

Department of Energy
Solar Market Pathways
Critical Load Document

Version 1 | November 20, 2015

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 214757-WO 21

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ARUP

1 Introduction

Viewing disaster preparation and resiliency through the lens of on-going sustainability is fairly new in the Emergency Response (ER) arena. Like other cities working on issues in the intersection of sustainability and emergency preparation, the City and County of San Francisco (CCSF) faces the challenge of continuing to use its sustainable energy resources when the grid goes down.

The San Francisco Solar+Storage for Resilience Project plans to integrate renewable photovoltaic generation with energy storage to provide power to facilities that are used in an emergency and require electricity for their continued operation.

This report is an interim document that aims to generate emergency load profiles for the following building types:

- Department Operating Center
- Recreational Center
- Police Station
- Fire Station
- Cooking Facility

Load profiles have been requested for the visited buildings. This report will be revised with the 15 minute interval data is provided and also extended to cover more buildings as they are visited.

2 Critical Load Calculation Methodology

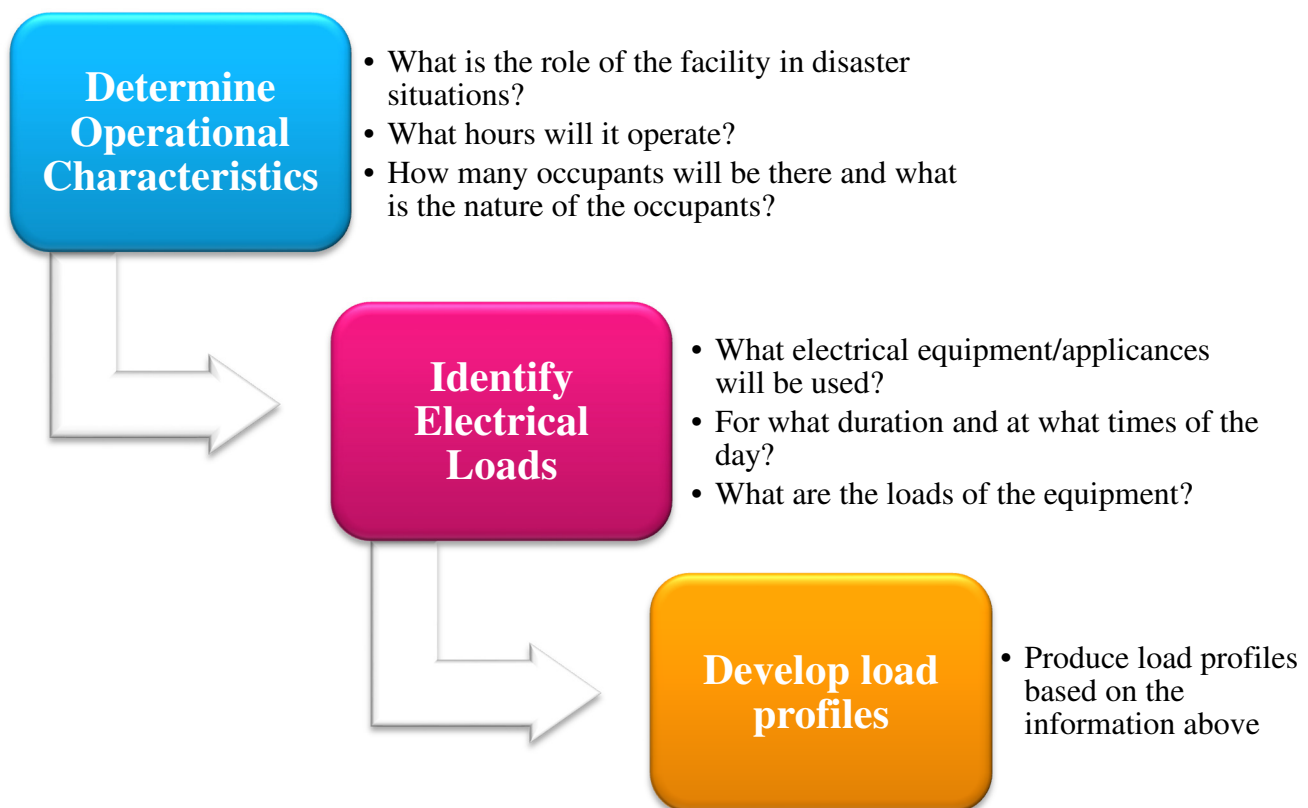
The City of San Francisco has identified a number of their buildings which are critical for disaster relief. A full database of these buildings has been created using an on-line map format. This map is the output for Task 2 of the SMPW's project.

