



# City of Tucson Commission on Climate, Energy, and Sustainability

## Report on Microgrids

Prepared by Microgrid Subcommittee:

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## I. Introduction

In March of 2023, the *Tucson City Council* adopted the *Climate Action and Adaptation Plan* (CAAP), known as *Tucson Resilient Together*, with a set of actions aimed at eliminating greenhouse gas emissions from the city by 2045. The emphasis now has changed to questions of how to accomplish this. One of the most useful avenues to pursue projects that can provide a stacked set of benefits to achieve multiple sustainability goals such as carbon reduction, multi-modal transportation, EV charging, stormwater harvesting, shade, and backup power for water pumping.

The *Tucson Commission on Climate, Energy, and Sustainability* (CCES) has been asked to review a proposal presented to City Council by Council Members Steve Kozachik and Kevin Dahl about building a microgrid system, possibly along the *Norte-Sur* corridor from the *Tucson International Airport* to the *Tucson Mall*. Before assessing a specific plan we propose to examine the conceptual framework needed to make such a grid work.

The CCES goals in this report are multiple:

1. To define what a microgrid is and how it fits into the CAAP. We see a microgrid as a centerpiece of climate action benefits that go beyond a self contained power unit to aid the residents in many ways.
2. To suggest goals and objectives for the City to pursue:
  - a. Short term — to assess locations where microgrid systems could have immediate needs in emergency situations (e.g., heat shelters, water pumping stations, emergency medical care, first responders, schools, and childcare centers).

- b. Long term — to start the process of developing a larger microgrid system that can benefit the needs of Tucson’s residents and achieve climate action goals. This will require a concerted effort by many of the different agencies of city government, in cooperation with the citizens of Tucson and local agencies. That would be where a large-scale electrified transport corridor such as the one described in the proposal can be more effective.

## II. What is a Microgrid

The Department of Energy (DOE) defines a microgrid as “a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode” (Ton and Smith, 25).

The DOE sees great potential in microgrids — they think that by 2035, microgrids will “represent essential building blocks for the future electricity delivery system” and will enhance “resilience, decarbonization, and affordability” (Office of Electricity).

At a basic level, any microgrid system would have to have:

1. An energy production and storage system
2. A distribution system within the boundaries of the microgrid
3. The ability to operate either connected or disconnected from the grid
4. The ability to operate independently of the grid for a period of time

Additionally, microgrids can incorporate renewable energy sources, advancing the transition to a decarbonized future. Note that currently, some microgrids are powered by diesel or natural gas — however, considering such microgrids is incompatible with what is required to move towards a net-zero future, and thus are not included in this report. We would also strongly advise against considering or building any such microgrid powered by non-renewable resources.

There are numerous examples of other communities across the country successfully deploying microgrids powered by clean energy. For details, see Appendix section A-1 [Examples of Microgrid Projects](#).

## III. Benefits of Microgrids

Microgrids provide opportunities for stacked benefits, such as improving affordability, access to water, and community resilience and social justice, as well as aiding in greenhouse gas reductions and Plan Tucson implementation.

## 1. Energy Cost Affordability

Microgrids can expand renewable energy, which can provide the city savings in yearly energy costs. Often, microgrids are able to be funded with little upfront money from cities — instead utilizing grants, tax incentives, or funding schemes such as Solar Power Purchase Agreements — and spare the city from the energy costs.

One such example is the City of San Diego. They began construction on eight microgrids on city owned community centers in July. The estimated cost of the project is \$5 million, while the estimated savings will be \$6 million (Kempe). Further analysis could be done on select City sites by analyzing energy usage and costs and comparing that to estimated costs if powered by a microgrid instead.

## 2. Access to Water

Another potential area for microgrids to be installed is at the numerous water pumps in the City of Tucson. There are over 200 water pumps in the City (Tucson “Drinking Water”), with an interactive map of them available [here](#).

As outlined in the City of Tucson’s One Water 2100 Master Plan (Figure 4.6), Tucson uses ~110,000 Acre-Feet of water per year (Marron, 4-5). That water is delivered to residents by pumping it from the Central Arizona Project and the groundwater reservoir. With the pumps being used so intensely, running them accounts for a third of the City’s energy expenditure (Buro and Happold, 111). And thus, in the case of a prolonged power outage, that represents a critical point of failure. In such a scenario, not only would air conditioning be unable to run in most of the city, but its citizens would soon run out of water.

Therefore, installing microgrids on these water pumps offers an opportunity to harden the resiliency of these critical City facilities, as well as potentially save a large amount of money every year on energy costs.

## 3. Community Resilience and Social Justice

Climate change hits hardest among people who are least able to cope with it. Electric bills are hard to pay when income is marginal. Housing insulation and leakage add to the burden of air conditioning and cooling systems that are often inadequate for low income housing. Children are forced to play indoors for longer periods. Elderly people are often totally shut in, especially when they have health issues.

