Resilience Valuation and Planning for Solar and Storage on Critical Infrastructure

Suzanne Groneman,[1] Dr. Mohammed Ben-Idris,[2] Timothy Farkas,[3] Alison Holm,[4] Wilson Rickerson,[5] and Shoshana Cohen[5]

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5 Converge Strategies

NREL Technical Monitor: Sara Farrar

NREL is a national laboratory of the U.S. Department of Energy
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CASE STUDY OF THE CITY OF RENO

RESILIENCE VALUATION AND PLANNING FOR SOLAR AND STORAGE ON CRITICAL INFRASTRUCTURE

Reno Cityscape: Stock Photo

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- Robert Balzar, private citizen

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Reno Cityscape: Natalie Lumbo

Executive Summary

In 2020, the City of Reno (the "City") was selected by the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) to participate in a collaborative research effort to develop novel applications of solar energy and other distributed energy resources in unique locations and contexts. The City of Reno team, which included the City's Sustainability Program, the University of Nevada, Reno (UNR) and the renewable energy and energy efficiency company Ameresco, was one of just eight teams selected to join Round 2 of the Solar Energy Innovation Network (SEIN) program.[1]

At the beginning of the SEIN program, the city-led team aimed to develop a replicable methodology for calculating a monetary value of resilience (i.e., a concrete dollar amount) that solar and storage could provide at Reno's new Public Safety Center and deliver a proof of concept for monetizing resilience benefits through an energy performance contract (or other contracting mechanism) to facilitate solar-plus-storage procurement. Through research and in-depth discussions with multiple city stakeholders, and the City ultimately determined that it would not need a quantified value of resilience and standard quantification methodology to pursue solar and storage development at the Public Safety Center. Instead, this project resulted in (1) a more refined set of parameters under which the City might pursue resilient energy infrastructure investment, (2) a clearer understanding of the various resilience factors and scenarios to be analyzed, (3) robust dialogues across previously siloed City operations and departments, and (4) the discovery and successful award of new funding sources for future resilient solar and storage projects.

This case study report documents the City's project evolution and the entrepreneurial ways through which the City approached the questions of how solar and storage could support their resilience efforts and how to value and pay for solar-plus-storage systems. This report documents how and why the City of Reno came to the specific conclusion to integrate solar and storage into their Public Safety Center retrofit project and apply for Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure and Communities (BRIC) funding. (The City of Reno applied for and was awarded FEMA BRIC funding in January 2021; leveraging work that was underway in this project.) This report provides an overview for other local governments to draw inspiration from when considering how to prioritize community values and pursue multi-stakeholder dialogue around resilient energy solutions. The City of Reno's experience can serve as a starting point for other communities interested in valuing the resilience benefits of solar and storage.

1 *For more information on the SEIN, see: https://www.nrel.gov/solar/market-research-analysis/solar-energy-innovation-network.html.*

Resilience Valuation and Planning for Solar and Storage on Critical Infrastructure

Case Study from the City of Reno

Project Background

As part of this program, the city-led team designed a project (the "Project"[2]) to develop a replicable methodology for calculating a monetary value of resilience (i.e., a concrete dollar amount) that solar and storage could provide at Reno's new Public Safety Center. The City was interested in how that value could be applied to an existing energy performance contract[3] (EPC) that the City had with Ameresco for the Public Safety Center, or to other financing mechanisms that would enable the City to procure solar and storage for resilience. The Project aimed to create a transferable valuation model and proof of concept for applying a value of resilience into EPCs that could be leveraged at other sites across Reno, the region, or even in other cities and counties nationally. The City designed this project to address and overcome barriers related to:

- Financing solar-plus-storage systems in markets where they may not currently be economically favorable.
- The lack of a standardized approach or framework for valuing and monetizing resilience benefits.
- Limited information about and examples to guide incorporating a resilience value into solar procurement at the city level.

In diving into research and analysis, however, the city-led team quickly learned that there is not an existing standard practice for valuing resilience or incorporating that value into solar and storage procurement options. Different decision makers may also have different philosophies on how value is assessed. Some stakeholders may require an evaluation of energy savings or other traditional payback sources, whereas others may focus on the cost of the failure to act on resilience. Some valuation pathways that appeared viable turned out to be dead ends or would require additional policy or other changes. New challenges emerged, and by working through these issues and opening new channels of dialogue with key stakeholders, the City ultimately concluded that it did not need to value resilience as a concrete dollar figure to make the case for pursuing solar and storage as a resilient infrastructure investment at the Public Safety Center and in other City initiatives. Calculating a specific dollar value turned out to be less relevant than establishing a more thoughtful approach to weighing the importance of resilient energy solutions against other City priorities. Rather than developing a robust quantification methodology for calculating a resilience value, the City ultimately determined that what it needed to focus on was providing public officials with a more concrete justification for investing in resilient energy infrastructure and pathways for paying for those investments.

2 *Throughout this case study, capitalized "Project" refers to the targeted effort the City of Reno undertook with support from the SEIN program to explore resilience valuation for solar and storage applications.*

3 *An energy performance contract (EPC) or energy savings performance contract is a financing mechanism whereby energy upgrades are paid for over time through cost savings resulting from reduced energy consumption.*

1. City of Reno Background Context

Building on recent climate goals and commitments as well as a desire to be proactive and innovative in planning at the local level, the City of Reno saw an opportunity to lead by example with renewable energy at its future Public Safety Center, which will be located in a retrofitted building originally occupied by a newspaper company. The new facility will house Reno's police services, as well as cold-storage for evidence and other electricity-dependent services that represent critical electrical loads for public health and safety, such as emergency dispatch. The co-location of emergency services presents both challenges and opportunities. A major challenge: housing multiple critical services in the same location means they could simultaneously be impacted in the event of a power interruption at the facility. Reno is vulnerable to hazards such as wildfires and floods.[4] A resilient backup power solution is therefore critical. The opportunity: both the City of Reno and the state of Nevada have ambitious renewable energy and related climate targets[5]; implementing innovative solutions to meet critical community needs with renewable power has the potential to meet multiple community objectives related to energy, resilience, and climate.

The City of Reno was inspired by a 2017 study from the San Francisco Department of the Environment[6] that explored the use of solar and storage to provide backup power during disasters. The San Francisco study focused on critical facilities such as police stations, fire stations, hospitals, and emergency shelters.[7] The City of Reno was particularly interested in exploring solar-plus-storage applications, which are potentially more reliable due to consistent use and maintenance, rather than relying solely on diesel generators, which are used intermittently, and failures are not easily detected until it's too late. The City's existing Public Safety Center and other sites involved in emergency response rely primarily on diesel generators for backup power. The San Francisco study provided a road map for assessing specific sites within a city for solar plus storage options and a host of options for financing the projects. The City of Reno sought to build on the San Francisco study by focusing on installing solar and storage at the City's new Public Safety Center, and by valuing and monetizing the resilience value created by supporting public safety services.

