PLANET TEXAS 2050

A UT Austin Grand Challenge

Equitable and Regenerative Cities Flagship Project Report
2021-2022 Focus: City of Austin's Resilience Hubs

September 2022

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1. Introduction and Context on Equitable and Regenerative Cities

This report documents work done by a group of University of Texas at Austin researchers, City of Austin (TX) residents, and City of Austin staff from September 2021- August 2022 as part of the Equitable and Regenerative Cities Flagship Project.

The Equitable and Regenerative Cities (ERC) Flagship Project is one of six flagship projects funded by the University of Texas at Austin Planet Texas 2050 Grand Challenge Research Program; ERC seeks to build a roadmap to vibrant urban futures. We see a direct line between equitable cities, where everyone has fair access to infrastructure, services, and jobs they need to prosper, and regenerative cities where we diversify our economies, create good jobs, and rebuild natural systems (e.g., waterways, green spaces). We believe that one way to create equitable, regenerative cities is to include residents in all stages of the development of "circular economy" tools and programs. In contrast with an economy that generates waste and leaves people behind, circular economies are designed to reduce waste through material reuse, cease harm done to natural systems, reduce toxicity and its impact on human health, and generate jobs that catalyze community development. In addition, our research project seeks to extend the circular economy approach by developing a participatory and inclusive framework as pathway towards developing more equitable and regenerative communities. Figure 1 (below) is an example of the types of city systems that interact in a circular economy.

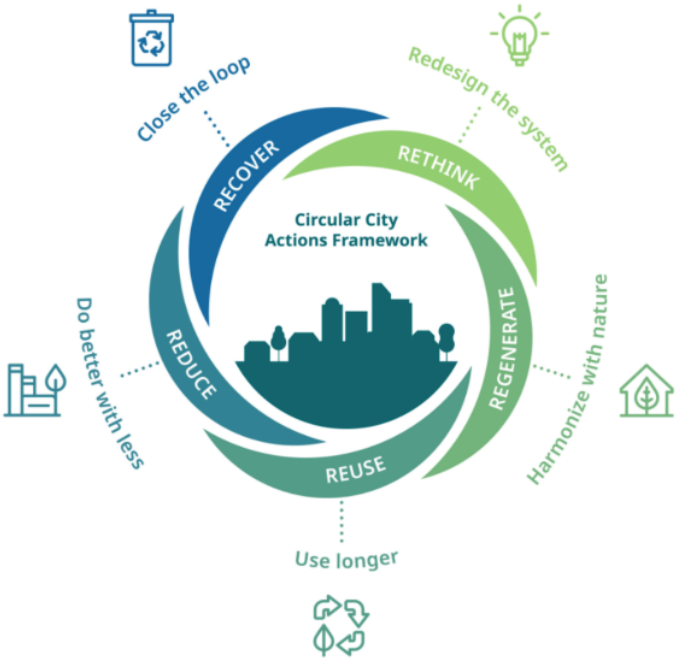

Figure 1: Circular Economy example (Local Governments for Sustainability, 2021).

As part of our FY22 work, the Equitable and Regenerative Cities Flagship Project sought to build our network, integrate new areas of expertise, and explore new mechanisms of participation by engaging three academic Cities Fellows and six Community Fellows. Cities Fellows are academics affiliated with the University of Texas at Austin who have expertise in a city system (e.g., energy, food, communications). Community Fellows are Austin-area residents with experience in circular economies or related topics, an interest in the subject matter, and a willingness to advise our research project. The cohort of three Cities Fellows and six Community Fellows has advised the development of a participatory, circular economy framework that can be used to conceptualize Resilience Hubs in Austin, Texas.

2. Resilience Hubs

The City of Austin defines Resilience Hubs as neighborhood centers designed to coordinate culturally sensitive, multilingual services to better meet the needs of diverse groups of community members and to provide a safe place for temporary shelter and relief during days of extreme heat or disaster events such as floods (City of Austin Resolution 20210408-028). In 2022, the City of Austin will establish six pilot Resilience Hubs and eventually expand Hubs throughout the city. Our project's aim is to develop a participatory, circular economy-based approach to generate recommendations for the City of Austin to consider in their conceptualization and implementation of the Hubs. Figure 2 is an example of a Resilience Hub.

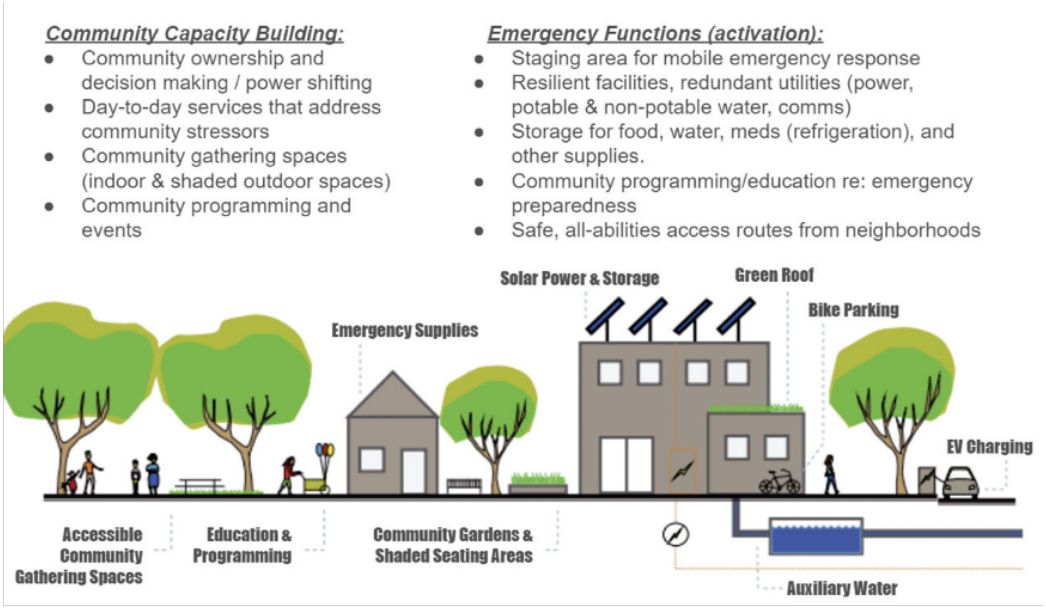

Figure 2: Resilience Hub Example (City of Austin, 2021)

3. Collaborative Process

The Equitable and Regenerative Cities Flagship project has a four-year timeline to conduct transdisciplinary[1] research activities, integrate input from residents and other stakeholders in all stages of this research, and produce academic and applied outputs. In Year 2 (2021-2022), we worked with a staff representative from the City of Austin and nine Fellows to co-develop the following process to integrate diverse disciplinary knowledge and lived experience into our research project:

- Spring 2021: worked with City of Austin Office of Sustainability staff member Marc Coudert to develop focus on Resilience Hubs for 2021-2022 research year.
- October - November 2021: developed and issued calls for participation for three Cities (UT based) Fellows.
- December 2021: developed and issued calls for participation for six Community (Austin-area based) Fellows; selected three Cities Fellows.
- January 2022: began meeting biweekly with Cities Fellows to share knowledge about Resilience Hubs, disciplinary expertise, and develop workshop format. Selected six Community Fellows.
- February 2022: met virtually as a full group following a Planet Texas 2050-hosted panel focused on the City of Austin's Resilience Hubs effort.
- April 2022: met in-person for a half-day workshop at UT (see appendix for full agenda).
- April 2022: collated and distributed notes from workshop; developed report outline.
- May - June 2022: Graduate Research Assistants and Cities Fellows wrote sections focused on areas of expertise for the draft report; draft report was shared with Community Fellows.
- June 2022: Community Fellows provided input on draft report via written comments and an opportunity to attend any of a series of six virtual "Discussion Meetings" designed to seek input in a more conversational, informal manner. During a Discussion Meeting, several Community Fellows suggested participating in additional short, informal interviews with Graduate Research Assistant Bianca M. Pizarro Vázquez which focused on integrating additional lived experience knowledge into the report.

[1] Transdisciplinary research integrates community members outside of academia and emphasizes shared problem solving among science, technology, and society in response to complexity (Schmidt 2011, 256).

- July and August 2022: UT leadership team (Fernanda Leite, Katherine Lieberknecht, Jonathan Lowell, Yu-Chen Lee, and Bianca M. Pizarro Vázquez) finished writing the draft report and shared a completed draft with UT Cities Fellows and Community Fellows for any additional input. Final report was finished by mid-August. Final report was distributed online in early September 2022.

