CITY OF SAN LUIS OBISPO

# CARBON NEUTRAL CITY FACILITIES PLAN

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PRESENTED BY

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# 1. EXECUTIVE SUMMARY

## CARBON NEUTRAL FACILITIES PLAN

In 2020, the City of San Luis Obispo (SLO) took a bold step in support of mitigating the impacts of climate change by adopting the Climate Action Plan for Community Recovery (CAP). This plan put forth a goal to engage in projects and initiatives that contribute positively towards achieving community carbon neutrality by 2035 and municipal operations carbon neutrality by 2030.

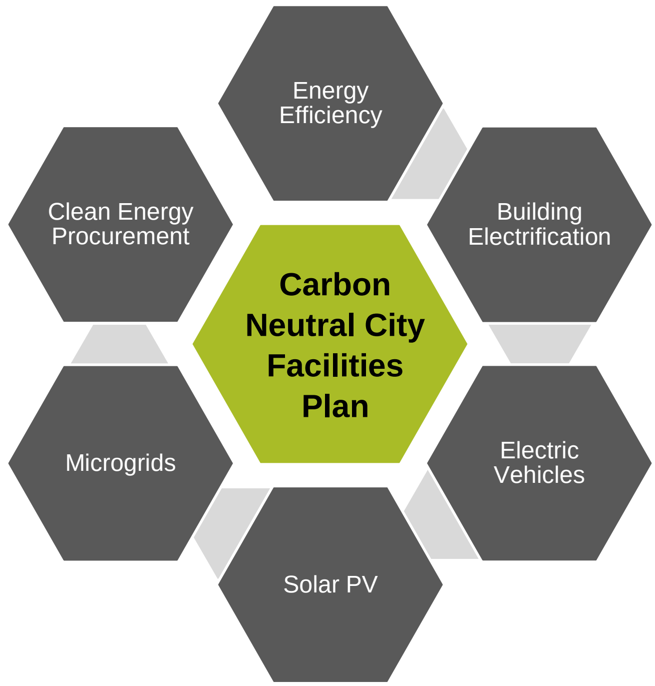



**Figure 1: City of SLO Carbon Neutral Strategies**

The Carbon Neutral City Facilities Plan (CNCFP) provides an implementation roadmap and strategic decarbonization framework for the City to achieve the goal of carbon neutral municipal operations. The recommended strategies will reduce the City's GHG emissions and impact on climate change, hedge against variable energy cost in the future, and improve city resilience of emergency operations during a public safety power shutoff (PSPF). The CNCFP enables the City of SLO to Lead by Example and to inspire community members to take action to reduce greenhouse gas emissions in their own homes and businesses.

The CNCFP provides a comprehensive analysis of the City's existing facilities and fleet of vehicles to identify key actions and projects that can reduce SLO's carbon emissions and annual utility bills. Specific strategies identified for the City include energy efficiency, building electrification, solar PV, microgrids and clean energy procurement. The fleet electrification roadmap is provided under the City Fleet Electrification Plan. The Consultant Team included energy, engineering and sustainability experts from Glumac, EcoShift (Blue Strike Environmental) and Optony.

## EXISTING CONDITIONS

This carbon neutrality plan focuses on buildings maintained through the General Fund and does not include water and wastewater treatment buildings and infrastructure. Based on assessment of utility bills for the covered facilities over the last several years, the City consumes approximately 2,600,000 kWh of electricity and 90,000 therms of natural gas annually, resulting in 1,068 metric tons of carbon dioxide equivalent emissions ($MTCO_2e$).

The City of San Luis Obispo's municipal facilities are well maintained and efficient facilities. The City has established best practices around preventative maintenance and has invested in various energy efficiency projects to limit the City's environmental impact and reduce operational costs. The facilities and maintenance team has proactively converted fluorescent lighting fixtures to LED over time at buildings across the City.

The majority of San Luis Obispo's buildings utilize natural gas for space and domestic hot watery systems. Converting these existing fossil fuel heating systems to all-electric alternatives will be important strategy for the City to achieve carbon neutrality. The most significant use of natural gas is at the SLO Swim Center which comprises approximately 69% of the City's use, within General Fund facilities. Figure 2 shows a breakdown in GHG emissions of city owned facilities based on utility use and emissions factors in 2019. This year was selected as the baseline year in the CNCFP since it represented typical operation before the impacts of COVID 19 on City operations. The top 5 facilities contributed 77% of GHG emissions, with the SLO Swim Center alone contributed 42% of the total facility related GHG emissions.

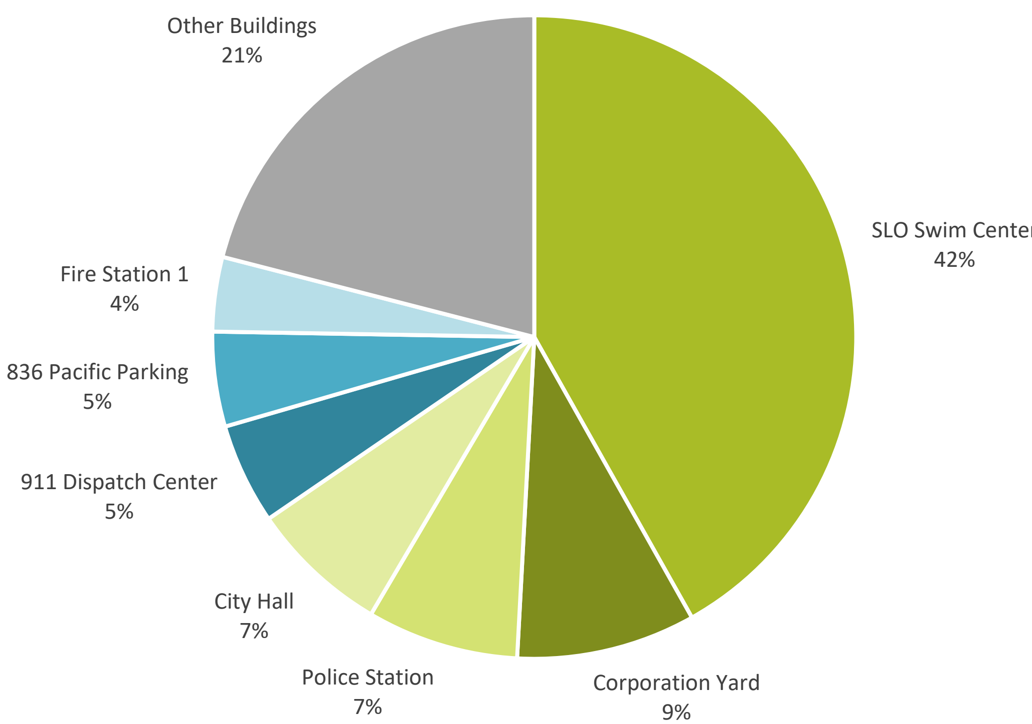


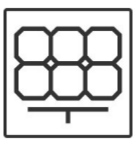
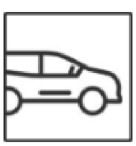

**Figure 2: City of San Luis Obispo Facilities GHG Emissions**

The SLO Swim Center, Fire Station 1 & 911 Dispatch Center, and City Hall were designated as "priority facilities" for the City to move forward with implementing building decarbonization projects in the immediate short term. These facilities generally had the highest natural gas use within the General Fund facilities. The priority projects include heat pump mechanical systems, heat pump domestic hot water, heat pump pool heating, LED lighting upgrades, and solar PV + microgrid. This will serve as an example and foundation for future electrification and efficiency projects with the City of San Luis Obispo, both at City owned facilities and within the greater local community.

## DECARBONIZATION STRATEGIES

Through building audits and meetings with facilities staff, various decarbonization projects and strategies were identified throughout the City. As electrical grids become cleaner in coming years and eventually move away from fossil fuels, the key driver in building decarbonization will be the elimination of natural gas systems in buildings. The following table includes recommended projects and potential impacts for the City of San Luis Obispo in four categories: Building Decarbonization, Renewable Energy, Microgrids and Electric Vehicles.

**Table 1: City of San Luis Obispo Carbon Reduction Strategies**

| Strategies | Recommendations & Approach | Projects | Impact |
|---|---|---|---|
|  **Building Decarbonization** | Electrify all city buildings by 2030 and continue to invest in energy efficiency upgrades | • LED Lighting Retrofits<br>• Heat Pump Water Heaters<br>• Space Heating Electrification<br>• Swim Center Electrification<br>• Induction Cooking | **Fossil Fuel Free Buildings**<br>Eliminate natural gas use to reduce total building energy by 40% and emissions by 360 MTE annually |
|  **Renewable Energy** | Implement priority solar PV projects by 2024 and procure 3CE Prime 100% clean power as soon as possible. Continue exploring other locations for solar PV | • Phase 1 Solar Installations<br>  ○ Swim Center<br>  ○ Bus Yard<br>  ○ Fire Station 1<br>• 3CE Prime “Opt-up” Power | **100% Clean Electricity**<br>Produce 1,400,000 kWh onsite with 832kW of solar PV to offset around 50% of electricity for City Facilities |
|  **Microgrids** | Develop a clean energy microgrid at Fire Station 1 and 911 Dispatch Center | • 131 kW solar PV<br>• 63 kW \| 511 kWh BESS<br>• 300 kW backup diesel generator (*existing*) | **Resilient City Services**<br>Provide at least 6 hours during an outage without reliance of diesel generators |
|  **Electric Vehicles[1]** | Transition all light duty vehicles to a fully electric fleet by 2030 | • Near Term (2023-2025)<br>• Mid Term (2026-2030)<br>• Long Term (2030-2040) | **All Electric Vehicles**<br>Reduce gasoline and diesel by 77,000 gallons and emissions by 849 MTE annually |

[1] Refer to the City of SLO Fleet Electrification reports for additional information.

## SCENARIO PLANNING

The project team evaluated various implementation scenarios to inform the City of San Luis Obispo 's facility decarbonization investment strategy and timeline. The analysis was provided using the Climate and Energy Scenario Analysis (CESA) tool which quantifies the financial and environmental impacts from various combination of energy and carbon mitigation measures. The following implementation scenarios were evaluated for the City of San Luis Obispo.

1. **Business-as-Usual (BAU)**
   Continued operation of existing campus systems
2. **Scenario I: Baseline Implementation**
   Implement high priority projects by 2027, all other projects by 2032
   Requires carbon offsets to achieve Council's goals
3. **Scenario II: 2030 Carbon Neutrality**
   Implement high priority projects by 2027, all other projects by 2030 (phased implementation)
4. **Scenario III: 2030 Carbon Neutrality (Expedited)**
   Implement high priority projects by 2027, all other projects by 2030 (early implementation)
5. **Scenario IV: 2028 Carbon Neutrality**
   Implement high priority projects by 2027, all other projects by 2028

The following image shows results of the scenario analysis from the CESA tool. These scenarios were compared against the City's goal of being carbon neutral by 2030 and also a Science Based Target[2] for Scope 1 and 2 GHG Emissions. Scenarios II, III and IV all meet the City's carbon reduction goals and exceed the cumulative emissions reduction required for a science-based target. The option to procure 100% clean electricity through 3CE[3] starting in either 2023 or 2030 was also evaluated.

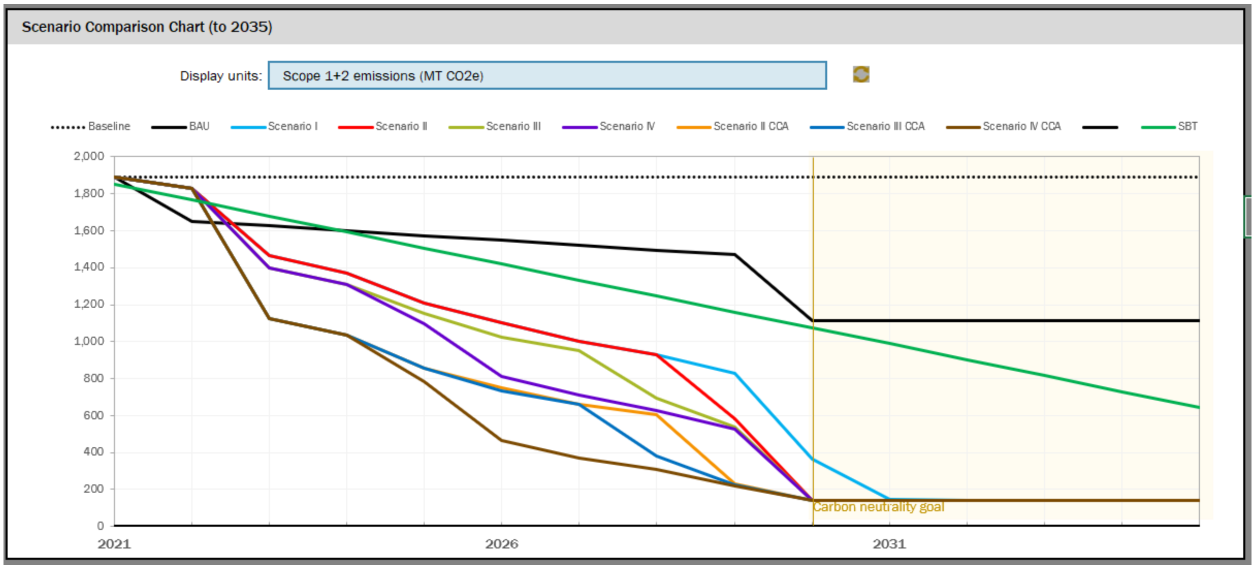



**Figure 3: City of San Luis Obispo Facilities Scenario GHG Emissions**

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[2] Science-Based Targets Initiative (SBTi) provide GHG emissions targets for organizations that will support reducing GHG emissions in line with the Paris Agreement goals to limit warming to 1.5°C.
[3] Central Cost Clean Energy (3CE) is the local Community Choice Aggregator (CCA)

All of the potential scenarios include transitioning to a fleet of electric vehicles as outlined in the City of San Luis Obispo Fleet Electrification reports. The remaining emissions after 2030 are from medium and heavy-duty vehicles that currently have no electric options.

It is recommended that the City of San Luis Obispo pursue an implementation roadmap that targets fully electrifying all buildings by 2030 as outlined in Scenario II. This scenario includes a strategy to implement high priority projects with significant GHG emissions reductions as soon as possible, and phasing other electrification projects between 2027 and 2030. This will meet the City's carbon neutrality targets and fits best within the City's current capital outlay. The resulting outcome will be a 52% reduction in cumulative GHG emissions through 2030 with electricity provided from 3CE Prime.

**Table 2: City of San Luis Obispo Facility Decarbonization Scenarios – GHG Emissions & Investment**

| | Cumulative GHG Emissions | | Building Decarbonization Projects | |
|---|---|---|---|---|
| Scenario | 2021-2030 [MTE] | Reduction [%] | Implementation [years] | Avg Investment [$ / yr] |
| Baseline | 18,903 | | | |
| Business as Usual (BAU) | 15,490 | 18% | - | - |
| Scenario I | 11,992 | 37% | 2025-2032 | $530,000 |
| **Scenario II + 3CE Prime** | **9,116** | **52%** | **2025-2030** | **$700,000** |
| Scenario III + 3CE Prime | 8,873 | 53% | 2025-2030 | $675,000 |
| Scenario IV + 3CE Prime | 8,167 | 57% | 2025-2028 | $1,000,000 |

Scenarios III and IV offer a more expedited pathway for the City to be carbon neutral and should be considered if additional funding and project management resources become available. Additional funding sources could include the general fund or other external sources through the Inflation Reduction Action (IRA) and grant programs.

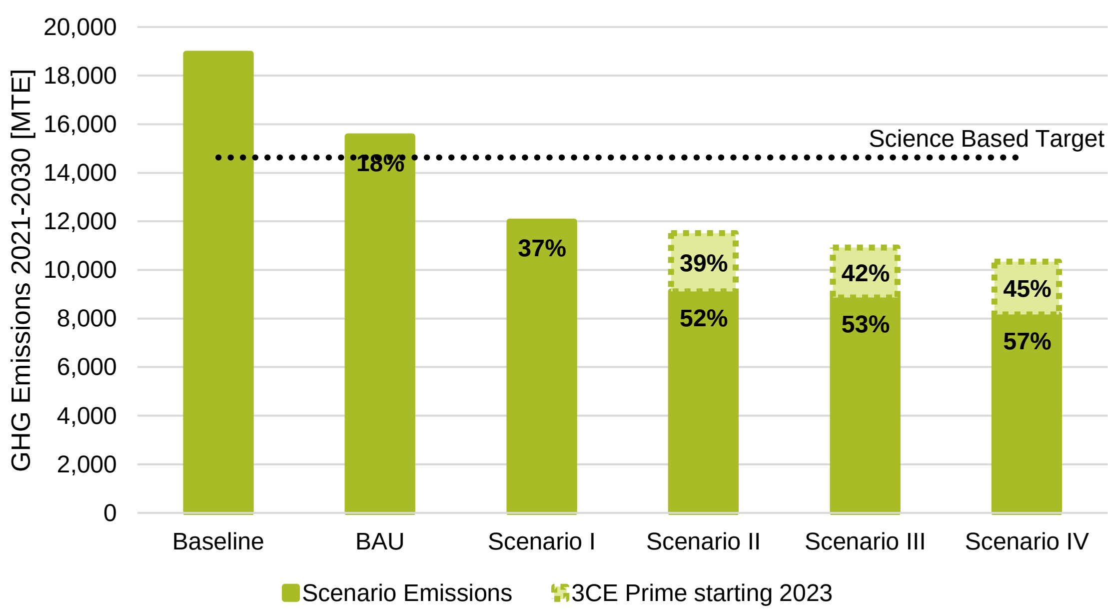


**Figure 4: City of San Luis Obispo Facility Decarbonization Scenarios - Cumulative GHG Emissions**

## RECOMMENDATIONS

It is recommended that the City moves forward with the implementation roadmap that targets fully electrifying all buildings by 2030, as outlined in Scenario II. This includes high priority projects with significant GHG emissions reductions as soon as possible and phasing other electrification projects over time. The following framework can be used to guide future capital planning efforts within the City.