History of Reno's Climate Actions & Goals

- 2015: Joined the Global Covenant of Mayors
- 2017: Launched ReEnergize Reno, the local Better Buildings Challenge
- 2018: Completed all goal areas under the City Energy Project
- 2019: City's first Sustainability and Climate Action Plan adopted

Through the Global Covenant of Mayors, the City committed to meet an interim carbon emissions reduction goal of 28% by 2025 (from 2008 levels). Total CO2e (carbon dioxide equivalent, the standard unit for measuring carbon pollution) emissions dropped from just over 3.2 million metric tons in 2008 to 2.75 million metric tons in 2014. This translates to a 13.62% drop in total emissions in six years. To reach its target and reduce emissions 14% by 2025, the City will need to take action through policies and programs focused on renewable energy, energy efficiency, green building, and electric vehicles.

4 *Washoe County. 2020. "Emergency Management and Homeland Security: Hazard Mitigation Plan." https://www.washoecounty.gov/em/Hazards/Hazard%20Mitigation%20Plan.php.*

5 *For example: Nevada has a 50% renewable portfolio standard, with 6% of annual requirement from solar, and a storage incentive with adders for critical infrastructure. Reno's targets and strategies for leading by example include: a 28% reduction from 2008 CO2e levels by 2025; meeting 50% of electricity needs for City facilities, increasing proportion of infrastructure and streetlights that use renewable energy by 2020 and reaching 100% by 2025; and increasing distributed renewable energy generation 15% by 2025 and encouraging energy storage.*

6 *City and County of San Francisco, Department of the Environment (SF Environment). "Solar and Energy Storage for Resiliency." https://sfenvironment.org/solar-energy-storage-for-resiliency.*

7 *SF Environment. 2017. Resilient Solar and Storage Roadmap. https://sfenvironment.org/sites/default/files/fliers/files/sfe_ee_solar_storage_roadmap.pdf;*

SF Environment. 2018. Solar and Energy Storage for Resiliency. https://sfenvironment.org/sites/default/files/fliers/files/sfe_en_solar_resilient_cost_benefit_analysis.pdf; Arup North America. 2015. Department of Energy Solar Market Pathways Critical Load Document.

2. Reno's Project Overview

For cities, disruptive events can impact the basic functions of local infrastructure and services, jeopardizing the safety of residents. But local governments also struggle with the upfront costs associated with being prepared for disruptive events. The City of Reno was therefore broadly concerned with how potential benefits associated with solar and storage systems could be valued and how that value could be incorporated into municipal procurement options to pay for solar and storage infrastructure.

This Project was motivated by a desire to demonstrate that solar and storage can be a viable resilient infrastructure solution, and to make the case for solar plus storage in emergency response and public safety to show how this technology can be cost-effective for local governments.

"The City of Reno approached this Project from the perspective of resilience being a public good that requires investment that may not pay for itself in standard economic terms"

The City of Reno approached this Project from the perspective of resilience being a public good that requires investment that may not pay for itself in standard economic terms. The City therefore needed to be able to understand how to determine and incorporate the value of resilience in some capacity to unlock resources from public sector and private sector partners. In Reno, as in many other cities nationally, solar and/or storage technologies have historically been treated as energy infrastructure that must produce an attractive payback, as opposed to being viewed as a necessary or functional resilient infrastructure project (i.e., one that would play a role in emergency power systems). Shifting the perspective to considering (and valuing) solar and storage in terms of community resilience and emergency management benefits is among the key outcomes of this Project. This paradigm shift evolves the payback framework typically applied to solar and storage decisions. Traditional cost-benefit analyses rarely prioritize solar and storage for back-up power, so being able to assign some form of societal value to these types of projects opens the door to ensure that the City of Reno can make better decisions about critical infrastructure. In Reno's case, being able to demonstrate that a solar and storage project would have a value to society beyond a simple monetary payback on energy savings may be enough to further the discussion, without needing a precisely calculated value. The important distinction for decision-making is that the financial value that the system could provide is greater than zero (and not negative); the analysis may not require more than this level of detail.

The City of Reno wanted to harness the clean energy market to meet its emergency management and resilience goals. Specifically, as part of this Project, the City used the following broad questions as a starting point for investigation, later refining and narrowing in on more specific questions (Section 5) as they gained more information:

- How do resiliency investments provide economic value, recognizing non-energy benefits?
- How can this value be monetized or otherwise considered in City budget and procurement decisions?
- What are the use cases for solar-plus-storage to shorten investment payback periods while achieving climate and sustainability goals?
- What are the related policy and contracting considerations for integrating resilience into procurement?

Reno investigated the resilience requirements of the Public Safety Center, the economics of solar plus storage for resilience, and the pathways for valuing the resilience benefits in a way that would unlock funding resources and enable acquisition and financing. In pursuing these lines of inquiry, the City effectively engaged external private and public sector partners and explored a series of potential policy and market innovations.

The proposed solar and storage project at the Public Safety Center requires the City of Reno to integrate issues that cut across multiple departments and disciplines: energy technology, environmental sustainability, public safety, emergency management, budgeting, state policy, utility regulation, finance,

and procurement. The Project was ambitious, and the Reno team managed the Project as four distinct, but closely related components. These components included:

- An assessment of the Public Safety Center's energy resilience needs and the ability of solar and storage to supply them
- An analysis of solar-plus-storage project economics and acquisition strategies
- Development of a resilience valuation methodology pathway
- Survey of funding and financing options to pay for a solar and storage system.

The cross-departmental and inter-disciplinary nature of the work required the City to build new internal and external teams, as discussed below in Section 3. The Project also created capacity building and learning opportunities within and across departments. The broad-based nature of the Project was also a key to its success: the City identified a way to support critical services using new technology in a way that would leverage expertise and funding from both the sustainability and emergency management domains.

The following sections describe these components in more detail and summarize the decisions and tradeoffs that the team considered along the way.

3. The City of Reno SEIN Project Team

The City of Reno's Sustainability Program led the Project effort and partnered with UNR and Ameresco on various aspects of modeling and analysis. While these three entities constituted the core project team under the SEIN program, the team also coordinated with other City departments, utilities, and other entities to incorporate their perspectives and workshop key issues as the Project developed.

