Integration of Energy Resilience into Hazard Mitigation Planning

This publication was prepared by the North Central Texas Council of Governments with funding provided by the State Energy Conservation Office.

WHITEPAPER INTRODUCTION:

Texas is accustomed to extreme swings in weather and natural disasters which impact the reliability and availability of energy services. These disasters are expected to increase as we deal with the impacts of a changing climate[i] leading local governments in a position where more than ever they may need to consider incorporating energy resilience plans into their Hazard Mitigation Plans. Winter Storm Uri dealt a difficult lesson that reliance on back-up diesel and natural gas generators may no longer be sufficient and more robust efforts should be considered to harden critical infrastructure against future disruption.

This whitepaper is intended to provide local governments and hazard mitigation planners with an assortment of options to consider for incorporation into their Hard Mitigation Plans. Some options are quicker to implement with quick wins, such as energy efficiency retrofits, while others take a longer-range planning approach with significant investment to ensure the greatest measure of energy resilience, such as Combined Heat and Power (CHP) projects. Communities should consider which measures best suit their needs, capabilities, budget, scale, and desired level of energy resilience.

When considering energy resilience, project planners should begin with a look at which energy services that may be impacted by outages. Energy services could include electricity, heating, air conditioning, refrigeration, hot water, etc. They will also want to examine the critical infrastructure and facilities in the built environment that they are seeking to mitigate impacts to.

Critical Facilities	High Potential Loss Facilities	Infrastructure Systems
Hospitals & medical facilities	Nuclear power plants	Water and wastewater
Police & Fire stations	Dams	Power utilities
Emergency operations centers	Military and civil defense installations	Transportation (roads, railways, waterways)
Evacuation shelters	Locations housing hazardous materials	Communication systems/centers
Schools		Energy pipelines and storage
Airports/heliports		

Figure 1 Critical Infrastructure and Facilities in the Built Environment, FEMA Local Mitigation Handbook[ii]

ENERGY EFFICIENCY:

As the fifth largest energy consumer in the world, with nearly 40% of the total energy usage and 70% of the electricity usage going towards buildings, Texas is not short on opportunities for energy and cost savings through energy efficiency projects within the built environment[iii]. A twin benefit of energy efficiency projects and programs is their positive impact on energy resiliency and overall grid stability. Energy efficiency measures also have associated short-term and long-term cost-savings or paybacks which help justify or pay for their implementation.

When on-site generation is paired with energy efficiency measures (through design, construction or retrofitting, and operations and maintenance of buildings) they are able to support both community and critical facility resilience. Energy efficiency can extend the supply of on-site power generation, whether by diesel generation or renewables, by reducing the total energy needed to power essential functions or critical facilities. This results in reduced on-site fuel storage needs and/or extended generator capacity, allowing for longer operations without grid-provided electricity. Stretching on-site generation in times of peak demand on the grid may also concurrently lower or provide a buffer against higher costs. When communities are able to operate under this extended capacity, it can relieve some of the burden placed upon emergency shelters or Emergency Management staff in implementing their contingency plans[iv].

Recommendations of energy efficiency projects can include lighting retrofits, installing lighting controls, LED retrofits, HVAC replacement, water efficiency retrofits, weatherization and tightening of the building envelope, cool roofs, cool pavement, etc.

To learn more on this topic, consider checking out this webinar "Facility Retrofits to Reduce Overall Energy and Water Consumption" on the Conserve North Texas website. If your local government is considering taking the next step in assessing and implementing energy efficiency measures, the State Energy Conservation Office (SECO) offers local governments Preliminary Energy Audits (PEAs) and technical assistance to help provide customized, on-site, energy-related services across a broad spectrum, ranging from a basic consultation to feasibility studies.

