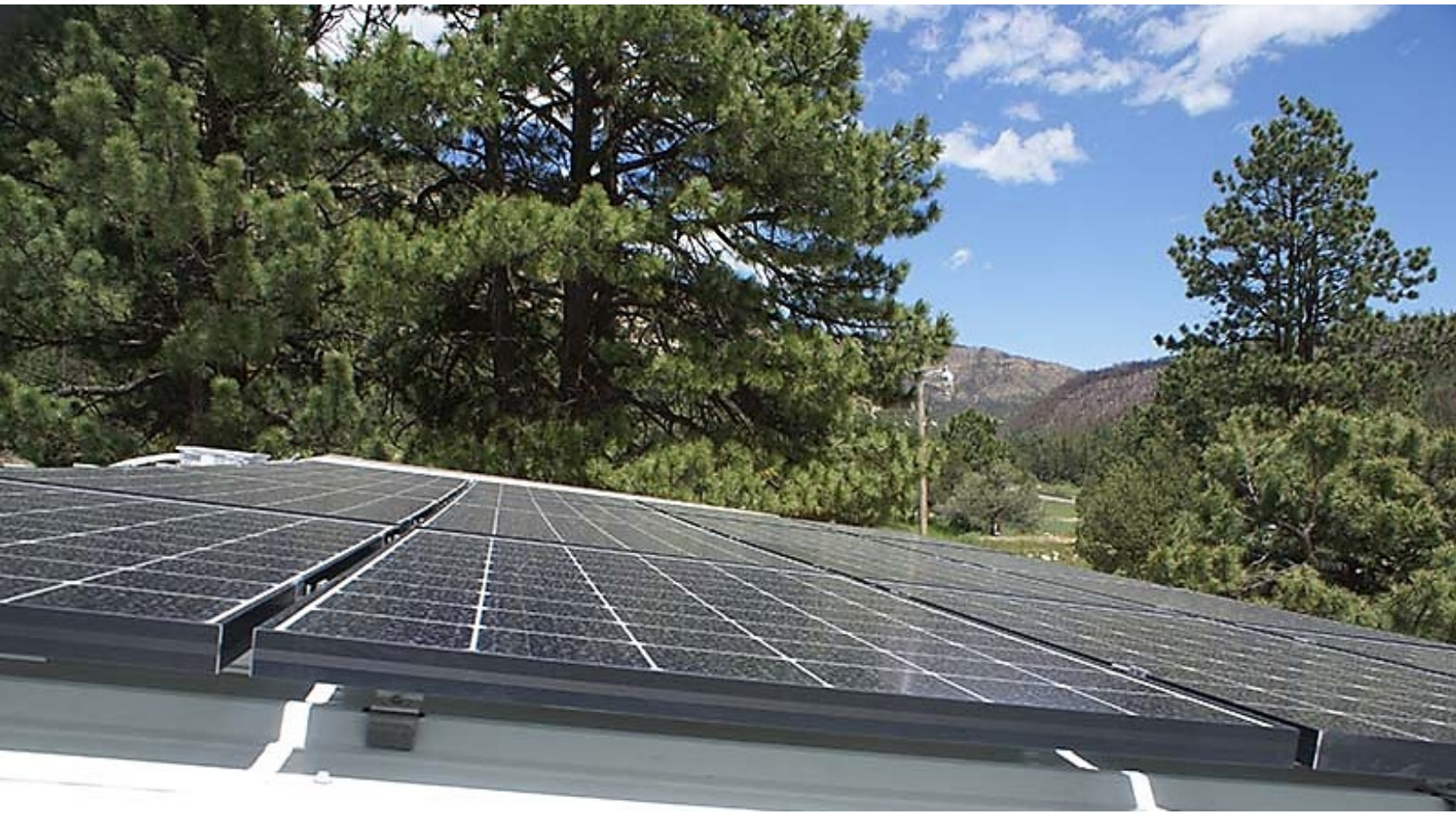
RESILIENT POWER PROJECT CASE STUDY

Cimarron District Forestry Office

Marriele Mango, Clean Energy Group

February 2020



RESILIENTPOWER

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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.resilient-power.org.

ACKNOWLEDGEMENT

The sources for much of the information in this case study come from our partners at the Energy Conservation and Management Division of New Mexico and from the Office of Energy Efficiency and Renewable Energy's article, "EERE Success Story – New Mexico's Forestry Division Saves Money by Switching to Solar," published in September 2019. The author would like to thank Geoff Oxnam from American Microgrid Solutions; Travis Simpkins and Amy Simpkins from muGrid Analytics; and Mark Gaiser, Louise N. Martinez, Jeremy Lewis, and Arnie Friedt from the Energy Conservations and Management Division of New Mexico for their valuable input and review of this case study.

