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# POWER RESILIENCE

## Guide for Water and Wastewater Utilities

EPA
epa.gov/waterresilience

# Overview

This guide includes information from water industry professionals on how to increase power resilience at drinking water and wastewater utilities. The purpose of this guide is to:

- Promote coordination and communication between water sector utilities and their electric and gas utilities
- Provide information on how to build power resilience using generators, fuel supply planning, on-site power, microgrids and other methods
- Highlight case studies from water utilities that have successfully implemented power resilience measures
- Identify planning considerations and resources for both short (e.g., 2-3 days) and long (e.g., several weeks) duration power outages


Power loss can have devastating impacts on drinking water and wastewater utilities and the communities they serve. Inoperable pumps at a drinking water utility can make firefighting difficult and cause local health care facilities and restaurants to close. Pressure loss can allow contaminants to enter the drinking water distribution system from surrounding soil and groundwater. For wastewater utilities, pump failure may lead to direct discharge of untreated sewage to rivers and streams or sewage backup into homes and businesses. Power loss can also impact water utilities through cascading infrastructure failures. For example, a chemical plant without power could discharge contaminants into source water supplies.

# Eight areas in which water sector utilities can increase power resilience are:

1. **Communication** – Establish capability to communicate with electric providers, local agencies and the public to help your utility respond more quickly and efficiently to a power loss.
2. **Power Assessments** – Conduct a power assessment to understand your essential equipment energy needs.
3. **Emergency/Standby Generators** – Learn how to select, maintain and register requirements for a fixed or portable emergency generator for your utility.
4. **Fuel** – Develop plans to ensure you have enough fuel for your generator during a power outage emergency.
5. **Energy Efficiency** – Increase your energy efficiency to allow you to operate on back-up power longer during emergencies and to reduce your electricity bills during normal operations.
6. **On-site Power** – Consider options for generating your own power.
7. **Black Sky Planning** – Prepare for long-duration, widespread power outages.
8. **Funding** – Learn about possible funding sources for resilience measures.

# 1. Communication

## TOP TIP: Get your utility on the priority list for power restoration.

Good relationships, information sharing and collaboration between water and electric utilities and local emergency management agencies (e.g., county, parish or city) are critical to having power restored quickly after an outage. Depending on the nature of the emergency and your local communication and response procedures, you may call your electric utility directly or you may need to coordinate through an emergency management agency (EMA). For more information on working with your EMA, see the EPA's Connecting Water Utilities and Emergency Management Agencies.

Becoming familiar with your county's emergency protocols and how response and recovery decisions are made, can help ensure that your utility is high on the power restoration prioritization list. Depending on your county's emergency protocols, the order in which power is restored to local critical infrastructure, such as your water utility, may be determined by your electric power provider, the local EMA or elected officials such as county commissioners. Communicate your emergency power needs and the consequences to the community should you have to cease operations due to a power failure. This should include details regarding "minimum" power requirements for essential functions only and any existing capabilities for back-up power and corresponding fuel requirements. Be sure you know who makes the power restoration prioritization list for your community and take steps to share relevant information with them. You should also become aware of and involved in the total community restoration plan. Your assistance may be needed to locate, prioritize and restore parts of the drinking water distribution system and wastewater collection system that serve critical infrastructure, such as mass care shelters.

### *Did you know?*

*When an electric utility is restoring service after a major outage, it generally prioritizes generating plants, transmission lines, substations, main circuits, critical customers, residential lines, transformers and then individual houses.*

# Step 1 – Make Contacts and Establish Emergency Communications Protocol

- Get to know the key staff or points of contact at your electric utility responsible for power restoration prioritization. You may find that you have a dedicated account representative who fulfills this role for your utility. If this is not the case, find that person who prioritizes your restoration. When possible, have face-to-face meetings.
- Ask for 24/7 emergency contact information for the electric utility, the local EMA and the local Emergency Operations Center (EOC) and save these numbers in your phone.
- Establish or verify, as applicable, the proper structure for the most efficient communications for power prioritization and restoration. Make sure that this structure is National Incident Management System (NIMS) compliant.
- Ensure that your community's emergency manager has your contact information in his or her cell phone so that when you call, your name will be recognized.

### *Did you know?*

*Many agencies and organizations share information and resources to support incident management activities at Emergency Operations Centers (EOCs). EOCs focus on the response to and the short-term recovery from an incident or natural disaster and provide access for cross-sector key personnel.*

# Step 2 - Request Key Information

- **Physical locations of critical assets.** Make sure your electric utility has the physical locations (Global Positioning System (GPS) latitude and longitude in degrees-minutes-seconds or in decimal degrees of the location) of all critical components of your water or wastewater system, as the physical address of your facilities can differ from your administrative address where bills are delivered. Give the physical address when reporting an outage. Also, request a review of the corresponding electric grid infrastructure that supports your critical assets. Depending on how your system is laid out, there may be different distribution feeders or substations for the treatment facility and individual pumping stations. Assess risks associated with the current electric power plan.

- **Critical Interdependencies.** You should also maintain situational awareness of activated, deactivated and non-activated mass care facilities, 911 centers, and other critical infrastructure locations. There may be a need to coordinate the restoration of electric power, water service and wastewater services to these assets.

- **Communication Resources.** Learn what communication resources, such as two-way radios or satellite phones, are available in your community. Be sure your radios are compatible with your response partners (e.g., P25 Standard). During a long-duration power outage, landlines and cellular phones may stop working. Conduct periodic tests with partners to ensure communications interoperability. Make sure you understand the procedures and processes for communicating with your electric utility during an outage and during the recovery process.

- **EOC street address.** Know where your local EOC is so that you can send a liaison there during an emergency if needed.

- **Mutual Aid Agreements.** Share information about your membership in mutual aid agreements such as your state's Water and Wastewater Agency Response Network (WARN).

- **Access.** Discuss what identification requirements or procedures are necessary to ensure that utility staff can access critical assets during an emergency when there are road closures and security checkpoints.

### *Did you know?*

*Most EOCs have representatives from the electric utility, gas utility, transportation sector and other critical infrastructure sectors. During a disaster, call the EOC if you have trouble contacting your electric utility. Better yet, obtain a seat for your utility at the EOC and you will be able to directly coordinate with the electric utility, fuel and transportation representatives.*

### Amateur Radio Emergency Service

*The Prince William County Service Authority has a great relationship with two local amateur radio clubs. Both clubs have their primary repeater sites on Service Authority property, including antennas on top of water towers. The Service Authority, county and radio clubs are working to establish alternative communications paths between the Service Authority Department Operations Center (DOC), the Prince William County Emergency Operations Center (EOC) and the Service Authority's Advanced Water Reclamation Facility. In November 2018, the Service Authority and the Prince William County Amateur Radio Emergency Service (PWCARES) entered into a Memorandum of Understanding (MOU) for emergency cooperation. During a widespread power outage when land lines and cellular phones may no longer work, amateur radio operators can provide vital communication services to the Service Authority.*

# Step 3 – Get on the Priority Power Restoration List

- Learn how critical customers are managed and prioritized in your community.
- Engage the power restoration prioritization list manager.
- Determine your utility's prioritization status and take additional measures to get as high on the priority list as possible.
- Inform the prioritization list manager of your "storm-ready" capabilities and be sure that he or she understands the consequences to the community of drinking water and wastewater service disruptions and reduced service levels. Ensure the list manager understands how quickly water services can degrade without power and how long it takes to restore water services once power is lost.
- Inform the list manager of the critical assets at your utility that rely on grid power including their individual power requirements (e.g., critical functions vs. administration building).
- Gain an understanding of the other critical infrastructure facilities prioritized in the community so that you can align water and wastewater support accordingly.
- Ask for annual updates to the critical customer and prioritization lists.

### Critical Customers

*Dominion Energy has worked closely with Virginia Emergency Operation Centers (EOCs) to identify the 10-20 most critical services in each of the EOC's jurisdictions. Once identified, these critical facilities are further assigned Special Condition Categories, and water and sewage treatment facilities are considered "Critical Infrastructure." These "Special Conditions" accounts are flagged so Dominion knows instantly when a water or wastewater treatment facility loses power. An intranet application allows Dominion Energy to remain focused on these locations to ensure critical infrastructure accounts receive the highest restoration priority.*

*In addition, during large-scale power outages, Dominion Energy establishes Electric Regional Operations Centers to better manage its response. Water utilities have a direct line to these centers and to representatives of Dominion Energy.*

# Step 4 – Planning, Training and Exercises

Planning, training and exercises allow power and water utility staff to learn, practice, test and improve emergency response plans (ERPs) and procedures. Often, these plans and procedures involve response partners. Consider the following options to enhance the quality of your training and exercises:

- Plan with your electric utility to know how various power outage scenarios will affect your utility and what steps you can take together to mitigate impacts.
- If your utility conducts planning activities or annual exercises, invite staff from your electric utility and local EMA.

o The EPA offers a Tabletop Exercise Tool for Water Systems to help utilities develop exercises for different scenarios.

o The EPA has also developed How to Develop a Multi-Year Training and Exercise (T&E) Plan to help water utilities create successful training plans.

