RESILIENT POWER PROJECT CASE STUDY

Solar Responders Brings Resilient Power to Puerto Rico's Fire Stations

Abbe Ramanan, Clean Energy Group October 2021























RESILIENT POWER PROJECT CASE STUDIES

This case study is one in a series by Clean Energy Group (www.cleanegroup.org) as part of The Resilient Power Project (www.resilient-power.org), a joint project with Meridian Institute (www.merid.org). This project seeks to expand the use of clean, distributed generation for affordable housing and critical community facilities to avoid power outages; to build more community-based clean energy systems; and to reduce adverse energy-related impacts on vulnerable populations. This case study series highlights installations of solar photovoltaic (PV) and battery storage (solar+storage) systems to demonstrate their economic, community resiliency, and health benefits. More information about this project and others can be found at www.resilientpower.org.

ACKNOWLEDGEMENTS

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Cover image: Solar panels on the roof of Fire Station Humacao. Photo courtesy of Solar Responders.

Table of Contents

THE CHALLENGE: Puerto Rico's Fire Stations Lack Access to Reliable, Resilient Power	 5		
THE SOLUTION: Solar+Storage in Local Fire Stations	11		
		APPENDIX B: Resilient Power System Design	19
		APPENDIX C: Photos	25



SOLAR RESPONDERS BRINGS RESILIENT POWER TO PUERTO RICO'S FIRE STATIONS

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LEARN MORE

Webinar: Bringing Resilient Power to Puerto Rico's Fire Stations

Recording available at https://www.cleanegroup.org/webinar/solarizing-puerto-ricos-fire-stations



SOLAR+STORAGE FOR PUERTO RICO'S FIRE STATIONS

Solar Responders equips Puerto Rico's fire stations with solar PV and battery storage (solar+storage) to provide backup power and ensure effective communication and emergency services during natural disasters.

THE CHALLENGE: An Unreliable Grid Can Hinder Emergency Services During a Crisis

Hurricane Maria made landfall in Puerto Rico on September 20, 2017, bringing with it a mix of high winds and extreme rainfall. Much of the island experienced flooding and structural damage along with a loss of electricity and water. Tens of thousands of residents were displaced from their homes.

Puerto Rico's grid, which had been dealing with service issues for many years, was decimated by Hurricane Maria. Over 3 million people lost power, resulting in the longest blackout in US history. Almost half the population lost power for over three months and more rural residents went without for a year or longer.¹

The loss of electricity was catastrophic for Puerto Rico's emergency services providers, who, in the face of an unprecedented crisis, found themselves ill equipped to tend to community members in desperate need of medical attention, fire services, and shelter. All 96 fire stations across the island lost grid service, leaving them unable to operate life-saving equipment as well as their communications systems.

To bring essential backup power to Puerto Rico's fire stations, Hunter Johansson, the CEO and founder of Solar Responders—advised by the now-retired Captain Richard Birt of Las Vegas Fire and Rescue, and Solar Responders Board Chair Nita Baum—engaged with the Puerto Rico State Fire Department in January of 2018. Over the following year, Solar Responders would build their relationship with the fire department's leadership to understand the unique challenges facing Puerto Rican fire stations.

¹ See https://www.vox.com/2018/4/13/17229172/puerto-rico-blackout-hurricane-maria



THE SOLUTION: Equip Critical Service Providers with

Solar+Storage

Solar Responders' mission is to provide solar+storage to all 96 fire stations in Puerto Rico through a multiphase approach. Twenty-three (23) fire stations were selected for Phase 1 and were chosen based on the emergency medical services they provide to the local community and their location in high-risk, earthquake prone areas.

Through a partnership with the Puerto Rico State Fire Department and AZ Engineering, Solar Responders has installed solar+storage systems at six fire stations in Puerto Rico to date: Fire Station Humacao, Fire Station Yauco, Fire Station Loíza, Fire Station Rincón, Fire Station Culebra, and Fire Station Cataño. Once Solar Responders can furnish all 23 of these stations with solar+storage, the organization will move on to Phase 2, which will address fire stations by their proximity to areas where the grid is weakest.