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Cover image: M. Gaiser, NM State Energy Office, 2019

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Featured Installations Page: Cimarron Forestry Office

More information about this project can be found on the Clean Energy Group's website, under Resilient Power Project's featured installation page. This webpage includes a project summary, photos, and links to additional resources, including webinar recordings, blog posts, and news articles.
This page is updated periodically with new information and materials.

www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations/cimarron-forestry-office/

Webinar: Cimarron District Office:
Supporting Firefighters in New Mexico with Solar+Storage

Clean Energy Group hosted this webinar in September 2019. Recording available at

www.cleanegroup.org/webinar/cimarron-district-office-supporting-firefighters-in-new-mexico-with-solarstorage/

Cimarron District Forestry Office

New Mexico State Energy Office equipped a remote forestry office with solar and battery storage to combat outages and power quality issues and to ensure effective communication and emergency services during wildfires.

THE CHALLENGE: **Power Reliability Issues Can Interfere with Emergency Services During a Crisis**

When severe weather hits, emergency service providers must oftentimes navigate both harsh conditions and its consequences on infrastructure. Road closures and/or blocked roadways, unreliable power, and hindered communication systems all become dangerous realities during severe weather and natural disasters. First responders and government emergency management facilities need to remain open and operational through even the most extreme circumstances.

In remote or rural locations, first responders oftentimes must overcome additional difficulties, such as securing fuel and navigating frequent power outages that disrupt critical equipment. Emergency fuel procurement best exemplifies these issues. Emergency backup power systems typically rely on either propane or diesel fuel to operate. In order to deliver fuel to remote offices during an emergency, providers may have to travel long distances in unsafe conditions. The result can be delayed fuel deliveries, which in turn leaves critical remote offices without power and unable to operate or coordinate with other emergency service providers through an emergency event. If an office is unable to conduct emergency operations from their facility, then the office must move to a new location with reliable power, which requires diverting valuable time and resources.

Unreliable power and poor power quality were increasingly problematic for the Cimarron District Forestry Office, a remote forestry office in New Mexico that covers 5.6 million acres of land and serves as Fire Command Center for the region in the event of a wildfire. The office was experiencing two to three power outages per year. Brownouts due to poor power quality were also problematic as they threatened office operations and damaged equipment. Electricity from the utility was historically unreliable as the office was located at the end of a utility feeder line that stretched over two mountain passes and through a forest.

When the power did go out, the only available emergency power source was an aging 20-kilowatt generator fueled by a 500-gallon propane tank. Although the delivery route for propane was typically reliable, it was

closed one to two days per year. The road closures could add up to eight hours in delivery delays. Additionally, during extreme weather and wildfires, open roadways could still be compromised and result in delays.

THE SOLUTION: **Resilient Power for Emergency Operations**

Resilient and reliable communications was a top priority for Cimarron District Fire Office and their partner organization, the Energy Conservation and Management Division of New Mexico (ECMD). Instances of computer failures and equipment replacement resulting from poor power quality and outages needed to be reduced or eliminated. Furthermore, as the Fire Command Center for a large region of the state, the office needed to be able to support an influx of staff and equipment and support longer hours of operation.

In an effort to address these issues, the Cimarron District Fire Office worked with ECMD to install solar PV paired with battery storage (solar+storage) at the Cimarron District Forestry Office in Ute Park. The system consisted of a lead-acid battery system connected to both a rooftop PV solar array and the grid. When power from the grid is unavailable, the system automatically islands to operate independently and immediately diverts solar array production to the battery system to power the isolated critical loads, including a well water pump and communication systems. This automatic transfer functionality was vital as Cimarron District staff had limited knowledge of power system operations and therefore needed minimal hands-on operational requirements. Manual intervention is only required when backup power is needed to support the full load of the office. The system was completed in June 2019 and is working as expected.

Backup Power. The battery will provide eight hours of backup power when operating all critical loads – well water pump, radio base stations, handheld radio charging stands, icemaker, electric tools, garage door openers, phone system, computer servers, lighting, computers, kitchen prep area, refrigerator, ceiling fan, and floor fans – and 20 hours or more of backup power during times when loads are minimal. If the site operators manually manage the loads, and the solar resource is adequate, a full 24 hours can be obtained.

The existing propane generator was determined to have useful life left and was incorporated into the system as an additional backup power resource. However, power from the generator is now directed through the inverter system to improve the power quality produced and reduce stress on sensitive equipment.

Economic Benefits. The solar+storage system was designed to both provide emergency backup power and economic benefits by offsetting utility bills. The system is expected to offset over 90 percent of the facility's electric costs, or approximately $2,225 in savings a year (the annual electric bill averages $2,460). When planned energy efficiency measures are completed, a 100 percent of the costs could be offset.

