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READINESS FOR RESILIENCE

A Resilient Technology Roadmap for Puerto Rico

With Partners:



GOVERNMENT OF PUERTO RICO
Puerto Rico Federal Affairs Administration



CENTRAL OFFICE FOR
RECOVERY, RECONSTRUCTION AND RESILIENCY



National Association of
State Energy Officials

Smart**Cities**Council



The Business Council
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PUERTO RICO

READINESS FOR RESILIENCY

Executive Summary



We must rebuild infrastructure with improved resiliency to better prepare for the next disaster, better withstand such disasters, and and recover more quickly.



The Government of Puerto Rico, led by the Puerto Rico Federal Affairs Administration (PRFAA) and the Central Office of Recovery, Reconstruction and Resiliency (COR3), has engaged in the *Readiness for Resilience* program to assist communities impacted by Hurricanes Maria and Irma rebuild critical infrastructure with smart resilience technology.

The Readiness for Resilience program, sponsored by Qualcomm, consists of a partnership between the Smart Cities Council, the Business Council for Sustainable Energy and the National Association of State Energy Officials (“Partners”).

The program in Puerto Rico included two stages: 1) a Readiness for Resilience workshop to build smart cities capacity and identify ways to incorporate smart technology into recovery project priorities; 2) the development of a “Resilient Technology Roadmap” detailing smart technology best practices and solutions that could be incorporated into the Government’s Economic and Disaster Recovery Plan.

A two-day Readiness for Resilience workshop was held December 4-5, 2018 in San Juan, Puerto Rico. It consisted of approximately 200 government officials from key agencies and municipalities, along with community groups, technology experts and local businesses and economic development groups.

The information gained from the working groups was used to develop this report, which contains a “Resilient Technology Roadmap” for Puerto Rico, linking local needs with potential resilient technology best practices and solutions. This roadmap outlines local priorities in the areas of Housing, Communications and IT, Energy, and Transportation. It identifies 14 smart resilience projects to address these priorities and maps them to recommendations from *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico*.

This Roadmap is just the beginning of what the Partners hope will be a multi-year engagement with Puerto Rico throughout the recovery process. The path to recovering and rebuilding from natural disasters like Hurricanes Maria and Irma must incorporate smart, resilient technologies and processes. Community leaders meeting face-to-face with technology experts and citizen stakeholder groups exchanging knowledge, experience, concerns and aspirations – that is the essence of the type of partnership needed to rebuild more resilient and adaptive communities.

PUERTO RICO

READINESS FOR RESILIENCY

WORKSHOP



GOVERNMENT OF PUERTO RICO
Puerto Rico Federal Affairs Administration



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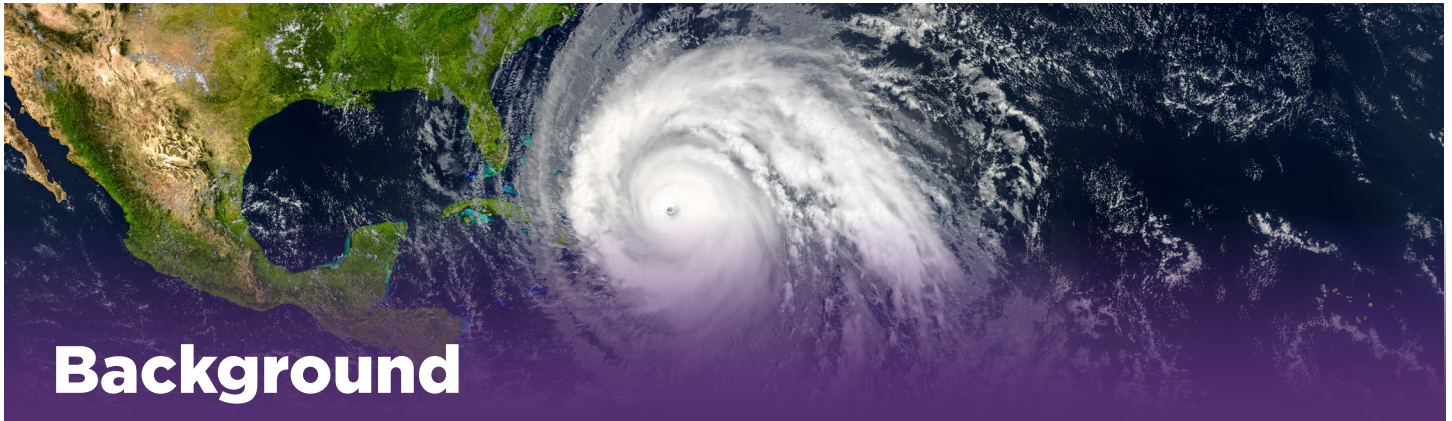
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The Government of Puerto Rico views the recovery effort as an opportunity to transform the Island by implementing solutions that are cost-effective and forward-looking, harness innovative thinking and best practices, and revitalize economic growth.



Impacts of Hurricanes Maria and Irma

Per the Government of Puerto Rico report *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico*:

“In September 2017, Puerto Rico suffered catastrophic damage as Hurricane Irma passed just north of San Juan. Hurricane Maria made a direct hit on the Island two weeks later. The hurricanes’ effects on people’s health and safety were devastating. Damage to critical infrastructure resulted in cascading failures of the lifeline systems of energy, telecommunications, water, and transportation. Because the disaster occurred at the end of a very active hurricane season, federal resources for disaster response were stretched. In addition, aid from other states was not readily available due to a lack of mutual assistance compacts and the geographical separation of more than 1,000 miles between Puerto Rico and the continental United States. Given the scale of the disaster, the limited response resources, and the failure of lifeline systems, emergency services were severely compromised and residents lacked electricity, food, and water for a prolonged period. And with roads impassable, residents had limited access to medical care. After the hurricanes, people lost their jobs, schools were closed, government services and private enterprise could no longer operate effectively, landslides caused flooding hazards, and wastewater polluted marine environments. While the hurricanes touched virtually every segment of the population, older adults, children, individuals with disabilities or chronic illnesses, and women were disproportionately affected by this disaster. “

The Road to Recovery

The Government of Puerto Rico issued its recovery plan *Transformation and Innovation in the Wake of Devastation: An Economic and Disaster Recovery Plan for Puerto Rico*, in August 2018. As stated in the plan “Catastrophic hurricanes and the resulting disasters are not unique to Puerto Rico. Coastal communities affected by Hurricane Katrina in 2005 also suffered widespread damage, severe interruption of essential services, and deep economic losses. Lessons learned from these past disasters suggest that the Island now faces a lengthy recovery.

Despite the unprecedented disaster and long road to recovery, Puerto Rico is far from defeated. As stated in the plan “The Government of Puerto Rico views the recovery effort as an opportunity to transform the Island by implementing solutions that are cost-effective and forward-looking, harness innovative thinking and best practices, and revitalize economic growth.”

The plan identifies nine (9) capital investment priority areas, eight (8) strategic initiatives and 270 courses of action as summarized below.

CAPITAL INVESTMENTS

Physical Capital 

ENERGY

Transform the energy system to ensure customer-centric, affordable, reliable, and scalable electricity that incorporates more renewables, microgrids, and distributed energy resources; can drive new businesses and employment opportunities; and can support residents' well-being.

COMMUNICATIONS/INFORMATION TECHNOLOGY

Modernize the telecommunications system to ensure fast, reliable, and resilient residential, commercial, and emergency communications that drive Puerto Rico's economy, prosperity, and well-being.

WATER

Rethink water systems to be safer, more reliable, and protected from future disasters to ensure the well-being of Puerto Ricans and the environment as well as the operations of government and businesses.

TRANSPORTATION

Rebuild and strengthen maritime, surface, and air transportation to ensure a flexible and reliable transportation system that moves people and goods, ensures economic continuity, and facilitates disaster response.

HOUSING

Repair and rebuild resilient residential housing that is safe and affordable to create a better built environment.

PUBLIC BUILDINGS

Repair, rebuild, and right-size the public buildings inventory to ensure stronger and more resilient public buildings that meet today's standards, mitigate against future disasters, represent innovative designs, and meet communities' needs.

Human Capital 

EDUCATION

Transform the education system to produce competitive graduates with the knowledge and skills needed to adapt to changes in the economy, the environment, and technology.

HEALTH AND WELL-BEING

Rebuild and enhance health and social service infrastructure and regional health care networks to ensure reliable and equitable access to health and social services and health-promoting communities, including an efficient and effective response to public health crises and other future disasters.

Natural Capital 

NATURAL ENVIRONMENT

Restore, plan for, and develop the natural environment so that marine and terrestrial ecosystems coexist sustainably with tourism, promote the economic development of Puerto Rico, serve as natural infrastructure to protect against storm damage, manage waste, and preserve the natural and cultural heritage of Puerto Ricans.

STRATEGIC INITIATIVES

OCEAN ECONOMY (BLUEtide)

Integrate and promote all of Puerto Rico's ocean-dependent industries and ecosystems as a cohesive effort to promote economic growth, improve quality of life for residents, and enhance the visitor's experience.

VISITOR ECONOMY

Develop a strong visitor economy to help position Puerto Rico as a global destination of investment, production, and wealth.

EMERGENCY SERVICES MODERNIZATION

Enhance public safety and first responders' ability to deliver reliable, modern, and integrated emergency services.

AGRICULTURAL TRANSFORMATION

Modernize agriculture to promote greater productivity and output and improve exports.

DIGITAL TRANSFORMATION

Build the capabilities and workforce needed to fundamentally transform key industry and government processes to become more user-focused, relevant, and efficient at addressing local needs and delivering basic services.

21ST-CENTURY WORKFORCE

Develop and protect human capital to establish a world-class workforce, increase labor force flexibility, and create high-quality employment opportunities aligned with economic growth strategies.

ENTREPRENEURSHIP

Expand opportunities for entrepreneurship and development of small to medium local businesses that can compete globally to promote economic development.

ADVANCED MANUFACTURING

Address policy and structural barriers to increase opportunities for investment and the growth of private-public partnerships.