This report contains knowledge and work from our UT Cities Fellows and ERC core team done before and after our April 2022 workshop, but was consolidated and organized based on discussions from the workshop, which included our Community Fellows and representatives from the City of Austin.

4. Vision of Fellows/Resilience Hubs effort (from workshop)

- Vision: How can a circular approach to Resilience Hubs reduce waste (e.g., material waste, "social" waste), reduce natural resource use (e.g., reduce water use by reusing water onsite, etc.) and regenerate/support socioecological systems (humans and ecosystems both)?
- How does public participation and power support this vision? How would this vision further equity and justice (or, flipped: how might this vision be centered around public participation and power, justice, and equity?)?

5. City Systems

Each Cities Fellow and Graduate Research Assistant focused on one particular city system and this system's connection to the City of Austin's Resilience Hubs efforts. The report section below provides a general introduction to each of these five systems: water, green infrastructure, energy, food, and communication systems. While Hubs will be designed to focus on immediate, urgent needs, such as shelter during an event, these places also have the potential to contribute more broadly to residents' well-being and safety by addressing longer term stressors, such as water and food security.

Water

Water is necessary for human survival, and a lack of it is one of the most pressing concerns that communities seek to address. Urban water demand and contamination are increasing as cities continue to expand. By 2030, worldwide water demand is estimated to be 40% higher than

existing available resources (2030 Water Resources Group 2009). Global climate change has a significant impact on the water cycle and has exacerbated the water crisis (UNESCO 2020). The linear model of water systems, which follows a take-use-dispose pattern, is a primary cause of the current water shortages and pollution. The linear water system is both environmentally and economically unsustainable, as it continuously drains water without returning it, making potable water even more difficult to access.

To contend with water shortages, it is critical to develop a circular system which allows for the reuse of water. By reusing and recycling water, a circular water model can help reduce overall water consumption. In a circular economy, water may perform a variety of functions and achieve its full potential. Water, for example, can be a service that provides supply and sanitation, as well as cooling and heating. Water can also be used as an input in industrial and agricultural activities. Through wastewater treatment and reuse, the circular economy model can also help to lower contamination. In addition, by improving the operation of water systems, greenhouse gas emissions are lowered and energy consumption is reduced. Given its full benefits, adopting circular economy principles in urban water systems presents an indispensable tool for people around the globe as well as future generations.

Green Infrastructure

Infrastructure is marked by the fact that it is largely invisible until moments of breakdown. While infrastructure is conventionally thought of as the physical elements such as roads, buildings, bridges, and the like, sometimes referred to as “grey infrastructure”, it can also include what Klinenberg (2018) calls “social infrastructure”. This refers to the ways in which people use spaces such as libraries, parks, sports facilities, schools, and community centers to create social networks. These networks are just as essential in efforts to prepare and respond to disasters and hazards.

The term “green infrastructure” (GI) tends to conjure an image centered around things like trees and parks; in other words, infrastructure that is not concrete or asphalt. However, residents, practitioners, and scholars continue to expand the definition of GI. Ecological planning literature situates GI as “interconnected system[s] of natural areas and open space that conserves ecosystem values, helps sustain clean air and water, and provides benefits to people and wildlife” (Coutts & Hahn 2015). As the public, policy makers, and practitioners seek to create climate adapted cities, much work remains to be done around integrating the concept of “greening” in ways that affect people and other living beings. This is particularly true in terms of ensuring that marginalized populations experience equitable distribution of GI-related

benefits and costs. From public safety to food security, green infrastructure will play a key role in creating future spaces where we can live and thrive.

Resilience Hubs present an opportunity to reimagine integrated green-grey-social infrastructure systems. For example, Resilience Hubs can be designed or retrofitted in ways that serve as demonstration areas where residents can learn about, adapt, and improve tools that can be used to increase household-scale resilience, such as plantings to increase shade and reduce energy use and cost, or gardens that can serve as public spaces that contribute to food security/sovereignty and community connection.

Energy

Energy systems in urban settings tend to refer to the infrastructure and operations related to supplying electricity. The electricity sector is comprised of four main pillars: generation, transmission, distribution, and retail sales. These pillars depict the process of generating electricity at a specified location where input resources can be maximized (e.g., proximity to bodies of water, high solar radiation, high wind speeds), transmit it close to where the demand is located, and distribute it. Electric utilities can be vertically integrated and hold ownership of the entire process and serve contiguous territories, while others have been a product of unbundling and liberalization of the 1990s which enabled their specialization on specific segments and functions of the electricity sector to deliver reliable electricity to their end customers (Steinhurst 2011).

In Austin, our electricity comes from a municipal electric utility, Austin Energy, which is non-profit by design, regulated by the Texas Public Utility Commission (e.g., rates), and is coordinated by the Electric Reliability Council of Texas (ERCOT) when participating in the electricity market (e.g., purchasing and selling electricity and associated services). From a centralized perspective, ERCOT coordinates the electricity infrastructure that powers more than 90% of Texans and covers close to 75% of Texas's land area. The total electricity consumption in 2021 was 391,579 TWh, with approximately 42% of that electricity being produced from natural gas fuel source, 19% from coal, 10% from nuclear, 24% from wind, and 4% from solar (ERCOT, n.d.).

In addition, households can own their own distributed energy resources (DER) (e.g., solar photovoltaics, storage), expanding the potential roles and relationships between utilities and their customers. These DER systems typically are installed using available rooftop areas with proper exposure to the sun's rays (insolation) values where solar photovoltaic (PV) systems are mounted. More recently, these systems have been paired with storage, rendering solar-plus-

storage electricity solutions (U.S. Department of Energy n.d.) with greater autonomy and the possibility to address loss of grid energy and provide other power and energy services.

For renters or owners without proper rooftop conditions, there are ways in which they can still participate in procuring clean energy sources (e.g., solar) without the need to own or have access to a rooftop through programs called community solar. The city of Austin has a community solar program with a two-tier rate: of 4.27 c/kWh (compared to a traditional power supply adjustment of 3.078 c/kWh) or even as low as 2.77 c/kWh for customers eligible for customer assistance programs (CAP) utility discounts (Austin Energy, n.d.).

Food

A food system is a web that connects all of the people, processes, and components that influence food from the point of production to consumption and recovery. A food system typically includes: 1) Food production, such as growing and harvesting food, 2) Food processing, like cleaning, mixing, and packaging food, 3) Food distribution and transportation, or the movement of food locally, regionally, and globally, with geographic reach varying depending on the amount of resources and food produced in the community, 4) Food marketing to consumers in physical spaces, in print, and online, 5) Food retail and consumer purchasing, which encompasses how people acquire food as well as the quantity, type, and quality of food retail available in a given community, 6) Food preparation and consumption, or the places and tools used to prepare and eat food, and finally, 7) Food recovery and nutrient cycling, like composting, which provides matter and energy to begin the food system cycle again (Figure 3).

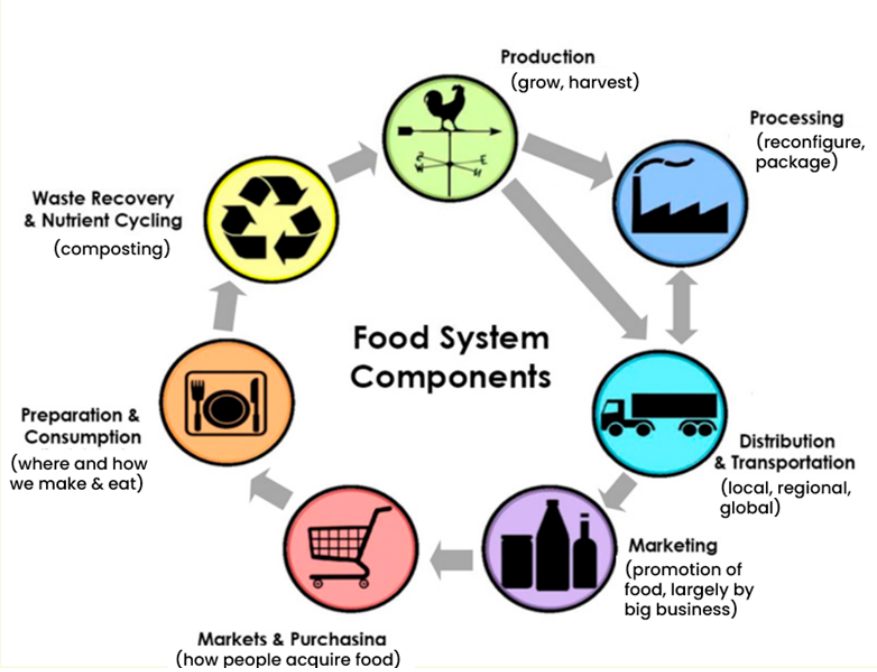

Figure 3: Food system components (University of Idaho, n.d.).