In the winter, the office will still rely on propane for heat. However, the solar+storage system is expected to offset the propane required by the generator by approximately 50 gallons a year, which will result in fewer propane deliveries and over $100 a year in savings.

Resilient Emergency Services. Reliable communication equipment is especially important when the office serves as Fire Command Center, at which point staffing swells from four people to twenty, and the office must support significantly more electricity-dependent equipment, such as computers and plotters to produce real-time maps.

During the Ute Park Fire in June 2018, which burned over 35,000 acres of land and destroyed 14 buildings, the Fire Command Center supported and coordinated 500 personnel, 8 helicopters, and 19 fire engines. For four days, the Cimarron District Forestry Office ran Ute Park Fire response operations entirely on a propane generator due to extended grid disruptions. While the generator was able to run the entire time without major electrical failures, office electronic devices and systems suffered long-term damages due to power quality issues. Due to this damage, control operations had to be moved to a different site and the propane generator was used only to maintain power at the office for the lighting and shops.

Resilient solar+storage will ensure that the Fire Command Center doesn't risk losing equipment to future power issues and can keep critical communication operational through a crisis. The project is the first of its kind for ECMD and demonstrates how solar+storage can reliably power critical emergency services at remote offices in the event of an outage, while also proving economically beneficial during hours of normal business operations.

Project Overview

Owner: The Energy Conservation and Management Division of New Mexico

Location: Ute, New Mexico

Equipment: 10.62-kW solar PV array; 8 X 200PLR EnergyCell VRLA-AGM lead acid batteries (8-kW/16-kWh); pre-existing 20-kW propane generator

Installed cost: $79,200[1]

Building loads supported by solar+storage: During an outage, the solar+storage system will provide power to a well water pump, radio base stations, handheld radio charging stations, an icemaker, electric tools, vehicle battery chargers, garage door openers, phone system, computers and computer servers, lighting, a refrigerator and kitchen prep area, and ceiling and floor fans.

Building loads supported by the gas generator: Heating/cooling systems and battery storage system

Services provided: Backup power

Supported infrastructure: Ranger Station and Fire Command Center

Battery vendor: OutBack Power

Project partners: Energy Conservation and Management Division of New Mexico, State Forestry Division Cimarron District Office, U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, Clean Energy Group, American Microgrid Solutions, muGrid Analytics

Solar System Details

Solar System Size: 10.62-kW solar array

Configuration: Rooftop solar

Solar System Annual Production: 16.1 MWh/year

Ownership Structure: The Energy Conservation and Management Division of New Mexico

Revenue Sources: Net metering and avoided cost of outages savings related to replacing damaged equipment due to power quality issues

Cost: $15,920

[1] The $79,200 does not include the cost of the pre-existing gas generator.

Energy Storage System Details

Type of technology and size (power-kW/ capacity-kWh): 8 X 200PLR EnergyCell VRLA-AGM lead acid batteries (8-kW/16-kWh)
Energy Storage Technology Provider: OutBack Power
Energy Storage System Location: Shop 2 of the District Office
Date of Service/Operation: June 2019
Energy Storage System Owner: The Energy Conservation and Management Division of New Mexico
Cost: $5,300
Funding Sources: U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, New Mexico State Forestry Office

FINANCIAL DETAILS

Project Costs. The purchase was made through a New Mexico state price agreement, with a total cost of $79,000. This total reflects the total cost of the rooftop solar array, batteries, design, install, inverter, and other equipment. The rooftop solar array system cost $15,920 and included $9,720 for solar panels, $3,800 for a radian inverter, $500 for system monitoring, and $950 for charge controllers. The batteries received a five percent discount from the vendor and cost $4,100; rack and wiring were an additional $1,200. The remainder of project costs went towards labor, trenching, travel time for the project, conduits and wire.

Project Financing. The New Mexico State Energy Office, through a grant from the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, provided almost $58,000 in funding toward the system. The remaining $21,000 was funded through the New Mexico State Forestry Office.

Potential Savings. Solar+storage is anticipated to reduce electric utility costs by 90 percent. When energy efficiency measures are completed, which will primarily consist of LED lighting upgrades, 100 percent of utility costs will be defrayed. Additionally, the office is expected to save $1,000–$2,000 a year in avoided costs related to replacing damaged equipment. Prior to the solar+storage installation, power quality issues such as brownouts contributed to premature failure of electronic equipment, which resulted in lasting damages.

LESSONS LEARNED

Numerous lessons were learned throughout the development and initial operations of Cimarron District Forestry Office project.

