. The Duck Curve—named after its resemblance to a duck—shows the difference in electricity demand and the amount of available solar energy throughout the day, produced by the California Independent System Operator in 2013. In response, utilities in the state are implementing new time-of-use (TOU) rate schedules to align demand with the midday solar bellies and steep evening necks.

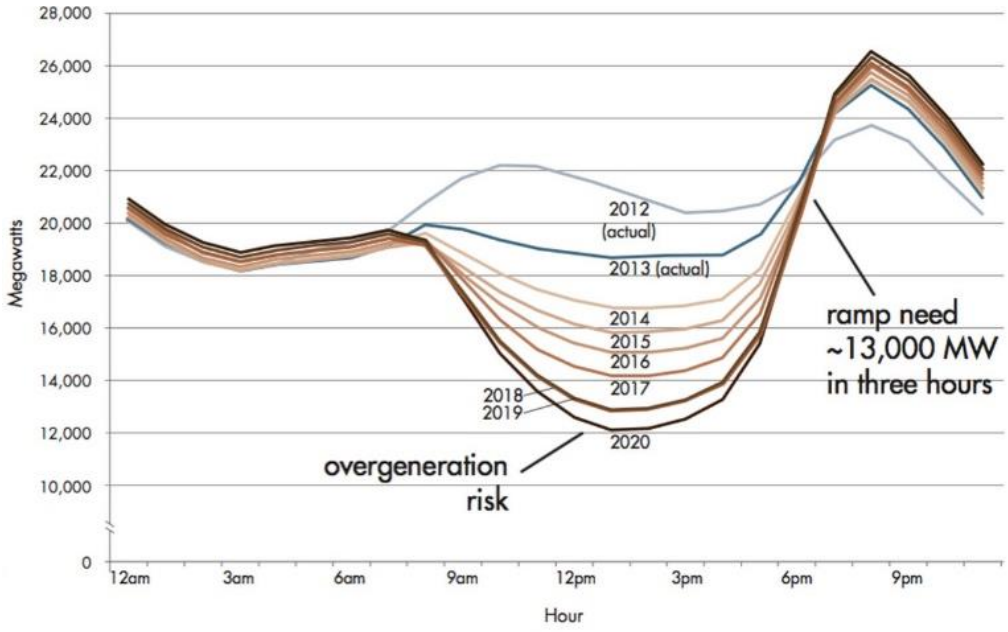


Figure 1: Duck Curve

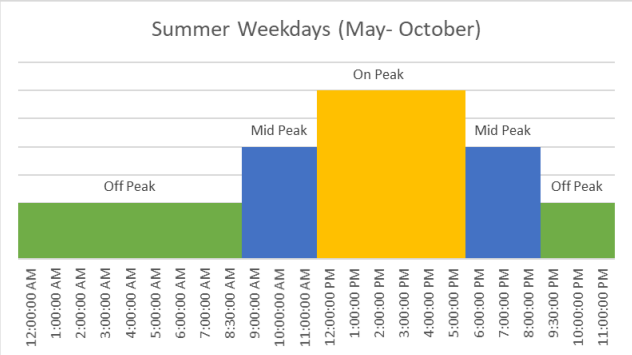
Each of California's largest utilities has proposed shifting the timing of peak rates later in the day in time-of-use (TOU) rate structure. Pacific Gas & Electric (PG&E) has already shifted TOU peak for residential customers and there are proposed settlements for commercial customers. PG&E will potentially be implementing the new structure for commercial customers late 2019. Southern California Edison (SCE) has proposed to shift peak for all customers, and a proposed decision that is pending at the CPUC would approve that. San Diego Gas & Electric (SDG&E) shifted peak hours last December for both residential and commercial customers. The most notable of

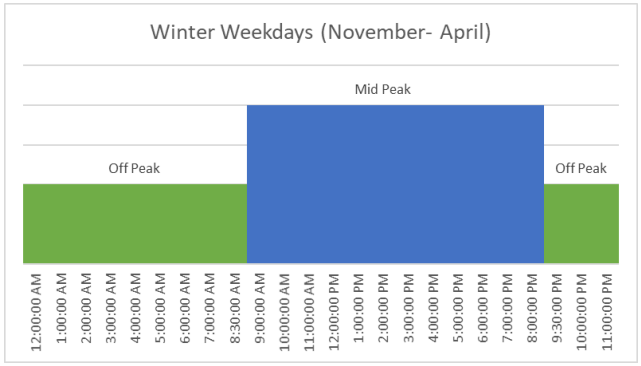
changes are the on-peak times. PG&E currently have peak times from 12 pm to 6 pm during summer months and no peak times during winter months. PG&E's new peak is 4pm to 9pm daily all year. The summer months are also changing from spanning six months (May- October) to four months (June to September).

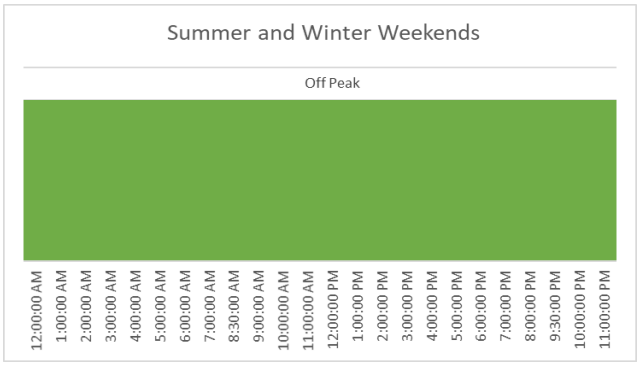
The charts in the next section display the current and proposed changes in Time of Use Schedules. This change will affect solar production because the energy produced will no longer be reducing the maximum pricing during the peak times; however, it is important to take note of the change because it will occur regardless.

Current PG&E Time-of-Use schedule:

		Hour	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Current rate schedule	Summer (May- October)	Weekday	Off Peak									Mid Peak			On Peak						Mid Peak			Off Peak		
		Weekend	Off Peak																							
Current rate schedule	Winter (November- April)	Weekday	Off Peak									Mid Peak												Off Peak		
		Weekend	Off Peak																							

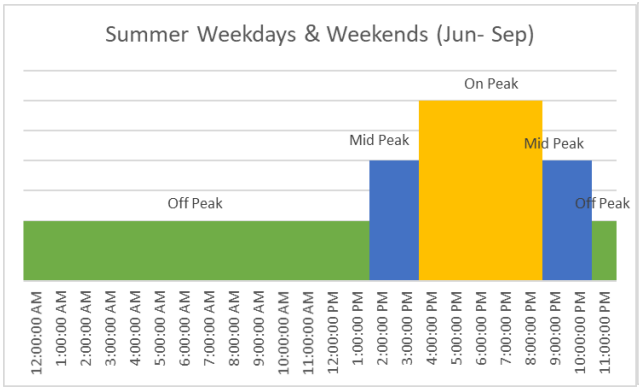


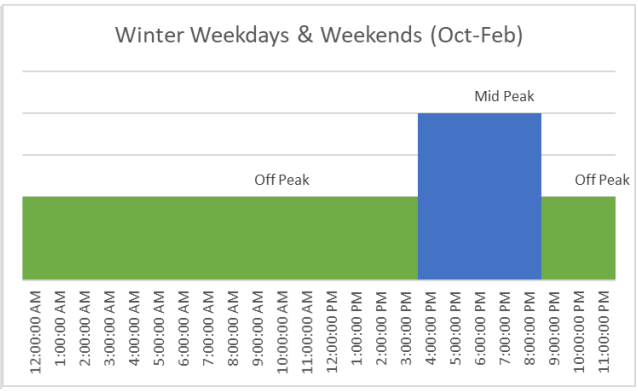


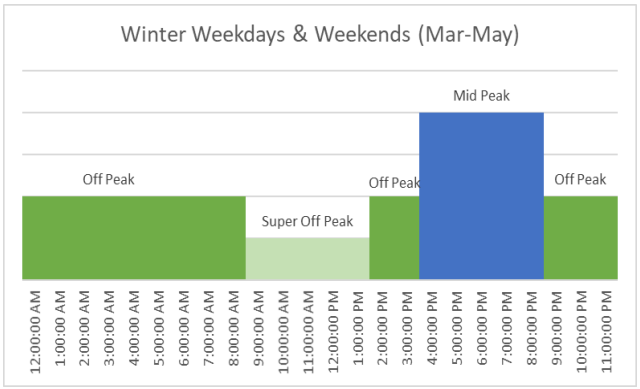


Proposed PG&E Time-of-Use Schedule:

		Hour	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
New rate schedule	Summer (June-September)	Weekday	Off Peak														Mid Peak		On Peak					Mid Peak		Off Peak
		Weekend	Off Peak														Mid Peak		On Peak					Mid Peak		Off Peak
New rate schedule	Winter (October- May)	Weekday	Off Peak																Mid Peak					Off Peak		
		Weekend	Off Peak																Mid Peak					Off Peak		
		March - May	Off Peak									Sup. Off Peak					Off Peak		Mid Peak					Off Peak		







Utility Charges Post-Rate Redesign

Figure 2 and Table 8 show the change in cost due to the effect of the rate redesign. The overall change is an increase in cost of approximately 7%. This increase in cost is a result of the Off-Peak period. Though there is an increase in the length of the Off-Peak period with respect to the On-Peak period, the charge for the Off-Peak period also increases. Sites including the wells, sports complex, and parks have a majority of Off-Peak periods due to night time lighting which is the cause for the increase in cost.

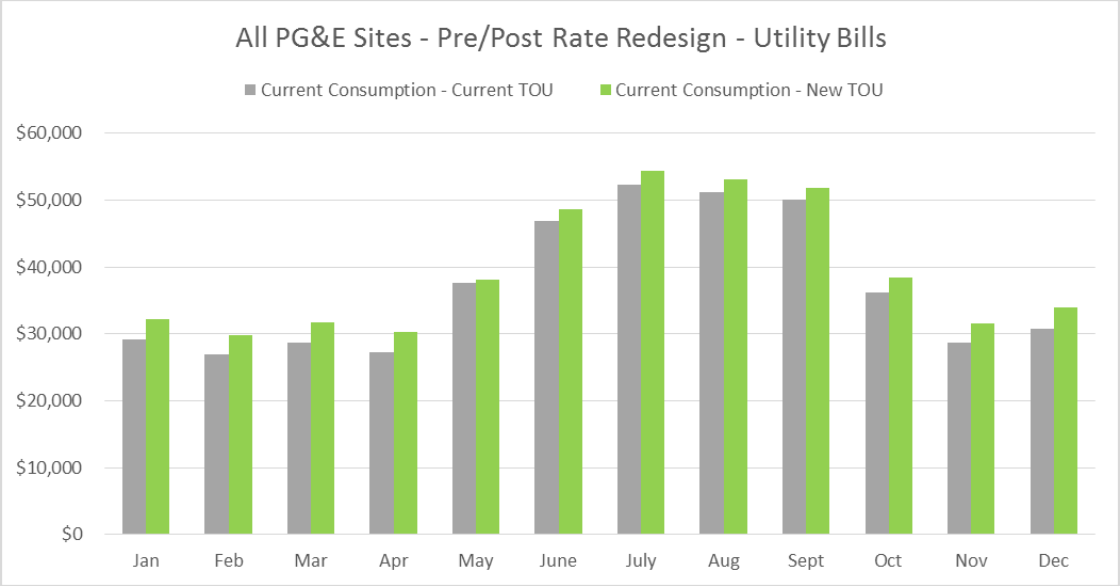


Figure 2: Graph of utility bill costs over a 12 month period for all sites under PG&E, pre and post-rate redesign charges.

Table 6: Sum of 12 month period for all sites under PG&E, pre and post-rate redesign charges.