Reno faces challenges related to limited resources and staff capacity shared by many other jurisdictions across the United States, but it was able to get other local resources with aligned interests to join the effort to explore solar and storage resilience value. The City considered existing relationships and existing partners to inform how the Project developed. For example, the Sustainability Program Manager was already working with Ameresco at the Public Safety Center site, had direct connections with UNR, and was able to integrate this Project into other initiatives at the local and state levels where appropriate. The strategy may look a little bit different in another community, but adapting the approach to how the City operates and the conversations that were already taking place was beneficial for exploring different pathways along the way. There was an ecosystem of people who already wanted to work together toward innovation, and understanding the motivations and specific areas of authority for these stakeholders was an important component of this Project.

This section summarizes who was involved and documents key perspectives that informed the Project.

City of Reno Stakeholders: The Project was led by the City of Reno's Sustainability Program, and the Project team engaged a variety of City departments and organizations, each of which had different motivations for the Project and perspectives to contribute. Key City stakeholders included:

- **Sustainability Program:** The Sustainability Program Manager saw an opportunity for this Project to help meet goals outlined in the City of Reno's Sustainability and Climate Action Plan. The Sustainability Program was motivated to incorporate sustainability goals related to solar, storage, and renewable energy into the Public Safety Center design. As a retrofitted facility, the Public Safety Center could also serve as a useful pilot project for integrating both sustainability and resilience solutions at a single facility, which could inform development across other projects as well.
- **City Council:** The City Council must make strong consideration to any new project cost, but if a project represents a cost that is in alignment with the City's Strategic Plan, then staff must make that case and connection. The City Council has an interest in implementing the Strategic Plan and saw this Project as an opportunity

to create new processes or policy to properly evaluate the benefits of proposed solar projects.

- **Emergency Management:** The Emergency Manager stated the effort would need to align with the County Hazard Mitigation Plan. This suggestion created an opportunity to align the work with the Federal Emergency Management Agency (FEMA) Building Resilient Infrastructure and Communities (BRIC) funding requirements, which also require alignment with the local Hazard Mitigation Plan. The Emergency Manager was interested in understanding how to mitigate the fallout from power outages or natural disasters (i.e., keeping roads open, open lines of communications, public health impacts) and felt that this Project got the City closer to finding the connections among resilience through solar plus storage, microgrid solutions, and disaster mitigation.
- **Public Works:** The City Public Works staff often sees that grants and other sources of funds require solar and/or an analysis of climate impacts. The Public Works Director saw an opportunity to create a model that the City can use when soliciting funds, as well as when evaluating the feasibility of solar plus storage in their department.

Ameresco: Ameresco has a long-standing relationship executing performance contracts with the City of Reno. The City initially hired Ameresco to scope and then implement a series of energy conservation upgrades and renewable energy installations in 2008,[8] and has subsequently worked with Ameresco on projects such as the upgrade of the Truckee Meadows wastewater treatment plant in partnership with the City of Sparks.[9] The EPC for the solar and storage system and other energy upgrades would be a new contract. From Ameresco's perspective, energy upgrades are financed based on projected future savings streams. Lower payback or no payback upgrades, such as resilience technologies, could hypothetically be integrated into performance contracts and cross subsidized by the savings from quicker payback technologies, but there are few examples, if any, of this type of contract. Ameresco was also interested in exploring pathways for placing a dollar value on societal values, such as public safety and safeguarding community economic prosperity.

University of Nevada, Reno: One of the main research goals of UNR's E-RESILIENCY (Energy Reliability, Security, Stability, Resilience, and Efficiency) Research Laboratory is developing solutions and tools that enhance reliability and resilience of the electric power supply. Quantifying participation of renewable energy sources and energy storage in enhancing grid resilience and developing resilience evaluation and valuation methods have been the focus of the research team at the E-RESILIENCY Research Laboratory over the last five years. The team at the E-RESILIENCY Research Laboratory found this collaboration to be a great opportunity to (1) discuss potential solutions and methodologies with local governments like the City of Reno, with national labs, and with other stakeholders such as Ameresco and NV Energy; and (2) develop a well-informed tool for resilience valuation through exchanging ideas with and receiving immediate feedback from the rest of the team members.

Although the City of Reno ultimately found that it did not need to quantify a specific resilience value dollar amount to justify pursuing solar and storage at the Public Safety Center, the work that UNR did through this Project to develop a framework for quantifying a value of resilience will likely be published through a peer-reviewed academic process. UNR will continue the academic pursuit of the methodology, while the City has opened the door to discussing solar (and storage where appropriate) at all new facilities. The pieces that ultimately ended up being used directly by the City of Reno in the shorter term are incorporated throughout this case study, especially in Section 5.2.

8 *Ameresco. 2012. "City of Reno, NV." http://www.ameresco.com/wp-content/uploads/2017/02/cs_cityofreno_mep.pdf.*
9 *City of Sparks. 2012. "Staff Report to Mayor and City Council." http://portal.cityofsparks.us/media/ytetq54b1yvjdkptn1kp5loc/STAFF_REPORT_TMWRF_ESCO_Aug_2012.pdf.*

Rendering of The City of Reno Public Safety Center

4. The Facility: Public Safety Center

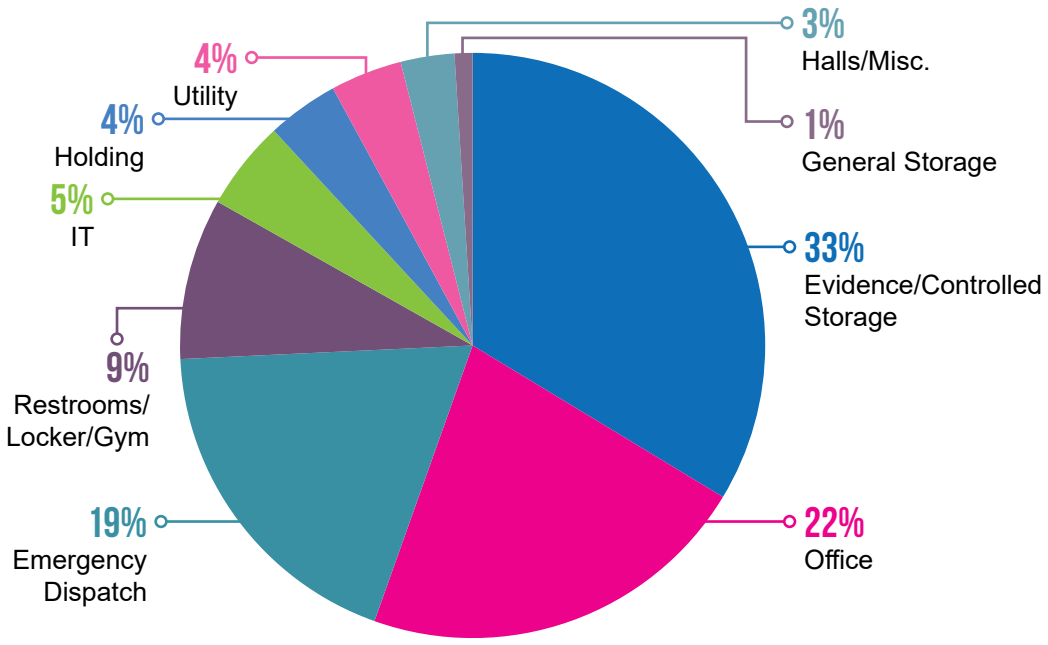
The City of Reno Public Safety Center will be located in a renovated building that formerly housed a local newspaper operation. The retrofitted building is planned to be occupied by late 2022. A first step for the City toward making this new facility a reality was to better understand the building's energy resilience requirements and capabilities. As a result of this work, solar and storage is now included in the final Public Safety Center design.

