

COVER PAGE

City of Burlington, Vermont - Burlington Electric Department (BED)

Project Title: Building Grid-edge Integration and Aggregation
Network of Thermal Storage (Building GIANTS)

PROJECT TITLE

Building Grid-edge Integration and Aggregation Network of Thermal Storage
("Building GIANTS")

CONCEPT PAPER IDENTIFICATION CODE TA2-380-E

TOPIC AREA Topic Area Two / Smart Grid Grants

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PROJECT LOCATION

Project locations include residential and commercial buildings contained within the City of Burlington, Vermont and connected to the electrical distribution system of the Burlington Electric Department with additional potential locations at the Burlington International Airport (which also is served by the Burlington Electric Department).

STATEMENT REGARDING CONFIDENTIALITY

Burlington Electric Department (BED) confirms that the contents of this Application include confidential information and sensitive data. BED asks that the Department of Energy, its successors and/or assigns, treat all information being used or held within this Concept Paper as strictly confidential. No material, content, information, or data may be shared outside of the Department of Energy, its successors and/or assigns, without the express, written consent of BED.

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Project Overview

Background

The City of Burlington, Vermont's largest city located in northern part of the state, has emerged as a leading city in the fight against climate change. The city's efforts to reduce carbon emissions, promote renewable energy, and protect natural resources have gained recognition and praise from around the world. Burlington Electric Department (BED), the largest municipally owned utility in the State, serving the city of Burlington, Vermont, has been behind many of these climate achievements and is at the forefront of efforts to address climate change. One of the keyways that BED is a climate leader is through its commitment to renewable energy. In 2014, BED began sourcing 100 percent of its electricity from renewable generation, earning the title of America's first all-renewable-energy city. This accomplishment has been featured internationally in connection with the 21st Conference of Parties (COP21) United Nations Conference on Climate Change in Paris.¹ Burlington Electric is building upon this success by advancing the City to reach Net-Zero Energy by 2030 in the electricity, ground transportation, and building sectors.

BED has been recognized for its leadership on climate action by organizations such as the C40 Cities Climate Leadership Group and the Sierra Club. The utility's efforts have helped Burlington become one of the greenest cities in the country and have served as a model for other communities looking to tackle climate change. In 2019 BED funded a Net Zero Roadmap for the City of Burlington², and more recently issued a bond to fund Net Zero activities, and championed a successful City ordinance change to reduce the reliance on fossil fuel in the heating sector.³

BED is composed of a traditional vertically integrated distribution utility (including owning renewable generating assets) and an energy efficiency utility. This unique combination (no other Vermont utility combines both functions) provides a broader knowledgebase that covers electrical engineering, electrified technologies, grid-edge devices, and energy efficiency. As a department, BED is unified by providing energy services to customers to achieve the Net Zero Energy goal by 2030.

The largest piece of the NZE roadmap is creating efficient, electrified buildings. Reducing energy use and demand in City-owned buildings is a critical first step to complement building electrification. The Net Zero Energy Buildings Pyramid, shown below, was developed by BED to help building owners visualize the actionable steps to reach net zero energy use in their buildings. The level and size of the layers of the pyramid signify the importance of each step, in

¹ Burlington International Recognition as a Climate Leader, <https://www.burlingtonelectric.com/burlington-electrics-100-percent-renewability-accomplishment-featured-internationally-in-connection-with-paris-climate-change-conference/>

² Burlington Net Zero Energy Roadmap, 2019. <https://www.burlingtonelectric.com/sites/default/files/inline-files/NetZeroEnergy-Roadmap.pdf>

³ Burlington Net Zero Energy Revenue Bond, 2021. <https://www.burlingtonelectric.com/an-investment-in-reliability-and-climate-progress/>

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relation to its impact on other steps in the pyramid, cost-effectiveness, and return on investment.⁴

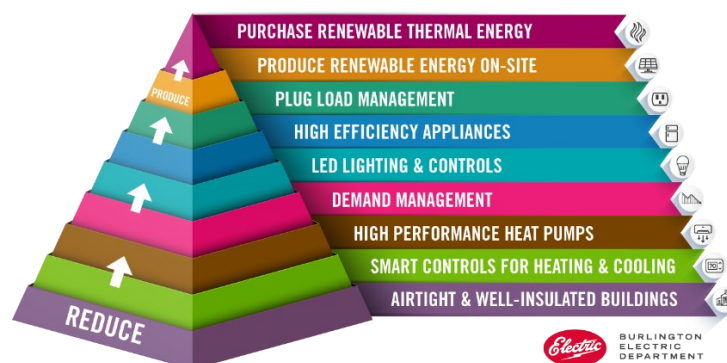


Figure 1: The base of the pyramid indicates the types of projects that have the highest impact. As you move up the pyramid, the impact decreases (though all are important pieces of the puzzle). Completing projects at the bottom of the pyramid increases the benefits of projects that fit into the upper layers.

Successes

In 2017 BED began working on what has become one of the first electric vehicle (EV) rates in the country, and the first in the State. This rate took an innovative approach that relies on the skillset of internal staff at BED to utilize the telemetry of networked level 2 electric vehicle supply equipment (EVSE), interacting with the webservices or application programming interface (API) developed by the EVSE manufacturer to offer customers discounted EV charging. Customers with a BED-approved EVSE can join this program and pay a rate to charge their EV equivalent to \$0.70 per gallon of gasoline. Currently, BED has the option to manage EV charging load under this rate dynamically and has 1MW / 3MWh under managed control.⁵ This is a significant benefit to BED's distribution system and is more cost effective than installing battery storage. In the proposed Building GIANTS project, BED will apply these same approaches to leverage grid-edge technologies in the thermal energy sector. This sector is critical to address, given the correlation between demand for thermal energy and peak periods on the electric grid.

BED began exploring thermal storage in 2016 with a novel program called Defeat the Peak.⁶ BED performs load forecasting and issues alerts when peak probability values exceeded a likelihood threshold. The program leverages the forces of altruism and community by providing a donation to a local charity, provided a load reduction target is met, funded by the collective peak energy reduced city-wide. The local charity is announced in advance and encouraged to use their own messaging in support of the program. To evaluate the savings, BED performs peak baselining to determine counterfactual peak energy usage. Twenty commercial buildings participate in this program and are able to reduce over 700 kW of peak electricity. Estimates

⁴ Net Zero Energy Buildings, BED. <https://www.burlingtonelectric.com/nze-buildings/>

⁵ Over 150 EV Customers enrolled with an average charging rate of 7.2kW per device (approximately 1 MW of demand) and an average of 20 kWh of daily charging (3 MWh of energy).

⁶ Defeat the Peak Launch, 2017. <https://www.burlingtonelectric.com/news-111/>

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from a recent paper using a difference in differences methodology have shown 1.8 MW of peak reduction city-wide.⁷ From Defeat the Peak, BED was able to see first-hand the cost-effectiveness of thermal storage. BED has improved upon this work by automating its own building energy management system (BEMS). This enables BED to respond to peak signals triggered by an automated load forecast and automatically shed load when Vermont's zonal locational marginal price (LMP) exceeds \$1,000 / MWh. This project was achieved due to the expertise of the BED staff who have backgrounds in building management systems, programming, wholesale energy markets and load forecasting.