All Sites	kWh	kW	Current Rate Cost	Proposed Rate Cost	Percent Change
Jan	181,981	576	$29,248	$32,144	10%
Feb	165,988	519	$26,993	$29,766	10%
Mar	170,066	539	$28,618	$31,720	11%
Apr	161,403	493	$27,249	$30,356	11%
May	220,819	498	$37,606	$38,055	1%
June	234,643	535	$46,925	$48,645	4%
July	263,208	548	$52,278	$54,353	4%
Aug	257,000	509	$51,234	$53,089	4%
Sept	235,577	670	$50,068	$51,791	3%
Oct	217,891	676	$36,242	$38,391	6%
Nov	175,265	604	$28,672	$31,544	10%
Dec	195,009	558	$30,699	$33,883	10%
Total/Max	**2,478,851**	**676**	**$445,831**	**$473,737**	**7%**

Energy Conservation Measures (ECM's)

After completing the preliminary survey of the city and its facilities, Trane recommends implementing the Energy Conservation Measures (ECMs) described in more detail below. These ECMs will reduce the utility expenditures of the city, allowing these funds to be reinvested into the city.

ECM #1: LED Lighting Upgrades

Trane recommends replacing existing interior and exterior lighting with new, compatible LED lighting. This upgrade will significantly improve the energy efficiency of the lighting systems. As for lighting control, Trane recommends installing wall-mounted and ceiling mounted occupancy sensors. LED lighting fixtures have longer effective useful life, which reduces both energy and maintenance costs. Lighting retrofits are proposed at the 23 sites listed below. The pictures below also show an existing fixture with older fluorescent tube technology and a new LED example.

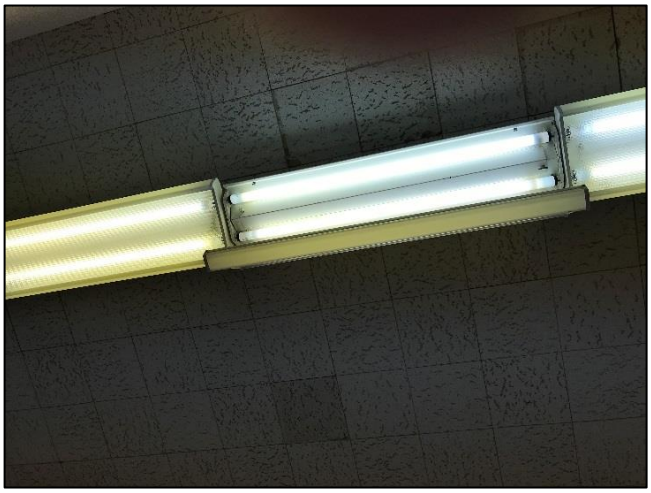


Figure 3: Existing non-LED Lighting (left), New LED Lighting (right)

Location Name	
Barber Shop	Well # 13 (at Gallo Park)
Arakelian Park	Well # 14
Council Chambers	City Hall
Fire Station	Country Lane Lift Station
Gallo Park	Parkside Storm Lift Station
Lil Guy's and Gal's Field	Police Station
Livingston Historic Museum	Walnut Child Development Center
Lucero Park	Well #8
Max Foster Sports Complex	Well #12
Memorial Park and Alvermaz Field	Well #15
Senior Citizens Center	Well #17
Well # 11	

ECM #2: HVAC Unit Replacement

The City of Livingston has a mixture of HVAC units including direct expansion packaged units, split condensing units, and small PTAC units. Several of the units that were audited are over 30 years old, well past their effective useful life. Operating HVAC systems beyond their useful life results in increased overhead cost due to inefficiencies and maintenance issues. Down time and lack of controllability can create occupant comfort issues and can result loss of occupants' productivity. With last year's extreme heat and humidity, some areas with older units were far outside occupied comfort conditions. Trane recommends replacing the aging HVAC units that are beyond their useful lives. The new equipment will have much higher operating efficiencies than the previous equipment leading to energy usage reductions. HVAC unit replacements are proposed at the following sites:

Location Name
Barber Shop
City Hall
Council Chambers
Livingston Historic Museum
Max Foster Sports Complex
Public Works
Senior Citizens Center
Walnut Child Development Center

Figure 4: Existing packaged RTU (left), new Trane RTU (right)

The photo above (left) shows an old Gas/Electric Rooftop Package Unit on top of the Senior Center. Wear and tear on the equipment from use and the elements are easy to see. Judging by the age and appearance of this unit, it is a prime candidate for replacement.

ECM #3: Energy Management System (EMS)

Currently, the HVAC systems around the city sites are independently controlled by thermostats, most of which are programmable. Several locations had issues with the operation of their HVAC Controls systems, judging by the notes left on the thermostats. Trane recommends the installation of a Trane Tracer Ensemble System (Tracer ES) including upgrading the existing thermostats to communicate to a central monitoring system which will allow for the monitoring and control of these units remotely by facility personnel. The images below illustrate one of the best opportunities for advanced controls. With an EMS, staff can set an alarm for room temperature, which would automatically send and alert if a high/low limit is reached, or if there are issues with the HVAC equipment. This remote notice can assist in avoiding the financial loss of goods or equipment, a problem noted by staff in regards to past issues at the Max Foster Vending/Kitchen Building. Also, city wide temperature setpoints and runtime schedules can be placed on equipment, setting a standard for efficiency and operation.

Figure 5: Existing Thermostat (left), Trane Controller & Tablet Interface (right)

Location Name
Barber Shop
City Hall
Council Chambers
Fire Station
Livingston Historic Museum
Max Foster Sports Complex
Police Station
Public Works
Senior Citizens Center
Walnut Child Development Center

ECM #4: Variable Frequency Drives (VFD) on Well & WWTP Motors

Trane recommends installing Variable Frequency Drives (VFDs) and Premium Efficiency Motors on the large well water pump motors. VFDs allow pumps to vary their speed to deliver exactly the flow and the pressure required at that specific time. This is opposed to a constant speed motor which "rides" the pump curve until flow and pressure balance at the motors full power. Based on fan and pump motor affinity laws, the reduction of motor speed does not correlate linearly to motor power in which, for example, a reduction of 50% speed is more than a 50% reduction in power. In conjunction with the installation of the VFD's, Trane is recommending replacing the existing motors with premium efficiency motors which typically have 25% less losses (i.e. are 25% more efficient) than standard efficiency motors. The reduction in motor load from the VFD installation and control along with the use of premium efficiency motors is estimated to result in a great deal of energy savings.

Trane also recommends programming and re-commissioning of the existing VFD's controlling the aerator motors at the Waste Water Treatment Plant. The existing motors are furnished with VFD's, but programming is lacking within the Building Automation System (BAS) and does not allow for automated aerator cycling to keep the biologics oxygenated but not to over aerate the Oxidation Ditch and waste energy. Currently an operator types in a new VFD run level (in percentage) and the oxygen level sensors are not programmed into the system.

The pictures below show an existing weathered pump motor without VFD control (left). In outdoor applications, motors will be selected to withstand the elements and VFD's will be housed in NEMA-3R weatherproof enclosures. Shown on the right, are a variety of VFD's available for every size motor in use at the City of Livingston.

Location Name
Tank Site
Waste Water Treatment Plant – (VFD controls and commissioning only)
Well # 9
Well # 11
Well # 12
Well # 14
Well # 15

ECM #5: Irrigation System Upgrades

The City of Livingston takes pride in their beautiful lush green parks which are a great contrast to the dry natural landscape in the rest of the area. Unfortunately, compliance with Governor Jerry Brown's water limitation mandates are pushing cities to find water reduction measures wherever possible. Trane recommends the installation of smart controllers at the City of Livingston parks to schedule irrigation events based on real-time weather information and ET requirements. Irrigation controls restrict excessive water use resulting in environmental and financial savings. Landscape irrigation is typically provided by time clock-based systems which tend to provide imprecise water delivery, even when advanced schedules are implemented. Areas can be overwatered, sprinkler systems can run while it is raining, and unchecked clock based controllers can continue to water areas on a summer demand well into the cooler seasons of the year.

Figure 6: Livingston Park (left), Smart Irrigation Controller (right)

Additional investigation can be done during the next phase to provide retro-commissioning of irrigation systems to improve water distribution, eliminate leaks and more effectively manage water delivery (e.g. cycle/soak programs, etc.). These additional distribution efficiency upgrades include installation of multi-trajectory stream nozzles on spray heads. Rather than simply "spray" water onto landscapes, MP Rotators deliver multiple streams of water at a steady rate. This slower application rate allows water to gently soak into the soil and achieves an even distribution throughout the area being irrigated. This increased efficiency results in 30% to 70% less water use when compared to traditional sprays and significantly reduces wasteful runoff. Additional savings may be researched in this phase to obtain irrigation sewer exemption credit opportunities per the water provider. Irrigation system upgrades were originally investigated at the following sites:

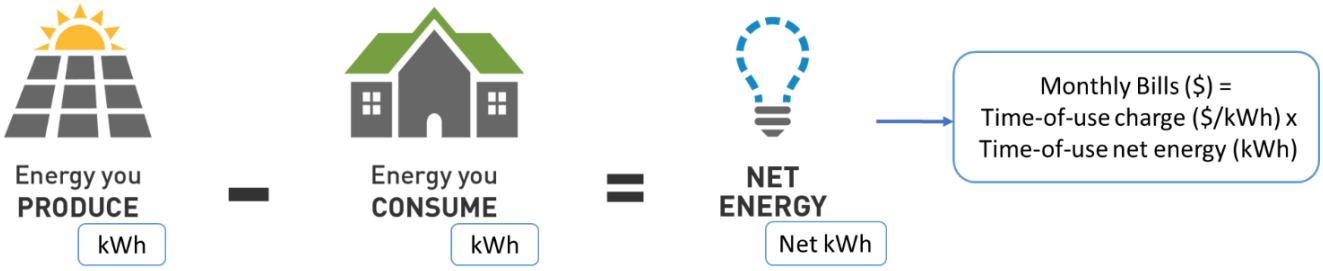
Location Name
Arakelian Park
Don Meyer Park
Gallo Park
Lil Guy's and Gal's Field
Lucero Park
Max Foster Sports Complex
Memorial Park and Alvermaz Field

ECM #6: Photovoltaic Systems

As mentioned previously in the utility section of this report, California is changing its current Time Of Use (TOU) schedules and shifting on-peak demand times. For this reason, Trane approached Solar PV under two different solar analysis strategies based on the two prominent solar programs available to the City of Livingston: Net Energy Metering (NEM) and Renewable Energy Self-Generation Bill Credit Transfer (RES-BCT). Details of the two programs are listed below.

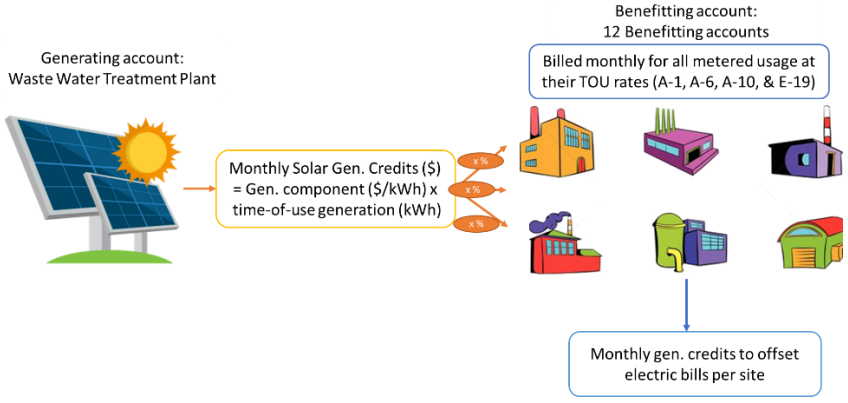
Net Energy Metering (NEM)

A net energy metering agreement is defined as measuring the difference between the energy (kWh) supplied by PG&E through the electric gird to the eligible customer-generator and energy (kWh) generated by an eligible customer-generator and fed back into the electric grid over a relevant period. At the end of the relevant period, a true up is performed by PG&E to bill the customer for energy (kWh) used during that period.
Net energy is defined as measuring the difference between the energy (kWh) supplied by PG&E and energy (kWh) generated by the solar system that gets fed back into the electric grid. Monthly bills are determined by applying the time-of-use net energy (kWh) and the time-of-use rate charge ($/kWh). If the energy (kWh) generated exceeds the energy (kWh) consumed at the end of the relevant period, there will be a compensation for any excess energy generated, which will be credited to future bill charges.