Roughly 270 specific courses of action have been linked with these capital investments and strategic initiatives.

Descriptions of these recovery actions—including estimated costs, possible funding sources, and potential implementers—are available in Chapter 12.



Resilience benefits accrue to organizations that prioritize the collection, collation, presentation, and sharing of data.

- Zolli & Healy, 2012



The Case for Smart Resilience

The United States 2017 National Security Strategy states that enhancing resilience includes the ability to withstand and recover rapidly from deliberate attacks, accidents, natural disasters, as well as unconventional stresses, shocks and threats to our economy and democratic system. Rodin, in *The Resilience Dividend*, adds that resilience-building efforts should seek to not just recover from, but also to revitalize, or adapt and grow stronger as a result of, disruptive experiences.

This takes not only improvements in physical infrastructure, also the incorporation of **Information and Communications Technology (ICT)** and the use of data to better prepare, respond, recover and revitalize. It also requires technology and data to improve connections and communications between people to make social networks more effective and resilient.

According to resilience literature, improving community and system resilience requires making them more:

- Aware, adaptive, diverse, integrated, self-regulating (Rodin, 2014)
- Resourceful, robust, redundant (100 Resilient Cities, City Resilience Framework)
- Adaptable, agile, cooperative, connected (Zolli & Healy, 2012)

Pervasive high-speed connectivity, the widespread use and declining costs of digital sensors and mobile devices, increases in computing power and distributed cloud computing, and advanced applications of artificial intelligence and data analytics are making it possible to be more connected, aware, integrated, adaptive, cooperative and self-regulating. Research by Zolli & Healy shows that “resilience benefits accrue to organizations that prioritize the collection, collation, presentation, and sharing of data”.

Critical to implementing smart and resilient technology is **reliable, secure and resilient energy systems**. Any investments made to rebuild and modernize infrastructure for resilience should include consideration of energy systems. The delivery of safe, secure and reliable power, heat and fuels is an essential and fundamental input for operations in all sectors and responding to extreme weather events and other disasters. Efficiency and alternative fuels in key end-use sectors, such as in buildings and vehicles, enables energy resources to last longer; in emergency situations, this may mean more comfortable shelters for affected citizens, continuity of operations for key facilities such as hospitals, and/or easier evacuation processes.

Energy systems are evolving and becoming more connected, providing enhanced resilience pre- and post-disaster and during “blue-sky” days. Innovative energy systems are more connected and integrated with public services, the built environment and transportation systems. They increasingly enable customers to communicate with these systems.

These enhancements rely on smart technology solutions that facilitate the collection of data via sensors along distribution networks, advanced analytics, and the incorporation of communications technologies. This optimizes performance, preempts problems, and allows for rapid response. To ensure resilience of these systems, strong cybersecurity protocols are required.

Technology Snapshots:

- Innovative energy systems increasingly integrate demand-response protocols for increased electric grid efficiency, as well as utility-scale and distributed renewable and clean energy technologies. As these applications expand, they will require upgrades to the grid system.
- Energy storage is also playing a larger role in the power, buildings, and transportation sectors – with significant resilience and energy performance benefits.
- Lighting systems represent 20 percent of U.S. energy use. Upgrading outdoor lighting systems can result in significant cost savings while providing other security, connectivity, and efficiency services. Higher efficiency technologies reduce load and ease the energy burden on strained communities post disaster.

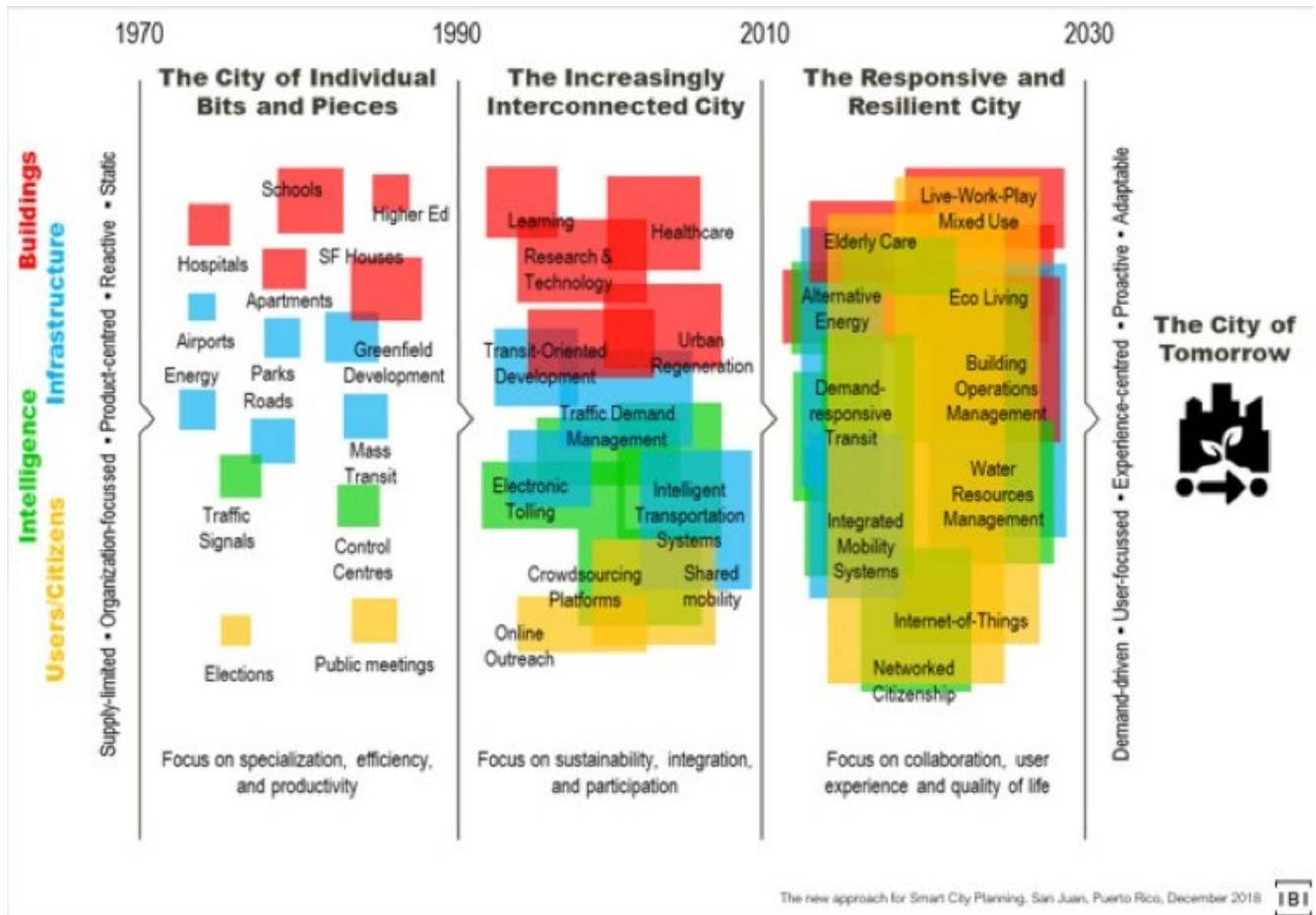
The intersection between the development of smart and resilient communities can be seen in the [Code for Smart Communities](#), which identified five (5) principles of smart urban development that closely align with the key resilience attributes:

- 1. Strategic:** Guided by a strategy that clearly identifies how investments in technology and data solutions will be made in order to accelerate livability, workability and sustainability outcomes.
- 2. Connected:** Access to best-in-class and ubiquitous connectivity while ensuring the interoperability of connected devices.

3. **Aware:** Invests in the collection, integration, analytics and communication of data as a basis for building awareness, insights and optimization of services and performance.
4. **Responsive:** A culture of ongoing positive change afforded through the insights and intelligence gathered from data and community collaboration.
5. **Innovative:** A culture of creativity, equity and agility to help advance opportunities for innovation.

The path to building smarter, more responsive and more resilient communities of the future is further captured by IBI Group in Figure 1, emphasizing a focus on collaboration, user experience and quality of life.

Figure 1: The Responsive and Resilient City of Tomorrow. Credit: IBI Group.





The goal of the Readiness for Resilience program is to help communities rebuild their infrastructure with smart technology best practices to improve resilience



Readiness for Resilience Program

In the aftermath of the devastating 2017 hurricane season that brought hurricanes Harvey, Irma and Maria, it became clear that more needed to be done to assist long-term recovery and better prepare for future events. Like so many concerned companies, organizations and individuals, Qualcomm made financial donations to communities impacted by these natural disasters and utilized its technology to help connect people and restore communications systems. But it also wanted to bring something new to the table and decided to focus on its strength - technology.

Qualcomm partnered with the Smart Cities Council, the Business Council for Sustainable Energy, and the National Association of State Energy Officials. The partners collectively created the “Readiness for Resilience” program that combined Qualcomm funding with the expertise and resources from the partner organizations and their networks.



The goal of the Readiness for Resilience program is to help communities, first in Puerto Rico and Texas, rebuild their infrastructure with smart technology best practices to improve resilience so that they become better prepared for the next natural disaster, better withstand such disasters, and recover more quickly, for the benefit of the people.

The program involves: 1) a discovery phase, using workshops to build stakeholder support and learn of local rebuilding needs and smart project priorities; 2) the development of a “Resilience Roadmap” with technology best practices and solutions to meet identified community rebuilding needs; and 3) pairing technology roadmaps with planned rebuilding initiatives and funding opportunities to ensure smart, resilient and sustainable technology is incorporated into infrastructure rebuilding.



Readiness for Resilience Workshops

“

Turning Puerto Rico into a platform for innovation is the greatest opportunity we are going to have to rebuild Puerto Rico in a stronger way.

”

Workshop Overview

On December 4-5, the Partner Organizations, including the Smart Cities Council, the Business Council for Sustainable Energy, and the National Association of State Energy Officials, held a Readiness for Resilience Workshop in San Juan, Puerto Rico. The event was held in collaboration with the Government of Puerto Rico’s Federal Affairs Administration (PRFAA) and the Central Office of Recovery, Reconstruction and Resiliency (COR3).