Each installation consists of a rooftop solar panel array and lithium-ion battery storage system that can serve the critical loads of each fire station—powering radios, lights, computer systems, telephones, refrigeration, and communal spaces. Fire fighters will be able to communicate with residents in need and provide life-saving emergency services. Local community members can also use the community rooms in the fire stations to power cell phones, refrigerate medications, and power medical equipment during outages.

Fire Station Rincón, the first station to install solar+storage, was completed in December 2018. Fire Station Cataño, the most recent installation, was completed in January 2021. So far, the combined stations have produced 100 megawatt-hours (MWh) of power and provided over 1,000 hours of backup power. In 2022, Solar Responders will work to increase the capacity of the solar+storage systems to provide at or near 100 percent of the energy needs of each fire station.

Backup Power. Regular hurricanes and earthquakes, as well as the continued instability of the electric grid, mean that outages are common in Puerto Rico. The six fire stations equipped with solar+storage systems can provide critical care services to their local community during these outages. Each system can provide up to 16 hours of backup power to the entire station, even when the sun is not shining. Each fire station is also equipped with a diesel generator as a redundancy measure should the solar+storage system run out of battery power.

Solar+storage installations empower communities to prioritize their needs in the event of an outage. The six fire stations equipped with solar+storage serve a population of 181,800 individuals, and all the stations play



a central role for the communities within their service areas. In addition to providing emergency services, solar+storage allows the fire stations to power important community functions. For example, following the 2020 earthquakes in Puerto Rico, Fire Station Yauco, which was in the epicenter of the earthquakes, was able to provide over 500 hours of backup power. During the island's primary elections in early August 2020, Fire Station Yauco provided electricity to the local polling station so residents could still cast their votes.

Reliable Power. Prior to the installation of solar+storage, all six fire stations relied on diesel generators for power, but those could often be unreliable. For instance, Fire Station Culebra, which was without grid service for over a year, had to rely on diesel power; however, getting fuel to the island proved difficult. The result was that the station went without power on a consistent basis. Solar+storage relies on renewable energy resources and therefore is not dependent on fuel supplies, the availability of which are especially unpredictable during a catastrophe. With solar+storage, the fire stations only need to rely on diesel generators as a redundancy measure.

Economic Benefits. The resilient power system can reduce a fire station's electric bill by 35-95 percent, depending on the size of the solar PV system as well as the load management needs of the station. Solar Responders is in talks with Department of Public Safety (DPS) of Puerto Rico and the government of Puerto Rico to reallocate these savings to cover the solar+storage system's operations and maintenance (O&M) costs. Pivoting to this model will allow a longer system life span, a revenue source to pay for system maintenance, and the fulfillment of Solar Responders' commitment to local fire fighters and communities.

Project Overview

Property Owner and Occupant: Puerto Rico Fire Department

System Owner and Manager: Solar Responders

Solar and Battery Storage Developer: AZ Engineering

Locations: Humacao, Yauco, Loiza, Rincón, Culebra, Cataño

Equipment:

- Fire Station Humacao: 20.52-kW PV array; Tesla Powerwall (54 kW); pre-existing diesel generator (40 kW)
- Fire Station Yauco: 11.4-kW PV array, Tesla Powerwall (27 kW); pre-existing diesel generator (40 kW)
- Fire Station Rincón: 10.05-kW PV array, Tesla Powerwall (27 kW); pre-existing diesel generator (40 kW)



- Fire Station Culebra: 10.2-kW PV array, Tesla Powerwall (27 kW); pre-existing diesel generator (40 kW)
- Fire Station Loiza: 12-kW PV array, Tesla Powerwall (27 kW); pre-existing diesel generator (40 kW)
- Fire Station Cataño: 15.6-kW PV array, Tesla Powerwall (39.5 kW); pre-existing diesel generator (40 kW)

Building loads supported by solar+storage: During an outage, the solar+storage system at each fire station will provide power to radios, lights, computer systems, telephones, and community rooms for 16 hours – longer if sun is available to recharge the battery.

Building loads supported by the diesel generator: The diesel generators can support select station loads in the event the battery system is depleted.