The Norte-Sur transit route was picked especially because many of its residents are historically underserved and are a vulnerable population. By investing in this transit route and fostering the community resilience of its residents, as well as delivering other stacked benefits such as shade, EV readiness, etc, the City will make strides towards boosting social justice and making Tucson more equitable.

## 4. Greenhouse Gas Emissions Reductions

One large benefit of solar-powered microgrids is the opportunity they offer to decarbonize our energy supply. Electricity production is the largest source of GHG emissions in the City of Tucson (Pima, 34), and the majority of Tucson Electric Power's electricity is generated from coal and methane sources (Tucson Electric Power, 22).

Building out renewable energy-powered microgrids would greatly help the City reduce the carbon emissions from energy generation. It would also assist in its own deadlines: namely, the City has committed to carbon neutrality in its operations by 2030, and has committed to community wide carbon neutrality by 2045. And of course, it is important to keep in mind the Intergovernmental Panel on Climate Change has set deadlines of halving all carbon emissions by 2030 and reaching complete net-zero carbon emissions by 2050.

TEP's current commitment is to use 70% renewable energy by 2035 (18). That task would be easier if the City could use microgrids combined with distributed generation, such as rooftop solar energy producers, to reduce costs as well as greenhouse gas emissions. Making coordinated use of local renewable power producers would help TEP reach its renewable portfolio targets more efficiently and sooner than projected.

Achieving higher renewable adoption will not only support the Tucson Resilient Plan, but will also result in overall cost savings. As was found in the [Cost Benefit Analysis](#) that was conducted on the Tucson Climate Action and Adaptation Plan, decarbonizing city buildings and facilities would abate over 80,000 metric tons of CO<sub>2</sub>e by 2030 (Buro Happold, 16). At a Net Present Value of \$6 per metric ton, this would save over \$480,000 over the next seven years. Microgrids will enable reduction in social costs by displacing sources of pollution.

## 5. Plan Tucson Considerations

As the city is looking at a solar-powered microgrid, it is natural to look at Tucson Resilient Together, the name of the City of Tucson's Climate Action and Adaptation Plan, for guidance as to how this would line up with goals outlined and approved by Mayor and Council. The Climate Action Team's complementary report on microgrids addresses this aspect.

For details on how microgrids align with Plan Tucson, refer to Appendix section A-4 [Alignment with Plan Tucson](#).

## IV. Trends in Similar Projects

CCES examined nine examples of existing community microgrid projects in the United States, (see Appendix A-1 [Examples of Microgrid Projects](#)). The following common trends were observed.

## 1. Relationship to Local Utilities

In all cases, the utilities are partners with the projects. In many cases utilities and cities are direct partners, such as with the Bronzville microgrid. In other cases the utility is municipally owned, and the municipality leads the project, such as in the Los Alamos project. In one case, such as Decatur Island, Washington, the utility is the owner and builder.

## 2. Relationship to Government

In all cases the local, state and federal governments are supportive. They have financial and technical support from federal agencies, and the state utility regulators are very supportive. In the Los Alamos and Albuquerque programs, there is an additional partnership with the Japanese New Energy and Industrial Technology Development Organization (NEDO), operating under the Japanese Ministry of Economy and Finance.

In some cases many governments have banded together to build microgrid systems. The East Bay, California program is a cooperative community choice aggregation program with four cities working together to contract a builder.

## 3. Reasons for Creation

All are concerned about hazards which could shut down the main power grid for long periods of time. The hazards range from earthquakes and fire in California, to sea storms in Island, and blizzards or wind storms in Chicago. All also see the potential going beyond emergency power to providing less expensive, renewable electric power to local residents.

For Tucson both reasons stand clear — the heat and storms of July 2023 underscore the need for “hardened sites” where people can go for relief or necessities in the case of grid shutdown.

The rationale for a microgrid system may be seen in the Berkeley Resilience Strategy:

“Micro-grids enable a facility or group of facilities to operate autonomously when the main grid is disrupted; can be powered by clean energy sources, such as solar and backup batteries; can be used to reduce facilities’ electricity consumption during periods of peak demand, when energy prices are at their highest; and can enhance the stability of the local grid. Unlike a diesel generator, which is only used when the grid is disrupted, a clean energy micro-grid can provide environmental and economic benefits every day, year-round” (Berkeley, 28).

## 4. Issues of Energy Management

All are facing the issue of how to connect with the main power grid and with each other. Albuquerque and Chicago are working on a management system to connect with other energy producers in the local grid. Distributed Energy Resource Management Systems (DERMS) are

technologies that enable microgrids to connect with each other and with other distributed energy courses (e.g., household or business buildings).

The Tucson proposal — of a linked set of microgrids connected to other building level energy sources — needs to pay particular attention to the development of DERMS.

## 5. Community Involvement

In the Decatur Island, WA, Bronzeville, IL, and East Bay, CA projects, communities were a strong part of the planning.

