# Virginia Energy Resilience Study: Case Studies for Community Energy Resilience

Contract No. *DE-EE0010414*
**Deliverable EOP-C**
December 2025
Virginia Department of Energy

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# Resilience Hub Planning
# In Blacksburg, Virginia

A Case Study on Local Energy Resilience

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September 2025

## Acknowledgements

The sources for much of the information in this case study come from partners at the Town of Blacksburg and Resilient Virginia. The authorÏ would like to thank Carol Davis, Blacksburg's Sustainability Manager, for her valuable input and participation in the Virginia Energy Resilience Study.

## Disclaimer

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## Resilience Hub Project Background

In 2025, the Town of Blacksburg (Town) partnered with the Virginia Department of Energy (DOE) to participate in the Virginia Energy Resilience Program, an initiative of the Renewables Advancing Community Energy Resilience (RACER) Program aimed at helping communities strengthen their energy resilience. As part of this effort, the Town took part in the Virginia Energy Resilience Study (VERS), which evaluated the town's capacity to endure power outages, identified key vulnerabilities, and provided recommendations for long-term improvements and solutions.

The initiative was led on behalf of the Town by Carol Davis, Sustainability Manager. Together, she collaborated with the DOE, researchers from James Madison University (JMU), community engagement specialists from Resilient Virginia, and engineers from APTIM. Through this partnership, the Town accomplished the following:

- Completed the **Virginia Community Energy Resilience Workbook and Scoring Tool** to assess existing resilience and identify long-term strategies for improvement. This was done through a multi-stakeholder roundtable session.
- Conducted **community engagement** through a survey to gather lived experiences, identify needed resources and services during outages, and gather feedback on the potential site for the energy resilience hub.
- Held **technical discussions with engineers** to develop design drawings for a resilience hub for the Town.

**Population**

Blacksburg, located in southwestern Virginia, has a year-round residential population of approximately 45,228. It is also home to the main campus of Virginia Tech, which brings in more than 38,000 students each academic year. While about 33% of students reside on campus, the remaining 67% live off-campus within the town. This transient and fluctuating student population presents a unique challenge for the town—making it difficult to consistently identify, reach, and address their needs, particularly during emergencies.

**Experience with Disaster**

Over the years, the town has experienced several significant weather events, with community members identifying some of the most impactful in recent history. These include the Winter 2025 ice storm, which caused widespread power outages; Hurricane Helene in the summer of 2024, which led to both power outages and an extended boil water advisory; and the powerful derecho of summer 2012, which also resulted in major power disruptions. Earlier events such as the ice storm of 1994 and the blizzard of 1993 similarly left many residents without power. In each of these events, downed trees and heavy debris significantly impacted local infrastructure — blocking roads, damaging property, and complicating emergency response efforts. In addition to these major incidents, Blacksburg frequently experiences high wind events, which continue to pose risks to power lines, roadways, and public safety.

**Residential Vulnerabilities**

Blacksburg has several populations with increased vulnerability during emergencies. A total of 834 households do not have access to a vehicle, which can limit evacuation and mobility options. Additionally, 3,027 individuals live with at least one physical disability, and 957 residents are unable to live independently—242 of whom are over the age of 65. There are 200 households that rely on well water, which may be more susceptible to disruption during severe weather events. Language can also be a barrier for some, as 286 households have limited English proficiency. Medical needs are another critical concern, with 317 individuals depending on home healthcare equipment that typically requires electricity. Economic vulnerability is also present, with 415 households considered energy-burdened, and 509 people aged 60 and older living in poverty. Furthermore, 221 elderly householders live alone, increasing the potential for isolation during crises. These factors highlight the importance of inclusive and accessible emergency planning across the community.

# The Challenge

On September 17, 2025, the Town partnered with Resilient Virginia to convene a multi-stakeholder roundtable focused on utilizing the Virginia Community Energy Resilience Workbook and Scoring Tool. Participants included representatives from emergency management—such as police, fire department, and rescue squad—as well as the town's public works, planning, and engineering departments; Virginia Tech's electric, facilities, and emergency management departments; the county public health department; the regional FEMA office; local community-based organizations and nonprofits; and local businesses. Together, they collaborated to assess the town's energy resilience and determine the primary energy vulnerabilities and brainstorm solutions.

**Public Health and Safety Assessment**
During an extended power outage, the majority of Blacksburg's public health and safety services are only able to operate for approximately two to three days before experiencing significant limitations. This includes essential services such as fire protection, rescue squad and ambulance operations, police response, acute medical care, as well as the functioning of public water and sewer systems. The limited duration of service continuity highlights the town's vulnerability to prolonged outages and underscores the critical need for enhanced resilience planning and backup infrastructure.

**Emergency Management Assessment**
Most of Blacksburg's emergency management services are equipped to continue operating for more than two weeks during an extended power outage. These include the Emergency Command Center, community shelter operations, public communications, debris clearing, and search and rescue efforts. However, some services face much shorter operational limits. Social services would be significantly constrained, with the ability to function for one day or less, while the animal shelter could maintain operations for only two to three days. These disparities highlight the need for targeted support and resource planning to ensure all critical services can be sustained during prolonged emergencies.

**Community Necessities Assessment**
During an extended power outage, some essential services in Blacksburg are expected to remain operational for more than two weeks, including phone and internet service, gas-powered buses, and K–12 schools. However, several other services would be significantly limited. Electric buses, gas stations, and banks and ATMs would likely only remain functional for one day or less. Grocery stores and pharmacies could continue operations for approximately two to three days, while the local food bank or food pantry is expected to be able to serve the community for about four to seven days. These limitations point to potential gaps in long-term community support and resource access during prolonged outages.

**Residential Vulnerabilities Assessment**
Blacksburg is equipped to provide cooling and warming centers during extreme heat and cold events; however, several critical gaps remain in the town's emergency response capabilities, particularly during extended power outages. If an outage lasts longer than one day, the town currently has no system in place to identify households that rely on home healthcare equipment or caregivers, limiting its ability to provide essential support such as power for medical devices and wellness checks. Communication during emergencies is also a challenge, as the public alert system operates only in English, leaving residents with limited English proficiency without accessible information. Additionally, there is no formal plan for delivering potable water to households dependent on well water during prolonged outages, though community volunteers have stepped in to fill this gap in the past. Similarly, while some residents lack transportation and may need assistance relocating to safer locations, the town does not maintain a formal list to identify and support them—relying instead on informal networks and neighbor-to-neighbor assistance during emergencies. These gaps highlight the need for more inclusive and coordinated planning to protect the most vulnerable members of the community.

**Primary Energy Vulnerabilities**
Blacksburg's primary energy vulnerabilities highlight several critical areas needing attention to ensure community resilience during power outages. Gas stations and grocery stores require reliable backup power sources to maintain these essential services when the main power is lost. Water availability is another major concern, as a backup power system is necessary to continue providing clean water once the town's stored supply, which lasts about 48 hours, is depleted. Additionally, limited backup fuel storage for gasoline and diesel poses a risk to sustaining critical infrastructure and public services; therefore, expanding fuel storage capacity and establishing multiple fuel distribution points are essential. Vulnerable populations also require better support through the creation of a centralized clearinghouse to quickly identify individuals who depend on medical equipment or need wellness checks during outages. Finally, emergency information must be accessible in multiple languages to effectively reach households with limited English proficiency, ensuring that all residents receive timely and understandable alerts during emergencies.

# Community Engagement

## Survey

On August 28, 2025, a Citizens Alert went out to Blacksburg community members seeking resident input through a survey.

**Text of Citizens Alert:**

> Resident Survey Open: Virginia Energy Resilience Study
> The Town of Blacksburg, with support from the Virginia Department of Energy and Resilient VA, is undertaking a process to evaluate areas of energy vulnerability during extended power outages. To better understand the needs of the community during these

incidents, the Town has developed a short survey for residents to share their experiences. Survey link: https://forms.gle/ybrgLpBgwVqi4R3n6 This survey will be open until September 12 and should take less than 10 minutes to complete. Citizen input will contribute to a case study that the Town of Blacksburg will use to help guide practical actions for improving energy resilience, emergency preparedness, and response.
For questions about this survey or the Virginia Energy Resilience Study, please email Town Sustainability Manager, Carol Davis at cdavis@blacksburg.gov for more information.

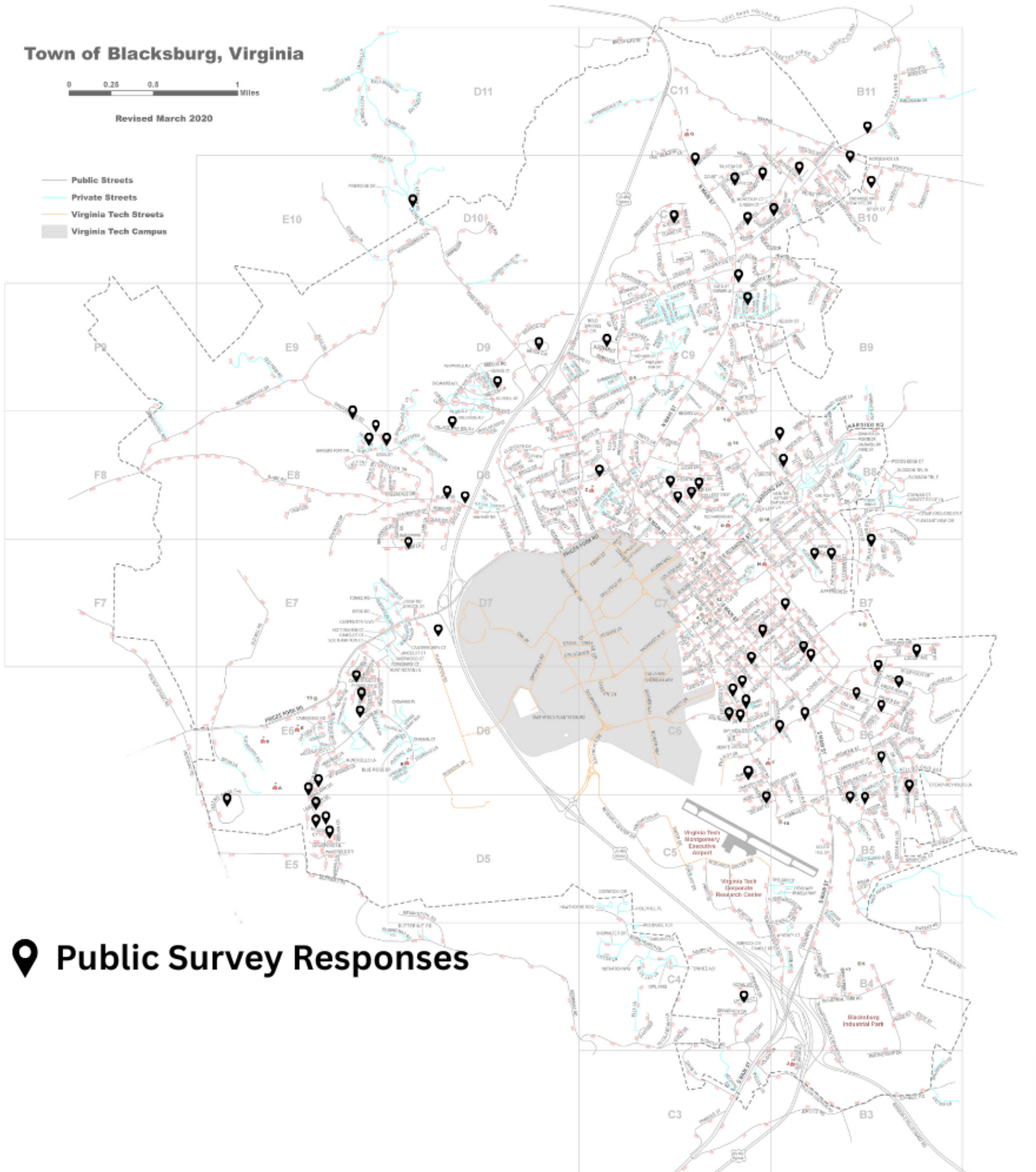
**Survey Questions:**

- Your Name (leave blank if you prefer to be anonymous)
- May we contact you for additional information?
- Email address
- Approximate location of your current residence: i.e. neighborhood (e.g. VT Residence Hall, Airport Acres, Woodbine, etc.) or street section (1300 block of Glade Rd., 700 block of Harding Ave., etc.)
- How long have you lived at this location?
- What are your role(s) in the community? Check all that apply.
- While living at your current residence, can you recall any extended power outages (longer than a day) or other disruptions to critical services (access to drinking water, cellular communications)?
- Please provide detail on the most significant power outages that you recall. What season/year did they occur (e.g. summer 2012), and what was the type and extent of the disruption (e.g. hours or days without power)? Estimates are okay.
- During these extended power outages, did you or someone in your household have significant difficulty with any of the following? Check all that apply.
- If you would like to provide additional detail on any of the elements you selected above, please do so here.
- During these extended power outages, were you aware of impacts beyond your household that were serious in nature, i.e. threatening to health/safety, damaging to public infrastructure, and/or the delivery of critical services? If yes, please describe.
- In the last year, how often have you experienced the following in your current residence? [Power outages lasting less than an hour]
- In the last year, how often have you experienced the following in your current residence? [Power outages lasting over an hour]
- In the last year, how often have you experienced the following in your current residence? [Internet connectivity issues]
- In the last year, how often have you experienced the following in your current residence? [Damage from wind]
- In the last year, how often have you experienced the following in your current residence? [Damage from flooding]
- Which resources do you think are most in need during emergencies? Check all that apply and add your own suggestions.

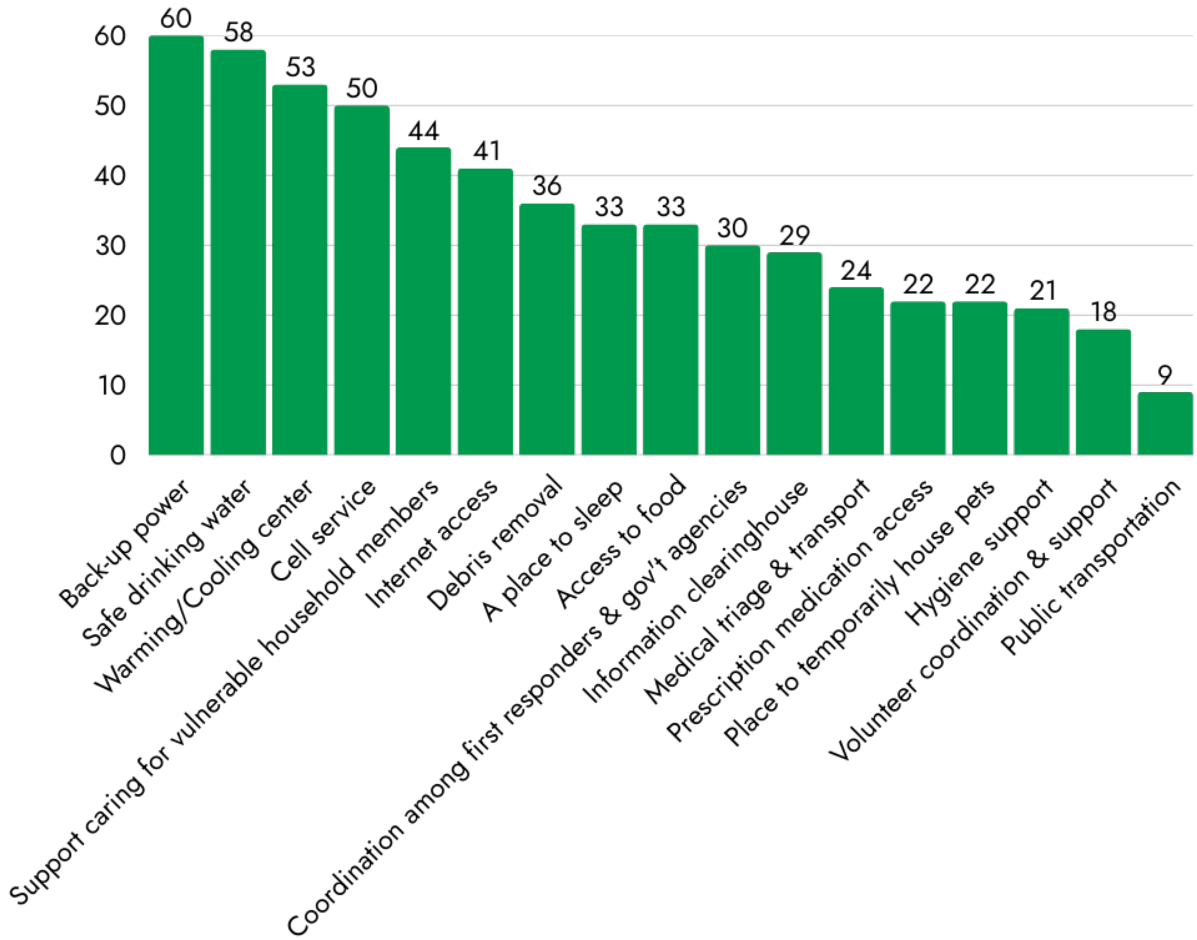
- If an Energy Resilience Hub was located in your community, what resources would your household be most likely to use during emergencies? Please select no more than 5 of the options listed below. Feel free to add your own suggestions.
- Energy Resilience Hubs are often located at established facilities, such as community centers, gymnasiums, or churches that have significant floor space and are in a location that is relatively convenient for people to get to. Blacksburg plans for the Recreation Center on Patrick Henry Drive to serve as the primary Energy Resilience Hub. Do you have any thoughts or concerns about this location or facility?
- What are some barriers that might prevent you from using or accessing an Energy Resilience Hub? Check all that apply and add any additional barriers.
- Are there any other buildings in the community that you feel could double as an Energy Resilience Hub? Tell us why you think this location would be advantageous for a primary or secondary Energy Resilience Hub for Blacksburg.
- Do you have any other suggestions, comments, or questions regarding creating an Energy Resilience Hub in Blacksburg?

## Survey Results

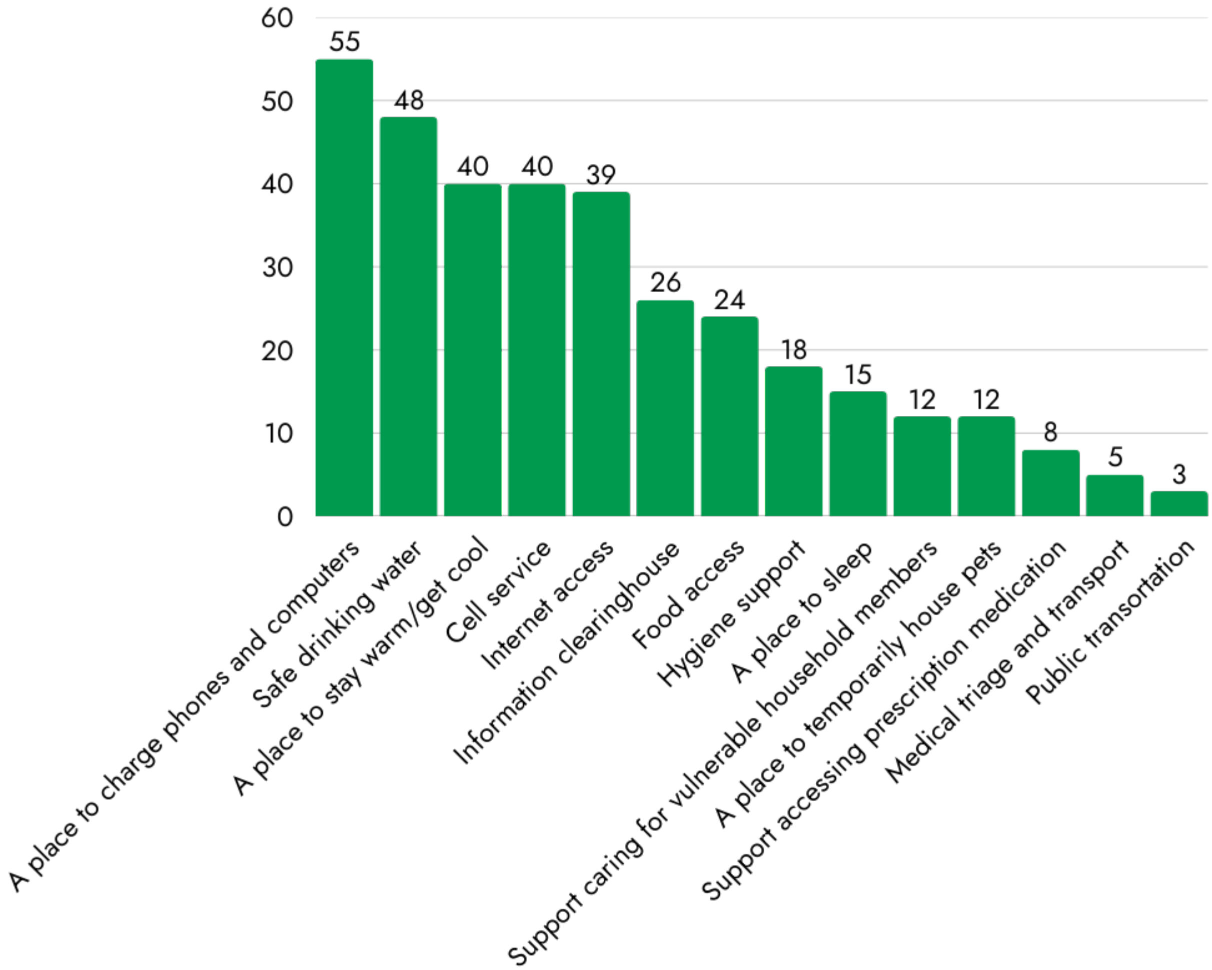
76 residents responded to the survey (see map below for approximate location of respondents)


Town of Blacksburg, Virginia
0 0.25 0.5 1 Miles
Revised March 2020
Public Streets
Private Streets
Virginia Tech Streets
Virginia Tech Campus
Public Survey Responses

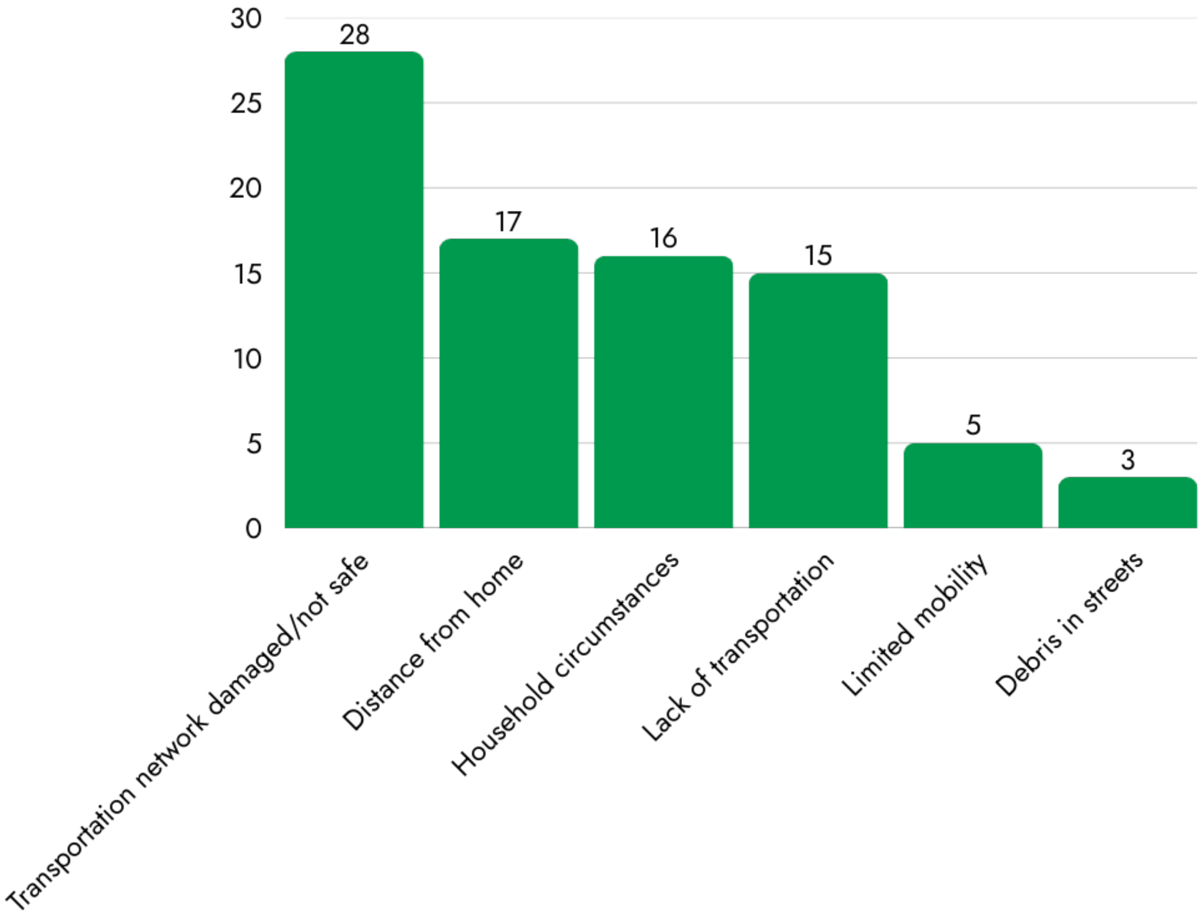
Resources Most Needed in an Emergency



Resources Most Likely to be Used During Emergencies



Barriers That Might Prevent Someone From Using or Accessing an Energy Resilience Hub




## Open House

On September 23, 2025, Blacksburg hosted an Open House for community members to learn more about the project and provide input, using the same questions from the survey. Attendance was minimal and did not result in any additional information. Feedback indicated that community members who would have attended the open house had already replied to the survey.

## The Solution: Equip local facility with Solar + Storage

Provided in APTIM drawings.

## Lessons Learned

The VERS project and accompanying community engagement process provided the Town with several important lessons to inform future resilience planning and implementation efforts:

- **Understanding the town's energy-resilience requires:**
  - **A systems-level perspective:** Assessing the town's energy resilience requires a systems-level perspective that considers the cascading effects and interconnected impacts across sectors.
  - **Engaging diverse representation:** It is crucial to engage representatives with diverse knowledge and expertise to help identify and address gaps in the town's understanding of its energy resilience.
- **Staff Capacity is a Key Consideration:** Implementing new resilience initiatives may require adequate staff capacity and cross-departmental coordination. Addressing staffing

limitations is important to ensure the successful planning, operation, and maintenance of resilience hubs and related programs.

- **Collaboration between Blacksburg and Virginia Tech:** Blacksburg and Virginia Tech must collaborate closely by reviewing their respective emergency plans to ensure mutual understanding and alignment. Coordinated planning will help clarify roles, streamline emergency response efforts, and prevent duplication of resources. Working together in this way is essential to strengthening overall resilience and building a more prepared, unified community.
- **Future Community Engagement:** Widespread community engagement requires time, intentional planning, and sustained effort. While the survey received a strong response, participation in the in-person meeting was limited. Given the town's size and the diverse availability of its residents, a one-size-fits-all approach to engagement is not effective. To ensure broad and representative input, future efforts must include multiple formats and be offered at various times to accommodate different schedules and preferences across the community.

| **Project Title:** | **Project #:** | **Date:** |
|---|---|---|
| Virginia Energy Resilience Study (VERS) | 77631041420 | 30-Sept-25 |

# BLACKSBURG, VA - SOLAR RESILIENCY STUDY FOR SOLAR PLUS STORAGE

APTIM
11400 PARKSIDE DR.
SUITE 400
KNOXVILLE, TN 37934
(865) 560-7800

Ethan Marsh ____________________
Preparer

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Reviewer

N/A ____________________
Design Verifier

Design Verification Method:

☒ N/A ☐ Independent Review ☐ Alternate Calculation ☐ Qualification Testing

Total Document Pages: 6
Total Attachment Pages: 16

| APTIM | BLACKSBURG, VA | |
|---|---|---|

**Summary**

The project site for Blacksburg is at Blacksburg Community Center, found at 725 Patrick Henry Drive, Blacksburg, VA 24060. Per correspondence with the town's representative(s), a permanent solar power installation with a battery energy storage system (BESS) would best fit the town's necessities if the local utility power were unavailable due to natural disasters or other unprecedented scenarios. The recommended approach for such installation is as follows:

> The solar panels would be installed on the northern portion of the building, tilted 30 degrees toward the south for maximum sun exposure. Having a roof installation would not require the property to render real estate to the equipment; if the roof is not favorable due to existing mechanical equipment, a solar carport (essentially a structurally sound carport with solar panels mounted on its roof) constructed at the community center's parking lot may be a welcomed an option.
>
> For the BESS, it would ideally be installed near the power distribution equipment that it will serve, physically inside the facility. If there is no available footprint within the building, meeting relevant National Electrical Code (NEC) and local codes, then installing the apparatus outside the building would be the next option, so long as the enclosure is rated for the outdoors and away from potential vehicle or pedestrian damage. Dimensions for the unit differ depending on the battery's capacity, but the typical footprint would be 26" W x 8" D x 70" H or smaller for a single unit; given the estimated critical loads, a second battery unit in parallel should be considered for the facility's fan, HVAC, and other large loads.
>
> Additional power distribution equipment would be required for this solar panel system, such as a subpanel and manual transfer switch. Ideally, any electrical loads or existing circuits the site wishes to energize during a power outage would be transferred to a new subpanel; an acceptable size for this subpanel would be a 125 Amp bus with 30-poles. Moreover, a manual transfer switch would be placed in between the existing distribution panel and the subpanel. This manual transfer switch would serve as a utility disconnect and provide the site an option to connect a mobile power source (a generator or other modular energy storage) to the new subpanel.

Prior to any construction work, the site's representatives should engage the local utility for their requirements on connecting a distributed energy resource (DER), if the intention is to have the solar panel system connected to the local grid for credits towards the monthly utility expense. At the time of this report, an application and approval are required for such endeavors.

## Load Analysis

- Peak Load (kWh): 33,000
- Estimated, Average Daily Load (kWh): 816.50
- Critical Loads: Refrigerator, lighting, multiple vent & exhaust units, and miscellaneous electrical loads *(exact electrical loads or circuits are to be verified).*
- Critical Equipment Operating Hours: 24 hours for the refrigerator and varied hours of use for other loads.
- Estimated, Critical Loads (kWh) 22.665

## Capacity Assessment

- Proposed Solar Array (kW): 25.229
- Recommended Battery Storage Size: 20kWh or ~0.77 hours (given the estimated, critical loads) and ~1.6 hours with two batteries in parallel.
- Resiliency Goal (hours/days of grid independence): The solar panel arrays would likely sustain the estimated critical loads alone, without the use of the BESS, during optimal daylight hours; the BESS shows its utility at night and when powering a larger load, such as the motor loads (ventilation & exhaust with other fans). Note that the BESS's runtime would be largely dictated by these continuous, motor loads.

## Proposed Equipment and Technology

- Solar Module Type/Model: Mission Solar Energy, Bifacial MSI10-550HT4T

- Number of Panels: 56 (2 sets of 14 x 2)
- Inverter Type and Capacity: Chint Power Systems, CPS SCA25KTL-DO, 25kW
- Battery Type and Capacity: Chint Power Systems, CPS ESSR-20KL1, 20kW
- Resiliency Features: Turnkey solution; parallel up to 60kWh of energy storage with no additional junction boxes; hybrid inverter; integrated AC and DC disconnect switches; PV, battery and generator inputs; PLC transmitter & Modbus monitoring; general UL and NEC compliance & arc-fault circuit protection & rapid shutdown.

## Installation and Integration

- Site Description: Roof or carport mount.
- Construction/Prep Requirements: Relevant permits required; recommend reviewing:
    A. 2021 Virginia Statewide Fire Prevention Code
    B. 2021 Virginia Energy Conservation Code
    C. 2021 Virginia Residential Code
    D. 2021 Virginia Building and Fire Code Related Regulations
    E. NEC 2020
- Utility Interconnection Details: Recommend reviewing:
    A. Appalachian Power's *Consumer Checklist*
    B. Appalachian Power's *DER Technical Interconnection and Interoperability Requirements (TIIR) for the AEP System*

## Summary & Recommendations

- Key Findings: The proposed components were sized per assumed, critical loads; proper verification will be required during the design effort. Regardless, the above components reflect an ideal scenario, with the following assumptions:

  A. The critical loads are accurate.

  B. Sufficient footprint for working and dedicated spaces are feasible for the new electrical equipment, per the NEC.

  C. The facility's roof, walls, and other frameworks are structurally sound.

  D. The local utility has a DER credit program for lowering a customer's utility expense.

- Comparison of Load vs. Capacity: As stated above, the proposed solar panel arrays have the capability to power all critical loads continuously, except for the larger motor loads; the solar panel arrays may be inadequate to sustain the inrush current. Note, the subpanel could be wired such that no large loads are powered by the solar plus storage (i.e., fans or HVAC units) to extend the BESS' runtime. As an example, removing the aforementioned load increases the single-unit BESS' operation from 0.77 to 0.96 hours (1.6 to 1.91 for two BESS units in parallel), assuming the solar arrays are not providing continuous power to the system. Another option to consider is expanding the solar arrays from 56 panels (2 sets of 14 x 2) to 96 (3 sets of 16 x 2) providing an additional 18.0 kW, as the site appears to have sufficient roof-space.

- Anticipated Benefits: This solar plus energy storage has great potential to provide a continuous stream of low-voltage power to the local community when necessary. Moreover, it will not be idle given the opportunity to decrease the electricity consumption of the facility.

## Attachment A: Engineering Design Information

| **Document Name** | **Reference** | **Quantity of Pages** |
|---|---|---|
| APTIM, Proposed Electrical Drawings | N/A | 2 |
| APTIM, Electrical Calculations | N/A | 3 |
| Vendor, Proposed Equipment's Cut Sheets | N/A | 11 |
| | | |
| | | |
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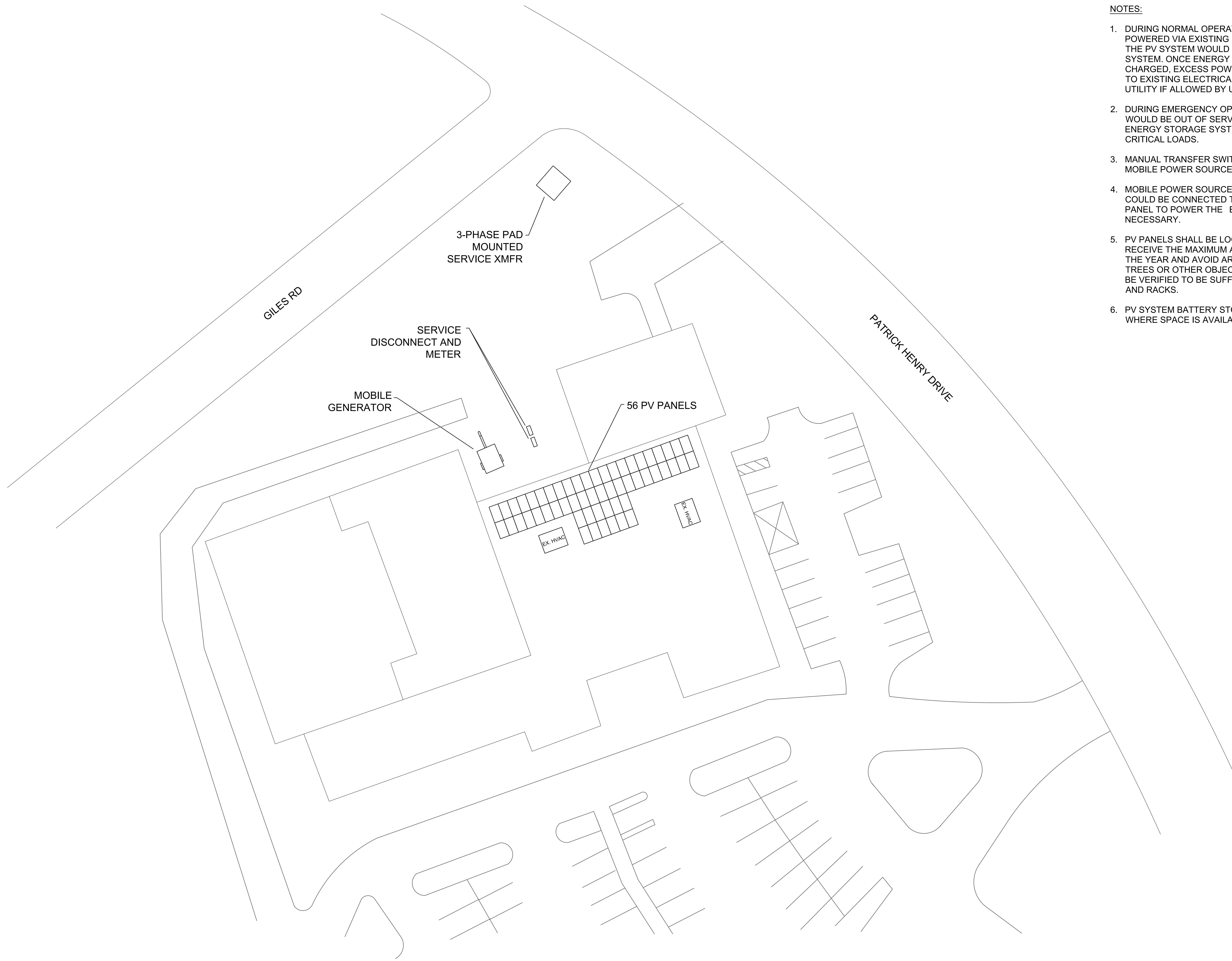



NOTES:

1. DURING NORMAL OPERATIONS, SITE SHALL BE POWERED VIA EXISTING UTILITY; SIMULTANEOUSLY, THE PV SYSTEM WOULD CHARGE ENERGY STORAGE SYSTEM. ONCE ENERGY STORAGE SYSTEM IS FULLY CHARGED, EXCESS POWER SHALL BE SENT UPSTREAM TO EXISTING ELECTRICAL DISTRIBUTION PANEL / UTILITY IF ALLOWED BY UTILITY COMPANY.
2. DURING EMERGENCY OPERATIONS, EXISTING UTILITY WOULD BE OUT OF SERVICE AND NOT POWER SITE. ENERGY STORAGE SYSTEM WOULD POWER ISOLATED, CRITICAL LOADS.
3. MANUAL TRANSFER SWITCH TO ALLOW OPTIONAL MOBILE POWER SOURCE IF AVAILABLE / NECESSARY.
4. MOBILE POWER SOURCE (WITH LARGER CAPACITY) COULD BE CONNECTED TO THE EXISTING DISTRIBUTION PANEL TO POWER THE ENTIRE SITE, IF AVAILABLE / NECESSARY.
5. PV PANELS SHALL BE LOCATED WHERE THEY WILL RECEIVE THE MAXIMUM AMOUNT OF SUN THROUGHOUT THE YEAR AND AVOID AREAS THAT ARE SHADED BY TREES OR OTHER OBJECTS. ROOF STRUCTURE SHALL BE VERIFIED TO BE SUFFICIENT TO SUPPORT PANELS AND RACKS.
6. PV SYSTEM BATTERY STORAGE SHALL BE LOCATED WHERE SPACE IS AVAILABLE INSIDE FACILITY.

| NO. | DESCRIPTION | DWN | CKD | APPD | DATE |
|---|---|---|---|---|---|
| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

FOR REVIEW ONLY! – NOT FOR CONSTRUCTION

PRELIMINARY PROGRESS DRAWINGS ARE NOT FOR CONSTRUCTION OR FABRICATION. BILL OF MATERIALS, SHOP DRAWINGS, ETC., CREATED FROM THESE DRAWINGS MAY BE REVISED AT THE EXPENSE OF THE CONTRACTOR.

