



COMMUNITY ENERGY RESILIENCE

Scoring Tool Planning Guide

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Scoring Tool Planning Guide

The Community Energy Resilience Scoring Tool is designed to help incorporated cities and towns evaluate their preparedness (or “readiness”) for extended electric power outages. They can use it to evaluate their entire locality or areas within it, like a census tract or neighborhood. The energy resilience of 32 community-wide services in 4 outage impact areas is measured by the tool. The impact areas are:

1. *Public Health and Safety*
2. *Emergency Management*
3. *Community Necessities*
4. *Support of Vulnerable Households*

The community resilience scoring method best represents the context of towns and cities with municipal governments. If your community is unincorporated but a county seat, the tool can also be quite helpful. Small counties with populations of about 25,000 or less could also use it effectively.

For all other places, the tool and its process can help you identify strengths, vulnerabilities, and gaps in your community’s preparedness for significant power outages. But the overall resilience scores themselves will not necessarily offer a good representation of your capabilities during an outage.

Virginia Energy Resilience Study

Virginia Department of Energy



project partners



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Preface

The Community Energy Resilience Scoring Tool, Planning Guide, and Excel worksheet were developed as part of the Virginia Energy Resilience Study funded by the Virginia Department of Energy.

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Introduction: The Purpose and Value of the Community Energy Resilience Scoring Tool

The purpose of the Community Energy Resilience Scoring Tool is to help communities understand their strengths and vulnerabilities when the electricity goes out for longer than a few hours. You can think of it as an outage “preparedness” or “readiness” tool.

In recent years, extreme weather events in Virginia—especially ice storms—have caused the power to go out for days at a time in parts of the state. In rural areas, some towns experience unpredictable, days-long blackouts because of aging infrastructure and limited resources. Without electricity, vital needs in a community cannot be met. And the longer an outage goes, the greater an impact it has.

Using the tool will help you understand your current energy resilience and vulnerability for 32 community-wide services representing 4 key outage impact areas: (1) public health and safety, (2) emergency management, (3) community necessities, and (4) household vulnerabilities. These impact areas represent critical needs that must be met when the electricity goes out in a community. Figure 1 shows the four areas and vital community services in each.

Once you have gained a deeper sense of your community’s capabilities and vulnerabilities to a long-term power outage by using the tool, you can strategically identify areas for improving your energy resilience.

How the Energy Resilience Tool Works

The Community Energy Resilience Scoring Tool uses a set of 4 worksheets that you should complete with a team of 2-4 community members. The worksheets give you a methodical way to organize information about energy needs and backup power capabilities during an electricity outage. Summary scores on a fifth worksheet let you complete a vulnerability analysis based on your scoring results. The vulnerability analysis will help you prioritize where and how to improve your community’s energy resilience during an outage.

The scoring itself is based on the amount of backup power or social capacity for action that is available for each of the community services. You will evaluate only the community services that are actually in your community—you might not have all of them. Instructions, explanation, and details are provided in this planning guide. The worksheets are provided in an Excel file that automates the scoring and gives you an interpretation of the results.



Figure 1. The four outage impact areas and their vital community-wide services

Organization of the Planning Guide

The introduction explains the value of this tool, discusses the nature of power outages and how that affects the tool, and gives an overview of the resilience scoring process and how to prepare for it. Please note that this scoring tool is not a general emergency or disaster planning tool (Box 1).

Step 1 guides you through identifying vital services present in your community, which is the first step of the resilience assessment process. Step 2 details how to determine the backup power capabilities for services in your community and how to conduct the resilience rating and scoring process. Step 3 explains the context

of your resilience ratings and scores, how to interpret them, and what their limitations are.

The guide ends with Vulnerability Analysis, which gives you guidance on how to take your community energy resilience results and prioritize areas for improved resilience.

Box 1

What the community energy resilience tool will and won't do for you

1. Our tool is not an emergency planning tool. It does not represent or substitute for official community emergency management planning or hazard mitigation. While it does consider the energy needs for some emergency responses, the tool does not address your preparedness for, protection from, or prevention of the physical and life-threatening dangers of natural disasters.
2. The tool will not tell you what the most important energy vulnerabilities are in your community. This is a judgment only your team can make. The tool does identify critical energy needs for keeping a community going during a long-term power outage, it organizes those needs into different impact areas, and it helps you understand when and how your energy needs are or are not getting met. But it doesn't weight them or say which ones are most important. Each community will prioritize its vulnerabilities based on local values and circumstances.
3. The tool WILL help you think about time and the impacts of a power outage without having to be an expert in risk analysis! Power outages are unpredictable, they last for different lengths of time, and their potential impacts on a community will change the longer they go on. The tool is designed to help you easily connect information about your energy preparedness to various "probabilities" of outages and weather events. It does this by using a common-sense approach to different kinds of power outages.

How to Think About Power Outages

Power outages are not all the same. The two main considerations are their frequency and impact. Frequency represents how often outages occur at a location. Impact represents how much harm they cause. Longer outages have greater impact, as do more widespread outages (those affecting a larger geographic area). Consequently, outages are often classified along a continuum that ranges from high-frequency, low-impact occurrences to lower-probability but higher-impact events. Figure 2 shows this continuum in the context of our everyday language about power outages and bad weather.

“Ordinary” outages are the most common. They usually last just seconds or minutes and typically affect only a few homes or neighborhoods. Ordinary outages are most often caused by a technical problem within the electrical grid, such as a transformer failing or a critter getting into something. Longer outages—perhaps a couple of hours—are also not unusual and easy to fix. For example, a car hits a utility pole or a storm causes tree limbs to fall on a few power lines. Ordinary outages are high frequency but low impact occurrences. They might happen several times a year in a community, but they don’t last long and generally cause little to no real harm. For most homes and businesses, ordinary outages are simply a nuisance and an inconvenience.

However, when outages last longer than a few hours, they have the potential to be harmful to the people who experience them. When entire communities lose their electricity for more than a couple of hours, it has the potential to be life threatening. Figure 2 reflects the growing harm of power outages as they last longer, cover a wider area, and result from increasingly severe weather: the impacts of power outages progress from ordinary to major, extreme, and catastrophic.

It is important not to underestimate the impacts of a power outage. Other kinds of energy systems also depend on electricity. When the power goes out, it’s not just about lights, electrical equipment, and things that plug in. For example:

- Heating systems also require electricity, even if they use natural gas, propane, or heating oil. These systems have electric controls, pumps, motors, and fans that require electricity to help make and circulate heat in a building. No

electricity means no heat in most circumstances.