Avoided Costs of Outages can be Significant. Located at the end of a long radial electrical line, the facility houses sophisticated fire management computers and data processing systems that have needed to be regularly replaced due to damage related to poor power quality issues. Repeated brownouts and blackouts have resulted in damage to computers and other critical devices, which then required repair or replacement. For the past four years, the cost of technology replacement has been $1,000 to $2,000 every year. Resilient power will eliminate the need for technology replacement by routing grid and backup power through inverters, which will remedy most power quality issues, reduce the impact of grid outages, and save the office potentially thousands each year.

Short Project Timelines are Achievable. The U.S. Department of Energy funds that partially supported this project required that the project be completed by June 30, 2019, which gave the Cimarron Forestry Office just under a year to conceive, develop, and implement a reliable energy solution. This timeline was also important to ensure that resilient power was in place before the next wildfire season. Even with unforeseen complications, it took 11 months from initial project conception to the solar+storage system being installed and operational. Onsite construction time was twelve weeks. The Forestry Office maintained business operations throughout the process.

There were multiple factors that contributed to the Cimarron Forestry Office's ability to complete this project in a relatively short timeframe. The first was dedicated and motivated staff from both the Cimarron District Forestry Office and ECMD. The second was due to a state price agreement that was in place for solar and battery storage, so the office was able to select a vendor quickly. And third was the vendor's close proximity to the office also helped to maximize construction time and minimize travel costs.

Some resiliency upgrades were deferred to accommodate cost and timeline limitations. An electric vehicle charging station was considered but ultimately abandoned due to the added complexity and costs and lack of urgent or immediate need. A separate solar panel system supporting the office's well pump was also initially included for added resiliency, but onsite water storage for over two thousand gallons of water would have been necessary for the proposed project, the cost of which would have pushed this option out of the price scope and project timeframe. The well pump was instead connected to the battery system as a critical load.

Remote Locations Present Unique Challenges. The most significant project interruption happened when an underground fiber and phone line was accidentally cut during system installation.

There was no documentation as to where the communications conduit was located, and the contractor could not locate it with a metal detector prior to digging. As there was no easy fix or alternative option, the office had to wait months for the line to be repaired. In addition to the inconvenience of delaying project development, the unexpected damage cost $4,000 in repairs. Moving forward, the office will insist that the flagging and marking of underground wires be a top priority.

There were also some unique considerations that had to be thought out before committing to solar+storage. Concerns were brought up regarding how wildfire smoke and tree shade would impact solar PV array energy production (due to state restrictions, the office is unable to cut any trees or tree limbs). Ultimately, the rooftop selected for the solar PV array was not subject to any significant shading. Additionally, it was determined that smoke would have to be very dense, which means the fire would have to be very close to the office, to result in any meaningful reduction in solar power generation.

APPENDICES

A. Resilient Power Goals
B. Solar System Design
C. Photos

APPENDIX A: Resilient Power Goals

Mode	Operational	Financial	Other
Normal Mode	• Provide continuous power to all facility loads • When facility becomes Command Center, serve surge loads of additional users and longer hours • Support power quality (no dips, sags, brownouts, flickers) • Minimize hands-on operational requirements • Provide remote system monitoring	• Reduce utility cost • Reduce cost of replacing damaged equipment due to power quality issues • Meet capital budget requirement (~100K)	• Reduce carbon emissions from generating and delivering energy to serve facility
Outage Mode	• Provide power to Critical Load (=100% of normal load) during an extended outage up to 72 hours • Hedge fuel supply risk with supplemental generation to propane unit • Minimize hands-on operational requirements • Provide remote system monitoring	• Optimize cost to serve critical load	• Support facility mission to protect and preserve the regional environment

Resilient Power operates in two conditions: Normal Mode (>99.9% of time on average) and Outage or "Island" Mode.

Source: American Microgrid and muGrid Analytics.