PROFESSIONAL SEAL

APTIM

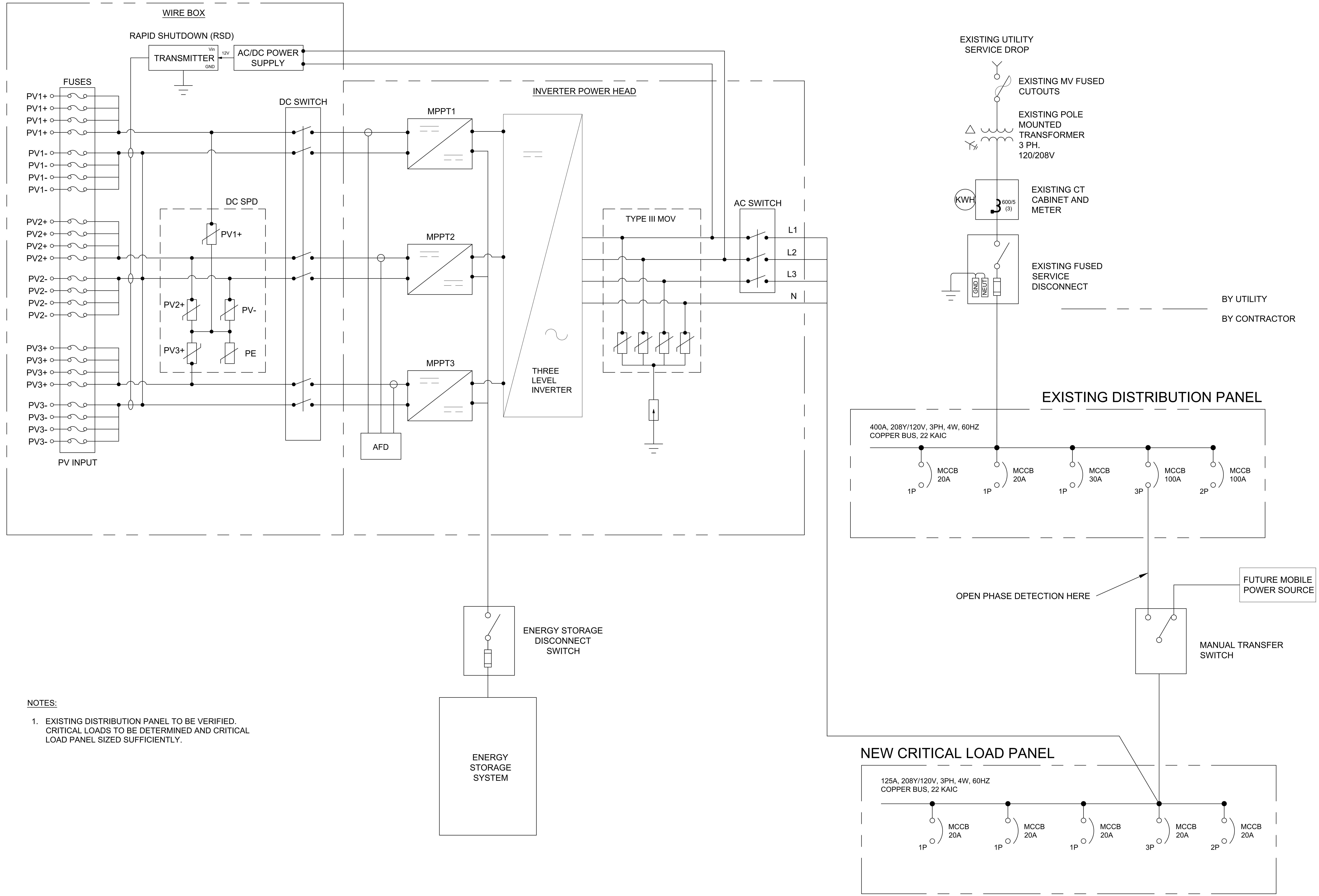
DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025
SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-001

VIRGINIA ENERGY RESILIENCE STUDY
BLACKSBURG COMMUNITY CENTER
725 PATRICK HENRY DRIVE, BLACKSBURG, VA 24060
APTIM PROJECT NO. 77631041420

ELECTRICAL
PV SYSTEM SITE PLAN

SHEET NO.
E-001

File: Blacksburg 725 Patrick Henry Dr.dwg
Plot Date/Time: Sep 30, 2025 - 7:58am
Plotted By: Robert.Childs




NOTES:

1. EXISTING DISTRIBUTION PANEL TO BE VERIFIED. CRITICAL LOADS TO BE DETERMINED AND CRITICAL LOAD PANEL SIZED SUFFICIENTLY.

| NO. | DESCRIPTION | DWN | CKD | APP'D | DATE |
|---|---|---|---|---|---|
| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

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PROFESSIONAL SEAL

APTIM

DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025
SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-002

VIRGINIA ENERGY RESILIENCE STUDY
BLACKSBURG COMMUNITY CENTER
725 PATRICK HENRY DRIVE, BLACKSBURG, VA 24060
APTIM PROJECT NO. 77631041420

ELECTRICAL
PV SYSTEM ONE-LINE DIAGRAM

SHEET NO.
E-002

File: Blacksburg 725 Patrick Henry Dr.dwg
Plot Date/Time: Sep 30, 2025 - 7:58am
Plotted By: Robert Childs

## Load Tabulation

**Single Phase**

| ID Tag No. | Item | Qty. | Voltage | FLA / VA | Units | Continuous | |
|---|---|---|---|---|---|---|---|
| | REFRIGERATOR | 1 | 120 | 2.3 | A | Yes | 345 VA |
| | LIGHTING (4,000 sqft space) | 4000 | 120 | 3.0 | VA | Yes | 15,000 VA |
| | MISCELLANEOUS (mobile devices…) | 1 | 120 | 20.0 | A | Yes | 3,000 VA |
| | UNIT VENT. & EXHAUST FAN | | 120 | 9.6 | A | Yes | |
| | | | | | | Single Phase Loads Subtotal | **18,345 VA** |

**Three Phase**

| ID Tag No. | Item | Qty. | Voltage | FLA / VA | Units | Continuous | |
|---|---|---|---|---|---|---|---|
| | | | | | | Three Phase Loads Subtotal | |

**SUMMARY**

| | |
|---|---|
| System Voltage | **240.0** |
| Connected Load | **18,345 VA** |
| Full Load Current (Single and Three Phase) | **76 Amps** |
| Conductor Material | **Copper** |
| Main Breaker Rating (sized to load main breaker at a maximum of 80%) | **100 Amps** |
| Main Panelboard Bus Rating (Minimum per main breaker rating) | **100 Amps** |
| Transformer design basis per full load current | **79,436.2 VA** |
| Minimum transformer size (80% load consideration) | **112.5 kVA** |
| Temperature rating of conductor | **75** °C |
| New Ambient temperature | **40** °C |
| Required conductor ampacity found from NEC formula in section 310.60(C)(4) | **114** A |

$$I = I' / \sqrt{\frac{T_c - T_a'}{T_c - T_a}}$$

**I** = Required ampacity of conductor after derating
**I'** = Ampacity corrected for ambient temp.
**Tc** = Temperature rating of conductor
**Ta'** = New ambient temperature
**Ta** = Ambient temperature from NEC table 310.16

| | |
|---|---|
| Minimum required conductor size (1 set of 4-1/C) | **2 AWG** |
| Minimum required parallel conductor size (2 sets of 4-1/C) | **6 AWG** |

**Table 1. Hourly Electric Load Profile**

| **Hour (HHMM, 24-hour)** | 0000 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| REFRIGERATOR | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 |
| LIGHTING (4,000 sqft space) | 3750 | 3750 | 3750 | 3750 | 3750 | 3750 | 3750 | 3750 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3750 | 3750 | 3750 | 3750 | 3750 | 3750 | 3750 | 3750 |
| MISCELLANEOUS (mobile devices…) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 |
| UNIT VENT. & EXHAUST FAN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 |
| **Total Hourly Load (VA)** | 4095 | 4095 | 4095 | 4095 | 4095 | 4095 | 4095 | 4095 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 12795 | 12795 | 12795 | 12795 | 12795 | 12795 | 12795 | 12795 |

# Solar PV String Sizing Tool - Regional Estimate

6/26/2025 V6.0.3

## Virginia Energy Resilience Study

### Project Name

BLACKSBURG # 56166

### Design Date

9/30/2025

| | | | | |
|---|---|---|---|---|
| Site Location (Lat/Lon)? | 37.1 | -80.2 | 13 Miles to Selected Station | |
| Temperature Source (ASHRAE or Manual) | ASHRAE 2% High Temp | | | |
| Country | United_States | | | |
| State/Province | Virginia | | Lat | Lon |
| ASHRAE Weather Station | VIRGINIA TECH ARPT | | 37.2 | 80.4 |

E3

| | ASHRAE | SELECTED |
|---|---|---|
| Extreme Low Temp | -15.3 °C | -15.3 °C |
| ASHRAE 2% High Temp | 32.3 °C | 32.3 °C |

### Module Specifications

| MODULE NAME | MISSION MSN10-550HT4T | MISSION MSN10-550HT4T | MISSION MSN10-550HT4T |
|---|---|---|---|
| Rated Power (STC) | 550 Wstc | 550 Wstc | 550 Wstc |
| Rated Power (t) [Regional Simulation Estimate] | 451 W(t) | 451 W(t) | 451 W(t) |
| Max System Voltage (Vdc) | 1500 Vdc | 0 Vdc | 1500 Vdc |
| Module Voc (STC) | 50 Vdc | 50 Vdc | 50 Vdc |
| Module Vmp (STC) | 42 Vdc | 42 Vdc | 42 Vdc |
| Module Imp (STC) | 13.1 Adc | 13.1 Adc | 13.1 Adc |
| Module Isc (STC) | 13.9 Adc | 13.9 Adc | 13.9 Adc |
| Module Isc(t) (Peak(1-hr)) | 14.8 Adc | 14.8 Adc | 14.8 Adc |
| Manufacturer's Fuse Rating (Max) | 30.0 Adc | 30.0 Adc | 30.0 Adc |
| Voc Temperature Coefficient (%/°C) | -0.290% | -0.290% | -0.290% |
| Vmp Temperature Coefficient (%/°C) | -0.340% | -0.340% | -0.340% |
| Type- MonoFacial (MF) / BiFacial (BF) / ThinFilm (TF) | MF | MF | MF |
| Adjusted Module Voc @ Low Temp | 56.1 Vdc | 56.1 Vdc | 56.1 Vdc |
| Adjusted Module Vmp @ High Temp | 35.9 Vdc | 35.9 Vdc | 35.9 Vdc |
| Adjusted Module Voc @ High Temp (1) | 50.9 Vdc | 50.9 Vdc | 50.9 Vdc |
| Adjusted Module Vmp @ Low Temp | 47.6 Vdc | 47.6 Vdc | 47.6 Vdc |

### Equipment Selection

| | | |
|---|---|---|
| Roof, Fixed, or Single Axis? | Roof | |
| MPPT 1 Module | MISSION MSN10-550HT4T | MonoFacial |
| MPPT 2 Module | MISSION MSN10-550HT4T | MonoFacial |
| MPPT 3 Module | MISSION MSN10-550HT4T | MonoFacial |
| Strings= 6 Total Modules 56 | | |
| Chint Inverter Model Number | SCA25KTL-DO/US-208 w/RSD | |

R

### Inverter Specifications

Inverter Model Number SCA25KTL-DO/US-208 w/RSD

**Output (AC)**

| | | | |
|---|---|---|---|
| Max Rated Output Power (W) \| (VA) | 25,000 W | \| | 25,000 VA |
| Rated Output Voltage | 208 VAC | | |
| Neutral Required | NO | | |
| Max. Rated Output Current ($I_{MAX}$) | 69.5 Aac | \| | 86.8 Aac ($I_{MAX}$ x 1.25) |
| Manufacturer Specified Maximum OCPD | NOT SPECIFIED | | |

**Input (DC)**

| | | | | |
|---|---|---|---|---|
| MPPTs \| Strings per MPPT | 3 | \| | 2 | 2 |
| Maximum Input Voltage | 1000 Vdc | | | |
| Target Wdc(t) Input (TOTAL \| MPPT) | 45000 Wdc | \| | 16667 Wdc | |
| DLR Target(t) (TOTA L \| MPPT) | 1.80 | \| | 2.00 | |
| DLR LIMIT(t) (TOTA L \| MPPT) | 2.00 | \| | 2.00 | |
| Max Isc(t) Input (TOTAL \| MPPT) | 108.0 Adc | \| | 36.0 Adc | |
| MPPT Voltage Range | 480 Vdc-Min | \| | 850 Vdc-Max | |
| DC Operation Range | 200 Vdc-Min | \| | 950 Vdc-Max | |
| Minimum Start Voltge | 300 | | | |
| Actual DLR (TOTAL \| MPPT) | 1.01 DC/AC Total | \| | 1.51 DC/AC (MPPT) | |

### System Design Parameters

Inverter Options

MPPT Range | Inverter Voltage Range

APPROVED 9/30/2025

INVERTER DESIGN COMPATIBILITY STATUS

High Voc Status | Isc Status | DC/AC Ratio (3hr) Status

TMY-Peak

### Array Design Options

| | MPPT 1 | MPPT 2 | MPPT 3 |
|---|---|---|---|
| String Length | 14 | 14 | 0 |
| String Length (Max \|\| Min) | 17 \| \| 14 | 17 \| \| 14 | 17 \| \| 14 |
| Number of Strings (2 Max.per MPPT) | 2 | 2 | 2 |

| | MPPT 1 | MPPT 2 | MPPT 3 | TOTALS | LIMIT MPPT | LIMIT Total |
|---|---|---|---|---|---|---|
| Connected Wdc (t)(DYNAMIC) | 12615 | 12615 | 0 | 25229 | 16667 | 45000 |
| Connected Isc(t)(DYNAMIC) | 29.7 | 29.7 | 0.0 | 89.0 | 36.0 | 108.0 |
| Connected Voc @$T_{MIN}$ | 785 | 785 | 0 | | 1000 | 1000 |
| | 712 | 712 | 0 | 712.4 | 480 | 480 |
| String Fuse Max (Manuf. Spec) | 30.0 | 30.0 | 30.0 | | | |
| String Fuse (NEC Alt. Estimated) | 20.0 | 20.0 | 20.0 | | | |
| SELECTED STRING FUSE (Suggestion) | 30.0 | 30.0 | 30.0 | | | |

◉ Select Manf. Spec
○ Select Alt Fuse

### Terms and Conditions

**THE USER OF THIS SIZING TOOL HAS ACKNOWLEDGED: The Chint Power Systems (CPS) String Sizing Tool is being offered free of charge to provide a Array design and Inverter constraint compatibility estimate based on a regional TMY simulation. The output of this tool will be used by CPS to determine compliance with inverter limits. A copy should be maintained in the site design records.**

CPS makes no representation or guarantee regarding the output of the String Sizing Tool regarding the Energy Production of your system.

Fuse rating determination is the responsibility of the Engineer of Record (EOR). The application of fuses greater than 20A must comply with the direction in the product manual, which may require skipping positions to facilitate thermal distribution.

**It is the responsibility of the system Design Engineer to ensure that the STC parameters of the PV Module are accurately entered.**

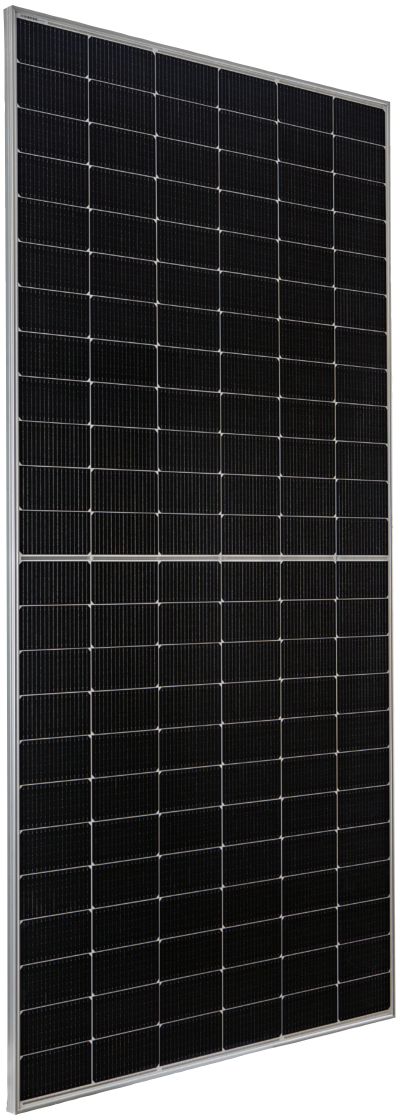
**The user agrees to use the String Sizing Tool at their own risk and the knowledge that CPS will not be liable to the user for any damages, injury or death as a result of the use of the String Sizing Tool.**

# MSI PERC Bifacial 144HC
## Transparent Backsheet

MISSION SOLAR ENERGY®

# 545-555W
Class leading power output

Positive Power Tolerance
**-0 to +5W**



# Solar Built for the Long Haul

Mission Solar Energy is headquartered in San Antonio, Texas. This product is tailored for commercial and utility applications. Every Mission Solar Energy solar module is certified and surpasses industry standard regulations, providing excellent performance over the long term. Mission Solar Energy is a proud member of the OCI Family of Companies.

## America's Module Company®

### Fair Trade Practices
- Free of forced labor at all stages of the supply chain
- Not subject to AD/CVD tariffs or investigations

### Certified Reliability
- Tested to UL 61730 & IEC Standards
- PID resistant
- Resistance to salt mist corrosion

### Advanced Technology
- Half-cut cell with 10 busbar
- Passivated Emitter Rear Contact
- Engineered for residential and commercial applications

### Extreme Weather Resilience
- Up to 5,400 Pa front load & 2,400 Pa back load
- Tested load to UL 61730 & IEC Standards
- Hail tests results exceed 25mm at 23 m/s

## FRAME-TO-FRAME WARRANTY

Degradation guaranteed not to exceed 2% in year 1 and 0.55% annually from years 2 to 25, with 84.8% guaranteed in year 25; 12-year Material and Workmanship coverage.
For more information, visit www.missionsolar.com/warranty

## CERTIFICATIONS

CEC

TÜV SÜD

ETL Listed C US Intertek

UL 61730 / IEC 61215 / IEC 61730

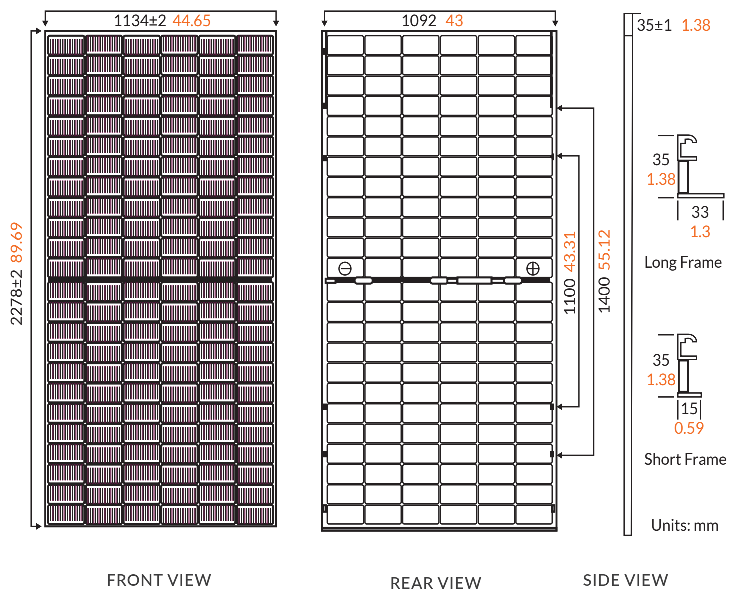
If you have questions or concerns about certification of our products in your area, please contact Mission Solar Energy.

Class Leading
**545-555W**

# MSI PERC Bifacial 144HC, Transparent Backsheet

## BASIC DIMENSIONS

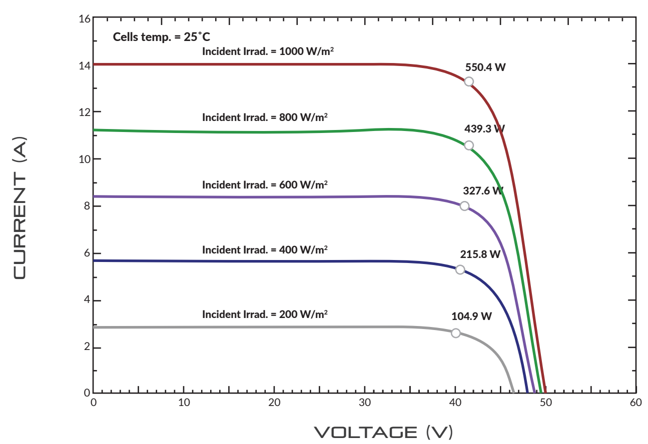
**[UNITS: MM/IN]**




## CURRENT-VOLTAGE CURVE

**MSI10-550HT4T, 144 HALF-CUT CELL SOLAR MODULE**

Current-voltage characteristics with dependence on irradiance and module temperature




## CERTIFICATIONS AND TESTS

| | |
|---|---|
| **MSI10-550HT4T IEC** | **61215, 61730, 61701** |
| **UL** | **61730** |

CEC

## ELECTRICAL SPECIFICATION

| PRODUCT TYPE | MSI10-xxxHT4T (xxx = $P_{max}$) | | | | |
|---|---|---|---|---|---|
| Power Output | $P_{max}$ | $W_p$ | 545 | 550 | 555 |
| Module Efficiency | | % | 21.30 | 21.50 | 21.69 |
| Tolerance | | W | 0/+5 | 0/+5 | 0/+5 |
| Short Circuit Current | $I_{sc}$ | A | 13.92 | 13.99 | 14.02 |
| Open Circuit Voltage | $V_{oc}$ | V | 49.65 | 49.80 | 49.95 |
| Rated Current | $I_{mp}$ | A | 13.04 | 13.11 | 13.19 |
| Rated Voltage | $V_{mp}$ | V | 41.80 | 41.95 | 42.09 |
| Fuse Rating | | A | 30 | 30 | 30 |
| System Voltage | | V | 1,500 | 1,500 | 1,500 |

## BIFACIAL OUTPUT | REARSIDE POWER GAIN

| | | | |
|---|---|---|---|
| 5%-Maximum Power (Pmax) | 572 | 578 | 583 |
| 5%-Module Efficiency STC(%) | 22.37 | 22.57 | 22.78 |
| 15%-Maximum Power (Pmax) | 627 | 633 | 638 |
| 15%-Module Efficiency STC(%) | 24.30 | 24.53 | 24.75 |
| 25%-Maximum Power (Pmax) | 681 | 688 | 694 |
| 25%-Module Efficiency STC(%) | 26.36 | 26.63 | 26.86 |

## TEMPERATURE COEFFICIENTS

| | |
|---|---|
| Normal Operating Cell Temperature (NOCT) | 45°C (±2%) |
| Temperature Coefficient of Pmax | -0.336%/°C |
| Temperature Coefficient of Voc | -0.285%/°C |
| Temperature Coefficient of Isc | 0.040%/°C |

## OPERATING CONDITIONS

| | |
|---|---|
| Maximum System Voltage | 1,500Vdc |
| Operating Temperature Rang | -40°F to 185°F (-40°C to +85°C) |
| Maximum Series Fuse Rating | 30A |
| Fire Safety Classification | UL Type 1 |
| Front & Back Load | Up to 5,400 Pa snow and 2,400 Pa wind load |
| Hail Safety Impact Velocity | 25mm at 23 m/s |

**Mission Solar Energy uses quality sourced materials that result in a Type 1 fire rating. Please note, the 'Fire Class' Rating is designated for the fully-installed PV system, which includes, but is not limited to, the module, the type of mounting used, pitch and roof composition.*

## MECHANICAL DATA

| | |
|---|---|
| Solar Cells Cell | PERC, 182mm x 91mm, 144 (6x24) |
| Orientation | 144 half-cut cells |
| Module Dimension | 2278(±2mm) x 1134(±2mm) x 35(±1mm) |
| Weight | 62.17 lbs. (28.2kg) |
| Front Glass | Front 3.2 mm, transparent backsheet |
| Frame Junction | Anodized aluminum profile |
| Box Cable | Protection class IP68 with 3 bypass-diodes |
| Connector | 1.2m, wire 4mmx² (12AMG) |
| | Staübli EVO2 MC4 |

## SHIPPING INFORMATION

| Pallet | Modules | 550W Bin | Total Weight |
|---|---|---|---|
| 20 | 620 | 341 kW | 39,868.4 lbs. / 18,084 kg |
| 15 | 465 | 255.75 kW | 29,901.3 lbs. / 13,563 kg |

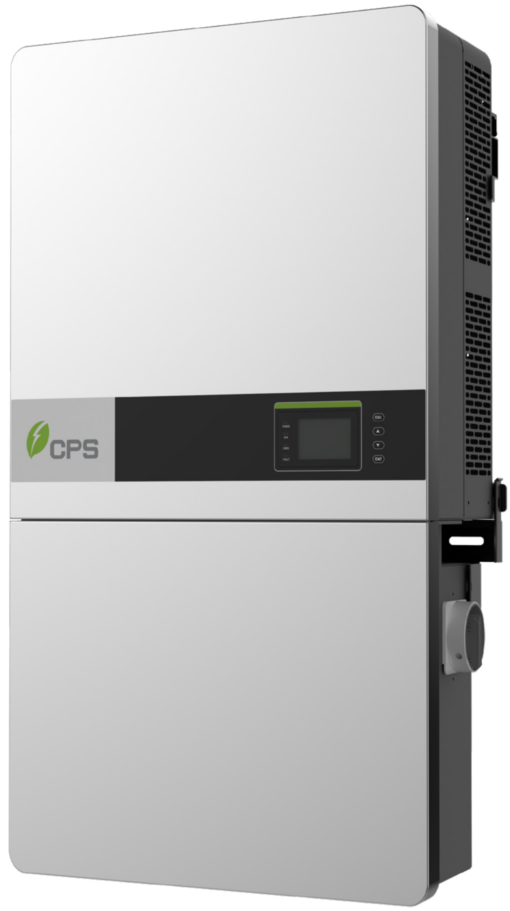
**PALLET [31 MODULES]**

| Weight | Height | Width | Length |
|---|---|---|---|
| 1993 lbs. (904 kg) | 50 in (1270 mm) | 44.5 in (1130 mm) | 91.1 in (2313 mm) |


Mission Solar Energy
8303 S. New Braunfels Ave., San Antonio, Texas 78235
www.missionsolar.com | info@missionsolar.com

# 25 kW-208 V, 1000 Vdc String Inverters for North America

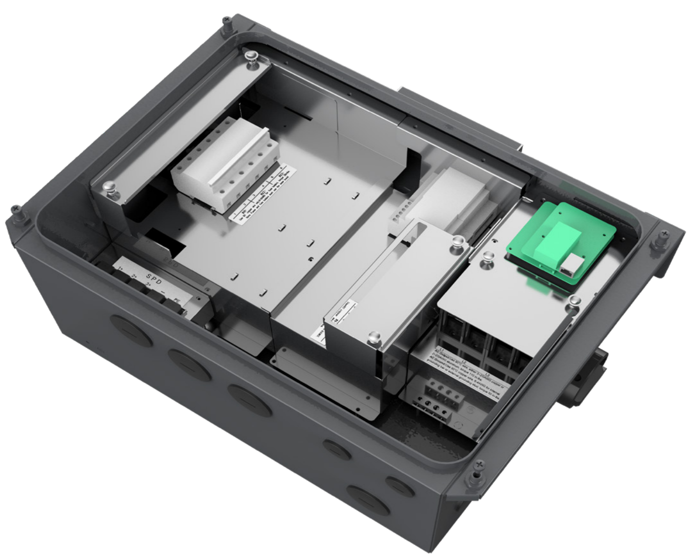
The CPS 25 kW-208 V three-phase string inverters are designed for rooftop and carport applications. The units are high performance, advanced, and reliable inverters designed specifically for the North American environment and grid. High efficiency at 97.0% peak and 96.5% CEC, wide operating voltages, broad temperature ranges, and a NEMA Type 4X enclosure enable this inverter platform to operate at high performance across many applications. The CPS 25KTL-208V product ships with the Rapid Shutdown wire box, fully integrated and separable with touch-safe fusing, monitoring, and AC and DC disconnect switches. The integrated PLC transmitter in the Rapid Shutdown wire box enables PVRSS-certified module-level rapid shutdown when used with APS RSD-S-PLC/RSD-D products. The CPS FlexOM Gateway enables monitoring, controls, and remote product upgrades.



CPS SCA25KTL-DO/US-208

## Key Features

- PVRSS-certified rapid shutdown
- UL-1699B compliant arc-fault circuit protection
- UL 1741-SB and IEEE 1547-2018 certified
- 15-90° mounting orientation for low-profile roof installs
- Optional FlexOM Gateway enables remote firmware upgrades
- Integrated AC and DC disconnect switches
- 3 MPPTs with 2 inputs each for maximum flexibility
- Copper- and Aluminum-compatible AC connections
- NEMA Type 4X outdoor rated, tough tested enclosure
- UL 1741-SA certified to CA Rule 21, including SA8-SA18
- Separable wire-box design for fast service
- Standard 10-year warranty with extensions to 20 years
- Generous 1.8 DC/AC inverter load ratio



SCA25KTL (208V) Rapid Shutdown Wire-box

C US

This device complies with part 15 of the FCC Rules



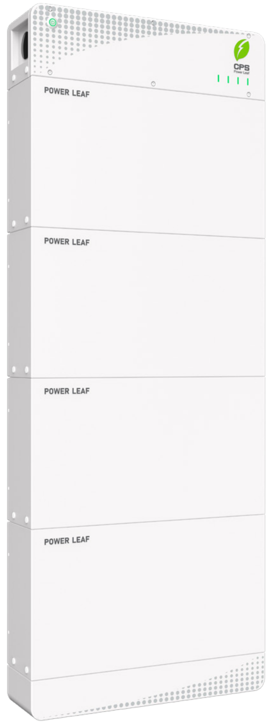


Chint Power Systems America
1380 Presidential Drive, Suite 100, Richardson, TX 75081
Tel: 855-584-7168 Mail: AmericaSales@chintpower.com Web: www.chintpowersystems.com

| | |
|---|---|
| Model name | CPS SCA25KTL-DO/US-208 |
| **DC Input** | |
| Max. PV power | 45 kW (17 kW per MPPT) |
| Max. DC input voltage | 1000 Vdc |
| Operating DC input voltage range | 200-950 Vdc |
| Startup DC input voltage / power | 330 V / 80 W |
| Number of MPPTs | 3 |
| MPPT voltage range for Pnom @ PF>0.99 | 480-850 Vdc |
| Max. PV short circuit current[1] | 108 A (36 A per MPPT) |
| Number of DC inputs | 6 inputs, 2 per MPPT |
| DC disconnection type | Load-rated DC switch |
| DC surge protection | Type II MOV |
| **AC Output** | |
| Rated AC output power @ PF>0.99 | 25 kW |
| Max. AC apparent power | 25 kVA |
| Rated output voltage | 208 Vac |
| Output voltage range[2] | 183-228 Vac |
| Grid connection type | 3Φ / PE / N (neutral optional) |
| Max. AC output current @ 208 Vac | 69.5 A |
| Rated output frequency | 60 Hz |
| Output frequency range[2] | 57-63 Hz |
| Power factor | >0.99 (±0.8 adjustable) |
| Current TRD @ rated load | < 3% |
| Max. fault current contribution (1 cycle RMS) | 64.1 A (0.92 PU) |
| Max. OCPD rating | 125 A |
| AC disconnection type | Load-break rated AC switch |
| AC surge protection | Type II MOV |
| **System and Performance** | |
| Topology | Transformerless |
| Max. efficiency | 97.0% |
| CEC efficiency | 96.5% |
| Standby / night consumption | < 3 W |
| **Environment** | |
| Enclosure protection degree | NEMA 4X |
| Cooling method | Variable speed cooling fans |
| Operating temperature range[3] | -22°F to 140°F (-30°C to 60°C) |
| Non-operating temperature range[4] | -40°F to 158°F (-40°C to 70°C) |
| Operating humidity | 0-100% |
| Operating altitude | 13123 ft / 4000 m (derating from 9843 ft / 3000 m) |
| Audible noise | <60 dBA @ 1 m and 77°F (25°C) |
| **Display and Communication** | |
| User interface and display | LCD+LED |
| Inverter monitoring | SunSpec, Modbus RS485 |
| Site-level monitoring | CPS FlexOM Gateway (1 per 32 inverters) |
| Modbus data mapping | CPS |
| Remote diagnostics / firmware upgrade functions | Standard / (with FlexOM Gateway) |
| **Mechanical** | |
| Dimensions (H × W × D) | 39.4 × 23.6 × 10.2 in (1000 × 600 × 260 mm) |
| Weight | Inverter: 123.5 lb (56 kg)<br>Wire box: 33 lb (15 kg) |
| Mounting / installation angle[5] | 15 to 90 degrees from horizontal (vertical or angled) |
| AC termination | M8 stud type terminal block (wire range: #6-3/0 AWG CU/AL; lugs not supplied) |
| DC termination[6] | Screw clamp, negative busbar[6] wire range: #14-#6 AWG CU |
| Fused string inputs (2 per MPPT) | 20 A or 25 A fuses provided (fuse values up to 30 A acceptable) |
| **Safety** | |
| Certifications and standards | UL 1741-SA/SB Ed. 3, UL 1699B, UL 1998, CSA-C22.2 NO.107.1-01, IEEE 1547-2018, FCC Part 15 |
| Selectable grid standards | IEEE 1547a-2014, IEEE 1547-2018[7], CA Rule 21, ISO-NE, HECO |
| Smart-grid features | Volt-RideThru, Freq-RideThru, Ramp-Rate, Specified-PF, Volt-VAR, Freq-Watt, Volt-Watt |
| **Warranty** | |
| Standard | 10 years |
| Extended terms | 15 and 20 years |

1) The sum of parallel-connected PV module short-circuit currents.
2) The "output voltage range" and "output frequency range" may differ according to the specific grid standard.
3) Active power derating begins at 45°C when PF=1 and MPPT≥Vmin, and at 50°C when PF=1 and MPPT≥700 Vdc.
4) See user manual for further requirements regarding non-operating conditions.
5) Shade Cover accessory required for installation angles of 75 degrees or less.
6) RSD wire-box only includes fuses and fuse holders on the positive polarity.
7) Firmware version 4.0 or later required.

# CPS 5-20 kWh Battery for North America




**CPS ESSR-05-20KL1/US Battery**

CPS is excited to introduce the 5-20 kWh modular batteries for use with CPS single-phase hybrid inverters to the North American market. The Power Leaf solution is scalable from 7.6 kW/5 kWh to 12 kW/20 kWh with up to four stackable battery units when connected to the CPS single-phase hybrid inverters.

The 5-20 kWh batteries are UL9540 certified with the CPS 7.6-12 kW single-phase hybrid inverters as a complete energy storage system (ESS).

## Key Features

- Fully integrated turnkey ESS solution when used with CPS single-phase hybrid inverters
- LFP batteries with high thermal stability and high energy density
- Parallel up to 60 kWh of energy storage with no junction boxes required
- Maximum up to 180 kWh by using multiple energy storages in parallel
- UL9540A tested
- 200 A AC passthrough
- Stackable batteries for simple installation and O&M
- UL 9540 certified with CPS 7.6-12 kW hybrid inverters
- Expandable capacity for small commercial applications

C US

This device complies with part 15 of the FCC Rules





Chint Power Systems America
1380 Presidential Drive Suite 100, Richardson, TX 75081
Tel: 855-584-7168 Mail: AmericaSales@chintpower.com Web: www.chintpowersystems.com

**CPS ESSR-05-20KL1/US Battery Data**

| Product Model | CPS ESSR-05KL1/US | CPS ESSR-10KL1/US | CPS ESSR-15KL1/US | CPS ESSR-20KL1/US |
|---|---|---|---|---|
| **General Data** | | | | |
| Nominal voltage | 51.2 V | | | |
| Operating voltage range | 44.8-57.6 V | | | |
| Max. current | 50 A | 100 A | 150 A | 200 A |
| Max. power | 2.5 kW | 5 kW | 7.5 kW | 10 kW |
| Rated energy | 5 kWh | 10 kWh | 15 kWh | 20 kWh |
| Usable energy | 5 kWh | 10 kWh | 15 kWh | 20 kWh |
| Depth of discharge | Up to 100% | | | |
| C-Rate | 0.5 | | | |
| Max. charge/discharge power | 2.5 kW | 5 kW | 7.5 kW | 10 kW |
| Discharging temperature range | 14°F to 122°F (-10°C to 50°C) | | | |
| Charging temperature range | 32°F to 122°F (0°C to 50°C) | | | |
| Recommended storage temperature | 68°F to 86°F (20°C to 30°C) | | | |
| Operating humidity range | 5-95% | | | |
| Interface and display | LED and mobile app (with CPS single-phase hybrid inverters) | | | |
| Communication | CAN (with CPS single-phase hybrid inverters) | | | |
| **Installation Specifications** | | | | |
| Max. parallel extensions | Up to 60 kWh | | | |
| Weight[1] | 132.3 lb (60 kg) | 229.3 lb (104 kg) | 326.3 lb (148 kg) | 423.3 lb (192 kg) |
| Dimensions (W × D × H)[1] | 26.4 × 7.1 × 25.6 in (670 × 180.3 × 650 mm) | 26.4 × 7.1 × 40.2 in (670 × 180.3 × 1020 mm) | 26.4 × 7.1 × 54.7 in (670 × 180.3 × 1390 mm) | 26.4 × 7.1 × 69.3 in (670 × 180.3 × 1760 mm) |
| Operating altitude | 9842 ft / 3000 m | | | |
| Installation method | Floor- or wall-mounted | | | |
| Cooling method | Natural convection | | | |
| Protection | NEMA 3R / IP65 | | | |
| Black start mode | Yes | | | |
| **Standard Compliance** | | | | |
| Certificates | UN 38.3, UL 1973, UL 9540, UL 9540A, UL 60730, FCC Part 15 | | | |
| **Warranty** | | | | |
| Standard | 10 years | | | |

1) Weight and dimensions include battery module, control module, and base.

Industrial Solutions

Representative Image

## Catalog No. TC35364

**Description: 200A 3P DBL THR N1 600V NONFUSE**

**UPC No 783164001792**

**Home > Switches & Disconnects > Disconnect & Safety Switches > Safety Switches > Double Throw**

Designed for commercial and industrial applications where safety, high performance and continuity of service are essential. Listed to UL standard 98 enclosed and dead front switches. Suitable for use as service equipment when installed in accordance with the National Electrical Code. Suitable for use as transfer equipment in standby systems in accordance with Article 702 of the National Electrical Code. Fusible and non-fusible switches available (consult BuyLog for interrupt ratings). 60/75 C conductor rating. Full cover interlocks. TC35364

### Descriptors

| | |
|---|---|
| Category | Double Throw |
| GO Schedule | SB |

### Specifications

| | |
|---|---|
| Voltage | 600 AC |
| Amperage | 200 A |
| Poles | 3 |
| Wires | 3 |
| Fusing | No Fuse |
| Enclosure | NEMA 1 (Indoor |
| Options | None |
| Wire Range (Cu/Al | 6-250 (Cu |
| 240 Vac, NEC Std, 3-ph | 30.0 hp |
| 480 Vac, NEC Std, 3-ph | 30.0 hp |
| 600 Vac, NEC Std, 3-ph | 30.0 hp |
| GSA Compliance | Yes |

### Classifications

| | |
|---|---|
| cUL Listed | Yes |
| UL Listed | Yes |

### Dimensions

| | |
|---|---|
| Height | 30.2 in |
| Depth | 8.9 in |
| Width | 17.9 in |
| Weight | 62.0 lb |

by ABB

Industrial Solutions

Representative Image

## Catalog No. TM30412C

**Description: 125A 30CRT 3P4W 208Y/120V 10KIC CMB**

**UPC No 783164190007**

**Home > Load Centers > Load Centers**

Main breaker load centers arrive with a main breaker installed for a convenient and swift install. Main breakers allow for the user to stop the flow of electricity in the load center, shutting off all the power in the residence. The TM30412C features spaces for 30, 1" breakers, a 125A main ampere rating, 3 phases, and a combination surface/flush enclosure.

### Descriptors

| | |
|---|---|
| Category | Load Centers |
| GO Schedule | R7 |

### Specifications

| | |
|---|---|
| Load Center Type | Standard |
| Input/Output Voltage | 208Y/120V ac |
| Interrupting Capacity Rating | 22 |
| Amperage | 125 A |
| Device type | Main Breaker |
| Enclosure | Indoor |
| Phase | 3 Phase |
| 1" Space | 30 |
| 1/2" Space | 0 |
| Feed | Top |
| Door | Yes |
| GSA Compliance | Yes |
| Circuit Breaker Style | Plug-In |
| NEMA Rating | NEMA 1 |
| Factory Installed Ground Kit | No |
| # Branch Circuit 250A | 30 |
| Enclosure Type | Indoor, Combination |
| Wires | 4 Wire |
| Service & Voltage | 3 Phase, 4 Wire, 208Y/120V ac |

### Classifications

| | |
|---|---|
| UL/CUL Listing | UL |

### Dimensions

| | |
|---|---|
| Width | 14.0 in |
| Depth | 3.7 in |

by ABB

**Publications**

| Title | Publication No. | Publication Type |
|---|---|---|
| Section 1 BuyLog: Load centers and circuit breakers<br><br>Guide includes product features, photos, product number selection guide, knockout drawings, wiring diagrams, accessories and options list. Only available on-line. | DET1023 | Application and Technical |

**Additional Documentation:** Visit our Publication Library to find technical documentation, time current curves, CSI Specifications and promotional literature.

# Resilience Hub Planning In Clinchco, Virginia

Authors: Appalachian Voices and The Town of Clinchco

Date – October 31, 2025

## Acknowledgements

The sources for much of the information in this case study come from partners in Dickenson County, stakeholders in the Town of Clinchco and leadership at Missionary Baptist Church. The authors would like to thank participants for their valuable input and participation in the Virginia Energy Resilience Study.

## Disclaimer

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## Resilient Hub Project Background

Clinchco, VA, is a former coal company town established by Clinchfield Coal Company in Dickenson County. This once-thriving community is now home to just over 350 residents with nearly 32% of the population living below the poverty line. Many issues in Clinchco, including the lack of energy resilience, stem from the decline of the coal industry and the subsequent lack of local revenue and investment in infrastructure. Dickenson County has faced environmental challenges at an increasing rate, and these events are compounded in Clinchco by its isolation, exposure to dangerous coal waste runoff, and limitations for the community to prepare for recovery. One of the most recent flooding events in Clinchco was a flash flood in February 2025, resulting in a declared state of emergency and leaving entire neighborhoods without power, access to transportation, and critical infrastructure. Residents have named a resilience hub as an important investment in the community to afford basic necessities to community members during these events.

