STARTUP microEra Power HOSTS conEdison, inc. EPRI NEW YORK STATE OF OPPORTUNITY. NY Power Authority

THERMAplus, MicroEra Power's Tunable Thermal Energy Storage

TECHNOLOGY SOLUTION

Heating and cooling residential and commercial buildings consumes 20% of global energy and drives peak loads, especially during extreme hot or cold weather. Thermal Energy Storage (TES) can **shift heating and cooling loads to off-peak and renewable-intensive periods**, reducing grid stress and energy costs. Also, TES supports renewable integration by providing flexible HVAC loads to absorb abundant wind and solar to avoid extremely low or negative pricing. Responsive TES can improve heat pump and chiller efficiency by 20-30% by shifting operation into the system's optimal efficiency range and to the optimal time of day based on outdoor temperature, e.g. running the chiller at night when it is cooler outside and storing cooling for use the next afternoon.

MicroEra Power is introducing THERMAplus®, a dynamic long-duration energy storage (LDES) system, which stores thermal energy, and is tunable to the specific temperature needs for heating, ventilation and air conditioning (HVAC) in different seasons and weather conditions. The melting point of our novel phase change materials for cooling can be fine-tuned between 43°F to 60°F (6°C to 16°C) to optimize cooling efficiency in humid vs. dry weather and changed seasonally to store heat between 104°F to 149°F (40°C to 65°C) in winter. THERMAplus integrates with a building's HVAC system and seasonally stores summer cooling and winter heating in a safe compact footprint, for **practical LDES in space-constrained, urban applications**.

THERMAplus is compatible with air-source and ground-source heat pumps and enables downsizing the heat pumps 30 – 50% to meet the average load on a design day, rather than the peak hour as THERMAplus takes care of the daily peaks. In ground-source applications, the geothermal ground loop can also be downsized, targeting the capacity of stored energy for the most severe 5 to 7 days, rather than seasonal storage of 90 to 120 days. In this hybrid geothermal configuration, THERMAplus may **enable up to 80% downsizing of the ground loop**.

Insulated Tanks for Stored Cooling and Stored Heat, in MicroEra Power's Lab in Rochester, NY

THERMAplus is a safe and affordable LDES solution for making heating and cooling loads flexible, cost-effective, and grid-responsive, serving large building, campus, and district energy applications.

PROJECT OVERVIEW

This EPRI-IEL project demonstrates MicroEra Power's THERMAplus system's ability to store heat and cooling using one tunable system, conditioned for thermal discharge at temperatures optimized for efficient heating and cooling of commercial

microEra Power

buildings. To accommodate a compressed timeline, two separate tanks were used for this project. In commercial deployments, the same tanks can be tuned to dynamically respond to seasonal requirements, releasing large amounts of thermal energy at specified phase-change temperatures to provide buildings or campus/district systems with stored heat in winter and stored cooling in summer.

The project started with interviewing utilities about grid pain points to inform prototype specifications and testing parameters. We focused on two types of tests, with slow charge and discharge rates for efficiency and fast charge and discharge rates for peak management and load flexibility. The lab test setup was upgraded for reliability and accuracy, and data acquisition and control software were developed to run the system. EPRI installed an independent set of sensors and data acquisition equipment to remotely measure and validate the capacity, power, and efficiency of the THERMAplus thermal storage modules for stored heat and stored cooling. The prototypes were tested under the use cases derived from utility interviews. Both EPRI and MicroEra Power analyzed the data and compiled results for this report.

Hardware preparation for the EPRI IncubatEnergy® demonstration at a meaningful lab scale at MicroEra Power involved these steps:

1. MicroEra Power designed and built two next-generation THERMAplus prototype modules, each containing 75 gallons of proprietary phase change materials, with innovative heat exchangers
2. To simulate sources for charging the thermal energy storage, the modules were connected to a lab chiller and the building's boiler loop. Note: In the real system, a heat pump supplies heat and/or cooling to charge the TES
3. EPRI's Subject Matter Expert in TES systems, Micah Sweeney, came onsite to install instrumentation for remote third-party measurement and verification

> The differentiator here with this technology is the benefit of providing thermal storage in winter, which will be enormously important as we decarbonize buildings and electrify heating stock.
>
> **Micah Sweeney, EPRI, Technical Leader**

> It's quite innovative to see technology that can adjust a phase change material's temperature to fit the requirements of the building. This innovation not only helps to minimize thermal losses during the charge and discharge cycle but also to optimize the efficiency of the HVAC equipment. MicroEra Power offers flexibility to store heating and cooling in one tunable system and can provide space, cost, and energy savings for our customers. Con Edison R&D is excited to sponsor this project and see how we can adapt on-site thermal energy storage to our market.
>
> **Silvia Khurrum**
> **Sr. Engineer/Project Manager R&D, Con Edison**

RESULTS & LEARNING

To demonstrate capacity for THERMAplus to store both cooling and heat, laboratory testing successfully demonstrated stored cooling at 43°F (6°C) and stored heat at 149°F (65°C) with the same active material, using a range of charging and discharging rates to reflect priorities of efficiency and peak management. Results fully met expectations.