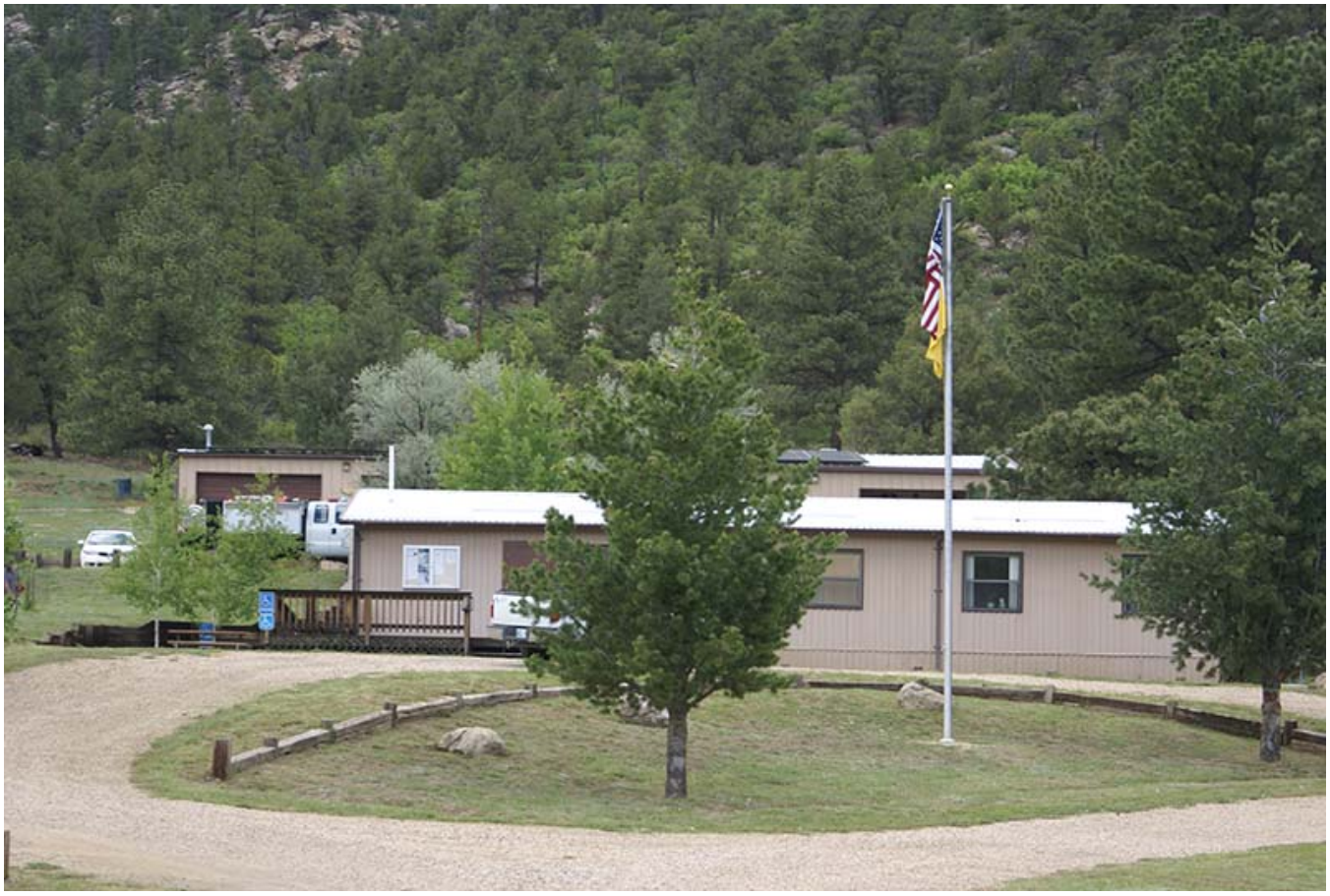
APPENDIX B: Resilient Power Options

	Base Case	Solar Only	Resilient Power$_1$	Resilient Power$_2$	Double-Conversion UPS
Solar PV sizing	NA	9.7kW	9.7kW	9.7kW	9.7kW
Battery sizing	NA	NA	8kW/16 kWh	16kW/32kWh	16kW/48kWh
Generator sizing	20kW propane	20kW propane	20kW propane	20kW propane	20kW propane
Resilience Hours (with generator)	72 hours	72 hours	72 hours	72 hours	72 hours
Average Additional Resilience Hours (solar + storage only)	0 hours	0 hours*	8.3 hours	17 hours	24 hours
Solar Penetration (Percentage of annual load offset by solar PV generation on site)	0%	100%	100%	100%	100%
Est. Capital Cost (ROM)	$0	$38,800	$54,800	$70,800	$119,800

