ZERO EMISSION FACILITY AND FLEET TRANSITION PLAN

TASK 1: EXISTING ELECTRICAL SUPPLY AND ELECTRICAL DEMAND BASELINE ASSESSMENT

SFMTA

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ACRONYMS AND ABBREVIATIONS

ACRONYM	TERM
BEB	Battery-electric bus
CAIDI	Customer Average Interruption Duration Index
CARB	California Air Resources Board
CPUC	California Public Utilities Commission
ICA	Integration Capacity Analysis
ICT	Innovative Clean Transit
kV	kilovolt
kVA	kilo-volt-ampere
MAIFI	Momentary Average Interruption Frequency Index
MDP	main distribution panels
MSB	Main switchboard
MW	megawatts
PG&E	Pacific Gas & Electric
PSPS	public safety power shutoffs
PVRAM	Photovoltaic and Renewable Auction Mechanism
NRV	non-revenue vehicles
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SFMTA	San Francisco Municipal Transportation Agency
SFPUC	San Francisco Public Utilities Commission
ZE	zero-emission(s)
ZEB	zero-emission bus

1 INTRODUCTION

1.1 STUDY BACKGROUND

San Francisco Municipal Transportation Agency (SFMTA) is a national leader in confronting climate change and is already embracing the prospects of a zero-emission (ZE) future. SFMTA is taking multiple steps to meet the requirements of the California Air Resource Board's (CARB) Innovative Clean Transit (ICT) regulation, which requires all transit agencies to operate 100 percent zero-emission buses (ZEBs) by 2040, and its own ambitious goals to operate all ZEBs by 2035.

The goal to operate all ZEBs by 2035 was a resolution adopted by SFMTA's Board in 2018 and requires SFMTA to begin purchasing 100% BEBs starting by 2025.

Pursuant to SFMTA's electrification goals, in February 2020, SFMTA partnered with WSP to provide a roadmap for SFMTA's transition to an all-ZEB fleet. Project elements include: facility modification recommendations at SFMTA's six bus yards, battery electric bus (BEB) modeling and analysis, financial modeling, and other supporting activities.

1.2 UTILITY BACKGROUND

The San Francisco Public Utilities Commission (SFPUC) provides electrical service for the SFMTA service area by way of the Pacific Gas & Electric (PG&E) electrical infrastructure. SFPUC acts as the major provider for all San Francisco public services, including SFMTA, and has ties to the Hetch Hetchy California reservoir and water system project, which provides some power. However, for all the facilities that are near the SFMTA sites, the distribution grid in the area is owned by PG&E, and SFPUC acts as an intermediary between PG&E and SFMTA.

Additionally, there is a "Bay Corridor Transmission and Distribution" project that is currently in process that may be able to provide more power to the various SFMTA sites. As part of this project, SFPUC is in the process of building a new 230 kilovolt (kV)/12kV GIS Substation to be completed in 2021, which is fed from PG&E's Potrero substation. SFPUC's new substation will feed an estimated total of 60 megawatts (MW) of existing and future loads through 12kV feeders.

1.3 REPORT PURPOSE AND STRUCTURE

The purpose of the Existing Electrical Supply and Electrical Demand Baseline Assessment Report is to document the condition of the existing electrical supply and demand infrastructure at each bus yard.

The WSP team collaborated with SFPUC and SFMTA staff to collect data and assess existing conditions. Tools such as PG&E's Photovoltaic and Renewable Auction Mechanism (PVRAM) system and Integration Capacity Analysis (ICA) system provided existing circuit[1] capacities, peak demand, time of demand peaks, and loads at circuits' substations, since substations may provide power to multiple sites. From there, an estimate of the total grid capacity that PG&E may have in the area was analyzed. However, it is important to note that estimates and assumptions need to be verified by both PG&E and SFPUC.

Site visits were conducted by SFMTA staff, Jacobs, and VGG on July 14th and 16th, 2020. During these visits, the project team observed operations, took photos, and captured sizing and configuration information for existing infrastructure. Islais Creek was inaccessible due to construction.

1 For the purposes of this report, circuit and feeder are synonymous, however, the main distinction is that a feeder can sever many different customers and that a circuit is a connection to said feeder.

The Existing Electrical Supply and Electrical Demand Baseline Assessment Report provides yard-specific information for each of SFMTA's six bus yards, as well as background on system-wide reliability, and next steps. Each yard's section is structured as follows:

1 **Existing Conditions** - *Provides information on existing locations and facilities, site circulation, and existing electrical infrastructure (power use date and capacity, substations, circuits, transformers, use of existing on-site generation, etc.).*

2 **Infrastructure Requirements** - *Outlines siting requirements to accommodate additional infrastructure and the potential capacity that each yard can tap into.*

The report concludes with information about San Francisco's grid reliability and conclusions and next steps towards electrification.

2 FLYNN YARD

2.1 EXISTING CONDITIONS

This section summarizes Flynn Yard's location and facilities, site circulation, and existing electrical infrastructure.

2.1.1 LOCATION AND FACILITIES

Flynn Yard is located at 1940 Harrison Street with electrical utility service provided by the SFPUC by way of PG&E infrastructure.

Currently, 124 diesel 60-foot articulated buses are stored, maintained, fueled, and serviced at Flynn Yard. The yard includes the following major site areas which are all housed within a single one-story structure: maintenance area with drive-through bays, transportation area built within the overall structure, stand-alone wash canopy, and a stand-alone fuel canopy.

A tire shop is located separately from the main facility in a building across Harrison Street. The southeast corner of the main Flynn Yard has a cutout which houses separate businesses not related to or owned by SFMTA.

Figure 2-1 and Figure 2-4 present Flynn Yard's existing conditions.

Figure 2-1. Flynn Yard - Aerial

Source: Google Earth

2.1.2 SITE CIRCULATION

Buses enter from Harrison Street and are parked in unassigned, stacked (nose-to-tail), 11’6”-wide lanes in the northern circulation area. Individual buses are then pulled from the storage area and taken by nightly service staff to the fuel lanes for fare retrieval, interior cleaning, and fueling before pulling forward to the bus wash lanes. After fuel and wash, buses are re-parked in the storage area. Buses remain parked until morning pullout unless a maintenance issue has been identified. Non-revenue vehicles (NRVs) are parked in a row of spaces near the transportation area adjacent to the bus circulation northernmost lane.

Figure 2-2 and Figure 2-3 present Flynn Yard’s bus parking and maintenance facility, respectively.

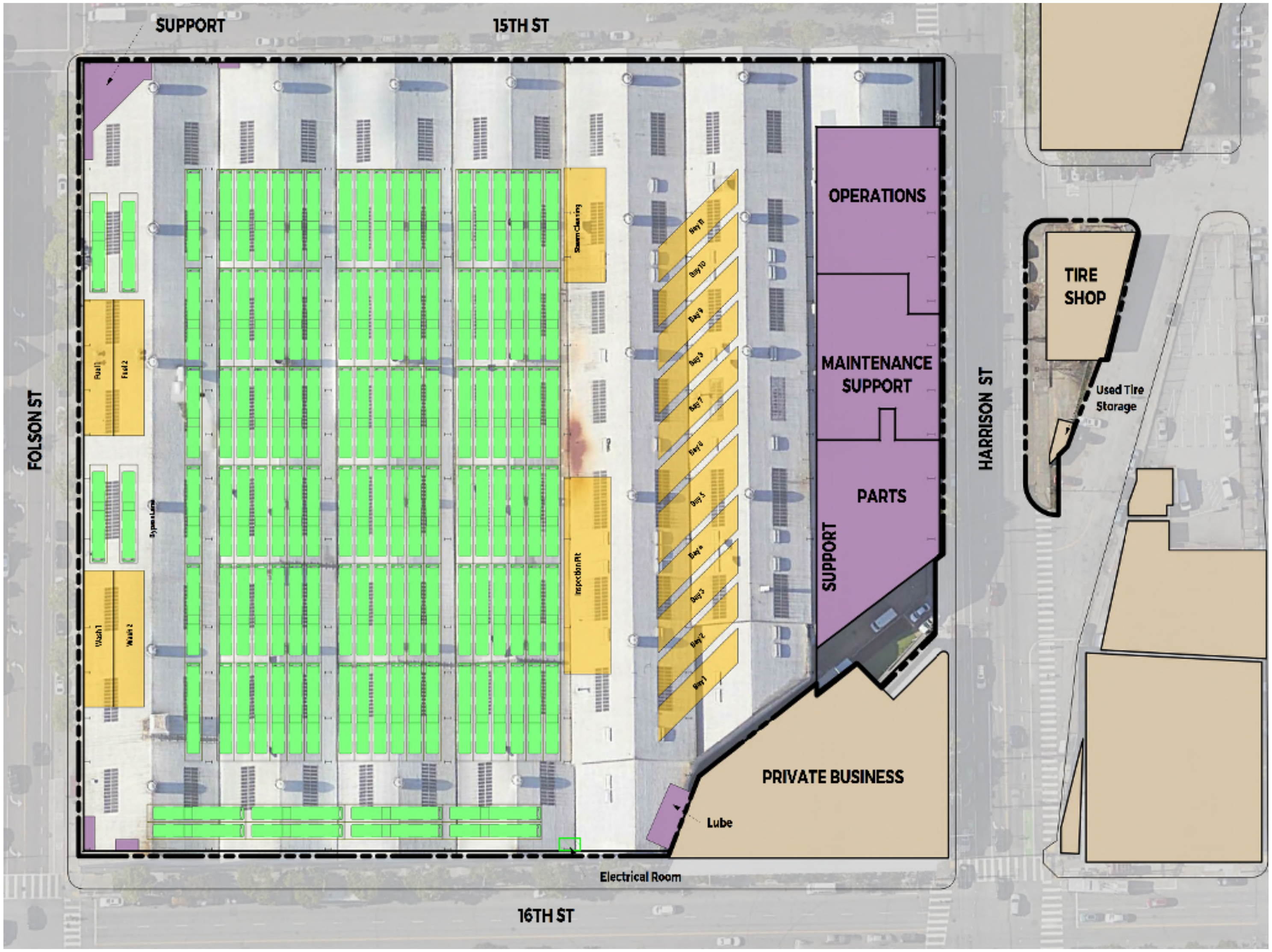
Figure 2-2. Flynn Yard - Bus Parking

Source: SFMTA

Figure 2-3. Flynn Yard – Maintenance Facility

Source: SFMTA

Figure 2-4. Flynn Yard – Existing Site Plan



Source: WSP

2.1.3 ELECTRICAL INFRASTRUCTURE

The following section provides information on the existing substation, circuit, transformer, switchboards and meter(s) that support Flynn Yard's electrical needs.

SUBSTATION

Flynn Yard's power is provided by the Potrero Substation that is located along Illinois Street between 23rd Street and 24th Street, approximately 2.2-miles from the yard.

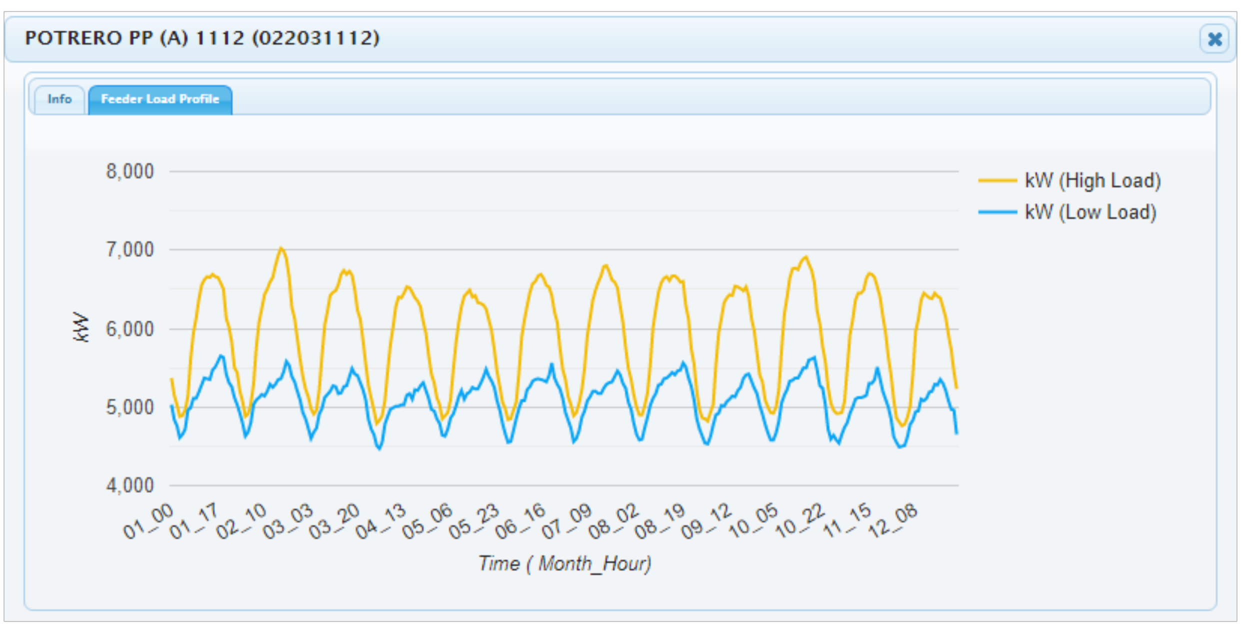
The Potrero Substation has a distribution capacity of 74 MW. The POTRERO PP (A) 1112 Circuit (Potrero 1112 Circuit) feeds Flynn Yard.

CIRCUIT

The Potrero 1112 feeder provides a 12-kV circuit that is fed from the Potrero Substation. The Potrero 1112 feeder has an existing capacity of 9.5 MW. PG&E estimates that the projected peak load of this circuit is 7.2 MW, leaving approximately 2.3 MW of available capacity. The circuit enters the yard on the ground floor of the southeast side of the property on Harrison Street and is one of two circuits that provide service to Flynn Yard.

Peak loads for the Potrero 1112 Circuit are monitored by PG&E and published on the ICA map, which shows the feeder's load profile averages for peak usage of power on the Potrero 1112 circuit by month and time of day for all customers who are served by this feeder. The load increases in winter months and has peaks at 9 AM and 8 PM. Usage is at its minimum between 2 AM and 6 AM. The x-axis on Figure 2-5 shows the month and hour of the load profile for the circuit. For example, 01_00 to 01_17 shows the average load profile of the circuit between the hours of 1:00 (1 AM) and 17:00 (5 PM) for the month of January. The high loads show the max average recorded loads for high demand days during that month, such as an unusually cold or hot day when HVAC usage is at its maximum. The low load shows the minimum average load, for when power usage was not as high. Table 2-1 shows load information for all customers in the area, not limited to the SFMTA Flynn Yard, who are served by the Potrero 1112 circuit. The metrics for this circuit are shown in Figure 2-5 and Table 2-1.

Figure 2-5. Flynn Yard - Potrero 1112's Load Profile



Source: PG&E

Table 2-1. Flynn Yard - Potrero 1112's Load Information

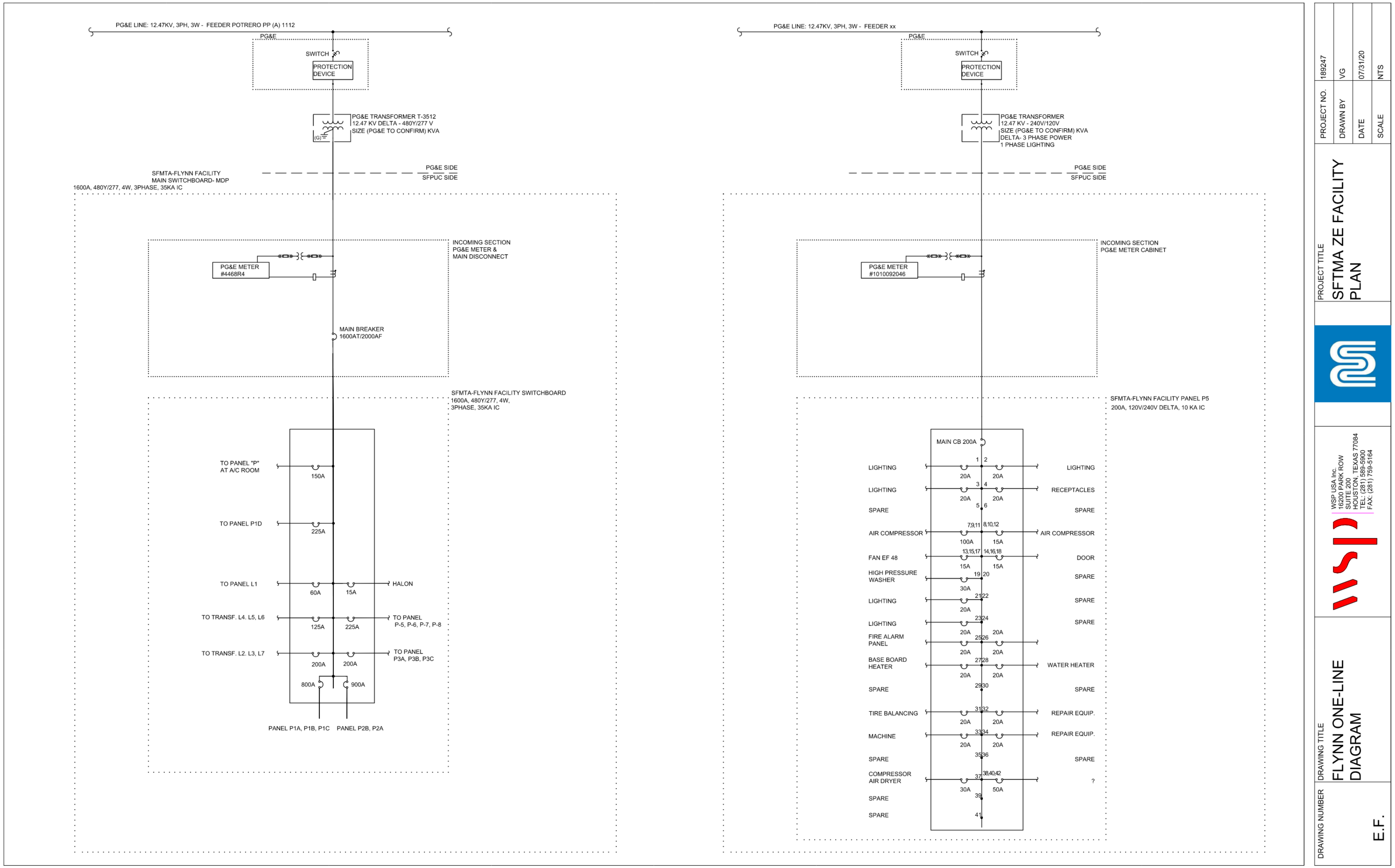
DESCRIPTION	DATA
Feeder Name	POTRERO PP (A) 1112
Feeder Number	022031112
Nominal Circuit Voltage (kV)	12
Circuit Capacity (MW)	9.52
Circuit Projected Peak Load (MW)	7.23
Substation Bank	1
Substation Bank Capacity (MW)	74.30
Substation Bank Peak Load (MW)	46.68
Existing Distributed Generation (MW)	0.42
Queued Distributed Generation (MW)	0.20
Total Distributed Generation (MW)	0.62
Total Customers	685
Residential Customers	480
Commercial Customers	119
Industrial Customers	73
Agricultural Customers	1
Other Customers	12

Source: PG&E

TRANSFORMER

Flynn Yard has two meters. The first, Meter 4468R4, is fed by a PG&E-owned and maintained pad-mounted transformer. The second, Meter 1010092046, is fed by a pole-mounted transformer maintained by PG&E. Based on as-built drawings, PG&E service is on the east side of Harrison Street, close to 16th street. Figure 2-6 presents the single-line diagram from the transformer(s) to the yard's electrical infrastructure.

