

Enhancing Resiliency of Clean Water Systems with Solar PV and Battery Backup Power



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1. Introduction

Access to clean and safe water is fundamental to public health, economic prosperity, and environmental sustainability. Water treatment and distribution facilities are critical infrastructure components that ensure communities across the United States and its territories have reliable access to potable water. However, these facilities are highly dependent on a continuous power supply to operate effectively. Power outages, whether due to natural disasters, grid failures, or other emergencies, can severely disrupt water services, posing significant risks to public health and safety.

In the wake of increasing natural disasters and grid vulnerabilities, enhancing the resiliency of water treatment and distribution facilities is paramount. Integrating solar photovoltaic (PV) systems with commercial battery storage offers a sustainable and reliable backup power solution that can maintain operations during grid outages. This white paper explores a comprehensive framework for implementing solar PV and battery backup systems in water treatment facilities, discusses the myriad benefits, and

outlines federal grants available to support such initiatives. Our aim is to provide stakeholders with actionable insights to bolster the resiliency of clean water systems, ensuring uninterrupted access to this vital resource.

2. Background

2.1. Water Treatment Facilities in the U.S. and Its Territories

The United States operates an extensive network of over 50,000 community water systems, serving more than 300 million people¹. These facilities are spread across diverse geographical regions, including rural areas and U.S. territories such as Puerto Rico, Guam, and the U.S. Virgin Islands. The facilities vary in size and capacity, ranging from small community-operated plants serving a few hundred people to large metropolitan systems serving millions.

Key Functions of Water Treatment Facilities:

- **Water Treatment:** Removal of contaminants and pathogens to produce safe drinking water in compliance with the Safe Drinking Water Act (SDWA).
- **Water Distribution:** Delivery of treated water through a network of pipes, storage tanks, and pumps to residential, commercial, and industrial users.
- **Wastewater Treatment:** Processing of sewage and industrial waste to protect environmental and public health, governed by the Clean Water Act (CWA).

2.2. Challenges Faced During Power Outages

Water treatment facilities are energy-intensive operations. They rely on electrical power for:

- **Pumping Systems:** Moving water from sources to treatment plants and then to distribution networks.
- **Filtration and Treatment Processes:** Operating equipment for chemical dosing, filtration, disinfection, and sludge handling.
- **Control and Monitoring Systems:** Running SCADA (Supervisory Control and Data Acquisition) systems for real-time monitoring and control.

Common Causes of Power Outages:

- **Natural Disasters:** Hurricanes (e.g., Hurricane Maria in Puerto Rico, 2017), floods, earthquakes, wildfires, and severe storms.
- **Grid Failures:** Aging infrastructure, equipment failures, or cyber-attacks compromising the electric grid's reliability.
- **Other Emergencies:** Accidents, human error, or planned maintenance that disrupt power supply.

Impacts of Power Outages:

- **Service Disruption:** Interruptions in water supply and pressure, leading to boil water advisories or complete loss of service.
- **Public Health Risks:** Increased potential for waterborne diseases due to inadequate treatment or contamination.
- **Economic Consequences:** Financial losses from operational downtime, emergency response costs, and infrastructure damage.
- **Environmental Hazards:** Untreated or partially treated wastewater discharge, harming aquatic ecosystems.

Communities in rural and disadvantaged areas often face greater challenges due to limited resources, making it imperative to find sustainable solutions to enhance facility resiliency.

3. Framework for Increasing Resiliency

Implementing solar PV panels combined with commercial battery systems provides a viable solution to enhance the resiliency of water treatment and distribution facilities. This section outlines a comprehensive framework for integrating these technologies.

3.1. Solar Photovoltaic (PV) Systems

Overview:

Solar PV systems convert sunlight directly into electricity using semiconductor materials. They are a mature technology with decreasing costs and increasing efficiency.

Components:

- **Solar Panels (Modules):** Made up of photovoltaic cells that capture sunlight and generate DC electricity.
- **Inverters:** Convert DC electricity to AC electricity compatible with facility equipment and the grid.
- **Mounting Structures:** Support panels on rooftops, ground-mounted arrays, or canopies over parking lots.
- **Balance of System (BOS):** Includes wiring, switches, and monitoring equipment.

Advantages:

- **Renewable Energy Source:** Sunlight is abundant and free, reducing reliance on fossil fuels.
- **Scalability:** Systems can be designed to meet small or large energy needs.
- **Low Operating Costs:** Minimal maintenance with no fuel costs after installation.
- **Reduced Environmental Impact:** Generates clean energy with no direct emissions.

3.2. Commercial Battery Storage Solutions

Overview:

Battery storage systems store excess electricity generated by solar panels or during off-peak grid hours for later use.