Energy resilience requirements: Energy resilience requirements are defined in this report as the energy needs of the building under both normal and emergency operating conditions. This includes the essential community functions that the building is intended to provide, and the electrical loads required to perform those functions.

Because the new Public Safety Center facility is a retrofitted newspaper building—which has very different uses and associated energy loads—and because the operations that will be located at the Public Safety Center had not previously been housed together, there were no historical load data available. This lack of data proved challenging for the Project team, making it more challenging to estimate potential critical load resilience requirements and conduct cost-benefit analyses for solar and storage projects. Based on this experience, in applying this Project to other facilities in Reno, the City is exploring whether there may need to be different approaches for valuing the resilience benefits of solar and storage at existing, new, or retrofitted facilities.

Despite challenges related to lack of historical load data, the City, Ameresco, and UNR developed initial estimates for total projected annual electricity consumption and estimated peak demand at different times of the year in order to strategically identify critical loads and relative load sizes. For example, UNR determined that peak energy demand of the building would occur in August, when air-conditioning loads are the highest. As seen in Figure 1, the evidence storage (which includes a refrigeration system) is the largest critical electrical load in the Public Safety Center, and the largest load overall. Secure and climate-controlled evidence storage is vital because some criminal cases may last for many months. Additional critical loads include emergency dispatch for first responders (i.e., the 911 call center), holding and detention, certain information technology systems, and sufficient lighting to safely staff the building.

Figure 1. Building Loads within the Public Safety Center, by Percentage



Energy resilience capabilities. Energy resilience capabilities include any existing energy generation and backup power systems (i.e., generators) that are already installed at the facility. There are already two Marathon diesel generators, 670 kW and 650 kW, and fuel storage tank at the building site that is being repurposed for use by the Public Safety Center building.

The proposed solar and storage system would be able to work in concert with the existing diesel generators and would stretch the existing fuel supplies so that the backup power system could perform in longer-duration power outages.

Source: University of Nevada, Reno

5. Developing the Project Implementation and Resourcing Strategy

With the Public Safety Center's energy resilience requirements and capabilities defined, the City and its partners moved forward with a strategy to assess energy opportunities and to finance the prioritized renewable energy and energy efficiency projects. The team investigated a series of refined questions that build off of the project's original questions (Section 2) and reflect the team's evolving efforts to get the project funded and procured. The updated questions relate to solar and storage system economics, potential deal structures, and opportunities for policy and business model innovations. The questions included:

- **System performance and economics:** How would the prioritized energy upgrades identified for the Public Safety Center perform economically?
- **Value of resilience:** How should the City place a value on sustaining the operations of the Public Safety Center during power interruptions, and how should that value be calculated?
- **Acquisition:** What procurement pathway should the City use to install the identified energy upgrades?
- **Funding and financing:** What funding and financing strategy should the City pursue in order to integrate a solar and storage system?

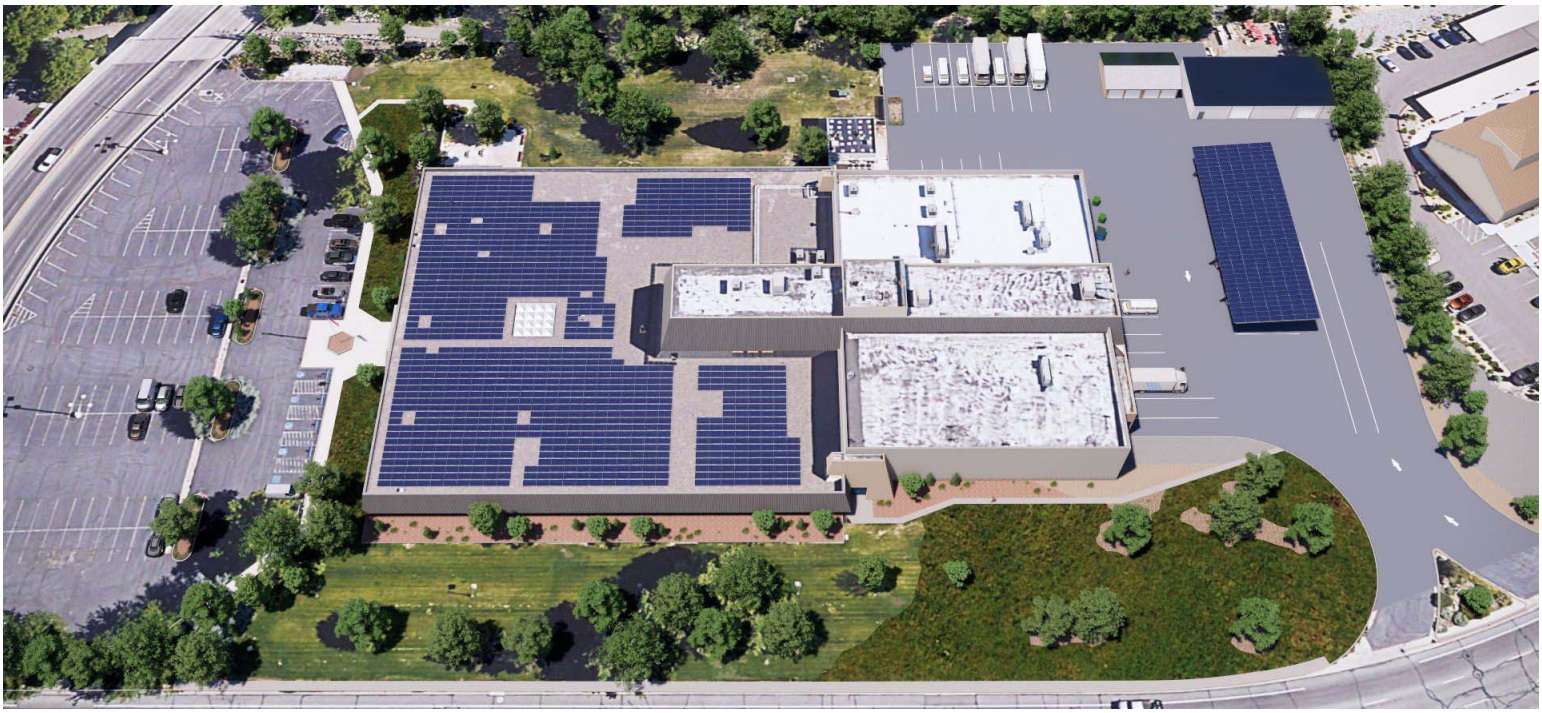
a. Solar and Storage System Performance and Economics