Task 4 of the SMPW's project requires a study into the emergency power provisions for these buildings and the feasibility of utilizing solar panels and battery storage technologies in place of traditional diesel back-up generators.

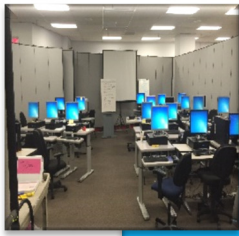
The study undertaken by Arup involved visiting the identified facilities, determining the power requirements of the building and assessing the viability of solar power providing this power. This report presents the indicative emergency load at each of the buildings visited.

This document outlines the process of determining the power loads of critical disaster relief buildings by way of site inspection and discussions with the facility operators.

Assessing the critical loads of a building in disaster relief mode is a three step process as outlined below.



Equipment loads were either directly noted off appliances and lighting or estimated. Determining which items of equipment will be used and for what duration are details that the facility operator can provide.



DOC

- Department Operations Center
- 1640 Mission St, San Francisco

Operational Characteristics

- Operates as an office facility for coordination of refuge centers and disaster relief efforts.
- The load information was gathered by observing the site with the DOC manager.
- Occupants: ~ 75 staff expected by the facility operator.
- Operating hours: Initial 24 hours, then 12 hours per day ongoing.

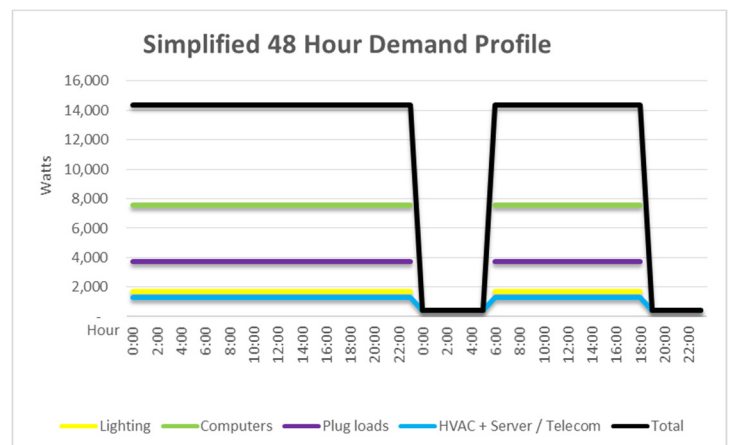
Identify Electrical Loads

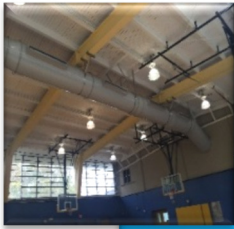
Load Type	Requirements (Diversity)	Load
Lighting	When the building is occupied (50%)	~95 x 36W = 3,420W 3,420 * 0.5 = 1,710W
Computers	35 x desktop (70%) 40 x laptop (80%) Diversified	35 x 250W 40 x 45W = 7,565W
HVAC	Server room (90%)	900W
Server / Telecom	Wifi, 2 x racks (70%) Diversified	600W 420W
Appliances	Photocopier (20%) TVs (100%) Microwave (20%) Hot water urn (30%) Coffee Pots (60%) Fridge (60%) Ham Radio (50%) Diversified	3 x 1000W 3 x 200W 2 x 1000W 2500W 2 x 800W 500W 250W = 10,450W = 3,735W
Maximum Demand		14,330W