Types of Batteries:

- **Lithium-Ion Batteries:** High energy density, suitable for quick response applications, widely used in commercial settings.
- **Flow Batteries:** Utilize liquid electrolytes; offer long cycle life and are suitable for large-scale storage.
- **Lead-Acid Batteries:** Traditional technology; lower cost but shorter lifespan and less environmentally friendly.

Functions:

- **Backup Power Supply:** Provides electricity to critical loads during outages.

- **Load Management:** Shifts energy use to off-peak times, reducing demand charges.
- **Grid Services:** Offers frequency regulation and voltage support if connected to the grid.

Benefits:

- **Energy Independence:** Enhances control over energy supply, reducing vulnerability to grid disruptions.
- **Operational Efficiency:** Optimizes energy use, potentially lowering overall energy costs.
- **Environmental Sustainability:** Supports the use of renewable energy, reducing greenhouse gas emissions.

3.3. Integration with Existing Infrastructure

Assessment:

- **Energy Needs Analysis:** Evaluate the facility's energy consumption patterns, peak demand, and critical loads that must remain operational during outages.
- **Site Evaluation:** Assess available space for solar PV installations, considering roof integrity, ground space, shading, and orientation. Structural analysis may be necessary for rooftop installations.

Design and Engineering:

- **System Sizing:** Determine the appropriate size of the solar PV array and battery storage to meet energy requirements during normal and emergency operations.
- **Control Systems:** Implement advanced energy management systems to optimize the use of solar energy and battery storage, ensuring seamless transition during outages.
- **Interconnection Strategy:** Decide on grid-tied, off-grid, or hybrid systems based on facility needs and regulatory considerations.

Installation:

- **Professional Installation:** Engage experienced and certified installers familiar with critical infrastructure projects.
- **Safety Measures:** Incorporate safety features such as disconnect switches, surge protection, and fire safety protocols.
- **Regulatory Compliance:** Obtain necessary permits and ensure compliance with national and local electrical codes, zoning laws, and environmental regulations.

Operation and Maintenance:

- **Monitoring Systems:** Implement real-time monitoring for performance tracking, fault detection, and maintenance scheduling.
- **Maintenance Plans:** Establish regular inspection routines for cleaning panels, checking electrical connections, and ensuring battery health.
- **Training Staff:** Train facility personnel on system operation, safety protocols, and emergency procedures.

3.4. Technical Considerations

Critical Load Prioritization:

- Identify essential equipment and processes that must remain operational during a power outage, such as:
 - Raw water intake pumps.
 - Treatment process equipment (e.g., filtration, disinfection).
 - Control systems and monitoring equipment.
 - Essential lighting and communications.

System Redundancy:

- Incorporate redundancy in critical components to enhance reliability.

Scalability and Future Expansion:

- Design systems with the potential for future expansion to accommodate growing energy needs or technological advancements.

Energy Storage Duration:

- Determine the required duration of backup power (e.g., hours, days) based on historical outage data and risk assessments.

Grid Interaction:

- **Net Metering:** Explore opportunities for net metering to sell excess energy back to the grid.
- **Island Mode Operation:** Ensure systems can operate independently from the grid during outages.

Regulatory Compliance:

- **Environmental Impact Assessments (EIAs):** Conduct assessments if required.
- **Interconnection Agreements:** Work with utility companies to establish agreements for grid-tied systems.

Financial Analysis:

- **Cost Estimates:** Include capital expenditures, operational costs, maintenance, and decommissioning.
- **Return on Investment (ROI):** Analyze payback periods and long-term savings.
- **Incentives and Tax Credits:** Factor in available federal, state, and local incentives.

4. Benefits of Solar PV and Battery Backup Systems

Implementing solar PV and battery backup systems in water treatment facilities offers numerous benefits that extend beyond mere operational advantages.

4.1. Operational Continuity

Uninterrupted Service:

- Ensures continuous operation of water treatment and distribution processes during power outages, preventing service disruptions.

Disaster Resilience:

- Enhances the facility's ability to function independently in emergencies, critical for community health and safety.

Reduced Downtime:

- Minimizes the risk of equipment damage from sudden shutdowns and restarts, extending the lifespan of facility assets.

Compliance with Regulations:

- Helps maintain compliance with environmental and public health regulations by preventing untreated discharges.

4.2. Environmental Advantages

Emission Reduction:

- Reduces greenhouse gas emissions and air pollutants by substituting fossil fuel-based electricity with clean, renewable energy.

Sustainability:

- Demonstrates commitment to sustainable practices, aligning with global efforts to combat climate change.

Resource Conservation:

- Decreases reliance on non-renewable energy resources, contributing to energy security.

Community Environmental Health:

- Improves local air quality, benefiting community health.