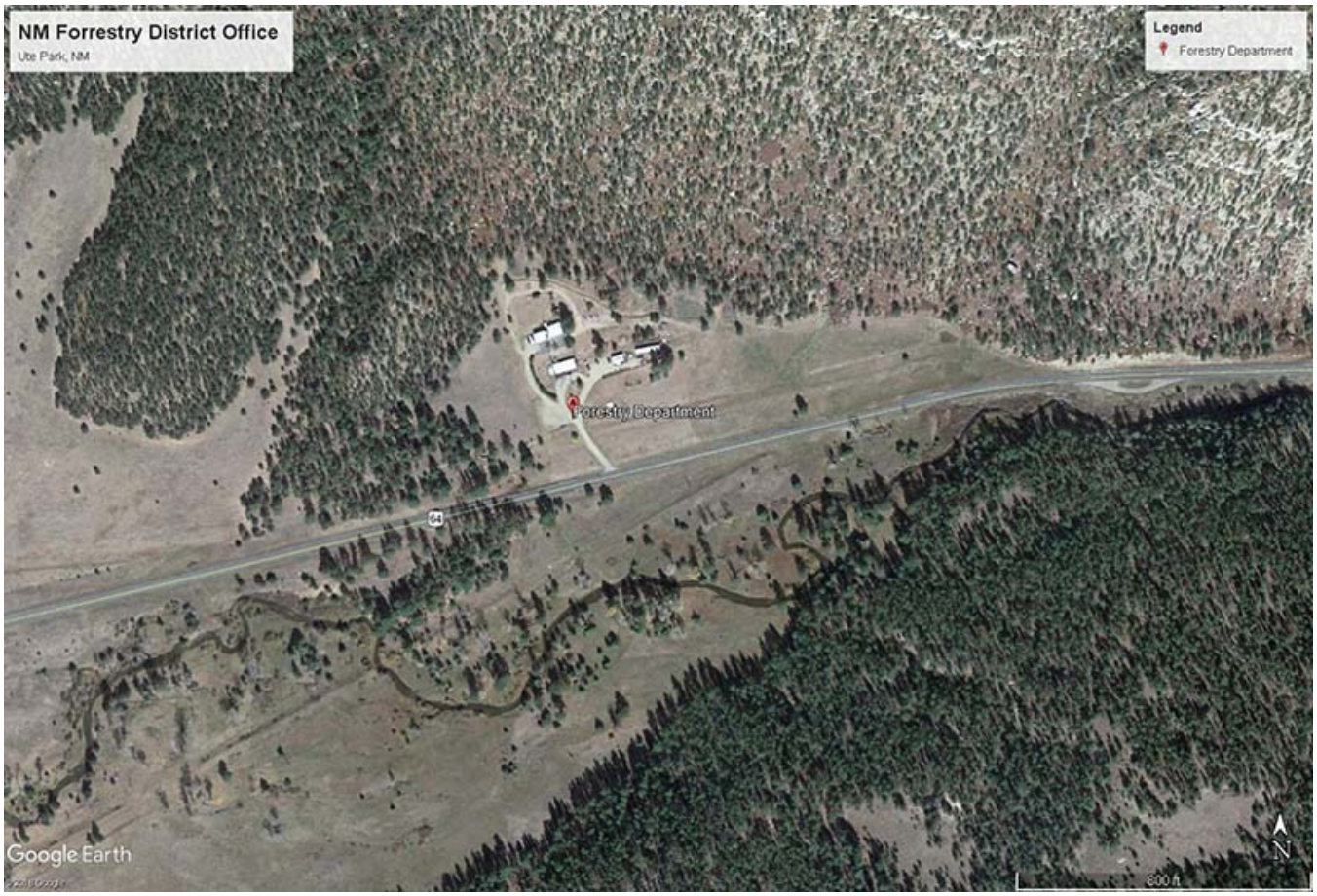
* - Depending on the configuration of the solar array, it may produce incremental resilience during an outage. This varies considerably with weather, time of day, season, atmospheric conditions (e.g. smoke from a forest fire) and electrical infrastructure. For the purpose of this analysis, we use this case to evaluate Solar PV on the results absent other solutions.

Source: American Microgrid and muGrid Analytics.

