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Final Technical Report (FTR)

Cover Page

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Signature of Certifying Official *Date*

By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate. I am aware that any false, fictitious, or fraudulent information, misrepresentations, half-truths, or the omission of any material fact, may subject me to criminal, civil or administrative penalties for fraud, false statements, false claims or otherwise. (U.S. Code Title 18, Section 1001, Section 287 and Title 31, Sections 3729-3730). I further understand and agree that the information contained in this report are material to Federal agency's funding decisions and I have any ongoing responsibility to promptly update the report within the time frames stated in the terms and conditions of the above referenced Award, to ensure that my responses remain accurate and complete.

1 Acknowledgement

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3 Reflections & Insights About the RCM Project

"Few can truly grasp the transformative potential of a research initiative like the RCM project, which sets a new standard for community-driven energy resilience planning and informed decision-making. Through rigorous analysis and validation of RCM project data and outcomes, I am convinced that 'community engagement is no joke.' This implies that meaningful community engagement goes far beyond conventional participation. It is a science that represents a disciplined approach, challenging existing frameworks of energy resilience planning and advancing new frameworks of energy resilience investments. By integrating rich qualitative insights from community members with robust quantitative data on power outages, the project delivers results that are both compelling and actionable. Throughout the analysis, every voice, perspective, and lived experience was considered, making the findings not just insightful but invaluable for today's energy resilience decision-making. It is truly remarkable to have experienced how this community-led research can shape resilient solutions for the future. Especially, witnessing the project's real-world impact is inspiring and highlights the vital role of data science in designing practical, community-focused energy strategies." - **Dr. Elvis Moleka** (Groundswell).

4 EXECUTIVE SUMMARY

The primary objective of the Resilient Communities, Maryland (RCM) project and its benefit to the public was to create a community-driven energy resilience framework that can be replicated across Maryland to enhance public safety and improve preparedness and recovery during hazardous events and extended power outages. To accomplish this, the RCM research conducted from February 2023 – July 2025 employed a Community-Based Participatory Research (CBPR) framework, grounded in A.C.E Impact Trailway Methodologies, to understand community perspectives and underscore the importance of community involvement in energy resilience decisions. Integrating CBPR approaches (demonstrated in Figures **1** and **2** in Exhibit **A1)** into energy resilience planning resulted in greater effectiveness and efficiency in understanding the impacts of energy infrastructure disruptions in each of the three jurisdictions.

While many people value community engagement, finding the best ways to gather meaningful community feedback can be difficult. The RCM research and its associated Framework provide a clear plan that planners and policymakers can use to collect helpful information for prioritizing resilience efforts. The research is relevant, timely, and flexible enough to be adapted to different communities, contexts, and concerns, making it valuable not only for Maryland but also for communities across the United States. Simultaneously, grounded by the Statement of Project Objectives (SOPO), the activities developed are specific enough to offer a coherent and practical structure for community engagement. The project team has had a rare opportunity to develop a conceptual research framework and field-test it within a single project, resulting in a stronger outcome than if the team had tried to combine insights from different projects later. The work demonstrates how integrating utility electricity planning, community planning, and research can foster opportunities for community participation in energy resilience decision-making. This project benefits the public by simplifying decisions about backup energy for people who are not energy industry experts, encouraging greater public involvement, and providing additional support for informed decisions once made. It also promotes the deployment of distributed energy resources (DERs) across the U.S., emphasizing its economic benefits such as improving grid efficiency and reliability, enhancing community energy resilience through reliable backup power, and improving the quality of local decision-making by encouraging consideration of factors beyond traditional cost-benefit analysis.

The RCM project contributed to the field by integrating CBPR approaches into energy resilience planning. The combination of qualitative community-driven data and quantitative utility outage data improves both the effectiveness and efficiency of assessing the impacts of disruptions to energy infrastructure. Another important contribution was the creation of a repeatable framework for evaluating and modeling energy resilience metrics. Additionally, the RCM research project promoted community engagement, resulting in more equitable stakeholder participation and improved decision-making related to siting resilient power infrastructure through microgrid activities.

TABLE OF CONTENTS

1 ACKNOWLEDGEMENT 2
2 DISCLAIMER 2
3 REFLECTIONS & INSIGHTS ABOUT THE RCM PROJECT 2
4 EXECUTIVE SUMMARY 3
5 BACKGROUND 6
5.1 Gaps in the Literature 6
5.2 Contributions to the Body of Knowledge 8
6 PROJECT OBJECTIVES 10
6.1 Budget Period 1 / Year 1 Tasks to be Performed 10
6.2 Budget Period 2 / Year 2 Tasks to be Performed 14
7 PROJECT RESULTS AND DISCUSSION 19
7.1 Project Results in Budget Period 1 19
7.1.1 **Task 1.0:** Establish program management systems and complete hiring 19
7.1.2 **Task 2.0:** Document existing energy equity metrics for community-driven resilience. 21
7.1.3 **Task 3.0:** Create the Baltimore Resiliency Council and Roundtable 22
7.1.4 **Task 4.0:** Develop an initial resilience framework for Baltimore. 24
7.1.5 **Task 5.0:** Develop an initial research dissemination plan 29
7.1.6 **Task 6.0:** Create the Montgomery County Resiliency Council and Roundtable . 29
7.1.7 End of Year 1 Project Goals (EOP Y1) 30
7.2 Project Results in Budget Period 2 30
7.2.1 **Task 7.0**: Refine and adapt the RCM framework in Montgomery County 30
7.2.2 **Task 8.0:** Create Eastern Shore Resiliency Council and Roundtable 34
7.2.3 **Task 9.0**: Refine and adapt the RCM framework for the rural Eastern Shore 36
7.2.4 **Task 10.0**: Develop the final resiliency framework document 40
7.2.5 **Task 11.0**: Finalize the dissemination plan for a resilience framework 41
7.2.6 End of Year 2 Project Goals (EOP Y2) 42
8 SIGNIFICANT ACCOMPLISHMENTS AND CONCLUSIONS 43
8.1 Significant Accomplishments 43
8.2 Challenges and Mitigating Solutions 45
8.3 Conclusions 47
9 PATH FORWARD 47
10 PRODUCTS 49
11 PROJECT TEAM AND ROLES 49
11.1 Groundswell – Project Lead 49
11.2 National Renewable Energy Laboratory (NREL) – Technical Analysis Lead 51
11.3 Ayika Solutions, Inc. (ASI) – Community Research Lead 52
11.4 DOE and Other Contributors 53
12 REFERENCES 54
13 APPENDICES 57
13.1 Exhibit A1: Community-Based Participatory Research (CBPR) 57
13.2 Exhibit A2: Critical Service Access: A Community-Driven Resilience Metric 59
13.3 Exhibit B: Existing Reliability Metrics 62

13.4 Exhibit C: Mapping the Universe of Desired Stakeholder Groups 64
13.5 Exhibit D: Service Scoring 67
13.6 Exhibit E: Service Landscapes 76
13.7 Exhibit F: Measuring Outage Consequences 79
13.8 Exhibit G: Mapping Neighborhood Critical Services 85
13.9 Exhibit H: Resilience Hub Siting 92
13.10 Exhibit I: Timeline of Needs 96
13.11 Exhibit J: Service Value Over Time 100
13.12 Exhibit K: Products 105
13.13 Exhibit L: Other Contributors to the Project 106
13.13.1 Maryland Energy Administration (MEA) 106
13.13.2 Baltimore Office of Sustainability – Local Government Advisor 107
13.13.3 External Advisory Group 107
13.13.4 Resilience Council 107
13.13.5 Roundtable 107
13.13.6 Special Thanks and Acknowledgments 108

ABBREVIATIONS/ACRONYMS

ASI	Ayika Solutions, Inc.
BGE	Baltimore Gas and Electric
CAIDI	Customer Average Interruption Duration Index
CAIFI	Customer Average Interruption Frequency Index
CBPR	Community-Based Participatory Research
CELID	Customers Experiencing Long Interruption Durations
CEMI	Customers Experiencing Multiple Interruptions
DERs	Distributed Energy Resources
DOE	U.S. Department of Energy
IEEE	Institute of Electrical and Electronics Engineers
IOUs	Investor-Owned Utilities
MAIDI	Momentary Average Interruption Duration Index
MAIFI	Momentary Average Interruption Frequency Index
MEA	Maryland Energy Administration
MED	Major Event Days
NREL	National Renewable Energy Laboratory
NSI	National Structure Inventory
PSI	Positive Social Impact
RACER	Renewables Advancing Community Energy Resilience
RC	Resilience Council
RCM	Resilient Communities, Maryland
RT	Stakeholder Roundtable
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SEIF	[Maryland's] Strategic Energy Investment Fund
SIMMs	Social Impact Measures & Metrics

5 BACKGROUND

Access to electricity is crucial for economic growth and prosperity (Bie et al., 2017). Power outages can interrupt access to essential services, including medical care, childcare, shelter, information, food, and other critical supplies (Clark et al., 2022; Bawaneh et al., 2019). These disruptions can be especially devastating for individuals who rely heavily on these services and cannot afford to spend extra time or money to regain access during an outage (Mitsova et al., 2021; Peterson et al., 2024). Resilience, as it applies to the RCM research, is defined as "a system's ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover quickly from disruptions through sustainable, adaptable, and holistic planning and technical solutions" (Hotchkiss & Dane, 2019, p.8; Clark et al., 2022). Consequently, resilience energy planning has gained increasing attention in recent years, with distributed energy resources (DERs)[1] offering a means by which to strategically deploy flexible, localized, and resilient energy solutions that enhance reliability and reduce costs (Cicilio et al., 2021). Many efforts in the literature have aimed to measure the value of energy resilience in the utility sector, emphasizing the importance of assessing vulnerability to disruptions during power outages, supporting risk-based decision-making, guiding infrastructure planning and operations, and quantifying recovery and restoration capabilities (Jeffers et al., 2023; Jeffers et al., 2020; Jeffers et al., 2018; Leddy et al., 2023; Stout et al., 2019). However, while the costs of extended power outages include compounded community hazards, economic and service disruptions, as well as public health risks (Ericson et al., 2022), measures by which to quantify the value of avoiding such outages have yet to be fully standardized.

5.1 Gaps in the Literature

The extant literature has primarily focused on measuring and valuing resilience in the power sector (at the utility level), including grid modernization, with limited research conducted on resilience in energy planning at the community level. For instance, Hotchkiss and Dane (2019) emphasized the need for a systematic approach to energy resilience that involves community feedback. Besides, the reliability metrics (Table **1** in Exhibit **B**) commonly used in the electric utility industry for transmission and distribution have limitations when assessing resilience (Cicilio et al., 2021). These metrics overlook key factors such as regional disparities, policy regulations, socioeconomic influences, system configurations, customer density, and hazard exposure. This is perhaps because energy *reliability* – a far more established concept than energy resilience – primarily addresses routine or short-term issues and the unexpected loss of system components due to credible contingencies (Cicilio et al., 2021). Additionally, traditional reliability metrics overlook major outages caused by unforeseen or high-impact events, such as major event days (MEDs) – i.e., the very scenarios in which the concept of resilience is most relevant. While resilience metrics are often used to measure

[1] These are small-scale energy technologies located close to where electricity is used, such as solar panels, battery storage systems, microgrids, electric vehicles, and demand response technologies. They help improve grid efficiency, resilience, and sustainability (Cicilio et al., 2021).

resilience, the two concepts are not synonymous – while a power system may be highly reliable, it may not necessarily be resilient. These established reliability metrics solely focus on the performance of the grid and do not reflect the priorities of community members who depend on the grid to meet their basic needs (Peterson et al., 2023; Hotchkiss et al., 2019; Day & Simcock, 2016).

Additionally, existing frameworks for combining metrics into actionable resilience assessments that do incorporate stakeholder engagement tend to focus on stakeholder engagement with experts rather than community members (Jeffers et al., 2020; Petit & Vargas, 2020; Anderson et al., 2019). One area in these resilience assessment frameworks where community participants can offer valuable insights is in metrics that measure the impacts of power outages. Recent reviews of energy resilience metrics have highlighted access to services as an emerging energy-related measure that can inform both infrastructure planning and resilience, ultimately benefiting local communities. This is because community involvement in energy resilience planning creates ownership and improves decision-making (Fry et al., 2023; González, 2019). A community-driven approach to energy resilience emphasizes the role of energy-enabled infrastructure, as demonstrated by the consistent provision of essential services within a neighborhood for its residents (McGookin et al., 2021; Ross & Day, 2022). Given that access to services changes dynamically over time, as various service locations become available or unavailable, it is crucial to measure the cumulative impact of disruptions at different service-providing locations at the household or neighborhood level, which can be aggregated by individual service categories (e.g., medical services) or by all services (Hart et al., 2024). Addressing routine disruptions and extreme events helps create a stable and resilient system. However, repairing and restoring systems affected by MEDs can be more complicated, mainly because outages tend to last longer than those caused by reliability issues. Resilience approaches to energy planning recognize that severe impacts on human well-being can result from infrequent but high-impact events (Peterson et al., 2023). Effective community resilience planning, therefore, must understand societal needs and ensure these needs are met (Hart et al., 2024; DeSalvo et al., 2014).

Against this backdrop, the RCM research developed a community-focused energy resilience framework, which was implemented across three Maryland jurisdictions: Baltimore (urban), Montgomery County (suburban), and the Eastern Shore (rural). The research highlights the fact that studies on the interdependence between electricity and other social, economic, and infrastructure systems have developed metrics, such as social burden, that better measure the benefits of resilience investments (Wachtel et al., 2022). Although these metrics incorporate social science methods and community participation to validate approaches, they have not yet been integrated into community engagement processes for energy planning. To address this, the project aimed to connect research with planning by collecting community feedback on hypothetical energy resilience investments through interactive discussions that can be adapted for use in many communities. The project focused on critical service access, a metric designed to help decision-makers identify resilience investments that maximize community access to essential services (Conway & Stewart, 2019; Conway et al.,

2018). Feedback from community members was used to improve both the interactive engagement tools and the critical service access metric itself (see Exhibit **A2**). For instance, input from rural residents led to expanding the distance radius used to calculate critical service access, which better reflects the longer distances residents may travel for services (Conway et al., 2018). Empowering communities involves transferring decision-making authority and resources to them, highlighting the importance of community perspectives in energy planning decision-making processes (Lovell et al., 2024; Dongier et al., 2002). To achieve this, the specific goals for this project were to:

- Develop and refine a community-driven framework for measuring community and energy resilience.
- Use this framework to identify priority sites (such as geographic areas, facility types, types of services offered by facilities, or other criteria identified through research) for implementing community energy resilience across the state.
- Expand the framework by sharing research results through MEA's energy resilience funding program.

5.2 Contributions to the Body of Knowledge

Consistent with the idea that energy resilience is a vital component of societal and community resilience, our work emphasizes the social benefits of resilient energy systems, which help maintain essential services such as food, water, and shelter (Bie et al., 2017). Energy solutions that aim to maximize access to services or ensure continuous power in accordance with community-defined needs, rather than simply increasing the total energy supplied, can bolster community resilience and support distributive services across various communities (Lovell et al., 2024). Engaging communities in siting these energy solutions ensures that community-specific needs are considered during the planning process (Clark et al., 2022). This work also contributes to efforts to measure the connection between community needs and energy system resilience. By ensuring that critical services—and the electrical infrastructure that supports them—remain available, communities are better able to meet their essential needs and maintain resilience.

Commonly cited energy resilience metrics often fail to connect infrastructure performance with human outcomes in a meaningful way (Peterson et al., 2023; Day & Simcock, 2016). For instance, the number of customers affected by an outage may indicate the geographical extent of the impact, while the lost load may indicate how much electricity those customers typically consume. However, neither of these metrics distinguish between outages at a grocery store, pharmacy, or library — locations where outages create different consequences for residents, depending on the services offered and the proximity of each location to surrounding community members. Likewise, while outage frequency or duration can highlight areas of the distribution grid that require repairs or preventive measures, such as tree trimming, these metrics do not offer specific insight into how outages affect essential services that community members depend on (Clark et al., 2018; DeSalvo et al., 2014). Additionally, because community

engagement in energy systems is uncommon, this project introduces a new approach to community involvement in resilience discussions, combining qualitative feedback from residents with quantitative power outage data to guide infrastructure planning and policymaking. This work advances the integration of community input beyond traditional decision-making methods for energy resilience. Ultimately, adopting this approach could improve how communities nationwide allocate resources for energy resilience investments.

Designed around a community-centered engagement model (A.C.E. Impact Trailway™), this project aimed to clarify the values that communities prioritize regarding energy resilience, recognizing community input as a crucial part of any decision-making process for resilience investments (McGookin et al., 2021; Ross & Day, 2022). This is because common reliability and resilience metrics only partially reflect community preferences. We sought to gain a comprehensive understanding of community members' experiences before, during, and after power outages, their varying levels of preparedness, and how the severity of outages within a specific time frame affects their daily needs and priorities. Through the RCM research project, we aimed to establish that community participation in energy resilience decision-making requires: 1) a neighborhood-scale, quantitative measure linking energy and resilience, 2) a process for including qualitative feedback from residents into that measure, and 3) acceptance of experts who oversee energy projects. This fills a clear gap in energy resilience research by connecting community input with quantitative decision support and providing analyses to inform local, state, and utility actions.

A key contribution involves identifying the best ways to inform investments in energy resilience infrastructure by integrating CBPR approaches into energy resilience planning (Ross & Day, 2022; González, 2019). This integration (qualitative community-driven data and quantitative utility power outage data) enhances[2] both the effectiveness and efficiency of evaluating the consequences of disruptions to energy infrastructure. Another noteworthy contribution to the field is that the RCM project established a replicable framework for assessing and modeling energy resilience metrics seen by its successful use in three different jurisdictions in the state of Maryland. Additionally, the research facilitated community participation, leading to more equitable stakeholder involvement and improved decision-making processes related to the siting of resilient power infrastructure, achieved through microgrid activities.

Ultimately, the RCM project seeks to scale the framework by applying its research findings through the Maryland Energy Administration's (MEA) energy resilience funding program. This approach advances the deployment of distributed energy resources by integrating community-driven insights into resilience planning, enabling smarter, more localized energy investment decisions. It also delivers economic value by strengthening

[2] In the RCM Framework Document, the project team captured feedback from Baltimore Gas and Electric (BGE) and Pepco Holdings, noting that the Framework's evidence-based approach—integrating community-informed qualitative insights derived through CBPR methods with quantitative utility outage data—enhances their key performance indicators for investments in energy resilience infrastructure by incorporating community-level perspectives on the impacts of energy systems.

energy resilience and reducing the social and economic impacts of infrastructure disruptions across Maryland and the broader United States. Strong partnerships and collaboration will be essential to realizing the full potential of the RCM research outcomes. Especially, the creation of networks that leverage both energy and non-energy stakeholder expertise helps fill knowledge gaps and ensures a comprehensive approach to energy resilience planning. However, the opportunity for technology transfer lies in the work of NREL's energy security and resilience research, whose goal is to reduce the likelihood and impact of disruptions to energy systems. For entities like the MEA and /or the state of Maryland, this ensures that essential services, critical missions, and communities can withstand and recover from evolving threats due to extended power outages. In addition, it provides such agencies the opportunity to collaborate in partnerships with DOE National Labs, such as NREL, via technology-partnership agreements (Technology Partnership Program | NREL)

6 PROJECT OBJECTIVES

As outlined in the SOPO, the RCM project encompasses two primary technical objectives and contributions as described below. Please refer to section 7 for a detailed discussion and analysis of results.

6.1 Budget Period 1 / Year 1 Tasks to be Performed

RCM will develop an initial community energy resiliency framework by studying performance-based and non-performance-based data for Baltimore City neighborhoods, relying heavily on community input provided first by a Community Resiliency Council and then integrated with a broader stakeholder Roundtable, via Step 1 of the A.C.E. Impact Trailway™ approach that is designed to create equitable partnerships centered around the community. The project will use the ACA-NET™ framework[3] as a guide to establish equitable partnerships. The project will also subsequently validate and refine this nascent framework in Montgomery County, Maryland, to identify ways in which the Baltimore framework can be adapted to fit Montgomery County's community priorities and physical infrastructure. The exact structure of community input will first be established via a Resiliency Council, followed by a broader stakeholder Roundtable.

Task 1.0: Establish program management systems and complete hiring
Task Summary: The Project Team will establish RCM program-specific project management, budgetary, and data management systems needed for successful project delivery.

Subtask 1.1: Create subrecipient work plans.
Subtask Summary: In collaboration with the subrecipients, Groundswell will create detailed work plans for each subrecipient that incorporate any relevant DOE requirements and include deliverable descriptions, deadlines, and payment structures.

[3] ACA-NET stands for Academic Institutions, Community, Agency Network.

Subtask 1.2: Develop protocols for data collection, sharing, and management.
Subtask Summary: Groundswell will create a legal structure for data sharing, including any personally identifiable information (PII), with the intent to enable community stakeholders to own their intellectual property contributions to the project.

Subtask 1.3: Hire and onboard new staff members.
Subtask Summary: Develop and post job descriptions, interview candidates, and hire and onboard successful candidates for the Resiliency Program Manager role and Resiliency Fellow role.

Subtask 1.4: Form an external advisory group and determine its operational structure.
Subtask Summary: Identify and recruit participants for an external advisory group that can provide periodic feedback on the replicability of emergent considerations and methodologies beyond the duration of the project.

Task 2.0: Document existing energy equity metrics for community-driven resilience.
Task Summary: Identify existing metrics and frameworks for community-driven resilience, including tools and methodologies such as the Resilience Inclusive Energy Master Planning process developed by Jeffers et. al. (2022), the Anderson et al (2019) model, and the Clear Sky Toolkit, to be used as a guide against which to iterate and expand upon through direct community input. Broaden baseline conditions assessed, adjust hazards for local conditions, and document differences in infrastructure quality within underserved communities (e.g., distribution grid disparities), and account for community-driven vulnerabilities.

***Milestone 1.2.1*:** Gaps in existing resilience frameworks and metrics identified for subsequent exploration and testing.

Task 3.0: Create the Baltimore Resiliency Council and Roundtable to feed insights from discussions and community-led direction into a technical decision-making context
Task Summary: Using the ACA-NET™ framework, identify and recruit community stakeholders who will participate in the community-only Resiliency Council and government, utility, and other stakeholders (e.g., academic institutions and other non-profit organizations) to participate in the Baltimore Roundtable. The ACA-NET™ framework is a collaborative partnership model that facilitates solution-oriented conversations, driven and led by the communities most impacted by the subject matter. Applying this framework, a community-only group will be formed (Resiliency Council), which will then participate in the larger Roundtable. At least one faculty or student member from the community will participate in each Roundtable. Recruitment for participants in the Resiliency Council subgroup (designed as a “safe space” for community members to voice opinions and perspectives outside of the larger stakeholder Roundtable) will begin first. It will strive for diversity of representation from within the community. Outreach to at least 15-20 potential participants is anticipated to secure the participation of 5-10 of these individuals.

Subtask 3.1: Map the universe of desired stakeholder groups for participation.
Task summary: Define different types of stakeholders who will be engaged in the project and the timeline for engagement of each.

Subtask 3.2: Develop outreach strategy and materials for stakeholder recruitment.
Task summary: Determine the outreach approach for each stakeholder group and create invitational outreach materials that provide a project overview.

Subtask 3.3: Finalize participation agreements for Baltimore Resiliency Council members.
Task summary: The participation agreement for Resiliency Council members will include a fixed stipend to honor each participant's time.

***Milestone 1.3.1*:** Convene the Baltimore Resiliency Council as a "safe space" for community members to voice key priorities and concerns regarding power outages and critical services needed to enhance resilience.

Subtask 3.4: Conduct an outreach campaign to recruit Baltimore Roundtable members.
Task summary: Contact identified stakeholder groups using various means of communication, adapted to the type of stakeholder being targeted. Recruitment will target government, utility, and other relevant stakeholders for the Roundtable.

Subtask 3.5: Complete Baltimore Roundtable recruitment
Task summary: Secure participation agreements, providing an overview of the purpose of the project.

Task 4: Develop an initial resilience framework for Baltimore.

Subtask 4.1: Gather existing information on power outages, natural hazards, and social vulnerability.
Task summary: Document current conditions by gathering quantitative and qualitative data from the Resiliency Council stakeholders on the human impacts that power grid outages have had on individuals and communities, as well as data on historical grid outages from utilities and the Baltimore City Office of Emergency Management.

Subtask 4.2: Define the community's energy resilience priorities via a multi-stakeholder process to define and develop a metric that dynamically characterizes energy resilience and a process for integrating community feedback into that metric.
Task Summary: Identify pain points and needs, conducting ranking exercises to select the highest priority services and types of facilities that could offer those services. Additionally, determine what the community would like to leave with after RCM, incorporating feedback into the project.

Subtask 4.3: Host the first Baltimore Roundtable meeting.

Task Summary: Convene the Resiliency Council and other stakeholders to share community-defined priorities and collaborate with other stakeholders to incorporate additional considerations.

Subtask 4.4: Define the role that DERs can play in increasing resilience and energy equity.
Task Summary: Share the technical limitations of DERs with the Resiliency Council and determine how the community would like to see DERs support recovery planning, both through the framing of Resiliency Hubs (siting, services provided, outage survivability time, etc.) and other innovative ideas generated by the Resiliency Council, including ideas about blue-sky benefits and costs.

Subtask 4.5: Combine qualitative and quantitative data to create measurable resilience metrics.
Task Summary: Based on community-defined priorities and the desired role of DERs, incorporate social impact measures and technical/performance-based measures to create a measurable valuation for resilience project implementation. Merge social impact metrics with technical energy equity metrics to create an interdisciplinary framework.

Milestone 1.4.1: Develop an initial resilience framework for Baltimore, including a database of service locations prioritized according to the community-determined metric and a summary of the community input process that influenced that prioritized database. The database of prioritized service locations will be compared with existing Baltimore Resilience Hubs to identify potential opportunities for new investments.

Subtask 4.7: Host the second Baltimore Roundtable meeting.
Task Summary: Convene the Resiliency Council and other stakeholders to review the resilience model and discuss feedback.

Task 5: Develop an initial research dissemination plan
Task Summary: Develop an initial plan for sharing work with a broader audience, including avenues each partner can utilize to disseminate the resilience framework and educate other stakeholders on what the framework is and how it can be used.

Subtask 5.1: Conference evaluation and planning
Task Summary: Identify and evaluate potential conferences during Year 2 to attend and present initial work.

Subtask 5.2: Documentation of initial research dissemination plan
Task Summary: Develop a written plan for the dissemination of research, with a timeline and proposed avenues for publication, presentation, and engagement.

Task 6: Create the Montgomery County Resiliency Council and Roundtable to feed insights from discussions and community-led direction into a technical decision-making context

Task Summary: Identify and contact stakeholders who will provide input on community resilience needs and priorities that should be represented in the framework, leveraging relationships created through the Project Team's existing resilience work in Montgomery County. Recruitment will be for both the Resiliency Council subgroup and other stakeholders (e.g., utility, government, academic institutions, and other non-profit organizations) who will participate in the Roundtable. Recruitment for participants in the Resiliency Council subgroup (designed as a "safe space" for community members to voice opinions and perspectives outside of the larger stakeholder Roundtable) will begin first. It will strive for diversity of representation from within the community. Outreach to at least 15-20 potential participants is anticipated to secure the participation of 5-10 of these individuals.

Subtask 6.1: Map the universe of desired stakeholder groups for participation.
Task Summary: Define different types of stakeholders who will be engaged in the project and the timeline for engagement of each, leveraging the map created for the City of Baltimore.

Subtask 6.2: Finalize participation agreements for Montgomery County Resiliency Council members.
Task Summary: The participation agreement for Resiliency Council members will include a fixed stipend to honor each participant's time.

***Milestone 1.6.1*:** Convene Montgomery Resiliency Council meeting as a "safe space" for community members to voice key priorities and concerns regarding power outages and critical services needed to enhance resilience.

Subtask 6.3: Conduct outreach to recruit Montgomery County Roundtable members.
Task summary: Contact identified stakeholder groups using various means of communication, adapted to the type of stakeholder being targeted. Recruitment will target government, utility, and other relevant stakeholders for the Roundtable.

Subtask 6.4: Complete recruitment for Montgomery County Roundtable.
Task summary: Secure participation agreements, providing an overview of the purpose of the project.

End of Year 1 (EY1) Milestones: Feedback from Baltimore stakeholders documented, initial resiliency framework developed and documented, and participation agreements for Montgomery County Resiliency Council finalized.

6.2 Budget Period 2 / Year 2 Tasks to be Performed

RCM will complete validation of the framework in Montgomery County, followed by validation of the initial framework within one municipality of the rural Eastern Shore, identifying if and how the framework works for a rural area. RCM will produce a documented framework and case studies, and create a research dissemination plan that includes presenting the findings at a conference with national attendance. The plan

will be shared broadly across team member networks and will be implemented statewide, shaping energy resilience programs and investments.

Task 7: Refine and adapt the RCM framework in Montgomery County.
Task Summary: Gather local data and share the nascent RCM framework with stakeholders in Montgomery County to determine regional adaptations that may be required.

Subtask 7.1: Gather existing information on power outages, natural hazards, and social vulnerability.
Task summary: Document current conditions by gathering quantitative and qualitative data from the Resiliency Council stakeholders on the human impacts that power grid outages have had on individuals and communities, as well as data on historical grid outages from utilities and the county's emergency management office.

Subtask 7.2: Define the community's energy resilience priorities via a multi-stakeholder process to define and develop a metric that dynamically characterizes energy resilience and a process for integrating community feedback into that metric.
Task Summary: Identify pain points and needs, conduct ranking exercises to select the highest priority services and types of facilities that could offer those services. Additionally, determine what the community would like to leave with after RCM, incorporating feedback into the project.

Subtask 7.3: Host the first Montgomery County Roundtable meeting.
Task Summary: Convene the Resiliency Council and other stakeholders to share community-defined priorities and collaborate with other stakeholders to incorporate additional considerations.

Subtask 7.4: Incorporate feedback from the Montgomery County Roundtable into the RCM framework.
Task Summary: Make changes to the framework based on priorities and differing conditions that the Resiliency Council and/or Roundtable identifies.

Subtask 7.5: Define the role that DERs can play in increasing resilience and energy equity.
Task Summary: Share the technical limitations of DERs with the Resiliency Council and determine how the community would like to see DERs support recovery planning, both through the framing of Resiliency Hubs (siting, services provided, outage survivability time, etc.) and other innovative ideas generated by the Resiliency Council, including ideas about blue-sky benefits and costs.

Subtask 7.6: Combine qualitative and quantitative data to create measurable resilience metrics.
Task Summary: Using community-defined priorities, merge social impact metrics with technical energy equity metrics to create an interdisciplinary framework.

Milestone 2.7.1: Develop an adapted resilience framework for Montgomery County, including a database of service locations prioritized according to a community-determined metric and a summary of the community input process that influenced that prioritized database.

Subtask 7.7: Host the second Montgomery County Roundtable meeting.
Task Summary: Convene the Resiliency Council and other stakeholders to review the edited framework and incorporate any additional considerations.

Subtask 7.8: Seek feedback from the Stakeholder Roundtable and from the external advisory group on the effectiveness of the framework.
Task Summary: Consult the Stakeholder Roundtable and external advisory group, document feedback on areas for improvement, and incorporate this feedback into the framework.

Task 8: Create Eastern Shore Resiliency Council and Roundtable to feed insights from discussions and community-led direction into a technical decision-making context
Task Summary: Identify and contact stakeholders who will provide input on community resilience needs and priorities that should be represented in the framework, leveraging the Project Team's connections with the University of Maryland, Eastern Shore, and the Town of Berlin. Recruitment will be for both the Resiliency Council subgroup and other stakeholders (e.g., government, utility, academic institutions, and other non-profit organizations) who will participate in the Roundtable. Recruitment for participants in the Resiliency Council subgroup (designed as a "safe space" for community members to voice opinions and perspectives outside of the larger stakeholder Roundtable) will begin first. It will strive for diversity of representation from within the community. Outreach to at least 15-20 potential participants is anticipated to secure the participation of 5-10 of these individuals.

Subtask 8.1: Identify the Eastern Shore jurisdiction in which to focus research and the test framework.
Task Summary: Evaluate potential municipalities on which to focus, based on team member relationships in Eastern Shore communities and other evaluation methods; select jurisdiction and document rationale.

Subtask 8.2: Map the universe of desired stakeholder groups for participation.
Task Summary: Define different types of stakeholders who will be engaged in the project and the timeline for engagement of each, leveraging the relationship mapping tools created for Baltimore and Montgomery County.

Subtask 8.3: Finalize participation agreements for Eastern Shore Resiliency Council members.
Task Summary: The participation agreement for Resiliency Council members will include a fixed stipend to honor each participant's time.

Milestone 2.8.1: Convene Eastern Shore Resiliency Council meeting as a “safe space” for community members to voice key priorities and concerns regarding power outages and critical services needed to enhance resilience.

Subtask 8.4: Conduct an outreach campaign to recruit Eastern Shore Roundtable members.
Task summary: Contact identified stakeholder groups using various means of communication, adapted to the type of stakeholder being targeted. Recruitment will target the government, utility, and other relevant stakeholders.

Subtask 8.5: Complete Eastern Shore Roundtable recruitment.
Task summary: Secure participation agreements, providing an overview of the purpose of the project. The participation agreement will include a fixed stipend to honor each participant’s time.