4.3. Cost Savings and Economic Benefits

Energy Cost Reduction:

- Lowers electricity bills by generating own power, especially during peak demand periods when electricity is most expensive.

Demand Charge Mitigation:

- Reduces demand charges by managing peak loads with stored energy.

Incentives and Credits:

- Access to federal tax credits, such as the Investment Tax Credit (ITC), state rebates, and renewable energy certificates (RECs), can offset installation costs.

Long-Term ROI:

- While initial capital costs are significant, long-term savings and stability in energy costs provide financial benefits over the system's lifespan.

Economic Development:

- Creates jobs and stimulates the local economy through the installation and maintenance of systems.

4.4. Enhanced Community Resilience

Public Health Protection:

- Ensures reliable access to safe drinking water, reducing the risk of waterborne illnesses during emergencies.

Community Trust:

- Builds confidence in public utilities' ability to provide essential services under adverse conditions.

Emergency Preparedness:

- Facilities can serve as critical hubs during disasters, supporting emergency response efforts.

Social Equity:

- Benefits disadvantaged communities by providing reliable services and potentially reducing utility costs.

5. Federal Grants and Funding Opportunities

Numerous federal grants and programs are available to support the implementation of solar PV and battery backup systems in water treatment facilities. Leveraging these opportunities can significantly reduce the financial burden and facilitate project implementation.

5.1. Overview of Relevant Federal Grants

Federal agencies offer a variety of funding mechanisms, including grants, low-interest loans, and technical assistance programs aimed at enhancing infrastructure resiliency, promoting renewable energy, and supporting environmental protection.

5.2. Key Agencies and Programs

1. Federal Emergency Management Agency (FEMA)

Hazard Mitigation Grant Program (HMGP):

- **Purpose:** Provides funding to states, territories, tribal governments, and local communities to implement long-term hazard mitigation measures after a major disaster declaration.
- **Eligibility:** State, local, tribal, and territorial governments. Private non-profit organizations may also be eligible.
- **Use of Funds:** Projects that reduce or eliminate future risk to lives and property, including backup power systems for critical facilities like water treatment plants.
- **Application Notes:** Requires a cost-benefit analysis demonstrating that the benefits of the project outweigh the costs.

Building Resilient Infrastructure and Communities (BRIC) Program:

- **Purpose:** Supports pre-disaster mitigation activities, encouraging the adoption of resilient building codes and innovative projects.
- **Funding Priorities:** Projects that mitigate risk to public infrastructure, incorporate nature-based solutions, and support community lifelines.

2. U.S. Department of Energy (DOE)

Solar Energy Technologies Office (SETO):

- **Funding Opportunities:** Periodically releases funding opportunity announcements (FOAs) for projects advancing solar technologies, including integration with critical infrastructure.
- **Technical Assistance:** Offers programs like the Solar Energy Innovation Network, providing support for innovative solar projects.

Energy Efficiency and Conservation Block Grant Program:

- **Purpose:** Helps local governments implement strategies to reduce energy use and fossil fuel emissions.
- **Use of Funds:** Renewable energy installations, energy efficiency upgrades, and development of energy plans.

3. U.S. Department of Agriculture (USDA)

Rural Energy for America Program (REAP):

- **Purpose:** Provides grants and guaranteed loans to agricultural producers and rural small businesses for renewable energy systems and energy efficiency improvements.
- **Eligibility:** Facilities located in rural areas with populations less than 50,000.
- **Funding Limits:** Grants cover up to 25% of total eligible project costs; loan guarantees up to 75%.

Water and Waste Disposal Loan & Grant Program:

- **Purpose:** Provides funding for clean and reliable drinking water systems in rural areas.
- **Use of Funds:** Construction, expansion, or improvement of water facilities, including renewable energy systems.

4. Environmental Protection Agency (EPA)

Clean Water State Revolving Fund (CWSRF):

- **Purpose:** Offers low-interest loans to fund water quality protection projects for wastewater treatment, non-point source pollution control, and watershed management.
- **Green Project Reserve (GPR):** Allocates funds specifically for green infrastructure, energy efficiency, and renewable energy projects at water facilities.
- **Benefits:** Flexible financing terms, including extended repayment periods and potential for principal forgiveness.

5.3. Application Process

Step 1: Identify Funding Opportunities

- Monitor federal agency websites, grants.gov, and the Federal Register for announcements.
- Subscribe to newsletters or alerts from relevant agencies.

Step 2: Eligibility Assessment

- Review eligibility criteria for each program to ensure your facility and project qualify.
- Consider partnering with eligible entities if necessary.