Heat pump Deployment and Low-Moderate Income customers

Decarbonizing the thermal sector is a priority for Burlington. BED offers substantial rebates up to 75 percent of the installed cost on ductless mini-split heat pumps and, new for 2023, is offering a \$500 rebate for a second heat pump. Also, BED has introduced a new tier of higher rebates for centrally ducted heat pumps offering up to 75 percent of installed cost for more heating-efficient systems. On-bill financing and partnerships with local credit unions have helped reduce the capital needed to invest in renewable heating and cooling. As a result of this, BED has seen strong growth in the adoption of this technology throughout the city. Around 2020, BED began offering enhanced incentives to income eligible customers. As a result of these incentives, BED has seen growth in the adoption of heat pumps by LMI customers, and LMI heat pump installations represent less than 20% of installation in 2022. In Burlington, however, the capital cost is only part of the equation, particularly for lower income customers. The near universal availability of inexpensive natural gas makes the operating economics of electric heating marginal vs fossil fuel. BED would like to address this operating cost challenge via a discounted electric rate for load-controlled heat pump heating. A reduced electric cost would make decarbonizing neutral or beneficial for lower income customers who may not be able to accept increased monthly charges in pursuit of decarbonization.

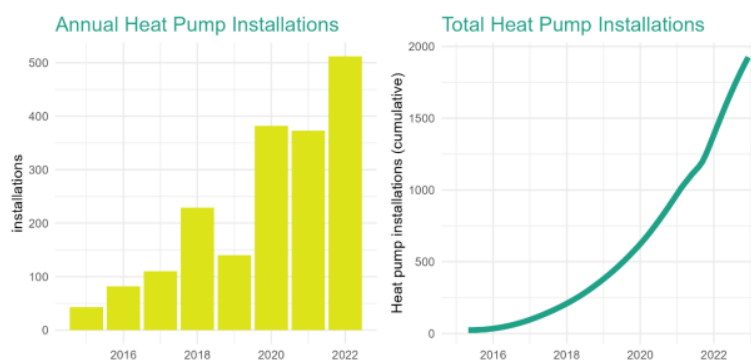


Figure 2: a) Annual heat pump installations; b) cumulative heat pump installations beginning in 2015

⁷ Pratt, B & Erickson, J. 2020. Defeat the Peak: Behavioral insights for electricity demand response program design. Energy Research & Social Sciences.

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Despite these efforts, and perhaps because of the operating cost challenge discussed above, Burlington is beginning to slip from the path necessary to reach Net Zero Energy by 2030 in the thermal sector, as shown in Figure 2 by the orange dotted line. This is an aggressive target to meet, but BED feels that to fully support heat pump adoption heat pumps must be operationally cost effective compared to natural gas.

Current Project Development

BED is engaged in two relevant pilot projects, titled the Flexible Load Rate Design Pilot Projects. The purpose is to evaluate the opportunities for FLM in the residential and commercial thermal storage spaces and to develop supporting rate design. BED received funding for these pilots through the State of Vermont (Grant # 02240-FY22-SEP-03), with funds ultimately provided by the DOE provided under DE-EE0005457. BED's proposal is to build on the projects, to deploy the tested technology or technologies, at scale, in its service territory.

Pilot 1 – Commercial Grid-Interactive Load Pilot:

For the first pilot, BED has partnered with a local, Vermont-based company, Dynamic Organics, to optimize and automate the BEMS of five commercial buildings in Burlington. Dynamic Organics (DO) is an aggregation company with expertise in BEMS, automation, and data engineering. This pilot project is building from the prior success BED has had with commercial HVAC setpoint adjustments with a focus on automating peak signals to fully capture the grid benefits of thermal storage. DO has developed a building energy dashboard to allow commercial facility managers to access the building energy data, evaluate peak scheduling request, and opt-in or out of requested flexible load management events. BED interacts with DO by providing peak event information, such as event start-time and duration. After a peak period has occurred, DO's dashboard generates the peak savings for the customer.

Pilot 2 – Heat Pump Measurement and Control Pilot:

BED's strategy to encourage faster adoption of a new technology is to reduce the upfront capital requirement, provide sufficient educational resources and customer support, and ensure the ongoing cost to operate the new technology is competitive to the conventional option. This second pilot focuses on the last part of this strategy – lowering a heat pump's operational cost relative to natural gas. To achieve this, the focus is on developing grid-edge aggregation and integration of buildings' effective thermal storage capability (via pre-heating and pre-cooling with integrated heat pumps) to generate grid-benefits and thus a lower the cost to serve from the wholesale electricity market. These savings are then passed along to participating customers in the form of a reduced rate for load-controlled heat pump consumption (and "end-use rate).

The potential to utilize the same structural process developed for managing EV charging and providing a discounted rate is the impetus behind this project. Similarly, the data requirements for this project are submetering and load control, in the form of setpoint adjustments (versus submetering and total charging interruption in the EV rate). BED is working with two technology providers, Emporia and Sensibo, that provide submetering and control devices, respectively,

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and that it is hoped will in combination provide functionality like that found in many Level 2 EV chargers.

This experience, along with BED's near universal AMI deployment with 15-minute interval load metering implemented under the ARRA program, has allowed BED to accomplish two things: to better evaluate the technical feasibility of residential and commercial thermal storage programs and to perform the necessary groundwork for a successful continuation with the Building GIANTS project.

Project Goal

The Burlington Electric Department (BED)'s proposed Building Grid-edge Integration and Aggregation Networks of Thermal Storage (Building GIANTS) project aligns with Objectives of Topic Area 2: Smart Grid Grants as it will provision a network of grid-edge devices (for sub metering and load control) at the distribution level to unlock the potential for thermal energy storage inherent in grid-interactive and efficient buildings (GEBs). With a focus on flexible load management in the thermal energy sector, this has spillover effects on managing the grid with greater efficiencies, including the integration of more renewable energy resources onto the distribution system by also permitting the eventual switch from simple cost saving control to load positioning equipment such as integrated heat pumps to match variable output of renewable energy production. This additional use-case will only become more critical as the future is poised to see substantial electrification of thermal technologies along with increasing saturation of renewable energy generation.

The Building GIANTS project addresses two of the six Priority Investments, as it will:

- Improve the visibility of the electrical system to grid operators, helping to quickly rebalance the electrical system with autonomous controls, through data analytics, software, and sensors.
- Aggregation and integration of distributed energy resources and other "grid-edge" devices to provide system benefits, such as renewable energy resources, electric vehicle charging infrastructure, vehicle-to-grid technologies and capabilities, and smart building technologies.

The proposed project will be to take the current pilots (Commercial Grid-Interactive Loads and Heat Pump Measuring and Control Pilots, discussed in the section above) and deploy at-scale. For clarity, these two subprojects will be called: commercial & industrial flexible load management (C&I FLM) and residential heat pump flexible load management (HP FLM). To achieve this, workforce development and community engagement are central components, as are process improvement and program management. Each of these will allow the pace and cost of deployment to improve. BED has an end of project goal to reduce the cost of enrollment to under \$200/kW of flexible load. This cost will include administrative, installation, hardware, and software costs of the program.

Critical Success Factors

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BED has workforce that are experienced in electrical engineering, electrical engineering, data science and programming, network optimization and computing. Additionally, BED's energy efficiency team is comprised of energy services engineers with expertise in residential, commercial, and industrial building energy and thermal efficiency. BED also has a department that focuses on diversity and equity for program design and community engagement.

Impact of DOE Funding

To mitigate the effects of climate change, it is critical to accelerate the conversion to, and adoption of, thermal electrification. At the same time, to minimize the cost, in terms of required system upgrades, the load needs to be controlled and diversified to the greatest extent practical. BED currently lacks funding opportunities to support the necessary upfront capital required to launch the proposed project at scale (i.e., after the completion of the two pilots discussed above). Additionally, the more the cost of electrification for climate improvement is borne, unassisted, by the electric utilities, the more those costs will increase rates and worsen the operating cost differences between renewable electricity and the fossil fuel alternatives. Without funding from the DOE to support the Building GIANTS project, BED will not be able to reach the scale or pace of enabling thermal storage in Burlington.