## The Challenge

Clinchco is a rural community isolated geographically from the surrounding towns in the county. With only a few roads in and out of town and miles to access critical infrastructure, weather disasters and power outages pose a dangerous threat to community members. Assessing the town community energy resilience challenges using the Energy Resilience Workbook created by the Center for the Advancement of Sustainable Energy at James Madison University identified resource availability and disparities.

The community has an ageing population, an estimated half of whom do not have access to a car or the ability to leave their homes. Therefore, the lack of available town resources, such as a rescue squad, an acute medical care facility, a communication and alert system, and a gas station, poses a significant threat to residents. This is especially important as weather-related emergencies and power outages increase.

The closest emergency shelter to Clinchco is located 7.8 miles from the center of town. Furthermore, each road out of town leading to the shelter is in the flood plain, as identified by FEMA. This may cause significant challenges to residents reaching the shelter during natural disasters.

Public transit is provided in town by Four County Transit, but it was uncertain if vehicles were housed in town. This was because transportation workers can keep fleet vehicles at their residences. The uncertainty of public transit, combined with high vehicle access within town, makes it less likely that residents will be able to travel to out-of-town shelters during an outage.

The town lacks a reliable source of produce, over-the-counter medication, fuel, and other crucial household items due to a shortage of local businesses. This further limits the ability of individuals stranded during emergencies to procure the necessary resources for safe sheltering within town.

Existing resources within town limits rarely have backup power, and those with existing generators were identified as in need of replacement. Such generators were not expected to be able to provide power for over twenty-four hours.

Additional challenges identified by the town, but not assessed in the workbook, included aging infrastructure. Clinchco struggles with outdated water systems, roads, and bridges, which can fail during daily operation and extreme weather. Should any of this infrastructure fail, it would impose an increased burden on county emergency response and the safety of residents sheltering at home.

## Community Engagement

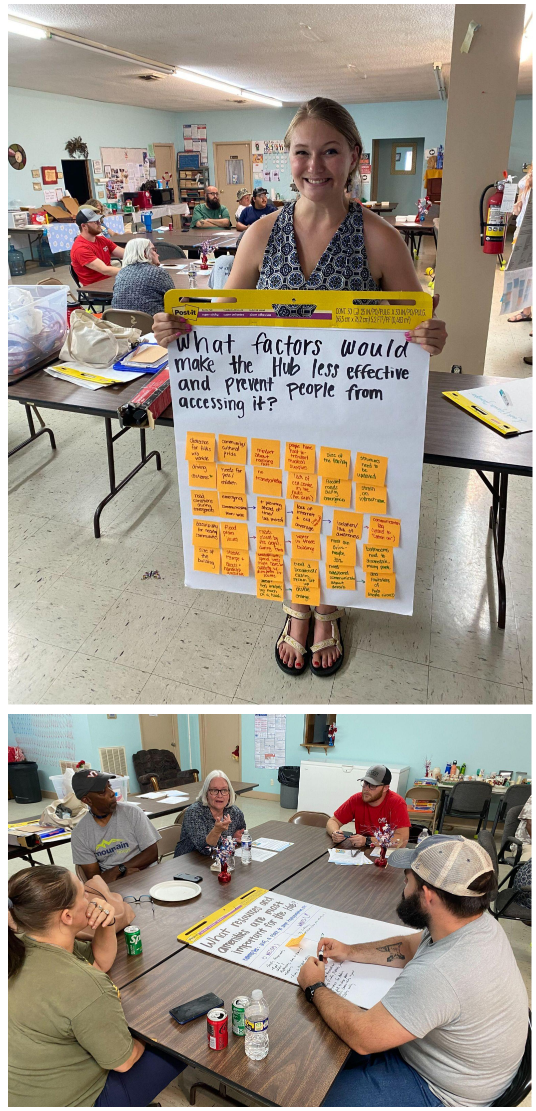



Figure 1: Top - Clinchco community members at a community resilience planning meeting. Bottom - sheet of community feedback for resilience hub planning. Image credit - Appalachian Voices

The Town of Clinchco, with technical assistance from Appalachian Voices, hosted input sessions for community stakeholders, community members, and county officials. The purpose of each meeting was to gather information about the perceived assets, gaps, opportunities, and considerations to take into account in planning a resilience hub for the town. At the initial community listening session, 13 residents provided input, listing and prioritizing 30 unique community needs for resilience. Stakeholders, such as members of the county planning commission, elected officials, and utility representatives, provided important context from their points of view in the stakeholders meeting.

To identify feasible locations for a town energy resilience hub, community members provided feedback on three prompts:

1. What resources and amenities are most important for the hub?
2. What factors make a resilience hub less effective and prevent people from accessing it?
3. Please list pros and cons of each proposed site - Clinchco Fire Department, Clinchco Missionary Baptist, the closed convenience store, and a school district-owned trailer.

Feedback provided by community members included, but was not limited to, Americans with Disabilities Act (ADA) accessibility, available space for various purposes, reliability of ownership, access to food preparation, building infrastructure, and visibility within the community. All feedback was then assessed across each proposed site to see which, if any, met a majority of the community's expectations.

Following the resilience hub community meeting, a second meeting of local stakeholders provided feedback on the Energy Resilience Workbook. This meeting highlighted the knowledge of local residents and stakeholders on the community, despite the inaccessibility of county emergency management personnel. Stakeholders were mostly able to address the checklists provided in the Energy Resilience Workbook or provide contacts for facilities not represented at the meeting. This feedback also provided important insight into residential vulnerabilities and the informal emergency practices experienced within the community.

## The Solution: Equip local facility with Solar + Storage

Using this qualitative feedback in tandem with county-provided data and the results of the workbook, participants were able to identify Clinchco Missionary Baptist Church as the ideal location for a future resilience hub. Clinchco is currently awaiting a solar PV + battery storage feasibility analysis through APTIM, as funded by the Virginia Department of Energy's Energy Resilience Planning Grant. Full feasibility analyses may be provided upon request.

### Backup Power

Providing solar PV, battery storage, and potentially a diesel generator, was identified as of interest by the town. Clinchco and Appalachian Voices have successfully coordinated with Clinchco Missionary Baptist to provide the required information to complete a feasibility study for the project.

*Figure 2: Clinchco Missionary Baptist Church - site of potential community energy resilience hub. Image credit - Appalachian Voices*

### Utilizing Existing Resources

Community and stakeholder engagement identified Clincho Missionary Baptist as a potential resource to build upon to support increased energy resilience for the town. Furthermore, the church was already able to provide many of the resources and amenities identified as important during an emergency event. These considerations included a working kitchen, clothes and food storage facilities, backup heat, reliable cooling equipment, handicap accessibility, entertainment equipment, space for sensory considerations, community centric location, outdoor signage, parking space, local familiarity, and local cultural importance.

### Energy Affordability

Energy affordability was identified as another benefit by Clinchco and the church. As energy bills are one of the highest annual costs to the facility, energy bill reductions would help with facility maintenance, accessibility, and improve community resources and services.

## System Details

The Town of Clinchco received an energy resilience feasibility study completed by AMPIM for the Clinchco Missionary Baptist Church. The study included recommendations for a solar PV, battery backup, and generator system to maximize resilience.

### Solar Energy

The feasibility study completed by AMPIM recommended an 18 kW rooftop solar PV array for Clinchco Missionary Baptist. A secondary option of a carport system over the church parking lot was also deemed feasible if the rooftop was not preferred. The solar array would be able to service most of the facility's electrical needs during full sunlight hours.

### Battery Backup

A 10 kW battery energy storage system was recommended to meet the town's resilience goals. Critical loads served include refrigerators, lighting, a single HVAC unit, and other miscellaneous electrical loads. This created an estimated critical load of 12.8 kWh. Subpanels may be adjusted to ensure that only critical loads are powered by the solar and battery backup system. Battery storage operation during non-sunlight hours may maintain loads for between 1.4 and 3.15 hours. Resilience may be increased by constraining load usage by necessity and use scheduling.

### Mobile Generator

Though not required, a mobile 24 kW generator was also modeled for the facility to ensure energy accessibility in the case of an outage. By adding a separate generator, the facility will be able to better sustain power during extended outages, power additional critical loads, and provide backup redundancy to maximize energy resilience. This generator may be fuel-based or non-fuel-based. Additionally, a mobile generator provides the ability to maneuver equipment in response to flood risks and other local needs.

### Additional Distribution Equipment

To properly utilize the solar panel, battery backup, and mobile generator system, a new subpanel and manual transfer switch would be needed. This new subpanel would house circuits for the critical loads the facility would need to maintain during an outage, ensuring that the demand for non-essential circuits does not reduce backup power availability. A manual transfer switch would serve as a utility disconnect and enable the use of the mobile generator during extended power outages.

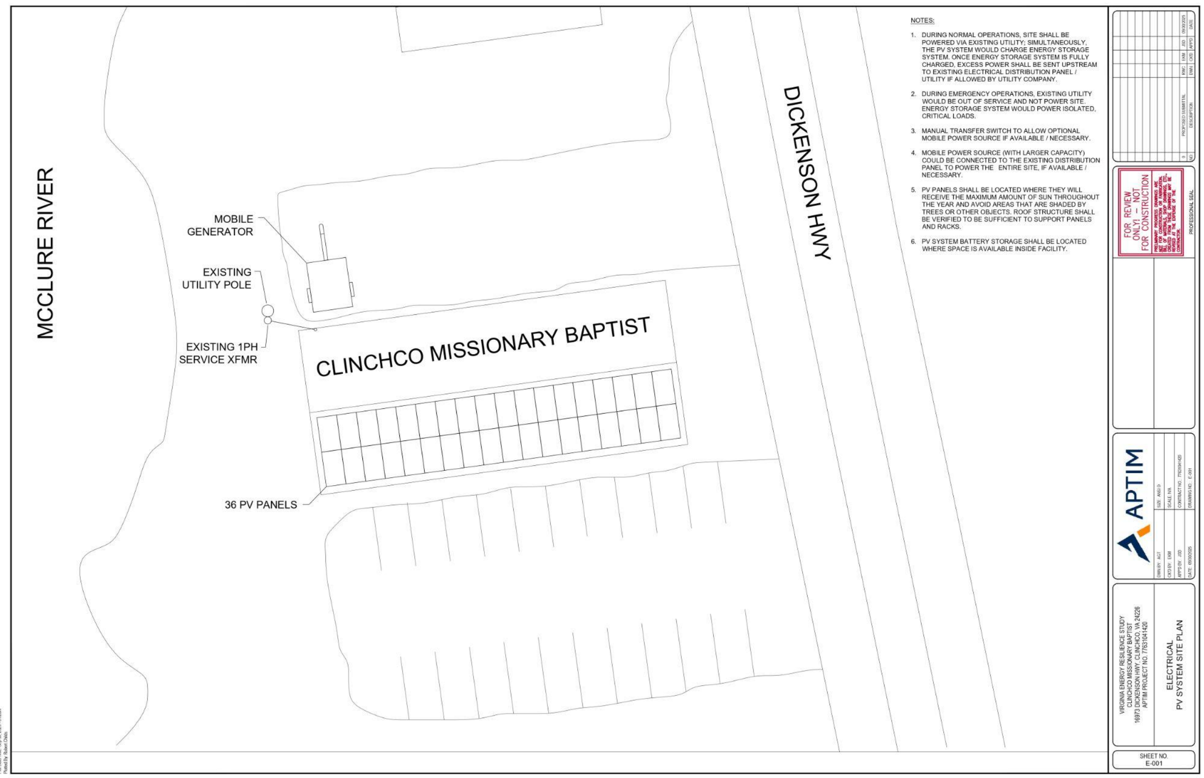



*Figure 3: Electrical PV System Plan by APTIM showing the potential layout of a solar PV and mobile generator system at Clinchco Missionary Baptist Church.*

## Financial Details

A financial analysis of the solar energy, battery storage, or mobile generator was not provided for Clinchco Missionary Baptist.

# Lessons Learned

## Emergency Management Department Capacity Limitations

During the Virginia Energy Resilience Study process, Clinchco experienced regular capacity challenges in working with the local emergency management department. This limited engagement and broader emergency planning coordination opportunities for the town. This may indicate a need for additional funding and support to rural emergency management departments. Despite this lack of capacity, community members and stakeholders were able to identify a pathway for increasing local energy resilience and should consider coordinating with the emergency management department prior to project implementation.

## Assessing Floodplain Risks

Appalachian Communities often face challenges due to their presence within the floodplain, as many communities and facilities are located in lower elevation pockets, typically near a stream or river. Clinchco is no exception to this, which added an additional challenge to siting a solar PV and energy storage system for the town. Of the sites identified through stakeholder and community engagement, all but one structure was both outside of a floodplain and feasible for solar development. Unfortunately, this site was not recommended as it was currently unoccupied and under new ownership. While it is best for resilience hubs to be placed outside of the floodplain entirely, this may not be an option. In such cases, weighing the benefits and drawbacks of each site and multiple site characteristics, not just flood plains, is crucial to determining the most appropriate site for the community.

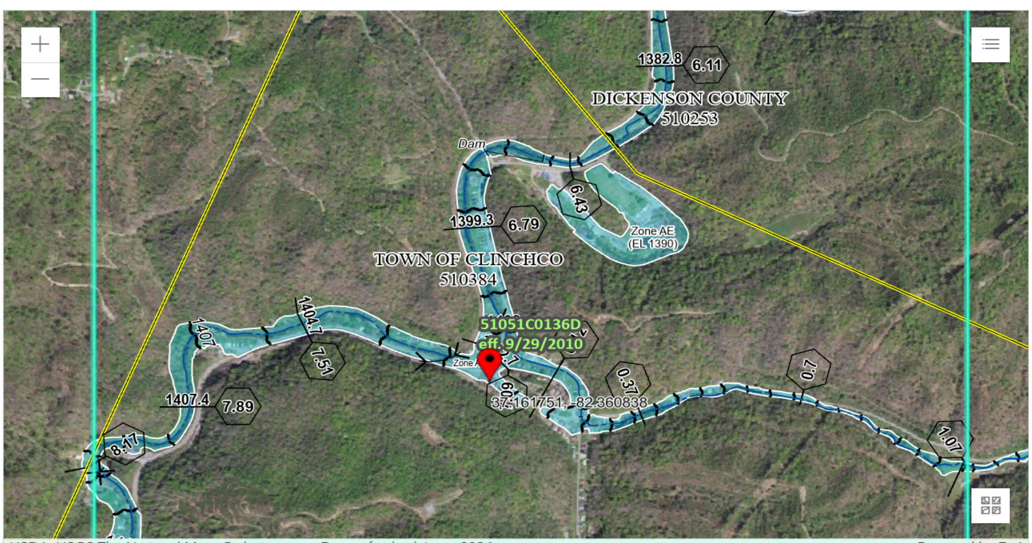



*Figure 4: Map of flood of Clinchco, VA. Image credit - USDA & USGS ([https://msc.fema.gov/portal/search?AddressQuery=clinchco%20VA](https://msc.fema.gov/portal/search?AddressQuery=clinchco%20VA))*

| **Project Title:** | **Project #:** | **Date:** |
|---|---|---|
| Virginia Energy Resilience Study (VERS) | 77631041420 | 30-Sept-25 |

# CLINCHCO, VA - SOLAR RESILIENCY STUDY FOR SOLAR PLUS STORAGE

APTIM
11400 PARKSIDE DR.
SUITE 400
KNOXVILLE, TN 37934
(865) 560-7800

Ethan Marsh ______________________

Preparer

Fermin Cabrera ______________________

Reviewer

N/A ______________________

Design Verifier

Design Verification Method:

☒ N/A ☐ Independent Review ☐ Alternate Calculation ☐ Qualification Testing

Total Document Pages: 6
Total Attachment Pages: 17

**Summary**

The project site for Clinchco is at Clinchco Missionary Baptist, found at 16973 Dickenson Hwy, Clinchco, VA 24226. Per correspondence with the town's representative(s), a permanent solar power installation with a battery energy storage system (BESS) would best fit the town's necessities if the local utility power were unavailable due to natural disasters or other unprecedented scenarios. The recommended approach for such installation is as follows:

> The solar panels would be installed on the southern portion of the building, for maximum sun exposure. Having a roof installation would not require the property to render real estate to the equipment; if the roof is not favorable, a solar carport (essentially a structurally sound carport with solar panels mounted on its roof) constructed at the church's parking lot could also be an option.
>
> For the BESS, it would ideally be installed near the power distribution equipment that it will serve, physically inside the facility. If there is no available footprint within the building, meeting relevant National Electrical Code (NEC) and local codes, then installing the apparatus outside the building would be the next option, so long as the enclosure is rated for the outdoors. Dimensions for the unit differ depending on the battery's capacity, but the typical footprint would be 26" W x 8" D x 70" H or smaller.
>
> Additional power distribution equipment would be required for this solar panel system, such as a subpanel and manual transfer switch. Ideally, any electrical loads or existing circuits the site wishes to energize during a power outage would be transferred to a new subpanel; an acceptable size for this subpanel would be a 100 Amp bus with 30-poles or less. Moreover, a manual transfer switch would be placed in between the existing distribution panel and the subpanel. This manual transfer switch would serve as a utility disconnect and provide the site an option to connect a mobile power source (a generator or other modular energy storage) to the new subpanel.
>
> Prior to any construction work, the site's representatives should engage the local utility for their requirements on connecting a distributed energy resource (DER), if the intention is to have the solar panel system connected to the local grid for credits towards the monthly

utility expense. At the time of this report, an application and approval are required for such endeavors.

## Load Analysis

- Peak Load (kWh): 3,960
- Estimated, Average Daily Load (kWh): 57.4
- Critical Loads (list key equipment/systems): Refrigerator, lighting, a single HVAC unit, and miscellaneous electrical loads *(based on correspondence with the site, exact electrical loads or circuits are to be verified).*
- Critical Equipment Operating Hours: 24 hours for the refrigerator and varied hours of use for other loads.
- Estimated, Critical Loads (kWh) 12.8

## Capacity Assessment

- Proposed Solar Array (kW): 16.2
- Recommended Battery Storage Size: 20kWh or ~1.40 hours (given the estimated, critical loads).
- Resiliency Goal (hours/days of grid independence): The solar panel arrays would likely sustain the estimated critical loads alone, without the use of the BESS, during optimal daylight hours; the BESS shows its utility at night and when powering a larger load, such as the single HVAC unit. Note that the BESS's runtime would be largely dictated by this continuous, motor load.

## Proposed Equipment and Technology

- Solar Module Type/Model: Mission Solar Energy, Bifacial MSI10-550HT4T
- Number of Panels:36 (3 sets of 6 x 2)
- Inverter Type and Capacity: Chint Power Systems, CPS ECH12K, 12kW

- Battery Type and Capacity: Chint Power Systems, CPS ESSR-20KL1, 20kW
- Resiliency Features: Turnkey solution; parallel up to 60kWh of energy storage with no additional junction boxes; hybrid inverter; integrated AC and DC disconnect switches; PV, battery and generator inputs; Wi-Fi monitoring; general UL and NEC compliance & arc-fault circuit protection & rapid shutdown.

## Installation and Integration

- Site Description: Roof or carport mount.
- Construction/Prep Requirements: Relevant permits required; recommend reviewing:
    A. 2021 Virginia Statewide Fire Prevention Code
    B. 2021 Virginia Energy Conservation Code
    C. 2021 Virginia Residential Code
    D. 2021 Virginia Building and Fire Code Related Regulations
    E. NEC 2020
- Utility Interconnection Details: Recommend reviewing:
    A. Appalachian Power's *Consumer Checklist*
    B. Appalachian Power's *DER Technical Interconnection and Interoperability Requirements (TIIR) for the AEP System*

## Summary & Recommendations

- Key Findings: The proposed components were sized per the requested, critical loads; the same components reflect an ideal scenario, with the following assumptions:
    A. The critical loads are accurate.

B. Sufficient footprint for working and dedicated spaces are feasible for the new electrical equipment, per the NEC.

C. The facility's roof, walls, and other frameworks are structurally sound.

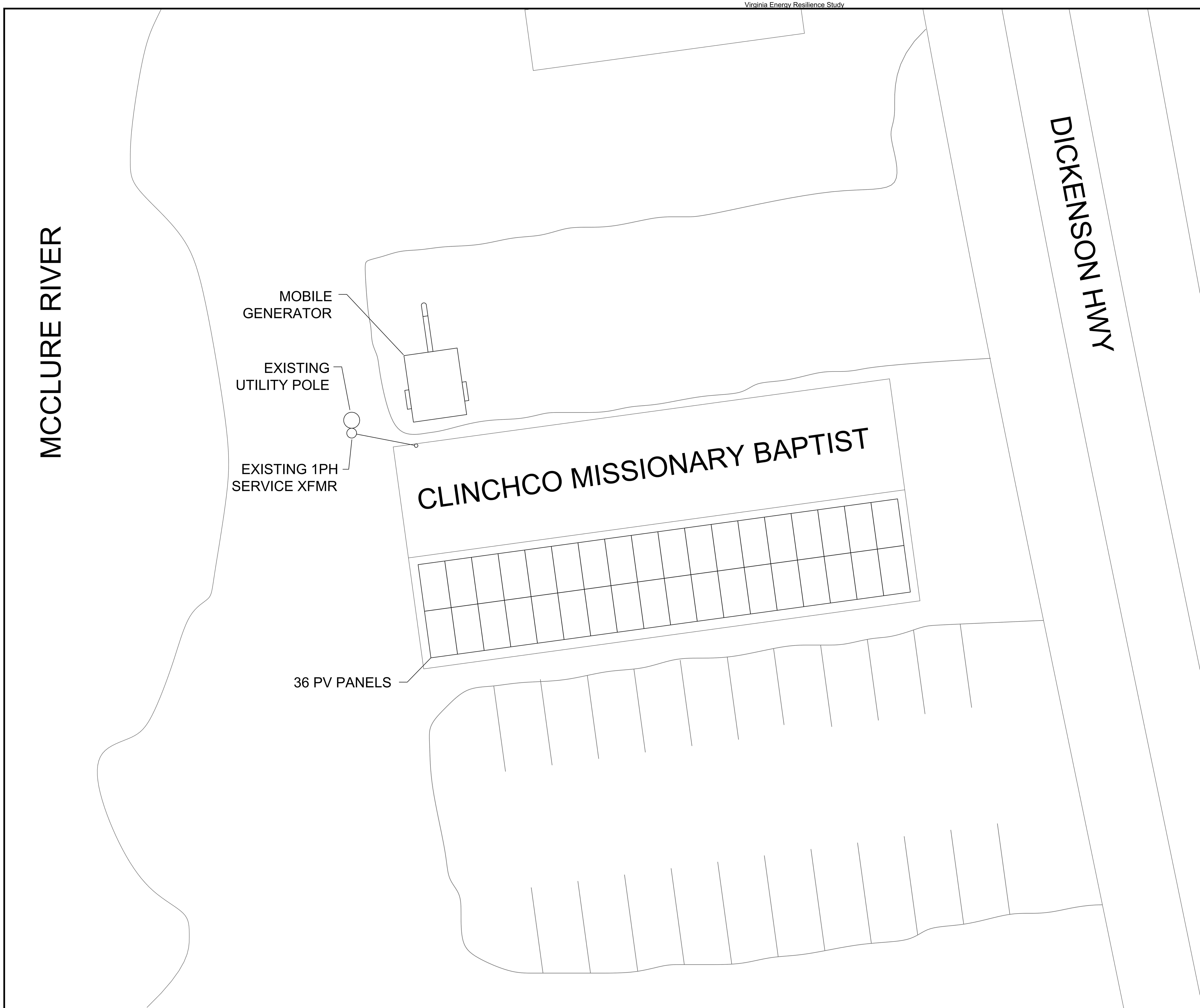
D. The local utility has a DER credit program for lowering a customer's utility expense.

- Comparison of Load vs. Capacity: As stated above, the proposed solar panel arrays have the capability to power all critical loads continuously, except for the single HVAC unit; the solar panel arrays may be inadequate to sustain the inrush current. Note, the subpanel could be wired such that no large loads are powered by the solar plus storage (i.e., removing the HVAC units, water heaters, and oil heaters) to extend the BESS' runtime. As an example, removing the HVAC load increases the BESS' operation from 1.40 to 3.14 hours, assuming the solar array are not providing continuous power to the system. Better stated, the proposed design and components could be scaled back to meet constraints like, necessity, constructability, scheduling.
- Anticipated Benefits: This solar plus energy storage has great potential to provide a continuous stream of low-voltage power to the local community when necessary. Moreover, it will not be idle given the opportunity to decrease the electricity consumption of the facility.

| | | |
|---|---|---|
| APTIM | **CLINCHCO, VA** | |

## Attachment A: Engineering Design Information

| Document Name | Reference | Quantity of Pages |
|---|---|---|
| APTIM, Proposed Electrical Drawings | N/A | 2 |
| APTIM, Electrical Calculations | N/A | 3 |
| Vendor, Proposed Equipment's Cut Sheets | N/A | 12 |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |




NOTES:

1. DURING NORMAL OPERATIONS, SITE SHALL BE POWERED VIA EXISTING UTILITY; SIMULTANEOUSLY, THE PV SYSTEM WOULD CHARGE ENERGY STORAGE SYSTEM. ONCE ENERGY STORAGE SYSTEM IS FULLY CHARGED, EXCESS POWER SHALL BE SENT UPSTREAM TO EXISTING ELECTRICAL DISTRIBUTION PANEL / UTILITY IF ALLOWED BY UTILITY COMPANY.
2. DURING EMERGENCY OPERATIONS, EXISTING UTILITY WOULD BE OUT OF SERVICE AND NOT POWER SITE. ENERGY STORAGE SYSTEM WOULD POWER ISOLATED, CRITICAL LOADS.
3. MANUAL TRANSFER SWITCH TO ALLOW OPTIONAL MOBILE POWER SOURCE IF AVAILABLE / NECESSARY.
4. MOBILE POWER SOURCE (WITH LARGER CAPACITY) COULD BE CONNECTED TO THE EXISTING DISTRIBUTION PANEL TO POWER THE ENTIRE SITE, IF AVAILABLE / NECESSARY.
5. PV PANELS SHALL BE LOCATED WHERE THEY WILL RECEIVE THE MAXIMUM AMOUNT OF SUN THROUGHOUT THE YEAR AND AVOID AREAS THAT ARE SHADED BY TREES OR OTHER OBJECTS. ROOF STRUCTURE SHALL BE VERIFIED TO BE SUFFICIENT TO SUPPORT PANELS AND RACKS.
6. PV SYSTEM BATTERY STORAGE SHALL BE LOCATED WHERE SPACE IS AVAILABLE INSIDE FACILITY.

| NO. | DESCRIPTION | DWN | CK'D | APP'D | DATE |
|---|---|---|---|---|---|
| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

FOR REVIEW ONLY! – NOT FOR CONSTRUCTION

PRELIMINARY PROGRESS DRAWINGS ARE NOT FOR CONSTRUCTION OR FABRICATION. BILL OF MATERIALS, SHOP DRAWINGS, ETC., CREATED FROM THESE DRAWINGS MAY BE REVISED AT THE EXPENSE OF THE CONTRACTOR.

PROFESSIONAL SEAL

APTIM

DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025

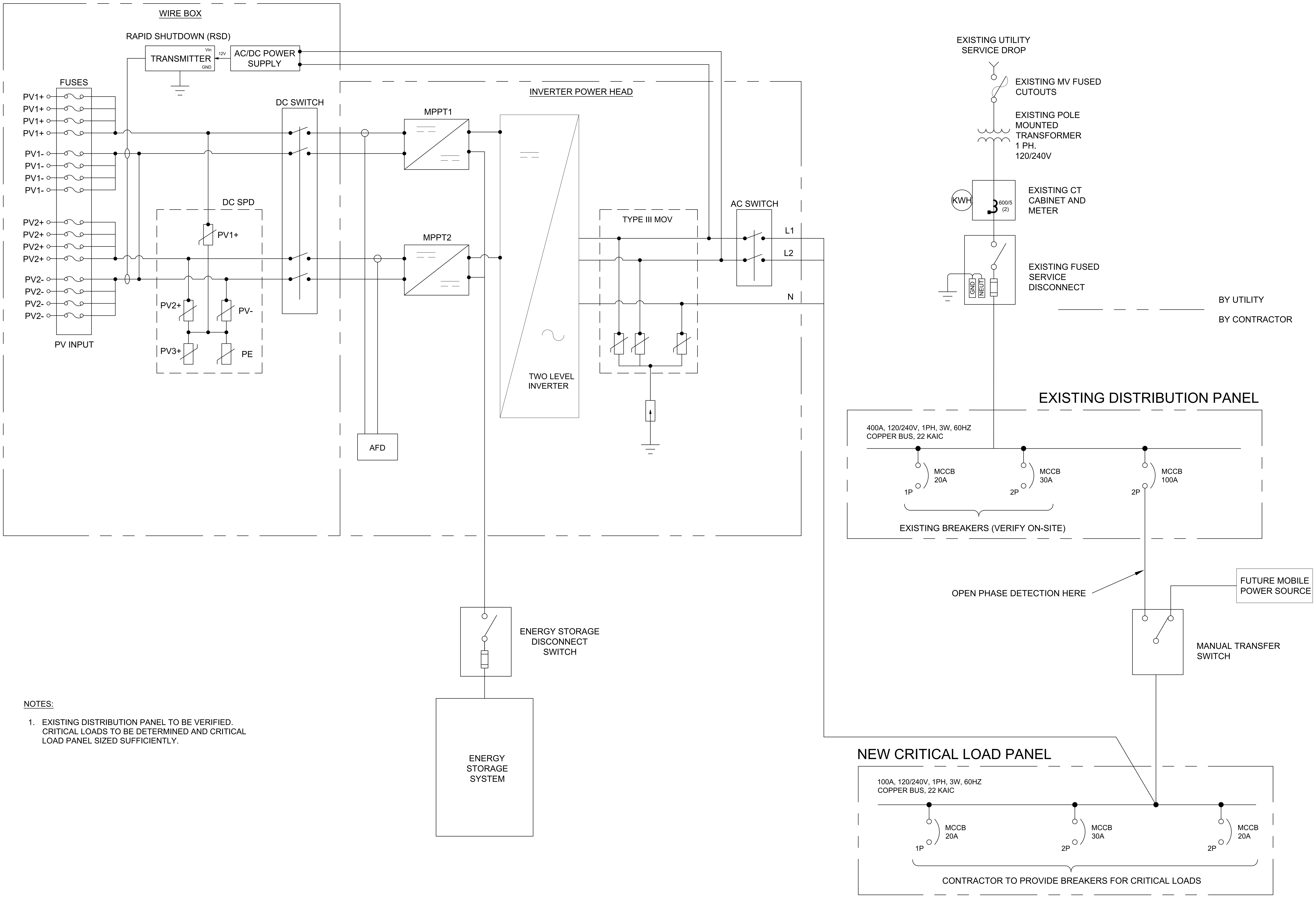
SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-001

VIRGINIA ENERGY RESILIENCE STUDY
CLINCHCO MISSIONARY BAPTIST
16973 DICKENSON HWY, CLINCHCO, VA 24226
APTIM PROJECT NO. 77631041420

ELECTRICAL
PV SYSTEM SITE PLAN

SHEET NO.
E-001

File: Clinchco Missionary Baptist 16973 Dickenson Hwy.dwg
Plot Date/Time: Sep 30, 2025 - 8:02am
Plotted By: Robert Childs




NOTES:

1. EXISTING DISTRIBUTION PANEL TO BE VERIFIED. CRITICAL LOADS TO BE DETERMINED AND CRITICAL LOAD PANEL SIZED SUFFICIENTLY.

| NO. | DESCRIPTION | DWN | CK'D | APP'D | DATE |
|---|---|---|---|---|---|
| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

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PROFESSIONAL SEAL

APTIM

SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 7763104142O
DRAWING NO.: E-002

DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025

VIRGINIA ENERGY RESILIENCE STUDY
CLINCHCO MISSIONARY BAPTIST
16973 DICKENSON HWY, CLINCHCO, VA 24226
APTIM PROJECT NO. 7763104142O

ELECTRICAL
PV SYSTEM ONE-LINE DIAGRAM

SHEET NO.
E-002

File: Clinchco Missionary Baptist 16973 Dickenson Hwy.dwg
Plot Date/Time: Sep 30, 2025 - 8:02am
Plotted By: Robert.Childs

## Load Tabulation

**Single Phase**

| ID Tag No. | Item | Qty. | Voltage | FLA / VA | Units | Continuous | |
|---|---|---|---|---|---|---|---|
| | REFRIGERATOR | 1 | 120 | 2.3 | A | Yes | 345 VA |
| | LIGHTING (1,000 sqft space) | 1000 | 120 | 3.0 | VA | Yes | 3,750 VA |
| | MISCELLANEOUS (mobile devices…) | 1 | 120 | 10.0 | A | Yes | 1,500 VA |
| | HVAC | 1 | 240 | 24.0 | A | Yes | 7,200 VA |
| | | | | | | Single Phase Loads Subtotal | **12,795 VA** |

**Three Phase**

| ID Tag No. | Item | Qty. | Voltage | FLA / VA | Units | Continuous | |
|---|---|---|---|---|---|---|---|
| | | | | | | Three Phase Loads Subtotal | |

**SUMMARY**

| | |
|---|---|
| System Voltage | **240.0** |
| Connected Load | **12,795 VA** |
| Full Load Current (Single and Three Phase) | **53 Amps** |
| Conductor Material | **Copper** |
| Main Breaker Rating (sized to load main breaker at a maximum of 80%) | **70 Amps** |
| Main Panelboard Bus Rating (Minimum per main breaker rating) | **70 Amps** |
| Transformer design basis per full load current | **55,404.0 VA** |
| Minimum transformer size (80% load consideration) | **75.0 kVA** |
| Temperature rating of conductor | **75** °C |
| New Ambient temperature | **40** °C |
| Required conductor ampacity found from NEC formula in section 310.60(C)(4) | **80** A |

$$I = I' \Big/ \sqrt{\frac{T_c - T_a'}{T_c - T_a}}$$

**I** = Required ampacity of conductor after derating
**I'** = Ampacity corrected for ambient temp.
**Tc** = Temperature rating of conductor
**Ta'** = New ambient temperature
**Ta** = Ambient temperature from NEC table 310.16

| | |
|---|---|
| Minimum required conductor size (1 set of 4-1/C) | **4 AWG** |
| Minimum required parallel conductor size (2 sets of 4-1/C) | **8 AWG** |

**Table 1. Hourly Electric Load Profile**

| **Hour (HHMM, 24-hour)** | 0000 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| REFRIGERATOR | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 | 345 |
| LIGHTING (1,000 sqft space) | 3750 | 3750 | 3750 | 3750 | 3750 | 3750 | 3750 | 3750 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3750 | 3750 | 3750 | 3750 | 3750 | 3750 | 3750 | 3750 |
| MISCELLANEOUS (mobile devices…) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 | 1500 |
| HVAC | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 | 7200 |
| **Total Hourly Load (VA)** | 4095 | 4095 | 4095 | 4095 | 4095 | 4095 | 4095 | 4095 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 9045 | 12795 | 12795 | 12795 | 12795 | 12795 | 12795 | 12795 | 12795 |

CPS

# Solar PV String Sizing Tool - Regional Estimate

6/26/2025 V6.0.3

## Virginia Energy Resilience Study

**Project Name**

CLINCHCO # 40495

**Design Date** 9/29/2025

| | | |
|---|---|---|
| Site Location (Lat/Lon)? | 37.9 | -82.2 | 
| | 41 Miles to Selected Station | |
| Temperature Source (ASHRAE or Manual) | ASHRAE 2% High Temp | |
| Country | United_States | |
| State/Province | West_Virginia | Lat / Lon |
| ASHRAE Weather Station | HUNTINGTON TRI-STATE ARPT | 38.4 / 82.6 |

E3

| | ASHRAE | SELECTED |
|---|---|---|
| Extreme Low Temp | -18.0 °C | -18.0 °C |
| ASHRAE 2% High Temp | 34.7 °C | 34.7 °C |

**Equipment Selection**

Roof, Fixed, or Single Axis? **Roof**

R

| | | |
|---|---|---|
| MPPT 1 Module | MISSION MSN10-550HT4T | MonoFacial |
| MPPT 2 Module | MISSION MSN10-550HT4T | MonoFacial |
| MPPT 3 Module | MISSION MSN10-550HT4T | MonoFacial |

Strings= 6 Total Modules 36

Chint Inverter Model Number **ECH12k-Hybrid 1 Phase**

**System Design Parameters**

Inverter Options

MPPT Range | **Inverter Voltage Range**

**APPROVED** 9/29/2025

**INVERTER DESIGN COMPATIBILITY STATUS**

| High Voc | Isc | DC/AC Ratio (3hr) |
|---|---|---|
| Status | Status | Status |

TMY-Peak

**Array Design Options**

| | MPPT 1 | MPPT 2 | MPPT 3 |
|---|---|---|---|
| String Length | 6 | 6 | 6 |
| String Length (Max \|\| Min) | 10 \| \| 4 | 10 \| \| 4 | 10 \| \| 4 |
| Number of Strings (2 Max.per MPPT) | 2 | 2 | 2 |

| | MPPT 1 | MPPT 2 | MPPT 3 | TOTALS | LIMIT MPPT | LIMIT Total |
|---|---|---|---|---|---|---|
| Connected Wdc (t)(DYNAMIC) | 5406 | 5406 | 5406 | 16219 | 7500 | 18000 |
| Connected Isc(t)(DYNAMIC) | 29.7 | 29.7 | 29.7 | 89.0 | 32.0 | 96.0 |
| Connected Voc @$T_{MIN}$ | 339 | 339 | 339 | | 600 | 600 |
| | 303 | 303 | 303 | 303.2 | 120 | 120 |

◉ Select Manf. Spec
○ Select Alt Fuse

INVERTER HAS NO STRING FUSES
Module Listing may require In-Line Fuse

**Module Specifications**

| MODULE NAME | MISSION MSN10-550HT4T | MISSION MSN10-550HT4T | MISSION MSN10-550HT4T |
|---|---|---|---|
| Rated Power (STC) | 550 Wstc | 550 Wstc | 550 Wstc |
| Rated Power (t) [Regional Simulation Estimate] | 451 W(t) | 451 W(t) | 451 W(t) |
| Max System Voltage (Vdc) | 1500 Vdc | 0 Vdc | 1500 Vdc |
| Module Voc (STC) | 50 Vdc | 50 Vdc | 50 Vdc |
| Module Vmp (STC) | 42 Vdc | 42 Vdc | 42 Vdc |
| Module Imp (STC) | 13.1 Adc | 13.1 Adc | 13.1 Adc |
| Module Isc (STC) | 13.9 Adc | 13.9 Adc | 13.9 Adc |
| Module Isc(t) (Peak(1-hr)) | 14.8 Adc | 14.8 Adc | 14.8 Adc |
| Manufacturer's Fuse Rating (Max) | 30.0 Adc | 30.0 Adc | 30.0 Adc |
| Voc Temperature Coefficient (%/°C) | -0.290% | -0.290% | -0.290% |
| Vmp Temperature Coefficient (%/°C) | -0.340% | -0.340% | -0.340% |
| Type- MonoFacial (MF) / BiFacial (BF) / ThinFilm (TF) | MF | MF | MF |
| Adjusted Module Voc @ Low Temp | 56.5 Vdc | 56.5 Vdc | 56.5 Vdc |
| Adjusted Module Vmp @ High Temp | 35.5 Vdc | 35.5 Vdc | 35.5 Vdc |
| Adjusted Module Voc @ High Temp (1) | 50.5 Vdc | 50.5 Vdc | 50.5 Vdc |
| Adjusted Module Vmp @ Low Temp | 48.0 Vdc | 48.0 Vdc | 48.0 Vdc |

**Inverter Specifications**

Inverter Model Number: ECH12k-Hybrid 1 Phase

**Output (AC)**

| | | |
|---|---|---|
| Max Rated Output Power (W) \| (VA) | 12,000 W | 12,000 VA |
| Rated Output Voltage | 240 VAC | |
| Neutral Required | YES' | |
| Max. Rated Output Current ($I_{MAX}$) | 28.9 Aac | 36.1 Aac ($I_{MAX}$ x 1.25) |
| Manufacturer Specified Maximum OCPD | NOT SPECIFIED | |

**Input (DC)**

| | | | |
|---|---|---|---|
| MPPTs \| Strings per MPPT | 3 | 2 | 2 |
| Maximum Input Voltage | 600 Vdc | | |
| Target Wdc(t) Input (TOTAL \| MPPT) | 18000 Wdc | 7500 Wdc | |
| DLR Target(t) (TOTA L \| MPPT) | 1.50 | 1.88 | |
| DLR LIMIT(t) (TOTA L \| MPPT) | 2.00 | 2.00 | |
| Max Isc(t) Input (TOTAL \| MPPT) | 96.0 Adc | 32.0 Adc | |
| MPPT Voltage Range | 120 Vdc-Min | 480 Vdc-Max | |
| DC Operation Range | 120 Vdc-Min | 550 Vdc-Max | |
| Minimum Start Voltge | 150 | | |
| Actual DLR (TOTAL \| MPPT) | 1.35 DC/AC Total | 1.35 DC/AC (MPPT) | |

**Terms and Conditions**

**THE USER OF THIS SIZING TOOL HAS ACKNOWLEDGED: The Chint Power Systems (CPS) String Sizing Tool is being offered free of charge to provide a Array design and Inverter constraint compatibility estimate based on a regional TMY simulation. The output of this tool will be used by CPS to determine compliance with inverter limits. A copy should be maintained in the site design records.**

CPS makes no representation or guarantee regarding the output of the String Sizing Tool regarding the Energy Production of your system.