Subtask 8.6: Host the first Eastern Shore Roundtable meeting.
Task Summary: Convene the Resiliency Council and other stakeholders to understand the applicability of proposed resilience coordination and information-sharing structures.

Task 9: Refine and adapt the RCM framework for the rural Eastern Shore jurisdiction
Task Summary: Gather local data and share the RCM framework with stakeholders in the Eastern Shore to determine regional adaptations that may be required.

Subtask 9.1: Gather existing information on power outages, natural hazards, and social vulnerability.
Task summary: Document current conditions by gathering quantitative and qualitative data from the Resiliency Council stakeholders on the human impacts that power grid outages have had on individuals and communities, as well as data on historical grid outages from utilities and the County’s emergency management office.

Subtask 9.2: Define the community’s energy resilience priorities via a multi-stakeholder process to define and develop a metric that dynamically characterizes energy resilience and a process for integrating community feedback into that metric.
Task Summary: Identify pain points and needs, conduct ranking exercises to select the highest priority services and types of facilities that could offer those services. Additionally, determine what the community would like to leave with after RCM, incorporating feedback into the project.

Subtask 9.3: Define the role that DERs can play in increasing resilience and energy equity.
Task Summary: Share the technical limitations of DERs with the Resiliency Council and determine how the community would like to see DERs support recovery planning, both through the framing of Resiliency Hubs (siting, services provided, outage survivability time, etc.) and other innovative ideas generated by the Resiliency Council, including ideas about blue-sky benefits and costs.

Subtask 9.4: Combine qualitative and quantitative data to create measurable resilience metrics.
Task Summary: Using community-defined priorities, merge social impact metrics with technical energy equity metrics to refine the emergent framework for resilience project site selection and prioritization.

Subtask 9.5: Review alignment of framework to community priorities
Task summary: Understand similarities and differences among Eastern Shore community priorities relative to those identified in Baltimore and Montgomery County.

Subtask 9.6: Incorporate feedback from Eastern Shore Resiliency Council into the framework
Task Summary: Refine the resilience framework based on priorities and differing conditions that the Resiliency Council identifies, documenting any significant differences between urban and rural settings.

Milestone 2.9.1: Develop an adapted resilience framework for Eastern Shore, including a database of service-prioritized locations according to the community-determined metric and a summary of the community input process that influenced that prioritized database.

Task 10: Develop the final resiliency framework document
Task Summary: Produce a framework that incorporates lessons learned from each of the three jurisdictions studied under the project.

Subtask 10.1: Compare and contrast the versions of the framework (metric + process) produced in each of the three locations to evaluate to what degree the framework can serve as a universal tool and to what degree the framework needs to be customized in each new location where it is applied.

Subtask 10.2: Seek feedback from the external advisory group on the effectiveness of the framework.
Task Summary: Consult the external advisory group and document feedback on areas for improvement and incorporate feedback into the framework.

Milestone 2.10.1: Draft of final resiliency framework, including case studies

Task 11: Finalize the dissemination plan for a resilience framework
Task Summary: Confirm avenues each partner can utilize to disseminate the resilience framework, educating other stakeholders on what the framework is and how it can be used. The dissemination plan will include collaboration with the state government to inform how Maryland can incorporate the framework into its resilience programs statewide.

Subtask 11.1: In alignment with Justice40, identify vulnerable priority areas in the state for replication.

Task Summary: Using existing data sources, overlay maps with climate change impacts, population demographics, utility performance, and social vulnerability data to identify high-priority areas for RCM framework dissemination and deployment.

Subtask 11.2: Incorporate priority areas into the dissemination plan.
Task Summary: Consider how to draw attention to priority areas and reach communities and other stakeholders with influence.

Subtask 11.3: Conduct a webinar to present key findings to Roundtable participants from all three geographic areas of study.
Task Summary: Share key findings with the broader community of practice.

End of Project (EOP) Goal*:* Publish and disseminate the Final Report, which will include the completed RCM community-driven energy resilience framework, three case studies, associated research findings and data sets, and information on how the RCM framework has been or will be implemented by project partners.

7 PROJECT RESULTS AND DISCUSSION

7.1 Project Results in Budget Period 1

7.1.1 **Task 1.0:** Establish program management systems and complete hiring

In Q1, project management systems were developed, and all hiring tasks were completed. Subrecipient agreements between Ayika Solutions, Inc. (ASI) and Groundswell were executed in Q2 (November 2023).

7.1.1.1 Subtask 1.1: Create subrecipient work plans.

In collaboration with the subrecipients, Groundswell developed detailed work plans for each partner that incorporate relevant DOE requirements, descriptions of deliverables, deadlines, and payment structures. By Q2, the Project Team had established RCM-specific project management, budgeting, and data systems essential for successful project completion, including a detailed work plan for ASI that incorporated DOE requirements and outlined deliverables, deadlines, and payment structures. Although NREL was not a direct subrecipient of DOE funds, Groundswell and NREL developed a comprehensive scope of work that covered NREL's deliverables and deadlines. In May 2023, Groundswell also created a RACI (Responsible, Accountable, Consulted, and Informed) matrix as a project management tool to define roles and responsibilities for each team member clearly. Additionally, Groundswell developed a project-wide Gantt chart to track progress toward goals and deliverables. Groundswell also collaborated closely with ASI to help this small business prepare to meet federal reporting and accounting requirements as a subrecipient under Groundswell.

7.1.1.2 Subtask 1.2: Develop protocols for data collection, sharing, and management.

Groundswell established a legal framework for data sharing, including any personally identifiable information (PII), intending to enable community stakeholders to retain ownership of their intellectual property contributions to the project. In September 2023, Groundswell hired an intellectual property attorney from Leading-Edge Law Group, LLC, to assist with contract negotiations with ASI, since both parties contributed their respective intellectual properties (IP) to the project. The relevant IP elements include marks—including existing trademarks and service marks—and copyrights. Trademarks and service marks were properly labeled in all primary deliverables. Each organization will retain ownership of any copyrighted property used to perform work on the project; however, Groundswell and ASI agreed that all final deliverables will belong to Groundswell and be subject to the federal government's copying and distribution rights under the RACER award. The agreement between Groundswell and ASI was signed in Q2. As part of developing protocols for data collection, sharing, and management, in Q1, the project team developed a research protocol for human subjects to gather data through focus groups and surveys. The protocol described the research methods used throughout the project, including detailed descriptions of the surveys and various focus groups (Resiliency Councils and Roundtables in each jurisdiction) conducted during the project. It also outlined the participant recruitment process, including inclusion/exclusion criteria, compensation terms, withdrawal procedures, data management, confidentiality, and participant consent processes.

The project team developed a Participant Consent Form that explains the research purpose, study procedures, risks and benefits, permission to use contributions, confidentiality measures, compensation, a note that participation is voluntary, and a space for a signature. The form indicated that while participants own their contributions to the project, the final report created by Groundswell will be the copyrighted property of Groundswell alone. The Participant Consent Form was provided to all members of the Resiliency Councils for signature before research activities started. In September 2023, all members of the research team also completed the CITI Program course titled "Social and Behavioral Research – Basic/Refresher" to improve our ability to conduct ethical and best-practice research. The project team decided that NREL's IRB review process was appropriate for the research. The research protocol, along with certificates of course completion for all research team members and the Participant Consent Form, was submitted to NREL's IRB Manager for review and approval on October 26, 2023.

7.1.1.3 Subtask 1.3: Hire and onboard new staff members.

Additionally, during the pre-award period through Q1, Groundswell created and posted job descriptions, interviewed candidates, and hired and onboarded successful candidates for the Resiliency Program Manager and Resiliency Fellow roles. After developing and validating the job descriptions following Groundswell's internal HR guidelines to ensure they met the requirements of the Award, Groundswell hired a firm to assist with initial outreach, recruitment, and background checks. Groundswell interviewed two candidates for the Resiliency Manager role and three for the Resiliency Fellow role. The Resiliency Manager was hired in April 2023, and the Resiliency Fellow in August 2023.

7.1.1.4 Subtask 1.4: Form an external advisory group and determine its operational structure.

In Q2 (December 2023), Groundswell began forming the Advisory Council. This council provided regular feedback throughout the project, especially on the replicability of emerging practices and methods. All project team members were directly involved in nominating candidates for 3-6 spots on the Council. The team identified six potential candidates and contacted the top five. After initial discussions about the role, three individuals with strong resilience backgrounds agreed to participate: Charmaine Brown of the MD Clean Energy Center, Melissa Deas of the Resilience Bureau – DC Homeland Security & Emergency Management Agency, and Naadiya Hutchinson of the Taproot Earth Resident Equity Advisory for the Baltimore City Climate Action Plan. These members brought extensive expertise and insights into both the state and city levels. The Advisory Council has met once each quarter, starting in December 2023.

7.1.2 **Task 2.0:** Document existing energy equity metrics for community-driven resilience.

During the pre-award period and continuing throughout the RCM project, the team, led by Groundswell with support from NREL and Ayika Solutions, researched and developed a set of existing energy equity metrics and identified current metrics and frameworks for community-driven resilience and blue-sky equity considerations based on the Resilience Inclusive Energy Master Planning process developed by Jeffers et al. (2022) and Anderson et al. (2019). The project team also coordinated with the Baltimore Social Environmental Collaborative to better understand energy resilience driven by community engagement. Additionally, throughout Q2, the RCM team continued to refine the research report, documenting energy equity metrics for community-driven resilience.

Milestone 1.2.1

After identifying and documenting the energy equity metrics using the CBPR approaches for community-driven resilience, the project team reached Milestone 1.2.1 by first creating the following list of datasets intended for visualization, analysis, and presentation during Baltimore Resiliency Council and Roundtable engagements.

- Dataset examining historical power outages
- FEMA National Risk Index
- FEMA & Argonne National Lab Resilience Meta-Index
- Energy Burden
- Google Sunroof Rooftop Solar Potential
- Resilience Hub Walksheds*
- Social Burden*
- Passive Survivability*

Metrics marked with an asterisk are experimental; they are discussed in resilience-related literature but are not included in national databases. Instead, they must be calculated for areas in Maryland by analyzing multiple input datasets. Unlike other metrics on the list, these do not have fixed methodologies or end-units, so the RCM team calculated these metrics iteratively with community input to find the most understandable aggregation level, segmentation, and visualization for RC members.

Regarding the identification of resilience metrics recognized or undervalued for Milestone 1.2.1, metrics like Resilience Hub Walksheds, Social Burden, and Passive Survivability are often absent from the literature. While other individual metrics are well-documented, their combined influence on decision-making and community-driven processes is overlooked in the literature. Recent reviews of energy resilience metrics emphasize access to services as a new energy-related measure that can guide both infrastructure planning and resilience efforts, ultimately helping local communities (Conway & Stewart, 2019). Critical service access assesses the relative availability of essential services within a neighborhood for residents (Conway et al., 2018). Access to services changes over time as various service locations become available or unavailable and can be measured at the household or neighborhood level, or grouped by individual service categories (e.g., medical services) or all services. Using a community-based participatory research approach, we demonstrated how these metrics could be applied by conducting a series of activities, the results of which are shown in the appendices of this report.

7.1.3 **Task 3.0:** Create the Baltimore Resiliency Council and Roundtable

This task aimed at establishing the Baltimore Resiliency Council and Roundtable to channel community insights into technical decision-making. In Q1, the project team identified and recruited community stakeholders who participated in the Baltimore Resiliency Council (RC) and the Baltimore Stakeholder Roundtable (RT). The project team utilized the RCM Academic-Community-Agency Network, modeled after ACA-NET™, to guide participation in the different groups. The ACA-NET™ framework is a collaborative partnership model designed to facilitate solution-oriented conversations led by communities in energy resilience planning and decision-making, as applied in this research. The RC consisted solely of individuals from various communities (who, by and large, were not energy experts in the traditional sense but provided information about their lived experiences), and served as a safe space to educate, inform, and involve residents.

The RT, created as a collaborative engagement space, also included members from government agencies, utilities, academia, and other stakeholders. Each Roundtable involved at least one faculty or student member from the community, as the framework specified. Establishing RCs and RTs in each jurisdiction provided a lasting mechanism for community engagement, aligning with community desires, even after the research project ends. Recruitment for participants in the RC subgroup—designed as a “safe space” for community members to share opinions and perspectives outside the larger RT—began in Q1 to foster diverse input from the community. The project team contacted at least 15-20 potential participants and secured the involvement of 12 of them, which contributed to the innovative findings of the RCM research.

7.1.3.1 Subtask 3.1: Map the universe of desired stakeholder groups for participation

As an initial step in mapping stakeholders—including community-based resilience council members, government agencies, utilities, academia, and other groups—the project team first sought to establish equitable partnerships from different stakeholder

groups from which data would be shared or collected throughout the project (not only in Baltimore, but also in Montgomery County and the Eastern Shore). Table **1** in Exhibit **C** shows the various groups along with descriptions of their purpose, the data collected, the frequency of data collection, the number of participants, and the locations where the groups were established.

7.1.3.2 Subtask 3.2: Develop outreach strategy and materials for stakeholder recruitment

From Q1 to Q2 of the project (October-November 2023), the project team focused on reaching out to potential RC members, as they were the first group to meet. The team directed its outreach efforts in West and Southwest Baltimore to gain a deep understanding of community needs. They sent emails and recruitment flyers to various organizations in Baltimore that promote community voices in energy resilience planning:

- Environmental nonprofits
- Community improvement, capacity building, and community development organizations
- Educational institutions, including prominent HBCUs
- Membership benefit organizations
- Houses of worship
- Human Services Offices
- Minority- and Women-Owned Small Businesses
- Neighborhood Associations in Districts 7, 8, 9, 10, 11 & 12

Overall, about 1,400 individuals and organizations were contacted to recruit participants for the Resiliency Council. The project team created a digital interest form, which received responses from 26 individuals. The form gathered information to help determine respondents' eligibility. Several respondents were ineligible because they lived outside Baltimore city limits. All respondents received a follow-up email informing them of their eligibility status, and the team outlined the next steps and logistics for participation. This included providing all meeting dates for eligible respondents and asking for confirmation that they could attend all meetings, which was a requirement for selection. Securing a meeting location was also an important part of the planning process. Additionally, in-person meetings fostered greater participation and trust between participants and the project team. The team identified two community centers that hosted all eight in-person meetings.

7.1.3.3 Subtask 3.3: Finalize participation agreements for Baltimore Resiliency Council members

In November 2023, the project team finalized participation agreements for 12 RC members, including a fixed stipend to compensate each participant for their time.

Milestone 1.3.1

In November 2023, the project team finalized participation agreements with 12 RC members, each receiving a fixed stipend to compensate for their time. The team completed recruitment for the two Baltimore groups—the RC and the broader RT—and achieved milestone 1.3.1 by hosting the first Baltimore Resiliency Council meeting in November 2023. The team aimed to secure 5 to 10 participants and ultimately

exceeded this target, with 12 individuals agreeing to take part in the project. The project team also developed an outline of the topics and desired outcomes for the community engagement sessions (RC and RT), summarized in Table **2** in Exhibit **C**. The topics and outcomes were intended to be consistent across all three jurisdictions. However, minor modifications were made based on feedback received during implementation in Baltimore through an iterative community-based participatory approach. The topics began with an education session on energy resilience, followed by an analysis of current documented data for the jurisdiction, including energy burdens by census tract, data from FEMA's National Risk Index, etc. They then moved on to explaining social impacts and measures, helping communities identify their pain points and needs.

7.1.3.4 Subtask 3.4: Conduct an outreach campaign to recruit Baltimore Roundtable members

The recruitment for Baltimore RC required significant effort, as shown by our outreach to 1,400 individuals and organizations. The focus on recruiting for the RC impacted our ability to concentrate on recruiting for the Baltimore Roundtable. However, the project team used its existing relationships within Baltimore to support the recruitment process, ensuring no delays in the project, and the results for Baltimore met expectations.

7.1.3.5 Subtask 3.5: Complete Baltimore Roundtable recruitment

To recruit participants for the Baltimore Roundtable (RT), a total of 23 potential individuals were invited, with eight ultimately agreeing to participate. The eight individuals represented the following organizations:

- Baltimore Gas and Electric (BGE)
- Morgan State University (a minority-serving institution)
- Maryland Energy Administration (MEA)
- City of Baltimore Department of Emergency Management
- City of Baltimore Health Department
- City of Baltimore Department of Planning
- University of Maryland

Groundswell held introductory calls with each representative to give a clearer understanding of the project and to confirm in writing the individual's intention to participate.

7.1.4 **Task 4.0:** Develop an initial resilience framework for Baltimore.

Task 4.0 involved gathering existing data on the effects of power outages, utility performance, extreme weather events, and social vulnerability, as well as identifying community pain points and needs through RC and RT engagement sessions. A plan that detailed the topics and desired outcomes for each session with the Baltimore RC and RT was completed in December 2023 (Q2). Context-setting information about the City of Baltimore, along with the baseline survey for Baltimore RC, has been drafted. Although the timeline for collecting data from participants was adjusted, impacting Milestone 1.4.1, the project team modified the milestone's underlying metric, resulting in no change to the overall performance period or the results obtained.

7.1.4.1 Subtask 4.1: Gather existing information on power outages, natural hazards, and social vulnerability

To gather existing information on the impact of power outages, utility performance, energy resilience, and social vulnerability, the project team collected specific data related to Baltimore, including a review of the City's Disaster Preparedness Plan. The Baltimore Office of Sustainability also participated in meetings, offering guidance on known hazards and risks facing the city. The project team collected ten metrics and sub-metrics related to social and environmental vulnerability in Baltimore from the White House Economic Justice Screening Tool (CJEST) and the FEMA Community Resilience Challenges Index (CRCI). Metrics were overlayed with council member addresses (which were voluntarily shared and anonymized) and integrated into interactive maps to allow council members to explore the distribution of community characteristics related to power outage outcomes, including: energy burden, air pollution, medical electricity dependency, diabetes prevalence, lack of green space, lack of health insurance, smartphone access, and mobile home prevalence. Each of the identified metrics above was then analyzed to produce a custom Heat & Power Outage Vulnerability Index for Baltimore (see Figure **1** in Exhibit **C**).

The index was integrated into an interactive map to support discussions with council members about how aspects of vulnerability can be combined to prioritize areas for energy resilience. Using NREL's research on resilience metrics and frameworks (Peterson, 2023), the project team created a draft baseline survey, which was distributed to RC participants during the first meeting. This survey served as a pre-survey, with its results compared to the post-survey conducted at the last RC meeting. However, while developing the baseline resilience survey, the project team encountered challenges in structuring the study to demonstrate improvements in the relevance and applicability of new resilience metrics compared to existing metrics, a milestone for the three jurisdictions. Given that this was a pre-engagement survey, subjects did not have an opportunity to learn about the metrics and topics before taking the survey. The challenge in showing improvement in metric applicability was mainly driven by the need to educate participants on existing, often technical, metrics, in addition to the research method involving small, in-depth focus groups. To effectively measure improvement in the relevance of a resilience metric, the project team would need to survey a much larger group of individuals. The project team proposed changes to the language and timing of the milestones to emphasize improvements in understanding metrics rather than perceived applicability. Furthermore, beginning in the pre-award period and continuing through Q3 of the project, the RCM team collaborated with BGE, the local investor-owned utility, to gather information on outage frequency and duration, including the feeders with the most outages. After numerous discussions and meetings with the utility on this topic, on 1/26/2024, the project team signed a three-way Non-Disclosure Agreement (NDA) between Groundswell, BGE, and NREL for access to the utility data.

7.1.4.2 Subtask 4.2: Define the community's energy resilience priorities via a multi-stakeholder process to define and develop a metric that dynamically characterizes energy resilience and a process for integrating community feedback into that metric.

Service Scoring

The project team designed a “Service Scoring” exercise that was deployed in Baltimore and subsequently in Montgomery County, in which Participants scored location types (e.g., library, school, pharmacy) on a scale of 0 to 5 based on the quality of service provided in various service categories (e.g., health, food, shelter). The Service Scoring activity encouraged RC members to evaluate the types of energy-dependent services their community needs, the locations that provide these services, and how the significance or importance of services differs across various service categories and location types. Visualizing the relationship between services and locations as a “scoring matrix” helps utilities and emergency managers move beyond simply labeling locations as “critical” or “not critical” towards a more continuous assessment and measurement of how crucial certain locations are for specific areas. This approach also enables community members to give practical feedback about their priorities.

The FEMA Lifelines (U.S. Department of Homeland Security, 2025) were utilized to define initial categories, where each location type could receive a score indicating its relative importance for services in that category (Figure **1** in Exhibit **D**). FEMA Lifelines, however, were designed to support top-down coordination of response and recovery efforts by emergency managers. The wide range of some FEMA Lifeline categories makes them challenging to use for prioritizing specific types of service locations, especially for energy investments. The broad links between many types of locations and various Lifelines led to a relatively uniform scoring system, where all locations received high service value. This uniformity made it hard to prioritize sites for specific service categories effectively. To achieve the goal of helping community members prioritize services or locations for energy resilience investments, the project team and Baltimore RC, working in collaboration, significantly enhanced the initial FEMA Lifelines to create service categories that were more specific to energy provision and better reflected individual household needs (Figure **2** in Exhibit **D**). Table **1** in Exhibit **D** provides more information about the five themes and associated categories and subcategories that were used to assign critical service scores to locations across Baltimore, while Tables **2** and **3** show the combined scores of critical service locations under different conditions.

Mapping Neighborhood Accessibility

In a separate activity the project team designed for the Baltimore RC, RC members were encouraged to think about the places they visit to fulfill their needs as a “service landscape," where proximity, transportation, service categories, and service quality interact to create areas of “higher access” and “lower access” to services during normal conditions—when the power system operates normally. Individual and clustered service locations each contribute different, measurable amounts to the “service landscape” of a single home, neighborhood, or city under typical conditions. This activity asked participants to review a map and a list of prioritized critical service locations, and to provide feedback on whether the locations, the services offered at those locations, and their rankings matched their lived experiences. This activity benefited RC members in visualizing service accessibility across their communities and understanding the ranked importance of each service location, highlighting which locations, services, or households might be priorities for energy resilience investments. Neighborhood

Accessibility offers utilities, emergency managers, and community members a richer context for resilience planning than simple maps or lists of potential priorities.

7.1.4.3 Subtask 4.3: Host the first Baltimore Roundtable meeting

The project team held the first meeting of the Baltimore RT on 1/18/2024. Attendees included RC members representing the community as well as representatives from academic and government agencies, aligning with the ACA-NET™ framework—a cooperative partnership model used to facilitate solution-oriented conversations driven and led by the communities most impacted. The team compiled a variety of resources into interactive maps, which were used during facilitated discussions to help community members understand different layers of social and environmental vulnerabilities in their city. The team also facilitated an interactive group exercise to "score" service locations in the Health & Medical category. Armed with this information, RC and RT members were equipped to begin identifying priority services, facility types, and/or specific locations that can support the most critical community priorities during extended power outages.

7.1.4.4 Subtask 4.4: Define the role that DERs can play in increasing resilience and energy equity

During the educational segments of the RC meeting agendas and throughout engagement activities, the project team explained to participants the advantages and limitations of resilient energy infrastructure, such as resilience hubs that combine solar and battery storage, in their communities under both clear and challenging conditions.

7.1.4.5 Subtask 4.5: Combine qualitative and quantitative data to create measurable resilience metrics

Service Landscapes

Critical service access is determined by all locations within a specific travel time threshold of a study area. The project team initially used a 20-minute round-trip drive time to measure critical service access in Baltimore (and subsequently in Montgomery County). However, feedback obtained from Eastern Shore RC members highlighted the importance of more distant locations in rural areas and their willingness to travel longer distances for the services needed. In response, the project team retroactively expanded the critical service access metric to include all locations within a 60-minute round-trip travel time. Because the relationship between travel time and service value is inversely exponential, locations farther from households in the study area have decreasing value for critical service access. This means that increasing the travel time radius affects critical service access differently for each study area and household, depending on their position within the study area and their proximity to transportation infrastructure that connects them to more distant locations (see Figure **1** in Exhibit **E**).

Table **1** in Exhibit **E** displays the additional locations and the increase in critical service access observed for Baltimore, Montgomery County, and the Eastern Shore when the drive time threshold expands from 20 minutes to 60 minutes. In each study area, the number of locations more than doubles, but the increase in critical service access is much smaller because the value of each location is inversely and exponentially related

to its travel time from households. This means locations farther away have less impact on critical service access.

Measuring Outage Consequences

Joining community-vetted service locations to utility feeder data allowed the project team to examine the spatial distribution of critical service access across electrical infrastructure during both normal conditions and extended power outages. Summarizing the spatial relationship between the distribution system and the broader social, economic, and transportation systems it serves can add critical context to utility decision-making. Utilizing electrical distribution system data, including the spatial location of feeders and multiple years of outage records for each feeder, provided to the project team by BGE (the investor-owned utility serving Baltimore City), the project team developed maps to display service access relative to feeder locations. Critical service access in Baltimore is mainly located in a ring surrounding the downtown area (see Figures **1** and **2** in Exhibit **F**). Such maps can provide an initial indicator of which components of electrical distribution infrastructure are the highest priority during normal conditions, using a metric vetted through community engagement.

Milestone 1.4.1

The project team successfully created an initial framework for Baltimore, which includes a list of prioritized service locations and specific sites in each RC member's neighborhood, as well as developing a Baltimore-specific case study, summarizing the community input process and observations from urban resident engagement. Most existing hubs within Baltimore City's Community Resiliency Hub Program are situated at facilities owned by community-serving organizations. To avoid limiting the perspectives of RC and RT members, the project team included a variety of service locations in the engagement exercises. Additionally, many Baltimore RC members reported being unfamiliar with the City's program, presenting an opportunity for the City to improve communication and raise awareness. The team thoroughly documented the community input process by creating a series of activity templates and meeting agendas. These resources were included in Appendix A of the "RCM Framework Document" submitted to the DOE on 7/31/2025. Additionally, the team developed a tagging system to categorize spoken and written feedback from the Baltimore RC based on its focus—whether it was about change or affirmation—related to the main components of the RCM Framework (see Figure **1** in Exhibit **G**). Feedback from Format 2 of the "Mapping Neighborhood Critical Services" activity recommended increasing the value of services provided by hospitals, grocery stores, and community centers based on their size, importance, and their spatial clustering with other services. It also suggested decreasing the value of services provided by assisted living facilities and the Institutional Population service theme in general, since those services are relevant for only a small subset of the population. See Figures **2** through **4** in Exhibit **G** for more information about the tagging schema, including detailed data from Baltimore.

[**Note: the SOPO does not contain a Subtask 4.6 due to a labeling error.]**

7.1.4.6 Subtask 4.7: Host the second Baltimore Roundtable meeting.

The second Baltimore RT meeting took place on 4/18/2024. The project team reviewed RC's feedback about service categories, scores, travel preferences, and location data, including how these inputs contributed to a new classification of different service types into five main themes. The project team also discussed the issues that this new framework can address and those that it cannot. Additionally, a Q&A session was held to promote dialogue among the attending stakeholders.

7.1.5 **Task 5.0:** Develop an initial research dissemination plan

The project team developed an outline of dissemination opportunities, including potential conferences, workshops, panels, and other events, at both the national and regional levels.

7.1.5.1 Subtask 5.1: Conference evaluation and planning

The project team developed an outline of potential regional and national conferences to attend and potentially present findings from the RCM project. For each event, the team identified the target audience, unique considerations, date, time, location, and travel budget (if applicable).

7.1.5.2 Subtask 5.2: Documentation of initial research dissemination plan

Groundswell researched and documented its initial dissemination plan in an Excel spreadsheet and shared it with the broader project team (NREL and ASI) on 10/1/2024.

7.1.6 **Task 6.0:** Create the Montgomery County Resiliency Council and Roundtable

This task aimed at establishing the Montgomery County Resiliency Council and Roundtable to channel community insights into technical decision-making. During Q4 of the project, the team started identifying local stakeholders by attending several events, including the Montgomery County Energy Summit from 4/15/2024 to 4/16/2024, a Village of Chevy Chase solar energy event on 4/17/2024, and a resilience hub workshop hosted by the Montgomery County Office of Emergency Management and Homeland Security on 5/21/2024, to recruit participants for both RC and RT in Montgomery County. Active recruitment for both groups took place from mid-April to mid-June (Q3-Q4 of the project), during which the project team contacted approximately 1,800 individuals and organizations. Twenty individuals reached out to Groundswell to express interest in joining the RC, with 12 selected for the final group, meeting the project's goal of 10 community members. For the RT, invitations were sent to 14 individuals from academia, local government, utilities, and non-profit organizations. Four accepted, representing Montgomery County government, two local HBCUs, and a local faith-based environmental nonprofit.

7.1.6.1 Subtask 6.1: Map the universe of desired stakeholder groups for participation

In addition to community members, the project team sought representation from academia, local government, utilities, and non-profits, as well as using the Climate and Economic Justice Screening Tool (CEJST) data to identify areas of higher socioeconomic vulnerability in suburban Montgomery County. The specific focus for Montgomery County RC member recruitment included the I-270 corridor between Silver Spring and Gaithersburg, covering Silver Spring, Germantown, Gaithersburg, Rockville,

North Bethesda, and Wheaton. Overall, 37 organizations and local government agencies across the county were contacted.

7.1.6.2 Subtask 6.2: Finalize participation agreements for Montgomery County Resiliency Council members

By 6/24/2024, the project team had secured a signed participation agreement from 12 individuals for Montgomery County RC, which included a stipend to honor each participant's time dedicated to the project. In Montgomery County, some participants were able to sign their participation agreements in advance; others signed during the first meeting of the RC.

Milestone 1.6.1

The project team convened all 12 members of the Montgomery County RC for its first meeting on 6/24/2024 (See Figure **5** in Exhibit **G**). Throughout the duration of the Montgomery County RC meetings, and in alignment with the project's CBPR-based research approach, the project team educated and engaged participants in a series of exercises designed to elicit qualitative and quantitative feedback about their lived experiences, preferences, and priorities about critical service access.

7.1.6.3 Subtask 6.3: Conduct outreach to recruit Montgomery County Roundtable members

Invitations were extended to 14 individual representatives of Montgomery County in academia, local government, utilities, and the non-profit sector.

7.1.6.4 Subtask 6.4: Complete recruitment for Montgomery County Roundtable

Four people—representing Montgomery County local government, local HBCUs (Howard and Towson), and a local faith-oriented environmental nonprofit—accepted the invitation. The project team provided an overview of the project in advance (via email) and in person during the first RT meeting.

7.1.7 End of Year 1 Project Goals (EOP Y1)

As of the end of Year 1, participation agreements for the 12 Montgomery County RC members were finalized (by 6/24/2024), and the project team had developed an initial iteration of the RCM Framework: a well-defined *process* of community engagement, including specific activities designed to gather relevant and applicable feedback from residents, centered around the *metric* of critical service access. Lessons learned in Baltimore shaped how the project team proceeded in the subsequent phases of the project in Montgomery County and the Eastern Shore.

7.2 Project Results in Budget Period 2

7.2.1 **Task 7.0**: Refine and adapt the RCM framework in Montgomery County

To adapt the framework deployment for the suburban area of Montgomery County, the project team revised the engagement sessions for the local RC and RT. Meetings were condensed into four consecutive weeknights—three RC meetings followed by one RT meeting—spanning two different weeks about four weeks apart. After starting in Baltimore, the team discovered that the monthly meeting schedule for the Baltimore RC

caused some challenges, such as needing to reintroduce background information at each meeting because too much time had passed. Additionally, during Montgomery County recruitment, it became clear that the meeting schedule needed to be flexible and responsive to community needs, especially when working with older populations who have varying availability.

7.2.1.1 Subtask 7.1: Gather existing information on power outages, natural hazards, and social vulnerability

After executing an NDA with Pepco on 12/5/2024, the project team obtained feeder-level power outage data specific to Montgomery County to guide discussions, follow-on analyses, and siting prioritization. Compiling extensive datasets for natural hazards and social vulnerability in Baltimore, the project team adjusted its approach to background data collection in Montgomery County, in alignment with the team's iterative and adaptive approach to the research. Centering critical service access as a replicable, actionable metric around which the project team could develop the community engagement framework, the more general metrics and indices around hazards and vulnerability were no longer needed for successful project delivery. The reason is that such metrics have limited utility in conversations with community members about highly local decisions and because they are often reported at census tract levels. The demographics, hazards, and vulnerability metrics can be helpful for decision makers operating at larger geographic scales, but general spatial trends have little bearing on localized decision-making.

7.2.1.2 Subtask 7.2: Define the community's energy resilience priorities via a multi-stakeholder process to define and develop a metric that dynamically characterizes energy resilience and a process for integrating community feedback into that metric

Activities undertaken with Montgomery County RC included:

- **Service Scoring Matrix.** Participants rated location types (library, school, pharmacy, etc.) on a scale of 0-5 based on the quality of service in various categories (health, food, shelter, etc.).
- **Mapping Neighborhood Critical Services**: Participants reviewed maps of their neighborhood showing nearby service locations, provided feedback on missing or erroneous locations, and selected a limited number to prioritize for resilient energy infrastructure. Participants were invited to present their selections and the rationale behind them to the group.
- **Timeline of Needs:** Participants identified their energy-dependent needs and placed those needs along a two-week timeline (see Exhibit **I**).
- **Service Value over Time:** Participants assigned a score (1-5) to categories of service (health, food, shelter, etc.) along a two-week timeline (see Exhibit **J**).
- **Resilience Hub Siting:** Participants selected a limited number of clustered locations to prioritize for resilient energy using interactive maps showing neighborhood critical service access and estimated costs of backup energy by location.