- Rechargeable batteries are a terrific source of backup electricity. But after they are run down, they can't be recharged without electricity. This is an issue for phones, computers, Internet access, the ability to communicate during an outage, and even some passenger vehicles.
- Gas stations can't pump gasoline or diesel. In a long-term power outage, vehicles can run out of fuel, and it may not be possible for them to be refueled.
- Many homes, businesses, and critical public services rely on diesel-powered generators to provide backup power during an outage. Generators will eventually run out of fuel, possibly very quickly. These have the same issue as vehicles; once a generator's supply of reserve fuel is used up, it may not be possible to refuel it.
- Because of this interdependence between electricity and other sources of energy, it is important to think about the impacts of power outages in terms of (1) how long they last, (2) other energy sources that need electricity in order to be accessible, and (3) when backup power might stop operating. The loss of backup power, or having none at all, is the point in time when energy resilience generally ends and vulnerability begins. The worksheets and their guidance give you a structured way to address these three considerations.



Figure 2. Power outages range from ordinary, high frequency (but low impact) occurrences to more devastating yet less frequent outage events

The scoring tool method is based on the common-sense description of power outages shown in Figure 2. You will assess backup power capabilities and social capacity in time increments that match the outage categories. The rating and scoring system is a scale from 0-4 that aligns to both the outage and the resilience capacity time increments. Community energy resilience in an outage increases as backup and social capacity increase. The scale represents no resilience capacity (0) to extreme resilience capacity (4).

The Resilience Scoring Process

Resilience scoring is a 3-step process followed by an optional vulnerability assessment. You will need a small team of people to do the work and clearly define the community that you want to evaluate. Each of these components is summarized here in the planning guide.

Your Assessment Team

A small team of community members is needed to conduct the community energy resiliency evaluation. The size of your team depends on how big of a community you are evaluating. The larger your city or town is, the more people you should have. This will save time and help you gather information more efficiently. The size of your team should probably not be larger than four people because it gets difficult to coordinate among the members. A very small town of less than 500 people could manage with a 2-person team. A city or town with fewer than about 3000 residents could get by with 3 people. Otherwise, aim for four.

If you are completing the assessment for an incorporated city or town, it is very important that you have one of the following people on your team. Their expertise is needed to answer the worksheets related to public health and safety and to emergency management. They won't necessarily know the answers, but they will know who to ask and how to find out.

- The town manager
- The mayor
- Someone in facilities management or public works
- Someone in public safety (police department, rescue squad, fire department)

- The emergency manager or coordinator

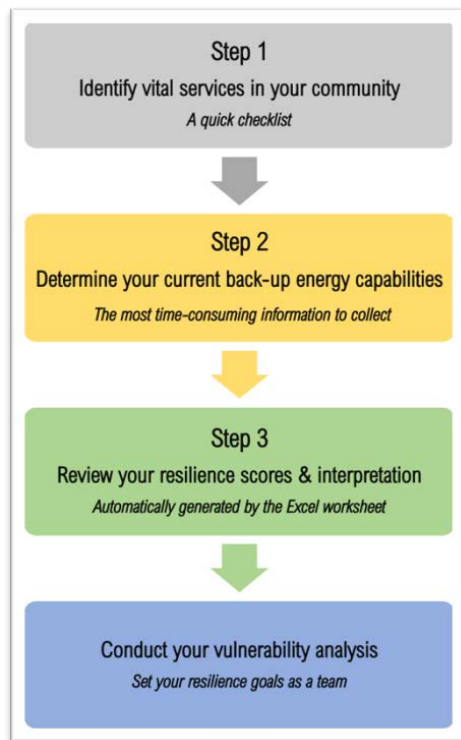
Cities and towns have different kinds of municipal staff. While your community may not have all the representatives listed above, they will at least have two of them. Other types of people who could be good team members include:

- Folks who are in the business community or members of a Chamber of Commerce.
- Charitable organizations like the United Way or other non-profits that support a food pantry, family and household assistance, or other kinds of social services.
- Anyone who has a good, basic understanding of your community and its vulnerable residents.
- Neighborhood leaders from neighborhood associations (these folks are very important if you are evaluating a Census tract within a city or town).

People with the kinds of backgrounds described above are especially valuable for helping with the community necessities and household vulnerability worksheets. Generally, you want to select team members based on the insights and networks that they might already have regarding one or more of the four outage impact areas. People who know who to talk to and can “open doors” for you will be helpful team members.

Overview of the Process

The community energy resilience assessment is a 3-step process. You complete all three steps for each of the four outage impact areas (public health and safety, emergency management, community necessities, and household vulnerability). After you have finished your energy resilience assessment, you conduct your vulnerability analysis (assessment). Vulnerability assessment helps you identify the outage vulnerabilities in your community that are most important to you. Each of these steps is summarized below. **Steps 1 and 2 of this planning guide give you detailed instructions for each step and how to use the Excel worksheets.**



Step 1: Identify vital services in your community

In Step 1 you identify which of the 32 community-wide services are present in your community. The checklist is part of this planning guide. Your team should be able to tick through it somewhat quickly. A short phone call, email, or text message to someone who would know should take care of anything you are unsure about.

Step 2: Determine your current backup energy capabilities

Step 2 is the core of the resilience assessment and scoring. For each of the services present in your community, you will need to find out how much and

what kind of backup power is available for it if a power outage happens. This information will be entered in the Excel worksheets through simple dropdown menus, and your resilience scores will be calculated from it.

Step 2 requires that you chat with community stakeholders to better understand the context and capabilities of any backup sources of power that are available. This is why it is the most time-consuming step.

You don't have to figure out what kinds of questions to ask of in Step 2. This planning guide suggests relevant stakeholders to talk to for each of the outage impact areas. It also gives you "prompting" (interview) questions to guide your conversations with them and get the information you need. Once you have the basic information about backup capabilities, you enter it into the Excel worksheets.

Step 3: Review your resilience scores and interpretation

Once you have entered your information into the Excel worksheets, the worksheets automatically assign resilience ratings for each of the community

services. Resilience scores are calculated from the ratings and basic interpretations of the scores are provided. In Step 3 you simply review these results to get a more complete picture of how prepared your community is for power outages of different lengths of time (as seen in Figure 2).

Completing Step 3 might be all that you want to do. If your goal is simply to understand your level of outage readiness and services that are at greatest risk, you are done. However, if you want to improve your community's ability to function well during an outage—or at least ensure key vital services are maintained for your residents—then you should also conduct the vulnerability analysis.

Vulnerability Analysis

A vulnerability is a specific community need that is not getting met during an outage. Vulnerabilities are defined by when they occur and who they affect. A vulnerability begins when the energy required to support community services and meet needs is no longer available. For example, a hospital has an emergency diesel generator that can run for 3 days. If the electricity hasn't been restored after 3 days, the generator runs out of fuel, and diesel isn't available to refuel the generator, then the vulnerability begins when the generator can't operate any longer. The people who are vulnerable are anyone in the hospital as well as community members who might need the hospital for urgent medical care.