Load profile

Time	Hours off Grid	Lighting	Computers	Plug loads	HVAC + Server / Telecom	Total (W)
0:00	1	1,710	7,565	3,735	1,320	14,330
1:00	2	1,710	7,565	3,735	1,320	14,330
2:00	3	1,710	7,565	3,735	1,320	14,330
3:00	4	1,710	7,565	3,735	1,320	14,330
4:00	5	1,710	7,565	3,735	1,320	14,330
5:00	6	1,710	7,565	3,735	1,320	14,330
6:00	7	1,710	7,565	3,735	1,320	14,330
7:00	8	1,710	7,565	3,735	1,320	14,330
8:00	9	1,710	7,565	3,735	1,320	14,330
9:00	10	1,710	7,565	3,735	1,320	14,330
10:00	11	1,710	7,565	3,735	1,320	14,330
11:00	12	1,710	7,565	3,735	1,320	14,330
12:00	13	1,710	7,565	3,735	1,320	14,330
13:00	14	1,710	7,565	3,735	1,320	14,330
14:00	15	1,710	7,565	3,735	1,320	14,330
15:00	16	1,710	7,565	3,735	1,320	14,330
16:00	17	1,710	7,565	3,735	1,320	14,330
17:00	18	1,710	7,565	3,735	1,320	14,330
18:00	19	1,710	7,565	3,735	1,320	14,330
19:00	20	1,710	7,565	3,735	1,320	14,330
20:00	21	1,710	7,565	3,735	1,320	14,330
21:00	22	1,710	7,565	3,735	1,320	14,330
22:00	23	1,710	7,565	3,735	1,320	14,330
23:00	24	1,710	7,565	3,735	1,320	14,330

Time	Hours off Grid	Lighting	Computers	Plug loads	HVAC + Server / Telecom	Total (W)
0:00	49				440	440
1:00	50				440	440
2:00	51				440	440
3:00	52				440	440
4:00	53				440	440
5:00	54				440	440
6:00	55	1,710	7,565	3,735	1,320	14,330
7:00	56	1,710	7,565	3,735	1,320	14,330
8:00	57	1,710	7,565	3,735	1,320	14,330
9:00	58	1,710	7,565	3,735	1,320	14,330
10:00	59	1,710	7,565	3,735	1,320	14,330
11:00	60	1,710	7,565	3,735	1,320	14,330
12:00	61	1,710	7,565	3,735	1,320	14,330
13:00	62	1,710	7,565	3,735	1,320	14,330
14:00	63	1,710	7,565	3,735	1,320	14,330
15:00	64	1,710	7,565	3,735	1,320	14,330
16:00	65	1,710	7,565	3,735	1,320	14,330
17:00	66	1,710	7,565	3,735	1,320	14,330
18:00	67	1,710	7,565	3,735	1,320	14,330
19:00	68				440	440
20:00	69				440	440
21:00	70				440	440
22:00	71				440	440
23:00	72				440	440





REC
Center

- Recreation Center
- 1900 Geary St,
San Francisco

Operational Characteristics

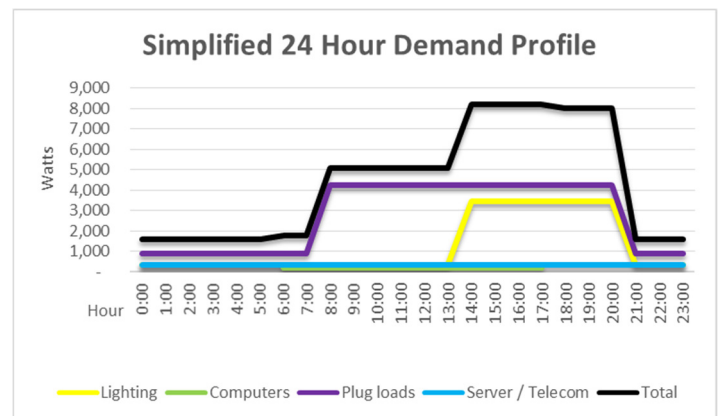
- Operates as a shelter. The gym will be used as living and sleeping quarters and the office space will be used by staff. It is expected that the occupants will use power for charging their phones and there may be some level of cooking on site. A fridge is also required for medication.
- Occupants: ~ 170 displaced people (based on 1 person per 60 sq²)
- Operating hours: 24 hours per day