7.2.1.3 Subtask 7.3: Host the first Montgomery County Roundtable meeting

The first meeting of the Montgomery County RT took place on 6/27/2024 at the Rockville Senior Center. The agenda included reviewing social vulnerability indices in

Montgomery County. The project team presented maps of the County with various indices—including energy burden, diabetes prevalence, heatwave frequency, lack of greenspace, lack of smartphone access, and mobile home prevalence—shown for each census tract. The meeting ended with a discussion about prioritizing energy resilience in Montgomery County and a Q&A session with the full RT and project team.

7.2.1.4 Subtask 7.4: Incorporate feedback from the Montgomery County Roundtable into the RCM framework

To gather qualitative data on the human impacts of power outages, the project team adjusted the RC and RT engagement activities in several ways, building on the conceptualization phase in Baltimore. This included:

- Providing printed materials for those who preferred paper copies and sharing meeting summaries and the next steps quickly to close feedback loops and reinforce learning.
- Including a new worksheet for the Service Scoring Matrix that allowed RC members to describe factors influencing the scores assigned to locations in each service category.
- After documenting the challenges that RC members experienced in completing activities in Baltimore, the team divided the Neighborhood Critical Services maps in Montgomery County by service category. It included labels for a limited range of top-ranking service locations to reduce information overload for Council members.
- In addition, the team introduced the Resilience Hub Siting activity in Montgomery County, which allowed RC members to review a mapped inventory of service locations within a given distance of their house before the concept of accessibility was introduced. As the project team had time to first establish foundational concepts of energy-dependent, proximity-driven services, this activity invited RC members to identify resilience priorities before additional context about service categories, service scores, transportation, clustering, and cost limitations was provided, which facilitated a comparison between the initial and final priorities.

The Montgomery County RC and RT engagements led to significant adjustments in the framework to better serve suburban areas. Participants emphasized the importance of critical services accessible inside the home during emergencies (e.g., thermal regulation, medical electrical devices, food storage, communication), especially for people with limited mobility, who cannot easily access alternatives in more public locations. This insight led to a reorganization of the framework, whereby residential locations are assigned scores based on the services they provide to residents. Furthermore, the original accessibility calculations weighted each household location equally; however, the updated and revised accessibility calculations weighted each household location by the estimated number of residents, which had the effect of increasing accessibility scores for facilities located near large numbers of residents. Based on feedback from RC members, the project team added several types of service locations that were initially missing from the pre-identified lists of service locations, including hardware stores, outdoor stores, and senior living facilities. RC members also

emphasized that the size of service locations matters, particularly for grocery stores, healthcare facilities, and schools (e.g., daycares vs. high schools).

7.2.1.5 Subtask 7.5: Define the role that DERs can play in increasing resilience and energy equity

In the educational sections of the RC meeting agendas and throughout engagement activities, the project team explained to participants the benefits and limitations of resilient energy infrastructure (such as resilience hubs, which combine solar and battery storage) in their communities, both in blue-sky (standard conditions) and dark-sky conditions (i.e., extended power grid outages).

7.2.1.6 Subtask 7.6: Combine qualitative and quantitative data to create measurable resilience metrics

Combining community-vetted service locations with utility feeder data allowed the examination of the spatial distribution of critical service access across electrical infrastructure during both normal conditions and extended power outages. This is important because evaluating the spatial relationship between the distribution system and the broader social, economic, and transportation systems it serves can add critical context to utility decision-making. For example, utilizing electrical distribution system data, including the spatial location of feeders and multiple years of outage records for each feeder obtained from Pepco, the project team developed maps to display service access relative to feeder locations. As shown in Figures **3** and **4** in Exhibit **F,** critical service access for Montgomery County is concentrated in smaller pockets throughout the county (e.g., Rockville, Silver Spring). Such maps can provide an initial indicator of which components of electrical distribution infrastructure might be the highest priority during normal conditions, based on community inputs.

Milestone 2.7.1

The project team successfully deployed the Framework in Montgomery County (suburban environment), after having already implemented it in Baltimore's urban setting, demonstrating its flexibility and applicability to both urban and suburban environments. A case study specific to Montgomery County, summarizing the community input process and observations from engagement with rural residents, was also developed by the project team. As a method of engaging community members to prioritize site locations in specific neighborhoods for energy resilience investments, the project team developed a Resilience Hub Siting Analysis. Participants choose a limited number of clustered locations to prioritize for such infrastructure, using interactive maps that display neighborhood access to critical services and estimated backup energy costs by location. RC members were divided into three groups, corresponding to the three stages of the microgrid/resilience siting game.

- **Step One**: The RC members were asked to select locations where the power should stay active during a disruption that causes power outages elsewhere, to build a microgrid. The group’s goal was to choose locations that provided the most benefits to the majority during a significant outage, while keeping costs low.
- **Step Two**: The RC members were instructed to explore possible microgrid sites and document information about each one. They were asked to complete an online form using a link provided by the project team to record their responses.

- **Step Three**: The RC members were directed to determine which microgrids would be the best investment for their community. After creating a list of the top three microgrids, the project team followed up with questions to clarify each option.

The results of this effort for Montgomery County are shown in Figures **1** and **2** in Exhibit **H**. The results indicate that RC members identified places of worship, grocery stores, and schools as the top three facilities for energy resilience investments through microgrids. A total of nine facilities or service locations were identified as potential microgrid sites, providing services that were broadly classified into 17 categories. The key factors for such selections included ease of access (proximity to people and to transportation), size/capacity to serve many people, physical attributes such as ample parking and the absence of floodplains, and clustering of multiple services. As identified by the RCM research, clustering of services is a crucial factor in energy resilience and microgrid investments. The team has also thoroughly documented the community input process, producing a series of activity templates and meeting agendas. These resources can be found in Appendix A to the “RCM Framework Document” delivered to DOE on 7/31/2025.

7.2.1.7 Subtask 7.7: Host the second Montgomery County Roundtable meeting

For this second RT meeting in Montgomery County, held on 8/22/2024, the project team introduced the concept of service accessibility. The RC members were invited to present their recommendations from the Resilience Hub Siting Analysis, and RT members were invited to provide feedback on the locations selected by the RC members. Two guest speakers contributed to the community discussions: David Comis from the MEA and Don Scheuerman from the Montgomery County Department of General Services, Office of Energy and Sustainability (OES). These individuals provided valuable insights to the Resiliency Council on the approaches that MEA and OES take to energy resiliency planning and investment processes. The contributions of these speakers helped RC members contextualize the emergent framework and inspired new questions and ideas for refinement of the framework.

7.2.1.8 Subtask 7.8: Seek feedback from the Stakeholder Roundtable and from the external advisory group on the effectiveness of the framework

As referenced above under Subtask 7.4, the Montgomery County RT meetings on 6/27/2024 and 8/22/2024 helped elucidate several significant adjustments in the framework to address suburban areas more effectively. Furthermore, the Advisory Group was briefed throughout the initiative's duration on project status, new considerations emerging from RC and RT discussions, and outstanding questions that had yet to be addressed.

7.2.2 **Task 8.0:** Create Eastern Shore Resiliency Council and Roundtable

This task aimed at establishing the Eastern Shore Resiliency Council and Roundtable to channel community insights into technical decision-making. Replicating the structure of the stakeholder groups in the emergent RCM Framework, the project team created a RC and RT in Maryland’s rural Eastern Shore to solicit community member input,

identify priority services based on participants' lived experiences, and ultimately to pair qualitative findings with utility outage data to demonstrate a proof-of-concept example of quantitative decision support that can be useful for utilities, regulators, and planners.

7.2.2.1 Subtask 8.1: Identify the Eastern Shore jurisdiction in which to focus research and the test framework

Using the CEJST tool, the project team identified both the target jurisdiction and the relevant stakeholder groups for Eastern Shore. Based on this analysis using the CEJST tool, Resiliency Council members were recruited from the towns of Princess Anne, Salisbury, and Pocomoke City, in alignment with the concentrations of census tracts that CEJST designates as under-resourced.

7.2.2.2 Subtask 8.2: Map the universe of desired stakeholder groups for participation

The project team sought representation from academia, local government, utilities, and non-profits. Outreach began early (during Q5 of the project) to allow adequate time for recruitment. The specific areas of focus for the Eastern Shore were determined to be the towns of Princess Anne, Salisbury, and Pocomoke City, in alignment with the census tracts that the CEJST tool designates as having a higher concentration of working families. See Subtask 8.4 for further details regarding entities that the project team contacted prior to convening stakeholders in the Eastern Shore.

7.2.2.3 Subtask 8.3: Finalize participation agreements for Eastern Shore Resiliency Council members

After extensive outreach and recruitment efforts, the project team ultimately secured participation agreements from 12 Resiliency Council members for the Eastern Shore. These agreements were finalized by 2/12/2025.

Milestone 2.8.1

The first meeting of the Eastern Shore Resiliency Council was held on 1/25/2025 and included 5 participants. Following a second wave of recruitment, the team onboarded seven additional members, and all 12 members participated in the joint RC and RT meetings on 2/22/2025 in Princess Anne, MD (See Figure **6** in Exhibit **G**). Throughout the duration of the Eastern Shore RC meetings, and in alignment with the project's CBPR-based research approach, the project team educated and engaged participants in a series of exercises designed to elicit qualitative and quantitative feedback about their lived experiences, preferences, and priorities about critical service access.

7.2.2.4 Subtask 8.4: Conduct an outreach campaign to recruit Eastern Shore Roundtable members

The Project Team recruited from a diverse array of stakeholders for the RT for the Eastern Shore. To identify these additional stakeholders, the method of selection stayed the same as previous Roundtables, where members of the project team nominated individuals who are professionally involved in climate, energy resilience, solar, emergency management, public health, environmental justice, local government, and/or the local utility (Delmarva).

Participation invitations were sent to 34 individuals in the following organizations:

- The University of Maryland Eastern Shore (a minority serving institution)

- The University of Maryland
- The Nature Conservancy Maryland/DC Chapter
- Maryland Department of Emergency Management (MDEM)
- Town of Princess Anne Planning & Zoning and Public Works Department
- City of Salisbury Sustainability Advisory Committee
- Pocomoke City Planning & Zoning Department
- Somerset County Office of Emergency Services
- Wicomico County Office of Emergency Services
- Worcester County Office of Emergency Services
- Maryland Voluntary Organizations Active in Disaster
- The City of Salisbury, Housing & Community Development and Planning Department
- Town of Sharptown
- Pocomoke City
- City of Fruitland
- Town of Hebron
- Town of Mardela Springs
- Town of Delmar
- Town of Ocean City
- University of Maryland Extension

7.2.2.5 Subtask 8.5: Complete Eastern Shore Roundtable recruitment

The project team secured the participation of 6 participants in the Eastern Shore RT. Consistent with the other jurisdictions, fixed stipends were provided for RC members but not for RT participants, who also attended voluntarily but in their official capacities.

7.2.2.6 Subtask 8.6: Host the first Eastern Shore Roundtable meeting

The first meeting of the Eastern Shore Stakeholder Roundtable occurred on 2/22/2025 in Princess Anne, Maryland. The agenda included a presentation from MEA regarding the state's perspective on supporting energy resilience, followed by a Q&A session, and a siting prioritization exercise ("microgrid game") undertaken together by the Resiliency Council and Roundtable members, which involved considerations of service accessibility. The meeting concluded with an open discussion about further developing energy resilience on the Eastern Shore (See Figure **7** in Appendix **G**).

7.2.3 **Task 9.0**: Refine and adapt the RCM framework for the rural Eastern Shore

The project team deliberately tailored the meeting frequency and structure to each jurisdiction. In the rural Eastern Shore, the team structured the engagement time across two intensive, full-day sessions to account for the longer travel times for participants, including the project team, based on feedback gathered from Baltimore and Montgomery County. (In contrast, Baltimore had monthly meetings.) Activities were revisited and structured in accordance with community feedback.

7.2.3.1 Subtask 9.1: Gather existing information on power outages, natural hazards, and social vulnerability

After signing a multiparty NDA on 2/3/2025, the team obtained feeder-level power outage data specific to the Eastern Shore from Delmarva (a subsidiary of Pepco Holdings, Inc.) to guide discussions and prioritization. Compiling extensive datasets for natural hazards and social vulnerability in Baltimore, the project team adjusted its approach to background data collection in Montgomery County and subsequently on the Eastern Shore, in alignment with the team's iterative and adaptive approach to the research. Centering critical service access as a replicable, actionable metric around which the project team could develop the community engagement framework, the more general metrics and indices around hazards and vulnerability were no longer needed for successful project delivery. The team found that such metrics have limited utility in conversations with community members about highly local decisions, because they are often reported at census tract levels. The demographics, hazards, and vulnerability metrics can be helpful for decision makers operating at larger geographic scales, but general spatial trends have little bearing on localized decision-making.

7.2.3.2 Subtask 9.2: Define the community's energy resilience priorities via a multi-stakeholder process to define and develop a metric that dynamically characterizes energy resilience and a process for integrating community feedback into that metric

Activities undertaken with the Eastern Shore RC included:

- **Mapping Neighborhood Critical Services**: Participants reviewed maps of their neighborhood showing nearby service locations, provided feedback on missing or erroneous locations, and selected a limited number to prioritize resilient energy infrastructure. Participants were invited to present their selections and the rationale behind them to the group.
- **Timeline of Needs:** Participants identified their energy-dependent needs and placed those needs along a two-week timeline.
- **Service Value over Time:** Participants assigned a score (1-5) to categories of service (health, food, shelter, etc.) along a two-week timeline.
- **Resilience Hub Siting:** Participants selected a limited number of clustered locations to prioritize for resilient energy using interactive maps showing neighborhood critical service access and estimated costs of backup energy by location.

7.2.3.3 Subtask 9.3: Define the role that DERs can play in increasing resilience and energy equity

In the educational portions of the RC meeting agendas and throughout engagement activities, the project team explained to participants the benefits and limitations of resilient energy infrastructure (such as resilience hubs, which combine solar and battery storage) in their communities, both in blue-sky and dark-sky conditions. The RC members affirmed the metric of service accessibility as a relatable and practical concept for these discussions.

7.2.3.4 Subtask 9.4: Combine qualitative and quantitative data to create measurable resilience metrics

Combining community-vetted service locations with utility feeder data allowed the project team to examine the spatial distribution of critical service access across electrical infrastructure during both normal conditions and extended power outages. Summarizing the spatial relationship between the distribution system and the broader social, economic, and transportation systems it serves can add critical context to utility decision-making. Utilizing electrical distribution system data, including the spatial location of feeders and multiple years of outage records for each feeder obtained from Delmarva Power, the project team developed maps to display service access relative to feeder locations (see Figures **5** and **6** in Exhibit **F**). Critical service access for the Eastern Shore is highly concentrated on only a few feeders in and around the town of Salisbury. Such maps can provide an initial indicator of which components of electrical distribution infrastructure might be the highest priority during normal conditions, using a metric vetted by community engagement.

7.2.3.5 Subtask 9.5: Review alignment of framework to community priorities

Service Landscapes

The project team initially used a 20-minute round-trip drive time to measure critical service access in Baltimore and Montgomery County. However, feedback from Eastern Shore RC members highlighted the importance of more distant locations in rural areas and their willingness to travel longer distances for the services needed. In response, the project team expanded the critical service access metric to include all locations within a 60-minute round-trip travel time. On the Eastern Shore, where relatively distant locations provide a disproportionate share of critical service access for specific households, the travel time adjustment ensures that these locations are mapped and ranked, significantly improving the alignment between Eastern Shore results and community priorities. Indeed, the increased travel time threshold causes critical service access to more than double for thousands of households (see Figures **2** and **3** in Exhibit **E**). Analyzing how different travel time thresholds impact critical service access helps us understand how power infrastructure, essential services, and households interact across urban, suburban, and rural areas. These findings underscore the importance and potential for aligning resilience metrics with community priorities and lived experiences.

7.2.3.6 Subtask 9.6: Incorporate feedback from Eastern Shore Resiliency Council into the framework

To gather qualitative data on the human impacts of power outages, the project team adjusted the RC and RT engagement activities in several ways, building on the conceptualization phase in Baltimore and the refinement phase in Montgomery County, toward streamlining the framework deployment in the Eastern Shore. This included:

- Running accessibility analyses for the local neighborhoods of each RC member.
- Creating updated maps tailored to the Eastern Shore's geographical and social context, including data on services, social vulnerability, demographics, and climate impacts.

- Refining activities and engagement materials based on observations and feedback from Montgomery County RC members. For example, we reconfigured the RC meeting agenda to increase the efficacy of the “Mapping Neighborhood Critical Services” activity by first establishing foundational concepts of energy-dependent, proximity-driven services. This activity invited Council members to identify resilience priorities before additional context about service categories, service scores, transportation, clustering, and cost limitations is provided, which facilitates a comparison between initial and final priorities.
- Formatting posters and updating presentation slides to ensure clear communication and effective stakeholder engagement.

The project team refined the process (structure of engagement activities) in the Eastern Shore to enable more efficient and effective solicitation of community feedback. Feedback from rural participants emphasized the relatively longer distances they must travel to access critical services relative to urban and suburban areas, and this insight led to an adjustment in the Framework in which service locations increased from an initial driving radius of 20-minute used in Baltimore and Montgomery County where service locations are closer and often more densely clustered, to within a 1-hour roundtrip driving radius in Eastern Shore. Aggregating comments by their associated service location types and reasons indicates the relationship between locations, services, and key resilience considerations (Figure **8** in Exhibit **G**). Many location types may be more important for community resilience than initial metrics indicate, and several location types may be less important. Location types linked to both “More Important” and “Less Important” tags—such as places of worship, schools, government buildings, fire & EMS, hospitals, grocery & convenience stores, childcare, and urgent care—may have complex factors influencing their resilience value for communities. Places of worship, schools, fire and EMS, hospitals/urgent care, and grocery/convenience store locations are associated with several simultaneous (and sometimes conflicting) reason tags, indicating that their resilience value may depend heavily on their size, staff, specific services, location, and surrounding community members.

Milestone 2.9.1

The project team successfully deployed the Framework in the Eastern Shore, demonstrating its flexibility and applicability to both rural and urban environments, as well as developing a case study specific to the Eastern Shore, and summarizing the community input process and observations from engagement with rural residents. The project team also conducted microgrid activities in Eastern Shore, Maryland, to identify priority sites for potential microgrid investments. The results shown in Figure **3** in Exhibit **H** indicate that hospitals, grocery stores, and government services are the top three facilities for microgrid development. Figure **4** in Exhibit **H** highlights the top reasons for service locations in microgrid investments using the community-based participatory approach. The key factors include ease of access and proximity (from the council member’s home to service locations and transportation), capacity to serve the public, and services offered that are somewhat unique or important, as well as the clustering of multiple services. The project team has also thoroughly documented the community

input process, producing a series of activity templates and meeting agendas. These resources can be found in Appendix A to the “RCM Framework Document” delivered to DOE on 7/31/2025.

7.2.4 **Task 10.0**: Develop the final resiliency framework document

The final RCM Framework Document serves as a roadmap to help stakeholders understand and replicate this body of work—whether in parts or as a whole—in their local contexts. It is a reference tool for practitioners and other stakeholders, supporting community-driven efforts in energy resilience and informed decision-making. Notably, the Framework acknowledges the crucial role that diverse perspectives play in enhancing energy resilience systems through the CBPR employed in the research. It targets municipalities, regulatory agencies, state and local governments, community organizers, utilities, and the public interested in a community-driven approach to energy planning, as well as community members looking to make informed decisions about energy infrastructure in their neighborhoods. The case studies describe how the project team iterated on the emergent Framework in each of the three jurisdictions and highlight notable observations and outcomes specific to each area.

7.2.4.1 Subtask 10.1: Compare and contrast the versions of the framework (metric + process) produced in each of the three locations to evaluate to what degree the framework can serve as a universal tool and to what degree the framework needs to be customized in each new location where it is applied.

The RCM Framework evolved over the course of the project through iterative refinement during engagement sessions in each of the three study areas. This iterative approach ensured a wider reach and allowed for ongoing refinement based on community feedback. Although the same *metric* (service accessibility) was used throughout the project and in each jurisdiction, the team adapted the *process* (e.g., specific engagement activities) in each of the three jurisdictions as the project evolved and the team learned which activities and communication strategies worked most effectively (see Table **1** in Exhibit **G**). Certain differences emerged in urban vs. rural areas. For example, rural participants emphasized the relatively longer distances they must travel to access critical services relative to urban and suburban areas, and this insight led to an adjustment in the Framework in which service locations are collected from within a 2-hour round-trip driving radius, increased from an initial driving radius of 1 hour used in Baltimore and Montgomery County. In addition, the project team found that engaging rural residents requires continuous presence, flexible schedules, and a willingness to host make-up or extra sessions (for example, the project one convened a virtual meeting in the Eastern Shore to accommodate participants who wished to join the RC after the initial RC convening had occurred).

Mapping Neighborhood Critical Services

As indicated in Figure **12** in Exhibit **G**, the categories of Food & Hydration, Institutional Population, and the Healthcare categories received comments across most Reason tags across all three jurisdictions. In contrast, Shelter & Mutual and Communication categories had a lower prioritization compared to the other service categories. See

Figures **9** through **11** in Exhibit **G** for a comparison of other results across all three jurisdictions.

7.2.4.2 Subtask 10.2: Seek feedback from the external advisory group on the effectiveness of the framework

The project team convened the external advisory group on 7/25/2025 to share the draft Framework Document and example results from the RCM project, including the pairing of service accessibility data with feeder-level outage data from utility partners. Upon the conclusion of the project team's presentation, the advisory group members offered supportive comments. They suggested that the research could help prompt new ways of thinking about mitigating the impacts of grid power outages, such as where to site investments (which could include solar and battery installations, but also other feeder infrastructure, such as reclosers) based on community members' access to services. Furthermore, group members were excited by the project team's visualization of critical service "restoration curves" and the potential to conduct these types of analyses at a neighborhood scale to optimize grid investments.

Milestone 2.10.1

Groundswell submitted the RCM Framework Document and three case studies to DOE via email on 7/31/2025. The final RCM Framework Document serves as a roadmap to help stakeholders understand and replicate this body of work—whether in parts or as a whole—in their local contexts. It serves as a reference tool for practitioners and other stakeholders, supporting community-driven efforts in energy resilience and informed decision-making. The case studies describe how the project team iterated on the emergent Framework in each of the three jurisdictions and highlight notable observations and outcomes specific to each area.

7.2.5 **Task 11.0**: Finalize the dissemination plan for a resilience framework

The project team finalized the Outreach and Dissemination Plan in July 2025 and submitted it to DOE via email on 7/31/2025 along with the RCM Framework Document. This plan outlines the activities that the RCM team will undertake over the next 12 months (September 2025 to September 2026) to promote the use and adoption of the research findings, including public presentations at industry conferences, webinars, and podcasts. Groundswell will lead the dissemination activities and, when appropriate, rely on RACER partners to facilitate connections and promotional opportunities identified within their networks. By effectively sharing outcomes with stakeholders, including energy practitioners, academics, policymakers, community members, and the public, who are interested in advancing sustainable energy initiatives and enhancing community resilience, we aim to encourage the adoption of innovative resilience strategies, foster collaboration, and inform future initiatives. Ultimately, the dissemination efforts are designed to maximize the project's long-term impact, enhance community preparedness, and contribute to the broader body of knowledge on resilience-building practices upon the project's completion.

7.2.5.1 Subtask 11.1: In alignment with Justice40, identify vulnerable priority areas in the state for replication

The goal of this subtask was to overlay maps with climate change impacts, population demographics, utility performance, and social vulnerability data to identify high-priority areas for RCM framework dissemination and deployment. Using the CEJST tool, the project team identified additional census tracts in counties that are suffering from underinvestment and overburdened by pollution, including:

- Western Maryland: Washington and Allegany Counties
- Central Maryland: Prince George's County
- Eastern Maryland: Dorchester, Somerset, and Accomack Counties

Many of these areas are served by utilities with which the project team has developed a working relationship, making them suitable candidates for deployment of the RCM Framework.

7.2.5.2 Subtask 11.2: Incorporate priority areas into the dissemination plan

Through partnership and close collaboration with MEA, the project team has an influential ally in the state government that can help share the RCM Framework and encourage other priority areas to utilize it. In addition, Groundswell plans to conduct extensive outreach about the project as summarized in the Dissemination Plan provided to DOE on 7/31/2025. Indeed, the primary goal of the Dissemination Plan is to share the knowledge, findings, and best practices developed throughout the resilience project with a broad and diverse audience well beyond the project's duration. This plan acknowledges the critical role that diverse perspectives play in advancing the development of energy resilience systems through the community-driven participatory approach adopted by the research (A.C.E. Impact Trailway™). By effectively sharing outcomes with stakeholders—including energy practitioners, academics, policymakers, community members, and the public—who are interested in advancing sustainable energy initiatives and enhancing community resilience, we aim to encourage the adoption of innovative resilience strategies, foster collaboration, and inform future initiatives.

7.2.5.3 Subtask 11.3: Conduct a webinar to present key findings to Roundtable participants from all three geographic areas of study

The project team presented a summary of key findings and an overview of results from the RCM research to the Roundtable participants from all three jurisdictions on 8/27/2025.

7.2.6 End of Year 2 Project Goals (EOP Y2)

Groundswell submitted the Framework Document and three case studies to DOE on 7/31/2025. The Outreach and Dissemination Plan described Groundswell's approach to sharing the work products with the field and with implementation partners, including MEA.

8 Significant Accomplishments and Conclusions

The primary goal of the RCM project, along with its benefits to the public, was to create a community-driven energy resilience framework that can be replicated across Maryland to enhance public safety and boost preparedness and recovery during hazardous events and prolonged power outages. To achieve this goal, the RCM research employed the A.C.E. Impact Trailway™, a CBPR framework (Exhibit **A1**) to understand community perspectives and highlight the importance of local involvement in energy resilience decisions (Hart et al., 2024; McGookin et al., 2021). This demonstrates not only the value of incorporating local viewpoints in designing and implementing energy resilience strategies but also the significance of using CBPR-based approaches to develop actionable solutions across the state. By engaging community stakeholders in decision-making, the project laid the groundwork for more community-focused and effective energy resilience investments. Additionally, the framework developed through this research provides a scalable model that other regions can adapt to strengthen their preparedness and recovery against energy infrastructure challenges, ensuring that community voices stay central to resilience planning and actions.

8.1 Significant Accomplishments

The project team is proud of the work that went into the research. The value of community engagement is widely recognized, but determining the best ways to elicit meaningful feedback from community participants can be challenging. The RCM framework offers a clear roadmap for energy resilience planners and policymakers to gather information that helps prioritize resilience efforts. It is flexible enough to fit different communities, contexts, and concerns, making it useful not just for Maryland communities but for communities across the United States. The activities developed through RCM are specific enough to guide community engagement efforts. Funding opportunities to develop a cohesive and practical approach to community engagement are rare. As a result, most engagement efforts are fragmented. The project team has had a unique chance to create a framework and field-test it within a single project, leading to a stronger outcome than if we had tried to consolidate insights from various disparate projects. Therefore, the value of the RCM project is demonstrated through its practical applications and implementation, including innovation and usage, as detailed in the RCM Framework documentation and case studies for each of the three jurisdictions in this study. The RCM research project facilitated community participation, leading to more equitable stakeholder involvement and improved decision-making processes related to the siting of resilient power infrastructure, achieved through microgrid activities (see Exhibit **H)**. A key takeaway from this research is that the project team successfully integrated community perspectives into resilience planning discussions, based on the community-centered, data-driven participatory research approach, encapsulated by the following remarks:

"It is hard to express just how much we achieved with the RCM research to advance the field of energy resilience and community engagement driven by decision science. The

project team has developed a framework that facilitates a structured examination of community norms and preferences regarding energy resilience—a topic that many are unfamiliar with. Furthermore, we have not only developed a theoretical framework but also identified best practices and created activities that anyone can use, thereby lowering barriers for those interested in engaging communities but unsure of how to begin. It might not be as exciting as saying 'we have identified a new technology that improves energy efficiency by 5%.' However, it is hard to overstate how valuable it is to know which questions to ask and how to ask them to gain meaningful insights in a completely new way, unlike traditional frameworks of energy resilience." – **Dr. Sara Peterson** (NREL).

The results from the RCM research show that community members can provide valuable feedback on energy resilience planning, especially when discussions are interactive and focused on participants' energy-dependent critical services: their needs, where they go to meet those needs, when those needs emerge over time, and how those needs should be prioritized in complex decisions. As a result, the contributions of the RCM research to the field and the importance of this work include the following findings: First, the shift from the FEMA Lifelines framework used in Baltimore to the more effective, community-driven categories used in Montgomery County and the Eastern Shore was based on discussions with council members, including methods for mapping and grouping rooted in RCM community engagement (see Figure **2** in Exhibit **D**). Co-developing the themes with community members created a classification system that reflects their real-life experiences.

Second, the data-driven community engagement framework is the most important innovation in this research. Besides involving community members in deciding how to approach different types of services, the project team developed a set of activities to gather community input on various aspects of resilience and prioritization. These engagement activities helped uncover revealed preferences rather than stated preferences, which means we now have a structured way to break down the 'value' of different locations into the components that matter most to people. There is value in directly asking community members what is most important to them or what would be most important for their community's resilience. However, the various activities developed in this study can also help clarify why specific responses were given. Discrepancies between revealed and stated preferences are intriguing—they may reveal additional data for consideration.

The microgrid activity stands out as the most innovative for several compelling reasons. First, it uniquely empowers community members to directly engage with and understand the tradeoffs of resilience investments—a hands-on approach that is rarely seen in other interactive energy activities. By simplifying real-world microgrid calculations, the activity bridges technical data with community perspectives, combining rigorous outage modeling with the lived experiences and values of residents. This integration fosters consensus and transparency, ensuring that key energy resilience investment decisions are community-driven, visible, and understandable to everyone. Ultimately, the microgrid activity transforms abstract planning into practical exploration, enabling

communities to co-design solutions that reflect their specific needs and priorities and demonstrating a model for how community-driven, inclusive, and transparent processes can lead to truly resilient energy systems.

Fourth, through the RCM project, we observed that energy resilience metrics often only measure electricity availability within a utility's service area (Jeffers et al., 2023; Petit & Vargas, 2020; Anderson et al., 2019). For example, the number of customers without power during a major storm or the number of outages lasting longer than a certain number of hours reflects the experience of the average customer over a year. Although these baseline metrics are important, they do not highlight other adverse effects of extended power outages, which are primarily caused by the loss of critical services that depend on electricity. These services include the acquisition, storage, and preparation of food, water, and fuel; medical treatments and prescription medications; maintaining thermal comfort and hygiene; communication with family and officials; and other indirect services, such as childcare and banking, that support community functions (see Figures **1** through **5** in Exhibit **I**). Research on the interdependence between electricity and other social, economic, and infrastructure systems has developed metrics, such as social burden, which better measure the benefits of specific resilience investments. However, while these metrics use social science research techniques and involve community participation to validate methods, they have not yet been integrated into community participation processes focused on energy planning.

As a result, the project aimed to bridge the gap between research and planning by examining critical service access, a metric designed to help decision makers identify energy resilience investments that maximize community access to essential services. Community feedback collected during the project was used to improve both the interactive materials used to engage community members and the critical service access metric itself (see Exhibit **A2**). For example, input from rural community members led to expanding the distance radius used to calculate critical service access to better reflect the longer distances community members may travel for critical services; feedback from early participants prompted a reduction in the amount of information provided about the critical service access metric before engaging in activities. Ultimately, the RCM project helps the public by simplifying decisions about backup energy for people who are not energy experts. This encourages and facilitates greater public participation in decision-making and more substantial support for those decisions once they are made. The project promotes distributed energy resources and economic benefits in the U.S. by highlighting the advantages of backup power, which are often difficult to quantify monetarily, and by localizing backup power decisions, increasing the likelihood that decisions are based on more than just financial cost-benefit analysis.

8.2 Challenges and Mitigating Solutions

The project team encountered and successfully addressed several major challenges during this research. First, since there was no prior research on the most effective methods for communicating energy resilience information to community members, we

tested various materials and agenda designs to see which ones best engaged community participants. Community engagement does not offer a controlled environment for systematically experimenting with these materials and agendas. Instead, we observed and assessed their effectiveness as community discussions took place, then made deliberate adjustments between engagements based on our observations. This approach formed the basis of the experiential learning method used in the research. Throughout this process, we learned that it is probably more effective to start with the simplest version of materials and agendas and gradually add complexity as needed, rather than beginning with the most detailed and complex versions and simplifying them later if needed.

Second, the team realized that presenting communities with hypothetical rather than actual investment decisions diminishes the perceived importance of community engagement and limits the depth of insights gained from their feedback. This opens the door for further research to examine how community involvement in real investment scenarios influences participant engagement and response quality. Future studies could explore how different levels of participation affect response usefulness and identify best practices for involving communities in investment research to achieve meaningful insights and actionable outcomes. Third, the project's focus on both framework development and its application across various jurisdictions at the same time created challenges in providing clear guidance during the Baltimore meetings, making them less targeted than intended. The team tackled this by using a trial-and-error approach, understanding that creating new frameworks inherently requires time and iteration. This experience highlighted the need to leave room for learning in the meeting and overall project schedule, and to adjust expectations accordingly.