- Ask your electric utility to allow you to attend any exercises or planning activities it hosts.
- Participate in national exercises focused on grid resilience such as GRIDEX and EARTH EX.
- Ask your local EMA to include both your utility and the electric utility in its exercises.
- Share your emergency response plans with your electric utility and EMA and ask for information and updates on their plans. Consider a dedicated planning component to emergency back-up power (generators).

***Grid hardening** - Activities such as tree-trimming help prevent weather related power outages. When talking to your electric utility, you can ask what grid hardening steps are being taken and what you can do to help. For example, do you have the resources to assist in tree-trimming? If your water utility has a remote pump station in the woods serviced by electric power from street lines, consider installing that service line underground along the access road. Although this is more expensive than typical pole installation, the service line will be better protected from tree falls.*

# Step 5 – Communicating with the Public

Develop a plan for how you will communicate boil water notices, water use restrictions and other information during a power outage. Many of the strategies below will only work during the first 24-48 hours of a power outage when cellular towers still have back up or battery power. Consider approaches for reaching the public that would work even if landlines, cellular phones and the Internet are not working

- Appoint a communications manager or Public Information Officer who can assist in getting the correct messages out to your customers before, during and after emergencies.
- Contact local news and radio stations to broadcast your messages or post on their social media accounts.
- Ask the fire department, local EMA and municipal office to help with your public messages. They may already have emergency communication systems such as reverse 911 in place. Check whether such systems would work for an extended period of time without power furnished by the electric grid.
- Develop an automated system to send emails and text messages to customers. Some areas may already have an emergency texting service that you can use.
- Post frequent, time-stamped updates on your utility's website.
- Utilize social media by posting updated information with a Facebook or Twitter account.
- Collaborate with homeowners' associations to post signs near different community gates and on community bulletin boards at the Town or City Hall.
- Train communications personnel in Crisis and Emergency Risk Communications (CERC) and Message Mapping for timely, accurate and productive crisis communications. The EPA offers numerous tools for Water Utility Communication During Emergency Response.

***Eye on the Weather*** - *Weather services can usually forecast storms 24 hours or more ahead of time. The EPA's mobile app Water Utility Response On-the-Go allows you to monitor and track all types of weather. For ice storms, you can also check the Sperry-Piltz Ice Accumulation Index (SPIA IndexTM), which gives a 0-5 ice accumulation and ice damage prediction index. The SPIA IndexTM covers the continental United States and provides predictions days before a storm, including power outage duration possibilities. In California, the Public Safety Power Shutdown (PSPS) is an operational practice of shutting off the power to a limited area during extreme and potentially dangerous weather conditions based on several factors such as red flag warnings, humidity levels and high wind conditions. Check to see if you have something similar in your state and ensure your utility is closely coordinated with the agency issuing the PSPS.*

# 2. Power Assessments

**TOP TIP: Register your power assessment needs into the U.S. Army Corps of Engineers (USACE) Emergency Power Facility Assessment Tool (EPFAT) database.**

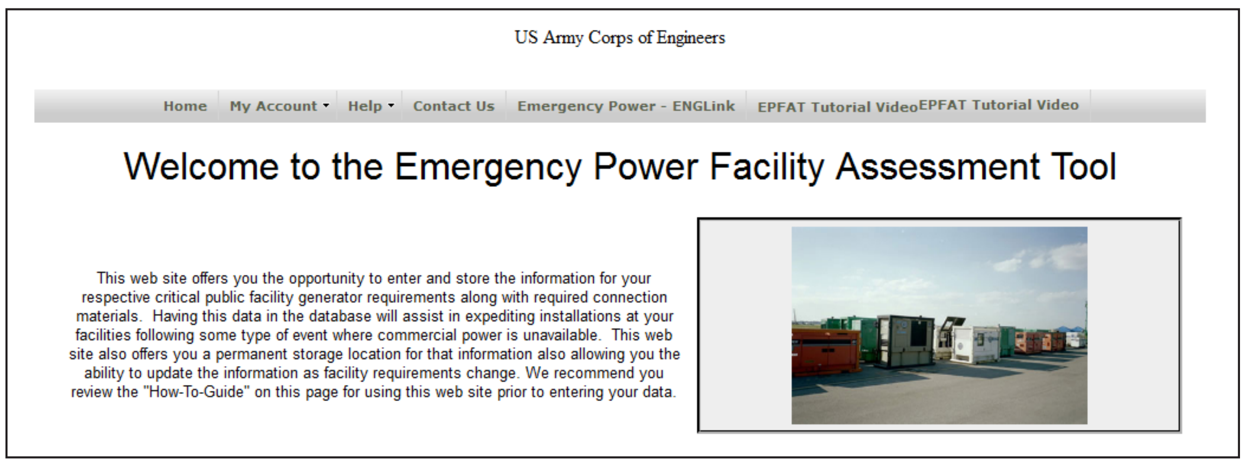
Power assessments determine your utility's emergency power requirements for critical equipment to maintain water and wastewater services. A power assessment team typically includes electrical, mechanical and operational subject matter experts. These are the appropriate utility professionals who can fully assess utilities' power needs and operational implementation requirements. They will inspect all infrastructure assets at your utility. You will determine electrical assets critical to your operation. Critical infrastructure components will be unique at each utility, but usually include treatment processes and key pumping stations. This information is required to properly size an emergency generator(s), and a reference to its location should be included in your ERP. You can learn more about power assessments and generators in the free, 2-hour online course, IS-815: ABCs of Temporary Emergency Power, offered by the Federal Emergency Management Agency (FEMA) Emergency Management Institute.

# Step 1. – Conduct an Emergency Power Assessment at Your Utility

- Conduct a Self-Assessment – Perform your own emergency power assessment, with the assistance of a qualified power assessment team.
- Consider Calling Prime Power – The USACE 249th Engineer Battalion may be able to provide free electric power assessments for utilities. They can be reached at 800-243-3472 or 703-805-2562.
- When you upgrade your facilities or build new components, re-assess your power requirements to determine if you also need to add generator capacity, battery banks or on-site renewable energy.
- Periodically review and update your emergency power requirements, especially when replacing assets and remodeling buildings.
- Consider installing stationary generators with automatic transfer switches at all “critical” facilities to ensure they will stay in operation should the power go out.
- If possible, conduct a hydraulic model-based assessment of how performance measures would be impacted when your facility is powered by generators instead of the electric grid, and how failures of one or more generators would affect performance.

# Step 2. – Keep Records of Your Assessment

- Maintain a copy of all information from the power assessment with your ERP, so you can easily locate it during emergencies. You should have a summary of the power requirements, siting requirements, location and capacity of any existing on-site generators at all critical infrastructure components.
- Generator-specific information requirements include the kilowatt, voltage and phase of the generator required. The assessment should also include the electrical connection type, either delta or wye.
- Appendix A is an example of a Generator Information Sheet* that a utility could use for each of its generators.
- The assessment should include the GPS latitude and longitude in degrees-minutes-seconds or in decimal degrees of the location of any existing or needed generators. If possible, record any decimal degree GPS data values to the sixth place to the right of the decimal point.
- The assessment should also include a basic order of materials with information on the number and length of cables needed to connect a generator to the utility's electrical system, the number and size of lugs to connect the cable runs, and the number and designed location of grounding rods required.
- Input your generator information in the USACE EPFAT database. States and FEMA use this database during widespread power outages to quickly determine where and what kind of generators may be needed. When possible, use GPS to identify the location of any existing generators. Enrollment in EPFAT is free.
- Keep your power assessment information up to date. The EPFAT database will remind you every three years to review your data.