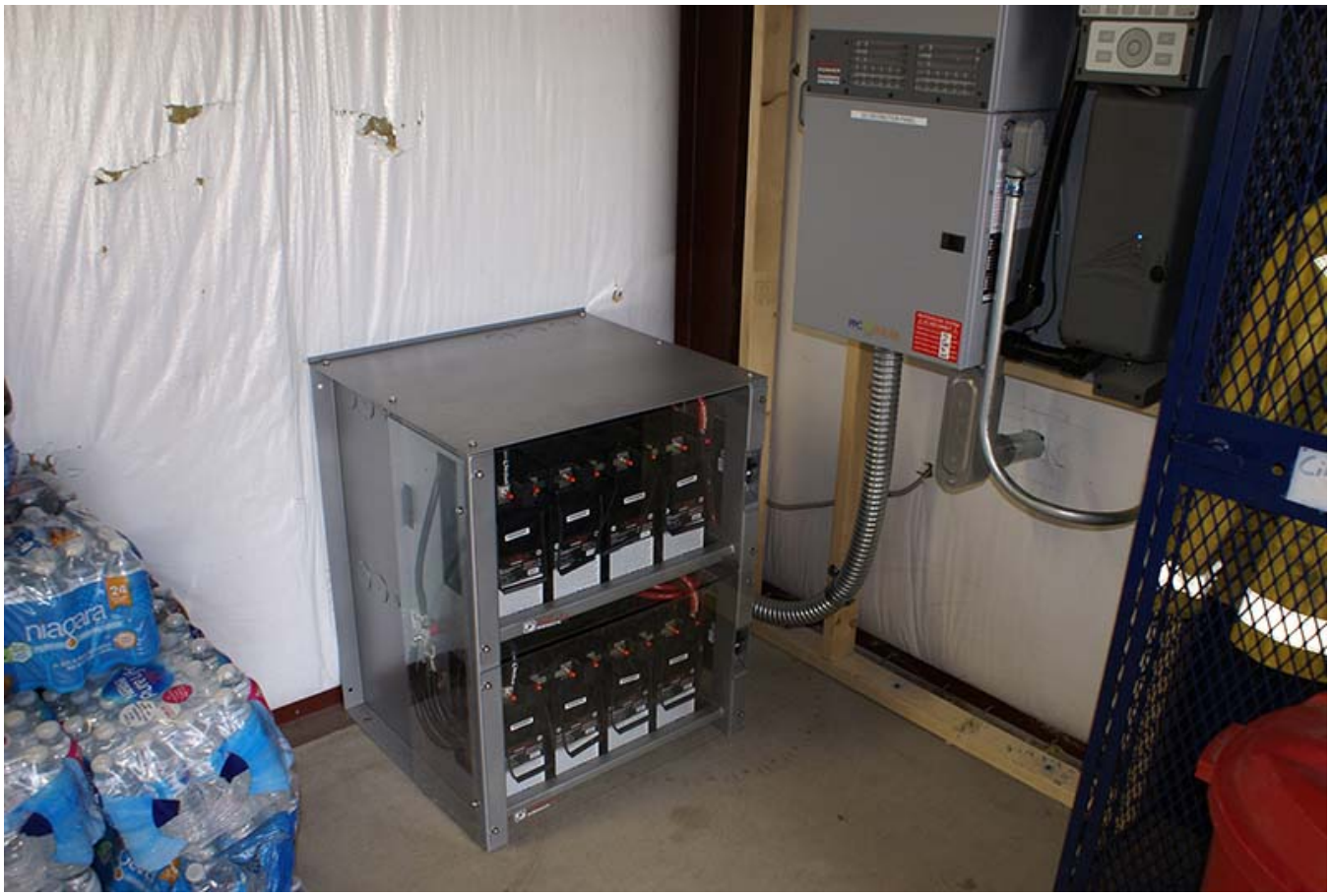
APPENDIX C: Photos



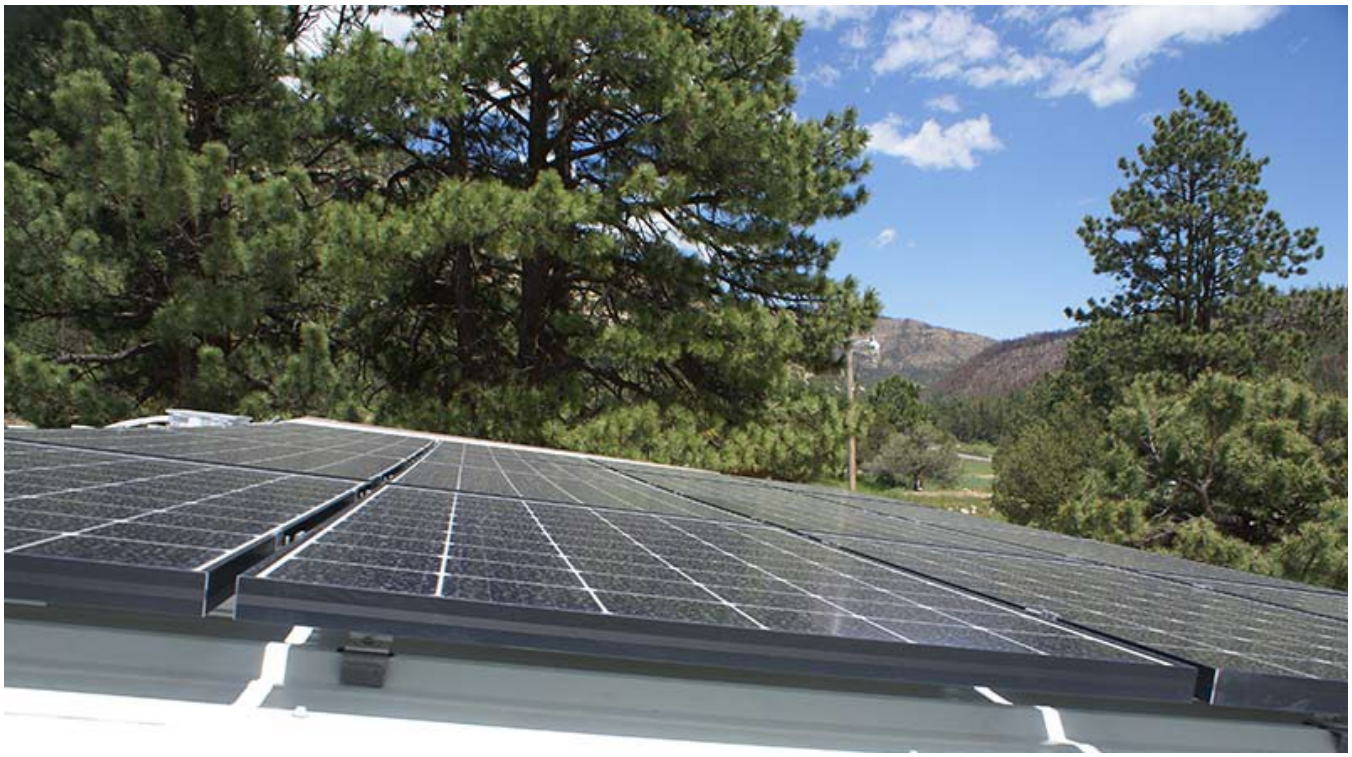
Cimarron District Forestry Office. Photo Credit: M. Gaiser, NM State Energy Office, 2019.