Fourth, the project faced a major challenge in tackling a complex question: “How can we effectively include community perspectives in resilience planning?” Unlike straightforward questions that yield clear, quantitative answers, such as “a grocery store can provide 5 times as much food as a convenience store,” this question lacked a definite endpoint or simple metric. To address this, the project team developed a flexible and iterative approach that focused on understanding diverse community perspectives. Instead of searching for a single ‘answer,’ the project team used participatory engagement techniques that provided nuanced insights. After each jurisdiction, the team reflected on what it learned and adjusted its approach accordingly. This adaptable process helped refine our questioning methods and engagement strategies over time. As a result, the project team created a practical framework for integrating community input into resilience planning, showing progress even without traditional, clear-cut answers. This approach shows how embracing complexity and iterative learning can lead to significant improvements in solving complex, multifaceted questions. The team saw the absence of traditional ‘answers’ not as a setback but as an opportunity to develop more contextually rich and flexible strategies, ultimately improving the ability to incorporate community perspectives effectively.

Finally, although developing community engagement activities required significant time and effort, the project team used lessons learned from each RC and RT meeting to

refine its approach. As a result, the team created a strong set of materials to support future community engagement efforts. Many assume that creating community engagement materials is easier than producing highly technical documents, but the opposite is true—clarifying concepts and designing activities to gather the right information is very challenging, yet the RCM team succeeded in doing so. Both the activities and the analytical methods used in this project could benefit others in the future.

8.3 Conclusions

Energy resilience planning is complex and multidimensional, making it challenging to fully evaluate the costs and benefits of resilience infrastructure, including non-financial benefits such as social factors and public health advantages. Any new infrastructure investment involves significant capital expenses and/or long-term operational costs. Traditional planning methods, such as cost-benefit analyses used during utility energy master planning, may not capture the full benefits of resilience investments. By analyzing and understanding a community's access to services—or the lack thereof—and the impacts of grid outages from a service access perspective, the value of resilience-focused investments can be better assessed. The RCM project is a step forward toward a community-informed approach. Consistent with emerging research, our experience suggests that energy resilience solutions are most successful when they incorporate community members' lived experiences and when community input guides decisions, such as physical infrastructure, power restoration plans, or other outcomes. Local knowledge of infrastructure, social and economic networks, environmental resources, and risks should, among other factors, shape strategies for energy resilience.

9 Path Forward

"The identified gap in the project was the need for a formal, scientific approach to engaging communities in energy resilience planning. Prior to this research, there was no formal approach; RCM is the first of its kind, attempting to understand energy resilience from a community perspective, augmented with quantitative utility power outage data. Future work could involve scaling the RCM framework through energy resilience funding programs and applying the framework to identify priority sites for community energy resilience efforts across other jurisdictions. Significant progress or research areas that could emerge include integrating social burden and accessibility with CBPR approaches to improve the efficiency of energy resilience planning." - **Dr. Erica Holloman-Hill** (ASI).

The project team is most proud that we managed to combine a strong quantitative analysis with meaningful community engagement, while continuously refining both throughout the project. Most projects focus on only one of these aspects, and few can improve their methods through iteration. To advance the research, Groundswell is actively seeking opportunities to apply the RCM Framework, which was developed to

guide actual resilience investments—when concrete funding for such investments is available or being proposed. For example, a recent award from the MEA will enable us to conduct technical feasibility studies for prospective resilience hubs in Central and Eastern Maryland. Elements of the RCM Framework may be used to identify and recruit suitable candidate sites to participate in this initiative. As a result, it could be beneficial for the framework to be applied in a community where a real resilience investment decision is taking place. For example, a community where the city is selecting sites to include in a grant application for funding a microgrid, or where a state or utility is assessing proposals for sites to install backup energy. Second, building on the approach used in RCM, where we connected each service location to the geographically closest feeder, we could map distribution feeders to the services they supply with power, provided we have full access to a utility's distribution system model. This would allow the creation of more accurate maps and insights into the implications of resilience investments.

Third, the utility feeder analyses we developed provide valuable insights, but the breadth of the geographic areas limits the actionable information. A potentially more useful analysis would focus on a smaller geographic region (e.g., a specific neighborhood within Baltimore City). Theoretically, the applied RCM framework could help identify the most important feeders in a neighborhood from a service access perspective, which could then be prioritized for resilient energy infrastructure. Fourth, future research could incorporate existing utility data on historical outage risk for each feeder. This addition would add a valuable and insightful dimension to the utility data sets, offering a more comprehensive view of infrastructure investment decisions.

Fifth, a potential obstacle to the future adoption of the Framework could be the small number of organizations that choose to implement it, because community input for energy resilience investments is not (yet) required (from a legal or regulatory perspective) or incentivized (from a business perspective). Implementation (and facilitation of RC meetings) requires time, deliberate effort, and knowledge or familiarity with energy resilience. A few organizations, such as Groundswell, are local, community-oriented, possess knowledge of energy resilience, and have established relationships with utilities and other stakeholders that can utilize the information provided by community residents.

Sixth, another area for future improvement is a more controlled comparison of feedback from communities that have recently experienced a prolonged power outage and those that have not. There is also an opportunity to utilize this framework, particularly the microgrid siting activity conducted at the end of each engagement, to analyze public decision-making processes more effectively. Siting criteria, such as the number of microgrids, the duration of outages, the available funding, or the services needed, can be adjusted to understand how community priorities and collaborative decision-making evolve when parameters change. Finally, the next step is to put this work into practice — to be truly valuable, we encourage practitioners to adopt and apply this framework in their contexts so the impact can be realized.

10 PRODUCTS

Refer to Table **1** in Exhibit **K** for a full list of conference presentations, products, and websites developed over the course of the research.

11 PROJECT TEAM AND ROLES

The core RCM project team included: Groundswell (project lead), the National Renewable Energy Laboratory (NREL), and Ayika Solutions, Inc. (ASI). The organization's primary roles and contributions to the project were:

11.1 Groundswell – Project Lead

Groundswell, a 501(c)(3) nonprofit organization that builds community power, served as the Prime Recipient, responsible for overall project leadership, management, budgeting, and reporting, as well as leading community partnerships and engagement activities. Groundswell designed the RCM project, co-facilitated engagement sessions, managed stakeholder coordination, and reviewed/analyzed community feedback. Groundswell Team Members included: David Wright (Principal Investigator), Dr. Elvis Moleka, Tiffani Lawson, Nicole Sonderegger, and Andre De Souza Coelho.

David Wright, as Principal Investigator for the grant, provided strategic and scientific leadership for the entire project, ensuring its design, execution, and outcomes aligned with the U.S. Department of Energy's objectives and research standards. David guided the development of the project's overarching framework, integrating technical modeling, stakeholder engagement, and policy-relevant insights into a cohesive approach. His leadership encompassed setting the research agenda, defining success metrics, and ensuring that the work aligned with both scientific and community priorities. David served as the primary link between DOE, the project team, and key partners, managing high-level relationships and ensuring alignment across multiple organizations, including NREL, Groundswell, and utility-based stakeholders. This involved translating technical outputs into actionable recommendations, as well as ensuring community input was effectively incorporated into modeling and analysis. He also oversaw the project's technical integrity, reviewing methodologies, validating results, and providing quality assurance for all deliverables. He ensured that each study area—Baltimore, Montgomery County, and the Eastern Shore—benefited from tailored research and engagement approaches while contributing to a shared body of knowledge to inform resilience planning nationwide.

Dr. Elvis Moleka played a pivotal role in co-leading the RCM project internally, leveraging his prior experience with the LIFT Project—a three-year DOE-funded initiative—to guide innovative research strategies. From the outset, he proposed and supported a rigorous mixed-methods approach, expertly integrating qualitative, community-driven insights with robust quantitative data to strengthen the scientific

foundation of the project. As the project progressed, Dr. Elvis Moleka assumed responsibility for strategic oversight and successfully managed all internal close-out activities. He directed the creation and refinement of critical deliverables, including the RCM Framework Document and comprehensive Case Studies, while meticulously tagging and analyzing written content from RC meetings across Montgomery County and the Eastern Shore. Dr. Elvis Moleka conducted validation, verification, and advanced visualization of project results—maintaining a sharp focus on cross-jurisdictional comparisons and the alignment of project outcomes with original goals. His professional credentials in risk management and quality auditing enabled him to maintain high standards, identify gaps, implement effective mitigation strategies, and approve all major deliverables. In addition, Dr. Elvis Moleka authored the 12-month Dissemination Plan, strategically researched venues for presenting RCM findings, expanded the literature review, and ensured robust bibliographical support. With a track record of more than 264 research manuscripts and technical reports completed to date, Dr. Elvis Moleka is recognized for his comprehensive authorship of the Final Technical Report, ensuring the project's lasting contribution to the field of energy resilience.

Tiffani Lawson led the overall implementation and coordination of community engagement efforts across Baltimore, Montgomery County, and the Eastern Shore. Her role involved translating the grant's strategic objectives into actionable plans tailored to each region's context, ensuring alignment with DOE requirements while facilitating on-the-ground responsiveness to community needs. She maintained oversight of the project lifecycle, including schedule management, compliance, stakeholder relations, and internal team coordination. Additionally, Tiffani led the production of RPPR1 Quarterly Reports, including PowerPoint presentations to the DOE, utilities, and other stakeholders. As a key part of her role, Tiffani developed and managed relationships with a broad spectrum of stakeholders, including municipal partners, community-based organizations, faith leaders, and technical collaborators, ensuring that engagement efforts were community-centered and trusted. She worked closely with the NREL team to co-design community meeting agendas, facilitate logistics, and support the integration of technical content into accessible, locally relevant formats. Throughout the project, she served as a central point of coordination for cross-functional teams, ensuring that roles were clear, deliverables were on track, and feedback loops between technical partners and community members remained active and effective.

Andre De Souza Coelho, Research Fellow at Groundswell, contributed to the RCM project by supporting its scientific foundation through conducting literature reviews, ensuring research standards compliance, and securing IRB approval. He helped prepare, organize, and facilitate community engagement sessions, including focus groups, to incorporate resident perspectives into decisions about resilient energy infrastructure. He also reviewed project results, communicated scientific contributions to partners, and assisted in preparing quarterly reports for the funder.

Nicole Sonderegger served as the initial senior project manager, supporting the project's launch for about the first year. Nicole applied her expertise in community-driven resilience to aid in project design, including refining the project scope (SOPO) to

meet DOE expectations. She helped develop success metrics, created and managed overall project timelines, established interim milestones, and formulated project plans to ensure coordination among ASI, NREL, and Groundswell. Nicole also led the production of the first two RPPRI Quarterly Reports.

11.2 National Renewable Energy Laboratory (NREL) – Technical Analysis Lead

NREL provided technical research, modeling, and resilience valuation expertise. They modeled and mapped critical services contributing to community resilience for each study area, co-designed engagement content, co-facilitated meetings, and refined models aligning technical outputs with community-prioritized outcomes. Key team members were Dr. Sara Peterson, Jordan Burns, and Maya Fein-Cole.

The NREL team applied a resilience metric – critical service access – to each of the three study areas and led integration of that metric into community engagement activities. The team also designed interactive materials, including activity instructions, guiding questions, and discussion prompts, to enhance participant engagement with resilience concepts and genuine investment opportunities. Additionally, Jordan fostered relationships with utilities, supported data sharing through Non-Disclosure Agreements (NDAs), and managed utility data analysis. This project benefited from the dedicated efforts of NREL's multidisciplinary team that integrated technical analysis, community engagement, and data visualization to support resilience planning. Team members ensured that technical findings were meaningfully incorporated into the broader project framework and resilience strategies. The team used diverse datasets, community feedback, and high-performance computing resources to model critical service access during both normal and extended outage conditions for the three study areas, iteratively refining the inputs and assumptions to align with community member feedback.

The NREL team collaborated with Groundswell team members to develop an agenda for focus group sessions, developed engagement materials, and created interactive tools to support public understanding and gather community-specific insights. These efforts informed the refinement of resilience metrics and contributed directly to the final framework and technical report. The NREL team facilitated many critical components of council meetings and roundtables, including leading discussions, presenting findings, and guiding collaborative activities. All meeting content was digitized and archived to support trend analysis and insight generation. A structured coding system was developed to analyze qualitative data, enabling rigorous documentation of participant feedback and thematic insights. The NREL team developed automated data analysis tools to assess critical service access, and both static and interactive cartographic products were developed to support community engagement. The team's collaborative approach and commitment to integrating community input were instrumental in shaping a robust and actionable resilience framework.

11.3 Ayika Solutions, Inc. (ASI) – Community Research Lead

AYIKA SOLUTIONS INC. (ASI) is a woman-owned, family-operated enterprise that specializes in developing innovative and practical community-driven solutions to current environmental issues. Since 2016, ASI has been fulfilling a professional void in culturally diverse environmental consulting firms available to provide scientific and technical expertise to academic institutions, governmental and non-governmental organizations, and community-based organizations. ASI's team of scientists and visionaries possesses unique environmental science/ecosystems/public health expertise that supports an interdisciplinary approach to providing scientifically sound, community-specific, and socially relevant environmental, climate, equity, and health information. ASI's primary role on the RCM project was to provide the community-driven science framework by applying the A.C.E. Impact Trailway™ and ACA-NET™ methodologies to ensure authentic community leadership in resilience planning. Key team members were Dr. Erica Holloman-Hill and Azania Heyward-James.

Erica Holloman-Hill, Ph.D., led Ayika Solutions Inc.'s contribution to the RCM project, leveraging decades of expertise in community-based participatory research (CBPR) and equitable resilience planning. She was responsible for introducing and guiding the A.C.E. Impact Trailway™, Ayika's proprietary CBPR framework, which became central to incorporating community-led perspectives into the project's design and implementation. Her contributions included establishing community-centric partnerships and collaborations, defining Social Impact Measures and Metrics (SIMMs) that reflected community priorities, and framing Positive Social Impact (PSI) as a measure of success. She facilitated collaboration between Groundswell, NREL, and community stakeholders, ensuring that diverse perspectives were integrated into decision-making and that resilience planning reflected both technical rigor and community-defined outcomes. Dr. Holloman-Hill also helped organize and co-facilitate Resilience Council and Roundtable meetings in all three jurisdictions, focusing on inclusive practices that community voices in energy resilience planning. Her leadership ensured that the project produced not only a replicable resilience framework but also a model for institutionalizing community engagement in energy resilience planning across Maryland and beyond.

Azania Heyward-James brought a socio-anthropological perspective to the RCM project that was essential for ensuring community engagement reflected both historical and current lived experiences. She introduced and focused on an ethnographically grounded methodology that recognized community members' knowledge about energy accessibility, affordability, and reliability, as well as the broader socioeconomic and health impacts of outages on community members. Her approach elevated qualitative insights as core evidence, directly linking them to technical analysis, and ensured that resilience planning was grounded in the community's contextual well-being. Her contributions were central to the implementation of Step 1 of the A.C.E. Impact Trailway™ framework, a CBPR approach that structured the creation of Resilience Councils and Stakeholder Roundtables across Baltimore, Montgomery County, and the Eastern Shore based on the ACA-NET™ framework. Azania helped facilitate activities such as the Service Scoring Matrix, Mapping Neighborhood Critical Services, and a

Timeline of Needs, which translated resident input into data systematically integrated with quantitative modeling. She also provided real-time facilitation support, monitoring participant engagement, clarifying technical content, and validating contributions so all participants felt valued and included. She bridged the gap between technical resilience metrics and community priorities by focusing on Positive Social Impact as a key measure of success. By consistently centering community perspectives, she ensured the project produced strategies that were technically sound, culturally relevant, and community-driven.

11.4 DOE and Other Contributors

The work would not have been possible without support from the U.S. Department of Energy's Solar Energy Technologies Office and the many other contributors summarized in Exhibit **L**.

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13 APPENDICES

13.1 Exhibit A1: Community-Based Participatory Research (CBPR)

The CBPR framework used in this study is a collaborative research approach that values and engages community residents, practitioners, and academic researchers as equal partners in the process. As research is increasingly being conducted and led outside academic institutions, CBPR[4] methodology offers a valid way to involve communities in research. The A.C.E. Impact Trailway™ proposed by Ayika Solutions, Inc. (ASI), is a CBPR approach designed to guide organizations (public and private) and practitioners (community members) through a facilitated process that leverages resources, activities, and milestones to co-define and develop Social Impact Measures & Metrics (SIMMs)™. ASI defines SIMMs as implementable measures and metrics designed to create measurable, positive social impact (PSI)™. ASI defines PSI as the positive, social (and community-driven/led) change desired by organizations and/or practitioners, guided by the goals of a project or program. In the context of energy resilience, the barriers that prevent non-energy experts from participating in energy system decisions (i.e., energy resilience planning) provided an opportunity to apply ASI's approach in support of the project's goals, as shown in Figure **1**.

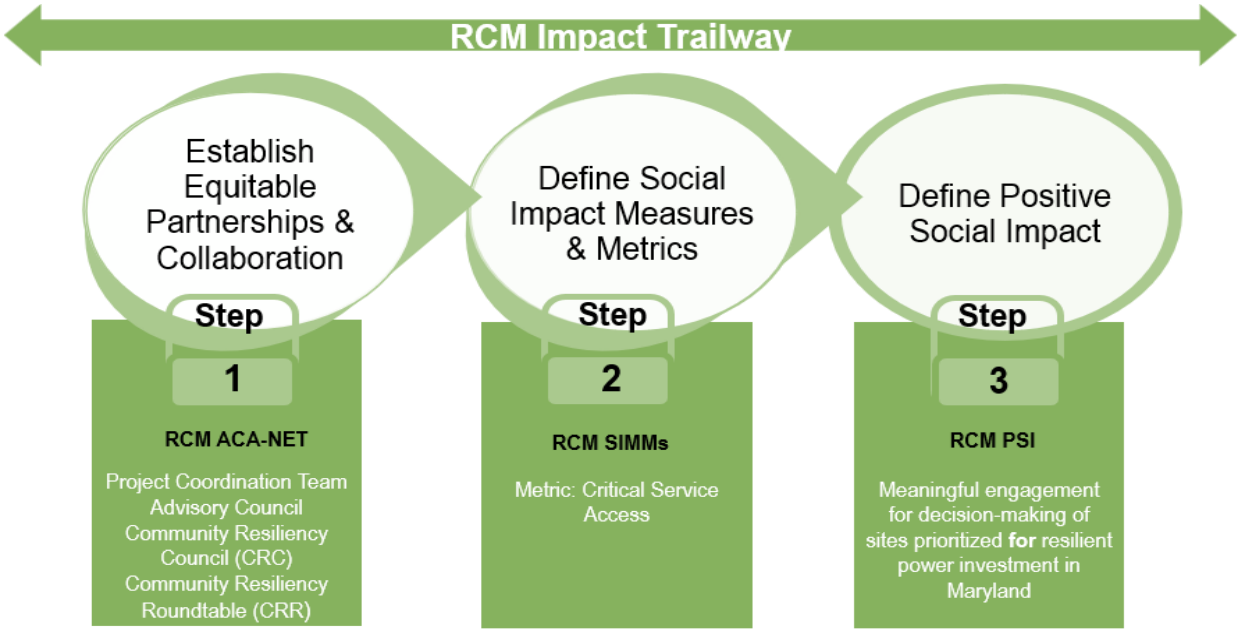

Figure 1
The RCM Impact Trailway. A Community-driven, CBPR-based Approach applied to Energy Resilience Planning.

[4] (Fry et al., 2023; Ross & Day, 2022).

The RCM Impact Trailway conceptual map outlines ASI's facilitated process (A.C.E. Impact Trailway™) that encompasses three steps:

- Step 1: Establish partnerships and collaborations. The creation of the RCM Academic-Community-Agency Network (RCM ACA-NET) harnesses both energy and non-energy stakeholder expertise, filling gaps in stakeholder knowledge about energy resilience planning through RCM Resilience Council (RC) and Roundtable (RT) meetings.
- Step 2: Define the Social Impact Measure and Metrics (SIMMs). The project utilizes critical service access, examining the locations, types, and quality of critical services to assess the potential impacts of resilience investments.
- Step 3: Define Positive Social Impact. The project goals frame the PSI.

Step 1 is crucial to establishing meaningful stakeholder engagement. The A.C.E. Impact Trailway™ utilizes the Academic Institutions-Community-Agencies- Network (ACA-NET™), a collaborative, community-centered approach to energy resilience, to guide the design and structure of Step 1.

The ACA-NET™ for this project comprised the following:

- Project team
- Advisory Group
- Community Resilience Council (RC)
- Stakeholder Roundtable (RT)

The project team co-facilitated the pilot of the RCM Impact Trailway in each of the three jurisdictions: Baltimore, Montgomery County, and the Eastern Shore. An external Advisory Group offered support and guidance to the project team throughout the project. The creation of RCs and RTs in each jurisdiction established a clear pathway for meaningful community engagement. The RCs were explicitly designed for community resident stakeholders and served as a separate space to educate, inform, and involve residents. RTs were created as a collaborative engagement space among academics/researchers, agencies, and community residents. Establishing RCs and RTs in each jurisdiction provided a lasting mechanism for community engagement, as desired by the community, even after the research project concludes. The RCM Impact Trailway also corresponded with the Community Engagement to Ownership model (Figure **2**). Specifically, the RCM Impact Trailway offers opportunities for communities in Maryland to become involved (Community Stance 3) and collaborate (Community Stance 4) in energy resilience planning for resilient power investments.

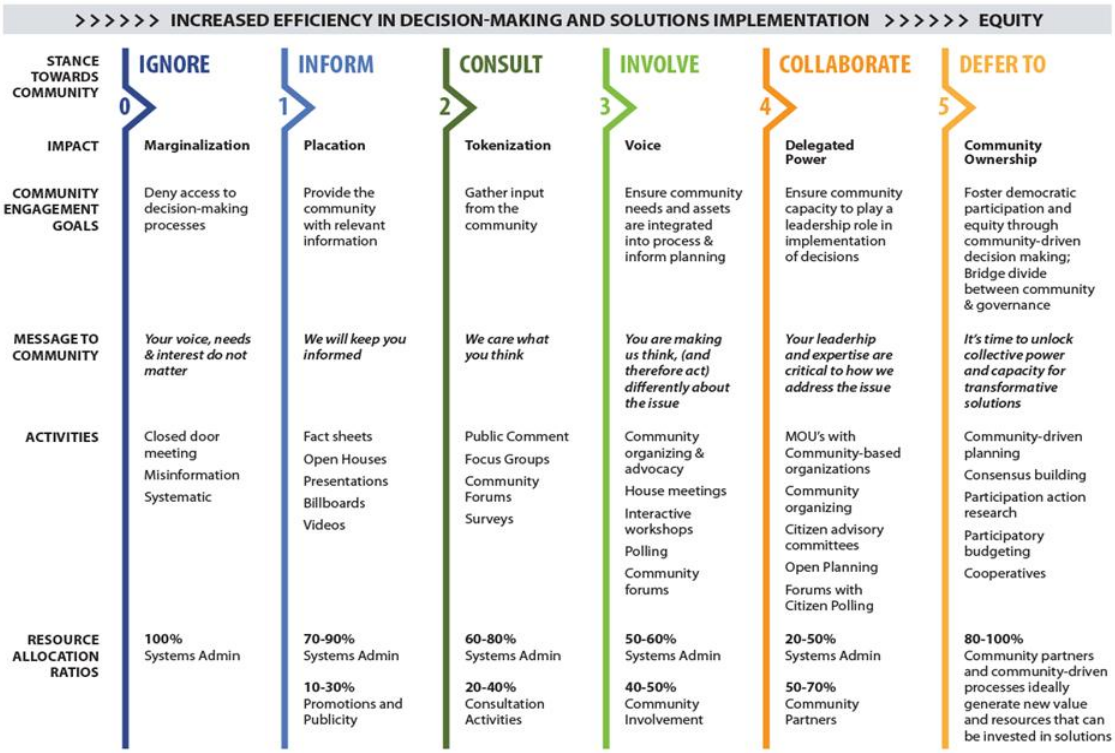

Figure 2
Modified Spectrum of Community Engagement to Ownership.

13.2 Exhibit A2: Critical Service Access: A Community-Driven Resilience Metric

In this study, community RC members provided feedback on critical service access modeled for their neighborhoods. Service locations and categories can be selected collaboratively with community members and ranked based on the type and quality of services they provide. The metric thus links service locations to the populations they serve. Calculating critical service access—a unitless metric—requires gathering data on service locations, scoring these locations across different types, and calculating travel time between each service location and every neighborhood resident using road data in a routing analysis. First, the value between each service location and each household is given by:

$$V_{h,j} = P_h \frac{S_j}{T_{h,j}^2} \qquad (1)$$

Where:
$V_{h,j}$ is the estimated critical service value between residential location *h* and non-residential service location *j*

P_h is the estimated population of residential location *h*[*]
S_j is a total service score assigned to non-residential service location *j*[**]
$T_{h,j}$ is the shortest travel time between residential location *h* and non-residential service location *j*

$V_{h,j}$ is then summed for every pair of residential and non-residential locations to establish an aggregated critical service access value for each residential location:

$$A_h = \sum_j V_{h,j} \qquad (2)$$

Where A_h is the critical service access for a given household, calculated by summing the value of all non-residential service locations, *j*, within a given drive time.[5]

$V_{h,j}$ is also summed across households to calculate an aggregated *contribution* to critical service access within the study area for each non-residential service location:

$$A_j = \sum_h V_{h,j} \qquad (3)$$

Where A_j is the contribution to critical service access for a given non-residential service location, calculated by summing its value for all residential locations, *h*, in the study area.

In addition to accessing services outside the home, each household is assumed to access a subset of critical services within their home, including heating and cooling, hygiene, communication, medication and food storage, food preparation, and the use of electrical medical devices. These in-home services are unique in two ways: (1) they do not require travel and therefore are not weighted by travel time, and (2) services provided inside residential locations have high value for residents, but no value for the wider community. In contrast, services provided outside the home have lower value for each resident — especially those who live relatively far from non-residential locations — but higher value for the community in aggregate. This is because the value of a single non-residential service location is calculated by summing the access-weighted service scores it provides to each household within a 60-minute drive radius.

[*] Estimated using an attribute included in the public National Structure Inventory (NSI) dataset (U.S. Army Corps of Engineers 2022).
[**] Aggregated across service categories shown in Table **2** in Exhibit **A2**.
[5] A 60-minute driving radius is what was established for the RCM project, but it should be noted that the best / most appropriate threshold might vary based on context.

In the equations above, each household *h* also serves as a service location *j* for its own residents, and the value $V_{h,j}$ between each household and its own services is calculated with a travel time of one minute to remove travel-time weighting, which can be simplified as:

$$V_{h,j=h} = P_h \cdot S_{j=h} \qquad (4)$$

Finally, the total critical service access of a study area is aggregated using:

$$A = \sum_h A_h \qquad (5)$$

Where A is the total access to critical services for a community of households, considering all non-residential service locations within a 60-minute travel time radius from the border of the given community boundary. Table **1** summarizes the drive radius for each jurisdiction based on the above calculations.

Table 1
Summary of Driving Radius for Critical Service Accessibility Calculation by Jurisdiction

County	Drive Radius	Unit for Population	Scoring Framework
Baltimore	20 minutes	*Hex bins*	FEMA lifelines
Montgomery County	20 minutes	households	Recategorized themes, incl. Institutional Population as a service theme
Eastern Shore	60 minutes	population	Recategorized themes, Institutional Population omitted as a service theme, and considered as a type of location from which people cannot travel as far for services.

Identify and map critical service locations

The project team obtained a list of critical service locations from publicly accessible sources. For example, in Baltimore, the team compiled a database of over 1,700 service locations across the city, as shown in Table **2**.

Table 2
Types, Subtypes, Data Sources, and Counts for the Baltimore City Service Location Database.

Type	Data Source	Count
Assisted Living	HIFLD Nursing Homes	508
Bank	HIFLD FDIC Insured Banks	70
Child Care Center	HIFLD Child Care Centers	237
College or University	HIFLD Colleges and Universities	16
Convention Center	HIFLD Convention Centers/Fairgrounds	2
Dialysis Center	HIFLD Dialysis Centers	28
EOC	HIFLD Local Emergency Operations Center HIFLD State Emergency Operations Centers	1
Fire & EMS	HIFLD Emergency Medical Service (EMS) Stations HIFLD Fire Stations	41
Food Bank	Maryland Food Banks	161
Gas Station	OpenStreetMap	148
Grocery Store	SNAP Retailer Locator	64
Hospital	HIFLD Hospitals	17
Library	Pratt Library Locations	22
Major Sport Venue	HIFLD Major Sport Venues	6
Nursing Home	HIFLD Nursing Homes	28
Pharmacy	Rx Open	195
Place of Worship	HIFLD All Places of Worship	732
Police Station	HIFLD Local Law Enforcement Locations	38
Public School	HIFLD Public Schools	166
Recreation Center	Baltimore City Department of Recreation & Parks	48
Resilience Hub	Baltimore City Community Resiliency Hub Program	9
Shelter	HIFLD National Shelter System Facilities	5
Super Store	SNAP Retailer Locator	26
Supermarket	SNAP Retailer Locator	21
Urgent Care	HIFLD Urgent Care Facilities	4

13.3 Exhibit B: Existing Reliability Metrics

Table 1
Reliability Metrics Definitions

	System Average Interruption Duration Index (SAIDI)	*It indicates the total duration of the average customer interruption.*
	System Average	*It indicates how often the average*

	Interruption Frequency Index (SAIFI)	*customer experiences an interruption.*
AVERAGE-BASED METRICS[6]	Customer Average Interruption Duration Index (**CAIDI**)	*It indicates the average time to restore service.*
	Customer Average Interruption Frequency Index (CAIFI)	*This indicates the number of interruptions each impacted customer experiences.*
	Momentary Average Interruption Duration Index (MAIDI)	*Indicates total duration of the average customer momentary interruption (i.e., interruptions lasting less than five minutes).*
	Momentary Average Interruption Frequency Index (MAIFI)	*It indicates how often the average customer experiences a momentary interruption (i.e., interruptions lasting less than five minutes).*
CUSTOMER-BASED METRICS	Customers Experiencing Long Interruption Durations (CELID)	*Indicates the ratio of individual customers who experience interruptions with durations longer than or equal to a given time. That time is either the duration of a single interruption or the total amount of time that a customer has been interrupted during the reporting period.*
	Customers Experiencing Multiple Interruptions (CEMI)	*Indicates the ratio of individual customers experiencing n or more sustained interruptions*

[6] Institute of Electrical and Electronics Engineers (IEEE) 1366 Reliability Metrics - Source: (IEEE, 2012, as cited in Leddy et al., 2023)

13.4 Exhibit C: Mapping the Universe of Desired Stakeholder Groups

Table 1
RCM Project Stakeholder Groups

Group Type	Description	Data Collection	Frequency & Duration	Participants	Location(s)
Resiliency Council	Community stakeholders, with diverse representations from within the community, aimed to: (a) collaboratively identify and validate resilience priorities and social resilience measures, (b) provide a safe space for community members to share their ideas, and (c) reduce power dynamics that may emerge during the Roundtable meetings when government and academia are present.	Pre-Selection Interest Form, Survey 1: Baseline (during first meeting). Focus group discussion: gather qualitative data during resiliency council meetings to compare and validate survey results. Survey 2: Conducted during the last meeting, aiming for a 10% improvement in the relevance and applicability of observed data relative to existing resiliency frameworks and metrics. Electronic and traditional data collection methods.	Once a month for 6 months, and meetings were held for 2 hours per meeting	5-10 Note: will not include RH leaders or anyone formally associated with/ Baltimore RH Program	Baltimore, Montgomery County, and the Eastern Shore
Roundtable	Consisted of Resiliency Council members, local government, utilities, and other stakeholders (e.g., academic institutions and non-profit organizations). The aim was to: (a) bring together and create a space for collaboration between Resiliency Council	Focus group discussion: Gather qualitative data during resiliency council meetings for comparison and validation of survey results.	Once per quarter (2 total) 2 hours per meeting	All Resiliency Council members: - 5-7 representatives from local government, academia, and utilities	Baltimore, Montgomery County, and the Eastern Shore

	participants and other relevant stakeholders to continue expanding the resilience framework emerging from Resiliency Council meetings; (b) work closely with The project team to incorporate insights from discussions and community-led directions into technical decision-making; and (c) facilitate solution-oriented conversations.			- One or more faculty or student members from a minority-serving institution (MSI) in the area	
External Advisory Group	The project team established an advisory group that provided periodic feedback on the replicability of our approach and methodologies beyond the project's duration.	N/A (no formal data collection expected)	Quarterly	3-6 participants to be nominated by the Project Team.	N/A

Table 2
Baltimore Resiliency Council and Roundtable Topics & Outcomes

Baltimore Resiliency Council & Roundtable Meeting Dates					
Meeting	**Date**	**Topic**	**Outcome**	**Meeting Duration**	**Location**
Resiliency Council Meeting #1	11/9/23	Welcome & Introduction Resilience Council & Baseline Survey	Introduction to the team, project, and overall logistics Conduct Baseline Survey	2.0 hours	Robert C. Marshall Recreation Center
Resiliency Council Meeting #2	12/7/23	Energy resilience	Identify community-led energy resilience priorities Mapping Discussion	2.0 hours	Robert C. Marshall Recreation Center

Resiliency Council Meeting #3	1/11/24	Introduction to Social Impacts & Measures	Document current conditions by collecting both quantitative and qualitative data from the Resiliency Council stakeholders on how power grid outages have affected individuals and communities, along with data on historical grid outages from utilities and the Baltimore City Office of Emergency Management.	2.0 hours	Robert C. Marshall Recreation Center
Roundtable Meeting #1	1/18/24	Introduction Community Priorities	To share community-defined priorities and work together with other stakeholders to include additional considerations.	2.0 hours	Robert C. Marshall Recreation Center
Resiliency Council Meeting #4	2/15/24	Prioritization of Social Impacts & Metrics	Identify pain points and needs and conduct ranking exercises to determine the highest priorities. SIMMs are implementable measures (activities) and measurable metrics (milestones) that will help achieve the community's desired outcomes. Additionally, assess what the community hopes to leave behind after RCM and incorporate feedback into the project.	2.0 hours	Morrell Park Recreation Center
Resiliency Council Meeting #5	3/14/24	Prioritization of Social Impacts & Metrics Continued		2.0 hours	Morrell Park Recreation Center
Resiliency Council Meeting #6	4/11/24	Exit Survey & Recommendations for Roundtable	Survey community members to assess the relevance and applicability of the refined metrics.	2.0 hours	Morrell Park Recreation Center
Roundtable Meeting #2	4/18/24	Resilience Model Overview	Review the resilience model and discuss information-sharing frameworks.	2.0 hours	Morrell Park Recreation Center

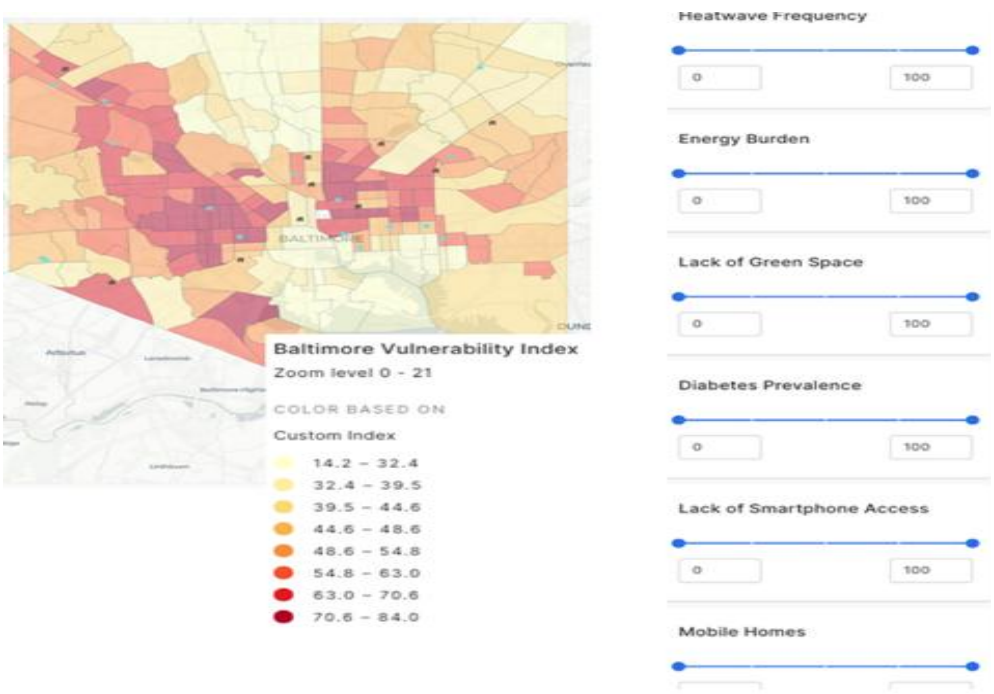

Figure 1
Baltimore Heat & Power Outage Vulnerability Index

13.5 Exhibit D: Service Scoring

FEMA Lifelines were utilized to define initial categories, where each location type could receive a score indicating its relative importance for services in that category (Figure **1**).