Services provided: Backup power

Supported infrastructure: Fire station

Battery vendor: Tesla, Glenn International (distributor)

Project partners: Puerto Rico Department of Public Safety, Puerto Rico Medical Emergency Corps Bureau, Puerto Rico State Fire Department, Hispanic Federation, Direct Relief, AZ Engineering, Clean Energy Group



Solar System Details

Solar System Size:

Fire Station Humacao: 20.52 kW

• Fire Station Yauco: 11.4 kW

• Fire Station Loíza: 12 kW

Fire Station Rincón: 10.05 kW

• Fire Station Culebra: 10.2 kW

• Fire Station Cataño: 15.6 kW

Configuration: Rooftop solar

Solar System Annual Production:

Fire Station Humacao: 27 MWh

Fire Station Yauco: 17 MWh

• Fire Station Loíza: 18 MWh

Fire Station Rincón: 13 MWh

Fire Station Culebra: 14 MWh

Fire Station Cataño: 19 MWh

Ownership Structure: Solar Responders owns the solar+storage system and has a five-year agreement with AZ Engineering to provide long-term maintenance. The Puerto Rico Fire Department owns and occupies the property.

Revenue Sources: Net metering, recouping financial savings from energy bills, foundations, private donations, and avoided cost of outages savings such as additional diesel for generators and equipment failure due to power outages. Solar Responders is in talks with DPS and the government of Puerto Rico to direct revenue generated by energy bill savings towards O&M costs for the systems.



Energy Storage System Details

Type of technology and size (power-kW/ capacity-kWh): Sizes varied between 27 kW and 54 kW, depending on the facility

Energy Storage Technology Provider: Tesla Powerwall

Energy Storage System Location:

- Fire Station Humacao: Rooftop
- Fire Station Yauco: Rooftop
- Fire Station Loíza: Rooftop
- Fire Station Rincón: Rooftop
- Fire Station Culebra: Rooftop
- Fire Station Cataño Rooftop

Date of Service/Operation:

- Fire Station Humacao: August 12, 2020
- Fire Station Yauco: August 13, 2020
- Fire Station Loiza: October 21,2020
- Fire Station Culebra: May 10, 2019
- Fire Station Rincón: December 30, 2018
- Fire Station Cataño: January 13, 2020

Energy Storage System Owner: Solar Responders

Cost: \$100,000 per station on average

Funding Sources: Direct Relief provided a grant for Fire Station Cataño, and the Hispanic Federation provided a grant for Fire Station Loíza. Other stations were funded through private donations. Clean Energy Group awarded Technical Assistance Funds for solar+storage feasibility assessments at Fire Stations Humacao, Yauco, and Loiza.



FINANCIAL DETAILS

Project Costs. Solar Responders paid for the solar+storage system components and installation through fundraising from private donors and foundations. Although the system cost varied by size, the average cost was \$100,000. This total reflects the total cost of the rooftop solar array, batteries, design, installation, inverters, fees, taxes, shipping, and other equipment.

Project Financing. Solar Responders raised funds from private donors, and received a grant from the Hispanic Federation, and a grant from Direct Relief.

Anticipated Savings. On average, fire stations are saving 35-95 percent on their energy bills every month, but savings vary by the size of the station. Solar Responders seeks to reinvest these savings towards the system's maintenance costs and other fire department needs.

Operations and Maintenance. To support system maintenance, Solar Responders provides a free training to the fire fighters on the solar+storage system that addresses operations, basic maintenance, and load reduction strategies during an outage. Solar Responders also has a five-year agreement with AZ Engineering for long-term maintenance of the system.

LESSONS LEARNED

Three main lessons were learned throughout the development and initial operations of the six solar+storage projects in Humacao, Yauco, Loíza, Rincón, Culebra and Cataño fire stations.

Local Training in Maintenance and Monitoring. Solar Responders invested time in getting to know local firefighters prior to installing solar+storage in stations. With the expertise of Captain Richard Birt and local teams working on the ground, the organization was able to train firefighters about the benefits and use of solar+storage in emergency situations. Solar Responders also trained firefighters on basic operations and maintenance strategies to keep the systems running optimally. This training also helped the fire fighters with load reduction strategies during an outage, so the solar+storage system can power the station through longer periods of time.

