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READINESS FOR RESILIENCE

A Resilient Technology Roadmap for Rebuiding Texas

With Partners:



SmartCitiesCouncil for Sustainable Energy





Table of Contents

Executive Summary	2
Discovery Workshops	4
Workshop Overview	4
Workshop Action Areas	5
Public Safety	6
Local Challenges and Priorities	6
Project Recommendations	7
Energy and Utilities	
Local Challenges and Priorities	10
Project Recommendations	11
Telecommunications and IT	
Local Challenges and Priorities	
Project Recommendations	14
Transportation and Mobility	
Local Challenges and Priorities	
Project Recommendations	17
Ideas to Action	19





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

The State of Texas, led by the Texas A&M AgriLife Extension Service, has engaged in the Readiness for Resilience program to assist communities impacted by Hurricane Harvey 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 includes three stages: 1) a discovery phase to build stakeholder support and learn of local rebuilding needs and 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, public-private partners and funding opportunities to ensure smart, resilient and sustainable technology is incorporated into infrastructure rebuilding.

The Partners held three Discovery Workshops on December 11, 12 and 13 in the Texas counties of Harris, Orange and Aransas, respectively. These community-based workshops were designed to directly engage impacted communities and elevate the firsthand experiences of local officials and residents in dealing with Hurricane Harvey before, during and after impact. The Harvey experience was different in each county, as are the recovery and rebuilding needs. Nonetheless, it is widely agreed across all regions that the recovery and rebuilding effort should include the adoption of innovative technology and processes to improve infrastructure and overall community resilience.



The information generated from the Discovery Workshops was used to develop this report, a "Resilient Technology Roadmap" for Texas, linking local needs with potential resilient technology best practices and solutions. This roadmap outlines local priorities in the areas of Public Safety, Telecommunications and IT, Energy and Utilities, and Transportation and Mobility. It identifies 16 smart resilience projects to address these priorities, and maps them to recommendations from *Eye of the Storm: Report of the Governor's Commission to Rebuild Texas*.

The Readiness for Resilience partners view the identified projects as a complement to the Governor's Commission report and looks forward to working with all parties on successful implementation of local project needs.

This Roadmap will be the basis for discussion at a **Summer 2019 Readiness for Resilience event**, which will convene community leaders, stakeholders, and technology experts to pave the way for local projects. Additional breakout sessions will be held to discuss how to establish public-private-partnerships and identify potential federal, state and local funding streams to accelerate resilience projects.

This Roadmap is just the beginning of what the Partners hope will be a multi-year engagement with Texas throughout the rebuilding process. The path to recovering and rebuilding from natural disasters like Hurricane Harvey 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.



Community leaders exchanging knowledge, experience, concerns and aspirations with technology experts and citizen stakeholder

Workshop Overview

groups—that is the essence of partnership.

Three Discovery Workshops were held in the Texas counties of Harris, Orange and Aransas on December 11, 12 and 13, respectively. These regional workshops were designed to go directly to the impacted communities and hear firsthand the experiences of local officials and residents in dealing with Hurricane Harvey before, during and after impact. Attendees were drawn from local and surrounding counties, providing the project team with a regional perspective of recovery and technology issues.

The Discovery Workshops were held to identify specific rebuilding priorities of the local communities and discuss innovative best practices and technology solutions to integrate into hurricane rebuilding projects to amplify resilience and other community benefits. This led to the identification by participants 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 AgriLife Extension, the following four areas were chosen to collect 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 Discovery 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:

Public Safety: How can Texas factor smart city technologies and processes into public safety priority areas to keep people safer during and after natural disasters?

Energy: How can Texas improve its energy resilience with smart city technologies and processes to build greater infrastructure resilience while creating co-benefits?

Telecom and IT: What smart technologies and design principles should Texas consider as it designs more connected, citizen-centered, affordable and resilient services?

Transportation and Mobility: What mobility solutions, technologies and standards might Texas consider as it moves to create a more intelligent, resilient and sustainable transportation system?

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Better using data and intelligence will improve our ability to be more efficient and effective in emergency preparedness, response and post-disaster recovery.

Public safety is the most critical concern in the wake of a natural disaster, and as such was a top focus area for all discovery workshops. At its core, smart public safety is about the use of data and intelligence to keep as many people as possible out of harm's way, and to be more efficient and effective in emergency preparedness, response and post-disaster recovery. A key aspect is resilient energy sources to ensure that public safety systems work before, during and after the event.

Local Challenges and Priorities

Common themes – Workshop participants at each regional workshop saw opportunities to use smart technology and data to better (1) coordinate response across agencies (2) direct people and resources during and immediately after the disaster and (3) plan and prepare for emergencies before they occur, with an eye to vulnerable populations. While there were a number of commonalities, there were also differences in focus across the three regions.