DOE investment would allow BED to dedicate staff time and partner with Dynamic Organics, technology providers, local contractors and assist with the upfront system/implementation costs and initial field hardware costs associated with the proposal. Building this workforce would otherwise take years to accomplish, and even then, may not reach the proposed scale absent funding. Better workforce alignment will result in higher probability of project success, faster adoption of thermal storage resources, increased decarbonization and grid benefits as stated in the Project Goals.

As noted, another long-term impact of funding the Building GIANTS is the ability for BED to defer system upgrades. Planning for system upgrades is challenging as it presents an investment risk given the uncertainty of when the distribution system's capacity will be surpassed. Putting efforts into reducing system upgrades that have immediate wholesale electricity market savings and incentivize customers to invest in renewable thermal options is a proactive endeavor. Without DOE's funding, BED feels strongly that it will not be possible to immediately advance this project.

After the initial deployments are performed, BED expects diminishing marginal cost of acquiring additional flexible thermal load. Furthermore, this approach is novel and success in this proposed project would have transferable benefits to electric utilities across the nation.

Community Benefit Plan

BED will capitalize on existing relationships with job and skills development organizations. Partner programs such as ReSource and Vermont Works for Women host paid, pre-apprenticeship programs and work to pull from surrounding community. BED collaborates with these programs to ensure they have access to identified trends and technology in our related

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sectors. The City of Burlington advertises job openings to alumni of these organizations. Many of the jobs related to this work are union jobs (IBEW), and employees not unionized are governed in accordance with the AFSCME contract.

Additionally, municipal policy is pushing capitol projects and large commercial entities to consider the impact heating systems have on the City resulting in multi-unit rental housing installing clean heat technology for their residents. By targeting large commercial projects, and reducing the overall impact on the City, should lessen the financial impact on small businesses.

Engagement Strategy

Burlington Electric is deepening relationships with City of Burlington Departments that work directly with historically DACs through its collaboration with the Burlington Lead Program, the City Land Steward's Office, the Community Justice Center, Trusted Community Voices and the Community and Economic Development Office. Outside of our municipal partnerships, we will be working with CVOEO's Community Ambassadors Program, Burlington Area Community Gardens (including three gardens set aside for resettled refugee families), and the Family Room. Much of our work is using their connections to support the community in understanding the drive to NetZero through town meetings, one-on-one relationship building, house parties, and attending their meetings to answer their questions.

Potential Long-Term Constraints

BED does not anticipate the Building GIANTS project to have any long-term constraints on the community's access to natural resources and Tribal cultural resources.

Climate Resilience Strategy

BED constantly seeks to increase the reliability and resilience of its distribution grid. BED's strategy involves maintaining overhead construction standards built to withstand high wind and heavy ice loading, relocating inaccessible lines to street sides, and relocating distribution lines underground. BED currently has 48% of all primary distribution lines located underground. Building a resilient grid can only achieve so much as far as reliability goes. Having visibility and ability to respond to system events has a significant impact to customers. Building GIANTS will play a critical role in the BED climate resiliency plan and be an integral resource controlled by the Distributed Energy Resource Managements Systems (DERMS). Increased situational awareness and coordinated grid management of distributed energy resources (DERs) by operators during extreme weather events can provide an alternative means of reducing demands during extreme temperature conditions, and at scale can help to reduce outages and outage durations for customers by having real-time load flexibility able to respond to operating system emergencies that call for the curtailment of demand (in lieu of breaking power at the substation).

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Technical Description

RELEVANCE AND OUTCOMES

Project

The Burlington Electric Department (BED)'s proposed Building Grid-edge Integration and Aggregation Network of Thermal Storage (GIANTS) project focuses on creating a network of grid-interactive efficient buildings (GEBs), whose coordinated dispatch uses the available building envelope and other thermal storage resources across residential, commercial, and industrial customers, coordinated via grid-edge gateways behind-the-customer meter, to enable the strategic and beneficial electrification of GEBs while minimizing the contribution to BED system peak demands.

Grid Outcomes

The approach to advancing coordinated dispatch of thermal storage as a mechanism to lower operational costs is a novel application for residential heat pump systems and commercial heating systems and has not been deployed with a focus on network optimization more generally. Ranging from supporting decarbonization to providing grid-resilience, the proposed Building GIANTS project is novel, relevant, and outcomes are many, with high-impact and transferability to other utilities.

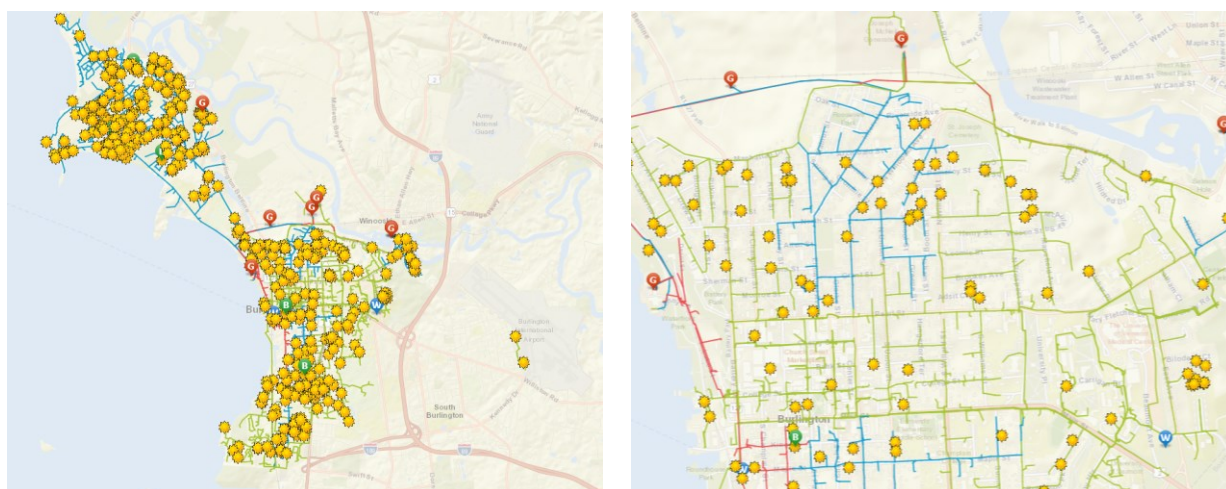


Figure 3: Distributed generation map developed by BED identifies feeders that can accept additional capacity on a scale of good, moderate, and low. A similar approach can be done in real time to assess and mitigate the impact of coincidental thermal load.

Thermal storage operated under a coordinated distributed management framework, can be cost-effective and does not have issues such as lifecycle degradation, fire potential, hazardous materials, or complicated control systems, all of which are risks that electrochemical battery storage presents for customers and buildings. The anticipated load control under this 3-year project proposal will provide approximately 4 MW of effective thermal storage (approximately

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6% of BED's peak load) at a deployed cost of approximately \$250/kW (and with minimal ongoing O&M costs). The expected marginal \$/kW will drop to \$215/kW and \$200/kW for the heat pump and C&I FLM projects respectively when the upfront programmatic and integration work is completed, customer enrollment timeline is reduced, and hardware costs are discounted by reaching scaled deployment levels.