Collaboration is Key. Much of Solar Responder's success is from being able to serve as a convener for government agencies, NGOs, and community organizations. Building partnerships and mutual agreements with local community organizations can go a long way towards building trust and future collaboration. Successful partnerships rely on the willingness of local organizations to want to enter a



partnership and the service provider's ability to listen and respect the time it takes to build trust and reach consensus. Recognizing their limited knowledge of on-the-ground conditions in Puerto Rico, Solar Responders invested time upfront in getting to know government officials as well as community members across Puerto Rico. Solar Responders met with individual fire fighters, their families, members of the local community around each fire station, building rapport and recognizing the fire station's role as a leader in each place. Through this process, Solar Responders centered its mission on a mutual-aid model.

Financial Flexibility is Necessary. While the DPS, which oversees the island's fire, emergency medical services, and police departments, was interested in pursuing solar+storage for fire stations, they expressed concerns about being able to afford the costs associated with system operation and maintenance. Rather than pursue more traditional models for solar+storage, such as a third-party leasing agreement, Solar Responders signed an agreement with DPS to own, operate, and maintain the solar+storage systems for ten years. As a newly formed nonprofit entity in both New York and Puerto Rico, Solar Responders has financial independence, low overhead, efficient operations, and strong ties to the community and industry leaders. This made them an ideal partner for DPS, who has minimal flexibility in their budget as their finances are regulated by the Puerto Rico Fiscal Oversight and Management Board.

Larger Systems Improve Environmental, Social, and Governance (ESG) Returns. Maximizing the amount of solar PV on the roof of each fire station increases the cost savings; and investing more in immediate solar+storage capacity can then create greater social benefit returns for investors. The system also decreases demand on Puerto Rico's vulnerable grid and reduces reliance on diesel generators and fossil-fuel generation overall. Solar Responders' systems have already provided more than 1,000 hours of backup power. Providing enough battery storage capacity to power the electricity needs for whole station, as opposed to only critical loads, will allow the fire stations to increase their operations over an extended period of time. To meet these needs and address future expansion efforts, increased fundraising is necessary.