A **community food system** integrates each component of a food system locally and includes plans to improve the economic, environmental, social, nutritional, and physical health of a community by design (Eames-Sheavly 2011). Community food systems incorporate a focus on food security, self-reliance, proximity, and sustainability (Eames-Sheavly 2011), four elements which make it distinguishable from a general food system framework and elucidate how a food system can function as part of an effective **circular economy**.

In the most recent estimates, 15% of Austin residents were food insecure (City of Austin 2021) and in samples of people living in marginalized neighborhoods, rates have been found to be closer to 40% (Janda et al 2022). Only 35% of the residents eligible for WIC (City of Austin 2020) and 42% of the residents eligible for SNAP (City of Austin 2018) were activity enrolled in those food assistance programs. In terms of self-reliance, less than 1% of the food consumed in Austin was produced in Travis County (City of Austin 2018). When considering proximity, there are pockets of the city where food is geographically inaccessible and in regard to sustainability, the city estimates that over 451 million pounds of food are wasted in Austin each year (City of Austin 2018).

The city has acknowledged a need for change and has worked in partnership with residents, local farmers, and businesses to improve the community food system. Some examples include garden programs, food justice grants for community organizations addressing food inequity,

and the *Fresh for Less* program which provides mobile food pantries and curbside food delivery in under-resourced communities across the city. In addition to these efforts, the city is currently developing its first comprehensive food plan, which can serve as the blueprint for building a strong and innovative community food system and circular economy.

Communications

A Resilience Hub has little chance for success without considering, in explicit terms at the outset in its design, the role that *human beings* will be expected to play in designing and building, maintaining, and finding ways to connect all residents to resilient electronic media systems, services, and devices. In times of emergency, households will require not only available, accessible, and affordable electronic media devices and services. They will also need, ahead of time, training and instruction not only about *which* devices and services to use in a crisis, but also *how* to use them when an emergency causes shortages, or the absence of, essential city systems like water, energy, food, shelter, public safety, or health services.

A "communications system" in this context of city systems refers to *emergency* communications that encompass two categories of interdependent resources: the ***conduits*** necessary to *facilitate* emergency communication in times of crisis, and the information ***content*** that needs to be distributed and shared via those conduits to keep people safe in their homes. Conduits concern *physical infrastructures* whereas content concerns *information infrastructures*. For both types of infrastructure, key considerations when planning resilient *communications* system infrastructures is to ensure that they are visible to their producers, distributors, and users 'before' rather than only 'upon' their breakdown, which is often the case with infrastructures of many kinds: they are visible only when they break down (Bowker & Star, 2000).

Conduits include the necessary hardware, firmware, and software resources that enable not only one-to-many but also one-to-one wired and wireless capabilities so that communication systems can connect with each other and also with those who need to use them. For example, telephone equipment and transmission facilities along with telecommunications networks that either alone or in combination with information systems, are necessary for the electronic distribution of all forms of information, including voice, data and images. In most basic terms, *telec*ommunication-related conduits require three elements: a transmitting resource that takes information and converts it to a signal, a transmission medium that carries that signal; and resources that enable receiving that signal and converting it into usable information.

Content includes the timely, relevant, and substantive updates that municipal officials need to communicate to residents related to weather, transportation, food, energy, shelter, health, and safety conditions. Content also includes neighborhood level updates that residents need to share with public officials as well as with community residents so that people are apprised of what is happening and what is needed to stay safe.

A primary feature, and thus a challenge for the design of Resilience Hubs with this particular *city system* in mind is that it is comprised of a combination of physical and informational infrastructure-related resources that are provided by public (governmental), private (profit-driven), and non-governmental (nonprofit mission-driven) organizations and institutions. To be equitably responsive in a crisis situation a Resilience Hub's communications system will need to anticipate potential breakdowns in either or both its conduit or content dimensions due to shortcomings in any of these three resource pools.

6. Examples of Interactions between Systems

City systems do not function in isolation. In recognition of the interaction between systems, we provide two examples below.

Food & Communications

Food is necessary for survival, and every component of a food system requires an effective communication system to be successful. For example, most food producers must connect with food processors, distributors, and retailers to get their product into the hands of consumers, which requires electronic or telephone communication to coordinate. Additionally, effective communication systems are needed to broadcast to the public where they can procure food during climate-related events. If communication is disrupted, producers may not know whether it's safe to deliver food or may venture out unnecessarily if a food retailer is not open to receive a planned delivery, which can lead to unsafe working conditions and food waste if conditions lead to spoilage. Similarly, consumers may leave their home in search of food, unaware that their usual grocer or convenience store is closed, creating a personal safety risk. If clear messaging is not provided about where people can access food through channels that effectively reach people at home, residents may not know where to find food and could subsequently go without. Having a strong communication system can ensure producers know when and where to deliver food to distributors and when and where distributors can deliver food to retailers or charitable food organizations. A strong communications system will also ensure residents know where they can go or who can deliver food to their home in times of

climate-related disaster. The communication system can ensure the food system continues to function effectively and helps to protect both producers and consumers.

Water & Energy

Water and energy systems are inextricably linked and mutually dependent. Energy is needed in nearly every step of the urban water system; water production, wastewater treatment, and water pumping are a few examples. Similarly, electricity generation requires water in multiple processes, for example in cooling (e.g., thermal power plants) and hydropower (e.g., reservoirs, run-of-river). For a more resilient city, water and energy security can be improved by reducing water use in the power generation process through conservation or reuse. Also, improving energy efficiency in water systems or using renewable energy can help mitigate water and energy insecurity

In the context of Austin, the nexus between water and energy systems became evident in the face of the 2021 recent winter storm, when potable water became unavailable and boil water notices were issued. This situation happened because a lack of power rendered water treatment plans unable to adequately treat water to remove contaminants. This inability to properly treat water forced approximately 2,000 community public water systems to issue the boil water order, which in some instances lasted weeks after Winter Storm Uri while repairs occurred (Texas Commission on Environmental Quality 2021). For households that relied on electricity for heating and cooking, having no electricity meant not being able to boil water to purify it, leading to unsafe practices to individually treat their water (e.g., unsafe outdoor stove usage, practices that increased fumes and fire hazards) (Booker and Romo 2021). Beyond that, other links intersect housing, water, and energy. For example, many improperly weatherized households ended up with burst water pipelines, causing flooding and permanent damage (e.g., molding) that have continued to impact communities (Oxner and Garnham 2021). Lower-income houses tend to have worse built envelope tightening, which directly impact the amount of energy consumed, and the propensity to have these water-related issues happening in future winter freezes (Texas Energy Poverty Research Institute 2021).

7. City Systems and Resilience Hubs

Resilience Hubs are neighborhood centers designed to coordinate culturally sensitive, multilingual services to better meet the needs of diverse groups of community members and to provide a safe place for temporary shelter and relief during days of extreme heat or disaster

events such as floods (City of Austin Resolution 20210408-028). Each city system has unique potential ways to interact with Resilience Hubs. They are described below.

Water

Resilience Hubs are places where people can access safe potable and non-potable water during severe weather events. Bottled water, for example, is securely stored in place for distribution during emergencies. Moreover, the Hub's water can be used for food preparation, toilets, or showering. Besides that, on-site water solutions (such as rainwater harvesting or water reuse systems) can be integrated into building design to reduce water consumption. Training sessions can be held to teach residents how to operate and maintain the systems. In this way, Resilience Hubs can operate as backup resources for the public in case a centralized water system fails. Via these services and provisioning, the Hub will be an ideal place for residents to go when climate-related events happen.

During times between disaster events, Resilience Hubs can be leveraged for educational purposes where the public can gather information about water systems and the importance of incorporating circular economy principles in our urban water systems. Resilience Hubs can also provide essential information to the public to help them reduce water consumption at a household level and increase the public's awareness of water conservation. Through postings, videos, social media, or hosting events in a Resilience Hub, residents can learn more about circular economy principles in their daily life and build trust in the Hub. Hubs can also serve as demonstration centers for residents interested in incorporating similar systems into their homes.