ENERGY CONSERVATION:

Closely aligned with energy efficiency measures are establishing strategies that help reduce energy waste, also referred to as energy conservation. Where energy efficiency focuses on using less energy to do the same tasks, such as lighting or cooling a building, using innovations in technology like LEDs and smart thermostats, energy conservation focuses on using less energy through behaviors and practices like turning off unneeded lights and raising the thermostat by several degrees. These strategies require little to no capital investments making them quick wins when establishing and beginning an energy resilience strategy. Energy conservation can fall into one of two categories 1) Behavioral Practices or 2) Operations and Maintenance (O&M) Practices. These strategies are usually part of a larger Energy Management Policy and Energy Management Plan.

Behavioral Practices

These are practices that can be adopted by building occupants and staff. They may require education or training for building occupants on their importance and impact to facilitate voluntary cooperation. These practices include behaviors such as turning off lights when not in a room, turning off computer monitors at night or during non-working hours, using natural light when feasible, providing feedback on energy usage, or goal setting and prompts for occupants. Energy savings from behavior practices can vary based on the number and types implemented. Research on this topic is ongoing and energy savings vary based on the types and amount of behavioral changes that are implemented.

Operations and Maintenance Practices

These are practices that can be adopted by building custodians, operators, and managers. Benefits of an O&M Program include minimal comfort complaints by occupants, equipment which operates adequately until the end of useful life, and potential energy savings of 5%-20% of whole building energy use depending upon the building type, baseline, and use. Examples include adjusting temperature setpoints by even just 1 degree, maintaining weather stripping on doors, or scheduling HVAC operations based on building occupancy.

To learn more about these strategies, and establishing Energy Management Policies and Plans, please check out the webinar "Lowering Local Government Energy Consumption Through Energy Planning and Policies" on the

Conserve North Texas website. If your entity is amenable or ready to begin implementing changes, the South-central Partnership for Energy Efficiency as a Resource (SPEER) offers a Building Operator Certification, a training and certification program for technicians and O&M staff, that provides energy-saving operational strategies.

BUILDING CODES

Building codes are widely recognized as an effective planning tool in mitigating damage from natural disasters. The National Institute of Building Sciences in their Natural Hazard Mitigation Saves: 2019 Report revealed that adopting up-to-date building code requirements saves $11 for every $1 that is invested. They also have a direct positive impact on energy resilience when codes are kept up to date and take resilience into consideration.

In recognition that building safety codes and standards must adapt to address the challenges of a changing climate, the International Code Council through the Global Resiliency Dialogue, is seeking to foster global collaboration in addressing evolving climate risks through codes and standards. They are creating international resiliency guidelines and enabling collaborative research efforts which can aid local jurisdictions across the globe to better prepare their buildings to withstand increasingly extreme weather events that have, and will continue to, increase in frequency and duration.

When on-site generation is paired with energy efficiency measures (through design, construction or retrofitting, and operations and maintenance of buildings) they are able to support both community and facility resilience. Energy efficiency can extend the supply of on-site power generation, whether diesel generation or renewables, by reducing the total energy needed to power essential functions or critical facilities. This results in reduced on-site fuel storage needs and/or extended generator capacity, allowing for longer operations without grid-provided electricity. When communities are able to operate under extended capacity, it can relieve some of the burden placed on emergency shelters or Emergency Management staff in implementing their contingency plans.

Below is a compilation of resources that can help guide local governments in their understanding of the role and importance of codes and their intersection with resiliency.

NIBS – Natural Hazard Mitigation Saves: 2019 Report

The Natural Hazard Mitigation Saves: 2019 Report created by the National Institute of Building Sciences (NIBS) dives deep into the cost-benefit analysis of natural hazard mitigation, ranging from adopting up-to-date building codes and exceeding codes to addressing the retrofit of existing buildings and utility and transportation infrastructure. It drives home the message that mitigation measures protect lives, improves safety, prevents loss of property, and is effective at decreasing disruptions to daily life. Users can view the full 658-page Report, an Overview, or a range of Fact Sheets for specific hazards and mitigating measures such as wind, floods, or wildland-urban interface fires.