**Table 3: City of San Luis Obispo - Facilities Decarbonization Framework**

### 1. Increase and Expedite Building Decarbonization Investments

**1A.** Implement high priority building electrification project by 2027
*$1.5M required – facilities include City Hall, Swim Center and Fire Station 1*

**1B.** Complete LED retrofits at all City facilities by 2024
*$0.25M required – phased implemented through CIP process*

**1C.** Complete other building electrification and energy efficiency projects by 2031
*$2.0M required – budget $700k per year from 2028-2030 (75% internal, 25% external)*

### 2. Generate or Procure 100% Clean Electricity

**2A.** Implement priority solar projects in 2023 and 2024
*Power Purchase Agreement (PPA) – no capital required, paid through operational savings*

**2B.** Develop Fire Station 1 and Dispatch Center microgrid by 2025, pending grant funding
*$0.650M for battery energy storage (BESS) and microgrid controls – currently pursuing grant funding*

**2C.** Procure 100% Clean Electricity through 3CE starting in 2023
*$20k annual cost for carbon free electricity – reduce City emissions by 521 MTE*

**2D.** Solicit proposal for sites with low priority solar projects
*Power Purchase Agreement (PPA) – no capital required, paid through operational savings*

### 3. Transition City Fleet to Electric Vehicles

**3A.** Implement EV charging infrastructure projects, phased through 2030
*$5.2M required – $1.7M between 2023-2025 and $3.5M between 2026-2030*

**3B.** Phased procurement of electric vehicles for all suitable vehicles by 2030
*$0.5M premium for EVs between 2023-2025 – EV is anticipated to have a lower total cost of ownership (TCO)*

### 4. Establish Carbon Neutral Facility Management Policies

**4A.** Develop a staffing and implementation strategy, including new delivery options
*Review options including additional staff, outsourced Project Management / Construction Management services, design-build*

**3B.** Establish standards for new construction design and ongoing maintenance
*Performance requirements, no new natural gas equipment replacement policy*

*Recommendations provided in the CNCFP report are based on best available information and results should not be construed as absolute. The project deliverables were developed as a dynamic resource for SLO which will allow the City to adjust and adapt over time. It is recommended that SLO continually tracks their progress towards carbon neutrality on an annual basis and updates their CNCFP every four years, as outlined in the Lead by Example plan.*

# 2. BACKGROUND INFORMATION

## 2.1 CITY OF SAN LUIS OBISPO

### CITY OVERVIEW

San Luis Obispo is located in California's Central Coast Region. San Luis Obispo is situated just eight miles from the ocean and is home to California Polytechnic State University. The City owns and operates a variety of buildings that are critical to a functional and resilience of San Luis Obispo. This study focuses on buildings maintained through the General Fund and thus does not include water and wastewater treatment buildings and infrastructure. Figure 5 provides a map of General Fund facilities that were included in this study.

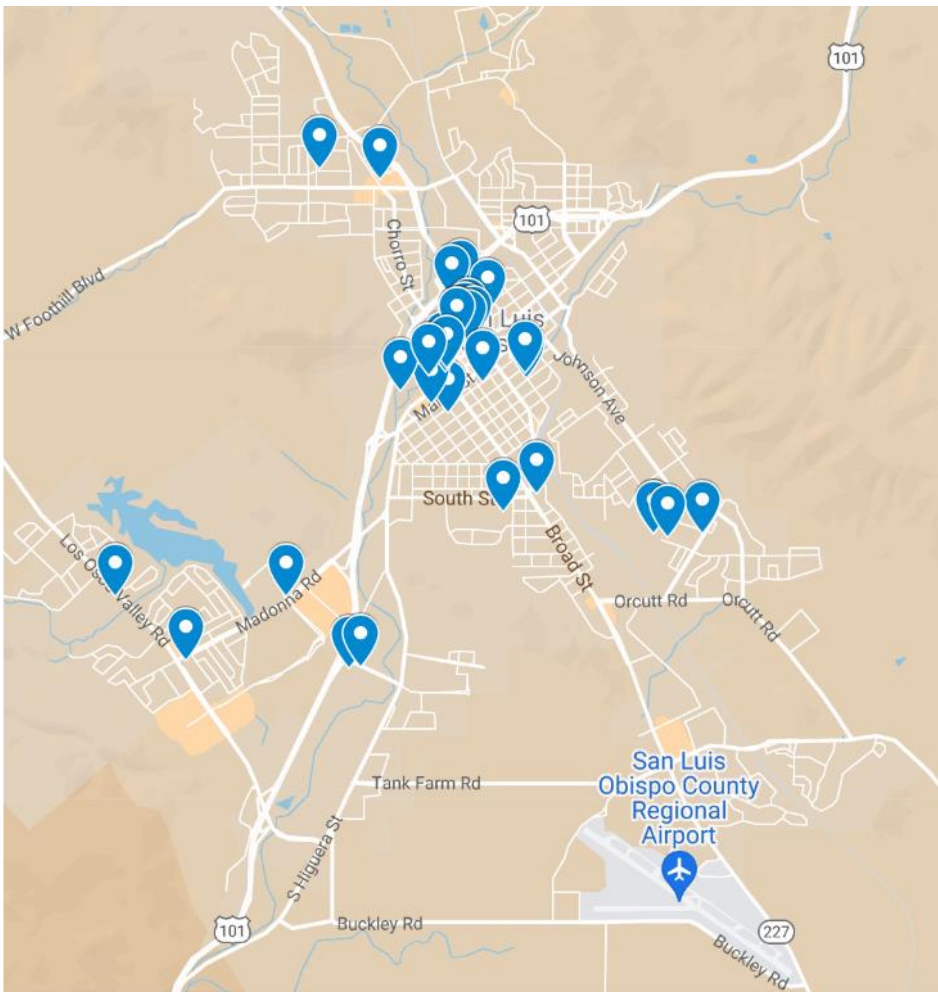


Figure 5: City of San Luis Obispo General Fund Facilities

## CITY OF SAN LUIS OBISPO POLICY

Several City policies form the basis of the Carbon Neutral City Facilities Plan. These include the Climate Action Plan for Community Recovery, Lead by Example, and the 2021-2023 Financial Plan and Capital Improvement Plan. The City of San Luis Obispo 2021-23 Goals include climate action strategies to "proactively address the climate crisis, continue to update and implement the Climate Action Plan for carbon neutrality, including preservation and enhancement of open space and the urban forest, alternative and sustainable transportation, and planning and implementation for resilience."

### CLIMATE ACTION PLAN FOR COMMUNITY RECOVERY

In 2020, the City took a bold step in fighting climate change by adopting the Climate Action Plan for Community Recovery (CAP). This plan built upon the existing Climate Action Plan established in 2012 and put forth a goal of community carbon neutrality by 2035. The CAP is built upon 6 pillars, which are shown in the figure below. Pillar 1, Lead by Example is what drives the CNCFP. A plan update was adopted by City Council in December of 2022 that reaffirms and recommits to these goals.


**Figure 6: Foundational 6 Pillars of the Climate Action Plan for Community Recovery.**

**LEAD BY EXAMPLE: A PLAN FOR CARBON NEUTRAL MUNICIPAL OPERATIONS**

Pillar 1 of the CAP is Lead by Example. This pillar goes one step further than the overall community carbon neutrality by 2035 goal and defines a goal of carbon neutral government operations by 2030. This pillar was operationalized as the Lead by Example plan, which was adopted by Council in 2021 and includes more detailed goals for municipal operations including energy use in buildings, city owned vehicles, and solar power purchase. Through Lead by Example, the City can inspire community members to take action within their own homes and habits to reduce carbon.

## 2.2 PROJECT BACKGROUND

In the Winter of 2021, the City engaged a team of consultants, Glumac | Optony | EcoShift, to develop a Carbon Neutral City Facilities Plan (CNCFP) for the existing municipal building stock and vehicle fleet. The intent of the CNCFP project was to develop a strategic roadmap for decarbonization measures to not only reduce the City's Scope 1 & 2 emissions, but also shelter the City from the variable cost of energy and risk of power shutoffs, adopt new technology and Lead by Example. Through Leading by Example, the City hopes to inspire community members to take action towards carbon reduction in their own lives. The findings of this CNCFP will help guide San Luis Obispo's energy strategy over the next eight years as the City works toward becoming carbon neutral by 2030.

This engineering study includes a robust assessment of City energy sources, demands, and utilization to identify clean energy alternatives and strategies to improve the efficiency of building operations. Through the course of their investigation, the consultant team identified numerous clean energy projects to reduce GHG emissions.

The CNCFP translated the identified energy efficiency and electrification projects into a planning tool that supported the development of a strategic roadmap for GHG reductions to achieve carbon neutrality. To accomplish this, the consultant team developed a custom-built climate and energy scenario analysis (CESA) tool to inform their recommendations for pursuing various GHG emission reduction projects. After the site investigation and energy analysis phases of the project were completed, all the clean energy projects identified across the City were input to the CESA tool.

The CESA tool allows for users to develop multiple clean energy implementation plans to reach the City's 2030 carbon neutrality target. As users are developing these prospective implementation scenarios, the tool continually tracks key metrics such as energy savings, emissions reductions, total project cost, net present value, etc. The CNCFP team developed multiple potential strategic energy plan scenarios and conducted a sensitivity analysis in the tool to help shape and guide the recommendation outlined in this report. The scenario analysis tool was developed to be a dynamic asset that will be turned over to City of San Luis Obispo's sustainability department at the conclusion of the project for their continued analysis and tracking of progress.

The strategic energy recommendations and scenarios developed in the CNCFP report are based on the best available information provided to the consultant team at this time. The project deliverables were developed with the intention and ability to be a dynamic resource for San Luis Obispo as the City navigates towards their 2030 carbon neutrality target. The team understands San Luis Obispo is a dynamic, growing municipality and needs an energy strategy that is flexible and can adapt to an ever-changing environment. It is recommended that San Luis Obispo continually tracks their progress towards carbon neutrality on an annual basis and updates their CNCFP every four years, as outlined in the Lead by Example plan.

## ENERGY UTILITIES

The City of San Luis Obispo's electricity is served by Pacific Gas & Electric (PG&E), and natural gas is served by Southern California Gas Company (SoCal Gas). The Community Choice Aggregation (CCA) program in California also allows for the City to purchase electricity from Central Coast Clean Energy (3CE)[4], the local CCA that serves communities in the central coast region from Santa Barbara to Santa Cruz County. When purchasing electricity from a CCA the power is still physically delivered to buildings by PG&E's transmission lines.

In accordance with the California Power Source Disclosure Program[5], utilities in California are required to disclose their electricity power mix and average annual GHG emissions factors. The following tables provide a summary of the energy generation mix of each electricity option and the average GHG emissions factor in 2021.

**Table 4: 2021 Electricity Power Mix SCE vs Constellation**

| | PG&E Base Plan | 3CE Choice | 3CE Prime | CA State Average |
|---|---|---|---|---|
| Eligible Renewables | 47.7% | 38.4% | 100.0% | 33.6% |
| *Biomass and Biowaste* | *4.2%* | *1.6%* | *0.0%* | *2.3%* |
| *Geothermal* | *5.2%* | *7.4%* | *0.0%* | *4.8%* |
| *Eligible Hydroelectric* | *1.8%* | *0.7%* | *0.0%* | *1.0%* |
| *Solar* | *25.7%* | *17.8%* | *50.0%* | *14.2%* |
| *Wind* | *10.9%* | *11.0%* | *50.0%* | *11.4%* |
| Coal | 0.0% | 0.0% | 0.0% | 3.0% |
| Large Hydroelectric | 4.0% | 11.8% | 0.0% | 9.2% |
| Natural Gas | 8.9% | 0.0% | 0.0% | 37.9% |
| Nuclear | 39.3% | 0.0% | 0.0% | 9.3% |
| Other | 0.0% | 0.0% | 0.0% | 0.2% |
| Unspecified Power | 0.0% | 49.8% | 0.0% | 6.8% |
| **GHG Emissions [lbs Co2e/MWh]** | **98** | **494** | **0** | **456** |

The source of electricity has significant impact on GHG emissions from City facilities. The CNCFP used emissions factors from 3CE Choice, which algins with CA state averages, in this study for the current electricity supply. 3CE has an adopted policy and is on track to achieve 100 percent carbon free resources by 2030, which would lower the effective GHG emissions coefficient to 0 lbs CO2e/MWh. California as a state has committed to having 100% carbon free power by 2045 which will be required for all utilities. Through 3CE the City of San Luis Obispo has the ability to purchase 100% carbon free electricity now to reduce their GHG emissions and meet their climate action goals.

[4] https://3cenergy.org/wp-content/uploads/2023/02/2021-3CE-Power-Content-Label-1.pdf
[5] https://www.energy.ca.gov/programs-and-topics/programs/power-source-disclosure

# 3. CITY FACILITIES

## 3.1 EXISTING CONDITIONS

The City of San Luis Obispo operates 31 different properties within the General Fund. This excludes the water treatment facilities and two historic structures. These buildings vary greatly in use, and include facilities such as City Hall, SLO Swim Center, four fire stations, a variety of parks, multiple offices, and community use centers. Buildings vary in age and condition. The Police Station has been included in this study, but is planned to be demolished and replaced within the planning horizon of this document.

Primary uses of electricity are lights, plug loads, fans, and cooling. San Luis Obispo's Facilities Maintenance team has been proactive in their efforts to convert from older style fluorescent lighting fixtures to LED alternatives, with several buildings already 100% LED. Electric vehicle plug load is expected to be an increasing source of electricity load at City Facilities; this topic is addressed separately in the City Fleet Electrification Plan.

Primary uses of natural gas within San Luis Obispo's buildings are heating, domestic hot water, cooking and pool heating. The majority of San Luis Obispo's buildings have rooftop package units with direct expansion (DX) cooling and natural gas heat or indoor natural gas furnaces. Larger buildings such as the Police Station and City Hall have air handling units with natural gas boilers. With the exception of three facilities, all buildings have natural gas hot water heaters. The Fire Stations, Ludwick Center, and Senior Center have natural gas cooking equipment. The most significant use of natural gas is pool heating at SLO Swim Center. The natural gas pool heating boilers and domestic hot water system at the Swim Center comprise approximately 69% of the City's natural gas use in General Fund buildings facilities.

The energy audit process for the CNCFP was a collaborative effort between the City and the consultant team. Walk through audits were performed at 20 City operated properties. Facilities not included in the audits included parks with restroom only facilities and low usage historical buildings such as Jack House and the residence at 610 Monterey. These audits were used to document existing conditions and identify energy efficiency and electrification projects. The major systems observed during the audits are described below. Each audit included the following:

- Review of as-built engineering drawings
- Building walkthrough, identifying any issues with HVAC or lighting
- HVAC system identification and operability observed.
- Lighting system observation
- DHW system type observation
- Known building system issues recorded
- Building occupancy schedule and diversity of space types noted
- Identification of potential sources of high energy usage, such as fountains, elevators, large computer labs, etc.

## BUILIDNG SUMMARY

The following table summarizes all City operated buildings included in this study. Building information was compiled through site assessments, as-built building records and drawings, as well as conversations with facilities staff. Additional building specific information is provided in the Building Energy Assessments summaries provided in the Appendix of this report.

**Table 5: City of San Luis Obispo Facilities with major systems identified.**

| Facility | Address | HVAC System | Domestic Hot Water System | LED Lighting | Other Natural Gas Uses |
|---|---|---|---|---|---|
| Art Center | 1010 Broad Street | | | | |
| Baseball Stadium | 900 Southwood Drive | N/A | N/A | 0% | |
| Bus Yard | 29 Prado Road | RTU - DX & Natural Gas | Natural Gas | 90% | |
| City Hall | 990 Palm Street | VAV AHU – NG Boiler & AC Chiller | Natural Gas | 100% | |
| Corporation Yard | 25 Prado Road | Natural Gas Furnace & Split System | Natural Gas | 70% | Cooking, Car Wash |
| County/City Library | 995 Palm Street | Heat Pump Fan Coil | N/A | N/A | |
| County/City Museum | 696 Monterey Street | Natural Gas Furnace & DX AC | Electric | 20% | |
| Fire Station 1 | 2160 Santa Barbara Street | RTU - DX & Natural Gas | Natural Gas | 95% | Cooking |
| Fire Station 2 | 136 North Chorro | Natural Gas Furnace & Window AC | Natural Gas | 15% | Cooking |
| Fire Station 3 | 1280 Laurel Lane | Natural Gas Furnace & Window AC | Natural Gas | 20% | Cooking |
| Fire Station 4 | 1395 Madonna Road | Natural Gas Furnace & Window AC | Natural Gas | 20% | Cooking |
| Historic Adobe | 466 Dana Street | | | | |
| Jack House | 536 Marsh Street | | | | |
| Johnson Park | 1020 Southwood Drive | N/A | N/A | 5% | |
| Laguna Lake Golf Course | 11175 Los Osos Valley Road | N/A | N/A | N/A | |
| Laguna Lake Park | 1395 Madonna Road | N/A | N/A | 5% | |
| Little Theater | 888 Morro Street | RTU - DX & Natural Gas | Natural Gas | 10% | |
| Meadow Park | 2333 Meadow Street | Natural Gas Furnace | Natural Gas | 50% | |
| Mission Plaza | Broad and Monterey | N/A | N/A | 35% | |
| Mitchell Park | 1415 Santa Rosa St | N/A | N/A | 25% | |
| Parking Structure | 842 Palm Street | N/A | N/A | 100% | |
| Parking Structure | 836 Pacific Street | N/A | N/A | 90% | |
| Parking Structure & Office | 919 Palm Street | Water to Water Heat Pump | Electric | 90% | |
| Parks and Recreation Office | 1341 Nipomo | Natural Gas Furnace & DX AC | Natural Gas | 30% | |
| Police – Auxiliary Buildings | 1016 Walnut Street | Natural Gas Furnace & DX AC | Natural Gas | 20% | |
| Police Station | 1042 Walnut Street | VAV AHU – NG Boiler & AC Chiller | Natural Gas | 15% | |
| Recreation Center | 864 Santa Rosa | RTU - DX & Natural Gas | Natural Gas | 40% | Cooking |
| Residence | 610 Monterey | | | | |
| Senior Center | 1445 Santa Rosa | Natural Gas Furnace & Heat Pumps | Natural Gas | 100% | Cooking |
| SLO Swim Center | 900 Southwood Drive | RTU - DX & Natural Gas | Natural Gas | 40% | Pool Heat |
| Throop Field | 375 Ferrini Drive | N/A | N/A | 0% | |
| Utilities Offices | 879 Morro Street | RTU - DX & Natural Gas | Electric | 40% | |
| 911 Dispatch Center | 1135 Roundhouse Ave | Natural Gas Furnace w/ Cooling Coil | Natural Gas | 25% | |

## TYPICAL BUILDING SYSTEMS

### HVAC SYSTEMS

Each facility has its own space conditioning system with no city operated central utility plant. Common HVAC equipment types at these buildings include rooftop packaged units (RTUs), natural gas furnaces/air handling units and DX cooling equipment. Two of the larger buildings, City Hall and the Police Station, are served by variable volume air handling units (VAV AHUs). The VAV AHU at both facilities has cooling needs served by an air cooled chiller and heating served by a natural gas boiler.