There are several grid benefits from BED's proposed Building GIANTS project. It will provide BED with the ability to have increased visibility and control of the distributed energy resources (DER) interconnected on its electric system. With greater situational awareness and control, system rebalancing and flexible load management of DER to avoid distribution upgrades can be achieved. Additionally, this work will support the further integration of renewable energy generation hosting capacity on the BED distribution system and greater control over peak demand for distribution, transmission, capacity, periods of high LMPs, as well as ISO-NE issued scarcity events or needs for other reliability-based load control associated with recent challenges in the ISO-NE winter resource/load balance.⁸

Some of these grid-outcomes generate direct monetary value in the form of avoided Wholesale Electricity Market (WEM), Forward Capacity Market (FCM) and Regional Network Service (RNS) costs. These savings will be accrued directly by BED, and will be passed on to participating customers through flexible end-use rates developed for heat pump, and large commercial and industrial customers with load control heating and cooling capabilities. Indirectly, these rates will incentivize further interest and investment into heating and cooling electrification in Burlington.

Technology description

Various hardware and software technologies will be leveraged to achieve the grid benefits enumerated above. The foundation for many of these will be using the Internet of Things (IoT) to enable intelligent decision-making (computing) to occur behind the customers' meter, at the grid-edge. These devices include temperature and humidity sensors, current transformers (CTs), communication relays, gateways to existing building management systems (BMS) at commercial buildings, and supervisory control and data acquisition (SCADA) systems at industrial facilities.

With the focus on submetering and flexible management of cold-climate heat pumps, two devices are currently being piloted for use. The Emporia Vue for submetering provides CTs that detect the current flowing from a breaker in an electric panel for breakers sized up to 50 Amps. Heat pumps typically have a dedicated breaker that ranges from 10-40 Amps. Emporia has a well-documented application programming interface (API) that BED has developed a data pipeline to pull in and store electricity interval readings. The Vue can provide insights into the electric panel on a second-by-second interval. Additionally, the potential exists to utilize the

⁸ ISO-NE Winter Energy-Security Initiatives Key Projects, <https://www.iso-ne.com/committees/key-projects/implemented/winter-energy-security-initiatives>

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CT's to concurrently monitor the operational cycles of more traditional heating systems at the same location.

Complimenting this submeter device is the Sensibo Sky or Air (premium version). This device connects to over 10,000 different heat pump and air conditioner models and acts as a smart remote control with a temperature and humidity sensor. The webservices provided by Sensibo, accessible via an API, are extensive and include obtaining temperature and humidity data, information of the state of the AC, and the ability to adjust the state of the AC and set timers for making an adjustment. Altogether, this grants access to a range of flexible load management techniques and the ability to create thermal storage by pre-heating and pre-cooling before load control events, as well as simply reducing the set points for more passive load control.

Connection to the goals of the FOA

The proposed Building GIANTS project aligns with Objectives of Topic Area 2: Smart Grid Grants with a focus of provisioning a network of grid-edge devices at the distribution level to unlock thermal energy storage potential, increase grid-insight, and integrate more renewable energy. More specifically, the goals addressed in the FOA are included here:

- Integrate variable renewable energy resources at the transmission and distribution levels; and, facilitate the aggregation and integration (edge-computing) of electric vehicles and other grid-edge devices or electrified loads.
- Improving the visibility of the electrical system to grid operators, to help quickly rebalance the electrical system with autonomous controls, through data analytics, software, and sensors.
- Aggregation and integration of distributed energy resources and other “grid-edge” devices to provide system benefits, such as renewable energy resources, electric vehicle charging infrastructure, vehicle-to-grid technologies and capabilities, and smart building technologies.

In addition to these goals highlighted by the FOA, BED has strategic goals of its own. with strong alignment with the FOA. At a high level, these goals include decarbonization to Net Zero, equity and environmental justice, and grid resilience. Each of these three topics are expanded upon in the Local Support section.

Feasibility

The project is ready for a larger deployment, today. Based on the initial success of the two pilot projects under the DE-EE0005457, the technology and the interacting software have proven to be feasible for BED's proposed Building GIANTS project. At the conclusion of the pilot projects in June, BED plans to file two (or more if a low income option is offered for heat pumps) rates with Vermont's Public Utilities Commission (PUC) for approval. These will provide the incentive structure needed to provide customer incentives under these two programs (Heat Pump FLM

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and the Commercial and Industrial FLM) and to achieve at least operational cost parity with fossil fuel heating alternatives.

Innovation and Impacts

There are currently very few time-varying electric rates focused on heat pump thermal storage, and even fewer that utilize temperature adjustments and submetering to evaluate and incent heat pump load control. The technology, though present, requires expertise in software programming, data integration, standardized data modeling, and integration of hardware from multiple vendors to enable the necessary functions for this type of dynamic rate.

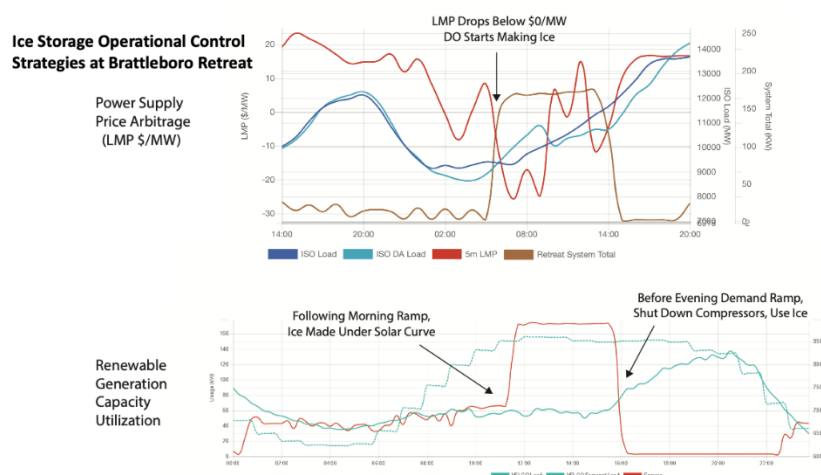


Figure 4: Example of the value of commercial thermal storage to shed load and build load based on LMP signals, renewable generation capacity, and system peak events. This is data provided under a program DO is running with GMP, which BED is working to launch a similar pilot program with three large commercial facilities.

Thermal storage in the commercial and industrial sectors is more common, however it has not gone as far as establishing an integrated network with grid-edge computing, or to tailor flexible load management schedules to fit the specific characteristics and needs of a facility. Dynamic Organics (DO) has developed a grid-edge controller that integrates with existing building management systems using industrial standard communication protocols, such as BACnet and Modbus, to align building and grid needs. DO has been operating this controller with a 3MWh ice storage system at the Brattleboro Retreat campus since 2018, and with over 30 buildings through the Green Mountain Power Flexible Load Management pilot programs since 2019. The DO controller can respond to grid conditions while balancing and maintaining campus comfort levels. An example of the value propositions available through DOs integrated controls operations with integrated ice storage is shown in **Figure 4**. BED is well positioned to take the lessons learned from DO and BED's current thermal and load control pilot program to further advance this work through this funding.

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BED is the only Vermont utility that is both a traditional distribution/generation utility and an “energy efficiency utility.” With deeper understanding into electrified thermal operations in customer buildings from this program, BED will have access to new data that can be leveraged for improved energy efficiency services to better support its customers. These include improved insight into the potential savings from weatherization, more informed project insight and customer proposals, and improved detection of building system performance issues.

There are many positive outcomes from this proposal. Chief among them is the benefits of deep thermal decarbonization, grid-benefits, and investment in local economy. An injection of funds will allow BED to offer better dynamic rate options leading to increased demand for installing heat pumps (residential and commercial) and provisioning of commercial building management systems with automated logic. This will provide steady work for electricians, building and energy efficiency contractors. Over time, a spatially diversified network will emerge that BED can call upon to reduce loading in order to improve distribution efficiencies, avoid circuit upgrades, and enable greater integration of renewable energy production.