The Excel spreadsheet generates summary scores that you will use for the vulnerability analysis. The vulnerability analysis itself is the last section of this planning guide. The vulnerability assessment is also available as a separate short Word document within the Excel file, too.

Define the community you will evaluate

The scoring tool can be used to evaluate the resilience of an entire city or town. It can also be used to analyze a smaller area within a community, like a census tract or neighborhood. Because the tool only scores one area at a time, you will need to define the places that you will evaluate.

The community resilience scoring method best represents the context of towns and cities with municipal governments. If your community is unincorporated but a

county seat, the tool can also be quite helpful. Small counties with populations of about 25,000 or less could also use it effectively.

For all other places, the tool and its process can help you identify strengths, vulnerabilities, and gaps in your community’s preparedness for significant power outages. But the overall resilience scores themselves may not offer a good representation of your capabilities during an outage.

In addition, the backup power information for cities with large populations can get complicated to manage for the scoring tool. For cities that have populations between 50,000 and 100,000, we suggest one of these two approaches:

Census tract or neighborhood only	Select a Census tract or neighborhood within your city for a focused energy resilience assessment. Use the workbook and scoring tool exactly as it is presented for the area that you pick.
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Split city/ Census tract or neighborhood	Evaluate the public health and safety and emergency management outage impact areas for the entire city. These are public services designed to be delivered throughout the city. For the community necessities and residential vulnerabilities outage impact areas, evaluate the census tract or neighborhood context only. It will be more manageable to gather information, interpret it, and make sense of community energy resilience and vulnerability at this scale.
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Cities larger than 100,000 people have a degree of complexity that is not easily captured with our scoring tool. Other resources exist that address holistic community resilience for cities of this scale and may be of interest to you.¹

The next sections of the planning guide provide instructions for each step of the resilience scoring process and when to use the Excel worksheets.

¹ See, for example: National Institute for Standards and Technology, *Community Resilience Planning Guide* (<https://www.nist.gov/community-resilience/planning-guide>) and the US Climate Resilience Toolkit (<https://toolkit.climate.gov/>).

STEP 1. Identify Vital Services in Your Community

The scoring tool evaluates 32 community-wide services in four impact areas. The impact areas are explained below.

Impact Area	Description
Public Health and Safety	The everyday public services in a community that are fundamental to protecting human health, life, and safety.
Emergency Management	The vital but temporary responses to protect the community during an emergency event and its immediate aftermath. Examples of emergencies include extreme weather events and natural disasters. Official emergency management is provided by government. Other organized emergency responses could be initiated by institutions within the community, like churches and charitable organizations.
Community Necessities	Community necessities represent the goods and services that people rely on to meet their everyday basic needs. Necessities are not luxuries. They are essential for people to function as individuals, families, and households. Most community necessities are provided by local businesses, but they might also be offered by local government or social service organizations.
Household Vulnerability	During an extended power outage, some people are especially vulnerable to the loss of electricity. An outage can make it challenging to safely shelter in place or can prevent them from leaving or evacuating their homes if they should. Their health and safety could be at severe risk. Community services in this category are designed to help households at greater risk in a power outage.

Resilience scoring in this tool is based almost exclusively on the availability of backup power or sources of energy during an electricity outage. This is because most vital community-wide services take place in buildings—or require

equipment—that operate directly or indirectly on electricity. Very simply, these services usually cannot be provided unless there is a source of energy to support them. The Household Vulnerability scoring is based on your community’s social capacity to identify and protect vulnerable people.

Table 1 is a checklist of the 24 community services for public health and safety, emergency management, and community necessities. (Household Vulnerability is not included here because it is addressed later in Step 2.) You will evaluate the availability of backup power for these services in Step 2 and enter that information in the Excel worksheets.

Identify in Table 1 the vital services that are physically within your community’s boundaries. If a service is located within the boundaries of your community, include it. It doesn’t matter who owns and/or operates it. If a service is not in your locality but is very nearby (about 1-5 miles) and you want to include it in your scoring, you can. This is optional. Please use good judgement in what you include. Common sense should tell you if including a nearby service better represents your community’s potential energy resilience or makes it less realistic.

✓ **Check the box if the service or facility is physically present in the community you are assessing.**

Community Service	Description
Public Health & Safety	
☐ 9-1-1 call center	A 9-1-1 call center for emergencies
☐ Fire protection	A fire station and fire protection. This might be a volunteer service, which you should include.
☐ Rescue squad or ambulance	A rescue squad or ambulance service. This might be a volunteer service, which you should include.
☐ Police department	A police department or law enforcement, such as a sheriff.
☐ Acute medical care facility	Acute medical care is when someone receives immediate, short-term treatment for a sudden major injury, illness, or medical condition. This care is usually provided at hospitals or urgent care clinics.

☐ Public water supply	A municipal water supply, which could be publicly or privately owned and operated. Check the box if there is a community water supply that is a public utility.
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☐ Public sewer and wastewater treatment	Sewer and a wastewater treatment system are operated within your community's jurisdiction.
--	--

☐ Public trash collection	A public waste management system is provided to all community residents. It can be publicly or privately owned and operated.
--	--

Emergency Management

☐ Emergency command center	Your community sets up a command center for its emergency management and coordination.
---	--

☐ Community shelter	A designated community shelter that is open to the public during an emergency.
--	--

☐ Distribution of necessities	Your community provides an organized distribution of groceries, prepared meals, water, clothing, personal hygiene products, baby products, or other basic provisions during an emergency.
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☐ Public communication	Your community provides information about the emergency through public communication such as webpage announcements, phone calls, text alerts, or social media.
---	--

☐ Special needs transportation	Your community provides transportation to people who are physically or mentally disabled and need to be relocated during an emergency.
---	--

☐ Animal shelter	An emergency shelter for household pets if people need to evacuate. (Some people will not leave if they cannot take their pets with them.)
---	--

☐ Debris clearing	An organized response to clear debris created by an emergency event.
--	--

☐ Search and rescue	Your community can mobilize search and rescue in an emergency.
--	--

Community Necessities

☐ Phone and Internet access

A public space for accessing the Internet and charging phones or other devices. (People need to communicate in an outage. And a public alert system will not be effective in a long-term outage if people cannot charge their phones or get online to receive messages.)

☐ Public transportation

Your community provides public transportation. This is typically a bus system or transportation services for the elderly and people with disabilities. These services might be offered by the local government or by non-profit organizations.

☐ Local TV or radio station

A local TV or radio station that broadcasts out of your community. Local TV and radio can be critical trusted sources of news and information during a major power outage or emergency event.

☐ Food bank or food pantry

A food bank or food pantry in your community that some residents regularly depend on for food.