Bill Credit Transfer (RES-BCT)

Another option for reducing expenditures for the city of Livingston would be participating in the RES-BCT Program. It allows a Local Government or city with one or more eligible renewable generating facilities to export energy to the grid and receive generation credits to benefitting accounts of the same Local Government. Solar generation on the order of a 2 MW solar system could be supported at the Waste Water Treatment which could be exported to receive renewable generation credits. Monthly time-of-use generation would be captured through a new service account at the site and the monthly generation credits in dollars are calculated based on the generation component of the associated time-of-use rate.



Proposed Solar PV Layouts for NEM

Trane analyzed four (4) sites for solar. These sites were supplied by PG&E, had the highest consumption, and had space for solar panels. The sites include Gallo Park (Well#13), Public Works Facility, Max Foster Sports Complex, and the Waste Water Treatment Plant (WWTP) due to their electricity use and available area for solar panels. The analysis was performed with the online software Helioscope and was sized after reducing the site consumption with the initial Energy Conservation Measures (ECM).Trane recommends the following sites have NEM 2.0 agreement PV systems installed:

Location Name
Well # 13 (Gallo Park)
Public Works
Max Foster Sports Complex
Waste Water Treatment Plant

Figure 7: Gallo Park

Figure 8: Public Works

Figure 9: Max Foster Sports Complex

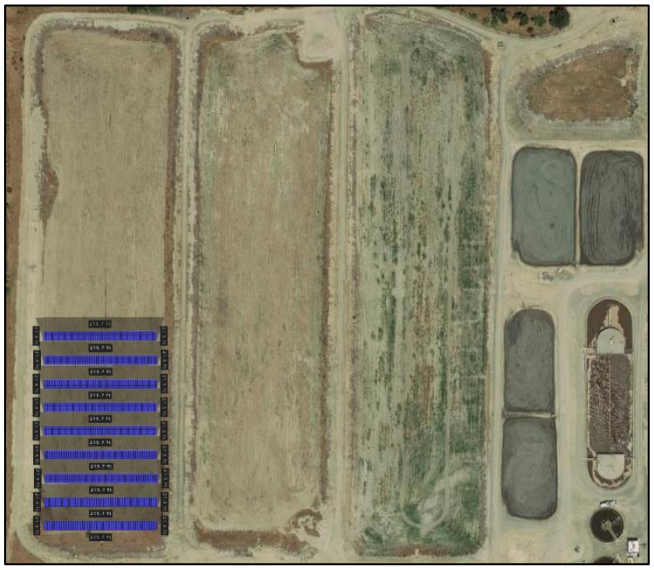


Figure 10: Waste Water Treatment Plant

Solar Credit Amounts for Pre & Post Rate Redesign for NEM Solar Sites – Graphs

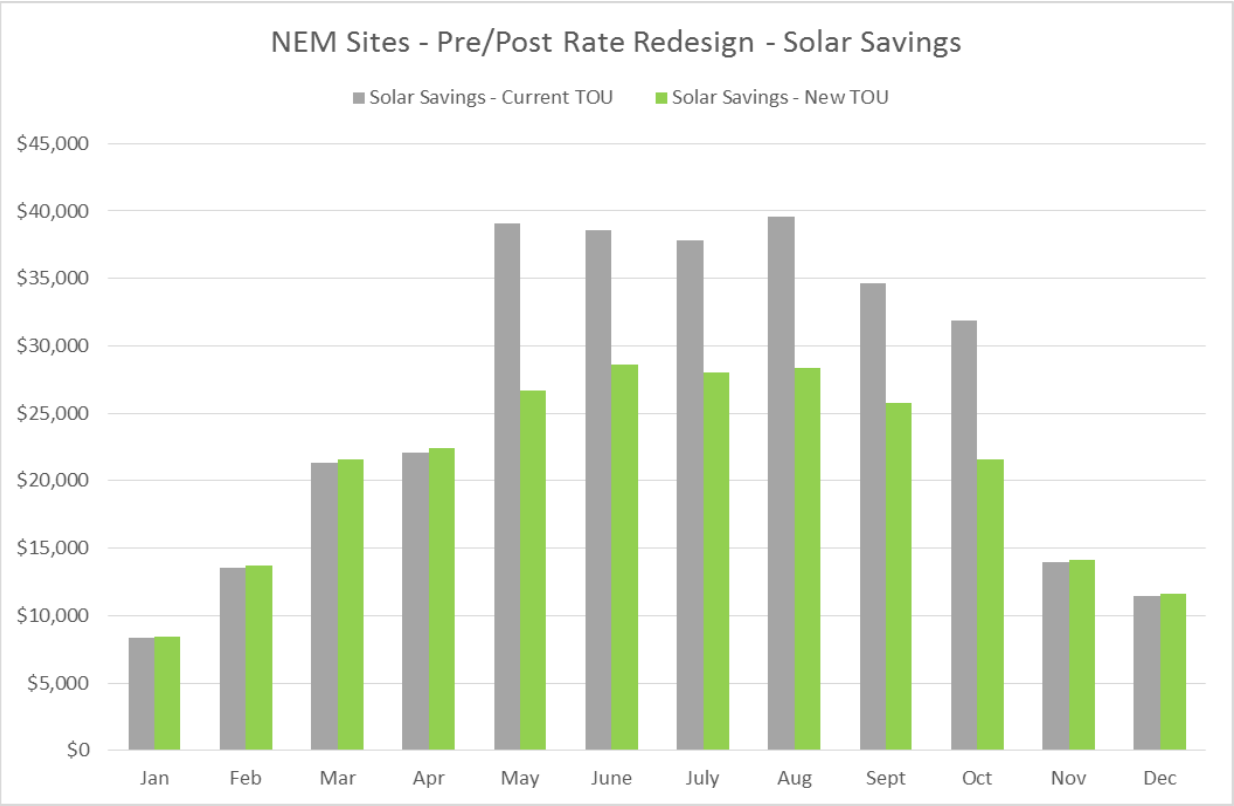


Figure 11: Total Solar Savings for all NEM site over 12 months.

Solar Credit Amounts for Pre & Post Rate Redesign for NEM Solar Sites – Tables

Table 7: Total solar savings for all NEM sites pre & post rate redesign.

NEM Sites	Current Rate Savings	Proposed Rate Savings	Percent Change
Jan	$8,335	$8,460	1%
Feb	$13,514	$13,684	1%
Mar	$21,365	$21,561	1%
Apr	$22,090	$22,381	1%
May	$39,098	$26,719	-32%
June	$38,607	$28,597	-26%
July	$37,842	$28,040	-26%
Aug	$39,603	$28,342	-28%
Sept	$34,680	$25,774	-26%
Oct	$31,879	$21,606	-32%
Nov	$13,986	$14,166	1%
Dec	$11,472	$11,630	1%
Total/Max	$312,471	$250,959	-20%

Solar Credits Continued

Figure 14 and Table 9 on the previous page display the total solar savings for all four NEM sites. The savings had to be calculated by first making sure all sites were on similar rates. The sites are on the following rates: Gallo Park (A-10), Public Works (A-1), Max Foster Sports Complex (A-6), and Waste Water Treatment Plant (E-19). The rate E-19 has a different structure than the other "A-type" rates, it has a demand charge where the others do not; therefore, for the analysis the site was changed to an A-6 rate. A-6 was chosen because it has the highest payback when analyzing solar.

The percentage change from current to proposed rate decreases expenditures by 20%. This is a result of the decrease in charges during peak solar generating times from PG&E. This difference in savings has been considered when calculating cash flows in the financial proforma and overall payback of the project including solar pv. Although this significant rate change occurs, the analysis conducted shows that solar is still a viable option for the City of Livingston under the NEM program.

Proposed Solar PV Layout for RES-BCT

Figure 12: Solar Site for RES-BCT program located at Waste Water Treatment Plant

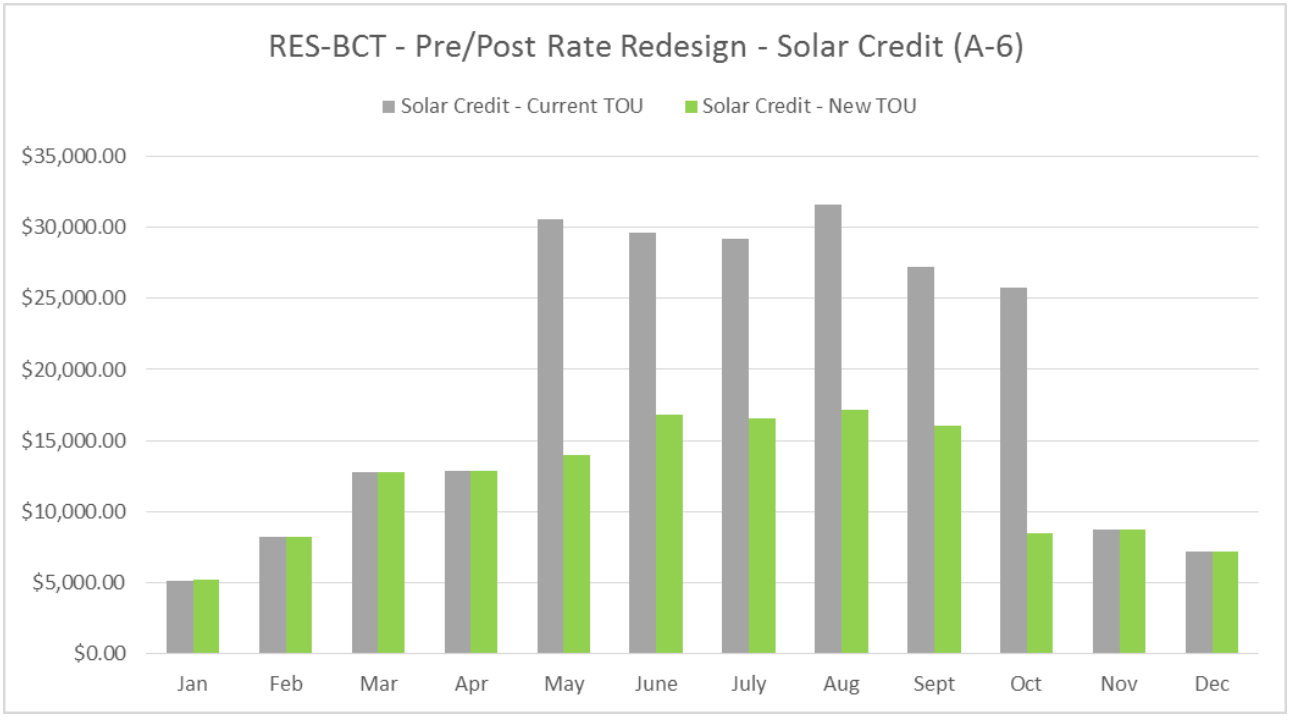


Figure 13: Pre/Post Rate Design for RES-BCT sites

All Sites	kWh	kW	Solar Credit on Current Rate	Solar Credit on Proposed Rate	Percent Change
Jan	55,890	703	$5,170.60	$5,175.26	0%
Feb	89,688	745	$8,215.86	$8,261.26	1%
Mar	139,457	746	$12,806.52	$12,805.72	0%
Apr	140,444	746	$12,860.68	$12,896.41	0%
May	151,928	736	$30,535.47	$13,944.87	-54%
June	150,705	662	$29,643.54	$16,847.11	-43%
July	147,846	667	$29,155.97	$16,566.26	-43%
Aug	153,506	675	$31,562.64	$17,150.26	-46%
Sept	144,928	685	$27,254.35	$16,036.41	-41%
Oct	135,104	724	$25,769.73	$8,463.26	-67%
Nov	95,316	691	$8,697.73	$8,772.21	1%
Dec	78,241	697	$7,183.24	$7,213.92	0%
Total/Max	1,483,053	746	$228,856.33	$144,132.96	-37%

Table 8: Pre/Post Rate Design for RES-BCT sites

As depicted in Figures 19, and Table 17, solar credits decrease with PG&E's upcoming rate changes. The overall change is a decrease in expenditures of approximately 37%. Due to an increase in the Off-Peak period during the day time, the dollar value for each hour of solar generation has also decreased. This applies uniformly across all four sites under the NEM program, as well as the large site analyzed under the RES-BCT program. The rate periods can be referenced in the Time of Use Schedule section. Though the decrease in expenditure is seen through the NEM and the RES-BCT programs, NEM is recommended by Trane because of its higher payback.