Figure 7: Rooftop Unit (RTU) with Dx Cooling + Natural Gas Heating – Ludwick Recreation Center.

### DOMESTIC HOT WATER

With the exception of three facilities, all building domestic hot water needs are served by natural gas water heaters. Most water heaters appear to be in good condition with no early retirement expected.

Figure 8: Typical natural gas water heater at City Hall

## LIGHTING

The City has been proactive in its efforts to replace older style fixtures with LED alternatives. While most buildings still have some amount of LED lighting, the transition to LED has begun in many buildings. The Swim Center, Santa Rosa Park, Damon Garcia Sports Complex and Baseball Stadium have outdoor sport lighting systems. Of the four facilities, only the Swim Center has been upgraded to LED sport lighting.

## MISCELLANEOUS SYSTEMS

Several buildings are outfitted with natural gas cooking equipment. These buildings include the fire stations, Corp Yard, Senior Center and Recreation Center. SLO Swim Center has natural gas pool heating equipment.

Figure 9: Natural gas boiler for pool heat at SLO Swim Center

# 3.2 ENERGY USE & GHG EMISSIONS

The City of San Luis Obispo purchases power through PG&E and natural gas through SoCalGas. Energy data was collected through a variety of sources, including CC-LEAP, Energy Star Portfolio Manager, and City utility bill records. Because of the a-typical usage patterns for much of the Covid 19 pandemic, a judgment call was made for each building regarding whether data from 2019, 2020 or 2021 should be used as representative. For buildings in which only partial data was available, data for missing months was projected based on building type, expected load profile, and historical data.

SLO Swim Center is the highest energy consuming facility and accounts for nearly 70% of the City's natural gas usage and over 40% of the total energy use at general fund facilities. Natural gas demands are primarily driven by pool heating equipment, domestic hot water systems for the showers, and the constant volume heating units serving the Bath House building. Electricity usage is driven primarily by pool pumps and associated equipment. The City has taken steps towards reducing electricity at the pool by turning down the pool pumps overnight and installing LED underwater and sport lighting on the pool deck.

**Table 6: City Facility Energy Use, Ordered Largest to Smallest**

| Facility | Electricity Usage - kwh | Natural Gas Usage - therm | Total Mbtu | Total Energy Usage |
|---|---|---|---|---|
| SLO Swim Center | 391,561 | 68,902 | 8,227 | 43.6% |
| Corporation Yard | 246,671 | 8,493 | 1,692 | 9.0% |
| Police Station | 231,060 | 6,324 | 1,421 | 7.5% |
| City Hall | 233,788 | 4,936 | 1,292 | 6.8% |
| 911 Dispatch Center | 250,760 | 426 | 899 | 4.8% |
| 836 Pacific Parking Structure | 246,166 | - | 841 | 4.5% |
| Fire Station 1 | 153,351 | 1,553 | 679 | 3.6% |
| 919 Palm Parking Structure and Office | 160,342 | - | 548 | 2.9% |
| 842 Palm Parking Structure | 122,372 | - | 418 | 2.2% |
| Fire Station 3 | 41,708 | 2,237 | 366 | 1.9% |
| Bus Yard | 61,175 | 1,364 | 345 | 1.8% |
| Ludwick Community/Recreation Center | 52,422 | 659 | 245 | 1.3% |
| Fire Station 4 | 35,946 | 1,183 | 241 | 1.3% |
| Fire Station 2 | 40,343 | 1,025 | 240 | 1.3% |
| Little Theater | 57,689 | 129 | 210 | 1.1% |
| Parks and Recreation Office | 32,580 | 968 | 208 | 1.1% |
| Senior Center | 22,855 | 1,011 | 179 | 0.9% |
| Utilities Offices | 26,027 | 757 | 165 | 0.9% |
| Laguna Lake Park | 38,456 | - | 131 | 0.7% |
| Baseball Stadium | 38,244 | - | 131 | 0.7% |
| Laguna Lake Golf Course | 28,116 | - | 96 | 0.5% |
| County/City Library (shared facility | 24,102 | - | 82 | 0.4% |
| County/City Museum (shared facility) | 12,415 | 254 | 68 | 0.4% |
| Art Center | 16,415 | - | 56 | 0.3% |
| Meadow Park | 10,535 | 43 | 40 | 0.2% |
| Police – Auxiliary Buildings | 10,390 | - | 35 | 0.2% |
| Jack House | 4,339 | 2 | 15 | 0.1% |
| Johnson Park | 806 | - | 3 | 0.0% |
| Historic Adobe | - | - | - | 0.0% |
| Mission Plaza | - | - | - | 0.0% |
| Mitchell Park | - | - | - | 0.0% |
| Residence | - | - | - | 0.0% |
| Throop Field | - | - | - | 0.0% |
| **Total** | **2,590,634** | **100,266** | **18,874** | |

Carbon emissions have been calculated based on building electricity and natural gas usage and applying eGRID and Energy Star Portfolio Manager emissions factors. Emissions track electricity and gas usage – the more energy a building uses the higher the emissions. As electrical grids become cleaner in coming years and eventually move away from fossil fuels, the key driver in building decarbonization will be the elimination of natural gas systems in buildings.

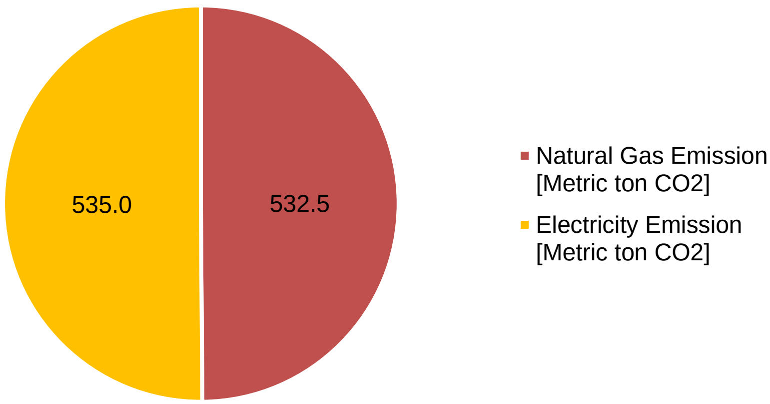


**Figure 10: City Facilities Energy Emissions Breakdown – 2019 Baseline**

Annual emissions associated with the City's building stock are driven primarily by the Swim Center electricity and natural gas usage. The next three drivers of city emissions are Corporation Yard, Police Station, and City Hall. The Police Station is planned to be demolished and rebuilt before 2030, and as such has been excluded from the carbon emissions reduction analysis.

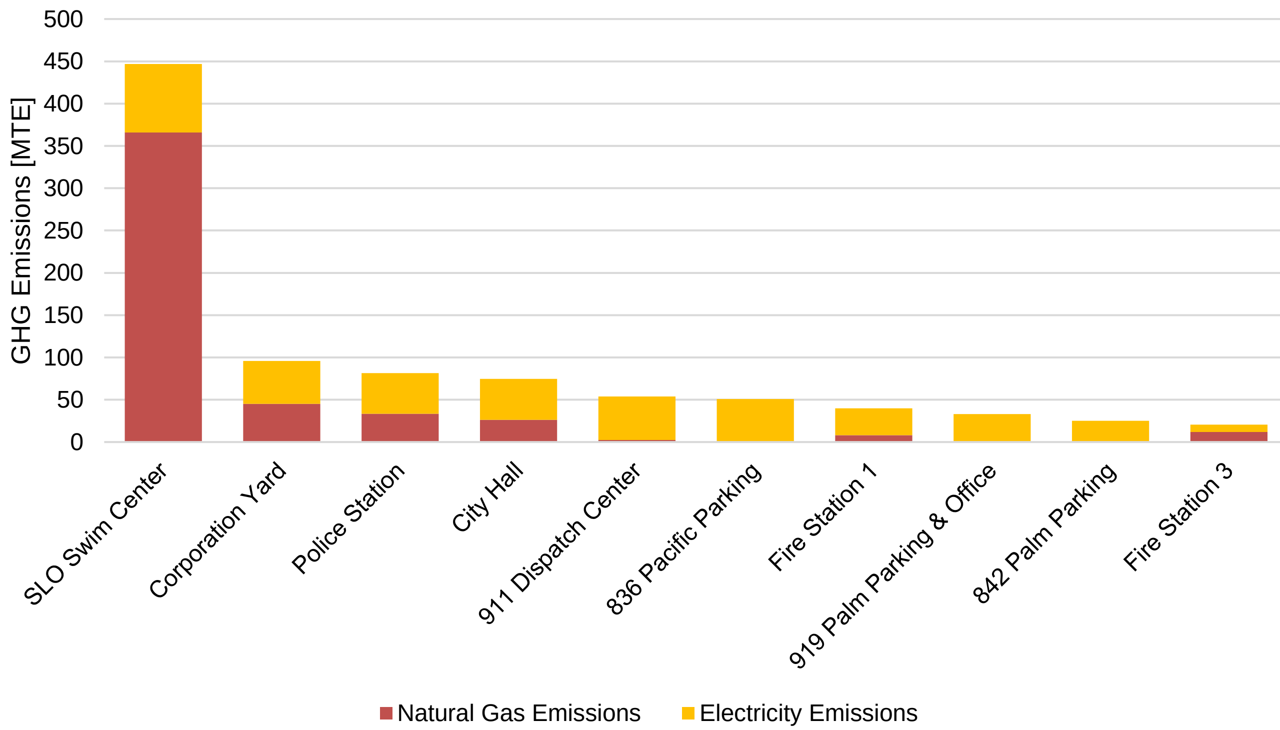


**Figure 11: GHG Emissions of Top 10 Carbon Intensive City Facilities**

# 4. BUILDING DECARBONIZATION

## 4.1 PROJECTS AND RECOMMENDATIONS

### SUMMARY OF STRATEGIES

The carbon neutrality plan provided an assessment of existing building conditions and energy use to identify building decarbonization measures across all city owned facilities. Building projects were grouped into the following categories. Additional information for specific measures is outlined in sections below.

**LED Lighting Retrofit**

Retrofit of existing light fixtures with LED sources or installation of new LED fixtures with modern lighting controls. Potential savings of 50-70% of lighting electricity use.

**Electrification – HVAC Systems**

Convert existing natural gas heating system including rooftop units (RTUs) and furnaces to an all-electric heat pump heating system. Potential savings of 60-80% for heating energy use (kBtu).

**Electrification – Domestic Hot Water Heaters**

Convert existing natural gas water heaters to electric heat pump water heaters. Potential energy savings of 70-80% for water heating energy use (kBtu).

**Electrification – Process Gas Equipment**

Specialty electrification projects include replacement of gas equipment such as kitchen stoves/ovens and clothes dryers with electric alternatives.

**Electrification – Pool Heating**

Provide supplemental heat pumps to provide pool heating at the SLO Swim Center. Potential energy savings of 60-70% (kBtu) for converting to heat pumps.

### BUILDING APPLICATION

Outlined below are all the buildings audited and applicable building decarbonization measures to each building. For each EEM, calculations were completed to provide an estimated energy savings. Results from these calculations for each building are outlined in the Energy Audit Summary Reports provided in the Appendix.

**Table 7: Decarbonization Measures at City Facilities**

| City Building | LED Lighting | Hydronic Heat Pumps | Heat Pump RTUw | Split System Heat Pumps | Heat Pump Water Heater | Electric Clothing Dryers | Electric Induction Cooking | Heat Pump Pool Heating |
|---|---|---|---|---|---|---|---|---|
| Art Center | | | | | | | | |
| Baseball Stadium | Y | | | | | | | |
| Bus Yard | | | Y | | Y | | | |
| City Hall | | Y | | | Y | | | |
| Corporation Yard | Y | | | Y | Y | Y | Y | |
| County/City Library (shared facility | Y | | | | | | | |
| County/City Museum (shared facility) | Y | | | Y | | | | |
| Fire Station 1 | | | Y | | Y | Y | Y | |
| Fire Station 2 | Y | | | Y | Y | Y | Y | |
| Fire Station 3 | Y | | | Y | Y | Y | Y | |
| Fire Station 4 | Y | | | Y | Y | Y | Y | |
| Historic Adobe | | | | | | | | |
| Jack House | | | | | | | | |
| Johnson Park | Y | | | | | | | |
| Laguna Lake Golf Course | | | | | | | | |
| Laguna Lake Park | Y | | | | | | | |
| Little Theater | Y | | Y | | Y | | | |
| Meadow Park | Y | | | Y | Y | | | |
| Mission Plaza | Y | | | | | | | |
| Mitchell Park | Y | | | | | | | |
| 842 Palm Parking Structure | | | | | | | | |
| 836 Pacific Parking Structure | Y | | | | | | | |
| 919 Palm Parking Structure and Office | | | | | | | | |
| Parks and Recreation Office | Y | | | Y | Y | | | |
| Police – Auxiliary Buildings | Y | | | Y | Y | | | |
| Police Station | | | | | | | | |
| Ludwick Community/Recreation Center | Y | | Y | | Y | | Y | |
| Residence | | | | | | | | |
| Senior Center | | | | Y | Y | | Y | |
| SLO Swim Center | Y | | Y | | Y | | | Y |
| Throop Field | | | | | | | | |
| Utilities Offices | Y | | Y | | | | | |
| 911 Dispatch Center | Y | | | Y | Y | | Y | |

# 4.2 BUILDING DECARBONIZATION PROJECTS

Energy efficiency and electrification projects were identified based on building use and current system types. Efficiency projects include those which do not involve fuel switching from natural gas to electricity. LED lighting upgrades fall in the efficiency category. Electrification projects involve switching a natural gas using technology to an electric alternative. Replacing natural gas furnaces with electric heat pumps would fall in the electrification category. Summaries of the various efficiency and electrification projects are below.

## LED LIGHTING UPGRADES

### EXISTING CONDITIONS:

The City's Facilities team has retrofitted non-LED lighting fixtures (T5, T8, CFL) with new LED bulbs either partially or fully at many City facilities. These efforts should continue at the remaining buildings that have not been fully retrofitted.

### PROJECT SUMMARY:

Interior fluorescent lamps and all exterior lamps should be replaced with equivalent LED lamps. Fluorescent T8 and T5 lamps can be replaced with linear LED lamps in the same fixture, or a complete fixture replacement may be chosen for aesthetic reasons. Similarly, screw and plug-in CFL bulbs can be replaced directly by equivalent LED lamps. If controls are also required to be upgraded, then replacing the entire fixture may be the best option because many LED fixtures have advanced occupancy and daylighting controls fully integrated dimming capabilities.

Projects were identified based on feedback from facilities staff on what buildings have been fully converted to LED fixtures.

### ENERGY SAVINGS:

Energy savings are typically 50% to 70% when fluorescent lamps are replaced by LEDs. For example, a typical T8 bulb uses 32W per bulb plus 10% to 15% additional energy by the ballast, versus 16W for an equivalent LED lamp. Additional cooling energy savings is also possible by reducing the heat load added the space from lighting fixtures. Energy savings were calculated based on existing lighting fixtures, proposed replacements and estimated space utilization.

### COST CONSIDERATIONS:

LED lighting retrofit costs were estimated based on specific building fixtures. The average construction was generally estimated to be roughly $2.00 per square foot. This assumed that LED bulbs are installed by City staff in existing fixtures. If the City replaces the entire fixture and upgrades lighting controls the installation cost will be higher.

LED lighting retrofits result in additional operational and maintenance cost savings as fixtures have a longer expected useful life and do not need to be replaced as frequently.

## HYDRONIC AIR TO WATER HEAT PUMPS

### EXISTING CONDITIONS:

The space conditioning needs of San Luis Obispo City Hall are currently served by a natural gas boiler and air-cooled chiller. The air-cooled chiller was recently installed in 2017 and is in excellent working condition. The natural gas boiler was installed in 1996 and is reaching the end of its useful life.

### PROJECT SUMMARY:

There is opportunity to take a major step towards building electrification at City Hall by replacing the natural gas boiler with an all-electric air to water heat pump (AWHP) system. Refer to High Priority Project summaries for additional project specific information. With enough ventilation air it is possible to locate the new AWHP within the existing mechanical room, however, the project team recommends installing the AWHP on a concrete pad outdoors adjacent to City Hall and Little Theater.

A primary consideration for the building operations team is the heating hot water (HHW) supply temperature reset necessary with the new system. The existing system was designed for a non-condensing boiler, requiring 180°F supply water. AWHP function at lower supply water temperatures, with a max of 149°F with a max set point ideally below 140°F or less. It has been shown that many variable air volume (VAV) box coils and air handling unit coils function are still capable of providing 90°F supply air temperature at lower hot water temperatures. The hot water reset should be tested and verified through a commissioning process as part of the AWHP installation.

Figure 12: AERMEC Heat Pump Unit

Heat pumps are less efficient at low load conditions. To reduce equipment cycling at low loads, the City may consider installing a buffer tank. The project team recommends providing space for a future buffer tank, with necessity determined by design engineer. The AWHP will have a primary pump and needs to be piped with a decoupler bridge to HHW distribution pumps (similar to a primary secondary arrangement). Building BMS needs to enable the AWHP and run pumps.

### ENERGY SAVINGS:

Energy savings from replacement of local building natural gas boilers with AWHP have been calculated assuming the efficiency of existing boilers is 80-85% and the coefficient of performance of AWHP units is generally between 2.5 and 4.0, varying based on weather conditions.