Ameresco initially worked with the City of Reno to identify a portfolio of energy upgrades that would save the City money and reduce carbon emissions. Ameresco's preliminary analysis was completed in December 2019. The draft scope included energy upgrades at City Hall, replacement of lighting in parks with LEDs, and energy conservation measures for the Public Safety Center.

In September 2020, Ameresco and the City modified the scope of work to add an analysis of solar photovoltaics (PV) and battery potential to the Public Safety Center to provide emergency backup power. The battery system would work in conjunction with existing diesel backup generation at the site. The proposed solar PV system would be installed both on the rooftop and a canopy in the Public Safety Center parking lot (Figure 2). Ameresco believes that the proposed solar-plus-storage system would be able to secure revenue from available federal, state, and utility incentives. NV Energy, for example, offers an energy storage incentive program that may benefit the proposed battery at the Public Safety Center.[10] Ameresco also identified that the City's existing solar power purchase agreements (totaling 1.4 MW) could be refinanced to allow the City to purchase solar

10 *NV Energy. 2021. "Energy Storage Incentives." https://www.nvenergy.com/cleanenergy/energy-storage.*

Figure 2. Public Safety Center Solar PV Rendering



Source: Ameresco, 2021

electricity at a lower effective rate, because the PV pricing was initially set 10 years ago when solar energy systems were more expensive.

The initial economics of the proposed EPC were attractive when the resilient solar and storage system, the replacement of lighting in the city parks, and the refinancing of existing solar power purchase agreements were blended. After additional engineering review, however, Ameresco and the City determined that the Public Safety Center building would also need additional upgrades, such as a roof replacement, which would weaken the economic performance of the EPC. As a result, the City and Ameresco investigated how the value created by a solar and storage system might unlock alternative sources of funding and enable the new project to move forward.

b. Value of Resilience

Ameresco's initial EPC analysis did not account for the value of sustaining the Public Safety Center's operations during power interruptions. There is a clear benefit to sustaining Public Safety Center operations during power interruptions and other emergencies, but quantifying a specific value is challenging. The City of Reno identified that calculating a value of resilience would be a useful measure for ensuring that solar, storage, and other distributed energy resources be seriously considered along with other alternatives and integrated into energy and infrastructure investment and planning practices. However, as the City ultimately found, a dollar figure may not matter as much, depending on the specific project or audience. There is a wide range of methodologies available for calculating a value of resilience, but each existing methodology has its limitations, and there is currently no standardized approach for customizing analyses to fit specific local jurisdictions.[11] It is also difficult to analyze the value of avoiding longer duration power outages (i.e., more than 24 hours), because the type of data that would demonstrate the benefits associated with resilience measures are difficult to collect due to the timing and nature of events.

As discussed in Section 3, UNR's E-RESILIENCY Lab led the development of resilience valuation metrics for solar generation and storage systems. The goal of the effort was to provide Reno decision makers with a resilience value to compare between alternatives and perform cost benefit analyses. The valuation metrics were developed

11 *National Association of Regulatory Utility Commissioners. 2019. The Value of Resilience for Distributed Energy Resources: An Overview of Current Analytical Practices.* https://pubs.naruc.org/pub/531AD059-9CC0-BAF6-127B-99BCB5F02198.

based on historical data of extreme events, historical outage data, classifications of critical loads to determine the likelihood of outages, expected outage durations, and average cost of outages. UNR used historical outage data and extreme events trends to extrapolate an estimate for the future costs of longer duration power interruption costs specifically for the Reno area. UNR then calculated the outage costs that a resilient solar and storage system deployed to support the Public Safety Center's critical loads would avoid.

Different groups assign different values to resilience. The analysis sought to find a way to compare the costs and benefits of solar and storage systems with existing primary and backup energy systems, incorporating variables such as operational cost savings, avoided costs, emergency response, resilience, and other public benefits. Reno sought to evaluate the relative value of having solar and storage versus not having them.

Ultimately, the most immediate benefit of this framework were the questions and discussion that it prompted, which allowed the City to consider and evaluate whether solar and storage is an appropriate solution. A calculated value of resilience ended up not being critical to the decision-making process. Following are some of the key discussion questions inspired by the value of resilience analysis:

- **Likelihood of an event:** What is the probability that a disruption will occur?
- **Longer-term service interruptions:** What is the expected service interruption time? (Only scenarios resulting in a 24+ hour blackout were considered.)
- **Seasonal variation of impacts:** When is the outage occurring? How will seasonal variability dictate potential impacts during an outage?
- **Sources of outage costs:** What are the potential costs of outages due to an extreme event? Are there existing models, such as the Interruption Cost Estimate (ICE) Calculator,[12] that can provide useful insights about local outage costs? Should we calculate cost in terms of damage to, for example, property, or the loss of critical public services such as police and fire, or economic damage to the greater Washoe County region?
- **Critical loads:** What are the critical loads at the facility? (For valuing resilience, not all loads have equal value. It may be worth paying for communications and some outlets, but not paying extra to keep other loads. How much thought has been given to load tiering? The marginal cost for keeping 100% of load is very expensive, whereas the first 25% is going to be a bargain.)