ICC – Whitepaper: The Important Role of Energy Codes in Achieving Resilience

The whitepaper *The Important Role of Energy Codes in Achieving Resilience* by the International Code Council (ICC) is a supplement to the 2018 report *Building Community Resilience through Modern Model Building Codes*. It examines the intersection of energy and resilience and the important role of energy codes in supporting community resilience. The report covers aspects of pre-disaster/mitigation, disaster/life-safety, and post-disaster/recovery. A table of *Select Energy Code Provisions Contributing to Resilience* provides readers with relevant sections of the IECC by topic, such as insulation, with supported resilience strategies and which relevant hazards are addressed.

May is Building Safety Month

Each year in May the International Code Council, its members, and professionals across the building safety landscape highlight the importance of building safety through proclamations, informational events, legislative briefings and more as part of their Building Safety Month campaign. Each week has a different focus and theme such as Energy & Innovation, Building Safety Careers, Disaster Preparedness, and Water Safety. The educational and interactive campaign is meant to raise awareness about the importance of building codes in ensuring safety in the spaces in which we live, work, and learn. Visit the campaign's website to learn more and access resources such as safety tips and a toolkit to help connect with your local community on the importance of codes.

The International Code Council - Resiliency Toolkit

Recognizing that "resilience starts with strong, regularly updated, and properly implemented building codes", the ICC has created a Resiliency Toolkit which underscores the role of codes in being a good first step towards creating resiliency[v]. Users of the toolkit will learn how provisions in the I-Codes include sustainability measures which make buildings more efficient and less wasteful; address disaster preparedness and recovery; and enable changes to the systems within the building or the structure itself post construction and occupancy. The toolkit includes content such as graphics, studies, reports, and other resources for anyone looking to learn more about resiliency of the built environment.