It is important to note that everyone in the community should have equal rights to obtain water resources from Resilience Hubs, including marginalized groups. Also, the water quality of distributed systems should be consistently monitored to reduce the risk of contamination. By integrating the latest technologies and digitization in the Hubs, stakeholders can have a better understanding of water reliability and resiliency and perform more efficient decision-making. Lastly, Resilience Hubs should be agile enough to be tailored to the community's needs as every community is unique.

Green Infrastructure

An expanded vision for green infrastructure in Resilience Hubs includes considerations of benefits, costs and harms, education, and exposure. For example, a Resilience Hub built with and around GI concepts can improve levels of climate adaptation, provide ecosystem benefits

(improved environmental conditions through natural or constructed environments) and social benefits, and draw from circular economic models to enhance well-being (Alves et al. 2018). Conversely, the location, design, or operation of a Hub could also inadvertently increase GI-related harms, such as concerns around air pollution and increased asthma risk stemming from street tree pollen (Eisenman et al. 2019). Hubs can serve as places for collective education in order to improve climate preparedness at home as well as at the city scale.

When discussing infrastructure and climate-related events it is also important to recognize the difference between exposure and vulnerability. During and after disasters there tends to be conversations about the level of vulnerability those affected by the event carried innately. Yet using such language silences the levels of exposure that these same residents experienced. When someone is exposed, there is a sense of actionable steps that can be taken to alleviate, or lessen, their level of exposure. When we speak of future disaster survivors as vulnerable, we take away their agency and misplace the blame away from the structural systems which dictate response and mitigation.

In addition, as we think about siting and creating Resilience Hubs it is important to recognize that the potential for green displacement (i.e., rising property values or other types of displacement stemming from creation of green infrastructure or climate adaptation systems) will continue to rise alongside all types of climate adaptation, including potentially tools such as Resilience Hubs. Seeking to alleviate green displacement does not mean that we avoid locating environmental benefits in marginalized communities, but it does require municipalities to holistically consider benefits and costs stemming from GI and, in response, proactively prevent displacement related to urban greening

Energy

Resilience, as defined by the Department of Energy, is the "ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate physical and cyberattacks, accidents, or naturally occurring threats or incidents."

Energy resilience has been proposed to be studied by Sandiz et al. (2020) through a framework lens that measures the resilience performance of an energy system in a community through a set of multiple metrics, dimensions, and phases. Figure 4 summarizes this framework, where a robust state with no alterations to the energy supply is on the left side. A shock, represented by the red arrow, disrupts the system, which can then undergo three dimensions over time: (1) engineering-designed resilience, where human intervention is not required, and the system

returns to its original state in a short timeframe; (2) operational resilience, which occurs upon the exceeding of the first dimension, and that requires decision-making processes to fully restore services; (3) community and societal resilience, consisting of the actions to enhance community cooperation with society (e.g., utilities) to ensure community wellbeing.

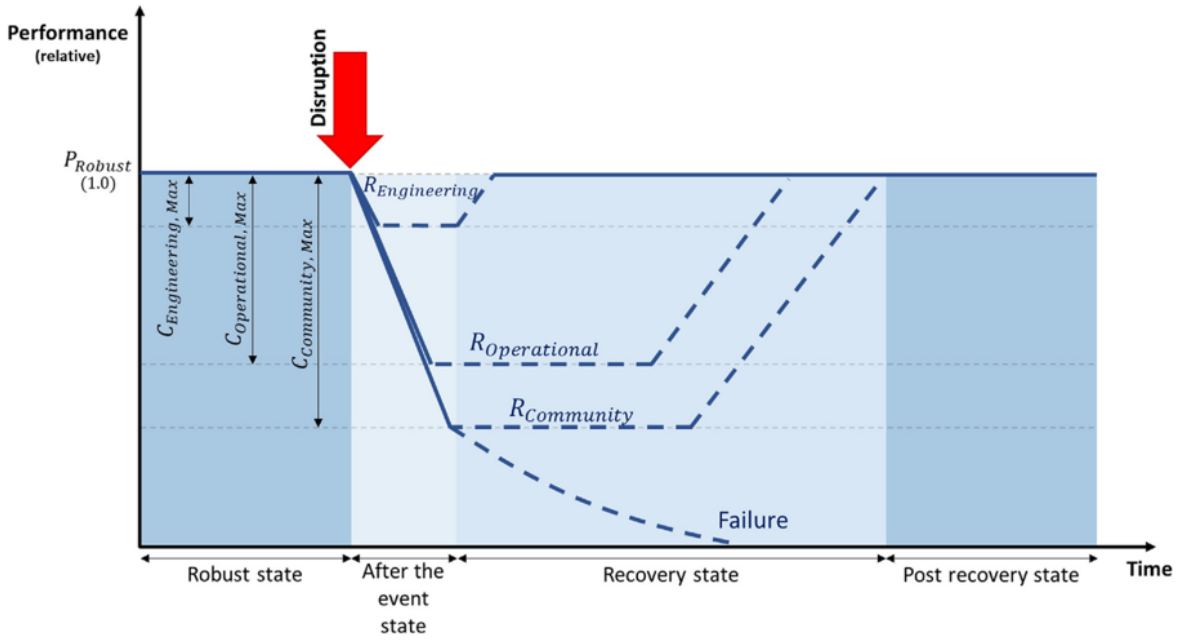

Figure 4: Conceptual multi-phase energy resilience trapezoid. Reproduced from S. Charani Shandiz et al. (2020).

Contextualizing the multi-phase energy resilience framework previously described, the first phase would consist on technical dimensions of the grid and affected customers. The second phase would revolve around the power mitigation, loss, and restoration process (e.g., hours of rotated blackouts, demand response approaches). The third phase would pertain to actions such as relocation of community members, resource sharing, access to information, community bonding, and volunteering, among others.

Adapting these energy resilience phases to the proper functioning of a Resilience Hub requires a holistic approach. First, having access to both an interconnected system (e.g., electric grid) and the deployment of DERs can play a critical role in the engineering and operational phases. Due to the historical implementation of shedding load through rotating blackouts, it is important for the Resilience Hubs to have the opportunity to access grid services whenever possible, especially given the spatial inhomogeneity of blackouts observed during Winter Storm Uri which disproportionately affected marginalized populations. In addition, providing

Resilience Hubs with solar-plus-storage can enable them to be self-sustained during power outages and also support the grid in managing frequency fluctuations during times in between events – opening the opportunity for revenue streams that could help pay for capital expenditure investments. Lastly, having robust communication channels and discussions with community members around their energy needs and what might be available in the Resilience Hubs can help improve the community resilience phase and shorten the time required for the community to go back to its initial robust state.

Food

During extreme weather events, Resilience Hubs can be a haven for the storage and distribution of food. Instead of food distributors having to journey far distances in unpredictable conditions to multiple retailers, they could divert to one or two Resilience Hubs nearest to their facility. Rather than residents taking the risk of walking, biking, busing, or driving to numerous retailers or food pantries that may be closed, they can travel to one location they know to be open for food pick-up. In some instances, residents will need to shelter at the Resilience Hubs. In which case, the Resilience Hubs should be adequately prepared to feed a predetermined number of community members three meals per day. In addition to food pick-up and feeding people in shelter, the city could also consider repurposing and weatherproofing city owned vehicles to deliver food from the Resilience Hubs to nearby residents that are unable to leave their homes.

The Urban Sustainability Directors Network has also recommended that Resilience Hubs serve as a space for **community sharing** (Baja 2019), which would allow community members and businesses that may have an abundance of food to share those goods. This is another opportunity to integrate a **circular economy** approach, whereby food that may otherwise be wasted or spoiled can be redistributed from those who have too much to those who don't currently have access to enough.

When the Resilience Hub is not activated for emergency response, it can continue to store, serve, and deliver food to those experiencing a food or health crisis by offering an onsite pantry or mobile market. The Resilience Hub can also provide community education resources, such as a local soil and food expert that can teach residents and community-based organizations how to grow their own food as well as how to protect crops and animals during extreme weather events (City of Austin 2018). Given the high rates of food insecurity and the low rates of federal food assistance participation among eligible residents in Travis County, the Resilience Hub initiative could also be another access point for enrolling residents into SNAP and WIC and informing residents about nearby community food resources. Providing residents with more

stable access to funds for purchasing food and direct food procurement programs will help the community become more resilient in preparation for a weather event.