These questions laid the foundation for many of the lines of effort discussed throughout this case study. They jump-started the discussion within the City of Reno around whether its facilities were resilient, given the likelihood of disasters and outages becoming more frequent and more expensive. Stakeholders acknowledged that resilience to longer-duration outages—which are outside of historical utility reliability planning processes and short-term events—is a new topic that the value of resilience analysis elevated to inter-departmental discussion.

c. Acquisition

As discussed in Section 5.1, the City of Reno originally planned to acquire the resilient solar and storage system for the Public Safety Center by using an EPC. The EPC allows the City to use projected future energy cost savings to pay for comprehensive building improvements that reduce energy and water use. The State of Nevada has passed multiple pieces of legislation to expand and update its performance contracting authority during the past decade, and the City of Reno has also actively partnered with the State to help scale-up performance contracting statewide.[13]

The savings from the proposed energy upgrades would be guaranteed by Ameresco under a multi-year performance contract. However, a "value of resilience" is not allowed under statute and can't be included in the EPC. The ongoing guarantees from Ameresco help provide risk management for the operation and lasting value of the improvements. See Section 6.2 for additional discussion of the state policy issues surrounding the incorporation of a resilience value into EPCs in Nevada.

12 *The ICE Calculator is available at: https://www.icecalculator.com/home.*

13 *U.S. Department of Energy. 2017. Developing an Energy Savings Performance Contracting Framework for Public Facilities in Nevada. https://www.energy.gov/sites/prod/files/2017/10/f37/WIP-NV-implementation-model.pdf.*

d. Funding and Financing

Under the EPC, the City of Reno could secure financing for the performance contract from either public or private sources that would be paid back by the savings and revenue generated by the a solar and storage project over time. To improve the economic performance of a solar and storage system and project payback, the City explored several different options for additional funding to monetize the resilience benefits of solar and storage. In other words, the City looked beyond the standard suite of clean energy incentives to identify additional funding opportunities that might be available given the Project's focus on critical facilities.

For each funding pathway, the City evaluated the process by which funding might be secured, the comparative ease of securing the funds, and whether and how a value of resilience might support a request for funds. These pathways are detailed in the following subsections.

i. City Funds

The City of Reno has funding within its own budget that could potentially be used to purchase energy resilience systems for critical facilities. The City reviewed internal sources that could be used for energy projects, such as capital improvement funds and air quality funds. The City also reviewed funds that have not historically been used for energy projects, but that could be relevant for the solar and storage project, given the focus on public safety, emergency management, and resilience. If the City chose to invest its own funds in the energy resilience system, a value of resilience could potentially help justify the investment during the budgeting process. However, budgets are limited, and the City decided not to purchase the energy resilience system outright, given competing City priorities and the availability of alternative funding sources for the solar and storage system.

ii. Utility Investment

Utilities can make investments in critical infrastructure hardening using ratepayer dollars in some circumstances. The City of Reno has a good working relationship with its utility, NV Energy. The City considered all options, including approaching NV Energy to finance, own, and operate the solar and storage system at the Public Safety Center. NV Energy could then potentially recover part or all of the investment from ratepayers through regulatory proceedings before the Public Utilities Commission of Nevada. A value of resilience could potentially help NV Energy justify its investment to the Public Utilities Commission. Although some utilities have proposed ratepayer cost recovery for resilient solar and storage systems and microgrids,[14] the track record of success to date has been mixed, and the process by which such systems are considered and approved by commissions is in its early stages.[15]

iii. Emergency Management Funds

Both federal and state governments provide emergency management funding for emergency power projects. FEMA, for example, makes funding available for backup power systems as part of programs such as its Hazard Mitigation Grant Program and the BRIC Program. The 2020 Washoe County Regional Hazard Mitigation Plan identifies several emergency generator projects at critical facilities as priorities for federal funds but does not focus specifically on solar and storage.[16] The City of Reno explored applying for emergency management funds to support the solar and storage system. FEMA requires applicants for its Hazard Mitigation Assistance programs to evaluate proposed projects using FEMA's Benefit-Cost Analysis (BCA) Toolkit.[17] The FEMA BCA Toolkit includes pre-calculated values for the benefits of sustaining

14 Duke Energy. 2019. https://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=f119cf86-96c4-4dc6-804a-7ffc57313606; Florida Public Service Commission. 2020. https://www.floridapsc.com/library/filings/2020/11531-2020/11531-2020.pdf.

15 National Association of Regulatory Utility Commissioners. 2019. The Value of Resilience for Distributed Energy Resources: An Overview of Current Analytical Practices. https://pubs.naruc.org/pub/531AD059-9CC0-BAF6-127B-99BCB5F02198; Sandia National Laboratories. 2021. Application of a Standard Approach to Benefit-Cost Analysis for Electric Grid Resilience Investments. https://www.synapse-energy.com/sites/default/files/Standard_Approach_to_Benefit-Cost_Analysis_for__Electric_Grid_Resilience_Investments_19-007.pdf; National Association of Regulatory Utility Commissioners. 2021. Regulatory Considerations for Utility Investments in Defense Energy Resilience. https://pubs.naruc.org/pub/9931AF59-1866-DAAC-99FB-17BF932AECF5.

16 https://www.washoecounty.us/em/2020_proposed_hazard_mitigation_plan/plan/Washoe Regional Final HMP_020520.pdf Washoe County. 2020. "Emergency Management and Homeland Security: Hazard Mitigation Plan." https://www.washoecounty.gov/em/Hazards/Hazard%20Mitigation%20Plan.php.

17 FEMA. 2021. "Benefit-Cost Analysis." https://www.fema.gov/grants/guidance-tools/benefit-cost-analysis.

FEMA: Benefit-Cost Sustainment and Enhancements

police, fire, and emergency response services.[18] The Toolkit considers several factors, including the number of people served by the facility, and the distance between the facility and alternate facilities that could provide the same service, and assigns additional benefits to the project for sustaining services that would otherwise be lost.[19]

After evaluating these and other project funding sources, the City of Reno elected to pursue funding through the FEMA BRIC Program to support the solar and storage system. The City of Reno applied for FEMA BRIC funding in January 2021—leveraging work that was underway in this Project—and was awarded. The City will be building on this work to advance renewable energy and energy storage systems that are complementary to the backup generation already in place. The new opportunity proposes to evaluate sites, safety, reliability, and size of necessary microgrids in City facilities.

18 FEMA. 2016. "Baseline Standard Economic Value Methodology Report." https://www.caloes.ca.gov/RecoverySite/Documents/Benefit%20Cost%20Sustainment.pdf.

19 FEMA. 2009. "Final BCA Reference Guide." https://www.fema.gov/sites/default/files/2020-04/fema_bca_reference-guide.pdf.

The Building Resilient Infrastructure and Communities (BRIC) Program:

The BRIC Program is an annual FEMA funding program for projects that reduce risks and hazards. Authorized through an amendment in 2018,[20] this program is one of the first to prioritize resilience in advance of disaster events, instead of focusing on recovery and reconstruction post-disaster.