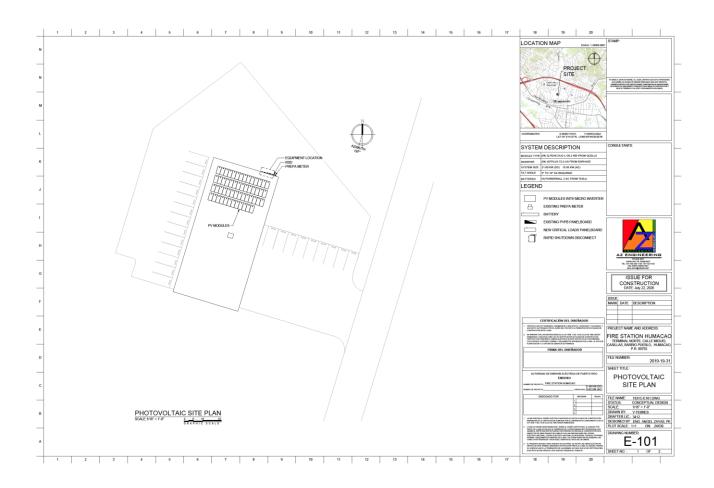


APPENDICES

A. Solar System Design B. Battery Storage System Design C. Photos

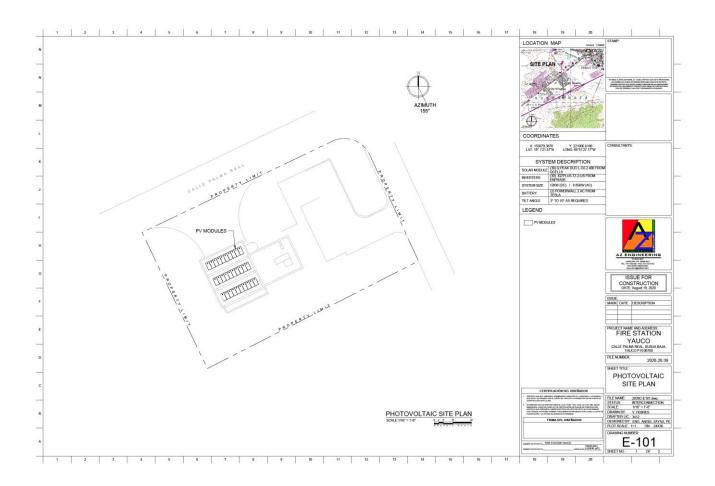
APPENDIX A: Solar System Design

Fire Station Humaco



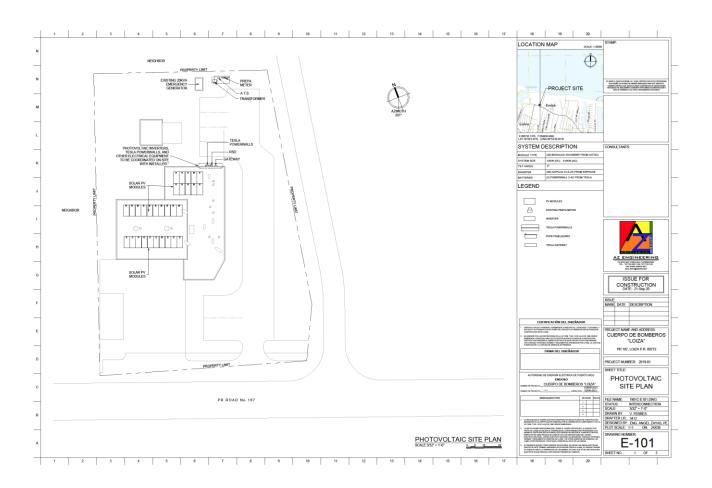


Fire Station Yauco



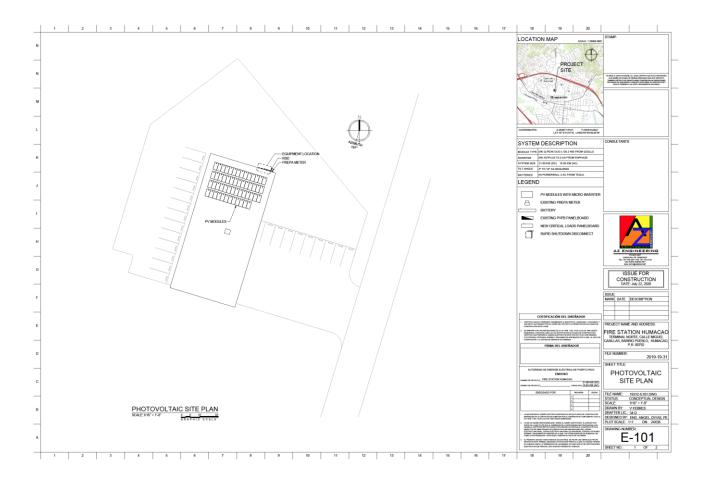