ECM #7: Battery Energy Storage

Trane explored adding batteries to both the single site RES-BCT PV agreement and the four sites NEM PV agreement; however, there are several challenges facing this measure. One of the largest challenges is that no Community Choice Aggregator (CCA) has been assembled for/near the city. A CCA enables governments to procure power on behalf of their residents which typical includes a large portion of renewable resources.

Trane analyzed several battery storage options on behalf of the district which yielded low energy cost offset which were not able to justify the current cost of the battery systems required. Trane recommends further analyzing this option pending the selection and sizing of the solar p.v. system, as well as with any future development in the progress towards creating a CCA.

Facility Improvement Measures (FIM's)

After surveying the city's facilities, Trane recommends a list of facility improvement measures that will provide additional services and improve services to the overall county's operations. Unlike ECM's, these measures do not conserve energy, but are still beneficial to the city in other ways. When bundled together with the previously described ECMs, the city can implement these much needed measures without an impact to their budget due to the utility expenditure offsets.

FIM #1: Additional HVAC Units & Insulation

The City of Livingston has several pump sites where structures have been built to protect the pump motor and the controlling VFD from the elements. Although some of the structures have exhaust fans to help reject the heat within the space, ventilation alone does not decrease the temperature of the rooms, especially during the hot summer months. Trane recommends the installation of new HVAC units to condition these buildings to protect the investment and functionality of both the pumps and the VFD's. New HVAC unit installations are proposed at Well Stations 8, 13, 16, and 17. The existing HVAC (Figure 16, left) shows the temporary fix to this summer's situation by utilizing window air conditioning units located in the middle of the rooms. Unfortunately, this is a poor application of this type of HVAC system since the refrigeration cycle requires heat to be rejected during the refrigeration gas condensing phase. For the window mounted unit shown, this heat rejection occurs at the back of the unit. So the cold air was coming out of the front of the unit while hot air is being blown outside of the unit within the same room. The installation of new equipment does not save energy but provides cooling to the pump and VFD's within the buildings thus allowing them to operate efficiently and also provide protection from early failure due to high ambient heat exposure. The lack of insulation (Figure 16, right) shows that several of the VFD buildings lack any form of insulation. The cost of new roof and wall insulation is included in this measure as well as the additional energy use of the new equipment being offset by the insulation.

Figure 14: Temporary HVAC (left), Existing Insulation (right)

FIM #2: Street Lighting Additions

The City of Livingston recently installed 24 street lighting poles along approximately 630 feet of Main Street. As per the City's request, an additional 1,542 feet of streets will have new street lighting poles added (approximately 58 new lighting poles). Since the new lights are being installed in areas without previous lighting, this measure is considered a facility improvement measure.

Figure 15: Existing Street Light (left), Additional Street Lighting (right)

FIM #3: Water Meter Upgrades

The City of Livingston is currently updating all of their manually read residential water meters to Sensus Radio Read residential water meters for accuracy and to reduce demands on city staff time. Since the replacements started, another option of a Sensus Fixed Base Smart Residential Water Meter is now available. Approximately 200 manually read water meters still need to be upgraded to Fixed Based Water Meters and approximately 3,400 residential water meters need to be modified from the Radio Read (Sensus 520R) to the Fixed Base (Sensus 520M) version. Due to the required installation of a Base Tower Station and the purchase of the 200 remaining meters, considerable capitol cost outside of this proposal is required which forced this FIM into a second option for the City of Livingston's review and approval.

Figure 16: Manual Read Residential Meter (left), Fixed Base Smart Meter (right)

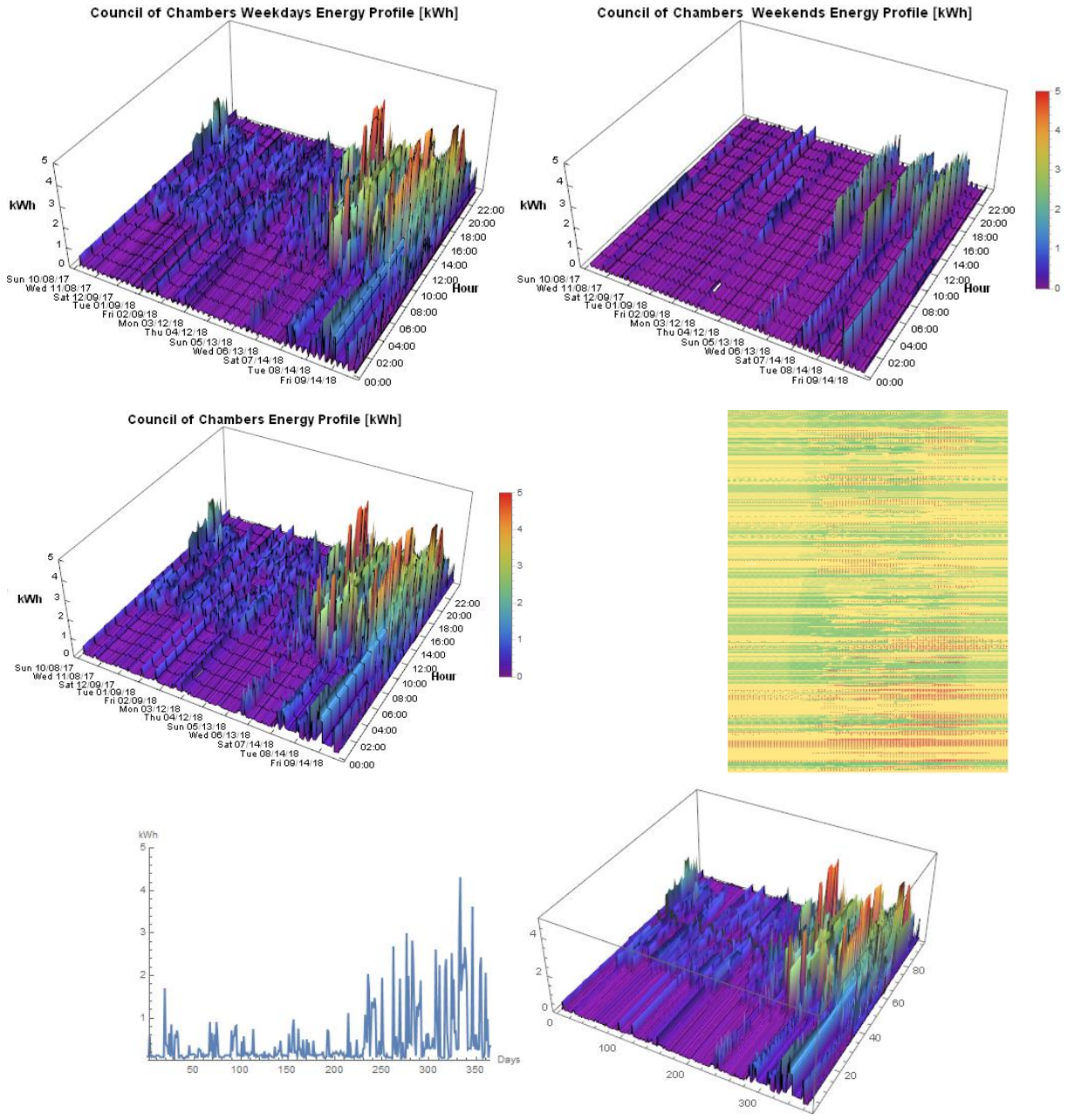
Energy Savings Overview

The following tables summarizes the estimated energy savings and incentives for the proposed energy conservation measures.

No.	Description	Annual Energy Savings			
		kWh/Yr	kW	kGal	Annual Savings ($)
ECM 1	LED Lighting Upgrades	129,759	47		$25,172
ECM 2	HVAC Replacements	48,157	35		$8,367
ECM 3	Energy Management System	37,112	–		$6,586
ECM 4	Variable Frequency Drives	935,270	–		$131,635
ECM 5	Irrigation Upgrades			25,668	$42,604
ECM 6	Solar Photovoltaic (Generation)	1,221,709	771		$250,959
Total		**2,372,007**	**853**	**25,668**	**$465,324**

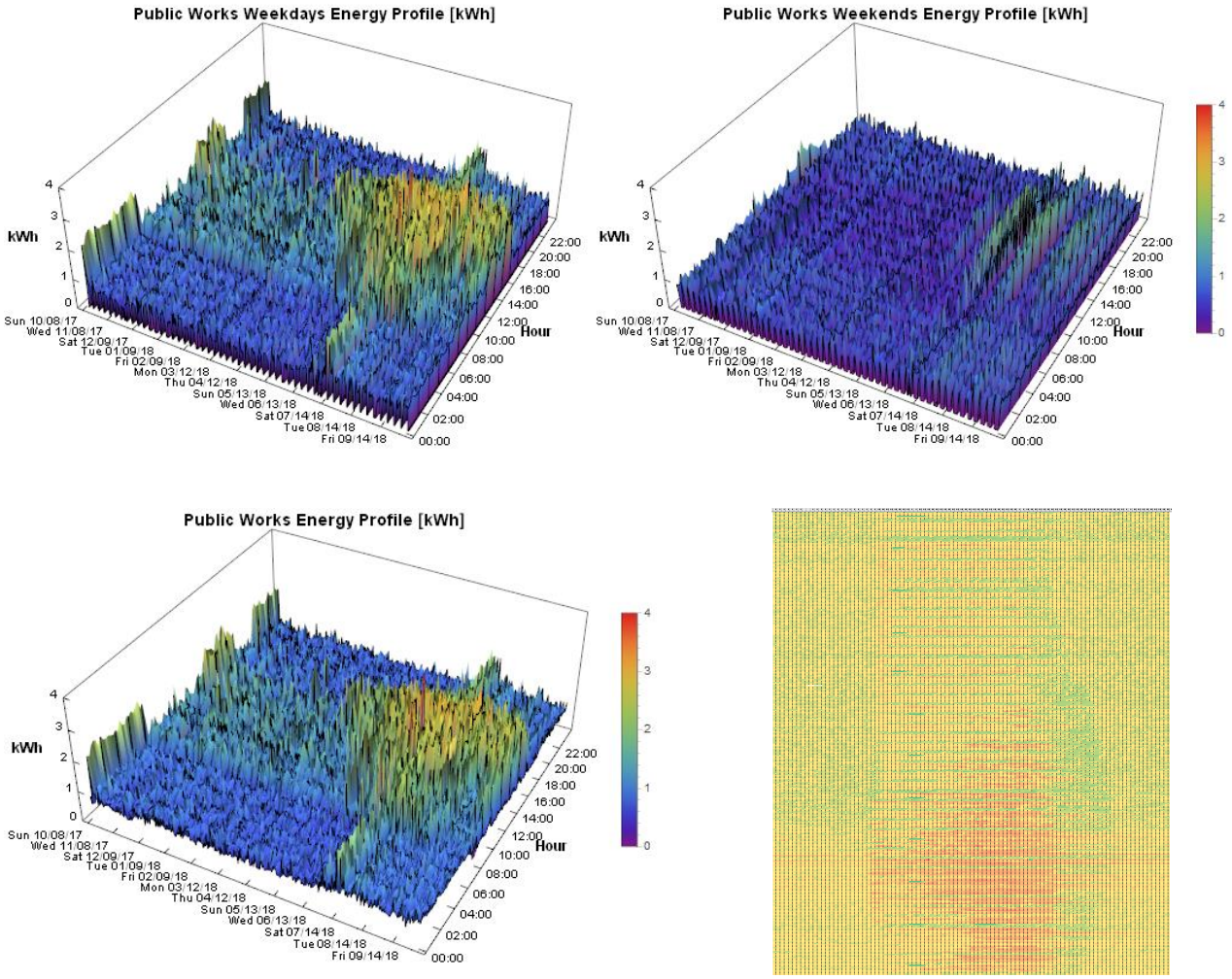
Appendix A: Additional Interval Data Analysis