BRIC, which replaces the FEMA Pre-Disaster Mitigation program, sets aside 6% of funds from federal post-disaster grant funding each year. Each state will receive at least $600,000 each annually. During FY2020, BRIC awarded $500 million in funding during the program's first year, and increased the budget to $1 billion in FY2021. Eligible applicants include all 50 states, U.S. territories, federally recognized tribal governments, and the District of Columbia, if they have been issued major disaster declarations in the last seven years. Due to COVID-19, all states fall into this category for the first time in American history, resulting in a significant funding opportunity that some communities might not have otherwise been eligible for.

BRIC specifically calls out community lifeline projects, such as energy (i.e., power and fuel) projects, as one of the program's priorities. Energy resilience, and specifically microgrids and resilient solar and storage projects, are eligible for support under BRIC. Several jurisdictions have specifically submitted microgrid projects for consideration in the FY2020 round of BRIC.

20 See Section 203 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act.

6. Policy Innovations Needed

In addition to the near-term pathways for securing funding, the City of Reno and its Project partners also used their SEIN Project as an opportunity to explore innovative ideas related to resilience and sustainable energy policy and finance. This section summarizes several of the ideas that could help enable the scale-up of sustainable and resilient energy solutions in Reno.

a. Commercial Property Assessed Clean Energy (C-PACE) Policy

The State of Nevada passed legislation enabling municipalities to set up programs for commercial buildings to finance clean energy upgrades and use their property tax payments as a repayment mechanism.[21] Building on lessons learned from this Project, the City of Reno proposed that State of Nevada C-PACE legislation be amended to allow for C-PACE projects on government owned, long-term lease projects. While this language was not included in the passage, the City proposed that resilience projects such as solar plus storage and microgrids be included as eligible projects under C-PACE. Energy resilience projects in other jurisdictions have been successfully financed using C-PACE.[22] The City believes utilizing C-PACE on land with a long-term lease on government property with privately owned improvements is ultimately possible and will continue to explore this.

b. Energy Performance Contracting for Resilience

Nevada state law allows for a broad range of energy and water measures to be included in performance contracts, and both direct energy savings as well as reductions in operations and maintenance expenses can be counted as savings streams within projects.[23] Under the SEIN Project, the City of Reno explored opportunities to include benefits beyond direct energy savings in performance contract pro formas if they are agreed to by the City and supported by state law. Specifically, the City of Reno investigated whether local governments could be allowed to include a value of resilience within the financial models that they agree to with energy service companies. The goal would be to expand the ability of local governments to use performance contracting to install a broader array of energy resilience measures. The City also investigated the definitional changes that would need to be made in Nevada statute in order to allow energy resilience measures to be incorporated in performance contracts (whether the value of resilience is included or not). A proposed bill in the 2021 Nevada Legislative Session would have amended the definition of "qualified improvement"[24] for performance contracting to add energy resilience measures. However, it did not meet the necessary deadlines and did not move forward.

7. Rating Agency Partnerships

Rating agencies are increasingly accounting for cities' exposure to climate risk and their climate planning when assessing municipal creditworthiness. Moody's, for example, has warned that a failure to plan for and implement climate resilience measures may result in future downgrades in municipal credit ratings.[25] Moody's has also stated that municipalities that "strengthen infrastructure and minimize economic disruption from natural disasters and long-term climate change" are better positioned to enhance their credit.[26] If ratings agencies downgrade the credit rating of municipalities, this would then increase the interest rate at which municipalities can borrow through bonding, and constrain municipalities' ability to invest in their own projects. The City of Reno engaged with rating agencies to explore whether and how projects such as the Public Safety Center energy resilience

21 PACE Nation. 2019. "PACE Legislation." https://www.pacenation.org/pace-legislation/.

22 Better Buildings Solution Center. "Greenworks Lending Funds Efficiency, Renewable and Microgrid Improvements Using Commercial PACE." https://betterbuildingssolutioncenter.energy.gov/implementation-models/greenworks-lending-funds-efficiency-renewable-and-microgrid-improvements-using.

23 https://www.leg.state.nv.us/NRS/NRS-333A.html. Nevada Governor's Office of Energy. "Statutes for Performance Contracts for Operating Cost-Savings Measures." https://energy.nv.gov/uploadedFiles/energynvgov/content/Programs/Statutes%20At-A-Glance%20-%20State%20vs%20Local.pdf.

24 Proposed definition: "Qualified improvement" means a qualified energy efficient improvement project, renewable energy project, water efficiency improvement project, or resilience project that is affixed to commercial property and intended to: Increase resilience, including but not limited to storm retrofits, flood mitigation, stormwater management, wind resistance, energy storage, and microgrids, seismic strengthening, indoor air quality, fire resistance and other resilience projects approved by the local government.

25 Moody's. 2017. "Climate change is forecast to heighten US exposure to economic loss placing short- and long-term credit pressure on US states and local governments." https://www.moodys.com/research/Moodys-Climate-change-is-forecast-to-heighten-US-exposure-to--PR_376056.

26 Moody's. 2019. "Largest US cities take proactive steps to mitigate credit risk from climate change." https://www.moodys.com/research/Moodys-Largest-US-cities-take-proactive-steps-to-mitigate-credit--PBM_1158519.

system would be viewed as "credit positive" from the standpoint of climate risk. Although these conversations remain in early stages and not yet actionable, the City is continuing to explore how increasing frequency and duration of disasters may impact city finances, what impact this could have on the city's credit score, and how that might impact the City's ability to secure financing in the future.

8. Key Insights and Lessons Learned

In undertaking this Project, the City of Reno built substantial internal capacity in evaluating what role solar and storage could play in meeting the City's resilience and sustainability goals. The City also began developing pathways for bridging the concept-to-implementation gap to pay for solar and storage systems. The following list summarizes several key insights the City of Reno gleaned through this process. These lessons learned can serve as a starting point for other local governments interested in understanding how resilience valuation—either in terms of financial value or broader societal benefits, which may or may not be precisely quantified—can factor into resilient infrastructure decision-making.

- **Partner with local stakeholders and institutions to develop creative pathways for understanding and solving problems.**
  Resilience engages multiple types of stakeholders with different interests and priorities. Finding common ground in the form of a shared pursuit—in Reno's case, a common research project—can provide a useful platform for engaging stakeholders that may not typically work together. This can foster win-win situations that expanded the available toolkit for resource-constrained institutions. In Reno's case, a research question around determining a value of resilience associated with solar and storage at the City's Public Safety Center provided an opportunity for engaging (a) multiple city departments, including emergency management and sustainability, which have different core missions but are both guided by the City's overarching plans and priorities; (b) academia, through the University of Nevada-Reno where graduate students received research credit for their efforts on this Project; and (c) private entities, like Ameresco, that are connected to different conversations and policies at the state and national level. Each of these entities had different perspectives and resources to bring to the discussion, which allowed for a more robust project development.