Fire Station Loiza



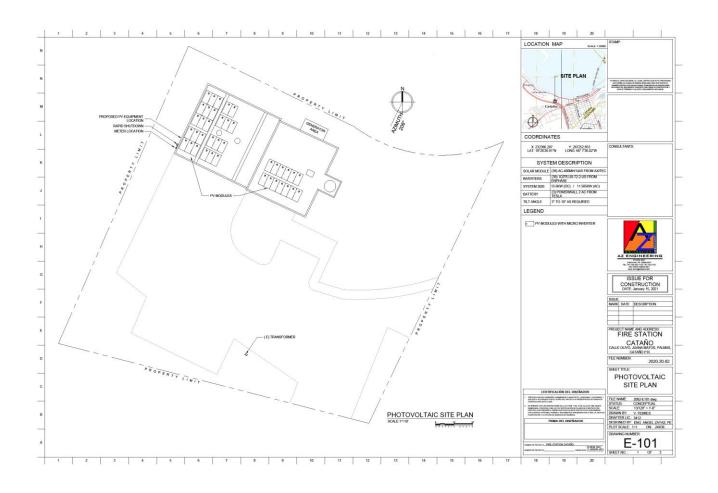


Fire Station Rincón



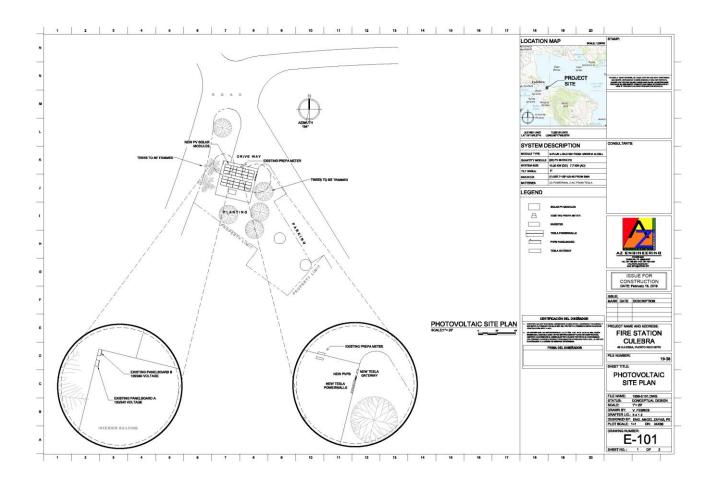


Fire Station Cataño





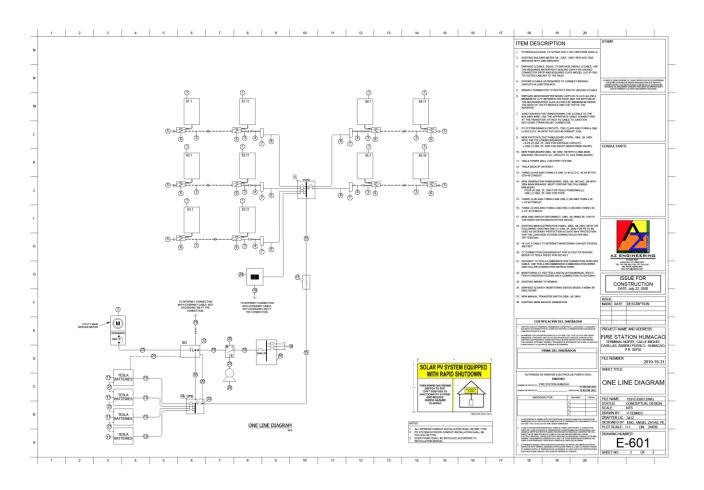
Fire Station Culebra





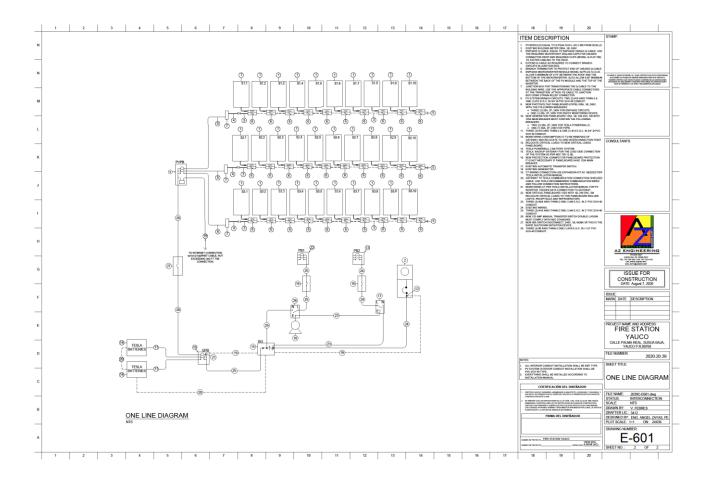
APPENDIX B: Resilient Power System Design