### COST CONSIDERATIONS:

The cost of the AWHP is just one factor to consider when evaluating the replacement of natural gas heating hot water boilers. The installation cost may vary widely between buildings depending upon the cost to remove the existing boilers, the scope of necessary modifications to heating hot water piping, and any upgrades that may be needed to the building’s electrical system. It is estimated that AWHPs will have a construction cost of $450 per MBH of heating.

## HEAT PUMP ROOFTOP UNITS

### EXISTING CONDITIONS:

Many buildings in San Luis Obispo are heated and cooled via constant volume packaged rooftop units. These buildings include Bus Yard, Fire Station 1, Little Theater, Recreation Center, SLO Swim Center and Utilities Offices. Units are outfitted with natural gas heat and often a direct-expansion (DX) refrdidgerant cooling coil.

### PROJECT SUMMARY:

Rooftop units (RTUs) with natural gas furnaces should be replaced with new high performance heat pump RTUs. The efficiency of older units is significantly worse than modern heat pump units. Typical cooling efficiency for existing RTUs is a SEER between 8.5-10, whereas for a new heat pump unit the expected cooling efficiency is up to 16 SEER. Existing RTUs have a heating efficiency around 80%, or a COP of 0.8. Heat pump RTUs have a heating efficiency between 2.5-4 COP.

Heat pump RTUs can usually be installed in the same location as the existing RTUs, but may require a curb adaptor in some instances. Converting from natural gas furnaces to electric heat pumps will not necessarily add electrical load if the existing RTUs have cooling. The electrical load is dependent on the equipment size and should be assessed on an individual unit basis. Existing RTUs should be replaced at the end of their expected life with the electric heat pump alternative. Early retirement of some good condition RTUs may be necessary to meet city decarbonization goals.


**Figure 13: Packaged Heat Pump Rooftop Unit (RTU).**

### ENERGY SAVINGS:

Energy savings of replacing natural gas furnaces in RTUs with heat pumps were calculated using the building energy models. Heat pump efficiency has coefficient of performance (COP) between 2.5 and 4.0, varying based on weather conditions, compared to 80% with existing furnaces.

### COST CONSIDERATIONS:

Heat pump RTUs are a slight premium compared to existing natural gas fired units, roughly 10% more expensive for equipment costs. It is estimated that new heat pump RTUs will have a construction cost of $4,000 per ton of cooling.

## HEAT PUMP SPLIT SYSTEMS

### EXISTING CONDITIONS:

Most buildings in San Luis Obispo  are heated and cooled via forced air natural gas furnaces. These furnaces are often outfitted with a DX cooling coil as well. Buildings with natural gas furnaces include Fire Stations 2, 3, and 4, as well as Corporation Yard, County/City Museum, Meadow Park, Parks and Recreation Offices, and several others.

### PROJECT SUMMARY:

Natural gas furnace systems should be converted to a heat pump split system. In buildings with recently replaced furnaces, it is possible to reuse the existing furnace as an air handling unit and replace the heating/cooling coils with a coil served by an outdoor heat pump unit. For older units it is recommended to replace the furnace entirely with a fan coil unit with coil served by an outdoor heat pump. Many buildings with existing furnaces have outdoor condensing units.

Typical cooling efficiency of new heat pump units is between 13-19 SEER, while the older units have a typical efficiency around 10 SEER. In heating mode new heat pump systems will have a typical efficiency between 2-3.5 COP, compared to a n efficiency around 85-90%, or 0.85-0.9 COP. Converting from natural gas furnaces to electric heat pumps will add electrical load to buildings. Added load shall be verified by design engineer and compared to available electrical capacity.

The new outdoor heat pump may be installed on the equipment pad/location previously occupied by the condensing unit. Indoor fan coil may be placed in similar equipment location to the existing furnaces in either vertical or horizontal orientation. Basis of design units would be York HMH7.

Figure 14: Outdoor Heat Pump Unit


Figure 15: Indoor Ventilation Unit

### ENERGY SAVINGS:

Energy savings of replacing natural gas furnaces with split system heat pumps were calculated using the building energy models. Heat pump efficiency has coefficient of performance (COP) between 2.5 and 4.0, varying based on weather conditions, compared to 80% with existing furnaces.

### COST CONSIDERATIONS:

Heat pump RTUs are a slight premium compared to existing natural-gas fired units, roughly 10% more expensive for equipment costs. It is estimated that new heat pump split systems will have a construction cost of $3,900 per ton of cooling.  Facilities with needed electrical upgrades will experience a higher estimated cost.

## HEAT PUMP WATER HEATERS

### EXISTING CONDITIONS:

Tank natural gas water heaters are standard at most City of San Luis Obispo buildings. Several buildings have instantaneous natural gas water heaters. At the individual building level water heaters are not typically a significant source of greenhouse gas emissions, but on aggregate they represent a significant portion of natural gas emissions.

### PROJECT SUMMARY:

Natural gas hot water heaters should be electrified with air to water heat pump hot water heaters. Typical efficiency of a gas water heater is between 80%-90%, whereas a heat pump water heater will have efficiency between 2.5-4 COP, greatly increasing efficiency and eliminating reliance on natural gas. In some locations with very little domestic hot water load it may make sense to electrify using instant hot electric resistance hot water heaters.

Electric resistance water heaters and heat pump water heaters will add electrical load to buildings. Water heaters represent a relatively low portion of building energy usage, and it is unlikely there will be issues with insufficient building electrical capacity. Small commercial heat pump water heaters are similarly sized to small commercial natural gas water heaters, and in most cases can be installed in the same location, with a confirmation of airflow circulation for operation of an AWHP in that location.

The best solution for electrification will depend upon the water demand in the building, current hot water system and distribution, and any space constraints since a heat pump water heater does have minimum space requirements for installation.

**Figure 16: Hybrid Electric Heat Pump Water Heater - AO Smith Voltex**

### ENERGY SAVINGS:

The typical efficiency of a gas water heater is between 80%-90%, whereas a heat pump water heater will have efficiency between 3-4 COP, greatly increasing efficiency and eliminating reliance on natural gas. Energy savings have been calculated assuming natural gas water heaters have a uniform energy factor (UEF) of 0.7 (the UEF accounts for stand-by energy losses) and new hybrid AWHP have a UEF of 2.8.

### COST CONSIDERATIONS:

It was assumed that all water heaters would be replaced with heat pump units to provide more conservative cost budgets. It is estimated that new 100-gallon heat pump water heater will have a construction cost of $16,000 per 100-gallon water heater and $9,000 per 60-gallon water heater.

## ELECTRIC INDUCTION COOKING

### EXISTING CONDITIONS:

Fire stations, Ludwick Recreation Center, Senior Center and Corp Yard all have natural gas cooking equipment.

### PROJECT SUMMARY:

Natural gas cooking appliances such as stovetops and ovens will need to be replaced with equivalent appliances that use electricity. Cooking equipment has a relatively long equipment life, so cooking equipment may need to be retired before end of life to meet decarbonization goals.

### ENERGY SAVINGS

Energy savings were estimated based on calculated cooking natural gas demand and estimated equipment efficiency. Natural gas stoves have a typical efficiency around 40%. If gas ranges have pilot lights, that efficiency drops to as low as 20%[6]. Induction cooking has an efficiency around 80%[7].


Figure 17: Electric Commercial Oven

### COST CONSIDERATIONS

The upfront cost to purchase and operate electric appliances is slightly more expensive than gas appliances and often requires significant electrical upgrades. Costs were estimated on a project-by-project basis. Various incentives are available through the CA Foodservice Instant Rebates Program[8].

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[6] https://www.greenbuildingadvisor.com/article/efficient-cooking
[7] https://www.aceee.org/files/proceedings/2014/data/papers/9-702.pdf
[8] https://www.caenergywise.com/instant-rebates/

## HEAT PUMP POOL HEATERS

### EXISTING CONDITIONS

Competition pool heating at SLO Swim Center is currently served by two Lochinvar natural gas boilers. The natural gas boilers were installed in 2012 and are in excellent working condition. Natural gas usage at SLO Swim Center accounts for approximately 42% of the city's carbon emissions.

### PROJECT SUMMARY

There is opportunity to take a major step towards building electrification and decarbonization by shifting load off the natural gas boilers with an electric air to water heat pump (AWHP) system. The natural gas boilers would remain functional for peak heating days and resiliency purposes, with approximately 75% of the total pool heating load (competition and therapy pool) shifted onto the AWHP system.

Boilers serving the competition pool should be electrified using a modular 1250 MBH air to water heat pump (AWHP) and associated piping and controls. The AWHP would be installed upstream of the existing heat exchanger (HX) and shift load off the natural gas boilers. Natural gas boilers would remain functional during peak conditions only and serve as a fully redundant back up. Hot water temperatures of the heating side HX loop would need to be reset from 145°F to 125-130°F. Temperatures on pool side HX loop would remain. The project team recommends installing the AWHP on a concrete pad outdoors adjacent to the existing mechanical room housing the competition pool equipment.

A primary consideration for the building operations team is the integration and tie in with existing pool heating loop and equipment. The AWHP will be installed outside the existing mechanical room, meaning that the unit will have to be piped back to the main loop. While the recommendation is to integrate with the existing loop with no additional heat exchanger, there is an option to install a second heat exchanger and heating loop to provide the primary means of pool heat. Feasibility of both options is to be analyzed and verified by the design engineer.

An additional consideration is the operating temperature of the mechanical side (not pool side) of the HX. Standard AWHP function at lower supply water temperatures, with a max of 130°F and recommended max set point of 120°F or less (higher temperature options are available, but they are more expensive). The hot water reset is not anticipated to be a major concern for the Swim Center so long as the pool side temperature is maintained, however, it will require monitoring by the operations team to verify.

Phase 2 and 3 electrification at the Swim Center involve electrifying the therapy pool heating system and removing the peaking natural gas boiler at the competition pool. These phases will likely require in an upgrade to the facilities electrical service.

### ENERGY SAVINGS:

Pool heating energy was estimated using metered data. Energy savings were estimated by assuming pool natural gas boilers have 80% efficiency and new AWHP have a COP of 4-5 to produce 115F supply hot water.

### COST CONSIDERATIONS:

It is estimated that heat pump pool heaters will have a construction cost of $450 per MBH of heating.

## ELECTRIC CLOTHING DRYERS

Several San Luis Obispo  facilities have natural gas clothing dryers. It has been confirmed that Fire Station 1 has a natural gas dryer and it is assumed that dryers at the other fire stations and Corp Yard are also natural gas, though this needs to be verified by the city. There are many commercially available electric clothing dryers. Design engineer is to verify that added electrical load is permissible with current building electrical service.

## 4.3 RESULTS

Energy savings associated with each measure are captured within the CESA tool and reported for reach building in the Appendix of this report. The following chart shows the cumulative energy use and savings by implementing the recommended strategies. San Luis Obispo can reduce energy use in city facility by 41% by 2030 through building decarbonization measures and will see a 67% reduction with the proposed solar PV projections, procured through a power purchase agreement (PPA).

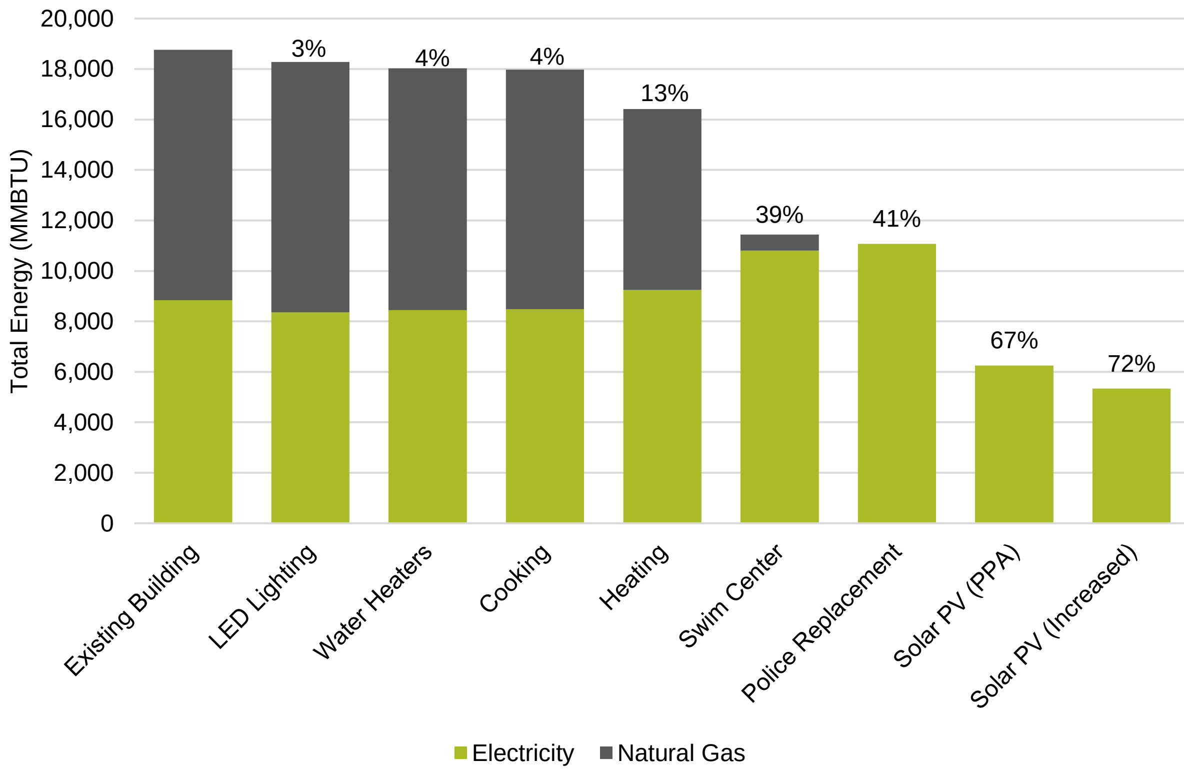



**Figure 18: Total Energy Use (MMBTU) and Energy Savings (%) from Building Decarbonization Projects**

# 4.3 HIGH PRIORITY PROJECTS

## CITY HALL ELECTRIFICATION

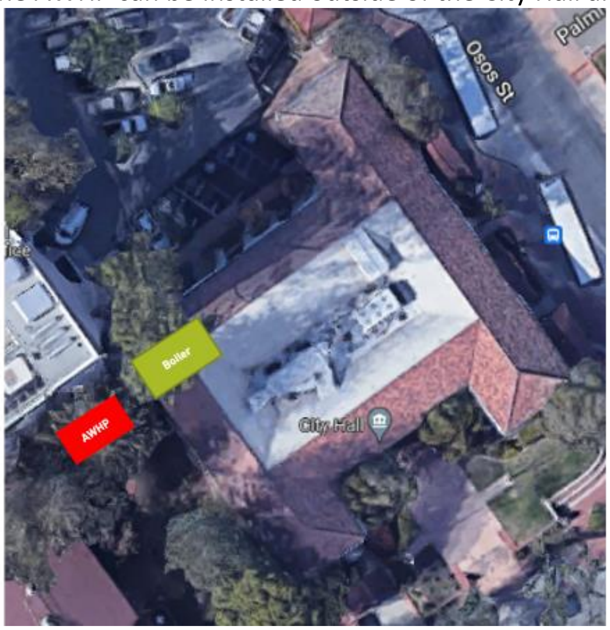
| | |
|---|---|
| **Project Name:** | Heating Hot Water Electrification |
| **Building:** | City Hall |
| **Preliminary Budget:** | $450,000 |
| **Project Type:** | Deferred Maintenance, Electrification |
| **Project Summary:** | The space conditioning needs of San Luis Obispo City Hall are currently served by a natural gas boiler and air-cooled chiller. The air-cooled chiller was recently installed 2017 and is in excellent working condition. The natural gas boiler was installed in 1996 and is reaching the end of its useful life. There is opportunity to take a major step towards building electrification by replacing the natural gas boiler with an all-electric air to water heat pump (AWHP) system. |
| **Recommendations:** | The project team recommends replacing the existing 760 MBH boiler with one (1) 600 MBH air to water heat pump. With enough ventilation air it is possible to locate the new AWHP within the existing mechanical room, however, the project team recommends installing the AWHP on a concrete pad outdoors adjacent to City Hall and Little Theater. With the AWHP system heating hot water supply temperatures will be reset from 180°F to 140°F. Temperature resets should be tested on VAV box and AHU coils to ensure existing coils are functional at 140°F. |
| **Key Considerations:** | A primary consideration for the building operations team is the heating hot water (HHW) supply temperature reset necessary with the new system. The existing system was designed for a non-condensing boiler, requiring 180°F supply water. AWHPs function at lower supply water temperatures, with a max of 149°F and recommended max set point of 140°F or less. It has been shown that many VAV box coils and air handling unit coils function just as well at 140°F or below and are still capable of providing 90°F supply air temperature. The hot water reset is not anticipated to be a major concern for City Hall, however, it will require monitoring by the operations team to verify.<br>Heat pumps are less efficient at low load conditions. To reduce equipment cycling at low loads the City of San Luis Obispo may consider installing a buffer tank. The project team recommends providing space for a future buffer tank, with necessity determined by design engineer.<br>City Hall has a 120/208V electrical service. While electrical capacity is not expected to be an issue, the design engineer will need to verify with AWHP manufacturer the availability of 208V equipment.<br>The AWHP will have a primary pump and needs to be piped with a decoupler bridge to HHW distribution pumps (similar to a primary secondary arrangement). Building BMS needs to enable the AWHP and run pumps. |

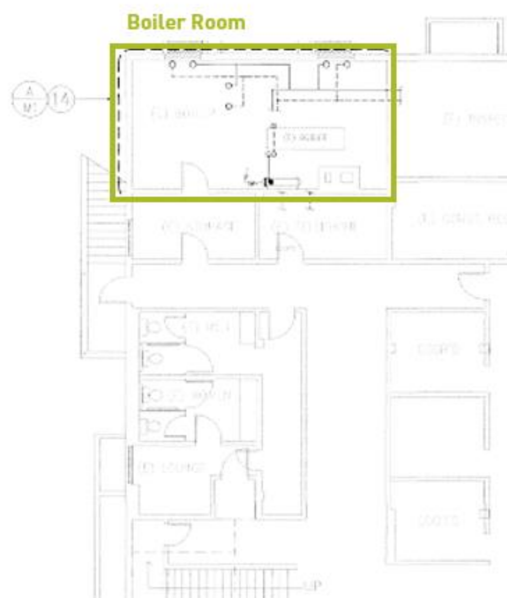
**Next Steps:**

1. Provide a Schematic Design to very verify required equipment capacity, size of mechanical pad and available space adjacent to City Hall. Provide a full detailed cost estimate.
2. Review HHW temperature reset with coils of concern.