Fuse rating determination is the responsibility of the Engineer of Record (EOR). The application of fuses greater than 20A must comply with the direction in the product manual, which may require skipping positions to facilitate thermal distribution.

**It is the responsibility of the system Design Engineer to ensure that the STC parameters of the PV Module are accurately entered.**

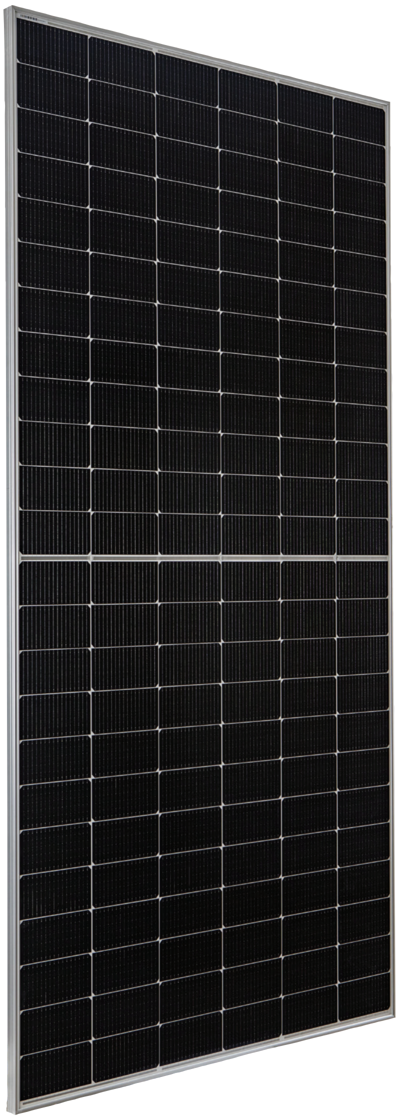
**The user agrees to use the String Sizing Tool at their own risk and the knowledge that CPS will not be liable to the user for any damages, injury or death as a result of the use of the String Sizing Tool.**

# MSI PERC Bifacial 144HC
## Transparent Backsheet

MISSION SOLAR® ENERGY

# 545-555W
Class leading power output

**Positive Power Tolerance**
**-0 to +5W**



# Solar Built for the Long Haul

Mission Solar Energy is headquartered in San Antonio, Texas. This product is tailored for commercial and utility applications. Every Mission Solar Energy solar module is certified and surpasses industry standard regulations, providing excellent performance over the long term. Mission Solar Energy is a proud member of the OCI Family of Companies.

## America's Module Company®

### Fair Trade Practices
- Free of forced labor at all stages of the supply chain
- Not subject to AD/CVD tariffs or investigations

### Certified Reliability
- Tested to UL 61730 & IEC Standards
- PID resistant
- Resistance to salt mist corrosion

### Advanced Technology
- Half-cut cell with 10 busbar
- Passivated Emitter Rear Contact
- Engineered for residential and commercial applications

### Extreme Weather Resilience
- Up to 5,400 Pa front load & 2,400 Pa back load
- Tested load to UL 61730 & IEC Standards
- Hail tests results exceed 25mm at 23 m/s

## FRAME-TO-FRAME WARRANTY

Degradation guaranteed not to exceed 2% in year 1 and 0.55% annually from years 2 to 25, with 84.8% guaranteed in year 25; 12-year Material and Workmanship coverage.
For more information, visit www.missionsolar.com/warranty

## CERTIFICATIONS

CEC

TÜV SÜD

c ETL us LISTED Intertek

UL 61730 / IEC 61215 / IEC 61730

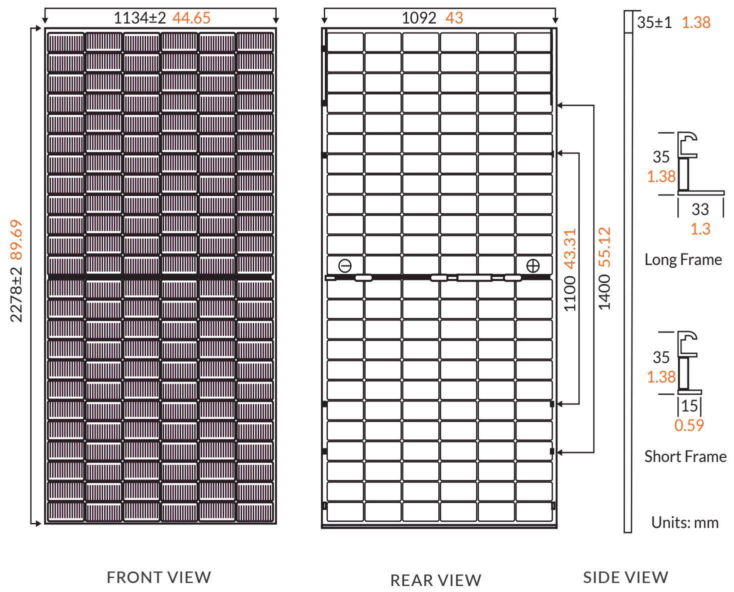
If you have questions or concerns about certification of our products in your area, please contact Mission Solar Energy.

Class Leading
**545-555W**

# MSI PERC Bifacial 144HC, Transparent Backsheet

## BASIC DIMENSIONS

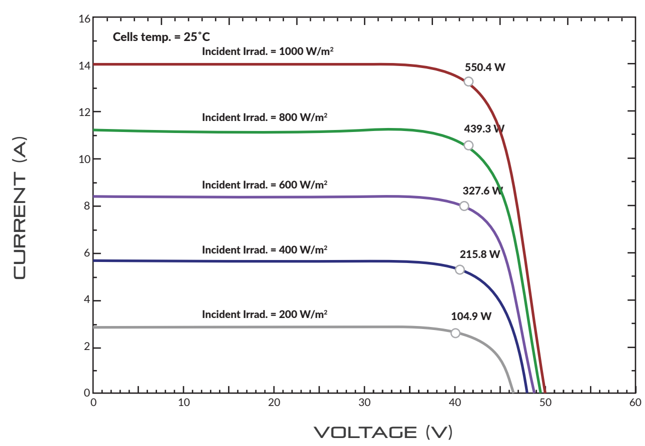
**[UNITS: MM/IN]**




## CURRENT-VOLTAGE CURVE

**MSI10-550HT4T, 144 HALF-CUT CELL SOLAR MODULE**

Current-voltage characteristics with dependence on irradiance and module temperature




## CERTIFICATIONS AND TESTS

| | |
|---|---|
| MSI10-550HT4T IEC | 61215, 61730, 61701 |
| UL | 61730 |

CEC

Intertek

Mission Solar Energy
8303 S. New Braunfels Ave., San Antonio, Texas 78235
www.missionsolar.com | info@missionsolar.com

## ELECTRICAL SPECIFICATION

| PRODUCT TYPE | | | MSI10-xxxHT4T (xxx = $P_{max}$) | | |
|---|---|---|---|---|---|
| Power Output | $P_{max}$ | $W_p$ | 545 | 550 | 555 |
| Module Efficiency | | % | 21.30 | 21.50 | 21.69 |
| Tolerance | | W | 0/+5 | 0/+5 | 0/+5 |
| Short Circuit Current | $I_{sc}$ | A | 13.92 | 13.99 | 14.02 |
| Open Circuit Voltage | $V_{oc}$ | V | 49.65 | 49.80 | 49.95 |
| Rated Current | $I_{mp}$ | A | 13.04 | 13.11 | 13.19 |
| Rated Voltage | $V_{mp}$ | V | 41.80 | 41.95 | 42.09 |
| Fuse Rating | | A | 30 | 30 | 30 |
| System Voltage | | V | 1,500 | 1,500 | 1,500 |

## BIFACIAL OUTPUT | REARSIDE POWER GAIN

| | | | |
|---|---|---|---|
| 5%-Maximum Power (Pmax) | 572 | 578 | 583 |
| 5%-Module Efficiency STC(%) | 22.37 | 22.57 | 22.78 |
| 15%-Maximum Power (Pmax) | 627 | 633 | 638 |
| 15%-Module Efficiency STC(%) | 24.30 | 24.53 | 24.75 |
| 25%-Maximum Power (Pmax) | 681 | 688 | 694 |
| 25%-Module Efficiency STC(%) | 26.36 | 26.63 | 26.86 |

## TEMPERATURE COEFFICIENTS

| | |
|---|---|
| Normal Operating Cell Temperature (NOCT) | 45°C (±2%) |
| Temperature Coefficient of Pmax | -0.336%/°C |
| Temperature Coefficient of Voc | -0.285%/°C |
| Temperature Coefficient of Isc | 0.040%/°C |

## OPERATING CONDITIONS

| | |
|---|---|
| Maximum System Voltage | 1,500Vdc |
| Operating Temperature Rang | -40°F to 185°F (-40°C to +85°C) |
| Maximum Series Fuse Rating | 30A |
| Fire Safety Classification | UL Type 1 |
| Front & Back Load | Up to 5,400 Pa snow and 2,400 Pa wind load |
| Hail Safety Impact Velocity | 25mm at 23 m/s |

**Mission Solar Energy uses quality sourced materials that result in a Type 1 fire rating. Please note, the 'Fire Class' Rating is designated for the fully-installed PV system, which includes, but is not limited to, the module, the type of mounting used, pitch and roof composition.*

## MECHANICAL DATA

| | |
|---|---|
| Solar Cells Cell | PERC, 182mm x 91mm, 144 (6x24) |
| Orientation | 144 half-cut cells |
| Module Dimension | 2278(±2mm) x 1134(±2mm) x 35(±1mm) |
| Weight | 62.17 lbs. (28.2kg) |
| Front Glass | Front 3.2 mm, transparent backsheet |
| Frame Junction | Anodized aluminum profile |
| Box Cable | Protection class IP68 with 3 bypass-diodes |
| Connector | 1.2m, wire 4mmx² (12AMG) |
| | Staübli EVO2 MC4 |

## SHIPPING INFORMATION

| Pallet | Modules | 550W Bin | Total Weight |
|---|---|---|---|
| 20 | 620 | 341 kW | 39,868.4 lbs. / 18,084 kg |
| 15 | 465 | 255.75 kW | 29,901.3 lbs. / 13,563 kg |

**PALLET [31 MODULES]**

| Weight | Height | Width | Length |
|---|---|---|---|
| 1993 lbs. (904 kg) | 50 in (1270 mm) | 44.5 in (1130 mm) | 91.1 in (2313 mm) |







C-MKTG-0037 VERSION: 4 VERSION DATE: 08/30/2024

# CPS 7.6-12 kW Single-Phase Hybrid Inverters for North America

**CPS ECH7.6-12K/US Hybrid Inverter**

CPS is excited to introduce the 7.6 kW, 9.6 kW, and 12 kW single-phase hybrid inverters to the North American market. The new Power Leaf solution includes a hybrid inverter that allows the connection of solar PV, battery storage, and/or generator power.

High energy density, flexible configuration, and an advanced energy management system (EMS) enables seamless transfer between grid-tied and off-grid modes. The single-phase hybrid inverter can be AC or DC coupled with an onsite PV array and has a generator input terminal allowing flexibility.

## Key Features

- NEC 2017/2020 PVRSS certified for rapid shutdown
- NEC compliant and UL listed arc-fault circuit protection
- Integrated AC and DC disconnect switches
- Separable wire box design for fast service
- 3 MPPTs with 2 PV inputs each for maximum flexibility
- Internal automatic double bypass function with no need for an external gateway or bypass switch
- Advanced EMS with configurable modes
- PV, Battery, and Generator inputs
- Full power capacity up to 113° (45°C)
- NEMA Type 4X outdoor rated enclosure
- UL 9540 certified with CPS 5-60 kWh battery

This device complies with part 15 of the FCC Rules

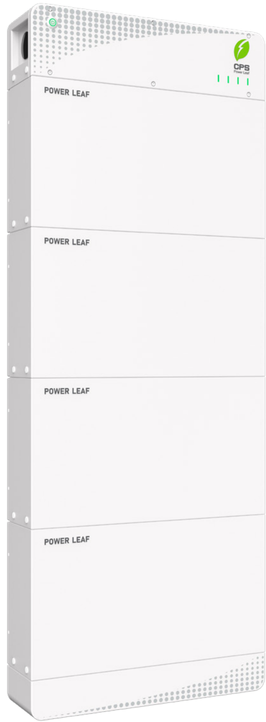


Chint Power Systems America
1380 Presidential Drive, Suite 100, Richardson, TX 75081
Tel: 855-584-7168 Mail: AmericaSales@chintpower.com Web: www.chintpowersystems.com

| **Product Model** | **CPS ECH7.6K/US** | **CPS ECH9.6K/US** | **CPS ECH12K/US** |
|---|---|---|---|
| **PV Input** | | | |
| Max. PV input power | 11.4 kW (7.5 kW per MPPT) | 14.4 kW (7.5 kW per MPPT) | 18 kW (7.5 kW per MPPT) |
| Max. PV input voltage | 600 $V_{DC}$ | | |
| Operating PV input voltage range | 120-550 $V_{DC}$ | | |
| MPPT voltage range | 150-480 $V_{DC}$ | | |
| Startup voltage | 150 $V_{DC}$ | | |
| Number of PV inputs | 6 inputs, 2 per MPPT, non-fused | | |
| Max. input current (clipping point) | 30 A | | |
| DC disconnection type | DC switch | | |
| Short-circuit current per MPPT | 40 A | | |
| **Battery Input** | | | |
| Battery type | Lithium-ion (CPS 5-20 kWh batteries) | | |
| Battery voltage range | 40-60 V | | |
| Max. charge/discharge current | 200 A / 152 A | 200 A / 192 A | 200 A / 200 A |
| Max. charge/discharge power | 10 kW / 7.6 kW | 10 kW / 9.6 kW | 10 kW / 10 kW |
| **Generator Input** | | | |
| Max. input current | 100 A | | |
| Max. input power | 24 kW @ 240 Vac | | |
| Operating input voltage range | 211.2-264 Vac (@ 240 Vac) | | |
| Full power input voltage range | 240-264 Vac (@ 240 Vac) | | |
| **AC Output (Grid)** | | | |
| Max. input current (on grid) | 200 A | | |
| Max. output current | 31.7 A | 40 A | 50 A |
| Max. output apparent power | 7.6 kVA | 9.6 kVA | 12 kVA |
| Standby / night consumption | < 50 W | < 50 W | < 60 W |
| Output voltage range | 183-228.8 Vac (@ 208 Vac) / 211.2-264 Vac (@ 240 Vac) | | |
| Max. OCPD rating | 200 A | 250 A | 250 A |
| Output frequency | 60 Hz | | |
| Grid connection type | Split phase with N | | |
| Rated grid frequency range | 57-63 Hz | | |
| Output voltage | 240 V / 208 V (120 Vac) | | |
| Current TRD @ rated load | < 3% | | |
| Power factor | > 0.99 (adjustable ±0.8) | | |
| **Backup Port** | | | |
| Max. output current (on grid) | 200 A | | |
| Max. output current (off grid) | 31.7 A | 40 A | 50 A |
| Max. output apparent power (off grid) | 7.6 kVA | 9.6 kVA | 12 kVA |
| On-grid / off-grid switching time | 20 ms | | |
| **General Data** | | | |
| Operating temperature range | -13°F to 140°F (-25°C to 60°C) / humidity up to 100% | | |
| Cooling method | Variable speed cooling fan | | |
| Audible noise | < 45 dB @ 1 m and 77°F (25°C) | | |
| Dimensions (H × W × D) | 36 × 20.4 × 9.3 in (912 × 518 × 234 mm) | | |
| Weight | Inverter: 101.7 lb (46.2 kg)<br>Wire box: 37.2 lb (16.9 kg) | | |
| User interface and display | LED, app, and web portal via Wi-Fi connection[1] | | |
| Inverter monitoring | Wi-Fi | | |
| Protection degree | NEMA 4X | | |
| Max. efficiency | 97.5% | | |
| CEC efficiency | 96.5% | | |
| Surge protection | DC Type II / AC Type II | | |
| **Standard Compliance** | | | |
| Certifications and standards | CSA 107.1-16, UL 1741/SA, UL 1741 SB, UL 1998, UL 1699B, FCC Part 15 | | |
| Selectable grid standards | IEEE 1547-2018, HECO, CA Rule 21 | | |
| **Warranty** | | | |
| Standard | 10 years | | |

1) Wi-Fi network connection required for web portal communication.

# CPS 5-20 kWh Battery for North America




**CPS ESSR-05-20KL1/US Battery**

CPS is excited to introduce the 5-20 kWh modular batteries for use with CPS single-phase hybrid inverters to the North American market. The Power Leaf solution is scalable from 7.6 kW/5 kWh to 12 kW/20 kWh with up to four stackable battery units when connected to the CPS single-phase hybrid inverters.

The 5-20 kWh batteries are UL9540 certified with the CPS 7.6-12 kW single-phase hybrid inverters as a complete energy storage system (ESS).

## Key Features

- Fully integrated turnkey ESS solution when used with CPS single-phase hybrid inverters
- LFP batteries with high thermal stability and high energy density
- Parallel up to 60 kWh of energy storage with no junction boxes required
- Maximum up to 180 kWh by using multiple energy storages in parallel
- UL9540A tested
- 200 A AC passthrough
- Stackable batteries for simple installation and O&M
- UL 9540 certified with CPS 7.6-12 kW hybrid inverters
- Expandable capacity for small commercial applications

C US

This device complies with part 15 of the FCC Rules



Chint Power Systems America
1380 Presidential Drive Suite 100, Richardson, TX 75081
Tel: 855-584-7168 Mail: AmericaSales@chintpower.com Web: www.chintpowersystems.com

**CPS ESSR-05-20KL1/US Battery Data**

| Product Model | CPS ESSR-05KL1/US | CPS ESSR-10KL1/US | CPS ESSR-15KL1/US | CPS ESSR-20KL1/US |
|---|---|---|---|---|
| **General Data** | | | | |
| Nominal voltage | 51.2 V | | | |
| Operating voltage range | 44.8-57.6 V | | | |
| Max. current | 50 A | 100 A | 150 A | 200 A |
| Max. power | 2.5 kW | 5 kW | 7.5 kW | 10 kW |
| Rated energy | 5 kWh | 10 kWh | 15 kWh | 20 kWh |
| Usable energy | 5 kWh | 10 kWh | 15 kWh | 20 kWh |
| Depth of discharge | Up to 100% | | | |
| C-Rate | 0.5 | | | |
| Max. charge/discharge power | 2.5 kW | 5 kW | 7.5 kW | 10 kW |
| Discharging temperature range | 14°F to 122°F (-10°C to 50°C) | | | |
| Charging temperature range | 32°F to 122°F (0°C to 50°C) | | | |
| Recommended storage temperature | 68°F to 86°F (20°C to 30°C) | | | |
| Operating humidity range | 5-95% | | | |
| Interface and display | LED and mobile app (with CPS single-phase hybrid inverters) | | | |
| Communication | CAN (with CPS single-phase hybrid inverters) | | | |
| **Installation Specifications** | | | | |
| Max. parallel extensions | Up to 60 kWh | | | |
| Weight[1] | 132.3 lb (60 kg) | 229.3 lb (104 kg) | 326.3 lb (148 kg) | 423.3 lb (192 kg) |
| Dimensions (W × D × H)[1] | 26.4 × 7.1 × 25.6 in (670 × 180.3 × 650 mm) | 26.4 × 7.1 × 40.2 in (670 × 180.3 × 1020 mm) | 26.4 × 7.1 × 54.7 in (670 × 180.3 × 1390 mm) | 26.4 × 7.1 × 69.3 in (670 × 180.3 × 1760 mm) |
| Operating altitude | 9842 ft / 3000 m | | | |
| Installation method | Floor- or wall-mounted | | | |
| Cooling method | Natural convection | | | |
| Protection | NEMA 3R / IP65 | | | |
| Black start mode | Yes | | | |
| **Standard Compliance** | | | | |
| Certificates | UN 38.3, UL 1973, UL 9540, UL 9540A, UL 60730, FCC Part 15 | | | |
| **Warranty** | | | | |
| Standard | 10 years | | | |

1) Weight and dimensions include battery module, control module, and base.

EATON
Powering Business Worldwide

pe.eaton.com

# Heavy Duty Double-Throw Safety Switch

**DT223UGK**

**UPC:**782113440019

**Dimensions:**

- **Height:** 25.02 IN
- **Length:** 11.19 IN
- **Width:** 11.95 IN

**Notes:**Suitable for service entrance use with a neutral or ground lug kit installed

**Warranties:**

- Eaton Selling Policy 25-000, one (1) year from the date of installation of the Product or eighteen (18) months from the date of shipment of the Product, whichever occurs first.

**Specifications:**

- **Type:** Heavy Duty, Double-Throw
- **Amperage Rating:** 100A
- **Enclosure:** NEMA 1
- **Enclosure Material:** Painted steel
- **Fuse Configuration:** Non-fusible
- **Number Of Poles:** Two-pole
- **Number Of Wires:** Two-wire
- **Voltage Rating:** 240 Vac, 250 Vdc

**Supporting documents:**

- Double-throw safety switch
- Eatons Volume 2-Commercial Distribution
- Drawing
- Expanded double-throw safety switch line
- Eaton Specification Sheet - DT223UGK

**Certifications:**

- UL Listed

**Product compliance:** No Data

## BR plug-on neutral loadcenters

**BR P 30 L _ 200 _ G W P1**

**Type designation**
**BR** = 1 inch (25.4 mm) breaker loadcenter

**Feature**
**P** = Plug-on neutral design

**Number of spaces** ①
08 10 12 16
20 24 30
40 42 60

① The number of circuits is equal to double the number of spaces.

**Main device**
**L** = Main lug only
**B** = Main breaker
**E** = Convertible with main lugs installed
**N** = Convertible (main device purchased separately)
**H** = 22 kAIC

**Bus material**
**Blank** = Aluminum
**C** = Copper

**Bus amperage**
**100** = 100 A
**125** = 125 A
**150** = 150 A
**200** = 200 A
**225** = 225 A

**Enclosure**
**Blank** = NEMA Type 1 indoor with combination trim
**R** = NEMA Type 3R rainproof
**S** = NEMA Type 1 indoor with surface trim

**Accessories installed**
**Blank** = None installed
**DG** = Double ground bar (for panels under 20 spaces)
**F** = Feed-through lugs
**G** = Ground bar

**Trim color**
**Blank** = ANSI 61 Gray
**W** = White (Indoor Only)

**Packaging**
**Blank** = Individually packed with cover attached
**P1** = Loadcenters palletized (no box), covers 4 per carton

## BR Electronic circuit breakers

**BR H N 1 15 DF _**

**Type designation**
**BR** = 1 inch (25.4 mm) breaker loadcenter

**High kAIC Rating**
**H** = 22 kAIC

**Neutral design**
**N** = Pigtail neutral wire
**P** = Plug-on neutral

**Number of poles**
**1** = Single-pole

**Amperes**
**15** = 15 A
**20** = 20 A
**30** = 30 A (GFI)

**Breaker function**
**DF** = Dual function
**AF** = Combination arc fault
**GF** = Ground fault
**EP** = Equipment protection (30 mA)

**Options**
**Blank** = UL®
**C** = Canada (CSA® only)

EATON
*Powering Business Worldwide*

# CH Plug-on neutral loadcenters

**CH P 32 L 225 X5 _**

**Type designation**
**CH** = 3/4 inch (19.1 mm) breaker loadcenter

**Feature**
**P** = Plug-on neutral design

**Number of spaces**

| | | | | |
|---|---|---|---|---|
| 08 | 10 | 12 | 14 | 16 |
| 20 | 22 | 24 | 30 | 32 |
| 40 | 42 | 60 | | |

The number of circuits is equal to double the number of spaces.

**Main device**
**L** = Main lug only
**B** = Main breaker
**E** = Convertible with main lugs installed
**N** = Convertible (main device purchased separately)

**Bus amperage**
**100** = 100 A
**125** = 125 A
**150** = 150 A
**200** = 200 A
**225** = 225 A

**Enclosure**
**R** = NEMA Type 3R rainproof
**X0** ① = 16.75 inch
**X1** ① = 18.75 inch
**X2** ① = 21 inch
**X3** ① = 23 inch
**X4** ① = 27 inch
**X5** ① = 29.13 inch
**X6** ① = 34.13 inch
**X7** ① = 37 inch
**X8** ① = 39 inch
**X9** ① = 45 inch
**X10** ① = 48.38 inch

① NEMA Type 1 indoor with no cover (to be ordered separately)

**Accessories installed**
**Blank** = None installed
**F** = Feed-through lugs
**G** = Ground bar

# CH Plug-on neutral loadcenter covers

**CHP X5 L F _**

**Type designation**
**CHP** = CH Plug-on neutral loadcenter cover

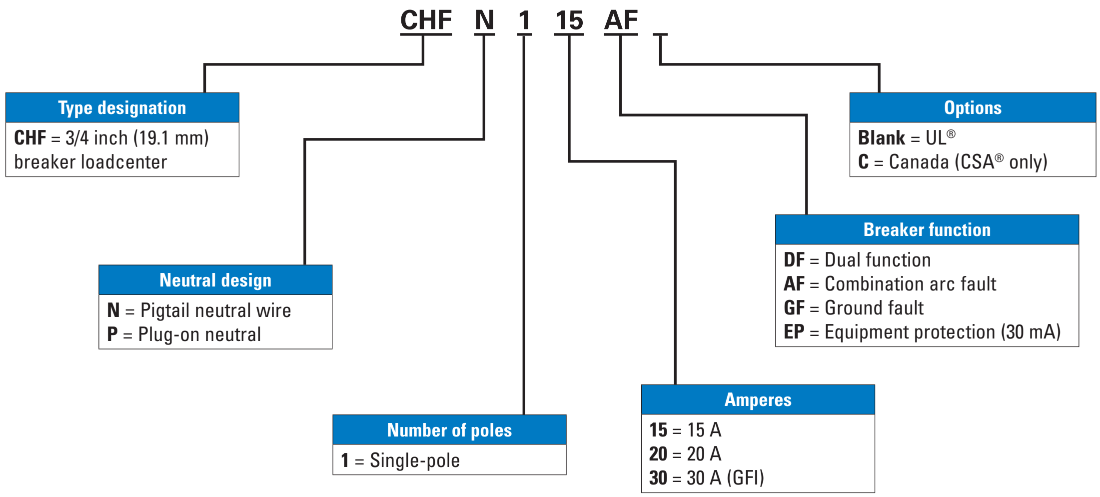
**Box size**
**X0** = 16.75 inch
**X1** = 18.75 inch
**X2** = 21 inch
**X3** = 23 inch
**X4** = 27 inch
**X5** = 29.13 inch
**X6** = 34.13 inch
**X7** = 37 inch
**X8** = 39 inch
**X9** = 45 inch
**X10** = 48.38 inch

**Main device / Maximum amperage**
**A** = 125A or below
**B** = 150A, 200A, 225A main breaker
**L** = 150A, 200A, 225A MLO
**N** = 150A, 200A, 225A convertible

**Mount**
**S** = NEMA Type 1 indoor with surface trim
**F** = NEMA Type 1 indoor with flush trim

**Options**
**Blank** = Sandalwood
**W** = White

# CHF Electronic circuit breakers*




**Note:** *The CH electronic breaker catalog numbers are not changing until 2019. In the meantime, the current CH pigtail and PON breaker catalog numbers can be purchased.

# CH Loadcenter cover selector

| Plug-On Neutral loadcenter catalog number | Flush cover | Surface cover | Flush cover UPC | Surface cover UPC |
|---|---|---|---|---|
| **CHP12L125X0** | CHPX0AF | CHPX0AS | 786689162269 | 786689162276 |
| **CHP14B100X1** | CHPX1AF | CHPX1AS | 786689162290 | 786689162306 |
| **CHP16L125X1** | CHPX1AF | CHPX1AS | 786689162290 | 786689162306 |
| **CHP16L200X5** | CHPX5LF | CHPX5LS | 786689162375 | 786689162382 |
| **CHP18B100X2** | CHPX2AF | CHPX2AS | 786689162313 | 786689162320 |
| **CHP20L125X2** | CHPX2AF | CHPX2AS | 786689162313 | 786689162320 |
| **CHP22B100X2** | CHPX2AF | CHPX2AS | 786689162313 | 786689162320 |
| **CHP22B125X2** | CHPX2AF | CHPX2AS | 786689162313 | 786689162320 |
| **CHP22N125X2** | CHPX2AF | CHPX2AS | 786689162313 | 786689162320 |
| **CHP24B150X5** | CHPX5BF | CHPX5BS | 786689162351 | 786689162368 |
| **CHP24B200X5** | CHPX5BF | CHPX5BS | 786689162351 | 786689162368 |
| **CHP24L125X2** | CHPX2AF | CHPX2AS | 786689162313 | 786689162320 |
| **CHP24L150X5** | CHPX5LF | CHPX5LS | 786689162375 | 786689162382 |
| **CHP24L225X5** | CHPX5LF | CHPX5LS | 786689162375 | 786689162382 |
| **CHP30B100X5** | CHPX5AF | CHPX5AS | 786689162337 | 786689162344 |
| **CHP30B125X5** | CHPX5AF | CHPX5AS | 786689162337 | 786689162344 |
| **CHP32B150X6** | CHPX6BF | CHPX6BS | 786689162399 | 786689162405 |
| **CHP32B200X6** | CHPX6BF | CHPX6BS | 786689162399 | 786689162405 |
| **CHP32B225X6** | CHPX6BF | CHPX6BS | 786689162399 | 786689162405 |
| **CHP32E225X6** | CHPX6NF | CHPX6NS | 786689162429 | 786689162436 |
| **CHP32L150X5** | CHPX5LF | CHPX5LS | 786689162375 | 786689162382 |
| **CHP32L225X5** | CHPX5LF | CHPX5LS | 786689162375 | 786689162382 |
| **CHP32N225X6** | CHPX6NF | CHPX6NS | 786689162429 | 786689162436 |
| **CHP42B200X7** | CHPX7BF | CHPX7BS | 786689162443 | 786689162450 |
| **CHP42B225X7** | CHPX7BF | CHPX7BS | 786689162443 | 786689162450 |
| **CHP42E225X7** | CHPX7NF | CHPX7NS | 786689162467 | 786689162221 |
| **CHP42L225X6** | CHPX6LF | CHPX6LS | 786689162412 | 786689162474 |
| **CHP42N225X7** | CHPX7NF | CHPX7NS | 786689162467 | 786689162221 |
| **CHP60B200X9** | CHPX9BF | CHPX9BS | 786689162238 | 786689162245 |
| **CHP60B225X9** | CHPX9BF | CHPX9BS | 786689162238 | 786689162245 |
| **CHP60E225X9** | CHPX9NF | CHPX9NS | 786689162252 | 786689162283 |

## Single-phase BR indoor convertible loadcenters

| Amperage rating | Space count | Recommended new plug-on neutral catalog number | New catalog number UPC | Similar previous designs |
|---|---|---|---|---|
| 125 | 12 | BRP12N125 | 786689053017 | BR1224N125 |
| 125 | 12 | BRP12N125G | 786689054953 | BR1224N125G |
| 125 | 12 | BRP12NC125 | 786689053031 | BR1224NC125 |
| 125 | 16 | BRP16N125 | 786689054960 | BR1624N125 |
| 125 | 20 | BRP20NC125 | 786689053314 | BR2024NC125 |
| 125 | 20 | BRP20N125 | 786689053284 | BR2024N125<br>BR2024N125BP |
| 200 | 12 | BRP12N200 | 786689053024 | BR1224N200 |
| 200 | 16 | BRP16N200 | 786689053147 | BR1632N200<br>BR1632N200G |
| 200 | 20 | BRP20N200 | 786689053291 | BR2040N200 |
| 200 | 20 | BRP20N200G | 786689053307 | BR2040N200G |
| 200 | 20 | BRP20NC200 | 786689053321 | BR2040NC200 |
| 200 | 30 | BRP30E200G | 786689055004 | BR3040NL200G<br>BR3060NLQN200G |
| 200 | 30 | BRP30EC200GP2 | 786689054526 | BR3040NLC200BG |
| 200 | 30 | BRP30N200 | 786689052911 | BR3040N200<br>BR3060NQN200 |
| 200 | 30 | BRP30N200G | 786689052928 | BR3040N200G |
| 200 | 30 | BRP30NC200 | 786689052966 | BR3040NC200<br>BR3040NC200B |
| 200 | 40 | BRP40E200G | 786689055028 | BR4040NL200G<br>BR4080NLQN200G |
| 200 | 40 | BRP40N200 | 786689044077 | BR4040N200<br>BR4050N200<br>BR4080NQN200 |
| 200 | 40 | BRP40N200G | 786689053048 | BR4040N200G |
| 200 | 40 | BRP40NC200 | 786689053055 | BR4040NC200 |
| 200 | 60 | BRP60E200 | 786689055066 | BR60120NL200W<br>BR60120NL200 |

## Single-phase CH indoor main breaker loadcenters

| Amperage rating | Space count | Recommended new plug-on neutral catalog number | New catalog number UPC | Similar previous designs |
|---|---|---|---|---|
| 100 | 14 | CHP14B100X1 | 786689055134 | CH14B100B |
| 100 | 18 | CHP18B100X2 | 786679189481 | CH18B100C |
| 100 | 22 | CHP22B100X2 | 786679189559 | CH22B100C<br>CH22B100CRN<br>CH24BPN100E |
| 100 | 30 | CHP30B100X5 | 786679189597 | CH30B100D |
| 125 | 22 | CHP22B125X2 | 786689055158 | CH22B125C |
| 125 | 30 | CHP30B125X5 | 786679189603 | CH30B125D |
| 150 | 24 | CHP24B150X5 | 786679189573 | CH24B150E<br>CH24B150EFT |
| 150 | 32 | CHP32B150X6 | 786689055165 | CH32B150J<br>CH32B150JFT<br>CH32B150JRN<br>CH32BPN150J |
| 200 | 24 | CHP24B200X5 | 786679189580 | CH24B200E |
| 200 | 32 | CHP32B200X6 | 786689055172 | CH32B200JP<br>CH32B200J<br>CH32B200JRN<br>CH32BPN200J |
| 200 | 42 | CHP42B200X7 | 786679189641 | CH42B200K<br>CH42B200KRN<br>CH42BPN200K<br>CH42NB200K |
| 200 | 60 | CHP60B200X9 | 786679189665 | CH60BPN200N |
| 225 | 42 | CHP42B225X7 | 786679189658 | CH42B225K |
| 225 | 60 | CHP60B225X9 | 786679189672 | CH60BPN225N |

# Resilience Hub Planning In Dante, Virginia

Authors: Appalachian Voices and Russell County, VA

October 31, 2025

## Acknowledgements

The sources for much of the information in this case study come from partners in Russell County, stakeholders in the Town of Dante, participants in the Community Strong project, APTIM, and American Microgrid Solutions (AMS). The authors would like to thank participants for their valuable input and participation in the Virginia Energy Resilience Study.

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## Resilient Hub Project Background

Dante, VA, is an unincorporated community, formerly a coal company town located along the Russell and Dickenson County lines in far Southwest Virginia. Dante has a population of 588 and faces myriad challenges in actualizing its community vision for moving forward in a post-coal economy. Dante was majorly affected by a lack of energy resilience during three major storms over the past year and a half including Hurricane Helene, flooding of February 2025, and flash flooding during the summer of 2025 that necessitated emergency rescues and repairs in the town.

# The Challenge

Dante, VA is an unincorporated community located near Dickenson, Russell, and Wise County towns. Using the Community Energy Resilience - Unincorporated Community Pilot Workbook and Scoring Tool created by the Center for the Advancement of Sustainable Energy at James Madison University, we were able to assess a variety of energy resilience challenges within the community.

Approximately 35% of the population is above 65 years of age, and 43.22% of Dante residents live below the poverty line, which heightens the stakes of resiliency issues. Aging populations may depend more heavily on shelter from extreme temperatures, access to perishable medication and health supplies, and transportation assistance. The lack of transportation assistance is particularly challenging as up to 49% of the population was estimated to have the inability to leave home on their own.

The financially vulnerable population also relies on a fixed income, increasing the threat of loss of food and drinking water, reliable shelter, and energy access. Without disposable income, households are less likely to be able to provide their own power backup infrastructure, such as residential generators or batteries. For those with backup generators, fuel costs and the lack of local fuel infrastructure provide additional barriers.

The community of Dante lacks crucial infrastructure, including grocery stores, restaurants, medical facilities, fire and rescue services, gas stations, and emergency shelters. This drastically decreases the accessibility of food, medication, emergency fuel, and emergency responders. Furthermore, water treatment and pumping infrastructure are available near the community, as provided by the county, but need new backup power sources to ensure water can reach households at higher elevations.

The types of weather events that often precede power outages often render the roadways in Dante inaccessible, limiting access to the resources in nearby communities. This includes winter storms, windstorms, and flood events. The First Street Foundation lists Dante as having an extreme risk from flooding, with 53% of properties at risk of flooding in the next 30 years. An increase in flooding will continue to pose a risk and necessitate energy resilience.

Additional challenges identified, but not covered in the workbook, include severely limited mobile services, limited landline access, a lack of sizable buildings to act as residential shelters, and limited internet accessibility. Communications challenges, such as internet access and mobile service, remain true during regular operation within the community. Flood events in 2024 and 2025 also identified a need for maintenance and repair of flood prevention infrastructure throughout the community.

## Community Engagement


*Figure 1: top - Dante community members attend listening sessions to gather information about resilience needs. Bottom - Dante Depot building behind a Welcome to Dante, Virginia sign.*

Before Dante worked on the Virginia Energy Resilience Study, energy resilience was already a consistent theme in the community. In 2024, the community of Dante partnered with Appalachian Voices on the Community Strong initiative, resulting in three listening sessions to gather information about resilience in Dante from community members. Although those sessions were not targeting solely energy resilience, several of the themes highlighted throughout the Community Energy Resilience - Unincorporated Community Pilot Workbook and Scoring Tool were echoed in those community gathering spaces including energy backup, emergency preparedness, and critical infrastructure.

Participating in VERS was a step that the community of Dante took to further those conversations and develop feedback and data to inform how the community moves forward. Early community input meetings highlighted energy resilience issues such as frequent flooding and storms resulting in power outages, a lack of basic services in the immediate area, the instability of a community generator, and the length of power outages for the average resident. Additionally, our community partners with Russell County gave thorough and community-informed feedback throughout the Virginia Energy Resilience Study process, confirming these anecdotal reports with gathered data and providing relevant context about the community's specific needs...

## The Solution: Equip local facility with Solar + Storage

During community meetings, 105 individuals named flooding and energy resilience as a priority and identified the Dante Depot as an ideal location for a resilience hub. To address this need, Russell County received two solar energy and battery storage feasibility analyses to assess possible resilience solutions. One analysis for a solar PV + battery storage system located at the depot was provided by American Microgrid Solutions, as funded by the Clean Energy Group's Technical Assistance Fund. A second analysis through APTIM for a mobile solar PV +

battery storage system was completed, as funded by the Virginia Department of Energy's Energy Resilience Planning Grant. Full feasibility analyses may be provided upon request.

### Backup Power

A stationary solar PV and battery storage system was assessed for the Dante Depot. The Depot, recognized as a historic and community-centric building, is currently being remodeled to serve as a community hub. Despite having one facility with generation capacity within the town, this new system would support increased resilience within the community while also showcasing innovation in rural Appalachia. The Depot would also provide several services to the community during regular operation, which would benefit from reduced energy costs.

### Mobile Power Options

Due to the community's position within the floodplain, the ability to deploy solar PV and batteries as needed would also increase the accessibility of resilient power during emergencies throughout the community. This was looked into as an alternative to stationary solar PV and battery storage options. This was also determined to be of interest as flooding events had previously impacted properties on which the stationary system may have been placed, causing additional concern to equipment and public safety.

### Resilient Water Systems

One leading challenge identified by the county during the Virginia Energy Resilience Study program was the inaccessibility of water during power outages. Due to the geography of Dante and nearby communities, water must be regularly pumped uphill to many households. These pumps do not currently have a reliable backup power system to ensure access to water during emergencies. Either a stationary or mobile solar PV plus battery storage system was identified as of interest to help continue operation during power outages.

## System Details

Energy resilience systems analyzed for Dante include a stationary solar PV plus battery storage array paired with a fuel-powered generator and a mobile solar PV plus battery storage system. Each system was modeled independently and will be used to determine the best fit for increasing energy resilience and addressing community needs.