☐ Grocery stores

A grocery store or other source of groceries community. The longer the power is out, the more likely it is that people will need to buy or replace groceries and other necessities.

☐ Gas stations

A gas station in your city, town, or Census tract. The longer the power is out, the more likely it is that people will need to refuel their vehicles. Note that most gas stations typically have a 2-to-4 day supply of gasoline under normal circumstances.

☐ Banks and ATMs

A bank, credit union, or ATM location in your city, town, or Census tract. The longer the power is out, the more likely it is that people will need cash to pay for basic necessities.

☐ Pharmacies

A pharmacy in your city, town, or Census tract. People who rely on prescription medications may need to refill their prescriptions during an extended power outage.

After you complete the Table 1 checklist, you are ready to start gathering the information you need in STEP 2 and start the resilience scoring process.

STEP 2. Determine Your Backup Power Energy Capabilities

The scoring tool uses the availability of backup power and social capacity during a power outage to assign resilience ratings and calculate community energy resilience scores. These factors are direct and indirect measures of your community's potential ability to keep these vital services going during power outages of different lengths in time.

Estimating Backup Power Capability

Your estimates of backup power capability for the scoring tool will not be an exact number. You will take what you have learned about backup power and select the description that best fits it. This method is used for the public health and safety, emergency management, and community necessities impact areas. Your capacity to help vulnerable households during an outage is measured through social capacity and is discussed separately in this section of the planning guide.

The descriptive backup estimates that you can select from, their assigned resilience ratings, and interpretation are shown below. The resilience ratings and their interpretation are designed to align with the types of power outages shown previously in Figure 2.

Once you have the information you need, you can enter it in the Excel worksheets, where you will get a dropdown menu of these choices. The worksheet will then automatically assign the ratings and interpret the resulting score.

Backup Capability	Resilience rating	Interpretation
No backup capability at all	0	No backup power, no resilience, and highly vulnerable during an outage.
One day or less	0.5	Backup power for 1 day or less, indicating resilience only for ordinary and short outages.
1-3 days	1	Backup capability of 1-3 days, indicating resilience for a major outage.
4-7 days	2	Backup capability of 4-7 days, indicating resilience for major to potentially extreme outages.
1-2 weeks	3	Backup capability of 1-2 weeks, indicating resilience for extreme outages.
More than 2 weeks	4	Backup power for more than 2 weeks, indicating resilience for extreme to potentially catastrophic outages.

There are three things that you need to consider as you complete Step 2:

1. What kinds of questions to ask to get the information you need. Box 2 provides suggestions for questions and interview techniques.
2. How to deal with inexact information. Your discussions with stakeholders may result in very clear-cut answers about backup capabilities. But often there will be a “fudge factor” about how long backup can continue. For example, an acute medical care facility might be able to make their generator last for up to 5 days depending on the circumstances, but their planning intended only 3 days. Be conservative in your evaluation and estimate. Mark their capacity as 2-3 days.
3. What to do if you have more than one of the same kinds of facility. You could have more than one fire station, grocery store, and so on. There are different ways you might deal with this.
 - If backup power information is easily available for some or all of them, take the average of what is available and use that. This is the best technique to use for Public Health and Safety and Emergency Management.
 - For the Community Necessities impact area, you could have many of the same kinds of businesses depending on the size of your community. Clearly it isn’t practical to talk to all of them and the information could be more difficult to interpret. We suggest two approaches in this situation.
 - One is a “typical” establishment approach. Local businesses often know what their peers are doing for certain kinds of things or what is common in their industry. You might be able to talk to just one person to get a sense of what everyone does. A gas station can tell you whether it has backup power and whether it is common for the others as well. A bank can tell you what it does during an outage and what is common practice for most banks. And so on. If you use this approach, select the backup option that best fits the general practice for that kind of business.
 - The other is to use the “dominant” establishment approach. You might have several of one kind of business, but one of them might be big and the most popular. A retailer like Wal-Mart is an example,

or a convenience store that has a lot of gas pumps. Members of your community might rely heavily on just one or two businesses for something, and you can focus on those. If you use this approach, select the backup option that best fits the practice for the dominant business.

You can mix these two approaches when you answer the Community Necessities Capabilities Worksheet. For example, one technique may be better for banks, but the other

Box 2

What Kinds of Questions Should You Ask Stakeholders in Step 2?

The key question to ask stakeholders is:

“Assuming that equipment and buildings have not been damaged, how long can this service continue to operate if the power goes out?”

Depending on their answers, you might want to ask some of these as a follow up:

- What is their source of backup power, if they have one?
- How would a longer-term outage affect their ability to use this backup power source? (For example, a diesel generator will need to be refueled once the reserve supply is used up. In an extended power outage, it may not be possible to refuel if local diesel suppliers don’t have electricity either.)
- Does the service provider rely on battery-powered equipment? Are they able to recharge it during an outage? How?
- Do the service providers need fuel for vehicles? How long is the reserve fuel supply expected to last in an outage?
- If equipment and buildings were damaged, do they still have an ability to provide their service? How?
- Why don’t the service providers have the ability to operate in a longer-term outage? Do they want to? What prevents them from achieving that?

When ending your conversation with a stakeholder, it is useful to wrap up with something like:

“Is there anything you think I should know about your energy needs or resilience that I haven’t already asked?”

Some of the best information in interviews often comes from this “what do you think I should know but haven’t asked?” closing question. Box 2, continued

There are also questions you can ask specific businesses or organizations related to the Community Necessities impact area. Below are some suggestions.

Radio Station

Ask if they are already part of a local or regional emergency management plan (or have considered that role in your community). Radio stations, especially AM radio, were an important lifeline in much of western North Carolina after Hurricane Helene.

Foodbank or Pantry

It is important to know how many people they serve and whether some community members (like the elderly or young families) are especially reliant on their resources. This is related to your vulnerability during a long-term outage.

Schools

How many children rely on the school for their breakfast or lunch for adequate nutrition? What happens when the school is closed? Is there another way to get meals to the children? (Some schools got very creative on this during the pandemic.)

Public Transportation

For a public transport system like a bus service, you can explore with them in general how their service would be affected by power outages of different lengths of time. You can also explore their ability to refuel during an outage, and whether they have a reserve supply.

Gas Stations

How many days of supply of gasoline/diesel do they normally have in their storage tanks? Even if they have backup power, they might run out of fuel and not be able to get resupplied easily.

Grocery stores

During bad weather and extended power outages, stores often run out of common food and supplies (eggs, toilet paper, and so on). Ask what they are most likely to run out of in a long-term outage. This will help you understand where shortages of necessities can occur.

better fits gas stations. Just make a note of which approach you are using in the worksheet.