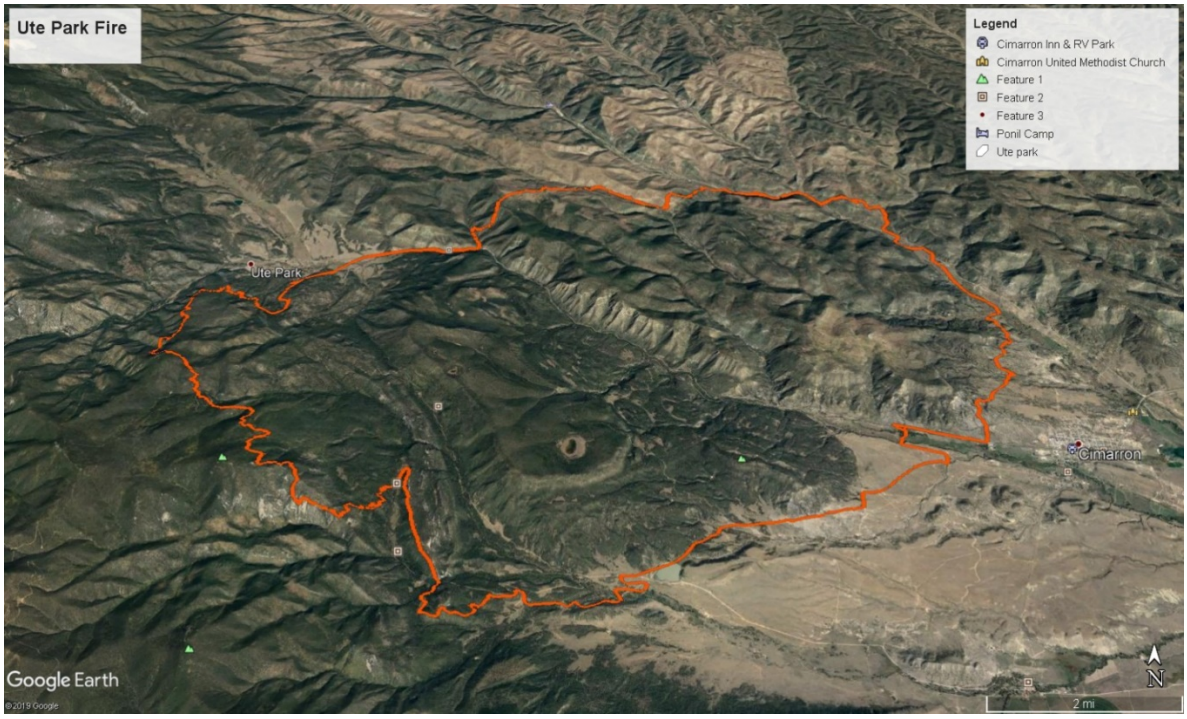
NM Forestry District office - Ute Park; Photo Credit: M. Gaiser, NM State Energy Office, 2019



Battery storage unit at Cimarron District Forestry Office. Photo Credit: M. Gaiser, NM State Energy Office, 2019.



Rooftop solar PV array at Cimarron District Forestry Office. Photo Credit: M. Gaiser, NM State Energy Office, 2019.



Aerial image of the boundaries of the Ute Park Fire. All of this area was burned over four days.
Image Credit: Google Earth

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