## Solar Energy

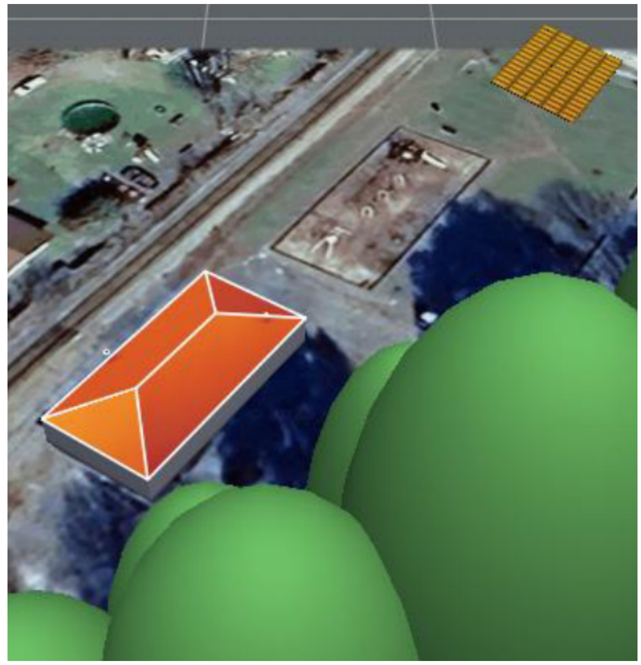

*Figure 2: Solar plus battery storage microgrid rendering for Dante Depot. Image credit: American Microgrid Solutions.*

A feasibility analysis completed by AMS indicated that a 36 kW solar PV system would be needed to generate approximately 96% of the power for the Dante Depot. As the Depot had not been operational prior to the analysis, energy bills from a comparable local facility were used as substitutes. Due to the Depot's shading concerns from a southward forested mountainside, the array was modeled as a ground-mounted system.

## Diesel Generator

The AMS feasibility study recommended the addition of a 34 kW backup diesel generator. This would provide a backup option for community members in the case an outage that extended beyond the typical length of support provided by solar and battery storage. The diesel generator would be capable of providing a minimum of 3.6 days of support, with a typical length of 19.5 days. A backup generator was included as resilience was listed as the number one priority for the Dante project and power outages often lasted multiple days.

## Energy Storage

36kW / 77 kWh Battery energy storage was recommended by the AMS feasibility study to provide resilience during short-term outages. This backup would be capable of providing a minimum of 2 hours of support, with a typical length of 24 hours. The lithium-ion battery would consist of an outside enclosure directly connected to the depot.

## Mobile Solar PV + Battery Storage

A mobile solar PV and battery storage system was by APTIM. This system would be used to distribute safe backup power systems throughout the community as needed during outages. It would increase the ability of Russell County to respond to on-ground impacts from emergencies on a case-by-case basis while providing some potential to connect to critical infrastructure during regular operations. With a recommended 11-kilowatt solar array and 90-kilowatt-hour battery, it was estimated that the solar array and mobile trailer would be able to provide 4-7 days of backup power, assuming the use of low-current draw equipment. This includes, but is not limited to, refrigerators, communication equipment, and critical personal medical devices. Community members have the ability to power equipment with higher current draws, which would result in a shorter resilience timeline.

## Financial Details

Assuming construction of all recommended systems assessed for the Dante Depot, a total capital cost of $451,000 was estimated for the project. This includes 36 kW of solar PV capacity, 36 kW of battery backup, 34 kW of Diesel Generator capacity, 20-year operations and maintenance, and scheduled part replacements. Of this amount, the solar PV system accounted for $179,300 of the total cost.

Incentives for the construction and operation of the system were identified through multiple sources. The clean energy Investment Tax Credits (ITC) were assessed to total 40% of the project cost, utilizing the additional 10% energy community bonus credit on top of the standard 30% credit. This was estimated to reduce the capital cost after ITC to $291,300.

The PJM Demand Response Program was considered as an incentive. PJM's voluntary program provides compensation for reduction of energy use during periods of high-power prices.

The Renewable Energy Credits (REC) market was assessed as a project incentive at a rate of $39.90 / MWh. RECS are tradable certificates that are produced when a facility generates renewable energy, representing environmental attributes of 1 MWh of solar energy generation. RECs may be sold to the grid or other customers through certified REC brokers.

Combined, non-ITC incentives were assessed to provide approximately $51,199 in incentives over 20 years.

The financial analysis determined that a negative cash flow was likely when all systems were taken into account. Without utilizing grant funding, the system was estimated to have a 20-year negative cash flow of $229,773.

| | Solar Only | Microgrid$_1$ | Microgrid$_2$ |
|---|---|---|---|
| Solar | 36 kW | 36 kW | 36 kW |
| Battery | -- | 36 kW / 77 kWh | 36 kW / 77 kWh |
| Generator | -- | -- | 34 kW |
| Sustainability (forecasted) | | | |
| Renewable Generation | 45,158 | 45,158 | 45,158 |
| Usage Offset by Renewables | 96% | 96% | 96% |
| Carbon Offset (metric tons) | 32 | 32 | 32 |
| Resilience (forecasted) | | | |
| Loads Supported | -- | 100% Building | 100% Building |
| Typical Length of Support | -- | 24 hours | 19.5 days |
| Minimum Length of Support | -- | 2 hours | 3.6 days |
| Financial (forecasted) | | | |
| Capital Cost | $179,300 | $399,200 | $451,000 |
| Capital Cost After ITC Rebate | $107,600 | $239,500 | $291,300 |
| Simple Payback Period (years) | 13.0 | -- | -- |
| 20-Year Cash Flow | $57,726 | ($153,621) | ($229,773) |

*Figure 3: Financial analysis for Dante solar, generator, and battery storage systems. Image credit: American Microgrid Solutions.*

Financial details of the mobile solar PV and battery storage were not assessed by APTIM as system benefits would primarily take place during power outages and would not currently power local businesses. Thus, they are not included in this case study.

# Lessons Learned

## Shading Challenges in Mountainous Terrain

Shading is a very common challenge for rooftop solar, but it presents a particular challenge for projects like those modeled in Dante, due to proximity to mountain slopes. This greatly limited the number of feasible buildings within the community. This resulted in the most feasible projects being either ground-mounted solar PV and storage, or mobile solar and storage systems. To mitigate the impact of shading, county leadership was flexible, approving additional feasibility analyses for mobile solar PV and battery storage to be completed.

## Utility Policy Barriers

Despite the promising net metering programs provided by utilities serving Dante, other policy barriers can present additional challenges that add on to the geographic and shading challenges otherwise experienced by small Appalachian communities. One such challenge the project had to navigate was restrictive policies around land ownership and crossing property lines when determining where a permanent solar energy structure could be placed. These challenges added additional red tape to overcome for projects to prove feasibility and expanded the need to assess mobile solar PV and battery storage opportunities.

## Economics Challenge for Small Projects

The Dante project is unique in that the building is projected to have relatively small energy consumption during regular operation. Furthermore, Russell County does not have a significant energy demand from nearby facilities. This limits the ability of a solar PV and energy storage system to offset project costs, thus resulting in a negative 20-year cash flow. This often results in projects that are in much greater need of financial and technical support to achieve local resilience goals. This challenge can be expected in many similar rural unincorporated communities.

# DANTE, VA - SOLAR RESILIENCY STUDY FOR MOBILE SOLUTION

APTIM
11400 PARKSIDE DR.
SUITE 400
KNOXVILLE, TN 37934
(865) 560-7800

Ethan Marsh ________________ ________________
Preparer

Fermin Cabrera ________________ ________________
Reviewer

N/A ________________ ________________
Design Verifier

Design Verification Method:

☒ N/A ☐ Independent Review ☐ Alternate Calculation ☐ Qualification Testing

## Summary

The city of Dante, VA has identified a need for a mobile resiliency solution to support a variety of locations across the city. Dante has identified a need to power several locations across the town, such as the Pump House, Bath House, the Dante Depot, and local residences across town. Dante has expressed interest in a permanent system to power the Pump House, along with a system that can be deployed to other locations with the capacity to fully power building loads. With these parameters in mind, APTIM Engineering would like to recommend the acquisition of the Power-Up Connect Green Grid, or any equivalent system available on the market.

## Load Analysis

- **Peak Load (kW):** N/A – Independent Mobile Solution (Note: Although through correspondence with Dante, it was indicated to APTIM that most of the "full building loads" would be small. However, with interest in powering the Pump House it is APTIM's suggestion that a larger unit be acquired as continuous current draw from motors would require a higher system capacity.)
- **Average Daily Load (kWh):** N/A - Independent Mobile Solution
- **Critical Loads (list key equipment/systems):** Critical loads identified by the city of Dante include pump motors, small building loads, personal mobile devices, personal medical devices, and other low current draw loads.
- **Critical Equipment Operating Hours:** System would allow for charging and powering of critical personal devices 24/7, with battery storage recharging occurring during the day.

### Capacity Assessment

- **Proposed Solar Array / Mobile Trailer:** Green Grid Mini Mobile Trailer
- **Recommended Battery Storage Size (kWh or hours of backup):** 20kWh
- **Resiliency Goal (hours/days of grid independence):** 4-7 days (assuming only powering low current draw equipment)
- **Estimated System Contribution to Outage Scenarios:** System would allow for charging of multiple small refrigerators, along with capacity to allow for the charging of personal mobile

devices or any critical personal medical devices. The system will have excess capacity after covering these devices and can be used as the community sees fit.

## Equipment and Technology

- **Solar Module Type/Model:** 1100W Solar Array
- **Number of Panels:** Integrated on Roof of Trailer
- **Inverter Type and Capacity:** Inverter type not listed in product datasheet – 30kVA output capacity
- **Battery Type and Capacity:** 90kWh LiFePO4 Battery Storage
- **Resiliency Features (microgrid controllers, islanding, etc.):** Consult Power-Up connect for additional information on the Green Grid system characteristics.

## Installation and Integration

- **Site Description (roof, ground-mount, canopy, etc.):** Trailer would be stored either outside in a parking lot (footprint of 8’ 4” H x 5’ W x 15’) or stored inside a facility with the appropriate space.
- **Construction/Prep Requirements:** If the trailer is to be stored outside and will not be connecting to a facility, no construction or prep requirements are necessary. If the trailer is to be connected to a facility, the facility will need to identify “critical loads” to be powered in the instance of an outage, and those critical loads will need to be diverted from the main facility electrical panel to a subpanel with a tie-in point to the trailer.
- **Utility Interconnection Details:** Mobile solution will not need to be connected to utility services / will not be back feeding compatible.

## Summary & Recommendations

- **Key Findings:** The Power-Up Connect Green Grid (or equivalent system) would provide sufficient capacity and output to allow the community of Dante to power their desired use cases. System will also allow for the possibility to power critical loads of a facility if the community chooses to do so in the future.
- **Anticipated Benefits (outage mitigation):** Proposed mobile solution will power any small building loads in the instance of an outage and will easily allow for community residents to keep small devices / equipment powered in the case of a short-term outage (i.e. 4-7 days). In the instance of a long-term outage, or in the instance of large equipment loads found in the Pump House, consultation with Power-Up Connect will be required to gather information on expected system run time.

# Attachment A: Engineering Design Information

| Document Name | Reference | Quantity of Pages |
|---|---|---|
| APTIM, Proposed Electrical Drawings | N/A | 2 |
| | | |
| | | |
| | | |
| | | |
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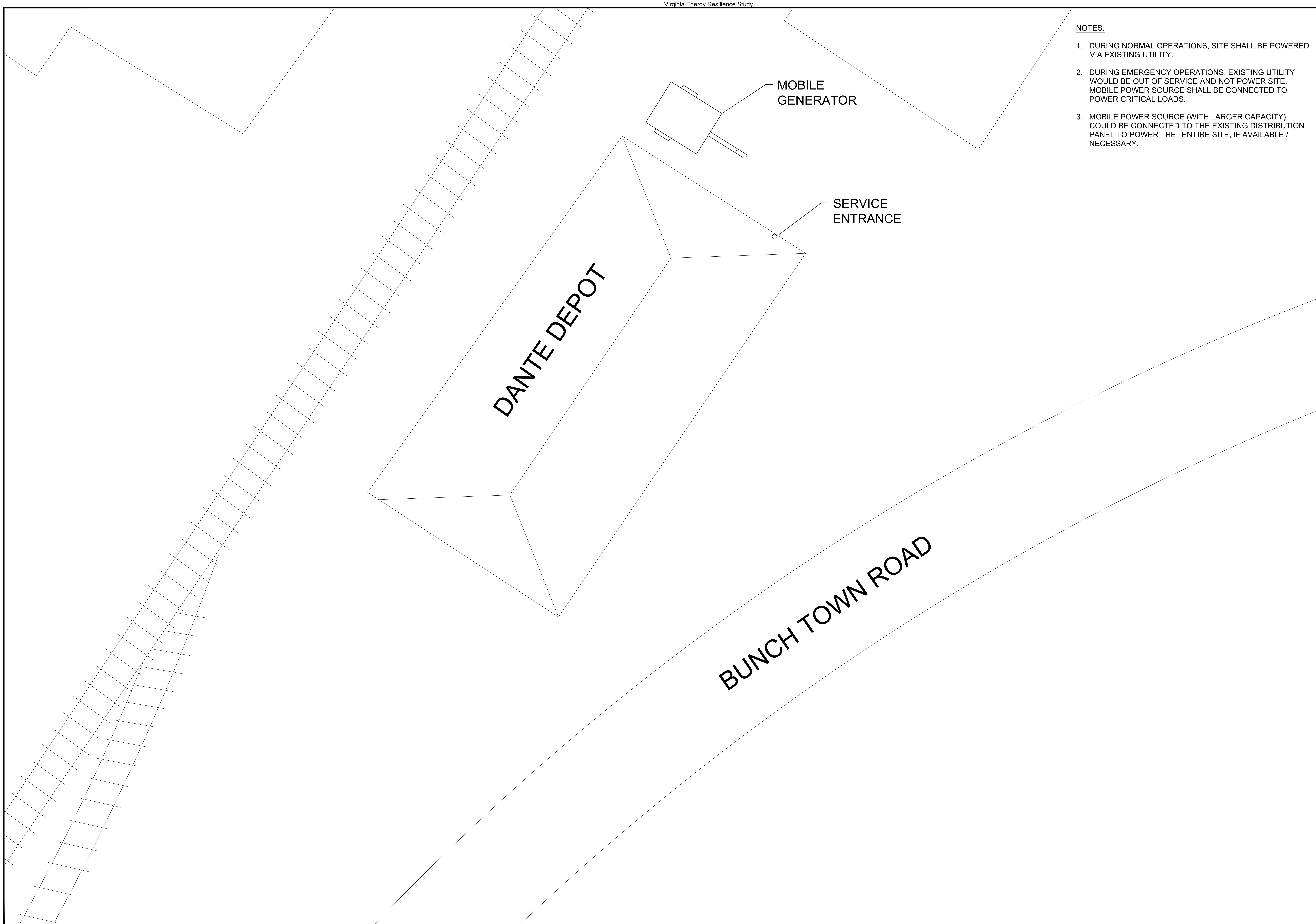


NOTES:

1. DURING NORMAL OPERATIONS, SITE SHALL BE POWERED VIA EXISTING UTILITY.
2. DURING EMERGENCY OPERATIONS, EXISTING UTILITY WOULD BE OUT OF SERVICE AND NOT POWER SITE. MOBILE POWER SOURCE SHALL BE CONNECTED TO POWER CRITICAL LOADS.
3. MOBILE POWER SOURCE (WITH LARGER CAPACITY) COULD BE CONNECTED TO THE EXISTING DISTRIBUTION PANEL TO POWER THE ENTIRE SITE, IF AVAILABLE / NECESSARY.

| NO. | DESCRIPTION | DWN | CK'D | APP'D | DATE |
|---|---|---|---|---|---|
| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

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PRELIMINARY PROGRESS DRAWINGS ARE NOT FOR CONSTRUCTION OR FABRICATION. BILL OF MATERIALS, SHOP DRAWINGS, ETC., CREATED FROM THESE DRAWINGS MAY BE REVISED AT THE EXPENSE OF THE CONTRACTOR.

PROFESSIONAL SEAL

APTIM

DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025
SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-001

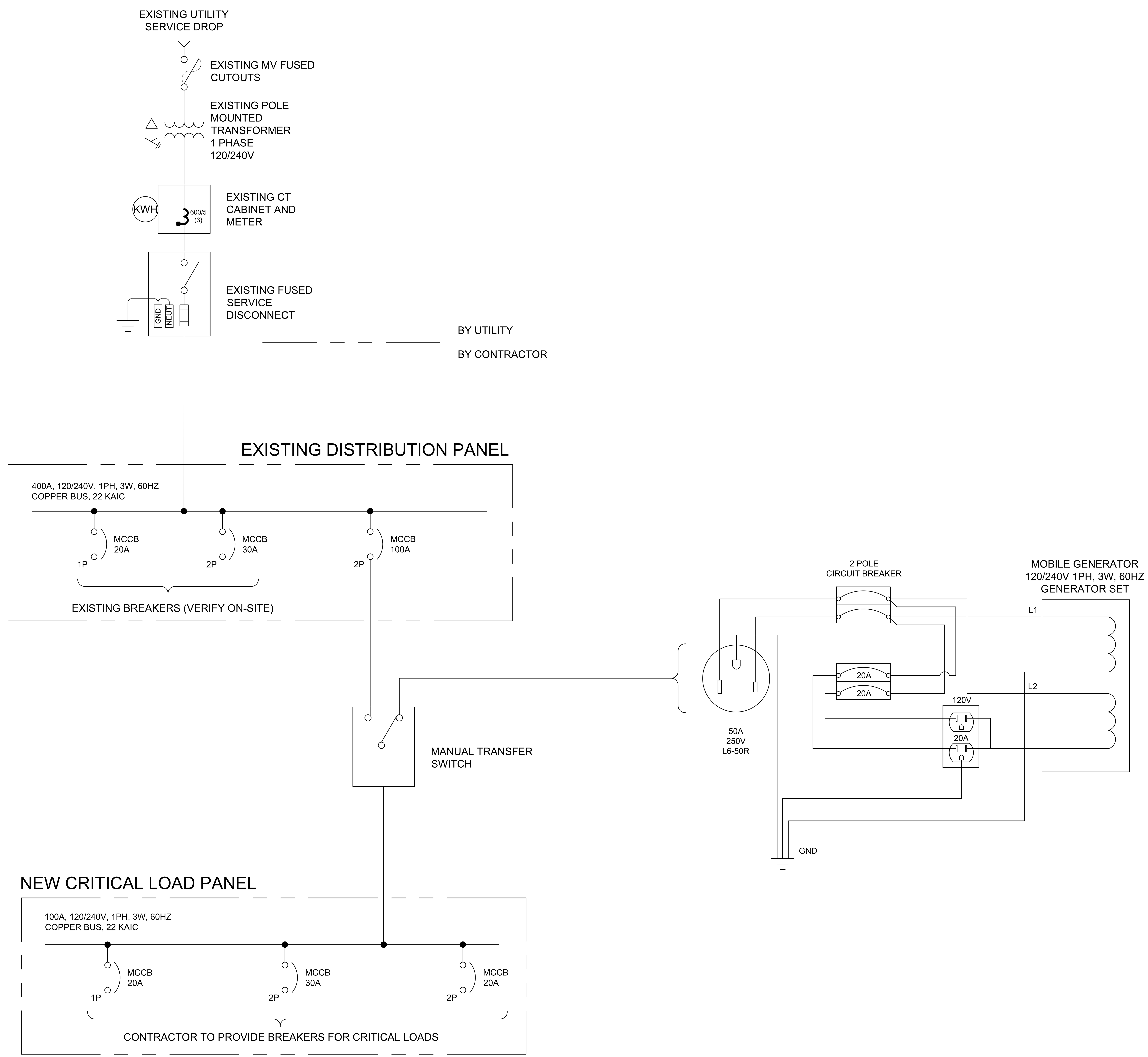
VIRGINIA ENERGY RESILIENCE STUDY
DANTE DEPOT, 457 BUNCH TOWN ROAD, DANTE, VA 24237
APTIM PROJECT NO. 77631041420

ELECTRICAL
MOBILE GENERATOR SITE PLAN

SHEET NO.
E-001

DE-EE0010414 EOP-C

File: Dante Depot 457 Bunch Town Rd.dwg
Plot Date/Time: Sep 30, 2025 - 8:06am
Plotted By: Robert.Childs




| NO. | DESCRIPTION | DWN | CKD | APPD | DATE |
|---|---|---|---|---|---|
| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

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PROFESSIONAL SEAL

APTIM

SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-002

DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025

VIRGINIA ENERGY RESILIENCE STUDY
DANTE DEPOT, 457 BUNCH TOWN ROAD, DANTE, VA 24237
APTIM PROJECT NO. 77631041420

ELECTRICAL
MOBILE GENERATOR ONE-LINE DIAGRAM

SHEET NO.
E-002

File: Dante Depot 457 Bunch Town Rd.dwg
Plot Date/Time: Sep 30, 2025 - 8:05am
Plotted By: Robert Childs

# Resilience Hub Planning In Dungannon, Virginia

Authors - Appalachian Voices and The Town of Dungannon

Date – October 31, 2025

## Acknowledgements

The sources for much of the information in this case study come from partners in Scott County, the Town of Dungannon, members of the Dungannon Community Association, and American Microgrid Solutions. The authors would like to thank participants for their valuable input and participation in the Virginia Energy Resilience Study.

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## Resilient Hub Project Background

*Figure 1: Dungannon Depot - site of proposed community energy resilience hub. Image credit: Appalachian Voices.*

Located in Scott County, VA, Dungannon is a community along the Clinch River with 289 individuals. In 2024, Appalachian Voices began hosting listening sessions for attendees to identify, prioritize, and design solutions for issues in their town. In continuing meetings, attendees and members of the Dungannon Community Association have consistently prioritized a resilience project: equipping the Dungannon Depot, a historic stop along the Clinchfield Railroad line, to serve as a resilience hub.

Dungannon is an ideal candidate for a common space during power outages that can provide immediate needs for a vulnerable population. Additionally, the proximity to the Clinch River is both an asset to the town, nicknamed the Heart of the Clinch, and a hindrance, often creating a need for floodwater resilience. The depot currently serves as a functional community center, a space where individuals and representatives hold meetings, community gatherings, and local festivities. Additionally, the property has a small outdoor park area, including a playground and picnic equipment, open to the public. Listening session attendees seek to expand upon its current role as a community gathering space and elevate it to a resilience hub. To that end, the depot has received a feasibility study for solar energy + battery storage. Community members seek to continue pursuing funding to obtain back-up energy for the site.

## The Challenge

Dungannon residents have identified a need for resilience in the community and have enumerated compounding factors that heighten the stakes of the existing gap. These resilience gaps were identified with town stakeholders, local officials, and the county emergency manager, using the Energy Resilience Workbook created by the Center for the Advancement of Sustainable Energy at James Madison University.

Dungannon’s remote, rural location provides limited access to emergency services and critical infrastructure during emergencies, especially those caused by inclement weather. Examples of these gaps include a lack of police department or rescue squad/ambulance service in town limits, a lack of backup power for the volunteer fire department, and no town-managed backup power for the public water system.

A lack of communication resilience in town necessitates more investment in resilient infrastructure; public communication and alerts are only available at a county level. Despite no indication of limited English-speaking individuals in census data, local stakeholders suggested that seasonal workers in local agriculture presented some need for non-English emergency communications. Cell phone signal is also severely limited throughout the town, further straining emergency communications and limiting the ability of residents to request assistance. Despite public Wi-Fi access being provided at the Dungannon Depot, no backup power exists on-site to ensure access during outages.

Demographically, more than 50% of Dungannon’s population lives below the poverty line, creating additional vulnerability to the impacts of power outages, including the loss of perishable food, medicine, and other necessities while on a fixed income. Impoverished households are also much less likely to be able to purchase and maintain household backup-power equipment, such as generators. For households with generators, the lack of a local fuel station with backup power causes additional barriers to energy access.

The aging population in Dungannon presents unique challenges as well; for example, 63 individuals were identified as vulnerable to extreme heat and cold, yet there are no warming or cooling centers in town. Estimates also indicated that 27% of town residents lack access to a vehicle, while the town lacks access to public transportation.

Though just outside of town limits, Dungannon was one of the few communities with existing solar energy infrastructure at an acute medical care facility. However, as the facility does not have on-site battery storage, the resilience factor is limited to reduced power bills during normal operation. Backup generators were also largely absent at critical facilities.

Scott County emergency management identified that the school building in Dungannon is listed as an emergency shelter. However, the shelter does not maintain backup power infrastructure and largely serves as a pickup point for residents in need of shelter and transportation to a shelter approximately 30 minutes away.

## Community Engagement

*Figure 2: Community stakeholder group at the Dungannon Depot during community meeting. Image credit: Appalachian Voices*

The Town of Dungannon's involvement in the Virginia Energy Resilience Study was due, in part, to a series of community engagement sessions that took place before the town applied; over the course of a year, 66 community members from Dungannon attended listening sessions in the Depot to name, prioritize, and design solutions for issues in the community. One of the recurring themes that arose from the sessions was a need for energy resilience, and community members named the old train depot as an ideal location for a resilience hub. Since those meetings, the town applied to participate in the VERS process and maintained its community-led approach to conducting the study.

The Dungannon Community Association has participated in further conversation to elaborate on what else the community building would need in order to function as an energy resilience hub and has contributed valuable information to the energy resilience study workbook through participation sessions. Earlier this fall, the members of the Dungannon Community Association (DCA) served as both community members and stakeholders in a workbook planning session purposed to help the town identify gaps in energy resilience in town as well as provide relevant information relating to the need for more resilience locally. The DCA consistently named themes specific to the community such as disability needs during power outages, lack of essential infrastructure, lack of communication structure during emergencies, and the reliability of resources such as clean drinking water.

## The Solution: Equip the Dungannon Depot with Solar + Battery Storage

Dungannon community members and officials identified solar energy generation plus on-site battery storage at the Dungannon Depot as a priority for increasing local energy resilience. The Dungannon Depot was selected as a well-known publicly owned space that was already serving as a community center with a working kitchen, library, bathrooms, and meeting space.

### Energy Efficiency

To strengthen the potential of the building to become a resilience hub, energy efficiency upgrade opportunities were assessed through an energy audit. The audit identified the need for new heat pumps, building envelope upgrades, and attic insulation. Combined, it was estimated that this would reduce energy use by approximately 30%. Between December 2024 and January 2025, the Depot received all upgrades identified in the audit. These upgrades will not only reduce the regular operation cost of the building through reduced energy bills, but will also increase the resilience of the building during emergencies by creating a safer, temperature-controlled, and energy-efficient community facility.

### Energy Affordability

Energy affordability was identified as the number one priority for increasing energy resilience for Dungannon. To address this priority, the analysis was asked to assess the energy savings benefits of generating enough solar electricity for each town-owned facility. This included the Depot, Town Hall, water treatment, wastewater treatment, and outdoor event facilities through a single, central solar system.

This opportunity was identified through the potential of municipal energy generation programs provided by the town’s electric provider, Appalachian Power. By providing the town with more affordable energy, additional funding would be able to go to other community improvement services and would support the continued operation and maintenance of all critical infrastructure.

### Backup Power

Backup power was identified as a secondary priority of the project. The Dungannon Energy Resilience Workbook identified that existing backup generators in town were reliant on access to fuel systems. However, this fuel system did not have an existing on-site generator to ensure access during power outages.

By providing the town with a solar-powered backup system, this project would diversify the resilience systems within the town, increasing the likelihood of being able to provide electricity to residents during emergencies. By placing this backup power at the Depot, Dungannon would also be able to provide residents with a warm or cool place to stay during the day, various recreational opportunities, and a working kitchen.

## System Details

The Town of Dungannon received a solar energy and battery storage feasibility analysis from American Microgrid Solutions, as funded by the Appalachian Solar Finance Fund. This study considered the possibility of participating in a municipal virtual net metering program through Appalachian Power to provide energy credits for other town-owned facilities. The full feasibility analysis may be provided upon request.

### Solar Energy

Several solar PV systems were assessed for the Town of Dungannon. Combined, the systems would have a capacity of 213 kW DC, produce 288,222 kWh in year 1 and generate 100% of the annual electric usage of the identified town facilities.

System 1 consisted of a 14.8 kW DC rooftop system, located on two covered shelters located behind the depot. The use of covered shelters was recommended to avoid any concerns with changing the look of the historic building. This system would pair directly with the on-site battery and provide power directly to the depot.

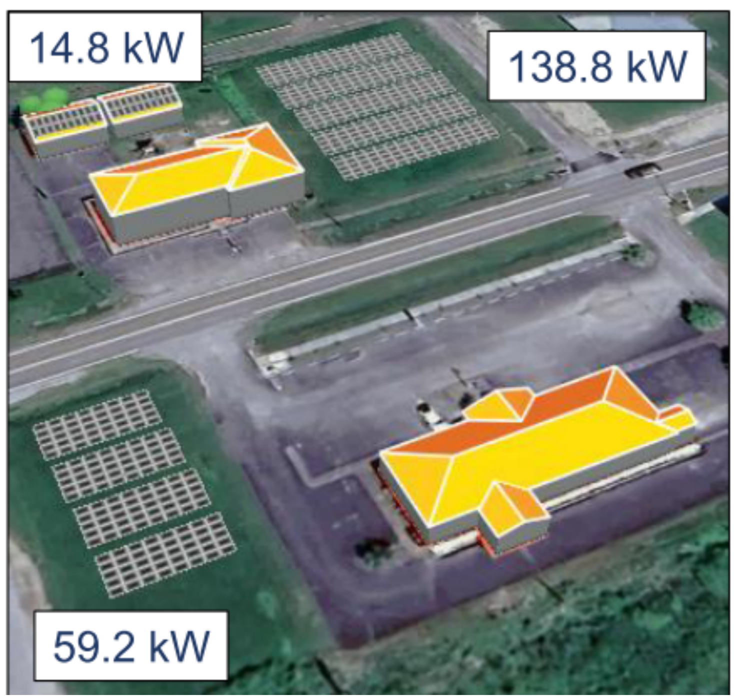

*Figure 3: Modeled solar plus battery storage microgrid for Dungannon facilities. Image credit: American Microgrid Solutions.*

Remaining solar PV systems were assessed to provide net-metering credits for remaining town-owned facilities, including the town hall and water & sewer treatment facilities, through virtual net metering programs available to municipalities. The system was modeled on two separate parcels of land adjacent to the depot, having a combined capacity of 198 kW DC.

Due to financial and spatial constraints, the town decided to pursue the 14.8 kW depot system and an initially unassessed rooftop solar PV system for the town hall.

### Energy Storage

A 36 kW / 115 kWh battery energy storage system was recommended to meet the town's resilience and affordability goals. The lithium-ion battery would be an outside enclosure directly connected to the depot. Battery size provides a typical backup power capacity of 67 hours for the facility, with a minimum capacity of 4 hours.

## Financial Details

Assuming construction of all systems assessed in the study, a total capital cost of $937,100 was estimated for the project. This includes 213 kW DC of solar PV capacity, 36 kW of battery backup, 20-year operations and maintenance, and scheduled part replacements. Of this amount, the solar PV system accounted for $659,900 of the total cost.

Incentives for the construction and operation of the system were identified through multiple sources. The clean energy Investment Tax Credits (ITC) were assessed to total 40% of the project cost, utilizing the additional 10% energy community bonus credit on top of the standard 30% credit. This was estimated to reduce the capital cost after ITC to $562,200.

The PJM Demand Response Program was considered as an incentive. PJM's voluntary program provides compensation for reduction of energy use during periods of high power cost.

The Renewable Energy Credits (REC) market was assessed as a project incentive at a rate of $39.90 / MWh. RECS are tradable certificates that are produced when a facility generates renewable energy, representing environmental attributes of 1 MWh of solar energy generation. RECs may be sold to the grid or other customers through certified REC brokers.

Combined, non-ITC incentives were assessed to provide approximately $231,000 in incentives over 20 years.

The financial analysis of all systems determined that a positive cash flow was likely when all systems were taken into account. Without utilizing grant funding, the systems were estimated to have a 10.4-year simple payback period and a 20-year cashflow of $544,224. This financial analysis indicated that the 14.8 kW DC solar PV and 36kW battery storage system was unlikely to provide positive cash flow over 20 years without significant grant funding support.

| | Solar-only | | Microgrid[1] | |
|---|---|---|---|---|
| Solar | | 213 kW | | 213 kW |
| Battery | | -- | | 36 kW / 115 kWh |
| **Financial Returns** | | | | |
| Capital Cost | | $659,900 | | $937,100 |
| ITC @ 40% | | $264,000 | | $374,800 |
| Grants | | $0 | | $0 |
| Capital Cost After ITC | | $395,900 | | $562,200 |
| Simple Payback (years) | | 6.0 | | 10.4 |
| NPV @6%, 20yrs | | $372,000 | | $36,100 |
| **Utility savings** | **First Year** | **20 Years** | **First Year** | **20 Years** |
| Energy Savings | $54,360 | $1,291,234 | $40,938 | $1,043,488 |
| Demand Savings | $0 | $0 | $0 | $0 |
| Other Savings | $0 | $123 | $0 | $123 |
| **Revenue & Cash Flow** | **First Year** | **20 Years** | **First Year** | **20 Years** |
| Total Utility Savings | $54,360 | $1,291,357 | $40,938 | $1,043,611 |
| All Non-ITC Incentives | $10,050 | $213,596 | $12,819 | $231,345 |
| Total O&M Expenses | ($1,814) | ($44,075) | ($4,525) | ($109,941) |
| Replacement capex | $0 | ($25,536) | $0 | ($58,548) |
| Capital Cost after ITC | $0 | ($395,950) | $0 | ($562,242) |
| **Cash flow** | **$62,596** | **$1,039,392** | **$49,232** | **$544,224** |

*Table 1: Financial analysis for Dungannon solar and microgrid systems. Image credit: American Microgrid Solutions.*

# Lessons Learned

## Need for Grant Funding to Support Small Projects

Despite the financial analysis showing positive cash flow of the full system, larger ground-mounted development requires significant resources from small communities, such as Dungannon, such as unutilized land area and willingness to take on debt. Due to the lack of these resources, the utility policy landscape, and the changing landscape of ITC incentives, the 14 kW solar PV and 36kW battery storage system have been identified as the best short-term path forward. Assuming this lack of such resources is common in small, rural communities indicates a greater need for grant funding support for communities when setting up energy resilience hubs that meet community needs. Specifically, grant funding would be needed to offset the cost of adding battery storage to otherwise financially beneficial solar PV projects.

## Community Engagement in Resilience Planning

Through in-depth community engagement, we were able to determine a variety of community resilience opportunities in Dungannon. An energy resilience hub was just one of such opportunities. Through this engagement, the town was able to collaboratively assess the preferred use of town property. This community assessment, in part, determined the preference for a 14 kW solar PV system due to community recommendations on how to use the property adjacent to the depot to best serve the community.

## Importance of Incremental Progress

While it is more financially beneficial to install solar PV and battery storage systems at full scale through a single process, this may not be feasible for many communities. Incremental progress on energy resilience with communities can often be more attainable while continuing to provide significant benefits. Though the feasibility analysis showed significant financial benefit from the 213 kW solar PV system, a variety of barriers stood in the way. The limited capacity of small, rural communities can amplify the effect of such barriers and may cause risk to an entire project. Thanks to grant funding opportunities identified for the project, 14.8 kW of solar PV, rooftop solar PV for the town hall, and battery storage are now being procured for the town.

# Resilience Hub Planning In Emporia, Virginia

A Case Study on Local Energy Resilience

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September 2025

## Acknowledgements

The sources for much of the information in this case study come from partners at the City of Emporia, Leslie King Consulting, and Launch! Consulting. The authors would like to thank Michael Rae and William Johnson for their valuable input and participation in the Virginia Energy Resilience Study.

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## Resilient Hub Project Background

In 2025, the City of Emporia (City) partnered with the Virginia Department of Energy (DOE) to participate in the Virginia Energy Resilience Program, an initiative of the Renewables Advancing Community Energy Resilience (RACER) Program aimed at helping communities strengthen their energy resilience. As part of this effort, Emporia took part in the Virginia Energy Resilience Study (VERS), which evaluated the city's capacity to endure power outages, identified key vulnerabilities, and provided recommendations for long-term improvements and solutions.

The City was interested in participating in the VERS project to align with their existing resilience efforts. These efforts included their work with the Research Institute for Social Equity (RISE) at Virginia Commonwealth University (VCU) to complete an overview of the Community Preparedness and Hazard Risk Reduction Project to address environmental issues facing disadvantaged communities in Emporia. As well as their work with George Mason University (GMU) to complete a greenhouse gas emissions study. The City aims to build upon these efforts to strengthen their resilience work.

The VERS initiative was led on behalf of the City by William Johnson, City Manager, and Mike Rae, Emergency Services Coordinator. Together, they collaborated with the DOE, researchers from James Madison University (JMU), community engagement specialists from Leslie King Consulting and Launch! Consulting, Inc. (Launch), and engineers from APTIM. Through this partnership, the City accomplished the following:

- Completed the **Virginia Community Energy Resilience Workbook and Scoring Tool** to assess existing resilience and identify long-term strategies for improvement.
- Conducted **community engagement** through an interactive conversation to gather lived experiences, identify needed resources and services during outages, and explore potential sites for an energy resilience hub.
- Held **technical discussions with engineers** to develop design drawings for a mobile resilience hub for the City.

The City of Emporia, Virginia, is a small independent city in southeastern Virginia, just north of the North Carolina border. Emporia is a regional hub for commerce and transportation. Its location at the crossroads of Interstate 95 and U.S. Route 58, along with rail connections, makes it an important waypoint on the Eastern Seaboard. Despite this role, Emporia remains one of Virginia's smaller cities with a population just under 6,000. The 2023 U.S. Census demographics show a median household income of $49,375, an employment rate of 50.5%, and a population that is 63.6% Black or African American, 19.6% White (non-Hispanic), and 6.9% identifying as two or more races including Hispanic.

The City operates under a council-manager form of government, maintains its own Emergency Services Department, and participates in regional planning through the Crater Multi-Regional Hazard Mitigation Plan. Emporia residents have faced more than a dozen federally declared disasters in the past two decades, mainly from hurricanes, tropical storms, and flooding, which is considered a moderate but persistent hazard. Limited resources and small scale constrain the city's capacity to manage large disasters, especially if disruptions occur on I-95 or U.S. 58.

Climate change is expected to worsen existing vulnerabilities. Longer summers, more frequent heat waves, and heavier rainfall could strain infrastructure and increase flooding risks. Combined with modest fiscal capacity, limited economic diversification, and vulnerable populations such as the elderly and low-income households, these trends present ongoing challenges.

## The Challenge

The City of Emporia faces a range of interrelated challenges that affect its resilience and long-term sustainability. Among these are its economic and social constraints. With a smaller population, a median household income of about $49,375, and a poverty rate above national averages, the city's fiscal capacity is limited. This constrains investments in infrastructure, emergency response resources, and long-term hazard mitigation. Vulnerable populations, including the elderly, low-income households, and those with limited transportation access are disproportionately at-risk during disasters and recovery periods.

From an environmental and hazard perspective, Emporia is challenged by recurring exposure to severe weather and flooding. The city has been included in more than a dozen federally declared disasters in the past two decades, primarily from hurricanes and tropical storms. Flooding is considered a persistent hazard, though the absence of repetitive-loss properties suggests localized but ongoing risk. Infrastructure vulnerabilities, particularly the reliance on I-95 and U.S. 58 as lifelines for transportation and commerce, pose additional challenges when disasters disrupt mobility and supply chains.

Looking ahead, climate change magnifies these pressures. Forecasts indicate hotter summers, more frequent heat waves, and heavier rainfall, all of which could overburden stormwater systems, increase flooding, and strain public health. Combined with limited economic diversification and resource constraints, these changes present ongoing challenges to adaptation.

## Community Engagement

As part of the VERS project, the City partnered with community engagement specialists to design and host an interactive public meeting aimed at fostering meaningful resident input. The goals of the session were to:

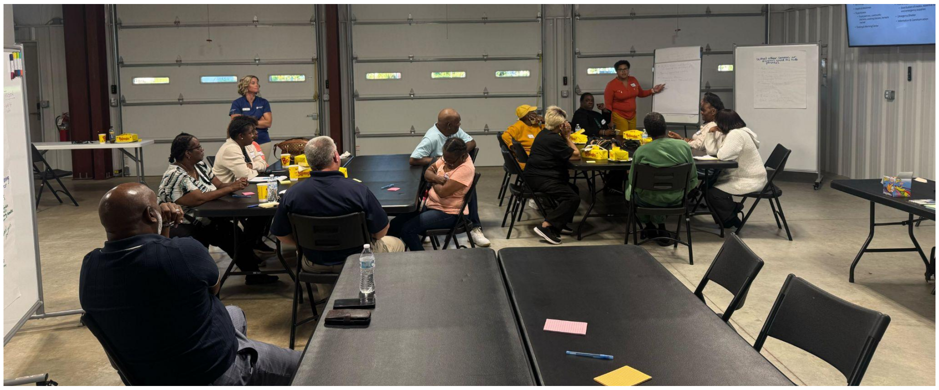
- Introduce the City's ongoing resilience initiatives.
- Provide an overview of the VERS project and share initial findings.
- Better understand the energy challenges faced by residents.
- Identify critical services and resources needed during power outages.
- Explore potential locations for an energy resilience hub.
- Ensure that community voices, particularly those most affected by energy burdens, were heard and feedback incorporated.

### *Engagement Overview*

The community conversation took place on August 28, 2025, from 6:00 p.m. to 8:00 p.m. at the City's Emergency Services Building. A total of 15 community members participated, sharing valuable feedback and insights. Additionally, two representatives from Dominion attended the meeting and shared information about programs and resources available to residents to enhance energy resilience at their homes.