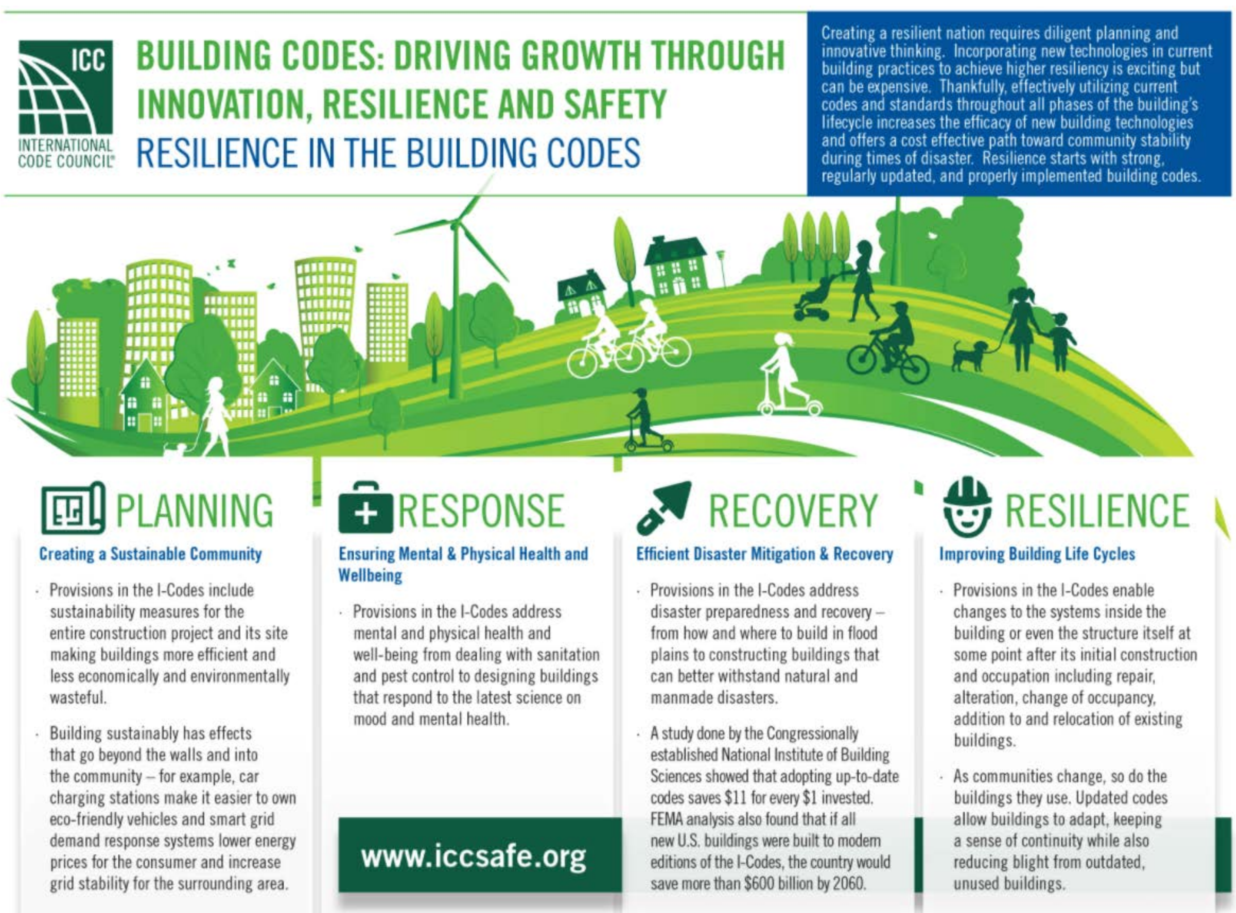

Figure 2. ICC Infographic on Resilience in The Building Codes

SOLAR + STORAGE AND MICROGRIDS:

Diesel or natural gas backup generators, while widely used and effective, are often only used for short periods of time in a given year. When not routinely maintained, they can fail. The lines can be vulnerable to freezing or gumming up in extreme cold as was witnessed during the winter storm Uri. A longer-term strategy worth considering as part of a larger Energy Resilience Plan is determining the feasibility of installing a microgrid to power critical facilities in the event of black-outs or disasters that affect energy supplies or the stability of the larger grid. Because of their effectiveness, microgrids have been recognized for their ability to mitigate across all hazards.

A microgrid is a group of interconnected loads and distributed energy resources that are located within clearly defined electrical boundaries and are able to act as a single controllable entity with respect to the grid. Examples of interconnected loads are a group of buildings, critical facilities, or a Wastewater Treatment Plant. Examples of distributed energy resources (DERs) can include solar PV, battery storage, microturbines, combustion turbines, natural gas-fired Combined Heat and Power reciprocating engines, and propane fueled reciprocating engines.

A microgrid has the capability to connect and disconnect from the larger grid at the point of common coupling, allowing it to operate in both grid-connected or island-mode. A microgrid that can island from the larger grid and "black start" without power from the larger grid can bring stability to the larger grid in times of stress while supplying energy security and resilience to the loads on the microgrid. It is important to note that microgrids are custom solutions with each one being unique in its configuration and assets, level of sophistication and complexity.

When considering a microgrid, local governments should take into consideration issues of jurisdiction, connection to the larger grid, siting, and ownership, as well as the overall finances and economics of the project.