Nearly 200 conference attendees heard directly from top government officials, industry and academia experts, and other stakeholders on ideas, plans and strategies to rebuild. Today, Puerto Rico already has ambitious plans, including mandating 100% renewable energy by 2050. It wants to learn from global smart cities best practices, but then improve upon them and deploy smart, resilient technologies throughout its infrastructure.

Omar Marrero, Executive Director of COR3 and the Puerto Rico Public-Private Partnerships Authority (the “P3 Authority”), stated that turning Puerto Rico into a “platform for innovation” is “the greatest opportunity we are going to have to rebuild Puerto Rico in a stronger way.” He said, “We cannot just rebuild what we had before. We cannot. We can’t afford it.”

That's because Puerto Rico now understands that preparation is an investment that pays off — a lesson it hopes to teach other cities. Puerto Rico's first data portal came in the wake of Hurricane Maria. Before, data was often impossible to access. Sometimes essential data was on paper, locked in someone's office. In part due to the necessity of being able to show the status of recovery efforts, it created an online data portal and now is more committed to using data to drive smart decisions.

The Readiness for Resilience Program is built on the premise that public private partnerships are essential to tackling major challenges cities and communities face. Thus, conference participants also received an overview from private sector experts on the what, why and how of smart cities and how digital innovations enable communities to attain new levels of resilience.



To demonstrate how public private partnerships can be put into action, industry partners provided case studies about successful smart, resilient projects being implemented around the world in the areas of energy, communications, housing and transportation.

The plenary sessions involving experts from the public and private sectors served to provide the necessary background for a series of breakout working group sessions interspersed throughout the workshop. Participants from government, industry and NGO's divided into one of four focus areas: energy, communications, housing and transportation. They discussed how to use technologies and smart approaches to make Puerto Rico more resilient in each of those areas.

The working group sessions proved to be the source of an invaluable exchange of ideas, data, and recommendations across each of the priority rebuilding areas of energy, telecommunication, housing and transportation. As outlined in the Readiness for Resilience Program, the information gained from the working group sessions was utilized to develop this Resilience Roadmap that consists of best practices and technology solutions that could be utilized to meet the rebuilding and resiliency needs identified. The overriding objective is to have the Resilience Roadmap serve as a guide to identify specific projects and funding sources and encourage the formation of public-private-partnerships to move such projects forward to make cities and communities more resilient to natural disasters, and importantly, capable of quick restoration and recovery.

Working groups identified specific rebuilding priorities of the local communities and discussed innovative best practices and technology solutions to integrate into hurricane rebuilding projects to amplify resilience and other community benefits. This led to the identification of potential “smart resilience” project ideas that were further vetted to identify benefits, stakeholders, potential technologies, critical success factors and next steps.

Workshop Action Areas

There are many opportunities to integrate smart cities technologies and processes to build greater disaster resilience. Based on the existing work conducted by the Government of Puerto Rico, the following four areas were chosen to get deeper community input.



Together these four areas intersect with almost all aspects of the community, and they represent some of the most foundational and impactful smart and resilient technology applications. The workshops brought community leaders from a variety of backgrounds together with resilience and technology experts to seek answers to the following questions in the priority areas:

- **Housing:** As Puerto Rico transforms its housing sector, how can it factor smart city technologies and processes into project design to make housing safer, more resilient and more affordable for residents?

- **Communications and IT:** What are the technology options and design principles Puerto Rico should consider as it moves toward providing affordable, high-speed internet service to all Puerto Rico communities to support education, health care, social services, the visitor economy, emergency services, and other sectors?

- **Energy:** How can Puerto Rico factor smart city technologies and processes into distributed, renewable energy projects to build greater infrastructure resilience and economic opportunities?

- **Transportation:** What are some of the ways Puerto Rico might infuse more smart technology and innovation into its road and bridge repair and design standards to improve the mobility of people, goods and service providers?

Project 1: Local Telecom Planning & Response
Project 2: Regional Telecom Hub

Part 2 - 45mins: Develop Smart Technology Use Scenarios

Smart Technology Opportunities	Potential Collaboration Opportunities	Business Model Innovations	Potential Benefits Above and beyond traditional solution	Beneficiaries
<p>1) - High speed internet - Data capture - Smart meters - Plan Radio (Voices)</p>	<p>Utilities define goals with municipality Local Land use Citizenship Critical Infrastructure Public Safety N & O/S Government Private Industry</p>	<p>Distributed energy Community Swirls</p>	<p>Reliability, resilience Community Resilience</p>	<p>Municipalities, Citizens, Business Everyone</p>
<p>2) - VSat - High band with Self Contained mobile communication - Low Band with open source community messaging</p>	<p>Military Govt</p>	<p>Emergency Comms Operations</p>	<p>Community Resilience Clear, coordinated, Federal-State-Local effort Rapid Response Redundant / High Availability</p>	<p>Critical Infrastructure Life saving/aid operations</p>



Housing



This is an opportunity to transform the housing sector to be safe, resilient, and forward-looking, particularly for those living in vulnerable circumstances.



Issues

Puerto Rico’s housing sector was hit hard by the hurricanes. According to the Economic and Disaster Recovery Plan for Puerto Rico, approximately 90 percent of the Island’s nearly 1.23 million households applied for immediate relief and housing assistance from FEMA, with 78 percent of these indicating damage to their structure or personal property.

Before the hurricanes, the housing market was experiencing significant challenges. As residents have moved away, home values have plunged, dropping 18 percent in Puerto Rico since 2010. As Puerto Rico’s economy has faltered, mortgage delinquencies have been increasing steadily for many years. Income disruptions caused by the hurricanes exacerbated this problem, and many households have not caught up on their payments. This has also resulted in an increase in applications for affordable rental housing units, which has not been met with an increase in supply, leading to long waiting lists.

Another housing challenge is that many people build without seeking permits. The lack of formal ownership records makes government service delivery and collection of property taxes very difficult and is a substantial barrier to disaster recovery efforts.

Recovery Strategies

According to the Economic and Disaster Recovery Plan for Puerto Rico: “this is an opportunity to transform the housing sector to be safe, resilient, and forward-looking, particularly for those living in vulnerable circumstances.” The plan outlines the following vision for its housing sector:

- Provide residents with safe and affordable places to live;
- Retrofit homes to make them less vulnerable to damage;
- Relocate households from the most dangerous areas;
- Increase insurance coverage to help rebuild structures in the event of a disaster;
- Clarify ownership records to bring the informal housing into the formal sector, which would facilitate government service delivery and collection of property taxes.

Puerto Rico seeks to repair and rebuild safe and affordable housing to create a better and more resilient physical environment for Puerto Rico's citizens:

- Make buildings safe and affordable for residents
- Restructure the housing sector - e.g. creating a central source of data related to the housing stock, including title, permits, land use, property tax, and location

Smart Project Recommendations

The working group identified three project ideas for factoring smart technologies, data and processes into the restructuring of the housing sector to achieve the goals and strategies outlined in the Recovery Plan.

Project H-1: Collaborative Smart City IT Knowledge Platform. Implementation of a collaborative IT platform to share vision and strategy, roadmaps, best practices, projects, solutions and providers. The system would unite state government and municipalities with citizens, providers and NGOs.

Project H-2: Resilient SMART House Designs. To accelerate implementation of quality sustainable, resilient and smart housing, the working group discussed the idea of having the University of Puerto Rico develop a portfolio of accredited smart housing designs. Each design would satisfy requirements for resiliency, sustainability, safety, affordability and wellness. The University would review national and international housing concepts and adapt to meet Puerto Rico requirements. The project would be developed in collaboration with state government and municipalities with citizens, solutions providers and international NGOs.

Project H-3: Accelerated Housing Retrofit Program. Develop a program to retrofit currently damaged and old housing. Focus on creating standard accredited solutions / modules for retrofit use. Solutions could be developed in partnership with University of Puerto Rico and piloted on 3-5 Municipalities. Consider engaging the insurance industry to understand how to incentivize the construction of more sustainable, smart, and livable housing in the wake of disaster.

Additional Considerations:

Project H-4: Institute Residential Energy Disclosure Policies. Energy disclosure policies and programs use labels, scores, and supplementary information in order to increase homeowner awareness and information on the energy performance of their properties. Energy disclosure policies inform the homebuying process and can help identify the need for energy efficiency and resiliency investments in properties that are up for sale, refinance, and rehabilitation.

(For more information: <https://naseo.org/issues/buildings/home-energy-labeling>)

Project H-5: Integrate Resilient Design into Affordable Housing Projects. Through the Puerto Rico Housing Finance Authority (PRHFA), the Commonwealth can incentivize low-income housing developers to integrate resilient systems and design into newly-constructed and rehabilitated homes and apartment buildings. For instance, PRHFA can require that for housing to be eligible for its subsidy and low-interest financing programs, developers must demonstrate that their design and construction will meet sustainability, energy performance, safety, and disaster resiliency standards.



Energy



Energy is critical infrastructure and powers critical infrastructure.



Issues

One hundred percent of Puerto Rico was without power as a result of hurricanes Maria and Irma. Without power, many other systems, including telecommunications, water and transportation, also failed.

According to the Government's Economic and Disaster Recovery Plan, Puerto Rico's electrical grid was vulnerable before the hurricanes due to a fragile system, dependency on fossil fuels, lack of skilled workers, and outstanding debt. These factors exacerbated the catastrophic situation caused by the hurricanes.

The Puerto Rico Electric Power Authority (PREPA) is undergoing a transformation of governance. A likely path forward is the privatization of PREPA's generation assets and the formation of public-private partnerships for leasing and operating transmission and distribution assets. Through support of the Southern States Energy Board, the Puerto Rican legislature will be developing an energy policy for a 30-year time horizon by December 2018 to support managing and maintaining these assets. An Integrated Resource Plan has also been released outlining the strategy.