Identify Electrical Loads

Load Type	Requirements (Diversity)	Load
Lighting	Gym (50%)	8 x 260W x 0.5= 2,080W
	- Office/Hall (50%)	32 x 36W x 0.5 = 1,040W
	- Hallways (50%)	20 x 32W x 0.5 = 320W
Computers	5 x laptop (80%)	5 x 45W
	Diversified	= 180W
Server / Telecom	Wifi, 1 x racks (70%)	500W
	Diversified	350W
Appliances (only fridge and charging loads are 24 hours)	TVs (100%)	2 x 200W
	Microwave (20%)	1000W
	Hot water urn (30%)	2500W
	Coffee Pots (60%)	3 x 800W
	Fridge (60%)	500W
	Ham Radio (50%)	250W
	Oven (20%)	2000W
	Phone charging (30%)	2040W
	TOTAL	= 16,760W
Diversified	= 4,227W	
Maximum Demand		8,197W

Load profile

Time	Hours off Grid	Lighting	Computers	Plug loads	Server / Telecom	Total (W)
0:00	1	320		912	350	1,582
1:00	2	320		912	350	1,582
2:00	3	320		912	350	1,582
3:00	4	320		912	350	1,582
4:00	5	320		912	350	1,582
5:00	6	320		912	350	1,582
6:00	7	320	180	912	350	1,762
7:00	8	320	180	912	350	1,762
8:00	9	320	180	4,227	350	5,077
9:00	10	320	180	4,227	350	5,077
10:00	11	320	180	4,227	350	5,077
11:00	12	320	180	4,227	350	5,077
12:00	13	320	180	4,227	350	5,077
13:00	14	320	180	4,227	350	5,077
14:00	15	3,440	180	4,227	350	8,197
15:00	16	3,440	180	4,227	350	8,197
16:00	17	3,440	180	4,227	350	8,197
17:00	18	3,440	180	4,227	350	8,197
18:00	19	3,440		4,227	350	8,017
19:00	20	3,440		4,227	350	8,017
20:00	21	3,440		4,227	350	8,017
21:00	22	320		912	350	1,582
22:00	23	320		912	350	1,582
23:00	24	320		912	350	1,582





SFPD

- San Francisco Police Department
- 1899 Waller St, San Francisco

Operational Characteristics

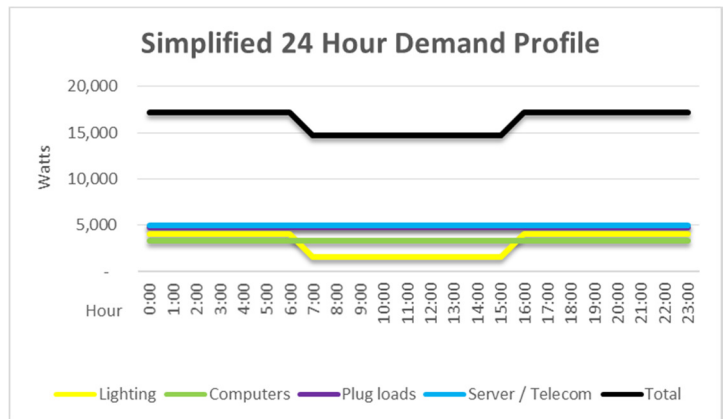
- Operates as normal with increased staff, 24 hours per day. Most of the police stations in San Francisco have back up diesel generators and onsite fuel to serve 50% of peak power requirements for up to 80 hours.
- Occupants: ~ 20 officers, citizens with concerns (transient)
- Operating hours: 24 hours per day