If you are having real trouble coming up with an estimate for a type of business or service, don't force it. The most conservative approach is to say that it has no backup power at all.

Estimating Resilience Capacity for Household Vulnerability

During an extended power outage, some households are especially vulnerable to the loss of electricity. These vulnerabilities can make it challenging to “shelter in place,” can prevent people from leaving or evacuating their homes when they should, and can put them at greater risk for their health and safety. **These vulnerabilities are created by the power outage itself**, and to be resilient, a community should have some way of protecting its vulnerable residents. A list of the vulnerabilities that are evaluated in this tool are shown in the table below.

Our scoring tool does not include other residential settings like health care facilities (such as nursing homes or rehab centers), prisons, detention centers, and boarding schools. People living in these places are critically vulnerable during power outages. However, backup power for these facilities can be (but isn’t always) regulated by the federal and state governments. It is consequently difficult to include them in the scoring tool and vulnerability assessment. If one of these facilities is located in your community, you might want to explore what their capabilities are for power outages of different lengths of time.

Household Vulnerability	Explanation
Lack of transportation	People who lack transportation may be forced to stay at home when, for safety’s sake, they should go somewhere else.
Homes on well water	Households that use well water will lose their water when the power goes out. The electric pressure tank and pump will not work.
Limited English capability	Households with a limited ability to communicate in English might not receive information about an outage, its duration, or the dangers of an imminent emergency event. This prevents them from taking appropriate action.

Dependence on home health care equipment	People who rely on durable electrically powered medical equipment—like oxygen concentrators or medication refrigerators—can quickly experience a crisis in a power outage. While some equipment has battery backup, not everyone can afford it and the battery storage does not last long. In widespread outages that last even a few hours, such folks typically go to emergency rooms and can overwhelm hospitals that are also trying to deal with acute care during an emergency event.
Dependence on home health care caregivers	People who rely on outside home health care attendants or caregivers can also be at risk during an extended outage or emergency because of challenges their caregivers experience. Medication management, meals, bathing, personal hygiene, and other critical health care could be interrupted. These are people who also may not be mobile or able to leave home easily (or at all).
Loss of home heating or cooling	Loss of home heating or cooling due to a power outage puts vulnerable people at risk of more severe health outcomes. These include those with certain medical conditions and the elderly and babies in particular.
Vulnerability to extreme heat but no power outage	Many types of people are especially vulnerable to extreme heat, which can dangerously affect their health. These include the elderly, babies, and people with certain medical conditions. Even if power is available, they may not be able to afford to adequately cool their home or may not have an air conditioner. Extreme heat is defined by Ready.gov as periods of high temperature and humidity, with temperatures of 90 degrees or higher for 2-3 days in a row. This is one of two indicators in the scoring tool that does not directly relate to a power outage. It addresses the lack of energy resilience due to affordability in a household.
Vulnerability to cold weather or extreme cold but no power outage	Some households may not be able to adequately heat their homes during a cold snap. The elderly and babies are especially vulnerable to cooler temperatures. Minimum indoor air temperatures for good health are 65 degrees in general and 68-70 degrees for vulnerable individuals. This is one of two indicators in the scoring tool that does not directly relate to a power outage. It addresses the lack of energy resilience due to affordability in a household.

Resilience scoring for household vulnerability does not consider backup power capabilities. It focuses instead on the community's social capacity to identify and protect vulnerable people. The Step 2 worksheet for Household Vulnerability contains a set of questions about your community that you need to answer. The response choices represent a progression of capability, from none to high. These form a scale of 0-4 that is comparable to the resilience scoring in the other impact areas.

You should be able to tell from the questions the types of stakeholders that you need to talk to. Your local and county government will have a social service department that can inform you about some vulnerabilities that may be within their responsibilities, like eldercare checks. Some charities, non-profits, and faith-based organizations may offer relevant services, such as support for people with limited English, providing emergency transportation, and so on. For this impact area, you know your community best, and your team should be able to sort out who best to talk to.

The questions that you need to answer are shown below.

Household Vulnerability	Explanation
Lack of transportation	For a power outage longer than 1 day, is your community able to identify households without transportation and relocate them to a safer place if needed?
Homes on well water	For a power outage longer than 1 day, is your community able to provide potable water for homes that use well water?
Limited English capability	Does your community have an alert system that helps people with limited English understand emergency or severe-weather warnings?
Dependence on home health care equipment	For a power outage longer than 1 day, is your community able to identify households dependent on home health care equipment and provide them with a source of electricity for their equipment if needed?
Dependence on home health care caregivers	For a power outage longer than 1 day, is your community able to identify households dependent on home health caregivers, do a wellness check, and then act on any needs?
Loss of home heating or cooling	Does your community have a shelter where vulnerable people can go to stay warm or cool during an extended power outage?
Vulnerability to extreme heat but no power outage	Does your community have a cooling center where vulnerable people can go during extreme heat, even if there is no power outage?
Vulnerability to cold weather or extreme cold but no power outage	Does your community have a warming center where vulnerable people can go during extreme cold, even if there is no power outage?

Your answer options and their resilience ratings are:

Answer Options	Resilience Rating
We have nothing like this at all	0
We have some experience with this through informal volunteer activity, but do not have any official plans.	1
We have no informal volunteer activity, but we do have official plans. We have not yet had to use our plans.	2
We have no informal volunteer activity, but do have official plans and have used them in the past.	3
We have both informal volunteer activity and official plans that have been used in the past.	4

When you have answers for the services and impact areas in Step 2, complete the Excel worksheets.

STEP 3. Review Your Resilience Scores and Interpretation

For Step 3, you should review the resilience ratings, scores, and interpretations for the services in your community. This will give you a more complete sense of what you are capable of—and what your limitations are—for power outages of different lengths in time.

In addition to the individual ratings and the impact area scores, the tool calculates an average community energy resilience score based on all the individual ratings. It generates a summary image with your overall rating (see Figure 3) and provides an infographic with additional details about your resilience and how to interpret the resilience ratings and scores.