Step 3: Prepare Proposal

- **Project Description:**
 - Clearly articulate the project's objectives, scope, and expected outcomes.
 - Highlight how the project aligns with the funding agency's goals and priorities.
- **Technical Feasibility:**
 - Include detailed engineering designs, system specifications, and integration plans.
 - Provide evidence of technical expertise and past project experience.
- **Financial Plan:**
 - Present a comprehensive budget outlining all costs and funding sources.
 - Demonstrate financial sustainability and cost-effectiveness.
- **Benefit-Cost Analysis:**
 - Quantify the benefits, including avoided damages, operational savings, and environmental impacts.
 - Use accepted methodologies and consider both direct and indirect benefits.

- **Community Impact:**
 - Describe how the project enhances community resilience, public health, and social equity.
 - Include letters of support from community stakeholders and local officials.

Step 4: Submission

- Follow the specific guidelines provided in the funding announcement.
- Ensure all required documents are complete and submitted before deadlines.

Step 5: Post-Submission

- Be prepared to provide additional information or clarification if requested.
- Engage with the funding agency throughout the review process.

Compliance Requirements:

- **Environmental Reviews:** Conduct environmental assessments or impact statements as required by NEPA.
- **Davis-Bacon Act:** Comply with prevailing wage requirements for labor.
- **Buy American Provisions:** Use U.S.-made materials and products when stipulated.
- **Reporting and Monitoring:** Establish systems for financial and performance reporting.

5.4. How We Can Assist

Our organization offers comprehensive support services to facilitate your project's success:

Grant Writing and Application Support:

- **Expert Guidance:** Leverage our experience in preparing successful grant applications.
- **Customized Proposals:** Tailor applications to meet specific funding agency requirements.

- **Documentation Assistance:** Help compile necessary technical, financial, and administrative documents.

Project Planning and Feasibility Studies:

- **Energy Audits:** Analyze current energy usage and identify opportunities for improvement.
- **Feasibility Assessments:** Evaluate technical and economic viability, including ROI calculations.
- **Risk Analysis:** Identify potential risks and develop mitigation strategies.

Technical Consulting:

- **System Design:** Provide engineering expertise for optimal system configuration.
- **Technology Selection:** Recommend appropriate technologies based on facility needs.
- **Integration Solutions:** Develop plans for seamless integration with existing infrastructure.

Regulatory Navigation:

- **Permitting Assistance:** Guide you through local, state, and federal permitting processes.
- **Compliance Management:** Ensure adherence to all regulatory requirements throughout the project lifecycle.

Project Management and Implementation Support:

- **Vendor Coordination:** Assist in selecting qualified contractors and suppliers.
- **Construction Oversight:** Monitor project progress to ensure quality and timeliness.
- **Training and Education:** Provide training for facility staff on system operation and maintenance.

6. Conclusion

Enhancing the resiliency of water treatment and distribution facilities is essential for safeguarding public health, ensuring environmental protection, and maintaining economic stability. The integration of solar PV panels with commercial battery storage systems presents a sustainable, cost-effective, and reliable solution to address power outage challenges.

By adopting this framework, facilities can achieve:

- **Operational Continuity:** Maintain critical services during emergencies.
- **Environmental Stewardship:** Reduce carbon footprint and promote sustainable practices.
- **Economic Efficiency:** Realize long-term cost savings and potential revenue streams.
- **Community Resilience:** Strengthen the community's ability to withstand and recover from adverse events.

Federal grants and funding opportunities are available to support these initiatives, making it an opportune time for facilities to invest in renewable energy solutions. With proper planning, technical expertise, and strategic partnerships, water treatment facilities can successfully implement these technologies and serve as models for resilience and sustainability.

We are committed to assisting organizations in navigating this journey, from conceptualization to implementation, ensuring that communities have access to clean, safe water, even in the face of emergencies.

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8. Contact Us

If you are interested in enhancing the resiliency of your water treatment and distribution facilities through solar PV and battery backup systems, we are here to help.

Future Energies Foundation

- **Email:** vs@futureenergies.org
- **Website:** www.futureenergies.org

Our Services Include:

- **Grant Identification and Application Assistance:** Navigating funding opportunities to secure financial support.
- **Feasibility Studies and Project Planning:** Providing detailed analyses to ensure project viability.
- **Technical Consulting and System Design:** Offering expert guidance on technology selection and system integration.
- **Project Management and Implementation Support:** Overseeing projects from inception to completion.

Together, we can build resilient infrastructure that ensures access to clean water for all communities, even in the face of emergencies. Let's collaborate to create sustainable solutions that benefit both your facility and the communities you serve.

Disclaimer: This white paper is for informational purposes only. While every effort has been made to ensure accuracy, we recommend consulting with professional advisors and relevant agencies for specific guidance related to your project.