## V. Legal Obstacles

In Arizona, any ambitious energy-related project — especially those that seek to accelerate the pace of decarbonization — will often run into the restrictive rules imposed by the Arizona State Legislature and the Arizona Corporation Commission (ACC). Unfortunately, this microgrid project is not an exception to that. During our exploration of this concept, we often discovered there exist numerous restrictions imposed by the ACC that preclude many ambitious, transformative projects. We have detailed some of them here. Note that if such restrictions are changed, loosened, or entirely removed in the future by the ACC, then many ambitious microgrid projects would be back on the table and should be seriously considered.

### 1. Restriction against transferring electricity across property lines

Such a restriction would preclude a City-run microgrid from generating electricity and delivering it to customers, be they business or residential, other community resilience centers, or even installations such as EV chargers. Solar panels on any City property can only power that property.

There might be some ways to “work around” this restriction. One possible way would be where the City enters into an agreement with TEP wherein the larger grid accepts energy generated from the microgrid, and that is virtually routed to the City’s desired property, reducing energy costs. However, such an agreement would be imperfect and may not be financially viable. Thus, this restriction clamps down on the potential size and scale of any microgrids the City might pursue.

### 2. Restriction against installing solar capacity beyond 125% of the property’s peak load

This restriction places upper limits on the generation capacity of any solar panel installation, reducing the flexibility offered. For instance, no more solar panels can be installed at the Donna Liggins Rec Center.

A comprehensive microgrid is still possible despite this restriction. A battery backup system can still be charged during the day and drawn from during the night or during grid

outages. It just places strict bounds on the scale of microgrid projects the City might pursue on individual facilities.

## VI. Recommendations

### 1. Short Term

Short term is defined as the scope of time less than one year.

#### a. Needs Assessment for Communities

Of the 281 recorded users of the six in city owned shelters in June/July 2023, some 50% (140) were at the Donna Liggins Center, which makes it the logical candidate for a pilot microgrid/resilience center program. If this location is chosen, it should be accompanied by a site assessment and a neighborhood outreach to determine how many people in the neighborhood would need to use the shelters, what their needs are (e.g., medical, mobility) and how they can be contacted, and in some cases, brought to the shelter. This neighborhood assessment would be best conducted by neighborhood volunteers, who know their own areas. It would be best to create a standardized neighborhood needs assessment questionnaire that can be translated and used throughout the Tucson community. The general idea is that a standardized questionnaire can provide consistent needs assessments and be used by people who are volunteers, not professional interviewers.

#### b. Direct City Staff to Study Microgrids

Direct city staff to work with professionals and members of academia to:

1. Conduct a benefit to cost analysis to assess the financial viability of microgrid projects.
2. Engineering analysis to assess the technical viability of microgrid projects.
3. Seek input from community groups that would be most affected by climate change-induced heat stress and other effects.
4. Monitor development of energy storage technology to find cost effective opportunities to expand renewable energy production.
5. Monitor developments of state energy policy to take advantage of opportunities that enhance microgrid development.
6. Monitor developments of other community level microgrids to take advantage of advancements in the field.

#### c. Create an Inventory of Community Resources

Create a GIS map of city owned sites that may serve as resilience centers. Overlay that with maps of urban heat island intensity, vegetative cover, low income residences or other areas where heat stress is likely to cause harm. Develop a priority list of places that need backup

power systems, (e.g., neighborhood shelters, water pumping stations, medical emergency facilities, first responders).

#### d. Identify Resilience Centers

We recommend identifying one or two locations that could be set up as resilience centers, with independent solar power and battery backup, do a needs assessment of the facilities, and plan the site.

The Climate Action Team report has already identified sites and has a recommendation that Donna Liggins would be a potential location for initial implementation. Donna Liggins has the highest cooling center attendance of all the city run shelters.

## 2. Long Term

Long term is defined as the scope of time longer than one year.

#### a. Community Outreach

City public information officers should commit to a public values monitoring process for the stacked benefits that community microgrids will enable.

#### b. Reduce Carbon Emissions

The pilot programs should be monitored to make sure they reduce carbon emissions and long term carbon reduction should be a high priority.

#### c. Build Partnerships for Joint Projects

Opportunities exist to partner with other municipalities, government bodies, and corporations to pool resources and access funding opportunities.

For example, funding is now available at the state level for resilience centers and indigenous nations for EV charging stations. Pima County also just received a \$1 million Climate Pollution Reduction Grant. Such opportunities should be acted upon immediately.

Please see Appendix section A-3 [Funding Opportunities](#) for an overview of grant funding opportunities, as identified by the CCES Microgrid Subcommittee.

#### d. Build Technical Partnerships

Los Alamos National Labs, in partnership with The New Energy and Industrial Technology Development Organization (NEDO) has experience deploying DC microgrids at Los Alamos. The City of Tucson should seek their expertise when designing and deploying its microgrid.