Council of Chambers



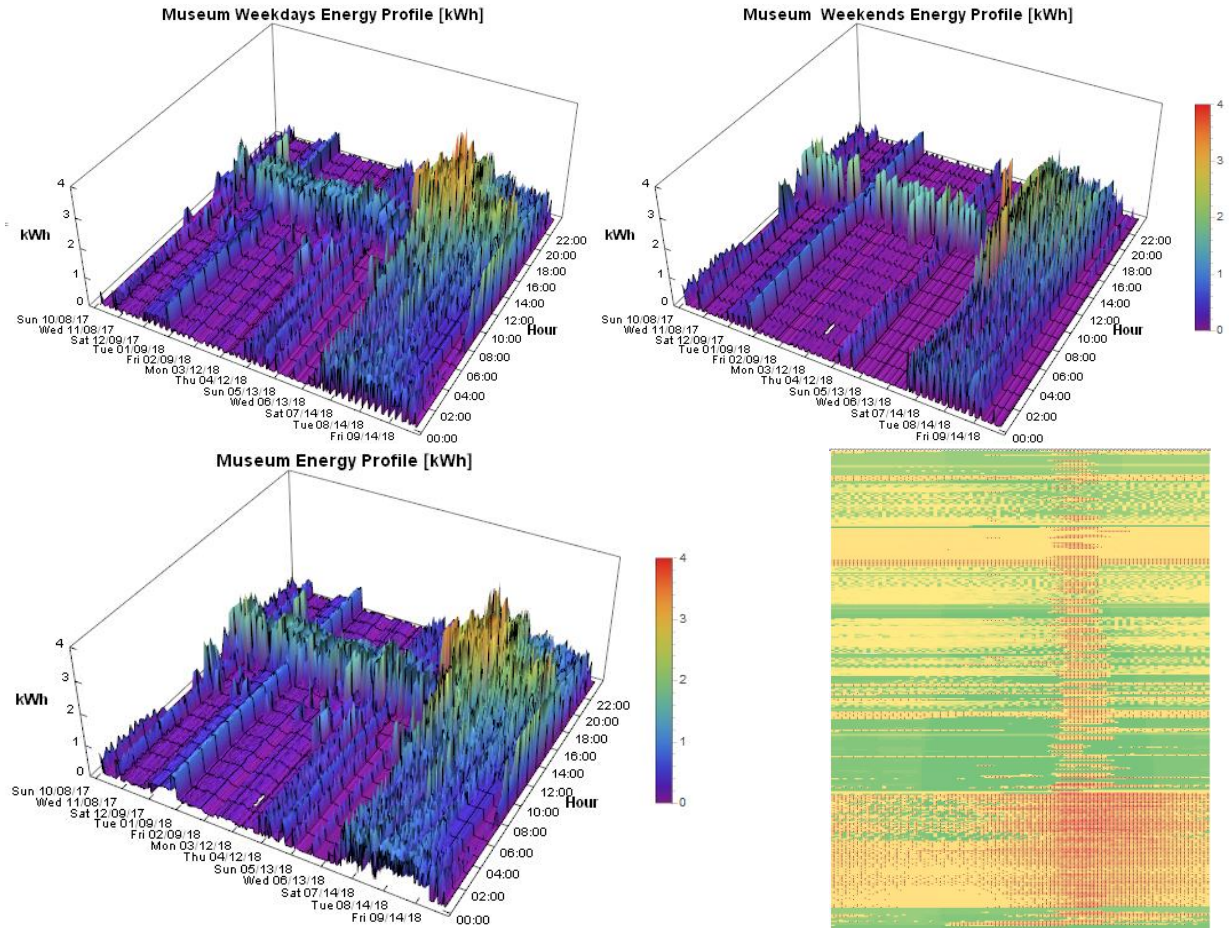
- Electricity consumption (kWh) is shown for each 24 hour period from October 8 2017 to October 7 2018. The greatest consumption is shown in red and the lowest is in purple. For the most recent year, the facility had the highest consumption at 5 kWh and peaked at 20 kW on September 5 2018 at 2:45pm. For the same period, the facility consumed 12,063 kWh.
- Daytime operation from 8 am to 8pm during non-summer months is observed in this facility. Energy usage ramps up in a higher increment from 8am until late at 10pm at night during summer months.
- There is minimum weekend operation, except for a few days in the summer months. Major energy usage comes from summer usage. No morning warmup or shutdowns are shown based on the interval data.

Public Works Load Analysis



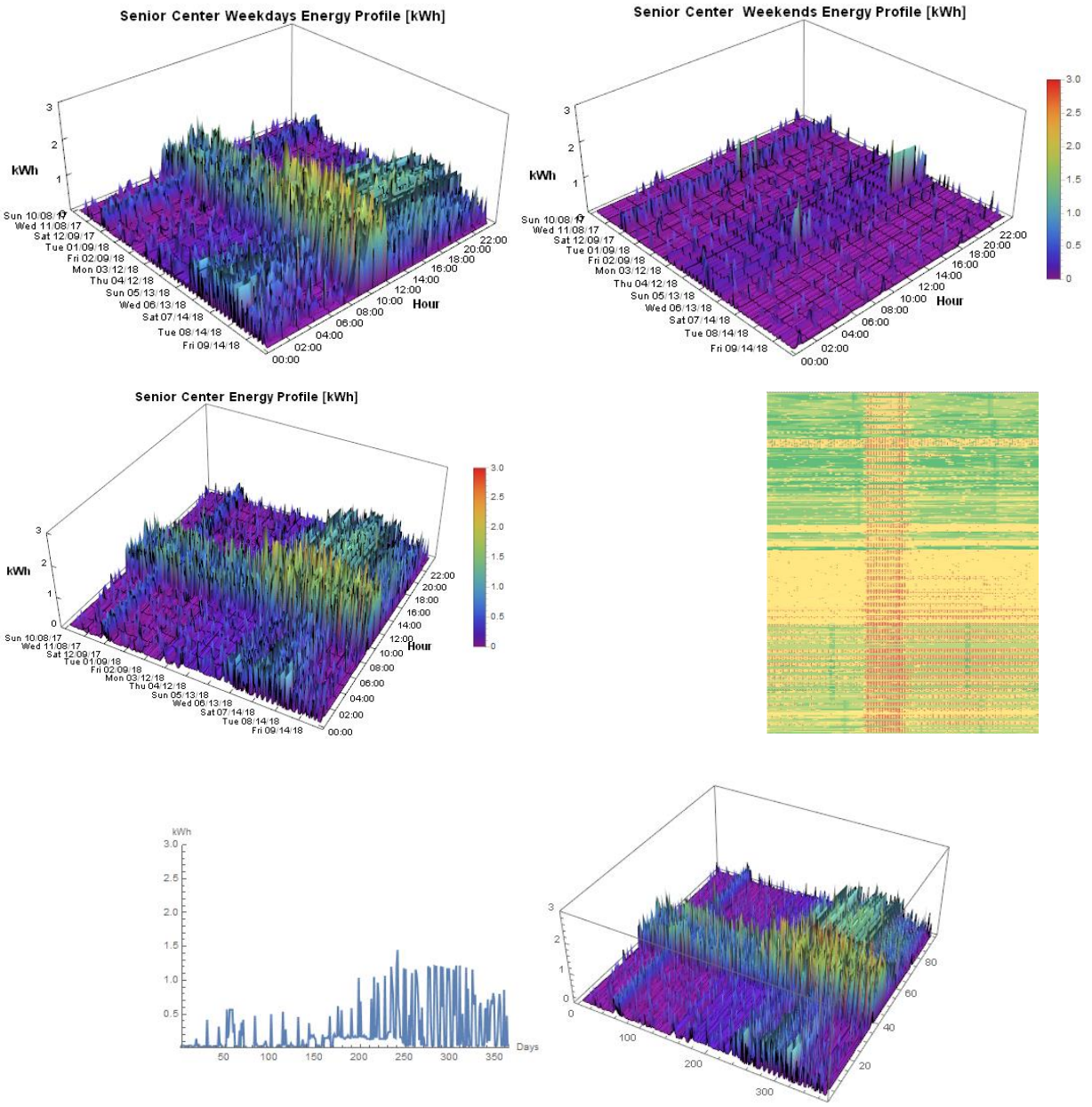
- Electricity consumption (kWh) is shown for each 24 hour period from October 8 2017 to October 7 2018. The greatest consumption is shown in red and the lowest is in purple. For the most recent year, the facility had the highest consumption at 4.7 kWh and peaked at 19 kW on July 16 2018 at around 9 am. For the same period, the facility consumed 32,293 kWh.
- Energy usage and peak demand are correlated with outside conditions during cooling season in summer months.
- The facility ramps up at around 6 am and shutdowns at around 5 pm. A consistent energy load are observed during night time and weekends.