Fire Station Humaco



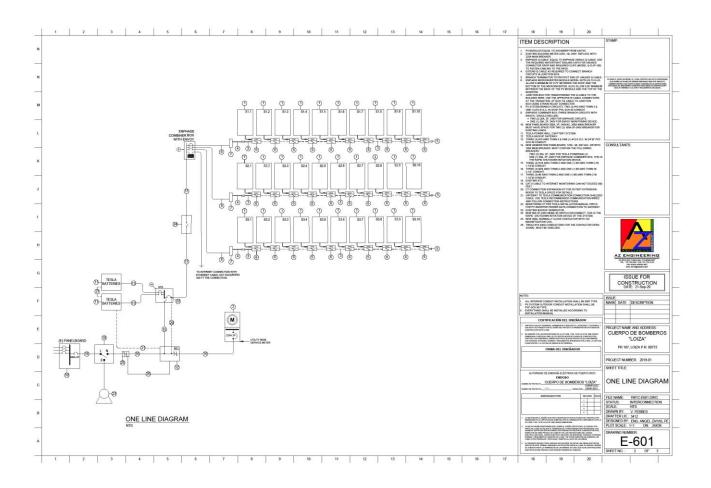


Fire Station Yauco



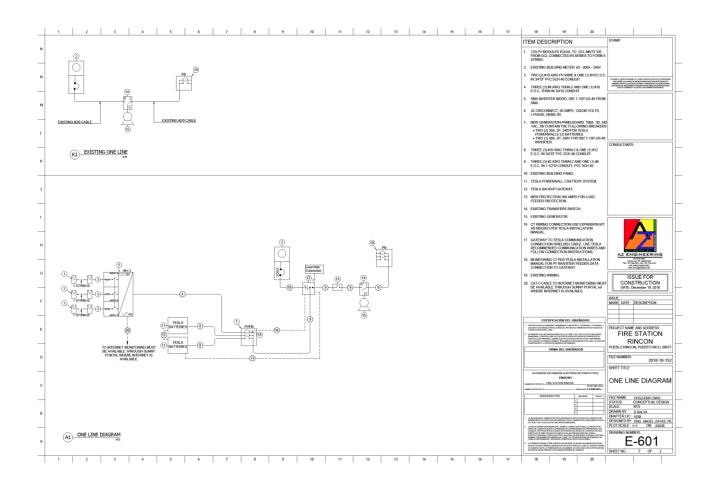


Fire Station Loiza



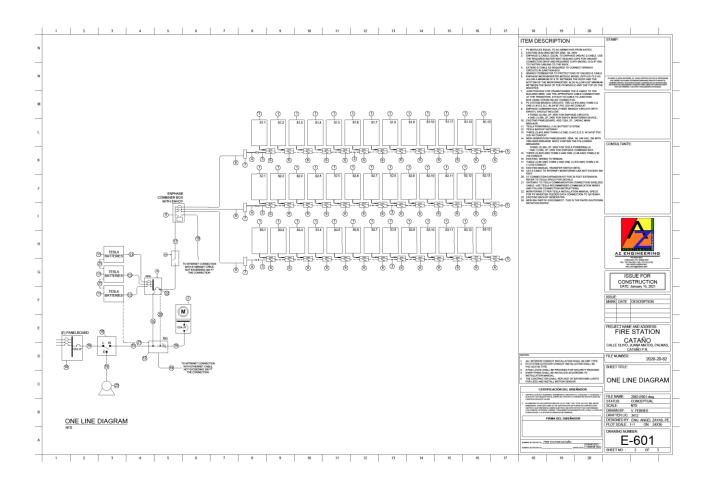


Fire Station Rincón



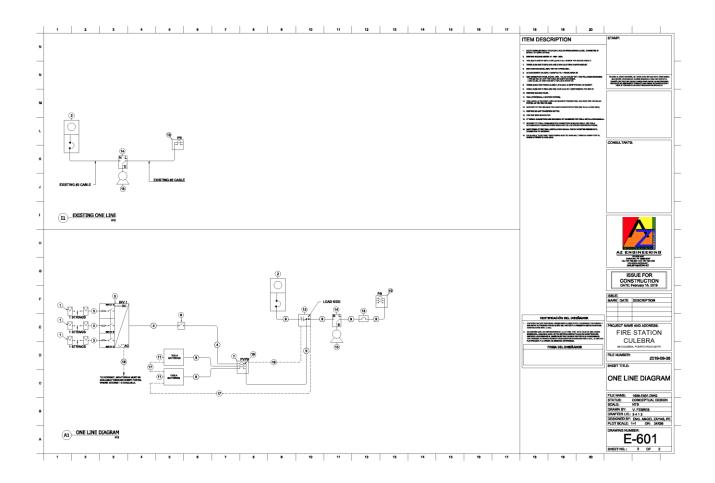


Fire Station Cataño





Fire Station Culebra





APPENDIX C: Photos



The solar panels on Fire Station Yauco. Photo credit: Solar Responders





Fire fighters and Solar Responders staff with the Tesla Powerwall at Fire Station Humacao. Photo credit: Solar Responders





Fire fighters and Solar Responders staff with the solar panels on Fire Station Humacao. Photo credit: Solar Responders





Solar panels on the roof of Fire Station Rincón. Photo credit: Solar Responders





Solar panels on the roof of Fire Station Cataño. Photo credit: Solar Responders





The roof of Fire Station Culebra. Photo credit: Solar Responders





Solar panels on the roof of Fire Station Loiza. Photo credit; Solar Responders





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