** Clicking this link will open a MS Word document you can modify and/or complete.*

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# 3. Generators

**TOP TIP: Know what type of generators you need and where you would get them during a power outage.**

## Choosing a Generator

Once you know your generator requirements, you need to make several decisions to find the best one for your utility. A generator is classified by its power rating. Two distinct power ratings are prime power and emergency standby. The average load factor for both types is 80 percent. The table below compares some general characteristics of the two types of generators.

| | Prime Power | Emergency Standby |
|---|---|---|
| **Length of use** | Rated for extended periods of operation at variable loads | Designed for short-term use; typically rated to operate no more than 200 hours per year |
| **Impact of operating longer than prescribed hours** | N/A | More frequent breakdowns and malfunctioning |
| **Cost** | More expensive because they are designed to meet operational loads for an extended period of time | Less expensive |

## Regulations

As you compare generator options, check local, state and federal regulations on generators, fuel storage and use and maximum permissible testing. In most cases, a local or state air permit is needed to install and operate a stationary generator. There are also federal regulations for stationary reciprocating internal combustion engines (RICE). Most states implement the federal air quality program and states can also impose additional requirements. The specific requirements depend on your jurisdiction, as well as the age, type and size of the generator. The regulatory requirements also depend on the type of fuel. Compression Ignition (CI) RICE run on diesel fuel while Spark Ignition (SI) RICE use natural gas, propane and gasoline.

# Step 1 – What Size Generator Do I Need?

The first step in choosing a generator for your utility is to determine the right size. Your power assessment can help you size your generator(s). The key components of a generator are: Voltage, Load, Phase and Rotation.

1. **Voltage** - The generator must have the appropriate voltage to match the motor(s) it will be powering.
2. **Load** - You need to know the Full Load Amps (FLA) of all the motor(s) you intend to run off the generator. This is the amount of current (amps) the motors will draw from the generator when producing their rated output horsepower. If running more than one motor you need to know the startup (inrush power) in kW's needed to start multiple motors. There are formulas for calculating this value.
3. **Phase (Rotation)** – Phase is a requirement for a single or multiphase generator based on what the generator will be powering. The direction of the motor rotation (i.e., clockwise or counterclockwise) determines the order of voltage waveform sequences, or the phase rotation. If incorrect, it could damage the pump(s) at startup.

In addition to knowing your equipment's electricity requirements, consider the following when sizing your generator:

- If you are relying on a single, large generator (e.g., greater than 500 kW), consider installing two smaller generators in parallel instead to increase backup power reliability. It is unlikely that both of the smaller generators will fail at the same time. While you would not be able to power everything if one failed, you could still maintain part of the load.
- There are limited generators that produce 2 MW or more. Segmenting your load (e.g., pumps) so that smaller generators used in combination can meet the demand will increase your chances of locating and receiving generators during an emergency and thus increase resilience.
- Determine whether a portable or stationary generator will work best for your critical infrastructure assets. Portable generators are better for smaller electric demands that do not require uninterrupted power. These generators can also be transported to multiple sites.
- If your electric demands are significant, consider larger, stationary generators fueled by either natural gas or diesel. These generators can start-up within 7 to 10 seconds of a power outage and provide power to critical equipment quickly.
- Supplement your planning with hydraulic modeling across multiple 'what if' scenarios to determine the service consequences of reduced power support and to explore the potential benefits of portable generators and 'rolling blackouts' of specific components.

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# Step 2 – Should I Buy, Rent or Borrow a Generator?

- Your state's Water and Wastewater Agency Response Network (WARN) can make it easier to borrow a generator and other resources during a regional emergency. If you are not a member, consider joining.
- Know what "type" of generator you may need and can receive from WARN partners. AWWA's Resource Typing Manual provides information on resource typing.
- Investigate how your state water sector associations and local emergency management agencies can help. In Florida, both the Florida Rural Water Association and the Florida Division of Emergency Management maintain generator pools for distribution as needed. A good working relationship with your local emergency manager will be critical to receiving a state or federal generator.
- Many private vendors sell or rent generators. If you plan to rent a generator, set up a contract with a vendor. Since many people may need to rent generators during a power outage, know where you stand in terms of priority with your generator vendor.
- Another option is to rent and store a portable generator during storm season.
- Appendix B is an example of a Generator Request Form*.

| Generator | Pros | Cons |
|---|---|---|
| On-site (purchased) | • You know you have one<br>• Reduced time to respond | • Could be costly and unaffordable<br>• You perform the maintenance<br>• The disaster that strikes your utility could also damage your generator |
| Off-site (rented or borrowed) | • Multiple sources to get one – EOC, WARN, vendor, FEMA<br>• Someone else performs the maintenance<br>• Costs less than buying | • Travel delays to get it to your site<br>• Your utility might not be high on the priority list to get a generator |

** Clicking this link will open a MS Word document you can modify and/or complete.*

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# Step 3 – What Type of Fuel Should I Use to Run my Generator?

In addition to portability, fuel type is an important consideration for selecting a generator.

- Diesel generators are the most common and offer the largest selection, availability and power range.
- Smaller water utilities with lower power requirements and fewer resources might consider portable, gasoline powered generators.
- Smaller water utilities can rotate several portable, gasoline generators between lift and pump stations as necessary. This method (rolling blackout) allows a utility to have backup power without buying a dedicated generator for each site.
- You could also consider bi-fuel generators to increase your fuel options during an emergency. These generators can switch between two different fuel types, such as natural gas and diesel. Usually this choice is automated and dictated by what fuel type is more efficient for the given conditions and needs, but the choice can also be made manually based on what fuel type is available. For example, if natural gas lines are broken or shut off during a disaster, diesel can be used.
- Natural gas generators do not require truck refueling and usually run quieter and with less air emissions than diesel generators. However, natural gas generators tend to produce less power than diesel generators and therefore your utility may require a larger natural gas generator to power the same load as a smaller diesel generator. You should also consider that the incident may affect natural gas delivery and prepare a contingency plan for such situation. For example, an earthquake could cause breaks in natural gas pipes, which would shut off supply to affected areas.

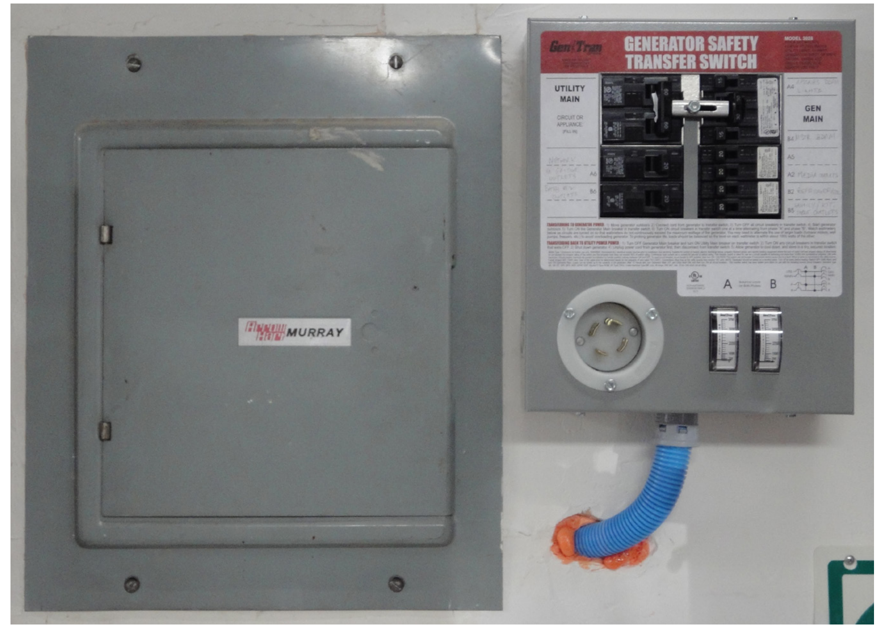
***Starting Currents and Generator Sizing -*** *Cross-line starts (as opposed to soft starts) of equipment require higher starting currents and therefore a larger generator. High and premium-efficiency motors also require higher starting currents and therefore a larger generator to handle the startup current draw.*

***Useful Tip:***
*If using multiple generators, try to select generators from the same manufacturer to make servicing the units easier.*