Houston-Galveston Region, with its highly-populated, flood-prone areas around Houston, identified three Public Safety priorities: 1. Better coordination and dissemination of information during the response phase 2. Streamlined access to funding and other resources during the recovery phase, and 3. Building more affordable and resilient housing and structures to improve preparedness and amplify long-term resilience.

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Southeast Texas, and nearby Newton County, consist of many rural areas and feature a key evacuation route of only two lanes with few gas, food and shelter resources along the way. It is not the first area to get emergency response support so localities have to do a lot themselves. A top priority is improving emergency evacuation processes and providing improved evacuee access to services. Efforts are hindered by a lack of robust communications and back-up power generation infrastructure.

Coastal Bend, consisting of the southern gulf coast areas of Texas which were ravaged by strong winds, focused on improved emergency planning and preparedness to improve the effectiveness of evacuation and recovery – including debris removal. The working group saw communications as a big gap – not only communications infrastructure and overcoming dead zones, but also addressing language barriers and reaching elderly populations.



Project Recommendations

Project PS-1: "Match.com"-style resilience tool: Integrated resilience tool for public to access people, processes, systems and data they need to assist with preparedness, response & recovery (Houston-Galveston and Coastal Bend). Recommendations included:

- Start with preparedness resources and extend to response and recovery.
- Go beyond providing a database of resources to offering localized, contextualized resources based on individual need
- Must be easily accessible and understandable to diverse populations and languages

 consider artificial intelligence techniques to match people and resources, natural
 language processing for ease of access, and intuitive visualization.
- Requires buy-in and contribution from key local, state and federal stakeholder groups, as well as individual citizens.

- Adherence to open information exchange standards such as <u>OASIS</u> for emergency management.
- Leverage existing resources such as the <u>climate resilience toolkit</u> and the Essential Elements of Information adopted by DHS.

Example use cases for how the "Match.com" resilience tool could provide value in the preparedness stage:

Project PS-1A: Localized damage prediction: Integrate past and live storm data (sea level rise, storm surge, pressure, wind etc.) with local infrastructure data (building age/ location etc.) and GIS and aerial/drone imagery. Use algorithms to predict damage at a highly localized level to better inform risk, evacuation needs, building codes and upgrades (Coastal Bend).

Project PS-1B: Proactive debris removal planning: Debris removal continued to plague parts of Texas well over a year after Hurricane Harvey. The resilience planning tool could be used to outline localized processes, removal resources and guidelines for debris removal before events occur. It would help community members and emergency responders understand rights of way, identify all the options for where to put debris and get MoU's in place in advance, consider options for handling debris (what can be salvaged, mulched, used for waste-to-energy, etc.), and provide safety guidelines. Following an extreme weather event, the community and emergency response personnel can collectively use the tool to identify where debris is an issue and map removal resources. It is important to consider such options in a holistic manner and with a view to provide additional community benefits in blue sky days as well in response to an event (Coastal Bend).

Project PS-1C: Evacuation scenario planning: Although no one can predict the exact impact of a natural disaster on evacuation routes, smarter planning tools can run multiple "who, what, when, where" scenarios that better prepare people before disasters occur. It would incorporate past data about how routes were impacted, where congestion occurred, resource shortages, most effective communications channels, etc. along with sea level rise, storm surge, flooding and wind damage predictions to inform state and local evacuation and safety planning – including evacuation timing and sequencing (Southeast TX).

Project PS-2: Resilient Buildings: Improving the resilience of homes and other buildings to natural disasters (Houston-Galveston and Coastal Bend):

- Combining general building/disaster risk assessment data with real-time sensor data to understand structural and performance risk – using moisture, vibration, environmental and other sensors.
- Improving access to resilient, sustainable material and repair guidelines through a web portal/mobile app from FEMA/HUD/State/local agencies including guidelines for repairs, permits, reputable contractors, and funding sources.

- Providing recognition, such as Smart Home America "Fortified Wise", and incentives, such as insurance company and low-income household incentives, to get people to participate.
- Streamlining procedural and funding issues it's currently a long process to get approval to take down dilapidated buildings and there's a lack of funding.

Project PS-3: Affordable Housing: Access and affordability of quality housing, especially with so many damaged homes and displaced people, is a short-medium-term recovery issue and a long-term resilience issue. Houston-Galveston workshop participants proposed a tracking tool that:

- Identifies housing needs in near real time
- Tracks funding received versus spent
- Provides access to key resources such as United Way Habitat for Humanity, Housing Authority resources, General Land Office, CBGD, etc.