Recovery Strategies

A top capital investment focus in the Economic and Disaster Recovery Plan for Puerto Rico, is energy. Specifically, Puerto Rico seeks to “develop an energy system that is customer-centric, affordable, reliable, and scalable; incorporates more renewables, microgrids, and distributed energy resources; and can drive new businesses and employment opportunities and support residents’ well-being.” The Plan outlines the following actions to achieve this transformation:

- Improve, harden and maintain electricity infrastructure
- Design build and maintain electrical systems with island-able portions of the grid
- Diversify energy sources to reduce reliance on imported fuel
- Enhance the emergency preparedness and response of the energy system
- Understanding the impact of tradeoffs on the cost of reconstruction and future resilience of the electrical grid

Smart Project Recommendations

Three working groups focused on different areas for energy sector transformation and how to factor in smart technologies, data and processes to improve outcomes, resulting in the following project ideas.

Project E-1: Distributed energy system. Transform from centralized fossil to distributed renewable power generation in Puerto Rico, utilizing Renewable Energy (RE), Energy Efficiency (EE), Demand Management, Storage, and Clean Generation Options (like CHP). Move toward a virtual power plant model and factor smart technologies into existing plans for microgrids, such as the Vieques project.

Specifically with respect to Vieques, working group participants explored enhancing the microgrid it to make it not dependent on imported or fossil fuels – the key is to evolve to storage and solar over time. They also recommended seeking opportunities to leverage electric vehicles to help with deploying and offering storage over time. They recommended using data analytics to facilitate vehicle and microgrid power management and optimization.

Considerations:

- Use federal funds to offer incentives to buy down storage for residential and commercial DG systems and/or electric vehicles purchases.
- Implement time of use rates and customer education programs.
- Partner with energy value chain for energy and automobile manufacturers, cruise, industrials, etc. to help build out the market.

- Explore whether CBDG funds could be used to buy down costs for storage or EV technologies.
- Making interconnection easy to existing grid – rules and laws on settlement issues are needed. Need an honest broker system.
- COR3 – supports EE; how can it replace ARRA funds or create revolving funds that are leveraging private capital.
- PREPA 2.0 (T&D only) – what is the relationship between privatization of the grid and distributed energy resources, governing rules and regulations.
- Energy market plan needs to be developed, with the support of the government. This would then be shared with investors/players. It could build upon grid modernization plan that is being developed.

Potential Near-term Actions

- Support first responders, NGOs to enable resilient power
- Vouchers/incentives for RE and storage (EE?, EVs?)
- Pass legislation to change interconnection and other policies
- Engage with collaborators (see list above)
- Work to develop business plan to get energy brokers in and build energy markets
- Communicate to give to better direction of recovery funds
- Community engagement/development – buyer aggregation/Coops (SMUD is a good model)

Project E-2: Community-level resilience and sustainability education. Create community-level opportunities for adopting resilient power systems and reducing energy consumption through educational programs.

This working group focused on the powerful role of community-level knowledge to drive action. For example, a mayor from one municipality shared his experience regarding their microgrid system adoption and was asked to provide advice to another community, one of the last to get their power restored, about how they can move forward in a similar way. Another municipal leader in the working group has been focusing on educating about building energy efficiency to reduce consumption, lower energy costs and place less burden on the grid.

The working group recommended using a grass roots approach that empowers municipalities to:

- Better understand their energy options
- Turn consumers into knowledgeable energy citizens

- Take greater control of their destinies with respect to energy resilience and associated economic development opportunities

The project would entail community-level education and empowerment on how to be resilient and sustainable with approaches such as:

- Technologies to improve energy efficiency and reduce peak load/ grid pressure
- Community microgrid systems
- Rooftop solar with storage
- In-home energy management
- IoT network to track consumption
- Data analytics
- Collective knowledge sharing tool/ app

Project E-3: Waste-to-Energy Tire Plant. Build a power production facility powered by syngas from scrap tires, addressing tire waste and oil import issues.

This innovative approach was envisioned as a way to address:

- The expense and environmental impacts of imported fossil fuel for power production
- The health and economic aspects of the large quantities of tire waste in Puerto Rico that often ends in landfill

One of the solution providers present for the workshop, Pennoni, presented a video on this process: <https://www.youtube.com/watch?v=0vQtyBacabg>

Additional Considerations:

Project E-4: Localized infrastructure monitoring. Improve monitoring of underground and above ground utility infrastructure at the connection level to provide household service visibility to expedite recovery.

- Piggyback on IoT technologies, sensors, monitoring and data opportunities on existing infrastructure such as energy, water, and buildings.
- Leverage fiber optic infrastructure and sensing technology.

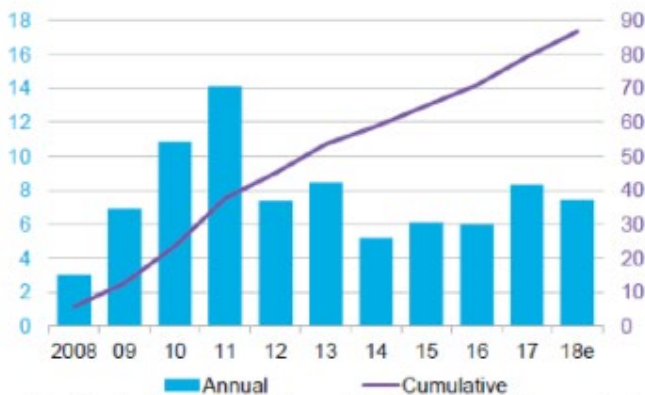
In addition to improved response and recovery post event, this approach will improve utility operations and maintenance, reduce costs and improve service quality, improve safety on an on-going basis, and enhance pre-disaster preparedness.

Project E-5: Smart Metering, Smart Grid, and Energy Efficiency. Better manage power outages, reduce financial losses, and shorten outage time by installing smart grid technologies and systems.

- Distribution automation devices (such as smart switches) identify faults in the distribution system and perform corrective actions automatically, lessening the need for field crews to locate and manually address faults.
- Advancing metering infrastructure communicates with utilities to verify outage status and dispatch repair crews accordingly.
- Baseline energy efficiency and energy management projects enable residential and business properties to better endure harsh weather conditions and extreme temperatures, without placing undue stress on the electric grid. When paired with smart grid and communications technologies, these measures enable effective communication to utilities to ensure field crews address highest-need outages first (for example, prioritizing households and residents that rely on medical equipment or properties that have been without power for extended periods of time).

Deployment: U.S. smart electricity meter deployments

U.S. smart meter deployments



Top 10 states by penetration, 2017



- Smart meter installations hit a peak in 2010 and 2011, supported by stimulus funding awarded in 2009. Many of the largest U.S. utilities took advantage of the Smart Grid Investment Grant to roll out smart meters across their territories. As grant funding dried up, deployments slowed, hitting a trough in 2014. Smart metering activity has since picked up though it remains well below the peak of 2011.
- Today 57% of U.S. electricity customers have a smart meter, but there is enormous regional variation. The top 10 states all have penetration greater than 80%. In contrast less than one in 10 customers has a smart meter in the bottom 10 states. Over 2016-17, Pennsylvania, Illinois, Texas and North Carolina were the most active smart metering markets, each deploying over a million meters according to estimates.
- The greatest cost saving for utilities from smart metering is replacing the need for manual meter reads. But a renewed focus on grid modernization and growing interest in dynamic retail tariffs is leading state regulators and utilities that have shied away from the technology to reassess the benefits of deployment. Hold-out states, such as New York and Rhode Island (where smart meters currently number in the hundreds), have both committed to extensive smart meter rollouts over the next five to 10 years.

Source: BloombergNEF, EIA. Note: there is a 10-month lag in official smart meter statistics, as a result 2018 figures include BloombergNEF estimates.



Communications and IT



Establish regional communication hubs that include resilient, redundant telecom systems that communities can rely upon in the midst of natural disaster.



Issues

The failure of Puerto Rico's communications infrastructure created challenges during the disaster. Following Hurricane Maria, police, fire, and emergency medical services were unable to respond to 911 calls. Cellular, landline, and internet services in Puerto Rico make extensive use of aerial fiber-optic cables. This condition made Puerto Rico's telecommunications infrastructure susceptible to damage from extreme weather and natural disasters, as happened during the hurricanes. Some infrastructure, such as poles that support those cables, were damaged by the winds, resulting in the loss of transmission capacity for voice and data communications. In addition, the remote location of many cell towers made it difficult to repair them and to refuel backup power generators to power essential equipment.

Degraded cellular service is of particular concern in Puerto Rico, where at least 80 percent of the population depends on cellular phones to communicate.

While numerous actions are under way to address short-term recovery needs, Puerto Rico is considering medium- and long-term solutions, as well as best practices for implementing them. Government agencies and the private sector play important roles in implementing and funding these solutions. To ensure an effective and innovative modernization of the telecommunications and information systems, Puerto Rico will implement actions using proven best practices, including those related to cyber and information security.

Recovery Strategies

The Economic and Disaster Recovery Plan for Puerto Rico started the mandate to modernize the telecommunications system to develop fast, reliable, and resilient residential, commercial, and emergency communications that drive Puerto Rico's economy, prosperity, and well-being. Key tenants include:

- Strengthen emergency communications systems to facilitate quick and effective disaster response.
- Create and sustain a robust and resilient communications infrastructure, including widely available broadband internet.
- Establish governance structures to support and monitor changing infrastructure.
- Take advantage of improved access to broadband services and information technology for the betterment of Puerto Rico.

Smart Project Recommendations

The telecommunications working group offered the following project recommendations for improving communications and IT.