# Step 3 – What Type of Fuel Should I Use to Run my Generator?

| Fuel Type | Pros | Cons |
|---|---|---|
| Diesel | • Powers large generators<br>• Lasts longer than gasoline<br>• Readily available<br>• Safer to handle and store | • Requires deliveries<br>• Requires on-site storage<br>• Risk of spills<br>• Environmental restrictions<br>• Limited storage life |
| Natural Gas | • Does not require truck delivery<br>• Does not require on-site storage<br>• Does not expire<br>• Supply is relatively inexhaustible | • Generator cost may be more expensive<br>• If natural gas service is interrupted, there are limited back-up options<br>• Risk of explosion |
| Propane | • Does not expire<br>• Easily available in rural areas | • Requires deliveries<br>• Requires on-site storage<br>• Limitation of generator size<br>• Leased storage tanks limit fuel provider choice<br>• Risk of explosion |
| Gasoline | • Powers smaller, portable generators<br>• Readily available | • Typical shelf life is 2-3 months or less if stored in the equipment<br>• Requires deliveries<br>• Requires on-site storage<br>• Risk of spills<br>• Worst storage life of all options<br>• Size limitations<br>• Risk of explosions |

# Step 4 – How Will I Connect a Generator to my Loads?

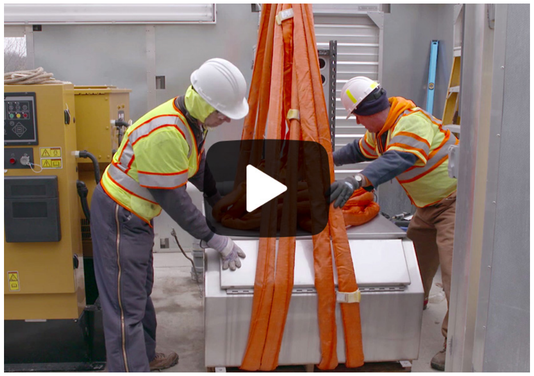



Generators require a special connection, or transfer switch, to rapidly connect to your facility's equipment and prevent potentially-harmful back-feeding into electric lines. Transfer switches allow you to easily switch back and forth between grid power and on-site generator power sources. See the additional tips below on installing transfer switches.

- Clearly depict the location of the transfer switch on site maps.
- Install transfer switches at eye level to make generators easier to connect in an emergency under poor weather and lighting conditions.
- Consider installing automatic transfer switches that automatically move from grid power to generator power when an outage is detected at unmanned facilities or at critical equipment.
- Consider connecting these sites into the utility SCADA system to know when the automatic transfer switch has been activated.
- Consider installing a manual transfer switch for facilities or other pieces of equipment that do not need to be automatically transferred to an alternate power source during a power outage. The likely dispatch time for an operator to access the site should be considered in the determination of a manual versus automatic transfer switch.
- Ensure that personnel responsible for manual transfers receive appropriate training on switch operations.
- The connection type for portable generators must be considered when sharing resources or ordering from an outside vendor. Examples of some known plug types are Appleton, single cable cam-locks, hardwired and outside building tap-box.

# Step 5 – Where Will I Keep a Generator?

Make sure you keep your generator at a secure location. Some tips include:



*Video: Generator Placement*

- Locate generators and their fuel tanks above flood levels. A common height requirement for critical infrastructure is 3 feet above the 100-year floodplain, although some utilities are using the 500-year floodplain for an added margin of safety. Check your local and state requirements.
- Consider installing a concrete pad to provide a stable surface for a portable generator during an outage.
- Use weatherproof enclosures to protect generators and electric equipment.
- Get an enclosure large enough to provide easy access to the generator's radiator, fuel tanks, air and oil filters and charging system.
- Cover a generator with a roof to increase its life expectancy. Position the generator pad so that a roof can be added later.
- Maintain three or four feet of clear space on all sides of the generator for adequate ventilation.
- Buy or rent a generator built with acoustical steel and sound insulation if it will be in a residential area.
- Address security at all planned mobile generator locations.
- For portable generators, consider where you will store them and how you will transport them to their potential areas of use.

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### *Case Study:*

*In southern Monmouth County, New Jersey, a wastewater pumping station was redesigned to utilize a mobile trailer to house the pumping station's expensive primary electric equipment and controls. This way, the trailer can be moved out of danger during floods. Cables and plugs provide the connection between the pump station and the electric and control equipment in the trailer. When a storm threatens, the utility removes the trailer and mounts a cheaper secondary electric and control system at the site. The secondary system then powers and operates the pump station on either grid or generator power until after the storm, when the trailer can be safely returned to the pumping station. A mobile enclosure may seem costly, but it saved the South Monmouth Regional Sewerage Authority an estimated $1.5 million in repair and recovery after Hurricanes Irene and Sandy.*

# Step 6 – How Should I Maintain a Generator?

If generators are not maintained, they will not function properly during emergencies. This could leave your utility without backup power when you need it the most. Maintenance requirements for generators vary, so be sure to have a contractor or trained utility staff perform scheduled maintenance as recommended by the manufacturer. Store printed maintenance manuals where they are protected and accessible.

## Generator Operation and Maintenance Tips

- Regularly run generators under full load for extended periods to test for any problems.
- Test the generator under load every time after it is serviced. One utility has specific requirements for load tests for a specific run time at each interval of 50%, 75% and 100% to fully test under expected loads for a proper time duration.
- Perform additional maintenance requirements for a generator that is planned to be used for 10 days or longer.
- Record all maintenance activities to assess performance and operating costs to inform predictive maintenance requirements and future buying decisions.
- When you change the oil in your generator, consider sending a sample to be tested for the presence of metals. Metals could indicate engine wear, which may indicate that other repairs are needed.
- Test fuel to make sure it is still viable. Consider fuel conditioning or fuel replacement on a regular basis to maintain the quality of the fuel in the tank.
- Consider service requirements when selecting the generator location for ease of service access and replacement.
- Consider National Fire Prevention Association (NFPA) 110 requirements.

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# Step 6 – How Should I Maintain a Generator?

## Generator Servicing Requirements

The manufacturer provides recommendations for operational generator service requirements. The standard service interval is 240 operational hours or 10 days of continuous operations. During emergencies, scheduled maintenance should be used instead of 'condition-based' or 'predictive' maintenance. Typical items serviced at this interval include:

- Change diesel engine oil.
- Change diesel engine oil filter(s).
- Change diesel engine fuel filter(s).
- Change diesel engine air filter(s).
- Check diesel engine coolant levels and replenish as required.
- Check items such as the fan belts for any abnormal wear or damage while the engine is turned off.

***Did you know?*** *During Hurricane Sandy, many generators failed after 24 to 48 hours because they had not been properly exercised and maintained.*

# Generator Use Tips

Your utility can take basic actions to prepare for disasters that may include power loss. Below are tips for utilities using generators in emergency situations. Keep in mind that when operating under emergency power protocols, you now have the added requirement of operating like an electric power utility: operating, providing logistics for and staffing your generators.

- ☐ Conduct a facility-specific generator needs assessment. This can significantly reduce response time during an emergency. If possible, couple this with a hydraulic modeling-based assessment of system service performance.
- ☐ Give completed assessment forms to your local EOC or emergency management agency and register the results in EPFAT.
- ☐ For large scale "notice" incidents, such as Category 3 and above hurricanes or major ice storms, go off the grid and use your generators in anticipation of a power outage. This can prevent operational disruptions and protect electric equipment.
- ☐ Monitor power quality and go off the grid and switch to generators if there is poor power quality. Power fluctuations can damage equipment.
- ☐ Consider using SCADA programming to inhibit some wells and boosters if a generator is installed. Some stations have too many motors for a portable generator to run. Running all the motors could cause the generator to kick-off due to the high load.
- ☐ Identify three-phase requirements and require monitoring capabilities and procedures. When power is restored, all three phases may not be available, which can damage three-phase equipment.
- ☐ Determine the need for protection against equipment failure caused by undervoltage, overvoltage or frequency variance.
- ☐ Keep smaller generators on trailers for emergencies. The generators can be safeguarded during the incident, but easily transported to sites when needed. Address operations, security and logistics (maintenance, fuel, parts) for mobile generators at each site.

# Generator Use Tips (continued)

- ☐ If possible, outfit portable generators with GPS to keep track of their locations when moved both inside the system, or outside (in the case of sharing a WARN resource).
- ☐ Maintain printed maintenance manuals and keep readily accessible.
- ☐ Keep basic maintenance supplies on hand (e.g., coolant, belts, oil, fuel filters) to quickly repair or service a generator if it breaks down.
- ☐ Develop an Asset Management Plan for your generators to make sure they and their resources are maintained properly.
- ☐ Plan for a "backup" to your backup power. One option is to reserve a portable generator from a rental pool during storm season and determine how you will connect it to your backup system.
- ☐ Outfit equipment connected to stationary generators with another generator cable connection to bring in an additional unit should the stationary generator fail.