Local Support

Burlington, Vermont is acclaimed as a city focused on the environment, supporting diversity, and the local economy. The city has shown its commitment to sustainability and reducing its reliance on imported fossil fuels by investing in one of the nation’s most ambitious climate goals – to seek to become a net-zero city by 2030. This has spurred an effort with community-wide support, to reduce energy consumption and transition from fossil to renewable energy sources. For diversity, Burlington is home to a large community of immigrants and refugees, including individuals from a wide range of cultural backgrounds and countries. This diversity is celebrated and supported through community events and initiatives and provides a vital and valued part of the community.⁹

Finally, Burlington's location in the heart of Vermont's renewable energy sector has helped to create a strong local economy based on sustainable practices, which has further strengthened the city's commitment to decarbonization. The proposed Building GIANTS project touches on every aspect of what makes Burlington unique and fits into many of the strategic goals of the City and BED. The sections below expand upon the alignment that this proposed project would have with the decarbonization, equity and the local economy goals.

Decarbonization:

A critical goal of the Building GIANTS proposal is to advance the pace of thermal decarbonization. Burlington, VT has a +95% saturation of natural gas providing thermal energy. At current market prices, it is more expensive to heat a home in Burlington with heat pumps

⁹ City of Burlington Diversity & Equity Strategic Plan, 2014.

[https://www.boarddocs.com/vt/burlingtonvt/Board.nsf/files/9LELGZ567D5D/\\$file/Communication%20City%20of%20Burlington%20Diversity%20%20Equity%20Strategic%20Plan.pdf](https://www.boarddocs.com/vt/burlingtonvt/Board.nsf/files/9LELGZ567D5D/$file/Communication%20City%20of%20Burlington%20Diversity%20%20Equity%20Strategic%20Plan.pdf)

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compared to natural gas.¹⁰ While this winter has seen this cost comparison move closer to parity in operating cost, heat pumps do not currently reduce the heating costs of a typical Burlington customer. Furthermore, many heat pumps in Burlington have been installed with crossover setpoints¹¹ between 30 to 40°F based on the comparatively low cost of natural gas.

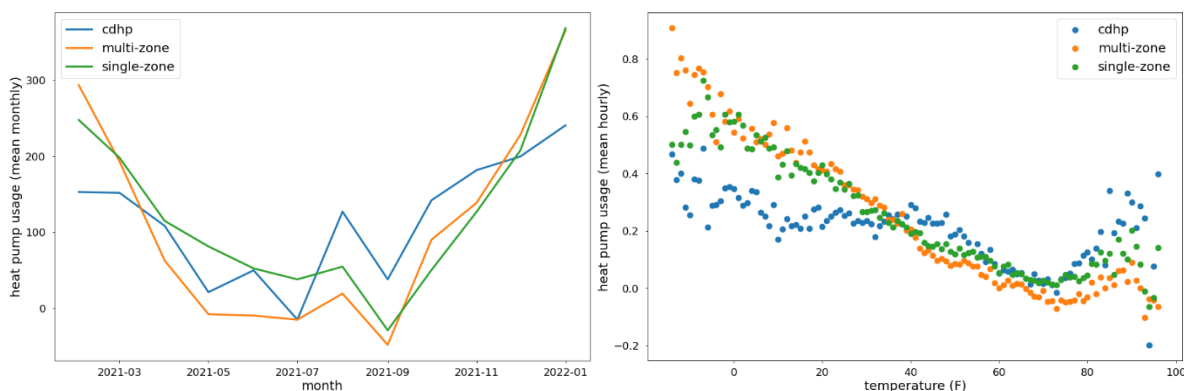


Figure 5: There is a distribution of cutoff temperatures where the heat pump reduces output and an additional heating source, typically fossil based, provides thermal energy. BED has seen this occurring at higher temperatures than expected, particularly for single-zone and centrally ducted heat pumps (CDHP). These results compared to expectations from the Technology Reference Manual prepared for the State of Vermont under the Renewable Energy Standard indicate these measures to be 46, 85 and 26 percent of what is expected.

From analyzing its smart meter 15-minute interval data, BED has found that many heat pumps have been installed primarily to be used for cooling. Due in part to operational economics vs natural gas, this technology is not reaching its full carbon reduction potential. Harnessing flexible load management will provide value that can be translated in lower heat pump operating costs via electric rate design.

Equity:

A successful energy transition cannot occur without sweeping adoption of electrified technologies (heat pumps and electric vehicles) by all customers. Burlington, VT is home to a significant number of households that are below the poverty line relative to the State and the country. Household income distributions are weighted more heavily in the low to moderate incomes ranges when compared to the national average, shown in **Figure 6**. Approximately 60 percent of residential customers rent their home, another indication that Burlington residents will benefit from a cost-effective and efficient heating program. Expecting these customers to invest in a decarbonization that may increase their heating costs (or at best not lower them) is not reasonable.

¹⁰ VGS residential rates converted to \$/kWh are XX compared to BED's XX residential rate.

<https://vgsvt.com/service/rates/>, <https://www.burlingtonelectric.com/bed-rates-fees/>

¹¹ Outdoor air temperature (OAT) that causes a dual-fuel heating system to change which is providing thermal energy.

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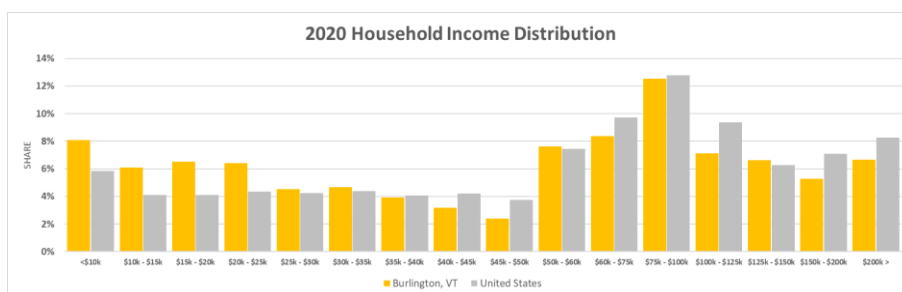


Figure 6: Comparing the Burlington, VT income distribution against the National distribution shows higher percentages in every household income range below \$35k.¹²

Local Economy:

Per the NZE Roadmap, over 50% of energy used in Burlington is for heating and cooling. Most heating (approximately 95%) in Burlington is fueled by natural gas. Analysis by the Energy Action Network indicates that for every dollar spent on fossil fuels in Vermont, only about a quarter of that money stays in the Vermont economy. In contrast, 70 cents of every dollar spent on electricity stays in the Vermont economy.¹³ Efforts to increase flexible electrification sourced from Burlington's 100% renewable electricity will have significant effects on the local and State economy.

As discussed above, by enabling end use rates that recognize flexible load control savings, the proposed Building GIANTS project will improve the operational economics of heat pumps. It will also support local workforce development. To successfully complete this project several industries will be called upon to perform the work, many of which are local businesses. These local businesses will include electricians, energy efficiency contractors, heat pump installers, controls technicians, and mechanical contractors who will ultimately maintain the equipment. Funding this project will provide investment in the local Burlington, Vermont workforce that will have resounding benefits to the local economy.