The meeting was structured in three main segments:

1. **Welcome and Overview** – Introduction to the City's resilience initiatives.
2. **Project Presentation** – Summary of the VERS project and initial study findings.
3. **Interactive Activities** – Facilitated activities to identify community challenges, prioritize needs, and propose potential sites for a resilience hub.



During the community conversation, participants first engaged in a whole-group discussion to identify the primary challenges they experience during power outages or other emergency events. Residents highlighted a range of issues, including:

- Limited availability of essential community services
- Downed trees and power lines creating access barriers
- Loss of Wi-Fi and disruptions to connectivity
  Concerns about water access, water bills, and water quality
- Difficulty keeping appliances running and preserving perishable food
- High utility bills and financial strain

Following this initial discussion, participants were divided into two small groups to further explore potential services and resources that an energy resilience hub could provide. Facilitated by engagement specialists, each group used flip charts to brainstorm ideas, which were then shared back with the full group to identify common priorities and areas of alignment.

The small group discussions focused on two guiding questions:

1. What do you need during a power outage or other emergency?
2. What other services or resources could an energy resilience hub provide?

Participants identified a variety of needs during an emergency event, including:

- Solar panels and backup power sources
- Residential generators
- Food and water distribution
- Reliable and specialized transportation services
- Assistance with home evacuations
- Access to communication tools such as cell phones, charging stations, and Wi-Fi
- A community alarm and alert system
- Emergency shelters and medical assistance

- Emergency supplies (e.g., flashlights, blankets)
- Animal sheltering options
- Channels to disseminate emergency alerts and information

Participants also envisioned additional community benefits that a resilience hub could offer, such as:

- Activity centers for older adults
- Medical support and information
- A call center for assistance and coordination
- Free youth programming (e.g., summer camps, after-school programs, daycare)
- Computer stations and access to technology
- Spaces for social gatherings and community events
- Educational programs and emergency preparedness training
- Emergency shelter services
- Childcare services
- A public transportation stop
- Partnerships with community organizations such as the Lion's Club
- Financial literacy programs
- Workforce and skill development opportunities

The final small group activity focused on mapping potential sites for an energy resilience hub. Participants were provided with printed maps of the City and asked to identify and evaluate possible locations, taking into account key considerations such as:

- Public vs. private property ownership
- Vacant lots and underutilized spaces
- Existing infrastructure limitations
- Proximity to or placement outside of city limits

Once potential sites were identified, participants were asked to rank their top three locations, with Rank 1 indicating the highest priority. They then discussed the strengths and weaknesses of each site to assess feasibility and suitability for future development.

The following locations/areas were identified by small group:

**Small Group #1**

1. **Former Georgia Pacific Building (620 Davis St, Emporia, VA 23847)**
    a. **Strengths:** Large industrial structure with ample roof and land area, utility access, and visibility as a major employer site.
    b. **Challenges:** Recent closure leaves uncertainty about site ownership and redevelopment costs; possible environmental remediation needs.
2. **Former Elementary School (Greensville County Training School, Emporia, VA 23847)**

a. **Strengths:** Recognizable landmark with community history, existing building footprint, and central location.
b. **Challenges:** Concerns about proximity to the police station were raised, and the building's age and condition may pose renovation challenges.

3. **Vacant Lot Across from Walmart (0 W Atlantic St, Emporia, VA 23847)**
   a. **Strengths:** Highly visible location along a major corridor, good accessibility, and sufficient open space for solar and storage installations.
   b. **Challenges:** Lack of existing structures means higher initial investment for construction and site preparation.

**Small Group #2**

1. **Emporia Shopping Center (514 N Main St, Emporia, VA 23847)**
   a. **Strengths:** Highly accessible, ample parking, well-known and visible location, and no existing flooding concerns.
   b. **Challenges:** Uncertainty regarding building availability.
2. **Abandoned Lowe's building (113 E Cloverleaf Dr, Emporia, VA 23847)**
   a. **Strengths:** Convenient location with good accessibility, ample parking, and a large space capable of accommodating many community members.
   b. **Challenges:** High cost of the building was identified as a significant barrier.
3. **Community Youth Center (800 Hailfax St, Emporia, VA 23847)**
   a. **Strengths:** Easily accessible, well-trusted community space with existing programming and community ties.
   b. **Challenges:** Limited size and existing flooding issues may constrain its suitability as a resilience hub.

The community engagement meeting successfully brought together diverse voices and experiences, providing residents with a platform to share concerns, contribute ideas, and envision a more resilient future for their community. Through collaborative discussions, participants helped identify key challenges experienced during power outages and emergencies, define essential services and resources needed to strengthen community resilience, and highlight potential locations for future resilience hubs. Participants also received information and resources to help them stay informed and enhance the resilience of their own homes. These insights can help the City prioritize investments, shape future initiatives, and build a stronger, more resilient community in the face of a changing climate.

## The Solution: Equip Local Facility with Solar + Storage

### *Backup Power*

Solar + storage provides the ability to keep critical services online during grid outages. Emporia is vulnerable to a range of severe weather hazards, including hurricanes and tropical storms moving inland from the Atlantic, winter storms and nor'easters that can bring heavy snow and ice, and intense summer thunderstorms. Historically, these vulnerabilities have caused flooding, wind damage, and extended power outages in the region. The City's location along the Meherrin River and near Interstate-95 places it in the path of tropical storm systems moving inland from the Atlantic. Residents have reported extended blackouts following major storms, leaving households (particularly those with seniors and medically vulnerable residents) without refrigeration for food and medication, air conditioning during heat emergencies, or power for oxygen machines and other critical medical devices.

By equipping a community anchor facility with rooftop or ground-mounted solar and paired battery storage, the site can island from the grid and continue powering essential loads such as lighting, refrigeration, communications, and HVAC for designated safe spaces. With nearly 25% of residents aged 65 or older and 23% of households below the poverty line, backup power is not just about comfort, it directly impacts survival and public health. A resilience hub ensures that residents have a reliable place to charge cell phones, store medicines, access cooling or heating, and shelter safely during extended outages.

### *Reliable Power*

Beyond emergencies, the system improves day-to-day reliability. Emporia's distribution grid, like many rural and small-city systems, is subject to voltage fluctuations and unplanned outages, particularly during high summer demand and severe weather. These interruptions disproportionately affect residents in manufactured housing and older housing stock, which are more vulnerable to temperature extremes and have fewer resources for backup power.

A solar + storage system stabilizes power by reducing peak demand stress on the grid, providing frequency response, and ensuring the chosen resilience hub has uninterrupted operations. For facilities like community centers, schools, or shelters, this reliability supports everyday services such as youth programming, senior activities, and community health programs, while guaranteeing backup in crisis conditions.

### *Economic Benefits*

Solar + storage offers tangible economic advantages for Emporia's residents and the city government. These advantages include the following:

- **Reduced utility bills:** Solar panels generate clean electricity, offsetting grid purchases. In Virginia, systems can be net-metered, lowering monthly costs for community-serving facilities already operating on limited budgets.
- **Peak shaving with batteries:** Storage discharges during expensive peak hours, cutting demand charges. For Emporia's small businesses and public facilities, this translates into meaningful savings.
- **Local economic development:** System installation supports jobs in solar construction, electrical contracting, and long-term maintenance; helping diversify a local economy that has been heavily reliant on manufacturing and is still recovering from closures like Georgia Pacific's 2025 shutdown.

For Emporia, with a majority of Black residents (57%), high poverty rates, and aging infrastructure, solar + storage resilience hubs offer more than environmental benefits. They provide life-saving backup power, equitable access to reliable electricity, and pathways for economic renewal in a community that faces repeated storm-related outages and long-standing vulnerabilities.

## Lessons Learned

The VERS project and accompanying community engagement process provided the City with several important lessons to inform future resilience planning and implementation efforts:

- **Early and Inclusive Community Engagement is Essential:** Meaningful engagement should begin at the very start of any planning or project process. Allowing sufficient time to involve community members, City departments, and other stakeholders ensures that a diverse range of voices and perspectives are heard and integrated into decision-making.
- **Funding is Critical to Building Resilience:** Additional funding opportunities are needed to help cities like Emporia better prepare for emergencies and advance resilience initiatives, such as the development and implementation of resilience hubs that require sustained investment and resources.
- **Increase Awareness of Existing Resilience Efforts:** Although the City has already implemented several resilience initiatives, many residents are unaware of the resources currently available to them. For example, a number of engagement participants did not know about the City's existing emergency notification system, which allows residents to opt in to receive alerts via text messages, emails, and phone calls during emergency events. Expanding outreach and communication efforts will be essential to ensure that all community members are informed and able to fully utilize these resources when emergencies occur.
- **Building Availability May Be Limited:** The community engagement activities highlighted that suitable buildings for resilience hubs may be scarce due to factors such as cost, size limitations, or flooding concerns. As a result, mobile resilience hubs represent a practical and flexible solution for increasing community resilience.
- **Staff Capacity is a Key Consideration:** Implementing new resilience initiatives will require adequate staff capacity and cross-departmental coordination. Addressing staffing limitations will be important to ensure the successful planning, operation, and maintenance of resilience hubs and related programs.
- **Balancing Immediate and Long-Term Solutions is Necessary:** The community expressed a strong desire for a resilience hub that can serve both emergency and everyday needs. However, due to limited time to assess feasibility of proposed sites, the decision was made to pursue a mobile solar + storage unit as an interim solution. With additional time and collaboration with engineers, the City may be able to identify a viable physical site in the future.

These lessons will help guide the City as it continues to strengthen its resilience strategy, foster deeper community partnerships, and pursue the resources needed to build a more prepared and connected community.

# EMPORIA, VA - SOLAR RESILIENCY STUDY FOR MOBILE SOLUTION

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Ethan Marsh ____________________
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Reviewer

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Design Verifier

Design Verification Method:

☒ N/A ☐ Independent Review ☐ Alternate Calculation ☐ Qualification Testing

## Summary

The city of Emporia, VA has identified a need for a mobile resiliency solution to support a variety of locations across the city. Emporia has identified a need to provide capability for residents to charge devices, store temperature dependent medications, power small electrical equipment, along with the future ability to connect the system to a new emergency shelter. Emporia has identified the address 709 West Atlantic Street, Emporia, VA to temporarily house the system as it is within close distance of the existing emergency shelter and has sufficient extra space to house the mobile unit. With these parameters in mind, APTIM Engineering would like to recommend the acquisition of the Power-Up Connect Green Grid Mini, or any equivalent system available on the market.

## Load Analysis

- **Peak Load (kW):** N/A – Independent Mobile Solution
- **Average Daily Load (kWh):** N/A - Independent Mobile Solution
- **Critical Loads (list key equipment/systems):** Critical loads identified by the city of Emporia include small refrigerators, personal mobile devices, personal medical devices, and other low current draw equipment.
- **Critical Equipment Operating Hours:** System would allow for charging and powering of critical personal devices 24/7, with battery storage recharging occurring during the day.

### Capacity Assessment

- **Proposed Solar Array / Mobile Trailer:** Green Grid Mini Mobile Trailer
- **Recommended Battery Storage Size (kWh or hours of backup):** 20kWh
- **Resiliency Goal (hours/days of grid independence):** 4-7 days (assuming only powering low current draw equipment)
- **Estimated System Contribution to Outage Scenarios:** System would allow for charging of multiple small refrigerators, along with capacity to allow for the charging of personal mobile devices or any critical personal medical devices. The system will have excess capacity after covering these devices and can be used as the community sees fit.

### Equipment and Technology

- **Solar Module Type/Model:** 730W Solar Array with 5W Solar Exhaust Fan
- **Number of Panels:** Integrated on Roof of Trailer
- **Inverter Type and Capacity:** 3000VA Inverter – 48V/120V AC
- **Battery Type and Capacity:** 20kWh LiFePO4 Battery Storage
- **Resiliency Features (microgrid controllers, islanding, etc.):** Four 20A, 125 VAC Surge protection outlets, AC battery charger with power cable, charging port with 50’ extension cord, Victron solar controller, with addition features available for add on.

### Installation and Integration

- **Site Description (roof, ground-mount, canopy, etc.):** Trailer would be stored either outside in a parking lot (footprint of 8’ H x 5’ W x 10’) or stored inside a facility with the appropriate space.
- **Construction/Prep Requirements:** If the trailer is to be stored outside and will not be connecting to a facility, no construction or prep requirements are necessary. If the trailer is to be connected to a facility, the facility will need to identify “critical loads” to be powered in the instance of an outage, and those critical loads will need to be diverted from the main facility electrical panel to a subpanel with a tie-in point to the trailer.
- **Utility Interconnection Details:** Mobile solution will not need to be connected to utility services / will not be back feeding compatible.

## Summary & Recommendations

- **Key Findings:** The Power-Up Connect Green Grid Mini (or equivalent system) would provide sufficient capacity and output to allow the community of Richmond to power their desired use cases. System will also allow for the possibility to power critical loads of a facility if the community chooses to do so in the future.

- **Anticipated Benefits (outage mitigation):** Current proposed mobile solution will not power any building loads in the instance of an outage but will easily allow for community residents to keep small devices / equipment powered in the case of a short-term outage (i.e. 4-7 days). In the instance of a long-term outage, sufficient time for system to recharge will be needed to continue to provide services (1999.6 peak sun hours).

# Attachment A: Engineering Design Information

| Document Name | Reference | Quantity of Pages |
|---|---|---|
| APTIM, Proposed Electrical Drawings | N/A | 2 |
| | | |
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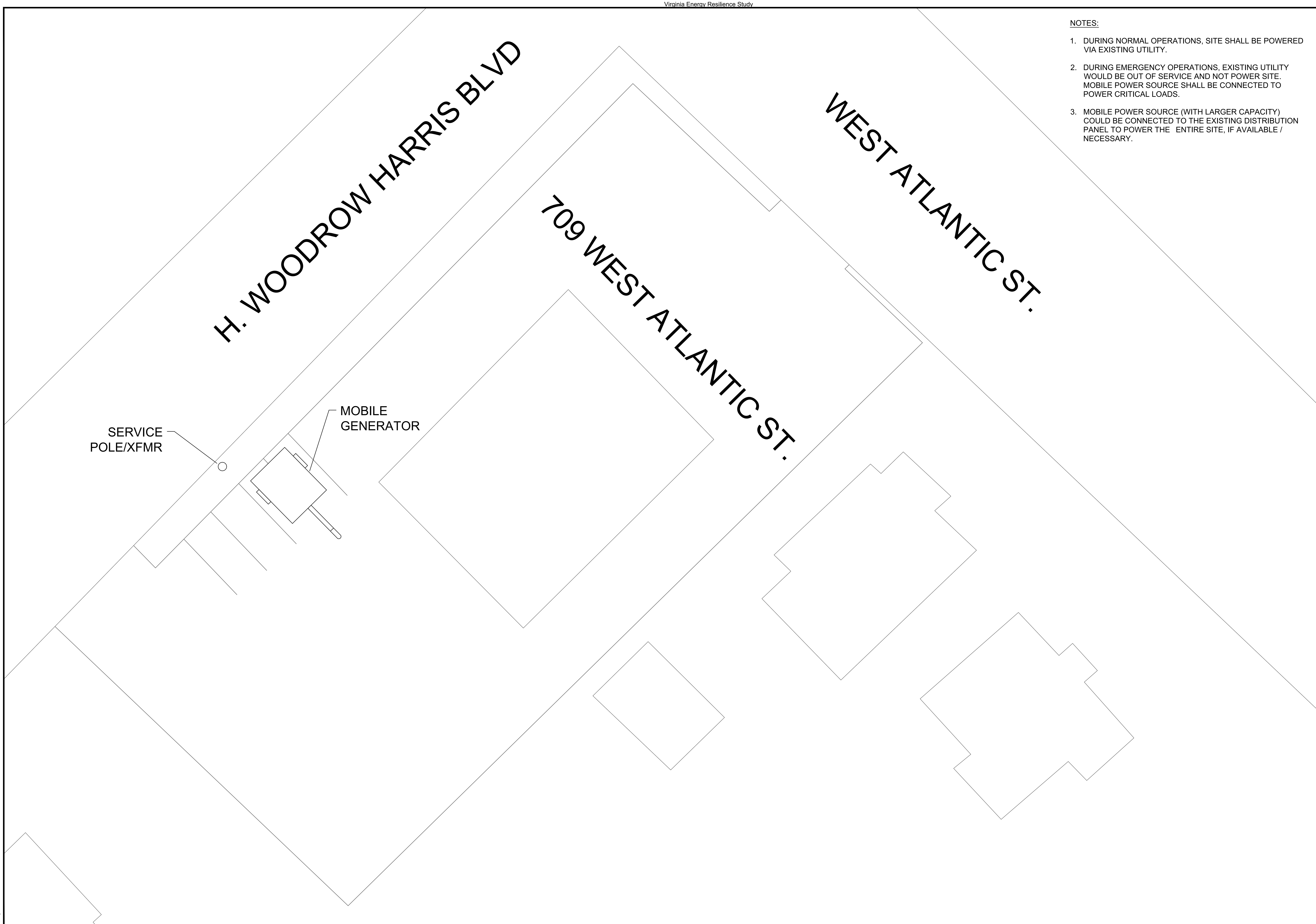


NOTES:

1. DURING NORMAL OPERATIONS, SITE SHALL BE POWERED VIA EXISTING UTILITY.
2. DURING EMERGENCY OPERATIONS, EXISTING UTILITY WOULD BE OUT OF SERVICE AND NOT POWER SITE. MOBILE POWER SOURCE SHALL BE CONNECTED TO POWER CRITICAL LOADS.
3. MOBILE POWER SOURCE (WITH LARGER CAPACITY) COULD BE CONNECTED TO THE EXISTING DISTRIBUTION PANEL TO POWER THE ENTIRE SITE, IF AVAILABLE / NECESSARY.

| NO. | DESCRIPTION | DWN | CK'D | APP'D | DATE |
|---|---|---|---|---|---|
| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

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PROFESSIONAL SEAL

APTIM

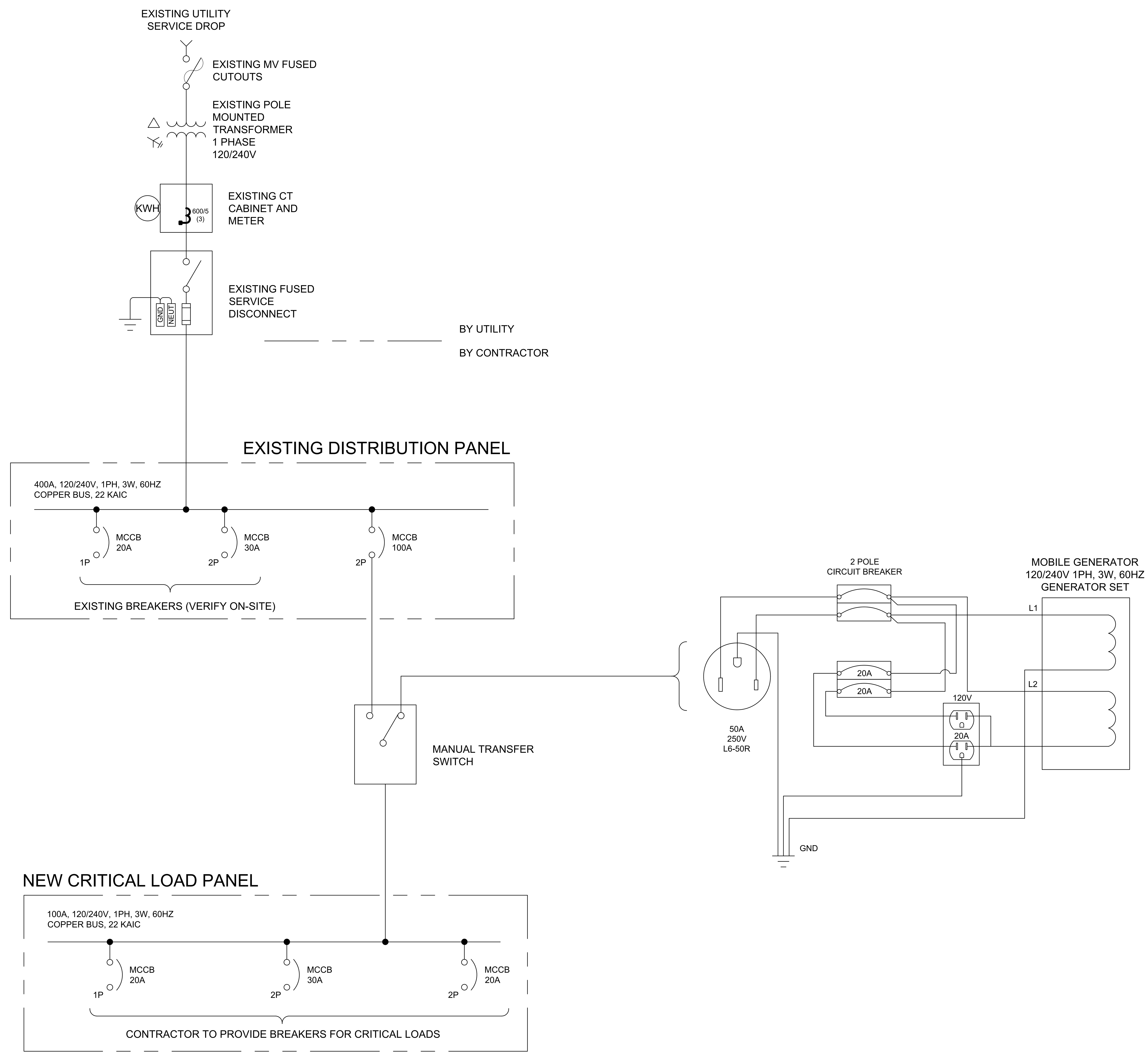
DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025
SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-001

VIRGINIA ENERGY RESILIENCE STUDY
709 WEST ATLANTIC STREET, EMPORIA, VA 24333
APTIM PROJECT NO. 77631041420

ELECTRICAL
MOBILE GENERATOR
SYSTEM SITE PLAN

SHEET NO.
E-001

File: Emporia 709 West Atlantic St.dwg
Plot Date/Time: Sep 30, 2025 - 8:10am
Plotted By: Robert.Childs




| NO. | DESCRIPTION | DWN | CKD | APPD | DATE |
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DWN BY: AGT
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APP'D BY: JSD
DATE: 09/30/2025

SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-002

VIRGINIA ENERGY RESILIENCE STUDY
709 WEST ATLANTIC STREET, EMPORIA, VA 24333
APTIM PROJECT NO. 77631041420

ELECTRICAL
MOBILE GENERATOR
SYSTEM ONE-LINE DIAGRAM

SHEET NO.
E-002

File: Emporia 709 West Atlantic St.dwg
Plot Date/Time: Sep 30, 2025 - 8:10am
Plotted By: Robert.Childs

# Resilience Hub Planning In Galax, Virginia

A Case Study on Local Energy Resilience

Trisha Porter, Resilient Virginia

September 2025

## Acknowledgements

The sources for much of the information in this case study come from partners at City of Galax and Resilient Virginia. The author would like to thank Tom Hager, Director and Building Official, City of Galax Building Department, for his valuable input and participation in the Virginia Energy Resilience Study.

## Disclaimer

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## Resilience Hub Project Background

In 2025, the City of Galax (City) partnered with the Virginia Department of Energy (DOE) to participate in the Virginia Energy Resilience Program, an initiative of the Renewables Advancing Community Energy Resilience (RACER) Program aimed at helping communities strengthen their energy resilience. As part of this effort, the city took part in the Virginia Energy Resilience Study (VERS), which evaluated the city capacity to endure power outages, identified key vulnerabilities, and provided recommendations for long-term improvements and solutions.

The initiative was led on behalf of the City by Thomas Hager, Director and Building Official, City of Galax Building Department. Together, he collaborated with the DOE, researchers from James

Madison University (JMU), community engagement specialists from Resilient Virginia, and engineers from APTIM. Through this partnership, the City accomplished the following:

- Completed the **Virginia Community Energy Resilience Workbook and Scoring Tool** to assess existing resilience and identify long-term strategies for improvement.
- Conducted **community engagement** through an interactive conversation to gather lived experiences, identify needed resources and services during outages, and explore potential sites for an energy resilience hub.
- Held **technical discussions with engineers** to develop design drawings for a resilience hub for a mobile resilience hub for the City.

**Population**
Galax is a city in southwestern Virginia with a population of 6,698 — 1,632 are under 18 years and 1,331 are aged 65 and older. The total number of households is 2,729.

**Experience with Disaster**
Galax has recently experienced a series of damaging flood events, including heavy rainfall in July and August 2025 which washed out roads and caused sinkholes and mud-covered areas and Hurricane Helene in September 2024. Helene's powerful winds brought down power lines and trees, resulting in prolonged power outages. Widespread flooding also affected numerous roads, homes, and businesses throughout the area.

**Residential Vulnerabilities**
Galax is home to a number of residents with heightened vulnerability during emergencies, underscoring the need for inclusive and targeted response planning. A total of 283 households do not have access to a vehicle, limiting mobility and evacuation options. Additionally, 908 individuals live with at least one physical disability, and 276 residents are unable to live independently — 139 of whom are over the age of 65. Between 10 and 15 households rely on well water, which can be disrupted during extended outages. Language barriers also present a challenge, with 30 households having limited English proficiency. Medical needs are significant, as 478 individuals depend on home healthcare equipment that often requires electricity. Economic vulnerability is also a concern, with 109 households classified as energy-burdened, and 365 residents aged 60 and older living in poverty. Furthermore, 245 elderly householders live alone, increasing the risk of isolation during emergencies. These factors highlight the importance of identifying and supporting at-risk populations in the city's emergency preparedness efforts.

# The Challenge

Tom Hager worked with key representatives in Galax to complete the Virginia Community Energy Resilience Workbook and Scoring Tool. Together, they collaborated to assess the city's energy resilience and determine the primary energy vulnerabilities and brainstorm solutions.

**Public Health and Safety**
During an extended power outage, most of Galax's public health and safety services can only continue operating for one day or less. These critical services include 9-1-1, police, acute medical care, public water, public sewer, and emergency shelters. A few services, such as the rescue squad/ambulance and public works, have the capacity to function for approximately two to three days. However, only fire protection and trash collection are capable of continuing operations for more than two weeks during such an outage.

**Emergency Management**
Most of Galax's emergency management services are only able to operate for one day or less during an extended power outage. These limited-duration services include the Emergency Command Center, community shelter, social services, animal shelter, and public communications. In contrast, the city is better equipped to sustain operations for more than two weeks for certain services such as debris cleaning, search and rescue, and special needs transport.

**Providing Community Necessities**
During an extended power outage, Galax can provide public transportation for approximately two to three days. However, many essential community services are far more limited, with the city only able to maintain them for one day or less. These services include phone and internet access, local TV or radio stations, local food banks or pantries, grocery stores, gas stations, banks and ATMs, pharmacies, and K-12 schools.

**Support for Residential Vulnerabilities**
Galax is able to provide cooling centers during extreme heat events, but it does not have a plan for warming centers in cases of extreme cold. For power outages lasting longer than one day, the city lacks a system to identify households dependent on home health care equipment or caregivers, which limits its ability to provide necessary support such as power for medical devices and wellness checks. Additionally, Galax does not have a public alert system that accommodates people with limited English proficiency, making it difficult for them to understand emergency information or receive guidance. The city also lacks a formal plan for delivering potable water to households relying on well water during extended outages. Furthermore, there is no formal list of residents without transportation to assist in relocating them to safer locations; past efforts have relied on informal and volunteer activities.

**Primary Energy Vulnerabilities**
A backup power source is urgently needed for the communications tower in Galax, as it supports multiple towers across the rural region, and a power loss would disrupt communications for a large area. Additionally, backup power is essential for maintaining critical services during outages, including public transportation, local food banks and pantries, grocery stores, gas stations, banks and ATMs, pharmacies, and K-12 schools. The city also faces challenges with limited backup fuel storage, highlighting the need for additional fuel reserves and multiple distribution points to sustain critical infrastructure and public services. To better support vulnerable populations, a centralized system is needed to quickly identify individuals

who require power for medical equipment or wellness checks during outages. Furthermore, emergency alerts must be accessible in multiple languages to effectively reach households with limited English proficiency.

# Community Engagement

A community meeting was held on August 27, 2025. Participants represented local government, business, nonprofits, and community members.

## Resources Most Needed During Emergencies

During emergencies, the most needed resources include access to electricity and auxiliary power, as well as water heaters and medical supplies. Critical infrastructure such as communication towers, water plants, shelters, and recreation centers play essential roles, alongside effective communication systems, emergency notifications, and reliable resource information. The ability to communicate with family and access to an information hub are vital, as is ensuring everyone can access the Emergency Operations Plan. Transportation, particularly scheduled services for the elderly, food preparation, and support for home-bound or shut-in residents are also crucial. Additionally, access to cash and banking services, as well as groceries, are key resources needed to help the community during emergencies.

## Resources and Amenities Most Important for a Resilience Hub

The most important resources and amenities for a resilience hub include reliable power, oxygen and other essential medical supplies, water, and facilities for food storage and preparation. Effective communication systems and a comprehensive resource directory are also crucial to support the community. Additionally, access to fuel is vital, with Galax needing two new fuel tanks to meet this demand. Equipment such as a forklift is necessary for efficiently off-loading supplies from delivery trucks, ensuring smooth operations during emergencies.

## Barriers That Might Prevent Someone From Using or Accessing an Energy Resilience Hub

Several obstacles may limit community members’ ability to use or access an energy resilience hub. Language barriers, especially among the Hispanic population, can make communication difficult. Trust is another key issue, as is the need for a stable and consistent volunteer base to provide ongoing support. Furthermore, limited storage capacity and poor communication networks add to the challenges of effectively meeting community needs during emergencies.

## Buildings in the Community That Could Double as an Energy Resilience Hub

- God’s Storehouse

- Communication Tower
- Radio Station
- Hospital

# Lessons Learned

The VERS project and accompanying community engagement process provided the City with several important lessons to inform future resilience planning and implementation efforts:

- **Understanding the city's energy-resilience requires:**
    - **A systems-level perspective:** Assessing the city's energy resilience requires a systems-level perspective that considers the cascading effects and interconnected impacts across sectors.
    - **Engaging diverse representation:** It is crucial to engage representatives with diverse knowledge and expertise to help identify and address gaps in the city's understanding of its energy resilience.
- **Staff capacity is a key consideration:** Implementing new resilience initiatives may require adequate staff capacity and cross-departmental coordination. Addressing staffing limitations is important to ensure the successful planning, operation, and maintenance of resilience hubs and related programs.
- **Ensure a shared understanding of the city's emergency plans:** Although Galax updated its emergency response plans after Hurricane Helene, these plans were not made accessible to community members, local organizations, or businesses. Making these plans available is critical to ensure a shared understanding of the city's emergency plans and how others can collaborate with the City to address any gaps in response efforts.
- **Funding is critical to building resilience:** Additional funding opportunities are essential to help Galax strengthen its emergency preparedness and advance resilience initiatives, including the development and implementation of resilience hubs, which require ongoing investment and resources. The city has gained valuable insights from its experience with Hurricane Helene and has identified strategies to improve its readiness for future events. However, putting these plans into action will require sustained financial support.

# GALAX, VA - SOLAR RESILIENCY STUDY FOR MOBILE SOLUTION

APTIM
11400 PARKSIDE DR.
SUITE 400
KNOXVILLE, TN 37934
(865) 560-7800

Ethan Marsh ____________________ ____________________
Preparer

Fermin Cabrera ____________________ ____________________
Reviewer

N/A ____________________ ____________________
Design Verifier

Design Verification Method:

☒ N/A ☐ Independent Review ☐ Alternate Calculation ☐ Qualification Testing

## Summary

The city of Galax, VA has identified a need for a mobile resiliency solution to replace the current support system for the emergency dispatch (Fire, EMS, Police) equipment in the instance of a grid outage. Currently, Galax only has outage support in the form of eight (8) extended charge car batteries wired in parallel that powers the communications tower during outages. Galax has identified the address 111 E Grayson St. Galax, VA to house the system as it is the location where the emergency dispatch communications tower resides. With these parameters in mind, APTIM Engineering would like to recommend the acquisition of the Power-Up Connect Green Grid Mini, or any equivalent system available on the market, as it has sufficient capacity to allow for the city to run the communications tower for an extended period of time during an outage, and would allow for easy connection of the system to the equipment.

## Load Analysis

- **Peak Load (kW):** N/A – Independent Mobile Solution (Note: APTIM correspondence with Galax has indicated that all communications equipment is expected to be low current draw equipment.)
- **Average Daily Load (kWh):** N/A - Independent Mobile Solution
- **Critical Loads (list key equipment/systems):** Critical loads identified by the city of Galax include communication equipment for local emergency dispatch and other low current draw loads to be determined by Galax.
- **Critical Equipment Operating Hours:** System would allow for powering of dispatch equipment 24/7, with partial battery storage recharging occurring during the day.

### Capacity Assessment

- **Proposed Solar Array / Mobile Trailer:** Green Grid Mini Mobile Trailer
- **Recommended Battery Storage Size (kWh or hours of backup):** 20kWh
- **Resiliency Goal (hours/days of grid independence):** 4-7 days (assuming only powering low current draw equipment)

- **Estimated System Contribution to Outage Scenarios:** System would allow for sufficient powering of emergency dispatch equipment on the communications tower. The system will also have excess capacity after covering these devices and can be used as the community sees fit.

## Equipment and Technology

- **Solar Module Type/Model:** 730W Solar Array with 5W Solar Exhaust Fan
- **Number of Panels:** Integrated on Roof of Trailer
- **Inverter Type and Capacity:** 3000VA Inverter – 48V/120V AC
- **Battery Type and Capacity:** 20kWh LiFePO4 Battery Storage
- **Resiliency Features (microgrid controllers, islanding, etc.):** Four 20A, 125 VAC Surge protection outlets, AC battery charger with power cable, charging port with 50’ extension cord, Victron solar controller, with addition features available for add on.

## Installation and Integration

- **Site Description (roof, ground-mount, canopy, etc.):** Trailer would be stored either outside in a parking lot (footprint of 8’ H x 5’ W x 10’) or stored inside a facility with the appropriate space.
- **Construction/Prep Requirements:** If the trailer is to be stored outside and will not be connecting to a facility, no construction or prep requirements are necessary. If the trailer is to be connected to a facility, the facility will need to identify “critical loads” to be powered in the instance of an outage, and those critical loads will need to be diverted from the main facility electrical panel to a subpanel with a tie-in point to the trailer.
- **Utility Interconnection Details:** Mobile solution will not need to be connected to utility services / will not be back feeding compatible.

## Summary & Recommendations

- **Key Findings:** The Power-Up Connect Green Grid Mini (or equivalent system) would provide sufficient capacity and output to allow the community of Galax to power their desired use cases. System will also allow for the possibility to power critical loads of a facility if the community chooses to do so in the future.
- **Anticipated Benefits (outage mitigation):** Current proposed mobile solution will not power any building loads in the instance of an outage but will easily allow for community residents to keep small devices / equipment powered in the case of a short-term outage (i.e. 4-7 days). In the instance of a long-term outage, sufficient time for system to recharge will be needed to continue to provide services (1999.6 peak sun hours).

# Attachment A:  Engineering Design Information

| Document Name | Reference | Quantity of Pages |
|---|---|---|
| APTIM, Proposed Electrical Drawings | N/A | 2 |
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NOTES:

1. DURING NORMAL OPERATIONS, SITE SHALL BE POWERED VIA EXISTING UTILITY.
2. DURING EMERGENCY OPERATIONS, EXISTING UTILITY WOULD BE OUT OF SERVICE AND NOT POWER SITE. MOBILE POWER SOURCE SHALL BE CONNECTED TO POWER CRITICAL LOADS.
3. MOBILE POWER SOURCE (WITH LARGER CAPACITY) COULD BE CONNECTED TO THE EXISTING DISTRIBUTION PANEL TO POWER THE  ENTIRE SITE, IF AVAILABLE / NECESSARY.


| NO. | DESCRIPTION | DWN | CK'D | APP'D | DATE |
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| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

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PROFESSIONAL SEAL

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| CK'D BY: EKM | SCALE: N/A |
| APP'D BY: JSD | CONTRACT NO.: 77631041420 |
| DATE: 09/30/2025 | DRAWING NO.: E-001 |

VIRGINIA ENERGY RESILIENCE STUDY
111 EAST GRAYSON ST, GALAX, VA 24333
APTIM PROJECT NO. 77631041420

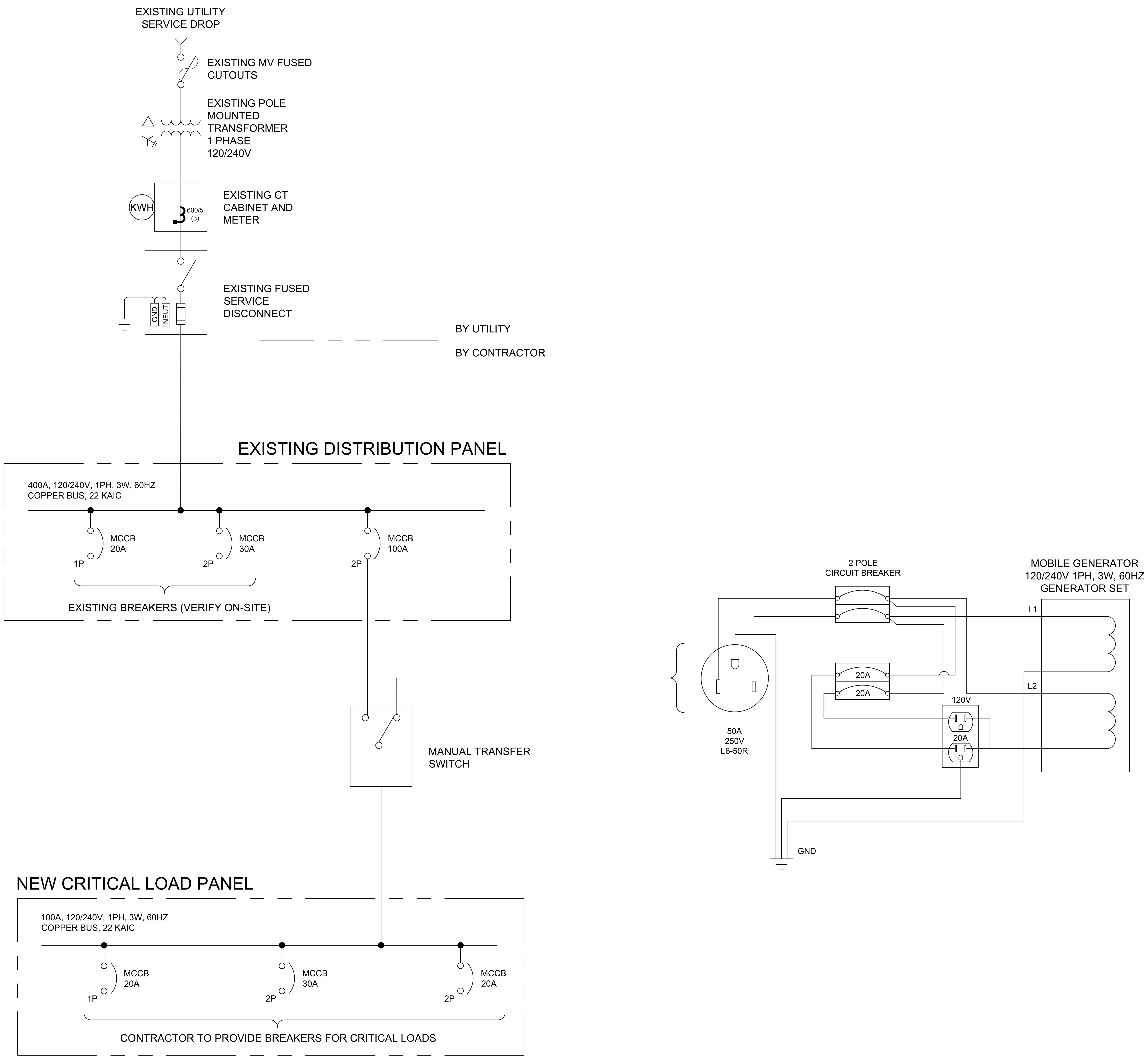
ELECTRICAL
MOBILE GENERATOR SYSTEM
SITE PLAN

SHEET NO.
E-001

File: Galax 111 E Grayson.dwg
Plot Date/Time: Sep 30, 2025 - 8:11am
Plotted By: Robert.Childs



DE-EE0010414 EOP-C




| NO. | DESCRIPTION | DWN | CK'D | APP'D | DATE |
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| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

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PROFESSIONAL SEAL

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SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-002

DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025

VIRGINIA ENERGY RESILIENCE STUDY
111 EAST GRAYSON ST, GALAX, VA 24333
APTIM PROJECT NO. 77631041420

ELECTRICAL
MOBILE GENERATOR SYSTEM
ONE-LINE DIAGRAM

SHEET NO.
E-002

File: Galax 111 E Grayson.dwg
Plot Date/Time: Sep 30, 2025 - 8:11am
Plotted By: Robert.Childs

# Resilience Hub Planning In Onancock, Virginia

A Case Study on Local Energy Resilience

Jessica Steelman, Resilient Virginia

September 2025

## Acknowledgements

The sources for much of the information in this case study come from partners in the Town of Onancock, Virginia and Jessica Steelman with Resilient Virginia. The authors would like to thank Matt Spuck, Onancock Town Manager for his valuable input and participation in the Virginia Energy Resilience Study.