Project PS-4: Volunteer Rescue Network: Extending public safety response through a system of volunteers using "ride-sharing" technology. This could include offering evacuation car-pooling, connecting volunteer expertise with special populations, matching people in need to volunteers offering food and shelter, matching pets and temporary foster homes, etc. (Houston-Galveston and Southeast TX). Considerations:

- Get potential volunteers pre-registered and approved before disaster strikes.
- Look to existing best practices such as 311 services for resource/supply coordination.
- Use technology to connect to resources and also to educate.
- Connect to non-governmental, not-for-profit, and grassroots organizations who have the pulse of the communities, their needs and their capacities.
- Developing resilience/contingency plans for access to fuel and/or electric charging prior to the event.



Energy is critial infrastructure and powers critical infrastructure.

About 300,000 electric utility customers in Texas experienced power outages the day after Hurricane Harvey made landfall, and restoration efforts continued into September. Electrical outages caused a ripple effect on communications, computing, water, sewer and other critical systems that are power dependent. Nineteen (19) drinking water systems and 31 wastewater systems went down and many more were threatened. Refining, oil and natural gas production were impacted, resulting in fuel shortages, and natural gas companies addressed natural gas leak risks at storage facilities and individual households.

Local Challenges and Priorities

Energy and utility-related resilience challenges varied across counties.

For **Houston-Galveston**, Harvey was more of a rain and flooding event than a wind event. That, as well as efforts to modernize and harden electric grid infrastructure following lke, kept power systems from being devastated. That said, electric outages did occur and were amplified by a lack of access to distributed generation and energy storage resources. Power outages impeded communications between communities and emergency responders. In addition, a water treatment plant that serves almost one-third of the Houston population, was almost lost.

Harris County participants identified the following go-forward priorities for extreme weather event recovery and resilience

- Stable and clean power generation
- Access to back up power during extreme weather emergencies
- Safe water availability
- Improving building codes relating to flooding and wind storms, and enabling counties to have more code authority.

Priorities for **Southeast Texas** include: 1) improving back up power generation – currently back-up generators are often diesel; and 2) improving planning and communications across entities in the field. The community also discussed the need for greater coordination and improved communication and resilience across ICT and energy assets – for instance, smart meters that alert utility responders to outages and enable them to prioritize power restoration efforts.

Parts of the **Coastal Bend**, which faced major wind damage, were without power for 21 days and had substantial water and natural gas pipeline damage. Power-dependent water and wastewater systems were also impacted. The area required a lot of outside utility help to repair and rebuild utility infrastructure. One of the challenging dynamics was the major damage to residences and other buildings. This forced people to leave and many have not returned, so utility revenue is down just as it is most needed to fund repairs. Damages to homes highlighted the need not just for smart and sophisticated technology improvements, but also baseline energy efficiency improvements (such as stronger building envelopes and more efficient heating and cooling systems) that are able to maintain more comfortable conditions for residents to shelter-in-place.



Project Recommendations

Project EU-1: Localized infrastructure monitoring: Improve monitoring of underground and above ground utility infrastructure at the connection level to provide household service visibility to expedite recovery (Houston-Galveston and Coastal Bend).

- Piggyback on IoT technologies, sensors, monitoring and data opportunities on existing infrastructure such as energy, water, natural gas and buildings.
- Leverage fiber optic infrastructure and sensing technology, pipeline sensors, individual household gas metering, CCTV

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 EU-2: Municipal Microgrids: Establish public-private partnerships to examine the feasibility of municipal microgrids that enable critical community assets to continue operating event during power outages or disruptions.

- Each community may wish to target specific campuses or infrastructure (such as police headquarters, shelters, or communications centers, among many others) depending on their individual assessments of disaster vulnerabilities and highimpact response strategies.
- Examine funding solutions, such as direct grants and utility rate-basing and coinvestment, or innovative financing structures such as Microgrid-as-a-Service agreements (as used in Montgomery County, Maryland).

Project EU-3: 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).



Reliable telecom systems, which can mean life or death in an emergency response situation, are foundational as well to the longterm economic resilience of communities.

Telecommunications and Information Technology are foundational to smart resilient communities, enabling people and systems to communicate with each other, directing first responders to where they're most needed, and enabling the collection, movement and analysis of data to improve situational awareness, predict and detect issues, enable resource coordination, and sponsor multi-agency and community communication and collaboration.

Local Challenges and Priorities

Common themes across the three Discovery Workshop regions included the need for:

- 1. more reliable baseline and emergency communications infrastructure.
- 2. improved information sharing with the public.
- 3. a standardized platform for agencies and communities engaged in recovery efforts. Lack of local-level coordination impedes response and recovery.

Houston-Galveston called for more stable communications systems to aid first responders and enable better access and response allocation. Some rural communities have unreliable connectivity and receive limited information – disruptive. Strong need for reliable, accurate community information platform before, during and after storm events.

In **Southeast Texas**, baseline cellular and internet service is unreliable and often unavailable during rain events—even for the Office of Emergency Management. In addition, workshop participants called for improved planning and communications across entities in the field.