### CONCEPTUAL LAYOUT

The AWHP can be installed outside of the City Hall and connected through the existing boiler room



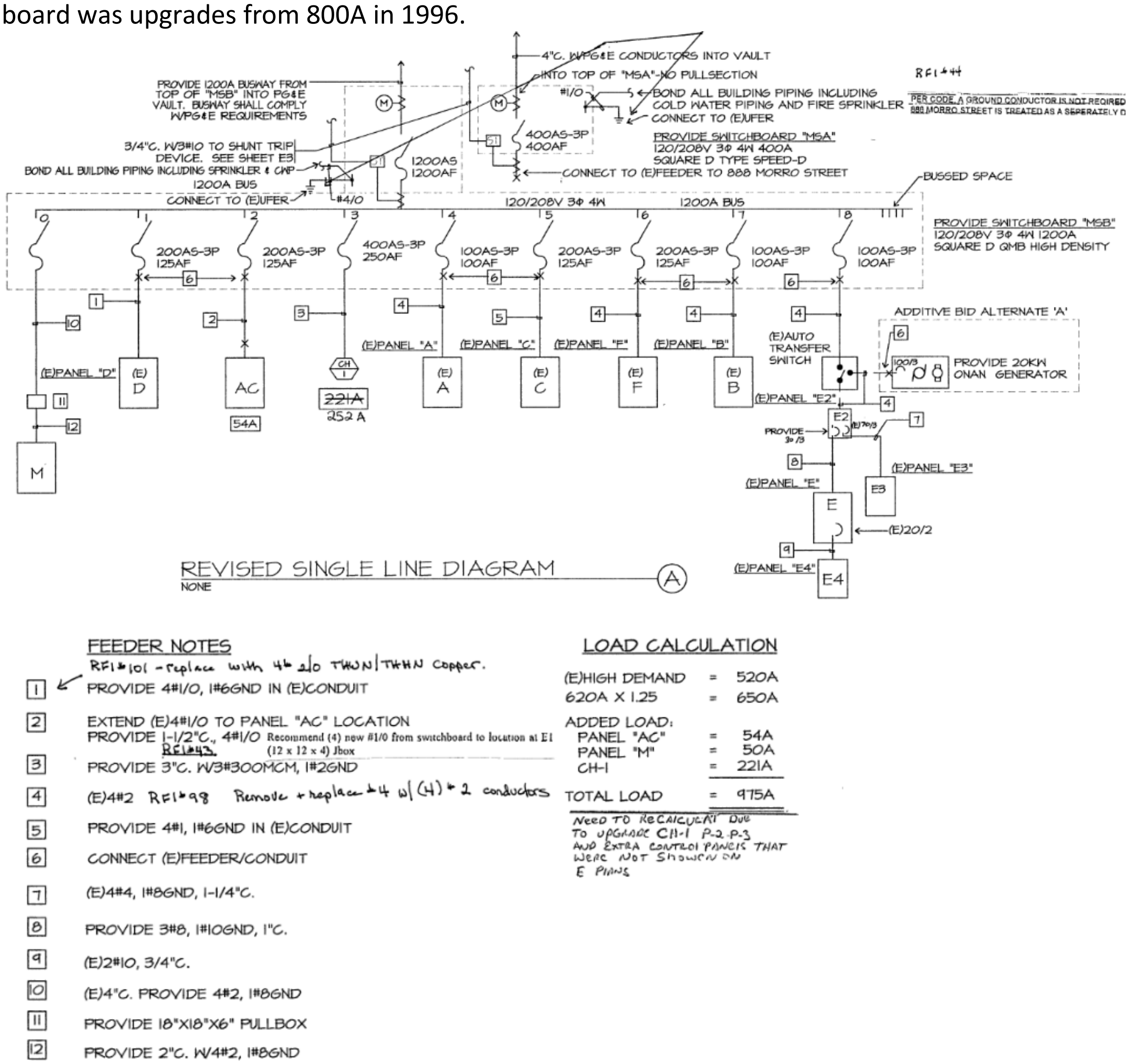




### EQUIPMENT SPECIFICATION

The AERMEC NYK air-to-water heat pump (AWHP) unit was used for budgeting. A 120/208V unit can provided with a factory installed transformer.

## EXISTING CONDITIONS

The building has a 1200A service at 120/208V and has spare capacity according to plans from the 1996 Seismic and HVAC Upgrades project – this should be verified. The electrical services and main switch board was upgrades from 800A in 1996.




The existing boiler was installed in 1996 and is nearing the end of it’s expected useful life.

| BOILER SCHEDULE | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MARK | MANUFACTURER | MODEL | TYPE | VOLTAGE–PHASE | INPUT (MBH) | OUTPUT (VBH) | FUEL | GPM | P.D. | EWT (F) | LWT (F) | OPER. WEIGHT | REMARKS |
| B 1 | PARKER | T-760 | DIRECT | 115V–1Ø | 760 | 608 | N.G. | 40 | . | 150 | 180 | 1320 LBS | TRIM GROUP AE SO BOILER CAN |

| PUMP SCHEDULE | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| MARK | MANUFACTURER | MODEL | TYPE | MOUNTING | HP | VOLTS PH | RPM | GPM/TDH (FT) | OPER. WT | REMARKS |
| P 1 | BELL & GOSSETT | SERIES 90 1-1/2A | IN-LINE | BASE | 1.0 | 208V–3Ø | 1750 | 40/50 | . | BRONZE |

## SWIM CENTER ELECTRIFICATION

**Project Name:** Pool Heater Electrification – Phase 1

**Preliminary Budget:** $750,000

**Project Type:** Electrification

**Project Summary:** The competition pool heating needs of San Luis Obispo Swim Center are currently served by two Lochinvar natural gas boilers. The natural gas boilers were installed in 2012 and are in excellent working condition. Natural gas usage at SLO Swim Center accounts for approximately 42% of the city's carbon emissions. There is opportunity to take a major step towards building electrification and decarbonization by shifting load off the natural gas boilers with an electric air to water heat pump (AWHP) system. The natural gas boilers would remain functional for peak heating days and resiliency purposes, with approximately 75% of the total pool heating load (competition and therapy pool) shifted onto the AWHP system.

**Recommendations:** The project team recommends installing a modular 1250 MBH AWHP, piping, and controls to serve the competition pool. The AWHP would be installed upstream of the existing heat exchanger (HX) and shift load off the natural gas boilers. Natural gas boilers would remain functional during peak conditions only and serve as a fully redundant back up. Hot water temperatures of the heating side HX loop would need to be reset from 145°F to 125-130°F. Temperatures on pool side HX loop would remain. The project team recommends installing the AWHP on a concrete pad outdoors adjacent to the existing mechanical room housing the competition pool equipment.

**Key Considerations:** A primary consideration for the building operations team is the integration and tie in with existing pool heating loop and equipment. The AWHP will be installed outside the existing mechanical room, meaning that the unit will have to be piped back to the main loop. While the recommendation is to integrate with the existing loop with no additional heat exchanger, there is an option to install a second heat exchanger and heating loop to provide the primary means of pool heat. Feasibility of both options is to be analyzed and verified by the design engineer.

An additional consideration is the operating temperature of the mechanical side (not pool side) of the HX. Standard AWHP function at lower supply water temperatures, with a max of 130°F and recommended max set point of 120°F or less (higher temperature options are available, but they are more expensive). The hot water reset is not anticipated to be a major concern for the Swim Center so long as the pool side temperature is maintained, however, it will require monitoring by the operations team to verify.

SLO Swim Center has a 277/480V 400 amp electrical service. AWHP standard configurations are designed for 480V.

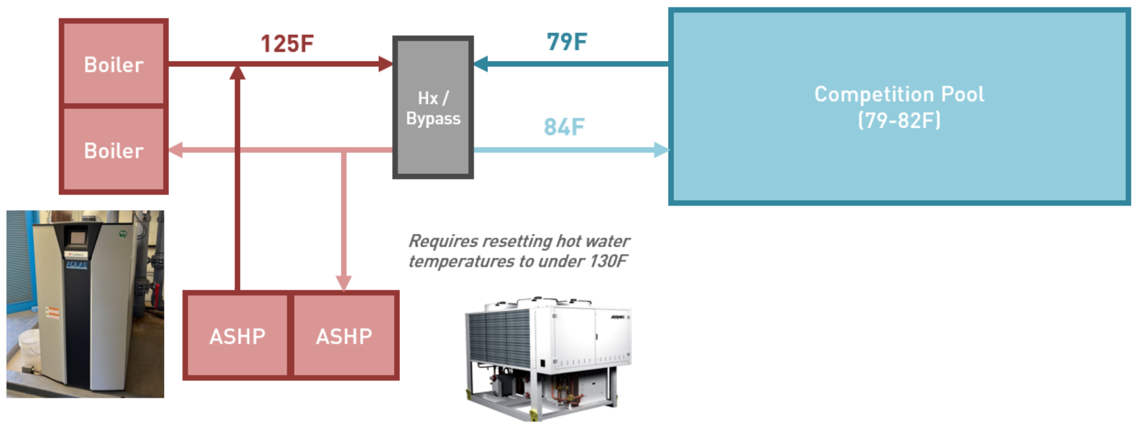
**Next Steps:**

1. Provide a Schematic Design to very verify required equipment capacity, feasibility of integration with existing heating loop, size of mechanical pad and available space adjacent to SLO Swim Center. Provide a full detailed cost estimate.
2. Review electrical system capacity and verify upgraded service for Phase 1 is not necessary.

## CONCEPTUAL LAYOUT

The AWHP can be installed outside of the mechanical room likely in the equipment yard and connected to the existing hot water distribution through the mechanical room. A high-level system schematic is shown below.

### HEAT PUMP – OPTION 1




## EQUIPMENT SPECIFICATION

An AERMEC NRP air-to-water heat pump (AWHP) unit was used for budgeting.

### NRP 0800-1800

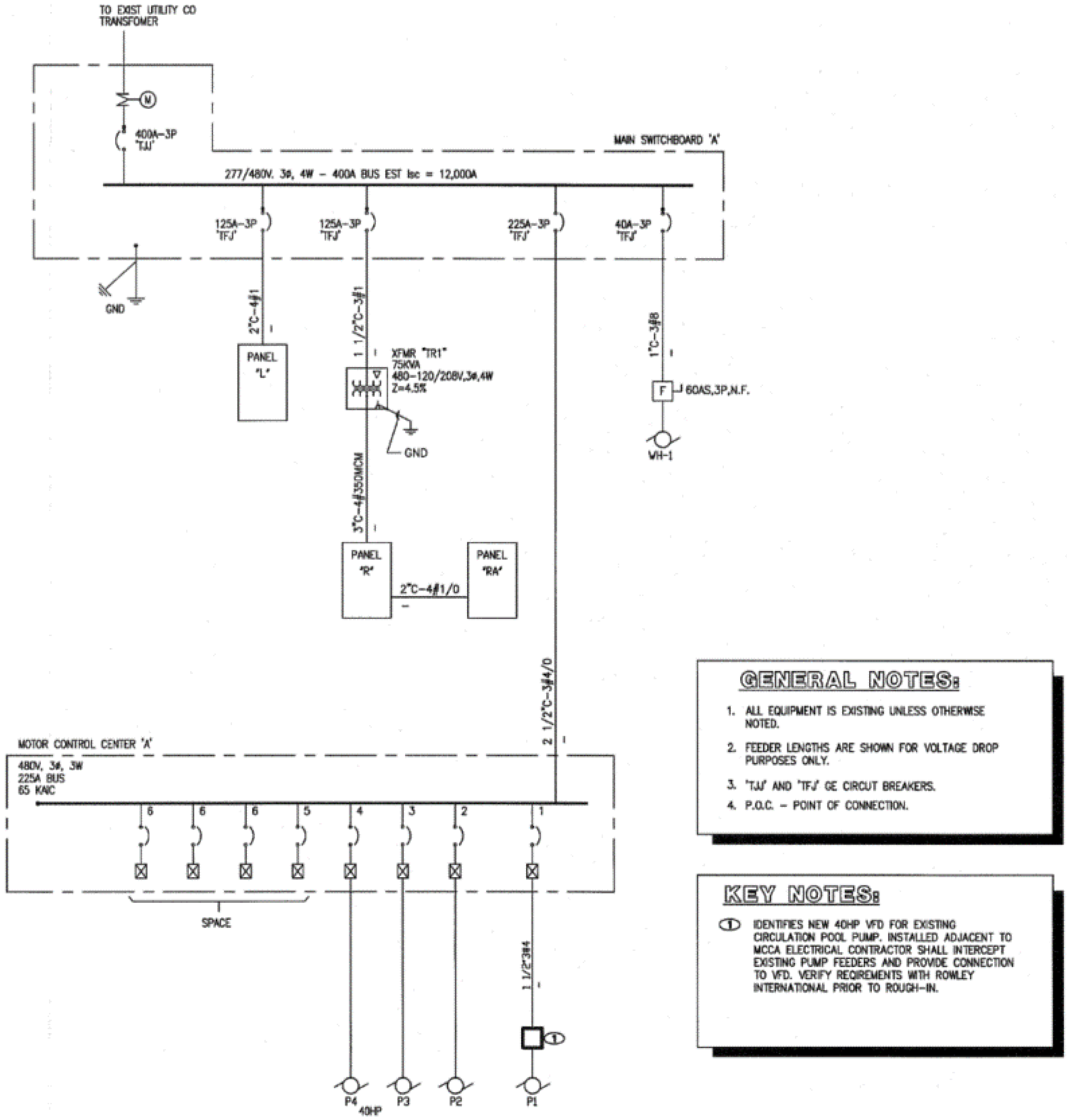
**Air-water multipurpose**

Cooling capacity 51.7 ÷ 120.3 ton
Heating capacity 738,278 ÷ 1,689,276 BTU/h

- High efficiency also at partial loads
- Units designed for 2 or 4-pipe systems
- Simultaneous and independent production of hot and chilled water

## EXISTING CONDITIONS

The mechanical building has a 400A service at 277/480V and has spare capacity according to plans from the 2013 Pool Heater Replacement drawings. This should be verified with onsite conditions.



EXISTING

PANEL "RA"

LOCATION: TRASH ENCLOSURE
MAIN: L.O.

BUS RATING 225A

120/208V, 3ø, 4W
MOUNTING: SURFACE

| DESCRIPTION | LCL | Voltamps A | Voltamps B | Voltamps C | LTG | REC | MTS | BKR | CKT NO | CKT NO | BKR | MTS | REC | LTG | Voltamps A | Voltamps B | Voltamps C | LCL | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| POOL AREA | | 1200 | | | | | | 30-2 | 1 | 2 | 20-1 | | | | 600 | | | | EXTERIOR LIGHTING |
| W/CKT #1 | | | 1200 | | | | | / | 3 | 4 | 30-2 | | | | | 1200 | | | POOL AREA |
| POOL AREA | | | | 600 | | | | 20-1 | 5 | 6 | / | | | | | | 1200 | | W/CKT #4 |
| POOL AREA | | 1200 | | | | | | 30-2 | 7 | 8 | 20-1 | | | | 800 | | | | POOL EQUIPMENT |
| W/CKT #7 | | | 1200 | | | | | / | 9 | 10 | 20-1 | | | | | 600 | | | POOL EQUIPMENT |
| POOL AREA | | | | 1200 | | | | 30-2 | 11 | 12 | 20-1 | | | | | | 600 | | POOL EQUIPMENT |
| W/CKT #11 | | 1200 | | | | | | / | 13 | 14 | 20-1 | | | | 500 | | | | CP-1 |
| POOL AREA | | | 1200 | | | | | 20-1 | 15 | 16 | 20-1 | | | | | 500 | | | SP-1 |
| CHLORINE PM | | | | 600 | | | | 20-1 | 17 | 18 | 20-1 | | | | | | 500 | | EN-1 |
| SP-1 | | 1200 | | | | | | 20-1 | 19 | 20 | 20-1 | | | | 900 | | | | SAP-1 |
| DSA-1 | | | 1200 | | | | | 20-1 | 21 | 22 | 20-1 | | | | | 900 | | | DEP-1 |
| POOL HEATER | | | | 1000 | | | | 20-1 | 23 | 24 | 20-1 | | | | | | 700 | | AUTO FLUSH REC |
| POOL CONTROLLER | | 500 | | | | | | 20-1 | 25 | 26 | 20-1 | | | | 800 | | | | EXISTING |
| AP-1 SPACE | | | 500 | | | | | 20-1 | 27 | 28 | 20-1 | | | | | 800 | | | EXISTING |
| EXISTING | | | | 500 | | | | 20-1 | 29 | 30 | 20-1 | | | | | | 800 | | EXISTING |
| EXISTING | | 500 | | | | | | 20-1 | 31 | 32 | 20-1 | | | | 800 | | | | EXISTING |
| EXISTING | | | 500 | | | | | 20-1 | 33 | 34 | 20-1 | | | | | 800 | | | EXISTING |
| EXISTING | | | | 500 | | | | 20-1 | 35 | 38 | 20-1 | | | | | | 800 | | EXISTING |
| SPARE | | 1200 | | | | | | 20-1 | 37 | 38 | 20-1 | | | | 800 | | | | EXISTING |
| BOILER CIRC PUMP | | | 1200 | | | | | 20-1 | 39 | 40 | 20-1 | | | | | 800 | | | EXISTING |
| BOILER CIRC PUMP | | | | 1200 | | | | 20-1 | 41 | 42 | 20-1 | | | | | | 800 | | EXISTING |

SUB-TOTAL PHASE A = 13000 VA PHASE B = 13400 VA PHASE C = 11800 VA

| | | | |
|---|---|---|---|
| TOTAL CONN LOAD | | = | 38200 VA |
| 25% OF LCL | 500 | = | 125 VA |
| 25% OF LM | 11160 | = | 2,790 VA |
| PANEL LOAD | | = | 41115 VA |
| FEEDER AMPS | | = | 114 A |

NOTES:

** NEW CIRCUIT BREAKER TO MATCH TYPE AND AIC RATING OF PANEL

## PANEL SCHEDULE AND SINGLE LINE DIAGRAM

SCALE NONE 1

The pool includes two natural gas boilers which are both in good working condition.