Communications

Resilience Hubs that embed digital inclusion strategies in their design have better potential to coordinate resource distribution and services before, during, or after events similar to the 2021 Winter Storm Uri. The pervasiveness of electronic media in facilitating the delivery of essential services, especially during emergencies, makes telecommunications a vital communications system to consider when building an equitable and regenerative city.

8. Stories of Impacts of Stressor Events on Each System

We collected stories of impact from our Cities and Community Fellows to contextualize the impact of stressor events to communities. We discuss impacts per city system in the following section.

Water

Winter Storm Uri in 2021 triggered several system disruptions that impacted the City of Austin. Water mains broke and pipes were damaged as a result of the extreme weather, causing city-wide water outages. Furthermore, the City of Austin issued a boil-water notice due to power outages at the city's major water treatment plant and low water pressure. Because of the breakdown of the water system, many people lost access to safe potable and non-potable water. Water outages were common during that time, so many residents had to melt snow to flush toilets and cook with bottled or boiled water. Furthermore, numerous people were unable to heat water before using it, causing them to seek alternatives. Boiling water on camp stoves or grills was employed as a solution in this case. To alleviate the situation, the city provided bottled water and prioritized high-need neighborhoods. Nonetheless, the system outage caused significant inconvenience to the public. This water stressor event in Austin demonstrated how urban systems are interconnected and how one system failure can have a significant influence on another.

In 2017, Hurricane Harvey brought devastating floods, with severe consequences for the environment and public health. According to the record, Hurricane Harvey poured over 270 trillion pounds of rainwater on Houston, causing significant injuries and fatalities. At the height of the storm, approximately 375 thousand Texas residents experienced drinking water issues and 61 public-water systems were not functioning and over 200 systems were under boil-water

notices. In addition, the failure of wastewater treatment plants resulted in sewage-tainted water flooding waterways and streets. Further, even six months after the floods, fecal bacteria levels in homes were higher than typical. Water pollution and sewage may have contributed to an increase in skin-related infections and other diseases among residents. The influence of water system failure on public health is self-evident as it may cause long-term and short-term diseases. This catastrophic occurrence further shade lights on the significance of resilience in preparing the city for unanticipated shocks.

To achieve the goal of making the city more resilient, it is critical to not just improve a single system but also to improve interactions between various systems. The concept of Resilience Hubs will equip the city to withstand disasters and prevent unintended consequences. People can rapidly access essential water resources and receive knowledge or information with the help of Resilience Hubs during disasters. That is, if appropriately implemented, Resilience Hubs have the potential to minimize damages.

Green Infrastructure

Green infrastructure can potentially provide critical services to residents during stressor events such as extreme heat, flooding, and associated disruptions of essential systems. When formal infrastructure systems fail due to stressor events, such as when municipal water service and energy service was interrupted during Winter Storm Uri of 2021, safely designed and implemented green infrastructure can contribute emergency provisioning, such as rainwater systems for household water use and home or neighborhood-scaled gardens for food. GI also has the potential to serve as a buffer for residents by cooling homes and public spaces, such as bus stops or Resilience Hubs, with shade through street trees or insulation via green roofs. And existing stormwater GI already helps to reduce flooding and improve water quality following large rain events, with the potential to contribute even more of these services if scaled up.

More indirectly but just as importantly, GI in the form of vegetation along trails and streets, in parks, and within Austin's numerous creeks contributed to Austinites' physical, mental, and emotional health during the Covid-19 pandemic, especially during the earlier phases of lockdowns when residents became highly dependent on "nearby nature" assets and the ability to gather and recreate outside.

Food

Researchers at UT Health reported that aspects of the SARS-CoV-2 (COVID-19) pandemic, such as reduced food availability and employment changes, heightened pre-existing food insecurity

disparities in Travis County (Janda 2021). When Winter Storm Uri hit in February of 2021, it further constrained a food system that was severely disrupted by COVID-19 food shortages and supply chain challenges.

During the storm, most grocery stores were closed or had empty shelves and few employees were able to safely get to work to operate the stores that remained open. The Central Texas Food Bank, an essential food system resource, was unable to distribute food due to icy road conditions and power outages that kept their main warehouse doors from opening. Additionally, 40% of Austin residents lost electricity, and many lost access to water due to pipes freezing and bursting. A boil water notice was in effect for four days, which impacted how the public and food businesses prepared food.

Despite the many challenges the city food system faced due to COVID-19 and Winter Storm Uri, neighbors, local food equity organizations, and business owners worked together to feed the community. For example, Nixta Taqueria owners partnered with Dough Boys, Trill Foods, and Casper Fermentables to redistribute food the restauranteurs had on hand through an open community fridge (Townsend 2021). Additionally, Good Work Austin, an organization dedicated to bringing small business owners together to support safe and fair working conditions accessed their established network of local restaurants to feed people experiencing food insecurity. Good Work Austin organizers connected restaurants that had a surplus of food, but no water or power, with restaurants that had no food, but running water and electricity. Chefs collaborated to cook and package meals and together coordinated a food recovery effort that delivered thousands of prepared dishes to Austinites in need of food. Since then, Good Work Austin has expanded on these efforts and delivered over two million meals to residents experiencing food insecurity. These examples provide a model that can inform the city's Resilience Hub strategies by leveraging existing community resources, informal and formal social networks, and systems of communication to recover and redistribute food to those most impacted by climate-related disaster.

Communications

Communications systems are critical to how society functions in normal times, but even more so during emergencies. We learned from Hurricane Katrina and other climate disasters like Winter Storm Uri in 2021 as well as from the global COVID-19 pandemic how essential information and communication technology (ICT) devices and services are to be able to access basic services and for participation in an increasingly digital society. The near complete societal shutdown that began in March 2020 required a transformative shift in how we approach our day-to-day lives wherein previously in-person activities relocated online. This change made

visible many pre-existing systemic and structural disparities that contributed to hardships suffered by those Austin residents for whom the right kinds of electronic devices, know-how, and broadband services were either unavailable, unaffordable, or simply too difficult to use. This is an almost tragic state of affairs for a city like Austin with so many high-tech companies and a strong reputation for technological innovation and an advanced communications infrastructure.

The City of Austin's digital inclusion efforts dating back 20 years have been trying for many years to address digital disparities. The city's programs already incorporate several aims advanced by the Urban Sustainability Directors Network, namely, "prioritizing daily community needs, shifting power to neighborhoods and residents, providing opportunities to address root causes of disproportionate exposure and sensitivity to unexpected … crises, and enhancing communities' capacity to adapt and thrive". These efforts, however, will not achieve their potential if they remain disconnected from other vital city systems like water, electricity, transportation, public safety, education, and healthcare.

9. Stories of Impacts of Stressors Events on Communities and Neighborhoods

Northwest Balcones neighborhood during Winter Storm Uri 2021 – by Matt Weldon

> Northwest Balcones neighborhood, Austin TX
> Medium home value per Zillow, "Data through May 31, 2022", for 78750: $804,016
> Medium home value per Zillow, "Data through May 31, 2022", for Austin: $686,669

Eighteen years of residence in the Northwest Balcones neighborhood of Austin has demonstrated the area to offer many of amenities and positive qualities of a late 1980s era suburban development. Road and park infrastructure is in good condition, and city services are reliable, as is electric power. Issues, when they arise, are of a "first world" nature – a temporary inconvenience in the form of noise, a road obstacle, or a short service interruption. The neighbors are amiable, if not well known to one another, as it is easy to fall into a somnolent homebound routine. The largest fault with the neighborhood is shared with many along the Hwy 183 corridor, a product of the era of their construction and design, that all retail amenities (groceries, clothing, restaurants, library, etc.) and any services not provided by a home itself are driving distance (> 2 miles) away from the home. Having access to a car is essentially a prerequisite to live in this area.

2021's Winter Storm Uri was novel for having interrupted some critical services for the neighborhood, namely water and electricity, and more temporarily the use of the roadways while they were iced over. How the neighborhood endured and responded may be illuminating in a couple aspects.

- ***Electricity:*** This neighborhood is served by the Pedernales Electric Cooperative. As the service territory of the coop is relatively sparsely populated and has few critical loads to serve (as compared to the Austin Energy service territory, with its larger density of people, hospitals, fire stations and etc.), it appears that the PEC was able to rotate power through its service area during the periods of mandatory load shed in a fairly equitable and consistent fashion. As customers, we did not know when we would have power nor for how long, but power rotations proved to be relatively periodic and for significant durations of time (i.e., ~ 6 hours of power out of every 18 hours, ~30% duty cycle). Note that all homes in this area are electric and there is no natural gas service available, so for comfort and prevention of pipes freezing having power on this consistent if intermittent basis was critical. Because power was continually available, it would have been possible to endure the extreme storm conditions essentially indefinitely. In our own home we tend to keep indoor temperatures in sync with the season and so normally have the house at 68 degrees F in winter. We never had the indoor temperature go below ~50 degrees F and could reheat the home to 68 degrees F each time power was restored.