Project Risks / Scalability

Support from the DOE would provide a stream of funding that will enable a workforce to form and scale deployment of heat pumps and commercial/industrial thermal storage technologies. An identified risk is the potential reluctance to adoption of these new technologies by BED's customers (either due to uncertainty or discomfort relinquishing some control of their heating cooling systems to BED). There are two ways this project will mitigate this risk. The first is by achieving operational parity with the operating costs of natural gas the lifecycle operational economic benefits of installing heat pumps will be improved. For commercial and industrial customers, there will be a value stream for performing the necessary BMS upgrades. Use of key

¹² [United States Census for Household Income Distribution, 2020](#)

¹³ Energy Action Network 2022 Report, https://www.eanvt.org/wp-content/uploads/2022/08/EAN-report-2022_web.pdf

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pilot program participants (such as Burlington's mayor and the BED General Manager) will be useful in reducing concerns.

To maintain a steady pipeline of customers, engagement is critical. BED is a trusted organization by its customers and routinely earns exceptional customer reviews and voter support for its initiatives, even in difficult times. BED has established longstanding partnerships with many City departments and community organizations who represent or provide essential services to Burlington. To ensure our engagement with the community is thoughtful and uses a DEIA lens, all City staff have participated in (and will continue to be required for new staff) a multi-session, anti-racial bias training hosted and facilitated by the City's Office of Racial Equity, Inclusion and Belonging. With their support, BED is aware of the need to prioritize Justice40 and support DEIA efforts through its services. Through its efficiency arm, BED has established trusted relationships to the contractor community. To assist in the development of new contractors, BED is collaborating with two local pre-apprenticeship programs hosted by ReSource Vermont and Vermont Works for Women. Additionally, BED has partnered with non-profit housing development organizations, like the Champlain Housing Trust to better serve its customers.

Smart Grid Development

The proposed Building GIANTS project meets multiple priority focus areas identified by the DOE for Topic Area 2. At a high level, the project aims to improve distribution capacity and resilience by integrating and aggregating a distributed thermal storage network to improve system efficiency and reliability. This will provide a higher degree of visibility and new tools operated at the grid-edge for BED's distribution engineers, power systems coordinators, and resource planners. The aggregation and integration of customer heat pump and HVAC systems will provide considerable system benefits. These include, but are not limited to, renewable energy integration, real-time and potentially automated distribution system rebalancing, alternatives to emergency load shedding requirements, and savings potential for capacity, transmission, and wholesale electricity markets. This project will give BED the ability to mitigate the impacts of extreme weather events and natural disasters on grid resiliency. Finally, and unique to BED as an energy efficiency utility, having greater insight into the nature of grid-edge thermal energy use will lend itself to innovative energy services to emerge. Applications of these are discussed further in Section Innovation and Impact. This proposed project, if awarded, will accelerate the pace of deployment and act as a model that can be replicated by other utilities.

Pathway to wider market adoption

The groundwork of this project has been started by BED during the current pilot projects, which are proving the functionality, feasibility and general viability of the hardware and software necessary to facilitate the development of the smart grid functions identified above. To achieve wider market adoption the work of the proposed Building GIANTS project will begin with workforce development and customer engagement. With support from DOE, workforce development will occur by strengthening existing partnerships with technology and software providers, contracting with local electricians, controls contractors, and mechanical contractors through a competitive RFP process, and communicating with our community partners identified

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in the Community Benefits Plan and Community Partnership Documentation. These groups will provide the technical, trade labor and community support needed for a successful project with wider market adoption. BED will deliver the final piece, programmatic and technical support. BED's Policy & Planning and Energy Services teams, highlighted by their resumes, provide technical customer support in the energy efficiency and building science spaces. Their skillsets will be impactful for troubleshooting issues, identifying technical improvements, and administering the project.

As has been the case with other programs, BED is open and willing to share methodology and lessons learned to other utilities. This project is very applicable to other electric utilities given the ubiquity of thermal electrification across the nation and the importance of managing this new load. As a result, this project has the opportunity for significant market adoption by way of program replication beyond Burlington.

Flexibility

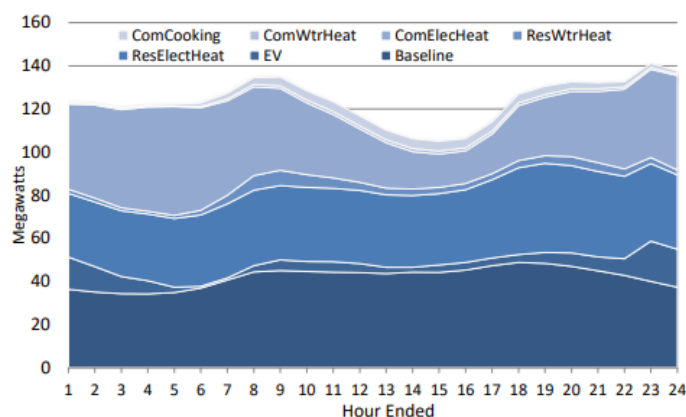


Figure 7: Winter peak day load shape in Burlington once the NZE 2030 Goal is achieved. Significant residential and commercial electric heat is used during the morning and evenings, which are when peaks generally occur. This indicates flexible load management potential for thermal heating.

The proposed project will enhance distribution system flexibility by utilizing residential, commercial, and industrial flexible load management, including thermal storage, to vary loads and reduce system peaks. From past projects, thermal energy needs have proven to be highly coincident with peak demand for electricity. The correlation between electricity usage and temperature is continuing to strengthen as new electrified thermal loads are installed each day across Vermont and New England. Similarly, solar development in Vermont has exceeded the pace of most other states. Burlington, VT has more solar PV capacity installed per capita than any other city in the Northeastern United States and is ranked fourth in the country for solar capacity per capita.¹⁴ Shown in Figure 3, there are many areas of Burlington that have overloaded circuits that are not ideal for new renewable generation to be sited. With greater

¹⁴ Shining Cities 2019, Top US Cities for Solar Energy. 2019. https://publicinterestnetwork.org/wp-content/uploads/2019/09/GA_Shiningcities2019_scrn.pdf

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demand side flexibility this distribution system can absorb larger amounts of distributed renewable energy (by aligning loads and solar generation solar will not be exported across the distribution system as much/often).

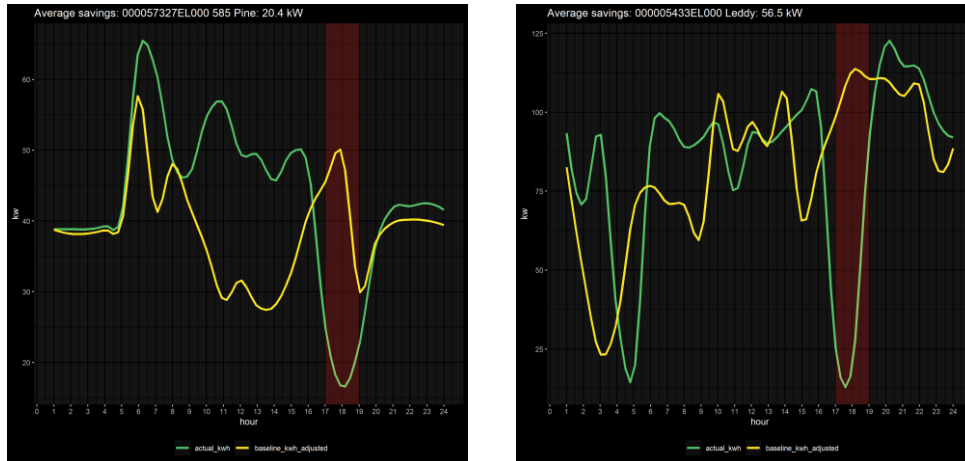


Figure 8: Peak flexibility shown by the actual load (green line) compared to baselined counterfactual (yellow line). The peak period is highlighted by the red bar, occurring over a 3-hour window of 17-19, hour ending.