(1) POOL HEATER - TWO (2) LOCHINVAR XPN 1520, 1,500,000 BTU/HR INPUT, 6" POOL WATER CONNECTION, 3/4" DOMESTIC WATER CONNECTION, 1 1/2" GAS CONNECTION, 97% EFFICIENCY, 1192 LBS.

(2) VARIABLE FREQUENCY DRIVE - H20 TECHNOLOGIES SMART PUMP CONTROL SYSTEM, MODEL #SPCS040

## EQUIPMENT SCHEDULE

## FIRE STATION ELECTRIFICATION

### PROJECT SUMMARY

**Project Name:** Building Electrification – HVAC, Domestic Hot Water, Cooking

**Building:** Fire Station 1 and 911 Dispatch Center

**Preliminary Budget:** $318,000

**Project Type:** Electrification, General Maintenance

**Project Summary:** There is opportunity to take a major step towards city decarbonization with the electrification of building heating, domestic hot water and cooking systems at Fire Station 1 and 911 Dispatch Center. The building heating systems are nearing the end of useful life and can be replaced with heat pump options. Similarly, natural gas water heaters can be replaced by heat pump options. Electric induction ranges can be used in place of traditional natural gas ranges.

Fire Station 1: The building heating needs of Fire Station 1 are currently served by seven natural gas/DX rooftop units. The natural gas rooftop units were installed in 2021 and are nearing the end of their useful life. It is recommended to replace these units with seven 5-ton packaged heat pump units capable of providing heating and cooling with no natural gas. Basis of design units would be Carrier Weather Maker with heat pump heating. Design to confirm if supplemental electric resistance is required. Domestic hot water is served by a tank type natural gas water heater. This heater will be replaced by a heat pump option. Basis of design would be AO Smith HPTU. Cooking is currently served by a natural gas range. Proposed replacement option is an electric induction range—manufacturer to be decided by SLO team. Any electrical upgrades should be coordinated with the microgrid and EV Charging projects

**Recommendations:** 911 Dispatch Center: The building heating needs of 911 Dispatch are currently served by four natural gas forced air furnaces. Cooling is provided by cooling coils served by an outdoor condensing unit. It is recommended to replace these units with four air source heat pump units. Heat pump units include an outdoor condensing unit and indoor fan coil type unit. Fan coil may be placed in similar equipment location in either vertical or horizontal orientation. Basis of design units would be York HMH7. Domestic hot water is served by a tank type natural gas water heater. This heater will be replaced by a heat pump option. Basis of design would be AO Smith HPTU. Cooking is currently served by a natural gas range. Proposed replacement option is an electric induction range—manufacturer to be decided by SLO team. In addition to these electrification measures it is recommended that the SLO team complete conversion of lighting to LED at 911 Dispatch. It is estimated that the building is currently 10% LED.

**Key Considerations:** Replacement heat pump options will be installed outdoors. Both 911 Dispatch and Fire Station 1 have outdoor condensing units currently in place. Heat pump units can be installed in similar location.

While electrical capacity at Fire Station 1 and 911 Dispatch are not expected to be an issue, the design engineer will need to verify.

**Next Steps:**

1. Provide a Schematic Design to very verify required equipment capacities.
2. Review electrical system capacity and verify upgraded service is not necessary.

## EQUIPMENT SPECIFICATION

**Fire Station 1:** Carrier Weather Maker Heat Pump RTU

**911 Dispatch Center:** York HMH7 with Indoor York JHET Air Handler

YORK

## YORK Technical Guide: HMH7 Series - 17 SEER Horizontal Discharge Modulating Heat Pump

R-410A 2 to 5 Nominal Ton

### JHET Fixed-Speed Air Handler

Highly efficient, "A" coil design for dependable comfort

| | |
|---|---|
| **Price Range** | $ |
| **Efficiency Range** | Good |
| **Sound Levels** | Good |
| **Warranties** | 10-year Parts Limited Warranty* |

# 5. RENEWABLE ENERGY

## 5.1 SOLAR PV

Solar photovoltaics (PV) systems were identified as the best on-site renewable energy system for the City of San Luis Obispo to generate renewable energy. Increasing solar photovoltaics within the City will help reduce the resilience of energy systems within San Luis Obispo and help to reduce utility costs for the City.

### PRIORITY SOLAR LOCATIONS

The City of San Luis Obispo has been engaged with ForeFront Solar to provide solar systems at three locations throughout the city. Collectively the solar PV arrays will provide 42% of the electricity required at General Fund facilities, after being fully electrified. The projects will be delivered through a power purchase agreement (PPA) which will finance the systems and use utility bill savings to cover the cost of the system. The following shows the proposed cumulative cost savings from the proposed systems.

| Site | PPA Rate | PPA Escalator | Solar System Size | Storage System Size | Y1 Production (kWh) | % Energy Offset | Pre-Solar Utility Bill | Year 1 Savings | Year 1 Savings (%) | 20 Year Savings |
|---|---|---|---|---|---|---|---|---|---|---|
| Sinsheimer Swim Center | $0.1649 | 0% | 410 | 0 | 687,763 | 87% | $187,064 | $34,171 | 18% | $2,120,757 |
| Firehouse / Data Center | $0.2004 | 0% | 131 | 0 | 221,685 | 55% | $104,865 | $4,206 | 4% | $435,136 |
| MOT / Bus Yard | $0.1772 | 0% | 291 | 0 | 502,630 | 13% | $849,920 | ($5,176) | -1% | $633,805 |
| Total | $0.1749 | 0% | 832 | 0 | 1,412,078 | 28% | $1,141,849 | $33,201 | 3% | $3,189,699 |

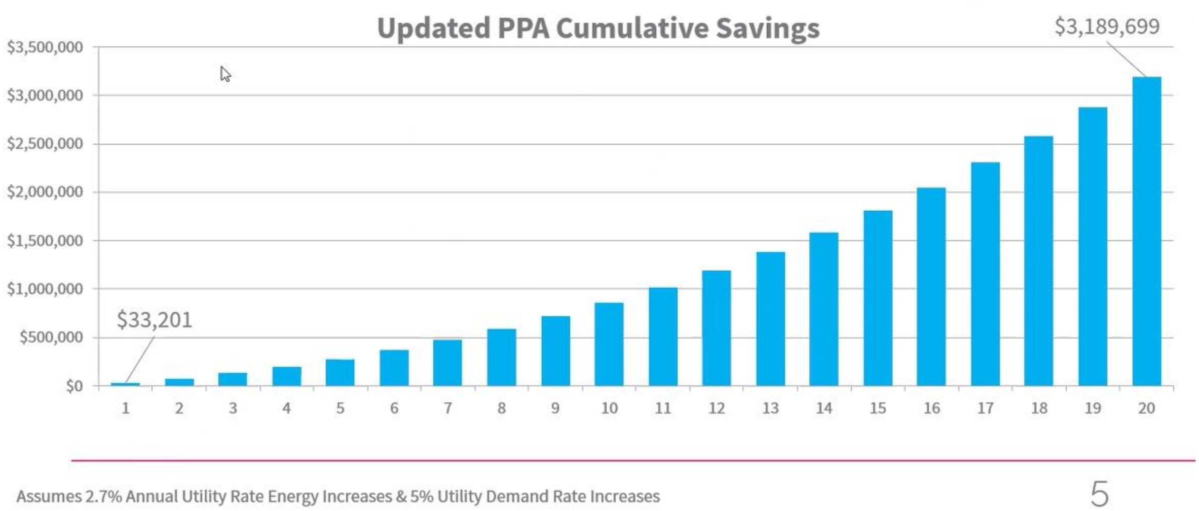



**Figure 19: ForeFront Solar Proposal - PPA Procurement**

### ADDITIONAL SOLAR LOCATIONS

The following locations can also be considered in a second phase. There locations could accommodate solar PV systems and would be less cost effective compared to the priority sites.

| Facility | Solar PV Capacity [kW] | Year 1 Generation [kWh] | Annual Offset [%] |
|---|---|---|---|
| City Hall | 80 | 123,000 | 53% |
| Fire Station 2 | 30 | 49,500 | +100% |
| Fire Station 3 | 31 | 51,150 | +100% |
| Fire Station 4 | 26 | 42,900 | +100% |

## SWIM CENTER


Figure 20: SLO Swim Center Solar PV Layout

### SYSTEM INFORMATION

- 409.5 kW-DC PV
- 687,763 kWh Year 1 production
- 87% offset of future load
- EVCS included
- 600A service upgrade required
- Requires PG&E IX App
- PPA Rate: $0.1664
- PPA Escalator: 0%
- Pre-Solar Utility Bill: $196,039
- Year 1 Savings: $39,131
- 20 Year Savings: $2,272,149
- Assumes 2.7% Annual Utility Rate Energy Increases
- Assumes 5% Utility Demand Rate Increases

## BUS YARD

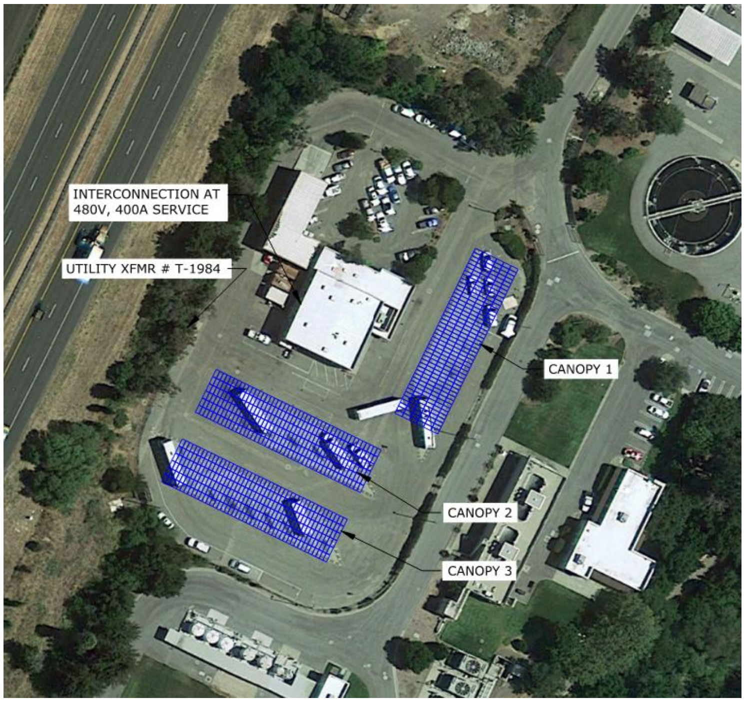



**Figure 21: Bus Yard Solar PV Layout**

### SYSTEM INFORMATION

- 295.6 kW-DC PV
- 510,186 kWh Year 1 production
- 13% offset of existing load (assumes NEM-A benefitting City's B-19 meter)
- No service upgrade required
  - Currently waiting on PG&E transformer upgrade
  - Tentatively planned for March 2023
- PPA Rate: $0.1787
- PPA Escalator: 0%
- Pre-Solar Utility Bill: $878,366
- Year 1 Savings: ($3,166)
- 20 Year Savings: $695,085
- Assumes 2.7% Annual Utility Rate Energy Increases
- Assumes 5% Utility Demand Rate Increases

## FIRE STATION 1


**Figure 22: Fire Station 1 Solar PV Layout**

### SYSTEM INFORMATION

- 131 kW-DC PV
- 221,685 kWh Year 1 production
- 55% offset of both meters
- Assumes EV energy consumption of 98,400 kWh
- No service upgrade required
- Requires PG&E IX App
- Solar only, resiliency ready
  - No BESS, microgrid
- PPA Rate: $0.1994
- PPA Escalator: 0%
- Pre-Solar Utility Bill: $109,248
- Year 1 Savings: $6,400
- 20 Year Savings: $491,186
- Assumes 2.7% Annual Utility Rate Energy Increases
- Assumes 5% Utility Demand Rate Increases

# 5.2 FIRE STATION 1 MICROGRID

## MICROGRIDS

Establishing microgrids at critical facilities within the City of SLO will improve the resilience of the City during an emergency when there is a loss of power. A microgrid can integrate various distributed energy resources and be optimized around lowering real time carbon emissions and utility costs, thus supporting the City's resilience, sustainability, and financial goals. A feasibility study was provided to assess developing a microgrid at the Fire Station 1 and 911 Dispatch Center campus which is an emergency facility that is critical for the resilience of the City and County of San Luis Obispo.

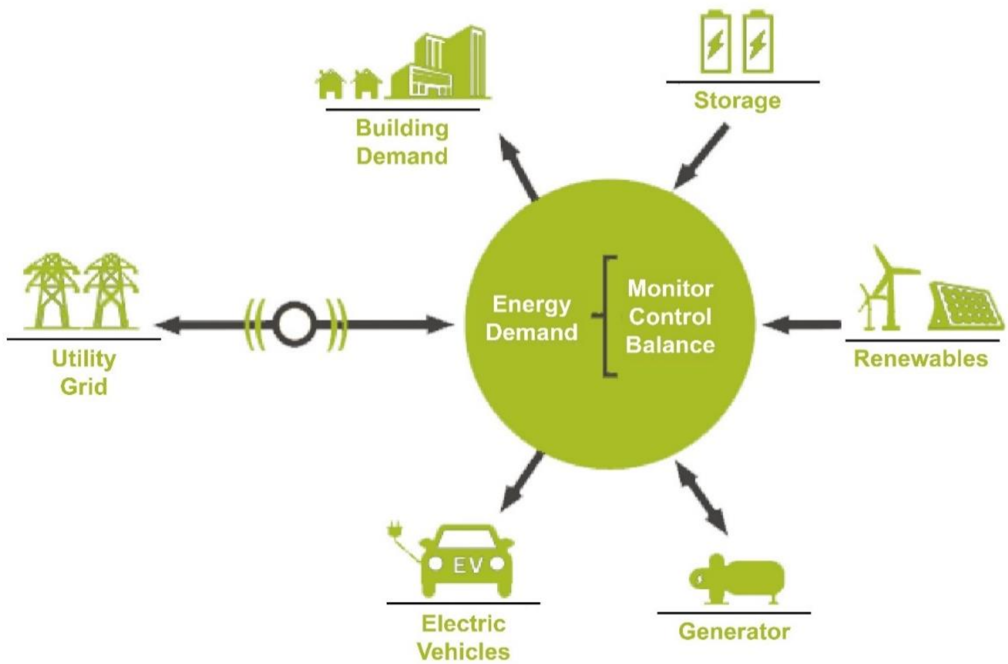



Figure 23: Microgrid System Diagram

## BACKGROUND & SUMMARY

The City owned parcel is home to both Fire Station 1, located at 2160 Santa Barbara Ave, and the 911 Dispatch Center, located at 1135 Roundhouse St. With both facilities having separate Pacific Gas & Electric (PG&E) meters, the total business-as-usual (BAU) consumption across all campus facilities is approximately 390,000 kWh per year. The site space available for solar PV and BESS is limited due to things like available parking areas, roof type and age, parcel size, flow of traffic for large emergency apparatuses, etc. Much of the current site electricity consumption can be met with a solar PV carport system, as was previously contracted with ForeFront Power ("ForeFront"), though a bit larger than originally discussed. This newly proposed 131 kW-DC solar PV carport system should offset approximately 55% of the anticipated near-future annual electricity consumption at campus facilities and save an estimated $491,186 over the course of the 20-year PPA term.

A BESS can be used to meet most, or all of the resilience needs of the site, though PG&E will limit the capacity of the BESS to meeting current demand of the site. In addition, the existing building electrical service has a remaining capacity of approximately 200 kW, which limits the amount of combined on-site PV and BESS capacity unless pursuing a potentially costly service upgrade. Typically, a BESS has benefits over a generator because it can be used to reduce utility demand charges as well as electricity costs during peak times, whereas a generator is only used during utility outages.

With a utility rate switch, the BESS would provide $14,918 in additional bill savings as well as reduce $CO_2$ emissions by approximately 1,116 pounds per year as compared to the existing diesel generator utilization. In anticipation of future Public Safety Power Shutoff (PSPS) events and worsening natural disasters, the proposed 63 kW / 511 kWh BESS microgrid would provide 6 hours' worth of noninterrupted back-up power to the Fire Station 1 and 911 Dispatch Center campus 88% of the year. For the BESS to work with the PV and grid to reduce demand and affiliated charges for both meters, the interconnection would have to be upstream of the feeder split from the generator. However, since the sites have relatively low and non-peaky demand profiles, the opportunity for demand savings is reduced, To avoid interconnection complexity, the BESS is sized sizing and complexity can be reduced by focusing on resiliency in coordination with the generator and just the Fire Station 1 meter.

Based on the significant upfront cost as well as guidance from the City regarding the ForeFront PPA, we recommend a short-term hold on proceeding with a BESS microgrid until additional state and/or federal funding is available. In the immediate term, we recommend proceeding with the solar PPA with ForeFront with design for future BESS microgrid. Based upon the time constraints related to NEM2.0 availability and supply chain constraints related to procurement, Optony recommends that the City proceed with PV-only at the Fire Station 1 and 911 Dispatch Center campus at the present time with the intent to have the future BESS fully or partially funded by external sources in the near future. Since said future BESS would benefit the site and City from an environmental, resilience, and gross financial perspective, the City should plan to submit applications for any and all future grant opportunities.

Additionally, the City should coordinate with ForeFront to ensure that the solar installation at the Fire Station 1 and 911 Dispatch Center campus is as ready as possible to be "plug-and-play" with a future on-site BESS development. The City should also note that, since PV installation with a PPA would result in ownership of the solar remaining with ForeFront, a future PV-tied BESS microgrid retrofit would almost certainly have to receive the approval of ForeFront, and possibly may have to be built and interconnected by them. We recommend continuing conversations with the ForeFront team regarding the eventual inclusion of a battery and how that will impact the existing PPA terms.