Figure 2-6. Flynn Yard - Single Line Diagram for PG&E Service Connection



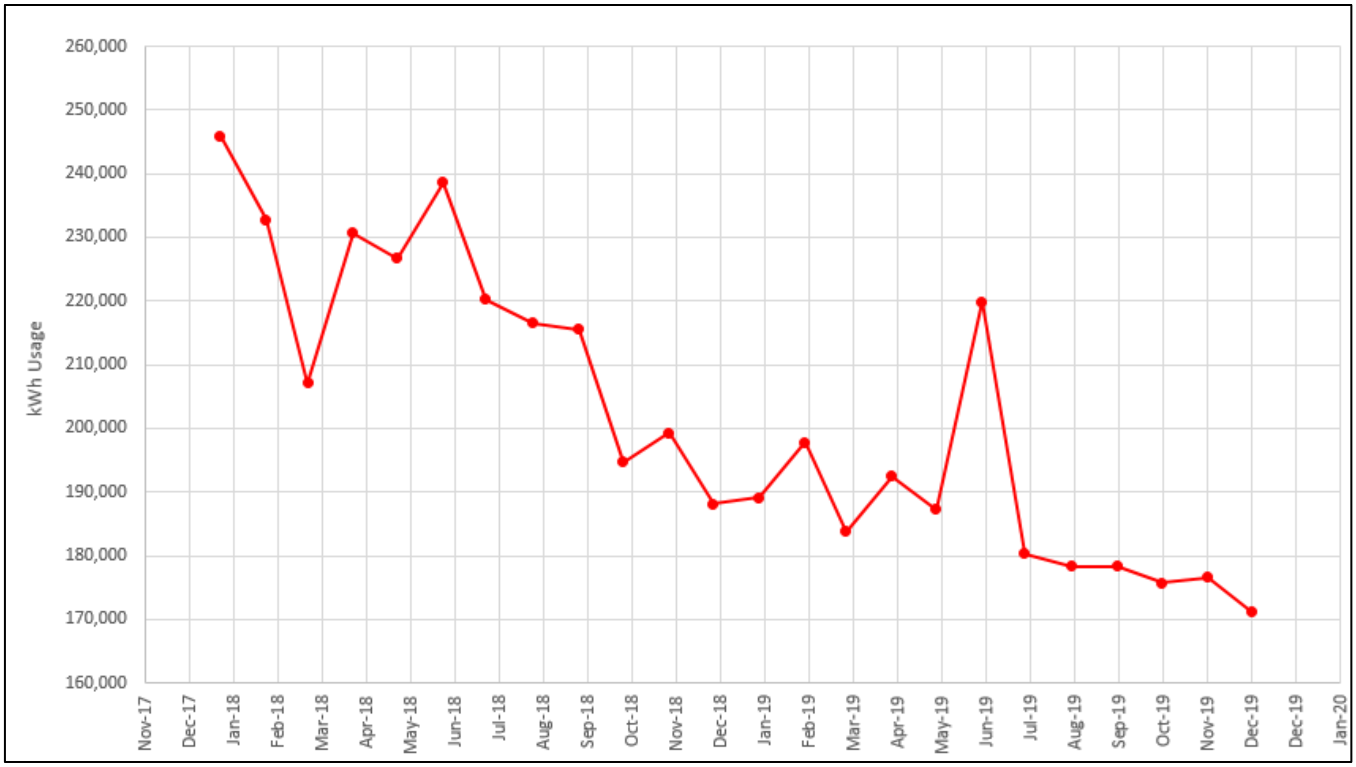
Source: SFMTA

METERS AND USAGE

Flynn Yard's primary meter (Meter RG4D8), serves the main yard while the minor meter (Meter 5369521605) is a for small loads located east, across the street at the tire/wash building.

Meter RG4D8's usage data between December 2017 and December 2019 reveals that the yard uses an average of 201,958 kilowatt-hour (kWh) per month, peaking at 245,929 kWh in December 2017. The maximum peak load on this meter is 454 kW, recorded on May 6, 2019 and the average cost per kWh is approximately $0.075. Figure 2-7 illustrates Meter RG4D8's usage.

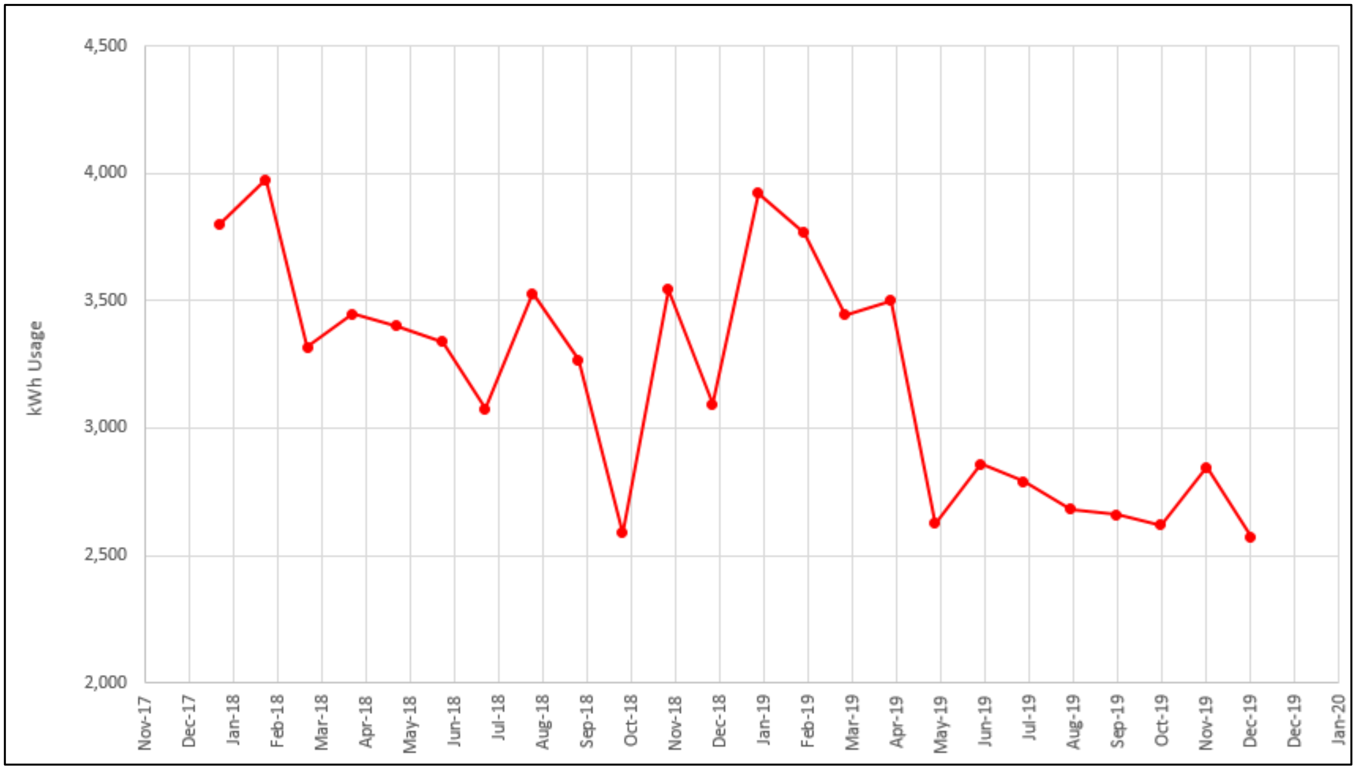
Figure 2-7. Flynn Division – Meter RG4D8's Usage (December 2017 – 2019)



Source: Jacobs, SFPUC

Meter 5369521605's usage data between December 2017 and December 2019 reveals that the yard uses an average of 3,194 kWh per month, peaking at 3,795 kWh in January 2018. The maximum peak load on this meter is 28 kW, recorded on January 7, 2019 and the average cost per kWh is approximately $0.075. Figure 2-7 illustrates Meter 5369521605's usage.

Figure 2-8. Flynn Yard – Meter 5369521605's Usage (December 2017 – 2019)



Source: Jacobs, SFPUC

SWITCHBOARD

The main distribution panels (MDPs) for both meters were installed in 1989 and are in fair condition.

The MDP for Meter RG4D8 is housed in the electrical room on the ground floor. The MDP consists of a480Y/277V, three-phase, 4W panels with a service capacity of 1,600A and 35kA of interrupting capacity.

The MDP for Meter 5369521605 is located on the northwest wall in the Wash building. The MDP is a 120/240V delta three-phase, 4W panel with a capacity of 200A and 10kA of interrupting capacity.

RESILIENCY

Flynn Yard currently has a 60-kW diesel generator permanently stationed on-site to serve as a backup for critical loads.

2.2 INFRASTRUCTURE REQUIREMENTS

To support BEBs, Flynn Yard will require additional electrical capacity, which will require site modifications to accommodate additional and enhanced electrical infrastructure. The following sections summarizes the location and space requirements, and infrastructure required to support BEB charging.

2.2.1 LOCATION AND SPACING

To support the proposed BEB charging distribution and infrastructure, the Flynn Yard will utilize overhead pantograph (or plug-in) charging mounted from a new overhead support structure frame. The existing structure inside of the Flynn facility has adequate spacing to allow for the independent support system to be constructed without modifications to the existing overhead structure.

Bus parking spaces in the interior bus parking area must be sized at a 12'-0" wide at a minimum to allow adequate spacing for the overhead support structure supporting the electrical infrastructure, charging equipment, and overhead distribution of power throughout the bus yard.

Two electrical utility service interrupters are expected to be required for bringing the new electrical service required to serve BEBs on this site and are proposed be located on the exterior of the site along 16th Street.

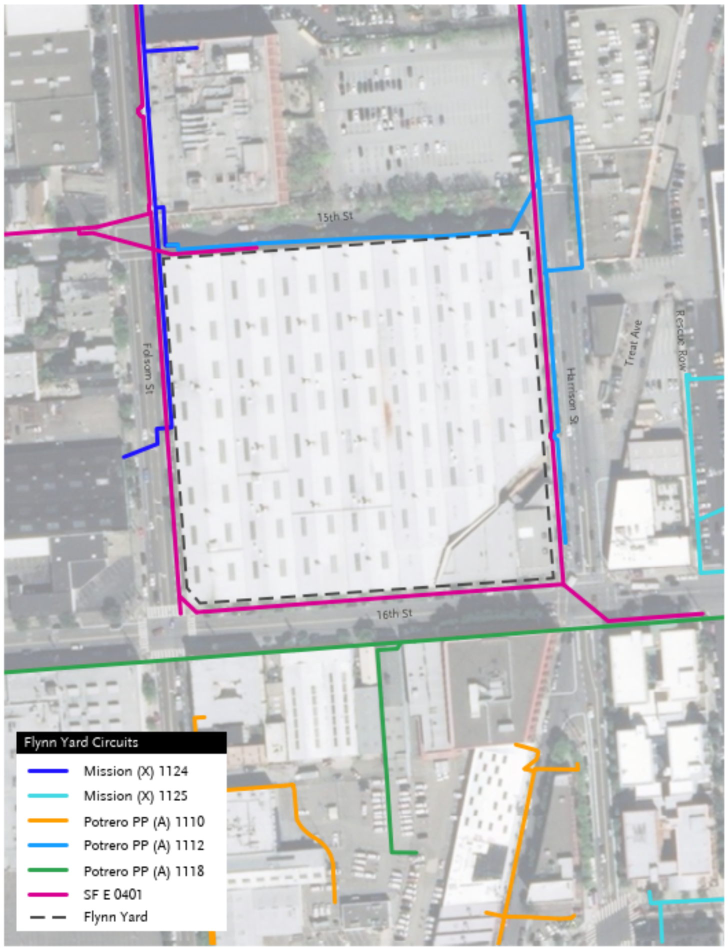
2.2.2 ELECTRICAL ENHANCEMENTS

It is very likely that existing capacity at Flynn Yard will not be sufficient to support a fleet of BEBs based on an initial estimated requirement of 9MW.

As previously mentioned, there is approximately 2.3 MW of available capacity on the Potrero 1112 Circuit, and per the existing single-line diagram, the existing MDP for Meter RG4DB has capacity for an additional 250-kW load.

There are three 12-kV and one 4.2-kV circuits near Flynn Yard, per PG&E's PVRAM map, a tool that shows available electric distribution lines, substations, and transmission lines available to properties in their service area. The adjacent circuits may be a factor in providing additional power to Flynn Yard. For example, the nearby POTRERO PP (A) 1118 has an available circuit capacity of 6.2 MW. Figure 2-9 and Table 2-2 present and provide information on nearby circuits.

Figure 2-9. Flynn Yard – Nearby Circuits



Source: PG&E

Table 2-2. Flynn Yard – Nearby Circuits Summary

CIRCUIT NAME	VOLTAGE	CIRCUIT CAPACITY (MW)	CIRCUIT MAX LOAD (MW)	SUBSTATION BANK CAPACITY (MW)	SUBSTATION BANK MAX LOAD (MW)	AVAILABLE CIRCUIT CAPACITY (MW)	AVAILABLE BANK CAPACITY (MW)
POTRERO PP (A) 1112	**12 kV**	**9.52**	**7.23**	**74.3**	**46.68**	**2.29**	**27.62**
POTRERO PP (A) 1110	12 kV	9.99	6.31	74.3	46.68	3.68	27.62
SF E 0401	4 kV	2.35	1.78	9.88	5.42	0.57	4.46
MISSION (X) 1124	12 kV	9.96	5.47	N/A	N/A	4.49	N/A
MISSION (X) 1125	12 kV	12.19	7.46	N/A	N/A	4.73	N/A
POTRERO PP (A) 1118	12 kV	9.99	3.78	74.3	46.68	6.21	27.62

Source: PG&E
Note: POTRERO PP (A) 1112 is Flynn Yard's existing circuit.

3 ISLAIS CREEK YARD

3.1 EXISTING CONDITIONS

This section summarizes Islais Creek Yard's location and facilities, site circulation, and existing electrical infrastructure.

3.1.1 LOCATION AND FACILITIES

Islais Creek Yard is located at 1301 Cesar Chavez Street with electrical utility service provided by the SFPUC by way of PG&E infrastructure.

Currently, 130 diesel buses (100 40-foot and 30 60-foot) are stored, maintained, fueled, and serviced at Islais Creek Yard. The yard includes the following separate structures and major site areas: a two-story maintenance building, two-story transportation building, and a combined fuel and wash building. Interstate 280 (I-280) traverses over the western side of the site with support columns located in the bus parking yard.

Figure 3-1 and Figure 3-3 present Islais Creek Yard's existing conditions.