Figure 1
Original FEMA Lifelines for Service Categories

Note. *Each location type can earn a score from 0 to 5 in each of the eight FEMA Lifeline categories, for a maximum of 40 service score points per location type.*

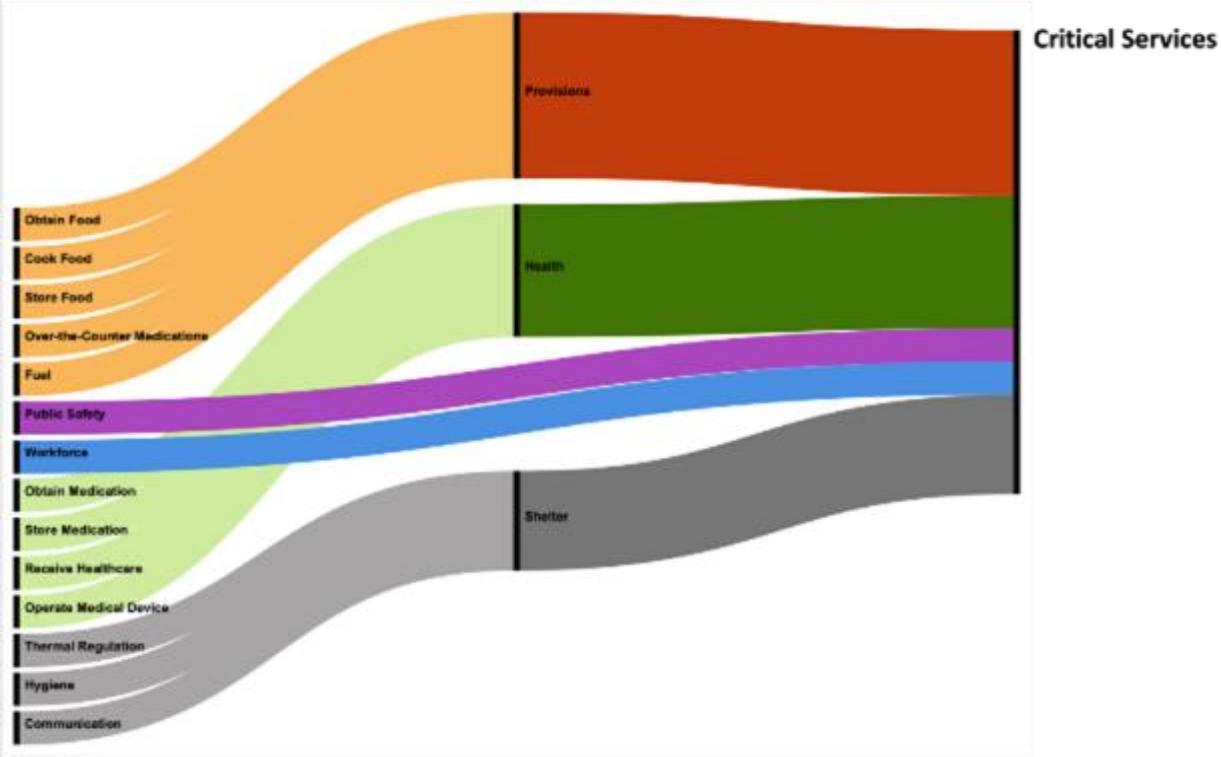

Figure 2
New RCM FEMA Lifelines for Service Categories
Note. *Final service categories and subcategories were developed with feedback from the RCs in Baltimore, Montgomery County, and the Eastern Shore.*

Table 1

*Descriptions of the five themes and associated categories and subcategories are used to assign critical service scores to locations across Seattle. Categories are assumed to be of equal importance for baseline resilience. See Appendix Tables **2** and **3** for detailed service scores assigned to each location type for each category.*

Provisions	
Places that support the acquisition and storage of supplies, including areas that are open to the public during normal operations, where residents can access food, gasoline, propane, or bottled water or other drinks for purchase or for free.	
Categories	**Subcategories**
Food & Water	Obtain, Store, Cook
Fuel	Obtain
Over-the-Counter Medications	Obtain

Health	
Places that support the maintenance of health, including areas that are open to the public during normal operations, where residents can access prescription medications, receive treatment for health conditions, or operate an electricity-dependent medical device.	
Categories	**Subcategories**
Medication	Obtain, Store
Healthcare	Procedure, Device
Public Safety	
Locations that help the city or county provide services residents rely on during normal operations and during emergencies. Includes places from which services are coordinated by government staff or dispatched to residents in need.	
Shelter	
Places that support indoor safety and activities that take place in safe, indoor conditions. Includes thermal regulation (staying warm or keeping cool), hygiene (washing clothes, dishes, or people; using toilets), and charging networked devices that facilitate personal communication.	
Categories	
Thermal Regulation	
Hygiene	
Communication	
Workforce	
Places that support the regular activities of residents, including schools, banks, childcare centers, and major employers, which may be paused temporarily during emergencies, but must resume for the community to return to normal.	

Table 2
Critical Service Scores During Normal Conditions

Non-Residential Service Locations		Provisions					Health				Public Safety	Shelter			Workforce	Total
Type	**Subtype**	**Cook Food**	**Obtain Food/Water**	**Store Food**	**Obtain Over-the-Counter Meds**	**Obtain Fuel**	**Obtain Prescription Meds**	**Store Meds**	**Healthcare Procedure**	**Operate Medical Device**		**Heating/Cooling**	**Hygiene**	**Communication**		
Bank	Bank	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**
Child Care Center	Child Care Center	0	0	0	0	0	0	0	0	0	0	0	0	0	3	**3**
College or University	College or University	0	0	0	0	0	0	0	0	0	0	0	0	2	2	**4**
Community Center	Community Center	0	0	0	0	0	0	0	0	0	0	0	0	5	0	**5**
Community Center	Official Shelter	0	0	0	0	0	0	0	0	0	0	0	0	5	0	**5**
Community Emergency Hub	Community Emergency Hub	0	0	0	0	0	0	0	0	0	0	0	0	5	0	**5**
Convention Center	Convention Center	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Convention Center	Official Shelter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Dialysis Center	Dialysis Center	0	0	0	0	0	0	0	4	0	0	0	0	0	0	**4**
EOC	EOC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
EV Charging Station	EV Charging Station	0	0	0	0	5	0	0	0	0	0	0	0	0	0	**5**
Food Bank	Food Bank	0	3	0	0	0	0	0	0	0	0	0	0	0	0	**3**
Fire & EMS	Fire & EMS	0	0	0	0	0	0	0	3	0	5	0	0	0	0	**8**

Gas Station	Gas Station	0	1	0	1	5	0	0	0	0	0	0	0	0	0	**7**
Grocery Store	Large	0	5	0	1	0	0	0	0	0	0	0	0	0	0	**6**
Grocery Store	Small	0	4	0	1	0	0	0	0	0	0	0	0	0	0	**5**
Grocery Store	Superstore	0	5	0	1	2	0	0	0	0	0	0	0	0	0	**8**
Hardware Store	Hardware Store	0	0	0	0	3	0	0	0	0	0	0	0	0	0	**3**
Heating/Cooling Center	Heating/Cooling Center	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Hospital	Trauma I	0	0	0	3	0	5	0	5	0	0	0	0	0	0	**13**
Hospital	Trauma II/III	0	0	0	3	0	4	0	4	0	0	0	0	0	0	**11**
Hospital	Other Hospital	0	0	0	3	0	3	0	3	0	0	0	0	0	0	**9**
Hospital	Long Term Care	0	0	0	2	0	3	0	2	0	0	0	0	0	0	**7**
Hospital	Rehabilitation	0	0	0	1	0	3	0	1	0	0	0	0	0	0	**5**
Hospital	Psychiatric	0	0	0	1	0	3	0	1	0	0	0	0	0	0	**5**
Hospital	Military	0	0	0	1	0	3	0	1	0	0	0	0	0	0	**5**
Library	Library	0	0	0	0	0	0	0	0	0	0	0	0	3	0	**3**
Major Sport Venue	Major Sport Venue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Major Sport Venue	Official Shelter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Nursing Home	Assisted Living	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Nursing Home	Nursing Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Pharmacy	Pharmacy	0	1	0	5	0	5	0	0	0	0	0	0	0	0	**11**
Place of Worship	Official Shelter	0	0	0	0	0	0	0	0	0	0	0	0	3	0	**3**
Place of Worship	Place of Worship	0	0	0	0	0	0	0	0	0	0	0	0	3	0	**3**
Police Station	Police Station	0	0	0	0	0	0	0	0	0	5	0	0	0	0	**5**
Public School	High School	0	0	0	0	0	0	0	0	0	0	0	0	2	5	**7**
Public School	Official Shelter	0	0	0	0	0	0	0	0	0	0	0	0	2	5	**7**
Public School	Other School	0	0	0	0	0	0	0	0	0	0	0	0	2	5	**7**

Section 202 Housing	Section 202 Housing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Shelter	Shelter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Urgent Care	Urgent Care	0	0	0	0	0	2	0	2	0	0	0	0	0	0	**4**

Residential Service Locations	**Provisions**					**Health**					**Shelter**				**Total**
Type	**Cook Food**	**Obtain Food/Water**	**Store Food**	**Obtain Over-the-Counter Meds**	**Obtain Fuel**	**Obtain Prescription Meds**	**Store Meds**	**Healthcare Procedure**	**Operate Medical Device**	**Public Safety**	**Heating/Cooling**	**Hygiene**	**Communication**	**Workforce**	
Dormitory	5	0	5	0	0	0	5	0	5	0	5	5	5	0	**35**
Hospital	5	0	5	0	0	5	5	5	5	0	5	5	5	0	**45**
Nursing Home	5	0	5	0	0	3	5	1	5	0	5	5	5	0	**39**
Single Family	5	0	5	0	0	0	5	0	5	0	5	5	5	0	**35**
Multi-Family	5	0	5	0	0	0	5	0	5	0	5	5	5	0	**35**

Table 3
Critical Service Scores During Long Outages

Non-Residential Service Locations		Provisions					Health					Shelter				
Type	**Subtype**	**Cook Food**	**Obtain Food/Water**	**Store Food**	**Obtain Over-the-Counter**	**Obtain Fuel**	**Obtain Prescription**	**Store Meds**	**Healthcare Procedure**	**Operate Medical Device**	**Public Safety**	**Heating/Coolin**	**Hygiene**	**Communicatio**	**Workforce**	**Total**
Bank	Bank	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Child Care Center	Child Care Center	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
College or University	College or University	0	0	1	0	0	0	1	0	1	0	0	0	2	2	7
Community Center	Community Center	0	0	1	0	0	0	1	0	1	0	3	0	5	0	11
Community Center	Official Shelter	0	1	3	0	0	0	3	0	5	0	5	5	5	0	27
Community Emergency Hub	Community Emergency Hub	0	1	3	0	0	0	3	0	5	0	5	3	5	0	25
Convention Center	Convention Center	0	0	1	0	0	0	1	0	1	0	2	0	0	0	5
Convention Center	Official Shelter	0	1	3	0	0	0	3	0	5	0	5	5	5	0	27
Dialysis Center	Dialysis Center	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4
EOC	EOC	0	0	0	0	0	0	0	0	0	4	0	0	0	0	4
EV Charging Station	EV Charging Station	0	0	0	0	5	0	0	0	0	0	0	0	0	0	5
Food Bank	Food Bank	0	3	0	0	0	0	0	0	0	0	0	0	0	0	3

Fire & EMS	Fire & EMS	0	0	0	0	0	0	0	3	0	5	0	0	0	0	8
Gas Station	Gas Station	0	1	0	1	5	0	0	0	0	0	0	0	0	0	7
Grocery Store	Large	0	5	0	1	0	0	0	0	0	0	0	0	0	0	6
Grocery Store	Small	0	4	0	1	0	0	0	0	0	0	0	0	0	0	5
Grocery Store	Superstore	0	5	0	1	2	0	0	0	0	0	0	0	0	0	8
Hardware Store	Hardware Store	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3
Heating/Cooling Center	Heating/Cooling Center	0	0	0	0	0	0	0	0	0	0	5	0	5	0	10
Hospital	Trauma I	0	0	0	3	0	5	0	5	0	0	0	0	0	0	13
Hospital	Trauma II/III	0	0	0	3	0	4	0	4	0	0	0	0	0	0	11
Hospital	Other Hospital	0	0	0	3	0	3	0	3	0	0	0	0	0	0	9
Hospital	Long Term Care	0	0	0	2	0	3	0	2	0	0	0	0	0	0	7
Hospital	Rehabilitation	0	0	0	1	0	3	0	1	0	0	0	0	0	~~0~~	5
Hospital	Psychiatric	0	0	0	1	0	3	0	1	0	0	0	0	0	0	5
Hospital	Military	0	0	0	1	0	3	0	1	0	0	0	0	0	0	5
Library	Library	0	0	0	0	0	0	0	0	0	0	3	0	3	0	6
Major Sport Venue	Major Sport Venue	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2
Major Sport Venue	Official Shelter	0	1	3	0	0	0	3	0	5	0	5	5	5	0	27
Nursing Home	Assisted Living	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nursing Home	Nursing Home	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pharmacy	Pharmacy	0	1	0	5	0	5	0	0	0	0	0	0	0	0	11
Place of Worship	Official Shelter	0	1	3	0	0	0	3	0	5	0	5	5	5	0	27
Place of Worship	Place of Worship	0	1	1	0	0	0	1	0	1	0	3	0	3	0	10
Police Station	Police Station	0	0	0	0	0	0	0	0	0	5	0	0	0	0	5
Public School	High School	0	0	1	0	0	0	1	0	1	0	3	0	3	5	14

Public School	Official Shelter	0	1	3	0	0	0	3	0	5	0	5	5	5	5	32
Public School	Other School	0	0	1	0	0	0	1	0	1	0	3	0	3	5	14
Section 202 Housing	Section 202 Housing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shelter	Shelter	0	1	3	0	0	0	5	0	5	0	5	5	5	0	29
Urgent Care	Urgent Care	0	0	0	0	0	2	0	2	0	0	0	0	0	0	4

Residential Service Locations	**Provisions**					**Health**					**Shelter**				**Total**
Type	**Cook Food**	**Obtain Food/Water**	**Store Food**	**Obtain Over-the-Counter Meds**	**Obtain Fuel**	**Obtain Prescription Meds**	**Store Meds**	**Healthcare Procedure**	**Operate Medical Device**	**Public Safety**	**Heating/Cooling**	**Hygiene**	**Communication**	**Workforce**	
Dormitory	5	0	5	0	0	0	5	0	5	0	5	5	5	0	**35**
Hospital	5	0	5	0	0	5	5	5	5	0	5	5	5	0	**45**
Nursing Home	5	0	5	0	0	3	5	1	5	0	5	5	5	0	**39**
Single Family	5	0	5	0	0	0	5	0	5	0	5	5	5	0	**35**
Multi-Family	5	0	5	0	0	0	5	0	5	0	5	5	5	0	**35**

13.6 Exhibit E: Service Landscapes

Figure **1** shows the additional locations considered in the critical service access metric for Montgomery County when the travel time threshold is increased from a 20-minute to a 40-minute to a 60-minute one-way drive radius. Increasing the travel time threshold by these increments enables locations in the Washington D.C. and Baltimore metro areas to contribute to critical service access for Montgomery County households, resulting in a significant increase in critical service access for the county. These results underscore the importance of coordination across jurisdictions and utility territory boundaries for resilience decision-making, since households in this area access critical services regardless of municipal or utility boundaries.

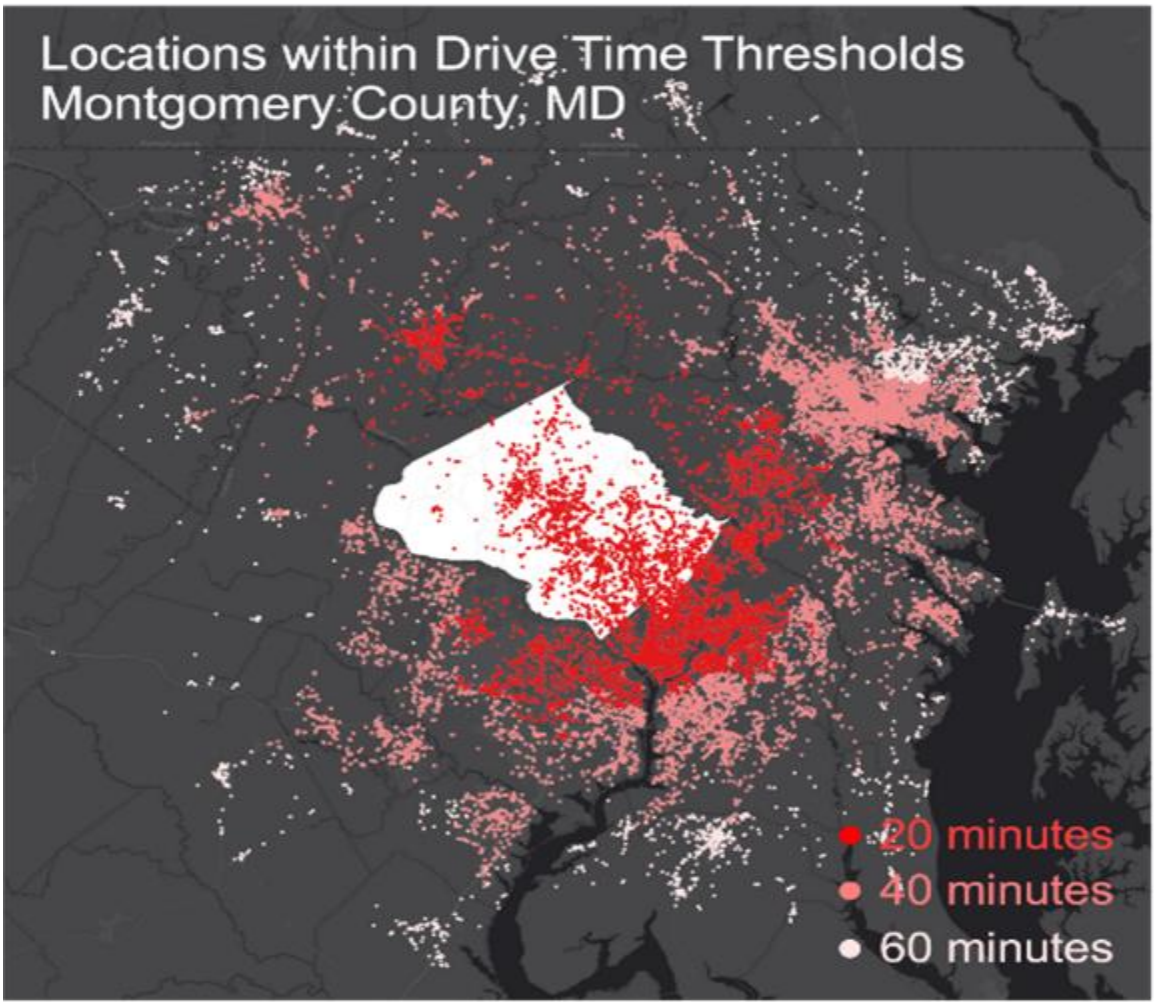

Figure 1
Locations considered in the critical service access metric for Montgomery County when the travel time threshold increases from a 20-minute to a 40-minute to a 60-minute one-way drive radius.

Table **1** displays the additional locations and the increase in critical service access observed for Baltimore, Montgomery County, and the Eastern Shore when the drive time threshold expands from 20 minutes to 60 minutes. The larger travel time threshold boosts critical service access in Montgomery County by over 80% because it adds thousands of densely clustered locations near Baltimore and Washington, D.C., to the list of accessible sites for Montgomery County households. Conversely, the increase in critical service access for Eastern Shore residents is only 15%, as fewer locations are added to this rural area, which is bounded by water, and travel times between households and services remain relatively long.

Table 1

The increase in the number of locations and critical service access is observed for Baltimore, Montgomery County, and the Eastern Shore when the drive time threshold is increased from 20 minutes to 60 minutes.

Drive Time	Count Locations	Critical Service Access
Baltimore		
20	7,214	47.54 M
60	19,329 +167.94% from 20 min	57.27 M +20.46% from 20 min
Montgomery County		
20	9,133	35.20 M
60	23,766 +160.22% from 20 min	64.43 M +83.04% from 20 min
Eastern Shore		
20	1,490	4.88 M
60	3,134 +110.34% from 20 min	5.61 M +14.96% from 20 min

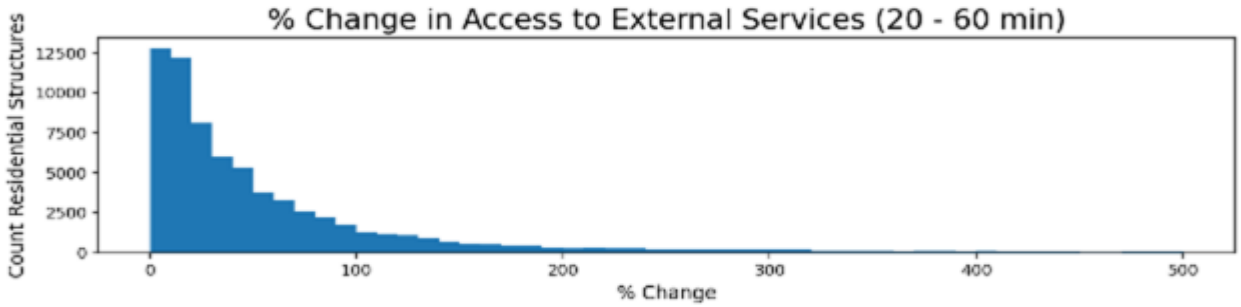

Figure 2
The percent change in critical service access observed in households across the Eastern Shore when the travel time threshold increases from a 20-minute to a 60-minute drive time radius.

Notable increases in household critical service access are mainly seen along small roads in very rural parts of the Eastern Shore, where residents live relatively far from town centers like Salisbury or Princess Anne (Figure **3**).

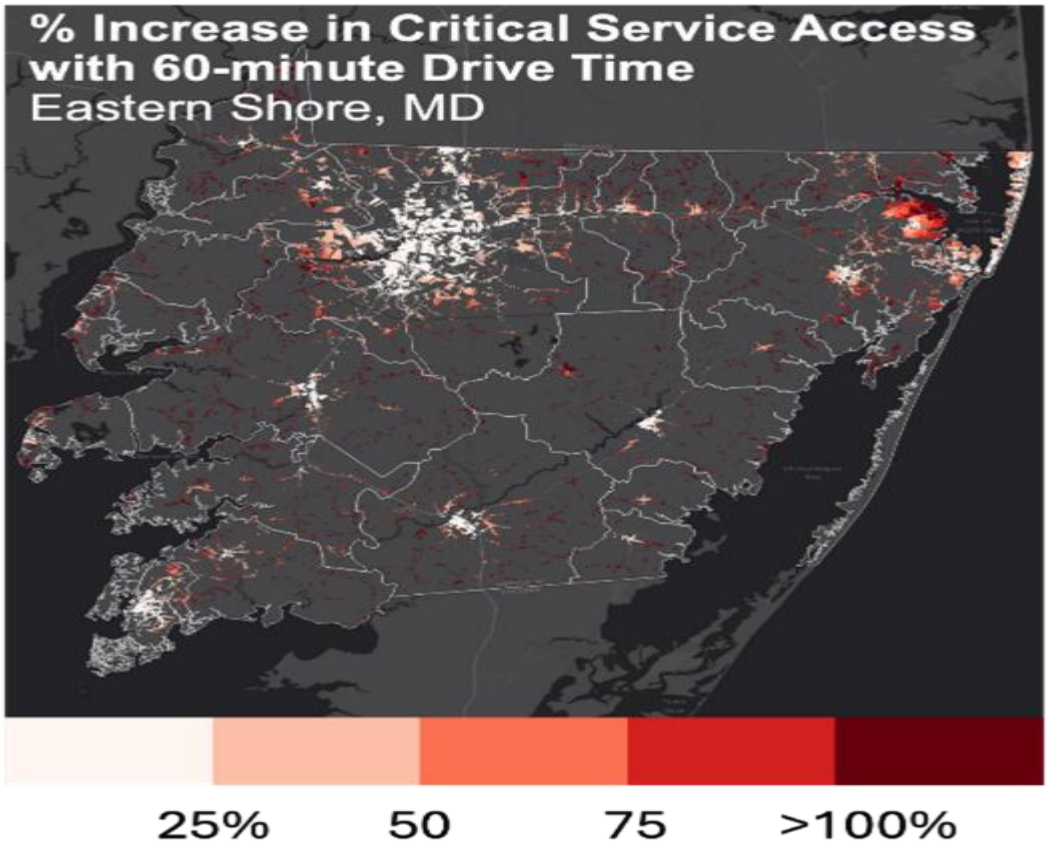

Figure 3
Spatial distribution of the percent change in critical service access observed for households across the Eastern Shore when the travel time threshold is increased from a 20-minute to a 60-minute drive time radius.

Analyzing how different travel time thresholds impact critical service access helps us understand how power infrastructure, essential services, and households interact across urban, suburban, and rural areas. These findings underscore the importance and potential for aligning resilience metrics with community priorities and lived experiences.

13.7 Exhibit F: Measuring Outage Consequences

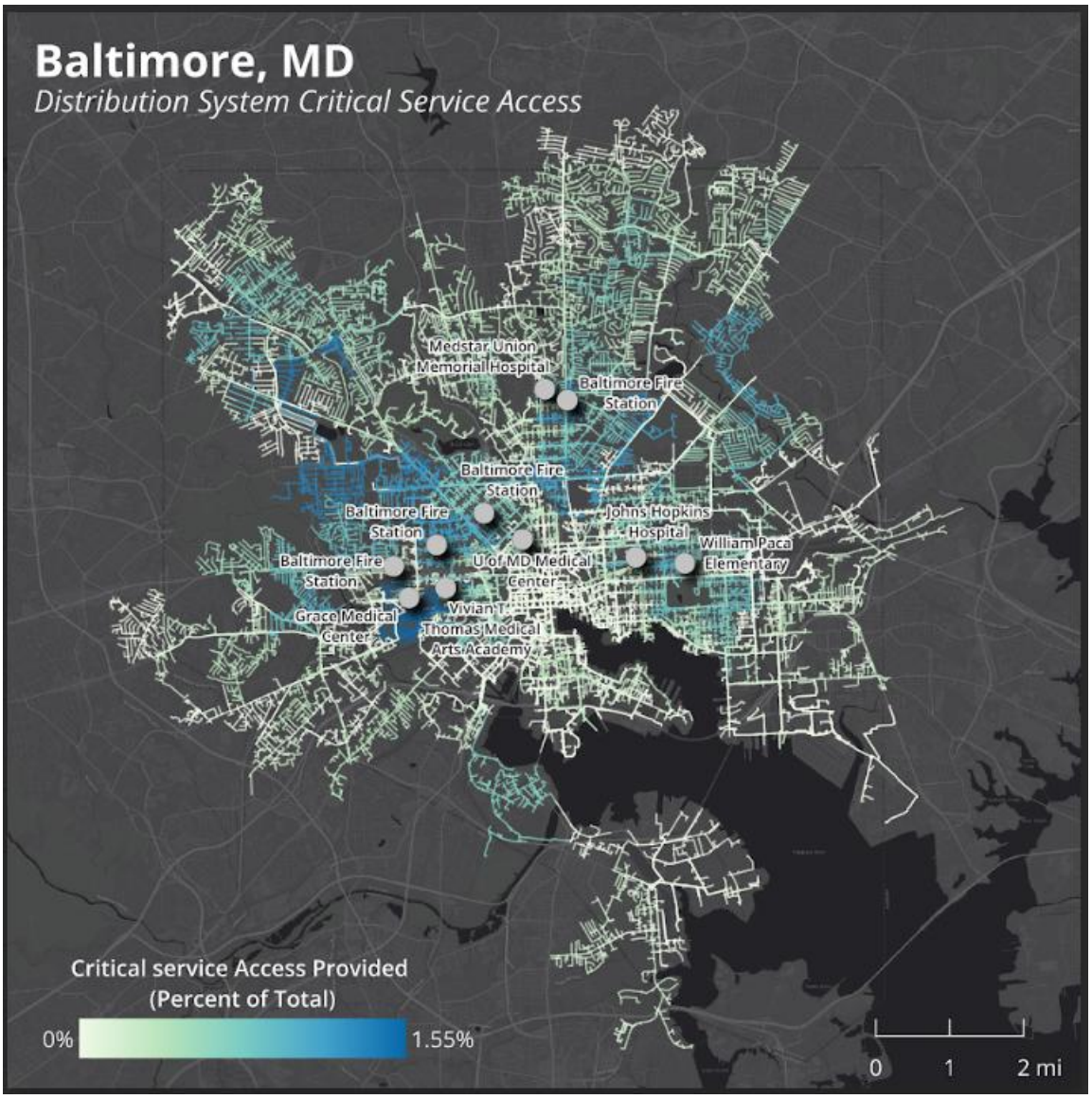

Figure 1
Contribution of electrical distribution system feeders to critical service access in Baltimore.

Critical service access changes during outages based on which sections of a distribution system are experiencing outages at a given time. Households with relatively high access to critical services during normal conditions can experience significant

decreases in access to critical services for relatively long periods if their critical service network intersects with distribution infrastructure that is particularly susceptible to long outages. Figure **2** shows the change in critical service access from a baseline of 100% during a recent historic outage chosen for Baltimore City (caused by a winter storm in December 2022).