## Disclaimer

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## Resilient Hub Project Background

In 2025, the Town of Onancock (Town) partnered with the Virginia Department of Energy (DOE) to participate in the Virginia Energy Resilience Program, an initiative of the Renewables Advancing Community Energy Resilience (RACER) Program aimed at helping communities strengthen their energy resilience. As part of this effort, Onancock took part in the Virginia Energy Resilience Study (VERS), which evaluated the Town's capacity to endure power outages, identified key vulnerabilities, and provided recommendations for long-term improvements and solutions.

The Town was interested in participating in the VERS project to align with their existing resilience efforts. These efforts include:

**RAFT Scorecard & Resilience Planning Partnership**
Onancock is participating in the Resilience Adaptation Feasibility Tool (RAFT) process—a collaborative program helping smaller localities assess and plan for coastal resilience.

- The Town completed a RAFT "scorecard" to identify vulnerabilities across infrastructure, planning, policy, and community dimensions.
- Based on RAFT findings, Onancock's Planning Commission adopted a Locality Resilience Action Checklist to guide implementation of priority resilience measures.
- As one near-term measure, the town installed duckbill valves in catch basins near the marina to reduce backflow flooding.
- The wharf area was raised and a new ramp installed after RAFT recommendations to reduce flooding at high tides.

**Stormwater & Drainage Projects in the Bayside Community**
A focused stormwater management and drainage repair plan is under development (or in proposal) for the Onancock Bayside Community.

- The plan targets approximately 12 culverts for replacement or enhancement, along with inspection and repair of others, over a ~13-month schedule.
- This infrastructure improvement is designed to reduce localized flooding and improve drainage in areas where aging or unmaintained ditches and culverts exacerbate flood risk.
- The initiative is explicitly aligned with regional efforts: Accomack County's drainage/comp plans, VDOT's flood mitigation priorities, and the Eastern Shore regional hazard mitigation plan.

**Participation in the Eastern Shore / Regional Hazard Mitigation Processes**
Onancock is included as a local participant in the Eastern Shore of Virginia Hazard Mitigation Plan (HMP), which evaluates flood, wind, coastal, and stormwater hazards and proposes mitigation strategies for towns across the region.

- Through the HMP, Onancock and neighboring towns are eligible to access hazard mitigation funding and coordination with state/federal agencies.

**Comprehensive Plan Integration**
In 2021, Onancock adopted a new Comprehensive Plan, which includes resilience and hazard-related components and mandates that the Planning Commission integrate resilience-related language into future ordinance and zoning updates.

- The Comprehensive Plan directs that resilience from weather-related damage must be addressed in land-use planning, infrastructure decision-making, and local code updates.

**Project Catalogs & Capital Improvements**

- Onancock has prepared a CFPF (Coastal Flooding and Protection Fund) application for a design for the Treatment Plant Administration Building to incorporate resiliency against flooding and facility-level mitigation.

- The town's scorecard process also assesses its infrastructure resilience (water/wastewater, stormwater, critical assets) and catalogs measures to improve those systems over time.

Many of Onancock's current resilience efforts are centered on planning, assessments, and initial infrastructure improvements, which provide a strong foundation but will need to scale into larger implementation measures such as rooftop solar with battery backup and expanded floodproofing. The localized drainage and stormwater projects in the Bayside area are particularly promising, as they directly address chronic flooding in one of the town's more vulnerable neighborhoods. Participation in regional efforts like the Eastern Shore Hazard Mitigation Plan also helps Onancock leverage funding and coordination opportunities, though long-term success will depend on the town's ability to adopt and carry out those strategies locally. Likewise, the RAFT-based approach offers a structured framework for resilience planning, but maintaining momentum and securing funding will be critical for translating assessments into real-world adaptation.

The Town of Onancock, Virginia, is a small independent Town on the Eastern Shore of Virginia, in Accomack County. Onancock sits on Virginia's Eastern Shore, serving as a small but important local center for commerce and access. Although it lacks major interstate junctions, Onancock is connected via VA-179 (Market Street) to U.S. Route 13, and benefits from regional bus service (STAR Transit), ferry connections, and burgeoning plans to link with the Eastern Shore Rail-to-Trail.

Despite these connections, Onancock remains a small town — in 2023 it had approximately 1,323 residents, with a median household income of $53,750. The demographic profile is roughly 52.8% White, 35.3% Black or African American, and 11.6% multiracial; about 2.4% identify as Hispanic/Latino. Roughly 25.7% of residents live below the poverty line.

Onancock operates under a mayor-council model, with a town manager executing council decisions. The Town maintains a portion of its streets (about 25%) while the Virginia Department of Transportation (VDOT) handles the rest. It also participates in the region's hazard mitigation efforts under the Eastern Shore of Virginia plan.

The town faces moderate flood risk, with 152 properties projected to be vulnerable over the next 30 years under rising sea levels and storm surges. It also has elevated wind risk from hurricanes and severe storms. With limited fiscal and staffing capacity, Onancock is constrained in its ability to manage large-scale disruptions, particularly those affecting Route 13 or local bridges and causeways.

Climate change is expected to intensify existing stresses. Longer, hotter summers and heavier rainfall could overwhelm stormwater systems, exacerbate flooding, and stress infrastructure such as roads, utilities, and drainage.

These risks are magnified by Onancock's modest revenue base, relatively high poverty levels, a large portion of the population reliant on fixed incomes or public assistance, and limited economic diversification. Together, these factors make resilience planning both critical and challenging.

## The Challenge

The Town of Onancock faces a range of interconnected challenges that affect its resilience and long-term sustainability. Among these are economic and social constraints. With a population of approximately 1,323 residents, a median household income of $53,750, and a poverty rate of about 25.7% (well above the national average), the Town's fiscal capacity is limited. These financial constraints reduce the ability to invest in infrastructure upgrades, emergency response resources, and long-term hazard mitigation. Vulnerable groups — including elderly residents, low-income households, and those with limited access to transportation — are disproportionately at risk during disasters and recovery.

From an environmental and hazard perspective, Onancock is challenged by recurring exposure to severe weather and flooding. Located on Virginia's Eastern Shore, the Town is low-lying and increasingly vulnerable to coastal storms, nor'easters, and hurricanes. The First Street Foundation projects that 152 properties in Onancock are at risk of flooding over the next 30 years due to sea-level rise and storm surge. While the Town has not reported a high number of repetitive-loss properties, flooding remains a persistent hazard. Its infrastructure is further stressed by its reliance on U.S. Route 13 for mobility, commerce, and emergency evacuation — a single major corridor that is highly vulnerable to storm-related disruptions.

Looking ahead, climate change will magnify these pressures. Projections for Virginia's Eastern Shore indicate hotter summers, more frequent and intense heat waves, and heavier rainfall events, all of which will strain stormwater systems, increase flooding, and raise public health risks. Combined with modest fiscal capacity, limited economic diversification, and the concentration of vulnerable populations, these changes pose ongoing challenges for adaptation and long-term community resilience.

## VERS Initiative

The VERS initiative was led on behalf of the Town by Matt Spuck, Town Manager. Mr. Spuck collaborated with the DOE, researchers from James Madison University (JMU), community engagement specialists from Resilient Virginia, and engineers from APTIM. Through this partnership, the Town accomplished the following:

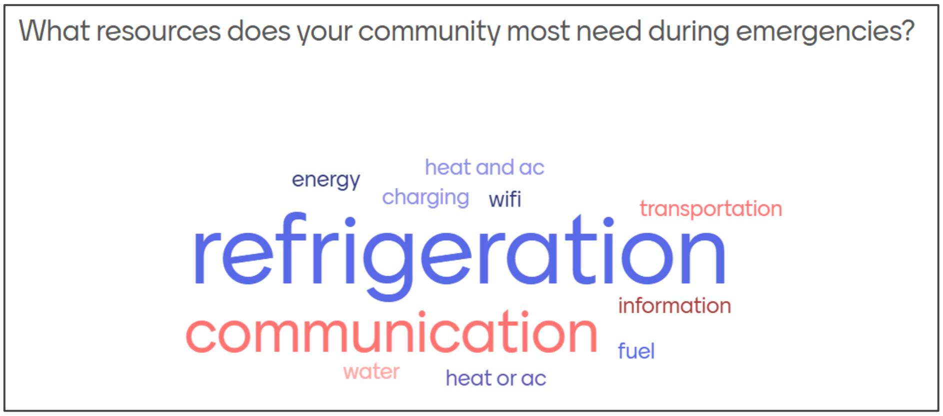
- Completed the **Virginia Community Energy Resilience Workbook and Scoring Tool** to assess existing resilience and identify long-term strategies for improvement.
- Conducted **community engagement** through an interactive conversation and community survey to gather lived experiences, identify needed resources and services during outages, and explore potential sites for an energy resilience hub.

Held **technical discussions with engineers** to develop design drawings for a mobile resilience hub for the Town.

## Community Engagement

As part of the VERS project, the Town partnered with a community engagement specialist to design and host an interactive virtual meeting aimed at fostering meaningful community member input. The goals of the session were to:

- Address the Town’s ongoing resilience initiatives;
- Provide an overview of the VERS project and share initial findings;
- Better understand the energy challenges faced by community members;
- Identify critical services and resources needed during power outages;
- Explore potential locations for an energy resilience hub; and
- Ensure that community voices, particularly those most affected by energy burdens, were heard and feedback incorporated.

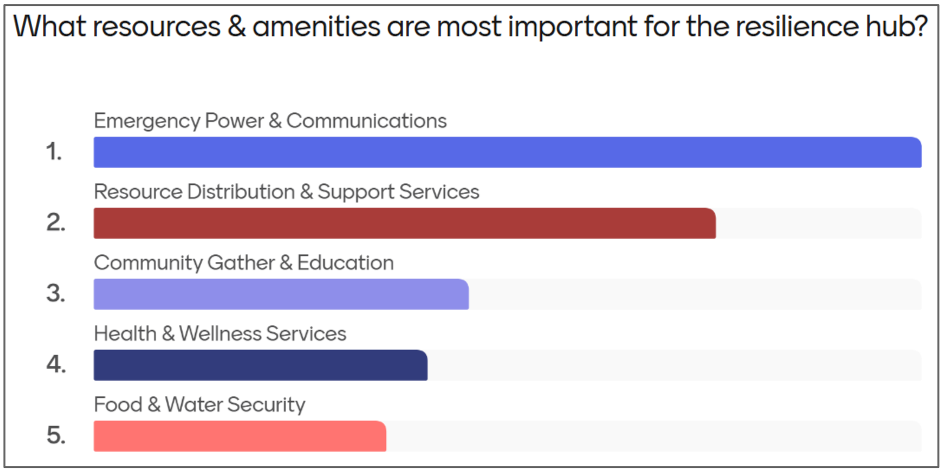



*Engagement Overview - Virtual Community Conversation*

A community conversation took place on September 22, 2025, from 1:00 p.m. to 2:00 p.m. virtually. A total of 3 community members (representing residents, local businesses, and the Onancock Business & Civic Organization) participated, sharing valuable feedback and insights. Additionally, one representative from A&N Electric Cooperative attended the meeting and shared information about programs and resources available to residents to enhance energy resilience at their homes.

The virtual community conversation was structured in three main segments:

1. **Welcome and Overview** – Introduction of community members and their role within the Town.
2. **Project Presentation** – Summary of the VERS project and initial understanding of a resilience hub.
3. **Interactive Activities** – Facilitated activities to identify community challenges, prioritize needs, and propose potential sites for a resilience hub.




During the community conversation, participants engaged in a discussion to identify the primary challenges they experience during power outages or other emergency events, highlighting issues including:

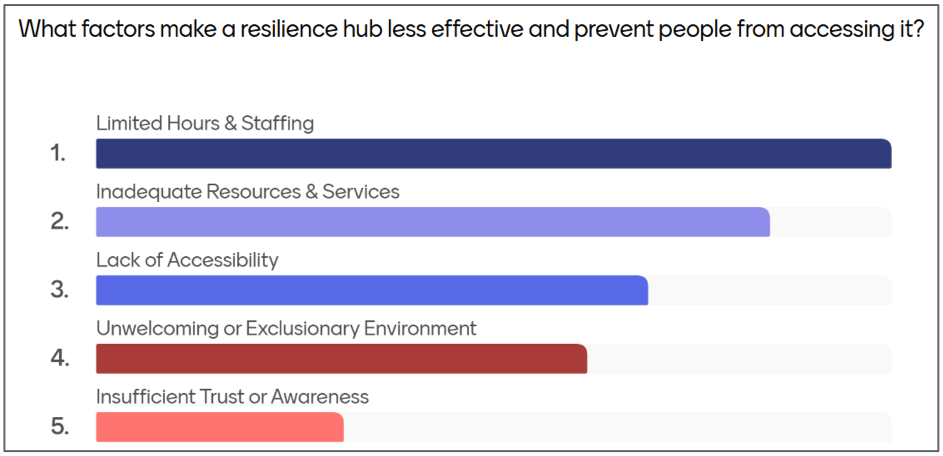
- Limited availability of emergency power
- Lack of resource distribution and support services
- Loss of communication tools (Wi-Fi, cell service, charging stations)

Participants identified a variety of needs during an emergency event, including:

- Backup power sources
- Food and water distribution
- Access to communication tools such as cell phones, charging stations, and Wi-Fi

Participants identified several barriers to a resilience hub being effective, including:

- Limited hours and staffing
- Inadequate resources and services
- Lack of accessibility




The Town Hall was identified as the only viable location to house the resilience hub, recognizing it was not ADA accessible and would require the installation of an elevator.

The community engagement meeting successfully brought together key stakeholders in the Town, providing stakeholders with a platform to share concerns, contribute ideas, and envision a more resilient future for their community. Through collaborative discussions, participants helped identify key challenges experienced during power outages and emergencies, define essential services and resources needed to strengthen community resilience, and highlight the preferred location for a future resilience hub. Participants also received information and resources to help them stay informed and enhance the resilience of their own homes. These insights can help the Town prioritize investments, shape future initiatives, and build a stronger, more resilient community in the face of a changing climate.

### *Engagement Overview - Energy Resilience Hub Community Survey*

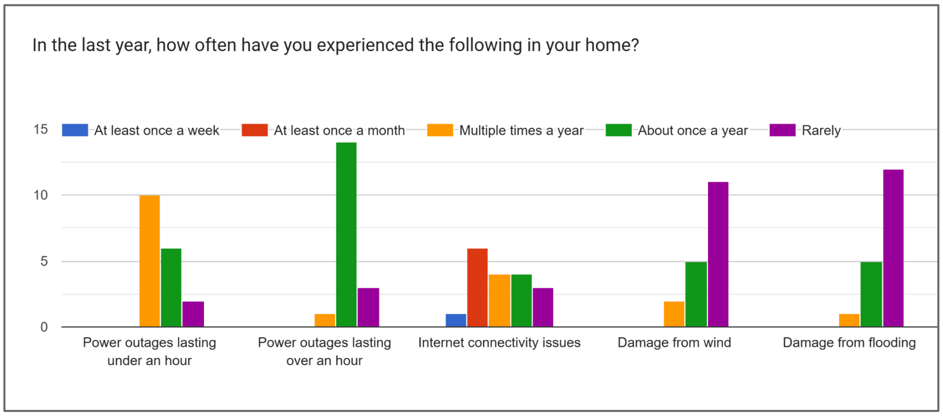
To broaden opportunities for community input and engagement, the Community Specialist developed a survey that the Town Manager distributed through their list of nearly 2,000 residents and stakeholders. Respondents included a total of 18 community members representing community members, business owners, community based organizations, Town Council members, first responders, and local government employees.

The survey asked participants to address various resilience-focused questions, including:

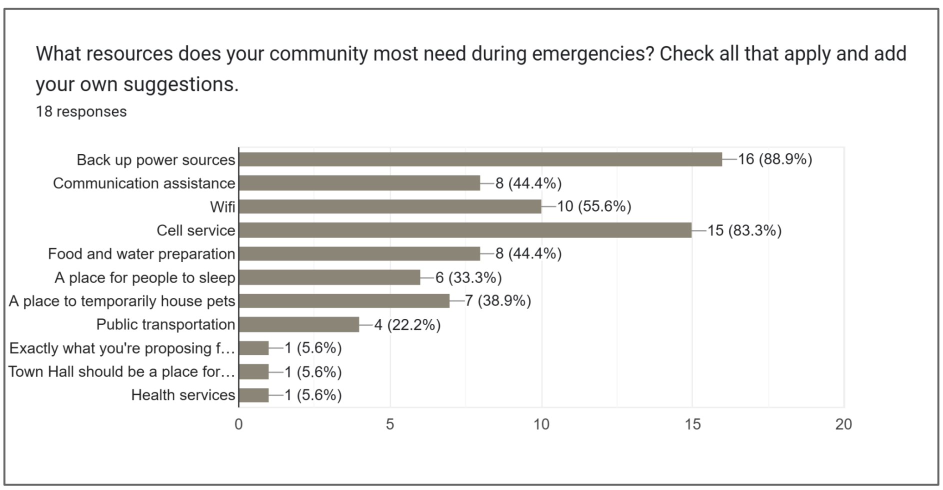
- How often they experienced various challenges over the last year;
- Critical resources needed during emergencies;
- Resources that would most likely be used during times of need;
- Barriers that would prevent community members from using the resilience hub; and
- Potential locations for the resilience hub.

A majority of participants noted experiencing the following challenges about once a year or more:

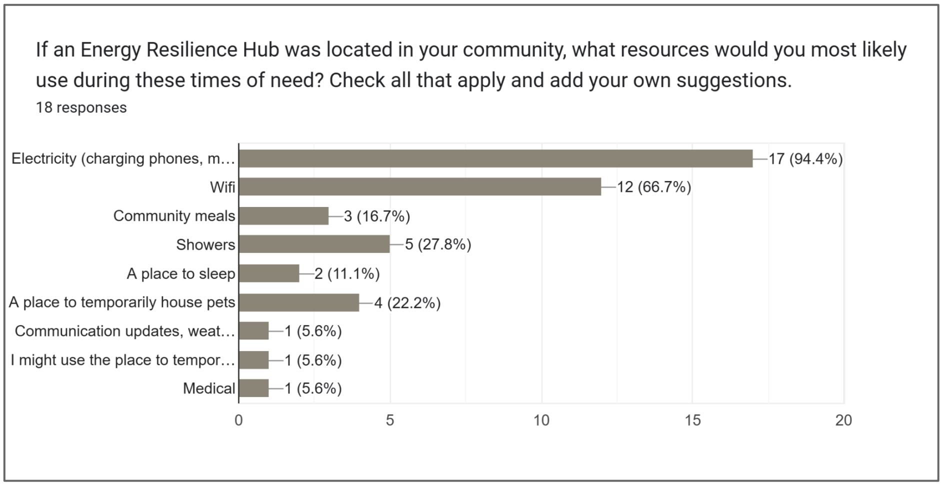
- Power outages lasting under an hour;
- Power outages lasting over an hour;
- And Internet connectivity issues.



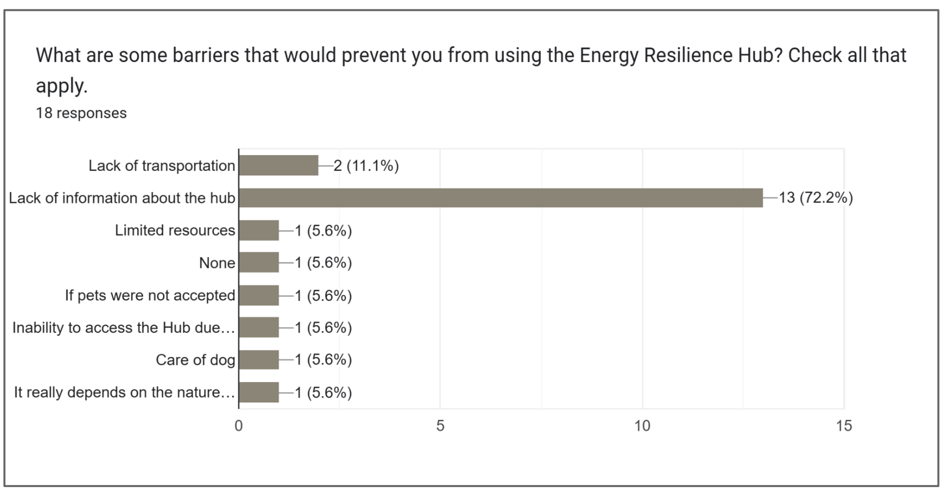

A majority of participants identified back up power sources and food and water preparation as most needed during emergencies within the community.



Despite a majority of participants identifying food and water preparation as a critical need, only 3% responded that they would use the resilience hub for community meals, where a majority responded that they would use the hub for electricity and Wi-Fi.




When it came to identifying barriers that would prevent community members from using the resilience hub, a majority noted a lack of information about the hub, with lack of transportation ranking second. It is important to note that the reason a lack of information about the resilience hub was ranked number one may be due to the resilience hub not yet being established and in its planning stages.




10

Survey participants identified a variety of locations for the resilience hub, including:

- Onancock Historical School
- Town Hall
- Churches
- National Guard facilities

Survey participants also identified the following needs

- Fresh food and water for pets
- Care of pets
- Heat and cooling
- Showers
- Laundry facilities
- Able-bodied staff and volunteers to help others

## The Solution: Equip Local Facility with Solar + Storage

### *Backup Power*

Community members consistently identified backup power as one of their most urgent needs during outages. Onancock is vulnerable to a range of severe weather hazards, including hurricanes and tropical storms from the Atlantic, nor'easters and winter storms, and summer thunderstorms. These events have historically caused flooding, wind damage, and extended blackouts. During engagement activities, residents emphasized that outages not only disrupt daily life but also pose serious risks to seniors and medically vulnerable residents who rely on refrigeration for food and medication, air conditioning during heat waves, and electricity for oxygen machines and other devices.

By equipping a community anchor facility (such as Town Hall, Onancock School, or another centrally located building) with rooftop or ground-mounted solar panels paired with battery storage, the Town could ensure that essential loads — lighting, refrigeration, communications, HVAC, and charging stations — remain available even when the grid is down. Nearly 26% of Onancock residents live below the poverty line, and close to one-quarter are age 65 or older. For these populations, backup power is not a matter of convenience but of health and survival. A resilience hub with solar + storage would provide a safe, reliable place for residents to charge phones, store medicines, access heating or cooling, and shelter safely during extended outages.

### *Reliable Power*

Beyond emergencies, Onancock residents reported frequent smaller outages and internet disruptions — sometimes lasting under an hour, sometimes longer. These interruptions disrupt work, school, and daily life, especially for those in older housing stock or manufactured homes that are more sensitive to temperature extremes.

A solar + storage system can help stabilize service by reducing peak demand stress on the grid, providing frequency response, and ensuring that a chosen resilience hub can operate uninterrupted. For facilities like schools, community centers, or Town Hall, this improves not only day-to-day reliability but also the delivery of services like youth programming, senior activities, and community health programs, while guaranteeing backup capacity during crises.

### *Economic Benefits*

Residents also raised concerns about limited resources and the Town's constrained fiscal capacity. Solar + storage systems can ease these constraints by:

- Reducing utility bills: Net metering allows facilities to offset grid purchases with their own solar generation. For Town-owned or community-serving buildings, this lowers ongoing operational costs.
- Shaving peak demand charges: Batteries discharge during the most expensive hours, reducing costs for public facilities and small businesses.
- Supporting local economic development: Installation and maintenance of solar + storage systems creates opportunities for local contractors and electricians, while signaling a shift toward energy diversification and resilience.

With a majority Black population (about 57%), high poverty rates, and aging infrastructure, Onancock's residents face disproportionate risks from storm-related outages. Establishing a solar + storage resilience hub would provide not just clean energy, but life-saving backup power, equitable access to reliable electricity, and long-term economic benefits that support a stronger and more resilient community.

## Lessons Learned

The VERS project and accompanying community engagement process provided the Town with several important lessons to inform future resilience planning and implementation efforts:

- **Early and Inclusive Community Engagement is Essential:**
  Engagement should begin at the outset of any project, with sufficient time built in to involve residents, Town departments, and local organizations. This ensures that a broad range of perspectives are incorporated into decision-making and that the solutions reflect community priorities.

- **Securing Sustainable Funding Remains a Critical Challenge:**
  Additional resources are needed to help Onancock better prepare for emergencies and to advance resilience initiatives, including the design and implementation of resilience hubs. Without consistent funding, these projects cannot be maintained or scaled to meet community needs.

- **Awareness of Existing Resilience Efforts Needs to be Expanded:**
  While the Town has implemented several initiatives, many residents remain unaware of available tools and services. For example, some engagement participants did not know about the Town's emergency notification system, which allows residents to receive alerts by text, email, or phone during emergencies. Enhanced outreach and communication will be necessary to ensure that all community members are informed and able to use these resources.

- **Physical Building Availability Presents Another Barrier:**
  Engagement participants noted that suitable facilities for resilience hubs are limited due to factors such as accessibility for those requiring an elevator.

- **Staff Capacity is a Key Consideration:**
  Successfully planning, operating, and maintaining resilience hubs will require adequate staffing and cross-departmental coordination. Addressing workforce and time limitations will be essential to ensure long-term success.

These lessons will help guide the Town as it continues to strengthen its resilience strategy, foster deeper community partnerships, and pursue the resources needed to build a more prepared and connected community.

# ONANCOCK, VA - SOLAR RESILIENCY STUDY FOR MOBILE SOLUTION

APTIM
11400 PARKSIDE DR.
SUITE 400
KNOXVILLE, TN 37934
(865) 560-7800

Ethan Marsh
Preparer

Fermin Cabrera
Reviewer

N/A
Design Verifier

Design Verification Method:
☒ N/A ☐ Independent Review ☐ Alternate Calculation ☐ Qualification Testing

## Summary

The city of Onancock, VA has identified a need for a mobile resiliency solution to compliment the existing propane generator resiliency system at the police station in the instance of a grid outage. Galax has identified the address 15 North St. Onancock, VA to house the system as it is the address of the police station. With these parameters in mind, APTIM Engineering would like to recommend the acquisition of the Power-Up Connect Green Grid Mini, or any equivalent system available on the market, as it has sufficient capacity and mobility to allow for the city to use as they see fit in emergency scenarios.

## Load Analysis

- **Peak Load (kW):** N/A – Independent Mobile Solution (Note: APTIM correspondence with Onancock has indicated that during previous renovations to the police station a new propane generator was installed that provides power to the entire facility.)
- **Average Daily Load (kWh):** N/A - Independent Mobile Solution
- **Critical Loads (list key equipment/systems):** No critical loads were immediately identified by the city of Onancock.
- **Critical Equipment Operating Hours:** System would allow for powering of small, low current draw equipment 24/7 while charged with partial battery storage recharging occurring during the day.

### Capacity Assessment

- **Proposed Solar Array / Mobile Trailer:** Green Grid Mini Mobile Trailer
- **Recommended Battery Storage Size (kWh or hours of backup):** 20kWh
- **Resiliency Goal (hours/days of grid independence):** 4-7 days (assuming only powering low current draw equipment)
- **Estimated System Contribution to Outage Scenarios:** System would allow for sufficient powering of any small equipment (mobile devices, small refrigerators, etc.) that the community might need in the instance of a grid outage.

### Equipment and Technology

- **Solar Module Type/Model:** 730W Solar Array with 5W Solar Exhaust Fan
- **Number of Panels:** Integrated on Roof of Trailer
- **Inverter Type and Capacity:** 3000VA Inverter – 48V/120V AC
- **Battery Type and Capacity:** 20kWh LiFePO4 Battery Storage
- **Resiliency Features (microgrid controllers, islanding, etc.):** Four 20A, 125 VAC Surge protection outlets, AC battery charger with power cable, charging port with 50' extension cord, Victron solar controller, with addition features available for add on.

### Installation and Integration

- **Site Description (roof, ground-mount, canopy, etc.):** Trailer would be stored either outside in a parking lot (footprint of 8' H x 5' W x 10') or stored inside a facility with the appropriate space.
- **Construction/Prep Requirements:** If the trailer is to be stored outside and will not be connecting to a facility, no construction or prep requirements are necessary. If the trailer is to be connected to a facility, the facility will need to identify "critical loads" to be powered in the instance of an outage, and those critical loads will need to be diverted from the main facility electrical panel to a subpanel with a tie-in point to the trailer.
- **Utility Interconnection Details:** Mobile solution will not need to be connected to utility services / will not be back feeding compatible.

## Summary & Recommendations

- **Key Findings:** The Power-Up Connect Green Grid Mini (or equivalent system) would provide sufficient capacity and output to allow the community of Onancock to power their desired use cases (assuming powering low current draw equipment) when said use cases are determined by the community. System will also allow for the possibility to power critical loads of a facility if the community chooses to do so in the future.

- **Anticipated Benefits (outage mitigation):** Current proposed mobile solution will not power any building loads in the instance of an outage but will easily allow for community residents to keep small devices / equipment powered in the case of a short-term outage (i.e. 4-7 days). In the instance of a long-term outage, sufficient time for system to recharge will be needed to continue to provide services (1999.6 peak sun hours).

# Attachment A: Engineering Design Information

| Document Name | Reference | Quantity of Pages |
|---|---|---|
| APTIM, Proposed Electrical Drawings | N/A | 2 |
| | | |
| | | |
| | | |
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| | | |
| | | |


NOTES:

1. DURING NORMAL OPERATIONS, SITE SHALL BE POWERED VIA EXISTING UTILITY.
2. DURING EMERGENCY OPERATIONS, EXISTING UTILITY WOULD BE OUT OF SERVICE AND NOT POWER SITE. EXISTING PROPANE GENERATOR CAN ACT AS BACKUP, OR MOBILE POWER SOURCE CAN BE CONNECTED TO POWER CRITICAL LOADS.
3. MOBILE POWER SOURCE (WITH LARGER CAPACITY) COULD BE CONNECTED TO THE EXISTING DISTRIBUTION PANEL TO POWER THE ENTIRE SITE, IF AVAILABLE / NECESSARY.

| NO. | DESCRIPTION | DWN | CK'D | APP'D | DATE |
|---|---|---|---|---|---|
| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

FOR REVIEW ONLY! – NOT FOR CONSTRUCTION

PRELIMINARY PROGRESS DRAWINGS ARE NOT FOR CONSTRUCTION OR FABRICATION. BILL OF MATERIALS, SHOP DRAWINGS, ETC., CREATED FROM THESE DRAWINGS MAY BE REVISED AT THE EXPENSE OF THE CONTRACTOR.

PROFESSIONAL SEAL

APTIM

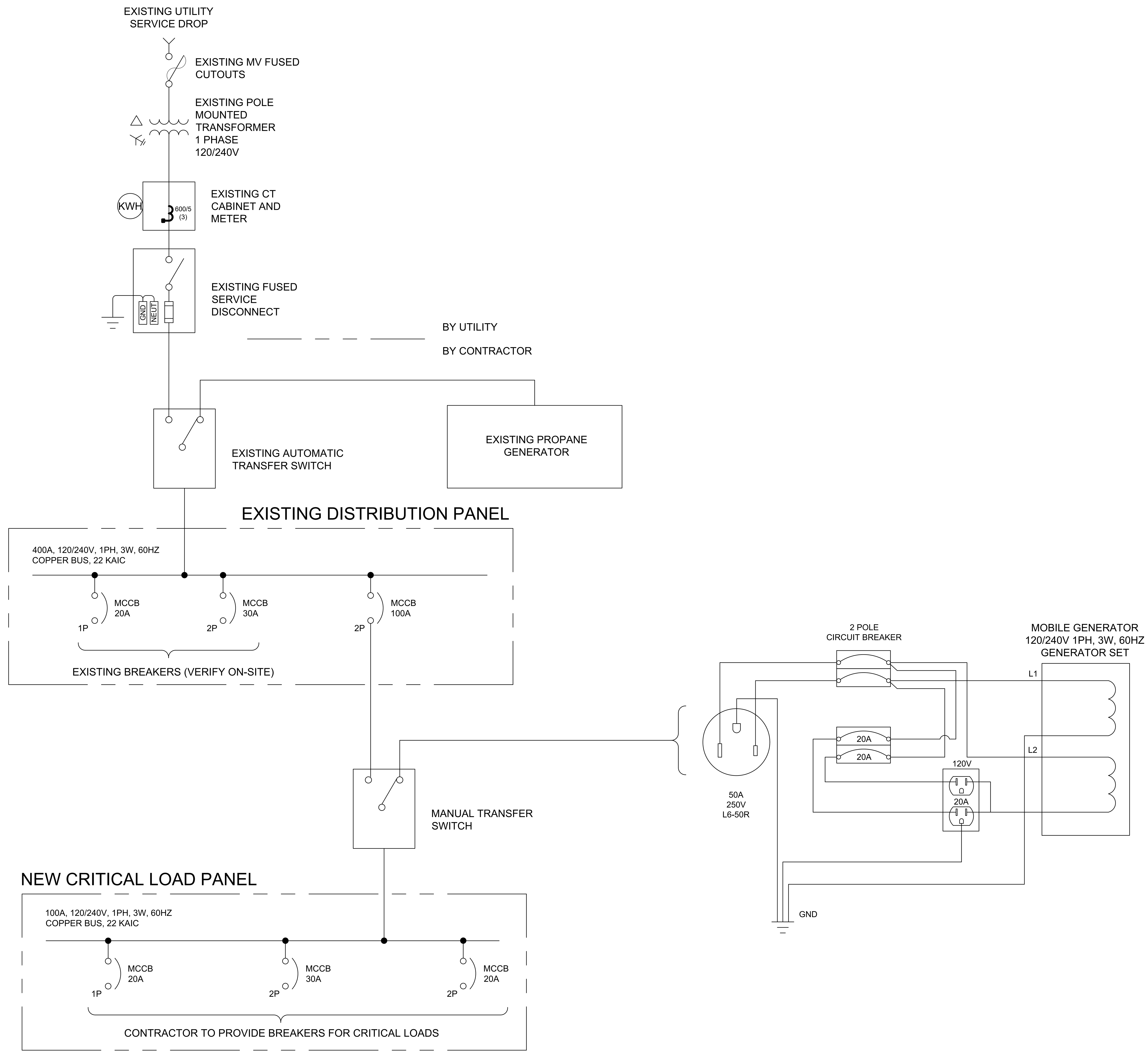
DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025
SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-001

VIRGINIA ENERGY RESILIENCE STUDY
15 NORTH ST, ONANCOCK, VA 23417
APTIM PROJECT NO. 77631041420

ELECTRICAL
MOBILE GENERATOR SYSTEM
SITE PLAN

SHEET NO.
E-001

File: Onancock 15 North St.dwg
Plot Date/Time: Sep 30, 2025 - 8:12am
Plotted By: Robert.Childs




| NO. | DESCRIPTION | DWN | CKD | APPD | DATE |
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| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

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PROFESSIONAL SEAL

APTIM

SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-002

DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025

VIRGINIA ENERGY RESILIENCE STUDY
15 NORTH ST. ONANCOCK, VA 23417
APTIM PROJECT NO. 77631041420

ELECTRICAL
MOBILE GENERATOR SYSTEM
ONE-LINE DIAGRAM

SHEET NO.
E-002

File: Onancock 15 North St.dwg
Plot Date/Time: Sep 30, 2025 - 8:13am
Plotted By: Robert.Childs

# Resilience Hub Planning In the City of Richmond, Virginia

A Case Study on Local Energy Resilience

Leslie King, Leslie King Consulting
Rebekah Cazares, Launch! Consulting, Inc.

September 2025

## Acknowledgements

The sources for much of the information in this case study come from partners at the City of Richmond, Leslie King Consulting, and Launch! Consulting. The authors would like to thank the City of Richmond's Office of Sustainability for their valuable input and participation in the Virginia Energy Resilience Study.

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## Resilient Hub Project Background

In 2025, the City of Richmond (City) partnered with the Virginia Department of Energy (DOE) to participate in the Virginia Energy Resilience Program, an initiative of the Renewables Advancing Community Energy Resilience (RACER) Program aimed at helping communities strengthen their energy resilience. As part of this effort, the City took part in the Virginia Energy Resilience Study (VERS), which evaluated the city's capacity to endure power outages, identified key vulnerabilities, and provided recommendations for long-term improvements and solutions.

The initiative was led on behalf of the City by staff from the Office of Sustainability. Together, they collaborated with the DOE, researchers from James Madison University (JMU), community engagement specialists from Leslie King Consulting and Launch! Consulting, Inc. (Launch), and engineers from APTIM. Through this partnership, the City accomplished the following:

- Completed the **Virginia Community Energy Resilience Workbook and Scoring Tool** to assess existing resilience and identify long-term strategies for improvement.
- Conducted **community engagement** through an interactive conversation to gather lived experiences, identify needed resources and services during outages, and explore potential sites for an energy resilience hub.
- Held **technical discussions with engineers** to develop design drawings for a mobile resilience hub for the City.

The City of Richmond prioritized assessing the energy resilience of the East End neighborhood as part of its commitment to advancing equitable climate action and infrastructure planning. This targeted focus supports the broader objectives of RVAgreen 2050, Richmond's comprehensive climate action and resilience framework, which seeks to achieve net-zero greenhouse gas emissions by 2050, strengthen community infrastructure against climate impacts, and center equity in all resilience initiatives.

The City of Richmond's East End neighborhood is a historically significant and rapidly evolving area located in the eastern portion of Virginia's capital city. The East End reflects a mix of historic neighborhoods, newer developments, and long-standing communities that continue to shape Richmond's cultural identity. The area's proximity to Downtown Richmond and major transportation corridors, including Interstates 64 and 95, makes it strategically important within the region's urban fabric.

Despite its strong cultural heritage, the East End faces a range of socioeconomic and environmental challenges. According to recent U.S. Census estimates, many East End neighborhoods experience higher rates of poverty and unemployment compared to citywide averages. The area has a predominantly Black population, with many households experiencing energy burdens, housing insecurity, and limited access to critical services during emergencies. Median household incomes are significantly lower than the City median, and a large proportion of residents are renters, which can limit their ability to invest in resilience improvements at the household level.

The East End is governed under Richmond's mayor–city council system and benefits from the City's participation in the Central Virginia Emergency Management Alliance and its Hazard Mitigation Plan. However, the neighborhood's infrastructure and housing stock are aging, with many homes located in low-lying areas vulnerable to flooding. Heavy rainfall, hurricanes, and severe storms have repeatedly impacted the community, with flooding along creeks and combined sewer overflow systems posing persistent risks. These vulnerabilities are compounded by limited green infrastructure, economic disinvestment, and historic inequities in resource allocation.

Looking ahead, climate change is expected to intensify existing hazards in Richmond's East End. Hotter summers, more frequent heat waves, and heavier precipitation will place additional strain on infrastructure, housing, and public health systems. Vulnerable populations, such as seniors, low-income households, and those without reliable transportation are at particular risk during prolonged power outages or extreme weather events.

Despite these challenges, the East End has significant strengths to build upon. Strong community networks, active civic organizations, and a growing focus on resilience and equity in city planning provide a foundation for meaningful progress. Continued investment in infrastructure upgrades, community engagement, and resilience initiatives such as resilience hubs will be essential to strengthen the East End's ability to withstand and recover from future emergencies.

## The Challenge

Richmond's East End neighborhood faces a complex set of interrelated social, economic, and environmental challenges that affect its overall resilience and long-term sustainability.

From a socioeconomic perspective, the East End experiences higher rates of poverty and unemployment than the citywide average. Many households have limited financial resources, and median household incomes in several East End census tracts fall well below Richmond's median. A large proportion of residents are renters, which can limit their ability to invest in home improvements that enhance resilience, such as backup power or floodproofing. Vulnerable populations, including seniors, low-income households, people with disabilities, and those without reliable transportation are disproportionately affected during and after emergencies, often facing barriers to evacuation, recovery, and access to essential services.

From an environmental and hazard perspective, the East End is exposed to recurring flooding, severe storms, and extreme heat events. Many homes and streets sit in low-lying areas near creeks or within combined sewer overflow zones, making them particularly vulnerable to flash flooding and infrastructure failures during heavy rainfall. Aging housing stock and limited green infrastructure further exacerbate these risks. Heat is another growing concern: urban heat island effects are more pronounced in the East End, where tree canopy coverage is lower and impervious surfaces are widespread, increasing health risks during prolonged heat waves.

Climate change is expected to intensify these existing challenges. Projections indicate hotter summers, more frequent extreme heat events, and heavier precipitation, which will place additional strain on stormwater systems, increase flood frequency, and heighten public health risks. At the same time, historic underinvestment, limited local resources, and inequitable infrastructure distribution make it more difficult for the community to adapt to these changes.

## Community Engagement

As part of the VERS project, the City partnered with community engagement specialists to design and host an interactive public meeting aimed at fostering meaningful resident input. The goals of the session were to:

- Introduce the City's ongoing resilience initiatives.
- Provide an overview of the VERS project and share initial findings.
- Better understand the energy challenges faced by residents.
- Identify critical services and resources needed during power outages.
- Explore potential locations for an energy resilience hub.
- Ensure that community voices, particularly those most affected by energy burdens, were heard and feedback incorporated.

### Engagement Overview

The community conversation took place on September 30, 2025, from 6:00 p.m. to 8:00 p.m. at the East End Public Library.