Figure 3-1. Islais Creek Yard - Aerial

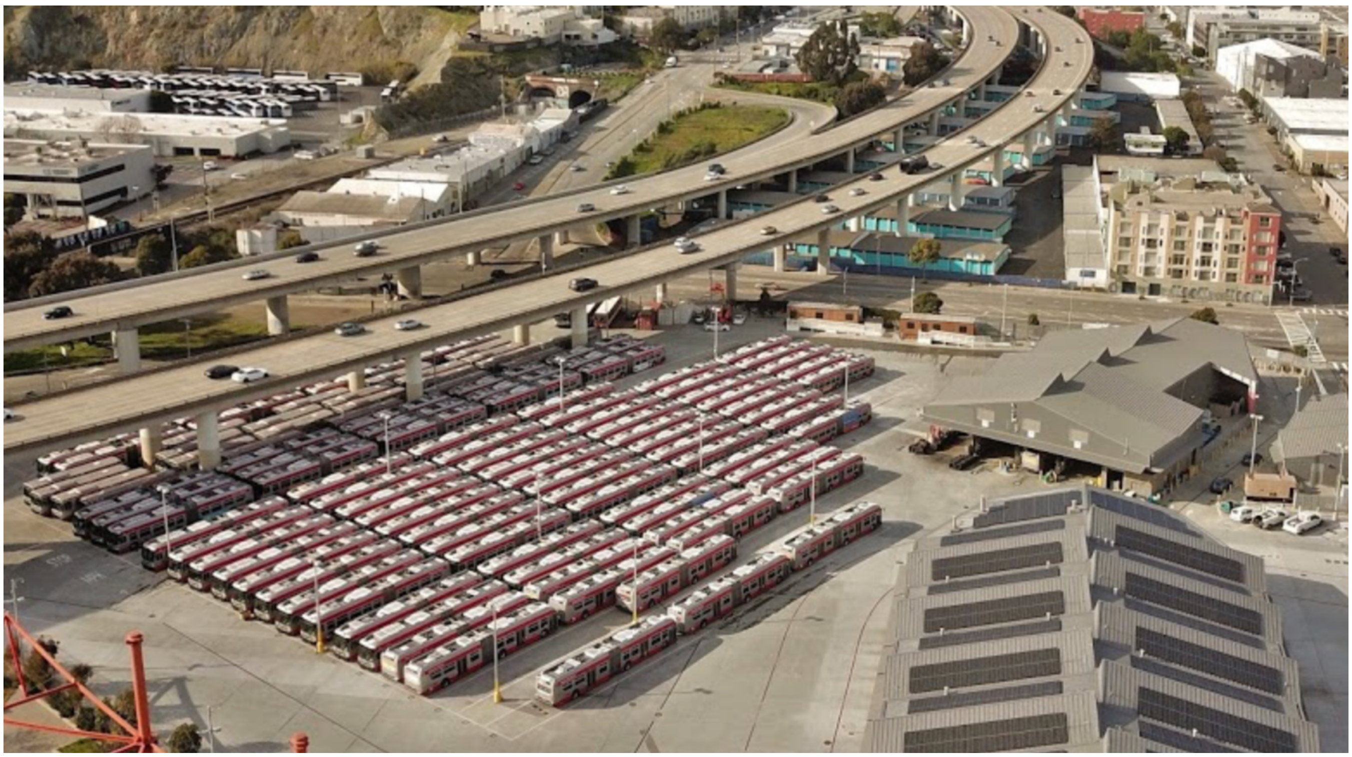
Source: Google Earth

3.1.2 SITE CIRCULATION

Buses enter from Indiana Street and are parked in numbered, stacked (nose-to-tail), 11 or 13 feet-wide lanes (Track 1 is easternmost). Individual buses are then pulled from the storage area and taken by nightly service staff to the fuel lanes for fare retrieval, interior cleaning, and fueling before pulling forward to the bus wash lanes. After fuel and wash, buses are re-parked in the storage area. Buses remain parked until morning pull out unless a maintenance issue has been identified. NRVs are parked throughout the site on facility exteriors and the yard perimeter.

Figure 3-2 presents Islais Creek Yard's existing parking and facilities with I-280 crossing the site.

Figure 3-2. Islais Creek Yard - Bus Parking



Source: Joe Howarth, May 2019

Figure 3-3. Islais Creek Yard – Existing Site Plan

Source: WSP

3.1.3 ELECTRICAL INFRASTRUCTURE

The following section provides information on the existing substation, circuit, transformer, switchboard and meter that support Islais Creek Yard's electrical needs.

SUBSTATION

Islais Creek Yard's power is provided by the Potrero Substation A that is located at 1201 C Illinois Street (23rd Street and Illinois Street), approximately 0.5 miles from the yard.

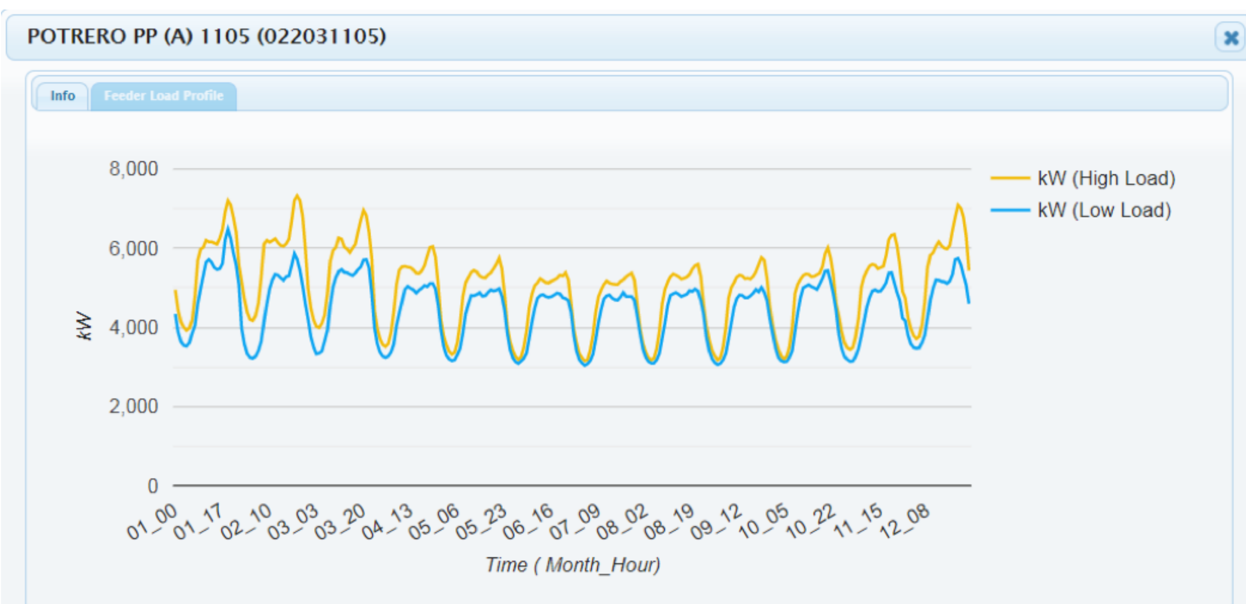
The Potrero Substation A has a capacity of 74 MW on Bank 1. The POTRERO PP (A) 1105 Circuit (Potrero 1105 Circuit) feeds Islais Creek Yard.

CIRCUIT

The Potrero 1105 Circuit is a 12-kV circuit that is fed from the Potrero Substation A. The Potrero 1105 circuit has an existing capacity of 9.99 MW. PG&E estimates that the projected peak load of this circuit is 5.14 MW, leaving approximately 4.85 MW of available capacity. The circuit enters the yard from the Indiana Street side of the property which enters the Annex Building.

Peak loads for the Potrero 1105 Circuit are monitored by PG&E and published on their ICA map. The load increases in winter months and has peaks at 9 AM and 8 PM. Usage is at its minimum between 2 AM and 6 AM. The metrics for this circuit are shown in Figure 3-4 and Table 3-1.

Figure 3-4. Islais Creek Yard - Potrero 1105's Load Profile



Source: PG&E

Table 3-1. Islais Creek Yard - Potrero 1105's Load Information

DESCRIPTION	DATA
Feeder Name	POTRERO PP (A) 1105
Feeder Number	022031105
Nominal Circuit Voltage (kV)	12
Circuit Capacity (MW)	9.99
Circuit Projected Peak Load (MW)	5.14
Substation Bank	1
Substation Bank Capacity (MW)	74.3
Substation Bank Peak Load (MW)	46.68
Existing Distributed Generation (MW)	0.43
Queued Distributed Generation (MW)	0
Total Distributed Generation (MW)	0.43
Total Customers	203
Residential Customers	1
Commercial Customers	136
Industrial Customers	57
Agricultural Customers	0
Other Customers	9

Source: PG&E

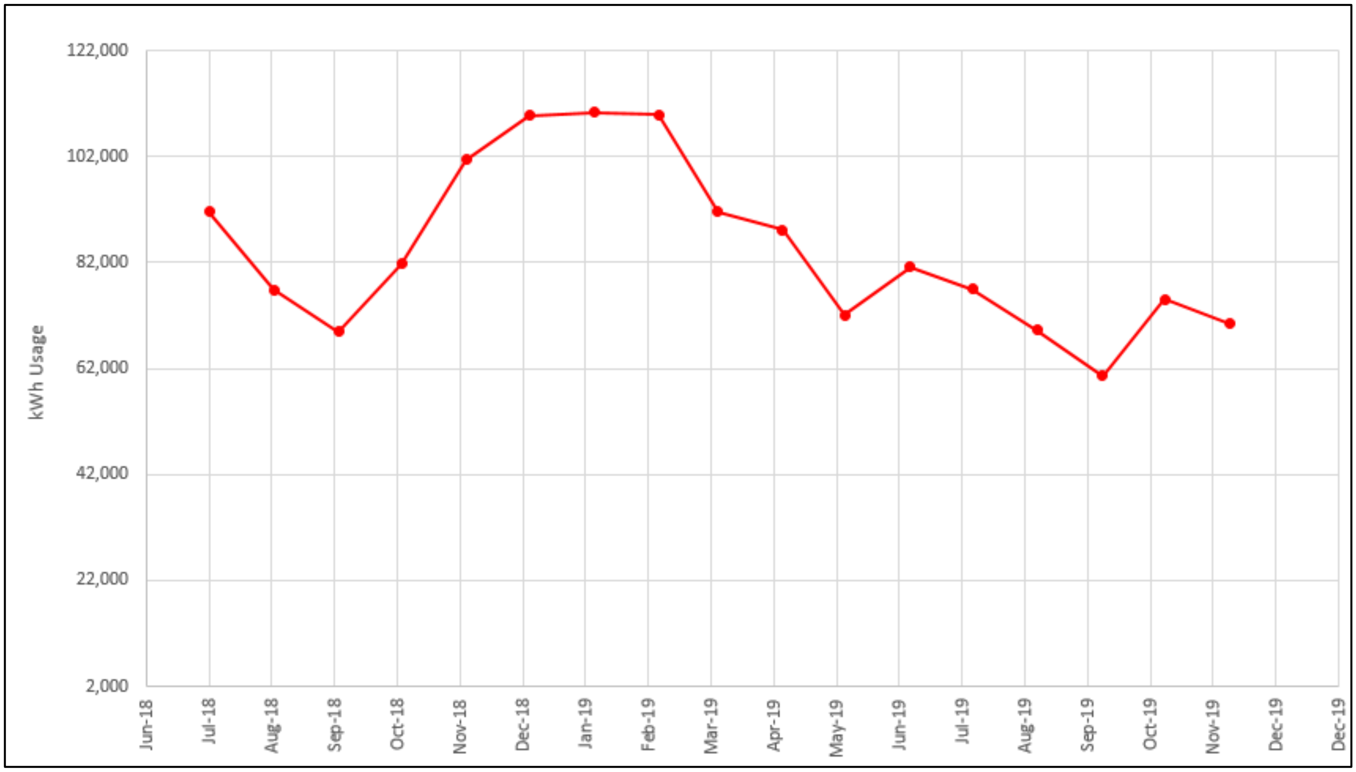
TRANSFORMER

The site's transformer is in the electric yard of the Annex Building and feeds the outdoor main switchboard (MSB). Unfortunately, due to site construction, the existing electrical service and connections cannot be verified at this time. Therefore, no single line drawing is provided for Islais Creek.

METERS AND USAGE

Meter 1010267289 was installed in May 2018, replacing meter 20P794. Meter usage data between May 2018 and November 2019 reveals that the yard uses an average of 83,144 kWh per month, peaking at 110,284 kWh in December 2018. The average cost per kWh is approximately $0.075, and the annual cost of electricity is approximately $75,000 per year. Figure 3-5 illustrates usage.

Figure 3-5. Islais Creek Division – Meter Usage (May 2018 – November 2019)



Source: Jacobs, SFPUC

SWITCHBOARD

MSB for the meter was installed in 2005 and is in fair condition. The MSB is in Room 185 of the Annex Building on the ground floor. MSB is a 480Y/277V, three-phase, 4W panel, with a 3,000A bus and 2,500A main breaker.

The switchboard feeds four sub-panels: DP-1, DP-2 (in the maintenance and operations building), MDP, and the Emergency Distribution Panel, located in the fuel and wash building.

RESILIENCY

Islais Creek Yard currently has a 750-kW standby generator with a 1,600A breaker. There is also a photovoltaic system that provides power through the inverter distribution panel which is rated 600A at 480V.

3.2 INFRASTRUCTURE REQUIREMENTS

To support BEBs, Islais Creek Yard will require additional electrical capacity, which will require site modifications to accommodate additional and enhanced electrical infrastructure. The following sections summarizes the location and space requirements, and infrastructure required to support BEB charging.

3.2.1 LOCATION AND SPACING

To support the proposed BEB charging distribution and infrastructure, the Islais Creek Yard will utilize overhead pantograph (or plug-in) charging mounted from a new overhead support structure frame. The existing bus parking area has adequate space to allow for the independent support system to be constructed without major site modifications. A portion of the site under I-280 and in its setback areas will be utilized for spare bus parking. No permanent construction is allowed within this setback area, and the charging equipment cannot be housed here although distribution is planned to pass through the area.

Bus parking spaces in the in the bus parking area must be sized at a 12'-0" wide at a minimum to allow adequate spacing for the overhead support structure supporting the electrical infrastructure, charging equipment, and overhead distribution of power throughout the bus yard.

Electrical utility service interrupters are expected to be required for bringing the new electrical service required to serve BEBs on this site and are proposed be located on in the existing electrical yard inside the site perimeter south of the Support building before feeding to the site's electrical equipment.

3.2.2 ELECTRICAL ENHANCEMENTS

As previously mentioned, there is approximately 4.9 MW of available capacity on the Potrero 1105 Circuit.

Additionally, the 12-kV POTRERO PP (AA) 1103 circuit is nearby Islais Creek Yard. This circuit has a capacity of 8.4 MW with a peak load of 4.5 MW, leaving approximately 3.9 MW of additional capacity. It is likely that existing capacity at Islais Creek Yard will not be enough to support a fleet of BEBs. The adjacent circuit may be a factor in providing additional power to Islais Creek Yard. Figure 3-6 and Table 3-2 present and provide information on nearby circuits.

Figure 3-6. Islais Creek Yard – Nearby Circuits

Source: PG&E

Table 3-2. Islais Creek Yard – Nearby Circuits Summary

CIRCUIT NAME	VOLTAGE	CIRCUIT CAPACITY (MW)	CIRCUIT MAX LOAD (MW)	SUBSTATION BANK CAPACITY (MW)	SUBSTATION BANK MAX LOAD (MW)	AVAILABLE CIRCUIT CAPACITY (MW)	AVAILABLE BANK CAPACITY (MW)
POTRERO PP (A) 1105	**12 kV**	**9.99**	**5.14**	**74.3**	**46.68**	**4.85**	**27.62**
POTRERO PP (A) 1103	12 kV	8.42	4.52	74.3	43.36	3.9	30.94

Source: PG&E
Note: POTRERO PP (A) 1105 is Islais Creek Yard's existing circuit. PG&E to verify.

4 KIRKLAND YARD

4.1 EXISTING CONDITIONS

This section summarizes Kirkland Yard's location and facilities, site circulation, and existing electrical infrastructure.

4.1.1 LOCATION AND FACILITIES

Kirkland Yard is located at 151 Beach Street/2301 Stockton Street with electrical utility service provided by the SFPUC by way of PG&E infrastructure.

Currently, 112 40-foot diesel buses are stored, maintained, fueled, and serviced at Kirkland Yard. The yard includes the following separate structures and major site areas: a maintenance canopy, one-story maintenance support building, one story transportation building, wash lane (centered in the yard), stand-alone fuel building, and fuel storage yard with support equipment.

Figure 4-1 and Figure 4-3 present Kirkland Yard's existing conditions.

Figure 4-1. Kirkland Yard - Aerial

Source: Google Earth

4.1.2 SITE CIRCULATION

Buses enter from Stockton Street and are parked in unassigned, stacked (nose-to-tail), 11-foot wide lanes, consisting of two lanes east of the fuel canopy. Individual buses are then pulled from the lanes and taken by nightly service staff to the fuel lanes for fare retrieval, interior cleaning, and fueling before pulling forward to the bush wash lane, Track 9, if being washed (not all buses are washed due to site restrictions). After fuel and wash, buses are re-parked in the lanes. Buses remain parked until morning pull out unless a maintenance issue has been identified. NRVs are parked in a row of spaces along the northern site perimeter, where possible.

Figure 4-2 presents Kirkland Yard's maintenance bay.

Figure 4-2. Kirkland Yard – Maintenance Bay

Source: SFMTA

Figure 4-3. Kirkland Yard – Existing Site Plan

Source: WSP

4.1.3 ELECTRICAL INFRASTRUCTURE

The following section provides information on the existing substation, circuit, transformer, switchboard and meter that support Kirkland Yard's electrical needs.