Project C-1: Regional Telecom Hubs. The working group recommended establishing regional communications hubs that include resilient, redundant telecommunications systems communities can rely upon in the midst of natural disaster. Participants suggested:

- A communications system with several layers — radio, wireless, fiber optic, satellite — that operate in parallel, which should be available to all agencies.
- The use of high bandwidth self-contained mobile communications. Mobile units can be shared across regions and agencies and directed to where they are needed the most.
- Low bandwidth open source community messaging

Project C-2: Local Telecom Planning and Response Training. The working group recommended regular training and testing activities to ensure preparedness. This could include:

- Municipal Involvement and education
- Annual drill awareness activities
- Municipal/State training on emerging comms
- Public awareness campaign

Additional Considerations

Project C-3: Resilient communications infrastructure: Recommend creating greater telecom system resilience by hardening and expanding infrastructure and creating more redundancy. This would improve baseline community connectivity while withstanding damage to assist in emergency response and recovery. Key tenants:

- Use diverse networks to create redundancy, including cellular, mesh and Wi-Fi.
- Consider buried fiber lines in areas more impacted by wind damage.
- Consider fiber optic sensing technology to continuously monitor structural integrity, water flow, vehicle movement, human traffic, digging activity, seismic activity, temperatures, liquid and gas leaks, and many other conditions and activities.
- Combine permanent and temporary towers for better connection and faster recovery after events.
- Leverage existing community infrastructure assets – utility and streetlight poles, buildings, vehicles, etc.
- Piggyback on other initiatives – such as the FirstNet public safety network and utility upgrades to communications infrastructure.





Transportation and Mobility



Transforming surface transportation into flexible and reliable systems that move people and goods to ensure economic continuity and facilitate disaster response.



Issues

The working group focused primarily on surface transportation, particularly tied to the Government's strategic recovery area of rebuilding and strengthening surface transportation.

According to the Economic and Disaster Recovery Plan for Puerto Rico, finances are challenging for Puerto Rico Highway and Transportation Authority (PRHTA), which funds and oversees major road and bridge projects. Major roads were in only fair condition before the hurricanes, and 80 percent of Puerto Rico's bridges were in fair or poor condition—an issue that hurricane damage compounded. About half of the municipalities surveyed identified road repair, maintenance, and other transportation infrastructure improvements as their number one priority for long-term investment in their jurisdiction.

Puerto Ricans are heavily dependent on their vehicles. Public transportation is generally considered inadequate, and ridership has been declining over the past decade. Adding to these challenges is a lack of clarity, in many cases, over which agency owns particular assets. In the absence of established legal ownership, it may be difficult to determine eligibility for funding needed to make repairs and investments in resilience

Recovery Strategies

The Government of Puerto Rico seeks to rebuild and transform surface transportation into flexible and reliable systems that move people and goods to ensure economic continuity and facilitate disaster response. This includes:

Prioritizing repairs to roads and bridges, and extending three key highways. PRHTA will harden, reengineer, or relocate infrastructure in high-risk areas to make it more resilient in future disasters, with a focus on the most cost-effective projects. Related to this effort, PRHTA will review its standards on road and bridge design. This will involve updates to include more innovative standards on roadway marking, lighting, drainage, and signs and signals (including using solar to power them) and better enforcement of both new and existing standards. In addition, PRHTA will develop an Intelligent Transportation System so that transportation operations across Puerto Rico can provide real-time traveler information, divert traffic away from crashes, clear crashes more quickly, and reduce the possibility of secondary crashes after an initial incident.

Developing new mobility options to supplement improvements to bus service. The Puerto Rico Metropolitan Bus Authority will make bus service more reliable and to develop additional options—such as ride-hailing, ride-sharing, expanded “publico” (jitney) service, inter-city bus service, bike- or scooter-sharing, and peer-to-peer car-sharing—will address the dearth of other mobility services, particularly outside of San Juan. In addition, PRHTA proposes two new high-capacity transit services—likely bus rapid transit—to give travelers another way to reach the San Juan airport, which is currently served by just three bus routes, and to give the 130,000 residents of Caguas a public transit option to reach nearby San Juan.

Smart Project Recommendations

Project T-1: Future-proofing transportation infrastructure. In transportation, Puerto Rico has a need for very basic infrastructure, which makes longer-term planning more difficult. This working group explored how to “future proof” roads and other transportation infrastructure so that basic elements will be in place when there finally is demand for things like electric or autonomous vehicles.

Additional Considerations

Project T-2: Real-time, coordinated evacuation and resource routing: Improve evacuation effectiveness and efficiency by using a variety of communications devices, sensors and data to route and reroute people to safety and resources in real-time during a disaster. Not just at the individual local level but using a multi-jurisdictional command center to coordinate across all evacuation areas, localities and agencies. With situations changing minute by minute, a near real-time understanding of roadway obstacles, gas availability, shelter, food and water, and emergency medical resources is vital.

Features include:

- Road, bridge and sewer sensors to track water levels and roadway obstructions.
- Real-time traffic counting sensors.
- Integration with existing mobile wayfinding apps such as Waze.
- Business and crowdsourcing app that keeps individuals and agencies up to date on the status of gas stations, restaurants, motels, emergency shelters, road closures, and other information to assist evacuees.
- Sensors/ tracking of emergency and rescue vehicles.
- Distress signal embedded in mobile apps to identify people who need help.
- Overarching analytics platform for live route planning.
- Sensors should be back-up battery powered.
- Emergency back-up communications systems along evacuation routes to ensure the system functions in emergencies.

Project T-3: Smart signage: In addition to strategically placing signage and incorporating real-time data to improve signage along evacuation routes, a smart system would use real-time triggers, such as roadway water-level sensors, to adjust signage, suggest reroutes and automate road closure gates.



Ideas to Action



Converting ideas into action requires Governor's Commission alignment, identifying funding and financing, and structuring people and processes for success.



The Readiness for Resilience workshops resulted in 16 smart resilience project concepts to address community rebuilding priorities. Converting these from ideas to implementable initiatives requires:

1. Alignment with recommendations from the Economic and Disaster Recovery Plan for Puerto Rico to ensure they connect to but are not redundant with initiatives that have government backing and resources.
2. Identification of funding and financing resources, including the consideration of non-traditional business models such as Public-Private Partnerships.
3. Adherence to governance best practices - the people and processes that set structures for success.

Alignment with Government's Report

The tables in this section map how the smart resilience project concepts align to recommendations from *An Economic and Disaster Recovery Plan for Puerto Rico*. The intent is to factor these project ideas into the Recovery Plan recommendations as they are acted upon, infusing smart principles into rebuilding practices.

Project Focus Areas + Technology Enablers

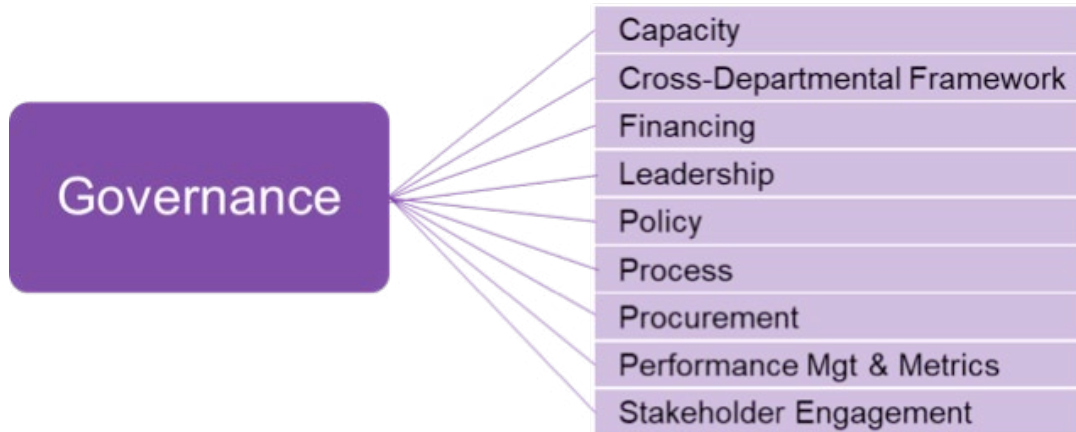
Seek opportunities for projects in one area to address multiple responsibility areas and look for technology coordination and synergies