## SITE DESIGN & KEY ASSUMPTIONS

As seen in Figure 24, the proposed solar PV design consists of a 131 kW-DC carport array located above the parcel's southernmost parking lot. This PV system is anticipated to produce approximately 221,685 kWh in Year 1. Dependent on future funding opportunities, the proposed BESS for integration into the existing microgrid ready PV system is 63 kW / 511 kWh, which is recommended to be installed near the existing generator and switchgear on the north side of the mechanic facility and will not trigger a utility service upgrade. By utilizing all available space at the Fire Station 1 and 911 Dispatch Center campus to develop rooftop and parking lot carport arrays, PV generation can be maximized to account for most if not all of the current and future annual electricity consumption on site. This further decreases the amount of annual GHG emissions from the use of non-renewable energy as well as can be paired with a battery microgrid to provide resilience to the campus and additional demand savings through peak shaving and energy arbitrage. Upon site condition review and evaluation of available space, ForeFront found that the limited and broken-up spaces of rooftop solar would not be financially beneficial to include in a PPA. The most efficient build would be single, medium sized carport array, which in turn keeps PV and BESS sizing below an electrical capacity number that would necessitate a utility service upgrade.

Figure 24: Proposed Solar PV Design

In addition to the constraints on the site, the City already holds solar development contracts with ForeFront, which allows the project to benefit from rapid action. By working with ForeFront to install a solar system that has microgrid ready components, the City can maximize savings in anticipation of the future installation of a BESS. Solar and battery installation pricing continues to increase with ongoing supply-chain constraints as well as the quickly approaching NEM2.0 application deadline of mid-April 2023. Below are key assumptions used in the analysis of the proposed solar PV and BESS microgrid:

### KEY ASSUMPTIONS

The analysis provided in this report is as an illustration of the potential financial, resilience, and environmental benefits of solar PV and battery energy storage systems. The assumptions and price points used in the financial modeling are based on current local market conditions within PG&E territory, as of March 1, 2023. Certain laws, regulations, tax incentives, rebates, programs and third-party provided information that is subject and anticipated to change over time.

- Proposed Microgrid Ready PV System Size: 131 kW-DC
- Proposed BESS: 63 kW / 511 kWh
- BESS Max Depth of Discharge: 50%
- Assumed BESS Price: $800 per kWh
- Assumed BESS O&M Price: $20 per kW
- Assumed Incentives: 30% base ITC + 10% adder
- Utility Electricity & Demand Rates: B-10 (Fire Station 1); B-19 (911 Dispatch Center)
- Utility Electricity Cost Escalation Rate: 3%[9]
- PV Panel Degradation Rate: 0.5% per year

[9] This may vary depending on release of PG&E rates.

- BESS Degradation Rate: 3% per year
- Discount Rate: 3%

## OWNERSHIP STRUCTURES

A high-level description of each applicable financial structure is provided below. These descriptions provide useful background for the financial analysis presented and can be used by the City to inform consideration of future projects. In general, the Direct Purchase financing structure provides the greatest long-term savings for entities eligible for incentives but in turn requires a significant initial project investment and ongoing O&M associated costs for the lifespan of the systems. A third-party ownership option typically provides the greatest savings for tax-exempt entities and is thus appealing for local governments, but the expansion of entities eligible for the Investment Tax Credit (IRA) as part of the Inflation Reduction Act (IRA) of 2022 makes cash purchase typically more desirable.

### DIRECT PURCHASE

The City would use existing cash reserves, grant funding, or a loan to purchase the system outright. Under this scenario, the site owner is responsible for all ownership concerns, including O&M, regular system cleaning, insurance, and monitoring of system production. This requires a significant up-front capital expenditure and ongoing operational costs but can often result in higher total savings than other ownership and financing structures. Usually, public agencies cannot take advantage of tax credit benefits, but the recently passed IRA is an exception for both solar and storage installations and extends eligibility of the ITC.

### THIRD-PARTY OWNERSHIP – POWER PURCHASE AGREEMENT

This structure enables site owners to receive electricity from a solar PV system at no upfront costs and allows the tax incentives (i.e., ITC) for solar installations to be monetized by the third-party. The City would enter a contract of typically 20 years with a third-party to purchase all energy produced by a solar PV system installed on the property in question. This third-party would own the solar PV system and be fully responsible for all ownership costs, including financing, O&M, insurance, and system output. The site host pays a fixed rate for the electricity produced by the solar array for the duration of the contract.

In PPAs that include a storage system, the simplest approach is to spread the additional cost of the storage system across the energy produced by the solar array and discharged by the battery and increase the fixed rate for electricity. PPAs typically include a yearly price escalator between 0-3%. The value of this escalator relative to the rate at which utility prices increase will affect the savings in future years. Monthly payments may be lower than current or projected utility bills starting on day one, resulting in immediate savings. It is important to note that, if the City moves forward with a project, final pricing will be offered by developers and are subject to the assumptions utilized in the analysis.

### INCENTIVES

As part of the recently passed IRA, the City is anticipated to be eligible for the full ITC base amount. The ITC is a federal tax credit for up to 30% that allows for significant cash-flow benefits and can lead to lower pricing for the installation of solar PV and battery energy storage via a direct reimbursement from the Internal Revenue Service (IRS). There are also additional ITCs, often referred to as adders, available for projects that meet specific requirements surrounding the use of domestic content or being located in an IRS defined energy community and/or low-income areas that have the potential to increase the base 30% ITC amount by 10%-20% per adder. The energy storage configuration in this analysis assumes that the battery is restricted to only charging from on-site solar energy and therefore is eligible to claim the full 100% ITC value. It is important to be aware of the time-sensitive nature of this tax credit, which is scheduled to step down beginning 2033.

The City may also be eligible for the anticipated Microgrid Incentive Program through PG&E. This program is intended to fund clean energy microgrids to support critical infrastructure facilities that keep communities safe.[10] The CPUC approved $200M with the anticipated launch date in 2023. The Grants Management department of the California Governor's Office of Emergency Services[11] may have an/or release grants surrounding battery storage as well as California Grants Portal.[12]

## MICROGRID MODELING

### RESILIENCE ASSESSMENT

Based on the proposed battery microgrid design and the historical energy consumption of the shared campus, the 63 kW/ 511kWh BESS would provide a 24-hour full ride-through (assuming NO load-shedding) in approximately 18% of annual grid outages. Modeling shows that a 6-hour ride-through, again without any load-shedding, would be possible in 100% of situations and a 12-hour ride-through possible in 83%. This assumes that the BESS remaining charge is limited to 50%. This ensures the battery has enough capacity at any given time to provide at least 6 hours' worth of backup power in the event of an outage or PSPS event. When accounting for the existing on-site 300 kW diesel generator that can provide additional back-up support to guarantee a full 24-hour ride through during extenuating circumstances and acknowledging that a larger battery capacity would require a costly utility service upgrade to the existing electrical switchgear, the solution that appears to best fit the constraints substantially is the system size developed in coordination between ForeFront and Optony and presented as the proposed BESS.

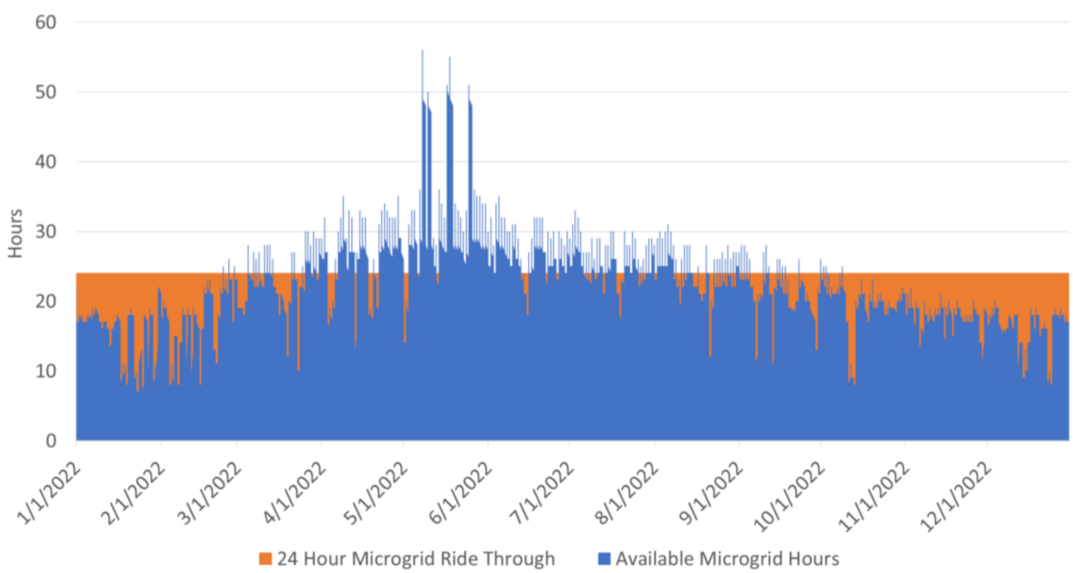



Figure 25: Available Microgrid Hours During Grid Outage

[10] https://www.pge.com/en_US/safety/emergency-preparedness/natural-disaster/wildfires/microgrid-incentive-program.page?WT.mc_id=Vanity_mipworkshops
[11] https://www.caloes.ca.gov/office-of-the-director/policy-administration/finance-administration/grants-management/
[12] https://www.grants.ca.gov/

## ENVIRONMENTAL IMPACTS

With the consideration of the City's community-wide Climate Action Plan goal of carbon neutrality by 2035, the environmental impacts of the proposed solar PV and BESS microgrid have been analyzed. The current PG&E energy mix used to power the Fire Station 1 and 911 Dispatch Center campus is estimated to produce approximately 332,726 pounds of $CO_2$ per year per kWh of electricity.[13] In the long term, the City's participation with Central Coast Community Energy (CCCE) will cut out most or all of those carbon dioxide emissions. However, use of the generator, while infrequent as depicted in Figure 3, will create some additional emissions. The PV will generate clean, local energy, whilst the BESS will take the place of most if not all of the associated generator emissions, rendering the generator use unnecessary except in the most long-lasting emergency situations.

By supplementing the utilization of the onsite 300 kW diesel generator with solar PV and BESS, the City can reduce the amount of $CO_2$ emissions from burning fossil fuels. The City is estimated to reduce $CO_2$ emissions by 496 pounds for every hour the generator does not need to run.[14] This assumes the generator utilizes an average of 22.1 gallons of diesel per hour, based on specifications of similar makes and models on the market.[15] Considering the average outage length in the given area is approximately 2 hours[3] and interruptions occur approximately 1.125 per year, the City would reduce its annual greenhouse gas (GHG) emissions by approximately 1,116 pounds.

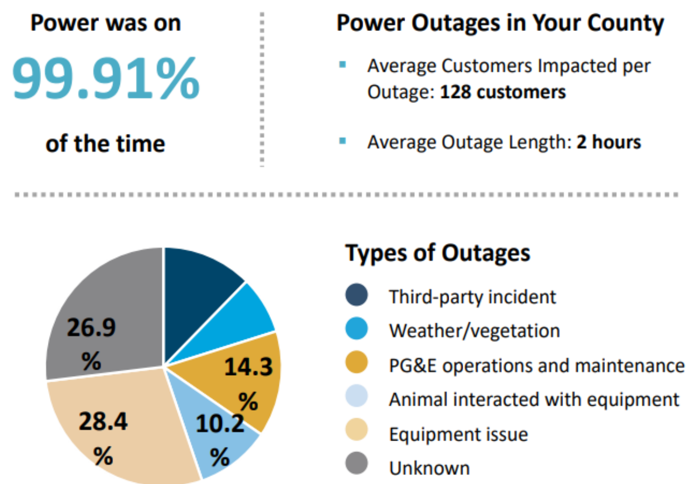



Figure 26: PG&E Power Outages

## FINANCIAL MODELING

Among facility reliability options, BESS is a more beneficial option than a diesel generator because, in addition to significantly lower GHG emissions, the BESS can also operate to reduce utility demand (power needed instantaneously from the electrical grid) and can shift energy needs from higher-priced periods of the day to lower-priced periods, through energy arbitrage. In many cases, the electrical bill savings from demand shaving and energy arbitrage can produce a compelling payback period for BESS. With the addition of a BESS, the City would experience an additional $15,000 in utility bill savings. There is widespread anticipation that grants from state and federal sources will become available in the near future, enabling the City's resilience goals to be met through over-arching infrastructure hardening, rather than having to be met through localized spending from the City's general fund. Additionally, the federal government's Investment Tax Credit could enable 30% or more of the future costs of a BESS installation to be compensated back to the City or credited to a future developer. The following analysis was provided for a cash purchase of the BESS systems. Please refer to Table 9 for key financial inputs and metrics and Table 10 for the associated pro forma.

[13] https://www.eia.gov/tools/faqs/faq.php?id=74&t=11
[14] https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references
[15] https://www.generac.com/Industrial/products/diesel-generators/configured/300kw-diesel-generator

Table 8: Key Financial Inputs & Metrics – Cash Purchase

| Key Financial Metrics | | | | Key Inputs | |
|---|---|---|---|---|---|
| **BESS Cost per kWh** | $800 | **Bill Savings Year 1** | $14,918 | **BESS Degradation** | 3% |
| **Upfront Payment** | $408,800 | **25-Year Bill Savings** | $472,009 | **Discount Rate** | 3% |
| **25-year O&M Cost** | $45,939 | **25-Year IRR** | 4% | **Payback Period** | 17 years |
| **Total Project Costs** | $454,739 | **25-Year ROI** | 40% | | |
| **Total Incentives** | $163,520 | **25-Year NPV** | $32,548 | | |
| **Net Payments** | $291,29 | | | | |

Table 9: Cash Purchase Pro Forma

| Years | Project Costs | O&M | Direct Pay - ITC | Electric Bill Savings | Total Cash Flow | Cumulative Cash Flow |
|---|---|---|---|---|---|---|
| Upfront | $ (408,800) | $ - | $ - | $ - | $ (408,800) | $ (408,800) |
| 1 | $ - | $ (1,260) | $ 163,520 | $ 14,918 | $ 177,178 | $ (231,622) |
| 2 | $ - | $ (1,298) | $ - | $ 14,825 | $ 13,527 | $ (218,095) |
| 3 | $ - | $ (1,337) | $ - | $ 14,713 | $ 13,376 | $ (204,719) |
| 4 | $ - | $ (1,377) | $ - | $ 14,582 | $ 13,205 | $ (191,513) |
| 5 | $ - | $ (1,418) | $ - | $ 14,429 | $ 13,011 | $ (178,503) |
| 6 | $ - | $ (1,461) | $ - | $ 14,254 | $ 12,793 | $ (165,709) |
| 7 | $ - | $ (1,505) | $ - | $ 14,054 | $ 12,549 | $ (153,160) |
| 8 | $ - | $ (1,550) | $ - | $ 13,831 | $ 12,281 | $ (140,878) |
| 9 | $ - | $ (1,596) | $ - | $ 13,581 | $ 11,985 | $ (128,893) |
| 10 | $ - | $ (1,644) | $ - | $ 13,304 | $ 11,660 | $ (117,233) |
| 11 | $ - | $ (1,693) | $ - | $ 20,256 | $ 18,563 | $ (98,671) |
| 12 | $ - | $ (1,744) | $ - | $ 20,137 | $ 18,393 | $ (80,278) |
| 13 | $ - | $ (1,796) | $ - | $ 19,994 | $ 18,198 | $ (62,080) |
| 14 | $ - | $ (1,850) | $ - | $ 19,823 | $ 17,973 | $ (44,108) |
| 15 | $ - | $ (1,906) | $ - | $ 19,624 | $ 17,718 | $ (26,390) |
| 16 | $ - | $ (1,963) | $ - | $ 19,395 | $ 17,432 | $ (8,958) |
| 17 | $ - | $ (2,022) | $ - | $ 19,135 | $ 17,113 | $ 8,155 |
| 18 | $ - | $ (2,083) | $ - | $ 18,842 | $ 16,759 | $ 24,915 |
| 19 | $ - | $ (2,145) | $ - | $ 18,514 | $ 16,369 | $ 41,284 |
| 20 | $ - | $ (2,209) | $ - | $ 18,150 | $ 15,941 | $ 57,224 |
| 21 | $ - | $ (2,276) | $ - | $ 27,501 | $ 25,225 | $ 82,450 |
| 22 | $ - | $ (2,344) | $ - | $ 27,350 | $ 25,006 | $ 107,456 |
| 23 | $ - | $ (2,414) | $ - | $ 27,165 | $ 24,751 | $ 132,206 |
| 24 | $ - | $ (2,487) | $ - | $ 26,945 | $ 24,458 | $ 156,665 |
| 25 | $ - | $ (2,561) | $ - | $ 26,687 | $ 24,126 | $ 180,790 |
| **Total** | **$ (408,800)** | **$ (45,939)** | **$ 163,520** | **$ 472,009** | **$ 180,790** | **$ -** |

## RATE STRUCTURE ANALYSIS

With the consideration of the PG&E-CCCE 3Cchoice program, the City would experience further bill savings in the form of reduced energy and demand charges by switching from the current rate schedules on both meters to B-19 Option S (voluntary). The tables below display a representation of estimated current and new electric bills for the Fire Station 1 and 911 Dispatch Center campus after the installation of a PV and BESS microgrid. The analysis is based on the most current rates (updated March 1st, 2023) under the facility's existing PG&E/CCCE commercial tariffs, B-10 and B-19, and anticipated switch to B-19 Option S. According to the California Public Utilities Commission (CPUC), customers taking service under NEM 2.0 may add battery storage to existing PV systems without altering their status.[16]

**Table 10: Comparison of Current and New Electricity Bills**

| Site | Current Charges | New Charges (w/o rate change) | New Charges (w/ rate change) |
|---|---|---|---|
| Fire Station 1 | $31,837 | $12,194 | $10,402 |
| 911 Dispatch Center | $49,453 | $27,858 | $24,429 |