SUBSTATION

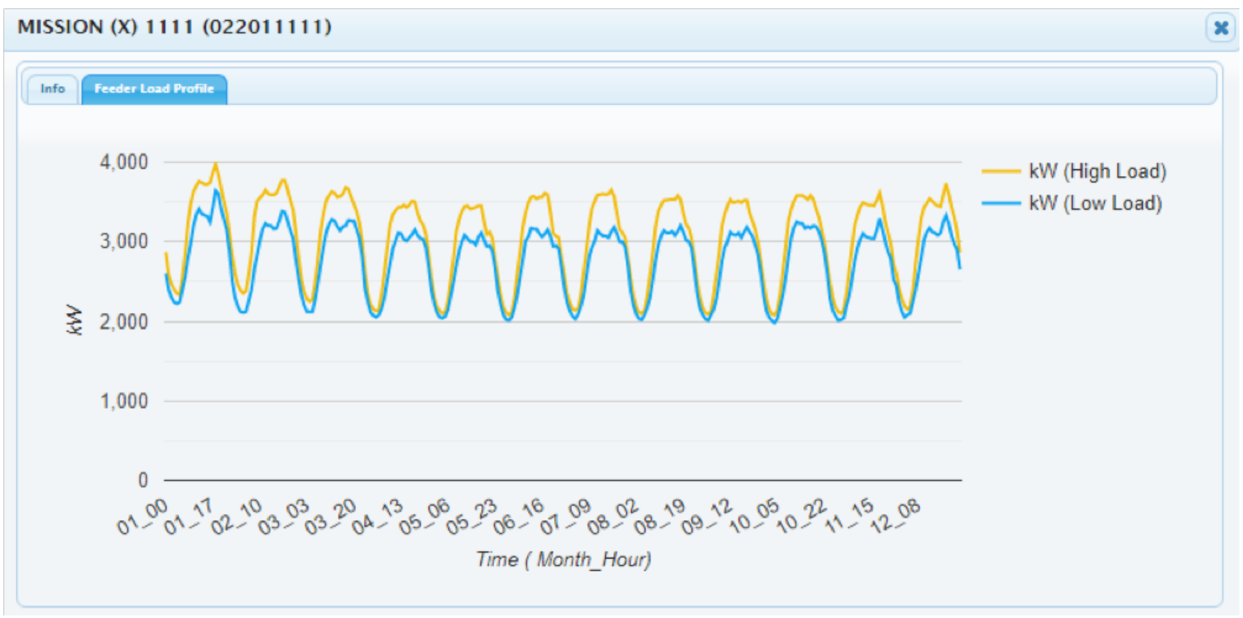
Kirkland Yard's power is provided by the Mission Substation. The detailed data for this substation is not in PG&E's PVRAM or ICA systems, which increases the importance of working with PG&E in future phases of this project.

CIRCUIT

The Mission 1111 Circuit is a 12-kV circuit that is fed from the Mission Substation. The Mission 1111 circuit has an existing capacity of 9.9 MW. PG&E estimates that the projected peak load of this circuit is 4.4 MW, leaving approximately 5.5 MW of available capacity. The circuit enters the yard (underground) on the north side of the property on Beach Street.

Peak loads for the Mission 1111 Circuit are monitored by PG&E and published on their ICA Map. The load increases in winter months and has peaks at 9 AM and 8 PM. Usage is at its minimum between 2 AM and 6 AM. The metrics for this circuit are shown in Figure 4-4 and Table 4-1.

Figure 4-4. Kirkland Yard - Mission 1111's Load Profile



Source: PG&E

Table 4-1. Kirkland Yard - Mission 1111's Load Information

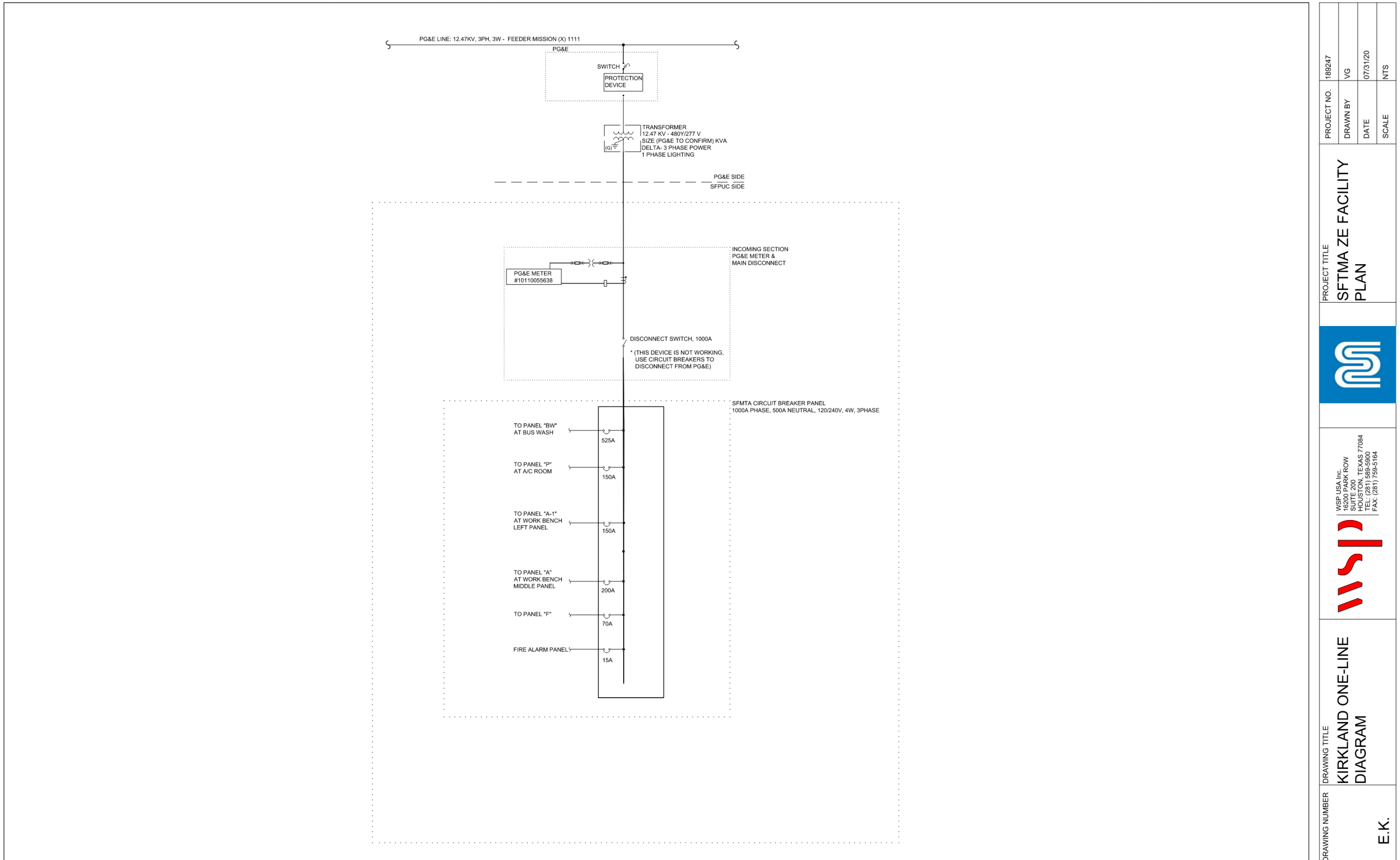
DESCRIPTION	DATA
Feeder Name	MISSION (X) 1111
Feeder Number	022011111
Nominal Circuit Voltage (kV)	12
Circuit Capacity (MW)	9.94
Circuit Projected Peak Load (MW)	4.43
Substation Bank	N/A
Substation Bank Capacity (MW)	N/A
Substation Bank Peak Load (MW)	N/A
Existing Distributed Generation (MW)	0.06
Queued Distributed Generation (MW)	0
Total Distributed Generation (MW)	0.06
Total Customers	2364
Residential Customers	1958
Commercial Customers	319
Industrial Customers	81
Agricultural Customers	0
Other Customers	6

Source: PG&E

TRANSFORMER

The transformer is in an underground vault and maintained by PG&E. Figure 4-5 presents the single-line diagram from the transformer to the yard's electrical infrastructure.

Figure 4-5. Kirkland Yard - Single Line Diagram for PG&E Service Connection



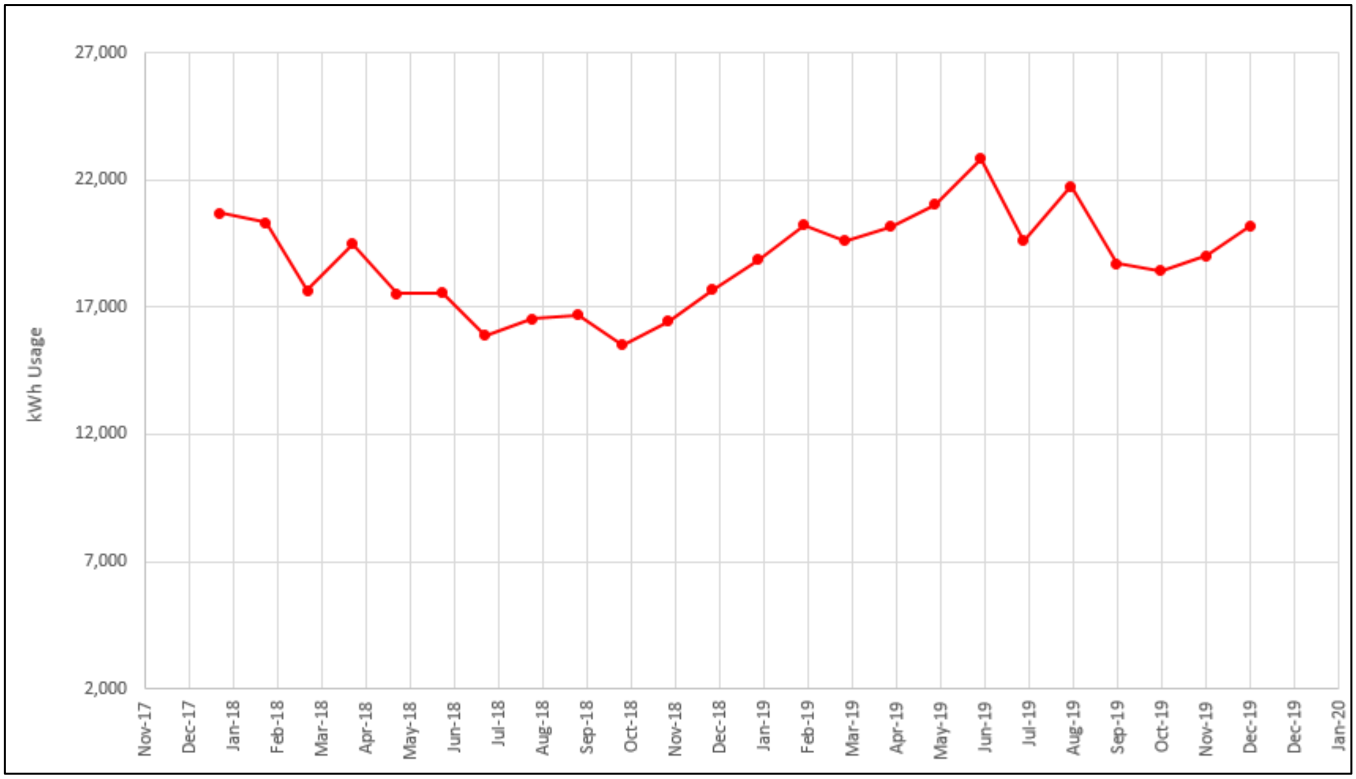
Source: SFMTA

METERS AND USAGE

Kirkland Yard's Meter 5725278405 is fed through a 120/240V, three-phase, 4W delta service.

Meter 5725278405's usage data between December 2017 and December 2019 reveals that the yard uses an average of 18,853 kWh per month, peaking at 22,836 kWh in May 2019. The maximum peak load on this meter is 51 kW, recorded on November 21, 2019 and the average cost per kWh is approximately $0.075. Figure 4-6 illustrates Meter 5725278405's usage.

Figure 4-6. Kirkland Division – Meter Usage (December 2017 – December 2019)



Source: Jacobs, SFPUC

SWITCHBOARD

The main switchboard was installed in 1991 and is in fair condition. Both the meter and the main panelboard are located in the electrical room (Room 134) in the maintenance building.

The switchboard is 120/240V, three-phase, 4W panel, with a 1,000A.

From the main switchboard, six circuit breakers are fed:

— 525A circuit breaker connected to Panel BW (bus wash)

— 150A circuit breaker connected to Panel P (A/C Room)

— 150A circuit breaker connected to Panel A-1 (maintenance building)

— 200A circuit breaker connected to Panel A (maintenance building)

— 70A circuit breaker connected to Panel F

— 15A circuit breaker connected to Fire Alarm Panel

RESILIENCY

Currently, there are no emergency electrical generators on the property.

4.2 INFRASTRUCTURE REQUIREMENTS

To support BEBs, Kirkland Yard will require additional electrical capacity, which will require site modifications to accommodate additional and enhanced electrical infrastructure. The following sections summarizes the location and space requirements, and infrastructure required to support BEB charging.

4.2.1 LOCATION AND SPACING

To support the proposed BEB charging distribution and infrastructure, the Kirkland Yard will utilize overhead pantograph (or plug-in) charging mounted from a new overhead support structure frame. The existing bus parking yard has adequate spacing to allow for the independent support system other than where the centrally located wash equipment currently exists.

Bus parking spaces in the bus parking area must be sized at a 12’-0” wide at a minimum to allow adequate spacing for the overhead support structure supporting the electrical infrastructure, charging equipment, and overhead distribution of power throughout the bus yard.

Two electrical utility service interrupters are expected to be required for bringing the new electrical service required to serve BEBs on this site and are proposed be located on the exterior of the site along Beach Street.

4.2.2 ELECTRICAL ENHANCEMENTS

It is likely that existing capacity at Kirkland Yard will be sufficient to support a fleet of BEBs if transformers and site infrastructure are upgraded. An additional 5.4 MW of capacity is required in a worst-case scenario for BEB charging at this site. As previously mentioned, there is approximately 5.5 MW of available capacity on the Mission 1111 Circuit. This will need to be verified by PG&E upon submission of a service request.

There are three 12-kV and one 4.2-kV circuits in the vicinity of Kirkland Yard. The adjacent circuits may be a factor in providing additional power. For example, the nearby MISSION (X) 1120 has an available circuit capacity of 5.8 MW. Figure 4-7 and Table 4-2 present and provide information on nearby circuits.

Figure 4-7. Kirkland Yard – Nearby Circuits

Source: PG&E

Table 4-2. Kirkland Yard – Nearby Circuits Summary

CIRCUIT NAME	VOLTAGE	CIRCUIT CAPACITY (MW)	CIRCUIT MAX LOAD (MW)	SUBSTATION BANK CAPACITY (MW)	SUBSTATION BANK MAX LOAD (MW)	AVAILABLE CIRCUIT CAPACITY (MW)	AVAILABLE BANK CAPACITY (MW)
MISSION (X) 1111	**12kV**	**9.94**	**4.43**	**N/A**	**N/A**	**5.51**	**N/A**
LARKIN (Y) 1119	12kV	9.19	5.87	N/A	N/A	3.32	N/A
MISSION (X) 1120	12kV	11.87	6.03	N/A	N/A	5.84	N/A
LARKIN (Y) 1136	12kV	8.34	7.22	N/A	N/A	1.12	N/A
BEACH (Q) 0402	4.16kV	2.18	1.82	1.98	1.84	0.36	0.14
LARKIN (Y) 1119	12kV	9.19	5.87	N/A	N/A	3.32	N/A

Source: PG&E
Note: MISSION (X) 1111 is Kirkland Yard's existing circuit.

5 POTRERO YARD

5.1 EXISTING CONDITIONS

This section summarizes Potrero Yard's location and facilities, site circulation, and existing electrical infrastructure.

5.1.1 LOCATION AND FACILITIES

Potrero Yard is located at 2500 Mariposa Street with electrical utility service provided by the SFPUC by way of PG&E infrastructure.

Currently, 168 overhead catenary trolley buses (75 40-foot and 93 60-foot) are stored, maintained, fueled, and serviced at Potrero Yard. The yard includes the following separate structures and major site areas: a one-story combined maintenance and transportation building, separate tire shop and body building, wash area, carbon-check area, and two separate bus parking yards. The upper yard and body/tire building are located on a deck above the maintenance building which is accessible from the north via 17th Street.