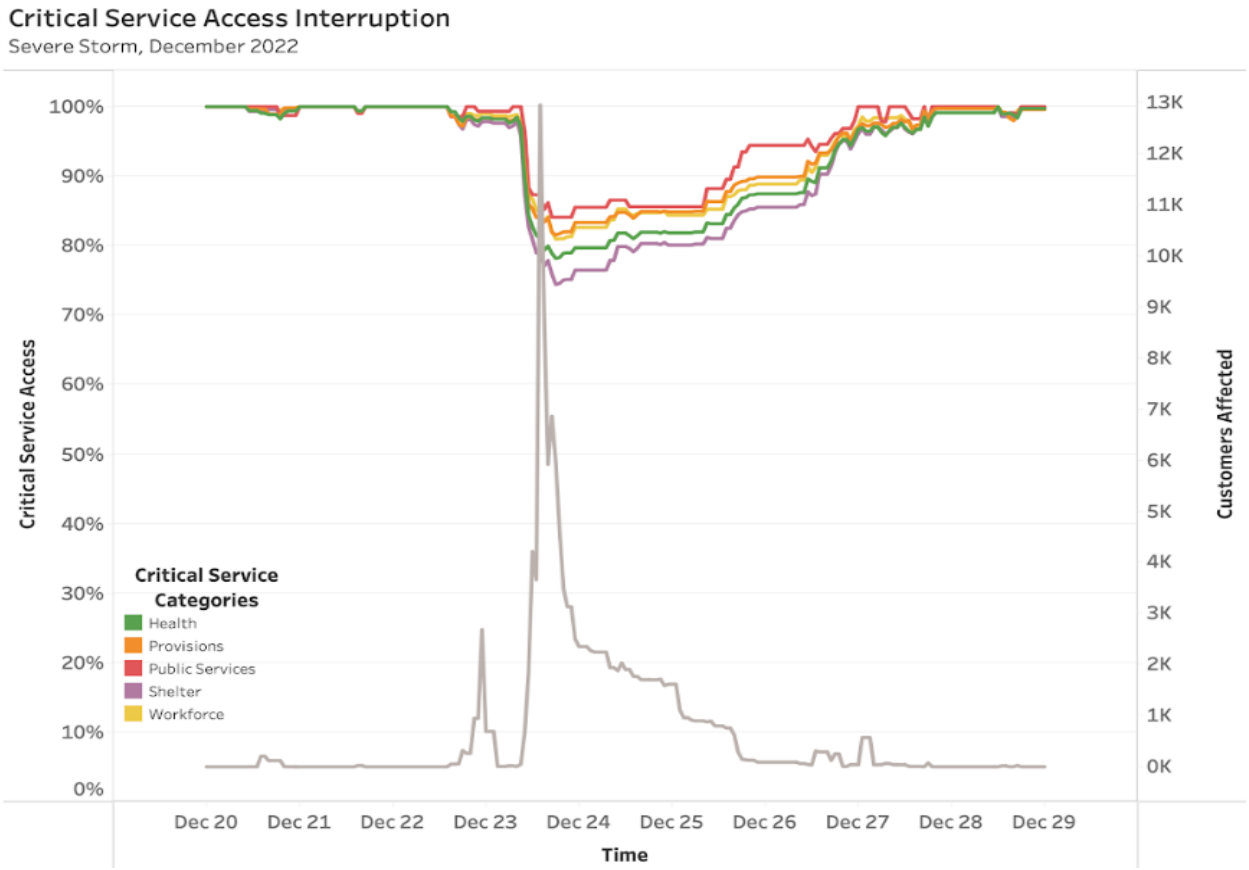

Figure 2
Change in critical service access from a baseline of 100% for all households in Baltimore during a power outage caused by a winter storm in December 2022.

One notable observation here is that outages caused by this storm reduced people's access to Shelter services (provided by all residential locations) to about 75% of the baseline for several days. Additionally, critical services recover more slowly than the overall "number of affected customers" metric indicates because critical service access depends on which types of services remain without power and their importance to customers. Analyses like this can help utilities identify where and for how long power outages have a tangible impact on customers, set strategic goals based on that understanding, and evaluate the potential benefits of energy resilience upgrades for informed decision-making.

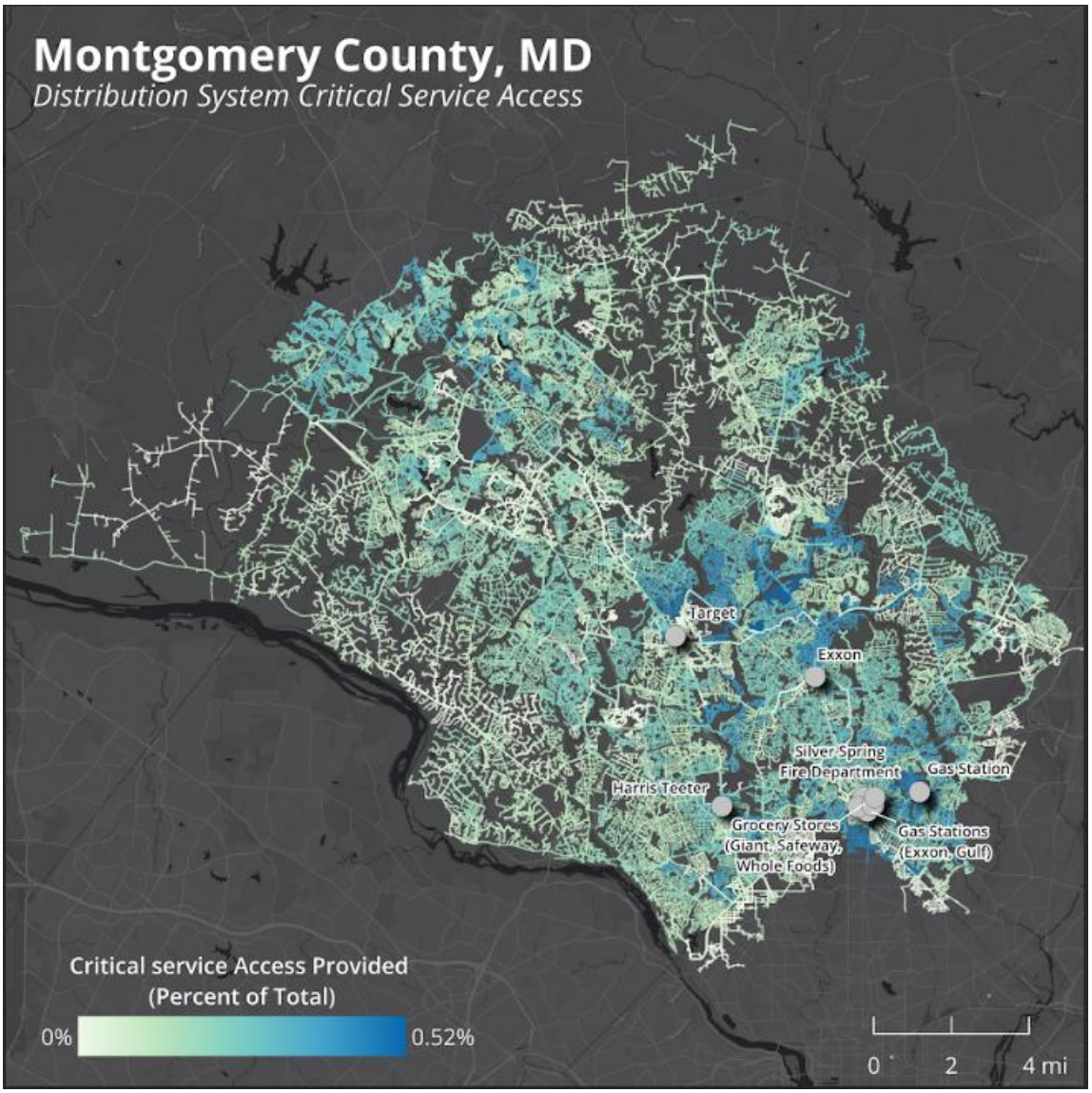

Figure 3
Contribution of electrical distribution system feeders to critical service access in Montgomery County.

Critical service access changes during outages based on which sections of a distribution system are experiencing outages at a given time. Households with relatively high access to critical services during normal conditions can experience significant decreases in access to critical services for relatively long periods if their critical service network intersects with distribution infrastructure that is particularly susceptible to long outages.

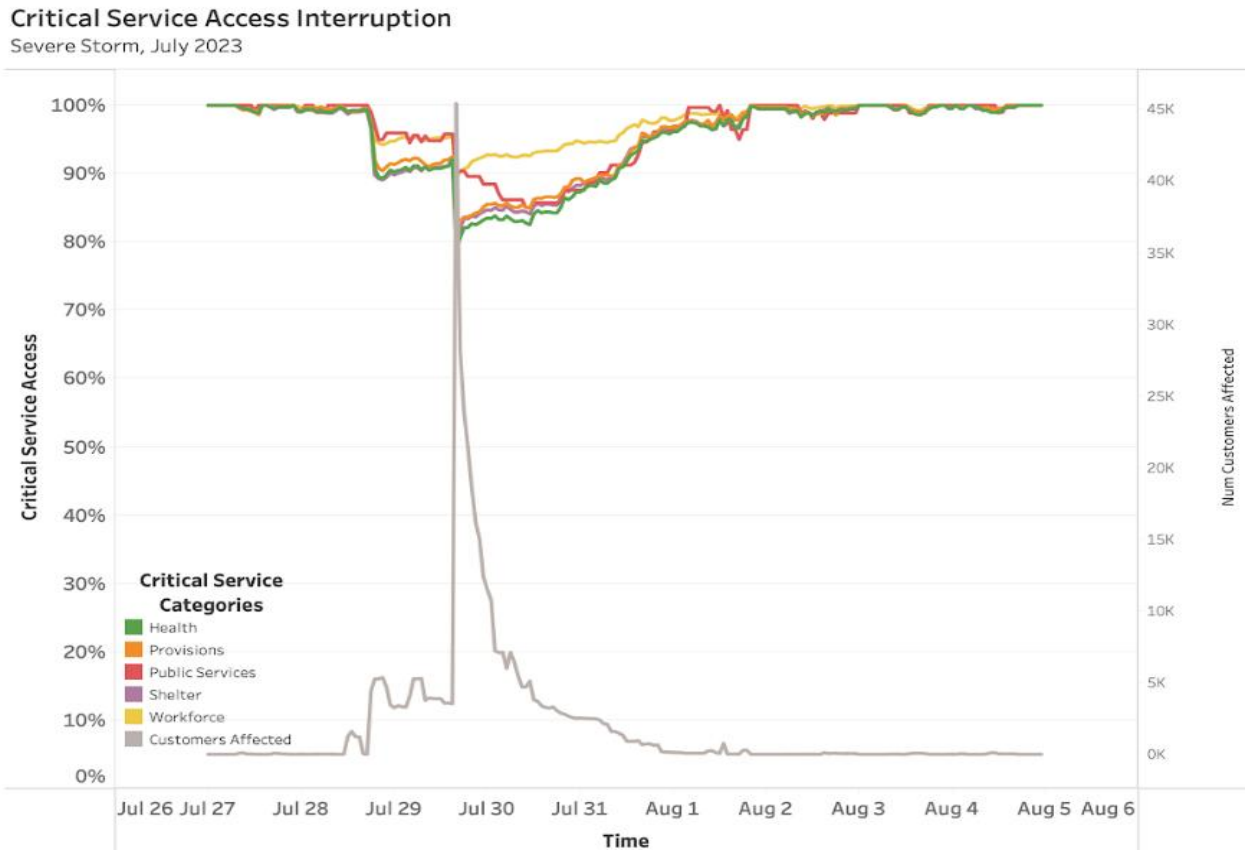

Figure 4
Change in critical service access from a baseline of 100% for all households in Montgomery County during a power outage caused by a storm in July 2023.

Figure **4** shows the change in critical service access from a baseline of 100% during a recent historic outage chosen for Montgomery County (caused by a severe storm in July 2023). Outages caused by this summer storm reduced access to Health services to roughly 80% of the baseline for several days. Access to all critical services is restored more gradually than the aggregated “number of customers affected” metric would indicate, as critical service access considers which kinds of services continue to lack power, and the value those services have for all customers. Analyses like this can help utilities identify where and for how long power outages have a real impact on customers, set strategic goals based on that understanding, and evaluate the potential benefits of energy resilience upgrades for informed decision-making.

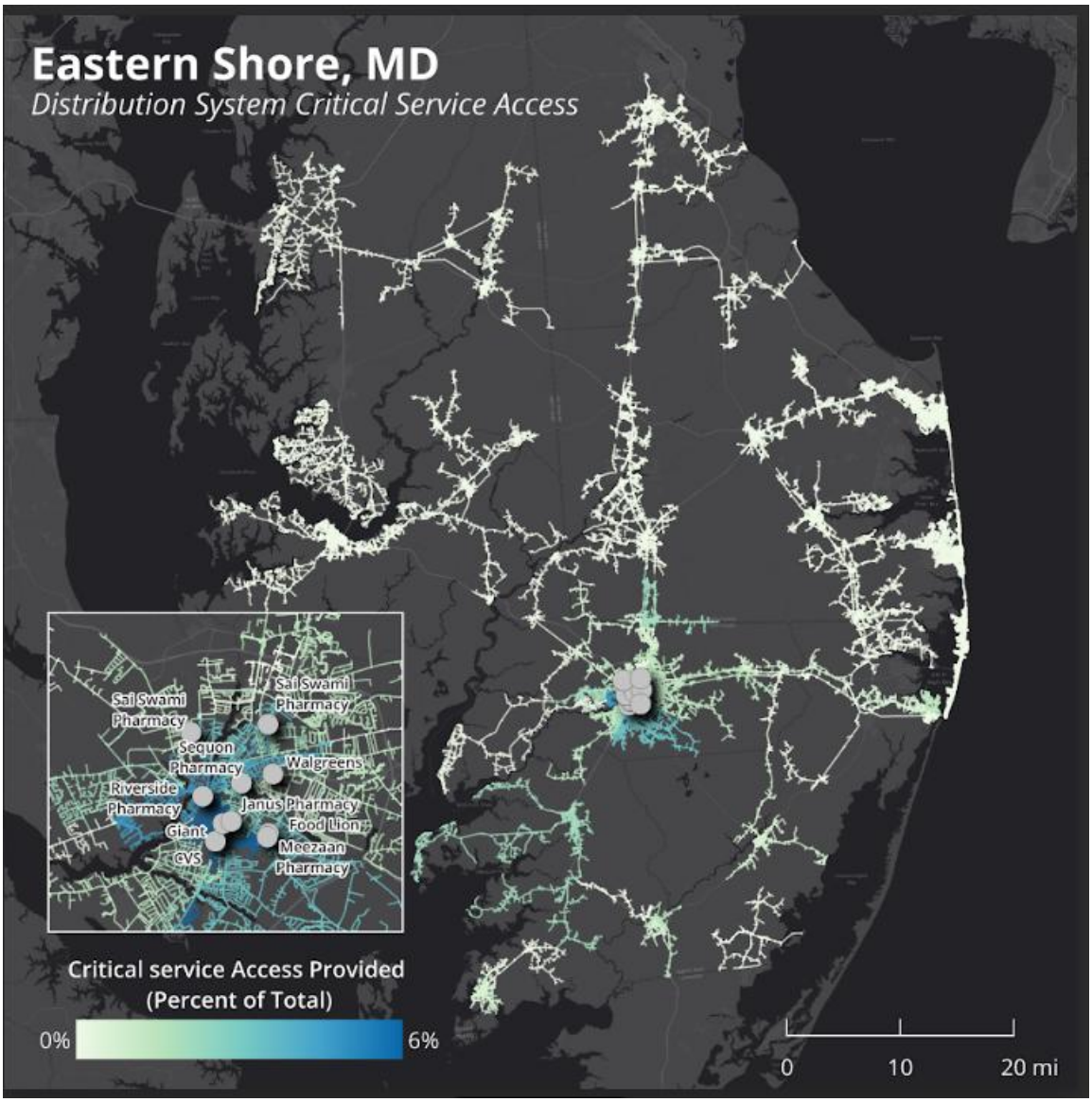

Figure 5
Contribution of electrical distribution system feeders to critical service access in Eastern Shore.

Critical service access changes during outages based on which sections of a distribution system are experiencing outages at a given time. Households with relatively high access to critical services during normal conditions can experience significant decreases in access to critical services for relatively long periods if their critical service network intersects with distribution infrastructure that is particularly susceptible to long outages. Figure **6** shows the change in critical service access from a baseline of 100% during a recent historic outage chosen for the Eastern Shore (caused by Tropical Storm in August 2020). This storm reduced people's access to all critical service categories to around 40% of baseline for one day, recovering back to 100% intermittently over

several days. Access to critical services is restored more gradually than the aggregated "number of customers affected" metric would indicate, as critical service access considers which kinds of services continue to lack power, and the value those services have for all customers.

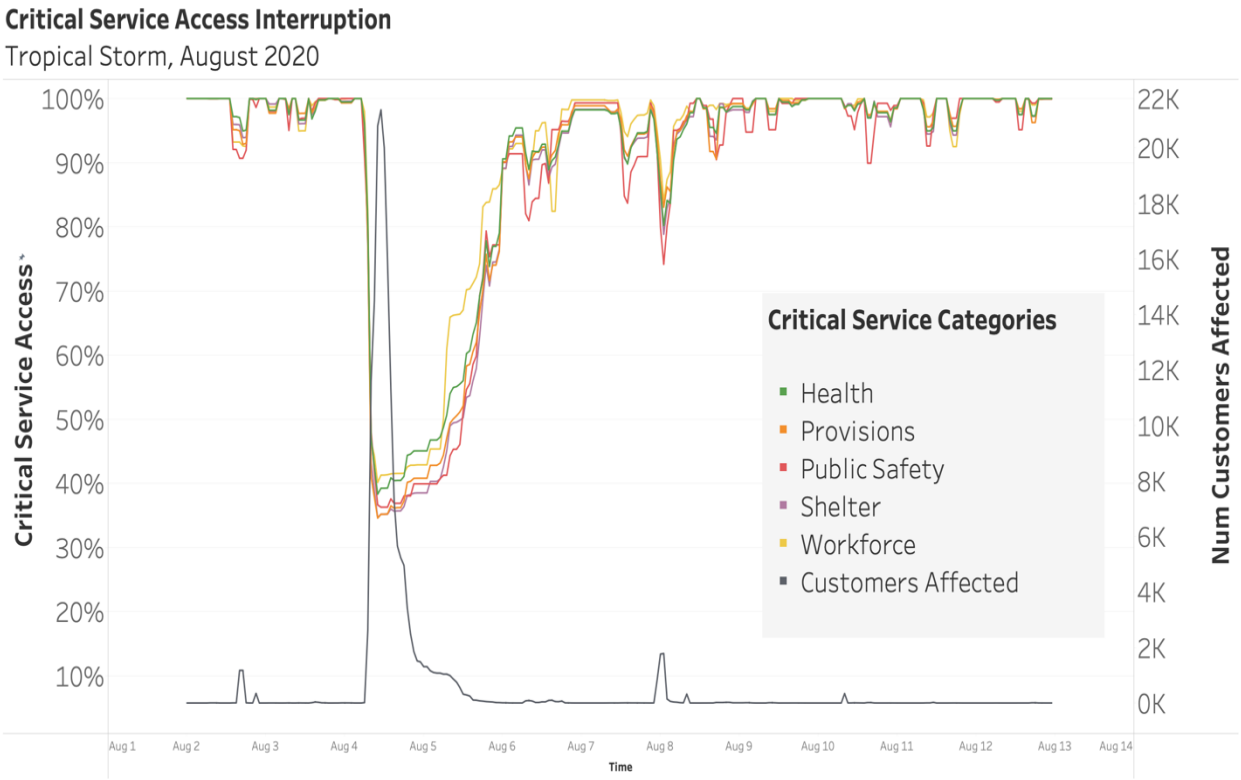

Figure 6
Change in critical service access from a baseline of 100% for all households in Eastern Shore during a power outage caused by a Tropical Storm in August 2020.

Analyses like this can help utilities identify where and for how extended power outages have a real impact on customers, set strategic goals based on that understanding, and evaluate the potential benefits of energy resilience upgrades for informed decision-making.

13.8 Exhibit G: Mapping Neighborhood Critical Services

Table 1

Activities undertaken in each study area.

Activity	Baltimore	Montgomery County	Eastern Shore
Service Scoring Matrix Participants assign a score (0-5) to location types (e.g., library, school, pharmacy) based on the quality of service provided in various service categories (e.g., health, food, shelter).	X	X	
Mapping Neighborhood Critical Services Participants review maps of their specific neighborhood showing nearby service locations and select a limited number to prioritize for resilient energy.	X	X	X
Timeline of Needs Participants identify their energy-dependent needs and place those needs along a two-week timeline.		X	X
Service Value over Time Participants assign a score (1-5) to categories of service (e.g., health, food, shelter) over a two-week timeline.		X	X
Resilience Hub Siting Participants select a limited number of clustered locations to prioritize for resilient energy, using interactive maps that show neighborhood critical service access and estimated costs of backup energy by location.		X	X

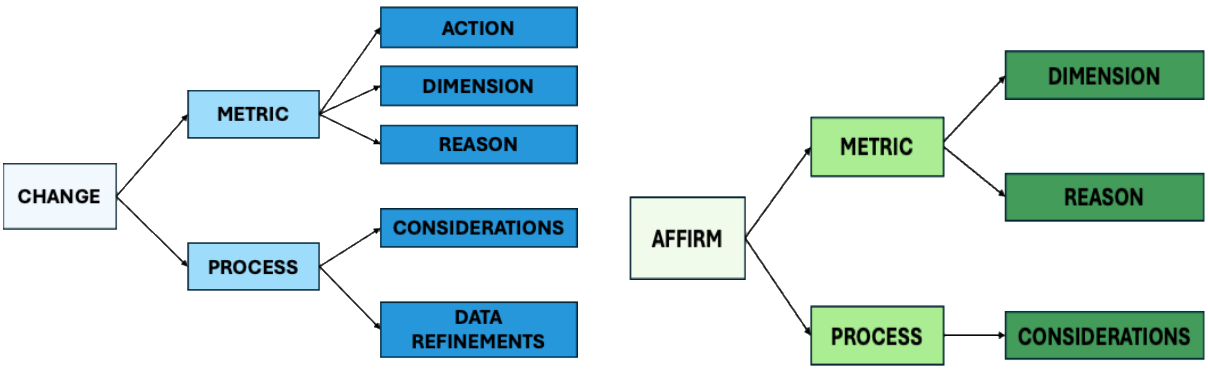

Figure 1

Written and verbal comments from each RC session were digitized and categorized into non-exclusive themes that establish each comment's orientation to the Resilient Maryland Framework metric or process.

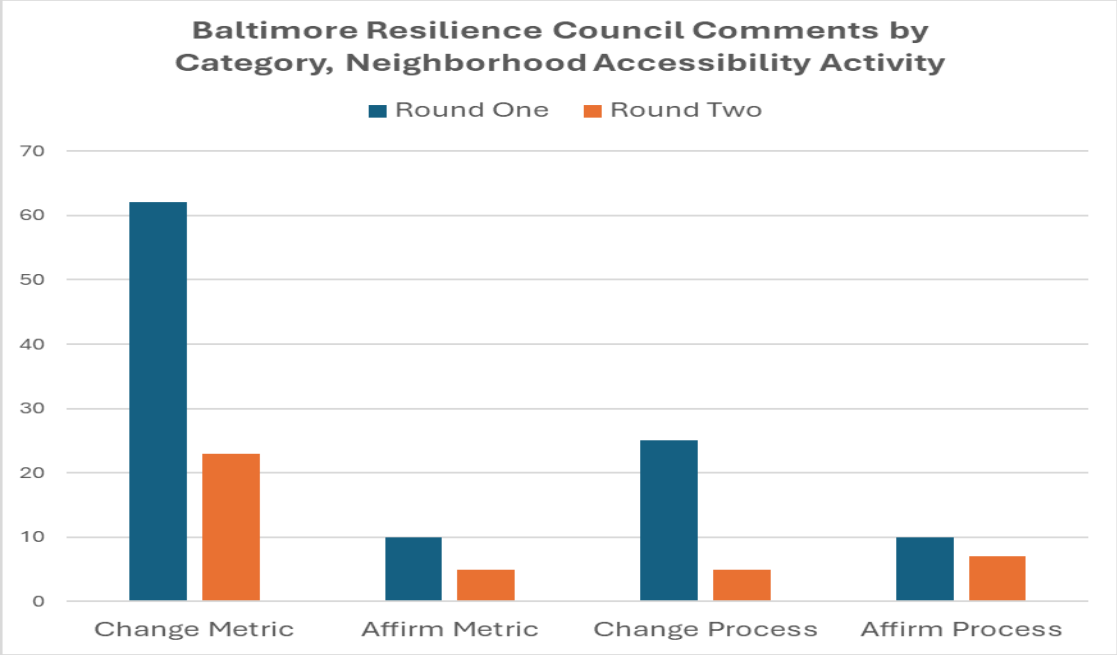

Figure 2

Baltimore RC received 102 comments in Round One of the metric activity and 39 comments in Round Two. Feedback in Round One included 62 comments about changing the metric, while in Round Two, there were only 23 comments about changing the metric.

Among comments categorized as “Change Metric,” feedback about increasing or decreasing the score for specific service locations, types of service locations, or types of services dropped by 80% between Round One and Round Two of the metric activity (Figure **3**). Feedback about adding service locations or routing rose slightly, while feedback about removing facilities was cut in half.

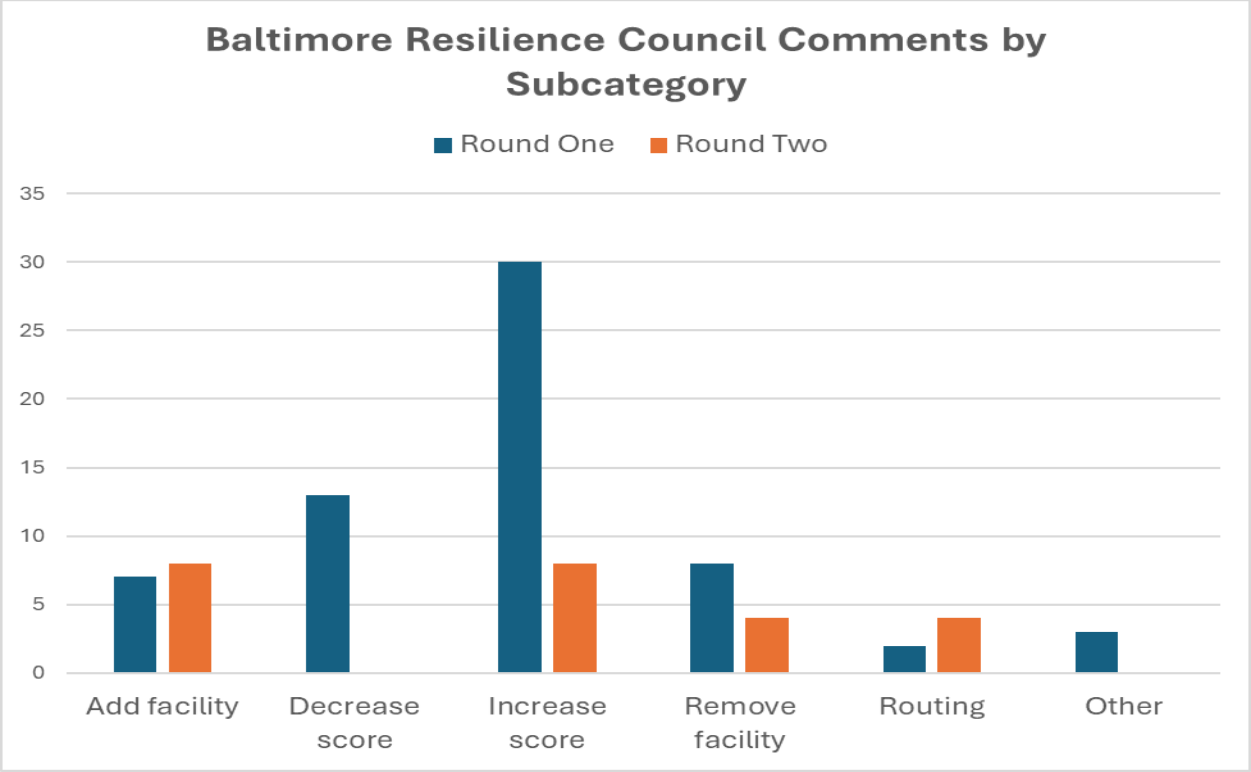

Figure 3

The Baltimore RC submitted 62 comments about changing the Resilient Maryland Framework metric. Of these, feedback during Round One included 45 comments related to adjusting the score of service locations or service types. In comparison, feedback during Round Two consisted of only eight comments about changing scores.

After Round One, the research team lowered scores for service locations and categories deemed less important. It introduced size-dependent scores for those considered more valuable when a location can serve larger populations. These improvements helped the Baltimore RC focus on more complex resilience issues during Round Two, such as prioritizing locations or services relevant only for a small part of the population ("Not Relevant"), ranking locations based on their specific services or proximity to other locations offering diverse services ("More Services"), and considering how travel time affects the value of service locations for different households ("Routing") (Figure **4**).

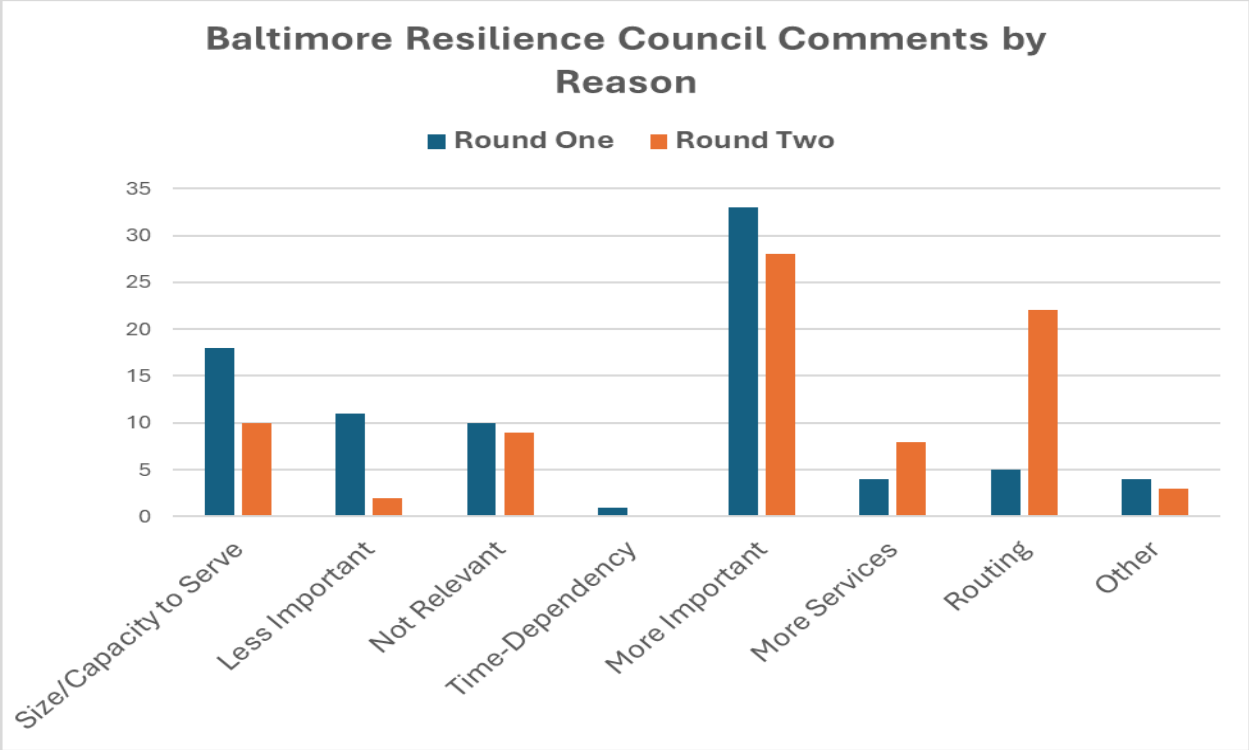

Figure 4

Baltimore RC comments are categorized by reasons supporting each comment. Improvements to the metric between Round One and Round Two of the neighborhood accessibility activities resulted in significant reductions in comments that emphasized services as Less Important or valued based on Size/Capacity to serve.

Figure 5

Initial convening of Montgomery County RC on 6/24/2024

Figure 6
Initial convening of Eastern Shore RC on 1/25/2025.

Figure 7
Initial convening of the Eastern Shore RT participants on 2/22/2025.