    - **A key takeaway:** Demand management, albeit mandatory, was effective in maintaining minimum ERCOT grid integrity. Intermittent power was adequate to maintain critical services within my home. The parts of Austin and Texas that suffered the most damage during Uri had no power for extended periods due to insufficient capacity (granularity) in the distribution utilities' ability to segment load and share limited power equitably over time. Though Austin Energy generated nearly twice as much power as was consumed within its service territory during the period of the storm, the load shed that was required of the utility to preserve broader grid stability surpassed its capacity to then serve all its customers even on an intermittent basis. The successful performance of (imposed) demand management shows that this technical capability is worthy of additional investment to achieve resilience. Strengthening the distribution grid's flexibility and increasing segmentation granularity would provide beneficial capability not only during emergency conditions as such infrastructure investment may also enable introduction of more distributed energy resources

(DER) and energy storage. Note that Austin Energy currently discourages installation of DER capacity greater than an individual home's demand because of limited distribution feeder hosting capacity, an abundance of caution, and a dearth of energy storage capacity.

Demand response is typically treated as a last resort, but it can be extremely effective if demand far outstrips generation for any reason. As my personal experience showed, load management can compensate for as much as a 2/3 generation capacity loss and likely more if good communication of durations and intervals is provided.

- **An observation on energy efficiency:** Neighbors spent more time walking outside than is typical during storm Uri due to the long intervals without power. I had several spontaneous conversations that made it clear that there is large variation in the insulation quality of the neighborhood housing stock. Some people's homes were dropping down into the 30s ºF range during periods without electricity, even though their homes were starting out much warmer than my own. This 20-degree difference in performance is much larger than I would have predicted prior to this large-scale natural experiment. Many homes in this neighborhood were built in the late 80s, such as my own which has not received any particular efficiency updates, but it is clear that many homes were built with poor insulation characteristics and merit specific attention for efficiency upgrades.

- **Water:** The loss of potable water, the unknown duration of that situation, and the prospect of frozen pipe damage being revealed when water pressure was restored, were the most stressful aspects of Uri in my neighborhood. Several homes have pools and many of their owners offered access to their pool water for gray water use. My family had stored potable water when it was clear that the system pressure was dropping and that all water service might be lost. We also collected snow, so we had adequate water for the 5-6 days we were without utility water and never felt particularly stressed for water access. To the best of my knowledge everyone in the neighborhood had access to transportation soon after the peak of the storm, financial resources such that no necessities were lacking, and most had access to alternatives to water and any other critical needs.

- **Communication:** Communication is undoubtedly an invaluable service, and it is interesting to become aware of how the many modes and digital platforms of communication available to us has led to fragmentation of information sources. There are few common channels on which a majority of neighbors might be expected to receive emergency communications regarding critical community systems. KUT, our local National Public Radio affiliate, was the channel to which I paid most attention during Uri. My cell phone is equipped with an FM radio receiver, so I consider it to be an information channel that I will nearly always have close at hand. KUT is a platform I use daily, and it still performs emergency broadcast tests and service announcements, so it is the only information platform I specifically turn toward in emergency conditions. If internet service remained active in an emergency, I would attempt to pull information on specific services and issues of interest to me from the respective service providers' websites. In the absence of electricity and cell service, there is no obvious communal pathway to inform our neighborhood of any emergency issue affecting it. Ad hoc neighbor to neighbor communication or some street signs methodology would have to evolve in the worst situations. If cell phone service remains available, several applications have demonstrated utility to cover various needs during and after recent disasters, but this again illustrates the benefits and complexity of diverse options as articles describing "warning fatigue" are also easily found.

Northeast Austin during Winter Storm Uri 2021– by Kenneth Thompson Sr.

- **Neighborhood Impact:** The moment we knew that things were going to be a little abnormal was when the power went out and did not come back for several days. Our first instinct was to call to check on other family members and convey our status at the time. We gathered all the firewood available, relocated a mattress in front of the fireplace, and spent the majority of the power outage contained to 200 square feet. While we had gas for a short time that allowed us to boil water to create heat, I thank my Iranian sister for the idea. We were fortunate that a neighbor owned a water-main set-off key. He politely went up and down the street, turning off the water at the main house, which brought instant relief about the pipes freezing. This action brought many fellows outside to begin conversations on the winter storm's impact on their households because we were stranded, mostly running low on candles and flashlight batteries. The darkest times were when we had no communicating capacity. My neighbor with a newborn ran out of food and came by and asked if we had two eggs to share, we gave them the two eggs and shortly walked over to take the remaining eggs in the crate, and

he was most gracious. As I began to return to my house, I slipped and hit my head on the ice-cold concrete. I did not know if I had injured myself or not, but I could not tell my wife I had fallen and hit her head on the ground. I could not tell her because we had no access to emergency services, and I did not want to consume her with worry. Each day I worried if the pain in my head was associated with the fall and my imagination. We eventually pulled planks from the fence to burn as firewood and wondered at the same time if the chemicals in the wood we inhaled were deadly in the long term as we do any and everything possible to stay warm. We were unable to communicate, leaving so many individuals and families absolutely variable not only to the weather conditions but also to the possibility of your community being overrun by firepower and those with warped mentalities.

- **Communication:** The only Black radio Station in Austin Texas KAZI 88.7 FM was off the air during the entire duration of the winter storm. This had multiple impacts on the community's access to resources (Northeast Austin is a predominantly Black neighborhood). The radio station is a primary method for churches to announce their services while engaging with the community. Essentially there was no format for the underserved to access any information to improve or maintain their quality of life.

- **Takeaways:** Each resident should have some element of resilience in the place they reside. The city enacts a tier resilience model providing each household with options that can provide some support during abnormal weather or natural events. Here are a few resources my household found useful:
    - 7 Emergency Preparedness Apps to Keep on Your Phone
    - 17 Apps To Help You Get Through The Hurricane - NPR
    - 16 emergency apps for wildfires, earthquakes and other ...
    - As flood alerts lit up phones, did 'warning fatigue' set in?

Mia Greer's Experience during Winter Storm Uri 2021—as told to Bianca M. Pizarro Vázquez

During disasters, the unpredictable takes the lead. Mia's story takes place during Winter Storm Uri in February 2021. The day after snow made landfall, Mia was faced with a seemingly impossible situation; no power or water. Although she proudly says she's from Michigan, she's not comfortable driving in ice. Conditions changed fast, and she became an older woman living alone in below-freezing weather, stranded. But as a leader deeply committed to her community and church, she would soon reach safety.

Mia's pastor, Charles Moody, was intentional about all his parishioners during this time. He arranged for those in immediate danger to be transported somewhere safe—Mia was one of them. At first, when she was contacted by a fellow church member, she refused the help: "she's, like, you need to come stay with me, and I'm, like, no girl, I'm fine you know, but when my pastor called me…" Pastor Moody knew her potential for stubbornness and immediately followed up; he would not rest until all of his parishioners reached a warm place to pass the storm.

A recurring theme in Mia's story, and so many others', is the need for a safe place.

One of Mia's unique strengths as a leader is her capacity to care for her loved ones who have moved away from her immediate community. During the storm she found herself unable to provide shelter to her late-son's childhood friends whom she calls "floor boys"; she was devastated by this. Yet it brought up a reminder of the inaccessibility to safe spaces some communities have compared to others. Mia, unable to house her "floor boys" encouraged them to seek out mending relationships, "They would call [me]: 'Mom what should we do? Where can we go?' And a lot of them I was, like, go home— call your mom. Because a lot of those kids didn't have good relationships with their parents." This might be difficult to approach at first, and although not all will be received with open arms, some might. This leaves a gap for those who are not blessed with natural support systems that will help guide them during a disaster. This is not an easy task, and it is one that should be guided by a love-based support ethic. Organizations like the one Mia helps to lead, Community Coalition for Health (C2H), is guided by such principles: they focus on connecting people with resources to improve their health and quality of life. For example, during the storm, Mia knew of a couple whose apartment was destroyed and who then had to move to a hotel with their son. Once her organization received Uri funds, Mia was able to pass them on to help the family with what was necessary for their survival. Unfortunately, as of August 2022, a year-and-a-half later, the couple is still living in the hotel. The apartment they called home was never repaired, and they cannot afford the expenses themselves.