Museum



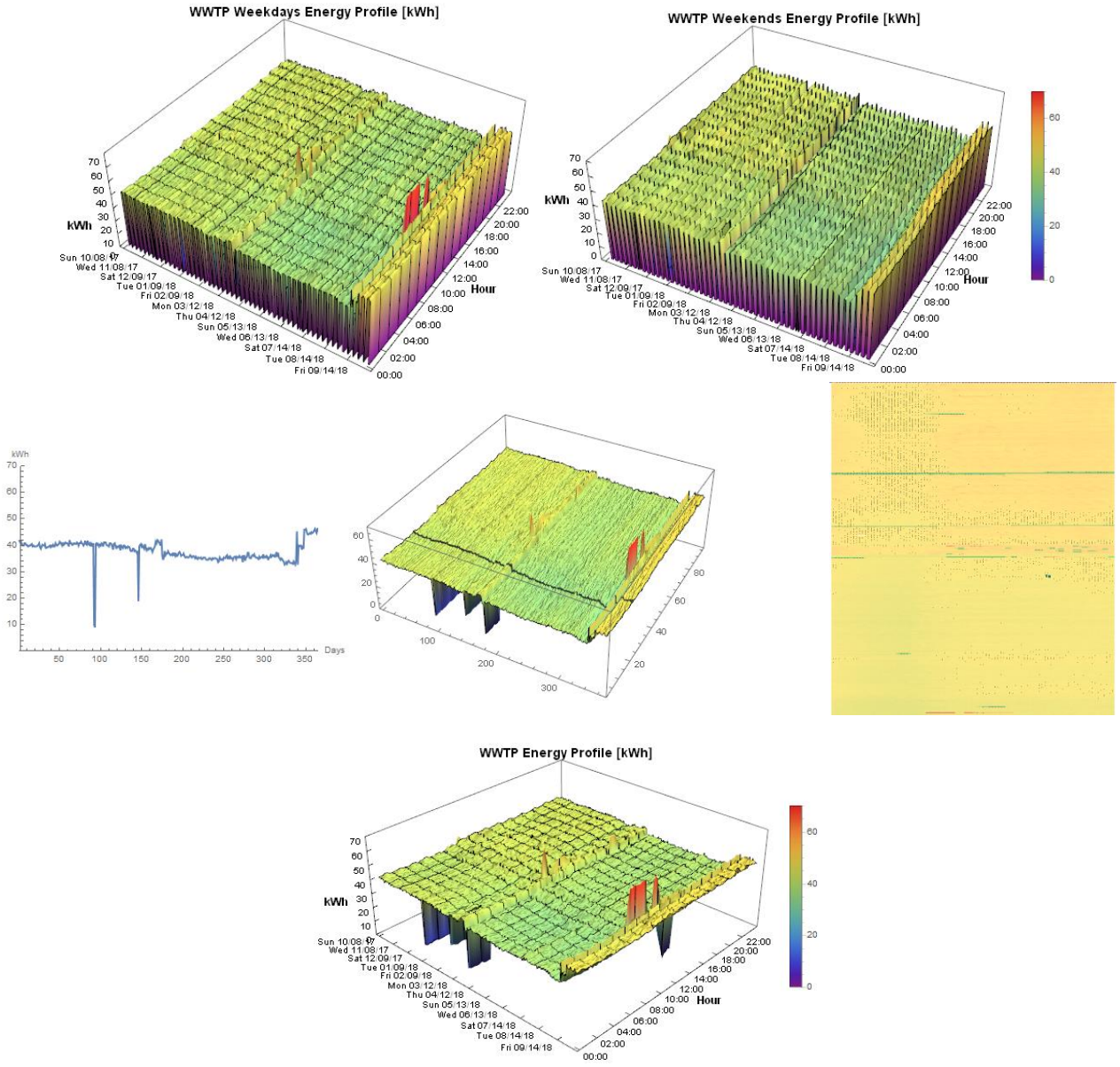
- Electricity consumption (kWh) is shown for each 24 hour period from October 8 2017 to October 7 2018. The greatest consumption is shown in red and the lowest is in purple. For the most recent year, the facility had the highest consumption at 3.5 kWh and peaked at 14 kW on July 6 2018 at 6:45pm. For the same period, the facility consumed 13,962 kWh.
- Energy usage from 2pm to 5pm on weekdays and weekends is observed at the museum.
- Peak demand is correlated with outside conditions during the cooling season as shown in the higher spikes during the afternoon period. At the other hours, energy usage is consistent as the equipment is operating for almost twenty four hours.
- No morning warmups or shutdowns are shown in this facility.

Senior Center



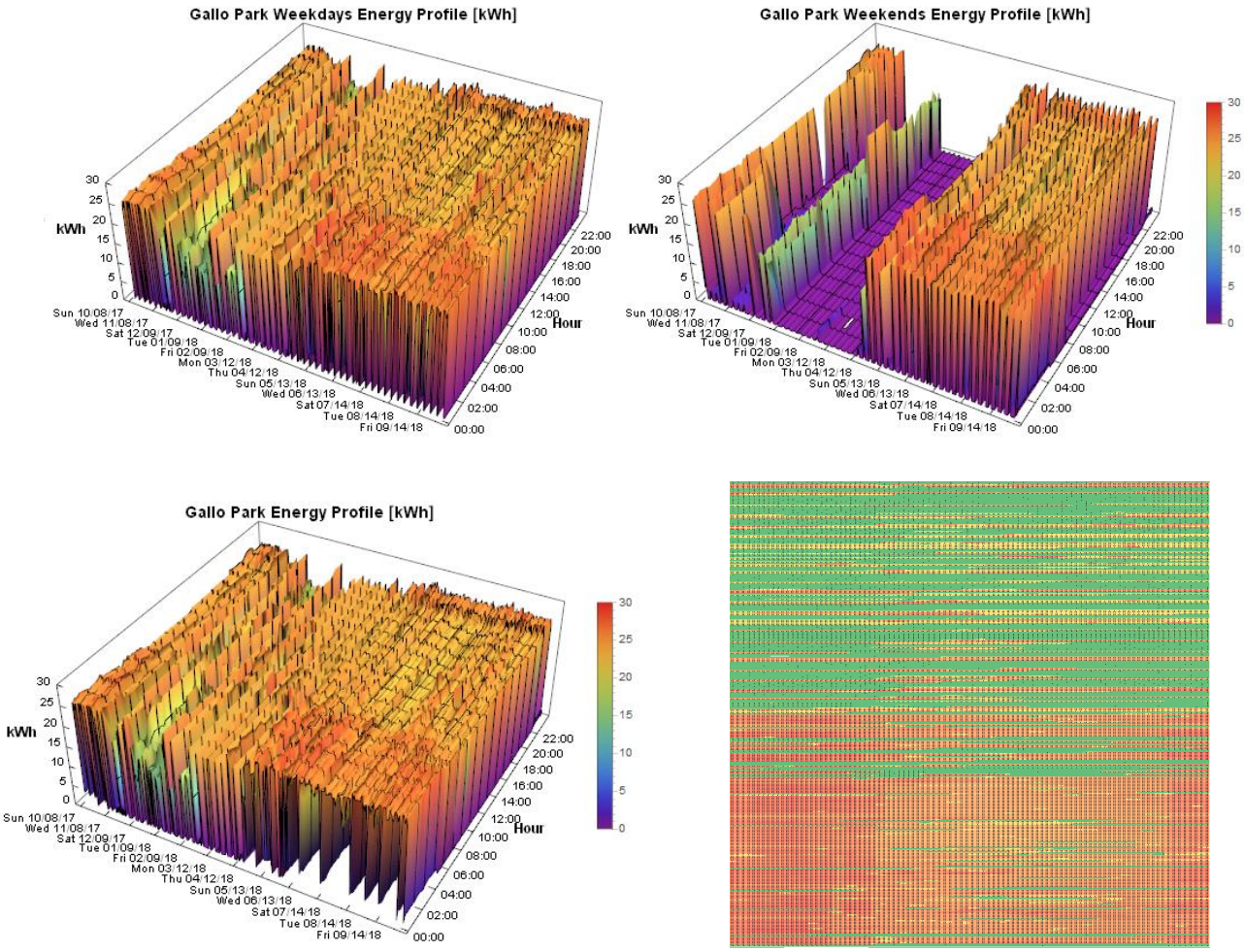
- Electricity consumption (kWh) is shown for each 24 hour period from October 8 2017 to October 7 2018. The greatest consumption is shown in red and the lowest is in purple. For the most recent year, the facility had the highest consumption at 2.5 kWh and peaked at 11 kW on September 24 2018 at 8:45 am. For the same period, the facility consumed 8,926 kWh.
- Energy usage from 9am to 1pm on weekdays is observed at the Senior Center, potentially for morning and lunch activities for the seniors. Minimum weekend operations are shown through the energy usage data.
- Peak demand is correlated with outside conditions during the cooling season as shown in the higher spikes during the summer morning periods and consistent energy draw throughout the afternoon and night time.
- No morning warmups or shutdowns are shown in this facility.

Waste Water Treatment Plant Load Analysis



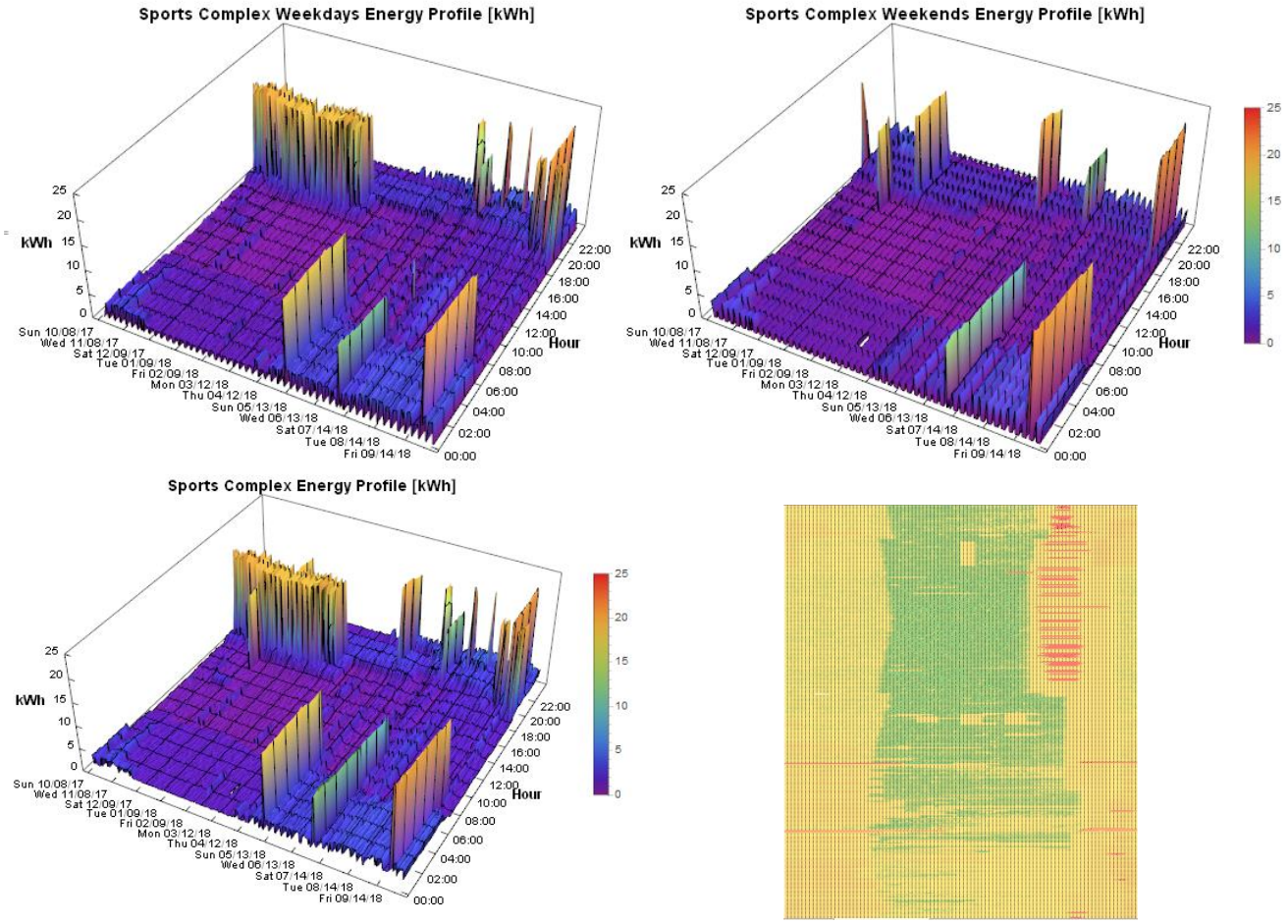
- Constant operation weekdays and weekends throughout the year, except for a few days potentially for maintenance purpose
- Increase in overall energy usage starting in September 2018 – need to investigate on causes for the increase