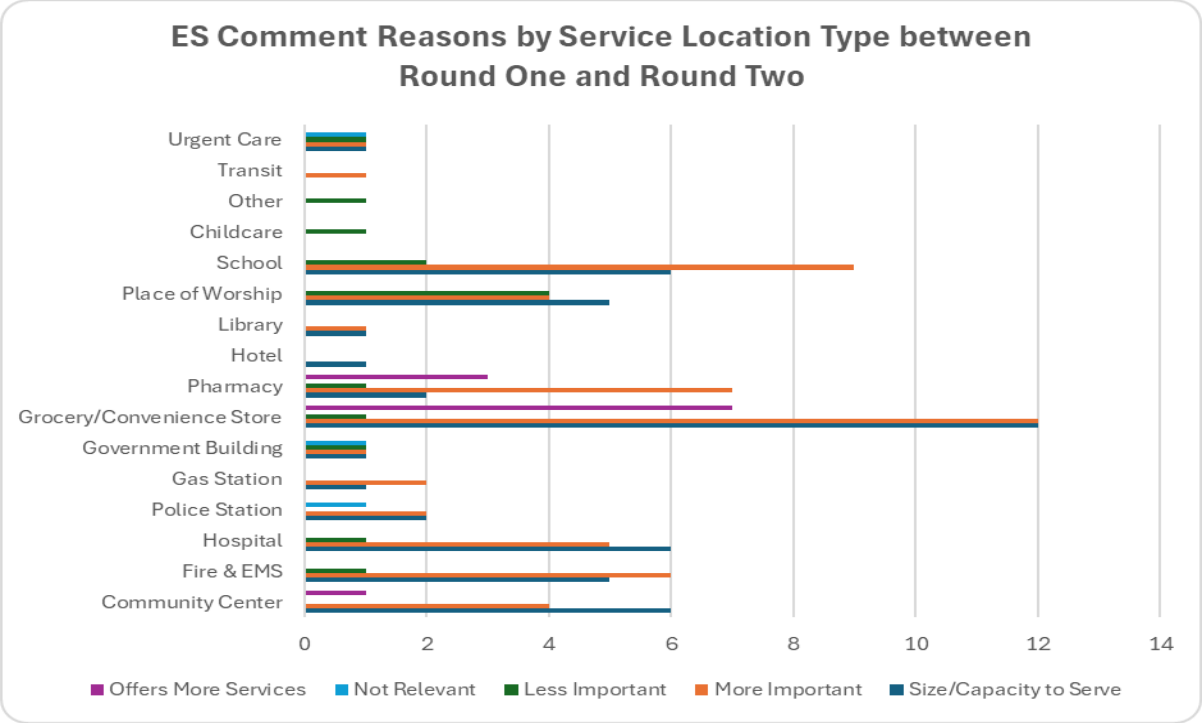

Figure 8

Aggregating comments by their associated service location types and reasons indicates the relationship between locations, services, and key resilience considerations.

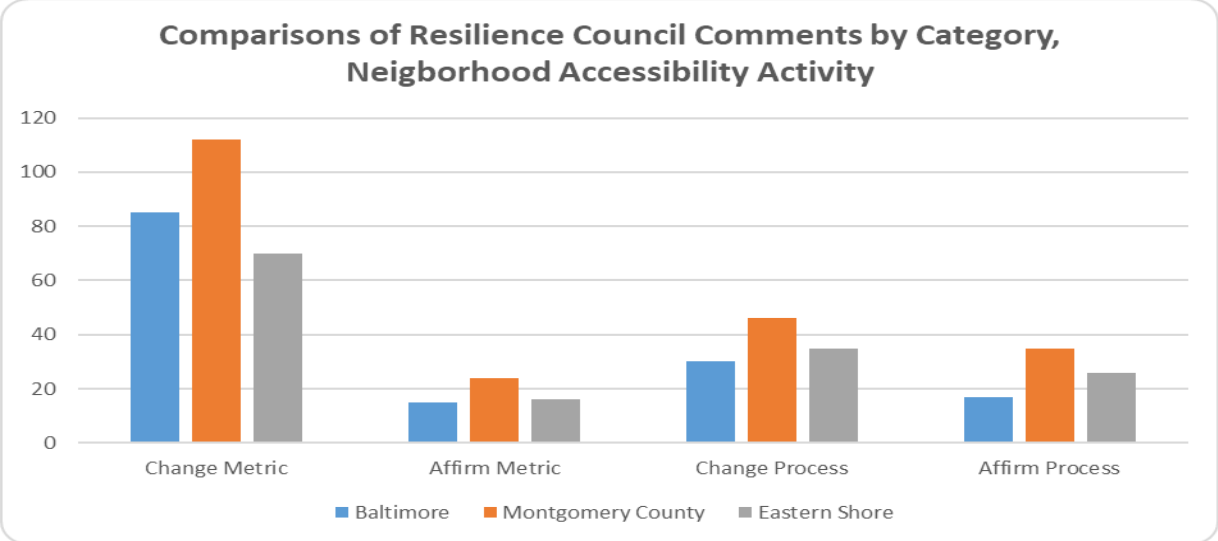

Figure 9

The RC received 511 comments across all three jurisdictions of the metric activity. The RCM project team received 52% of comments regarding the need to change the metric, highlighting the importance of incorporating community voices into energy resilience planning and strategic decision-making.

Among comments categorized as “Change Metric,” feedback regarding increases or decreases in scores for specific service locations, types of service locations, or types of services is shown in Figure **10**.

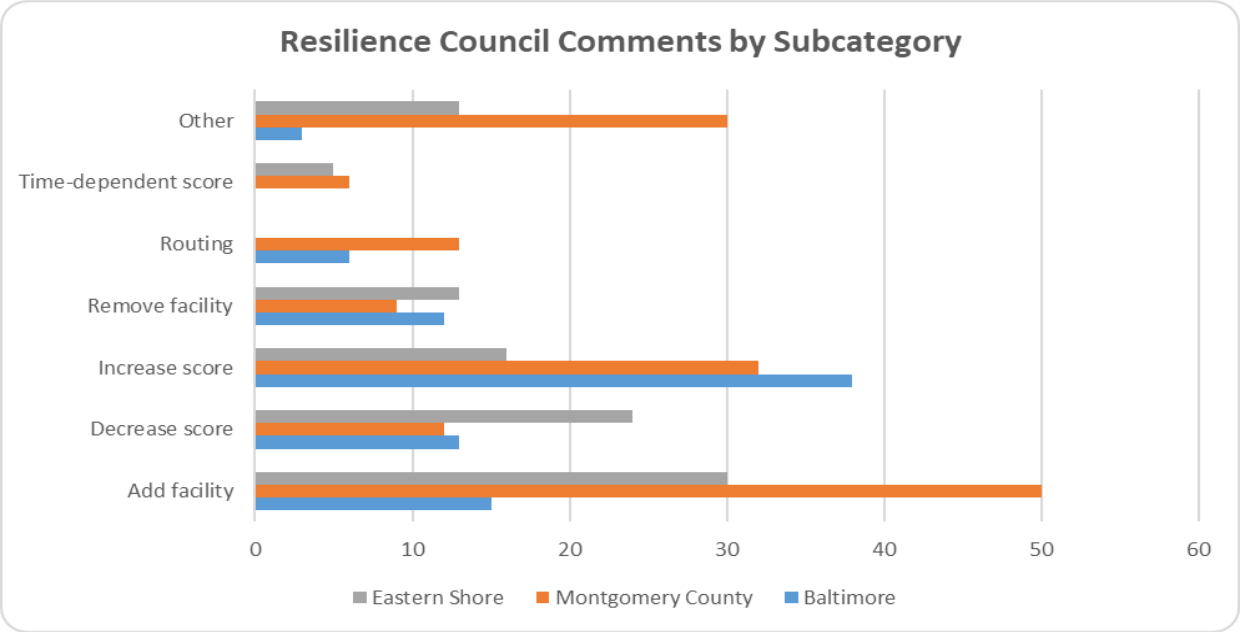

Figure 10
Adding a facility (28%), increasing the score (25%), and decreasing the score (14%) for critical services facilities were the RC members' top reasons for changing the metric.

Comments across all categories and subcategories were further organized based on the reasons supporting each comment. Figure **11** shows the frequency of reasons supporting Council comments in Round One and Round Two of the neighborhood accessibility activities.

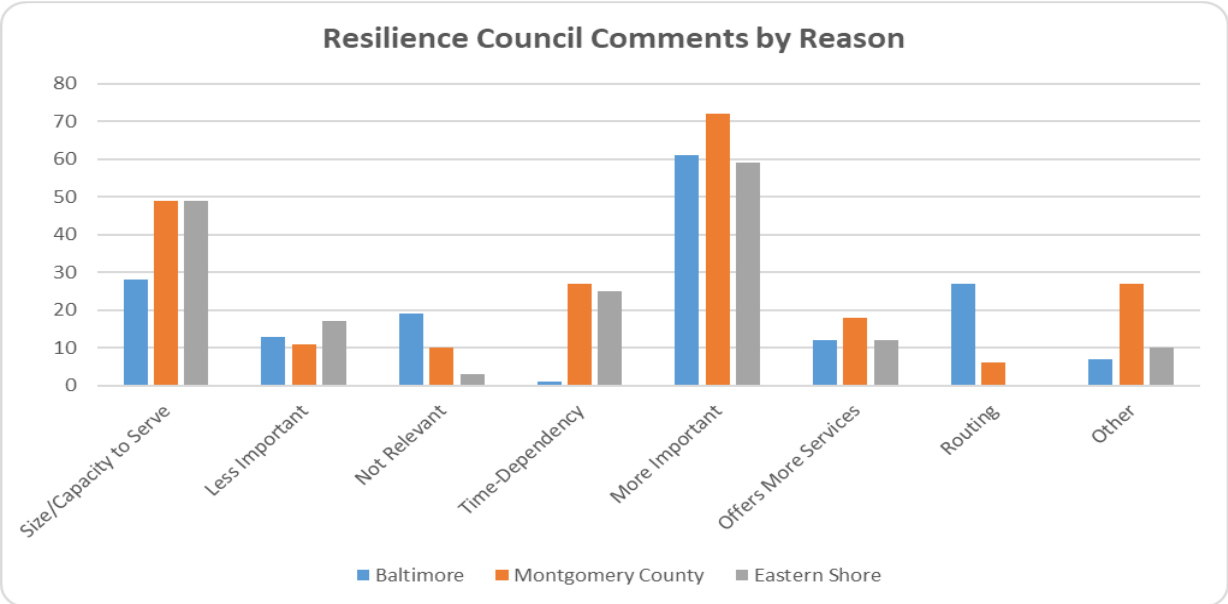

Figure 11
Across all jurisdictions, reasons categorized as "More Important" and Size/Capacity to Serve were the RC Members' top choices.

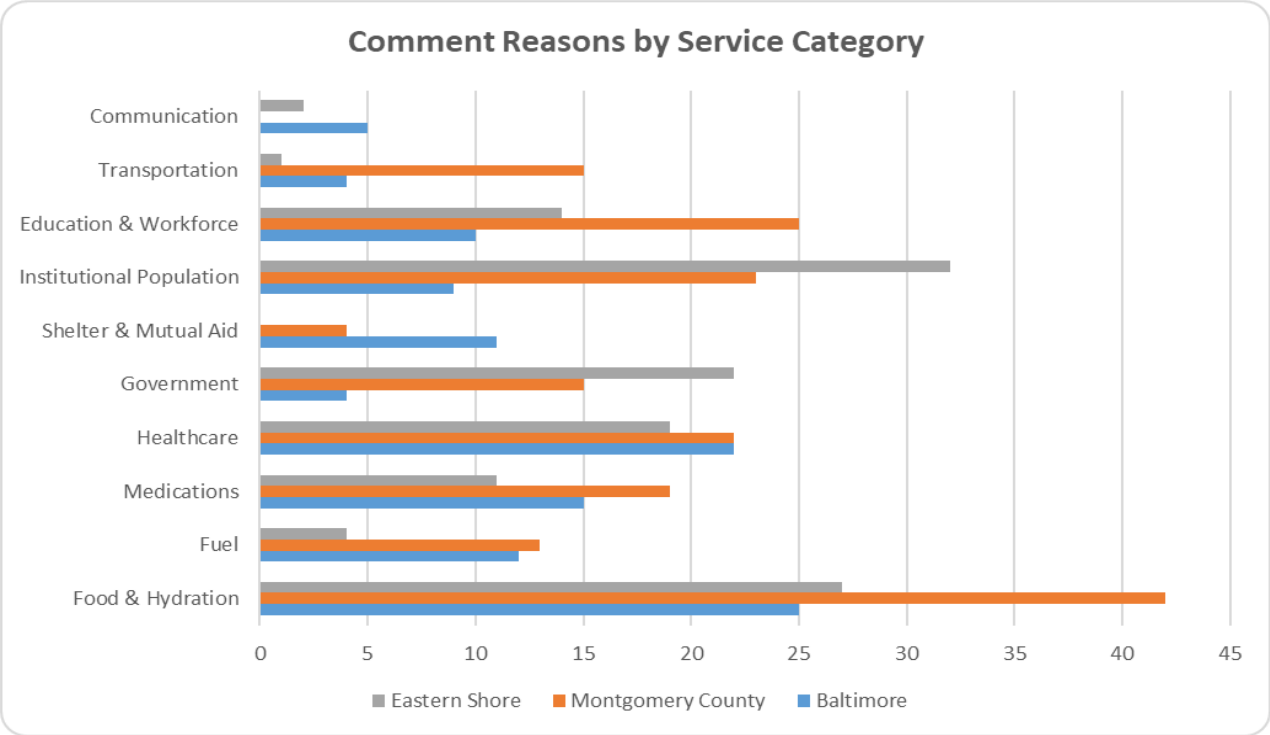

Figure 12
Aggregating comments by their associated service category and reasons provides a more general indication of the relationship between resilience valuation and types of resilience services.

13.9 Exhibit H: Resilience Hub Siting

The results shown in Figure **1** indicate that places of worship, grocery stores, schools, gas stations, and banks were identified by RC members as the top five facilities for a microgrid. Cabin John Village Shopping Center (Seven Locks & Tuckerman), Giant & Walter Johnson High School (on Old Georgetown & Democracy), along with Clarksburg Village Center and places of worship—particularly in Downtown Silver Spring—were identified as the top service locations for a microgrid.

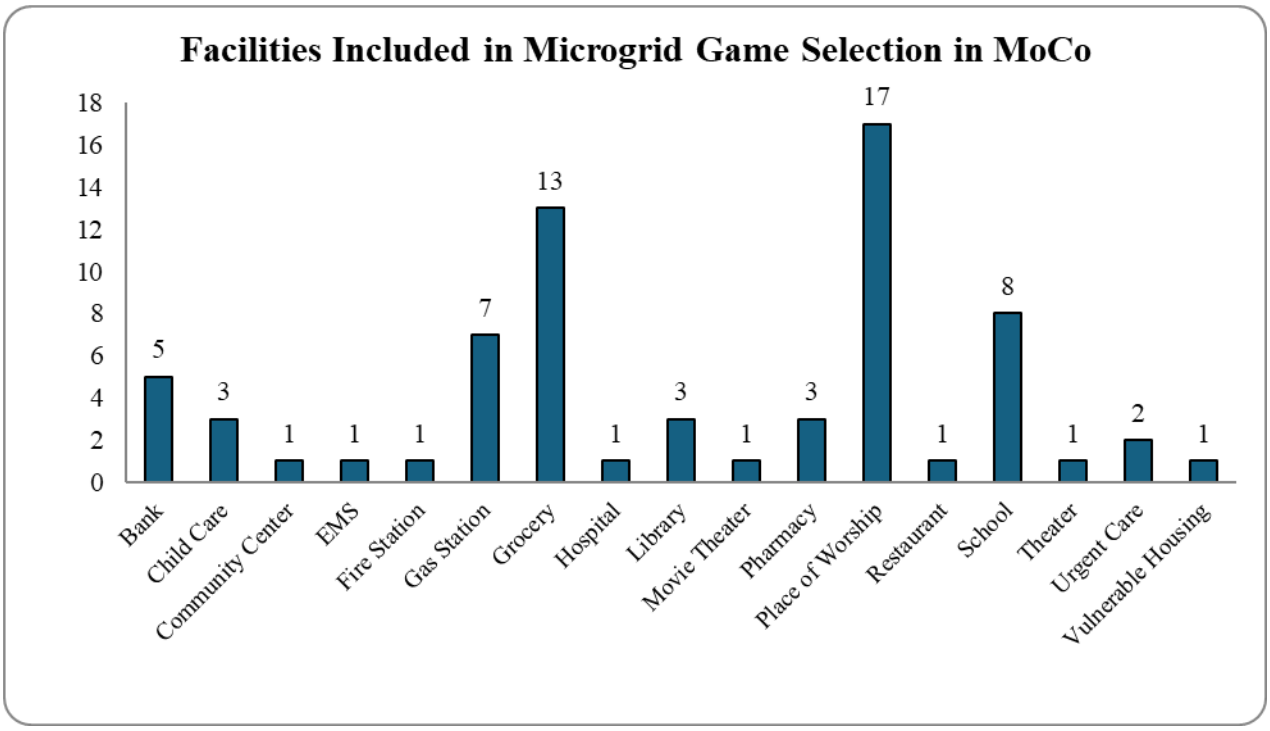

Figure 1

Facilities Included in Resilience Siting in Montgomery County

***Note**. A total of nine facilities or service locations were identified as potential microgrid sites, such as: Cabin John Village Shopping Center (Seven Locks & Tuckerman), Downtown Silver Spring, Clarksburg Village Center, Silver Spring South (Eastern & Georgia Avenue), Olney (Laytonville), Twinbrook (overlaps with Rockville), Giant & Walter Johnson High School (on Old Georgetown & Democracy), Jewish Community Center on Montrose, and Rockville—providing services that were broadly classified into 17 categories as depicted in the figure.*

Following Step 3, the RCM project team further analyzed why a specific facility was considered a good fit for microgrid investment. Based on the council member's responses, these responses were coded by the project team into the following themes: ability to serve, clustering of multiple services, ease of access (proximity to people and transportation), ease of parking and bringing things home, physical attributes of the location (such as being out of a floodplain and availability of parking lots), offering somewhat unique or important services, size and capacity to serve many people, specific vulnerability considerations, and water sanitation (including showers and toilets). These results are presented in Figure **2**, highlighting the top choices for service locations in microgrid investments using the community-based participatory approach. The key factors include ease of access and proximity (from the council member's home to service locations and transportation), size and capacity for service, physical attributes such as ample parking and the absence of floodplains, and clustering of multiple services. As identified by the RCM research, clustering of services is a crucial factor in energy resilience and microgrid investments.

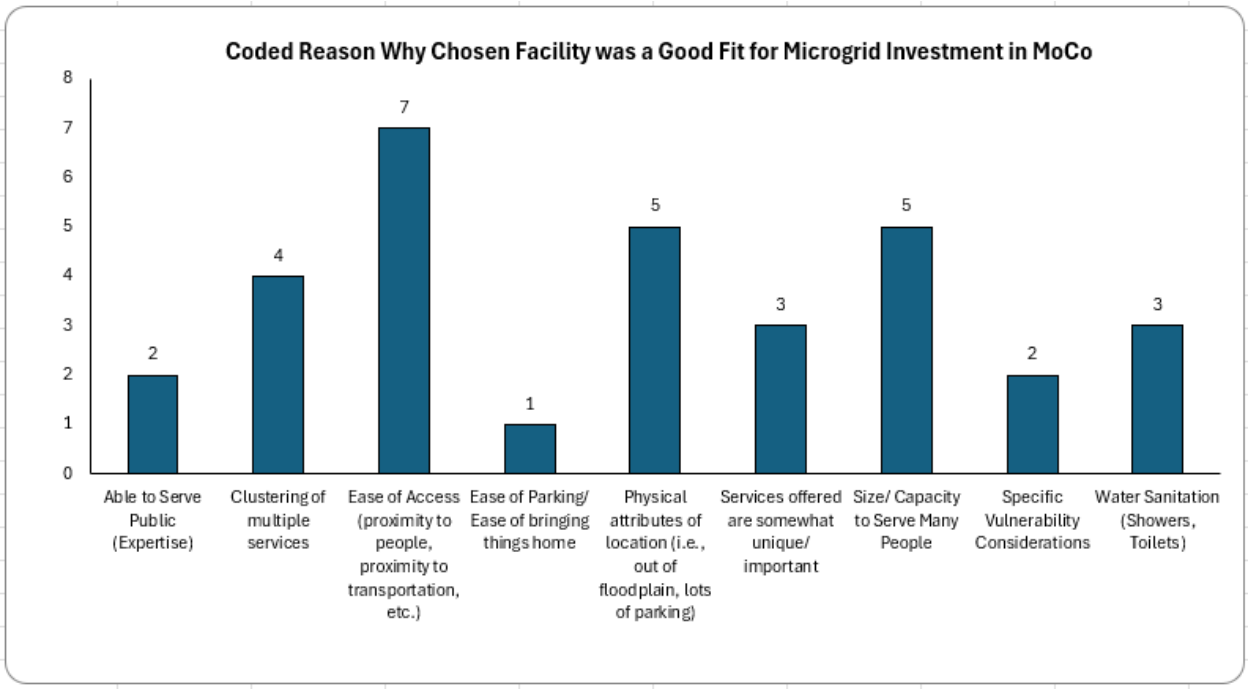

Figure 2

Reasons provided by RC as to why a facility was a good fit for Microgrid Investment in Montgomery County

Note. *The Project team collected responses from RC members' groups and categorized them into the following themes: ability to serve, clustering of multiple services, ease of access (proximity to people and transportation), parking convenience and bringing items home, physical attributes of the location (such as being out of the floodplain and availability of parking lots), offering somewhat unique or essential services, size and capacity to serve many people, specific vulnerability considerations, and water sanitation (including showers and toilets).*

The RCM project team also conducted microgrid activities in Eastern Shore, Maryland, to identify priority sites for potential microgrid investments. The results shown in Figure **3** indicate that hospitals, grocery stores, and government services are the top three facilities for microgrid development. These were selected by RC members as the top five facilities for a microgrid, along with Places of Worship. Tidal Health in Salisbury, Food Lion at Prince Anne, Downtown Salisbury, Roosevelt's Church (Word of Life Center), and churches in Delmar were identified as the leading service locations for a microgrid.

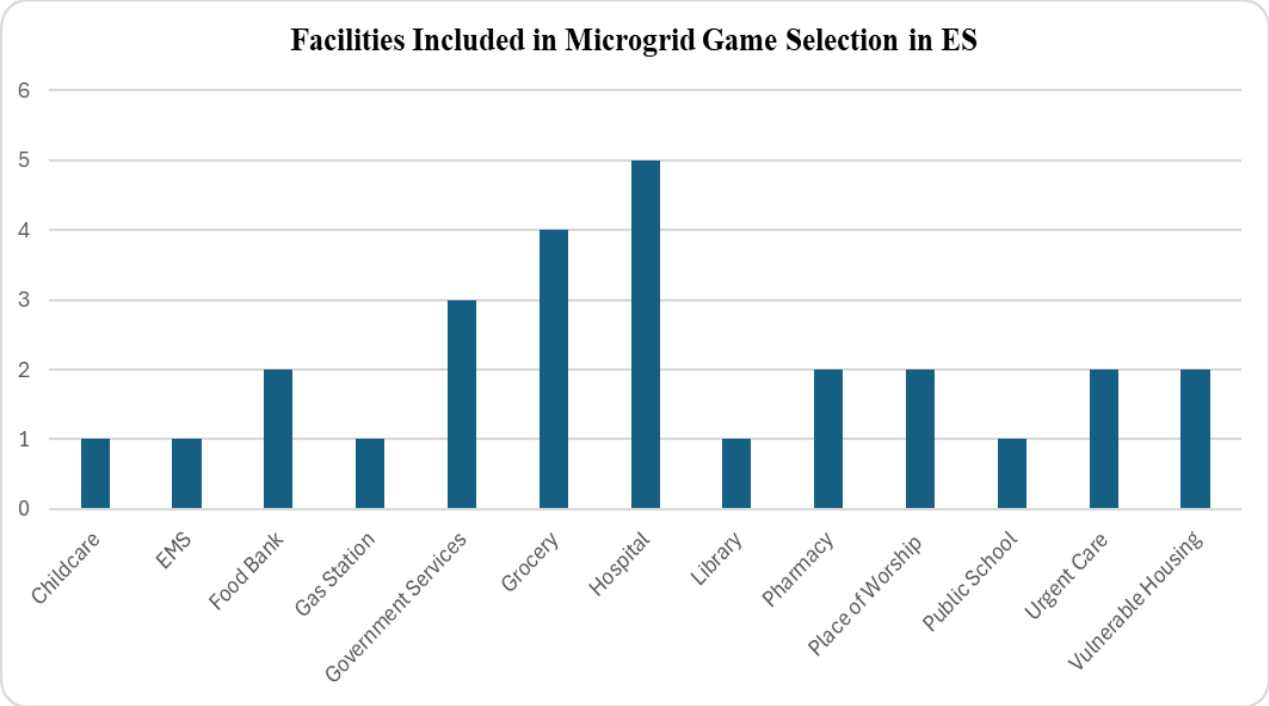

Figure 3
Facilities Included in Resilience Siting in the Eastern Shore
Showing the top priority sites for a microgrid in Eastern Shore, as well as associated facility types: Tidal Health in Salisbury, Food Lion at Prince Anne, Downtown, Roosevelt's Church (Word of Life Center), and churches in Delmar.

The project team further examined why a specific facility was deemed a good fit for microgrid investment. Based on the council member's responses, feedback was coded by the project team into the following themes: ability to serve, clustering of multiple services, ease of access (proximity to people and transportation), ease of parking and bringing things home, physical attributes of the location (such as being outside a floodplain and availability of parking lots), offering somewhat unique or important services, size and capacity to serve many people, specific vulnerability considerations, and water sanitation (including showers and toilets). These results are presented in Figure **4**, highlighting the top reasons for service locations in microgrid investments using the community-based participatory approach. The key factors include ease of access and proximity (from the council member's home to service locations and transportation), capacity to serve the public, and services offered that are somewhat unique or important, as well as the clustering of multiple services.

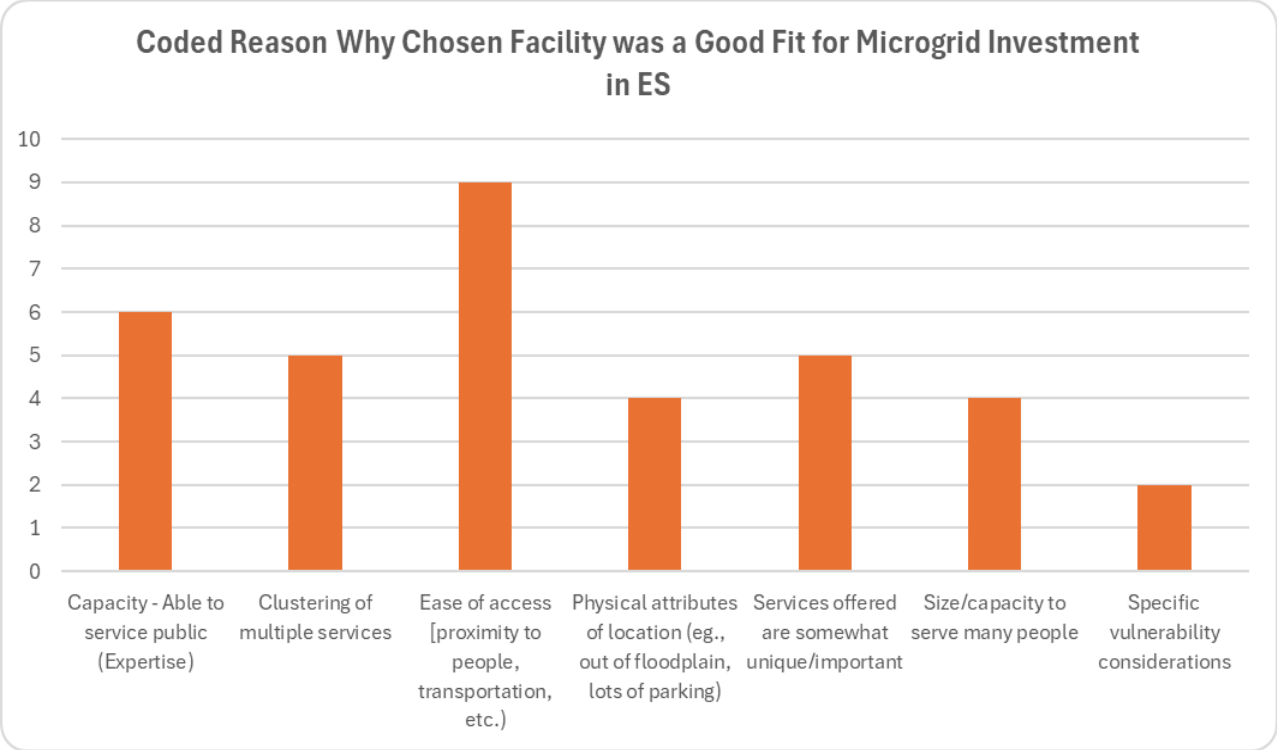

Figure 4

Reasons provided by RC as to why a facility was a good fit for Microgrid Investment in the Eastern Shore

Note. *The Project team collected responses from the RC members' groups. It categorized them into the following themes: capacity and ability to serve, clustering of multiple services, ease of access (proximity to people and transportation), offering somewhat unique or essential services, size and capacity to serve many people, and specific vulnerability considerations.*

13.10 Exhibit I: Timeline of Needs

Participants identified their energy-dependent needs and mapped those needs along a two-week timeline. The project team verbally guided RC members through a typical week, considering how different activities or events might impact their lives. The responses were written on sticky notes, and the frequency was grouped into broader themes across the weekly timeline. The reported activities were sorted by the day of the week, from Monday to Sunday, and RC members also listed activities they performed daily. If an activity recurred, members were asked to indicate when it first affected them and then specify its recurrence on the sticky note (e.g., daily, weekly). The results are shown below (Figure **1**) for the "coded activities" worksheet, covering Monday through Sunday.

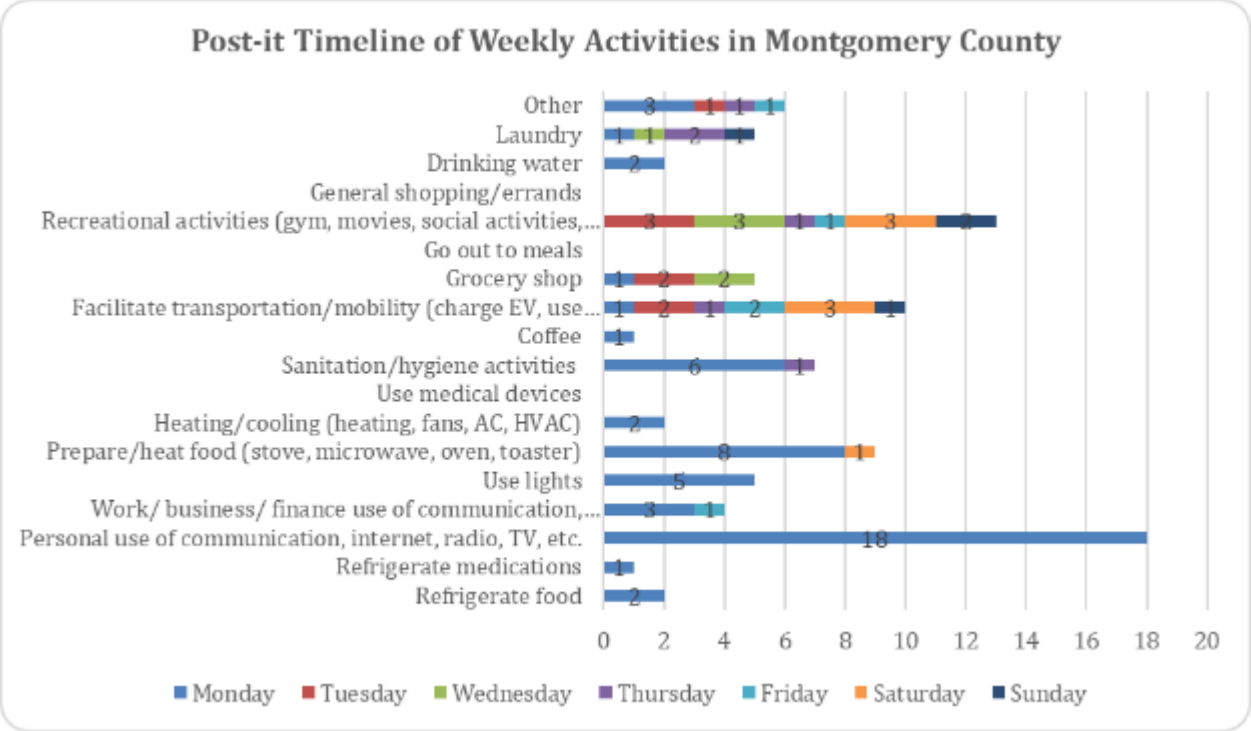

Figure 1

Weekly Timeline of Needs in Montgomery County

Note. *The project team aggregated the frequency of daily post-it notes against the coded activities. Monday had the highest frequency for personal use of communication, the internet, radio, TV, etc., and preparing/heating food (using stoves, microwaves, ovens, and toasters), which were among the most frequently coded activities.*

When comparing weekly activities to the timeline of needs in Montgomery County, Monday and Tuesday had the highest frequencies, while Sunday had the lowest. Personal use of communication, the internet, radio, TV, preparing or heating food (stove, microwave, oven, toaster), and sanitation or hygiene activities were the top three choices for RC members on Monday. Between Tuesday and Sunday, recreational activities (gym, movies, social activities, etc.) were the main priorities for RC members' weekly activities. Whereas, as shown in Figure **2**, when comparing weekly activities to a post-it timeline of needs in Eastern Shore, associated with coded activities, Saturday had the highest frequency, while Sunday had the lowest.