The applications of thermal storage are in the C&I HVAC space and in residential heat pumps. Based on load flexibility achieved from current and prior work, BED has established the expected demand flexibility to be achieved by the proposed Building GIANTS, along with the cost to achieve such flexibility. The two tables, below, highlight these metrics and illustrate the impact of the project with an estimate of approximately 4 MW of flexible load from thermal management. As the project progresses into the fifth and final year, it is expected that the marginal cost of acquiring an additional kW of thermal flexibility will be reduced substantially. In each project BED estimates payments for flexibility on a \$/kW basis will reduce by approximately 10% and 30% for the heat pump and C&I programs, respectively. In both cases, when considering the cost of the flexibility over the lifetime of the control and submetering technologies, BED estimates these devices to be cost-effective, particularly when compared to conventional forms of storage.

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Workplan (40%)

Project Objectives

The Burlington Electric Department (BED)'s proposed Building Grid-edge Integration and Aggregation Networks of Thermal Storage (Building GIANTS) will provision a network of grid-edge devices at the distribution level to unlock thermal energy storage potential contained in dynamically controlled electric HVAC equipment. With a focus on flexible load management in the thermal energy space, this project has spillover effects on managing the grid with greater efficiencies and resilience, including the integration of more renewable energy resources onto the distribution system. This use-case will only become more critical as the future is poised to see substantial electrification of thermal technologies coupled with the renewable energy needed to power these loads. The objectives of this project fall into three phases, each building upon one another and having a distinct phase objective.

The objective of the first phase is to form a robust and efficient workforce and community to enable thermal storage in support of Burlington's Net Zero goal. BED has staff who are dedicated to the success of the proposed project with expertise in electrical engineering, data science and software programming, energy efficiency, energy services, program equity and sustainability. As a public power utility, BED strives to serve its community to the highest level and is motivated to provide renewable energy at the lowest possible price consistent with safety and reliability. Due to this, community partnerships have been a longtime focus for BED. The other parts of the workforce include technology and software providers, local electricians, energy efficiency contractors, heat pump installers, controls technicians, and mechanical contractors. Community partners will be vital as they provide community engagement and outreach to BED's customers, particularly those within disadvantaged communities.

Phase two aims to accelerate the deployment of devices by maintaining a strong customer pipeline. Supporting this objective is educational materials and community outreach. This proposed project will allow BED to better serve Burlington customers with a focus on diversity, equity, inclusion, and accessibility. Burlington has a significant low-to-moderate income population that has a high energy burden (especially in relationship to income). This program will provide a non-fossil renewable thermal energy pathway, that is cost effective for all to participate in. Furthermore, BED has an Energy Assistance Program that will support customers that are income eligible

The objective of the final phase is to reduce the marginal cost of acquiring thermal storage. BED will look for process improvement by identifying inefficiencies and research alternative or supplemental technologies to better serve customers.

Technical Scope Summary

The overarching approach of the proposed project will be communication and collaboration to reach market-wide adoption with efficiency and cost in mind. This project is unique as it involves the management of technology that is owned by the customer. To ensure customers

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are supported and feel comfortable with this project, it is important for all members of the workforce to communicate effectively.

The scope of work will fall into four tasks, the first of which begins with compiling a Project Management Plan (PMP), NEOA Compliance, a Cybersecurity Plan and establishing a schedule of briefings to DOE. This will be accomplished by BED staff and will be concurrent with Task 2: Workforce Development.

Workforce development will focus on launching a request for proposal for local electricians. It will also develop contracts to support data sharing with device manufacturers, a contractor agreement with Dynamic Organics, and the refinement of a customer agreement enabling customers to participate in one of the two programs. BED staff will work to develop these contracts with assistance from City of Burlington's Attorney office or McNeil, Leddy & Sheahan. This work will take place during the first 6 months of the project (1/1/2024 – 6/1/2024).

The third task involves accelerating the deployment of devices. This period will run from (6/1/2024 – 12/31/2026). The work to support this effort will include community outreach events, development of customer education materials and webpages, and community partnerships. The milestones of this task are to ensure Justice40 and DEIA metrics are being met and the deliverables of the SOPO are achieved.

The final task focuses on reducing the marginal cost of acquiring thermal storage. This will be accomplished by BED staff and select workforce members by evaluating the customer enrollment process for inefficiencies. BED will also spend time researching alternative approaches, culminating into a New Technologies Report (subtask 4.4).

There are no critical Go/No-Go decision points for the proposed project if awarded. The proposed Building GIANT project has the benefit of being viable and feasible for deployment now and as a follow-on to existing DOE funded research pilots. There are no anticipated barriers or red flags to achieving the goals if the project is awarded.

Potential risks of achieving milestones will be BED's and Partner's ability to engage customers effectively and to solicit installations/participation (though the actual risk is that the proposed number of units would not be deployed more than that there would be no action or some cessation of the project). Having strong community partners will help to reduce the friction of customer enrollment and reach customers with a focus on DEI and Justice40.

WBS and Task Description Summary:

Task 1.0: Project Management and Planning

BED will complete the Project Management Plan (PMP) within 30 days of award. BED will, as required, provide documentation necessary for National Environmental Policy Act (NEPA) compliance and compile a Cybersecurity Plan (CSP), revising and resubmitting as necessary. BED will also schedule routine briefings with DOE on an annual basis to update plans, progress and results of the technical effort. Financial accounting management will also occur quarterly.

Task 2.0 Workforce Development

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BED will put out a request for proposal to engage local electricians for the installation of Emporia Vue devices in customer's homes. BED shall develop contracts for the work to be performed with contractors, devices manufacturers and customers. The first batch of devices will be ordered and inventoried as well. Finally, in partnership with Vermont Works for Women and ReSource Vermont, a student shadowing program will be established to learn from electricians performing subtask 3.4.

Task 3.0 Accelerating Deployment

Educational and communication materials will be developed to explain the two programs being offered to customers. Coordination with community partners, explained further in the CBP, will take place and involve outreach events.

For the heat pump program, BED will work with interested customers to schedule electricians selected through the RFP in subtask 2.1. Additional assistance will be provided with Sensibo Air installations for customers struggling to complete this process on their own. This work will be provided by ReSource and Vermont Works for Women.

The commercial & industrial flexible load management program will begin with BED's energy services and policy and planning teams performing outreach to commercial and industrial customers. Dynamic Organics (DO) will join when the customer executes a Customer Agreement (subtask 2.4). DO will write up the design and documentation for each facility to be performed by the building's controls contractor. The controls contractor will complete this work and DO will integrate and commission the customer's thermal energy system into their software platform. BED will store necessary customer information and pull in device data necessary for controls, billing, and program operations. Forecasting and grid management events will also be performed by BED.

Task 4.0: Marginal Cost Reduction

BED will work to understand the customer and contractor experience through surveys and check-ins. These interactions will provide useful information to implement process improvements, with a focus of correcting inefficiencies. BED will perform the New Technologies Report to evaluate supplemental or alternative technologies that can be used to enable thermal storage within the scope of this project. Finally, BED will validate data and deliver a final project report.