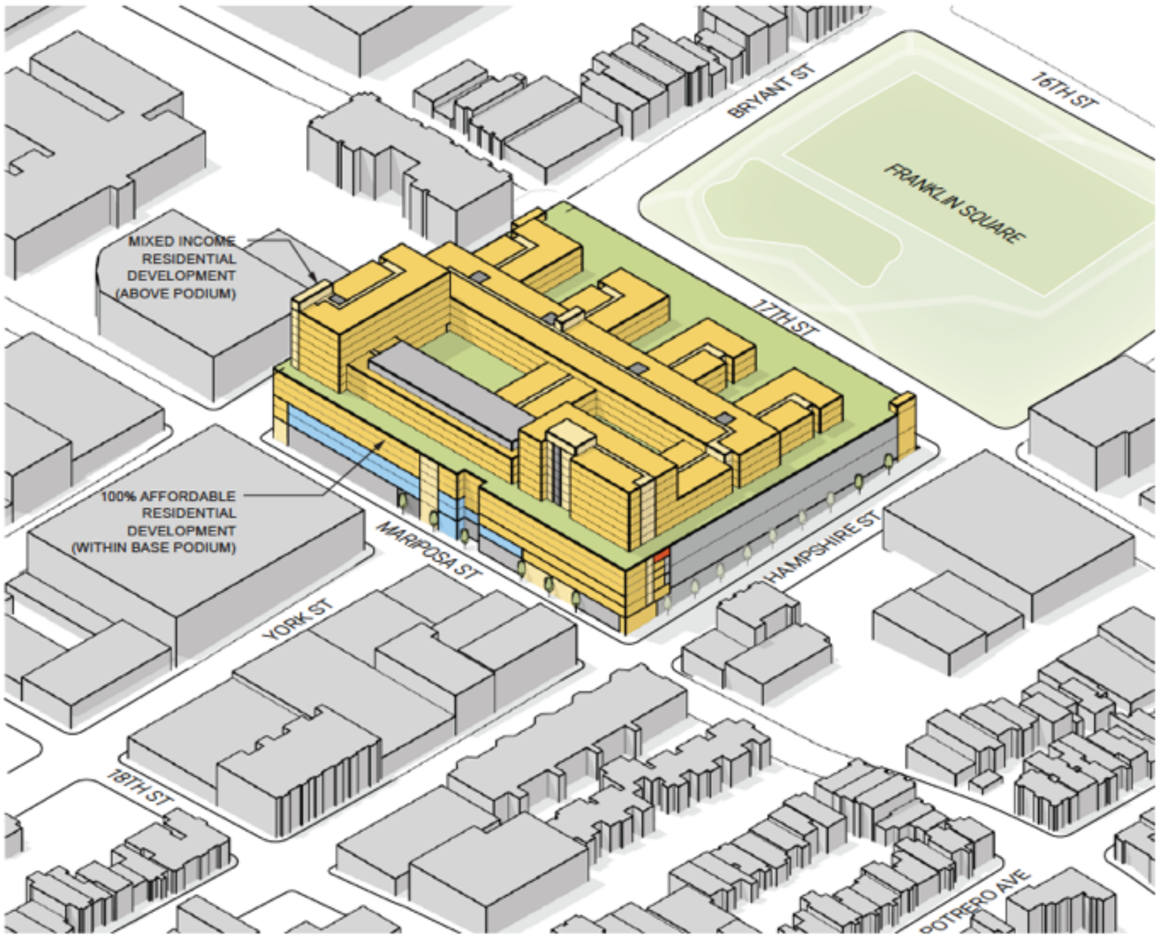
Figure 5-1 presents Potrero Yard's existing conditions.

Figure 5-1. Potrero Yard - Aerial

Source: Google Earth

There are plans to reconstruct and expand the Potrero Yard facility. Features include a partial basement for loading and lower floor work areas, 600,000 to 650,000 square feet of public transit use, and between 525 to 575 residential units above, including ground floor commercial uses along Bryant Street. The total square footage of the development is 1 to 1.3 million square-feet (Figure 5-2).

Figure 5-2. Potrero Yard - Future Plans



Source: SFMTA

5.1.2 SITE CIRCULATION

Buses enter the main yard from Mariposa Street and are parked in unassigned, stacked (nose-to-tail), 11’6”-wide lanes in front of the carbon check area. Individual buses are then pulled from the lanes and taken by nightly service staff to have their carbon checked, fares retrieved, and interior cleaned cleaning before pulling into the bush wash area, if being washed. After fuel and wash, buses are re-parked in the lanes. Buses remain parked until morning pull out unless a maintenance issue has been identified. NRVs are parked along the western site perimeter.

Figure 5-3presents Potrero Yard’s bus parking.

Figure 5-3. Potrero Yard – Bus Parking

Source: SFMTA

5.1.3 ELECTRICAL INFRASTRUCTURE

The following section provides information on the existing substation, circuit, transformer, switchboard and meter that support Potrero Yard's electrical needs.

SUBSTATION

Potrero Yard's power is provided by the Potrero Substation that is located along Illinois Street between 23rd Street and 24th Street, approximately 1.7 miles from the yard.

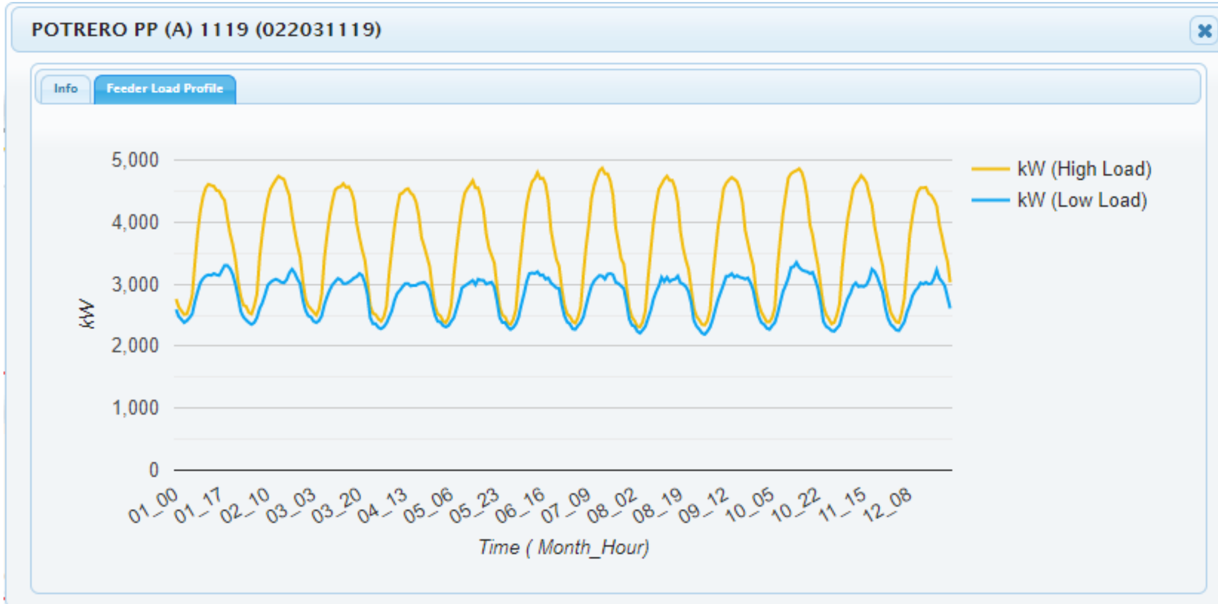
The Potrero Substation has a distribution capacity of 74 MW. The POTRERO PP (A) 1119 Circuit (Potrero 1119 Circuit) feeds Potrero Yard.

CIRCUIT

The Potrero 1119 Circuit is a 12-kV circuit that is fed from the Potrero Substation. The Potrero 1119 circuit has an existing capacity of 8.2 MW. PG&E estimates that the projected peak load of this circuit is 5.7 MW, leaving approximately 2.5 MW of available capacity.

Peak loads for the Potrero 1119 Circuit are monitored by PG&E and published on their ICA map. The load increases in winter months and has peaks at 9 AM and 8 PM. Usage is at its minimum between 2 AM and 6 AM. The metrics for this circuit are shown in Figure 5.4 and Table 5-1.

Figure 5-4. Potrero Yard – Potrero 1119's Load Profile



Source: PG&E

Table 5-1. Potrero Yard - Potrero 1119's Load Information

DESCRIPTION	DATA
Feeder Name	POTRERO PP (A) 1119
Feeder Number	022031119
Nominal Circuit Voltage (kV)	12
Circuit Capacity (MW)	8.19
Circuit Projected Peak Load (MW)	5.69
Substation Bank	2
Substation Bank Capacity (MW)	44.60
Substation Bank Peak Load (MW)	39.98
Existing Distributed Generation (MW)	0.2
Queued Distributed Generation (MW)	0.04
Total Distributed Generation (MW)	0.24
Total Customers	1,304
Residential Customers	955
Commercial Customers	220
Industrial Customers	114
Agricultural Customers	1
Other Customers	14

Source: PG&E

TRANSFORMER

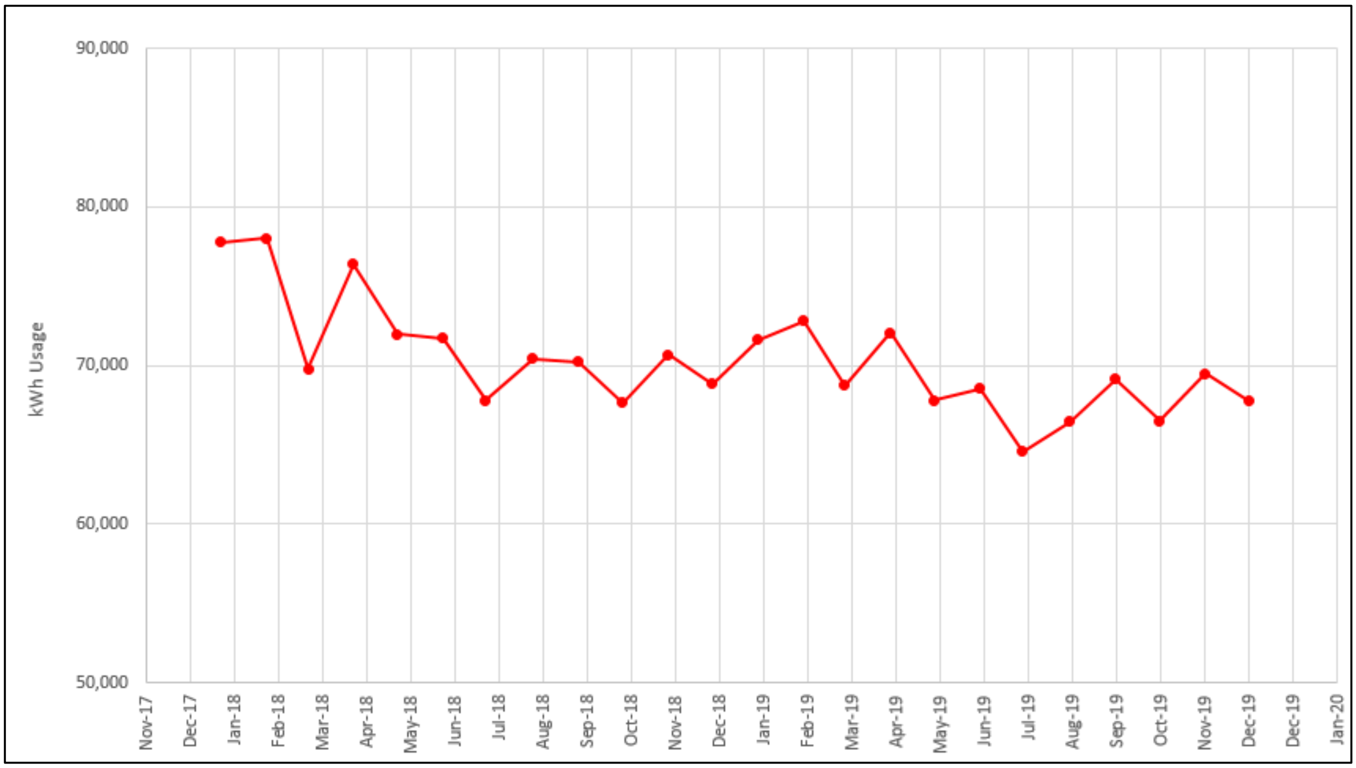
The transformer is in an underground vault and maintained by PG&E. No single-line diagram is provided at this time due to Potrero Yard plans to be completely rebuilt. PG&E has been unable to confirm transformer sizes and line connections pending a new service request.

METERS AND USAGE

Potrero Yard's Meter 5725278405 is fed through a 120/240V, three-phase, 4W delta service.

Meter 5725278405's usage data between December 2017 and December 2019 reveals that the yard uses an average of 18,853 kWh per month, peaking at 22,836 kWh in May 2019. The maximum peak load on this meter is 51 kW, recorded on November 21, 2019 and the average cost per kWh is approximately $0.075. Figure 5-5 illustrates Meter 5725278405's usage.

Figure 5-5. Potrero Division – Meter Usage (December 2017 – December 2019)



Source: Jacobs, SFPUC

SWITCHBOARD

The existing switchboard and internal electronics are planned to be replaced by a new building by the time the bus fleet is to be electrified. The estimated gear needed is still under design consideration.

RESILIENCY

Currently, there are no emergency electrical generators on the property, however the new site design may be able to incorporate additional resiliency options.

5.2 INFRASTRUCTURE REQUIREMENTS

To support BEBs, Potrero Yard will require additional electrical capacity, which will require site modifications to accommodate additional and enhanced electrical infrastructure. The following sections summarizes the location and space requirements, and infrastructure required to support BEB charging.

5.2.1 LOCATION AND SPACING

To support the proposed BEB charging distribution and infrastructure, the Potrero Yard will utilize overhead pantograph (or plug-in) charging mounted supported overhead from the new structure being developed. The new structure of the proposed Potrero facility is being designed with spacing and loading to allow for the electric charging equipment to be mounted and distributed overhead. The supporting equipment will be located in alcoves to the side of the bus parking areas as well as in the facility basement.

Bus parking spaces in the in the interior bus parking area must be sized at a 12'-0" wide at a minimum to allow adequate spacing for the overhead support structure supporting the electrical infrastructure, charging equipment, and overhead distribution of power throughout the bus yard.

Four electrical utility service interrupters are expected to be required for bringing the new electrical service required to serve BEBs on this site and are proposed be located on the exterior of the site along 17th Street.

5.2.2 ELECTRICAL ENHANCEMENTS

It is likely that the existing capacity at Potrero Yard supported by the Potrero 1119 circuit alone will not be sufficient to support a fleet of BEBs as 16.4 MW of additional capacity may be required in the worst-case scenario. This does not include the additional expected load from residential/commercial projects that are in planning phase as of June 2020.

As previously mentioned, there is approximately 2.5 MW of available capacity on the Potrero 1119 Circuit. The existing electrical equipment on-site will be replaced with the new building.

There are three 12-kV and one 4.2-kV circuits in the vicinity of Potrero Yard. The adjacent circuits may be a factor in providing additional power. For example, the nearby MISSION (X) 1125 has an available circuit capacity of 4.7 MW. Figure 5-6 and Table 5-2 present and provide information on nearby circuits.

Figure 5-6. Potrero Yard – Nearby Circuits

Source: PG&E

Table 5-2. Potrero Yard – Nearby Circuits Summary

CIRCUIT NAME	VOLTAGE	CIRCUIT CAPACITY (MW)	CIRCUIT MAX LOAD (MW)	SUBSTATION BANK CAPACITY (MW)	SUBSTATION BANK MAX LOAD (MW)	AVAILABLE CIRCUIT CAPACITY (MW)	AVAILABLE BANK CAPACITY (MW)
POTRERO PP (A) 1119	**12kV**	**8.19**	**5.69**	**44.59**	**39.98**	**2.5**	**4.61**
MISSION (X) 1125	12kV	12.19	7.46	N/A	N/A	4.73	N/A
POTRERO PP (A) 1101	12kV	9.52	7.82	74.3	43.36	1.7	30.94
SF E 0409	4.16kV	2.35	0.86	9.88	2.92	1.49	6.96

Source: PG&E
Note: POTRERO PP (A) 1119 is Potrero Yard's existing circuit.

6 PRESIDIO YARD

6.1 EXISTING CONDITIONS

This section summarizes Presidio Yard's location and facilities, site circulation, and existing electrical infrastructure.

6.1.1 LOCATION AND FACILITIES

Presidio Yard is located at 949 Presidio Avenue with electrical utility service provided by the SFPUC by way of PG&E infrastructure.

Currently, 132 40-foot overhead catenary trolley buses are stored, maintained, fueled, and serviced at Presidio Yard. The yard includes the following separate structures and major site areas: a two-story combined maintenance and transportation building, wash area, carbon check area, and bus parking yard.

Figure 6-1 and Figure 6-3 present Presidio Yard's existing conditions.

Figure 6-1. Presidio Yard - Aerial

Source: Google Earth

6.1.2 SITE CIRCULATION

Buses enter the main yard from Presidio Avenue and are parked in unassigned, stacked (nose-to-tail), 11’6”-wide lanes in front of the carbon check area. Individual buses are then pulled from the lanes and taken by nightly service staff to have their carbon checked, fares retrieved, and interior cleaned cleaning before pulling into the bush wash area, if being washed. After fuel and wash, buses are re-parked in the lanes. Buses remain parked until morning pull out unless a maintenance issue has been identified. NRVs are parked along the northern site perimeter. Figure 6-2 presents Presidio Yard’s maintenance bay.

Figure 6-2. Presidio Yard – Maintenance Bay

Source: SFMTA

Figure 6-3. Presidio Yard – Existing Site Plan

Source: WSP

6.1.3 ELECTRICAL INFRASTRUCTURE

The following section provides information on the existing substation, circuit, transformer, switchboard and meter that support Presidio Yard's electrical needs.

SUBSTATION

Presidio Yard's power is provided by the SF G Substation that is located on Broderick Street, between Ellis Street and Geary Boulevard, approximately 0.5 miles from the yard.