*Video: Paralleling Generators*

# 4. Fuel

**TOP TIP: Have multiple ways to get and move fuel during an emergency.**

You must maintain fuel on-site and have multiple ways to obtain additional fuel from vendors and other sources during emergencies. It may be difficult or impossible to get fuel from outside sources to keep your generators operating for an extended period. Your fuel suppliers may stop their operations due to the power loss, transportation difficulties or other damage. If you lease propane fuel tanks, the supplier from whom you leased them is typically the only one who can fill them. Buying your own propane storage tanks may give you more supplier options.

*Video: Fuel*

To keep your generators running during an emergency, you should develop a fuel plan that addresses:

- How much fuel you need to operate each of your generators for one day
- Total on-site fuel capacity
- How you will re-fuel your generators, including those in remote locations
- Contracts with multiple fuel vendors
- Plans for using alternate fuel, such as for bi-fuel generators
- Multiple options to move fuel during an emergency
- Staffing the significant 'extra' operation of fuel supply
- Risks associated with conducting a resupply operation in a seriously-disrupted operational environment

***Fuel Tank Sizing -*** *You do not want to run out of fuel during a power outage. One utility manager recommends storing enough fuel to run a generator at 70% load for five days. Typically, having this amount of fuel on hand enables this utility to run a generator for seven to nine days without running out of fuel, while it transitions to a continual resupply situation.*

The rule of thumb that the USACE and 249th Engineering Battalion uses to calculate diesel fuel requirements is:

0.07 gallons/hour x kW size of the generator x 24 hours/day = gallons of fuel required per day

# Tips

- ☐ Determine fuel storage constraints (regulatory and security). Fuel regulations vary by state and local jurisdiction.
- ☐ Know and continually update your fuel demands – how much fuel do you need to run your generators for 24 hours? One week? One month? Do some generators burn through fuel faster than others?
- ☐ Write refueling requirements into generator rental contracts. For example, the generator must be delivered with a 24-hour fuel supply.
- ☐ Add fuel management into your generator maintenance schedule to ensure availability of clean, reliable fuel.
- ☐ Clean all fuel tanks at least every five years to avoid sludge build up.
- ☐ Use gel and fuel additives (e.g., algaecides) to reduce biological activity that produces fuel sludge.
- ☐ Use a portable fuel polishing unit to avoid contamination and to ensure fuel is always ready to use.
- ☐ Refill fuel tanks before they are empty to avoid drawing up any fuel sludge accumulation.
- ☐ Ask if your fuel service provider can remotely monitor your fuel tank levels and automatically dispatch a truck to fill them when they fall below an agreed upon level. This ensures your tanks are as full as possible in the event of a no-notice incident such as an earthquake.
- ☐ Have multiple vendors from different supplier regions under contract so that you can maintain your fuel supplies if one vendor cannot deliver.
- ☐ Create a map of all your fuel providers and note details such as the types of fuel they sell and their backup power options (e.g., do they have their own generator or would they need you to hookup one of your portable generators in order to pump fuel?).
- ☐ Ask your vendor to store additional fuel for your utility during storm months.
- ☐ Ask your WARN and local EOC to help provide fuel for your utility's generators during an emergency.

# Tips (continued)

- ☐ Coordinate your fuel needs with other critical infrastructure in your area (e.g., hospitals, police stations, schools), as it may be possible to have multiple deliveries from one fuel truck and realize economies of scale when establishing contracts.
- ☐ Be aware of limits on who can refuel leased fuel storage tanks. You can purchase your own tanks if necessary.
- ☐ Have fuel filters (at least one complete filter set per generator) on hand because they will not be readily available during an emergency.
- ☐ Be prepared to move your own fuel without contractors. Trucks with mounted 100-gallon fuel tanks do not need HazMat placards. Generally, any tank over 119 gallons requires hazardous materials placarding and licensing.
- ☐ Reduce your energy consumption while using generators using pre-planned protocols to make the most of the available fuel.
- ☐ Consider green power options that could supply some of your equipment during an outage and offset the need for a generator and fuel supply.
- ☐ Consider establishing a local and regional emergency fuel plan to increase the availability through emergency channels during a disaster.

## *Reducing Fuel Consumption*

*In 2012, the New Brunswick Water Utility in New Jersey was able to stay operational for an additional six days during Superstorm Sandy by reducing generator fuel consumption. Thinking creatively, the operators put the entire plant on gravity filters, shutting down the energy consumptive membrane filters. This operational change successfully reduced fuel consumption by approximately two-thirds (from 120,000 gal/day to 40,000 gal/day).*

# 5. Energy Efficiency

**TOP TIP: Install energy efficient equipment to reduce energy needs and increase power resilience.**

Energy efficiency will help your utility save on annual electric bills and increase your resilience during power outages. If you decrease your energy use, you can run your generators longer with less fuel. For more information regarding energy efficiency for water utilities, see the EPA's Ensuring A Sustainable Future: An Energy Management Guidebook for Wastewater and Water Utilities.

You can also conduct an energy assessment at your drinking water or wastewater utility using the ENERGY STAR Portfolio Manager®. Following this initial assessment, you can perform a more detailed audit to determine what energy efficiency projects would be most beneficial for your utility. Many electric power providers will conduct an energy efficiency audit to help you reduce your energy needs. Your municipal or local government may be willing to help pay for a portion of the audit's costs.

### *Electricity Savings through Efficiency*

*Stockbridge Water in Massachusetts spent nearly one-third of its budget on electric costs and decided to look for ways to increase energy efficiency. The utility was able to reduce energy use by changing all lighting to electronic ballast lighting. In addition, by changing to heat pumps (keeping the older electric heat system as a backup), the utility saved 60-65% in annual electric costs.*

***Useful Tip:*** The Database of State Incentives for Renewables & Efficiency *(DSIRE) is a comprehensive source of information on incentives and policies that support renewable energy and energy efficiency in the United States. Funded by the U.S. Department of Energy, DSIRE finds programs and resources that can help you attain your energy goals.*

# 6. On-Site Power

**TOP TIP: Generate power on-site to allow your utility to function during grid outages.**

Another option to prevent power outages at your utility is to consider installing on-site, off-grid power, known as distributed energy resources (DER). DER refers to self-sufficient, off-grid power generation, power storage and electric load control technologies that are located on-site at your utility and operated for your benefit. The opportunities and regulations for DER vary by state so check your local and state requirements. DER options include:

- **Anaerobic digestion of biomass** and waste methane can be pressurized and filtered as a low-BTU natural gas to produce electric power and heat. Over 600 wastewater facilities utilize their waste gas for energy.
- **Photovoltaic Solar panels** absorb sunlight as a source of energy to generate electricity. They can be installed in a variety of ways at water utilities including ground mount, canopy and rooftop systems.
- **Wind turbines** convert kinetic energy from wind into electrical energy and can be installed at water utilities.
- **Battery banks** are now standardized systems that store energy from the grid or from on-site renewable sources that generate power only during certain times of the day (e.g., solar, wind).
- **Fuel cells** are devices that convert the energy from either natural gas, biogas or hydrogen into electricity through a chemical reaction.
- **Traditional internal combustion engines** are engines that burn fuel to produce power, such as generators.
- **Combined Heat and Power (CHP)** is the simultaneous generation of electricity and heat from a source such as biogas, natural gas or comingled gas. CHP can be 75% efficient. There is significant opportunity for CHP technology at wastewater treatment plants with anaerobic digesters, which produce biogas as a waste product. Benefits of CHP at a wastewater utility include energy cost savings, government and utility incentives, emissions reductions and enhanced power resilience.