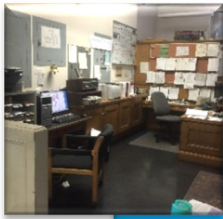
Identify Electrical Loads

Load Type	Requirements (Diversity)	Load
Lighting	Indoor – 24h (100%) Outdoor – night (100%)	32 x 50W = 1,600W 10 x 250W = 2,500W
Computers	10 x desktop (90%) Diversified	15 x 250W = 3,375W
HVAC	Server room (90%)	1,350W
Server / Telecom	Wifi + racks (90%) Diversified	4000W = 3,600W
Appliances	Photocopy (20%) TVs (100%) Microwave (20%) Coffee Pots (60%) Fridge (60%) Ham Radio (50%) Communications (80%) Misc. Loads (50%) TOTAL Diversified	1000W 4 x 100W 1000W 2 x 800W 500W 250W 2,000W 1,000W = 8,250W = 4,745W
Maximum Demand		17,170W

Load profiles

Time	Hours off Grid	Lighting	Computers	Plug loads	Server / Telecom	Total (W)
0:00	1	4,100	3,375	4,745	4,950	17,170
1:00	2	4,100	3,375	4,745	4,950	17,170
2:00	3	4,100	3,375	4,745	4,950	17,170
3:00	4	4,100	3,375	4,745	4,950	17,170
4:00	5	4,100	3,375	4,745	4,950	17,170
5:00	6	4,100	3,375	4,745	4,950	17,170
6:00	7	4,100	3,375	4,745	4,950	17,170
7:00	8	1,600	3,375	4,745	4,950	14,670
8:00	9	1,600	3,375	4,745	4,950	14,670
9:00	10	1,600	3,375	4,745	4,950	14,670
10:00	11	1,600	3,375	4,745	4,950	14,670
11:00	12	1,600	3,375	4,745	4,950	14,670
12:00	13	1,600	3,375	4,745	4,950	14,670
13:00	14	1,600	3,375	4,745	4,950	14,670
14:00	15	1,600	3,375	4,745	4,950	14,670
15:00	16	1,600	3,375	4,745	4,950	14,670
16:00	17	4,100	3,375	4,745	4,950	17,170
17:00	18	4,100	3,375	4,745	4,950	17,170
18:00	19	4,100	3,375	4,745	4,950	17,170
19:00	20	4,100	3,375	4,745	4,950	17,170
20:00	21	4,100	3,375	4,745	4,950	17,170
21:00	22	4,100	3,375	4,745	4,950	17,170
22:00	23	4,100	3,375	4,745	4,950	17,170
23:00	24	4,100	3,375	4,745	4,950	17,170





SFFD

- San Francisco Fire Department
- 3305 3rd St, San Francisco

Operational Characteristics

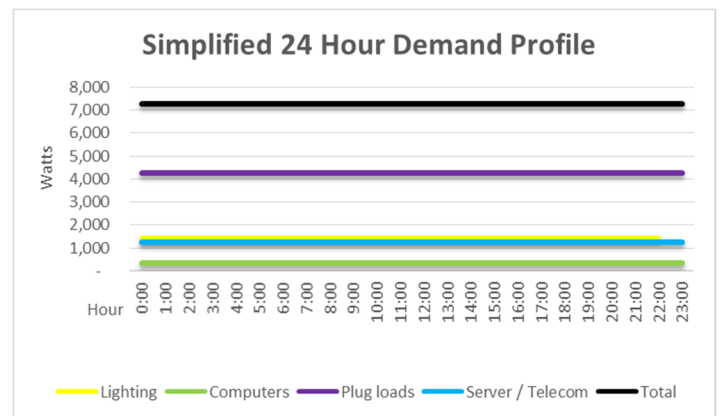
- Operates as normal with increased staff. Fire fighters sleep in the facility, heat meals in the microwave and staff the office. The facility has a 50kW back-up generator. The generator is tested on a weekly basis.
- Occupants: ~ 10 officers
- Operating hours: 24 hours per day