When we take a look behind the scenes of "community" we see intricately designed webs of networks; some nest within each other, some spread throughout multiple time zones, some never cross paths. Many still need work; some are not tightly bound and destined to become lost in systems built upon white supremacy and exploitation. Infrastructural work provides the opportunity to rewire the algorithmic nature of city making. Resilience hubs can become a pathway to this transformation, but only if done with such intention. Stories like Mia's lead us to reflect on the following necessities within resilience hubs:

- stronger communication
- pre-disaster knowledge of where people with critical conditions live (e.g., dialysis)

- comprehensive training for those who work and volunteer at the hub (e.g., anti-discriminatory training)
- funding allocation to and direct partnership with local organizations.

Although these may be difficult requests to make of the City of Austin, these necessities are an important challenge to harm resulting from the status quo.

Trust and the love-based support ethic remain at the center of conversations about community safety. As we witnessed with Mia's story, she was able to help others and receive help herself during time of deep crisis because of the years she spent developing her personal and working relationships with her church leadership and her son's friends; because of her care for her children and their loved ones, and because of her commitment to the improved well-being of her community.

Hyde Park and West Campus during Winter Storm Uri 2021 —by Bianca Pizarro Vazquez

Lived experience can inform most (if not all) elements of an equitable, circular approach to Resilience Hubs. During my own experience living in Austin as a graduate student and researcher in the Community and Regional Planning program, I lived in two culturally and geographically different homes. One was a two-story house in Austin's Hyde Park neighborhood which I shared with four other 20-something year-olds during the 2020-21 academic year. This past year (2021-22), I shared a lease for a condo with a fellow graduate student in West Campus. In both places, I was faced with challenging situations brought about by climate change in the urban environment.

The first began to unfold on February 15th, 2021, during Winter Storm Uri, when the pipes burst in our house, and we lost power for an extended period of time. The temperature had dropped below freezing; one of the rooms leased in the home, which was not built to be a bedroom, and withstand such intense temperature changes, was impossible to inhabit.

The second was at a smaller scale, but during late March 2022 there was a tornado warning, with its touchdown announced by a particularly loud emergency alert that supposed to reach all those expected to be affected. University of Texas students also received warning texts (see Figure 5). The instructions at the time of the event were not very effective at reaching people.

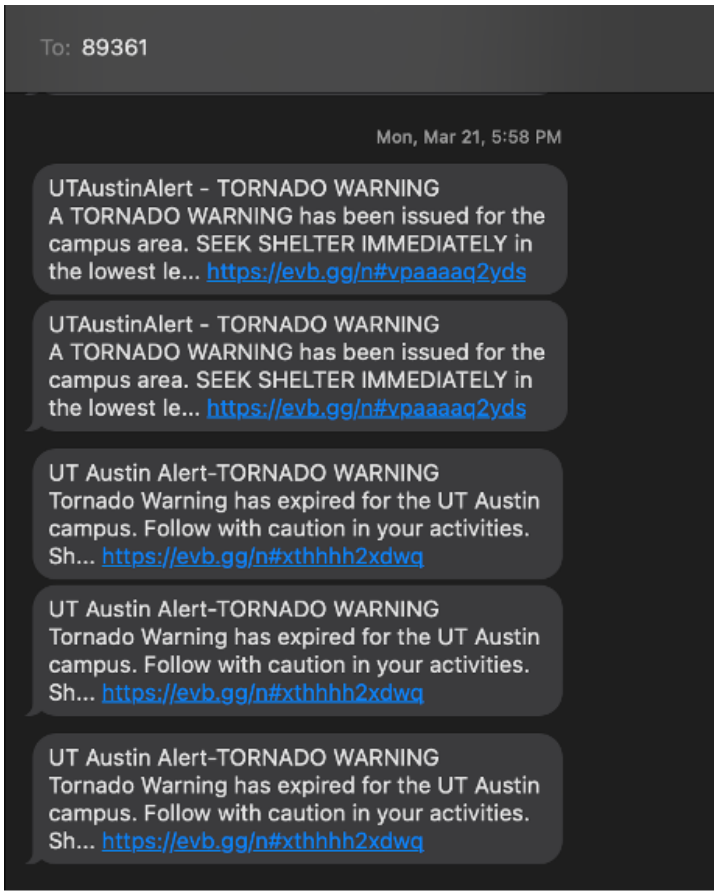

Figure 5: Warning texts from the University of Texas at Austin.

10. Recommendations and Areas for Further Exploration

We encouraged our Cities and Community Fellows to provide suggestions and identify areas that deserve further exploration. Below is a description of the discussions concerning each system.

Water

The following aspects should be carefully considered in order to strengthen the resilience of urban water systems:

- Resilience Hubs can provide emergency water resources for neighborhoods during disasters. For example, community-owned bottling systems can provide potable water, and other on-site water systems can satisfy non-potable water demands (e.g., shower and flushing toilet).

- Resilience Hubs should ensure equitable distribution of water supplies, and security issues of provided water resources should also be addressed. Economic issues such as the cost of developing and maintaining water systems should be carefully evaluated when planning for Resilience Hubs.
- Distributed water systems are agile and flexible as they have abilities to shift quickly. Therefore, they can be integrated with Resilience Hubs to provide water supplies to communities, such as rainwater harvesting systems or on-site water treatment facilities. However, they should not be treated as private wells and should be equitable.
- The city should find ways to build trust in Resilience Hubs by providing resources and information about water so that people will go during disaster/non-disaster times. For instance, hosting events at Resilience Hubs to promote available resources/services at hubs and sharing information through social media to reach more citizens.
- Make the Resilience Hub a "retail" location that people can access all the information about circular economy principles in urban water systems. For example, Resilience Hubs can provide information about water conservation and utility savings.

Food

When planning food systems for Resilience Hubs, the following factors should be properly taken into account:

- Prioritize community leadership and ownership: Given prior experiences of injustice when interfacing with city government, community fellows emphasized the importance of ensuring residents feel the Resilience Hub is a trusted and welcome resource. One strategy may be to hire and train community leaders and neighbors to manage the Resilience Hubs and to allocate decision-making opportunities and power to the community whenever possible.
- Continue to build a local food growing and harvesting program; community resilience includes having widespread and bountiful local food production. Training, investing, and building up Austin's local farming culture can help avert some of the food supply stress that occurs when global and regional food transportation is restricted by extensive disaster. Resilience Hubs can be a place for farmers to sell and distribute their goods, a location to recruit new employees, and a venue to train interested residents on how to successfully begin and operate a farm or smaller-scale food production.
- Integrate the Resilience Hub with the efforts of existing food justice organizations and financially compensate those organizations for sharing their knowledge and time.

There are numerous food justice organizations working towards improving Austin's community food system that can help weave a thriving community food system into the Resilience Hub initiative.

- Ensure cultural humility, competency, and equity: The emergency food system model often operates in crisis mode, redistributing whatever food is available. While sometimes this is unavoidable, it can result in excessive food waste if the person receiving food can't or won't eat it. For example, when discussing former encounters with emergency food distribution one of the Community Fellows remarked,

  You know, I have pre-existing conditions and during COVID and with other things going on, my community coordinated some free food delivery for me. Because I live in a predominantly Hispanic community, the box of food had many items tailored to that community, but that didn't fit my family's food culture. When we're thinking about the Resilience Hubs, I hope that we can also have foods that are culturally relevant. I don't want kale, I want greens. I don't want sweet breads; my family members have insulin resistance. *So, I think it's important that we consider these things, the type of food the Resilience Hubs distribute and that it's wanted and healthy.*

  Research within the charitable food system has shown that giving people freedom to choose their food is associated with greater nutritional benefit and self-empowerment (An 2019). Numerous technological advancements have been made to inventory control systems that could allow community members to assess Resilience Hub food inventory and pre-select food through their mobile device or tablets onsite at the Resilience Hub. While this would take an infrastructure investment, it may help Resilience Hub leaders to better manage food inventory, increase community satisfaction, and reduce waste.

- Carefully plan how food procurement, distribution, promotion, and consumption will operate and request frequent feedback from community members to adapt to changing needs.