## Renewable Energy Portfolio

*The Narragansett Bay Commission operates the two largest wastewater treatment facilities (WWTF) in Rhode Island. Its annual energy use is 36,312,890 kilowatt-hours/year. In response to statewide goals for renewable energy, the Narragansett Bay Commission completed several renewable energy projects. In 2012, it installed three 1.5 MW wind turbines at the Field Point WWTF. At Bucklin Point WWTF, there are three anaerobic digesters. The commission has been using about half of the biogas to heat the digesters. In 2018, it built a new combined heat and power (CHP) system to burn the remaining biogas in reciprocating engines to produce power. In addition to these projects, the commission receives net metering allowances for its offsite wind turbines and solar photovoltaic energy farms. The Narragansett Bay Commission now utilizes renewable energy for more than 90 percent of its annual energy demands.*

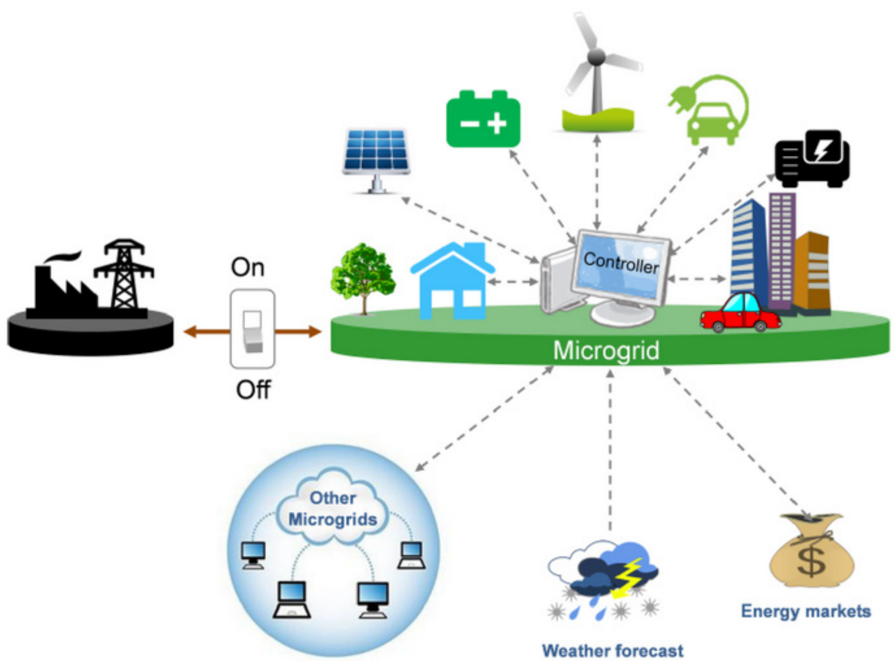
## Wind, Solar and Batteries


*The Atlantic County Utilities Authority (ACUA) serves 14 municipalities in Atlantic County, New Jersey and a population of over 230,000 residents. Its wastewater treatment plant has a capacity of 40 million gallons per day (MGD) and currently treats about 26 MGD. The treatment plant has an energy demand of approximately 2.5 MW. The 7.5 MW Jersey Atlantic Windfarm provides about 60 percent of the utility's electricity through a fixed purchase agreement. ACUA also has 500 kW of solar onsite, including ground mount, canopy and rooftop systems. ACUA has a land lease agreement with Viridity Energy, who installed, owns and operates a 1 MW battery energy storage at ACUA. Viridity uses the frequency regulation market to get a return on its investment and shares in the savings ACUA sees from a reduction in peak load charges on its electric bills. The 1 MW battery storage could provide 15 minutes of back-up power to the entire treatment plant. During a longer power outage, the utility would switch from battery storage to back-up generators. ACUA plans to obtain additional batteries so it can operate as an island, independent of the grid.*

# Microgrid

A central concept to DER is the microgrid. According to the U.S. Department of Energy Microgrid Exchange Group, "A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode." During a power outage, you could switch to your own electric microgrid powered by various sources such as solar photovoltaics, wind turbines, biogas and usually battery banks. In the community, microgrids are often used to link critical public services and critical private businesses together in their own, larger microgrid. These key facilities could become "islands" of power during an outage.

DER and microgrids are emerging technologies and you need to check your state regulatory commission rules on grid interconnection if the system is to interface on-and-off the electric grid. If the microgrid is only dedicated to critical loads, you may not need to address those regulatory issues. The EPA offers a number of energy resources on renewable energy, energy efficiency and emerging technologies.




***One Use for On-Site Power***

*As you consider the benefits of various types of DER at your utility, think about using solar or wind power for telemetry systems. Then your source of information about remote facilities would be independent from grid power.*

# Microgrid

## *Microgrid with Combined Heat and Power*

*The Greater Lawrence Sanitary District (GLSD) augments its Combined Heat and Power (CHP) fuel source digestion facilities with food waste at its 52 MGD treatment plant. This greatly boosts methane production and the ability to power the District's treatment processes and net-meter power to the grid for its off-site pumping station. GLSD benefits from a Massachusetts law that does not allow producers of one ton or more of food waste per week to use landfills or incinerators to dispose of that waste. A Waste Management CORe® facility creates an engineered bioslurry from food waste and delivers three to five truckloads of slurry to GLSD each day.*

*Based on this project, GLSD can:*

- *Fuel its cogeneration engines with natural gas*
- *Fuel its cogeneration engines with biogas*
- *Produce 3.2 MW of power, enough to sustain full wastewater treatment plant (WWTP) operations during an extended power outage*

*In the event of a power outage, the CHP shuts down, but can then be restarted by GLSD using natural gas. The natural gas can then be switched to biogas. These abilities provide operational reliability and flexibility and demonstrate that continued WWTP operations during a long-duration power outage with a clean energy source is possible. Off-site pumping stations still require backup diesel generators in the event of a power outage, but GLSD is well on its way to net zero operations.*

7
Black Sky Planning

Step 1
Define Top Level Goals

Step 2
Establish Minimalist Service Levels

Step 3
Develop Internal Requirements

Step 4
Develop External Requirements

# 7. Black Sky Planning

**TOP TIP: Consider how your utility could sustain operations during a power outage lasting several weeks or longer.**

A black sky incident is generally defined as a long duration power outage, lasting at least 30 days, that impacts a large region including several states. Hazards that could cause a black sky incident include a cyber attack, high altitude electromagnetic pulse (EMP), coordinated kinetic attack (e.g., physical attacks on key elements of power grid), geomagnetic disturbance (i.e., space weather), large-scale earthquake and extreme terrestrial storm (e.g., Hurricane Maria). The National Oceanic and Atmospheric Administration issues alerts, watches and warnings for space weather just like it does for hurricanes and other weather events, which may provide you some time to take pre-planned actions in advance. Learn more at www.swpc.noaa.gov/alerts-watches-and-warnings.

Many utilities that are prepared for power outages lasting two to three days may not be able to maintain full operations during an outage lasting one week or longer. Fuel, treatment chemicals, transportation and other critical interdependencies could be a challenge for water utilities due to disruption of supply chains and extreme competition for resources. The Electric Infrastructure Security (EIS) Council published the free EPRO Handbook II Volume 2: Water Sector Resilience for Black Sky Events. Some key planning considerations identified in the book as well as recent EPA Black Sky Exercises are outlined.

# Step 1 – Define Top Level Goals

- ☐ What are the basic, overarching goals your utility wants to achieve during a black sky incident?
- ☐ What are the threats to public health and safety due to long-term disruption of drinking water or wastewater services that you wish to avoid?

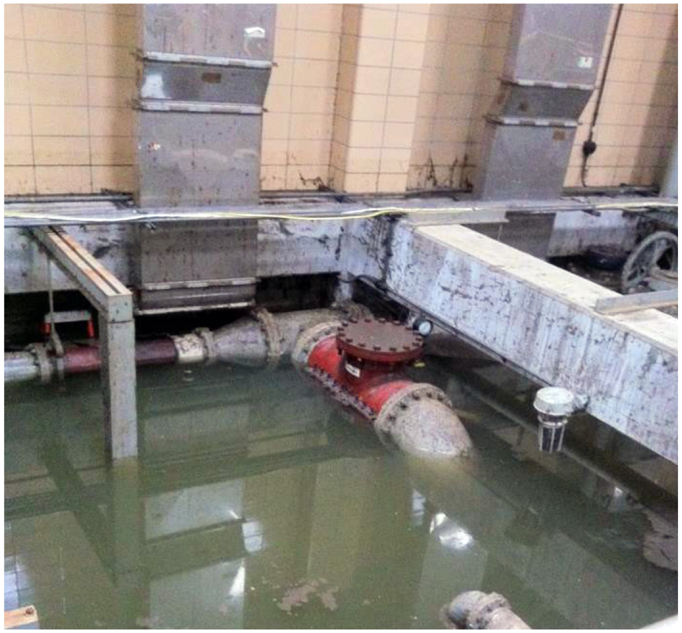
## *Long-term Backup Generator Use*

*During Superstorm Sandy in 2012, the Bay Park Sewage Treatment Plant on Long Island, New York lost all power. The utility produced its own power with on-site generation units, and the flooding from Sandy damaged multiple secondary systems on which those units relied. Bay Park was effectively left without primary power for more than one year. The plant operated with backup power from two pods of two diesel generators each, each pod capable of producing 3 MW. Based on Bay Park's experiences post-Sandy, here are some considerations for long-term operation of standby generators:*