**Table 12: Current Fire Station 1 Electric Bill (PG&E/CCCE B-10)**

| Time Periods | Energy Use (kWh) | | | | Max Demand (kW) | Charges | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Bill Ranges & Seasons | Peak | Part-Peak | Off-Peak | Super Off Peak | NC / Max | Other | NBC | Energy | Demand | Total |
| 1/1/2021 - 2/1/2021 W1 | 2,836 | - | 8,615 | - | 34 | $213 | $336 | $1,533 | $634 | $2,715 |
| 2/1/2021 - 3/1/2021 W1 | 2,484 | - | 7,984 | - | 28 | $192 | $307 | $1,396 | $522 | $2,417 |
| 3/1/2021 - 4/1/2021 W2 | 2,674 | - | 6,299 | 2,612 | 36 | $213 | $340 | $1,470 | $671 | $2,695 |
| 4/1/2021 - 5/1/2021 W2 | 2,334 | - | 5,737 | 2,362 | 28 | $206 | $306 | $1,320 | $522 | $2,354 |
| 5/1/2021 - 6/1/2021 W2 | 2,052 | - | 5,281 | 2,079 | 23 | $213 | $276 | $1,190 | $429 | $2,108 |
| 6/1/2021 - 7/1/2021 S | 2,555 | 2,244 | 6,790 | - | 45 | $206 | $340 | $1,763 | $839 | $3,148 |
| 7/1/2021 - 8/1/2021 S | 2,812 | 2,388 | 7,219 | - | 32 | $213 | $364 | $1,895 | $597 | $3,069 |
| 8/1/2021 - 9/1/2021 S | 2,728 | 2,304 | 6,960 | - | 32 | $213 | $352 | $1,831 | $597 | $2,992 |
| 9/1/2021 - 10/1/2021 S | 2,642 | 2,110 | 6,661 | - | 31 | $206 | $335 | $1,746 | $578 | $2,865 |
| 10/1/2021 - 11/1/2021 W1 | 2,574 | - | 8,763 | - | 36 | $213 | $332 | $1,506 | $671 | $2,723 |
| 11/1/2021 - 12/1/2021 W1 | 2,243 | - | 7,333 | - | 32 | $206 | $281 | $1,275 | $597 | $2,359 |
| 12/1/2021 - 1/1/2022 W1 | 2,367 | - | 7,838 | - | 28 | $213 | $299 | $1,358 | $522 | $2,392 |
| **Total** | **30,301** | **9,046** | **85,480** | **7,053** | **-** | **$2,508** | **$3,867** | **$18,282** | **$7,180** | **$31,837** |

[16] https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M498/K526/498526033.PDF

**Table 13: Current 911 Dispatch Center Electric Bill (PG&E/CCCE B-19)**

| Time Periods | Energy Use (kWh) | | | | Max Demand (kW) | | | Charges | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bill Ranges & Seasons | Peak | Part-Peak | Off-Peak | Super Off Peak | NC / Max | Peak | Part-Peak | Other | NBC | Energy | Demand | Total |
| 1/1/2021 - 2/1/2021 W1 | 4,399 | - | 16,624 | - | 34 | - | - | $213 | $616 | $1,867 | $958 | $3,654 |
| 2/1/2021 - 3/1/2021 W1 | 4,043 | - | 15,088 | - | 36 | - | - | $192 | $561 | $1,701 | $1,014 | $3,468 |
| 3/1/2021 - 4/1/2021 W2 | 4,440 | - | 12,204 | 4,512 | 39 | - | - | $213 | $620 | $1,762 | $1,099 | $3,694 |
| 4/1/2021 - 5/1/2021 W2 | 4,334 | - | 11,882 | 4,435 | 41 | - | - | $206 | $606 | $1,719 | $1,155 | $3,686 |
| 5/1/2021 - 6/1/2021 W2 | 4,519 | - | 12,288 | 4,654 | 40 | - | - | $213 | $629 | $1,786 | $1,127 | $3,755 |
| 6/1/2021 - 7/1/2021 S | 4,705 | 3,743 | 13,489 | - | 49 | 47 | 49 | $206 | $643 | $1,977 | $2,327 | $5,154 |
| 7/1/2021 - 8/1/2021 S | 4,969 | 3,928 | 13,991 | - | 42 | 39 | 42 | $213 | $671 | $2,067 | $1,975 | $4,926 |
| 8/1/2021 - 9/1/2021 S | 4,988 | 3,972 | 13,975 | - | 40 | 40 | 40 | $213 | $672 | $2,072 | $1,925 | $4,883 |
| 9/1/2021 - 10/1/2021 S | 4,754 | 3,801 | 13,669 | - | 43 | 39 | 42 | $206 | $652 | $2,002 | $2,003 | $4,863 |
| 10/1/2021 - 11/1/2021 W1 | 4,697 | - | 17,584 | - | 39 | - | - | $213 | $653 | $1,980 | $1,099 | $3,945 |
| 11/1/2021 - 12/1/2021 W1 | 4,418 | - | 16,632 | - | 38 | - | - | $206 | $617 | $1,870 | $1,070 | $3,764 |
| 12/1/2021 - 1/1/2022 W1 | 4,361 | - | 16,464 | - | 35 | - | - | $213 | $611 | $1,850 | $986 | $3,659 |
| **Total** | **54,627** | **15,444** | **173,890** | **13,601** | **-** | **-** | **-** | **$2,508** | **$7,552** | **$22,655** | **$16,738** | **$49,453** |

**Table 1411: New Fire Station 1 Electric Bill (PG&E/CCCE B-10)**

| Time Periods | Energy Use (kWh) | | | | Max Demand (kW) | Charges | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Bill Ranges & Seasons | Peak | Part-Peak | Off-Peak | Super Off Peak | NC / Max | Other | NBC | Energy | Demand | Total |
| 1/1/2021 - 2/1/2021 W1 | 673 | - | 6,157 | - | 19 | $213 | $204 | $864 | $354 | $1,635 |
| 2/1/2021 - 3/1/2021 W1 | 554 | - | 5,041 | - | 17 | $192 | $172 | $708 | $317 | $1,389 |
| 3/1/2021 - 4/1/2021 W2 | 37 | - | 2,979 | 290 | 17 | $213 | $130 | $396 | $317 | $1,056 |
| 4/1/2021 - 5/1/2021 W2 | -363 | - | 1,536 | 7 | 13 | $206 | $96 | $126 | $242 | $671 |
| 5/1/2021 - 6/1/2021 W2 | -685 | - | 3 | -610 | 11 | $213 | $59 | $174 | $205 | $303 |
| 6/1/2021 - 7/1/2021 S | -494 | -1,174 | 2,113 | - | 16 | $206 | $97 | $22 | $298 | $623 |
| 7/1/2021 - 8/1/2021 S | -389 | -1,215 | 2,956 | - | 18 | $213 | $111 | $152 | $336 | $811 |
| 8/1/2021 - 9/1/2021 S | -277 | -935 | 3,057 | - | 14 | $213 | $114 | $227 | $261 | $815 |
| 9/1/2021 - 10/1/2021 S | -68 | -623 | 3,716 | - | 19 | $206 | $135 | $403 | $354 | $1,098 |
| 10/1/2021 - 11/1/2021 W1 | 261 | - | 4,012 | - | 19 | $213 | $144 | $533 | $354 | $1,244 |
| 11/1/2021 - 12/1/2021 W1 | 218 | - | 4,071 | - | 15 | $206 | $133 | $533 | $280 | $1,151 |
| 12/1/2021 - 1/1/2022 W1 | 314 | - | 5,434 | - | 16 | $213 | $171 | $715 | $298 | $1,397 |
| **Total** | **-219** | **-3,947** | **41,075** | **-313** | **-** | **$2,508** | **$1,565** | **$4,504** | **$3,618** | **$12,194** |

**Table 15: New Fire Station 1 Electric Bill (PG&E/CCCE B-19 Option S)**

| Time Periods | Energy Use (kWh) | | | | Max Demand (kW) | | | Charges | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bill Ranges & Seasons | Peak | Part-Peak | Off-Peak | Super Off Peak | NC / Max | Peak | Part-Peak | Other | NBC | Energy | Demand | Total |
| 1/1/2021 - 2/1/2021 W1 | 673 | - | 6,157 | - | 19 | 14 | - | $213 | $204 | $576 | $411 | $1,404 |
| 2/1/2021 - 3/1/2021 W1 | 554 | - | 5,041 | - | 17 | 11 | - | $192 | $172 | $472 | $355 | $1,191 |
| 3/1/2021 - 4/1/2021 W2 | 37 | - | 2,979 | 290 | 17 | 10 | - | $213 | $130 | $260 | $301 | $904 |
| 4/1/2021 - 5/1/2021 W2 | -363 | - | 1,536 | 7 | 13 | 7 | - | $206 | $96 | $80 | $227 | $610 |
| 5/1/2021 - 6/1/2021 W2 | -685 | - | 3 | -610 | 11 | 7 | - | $213 | $59 | $115 | $190 | $347 |
| 6/1/2021 - 7/1/2021 S | -494 | -1,174 | 2,113 | - | 16 | 8 | 14 | $206 | $97 | $66 | $282 | $519 |
| 7/1/2021 - 8/1/2021 S | -389 | -1,215 | 2,956 | - | 18 | 6 | 7 | $213 | $111 | $33 | $301 | $657 |
| 8/1/2021 - 9/1/2021 S | -277 | -935 | 3,057 | - | 14 | 7 | 12 | $213 | $114 | $103 | $249 | $679 |
| 9/1/2021 - 10/1/2021 S | -68 | -623 | 3,716 | - | 19 | 7 | 17 | $206 | $135 | $254 | $329 | $924 |
| 10/1/2021 - 11/1/2021 W1 | 261 | - | 4,012 | - | 19 | 13 | - | $213 | $144 | $354 | $346 | $1,057 |
| 11/1/2021 - 12/1/2021 W1 | 218 | - | 4,071 | - | 15 | 9 | - | $206 | $133 | $354 | $263 | $956 |
| 12/1/2021 - 1/1/2022 W1 | 314 | - | 5,434 | - | 16 | 7 | - | $213 | $171 | $475 | $295 | $1,154 |
| **Total** | **-219** | **-3,947** | **41,075** | **-313** | **-** | **-** | **-** | **$2,508** | **$1,565** | **$2,781** | **$3,549** | **$10,402** |

**Table 126: New 911 Dispatch Center Electric Bill (PG&E/CCCE B-19)**

| Time Periods | Energy Use (kWh) | | | | Max Demand (kW) | | | Charges | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bill Ranges & Seasons | Peak | Part-Peak | Off-Peak | Super Off Peak | NC / Max | Peak | Part-Peak | Other | NBC | Energy | Demand | Total |
| 1/1/2021 - 2/1/2021 W1 | 1,439 | - | 13,125 | - | 29 | - | - | $213 | $428 | $1,229 | $817 | $2,687 |
| 2/1/2021 - 3/1/2021 W1 | 1,344 | - | 10,969 | - | 29 | - | - | $192 | $365 | $1,044 | $817 | $2,419 |
| 3/1/2021 - 4/1/2021 W2 | 304 | - | 8,091 | 1,167 | 29 | - | - | $213 | $305 | $751 | $817 | $2,085 |
| 4/1/2021 - 5/1/2021 W2 | 80 | - | 6,963 | 647 | 28 | - | - | $206 | $268 | $605 | $789 | $1,868 |
| 5/1/2021 - 6/1/2021 W2 | -84 | - | 6,414 | 132 | 26 | - | - | $213 | $245 | $513 | $732 | $1,703 |
| 6/1/2021 - 7/1/2021 S | -273 | -1,371 | 7,969 | - | 34 | 14 | 17 | $206 | $270 | $431 | $1,251 | $2,158 |
| 7/1/2021 - 8/1/2021 S | -224 | -309 | 7,991 | - | 28 | 10 | 28 | $213 | $295 | $529 | $1,069 | $2,106 |
| 8/1/2021 - 9/1/2021 S | -76 | -584 | 9,364 | - | 36 | 11 | 33 | $213 | $320 | $628 | $1,332 | $2,492 |
| 9/1/2021 - 10/1/2021 S | 125 | 219 | 10,142 | - | 35 | 9 | 33 | $206 | $349 | $781 | $1,273 | $2,609 |
| 10/1/2021 - 11/1/2021 W1 | 774 | - | 11,652 | - | 31 | - | - | $213 | $374 | $1,031 | $873 | $2,491 |
| 11/1/2021 - 12/1/2021 W1 | 1,523 | - | 12,211 | - | 29 | - | - | $206 | $404 | $1,166 | $817 | $2,593 |
| 12/1/2021 - 1/1/2022 W1 | 1,060 | - | 13,538 | - | 28 | - | - | $213 | $428 | $1,217 | $789 | $2,647 |
| **Total** | **5,992** | **-2,045** | **118,429** | **1,946** | **-** | **-** | **-** | **$2,508** | **$4,051** | **$9,925** | **$11,375** | **$27,858** |

**Table 137: New 911 Dispatch Center Electric Bill (PG&E/CCCE B-19 Option S)**

| Time Periods | Energy Use (kWh) | | | | Max Demand (kW) | | | Charges | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bill Ranges & Seasons | Peak | Part-Peak | Off-Peak | Super Off Peak | NC / Max | Peak | Part-Peak | Other | NBC | Energy | Demand | Total |
| 1/1/2021 - 2/1/2021 W1 | 1,439 | - | 13,125 | - | 29 | 17 | - | $213 | $428 | $1,229 | $716 | $2,586 |
| 2/1/2021 - 3/1/2021 W1 | 1,344 | - | 10,969 | - | 29 | 19 | - | $192 | $365 | $1,044 | $697 | $2,299 |
| 3/1/2021 - 4/1/2021 W2 | 304 | - | 8,091 | 1,167 | 29 | 11 | - | $213 | $305 | $751 | $538 | $1,807 |
| 4/1/2021 - 5/1/2021 W2 | 80 | - | 6,963 | 647 | 28 | 16 | - | $206 | $268 | $605 | $546 | $1,625 |
| 5/1/2021 - 6/1/2021 W2 | -84 | - | 6,414 | 132 | 26 | 14 | - | $213 | $245 | $513 | $486 | $1,457 |
| 6/1/2021 - 7/1/2021 S | -273 | -1,371 | 7,969 | - | 34 | 14 | 17 | $206 | $270 | $511 | $588 | $1,575 |
| 7/1/2021 - 8/1/2021 S | -224 | -309 | 7,991 | - | 28 | 10 | 28 | $213 | $295 | $659 | $534 | $1,701 |
| 8/1/2021 - 9/1/2021 S | -76 | -584 | 9,364 | - | 36 | 11 | 33 | $213 | $320 | $787 | $635 | $1,955 |
| 9/1/2021 - 10/1/2021 S | 125 | 219 | 10,142 | - | 35 | 9 | 33 | $206 | $349 | $1,009 | $622 | $2,187 |
| 10/1/2021 - 11/1/2021 W1 | 774 | - | 11,652 | - | 31 | 16 | - | $213 | $374 | $1,031 | $626 | $2,244 |
| 11/1/2021 - 12/1/2021 W1 | 1,523 | - | 12,211 | - | 29 | 19 | - | $206 | $404 | $1,166 | $737 | $2,513 |
| 12/1/2021 - 1/1/2022 W1 | 1,060 | - | 13,538 | - | 28 | 13 | - | $213 | $428 | $1,217 | $624 | $2,482 |
| **Total** | **5,992** | **-2,045** | **118,429** | **1,946** | **-** | **-** | **-** | **$2,508** | **$4,051** | **$10,522** | **$7,349** | **$24,429** |

# 6. DEFINITIONS

**Air Conditioning (AC)** Typical term for building heating and cooling equipment.

**Air Cooled Chiller (AC Chiller)** A piece of mechanical equipment that cools water (chilled water) by rejecting heat to air.

**Air to Water Heat Pump (AWHP)** A piece of mechanical equipment that transfers heat from outside air to water for the purpose of building heat or domestic hot water heat. Air to water heat pumps may also run in the opposite cycle and reject heat from a water based system to outside air for the purpose of cooling a building.

**Building Management System (BMS)** A building control system that monitors various systems in a building.

**Business as Usual (BAU)** The business as usual or maintain the status quo case for use in scenario analysis.

**Chilled Water (CHW)** Is the means of cooling in a building served by equipment with chilled water cooling coils.

**Climate Energy Scenario Analysis (CESA)** A tool for comparing different pathways to carbon neutrality. Provides metrics about carbon and cost.

**Coefficient of Performance (COP)** A means of measuring mechanical equipment efficiency. 1 COP = 100%.

**Direct Expansion (DX)** A means of cooling air with a refrigerant based coil and compressor system.

**Domestic Hot Water (DHW)** Hot water used in sinks, showers, pools, etc.

**Electric Vehicles (EV)** Fully electric vehicles.

**Greenhouse Gas (GHG)** The bioproduct of combustion based systems. These gases trap heat in the earth's atmosphere and warm the earth's surface.

**Heat Exchanger (HX)** A mechanical device used to transfer heat from one fluid loop or airstream to another.

**Heating Hot Water (HHW)** The means of delivering heat in a building served by a boiler or heat pump system.

**Heating Ventilation and Air Conditioning (HVAC)** Industry standard acronym.

**Kilowatt Hour (kWH)** Energy metric typically used for electricity.

**Megawatt Hour (MWH)** Energy metric typically used for electricity.

**Metric Tons of Carbon Dioxide Equivalent Emissions (MTCO2e or MTE)** Metric to quantify greenhouse gas emissions.

**Natural Gas (NG)** Fossil fuel based energy typically used for building heat, domestic hot water, and cooking.

**Power Purchase Agreement (PPA)** A long term electricity supply agreement typically using solar.

**Rooftop Unit (RTU)** A packaged mechanical unit that delivers heating and cooling. Units typically run constant volume and are typically served by natural gas heat and direct expansion cooling.

**Seasonal Energy Efficiency Ratio (SEER)** Energy efficiency rating typically used for packaged DX cooling equipment. A ratio of cooling capacity to power input.

**Thousand British Thermal Units (MBH)** Energy unit typically used for natural gas and heating hot water.

**Total Cost of Ownership (TCO)** The overall cost of a product or project over the equipment or project's lifespan. Includes direct and indirect costs.

**Variable Air Volume Air Handling Unit (VAV AHU)** Typical mechanical HVAC unit used in buildings with multiple zones of usage.

**Water to Water Heat Pump (WWHP)** A mechanical piece of equipment that transfers heat from one water source, such as groundwater, to a building side water source.

# 7. APPENDIX

## BUILDING ENERGY ASSESSMENTS

## CESA TRAINING MATERIALS