Milestone Summary

SMART Milestones - End Use Metering and Load Control of Heat Pump Loads		
	Explanation of Goal	Actions related to goal
Specific	Placing equipment in the home to submeter and control heat pump's AC state. Enables flexible load management and a bill credit to reduce the cost to operate.	Partner with equipment manufacturer and installers; partner with housing developers; partner with private residents (renters and homeowners)
Measurable	Year 1: 300 total homes; 120 DAC Year 2: 500 total homes; 200 DAC Year 3: 700 total homes; 280 DAC	Community outreach Marketing and Education Community Partnerships

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Action-Oriented / Achievable	The goal is within reason as we already have 2,000 heat pumps deployed in Burlington. Also have resources and local labor force to begin with.	Energy Services, Program & Equity Analyst, Policy & Planning
Realistic/Relevant	This is achievable as we have proven it will work through the current pilot program. This project connects with BED's NZE goal of decarbonization and supports BED's Strategic Plan for flexible rates.	Obstacles include community engagement, education and outreach, devices functionality, vendor exposure.
Time-bound	Everything can be completed within the three year project window.	See Gantt Chart in Technical Volume

SMART Milestones - Large Commercial Flexible Load		
	Explanation of Goal	Actions related to goal
Specific	Work with Dynamic Organics and controls contractor to enable commercial & industrial grid-interactive efficient buildings that can provide thermal storage.	Partner with equipment manufacturer and installers; partner with housing developers; partner with private residents (renters and homeowners)
Measurable	Year 1: 10 facilities Year 2: 15 facilities Year 3: 20 facilities	Community outreach Marketing and Education Community Partnerships
Action-Oriented / Achievable	The goal is feasible as Burlington has many commercial buildings with BMS with the ability to participate in this program.	Energy Services, Program & Equity Analyst, Policy & Planning
Realistic/Relevant	This is achievable as we are proving the capabilities with DO in the current pilot. This connects w/ NZE - decarbonization of thermal and BED's Strategic Plan - flexible rates Demonstrated ability via current pilot	Obstacles include community engagement, education and outreach, devices functionality, vendor exposure.
Time-bound	Everything can be completed within three years.	See Gantt Chart in Technical Volume

Go/No-Go Decision Points

There are no critical Go/No-Go decision points for the proposed project other than the grant award itself. The proposed Building GIANT project has the benefit of being viable and feasible for deployment now. There are no anticipated barriers or red flags to achieving the goals.

End of Project Goal

- A comprehensive workforce of electricians, building controls contractors, hardware and software providers
- Achieving cost reductions in \$/kW-year on track expected marginal cost of thermal storage
- 4 MW under active load control with little customer override of event signals
- Reduced enrollment timeline and friction
- Strong enrollment queue for customers to participate in thermal energy storage programs
- Demonstration additional customer services, such as energy modeling and device health

Project Schedule

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Project Gantt														END OF FUNDING
Year		1				2				3				
Quarter		1	2	3	4	1	2	3	4	1	2	3	4	
Subtask	Task 1: Project Mgmt & Planning													Final
1.1 Project Management Plan														
1.2 NEPA Compliance														
1.3 Cybersecurity Plan														
1.4 Continual Briefings		FY1												
1.5 Award Financial Management		FY2												
Subtask	Task 2: Workforce Development													
2.1 Electrician Selection														
2.2 Data sharing agreement														
2.3 Dynamic Organics Agreement														
2.4 Customer Agreement														
2.5 Device Inventory														
2.6 Student Shadowing Program														
Subtask	Task 3: Accelerating Deployment													
3.1 Customer Education Resource														
3.2 Coordinate with Community Partners														
3.3 Marketing, Press Release, Community Outreach														
3.4 HP FLM - Emporia Vue Installations														
3.5 HP FLM - Sensibo Installation Assistance														
3.6 C&I FLM - Onboarding & Enrollment														
3.7 C&I FLM - Design & Documentation														
3.8 C&I FLM - Controls Programming														
3.9 C&I FLM - Integration & Commissioning														
3.10 C&I FLM - Annual License & Maintenance														
3.11 Grid Management														
3.12 Customer Billing														
Subtask	Task 4: Marginal Cost Reduction													
4.1 Customer Surveys														
4.2 Contractor Check-ins														
4.3 Process Improvement														
4.4 New Technologies Report														
4.5 Data Validation & Project Final Report														

Project Management

BED is currently developing an internal working group focused on heat pumps. This group will create an interdisciplinary team comprised largely of the team members listed in this project proposal. This will help to ensure strong communication and collaboration exist within BED for this project. There is also significant expertise across BED that will be levered in the proposed project, which include the following.

Engineering has a strong understanding of grid capacity requirements, having evaluated what is needed to prepare BED's distribution system for reaching Net Zero Energy. This work involves understanding of network constraints and requirements at the circuit level.

BED's Energy Services and Customer Care teams have knowledge of energy efficiency, building management systems and providing technical customer support. They will serve to provide technical support for this proposed project and guidance on educational documents to answer questions and engage participation.

The Policy & Planning team has a background in power supply, program design and management, software programming, data management and forecasting of generation and load. This team will be tasked with overseeing the project and coordinating with other team members within BED, outside contractors and technology providers.

BED has an Equity Analyst and Director of Sustainability who have strong insight and connections to the various communities of Burlington. This team will help to ensure customers are aware of these program offerings and we see participation of disadvantaged community members.

Mitigating Risks

Risks inherent to this project will be cybersecurity and avoiding stranded devices. BED's IT team is knowledgeable about cybersecurity risks and will continue to evaluate potential risks associated with devices being used by BED. It is difficult to mitigate risks of stranded assets, however as the majority of this project involves software and labor costs there is not a

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significant risk in hardware that becomes obsolete. Another risk is ensuring BED has qualified contractors to perform the installation work. BED has a purchasing department with experience in developing requests for proposals (RFPs). When possible, this will be used to attain a qualified workforce.

Technical Qualifications and Resources

Qualification of Team:

- Policy & Planning
 - ISO-NE markets and Power Supply / Planning
 - Program and rate design / management
 - Database management and data engineering
 - Programming, visualization and data science
- Energy Services
 - Run the "Energy Efficiency Utility" arm of BED
 - Expertise in building controls and building science
 - Energy efficiency engineering
- Sustainability / Diversity Equity and Inclusion
 - Focus on providing DEI lens to BED programs
 - Community outreach and engagement
- Distribution Engineers
 - Distribution planning and optimization

Describe the project team's existing equipment and facilities

There are no existing equipment and facilities required for the successful completion of the proposed project.

Previous Work

In 2017 BED began working on what has become one of the first electric vehicle (EV) rates in the country, and the first in the State. The fundamental goals behind this project were to accurately submeter EV charging and manage EV charging in a scalable and cost-effective manner. After researching a number of options and rate structures, BED took an innovative approach which relied on the skillset of BED staff. Instead of outsourcing this work to a DER aggregator, BED used networked level 2 electric vehicle supply equipment (EVSE), interacting with the webservices or application programming interface (API) to offer a discounted EV charging. Customers in this program pay a rate to charge their EV equivalent to \$0.70 per gallon of gasoline. BED has automated the process to dynamically manage EV charging. This involves BED running a peak forecast that generates peak probabilities and schedules peak events. After several years of running this program, BED has 1MW / 3MWh under managed control.¹⁵ This is a significant benefit to BED's distribution system and is more cost effective than installing battery storage. In the proposed Building GIANTS project, BED will apply these same approaches to leverage grid-edge technologies in the thermal energy sector.

¹⁵ Over 150 EV Customers enrolled with an average charging rate of 7.2kW per device (approximately 1 MW of demand) and an average of 20 kWh of daily charging (3 MWh of energy).

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Time Commitment

BED Department Hourly Commitment	Year 1	Year 2	Year 3
Policy & Planning	586	502	710
Energy Services & Customer Care	430	850	950
Engineering / IT	136	168	280
Equity Analyst, Sustainability	258	298	338

DOE Services

Technical services provided by DOE/NNSA FFRDCs is not applicable to this project.