The EMerge Alliance is an industry group of engineers, equipment manufactures, utilities, and industry associations, which works on standardization of microgrid technology. The alliance has

DC and AC/DC microgrid standards in work (EMerge). To ensure that standards uphold the resilience objectives of the City of Tucson, the city should join the alliance as a general member or utility member to influence the development of DC microgrid standards so that microgrid standards align with City of Tucson goals.

# Appendices

## A-1: Examples of Microgrid Projects in the US

This table represents the microgrid projects that CCES examined, which is a subset of microgrid projects in the US.

Project	Location	Solar (MW)	Fossil (MW)	Storage (MWh)	Funding	Source
Resilient Municipal Critical Facilities Program	Oakland, California	3.1	0	6.2	> \$2,000,000	(Grid Deployment Office)
Bronzeville Microgrid	Chicago, Illinois	0.75	5.5	0.5	\$25,000,000	(John)
Los Alamos Microgrid Project	Los Alamos, New Mexico	2.0	0	8.3	\$53,000,000	(Smart Energy International)
Decatur Island	San Juan County, Washington State	0.504	0	2.6		(Howland)
Hunts Point Resiliency Project	New York City, New York	0.52	3.2	0.6	\$71,000,000	(NYCEDC)
Southcrest Recreational Center	San Diego, California	0.96	0	2.175	\$5,500,000	(Walton)
Microrred de la Montaña	Puerto Rico	0.126	0	0.185	\$17,500,000	(Cohn)
Brookville Smart Energy Depot	Montgomery, Maryland	5.0	0	7.35		(Hudson)
Menlo Park Community Campus	Menlo Park, California	0.615	0.4	0.25	\$5,700,000	(Menlo Park)

A more comprehensive list can be found at the DoE microgrid database <https://doe.icfwebservices.com/microgrid>

## A-2: Microgrid-related Areas of Opportunity

Solar-powered microgrids are a relatively novel concept and offer incredible opportunities to bring clean energy to communities in ways previously not possible, and to provide power to various facilities in new, innovative ways. Communities all around the country and the world have discovered and applied microgrids in novel and innovative ways, and there are many exciting opportunities the City of Tucson could explore and incorporate when pursuing a microgrid project. Some such ideas are detailed here. These may or may not be necessarily tied to the base idea we analyzed of installing solar panels on critical City-owned facilities.

### Solar-powered Electric Bus Charging Depot

Montgomery County, MD constructed the Brookville Smart Energy Bus Depot, a depot that uses a 3 MW/4.3 MWh solar-powered microgrid to charge 70 electric buses (Butchko). It is estimated to abate 160,000 tons of GHG emissions by 2050. Such an opportunity is present here in Tucson as well.

Recently, the City received a \$21.5 million federal grant to buy 39 buses fueled by compressed natural gas (CNG), a fuel source that emits large amounts of methane, a greenhouse gas significantly more planet-warming than carbon dioxide. Despite that, the City championed this purchase as a climate win and a move towards “decarbonizing” their fleet. When questioned as to why electric buses were not pursued, the City said that among other reasons, there wasn’t sufficient infrastructure to support these buses, including charging capacity.

Microgrids prevent this from occurring again in the future, by supporting the adoption of a fully electric bus fleet in Tucson, allowing for completely carbon free transportation. It is also likely that the power generated could be utilized to aid community resilience. Vehicle-to-grid technology could also be harnessed with such a project.

### Solar-powered Electric Vehicle Charging Stations

Similar to solar-powered microgrids charging stations for electric buses, there is also an opportunity for the City to invest in building microgrids that will function as public-serving electric vehicle charging stations. Such facilities, especially if installed in many locations across the city, would help with the EV readiness of the City of Tucson — a specific goal the City has outlined for itself.

### Installing Microgrids in Schools

When it comes to community resilience, schools represent a critical aspect that will only continue to become more important. Already, public schools across the country serve as convening locations and shelters during emergencies. In Tucson, there is significant opportunity to partner with the numerous schools across towns and install solar-powered microgrids.

Such an undertaking would greatly bolster community resilience by offering citizens all across the cities access to a new class of hardened community resilience centers that they can go to

seek shelter in during times of excessive heat or other extreme weather events. Additionally, during normal usage, such installations would save the school money on energy costs, freeing up their financial resources and allowing them to invest more into the education of the next generation of Tucsonans.

Additionally, as schools continue to switch to electric school buses, the application of vehicle-to-grid technology stands out as a great opportunity to greatly boost community resilience. Previous research into community resilience and heat resilience by the city, as well as numerous organizations across the country consistently identify schools as a key player, so such an important opportunity should not go under-noticed.