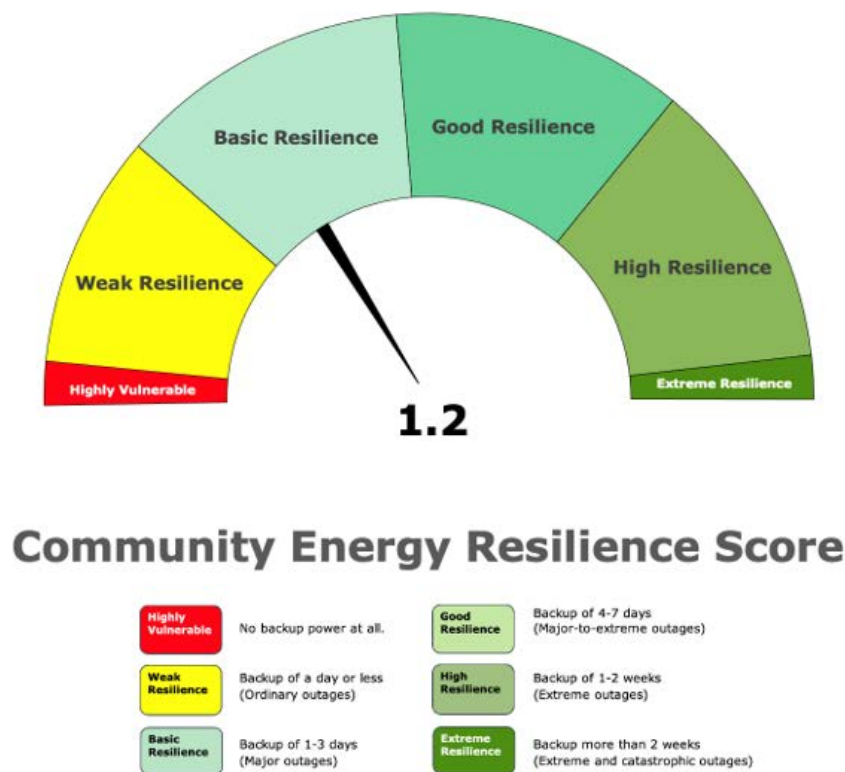


Figure 3. Example of the resilience rating graphic produced by the scoring tool

Your community energy resilience ratings and scores are measures of how well your community can potentially cope with and recover from electric power outages of different lengths of time. The higher the rating or score, the better prepared you are to provide vital community services—with little disruption—for longer periods of time.

The scores measure only the resilience of services that you evaluated—those actually located in or very near your community. The fewer services that you have, the more dependent you are on other places and organizations to support your community during an outage. The score isn't a complete picture of your energy resilience and vulnerabilities, and it could overstate or understate what is "true."

In addition, the scoring includes types of household vulnerabilities that may not be present in your community (such as homes on well water or a notable number of households with limited English abilities). As a consequence, the scoring may very slightly understate your overall community energy resilience.

Real community energy resilience is therefore more complex than these numbers suggest. However, our scoring scale and the severity of outages that it represents is both meaningful and useful. You can use it to identify vulnerabilities and threats to life, health, safety, and critical basic needs that are created by a power outage in your community. You can use it to track your progress over time or to target specific areas for improvement.

The next step is to make practical use of your scores. You will do this in a Vulnerability Analysis. The vulnerability assessment helps you process the scores and answer a critical question: **given our current levels of preparedness for an outage, which vital services are most likely to be affected, when, and how serious would the impacts be?**

Vulnerability Analysis

A vulnerability analysis (or assessment) helps you make practical use of your community's energy resilience scores. When taken together, resilience scoring and vulnerability analysis will give you a more complete picture of your community's ability to cope with and recover from a power outage. Once you have your energy resilience scores, the vulnerability assessment helps you process them and answer a critical question: given our current levels of preparedness for an outage, which essential services are most likely to be affected, when, and how serious would the impacts be?

By now you have realized that outage duration matters. Extended power outages of a day or longer are disruptive to a community and vulnerable households. Short outages might be manageable, but longer outages can quickly become threats to life, health, and safety. Very simply, a vulnerability assessment will help you see where the long-term loss of electricity could cause the greatest harm in your community. These insights can help you set goals for reducing outage vulnerabilities and prioritizing resilience efforts.

This vulnerability assessment guides you through five sets of prompting questions. It concludes with a summary of opportunities for improved backup electrical power and more resilient public transportation. Finally, it suggests ways to get ideas about how to improve energy resilience for specific types of vital community services.

Overview of the Vulnerability Assessment Process

The vulnerability analysis method provided here is qualitative. You don't have to do any data analysis or get any new statistics. The method involves a series of steps; each step presents a set of "prompting" questions. These questions ask you to review specific color-coded resilience scores created in the Energy Resilience Scoring Tool (the Microsoft Excel file) and make some interpretations. The prompting questions are designed to help you process your energy resilience scores, identify major vulnerabilities and resilience needs, and be able to take next steps.

Before you begin, make sure that you have completed all your resilience scoring. You will need the color-coded scores from the scoring tool Excel worksheet labeled “Part 3. Vulnerability Analysis.” This worksheet can be printed out on one page for reference while you work through the prompting questions.

To do the Vulnerability Analysis, you should first complete your resilience scoring.

You will also need to use color-coded resilience scores created by the Energy Resilience Scoring Tool. You will find these in the Excel file on the worksheet labeled “Part 3. Vulnerability Analysis.”

The Context of Vulnerability

Vulnerability during a power outage begins at the point in time when a vital community service cannot be offered because there isn’t a source of energy. For most services, the entire community will potentially be affected.

One of most important things that affects the vulnerability of a community during a long-term power outage is mobility. Many people can cope and make do for a day or so, but after that they just leave. They might go to family, friends, or hotels where power is available until their community recovers. However, many community members cannot do this. They might not have any place to go because they can’t afford it or because they don’t have other people they can rely on. Your community might be geographically isolated and there isn’t anywhere else people could easily get to.

As you think about who is vulnerable, also think about how that might change over time. For example, for a 2-3 day power outage, everyone in your community might be impacted by it. But after a week or more, only those who are still present will be affected. These residents could be experiencing exceptional hardship because of their inability to go somewhere safer. So, another way of thinking about “who is vulnerable” is by reflecting on who will be hit the hardest by an outage because of limited resources for managing its impacts or leaving.

During an extended power outage, your community will be potentially vulnerable in several different ways:

1. You have a critical community function physically located in your community, but it has either (a) no backup power at all, or (b) backup power is available

for less time than you would like.

2. Your community has “gaps” in services that are provided locally. It relies on the county or other entities to provide essential services that are physically outside of your community.
3. Your community is not able to support households that are especially vulnerable to a power outage.
4. There are interdependent energy vulnerabilities in your community. For example, a gas station might have backup power but could run out of fuel. Or you have a public alert system that can be powered a long time, but people have no ability to recharge batteries on their phones or computers.

Step 1. Gaps In Local Vital Services

The purpose of this step is to identify services that are not located in your community and reflect on how that might make you vulnerable. **In this step you only evaluate the scores for Public Health and Safety, Emergency Management, and Community Necessities.**

1. Look at the color-coded resilience ratings on the “Part 3. Vulnerability Analysis” worksheet. Identify any that are marked “Not Applicable.” These are services that are not located in your community. These are gaps. Gaps mean that you are dependent on other places to meet vital needs when the electricity goes out. They may or may not be located nearby. Your resilience is only as good as the ability of these other places to support you during the outage or the ability of your community members to travel to those places. In a widespread outage, these other places may not have power either.
2. Are there any gaps that you would like to try and fill locally? What are they? How long of an outage do you want to be prepared for if you try to fill this gap?
3. To improve your community’s energy resilience where there are gaps, you can:
 - a. Provide the vital service locally and ensure backup power capability for the length of time you think is necessary.
 - b. Talk to the outside organizations and places that provide the services missing in your community. Find out what their capabilities are during an extended power outage and how that could affect your community.