"Smart for Resilience" Projects	An Economic and Disaster Recovery Plan for Puerto Rico Capital Investments – Strategic Initiatives													Technology Enablers						
	Energy	Communications & IT	Water	Transportation	Housing	Public Buildings	Education	Health & Well Being	Natural Environment	Ocean Economy	Visitor Economy	Emergency Services	Agricultural Transformation	Digital Transformation	21 st Century Workforce	Entrepreneurship	Advanced Manufacturing	Computing	Connectivity	Instrumentation & Control
Project H-1: Collaborative Smart City IT Knowledge Platform					•	•	•	•						•	•	•		<ul style="list-style-type: none"> Analytics Dashboards Data Platform Mobile App 	<ul style="list-style-type: none"> WiFi RF Mesh Cellular 	
Project H-2: Resilient SMART House Designs					•	•	•							•	•	•		<ul style="list-style-type: none"> Analytics Dashboards Data Platform Mobile App 	<ul style="list-style-type: none"> WiFi RF Mesh Cellular 	
Project H-3: Accelerated Housing Retrofit Program						•	•								•	•		<ul style="list-style-type: none"> Analytics Digital Services 		
Project E-1: Distributed energy system	•	•			•	•									•	•		<ul style="list-style-type: none"> AI/AR Dashboards Digital Services Privacy/Security Interoperability 	<ul style="list-style-type: none"> RF Mesh Cellular 	<ul style="list-style-type: none"> Controls Meters Sensors
Project E-2: Community-level resilience and sustainability education	•	•			•	•	•	•							•	•		<ul style="list-style-type: none"> AI/AR Dashboards Digital Services Privacy/Security Interoperability 	<ul style="list-style-type: none"> RF Mesh Cellular 	<ul style="list-style-type: none"> Controls Meters Sensors
Project E-3: Waste-to-Energy Tire Plant	•	•		•				•								•		<ul style="list-style-type: none"> Dashboards Digital Services 		<ul style="list-style-type: none"> Controls Meters Sensors
Project E-4: Localized infrastructure monitoring	•	•	•		•	•		•						•	•			<ul style="list-style-type: none"> AI/AR Blockchain Dashboards Digital Services Privacy/Security Interoperability 	<ul style="list-style-type: none"> RF Mesh Cellular 	<ul style="list-style-type: none"> Controls Meters Sensors
Project E-5: Smart Metering, Smart Grid, and Energy Efficiency	•	•	•		•	•		•						•	•			<ul style="list-style-type: none"> AI/AR Blockchain Dashboards Digital Services Privacy/Security Interoperability 	<ul style="list-style-type: none"> RF Mesh Cellular 	<ul style="list-style-type: none"> Controls Meters Sensors
Project C-1: Regional Telecom Hubs	•	•					•							•	•			<ul style="list-style-type: none"> Analytics AI/AR Blockchain Cloud Dashboards Data Platform Digital Services Location/GIS Networking Privacy/Security Interoperability 	<ul style="list-style-type: none"> Cellular WiFi RF Mesh LPWAN/LoRa WAN Satellite Other 	<ul style="list-style-type: none"> Controls Sensors
Project C-2: Local Telecom Planning and Response Training	•	•				•	•				•		•	•				<ul style="list-style-type: none"> Analytics Dashboards Data Platform Mobile App 	<ul style="list-style-type: none"> Cellular WiFi RF Mesh LPWAN/LoRa WAN Satellite Other 	<ul style="list-style-type: none"> Controls Sensors
Project C-3: Resilient communications infrastructure	•	•					•				•		•	•				<ul style="list-style-type: none"> Analytics AI/AR Blockchain Cloud Dashboards Data Platform Digital Services Location/GIS Networking Privacy/Security Interoperability 	<ul style="list-style-type: none"> Cellular WiFi RF Mesh LPWAN/LoRa WAN Satellite Other 	<ul style="list-style-type: none"> Controls Sensors
Project T-1: Future-proofing transportation infrastructure				•							•				•			<ul style="list-style-type: none"> Analytics AI/AR Blockchain Cloud Dashboards Data Platform Digital Services Location/GIS 	<ul style="list-style-type: none"> WiFi RF Mesh Cellular 	<ul style="list-style-type: none"> Cameras Controls GPS Sensors
Project T-2: Real-time, coordinated evacuation and resource routing		•	•				•						•	•	•			<ul style="list-style-type: none"> Analytics AI/AR Blockchain Cloud Dashboards Data Platform Digital Services Location/GIS 	<ul style="list-style-type: none"> WiFi RF Mesh Cellular 	<ul style="list-style-type: none"> Cameras Controls GPS Sensors
Project T-3: Smart signage		•	•				•						•	•	•			<ul style="list-style-type: none"> Analytics AI/AR Blockchain Cloud Dashboards Data Platform Digital Services Location/GIS 	<ul style="list-style-type: none"> WiFi RF Mesh Cellular 	<ul style="list-style-type: none"> Cameras Controls GPS Sensors

Governance Recommendations

Successful smart technology projects use smart governance practices. Figure 6 outlines some of the governance considerations for smart resilience program implementation. This is followed by specific recommendations.

Figure 6: Smart Cities Governance Considerations. Source: Smart Cities Council

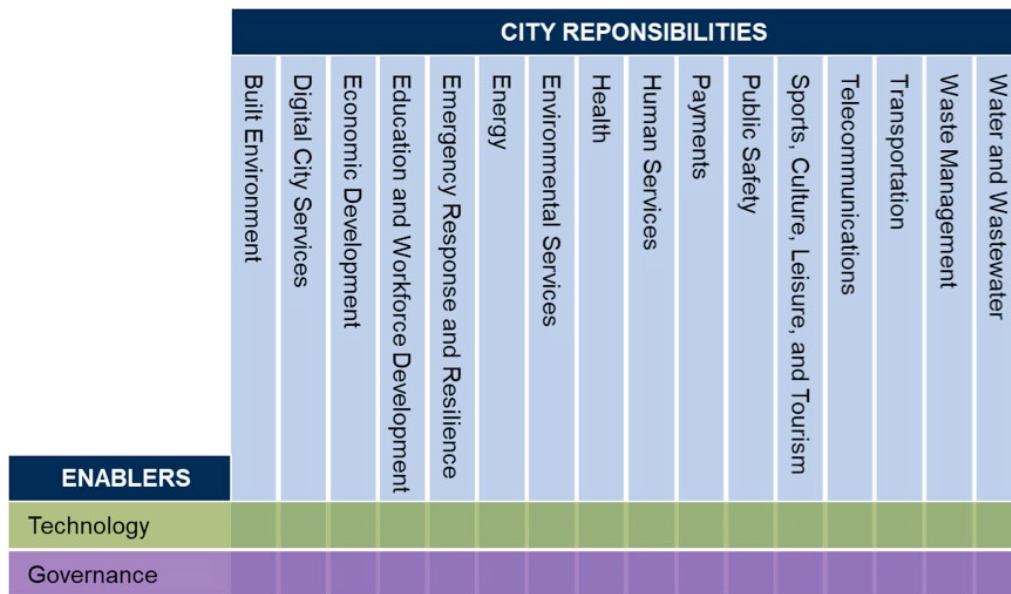


Include smart technology guidelines in rebuilding project planning and procurement:

Ensure projects adhere not only to updated building codes and flood maps, but also to modern connectivity, interoperability, data collection, energy management and automation standards. **Priority must go to making the most of existing investments**, not just new ones. Typically, that means retrofitting existing assets - streets, buildings, equipment - with sensors and communications. From an **interoperability** perspective, adhere to open standards to ensure systems use predefined mechanisms to talk to each other. Also use open integration architectures and loosely coupled interfaces so that components can be swapped in and out. **Energy resilience** is also critical. Consider energy resources availability for homes, business, communities - as well as at the municipal and county levels. Forge partnerships to ensure access to power and other energy resources needed for communications, transportation and housing in advance of an event. Consider how these investments help achieve other community needs and how they can provide valuable benefits every day. This helps with community buy in and financing.

Adopt a cross-departmental framework: The Smart Cities Framework - Figure 7 - provides a way to factor smart technology principles into community rebuilding and revitalization projects. Smart principles include looking for ways to multi-purpose projects and investments to achieve multiple benefit streams. For instance, solutions and technologies implemented in one city responsibility area should also be assessed to see how they can benefit other responsibility areas.

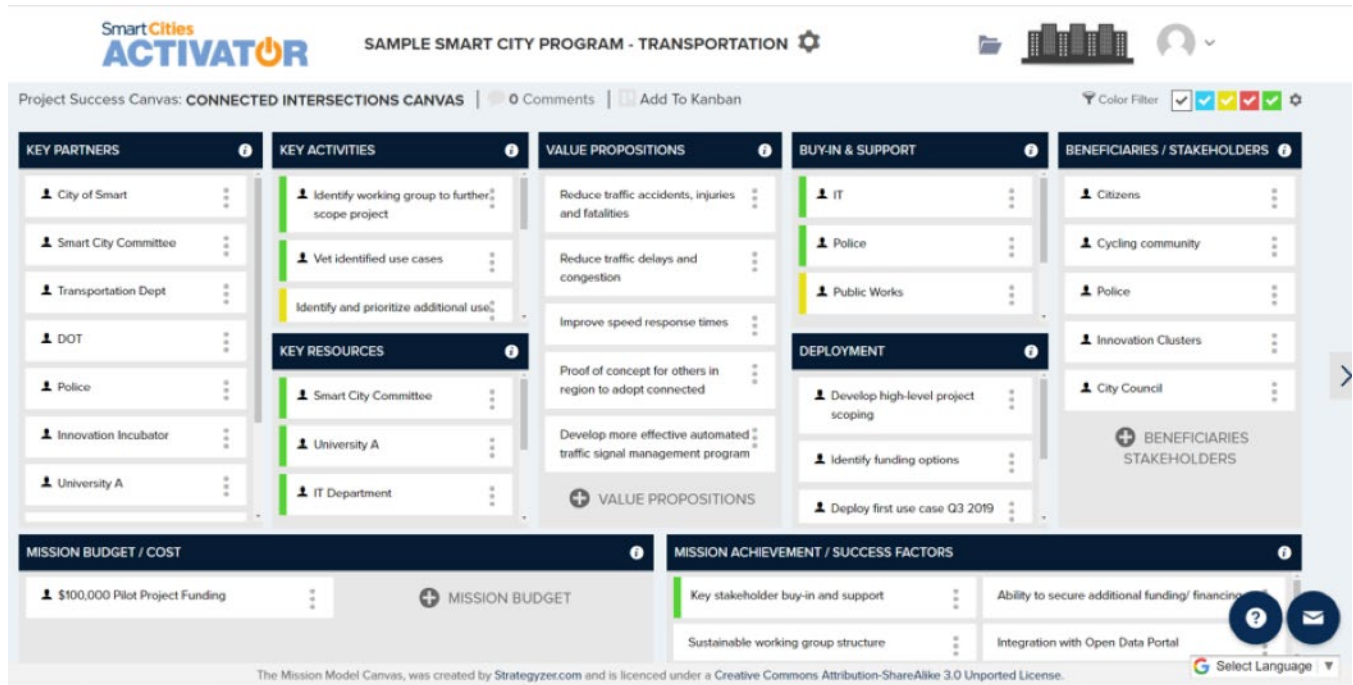
Figure 7: Smart Cities Framework. Source: Smart Cities Council



Collaboratively scope projects: Further develop each Discovery Workshop project concept by formalizing stakeholder roles and responsibilities, and identifying measurable targets, actions, funding mechanisms, implementation timelines and success factors. Consider using collaborative, digital planning tools and structured project templates to align stakeholders and make it easy to compare across projects.

Define and track metrics as part of project scoping. Set targets so you can measure progress and show how the outputs of investments and activities are delivering outcomes. [ISO 37120](#) is one resource for metrics, providing over 100 metrics for sustainable, smart and resilient cities. Also **use a baseline of current performance** to track progress and help frame the success of future performance. Ensure your governance arrangements allow for **clear responsibilities** to be identified for the function of ongoing monitoring, reporting and communication of the intended outcomes.