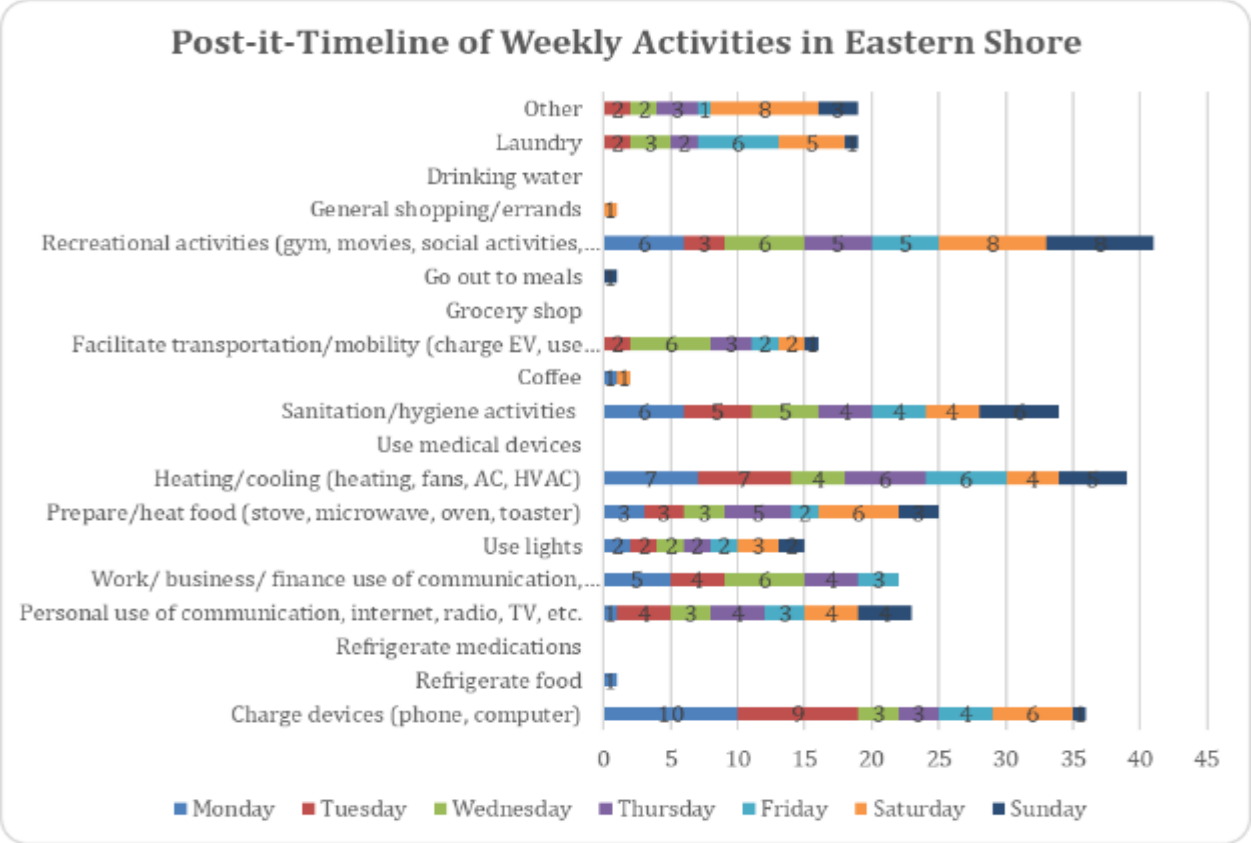

Figure 2

Weekly Timeline of Needs in Eastern Shore

***Note**. The RCM Team compiled the frequency of daily post-it weekly activities against the coded activities. The results show that recreational activities (gym, movies, social activities), heating/cooling (heating, fans, AC, HVAC), and charging devices (phone, computer) were performed weekly. Monday and Tuesday had the highest frequency of charging devices (phones, computers, etc.), while between Wednesday and Friday, the most common activities among RC members were facilitating transportation (which makes sense for the rural Eastern Shore communities), heating, and, to a lesser extent, recreational activities. Meanwhile, recreational activities primarily dominated RC members' choices on Saturday and Sunday.*

How and When Would Power Outages Affect You?

The project team completed two sets of activities to better understand how and when power outages affected community members. The first activity tracked when people indicated they would first notice power outages, while the second activity focused on when they would be significantly impacted. The numbers for these two tables were generated by analyzing the placement of RC members' stickers on a large timeline poster over 14 days, as shown in Figure **3**. In both cases, if the RC member marked exactly at one, it was coded as 0-1, and so on.

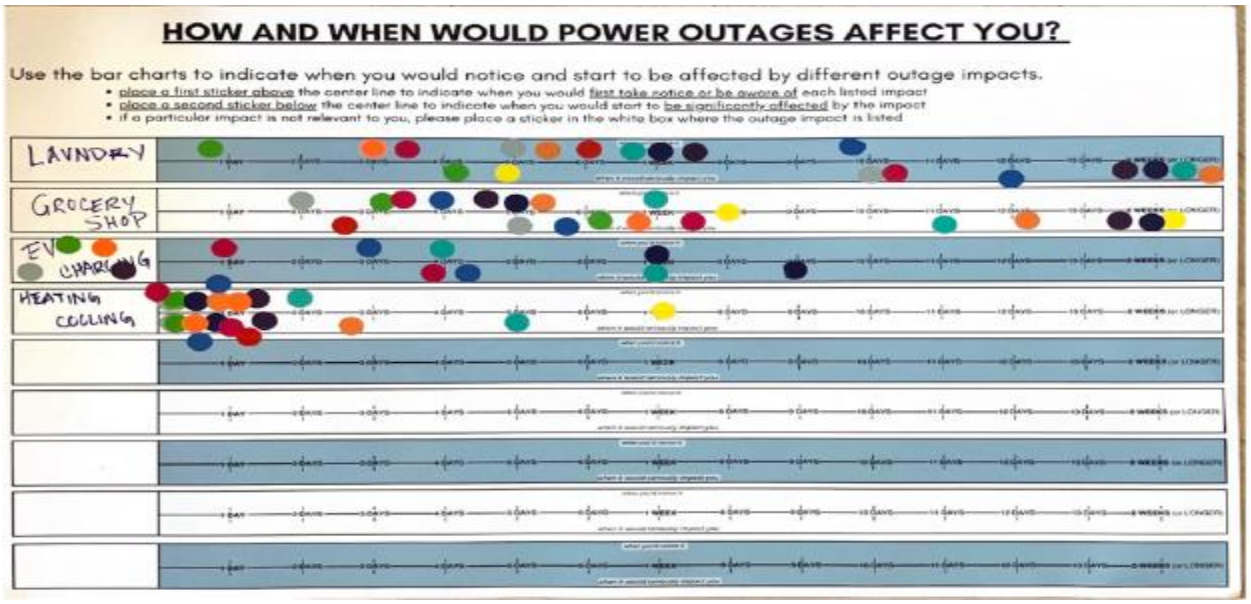

Figure 3
Example worksheet of the responses collected from RC members.

In Figure **4**, the project team summed the total scores for various daily activities, including Laundry, Grocery Shopping, EV Charging, Heating/Cooling, Recreation (gym/pool), Recreation (entertainment), Elevators/Mobility Assistance, Showers, Traffic Lights, Medical Needs, WIFI, Communication, Potable Water, Sewage, and Refrigeration—tracking when RC members first noticed issues and comparing those to when power outages significantly impacted them.

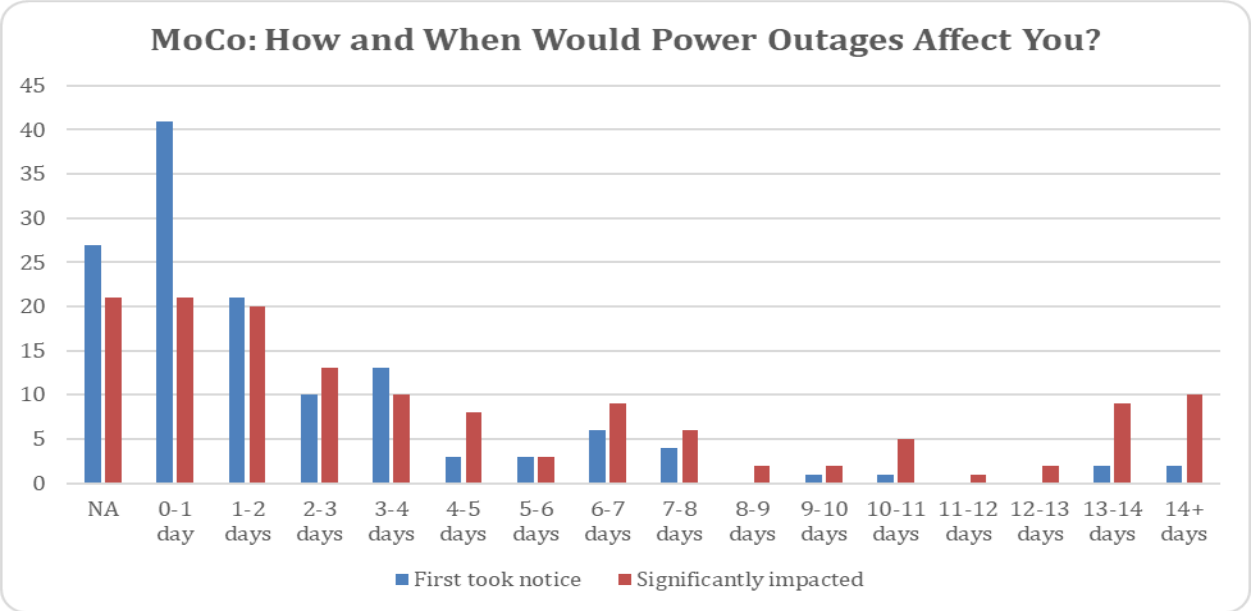

Figure 4.
How and When Power Outages Affect You in Montgomery County?

***Note**. As expected, the results are positively skewed, showing that power outages are immediately felt within the first few days (between 1 and 3 days) of an extreme event, and in rare circumstances after 13 days. The impact on daily activities such as Laundry, Grocery Shop, EV Charging, Heating/Cooling, Recreation (gym/pool), Recreation (entertainment), Elevators/ Mobility Assistance, Showers, Traffic Lights, Medical Needs, WIFI, Communication, Potable Water, Sewage, Refrigeration—is higher during the first few days of occurrence and the effect gradually decreases after the 8th day. However, if the issue is not resolved, community members can experience the adverse effects of power outages for up to 14 days.*

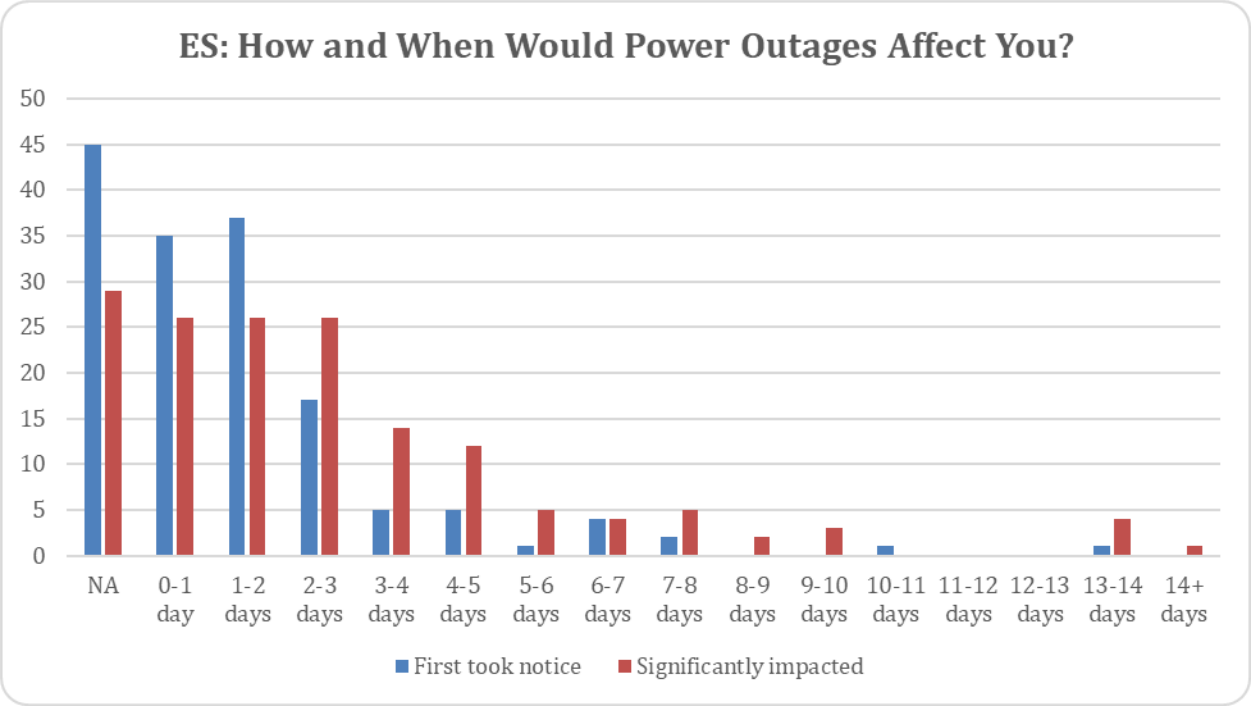

Figure 5.

How and When Power Outages Affect You in the Eastern Shore?

Like Montgomery County, the results show that power outages are immediately felt within the first few days (between 1 and 3 days) of an extreme event, and rarely after 14 days. However, on the Eastern Shore, the impact of power outages is much more severe, partly due to its rural nature compared to Montgomery County, as shown by the sharp spikes during the first four days of an outage, with the effect gradually decreasing after the sixth day. Still, if the issue is not resolved, community members can experience the adverse effects of power outages after the 14th day.

13.11 Exhibit J: Service Value Over Time

The impact of a power outage on households largely depends on its duration, with longer outages causing more serious effects on families and communities. Similarly, the importance of energy resilience for specific locations or services is heavily influenced by how extended outages are expected to last in each area. Feedback from RC members about when disruptions to specific activities feel “significant,” and how these activities relate to broader service categories, is shown in Figures **1** through **3** in Montgomery County. The results show that disruptions to services associated with “Shelter” become impactful relatively quickly (Figure **1**). In contrast, disruptions to services related to

“Provisions” become gradually more impactful over time (Figure **2**). Disruptions to services associated with “Recovery” do not become impactful until a power outage approaches two weeks in duration (Figure **3**).

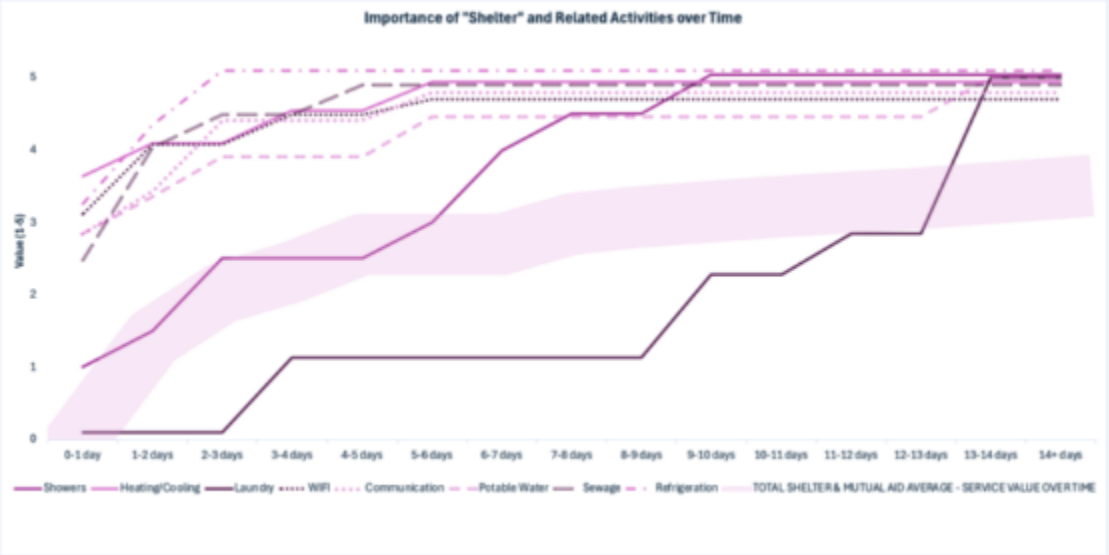

Figure 1
Average responses given by RC members regarding the importance of critical services in the Shelter category over time.

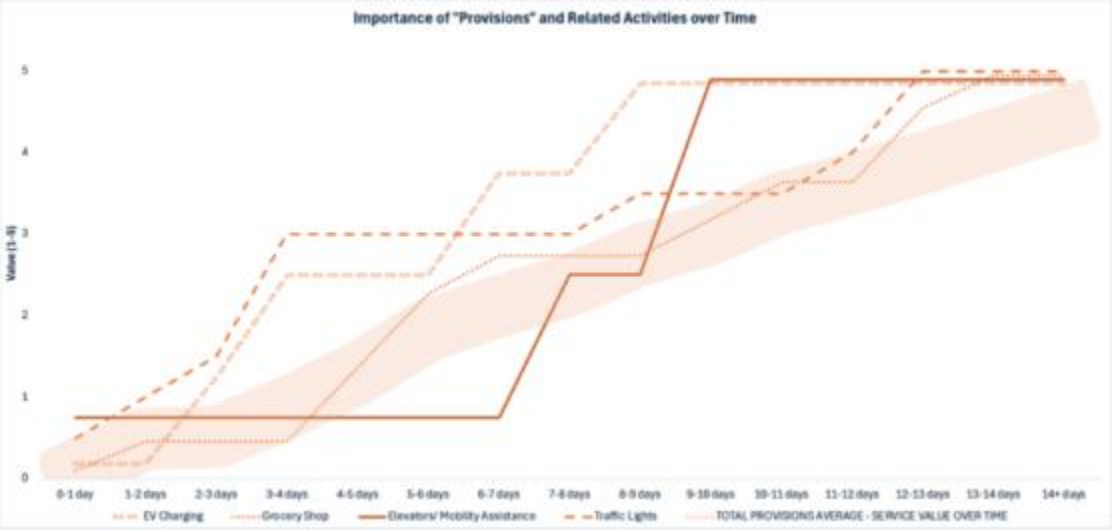

Figure 2
Average responses given by RC members regarding the importance of critical services in the Provisions category over time.

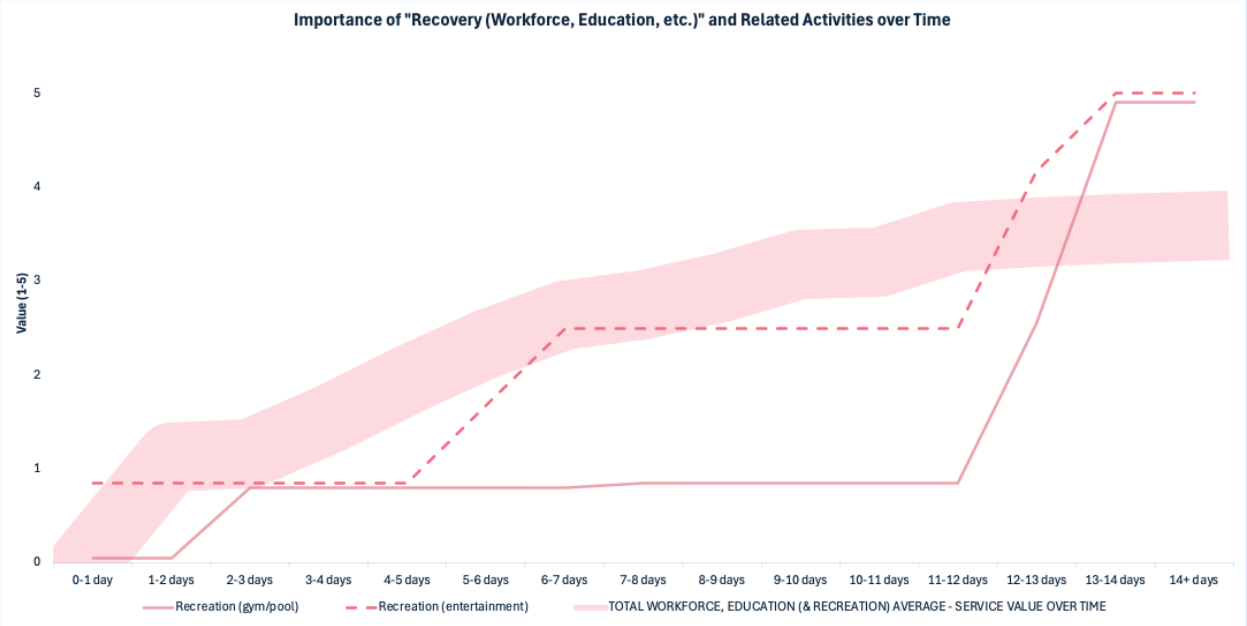

Figure 3
Average responses given by RC members regarding the importance of critical services in the Recovery category over time.

Valuing Service Types and Service Locations

In the community-driven engagement activity focused on valuing service types and locations, RC members were asked the following questions: What would make a specific service type more valuable, and what would make all service types more valuable? What would make a specific service type less valuable, and what would make all service types less valuable? These results are presented in Tables **1** through **4**.

Table 1
Reasons why the Service Facility Would Be More Valuable in Montgomery County

Reasons why More Valuable (Coded Themes)	**Total Frequency**
Ability to take good from the facility & use elsewhere (not dependent on staying in the location)	4
Amount & variety of goods/services in a single facility	1
Clustering of services (distance/ accessibility/ proximity to other services)	2
Communication about / awareness of / responsiveness of / confidence in location & services provided	10
Cooperation/ responsiveness to community needs	3
Cost/ price/ affordability	2
Distance/ accessibility/ proximity to home/ self, or accessibility via public transit	23
Location is not relevant to service type/location does not matter if the service is provided	3
Payment types (i.e., takes cash)	2

Running water/toilets/sanitation capacity	9
Safety, efficiency, order, and cleanliness of the facility	7
Self-sustainability (e.g., has a generator, can function without power, has necessary workers)	4
Service hours	4
Service is particularly important	5
Service value is time-dependent	4
Size/capacity of facility (and facility's resources)	8
Type, amount, and variety of goods/services in a single facility	15

***Note**. These were the coded responses for Montgomery County, showing what would make a specific service type more valuable and what would improve the value of all service types according to the RC members. The project team then compiled the total responses across these categories: provisions (food, fuel, hydration), health and medical (medications, medical care), government and emergency services (government, shelter, mutual aid), institutional population, and education and workforce.*

Table 2

Reasons why the Service Facility Would Be Less Valuable in Montgomery County

Why Facility Would Be Less Valuable (Coded Themes)	**Total Frequency**
The facility does not have adequate staffing	1
Far from other services	1
Insufficient size/capacity of facility (small physical size/ limited storage)	7
Lack of communication (e.g., unsure if the facility is open)	3
Lack of payment options (i.e., does not take cash)	2
Limited types, amounts, and variety of goods/services; poor quality of goods/services	5
Running water/toilets/sanitation capacity	4
Safety, efficiency, order, and cleanliness of the facility	5
Selfishness/self-interest	2
Specific vulnerabilities	5
Too distant/ inaccessible to home/ self	22
Too expensive	3

***Note**. These are the coded responses for Montgomery County, indicating what would make a specific service type less valuable and what would not increase the value of all service types, as identified by the RC members. The project team then combined the total responses across the following categories: provisions (food, fuel, hydration), health and medical (medications, medical care), government and emergency services (government, shelter, mutual aid), institutional population, and education and training workforce.*

Table 3

Factors Increasing Value or Importance of a Service Location in the Eastern Shore

Reasons Why MORE Valuable	**Total Frequency**
Parking availability, gas stations	9

Clustering of services (shopping center, restaurant, proximity to other services)	10
Police department, schools, colleges, churches	19
Cooperation and responsiveness to community needs	6
Cost, price, affordability, and availability	11
Distance, accessibility, proximity to home, or accessibility via public transit	12
Location is not relevant to the service type if the service is provided (e.g., Food bank, social service)	2
Running water, toilets, and sanitation capacity	1
Safety, security, efficiency, order, and cleanliness of the facility	17
Self-sustainability (e.g., has a generator, can function without power, has necessary workers)	0
Service hours, drive-thru, pharmacy, hospital, urgent care/and nursing homes	36
Fast service is particularly important	5
Environmental factors, surrounding infrastructure	9
Size/capacity of facility (and facility's resources)	1
Other	11

***Note**. These were the coded responses for Eastern Shore, indicating factors that increase the value or importance of a service location according to the feedback from RC members. The RCM project team then combined the total responses across these categories: Provisions (Food & Water, OTC Medications, and Fuel), Health & Medical (Rx Medications and Healthcare – Services, Procedures, and Medical Devices), Public Services (Routine services like Fire, Police Department, and Emergency Services such as Shelter and Mutual Aid), as well as Education & Workforce (Schools).*

Table 4

Factors Decreasing the Value or Importance of a Service Location in the Eastern Shore

Why Facility Would Be Less Valuable (Coded Themes)	**Total Frequency**
The facility does not have adequate staffing, and long wait times	23
Far from other services, lacks parking, and has no gas station	7
Insufficient size/capacity of facility (small physical size/ limited storage)	6
Overcrowded and overpopulated spaces	5
No emergency station, lack of schools	2
Limited types, amounts & variety of goods/services; poor quality of goods/services	21
Running water/toilets/sanitation capacity	2
Safety (crimes), efficiency, order, and cleanliness of the facility	9
No pharmacy, no hospital, no urgent care, and no nursing homes	8
Specific vulnerabilities (outdated facility, lack of transportation)	13

Too distant/ inaccessible to the home or the shopping center	4
Too expensive	13
Environmental factors and surrounding infrastructure	10
Other (including unemployment/job, resource allocation)	12

Note. *These are the coded responses for Eastern Shore, showing what would decrease the value of a specific service type.*

13.12 Exhibit K: Products

The following conference presentations were given during the RCM research project.

Table 1
Notable RCM Conference Presentations and Website

Presentation/Title	Author	Conference Name	Conference Type	Date
Quick Talk: Resilient Communities Maryland	Tiffani Lawson	RE+Mid Atlantic	Presentation	7/27/2023
Session #3: Building Equity and Justice into Resilience Planning	Tiffani Lawson	Resilience Week	Panel Speaker	11/28/2023
Pennsylvania Microgrids for Resilience Study: Microgrid Deployment Scenarios	Tiffani Lawson	Smart Electric Power Alliance Virtual	Presentation	3/7/2024
Innovation Alley at the Montgomery County Energy Summit	Tiffani Lawson	Montgomery County Energy Summit	Tabeling	4/15/2024
Resilience Hub Action Panel	David Wright	Montgomery County Resilience Hubs Action Panel	Panel Speaker	5/21/2024
Resilience Hubs Climate Equity Speaker Series	Tiffani Lawson	Resilience Hubs Climate Equity Speaker Series w/SELF's Southern + Accelerator	Presentation	9/17/2024

Websites:

URL	Description of Website	Project Information Description
https://groundswell.org/resilient-communities-in-maryland/	Landing page to help with recruitment for the Resilience Council	The website provided an open platform for anyone interested in RCM to learn more, access information, and register to become a Resilience Council member.

Products:

Product Name	Description
RCM Framework Document	The RCM Framework Document served as a roadmap to help stakeholders understand and replicate our work—whether in parts or as a whole—in their local contexts. It also served as a reference tool for practitioners and other stakeholders, supporting community-driven efforts in energy resilience and informed decision-making.
Three Case Studies	The three case studies, one for each jurisdiction: Baltimore, Montgomery County, and the Eastern Shore, demonstrated the successful application of the RCM Framework.
Dissemination Plan	The primary goal of this dissemination plan is to share the knowledge, findings, and best practices developed throughout the RCM project with a broad and diverse audience.
The Final Technical Report	The Final Technical Report (FTR) served as the official record of the project's objectives, accomplishments, and how the research contributed to technology development and the broader public benefit.

13.13 Exhibit L: Other Contributors to the Project

13.13.1 Maryland Energy Administration (MEA)

MEA connected the project to state-level resilience and energy policy implementation. They participated in community meetings and helped align the project scope with current Maryland initiatives. The MEA also supported the project by attending

community meetings and providing input on the project's scope throughout the process. Team Members: Brandon Bowser and David Comis.

13.13.2 Baltimore Office of Sustainability – Local Government Advisor

The Baltimore Office of Sustainability provided advisory input and facilitated access to local resilience data and networks. They shared data, best practices, and lessons learned from Baltimore's long-standing Community Resiliency Hub Program and ensured alignment with municipal policies. They also advised on coordination structures and local policy alignment, including supporting stakeholder convening and replication efforts in other jurisdictions. Their role was key to connecting the RCM framework to city emergency planning resources. Team Members: Aubrey Germ, Valerie Rupp, Ava Richardson.

13.13.3 External Advisory Group

The External Advisory Group provided quarterly guidance and feedback on the replicability of the research approach and methodologies beyond the duration of the project. The External Advisory Group included the following members:
Charmaine Brown, Maryland Clean Energy Center, Maryland Commission on Climate Change
Naadiya Hutchinson, Just Transition Lawyering Manager, Taproot Earth Resident Equity Advisory for the Baltimore City Climate Action Plan
Shane Lee, Sustain Our Future Foundation Program Coordinator
Mac McComas, Senior Program Manager at Johns Hopkins University 21st Century Cities Initiative
Vernice Miller-Travis, Executive Vice President at Metropolitan Group
Kenya Troutman, Resilience Program Coordinator, DC Homeland Security and Emergency Management Agency

13.13.4 Resilience Council

The Resilience Council consisted of twelve community stakeholders representing a diverse cross-section of the local population. This group was intentionally formed to serve as a safe space for community members to share their ideas, free from the power dynamics that can arise in mixed settings involving government or academic institutions. The Council played a vital role in identifying and validating the community's resilience priorities and in developing meaningful social resilience measures that reflect lived experiences and local context. Each research location has its own Resilience Council:
Baltimore Resilience Council
Montgomery County Resilience Council
Eastern Shore Resilience Council

13.13.5 Roundtable

The Roundtable consisted of a group of five to seven representatives from local government, utilities, academic institutions, and nonprofit organizations. It was designed to foster collaboration among institutional stakeholders and the community. The Roundtable provided a platform to integrate insights and direction from the Resilience Council into technical planning and decision-making processes. It helped translate

community-identified needs into actionable strategies and facilitated solution-oriented conversations about energy resilience and preparations for power outages or other disruptive events.

Baltimore Roundtable

Chloe Bean (BRT), Senior Policy Analyst, Utility of the Future, Baltimore Gas and Electric (BGE)
David Comis, Energy Program Manager, Maryland Energy Administration
Kimberly Eshleman, Director, Office of Public Health Preparedness and Response, Baltimore City Health Department
Mike Hunninghake, Program Director, Sustainable Maryland, Environmental Finance Center, University of Maryland School of Architecture, Planning and Preservation
James Hunter, Ph.D., Associate Professor, Civil Engineering, Morgan State University
Michelle (Shelly) Smith, Preparedness Section Chief, Baltimore City Office of Emergency Management

Montgomery County Roundtable

Lester Facey, Ph.D., Adjunct Faculty, Environmental Science & Studies, Towson University
Joelle Novey, Director, Interfaith Power & Light (DC.MD.NoVa)
Lemir Teron, Ph.D., Associate Professor, Department of Earth, Environment and Equity, Howard University
Doug Weisburger, Senior Planning Specialist, Sustainability Programs, Department of Environmental Protection, Montgomery County Government

Eastern Shore Roundtable

Dr. Joseph Arumala, Professor, University of Maryland Eastern Shore, Department of the Built Environment, Construction Management Technology Program
Dan Brandewie, Planning Director, Planning and Zoning Department, Pocomoke City
Laraine Buck, Planner, Department of Emergency Services, Somerset County Office
Humna Sharif, Climate Adaptation Manager, The Nature Conservancy Maryland/DC Chapter
Izabell Wilk, Planning and Zoning Coordinator, Town of Princess Anne

13.13.6 Special Thanks and Acknowledgments

Lastly, the project team sincerely thanks the many individuals and organizations whose time, expertise, and support were vital to this effort.

Academic Partners

- University of Maryland
- University of Maryland Extension

- University of Maryland Eastern Shore
- Walter Woods, University of Maryland Eastern Shore
- Diamond Nwaeze, University of Maryland Eastern Shore
- Kayle Krieg, University of Maryland
- Drew Schiavone, Ph.D., University of Maryland Extension

Government and Public Sector Partners

- Tessa Lovro, Maryland Department of Emergency Management
- Don Scheuerman, Jr., Office of Energy and Sustainability, Montgomery County, MD
- Douglass Weisburger, Division of Energy, Climate & Compliance, Montgomery County Department of Environmental Protection
- Mara Parker, Office of Emergency Management and Homeland Security, Montgomery County, MD
- Sujay Ali, Hub Coordinator, Department of Health and Human Services, Montgomery County, MD
- City of Baltimore Department of Recreation and Parks
    - Alicia Bolling, Morrell Park Recreation Center
    - Antonio Jones, Robert C. Marshall Recreation Center
- Silver Spring Recreation and Aquatic Center, Silver Spring, MD
- Rockville Senior Center, Rockville, MD
- Hawks Corner, Princess Anne, MD

Nonprofit and Community Partners

- Humna Shariff, The Nature Conservancy Maryland/DC Chapter
- Mariana Rosales, The Nature Conservancy Maryland/DC Chapter
- Joelle Novey, Interfaith Power & Light (DC.MD.NoVA)
- Robin Lewis, Interfaith Power & Light (DC.MD.NoVA)
- Aubrey Germ, formerly Baltimore Office of Sustainability
- Kristen Baja, Co-Executive Director, Embodied Ecosystem
- Brandy Espinola, University of Maryland
- Montgomery County Green Bank
- Michael Simmons
- Billy Humphrey, City of Refuge