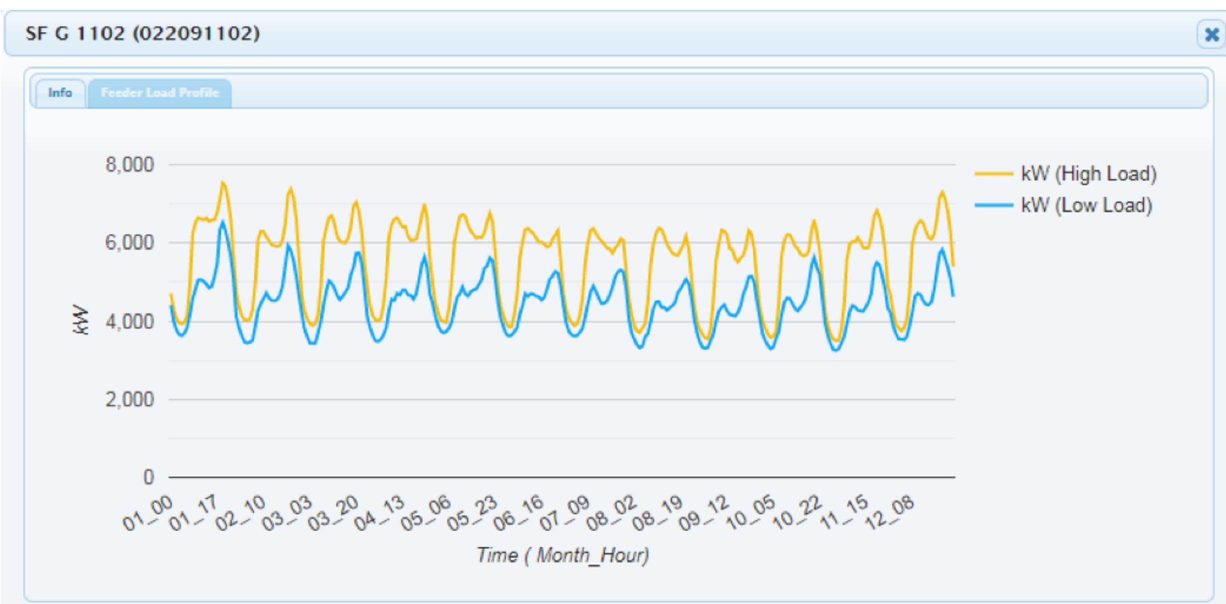
The SF G Substation's capacity is not available in PG&E's PVRAM system but supports at least 14 circuits, to be verified by PG&E. The SF G 1102 Circuit G feeds Presidio Yard.

CIRCUIT

The SF G 1102 Circuit is a 12-kV circuit that is fed from the SF G Substation. The SF G 1102 circuit has an existing capacity of 11 megawatts MW. PG&E estimates that the projected peak load of this circuit is 5 MW, leaving approximately 6 MW of available capacity. The circuit enters the property on the ground floor of Presidio Avenue and is the only circuit providing service to the yard.

Peak loads for the SF G 1102 Circuit are monitored by PG&E and published on their ICA map. The load increases in winter months and has peaks at 9 AM and 8 PM. Usage is at its minimum between 2 AM and 6 AM. The metrics for this circuit are shown in Figure 6-4 and Table 6-1 below. It should be noted that the load profile includes the usage by other customers who receive power from the same feeder.

Figure 6-4. Presidio Yard – SF G 1102's Load Profile



Source: PG&E

Table 6-1. Presidio Yard – SF G 1102's Load Information

DESCRIPTION	DATA
Feeder Name	SF G 1102
Feeder Number	022091102
Nominal Circuit Voltage (kV)	12
Circuit Capacity (MW)	10.97
Circuit Projected Peak Load (MW)	5.02
Substation Bank	N/A
Substation Bank Capacity (MW)	N/A
Substation Bank Peak Load (MW)	N/A
Existing Distributed Generation (MW)	0.01
Queued Distributed Generation (MW)	0.01
Total Distributed Generation (MW)	0.02
Total Customers	1,317
Residential Customers	1,166
Commercial Customers	92
Industrial Customers	54
Agricultural Customers	0
Other Customers	5

Source: PG&E

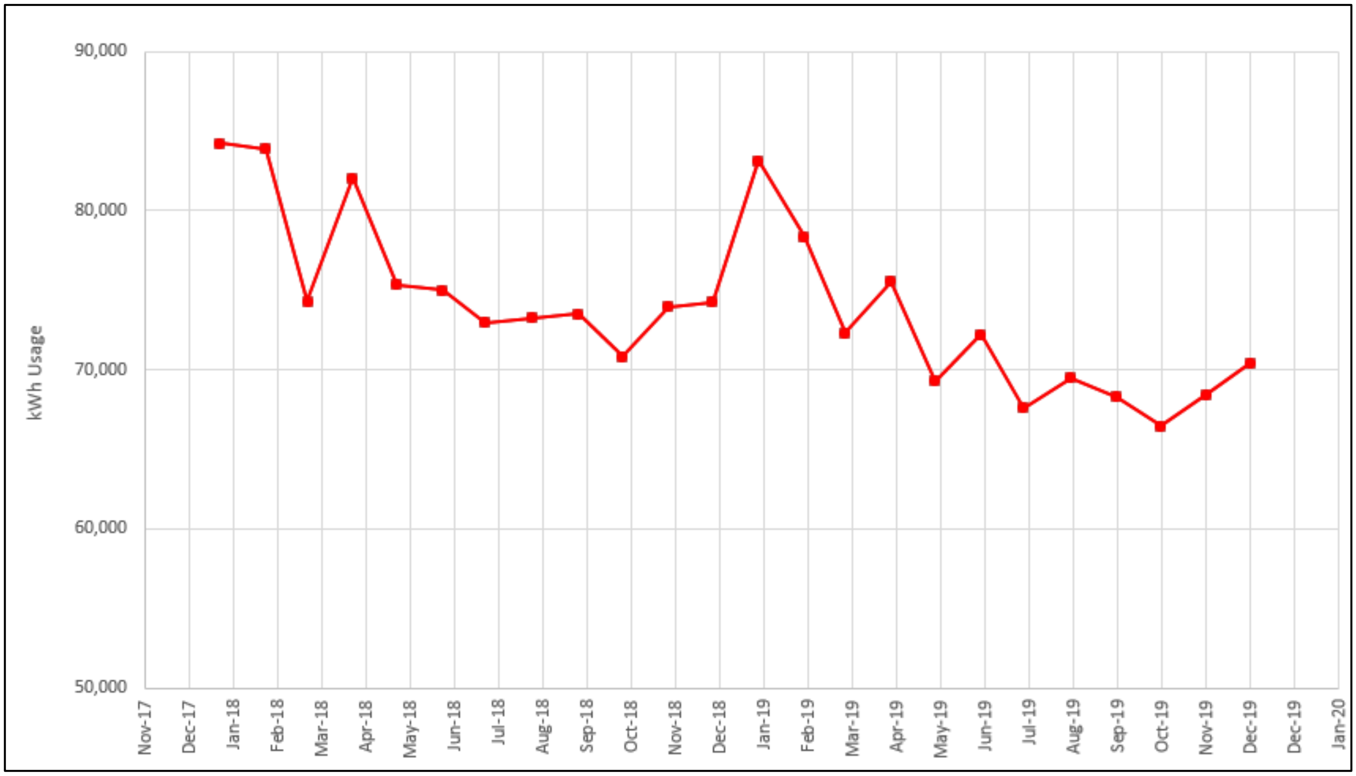
TRANSFORMER

The transformer is in an underground vault and maintained by PG&E. No single-line diagram is provided at this time due to Presidio Yard plans to be completely rebuilt. PG&E has been unable to confirm transformer sizes and line connections pending a new service request.

METERS AND USAGE

The meter's usage data between December 2017 and December 2019 reveals that the yard uses an average of 73,966 kWh per month, peaking at 84,242 kWh in December 2017. The average cost per kWh is approximately $0.075. Figure 6-5 illustrates the meter's usage.

Figure 6-5. Presidio Division – Meter Usage (December 2017 – December 2019)



Source: Jacobs, SFPUC

SWITCHBOARD

The main switchgear, secondary transformers, and 20 percent of the circuit breaker panels were installed in 1988. The meter and panels are in the electrical room on the ground floor of the facility. The distribution panel is a 208Y/120V, three-phase, 4W panel with a service capacity of 2,000A.

RESILIENCY

Currently, there are no emergency electrical generators on the property.

6.2 INFRASTRUCTURE REQUIREMENTS

To support BEBs, Presidio Yard will require additional electrical capacity, which will require site modifications to accommodate additional and enhanced electrical infrastructure. The following sections summarizes the location and space requirements, and infrastructure required to support BEB charging.

6.2.1 LOCATION AND SPACING

To support the proposed BEB charging distribution and infrastructure, the Presidio Yard will utilize overhead pantograph (or plug-in) charging mounted from a new overhead support structure frame. The existing bus parking yard has adequate spacing but will require the overhead catenary cable system to be removed prior to installation of the proposed overhead support structure for BEB equipment and distribution.

Bus parking spaces in the in the bus parking area must be sized at a 12'-0" wide at a minimum to allow adequate spacing for the overhead support structure supporting the electrical infrastructure, charging equipment, and overhead distribution of power throughout the bus yard.

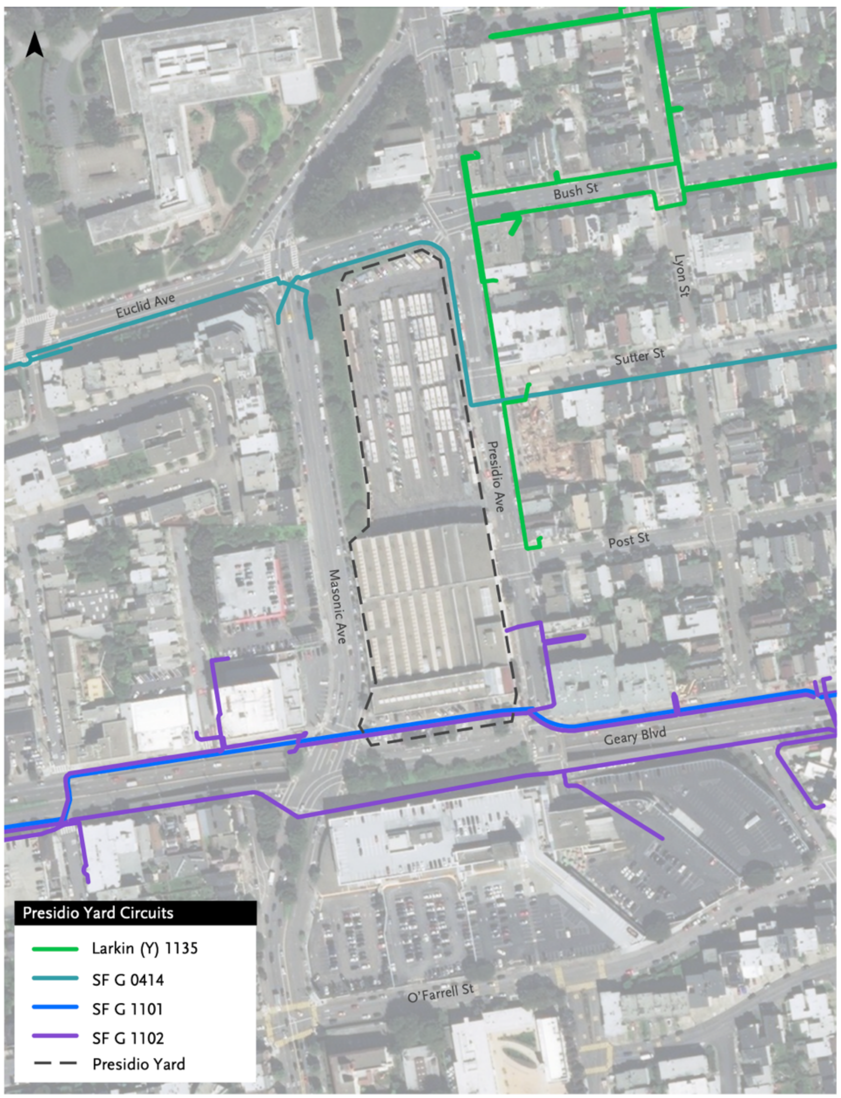
Two electrical utility service interrupters are expected to be required for bringing the new electrical service required to serve BEBs on this site and are proposed be located on the exterior of the site along Presidio Avenue.

6.2.2 ELECTRICAL ENHANCEMENTS

As previously mentioned, there is approximately 6 MW of available capacity on the SF G 1102 Circuit.

Additionally, there are two 12-kV and one 4.2-kV circuits in the vicinity of Presidio Yard. It is likely that existing capacity at Presidio Yard will not be sufficient to support a fleet of BEBs. The adjacent circuits may be a factor in providing additional power. Figure 6-6 and Table 6-2 present and provide information on nearby circuits.

Figure 6-6. Presidio Yard – Nearby Circuits



Source: PG&E

Table 6-2. Presidio Yard – Nearby Circuits Summary

CIRCUIT NAME	VOLTAGE	CIRCUIT CAPACITY (MW)	CIRCUIT MAX LOAD (MW)	SUBSTATION BANK CAPACITY (MW)	SUBSTATION BANK MAX LOAD (MW)	AVAILABLE CIRCUIT CAPACITY (MW)	AVAILABLE BANK CAPACITY (MW)
SF G 1102	**12kV**	**10.97**	**5.02**	**N/A**	**N/A**	**5.95**	**N/A**
LARKIN (Y) 1135	12kV	8.34	7.31	N/A	N/A	1.03	N/A
SF G 0414	4.16kV	2.42	1.93	21.4	8	0.49	13.4
SF G 1101	12kV	11.18	3.89	N/A	N/A	7.29	N/A

Source: PG&E

7 WOODS YARD

7.1 EXISTING CONDITIONS

This section summarizes Woods Yard's location and facilities, site circulation, and existing electrical infrastructure.

7.1.1 LOCATION AND FACILITIES

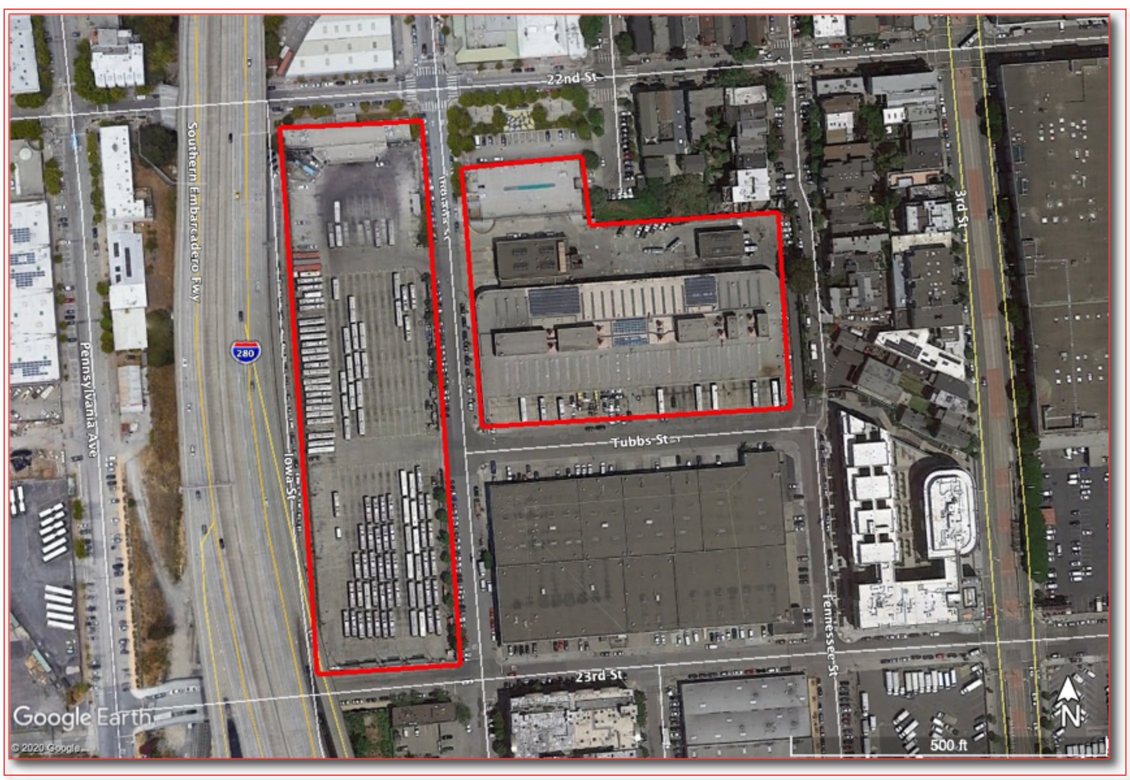
Woods Yard is located at 1001 22nd Street and 1098 Indiana Street with electrical utility service provided by the SFPUC by way of PG&E infrastructure.

Currently, 257 diesel buses (227 40-foot and 30 30-foot) are stored, maintained, fueled, and serviced at Woods Yard. The site is bisected from north to south by Indiana Street. The yard includes the following separate structures and major site areas: on the west side of Indiana Street, a two-story maintenance building and bus storage area; on the east side of Indiana Street, a two-story tire shop and operations, a stand-alone fuel building, and a stand-alone wash building.

SFMTA plans to add nine 40-foot battery electric buses to the northwest portion of the existing Woods yard which will be incorporated into the upcoming tasks of this project and carried forward across the project. This is not currently shown in the existing condition drawings.

Figure 7-1 and Figure 7-3 present Woods Yard's existing conditions.