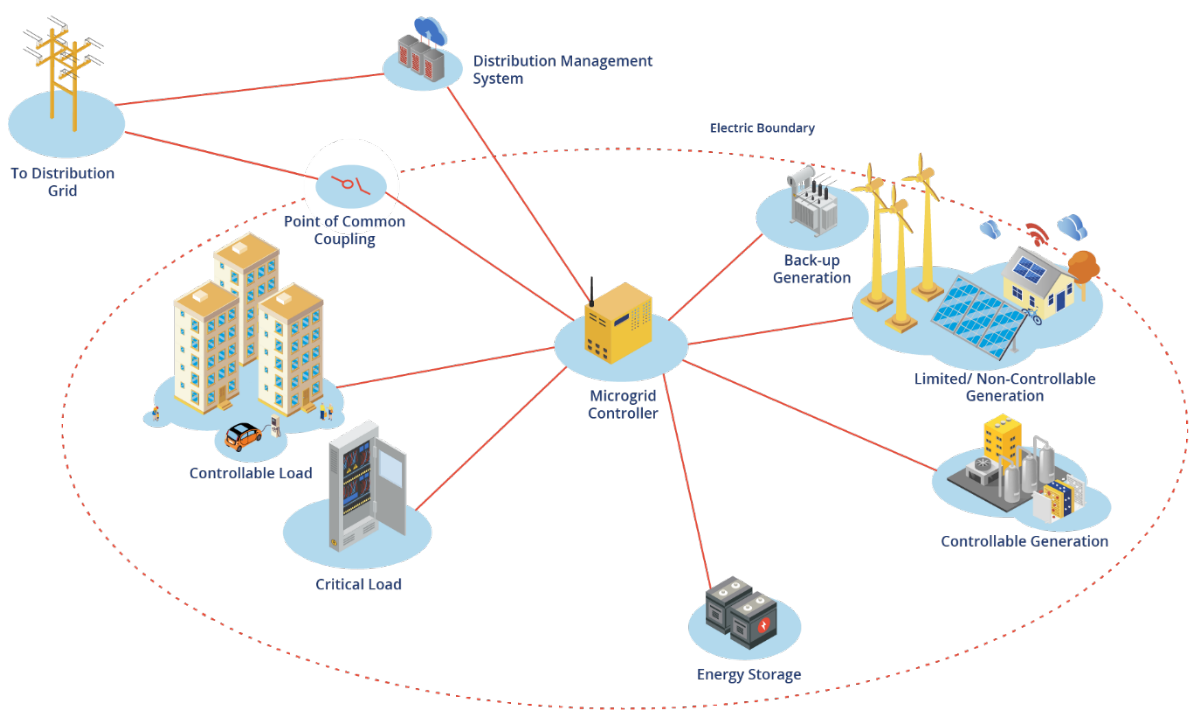

Figure 3. Example Microgrid, Smart Electric Power Alliance[vi]

If regulatory or financial hurdles make a microgrid project not feasible, local governments and communities may wish to look at installing individual solar + storage projects at critical facilities as a more cost-effective resilience strategy. Solar + storage projects would ideally be combined with energy efficiency and demand response technologies at the individual facilities to help reduce peak usage and provide back-up power during times of outages. Solar + storage, coupled with energy efficiency measures, provide benefits year-round by lowing energy demand and costs.

To learn more about microgrids and how they work, consider visiting the following Department of Energy's resources How Microgrids Work and The Role of Microgrids in Helping to Advance the Nation's Energy System.

To explore how communities in another state are examining the feasibility of deploying microgrids as a pre-disaster mitigation technique, consider reading the study Microgrid Feasibility Studies - Wisconsin Office of Energy Innovation Grant by the Smart Electric Power Alliance (SEPA). This study examined the feasibility of deploying microgrids to bolster emergency preparedness and resilience at 3 critical infrastructure facilities and 1 resilience hub in Wisconsin. The report covers the proposed microgrid scenarios, costs, benefits, and potential next steps.

COMBINED HEAT AND POWER (CHP):

Combined Heat and Power (CHP), also referred to as cogeneration, is a form of distributed generation that is located at or near a building or facility. It is an integrated system that can provide concurrent production of electricity or mechanical power, and useful thermal energy (for heating and/or cooling) from a single source of energy. CHP can use a variety of fuels (solar + storage, turbine, natural gas, etc.) to generate electricity or power at the point of use, allowing the heat that would normally be lost in the power generation process to be recovered to provide needed heating and/or cooling[vii]. It is more efficient than separate heating/cooling and electricity generation systems, resulting in lower operational costs, and the ability to provide grid stability and energy resilience. CHP systems can be very small or large depending on the application and needs of the site and can be used in a wide array of facility types such as hospitals, police and fire stations, or WWTPs.