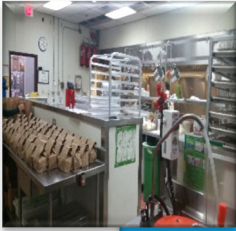
Identify Electrical Loads

Load Type	Requirements (Diversity)	Load
Lighting	Front of House (80%)	~20 x 40W x 0.8 = 640W
	Rest of House (80%)	~30 x 32W x 0.8 = 768W
Computers	2 x desktop (70%) Diversified	2 x 250W = 350W
HVAC	Server room (90%)	720W
Server / Telecom	Wifi, + racks (90%)	540W
Appliances	Printer (20%)	200W
	TVs (100%)	2 x 100W
	Microwave (20%)	1000W
	Coffee Pots (60%)	800W
	Fridge (60%)	500W
	Ham Radio (50%)	250W
	Comms (80%)	1000W
	Fire Trucks (40%)	3 x 1300W
	Misc. Loads (50%)	1000W
	TOTAL	= 8600W
	Diversified	= 4270W
Maximum Demand		7,288W

Load profiles

Time	Hours off Grid	Lighting	Computers	Plug loads	Server / Telecom	Total (W)
0:00	1	1,408	350	4,270	1,260	7,288
1:00	2	1,408	350	4,270	1,260	7,288
2:00	3	1,408	350	4,270	1,260	7,288
3:00	4	1,408	350	4,270	1,260	7,288
4:00	5	1,408	350	4,270	1,260	7,288
5:00	6	1,408	350	4,270	1,260	7,288
6:00	7	1,408	350	4,270	1,260	7,288
7:00	8	1,408	350	4,270	1,260	7,288
8:00	9	1,408	350	4,270	1,260	7,288
9:00	10	1,408	350	4,270	1,260	7,288
10:00	11	1,408	350	4,270	1,260	7,288
11:00	12	1,408	350	4,270	1,260	7,288
12:00	13	1,408	350	4,270	1,260	7,288
13:00	14	1,408	350	4,270	1,260	7,288
14:00	15	1,408	350	4,270	1,260	7,288
15:00	16	1,408	350	4,270	1,260	7,288
16:00	17	1,408	350	4,270	1,260	7,288
17:00	18	1,408	350	4,270	1,260	7,288
18:00	19	1,408	350	4,270	1,260	7,288
19:00	20	1,408	350	4,270	1,260	7,288
20:00	21	1,408	350	4,270	1,260	7,288
21:00	22	1,408	350	4,270	1,260	7,288
22:00	23	1,408	350	4,270	1,260	7,288
23:00	24	1,408	350	4,270	1,260	7,288





Salvation
Army

- Salvation Army
- 850 Harrison St,
San Francisco

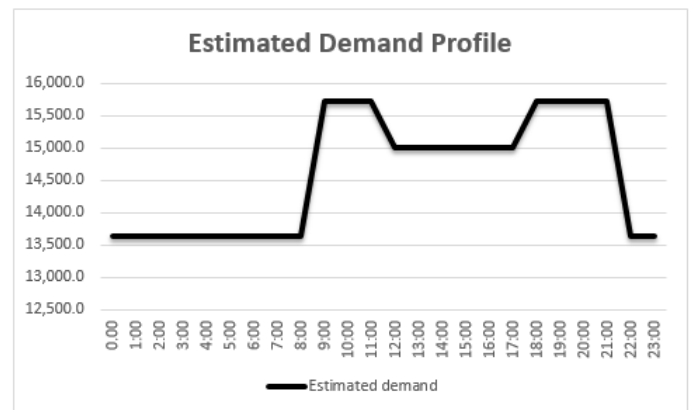
Operational Characteristics

- Working around the clock in shifts to provide up to 20,000 meals per day. The facility has a 350kW generator and 1000 gallons of onsite fuel storage. It was not determined when the generator was last tested. Electrical loads were assessed from the site bill data.
- Occupants: ~ 30 staff +
- Operating hours: 24 hours per day

Develop load profiles

In the case of the Salvation Army they provided billing data covering days which represented their expected disaster relief operations.

The billing data provided daily kWh usage figures with peak, part peak and off-peak usage indicated. This was used to estimate the 24 hour demand profile.



Identify Electrical Loads

Load Type	Requirements
Lighting	Up to 100%
Computers	1
HVAC	None
Server / Telecom	Wifi, 1 x racks
Appliances	Electric ovens x 6 Industrial sized electric fry pans x 2 Cool rooms x 2 Freezer room Food warmers x 6 Coffee machine Industrial dishwasher Charging food truck