- *Despite having 5,000 gallons of diesel fuel storage at each standby generator pod, fuel deliveries were required every 24 hours. Fortunately, the roads around Bay Park were passable within one week after Sandy made landfall.*
- *Frequent load shedding to perform maintenance on the standby generators was challenging. Therefore, the 2 MW generators in each pod were replaced with two 1 MW generators each to make maintenance easier.*
- *Diesel generators are noisy, and since the generators were used long-term, there were numerous community complaints. Bay Park regularly conducted public meetings on the progress and timeline to restore primary power.*
- *"Emergency" use of the generators was allowed for 500 hours before state air quality standards applied. Therefore, Bay Park eventually replaced their standby diesel generators with natural gas generators to meet emission requirements.*
- *FEMA reimbursement for the rental charges of the standby generators became difficult because Bay Park had used them so long. In this case, purchasing the generators would have cost less than renting them.*
- *The flooding and noise issues led Bay Park to reconsider its standby generator placement. Bay Park's generators are now on the roof (out of a flood's reach), shielded by a building for noise abatement and as far as possible from residential neighbors.*
- *Continuous run or prime power rated backup generators, not standby rated, can typically provide up to full power for your utility as long as you need it. Standby or emergency generators are not designed to run continuously for long periods of time. They need to be frequently taken offline for maintenance and if used for longer periods of time, need to be de-rated, or run below their full power rating.*

## Step 2 – Establish Minimalist Sustainable Service Levels

- ☐ What are the “bare minimum” goals for meeting customer needs as your fuel and treatment chemical supplies dwindle during an extended wide area blackout?
- ☐ Will you reduce treatment and/or stop serving some pressure zones?
- ☐ Have you discussed or developed plans on your expected levels of treatment and service during a prolonged power outage with your local EMA, critical customers and your state regulatory authority so that they can plan appropriately?
- ☐ Have you segregated the electric loads to their own breaker boxes so that the facility could have the option for dedicated on-site electric renewable or generator systems?



# Step 3 – Develop Internal Requirements

☐ Make carefully prioritized investments in backup power, onsite fuel storage and other necessary infrastructure to support your goals and minimum service levels.

- What alternative and temporary emergency power resources do you have at your treatment plant(s) and pumping stations?
- How much fuel do you have onsite? How many days will it last? How will you source and deliver it?
- How many days of treatment chemicals do you need to store?
- Obtain renewable energy resource assessments on what the facility has available on-site: waste heat, solar, wind, methane, biomass (for biogas) and water.

☐ Develop the specific procedures within your utility's emergency response plan to achieve those service levels.

- What is your plan for pumping and treating water, based on your available alternative and temporary emergency power resources, fuel and chemicals? Does this correspond with your goals for providing services during an extended power outage?
- Do you have plans to ensure that your employees can work (e.g., do they have transportation, do their families have the support they need?) during extended power outages?
- What is your plan for restoration of service following a prolonged outage of the electric grid, especially when you have not been able to operate for an extended period of time (e.g., reactivating wastewater treatment, transitioning a contaminated distribution system from Do Not Use to Boil Water Notice to Potable)? What are your requirements for additional resources? Have you incorporated risk into your activities, supply chain for resources, etc.?

☐ Evaluate the opportunities, challenges, benefits and risks of expanded onsite fuel and chemical storage.

☐ Procure black sky-secure communications capabilities that can operate for over 30 days without satellite, cell service and grid power.

# Step 4 – Develop External Requirements

- [ ] What are the support requirements your utility will need to achieve black sky service levels?
    - Do you have contracts to rent generators, if you do not own them? Have you installed transfer switches?
    - Are your emergency power needs listed in the U.S. Army Corps of Engineers' Emergency Power Facility Assessment Tool (EPFAT)?
    - Who will repair and maintain your emergency generators during a prolonged period of use?
    - Does your electric provider know which of your facilities are the highest priorities for power restoration?
    - Do you have contracts to provide fuel during an emergency? Is your vendor prepared to pump and move fuel without grid power?
    - Have you worked with your local EMA to establish a local and regional emergency fuel plan and to coordinate fuel deliveries to generators from multiple agencies in the most efficient manner possible?
    - How resilient are your chemical vendors and their supply chains?
    - How will you communicate with your local EMA during a widespread power outage when landlines, cell phones and the Internet do not work?
    - How will you communicate information about water advisories, reductions in service and emergency disinfection to the public during a widespread power outage when landlines, cell phones and the Internet do not work?
- [ ] What are the policy changes your utility will need to achieve black sky service levels?
    - Clean Air Act waivers
    - Other local air quality regulation waivers
    - Fuel storage and transportation waivers
    - Water quality waivers from primacy agencies
    - Regional level emergency fuel planning

# Step 4 – Develop External Requirements (continued)

- ☐ What are your ongoing activities with key external service providers?
  - Coordination and contact information exchange
  - Collaboration regarding planning and resilience investments
  - Mutual conduct of workshops and exercises
- ☐ Compile a list of resilience investments that address specific black sky events
  - Differentiate from gray sky resilience investments but leverage them as much as possible

8
Funding

Federal Resources

Sample Projects and Funding Sources

# 8. Funding

**TOP TIP: Use EPA's Fed FUNDS website to determine your eligibility for funding power resilience projects.**

Power resilience may require an investment from your utility. This investment can reduce recovery costs and help to maintain operations during disasters. Utilities can implement some power resilience measures using internal funding. Other efforts may require capital investment through the utility's capital improvement plan and/or local government funding.  Also, there is some external funding from state and federal agencies that is available to utilities depending on the type of utility and the measures that you are trying to fund. Examples of power resilience projects that have been funded successfully through external sources include:

- Purchase, rental or upgrade of emergency generators and fuel supply facilities
- Electric connections (transfer switches) to receive emergency generators
- Elevation or protection of electric panels and generators from hazards
- Flood protection around an electric substation and transformers
- Purchase or subsidized costs of microgrid technology
- Energy efficiency measures

Utilities should identify, prioritize and prepare a list of resilience investments to be used in the event of a disaster. Besides providing a schedule of restoration projects, such list can serve as guidance when conducting initial restoration activities, during a period of major confusion. For example, you could replace 3 large pumps with 4 or 5 smaller pumps that enable you to get under the 2MW threshold that would otherwise restrict the number of available emergency generators.

8
Funding

Federal Resources

Sample Projects and Funding Sources

# 8. Funding

On-site renewable energy, energy storage and energy efficiency have unique sources of financing that attract private sector dollars to pay for installation. Most of these approaches are common throughout the United States, and some are explicitly supported by state laws or regulations:

1. Energy Performance Service Contracts (ESPC) are where these energy efficiency and renewable options are financed and installed by a private company, for a price competitive to what would be paid to the electric utility. Companies that perform this kind of work are called Energy Service Companies (ESCO).

2. Energy Leases are offered routinely by renewable energy and energy storage companies (battery banks). Usually leases are for 3 – 7 years, some longer. At the end of the lease the system is retrieved or may be able to be acquired for a nominal fee.

3. Power Purchase Agreements (PPAs) are 15 to 20-year contracts which sell electric power at a pre-approved electric rate that is competitive with power from the electric utility grid. These have escalating clauses for component repair. In the twelve months through May 2018, utility scale solar power generated over 50 terawatt-hours (TWh) primarily financed through PPAs. As of January 30, 2018, the 89,077 MW of wind power installed across 41 states was financed primarily through PPAs.

What these three financial tools have in common is that they do not impose cost to the customer, but those customers also have the option to sign a long-term contract for electric power or energy savings.

# Federal Resources

The EPA's tool Federal Funding for Utilities – Water/Wastewater – in National Disasters (Fed FUNDS) provides comprehensive information on funding programs from various federal agencies including FEMA, the EPA, the U.S. Department of Agriculture (USDA), the U.S. Department of Housing and Urban Development (HUD) and the Small Business Administration (SBA). For example, the state-administered Drinking Water State Revolving Fund (SRF) and Clean Water SRF support a wide range of infrastructure projects. Eligible projects could include resilience components such as energy efficient upgrades and alternative power sources. States establish priorities for using SRF funds and assistance is typically in the form of low-interest loans.  To access Fed FUNDS, click the image below.

## Federal Funding for Water and Wastewater Utilities in National Disasters (Fed FUNDS)

This website gives utilities information about federal disaster funding programs. Although Fed FUNDS focuses on major disasters, you can use the information for any incident that disrupts water or wastewater services or damages critical infrastructure. Learn more about water resilience.