- **Leverage different stakeholder perspectives to determine the goals of a resilience valuation approach at the beginning of the decision-making process.**
  Have conversations with different types of stakeholders about what their motivations for valuing resilience are, and what they need out of a resilience valuation approach. Do they need a specific dollar value, or not? How would a dollar value be used, and by whom? Conducting a needs assessment with relevant stakeholders and developing a problem statement can help clarify early on what the core issues are and what information different stakeholders need to make decisions. This clarifies what outputs and level of detail different stakeholders are seeking from a resilience valuation methodology or approach and can help surface assumptions earlier in the process. Understanding the intended audience, what decisions they are making, what evidence or information they require to make those decisions, and their available resources are critical elements for designing a resilience valuation methodology.

  Reno's operating assumption at the beginning of this Project was that they would need a robustly-quantified dollar value of resilience that solar and storage systems could provide to justify investing in resilient solar and storage projects. They discovered that the precise dollar figure of the value of resilience was not necessary for deciding to pursue solar and storage infrastructure investments for resilience purposes. What was important was demonstrating the potential resilience benefits of solar and storage and communicating the relationship between anticipated hazards,

anticipated consequences if those hazards were to occur, and ways in which solar and storage systems could mitigate or lessen those negative societal impacts. Early in the process, the City sought to clarify with municipal decision makers how "value" can be demonstrated in order to allow solar and storage projects to move forward. The City also opened dialogues with potential local, state, federal, and utility funders to explore how "value" plays into their decision-making process, and how societal resilience value associated with solar and storage would need be demonstrated to secure funding for solar and storage projects. As a result, Reno was able to focus their efforts on evaluating and prioritizing specific infrastructure investments at specific facilities. This also allowed the City to move forward with planning (and eventually implementing) a solar and storage project at the Public Safety Center by defining what a failure to act would cost in terms of negative societal impacts, rather than a specific dollar figure. This articulation was sufficient for the City of Reno's City Council to approve the solar and storage project to mitigate potential impacts related to a power failure at the Public Safety Center.

- **Consider possible funding pathways and next steps during your initial project conceptualization phase.**

  Because resilience may create an opportunity for funding that had not been previously discovered. Map and connect with federal, state, and utility grant and incentive program managers across the life cycle of a project. Sometimes a simple tweak in the beginning or middle of the project can help with eligibility for funding. Consider how to best prioritize or assign value to the critical functions and services performed by specific facilities (and electrical loads) so that you can make a recommendation or decision on what type of project to pursue. Ultimately, the City of Reno identified funding pathways that did not require a quantified value of resilience to move forward with the proposed solar and storage project at the Public Safety Center.

- **Recognize that resilience valuation is a practice and not a fixed number.**

  The value of resilience is not universal—there are too many variables that will be different for every user or site. The impact to society of a power disruption at a police station will be different than impacts associated with loss of power at a water treatment plant, for example. For the City of Reno, the Project team discovered that the value of resilience that solar and storage could provide was more about the cost of the failure to act than about valuing or evaluating energy savings or other traditional payback sources.

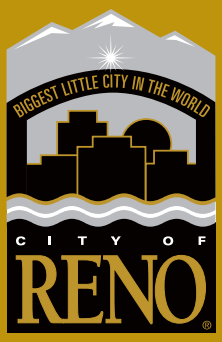
Ultimately, valuing resilience in this context came down to understanding and thinking critically about the range of impacts that a power disruption lasting more than 24 hours at the Public Safety Center could have, both at that site specifically and for the Reno community. This thread is one that the City of Reno, UNR, and other partners are continuing to explore. But the pathway to this realization was not necessarily linear. The City of Reno team was initially considering a wide range of potential factors—like impacts on community quality of life or impact on the City's credit rating—and how to quantify those variables in a way that would allow the City to calculate a dollar value of resilience associated with a solar and storage system. What ended up proving more useful than a static number, however, was the process of thinking through broader implications of long-duration power outages, the need for resilient energy infrastructure investments, and levers available for paying for renewable energy systems. This practice increased decision-makers' level of familiarity with solar and storage options. Considering impacts for a specific site—in this case, the Public Safety Center—also proved a more manageable scale for thinking through bigger-picture issues related to deploying solar and storage for resilience. The Public Safety Center provided a tangible, near-term example which rooted conversations in actionable decision points. It also reinforced partnerships with relevant community stakeholders, which was critical to exploring the issues from multiple standpoints (e.g., city budgeting, academia, energy contracting).

9. Conclusion

This Project has benefited the City of Reno at many levels, from knowledge-sharing via presentations to various audiences, to creating a new demand for implementing solar and/or storage options in capital improvement projects. At the start of this Project, the Project team assumed that a standardized resilience valuation methodology would need to be created, and that a city-wide policy would need to be adopted requiring city departments (or other audiences) to use that resilience valuation methodology to determine whether to pursue solar and storage at that all new or retrofitted facilities. In the end, the City is moving forward with a solar and storage system for the Public Safety Center. And department Directors across Reno city government have become so interested and engaged that requirements for solar and/or storage are making their way into initial designs for Requests for Proposals for new city facilities and major retrofits, even without a standardized resilience valuation methodology or policy.

There has been substantial interest in the work beyond the City of Reno, as well. The Project team has been invited to present to national audiences at Resilience Week, for the American Planning Association, for the FEMA BRIC Program, and for the National Association of State Energy Officials. Ultimately, the interest is less on the value of resilience itself, and more on how the value can be implemented. There is an interest—both at the state and local government levels to repeat what the City of Reno has done.

This Project is proving to be a catalyzer for the City of Reno to further explore the role of solar and storage across city priorities. Although the defined SEIN Project period has concluded, stakeholder engagement around solar and storage for resilience in Reno is growing. As is interest in identifying creative funding and financing pathways for solar and storage projects. Perhaps most importantly, new facilities or major rehab projects being proposed in Reno now have solar and storage as part of their initial design considerations; City staff and decision-makers are now more interested in pursuing solar and storage for resilience from the outset of new projects. The Reno SEIN Project has laid the foundation for other cities, states, and even private companies to utilize the concept and make it their own. Within Reno, two City-led development projects that have been conceptualized since the beginning of the SEIN Project both include solar PV systems; one will include storage for resilience, the other will not after City stakeholders determined that the facility did not require a backup power solution. This represents a changed landscape in Reno for considering solar and storage as part of City projects—there is now more momentum, knowledge, and capacity at several levels to engage in this dialogue, which is paving the way for future solar efforts across the City.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