Awareness helps you understand your vulnerabilities and resilience better.

- c. Create or improve power outage coordination plans with the outside organizations or places that provide the services missing in your community.

Step 2. Vital Services with No or Less Than One Day of Backup Power

The purpose of this step is to identify the vital services that you included in your scoring that have low (or no) energy resilience. These services experience almost immediate vulnerability when the power goes out for just a few hours. **In this step you only evaluate the scores for Public Health and Safety, Emergency Management, and Community Necessities.**

1. Look at the color-coded resilience ratings on the “Part 3. Vulnerability Analysis” worksheet. Identify any that are marked as 0 or 0.5. Review the interpretation of these ratings.
2. Which of these vulnerabilities represent threats to life, health, and safety in the short run (1-3 days)? Which are threats in the long run (think in terms of 3-7 days, a week, and 2 weeks).
3. What short run vulnerabilities are important priorities to fix? What long run vulnerabilities are important priorities to fix? How do these priorities differ in terms of their cost or degree of complexity to fix?
4. To improve your community’s energy resilience when a vital service is highly vulnerable, you can:
 - a. Create backup power or add to the length of its existing backup power capability.
 - b. Create or strengthen power outage plans and coordination.
 - c. Find ways to partner with outside organizations or places to provide the service during an outage (assuming they are not also affected by it).
 - d. Redesign the services so that they can still be provided, but with less energy (thus requiring less backup power and/or making backup power last longer).
 - e. Explore alternative ways to provide the services that use existing backup energy somewhere else in the community or in a manner that doesn’t require electricity or a fuel.

- f. Improve individual power outage awareness and preparedness. This empowers community members to create household resilience that can offset at least some community-wide vulnerabilities.

Step 3. Services That Could Benefit from Strengthened Resilience

The purpose of this step is to identify the vital services that you included in your scoring with existing energy resilience, but that could benefit from being strengthened. **In this step you only evaluate the scores for Public Health and Safety, Emergency Management, and Community Necessities.** You will look for services that have less backup power than seems appropriate given the growing risks of extreme weather events and power outages. Reflecting on local knowledge about your community's history of past outages and emergency events can give you insight into how often longer outages occur, what problems were created, and how long of an outage you might want to prepare for. Add to that the changing risks for your community that are expected in the future.

In addition, look for members of your community who might be particularly affected or harmed when the backup power for a vital service is no longer available. Threats to their life, health, safety, or critical basic needs are red flags that the energy resilience should be improved.

1. Look at the color-coded resilience ratings on the "Part 3. Vulnerability Analysis" worksheet. Identify any that are marked as 1 or 2. Review the interpretation of these ratings.
2. Which of the vital services rated as 1 (1-3 days of backup power) could benefit from a longer backup period? When backup power for the service runs out, who in the community could have their life, health, safety, or critical basic needs threatened?
3. Which of the vital services rated as 2 (4-7 days of backup power) could benefit from a longer backup period? When backup power for the service runs out, who in the community could have their life, health, safety, or critical basic needs threatened?
4. Which of the vital services that you identified are priorities for strengthened resilience?

5. To strengthen an existing energy resilience, your community can:
 - a. Add to the length of its existing backup power capability.
 - b. Create or strengthen power outage plans and coordination for the time when backup power is no longer available.
 - c. Find ways to partner with outside organizations or places to provide the service at the time backup power is no longer available (assuming they are not also affected by it).
 - d. Redesign the services so that they can still be provided, but with less energy (thus requiring less backup power and/or making backup power last longer).
 - e. Explore alternative ways to provide the services that use existing backup energy somewhere else in the community or in a manner that doesn't require electricity or a fuel.
 - f. Improve individual power outage awareness and preparedness. This empowers community members to create household resilience that can offset at least some community-wide vulnerabilities.

This vulnerability analysis does not have you review vital services that are already highly energy resilience (these are rated as a 3 or 4). You can certainly do that. Simply follow the same steps as above. However, it's likely that your community's priorities will be on services with less resilience.

Step 4. Interdependent Vital Services or Energy Systems

The purpose of this step is to identify vital services that have connected (or interdependent) resilience and vulnerability. This reflects the general idea that “a chain is only as strong as its weakest link.” In Step 4 you will identify the connected links and look for potential weaknesses. You won't be working with the resilience scores. Instead, you will look for connections between the services: which ones depend on another, and how does a power outage affect this? **You will reflect on all the vital services in your community for this step.**

1. Briefly review all the vital services for the four impact areas on the “Part 3. Vulnerability Analysis” worksheet.

2. Below are examples of interdependent energy systems and outage vulnerabilities that are commonly found in communities:
- Public transportation that depends on a fuel to operate. Taxicab, Uber, and Lyft drivers need gasoline for their vehicles. If gas stations can't operate during an outage (gas pumps need electricity), these public transportation services probably won't be available after a very short period.
 - Public busses that depend on a fuel to operate. Most public transportation systems have a fuel depot/reserve. But the depot will need backup electrical power to operate the pumps. In addition, once the reserve fuel is used up, the depot will need to be refueled. A public transit system can operate only if (and as long as) stored fuel can be pumped and distributors can resupply the fuel. The backup power capabilities and fuel availability for local distributors are also connected to public transit as a vital service.
 - Public transportation requires clear roads. If a weather event creates road obstructions, then debris clearing (a vital service) is also required.
 - Most backup power is provided by generators running on diesel, LP gas, or natural gas. Any backup generator that relies on diesel or another fuel has the same fuel interdependence and constraints as public transportation and transit.
 - Basically, any vital service that uses a fuel has the same interdependence problem as generators and transportation systems. Examples include the equipment and machinery used for debris clearing or search and rescue operations.
 - Public communication and alert systems (like radio, social media, or text messaging) often have backup power. However, for these systems to be effective, people must also have a way of recharging their phones, tablets, and computers (or powering a radio) to receive these messages. After a day, many devices will be out of power.
 - The ability to support vulnerable households that are dependent on durable electric medical equipment requires an ability to charge equipment batteries or a place to relocate with electric power.