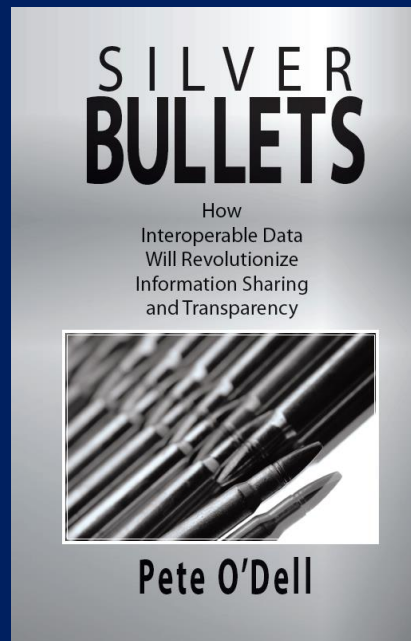
Figure 8: Sample Planning Template: Project Success Canvas. Source: Smart Cities Council, Smart Cities Activator



Revamp outdated procurement policies that impede progress and innovation. Adopt standardization around clauses, terms & conditions, evaluation criteria (including smart technology principles) and sub-contracting guidance. Promote greater engagement with other communities and counties to understand what has worked well and foster closer collaboration. Also look to **organize collective procurement processes** that take advantage of knowledge and synergies from different public authorities with similar needs. Consider **Public/Private Partnerships** as a mechanism to work closer with industry and procurement professionals to deliver projects while offsetting financial and technical risk. This will be explored in detail in the Spring / Summer 2019 Readiness for Resilience workshop.

Engage citizens and end-users – generate dialogue and create forums for exchange with the community around challenges and potential solutions.

“Our future is becoming complex and intertwined, with many issues interacting in ways we wouldn’t have anticipated. Think of interoperable data as a means to overcome the challenges.”



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Making use of interoperable data is an opportunity for every organization, big or small. Key benefits can include:

- **Enabling information sharing with trusted partners**
- **Enhancing system capabilities and longevity**
- **Lowering overall costs of information applications**
- **Improving the breadth and quality of information**
- **Increasing the speed and accuracy of decisions**
- **Improving transparency and speed of disclosure of information to valid constituents**
- **Preserving data for future uses, including those not yet conceived**

Funding and Financing Options

One of the biggest obstacles to overcome with any smart resilience project is securing funding or financing. Figure 5 provides an overview of some of the available funding sources. The Spring/Summer 2019 Readiness for Resilience workshop will further map funding and financing options to the smart resilience projects identified in the Discovery Workshops to move them toward implementation.

Figure 5 Hurricane Harvey Recovery Funding/ Finance Inventory. Source: National Association of State Energy Officials:

Hurricane Maria/Irma Disaster Recovery: Funding and Financing Inventory for Smart Technologies and Infrastructure in Puerto Rico: Prepared by the National Association of State Energy Officials (NASEO)							
Type of Funding	Agency(ies)	Structure of Funds/Assistance	Program Name	Target Applicants	Key Program Features	Relevance to Smart Technologies	For more information, visit:
Federal	U.S. Department of Housing and Urban Development, Puerto Rico Department of Housing	Grants	Community Development Block Grant—Disaster Recovery (CDBG-DR) Program	"Pending appropriation of funds by Congress, Members of the public impacted by a disaster cannot receive CDBG-DR funds directly from	Affected taxpayers can claim disaster-related property damage, destruction, and theft losses attributable to a federally declared disaster.	While there is no direct connection to smart technologies, reimbursements for disaster-related expenses may be used to rehabilitate or replace property. These reimbursements (insurance payments, cash gifts, etc.) must be subtracted from the loss claims to the IRS.	https://www.irs.gov/newsroom/tax-relief-presidentially-declared-disaster-areas
Federal	Internal Revenue Service	Tax Relief	Tax Relief: Presidentially Declared Disaster Areas	"Affected Taxpayers," i.e. individuals and businesses located in the disaster area, those whose tax records are located in the disaster area, and relief workers. The same relief will also apply to any places added to the disaster area.	Affected taxpayers can claim disaster-related property damage, destruction, and theft losses attributable to a federally declared disaster.	While there is no direct connection to smart technologies, reimbursements for disaster-related expenses may be used to rehabilitate or replace property. These reimbursements (insurance payments, cash gifts, etc.) must be subtracted from the loss claims to the IRS.	https://www.irs.gov/newsroom/tax-relief-presidentially-declared-disaster-areas
Federal	Federal Emergency Management Agency	Insurance	National Flood Insurance Program	Home and business owners and tenants in communities that participate in the NFIP program.	Purchase of flood insurance is mandatory for all federal or federally-related financial assistance for the acquisition and/or construction of buildings in high-risk flood area.	Designed to restore property to pre-disaster condition. However, NFIP reduces flood insurance premiums for property owners in communities that promote elevation, outreach projects, hazard disclosure, floodplain mapping, stormwater management, flood warning and response, and other efforts. The program also offers "Increased Cost of Compliance" coverage for substantially damaged property and for additional measures needed to meet the floodplain management ordinance in a community.	https://www.fema.gov/national-flood-insurance-program
Federal	Federal Emergency Management Agency	Grant	Flood Mitigation Assistance Grant Program	States, Territories, federally-recognized tribes and local communities participating in the National Flood Insurance Program.	Funds projects and planning that reduces or eliminates long-term risk of flood damage to structures insured under the National Flood Insurance Program. Local communities may sponsor applications on behalf of homeowners, businesses, and nonprofits and then submit the applications to their State.	Funding support the development of mitigation strategies, data collection, and proven techniques that integrate cost-effective natural floodplain restoration solutions and improvements to NFIP-insured properties.	https://www.fema.gov/flood-mitigation-assistance-grant-program

Type of Funding	Agency(ies)	Structure of Funds/Assistance	Program Name	Target Applicants	Key Program Features	Relevance to Smart Technologies	For more information, visit:
Federal	Federal Emergency Management Agency	Grant	Pre-Disaster Mitigation Grant Program	States, Territories, federally-recognized tribes and local communities participating in the National Flood Insurance Program.	Planning and project grants support implementation of a sustained pre-disaster natural hazard mitigation program and public awareness-raising efforts. Local communities may sponsor applications on behalf of homeowners, businesses, and nonprofits and then submit the applications to their State Emergency Management Agency.	Funds can support mitigation, resilient infrastructure projects, planning, and program management costs. The "Resilient Infrastructure Competitive Funding" project type provides the opportunity to advance capital projects on a community level, ready for investment that will reduce risks, prevent loss of life and leads to significant savings by reducing damage from future disasters and lowering flood insurance premiums.	https://www.fema.gov/pre-disaster-mitigation-grant-program
Federal	Small Business Administration	Loans	Low Interest Disaster Loan Program	Homeowners and renters in declared disaster areas	Loans cover losses not fully covered by insurance or other means. Up to \$200k to repair or replace property to pre-disaster condition or up to building code.	Loan increases may be available to make improvements that project the property from future disasters (retaining walls, seawalls, sump pumps, safe rooms, storm shelters). Local governments may wish to examine and update building codes to ensure rebuilt homes are built to be resilient and/or energy-efficient to the extent possible.	https://www.disasterassistance.gov/get-assistance/forms-of-assistance/4477
Federal	Economic Development Administration	Grants or cooperative agreements	"Economic Adjustment	Homes that sustained less than \$17,000 in FEMA verified loss. FEMA determines an applicant's eligibility for the PREPS program.	Supplements emergency sheltering when communities are faced with needs that significantly exceed existing capacity. Provides immediate, temporary repairs. As a Hurricane Harvey Public Assistance program, FEMA pays for 90 percent of the expenses, and the GLO will use up to \$75,000,000 of the CDBG-DR Harvey allocation to cover repairs performed on homes.	Funds may be used for basic, emergency home repairs to enable sheltering-in-place. No apparent direct connection to smart or resilient rebuilding, but eligible emergency work may include utilities essential for water, hot water, HVAC, and food preparation, as well as securing and weatherproofing properties.	http://recovery.texas.gov/local-government/programs/fema-housing-sheltering/index.html
Federal	Federal Highway Administration	Grants	Emergency Relief Program	Federal-aid highways and roads on Federal lands	Supports the repair or reconstruction of roads which have suffered serious damage as a result of (1) natural disasters or (2) catastrophic failures from an external cause. Supplements the commitment of resources by States, their political subdivisions, or other Federal agencies to help pay for unusually heavy expenses resulting from extraordinary conditions.	Activities to plan, design, and construct highways to adapt to current and future climate change and extreme weather events are eligible for reimbursement. This includes the construction of projects or features to protect existing eligible assets from impacts and damage from extreme weather events.	https://www.fhwa.dot.gov/federalaid/120924.cfm
Federal	Federal Emergency Management Agency	Grants	Public Assistance Program in Puerto Rico	Eligible applicants include state and territorial governments, Indian Tribal governments, local government, and private nonprofit organizations.	"FEMA provides supplemental Federal disaster grant assistance for debris removal, emergency protective measures, and the restoration of disaster-damaged, publicly	Financed improvements must be permanently fixed to the real property and have a demonstrated capacity to decrease water or energy consumption.	https://www.texaspaceauthority.org/



Key State Energy Resilience Opportunities Under the Disaster Recovery Reform Act of 2018

On October 5, 2018, President Trump signed H.R. 302, which contains the Disaster Recovery Reform Act of 2018 (DRRA). This important change in how the United States rebuilds following disasters and invests in resilience to lessen the impact of disasters includes new opportunities for State and Territory Energy Offices to collaborate with state emergency management agencies, local governments, and the private sector to enhance energy-related resilience. Following are key provisions with energy-related elements. In particular, a significantly enhanced Pre-Disaster Mitigation Grant Program to be offered to states by the Federal Emergency Management Agency (FEMA) presents new opportunities for State Energy Office and state emergency management agency cooperation to enhance energy system resilience, as well as the resilience of energy elements of the buildings and communities.