It is also important to note that in Tucson, districts such as the Tucson Unified School District have already begun taking steps towards this. TUSD has undertaken the Solar Generation Project, providing the district with 23.8 MW of solar capacity and saving it millions of dollars in energy costs (Vernachio). And currently, the AZ Youth Climate Coalition — an official community partner of the City of Tucson in its Tucson Resilient Together work — is working alongside TUSD to develop and pass a comprehensive Climate Action Resolution. City interest in such a resolution and working with TUSD would unlock the chance to transform the state of community resilience in Tucson and offer a far more expansive and secure network of resources for the city's most vulnerable populations.

## Installing Utility-Scale Battery Backup

A possible idea that came up during our discussions, with not an extensive amount of research conducted, is an opportunity for the City to partner with TEP to install utility-scale battery backup systems across the city in strategically placed locations. These battery systems could then be drawn upon during periods of extreme heat to bolster the resilience of the grid. They could possibly be placed and designed so as to be able to deliver electricity to its target sites even when, for example, power poles are knocked down.

## Stormwater Harvesting

Members of CCES toured the Norte-Sur and struck up conversations with residents of the route and users of the existing bus system. One such idea that came up during these conversations, as well as that which was included in the original proposal, was the possibility of rainwater harvesting.

Any microgrid installation could be designed with harvesting rainwater in mind, possibly complementing the City's existing Storm to Shade efforts. In this way, the microgrid installation would prove even more useful in the City's climate action and adaptation efforts.

## A-3: Funding Opportunities

CCES put together a spreadsheet that aggregates funding sources from various federal departments and provides detailed information on grants as well as tax incentives. View it at [microgrid funding](#), or it will be transmitted alongside this document.

Note that a lot of the grants require matching funds — it is likely that when ultimately pursuing a microgrid project, the City will have to commit some money of their own. However, the economic benefit of microgrids is undeniable, and it is very likely the City will end up saving money by installing a microgrid.

It is also beneficial to consider the Cost Benefit Analysis that was conducted on the Tucson Climate Action and Adaptation Plan. A microgrid project from the City of Tucson would fall under the action E-1.4, as well as possibly E-1.5 and E-3.4. For these actions, the Cost Benefit Analysis found that a Benefit-Cost ratio of 1.11x, meaning the City gained \$1.11 in benefits for every \$1 spent; as well as a Net Present Value of \$6 per mt of CO<sub>2</sub>e reduced, meaning that the City saved \$6 for every mt of CO<sub>2</sub>e reduced (Buro Happold, 16).

Finally, another method of funding to consider is using a Solar Service Agreement (SSA)/Solar Power Purchase Agreement (SPPA). The City has already engaged with contractors such as SOLON and entered in SPPAs in the past, and they are also working with TEP to land on a VPPA. So, using a SPPA to fund these microgrids with no upfront-cost remains an extremely viable option.

## A-4 Alignment with Plan Tucson

Part of CCES's mandate is that it will advise Mayor & Council on how best to meet the "climate/energy/sustainability goals" outlined in Plan Tucson. What follows is a list of identified Plan Tucson policies that a microgrid project would help advance.

- **EC1:** A solar-powered microgrid that powers community resilience centers, water pumping stations, or other critical facilities would advance the City's goals as it "strive[s] for net zero energy facilities."
- **EC3:** A microgrid that provides shade to pedestrians and cyclists and prevents some sun from reaching asphalt would aid in "reduc[ing] the urban heat island effect."
- **EC4:** A solar-powered microgrid that powers community resilience centers, water pumping stations, or other critical facilities would advance the City's goal to "[i]ncrease the use of low carbon and renewable energy sources."
- **EC5:** A solar-powered microgrid that is funded with grants, tax incentives, and/or SPPAs would advance the City's goal to "identify appropriate new financing opportunities for energy efficiency and solar energy installations"
- **EC6:** A solar-powered microgrid that powers community resilience centers, water pumping stations, or other critical facilities would advance the City's goal to "[i]ncrease

the use of solar power and other renewable energy sources for City infrastructure, facilities, and operations.”

- **EC7:** A solar-powered microgrid installed at partnered community sites, such as at TEP substations or on schools would advance the City’s goal to “[f]acilitate community use of solar power and other renewable energy sources.”
- **EC8:** A solar-powered microgrid that powers community resilience centers, water pumping stations, or other critical facilities would advance the City’s goal to “prepare for the effects of climate change on City infrastructure, facilities, and operations.”
- **EC9:** A solar-powered microgrid that powers community resilience centers, water pumping stations, or other critical facilities would advance the City’s goal to “address the vulnerability of the community’s health and safety, economy, and natural resources to climate change, and develop assurances that vulnerable and disadvantaged populations are not disproportionately impacted by climate change.”
- **PS9:** A solar-powered microgrid that powers community resilience centers, water pumping stations, or other critical facilities would advance the City’s goal to “ensure that all residents have access to food, water, shelter, and medical services in the event of an emergency.”
- **PH6:** Working on a microgrid offers the opportunity to collaborate with other jurisdictions, such as Pima County, as the City works to “[c]ollaborate with the Pima County Health Department on emergency service preparedness.”
- **WR1:** In the event of a long-term outage, it is possible water supplies would be disrupted by water pumps no longer working. In that event, microgrids powering water pumps would be critical to avoid a potentially disastrous water crisis. This would advance the City’s goal to ensure that the water supply has the infrastructure needed for “long-term reliability.”
- **EQ7:** A solar-powered microgrid that saves the City large sums of money on yearly energy costs would advance the City’s goal to “develop practices to reduce utility, fuel, and procurement costs and ... demonstrate City leadership in sustainable practices and improve operational efficiencies.”
- **PI1:** A solar-powered microgrid that powers community resilience centers, water pumping stations, or other critical facilities would advance the City’s goal to “maintain public infrastructure and facilities that are fundamental to ... sustaining and enhancing living conditions in the community.”
- **PI3:** A solar-powered microgrid that powers community resilience centers, water pumping stations, or other critical facilities, as well as save the City money on yearly energy costs would advance the City’s goal to “expand the use of state-of-the-art, cost-effective technologies and services for public infrastructure and facilities.”