- An emergency community shelter that supports vulnerable households will likely run on a generator, with the limitations described above.
3. Look over your vital services after thinking about the above examples. What kinds of interdependencies exist in your community? Where are the vulnerabilities? What would you like to fix or improve?
 4. To strengthen the energy resilience of vital services that are interdependent, your community can:
 - a. Create or add backup power for fuel pumps and communication systems.
 - b. Expand fuel storage capacities.
 - c. Strengthen contracts and outage coordination with fuel distributors.
 - d. Create a community “hub” (with electric power during an outage) that provides access to the Internet and charging for personal devices.
 - e. Invest in a mobile charging station that can move around the community and charge personal devices and medical equipment (as an example).
 - f. Establish a community “resilience hub” (with energy during an outage) that might provide multiple services, such as emergency shelter, distribution of necessities, access to the Internet, and a source of electricity for charging devices or operating medical equipment.

Step 5. Support of Vulnerable Households

The purpose of this step is to evaluate how well your community can protect households that are especially vulnerable during a power outage. The vital community services in Public Health and Safety, Emergency Management, and Community Services are provided and intended to benefit the entire community. However, communities also provide social services to support the most vulnerable of its members. This support enhances community energy resilience; these are public services that are provided to meet specific needs rather than service the community as a whole. **In this step you will only evaluate the scores for the Support of Vulnerable Households impact area.**

1. Look at the color-coded resilience ratings on the “Part 3. Vulnerability Analysis” worksheet. Review the interpretation of these scores.
2. Identify which of these household vulnerabilities are not relevant to your

community. For example, cities don't usually have homes on well water. Some towns may not have many (or any) community members with limited English abilities. Your community may be in a climate without extreme heat or extreme cold. You can cross out any that are not relevant and exclude them from your vulnerability analysis.

3. Review the remaining household vulnerabilities. Which vulnerabilities are not supported at all (rated 0)? Which ones does your community have limited experience with (rated 1 or 2)?
4. For the household vulnerabilities rated as 0, 1, or 2, which ones represent threats to life, health, safety, or critical basic needs?
5. Which of these household vulnerabilities are your priorities for strengthening energy resilience?
6. Improving your community's support of vulnerable households often requires complex coordination between public and private partners. You can:
 - a. Create ways to identify homes dependent on durable electric medical equipment. This is often done through a voluntary registry managed by the electric utility, fire department, or police department.
 - b. Create ways for households dependent on home health caregivers to self-identify and be supported by wellness checks. This can be done (for example) through partnerships between social service organizations, agencies on aging, faith-based organizations, and private home health caregiver companies.
 - c. Establish warming or cooling centers that are available when there is no power outage; this strengthens community energy resilience even when electricity is available by protecting vulnerable households and the homeless.
 - d. Establish emergency shelters (with power) for outages that occur in the winter and during periods of extreme heat.

Our scoring tool does not include other residential settings like health care facilities (such as nursing homes or rehab centers), prisons, detention centers, and boarding schools. People living in these places are critically vulnerable during power outages. However, backup power for these facilities can be (but

isn't always) regulated by the federal and state governments. It is consequently difficult to include them in the scoring tool and vulnerability assessment. If one of these facilities is located in your community, you might want to explore what their capabilities are for power outages of different lengths of time.

Opportunities for Backup Power and More Resilient Public Transportation

There are several common approaches to providing backup electrical power, each with advantages and limitations. In addition, some simple measures could improve the energy resilience of public transportation systems or vehicles used by a community's facilities management.

The most widely used option is the **conventional electric generator**. Generators are typically powered by diesel, gasoline, propane, or natural gas. These generators are well understood, relatively inexpensive upfront (depending on their size), and able to deliver high power output. Their main limitation is fuel dependence. Generators can only operate as long as fuel deliveries continue or on-site fuel supplies last. During widespread or extended outages, refueling may become difficult.

Another option is **battery energy storage systems**. Many battery storage systems can be integrated into a building and are charged by the power grid. These systems release electricity when there is an outage. Batteries are quiet, produce no on-site emissions, and can respond instantly to power interruptions. They are especially useful for short- to medium-duration outages or for maintaining uninterrupted power to sensitive equipment. Newer, large building-integrated storage can potentially last 1-2 days. However, once used up, batteries must be recharged, which usually requires grid power or another electricity source.

A third approach combines **renewable energy systems with energy storage**, most commonly solar photovoltaic (PV) panels paired with batteries. These systems can be permanently installed on buildings or deployed as portable generating units for temporary or mobile applications. During daylight hours, solar panels can recharge batteries while simultaneously supplying power, extending the duration of backup electricity without the need for fuel. Renewable systems are particularly attractive for outages that last days or weeks, for remote locations, or situations where fuel access is uncertain. Their performance depends on available sunlight and the amount of battery capacity.

Two planning considerations apply to all backup electric power options. First, you

need to decide how long you want the backup power to operate—hours, days, or weeks. This represents how much energy resilience you want. Short outages may be easily served by batteries alone, but longer outages will require fuel-based generators or renewable systems that can replenish stored energy. Second, backup systems must be properly sized. The power capacity (kilowatts) must be big enough to run critical equipment, and the energy capacity (kilowatt-hours) must match the total electricity demand for the desired backup period.

Transportation vehicles are a special challenge during a power outage because of potential refueling limitations. There are measures that can help, however. The lowest hanging fruit is to ensure that all vehicles are topped off daily or as often is practical. This applies to vehicles that are fuel-powered as well as electric or hybrid vehicles. Maintaining a modest fuel reserve that can be used in an emergency for compact cars, four-wheelers, motorcycles, etc. could be helpful, especially if roadways were compromised. Backup generators can be used to charge an electric or plug-in hybrid vehicle but are still limited by the available supply of fuel. Some newer-model hybrid pickup trucks are equipped with onboard power supplies that have a “reverse charging” capability; they can generate as much as 7 kW of electricity or higher for hours and sometimes days depending on the electrical load. Selectively upgrading pickup trucks to such a hybrid model can provide emergency charging for a number of critical devices.

Where to Get Ideas for Community Energy Resilience

The best way to get ideas for how to provide energy during power outages is to do basic Internet research. Googling warming centers, cooling centers, resilience hubs, and mobile charging stations will provide lots of information. There are also a number of case studies and reports that can be found by searching for “power outages and durable medical equipment.” Interesting cases and ideas will emerge from simple Internet searches like “power outages backup for grocery stores” (or fire departments, police stations, animal shelters, banks, gas stations, stores, etc.). If you want to narrow in on renewable energy options, just add that to your keyword string. An example is “power outages renewable energy for grocery stores.” If you are willing to use AI tools, write a specific prompt about what you want to know and ask the AI to provide links to credible sources.

Networking with emergency managers and sustainability planners will also give you lots of ideas. Almost all counties and cities in the US have a designated emergency manager that is also plugged into a statewide (or national) network. Many areas also have sustainability planners in city or county government or a regional planning organization.



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