Green Infrastructure

Fellows suggested that green infrastructure systems be multifunctional and system-oriented, inclusive, flexible, accessible, educational, and free. Green infrastructure may provide several contributions to Resilience Hubs operations as well as direct provisioning for residents at the household and neighborhood scale. Fellows emphasized the importance of ensuring that existing and new GI systems are perceived as relevant to diverse and historically underserved

residents. In addition, concerns about how GI may inadvertently exacerbate displacement, due to rising property values as well as the perception that GI is for high-income households, need to be considered and addressed when supporting and expanding GI systems in neighborhoods and in Resilience Hubs. To quote a Fellow:

> *How can we redefine green infrastructure as something that is not just for white people? How can we better incorporate multi-dimensional diversity in to GI? How do we answer WIIFM—"what's in it for me?*

Using a systems approach can help better connect green infrastructure to the social environment, a critical step for evaluating how GI benefits and costs are distributed, as well as ensuring that all residents understand the connections between GI and human health and well-being. Considerations of GI are really discussions about how residents have (or do not have) access to clean air, clean and abundant water, green space that supports physical, mental, and emotional health, and safety from climate-related events such as heat and flooding. To do this, we must consider the following:

- Consider how GI (e.g., tree canopy and green roof) can contribute to heat mitigation, both for Hubs as well as at the household and neighborhood scales; ensure that these GI systems prioritize under-resourced communities, including low-income households and communities of color.
- Consider how GI such as community gardens, food forests, church gardens, household gardens, and urban agriculture can contribute to greater food security and sovereignty, especially during climate-related events that disrupt the existing food system.
- Consider the human well-being and health contributions of GI, which may be a possible connection for coalition building.
- Leverage Austin's long history of GI-related flood and stormwater protection and ensure that under-resourced communities receive their fair share of this infrastructure;
- Consider how Hubs can serve as demonstration and learning centers for heat, flooding, water quality, well-being/health/safety, food security, and climate mitigation related GI.
- Leverage GI-related jobs and workforce development, including training, partnerships, and apprenticeships; consider using Hubs as dual-purpose locations for workforce development in non-emergency times.
- Consider how Hub-related GI systems interact with environmental and racial justice, land back programs, and anti-displacement work, including pro-actively addressing concerns about displacement stemming from GI.
- Possible stressor-related services supported by GI systems: onsite wastewater treatment (for Hubs as well as block scale); onsite cooling for Hubs, homes, and public

spaces via tree canopy and green roof establishment and maintenance; food production at Hubs and homes through gardens; continued and expanded stormwater/flood/water quality mitigation through GI stormwater systems such as rain gardens.

- More thoughtful consideration about how GI systems are understood, publicized, and recognized to help better make the case that GI systems are critical for all residents, including low-income and Black, Indigenous, and People of Color (BIPOC) communities. Possible pathways may be addressing visible GI gaps, such as tree canopy cover; better connecting GI to jobs and workforce development, such as through programs like the Austin Civilian Conservation Corps, and better explaining the potential for GI systems to reduce household costs (e.g., through reduced utility bills) and contribute to every-day household decisions and needs; and focusing on coalition building around, and community co-design of, new GI systems. There may also be opportunities to connect with residents already concerned about pollution and toxicity but who may not be thinking about GI.
- Other questions to consider: can Hubs be places for residents to rebuilt trust with the City of Austin? How can marginalized communities have a stronger voice in GI planning and Hubs?

Energy

A lower reliance on Resilience Hubs could be accomplished by strengthening the electrical grid upstream (e.g., generation assets) through:

- Enforcing weatherization of power plants. Many thermal plants suffered forced outages due to their inability to withstand sub-freezing temperatures, as well as the freezing of natural gas pipelines that fed into power plants.
- Increasing eligibility for natural gas power plants to be labeled as critical loads. Many power plants were not identified as critical by utilities due to improper paperwork filing, which further aggravated the situation of not having power capacity available.
- Accelerate the decommissioning of unreliable thermal power plants that have shown a poor operational track record during cold weather events and that are significant air pollutants contributors.

Furthermore, a set of additional topics could be explored to further complement the intersection with Resilience Hubs:

- Regulations and mechanisms to support the deployment of DER and demand response across user types.

- Evaluate rotating blackout methodologies and circuit topology to ensure these blackouts are enforced in an equitable manner.
- Ensure proper siting of Resilience Hubs with an adequate system sizing that can satisfy the minimum needs, as identified by community members.
- Evaluate reliable two-way communication protocols in multiple languages to reach out a broader segment of the population, with clear requests and instructions on how to respond to the extreme weather event as it relates to electricity consumption, and access to the Resilience Hub.

Communications

Any Resilience Hub being built by the city should include a plan that makes available to all city residents affordable access to the specific technology devices and online resources needed to access essential services during an emergency crisis or disaster. Staff from the City's Office of Telecommunications and Regulatory Affairs (TARA) have suggested at least two possible plug-in points that relate to communications systems and Resilience Hubs in Austin:

- Device ownership: many devices are retired before end of life, especially in a tech sector that needs to stay up to date technologically. How can we build sustainable refurbishment partnerships that direct refurbished devices to those who need them?
- Emergency preparedness and digital connectivity: If we are spreading information via internet/websites or messages to digital devices, how do we make sure people with no devices or little/no digital literacy have access to that information? Austin FreeNet is currently building out a digital navigators program to train folks on how to navigate digital resources (and to share that info with others). There could be an intersection between digital navigation services and the Resilience Hubs.

Additionally, in collaborations with churches, schools, hospitals, fire stations, community health centers, neighborhood associations, homeowner associations (HOAs), and nonprofit organizations, consider designing and testing outreach and related feedback loops as well as telephone trees and platforms such as Next Door to co-develop a standardized template for each designated geographic association and community, making sure to include mobile home parks. The goal would be to have each cluster of participating geographically defined areas register its *communications system* disaster plan with the closest Resilience Hub location.

Each association should also be given templates in more than just English for communicating by phone alerts, regular mail, door to door, radio, and also email its *communications system*

disaster plan so that households that include renters, lessees, or owner-occupants to know exactly who to call, where to go, etc. during a major disaster.

Keep in mind that many resident associations and communities are located *outside* City Council districts even though association/community members receive some city services. For that reason, working primarily through Council districts to identify associations/communities *will not* reach all residents. Examples can be found in Eastern Crescent areas of Austin's larger metropolitan district where residents have an Austin zip code and Austin electricity but not Austin water or gas. The latter two are provided by private water and gas service companies.

11. Final Reflections about a Participatory, Circular Approach to Resilience Hubs

Cities Fellows (UT-based), Community Fellows, and City staff, greatly valued learning more about the City's Resilience Hubs process as well as the Fellows' disciplinary expertise and lived experiences. In this report, we share findings from our collaborative approach to considering key urban systems—water, green infrastructure, energy, food, and communications— as individual systems and through the lens of a circular economy framework that integrates all systems. In addition, we've presented some examples of how local knowledge of past stressor events here in Austin may help inform the development of the physical and social aspects of the Resilience Hubs.

In conclusion, we'd like to offer a couple of observations. 1) While the Resilience Hubs will serve as places of provisioning and shelter during extreme events, and provide day-to-day programming and activities that will ideally contribute to increased capacity to deal with future shocks and stressors at the neighborhood and household level, there is much in turn that the Resilience Hubs can learn from residents such as the UT and Community Fellows who participated in our project. To paraphrase a Fellow, communities with low-income and BIPOC communities have been practicing the circular economy long before it was called that, reusing resources to make clothing out of sugar bags, quilts out of the clothing when it got old, and nourishing soups out of leftover food. Likewise, the "meemaw/auntie" (i.e., informal, familial) network of communication and care provides a valuable example of how a participatory approach to developing and managing Hubs can leverage generations of community wisdom and connections. 2) Thinking through resilience hubs within a participatory and circular framework makes something very clear: resilience hubs cannot exist in isolation and their capacity to succeed in making Austin's communities safer, more prepared, and more resilient must be tied to larger efforts towards making the city's services and systems more equitable.

We look forward to continuing our work with the Fellows this year to find additional ways of sharing their ideas and knowledge.

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Appendix A: April 1st Workshop Agenda

9:00: Breakfast and hellos

9.10: Short (re)introductions with icebreaker

9.30: overview of workshop agenda and purpose; time for questions

9.50: Marc Coudert provides update of resilience hubs program

10.15: 10 min break

10.25: Interactive talks on urban systems (food, communication, energy, water, and green infrastructure systems)

11: Exercises and activities to draw connections between systems and brainstorm recommendations for resilience hubs

12.45 overview of next steps

1 pm: Lunch