- **PI5:** A solar-powered microgrid that is funded with grants, tax incentives, and/or SPPAs and installed to power community resilience centers, water pumping stations, or other critical facilities would advance the City’s goal to “expand and diversify funding mechanisms for the repair, upgrade, maintenance, and service expansion of public infrastructure and facilities.”Grid Security

## A-5 Notes and Mentions

During our time researching the potential of a microgrid project in Tucson, we came across numerous pieces of information to consider. Some of this information does not fit neatly into the other sections we’ve outlined in this document, so we have gathered them here.

### Shade Hanging Over the Edge of a Building

One aspect of the microgrid proposal was such a project providing shade to bicyclists and pedestrians by hanging over roads, walkways, and protected bike paths.

We researched the possibility of a microgrid project providing shade by having the solar panels hang over the edge of a building. We did not find any significant examples of this, but we did not find any concrete reasons such a project wouldn’t be possible.

Most likely, any solar panels hanging over the edge of a building will cast shade over the building itself, serving to preserve the existing thermal mass of a building, thus reducing cooling costs during the summer. But it may not give a lot of shade outside. For the solar panels to truly fully shade such sidewalks and bike paths, an additional metal beam may be needed.

### Size of Battery for Grid Outages

The size of the battery installed in any microgrid project — and thus the cost of the project — depends greatly on how long the microgrid is expected to power any facility for in the case of grid instability or grid outage.

However long any battery storage system is expected to last depends greatly on a variety of factors, and will ultimately be at the City’s discretion when they make a project. And it is very possible that, given the scale of the climate crisis, any such estimate will likely eventually fall short, and there will be a grid outage for longer than the capacity of the installed battery storage system.

A useful resource when considering this will be the City’s work it’s done regarding heat resilience planning. To our knowledge, they are currently developing a heat resilience plan with ARPA funding. Additionally, action item CR-2.1 of Tucson Resilient Together directs the City to develop a “comprehensive urban heat mitigation strategy and implementation plan”: community resilience centers — and how long they are expected to operate during a grid outage — might fall within the scope of such a document.

Another useful resource when thinking about how to address this is a benefit/cost analysis that looks at Resiliency Value for different battery storage sizes. Such an experiment was conducted by New York State as it analyzed the Hunts Point Resilience Project, whose results you can view [here](#). With a discount rate of 7%, it found the Net Present Value of the resiliency improvements to add up to \$36.7 million. And with a discount rate of 3%, that number increased greatly to \$62.35 million.

## Solar in Rights of Way

Another aspect of the microgrid proposal talked about was installing elevated solar panels in City rights-of-way. We researched this aspect, and have found 2 applicable precedents:

### 1. Microgrids in highway interchanges

Highway interchanges often take a large amount of land, with a lot of it being completely undeveloped. Communities across the country have [installed microgrids](#) in these empty patches in highway interchanges, at a safe distance from the roads. Fortunately, Tucson does not have a large part of its land taken up by highway interchanges; but in the parts that are, installing microgrids there is a real possibility.

### 2. Solar panels covering canals

California is [piloting a project](#) where sections of a canal are covered with solar panels, thus generating clean electricity as well as preventing water from evaporating. Such a project has also already been accomplished in a village in India.

This demonstrates an example of a municipality using rights-of-way to shade something using solar panels; thus, in this way, Tucson would not be the first community to attempt such a project, if it were to pursue that path.

## Clean Energy to Communities Program (C2C)

The US Department of Energy offers [the C2C program](#), offering communities access to energy experts for 40-60 hours over 1-2 months.

We are flagging this resource here for the City to consider and use if or when it actively pursues a microgrid project.

## EPA's Environmental Justice Screen Tool (EJScreen)

The EPA's [EJScreen tool](#) is a useful tool that provides information on a variety of topics such as health disparities, socio economic indicators, pollution levels, etc in communities across the US. This will be a useful tool for the City to help determine the impacts of any possible microgrid project.