The measured stored cooling capacity was similar to ice storage (of equivalent volume) at an average of **4.60 ton-hours (16.2 kWh-thermal)**, but at a more optimal temperature for air conditioning. This could enable a heat pump or standard water-based chiller to operate more efficiently and avoid (a) the cost of an expensive deep-cycling chiller required for ice storage, and (b) the need to use expensive and less-efficient glycol antifreeze. The measured stored heating capacity was about 50% greater than stored cooling capacity at an average of **84163 BTU (24.7 kWh-thermal)**. These tests are at a meaningful scale; fielded installations will be 10x to 100x larger, resulting in grid-relevant, flexible demand side loads in the megawatts for large buildings.

The THERMAplus modules performed well across a wide range of cycle times, with an average **round-trip efficiency of 91% for stored heating** and 82% for stored cooling. The prototypes were well insulated on the bottom and sides, but less well insulated on the top and piping. We expect round-trip efficiency to be

microEra Power

higher in actual products. Tests were conducted with charge and discharge times ranging from **3.5 hours to > 12 hours**, demonstrating great flexibility in how the modules can be cycled. While slower cycles are generally more efficient for the heat pump, based on lower temperature lift, the modules can be charged very quickly, when it is cost-effective to do so. This will become valuable for utilities and market participants looking to avoid very low or negative pricing when renewable power is abundant and surplus to real-time needs. THERMAplus can flatten grid peaks and fill in the valleys of demand, responsive to availability and pricing.

Collaboration with EPRI brought third party performance validation, strengthening confidence in the performance of MicroEra Power's THERMAplus technology.

IMPLICATIONS & NEXT STEPS

Design is underway for the next generation of THERMAplus modules, supported by a U.S. Department of Energy SBIR Phase II grant for geothermal heat pump applications (pilot installation at a college in Massachusetts), and two NYSERDA projects, one for integration with air-source heat pumps and another for monetization of byproduct heat, e.g. from data centers. In addition to hardware development, both the DOE and NYSERDA projects cover heat pump and building integration.

Grid-interactive software can make a fleet of distributed THERMAplus sites visible to utility operations in terms of feeder-by-feeder load optimization. MicroEra Power's expert in grid-interactive software is developing this aspect of the product. This level of demand-side flexibility is essential as new peaky loads such as heat pumps and EV fast charging come online. THERMAplus compact footprint, low system cost, flexibility to provide four-season TES value, and safety should make THERMAplus the go-to technology for urban decarbonization and resiliency.

MicroEra Power is seeking demonstration projects and paid pilots with utility partners and corporate early adopters in a variety of regions and climate zones. While the stored heat and stored cooling configuration applies to four-seasons markets in North America and Europe, THERMAplus can be adapted to cooling-dominant markets (Arizona, Nevada, California, or southern Europe) or heating-dominant markets (Alberta, Alaska, or Scandinavia). For example, in hot, dry climates like Arizona, where it is humid for only a few months a year, storing cooling at 60°F (16°C) during the dry season is dramatically more efficient than ice storage. For example, in Alberta there can be periods of extremely cold weather, where storage is needed at 149°F (65°C) for load shifting and demand response. However, during periods of mild winter weather, THERMAplus can store heat at intermediate temperatures, significantly increasing system efficiency and heat recovery potential.

Next to evaluate is THERMAplus performance in a hybrid geothermal application for large building or district thermal systems. Our engineered thermal energy storage handles the peak power of daily thermal loads efficiently and flexibly, while the geothermal ground loop provides sufficient energy storage to maintain HVAC performance during extreme weather events, which typically last 5 days or less. An air-source component is used in less severe weather and to re-balance the ground loop when the extreme weather has passed.

> The temperature at which that material changes phase is tunable. It can happen at different temperatures.... So that's an interesting concept. We think that we will have a lot of opportunities to utilize a thermal energy storage system in different applications, especially in the retrofit markets where we are looking at different kinds of buildings, and different kinds of duty cycles...in terms of their HVAC for cooling and heating. A variable or tunable energy storage solution has promise.
>
> **Guy Sliker, Director, Customer Solutions R&D, NYPA**

RESOURCES

JAMES GRIEVE
CTO, MicroEra Power
mjg@microerapower.com

ALAN ETTLINGER
Senior Director Research, Technology Development and Innovation, NYPA
Alan.Ettlinger@nypa.gov

GUY SLIKER
Director, Customer Solutions R&D, NYPA
guy.sliker@nypa.gov

KING LOOK
Director, R&D, ConEdison
LookK@coned.com

ERIC DAVIS
Section Manager, R&D, ConEdison
davise@coned.com

SILVIA KHURRUM
Project Manager, R&D, ConEdison
KHURRUMS@coned.com

MICAH SWEENEY
Technical Leader, EPRI
msweeney@epri.com

INCUBATENERGY LABS

RESOURCES

DAN KILLOREN, PH.D.
Program Manager
Global Innovation Hub
dankilloren@epri.com

JERRY LIGRANI
Program Lead
Incubatenergy® Labs
jligrani@epri.com

labs.incubatenergy.org

2023 INCUBATENERGY LABS ENERGY PROVIDERS

Ameren
AMERICAN ELECTRIC POWER
aps
conEdison, inc.
elia | Elia Group
enel
entergy
FORTIS INC.
Grupo Energía Bogotá
NEW YORK STATE OF OPPORTUNITY. NY Power Authority
PG&E
PGE
SOUTHERN CALIFORNIA EDISON® An EDISON INTERNATIONAL® Company
SRP
TVA
Xcel Energy®

3002028656 March 2024

EPRI
3420 Hillview Avenue, Palo Alto, California 94304-1338 USA
800.313.3774 • 650.855.2121 • www.epri.com