Figure 7-1. Woods Yard - Aerial



Source: Google Earth

7.1.2 SITE CIRCULATION

Buses enter the bus storage area from Indiana Street and are parked in unassigned, stacked (nose-to-tail), 12-foot lanes. Individual buses are then pulled from the storage area and taken by nightly service staff across Indiana Street to the fuel lanes for fare retrieval, interior cleaning, and fueling before pulling forward to the bus wash lane. After fuel and wash, buses are re-parked in the bus storage area. Buses remain parked until morning pull out unless a maintenance issue has been identified. NRVs are parked in a row of spaces along the northern site perimeter between fuel and wash areas.

Figure 7-2 presents Woods maintenance staging.

Figure 7-2. Woods Yard – Maintenance Staging

Source: SFMTA

Figure 7-3. Woods Yard – Existing Site Plan

Source: WSP

7.1.3 ELECTRICAL INFRASTRUCTURE

The following section provides information on the existing substation, circuit, transformer, switchboards and meter(s) that support Woods Yard's electrical needs.

SUBSTATION

Woods Yard's power is provided by the Potrero Substation A that is located at 1201 C Illinois Street (23rd Street and Illinois Street), approximately 0.25 miles from the yard.

The Potrero Substation A capacity information has been requested by PG&E but cannot be provided until a service request has been completed. Two circuits from Potrero Substation A fed the Woods Yard. The POTRERO PP (A) 1116 Circuit (Potrero 1116 Circuit) and the POTRERO PP (A) 1101 (Potrero 1101 Circuit). The former provides power to the operations building on the west side of the Woods complex (Meter RG483), and the latter provides power for all buildings on the east side of the complex (Meter RG482). These were confirmed on site visits on July 16th, 2020.

CIRCUIT

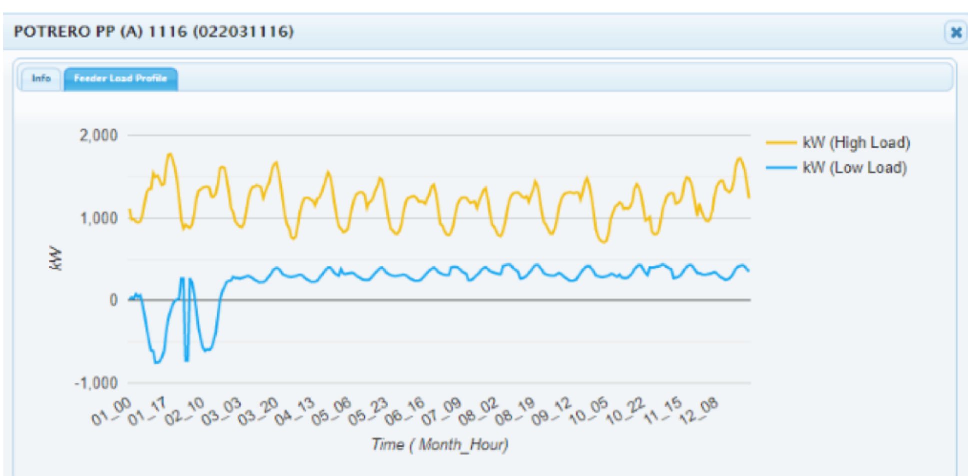
The Potrero 1116 Circuit is a 12-kV circuit that is fed from the Potrero Substation A. The Potrero 1116 circuit has an existing capacity of 10 MW. PG&E estimates that the projected peak load of this circuit is 8 MW, leaving approximately 2 MW of available capacity.

The Potrero 1101 Circuit is a 12-kV circuit that is fed from the Potrero Substation. The Potrero 1101 circuit has an existing capacity of 9.5 MW. PG&E estimates that the projected peak load of this circuit is 7.8 MW, leaving approximately 1.7 MW of available capacity.

It should be noted that the SFMTA is adding a 3MW circuit to supply power for nine charging stations during the battery electric bus pilot program. This new circuit has not been considered in this report regarding existing usage.

Peak loads for both circuits are monitored by PG&E and published on their ICA map. The loads increase in winter months and have peaks at 9 AM and 8 PM. Usage is at its minimum between 2 AM and 6 AM. The metrics of Potrero 1116 are shown in Figure 7-4 and Table 7-1, and metrics for Potrero 1101 are shown in Figure 7-5 and Table 7-2.

Figure 7-4. Woods Yard - Potrero 1116's Load Profile



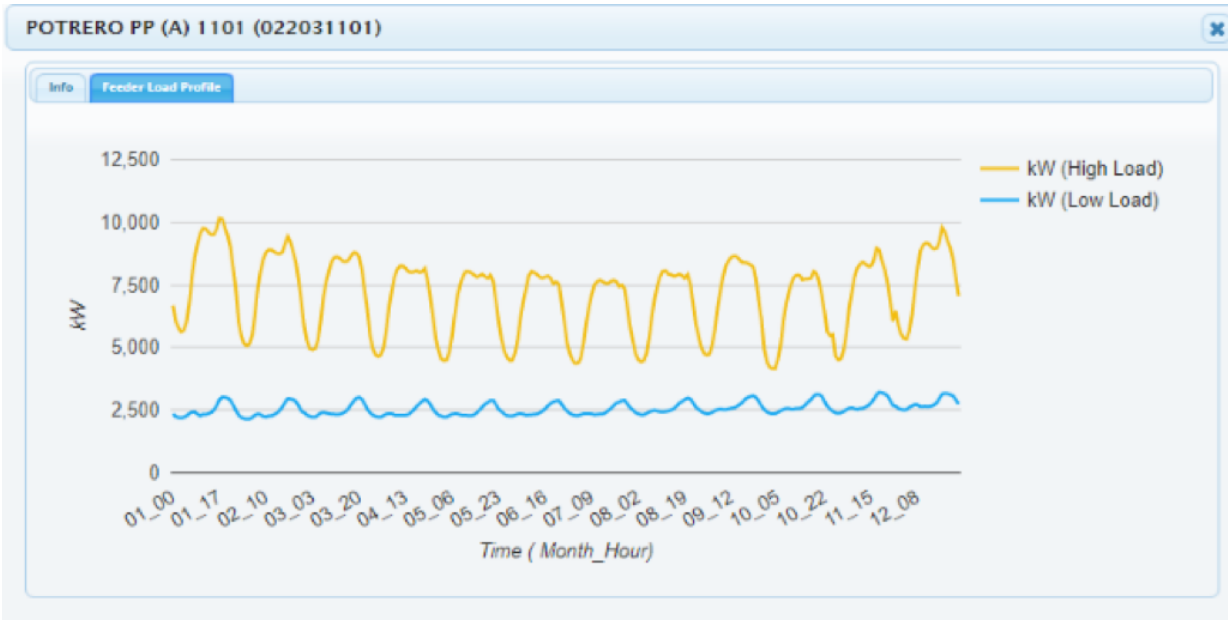
Source: PG&E

Table 7-1. Woods Yard - Potrero 1116's Load Information

DESCRIPTION	DATA
Feeder Name	POTRERO PP (A) 1116
Feeder Number	022031116
Nominal Circuit Voltage (kV)	12
Circuit Capacity (MW)	9.99
Circuit Projected Peak Load (MW)	8
Substation Bank	2
Substation Bank Capacity (MW)	44.6
Substation Bank Peak Load (MW)	39.98
Existing Distributed Generation (MW)	0.34
Queued Distributed Generation (MW)	0.01
Total Distributed Generation (MW)	0.35
Total Customers	1271
Residential Customers	1190
Commercial Customers	47
Industrial Customers	21
Agricultural Customers	0
Other Customers	13

Source: PG&E

Figure 7-5. Woods Yard - Potrero 1101's Load Profile



Source: PG&E

Table 7-2. Woods Yard - Potrero 1101's Load Information

DESCRIPTION	DATA
Feeder Name	POTRERO PP (A) 1101
Feeder Number	022031101
Nominal Circuit Voltage (kV)	12
Circuit Capacity (MW)	9.52
Circuit Projected Peak Load (MW)	7.82
Substation Bank	10
Substation Bank Capacity (MW)	74.30
Substation Bank Peak Load (MW)	43.36
Existing Distributed Generation (MW)	0.82
Queued Distributed Generation (MW)	0.02
Total Distributed Generation (MW)	0.84
Total Customers	5441
Residential Customers	4793
Commercial Customers	486
Industrial Customers	139
Agricultural Customers	0
Other Customers	23

Source: PG&E

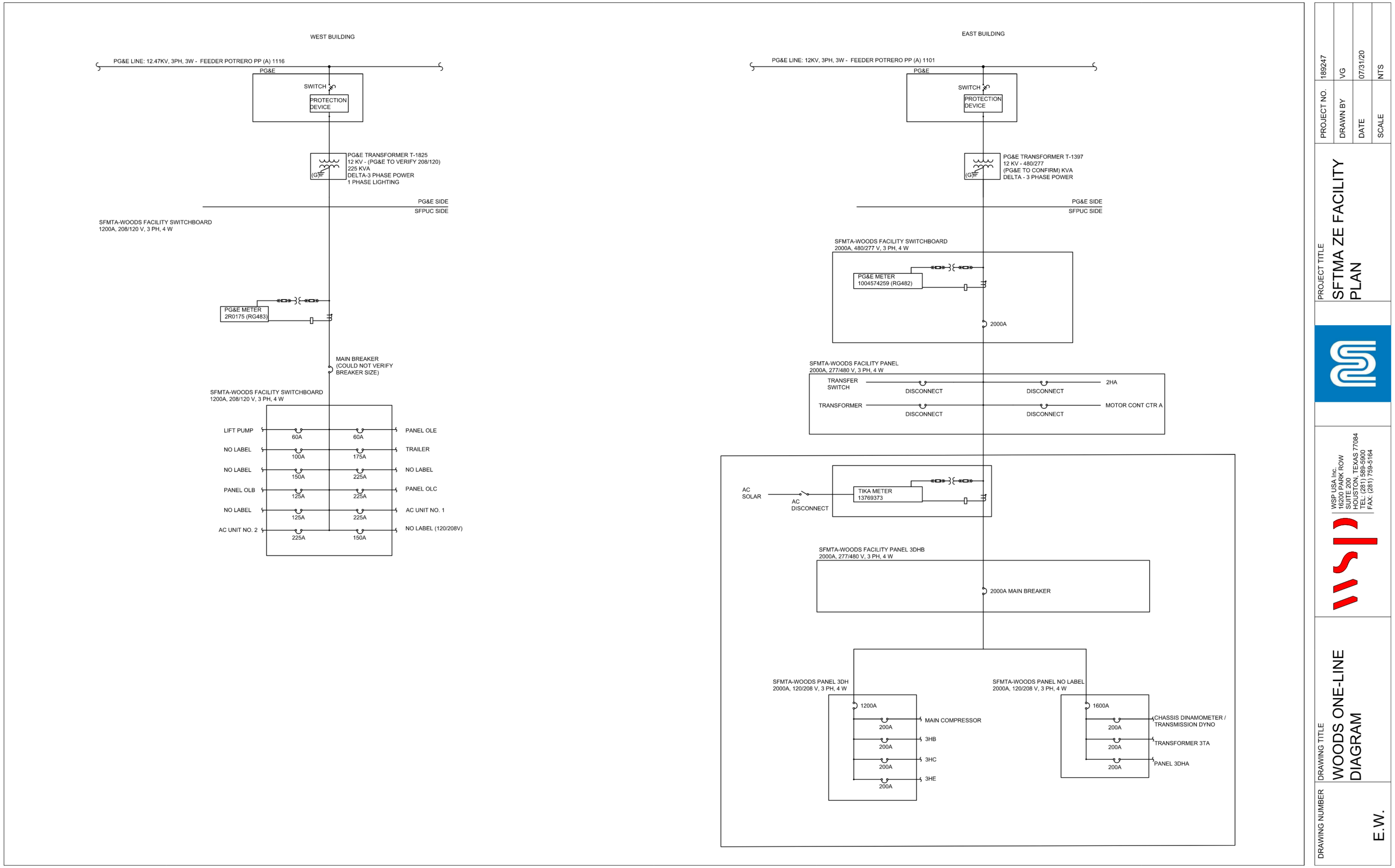
TRANSFORMER

The site transformer for Potrero 1116 is in Room 101 on the first floor of the operations building and feeds a main distribution panel ODP.

The site transformer for Potrero 1101 The site transformer is in an exterior cage, room 189A, on the ground floor and feeds a main distribution panel.

Figure 7-6 on the following page presents the single-line diagram from the transformer(s) to the yard's electrical infrastructure.

Figure 7-6. Woods Yard - Single Line Diagram for PG&E Service Connection



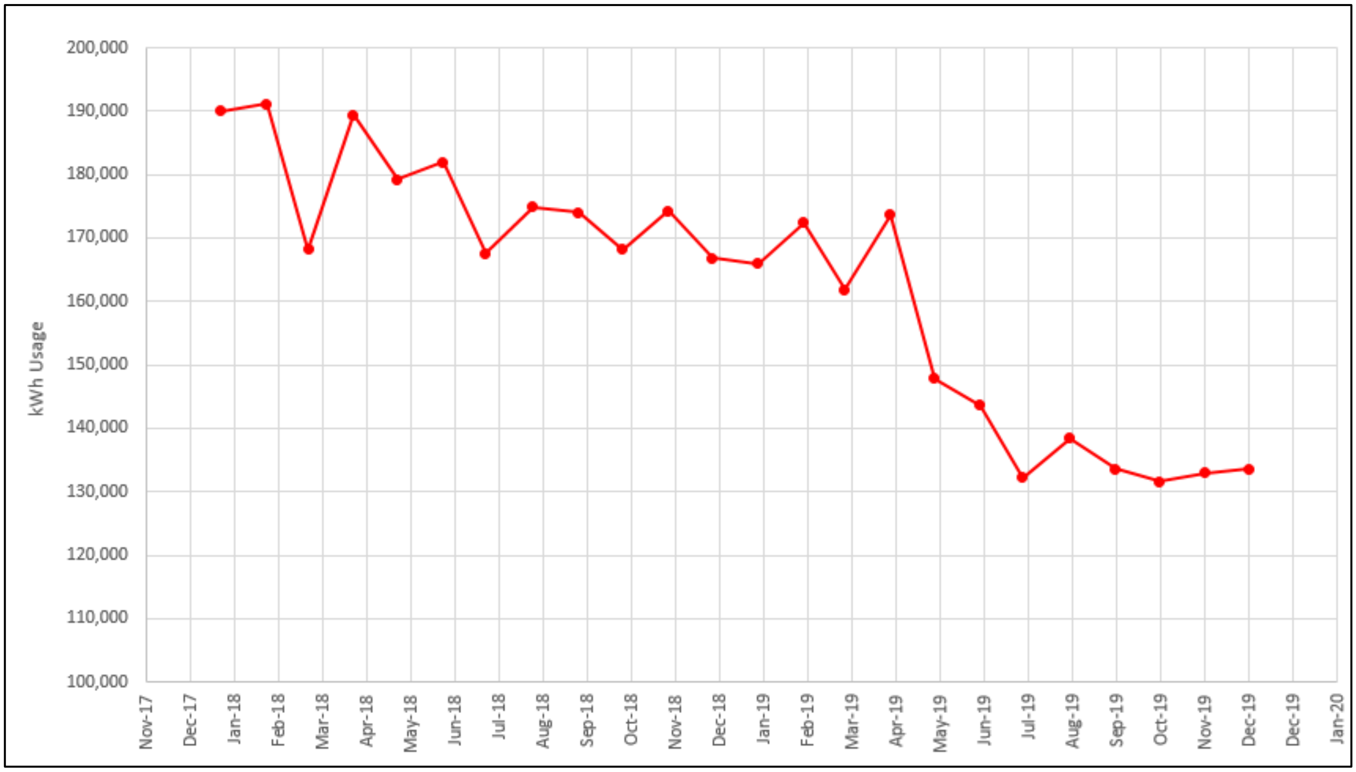
Source: SFMTA

METERS AND USAGE

Meter RG483 provides power to the operations building on the west side of the Woods complex and Meter RG482 provides power for all buildings on the east side of the complex.

Meter RG482's usage data between January 2018 and December 2019 reveals that the yard uses an average of 162,226 kWh per month, peaking at 191,097 kWh in February 2018. The average cost is approximately $0.075 per kWh. Figure 7-7 illustrates Meter RG482's usage.