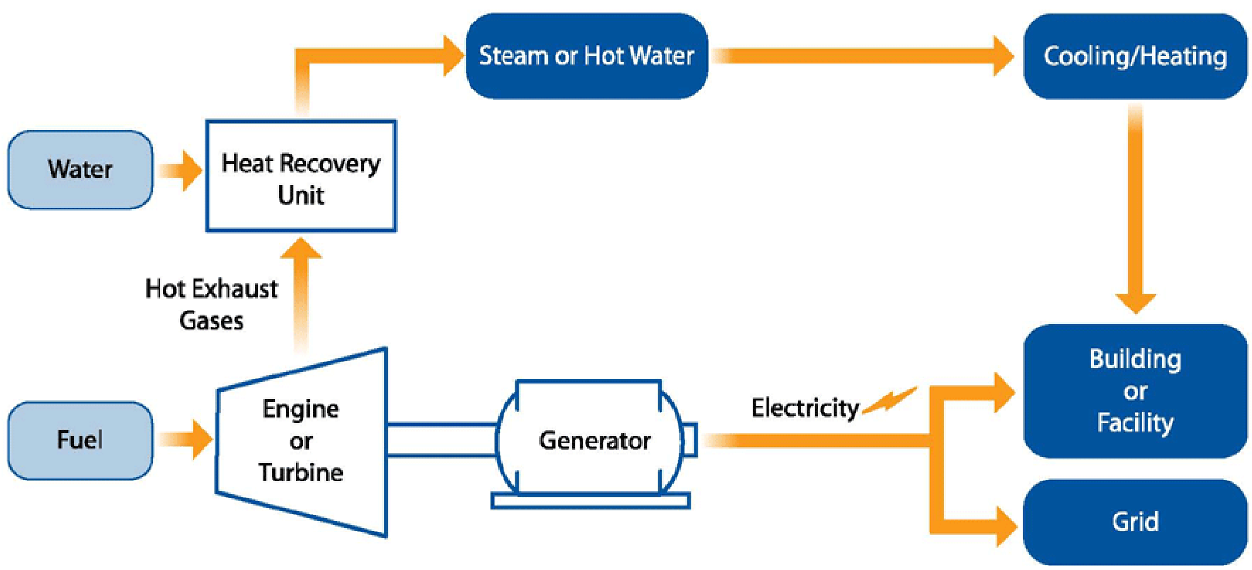

Figure 4. Example CHP Configuration - Combustion Turbine, or Reciprocating Engine, with Heat Recovery Unit, EPA[viii]

CHP systems do require a capital investment to install so local governments may want to explore funding mechanisms that can help offset the costs. The Department of Energy's CHP Technical Assistance Partnership (CHP TAPs) can help local governments explore the cost-savings and resilience of CHP, microgrids, solar + storage all at no cost. The CHP TAPs help by running early-stage critical infrastructure studies to see how resilient sites are and if there are opportunities for projects such as microgrids, solar + storage and/or CHP.

An Important note for Local Governments on CHP:

Texas House Bill 1864 (10 Tex. Gov. Code §2311) requires that entities responsible for all critical governmental facilities to formally consider the feasibility of implementing combined heat and power (CHP) technology prior to the construction, extensive renovation or replacement of major heating, ventilation and air conditioning equipment in critical buildings and facilities.

SECO has established a set of guidelines for evaluating critical government facilities for CHP purposes. Local governments are strongly encouraged to read and become familiar with the guidelines to see how they may be affected. A policy profile produced by the CHP TAP program, Texas Critical Infrastructure Policy for State Facilities, is also suggested reading to become familiar with the policy and guidelines.

Facility Types Impacted by 10 TGC §2311 Could Include:

- Command and control centers
- Prisons or jails
- Communications or data centers
- Hazardous waste storage facilities
- Hospitals
- Shelters
- Police or fire stations
- Water or wastewater facilities
- Biological research facilities
- Food preparation or food storage

To learn more about the topic of CHP, below is a list of resources and information available on the topic from the Department of Energy and the Southcentral CHP Technical Assistance Partnership (TAP). Communities interested in examining microgrids or CHP as potential strategies for energy resilience are encouraged to explore these resources and reach out to the Southcentral CHP TAP for assistance in exploring their feasibility.