Gallo Park Load Analysis



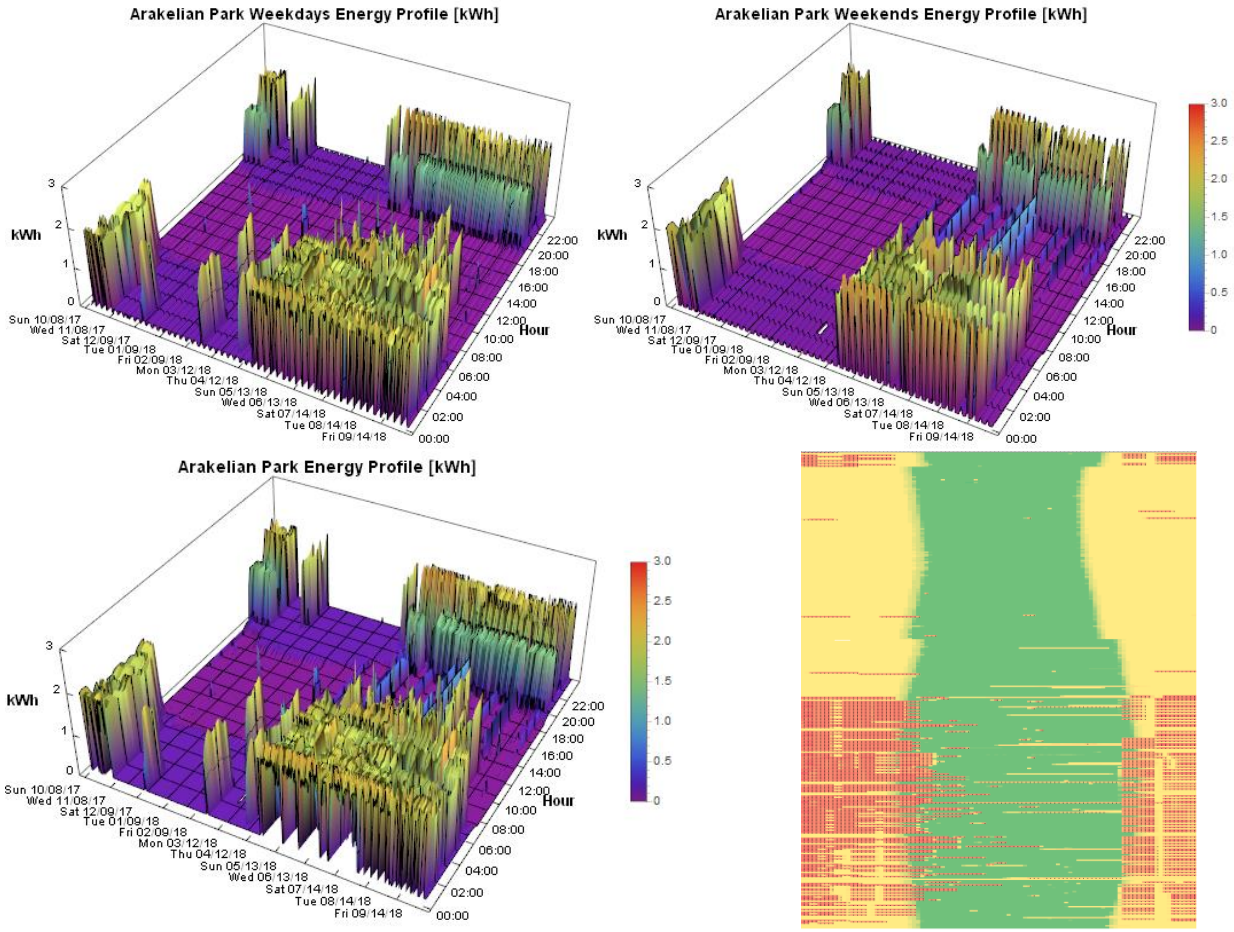
- Electricity consumption (kWh) is shown for each 24 hour period from October 8, 2017 to October 7, 2018. The greatest consumption is shown in red and the lowest is in purple. For the most recent year, the facility had the highest consumption at 28 kWh and peaked at 113 kW on April 27 2018 at around 3:30pm. For the same period, the facility consumed 485,563 kWh.
- Energy use and peak demand are correlated with a pre-defined schedule of operations throughout the year. Minimum operations are shown from November to Mid-April, except for a few days.
- During the summer months from June to September, the facility has a scheduled night time load from 10 pm to 7 am. It could potentially contributed by park lights or well pumping equipment.

Max Foster Sport Complex Load Analysis



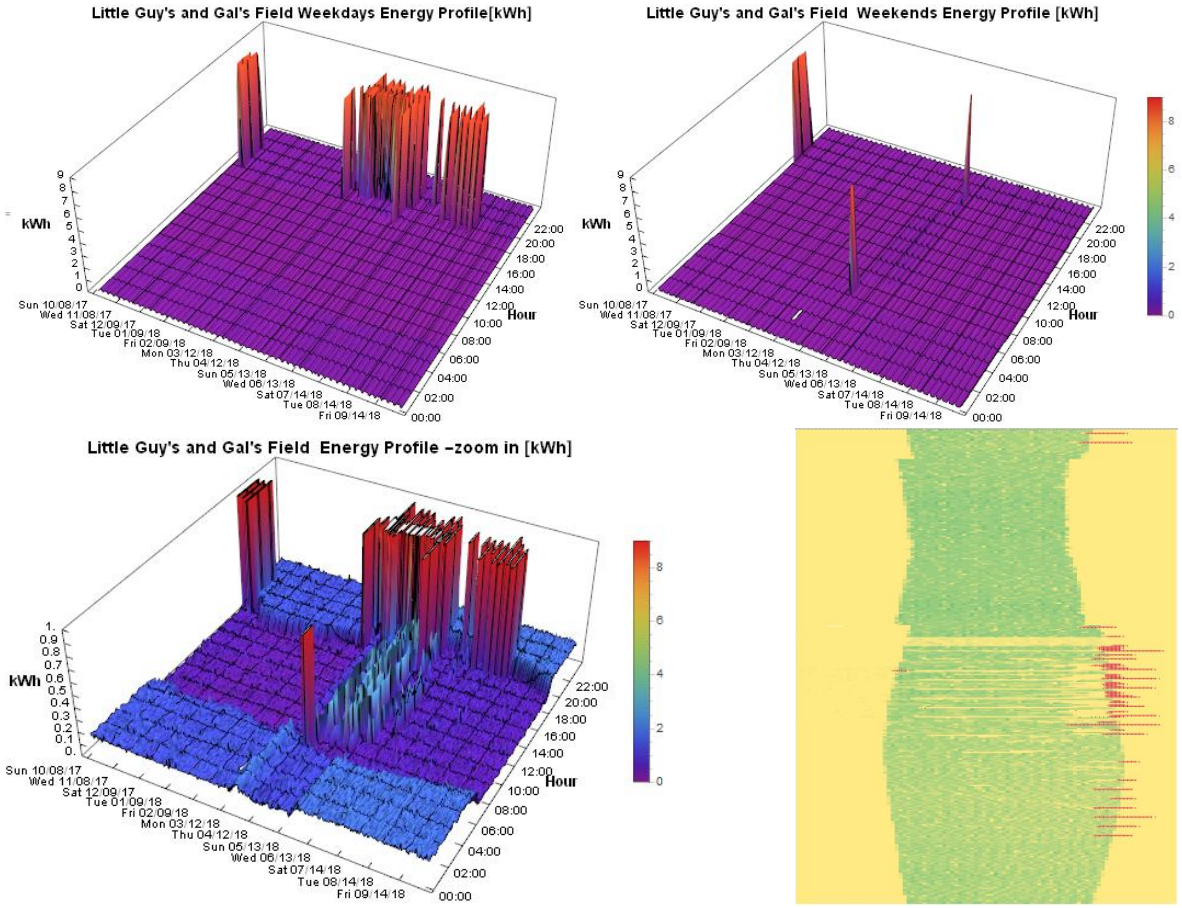
- Night time load due to outdoor lighting throughout the year
- Most of the main usage occurred from 5 pm to 8 pm from October to February
- Seemingly random energy spikes occurred for a few nights during summer months
- Increase in load during summer months, this could be due to summer festival

Arakelian Park



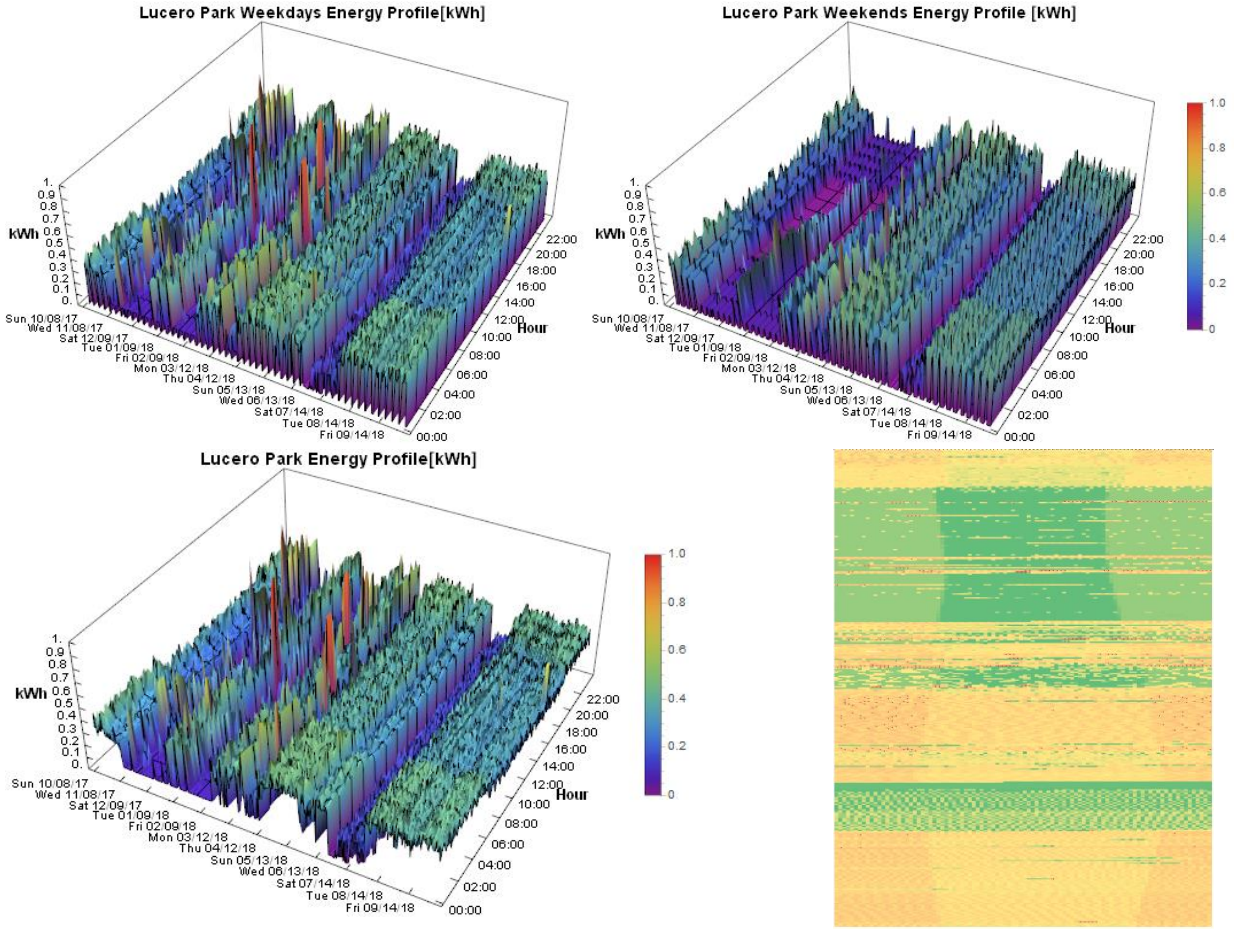
- Electricity consumption (kWh) is shown for each 24 hour period from October 8 2017 to October 7 2018. The greatest consumption is shown in red and the lowest is in purple. For the most recent year, the facility had the highest consumption at 2.5 kWh and peaked at 9.4 kW on May 25 2018 at 10:15pm. For the same period, the facility consumed 12,130 kWh.
- Energy usage from 7pm to 7am daily is observed at the facility starting in April until October. Peak demand at nighttime is correlated with exterior parking lot operation based on photocell sensors.
- Lower nighttime energy usage is observed during winter months from November to March in comparison to the energy usage in other months.