Harvey also devasted communications infrastructure in the **Coastal Bend** so they could not even start the process of asking for assistance. The county seeks communications infrastructure hardening as well as hardening some key shelters to act as local command centers. More broadly, the county wants city, county, school, fire, public safety, wardens and other key officials to have access to robust and interconnected communications infrastructure, as opposed to disconnected assets and processes.



Project Recommendations

Discovery Workshop participants identified the following initiatives that have the potential to address local needs:

Project TI-1: Resilient communications infrastructure: All regions recommended 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.

Project TI-2: Integrated community notification system: : All regions recommended improving the way storm related information gets to the public. A multi-faceted notification system to get key information out to the public, better guide evacuation, and assist people during and in the aftermath disasters. Considerations:

- Types of notifications: evacuation routes, roadway water levels, danger alerts, missing persons, places to shelter people and pets, etc.
- Should be a system that residents can sign up for.
- Needs to connect at the grass roots/ community level.
- Look to the Amber Alerts system how can similar be used for natural disasters.
- Use visual notifications along evacuation routes, such as digital signage.
- Multi agency coordination including people who need transport help (EMS, utilities, schools, places of worship).
- Encourage media participation and coverage.

Project TI-3: Interlocal mobile communications system: Develop self-contained, mobile communications and IT system(s) for use in emergency and high-impact events. Mobile units can be shared across regions and agencies and directed to where they are needed the most (Coastal Bend). Potential features:

- Resilient communications, power and computing
- Sensors, cameras and potentially drones to expand reach
- Measure current weather, traffic, road conditions, air quality, debris
- Requires intergovernmental agreements and updated processes

Project TI-4: Telecom system gap analysis: Conduct a gap analysis of local connectivity and power and develop plan to fill gaps to improve emergency response planning, response and recovery (Coastal Bend). Consider:

- Local connectivity
- Integration across systems
- Back-up power
- Resources, manpower, knowledge
- Benefit-risk analysis
- Community education
- Access to public resources schools, libraries
- Ability to plug into / subscribe to first responder community
- Legislative and regulatory barriers
- Funding sources



Streamlining transportation with technology and data enables quicker evacuation, faster rescue, and more effective recovery.

Transportation and Mobility issues overlap with Public Safety – spanning evacuation, emergency rescue, the movement of goods and resources to aid recovery, making roadways more resilient, and clearing transportation routes. Streamlining transportation and mobility with technology and data enables quicker evacuation, faster rescue, and more effective recovery.

Local Challenges and Priorities

All Discovery workshop regions expressed the need to incorporate more intelligence to streamline evacuation processes, keep more roadways open and enable better coordination across agencies.

Houston-Galveston workshop participants called for improved and more realtime broadcasting of information to the public about evacuation routes and closed roadways.

As outlined in the Public Safety section, a top priority from **Southeast Texas** workshop participants was improving emergency evacuation processes and evacuee access to services. Not just for Orange County residents, but also for those from across the State who evacuate through Newton and Orange counties.

For the **Coastal Bend**, opening up transportation routes after disasters, removing debris, and addressing the mobility needs of vulnerable populations (i.e., retirees, elderly, and poor) are priorities.



Project Recommendations

Project TM-1: 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 (Houston-Galveston and Southeast TX).

Features suggested by working group participants:

- 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 TM-2: 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 (Houston-Galveston and Southeast TX)

Project TM-3: Evacuation transportation assistance: Multi-agency and jurisdiction coordination to identify and assist with transportation and evacuation needs (Houston-Galveston and Coastal Bend). Components may include:

- A database of people who need assistance with input from utilities, EMS, schools, houses of worship, etc.
- Evacuation criteria and transportation options
- A staging area for transportation alternatives
- Utilizing school buses, public transit
- Model on CAN database

Project TM-4: Roadway flood protection: As roadways are being repaired, seek opportunities to upgrade materials and incorporate green stormwater infrastructure and other sustainable design principles to improve drainage and reduce flood risks. Also incorporate water-level, traffic count, environmental and other sensors to enable real-time condition monitoring, reporting and route management (Houston-Galveston).

Project TM-5: Use of Alternative Fuel Vehicles in Emergency Response Fleets: Invest in alternative fuel vehicles in order to mitigate the impact of disruptions in petroleum and electricity supply, which may hinder emergency vehicles from providing critical response services for extended periods of time.

- Track locations of fleets and fueling/charging infrastructure using GIS (for instance, the Initiative for Resiliency in Energy through Vehicles (iREV) Tracking Tool, available at https://naseo.org/irev).
- Update state and local Emergency Operations Plans to promote future investments of alternative fuel vehicles and associated charging/fueling infrastructure as part of state and municipal fleet upgrades.



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

The Texas Discovery 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 Governor's Commission to Rebuild Texas Report to ensure they connect to but are not redundant with initiatives that have state 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.