Better Buildings' – Combined Heat and Power for Resiliency Accelerator

The Better Buildings' Combined Heat and Power for Resiliency Accelerator worked to support and expand the consideration of CHP solutions to keep critical infrastructure operational every day and night regardless of external events. This collaborative effort with states, communities, utilities, and other stakeholders, examined the perceptions of CHP among resiliency planners, identified gaps in current technologies or information relative to resiliency needs, and developed plans for communities to capitalize on CHP's strengths as a reliable, high-efficiency, lower-emissions electricity, and heating/cooling source for critical infrastructure[ix]. Through the efforts of this accelerator, a host of solutions and resources have been produced to help guide users such as the following.

- The CHP Basics and Benefits is a great place to start as it provides a summary of basic CHP technology facts and the benefits of utilizing CHP.
- A Distributed Generation For Resilience Planning Guide is a report that provides information and resources on how DG, with a focus on combined heat and power (CHP), can help communities meet resilience goals, and ensure critical infrastructure remains operational regardless of external events.
- The Distributed Generation (Dg) For Resilience Planning Guide complements the above guide by providing technical assistance through web-based tools and information. When used in combination with a survey of critical infrastructure at a regional level, this guide also provides users with tools and analysis capabilities to help decision makers, policy makers, utilities, and organizations determine if DG is a good fit to support resilience goals for critical infrastructure in their specific jurisdiction, territory, or organization.
- The CHP for Resiliency in Critical Infrastructure fact sheet provides examples of real-world installations of CHP at critical infrastructure facilities across the U.S., highlights the benefits that CHP systems can offer to critical infrastructure facilities, and reviews details on the economic impacts of grid outages.
- The CHP for Resilience Site Screening Tool (Web-Based) is a web-based version of the CHP Site Screening Tool can provide a quick individual site screening assessment for CHP based on a few simple user inputs and pre-determined metrics.

Southcentral CHP Technical Assistance Partnership

If your municipality or local government is considering a CHP project, the Southcentral CHP Technical Assistance Partnership (CHP TAP) is available to help. The CHP TAP offers complimentary screenings, technical assistance, and expert advice to help determine if CHP is a good fit for your site. As leading experts in CHP—as well as microgrids, heat to power, and district energy—they work with sites to screen for CHP opportunities as well as provide advanced services to maximize the economic impact and reduce the risk of CHP from initial screening to installation.

Department of Energy Fact Sheets

Also available is a fact sheet from the DOE's Better Buildings Initiative on The State of CHP: Texas. This fact sheet is a general overview of CHP projects located within the state of Texas broken down by technology, project size, fuel type, application, sector and more.

CASE STUDIES:

The following case studies are examples of how tools such as CHP and Microgrids can be incorporated into a community's energy resilience plans for their critical facilities.

FEMA Hazard Mitigation Assistance - Mitigation Action Portfolio

The FEMA Hazard Mitigation Assistance – Mitigation Action Portfolio, released in August of 2020, provides users with real examples of projects across the U.S. that address the full range of hazards of concern along with the community lifelines. Of interest for energy resilience in hazard mitigation are the Blue Lake Rancheria Tribe Microgrid and the Bronzeville Microgrid Project. Both projects are considered to address all hazards as a primary hazard in addition to specific hazards of concern for their locality.

University of Texas at Austin – 50-MW Microgrid CHP System

This project profile fact sheet from the Department of Energy's CHP Technical Assistance Partnership program features the microgrid CHP system at the University of Texas at Austin. The campus' CHP-based microgrid provides the university with independence and versatility in the generation of their electricity, chilled water and heating needs throughout the campus. While the campus system is connected to the city's surrounding electrical grid, and operating parallel to it, the connection is only for emergency backup to the campus' microgrid. Notable is the fact that the campus has had only four CHP system outages in 35 years.

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