Little Guy's and Gal's Field



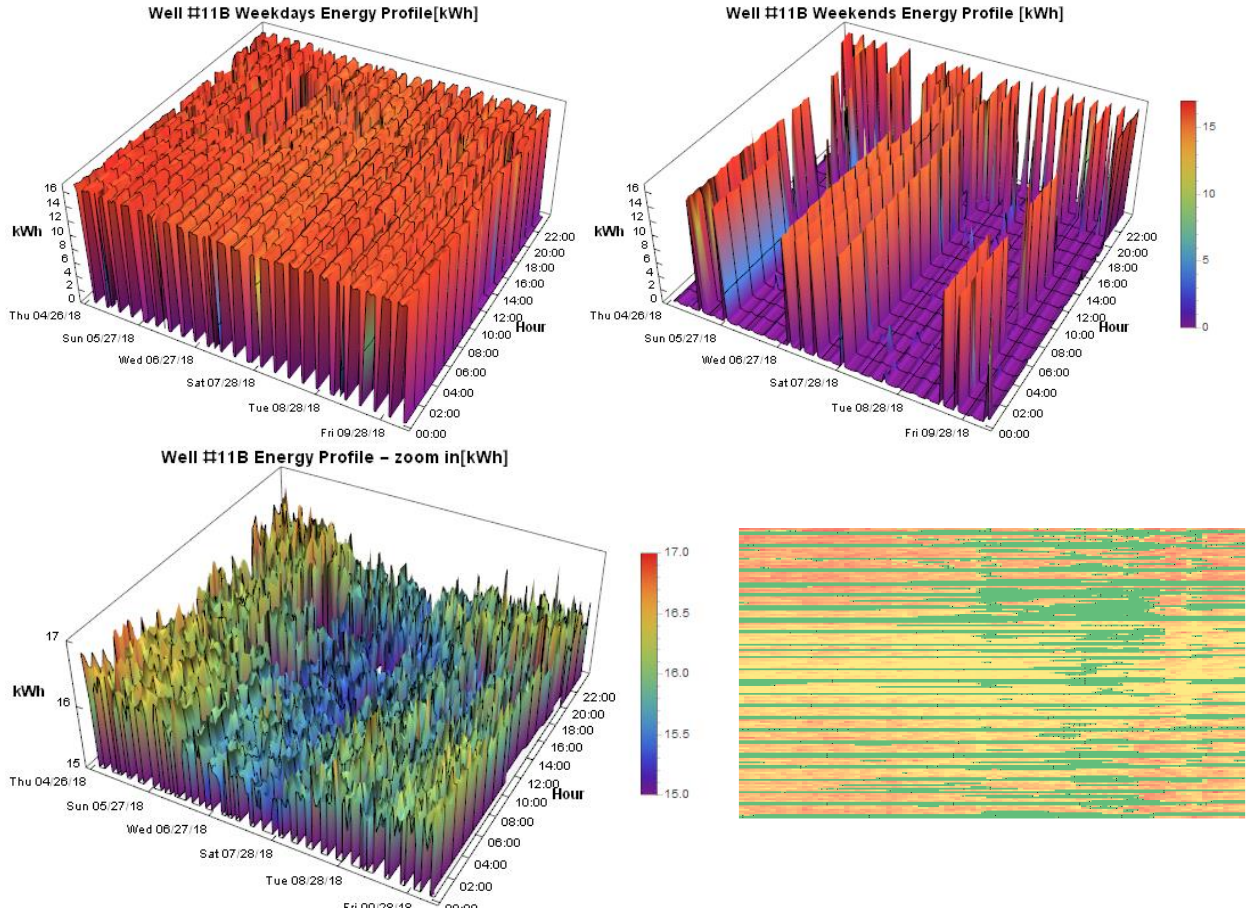
- Electricity consumption (kWh) is shown for each 24 hour period from October 8 2017 to October 7 2018. The greatest consumption is shown in red and the lowest is in purple. For the most recent year, the facility had the highest consumption at 8.8 kWh and peaked at 35.22 kW on May 19 2018 at 8:00pm. For the same period, the facility consumed 7,077 kWh.
- Energy usage from 7pm to 7am daily is observed at the facility for the entire year. Peak demand at nighttime is correlated with exterior parking lot operation based on photocell sensors.
- Higher energy spikes are observed from 6pm to 9pm for a few days in the summer months.

Lucero Park



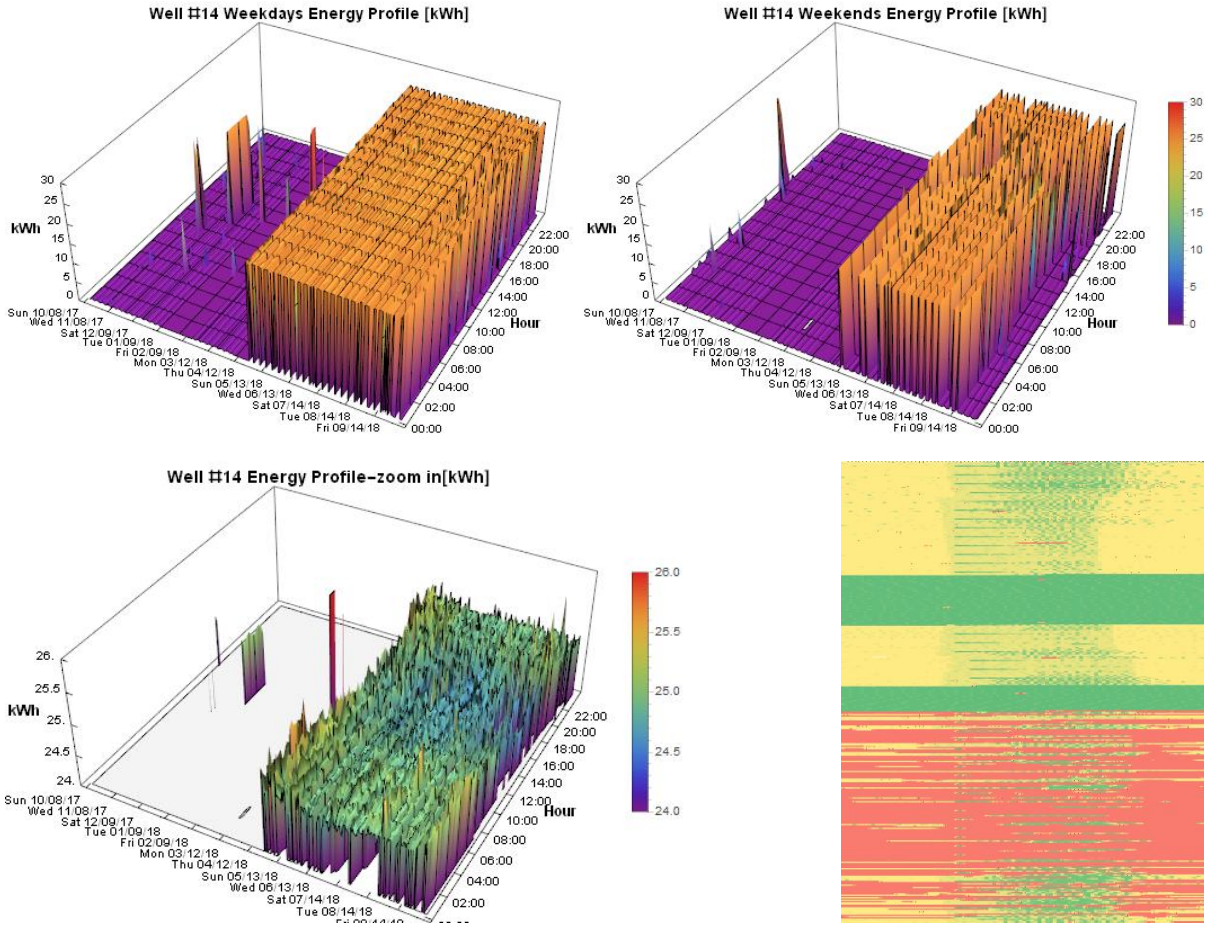
- Electricity consumption (kWh) is shown for each 24 hour period from October 8 2017 to October 7 2018. The greatest consumption is shown in red and the lowest is in purple. For the most recent year, the facility had the highest consumption at 1 kWh and peaked at 4 kW on January 9 2018 at 11:00am. For the same period, the facility consumed 7,559 kWh.
- Energy usage from 7pm to 7am daily is observed at the facility for the entire year. Peak demand at nighttime is correlated with exterior parking lot operation based on photocell sensors.
- Higher energy spikes are observed throughout the entire day in the summer months.

Well #11B



- Electricity consumption (kWh) is shown for each 24 hour period from April 26 2018 to October 7 2018. The greatest consumption is shown in red and the lowest is in purple in the top graph. The adjusted scale is from 15 to 17 kWh at the bottom left graph as it is able to show the variation in energy profile. For the same period, the facility had the highest consumption at 17 kWh and peaked at 67 kW on April 29 2018 at 11:00 pm. the facility consumed 158,483 kWh.
- Energy usage ranges from 15 kWh to 17 kWh for most of the time. This well facility is being utilized more often on weekdays than on weekends.
- Peak demand is not correlated with outside conditions. It is observed that this facility is operating as required. No morning warmups or shutdowns are shown in this facility.

Well #14



- Electricity consumption (kWh) is shown for each 24 hour period from October 8 2017 to October 7 2018. The greatest consumption is shown in red and the lowest is in purple. The adjusted scale is from 24 to 26 kWh at the bottom left graph as it is able to show the variation in energy profile. For the most recent year, the facility had the highest consumption at 29 kWh and peaked at 114 kW on April 9 2018 at 11:45am. For the same period, the facility consumed 282,228 kWh.
- Energy usage of the facility ranges from 0 to 1 kWh during night time in the month of October to March, except for January. Data also shows that there is no energy usage in the month of April.
- Energy usage ranges from 24 kWh to 26 kWh for most of the time since April 24 2018. This well facility is being utilized both on weekdays and weekends.
- Peak demand is not correlated with outside conditions. It is observed that this facility is operating as required. No morning warmups or shutdowns are shown in this facility.

Appendix B: Solar Photovoltaic Information

System sizing and performance data can be reference for the 4 site NEM analysis below.

Module DC Nameplate	297.6 kW
Inverter AC Nameplate	240.6 kW Load Ratio: 1.24
Annual Production	446.4 MWh
Performance Ratio	82.7%
kWh/kWp	1,499.9

Figure 17: Gallo Park Solar Size

Module DC Nameplate	20.5 kW
Inverter AC Nameplate	24.1 kW Load Ratio: 0.85
Annual Production	28.81 MWh
Performance Ratio	65.9%
kWh/kWp	1,406.7

Figure 18: Public Works Solar Size

Module DC Nameplate	17.6 kW
Inverter AC Nameplate	24.1 kW Load Ratio: 0.73
Annual Production	29.66 MWh
Performance Ratio	83.1%
kWh/kWp	1,685.1

Figure 19: Max Foster Sports Complex Solar Size

Module DC Nameplate	662.4 kW
Inverter AC Nameplate	553.4 kW Load Ratio: 1.20
Annual Production	1.053 GWh
Performance Ratio	74.5%
kWh/kWp	1,589.5

Figure 20: Waste Water Treatment Plant