Energy Sector Considerations

National Public Infrastructure Pre-Disaster Hazard Mitigation Program (Section 1234) significantly enhances the Pre-Disaster Hazard Mitigation program (PDM) and provides technical and financial assistance to state and local governments to establish and implement published consensus-based, specifications and standards; and to incorporate hazard-resistant designs and establish minimum acceptable criteria for hazard mitigation project design, construction and maintenance. The act states that the President may set aside from the Disaster Relief Fund, with respect to each major disaster, an amount equal to 6 percent of the estimated aggregate amount of federal assistance under the following programs: Essential Assistance, Public Assistance, Debris Removal, Individual Assistance, Unemployment Assistance and Crisis Counseling Assistance and Training. The aggregate amount must be set no later than 180 days after a federal disaster declaration and cannot be reduced, increased, or changed.

Indications from the Administration and FEMA are that they intend to make the full 6 percent available. Based on last year's disaster funding this equates to about \$1 billion for the program – many times the amount previously provided for these critical investments. Importantly, all funding expended from the public infrastructure investment set-aside "shall not be considered part of FEMA's regular appropriations for non-Stafford activities, also known as the Federal Emergency Management Agency's Disaster Relief Fund base." This provides a significant opportunity for State and Territory Energy Offices to expand their role in pursuing and advising on energy-related PDM projects.

Code Implementation and Enforcement (Section 1206) authorizes FEMA to provide federal emergency assistance "to State and local governments for building code and floodplain management ordinance administration and enforcement, including inspections for substantial damage compliance." This addition will enable State governments to use Stafford Act funds to hire and train additional staff for implementation and enforcement of building codes for 180 days following a major disaster declaration.

Listing of Disaster Recovery Funding Resources

58 Resources described below contain a wide range of federal, private, and non-profit funding, program and technical assistance resources that may be available pre and/or post disaster.

Another option is to open www.grants.gov, type in your key words and this will provide you with a good selection of available grants.

Federal Department/Agency Specific Resources

U.S. Department of Agriculture (USDA)

- Disaster Assistance Program: <https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/index>
- The Extension Disaster Education Network EDEN: Reducing the Impacts of Disasters Through Education: <http://eden.lsu.edu/Pages/default.aspx>
- U. S. Forest Service National Urban and Community Forestry Program: <http://www.fs.fed.us/ucf/nucfac.html>
- NRCS Emergency Watershed Protection (EWP) Program: <http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/>
- NRCS Emergency Watershed Protection Program: Floodplain Easement Option (EWP FPE): http://www.nrcs.usda.gov/wps/portal/nrcs/detail/tn/newsroom/?cid=nrcs143_008225
- Natural Resources Conservation Services (NRCS) Technical Assistance: <http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/technical/>
- Rural Development : Community Facilities Direct Loan and Grant Program : <http://www.rd.usda.gov/programs-services/community-facilities-direct-loan-grant-program>
- Rural Development : Intermediary Relending Program : <http://www.rd.usda.gov/programs-services/intermediary-relending-program>
- Rural Development : Rural Community Development Initiative Grants: http://www.rurdev.usda.gov/HAD-RCDI_Grants.html
- Rural Development : Programs & Services for Communities & Nonprofits: <http://www.rd.usda.gov/programs-services/programs-services-communities-nonprofits>
- NRCS Small Watershed Program: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/ca/programs/?cid=nrcs144p2_064043 assists
- NRCS Watershed Surveys and Planning: <http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wsp/>
- Rural Development : Water & Waste Disposal Technical Assistance & Training Grants: <http://www.rd.usda.gov/programs-services/water-waste-disposal-technical-assistance-training-grants>

U.S. Department of Commerce

- EDA Funding Opportunities: <https://www.eda.gov/funding-opportunities/>
- EDA Regional Innovation Strategies Program (RIS): <https://www.eda.gov/oie/ris/>
- NOAA: Digital Coast: <http://coast.noaa.gov/digitalcoast/>
- NOAA: Coastal & Waterfront Smart Growth: <http://coastalsmartgrowth.noaa.gov/>
- NOAA : National Weather Service: Automated Flood Warning System: <http://water.weather.gov/afws/>

U.S. Army Corps of Engineers (USACE)

- Public Law 84-99 Rehabilitation Program: <http://www.iwr.usace.army.mil/Missions/FloodRiskManagement/FloodRiskManagementProgram/PartnersinSharedResponsibility/USACEStaff/PL8499RehabilitationProgram.aspx>

U.S. Department of Energy

- Weatherization and Intergovernmental Programs Office: <http://energy.gov/eere/wipo/weatherization-and-intergovernmental-programs-office>
- Texas Contacts for the weatherization program: <https://nascsp.org/state-contacts/texas/>
- National Renewable Energy Laboratory: Technology Deployment, Disaster Resiliency and Recovery: http://www.nrel.gov/tech_deployment/disaster_recovery.html

Federal Emergency Management Agency (FEMA)

- Community Disaster Loan Program: <https://www.fema.gov/community-disaster-loan-program>
- Fire Management Assistance Grant Program: <https://www.fema.gov/fire-management-assistance-grant-program>
- Hazard Mitigation Assistance : Hazard Mitigation Grant Program (HMGP): <https://www.fema.gov/hazard-mitigation-grant-program>
- Hazard Mitigation Assistance : Pre-Disaster Mitigation Grant Program (HMGP): <http://www.fema.gov/pre-disaster-mitigation-grant-program>
- Hazard Mitigation Assistance: Flood Mitigation Assistance Grant Program: <https://www.fema.gov/flood-mitigation-assistance-program>
- Repetitive Flood Claims Grant Program: <https://www.fema.gov/repetitive-flood-claims-grant-program-fact-sheet>
- Severe Repetitive Loss (SRL) Grant Program: <https://www.fema.gov/media-library/resources-documents/collections/14>

- Transit Security Grant Program:
<https://www.fema.gov/transit-security-grant-program>
- Unified Federal Environmental and Historic Preservation Review for Presidentially Declared Disasters: <https://www.fema.gov/unified-federal-environmental-and-historic-preservation-review-presidentially-declared-disasters>
- Emergency Management Performance Grant Program:
<https://www.fema.gov/emergency-management-performance-grant-program>
- Fire Prevention & Safety Grants:
<https://www.fema.gov/fire-prevention-safety-grants>
- Tribal Homeland Security Grant Program:
<https://www.fema.gov/fy-2014-tribal-homeland-security-grant-program-thsgp>

U. S. Department of Housing and Urban Development (HUD)

- Community Development Block Grant Entitlement Program:
<https://www.hudexchange.info/cdbg-entitlement/>
- Community Development Block Grant : Section 108 Loan Guarantee Program:
<https://www.hudexchange.info/section-108/>
- Community Development Block Grant Disaster Recovery (CDBG-DR) Program:
<https://www.hudexchange.info/cdbg-dr/>
- Office of Public and Indian Housing : Main Street Grants Program Hope VI:
<http://www.hud.gov/mainstreet>
- Capacity Building for Community Development and Affordable Housing Grants:
<http://portal.hud.gov/hudportal/HUD?src=/hudprograms/capacitybuilding>

U.S. Department of the Interior

- Fish and Wildlife Service: National Coastal Wetlands Conservation Grant Program: <http://www.fws.gov/coastal/CoastalGrants/>
- National Park Service : Federal Lands to Parks Program:
<http://www.nps.gov/ncrc/programs/flp/index.htm>
- National Park Service : National Register of Historic Places:
<http://www.nps.gov/nr/>
- National Park Service : National Trails System: <http://www.nps.gov/nts/>
- National Park Service : Rivers, Trails, and Conservation Assistance Program:
<http://www.nps.gov/rtca>
- National Park Service : State, Tribal, and Local Plans and Grants:
<http://www.nps.gov/orgs/1623/index.htm>
- National Park Service : Historic Preservation Fund Grants:
<https://www.nps.gov/preservation-grants/index.html>
- USGS : National Gap Analysis Program: <http://gapanalysis.usgs.gov/>

U.S. Department of Transportation

- Transportation Investment Generating Economic Recovery (TIGER) Discretionary Grants: <http://www.dot.gov/TIGER> (due: April 2020, Yearly)
- Federal Highway Administration : Recreational Trails Program: http://www.fhwa.dot.gov/environment/recreational_trails/
- Federal Transit Administration : Grant Programs: <https://www.transit.dot.gov/grants/13070.html>
- Federal Transit Administration: Public Transportation Emergency Relief Program: <https://www.transit.dot.gov/funding/grant-programs/emergency-relief-program/emergency-relief-program>
- Transportation.gov: Rail Programs: <https://www.transportation.gov/policy-initiatives/recovery/rail-programs>
- Federal Highway Administration : MAP-21: Moving Ahead for Progress in the 21st Century: <http://www.fhwa.dot.gov/map21/factsheets/mp.cfm>
- Recovery Resource Guide: A Transportation Stakeholder Guide to Recovery: https://cms.dot.gov/sites/dot.gov/files/docs/RECOVERY%20RESOURCE%20GUIDE_Final%20Version_08-27-2014.pdf

Environmental Protection Agency (EPA)

- Smart Growth: Building Blocks for Sustainable Communities: <https://www.epa.gov/smartgrowth/building-blocks-sustainable-communities>
- Smart Growth Implementation Assistance Program: <https://www.epa.gov/smartgrowth/smart-growth-implementation-assistance>

General Services Administration (GSA)

- GSA Programs for State and Local Customers, including Disaster Purchasing Program: <http://www.gsa.gov/portal/content/105300>

Selected Non-Federal Recovery Resources

- National Voluntary Organizations Active in Disasters Resources: <http://www.nvoad.org/>
- Regional Catastrophic Preparedness Grant Program (RCPGP): <https://www.federalgrantswire.com/regional-catastrophic-preparedness-grant-program-rcpgp.html>

Resources



- Resilience in Action: Case Study Slide Deck: [https://www.bcse.org/images/2019/Foundation/Readiness for Resilience_6.3.19.pdf](https://www.bcse.org/images/2019/Foundation/Readiness%20for%20Resilience_6.3.19.pdf)



- Resilience in a Transforming Energy Landscape – Findings from the 2019 Sustainable Energy in America Factbook: www.bcse.org/factbook