The meeting was structured in three main segments:

1. **Welcome and Overview** – Introduction to the City's resilience initiatives.
2. **Project Presentation** – Summary of the VERS project and initial study findings.
3. **Interactive Activities** – Facilitated activities to identify community challenges, prioritize needs, and propose potential sites for a resilience hub.

During the community conversation, participants first engaged in a whole-group discussion to identify the primary challenges they experience during power outages or other emergency events. Residents highlighted a range of issues, including:

Following this initial discussion, participants were divided into two small groups to further explore potential services and resources that an energy resilience hub could provide. Facilitated by engagement specialists, each group used flip charts to brainstorm ideas, which were then shared back with the full group to identify common priorities and areas of alignment.

The small group discussions focused on two guiding questions:

1. What do you need during a power outage or other emergency?
2. What other services or resources could an energy resilience hub provide?

The final small group activity focused on mapping potential sites for an energy resilience hub. Participants were provided with printed maps of the City and asked to identify and evaluate possible locations, taking into account key considerations such as:

- Public vs. private property ownership
- Vacant lots and underutilized spaces
- Existing infrastructure limitations
- Proximity to or placement outside of city limits

Once potential sites were identified, participants were asked to rank their top three locations, with Rank 1 indicating the highest priority. They then discussed the strengths and weaknesses of each site to assess feasibility and suitability for future development.

## The Solution: Equip Local Facility with Solar + Storage

### *Backup Power*

Solar + storage keeps critical community services running during grid failures. Richmond's East End, home to neighborhoods such as Fulton, Creighton, and Church Hill, faces compounded vulnerabilities: a high proportion of low-income and Black households, aging housing stock, and elevated energy burdens (with many households spending more than 6% of income on utilities). These factors mean that power outages hit East End residents especially hard, threatening access to refrigerated medications, air conditioning during summer heat waves, and communications during storms.

City-wide, severe weather routinely causes major blackouts. In July 2025, a strong storm left more than 12,000 Richmond residents without power, with thousands in the East End affected due to downed trees and damaged distribution lines. Installing solar + storage at a trusted community space in the East End would allow the facility to island from the grid and continue powering essential services during extended outages, such as lighting, refrigeration, HVAC, and device charging. This ensures that residents, particularly seniors and medically vulnerable populations, have a safe, reliable refuge when the grid fails.

### *Reliable Power*

Even outside of emergencies, Richmond's grid experiences stress during peak summer demand and remains vulnerable to storm damage. Analyses show that over 94% of Virginia's major power outages since 2000 were caused by extreme weather. The East End, with dense tree canopy and many above-ground power lines, is especially prone to local service interruptions during thunderstorms and tropical storm remnants.

Solar + storage mitigates these vulnerabilities by stabilizing voltage and frequency, reducing peak load strain, and ensuring resilience hub operations are uninterrupted. For facilities like recreation centers, churches, or community health spaces in the East End, this reliability supports daily youth programming, food distribution, and health services, while guaranteeing backup power during crises.

### *Economic Benefits*

The East End also stands to gain from the financial advantages of solar + storage:

- **Reduced bills for community facilities:** Solar panels generate clean electricity, offsetting grid purchases. In Virginia, systems can be net-metered, lowering monthly costs for community-serving facilities already operating on limited budgets.
- **Peak shaving through storage:** Batteries discharge during peak hours, cutting costly demand charges and smoothing grid demand. For Richmond's small businesses and public facilities, this translates into meaningful savings.

- **Local economic development:** Solar + storage creates installation, maintenance, and monitoring jobs in Richmond. Importantly, this helps prepare for Virginia's rising energy demand; with data center growth, state regulators warn of possible rolling blackouts in the coming decade, a risk that resilience hubs in neighborhoods like the East End can help buffer against.

For Richmond's East End, a historically Black community with high energy burdens and repeated outage exposure, solar + storage resilience hubs are not just technical upgrades but equity investments. They address both immediate survival needs during storms and long-term economic and health resilience.

## Lessons Learned

The VERS project and accompanying community engagement process provided the City with several important lessons to inform future resilience planning and implementation efforts:

- **Early and Inclusive Community Engagement is Essential:**
  Meaningful engagement should begin at the very start of any planning or project process. Allowing sufficient time to involve community members, City departments, and other stakeholders ensures that a diverse range of voices and perspectives are heard and integrated into decision-making.
- **Funding is Critical to Building Resilience:** Additional funding opportunities are needed to help cities like Richmond better prepare for emergencies and advance resilience initiatives, such as the development and implementation of resilience hubs that require sustained investment and resources.
- **Increase Awareness of Existing Resilience Efforts:** Although the City has already implemented several resilience initiatives, many residents may be unaware of the resources currently available to them. Expanding outreach and communication efforts will be essential to ensure that all community members are informed and able to fully utilize these resources when emergencies occur.
- **Resource Availability May Be Limited:** In Richmond's East End, resources may be limited in terms of building availability to easily implement a solar + storage hub on an existing building. This City can consider implementing a mobile hub solution in the interim to improve resilience in the East End during power outages.
- **Staff Capacity is a Key Consideration:** Implementing new resilience initiatives may require adequate staff capacity and cross-departmental coordination. Addressing staffing limitations is important to ensure the successful planning, operation, and maintenance of resilience hubs and related programs.
- **Aligning with Existing Resilience Efforts:** The City's Office of Sustainability has many existing lines of resilience work currently underway. In order to avoid overwhelming or confusing residents, it is important to ensure that it is clear from the onset of a project how initiatives connect and contribute to long-term goals. This alignment will help to avoid duplicative efforts and incorporate insights across projects.

These lessons will help guide the City as it continues to strengthen its resilience strategy, foster deeper community partnerships, and pursue the resources needed to build a more prepared and connected community.

# RICHMOND, VA - SOLAR RESILIENCY STUDY FOR MOBILE SOLUTION

APTIM
11400 PARKSIDE DR.
SUITE 400
KNOXVILLE, TN 37934
(865) 560-7800

Ethan Marsh ______________________ ______________________
Preparer

Fermin Cabrera ______________________ ______________________
Reviewer

N/A ______________________ ______________________
Design Verifier

Design Verification Method:

☒ N/A ☐ Independent Review ☐ Alternate Calculation ☐ Qualification Testing

## Summary

The city of Richmond VA has identified a need for a mobile resiliency solution to support a variety of locations across the city. Richmond has identified a need to allow low-mobility senior citizens to charge devices, store temperature dependent medications, and any of their other needs, along with supplying the same services to several public housing communities across the city. Richmond has identified the address 701 N. 25th Street, Richmond, VA to house the system as it is within close distance of the public housing communities, and across the street from a local senior center. With these parameters in mind, APTIM Engineering would like to recommend the acquisition of the Power-Up Connect Green Grid Mini, or any equivalent system available on the market.

## Load Analysis

- **Peak Load (kW):** N/A – Independent Mobile Solution
- **Average Daily Load (kWh):** N/A - Independent Mobile Solution
- **Critical Loads (list key equipment/systems):** Critical loads identified by the city of Richmond include small refrigerators, personal mobile devices, personal medical devices, and other low current draw loads.
- **Critical Equipment Operating Hours:** System would allow for charging and powering of critical personal devices 24/7, with battery storage recharging occurring during the day.

### Capacity Assessment

- **Proposed Solar Array / Mobile Trailer:** Green Grid Mini Mobile Trailer
- **Recommended Battery Storage Size (kWh or hours of backup):** 20kWh
- **Resiliency Goal (hours/days of grid independence):** 4-7 days (assuming only powering low current draw equipment)
- **Estimated System Contribution to Outage Scenarios:** System would allow for charging of multiple small refrigerators, along with capacity to allow for the charging of personal mobile devices or any critical personal medical devices. The system will have excess capacity after covering these devices and can be used as the community sees fit.

## Equipment and Technology

- **Solar Module Type/Model:** 730W Solar Array with 5W Solar Exhaust Fan
- **Number of Panels:** Integrated on Roof of Trailer
- **Inverter Type and Capacity:** 3000VA Inverter – 48V/120V AC
- **Battery Type and Capacity:** 20kWh LiFePO4 Battery Storage
- **Resiliency Features (microgrid controllers, islanding, etc.):** Four 20A, 125 VAC Surge protection outlets, AC battery charger with power cable, charging port with 50' extension cord, Victron solar controller, with addition features available for add on.

## Installation and Integration

- **Site Description (roof, ground-mount, canopy, etc.):** Trailer would be stored either outside in a parking lot (footprint of 8' H x 5' W x 10') or stored inside a facility with the appropriate space.
- **Construction/Prep Requirements:** If the trailer is to be stored outside and will not be connecting to a facility, no construction or prep requirements are necessary. If the trailer is to be connected to a facility, the facility will need to identify "critical loads" to be powered in the instance of an outage, and those critical loads will need to be diverted from the main facility electrical panel to a subpanel with a tie-in point to the trailer.
- **Utility Interconnection Details:** Mobile solution will not need to be connected to utility services / will not be back feeding compatible.

## Summary & Recommendations

- **Key Findings:** The Power-Up Connect Green Grid Mini (or equivalent system) would provide sufficient capacity and output to allow the community of Richmond to power their desired use cases. System will also allow for the possibility to power critical loads of a facility if the community chooses to do so in the future.

- **Anticipated Benefits (outage mitigation):** Current proposed mobile solution will not power any building loads in the instance of an outage but will easily allow for community residents to keep small devices / equipment powered in the case of a short-term outage (i.e. 4-7 days). In the instance of a long-term outage, sufficient time for system to recharge will be needed to continue to provide services (1999.6 peak sun hours).

# Attachment A: Engineering Design Information

| Document Name | Reference | Quantity of Pages |
|---|---|---|
| APTIM, Proposed Electrical Drawings | N/A | 2 |
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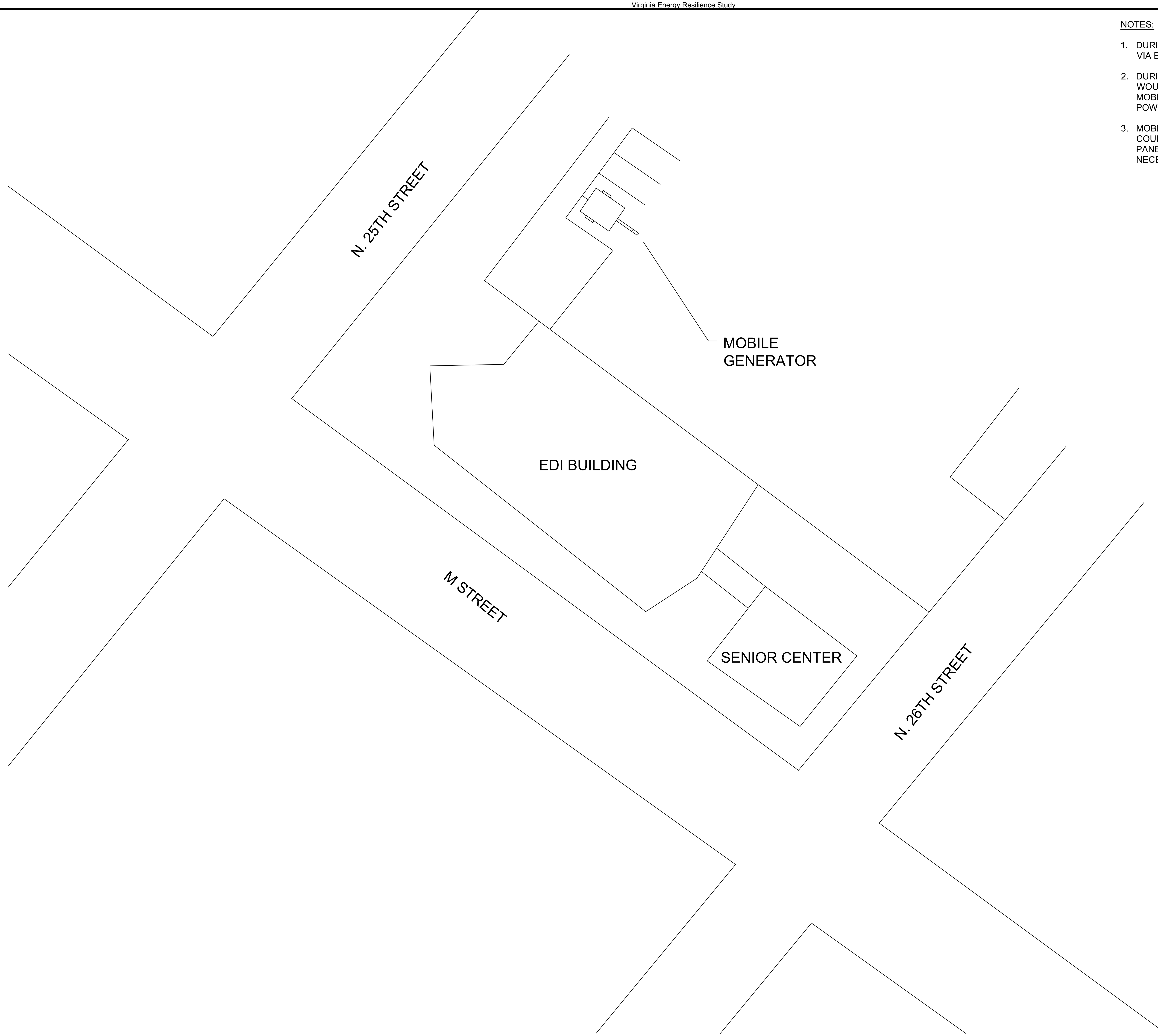


NOTES:

1. DURING NORMAL OPERATIONS, SITE SHALL BE POWERED VIA EXISTING UTILITY.
2. DURING EMERGENCY OPERATIONS, EXISTING UTILITY WOULD BE OUT OF SERVICE AND NOT POWER SITE. MOBILE POWER SOURCE SHALL BE CONNECTED TO POWER CRITICAL LOADS.
3. MOBILE POWER SOURCE (WITH LARGER CAPACITY) COULD BE CONNECTED TO THE EXISTING DISTRIBUTION PANEL TO POWER THE ENTIRE SITE, IF AVAILABLE / NECESSARY.

| NO. | DESCRIPTION | DWN | CKD | APPD | DATE |
|---|---|---|---|---|---|
| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

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PROFESSIONAL SEAL

APTIM

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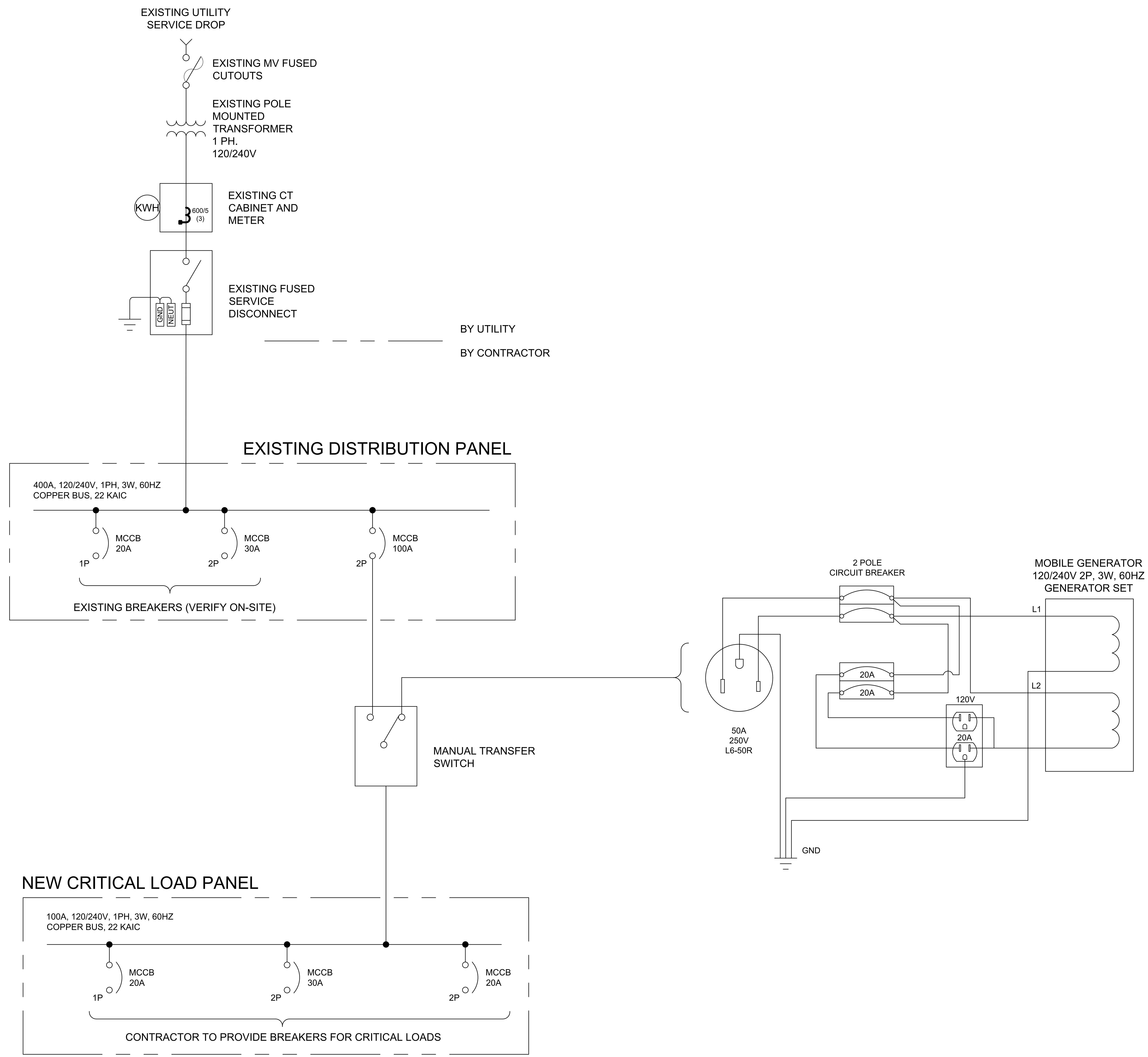
| DWN BY: AGT | SIZE: ANSI D |
| CK'D BY: EKM | SCALE: N/A |
| APP'D BY: JSD | CONTRACT NO.: 77631041420 |
| DATE: 09/30/2025 | DRAWING NO.: E-001 |

EDI BUILDING
701 N. 25TH STREET
RICHMOND, VA 23223
APTIM PROJECT NO. 77631041420

ELECTRICAL MOBILE GENERATOR SYSTEM SITE PLAN

SHEET NO.
E-001

File: Richmond.dwg
Plot Date/Time: Sep 30, 2025 - 9:13am
Plotted By: Robert.Childs

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APTIM

DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025

SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-002

EDI BUILDING
701 N. 25TH STREET
RICHMOND, VA 23223
APTIM PROJECT NO. 77631041420

ELECTRICAL
MOBILE GENERATOR ONE-LINE DIAGRAM

SHEET NO.
E-002

File: Richmond.dwg
Plot Date/Time: Sep 30, 2025 - 8:15am
Plotted By: Robert.Childs

# BUCHANAN, VA - SOLAR RESILIENCY STUDY FOR MOBILE SOLUTION

APTIM
11400 PARKSIDE DR.
SUITE 400
KNOXVILLE, TN 37934
(865) 560-7800

Ethan Marsh ______________________ ______________________

Preparer

Fermin Cabrera ______________________ ______________________

Reviewer

N/A ______________________ ______________________

Design Verifier

Design Verification Method:

☒ N/A ☐ Independent Review ☐ Alternate Calculation ☐ Qualification Testing

## Summary

The city of Buchanan, VA has identified a need for a mobile resiliency solution to support a variety of locations across the city. Buchanan has specifically requested a mobile solution to meet the following needs:

1. Ability to connect to fuel station(s), fuel pumps during long term outages (4-7 days) to allow for filling of emergency and city/town vehicles.
2. Ability to connect to water pumps for distant localities.
3. A maximum draw of 120A at 120VAC.
4. Ability to power Starlink communications equipment.
5. Low current 120VAC and/or 5VDC for charging personal devices and equipment.

With these parameters in mind, APTIM Engineering would like to recommend the acquisition of one or more Power-Up Connect Green Grid units, or any equivalent system available on the market. Based on the requirements provided by Buchanan, APTIM Engineering finds that multiple units (2-3) would best suit the county's needs.

## Load Analysis

- **Peak Load (kW):** N/A – Independent Mobile Solution (Note: Through correspondence with Buchanan, interest in powering multiple pump station suggests that a larger unit be acquired as continuous current draw from motors would require a higher system capacity.)
- **Average Daily Load (kWh):** N/A - Independent Mobile Solution (Note: Pump specifications were not provided to APTIM during this analysis. Further investigation will be required before purchase of unit(s))
- **Critical Loads (list key equipment/systems):** Critical loads identified by the County of Buchanan include pump motors, personal mobile devices, personal medical devices, and other low current draw loads.
- **Critical Equipment Operating Hours:** System would allow for charging and powering of critical personal devices 24/7, with battery storage recharging occurring during the day. Further consultation with unit vendor will be required to attain proper estimates of unit life span when powering motors.

## Capacity Assessment

- **Proposed Solar Array / Mobile Trailer:** Green Grid Mini Mobile Trailer
- **Recommended Battery Storage Size (kWh or hours of backup):** 90kWh
- **Resiliency Goal (hours/days of grid independence):** 4-7 days (assuming only powering low current draw equipment)
- **Estimated System Contribution to Outage Scenarios:** System(s) will allow for powering of fuel/water pumps, along with capacity to allow for the charging of personal mobile devices and/or wireless communication equipment. The system will have excess capacity after covering these devices and can be used as the community sees fit. (Note: Excess capacity is only true for powering low current draw devices – excess capacity might not be available when powering pump stations. Further consultation with vendor will be required before unit acquisition.

## Equipment and Technology

- **Solar Module Type/Model:** 1100W Solar Array
- **Number of Panels:** Integrated on Roof of Trailer
- **Inverter Type and Capacity:** Inverter type not listed in product datasheet – 30kVA output capacity
- **Battery Type and Capacity:** 90kWh LiFePO4 Battery Storage
- **Resiliency Features (microgrid controllers, islanding, etc.):** Consult Power-Up connect for additional information on the Green Grid system characteristics.

## Installation and Integration

- **Site Description (roof, ground-mount, canopy, etc.):** Trailer would be stored either outside in a parking lot (footprint of 8' 4" H x 5' W x 15') or stored inside a facility with the appropriate space.

- **Construction/Prep Requirements:** If the trailer is to be stored outside and will not be connecting to a facility, no construction or prep requirements are necessary. If the trailer is to be connected to a facility, the facility will need to identify "critical loads" to be powered in the instance of an outage, and those critical loads will need to be diverted from the main facility electrical panel to a subpanel with a tie-in point to the trailer.
- **Utility Interconnection Details:** Mobile solution will not need to be connected to utility services / will not be back feeding compatible.

## Summary & Recommendations

- **Key Findings:** The Power-Up Connect Green Grid (or equivalent system) would provide sufficient capacity and output to allow the community of Buchanan to power their desired use cases. In some instances when powering pumps, 2 or more units might need to be daisy-chained together to supply sufficient power. This will need to be verified with the vendor before unit acquisition. System will also allow for the possibility to power critical loads of a facility if the community chooses to do so in the future, assuming proper modifications to the building's power panel are installed.
- **Anticipated Benefits (outage mitigation):** Proposed mobile solution will power any small building loads in the instance of an outage and will easily allow for community residents to keep small devices / equipment powered in the case of a short-term outage (i.e. 4-7 days). In the instance of a long-term outage, or in the instance of large equipment loads found in the Pump House, consultation with Power-Up Connect will be required to gather information on expected system run time.

# Attachment A: Engineering Design Information

| Document Name | Reference | Quantity of Pages |
|---|---|---|
| APTIM, Proposed Electrical Drawings | N/A | 2 |
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NOTES:

1. DURING NORMAL OPERATIONS, SITE SHALL BE POWERED VIA EXISTING UTILITY.
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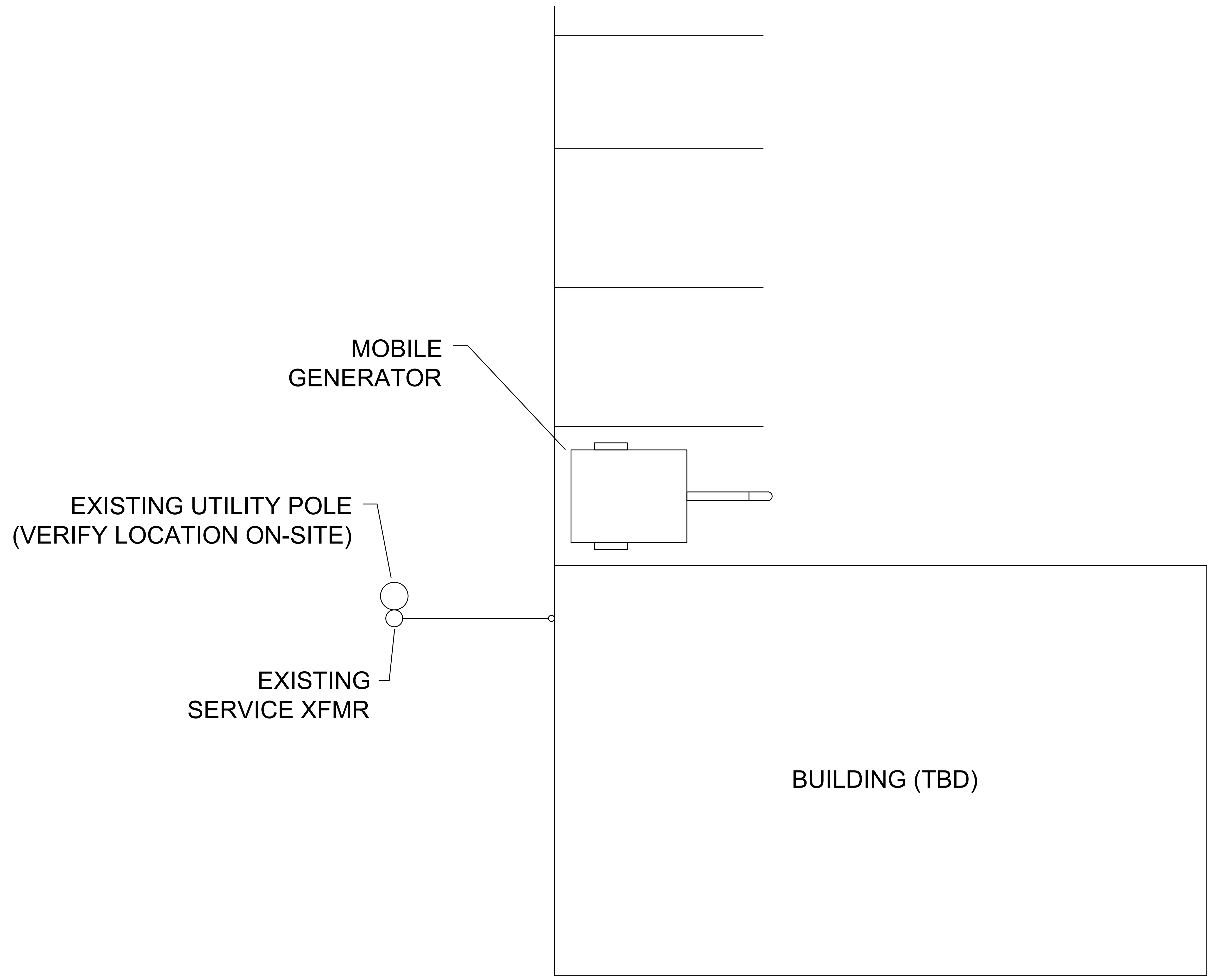


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PROFESSIONAL SEAL

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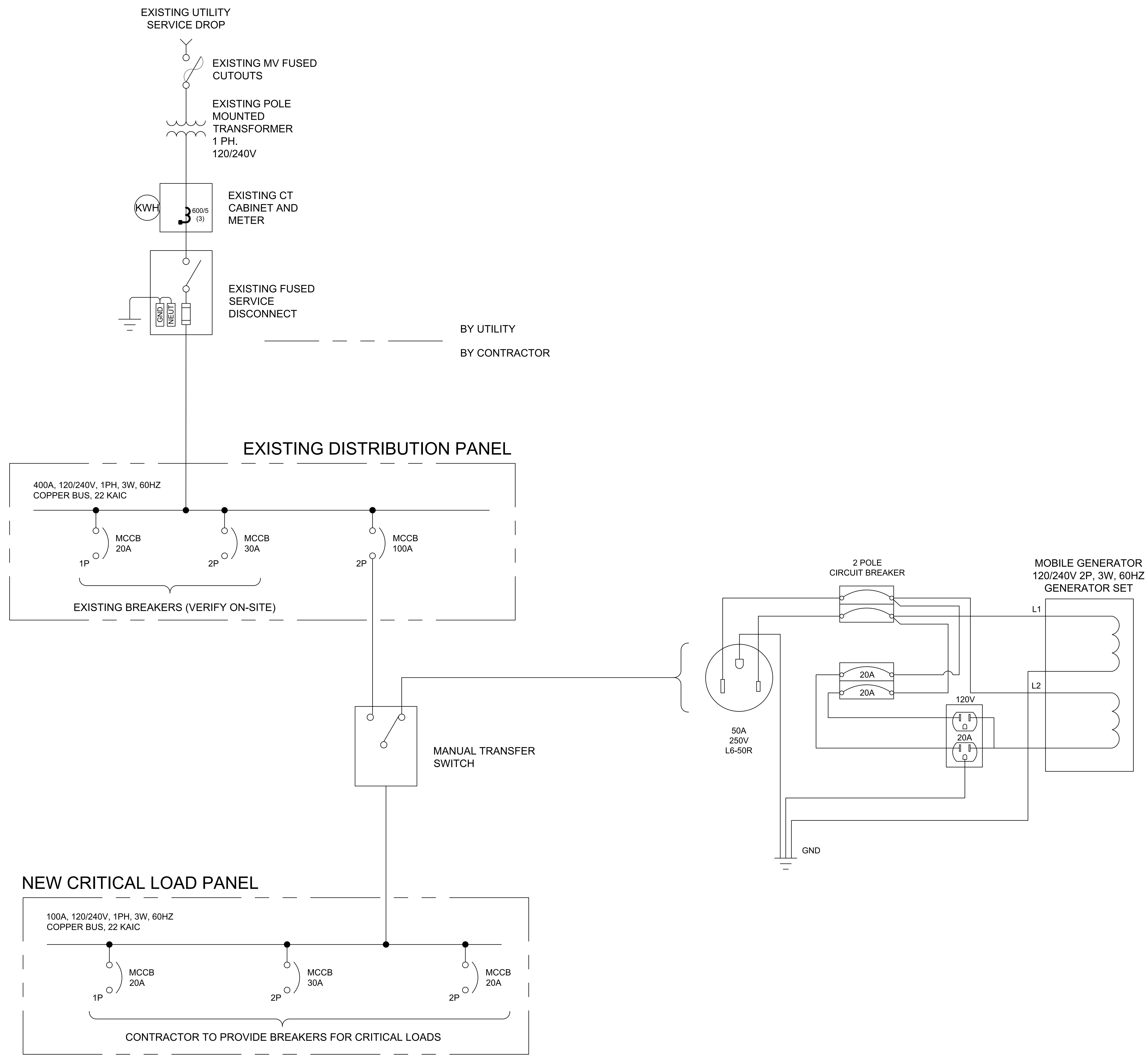
DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025
SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-001

BUCHANAN COUNTY, VA
APTIM PROJECT NO. 77631041420

ELECTRICAL MOBILE GENERATOR SYSTEM SITE PLAN

SHEET NO.
E-001

File: Buchanan County.dwg
Plot Date/Time: Sep 30, 2025 - 7:40am
Plotted By: Robert.Childs

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APTIM

DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025
SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-002

BUCHANAN COUNTY, VA
APTIM PROJECT NO. 77631041420

# ELECTRICAL
# MOBILE GENERATOR ONE-LINE DIAGRAM

SHEET NO.
E-002

File: Buchanan County.dwg
Plot Date/Time: Sep 30, 2025 - 7:40am
Plotted By: Robert.Childs

# WACHAPREAGUE, VA - SOLAR RESILIENCY STUDY FOR MOBILE SOLUTION

APTIM
11400 PARKSIDE DR.
SUITE 400
KNOXVILLE, TN 37934
(865) 560-7800

Ethan Marsh ______________________ ______________________
Preparer

Fermin Cabrera ______________________ ______________________
Reviewer

N/A ______________________ ______________________
Design Verifier

Design Verification Method:
☒ N/A ☐ Independent Review ☐ Alternate Calculation ☐ Qualification Testing

## Summary

The city of Wachapreague, VA has identified a need for a mobile resiliency solution to support a variety of locations across the city. Wachapreage identified 6 Main St. as a potential location to house the mobile unit. Wachapreague did not identify any specific critical loads they would like to power with this mobile solution, so APTIM Engineering proceeded with developing a general "catch all" recommendation. It is to APTIM's understanding that before Wachapreague continues with an energy resiliency solution, the community will identify specific use cases. With these parameters in mind, APTIM Engineering would like to recommend the acquisition of the Power-Up Connect Green Grid Mini, or any equivalent system available on the market.

## Load Analysis

- **Peak Load (kW):** N/A – Independent Mobile Solution (Note: No explicit loads were identified by the community of Wachapreage)
- **Average Daily Load (kWh):** N/A - Independent Mobile Solution
- **Critical Loads (list key equipment/systems):** No critical loads were identified by the community of Wachapreague.
- **Critical Equipment Operating Hours:** System would allow for charging and powering of critical personal devices 24/7, with battery storage recharging occurring during the day. When system is obtained, the community can use as they see best fit.

## Capacity Assessment

- **Proposed Solar Array / Mobile Trailer:** Green Grid Mini Mobile Trailer
- **Recommended Battery Storage Size (kWh or hours of backup):** 20kWh
- **Resiliency Goal (hours/days of grid independence):** 4-7 days (assuming only powering low current draw equipment)
- **Estimated System Contribution to Outage Scenarios:** System would allow for powering of small building loads, small electrical equipment, personal devices, small medical devices, or any other low current draw equipment.

### Equipment and Technology

- **Solar Module Type/Model:** 730W Solar Array with 5W Solar Exhaust Fan
- **Number of Panels:** Integrated on Roof of Trailer
- **Inverter Type and Capacity:** 3000VA Inverter – 48V/120V AC
- **Battery Type and Capacity:** 20kWh LiFePO4 Battery Storage
- **Resiliency Features (microgrid controllers, islanding, etc.):** Four 20A, 125 VAC Surge protection outlets, AC battery charger with power cable, charging port with 50' extension cord, Victron solar controller, with addition features available for add on.

### Installation and Integration

- **Site Description (roof, ground-mount, canopy, etc.):** Trailer would be stored either outside in a parking lot (footprint of 8' H x 5' W x 10') or stored inside a facility with the appropriate space.
- **Construction/Prep Requirements:** If the trailer is to be stored outside and will not be connecting to a facility, no construction or prep requirements are necessary. If the trailer is to be connected to a facility, the facility will need to identify "critical loads" to be powered in the instance of an outage, and those critical loads will need to be diverted from the main facility electrical panel to a subpanel with a tie-in point to the trailer.
- **Utility Interconnection Details:** Mobile solution will not need to be connected to utility services / will not be back feeding compatible.

## Summary & Recommendations

- **Key Findings:** The Power-Up Connect Green Grid Mini (or equivalent system) would provide sufficient capacity and output to allow the community of Wachapreague to power their desired use cases, once identified. Use cases should fall into low current draw equipment powering and charging of personal devices. System will also allow for the possibility to power critical loads of a facility if the community chooses to do so in the future.

- **Anticipated Benefits (outage mitigation):** Current proposed mobile solution will not power any building loads in the instance of an outage but will easily allow for community residents to keep small devices / equipment powered in the case of a short-term outage (i.e. 4-7 days). In the instance of a long-term outage, sufficient time for system to recharge will be needed to continue to provide services (1999.6 peak sun hours).

# Attachment A: Engineering Design Information

| Document Name | Reference | Quantity of Pages |
|---|---|---|
| APTIM, Proposed Electrical Drawings | N/A | 2 |
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NOTES:

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| NO. | DESCRIPTION | DWN | CK'D | APP'D | DATE |
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| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

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PROFESSIONAL SEAL

APTIM

DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025

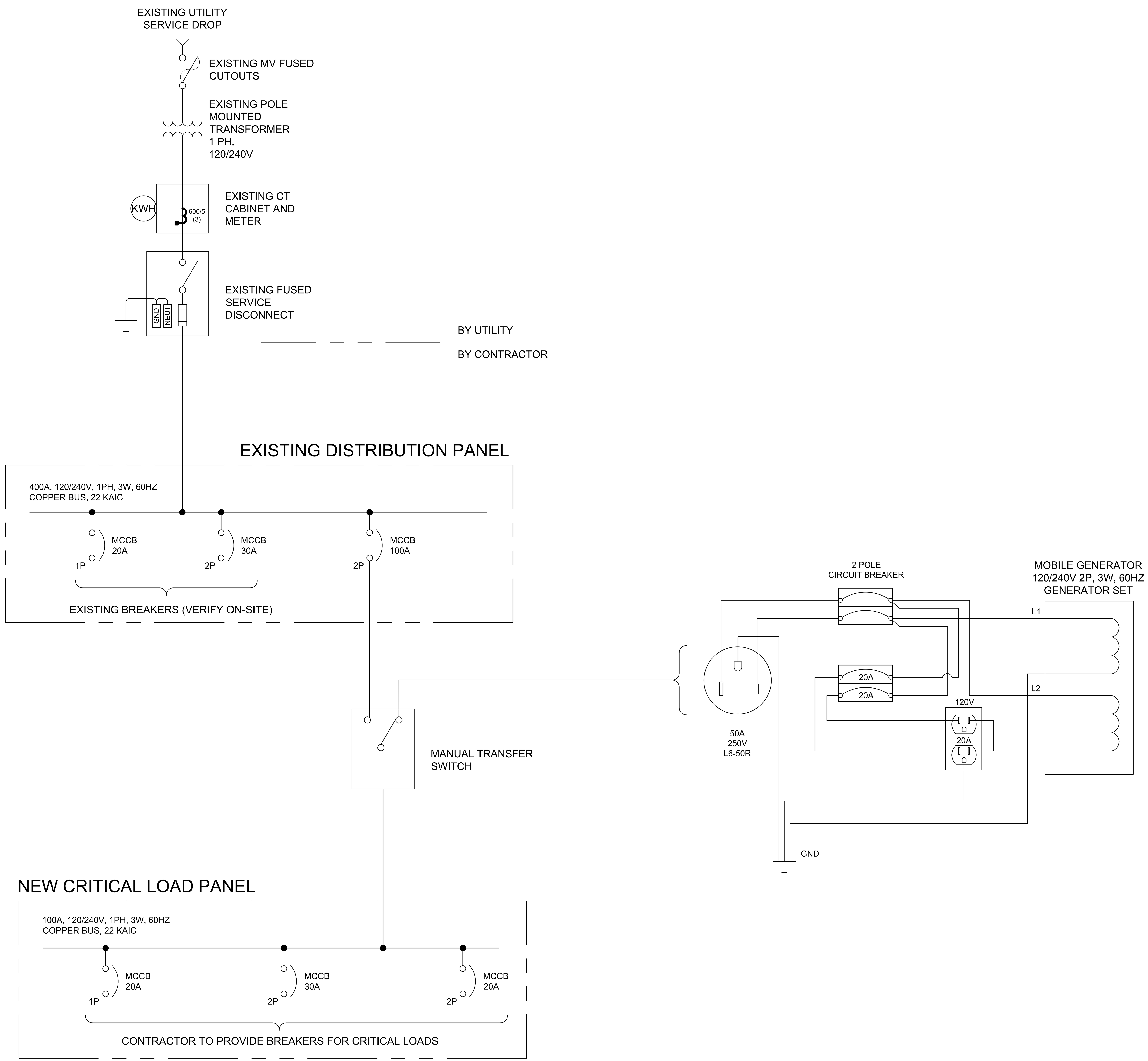
SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-001

VIRGINIA ENERGY RESILIENCE STUDY
6 MAIN STREET, WACHAPREAGUE, VA 23480
APTIM PROJECT NO. 77631041420

ELECTRICAL
PV SYSTEM SITE PLAN

SHEET NO.
E-001

File: Wachapreague 6 Main Street.dwg
Plot Date/Time: Sep 30, 2025 - 12:29pm
Plotted By: Robert.Childs




| NO. | DESCRIPTION | DWN | CK'D | APP'D | DATE |
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| 0 | PROPOSED SUBMITTAL | RWC | EKM | JSD | 09/30/2025 |

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DWN BY: AGT
CK'D BY: EKM
APP'D BY: JSD
DATE: 09/30/2025
SIZE: ANSI D
SCALE: N/A
CONTRACT NO.: 77631041420
DRAWING NO.: E-002

VIRGINIA ENERGY RESILIENCE STUDY
6 MAIN STREET, WACHAPREAGUE, VA 23480
APTIM PROJECT NO. 77631041420

# ELECTRICAL MOBILE GENERATOR ONE-LINE DIAGRAM

SHEET NO.
E-002

File: Wachapreague 6 Main Street.dwg
Plot Date/Time: Sep 30, 2025 - 12:29pm
Plotted By: Robert Childs