### Find the Right Funding

- Answer a series of questions to find the best disaster funding program(s) for your utility

### Overview of Funding Opportunities


- Eligibility and application process information (and more!) for all funding opportunities

# Sample Projects and Funding Sources

To assist you in locating potential funding sources, the table below has been completed based on a broad interpretation of funding eligibility and policy. Individual utility projects will need evaluation on a case-by-case basis. Talk to your utility supervisor, local emergency manager, town manager and state hazard mitigation officer to determine the availability of funding opportunities for your power resilience project.

| Sample Power Resilience Project | Possible Funding Sources | | | | |
|---|---|---|---|---|---|
| | EPA SRF | FEMA PA | FEMA HMG | HUD CDBG | USDA WEP |
| Repair generator or fuel tank | | X | | | X |
| Elevate existing generators, electric equipment etc. | X | X | X | | X |
| Purchase generators and fuel storage | X | | X | X | X |
| Install electric wiring hookups (e.g., transfer switches) to accept generators | X | | X | | X |
| Develop and implement emergency power plan | X | | X | | X |
| Harden grid link or multiple independent feeds | X | | X | | X |
| Replace damaged equipment with energy efficient versions | X | X | | X | X |
| Add power (e.g., dual fuel, cogeneration, solar, wind) | X | X | X | | X |

***Table Key:*** *SRF = State Revolving Fund; PA = Public Assistance; HMG = Hazard Mitigation Grant; CDBG = Community Development Block Grant; WEP = Water and Environmental Programs*

# Appendices

# Appendix A: Existing Generator Information Sheet

**1. Facility Information**

Site Name: ______________________ Address: ________________________________________

Latitude (N):____________________________ Longitude (W): ____________________________

Major motors, in starting order, used for facility operations (*e.g., 75 HP 2 Quantity 460 Volts 3 Phase*):

_____ HP _____ Quantity _____ Volts _____ Phase ☐soft start ☐ACL (across the line)

_____ HP _____ Quantity _____ Volts _____ Phase ☐soft start ☐ACL (across the line)

_____ HP _____ Quantity _____ Volts _____ Phase ☐soft start ☐ACL (across the line)

_____ HP _____ Quantity _____ Volts _____ Phase ☐soft start ☐ACL (across the line)

**2. Generator Information**

Power (kW): __________ Voltage (V):__________ Phase(s): __________

Configuration: ☐Wye ☐Delta

Transfer Switch: ☐Auto ☐Manual

Generator Location: ☐Inside ☐Outside

Generator Type: ☐Portable ☐Stationary

Cable Length (ft): ___________ Cable Size (MCM or AWG): __________

**3. Engine Information**

Engine Make: _________________ Engine Model: ___________________

Engine Serial Number: _________________ Battery Voltage: _____________________

Primary Fuel Filter: __________ Secondary Fuel Filter: __________ Coolant Filter: __________

Oil Filter: __________ Oil Type: __________ Oil capacity: __________

Air Filter: __________ Fuel Type: ___________ Fuel Capacity: __________

Gallons per hour: ________ Max Run Hours (100% load)*: __________

Diesel Emissions Fluid (DEF) Tank Capacity: __________

**4. Additional Notes** (e.g., hitch requirements for portable generator, site specific directions, clearance issues with overhead lines)

**Facility Information**

*Site Name*: site name for stationary generator or write “portable” for portable generator

*Address:* physical location for stationary generator; storage location for portable generator

*Latitude and Longitude*: provide six places to the right of the decimal point for latitude and longitude to indicate a more precise location. If presented in degrees-minutes-seconds, the seconds should be listed four decimal places to the right of the whole number of seconds for equivalent accuracy.

*Major motors*: provide the horsepower, quantity, volts, and phases of the major motors that will be powered by the generator, in starting order, and whether they are soft start or across the line start

**Generator Information**

*Power:* the power output of the generator in kilowatts (kW)

*Voltage*: voltage is a measure of pressure

*Phase(s):* generators can be single or three-phase

*Configuration:* 3-phased power can be in a wye configuration in the shape of a “Y” or a delta configuration in the shape of a triangle

*Transfer switch:* does the generator start up automatically or require a manual switch?

*Generator Location:* is the generator located inside or outside?

*Generator Type:* a portable generator can be moved between locations and a stationary one is at a fixed location

*Cable Length*: length of cable between generator and load

*Cable Size:* size of cable in Thousand Circular Mils (MCM) or American Wire Gauge (AWG)

**Engine Information**

*Engine Make and Model:* the manufacturer of the engine and the engine model number

*Engine serial number:* the serial number on the engine

*Battery voltage:* the size and number of batteries the engine requires

*Filters:* the type of filters each system requires; note – some engines do not have a secondary fuel filter

*Oil:* the type and capacity of oil

*Fuel:* the type and capacity of fuel (e.g., diesel)

*Gallons per hour:* the number of gallons of fuel needed per hour

**Max run hours:* for fuel planning only, the maximum number of hours the engine can run before refueling assuming 100% load (generators should run closer to 70% or 80% load)

*Diesel Emissions Fluid (DEF) Tank Capacity:* the capacity of DEF tank

# Appendix B: Generator Request Form

**1. Facility Information**

Site Name: ______________________  Address: ________________________________________

Latitude (N):____________________________ Longitude (W): ____________________________

Contact Name: __________________________ Phone: ____________  Email: ____________________

Major motors, in starting order, used for facility operations (*e.g., 75 HP 2 Quantity 460 Volts 3 Phase*):

_____ HP _____ Quantity _____ Volts _____ Phase  ☐soft start  ☐ACL (across the line)

_____ HP _____ Quantity _____ Volts _____ Phase  ☐soft start  ☐ACL (across the line)

_____ HP _____ Quantity _____ Volts _____ Phase  ☐soft start  ☐ACL (across the line)

_____ HP _____ Quantity _____ Volts _____ Phase  ☐soft start  ☐ACL (across the line)

**2. Needed Generator**

Power (kW): __________  Voltage (V): __________  Phase(s): __________

Configuration: ☐Wye  ☐Delta  Cable Length (ft): ___________ Cable Size (MCM or AWG): __________

On-site cable configuration: __________________________ Preferred Fuel Type: _______________

**3. Assessment Details**

Main Breaker Current (Amps): __________

Service Drop Type: ☐Overhead  ☐Underground

If overhead, is there sufficient clearance for trailer? ☐ Yes  ☐No  ☐N/A

Anticipated On-site Location of Temporary Generator: _________________________________________

**4. Hitching Requirements**

Trailer Hitch: ☐ Pintel ☐ Ball   Trailer Height: _____________

Electrical connections: _________________________ Generator and Trailer Weight: ______________

**5. Additional Notes** (e.g., site specific directions, clearance issues with overhead lines)

**Facility Information**

*Site Name and Address*: location and address for requested generator

*Latitude and Longitude*: provide six places to the right of the decimal point for latitude and longitude to indicate a more precise location. If presented in degrees-minutes-seconds, the seconds should be listed four decimal places to the right of the whole number of seconds for equivalent accuracy.

*Contact:* name, email and phone number for a point of contact for the generator

*Major motors*: provide the horsepower, quantity, volts, and phases of the major motors that will be powered by the generator, in starting order, and whether they are soft start or across the line start

**Needed Generator**

*Power:* the power output of the generator in kilowatts (kW)

*Voltage*: voltage is a measure of pressure

*Phase(s):* generators can be single or three-phase

*Configuration:* 3-phased power can be in a wye configuration in the shape of a "Y" or a delta configuration in the shape of a triangle

*Cable Length*: length of cable needed to connect generator to load in feet

*Cable Size:* size of cable in Thousand Circular Mils (MCM) or American Wire Gauge (AWG)

*On-site cable configuration*: onsite cable connection for a generator (e.g, appleton, camlock, etc.)

*Preferred Fuel Type:* type of fuel (e.g., diesel) that is preferred

**Assessment Details**

*Main Breaker Current:* size of the circuit breaker in amps that controls all electric current in the building

*Service Drop Type:* are the electrical lines overhead or underground?

*Transformer Mount Type:* is the transformer mounted on a pad or a pole?

*Anticipated On-site location*: describe where the generator will be placed

**Hitching Requirements**

*Trailer Hitch:* type of hitch

*Trailer Height:* height of the trailer/hitch

*Electrical connections:* describe electrical connections needed for trailer

*Generator and Trailer Weight:* combined weight of generator and trailer