## Vehicle to Building (V2B) Technology

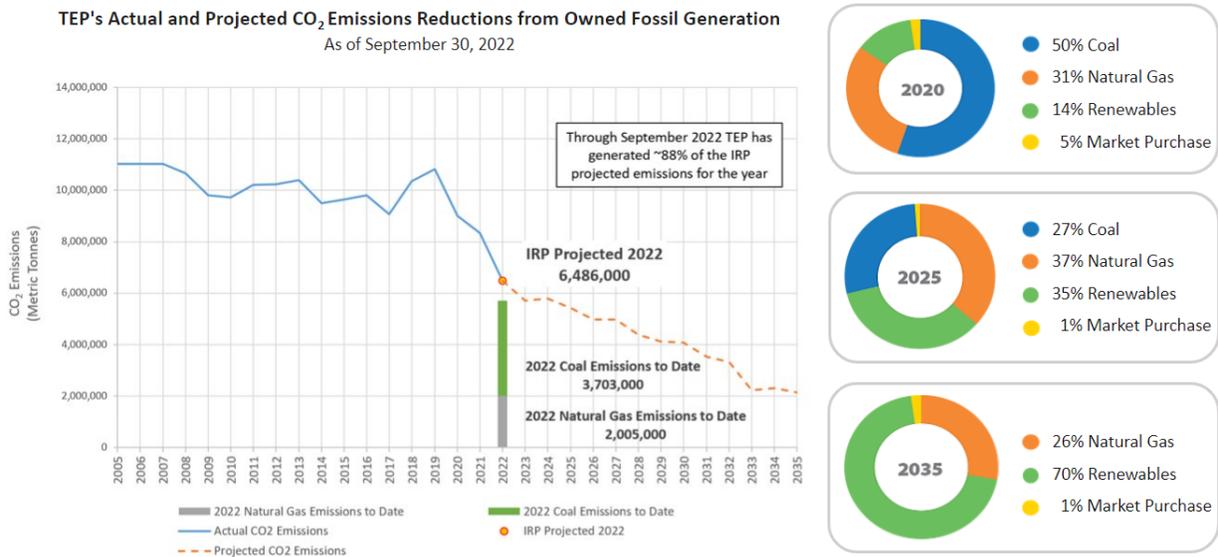
Vehicle to building technology enables utilizing energy storage resources in electric vehicles to also be used to power buildings. Vehicle to building technology is in early stages of commercialization. For example Ford's F-150 Lightning is capable of bidirectional charging with its Ford Charging Station Pro charger. The charger “[a]llows the vehicle to act as a backup power source for the house during a power outage” (Hsieh). This can provide backup power for a home for up to ten days.

Furthermore, there are municipal pilot programs for vehicle to building technology. An example of this is Boulder Colorado, which is testing bidirectional charging with one of its fleet vehicles and attaching it to a recreation center (Lehrman). This technology has the potential to do peak demand shaving by using the vehicle as a resource during high demand periods, then allowing the vehicle to charge during the evenings.

## CO2 Reduction Glidepath

Provided is TEP’s projection for future carbon emissions reductions.

### CO<sub>2</sub> Reduction Glidepath and Retail Energy Mix



## Works Cited

- Berkeley, City of. "Berkeley Resilience Strategy". 2016, [https://berkeleyca.gov/sites/default/files/2022-03/Berkeley\\_Resilience\\_Strategy.pdf](https://berkeleyca.gov/sites/default/files/2022-03/Berkeley_Resilience_Strategy.pdf), Web. 11 Aug 2023.
- Buro Happold. "City of Tucson Cost-Benefit Analysis and Multi-Criteria Analysis of Key Climate Action and Adaptation Strategies". Autocase, 24 Feb 2023, [https://assets.tucsonaz.gov/share/gis-photos/ClimateAction/CAAP/PlanDocuments/Technical\\_Memo\\_-\\_Tucson\\_-\\_CBAMCDA\\_Final\\_shared.pdf](https://assets.tucsonaz.gov/share/gis-photos/ClimateAction/CAAP/PlanDocuments/Technical_Memo_-_Tucson_-_CBAMCDA_Final_shared.pdf). Accessed 19 Aug 2023.
- Butchko, Dominic. "Montgomery Completes Nation's Largest Bus Microgrid Project". Maryland Association of Counties, 1 Nov 2022, <https://conduitstreet.mdcounties.org/2022/11/01/montgomery-completes-nations-largest-bus-microgrid-project/>. Accessed 19 Aug 2023.
- Cohn, Lisa. "Microgrids Bring Wealth and Health to Puerto Ricans Without Power for More than a Year". *Microgrid Knowledge*, 30 Jun 2023, <https://www.microgridknowledge.com/remote-microgrids/article/33007498/puerto-rico-co-operative-plans-30-rural-microgrids-for-citizens-who-lost-power-for-more-than-a-year>. Accessed 9 Aug 2023.
- EMerge Alliance. Our Standards. 2023, [www.emergealliance.org/standards/our-standards](http://www.emergealliance.org/standards/our-standards), Web. Accessed 12 July 2023.
- Grid Deployment Office. "Grid Resilience and Innovation Partnerships (GRIP) Program". Department of Energy, n.d., <https://www.energy.gov/gdo/grid-resilience-and-innovation-partnerships-grip-program>, Accessed 19 Jul 2023.
- Howland, Ethan. "Washington State Cooperative Installs First of Many Microgrids Planned for Islands". *Microgrid Knowledge*, 26 Feb. 2021, <https://www.microgridknowledge.com/distributed-energy/article/11428230/washington-state-cooperative-installs-first-of-many-microgrids-planned-for-islands>. Accessed 19 Aug 2023.
- Hsieh, Nelson. "Ford F-150 Lightning vs. Tesla Cybertruck: Spec Comparison Chart". *Volt Equity*. 25 May 2023. Web. Accessed 15 Aug 2023.
- Hudson, Mary. "Montgomery County Completes Nation's Largest Bus Microgrid and Charging Infrastructure Project in Silver Spring". *Montgomery County*, 31 Oct 2022, [https://www2.montgomerycountymd.gov/mcgportalapps/Press\\_Detail.aspx?Item\\_ID=42340](https://www2.montgomerycountymd.gov/mcgportalapps/Press_Detail.aspx?Item_ID=42340). Accessed 19 Jul 2023.