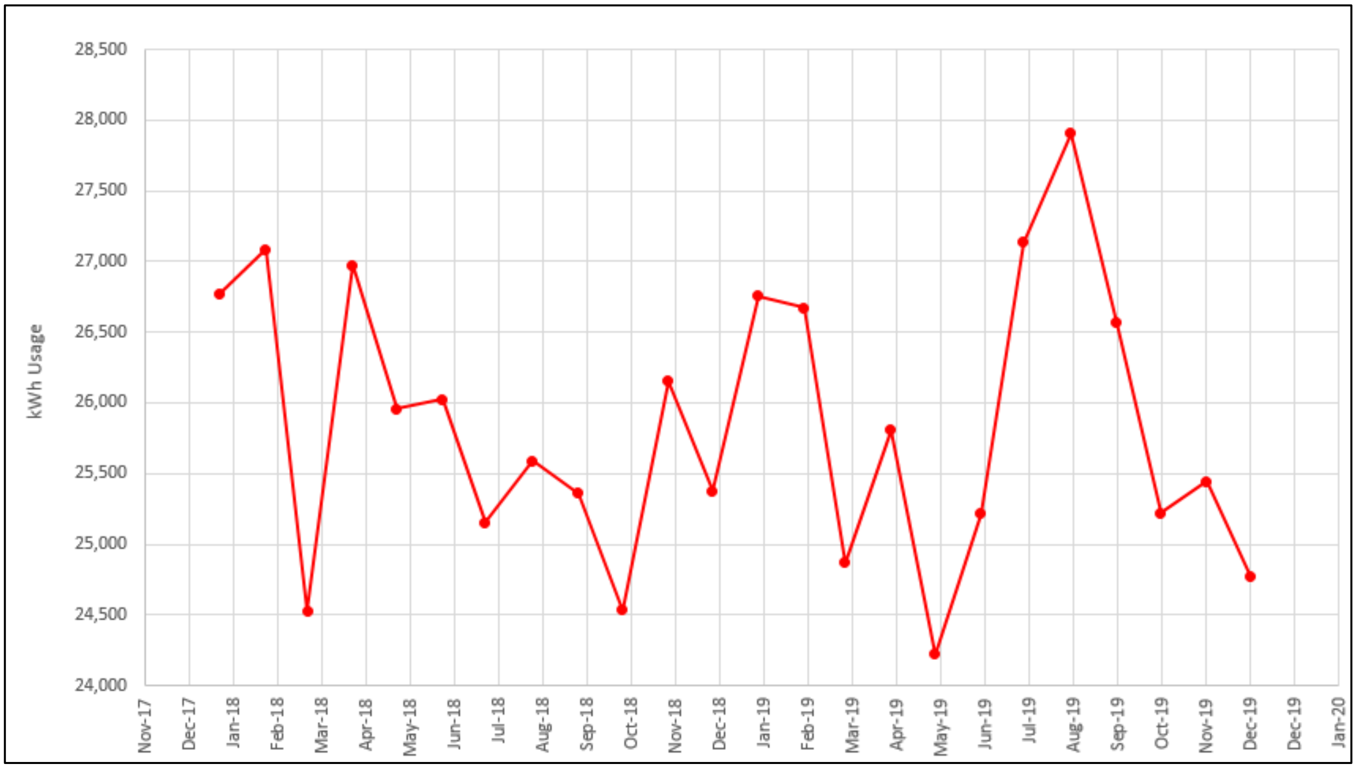
Figure 7-7. Woods Division – Meter RG482's Usage (January 2018 – December 2019)



Source: Jacobs, SFPUC

Meter RG483's usage data between January 2018 and December 2019 reveals that the yard uses an average of 25,837 kWh per month, peaking at 27,906 kWh in August 2019. The average is approximately $0.075 per kWh. Figure 7-8 illustrates Meter RG483's usage.

Figure 7-8. Woods Yard – Meter RG483's Usage (January 2018 – December 2019)



Source: Jacobs, SFPUC

SWITCHBOARD

The main distribution panels for both meters were installed in 1973 and are in fair condition.

The main distribution panel ODP for Meter RG48 is housed in the electrical room number 103 on the ground floor. ODP is a 208Y/120V, three-phase, 4W panel with a 1,200A bus and main breaker. The main feeder utilizes 4 #500 MCM cables per phase. The main distribution panel MP for Meter RG48 is housed in the exterior cage room 189A.

RESILIENCY

There is a 450-kW diesel emergency generator on site.

7.2 INFRASTRUCTURE REQUIREMENTS

To support BEBs, Woods Yard will require additional electrical capacity, which will require site modifications to accommodate additional and enhanced electrical infrastructure. The following sections summarizes the location and space requirements, and infrastructure required to support BEB charging.

7.2.1 LOCATION AND SPACING

To support the proposed battery electric bus charging distribution and infrastructure, the Woods Division will utilize overhead pantograph (or plug-in) charging mounted from a new overhead support structure frame. The existing bus parking area has adequate space to allow for the independent support system to be constructed without major site modifications.

Bus parking spaces in the bus yard must be sized at a 12’-0” wide at a minimum to allow adequate spacing for the overhead support structure supporting the electrical infrastructure, charging equipment, and overhead distribution of power throughout the bus yard. BEB Parking and Equipment Layouts are in development to be included in the Task 2 report for this project.

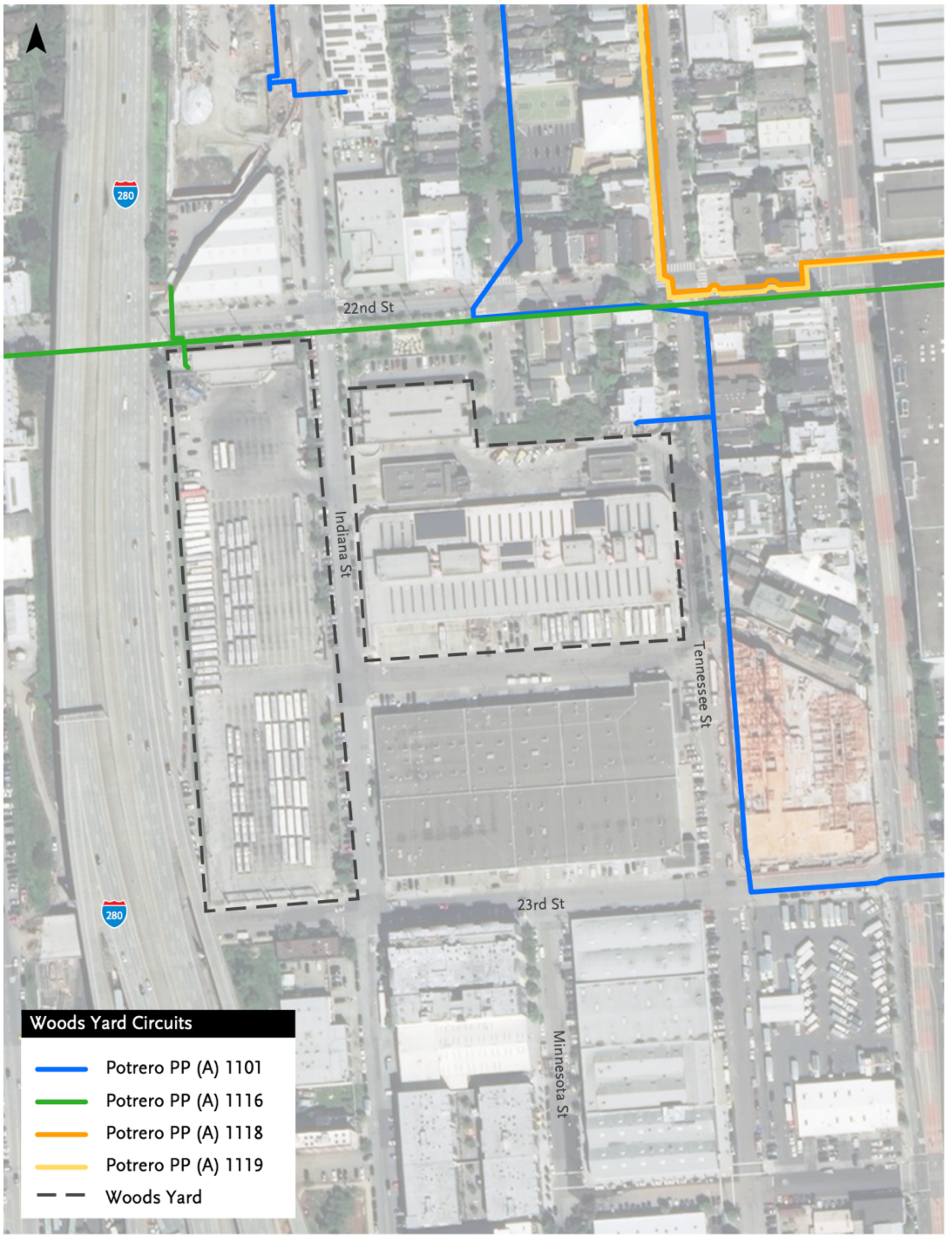
Two electrical utility service interrupters are expected to be required for bringing the new electrical service required to serve BEBs on this site and are proposed be located on the exterior of the site along Iowa Street.

7.2.2 ELECTRICAL ENHANCEMENTS

As previously mentioned, there is approximately 2MW of available capacity on the Potrero 1116 Circuit. There is approximately 1.7 MW of available capacity on the Potrero 1101 Circuit.

Additionally, there are five 12-kV circuits in the vicinity of Woods Yard, according to PG&E’s PVRAM map, a tool that shows available electric distribution lines, substations, and transmission lines available to properties in their service area. It is likely that existing PG&E circuit capacity at Woods Yard will not be sufficient to support a fleet of BEBs. The adjacent circuits may be a factor in providing additional power to Woods Yard. For example, the nearby POTRERO PP (A) 1118 has an available circuit capacity of 6.2 MW. Figure 7-9 and Table 7-3 present and provide information on nearby circuits.

Figure 7-9. Woods Yard – Nearby Circuits



Source: PG&E

Table 7-3. Woods Yard – Nearby Circuits Summary

CIRCUIT NAME	VOLTAGE	CIRCUIT CAPACITY (MW)	CIRCUIT MAX LOAD (MW)	SUBSTATION BANK CAPACITY (MW)	SUBSTATION BANK MAX LOAD (MW)	AVAILABLE CIRCUIT CAPACITY (MW)	AVAILABLE BANK CAPACITY (MW)
POTRERO PP (A) 1101	**12 kV**	**9.52**	**7.82**	**74.3**	**43.36**	**1.7**	**30.94**
POTRERO PP (A) 1116	**12 kV**	**9.99**	**8**	**44.6**	**39.98**	**1.99**	**4.62**
POTRERO PP (A) 1107	12 kV	8.42	0.62	74.3	46.68	7.8	27.62
POTRERO PP (A) 1109	12 kV	8.42	6.84	74.3	46.68	1.58	27.62
POTRERO PP (A) 1117	12 kV	11.87	4.55	74.3	46.68	7.32	27.62
POTRERO PP (A) 1118	12 kV	9.99	3.78	74.3	46.68	6.21	27.62
POTRERO PP (A) 1119	12 kV	8.19	5.69	44.6	39.98	2.5	4.62

Source: PG&E
Notes: POTRERO PP (A) 1101, POTRERO PP (A) 1116 are existing circuits. PG&E to confirm. There are multiple banks at the Potrero substation, so different banks will show different capacities and loads.

8 RELIABILITY

8.1 RELIABILITY INDICES

Power reliability is an important factor when considering the transition to BEBs. Without an understanding of existing reliability or measures in place to mitigate the risks of an outage, any disruption in electrical flows can be devastating to SFMTA's service.

The California Public Utilities Commission (CPUC) monitors reliability for utilities around the state to ensure that entities and the public are aware of performance. WSP gathered information from the CPUC as it relates to the San Francisco district.

Table 8-1. Electric Power Distribution Reliability Indices

INDEX	MEASURE
Customer Average Interruption Duration Index (CAIDI)	Average outage duration if an outage is experienced, or average restoration time
System Average Interruption Duration Index (SAIDI)	Average outage duration per customer
System Average Interruption Frequency Index (SAIFI)	How often a customer can expect to experience an outage
Momentary Average Interruption Frequency Index (MAIFI)	The frequency of momentary interruptions

Source: PG&E

8.2 PG&E RELIABILITY

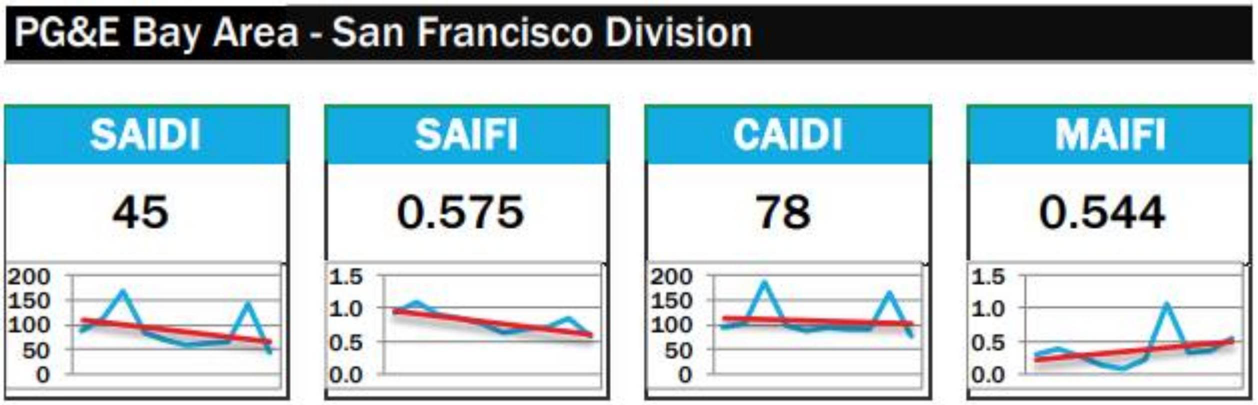
Reliability metrics can vary from year to year based on power outage events, such as, the Camp Fire in Paradise, California in 2018. Therefore, CPUC generally uses 10-year rolling averages to show improvements over time. PG&E improved on all reliability metrics between 2006 to 2015, when the following charts were created. After PG&E's transmission lines caused the deadliest fire in California history (the Camp Fire), PG&E and CPUC began to implement public safety power shutoffs (PSPS) in 2019. The resulting harm to PG&E's reliability has not been publicly reported yet. Fortunately, SFTMA was not impacted by any PSPS events in 2019. Since SFMTA's divisions and assets are located with the City and County of San Francisco, away from wildfire risk, there is no anticipated impact from PSPS events to SFMTA operations in the future.

Even within PG&E, the different districts can have large differences in reliability. The San Francisco district is one of the best performers in the PG&E system, and in California as a whole (including non-PG&E power providers). For all four metrics (Table 8-1), lower numbers indicate more reliability. For example, if an average outage duration (CAIDI) is experienced, the number represents the number of minutes of the outage, so an outage of only 10 minutes shows a more robust system then an average outage of 45 minutes.

Figure 8-1 presents metrics for the San Francisco district. The left side of each chart is the year 2006, and the end of each chart is the year 2015, when this comprehensive overview was completed. Despite some anomalies, performance generally improved within this timeframe. The red line is the overall trend line.

Based on the data, it is estimated that each customer within PG&E's San Francisco district can expect one power outage within two years, and it will probably last around 78 minutes (by multiplying 0.575 average outages per year * 78 minutes per outage = 45 minutes of average outage minutes per year). Similarly, there are only 0.544 momentary outages per year, or approximately one every other year.

Figure 8-1. San Francisco Division Metrics (2006-2015)



Source: CPUC

9 CONCLUSION AND NEXT STEPS

The existing electrical infrastructure is adequate for current SFMTA operations; however, upgrades will be required to support a large deployment of BEBs. These upgrades will be in the form of both on-site electrical upgrades and (possibly) PG&E distribution upgrades.

Most of the existing switchgear and transformers will likely be too small to accommodate a full-BEB fleet. Details of these will be outlined in the subsequent Task 2 "Facilities Power Needs and Technology Assessment Report." The biggest challenge SFMTA will face with the new electrical upgrades is that it is likely that SFPUC will be providing primary voltage service. This means that the point of demarcation between the utility-owned infrastructure and the SFMTA-owned infrastructure will be an interrupter vault in the sidewalk adjacent to the distribution lines. Therefore, the transformer to step down the power from 12kV to 480V will be SFMTA-owned, and there may be multiples of them, as well as substantially larger switchgear than what currently exists.

9.1 NEXT STEPS

PG&E ENGAGEMENT

The most important next step will be PG&E engagement. While the WSP team and SFMTA staff do have some visibility into the PG&E system with the PVRAM tool, only PG&E can make the determination of how best to meet SFMTA's power requirements and what impact that will have on their grid. Based on the analysis in this report, the WSP team can estimate the capacity of the distribution grid based on the nearby circuits' available capacity, as shown in Table 9-1.

Table 9-1. Grid Capacity Summary

YARD	NUMBER OF NEARBY CIRCUITS	MAX CAPACITY OF SINGLE NEARBY CIRCUIT (MW)	AVERAGE CAPACITY OF NEARBY CIRCUITS (MW)	SURROUNDING GRID CAPACITY (MW)
Flynn	6	6.21	3.67	21.97
Islais Creek	2	4.85	4.37	8.75
Kirkland	6	5.84	3.25	19.47
Potrero	4	4.73	2.61	10.42
Presidio	4	7.29	2.94	14.76
Woods	7	7.80	4.16	29.10

Source: PG&E

The numbers above look promising from an overall grid capacity standpoint. Unfortunately, these decisions are out of scope for SFPUC, so some way to engage PG&E and get timely input will be necessary to help determine what can be done at each facility and the possible timeline of deployment in order to meet SFMTA's ultimate goal of full electrification by 2035. These details and the needs required will be further investigated in Task 2 of this project.

TASK 2 ACTIVITIES

Determine fleet requirements. The WSP team will coordinate with SFMTA on final fleet numbers (by yard). This will inform BEB modeling and charging infrastructure requirements.

Refine facility power needs. Based on the modeling and fleet size, the WSP team will provide calculations for minimum, average, and maximum power needs, and coordinate those with SFPUC and PG&E as needed.

Develop one-line electrical diagrams. Each facility will have preliminary one-line diagrams for proposed new electrical infrastructure at each site required to support the BEB deployment.

Recommend specific charging solutions. Each facility will be evaluated for specific technology and charging needs. This will include structural improvements, capital cost, operation and maintenance impacts, and value-analysis for performance versus cost.

These and other items will be further explored in Task 2's *Facility Power Needs and Technology Assessment Report.*