John, Jeff St. "The country's first neighborhood microgrid is coming online in Chicago". *Canary Media*, 9 Feb 2023, <https://www.canarymedia.com/articles/grid-edge/the-countrys-first-neighborhood-microgrid-is-coming-online-in-chicago>. Accessed 19 Jul 2023.

Kempe, Ysabelle. "Solar-powered 'microgrids' coming to San Diego public buildings as first of 8 projects breaks ground". *SmartCities Dive*, 11 Jul 2023, <https://www.smartcitiesdive.com/news/solar-microgrid-san-diego-city-buildings-shell-new-energies/686042/>. Accessed 19 Jul 2023.

Lehrman, Matt. "Vehicle-to-Building EV Pilot". *City of Boulder*. n.d. Web. Accessed 16 Aug 2023.

Menlo Park, City of. "City Council to consider \$5.72M for clean energy infrastructure". 21 Dec 2021, <https://menlopark.gov/News-articles/Sustainability-news/20211227-City-Council-to-consider-5.72M-for-clean-energy-infrastructure>. Accessed 16 Aug 2023.

NYCEDC, *Hunts Point Resiliency*. n.d., <https://edc.nyc/project/hunts-point-resiliency>. Accessed 5 Aug 2023.

Office of Electricity. *Grid Systems*. Department of Energy, n.d., <https://www.energy.gov/oe/grid-systems>. Accessed 19 Jul 2023.

Marron, Corin A., "One Water 2100 Plan Draft". Carollo Engineers, May 2023, <https://tucsononewater.com/wp-content/uploads/2023/05/One-Water-2100-Plan.pdf>. Accessed 8 Aug 2023.

Smart Energy International. "Los Alamos Smart Grid project launched in New Mexico". Clarion Events Group, 25 Sep 2012, <https://www.smart-energy.com/regional-news/north-america/los-alamos-smart-grid-project-launched-in-new-mexico/>. Accessed 19 Aug 2023.

Ton, Dan T. and Merrill A. Smith, "The U.S. Department of Energy's Microgrid Initiative". *The Electricity Journal*, vol. 25, no. 8, 2012, pp. 84-94.

Tucson, City of. *Drinking Water Distribution System*. n.d. <https://www.tucsonaz.gov/Departments/Water/About-Your-Water-Quality/Water-Quality-Monitoring/Drinking-Water-Distribution-System>. Accessed 8 Aug 2023.

Tucson, City of. *Solar Tucson: Keep Tucson Shining*. n.d., <https://climateaction.tucsonaz.gov/pages/solartucson>. Accessed 22 Aug 2023.

Tucson Electric Power. *2020 Integrated Resource Plan*. 26 June 2020, <https://docs.tep.com/wp-content/uploads/TEP-2020-Integrated-Resource-Plan-Lo-Res.pdf>. Accessed 7 Sep 2023.

Vernachio, Veronika. "TUSD Solar Generation Project saves district \$2.8 million". *KGUN9 Tucson*, 2019 Oct 28,

Walton, Rod. "Making for a Stronger San Diego: Gridscape Launching Solar-Storage Backup to Fortify Municipal Sites". *Microgrid Knowledge*, 11 Jul 2023, <https://www.microgridknowledge.com/solar-microgrids/article/33007970/making-a-stronger-san-diego-gridscape-launching-solar-microgrids-to-fortify-municipal-sites>. Accessed 19 Jul 2023.