NEW ENGLAND CHP Technical Assistance Partnerships

PROJECT PROFILE

# University of Massachusetts Amherst Microgrid

## 16 MW CHP System with 5 MW Solar PV and 4 MWh Battery Storage

## Site Description

The University of Massachusetts (UMass) in Amherst, Massachusetts is long known for its national and international reputation for excellence. UMass Amherst typically enrolls over 23,000 undergraduate students and offers over 100 separate degree programs. In 2009, UMass Amherst completed its new 45,000 square foot central heating plant, replacing the campus's 80-year-old coal-burning power plant.

**UMass Amherst's central heating plant**
Photo courtesy of UMass Amherst

The central heating plant supplies all of the steam and most of the electricity required by the 200+ buildings covering 10 million square feet of building space on the 1,450-acre campus. The plant consists of a combined heat and power (CHP) system including a 10 MW combustion gas turbine, 4 MW low-pressure steam turbine, a 2 MW high-pressure steam turbine, and a heat recovery steam generator (HRSG).

In 2015, the University installed three large solar photovoltaic (PV) parking canopies at the Robsham Memorial Center for Visitors that are capable of producing an estimated 330,000 kWh annually. In the same year the University also installed a solar hot water system to preheat condensate water for the steam production process, reducing fossil fuel usage.

In 2017, UMass installed an additional 15,000 PV panels across campus, providing 5.5 MW (DC) of electrical power for the campus to use at a heavily discounted rate. The University was awarded a $1.1 million state grant from the Advancing Commonwealth Energy Storage (ACES) program to construct a large battery at the central heating plant on campus. The battery storage project consists of a 1.3 MW/4 MWh lithium-ion battery installed by Borrego and became operational in June of 2019.

## Quick Facts

**LOCATION:** Amherst, Massachusetts
**MARKET SECTOR:** University/Education
**FUEL:** Natural gas, oil
**MAX CHP CAPACITY:** 16 MW
**FACILITY PEAK LOAD:** 21 MW
**POLLUTION CONTROL:** Selective catalytic reduction (SCR), Oxidation catalyst
**ENVIRONMENTAL BENEFITS:** Roughly 97% emission reduction from CHP; annual reduction of roughly 8,000 metric tons $CO_2$ from Solar PV[1]
**AVERAGE CAPACITY FACTOR:** ~75%
**ANNUAL ENERGY OUTPUT IN 2019:** 101 million kWh electricity, 1.063 billion pounds of steam
**EQUIPMENT:** 10 MW gas turbine; 2 and 4 MW steam turbines; 5,335 kW solar PV; 1.3 MW/4 MWh Li-ion battery storage
**CHP IN OPERATION SINCE:** April 2009

**Battery storage project near the central heating plant**
Photo courtesy of UMass Amherst

1. EPA (2019) AVERT, U.S. national weighted average $CO_2$ marginal emission rate, year 2018 data. U.S. Environmental Protection Agency, Washington, DC.

## Reasons for Installing Microgrid

The campus' old coal-fired central heating plant, built in the early 1900's and expanded over the years, could no longer obtain operating permits from the state due to new emission standards. In order to satisfy state requirements, the campus would have to switch to natural gas. This required the transition from a relatively inexpensive fuel to one that was more expensive, as well as the construction of a new natural gas-fired central heating plant. After exploring its options, UMass Amherst decided to maximize its value from this new fuel through a combustion turbine-based CHP system. Solar was implemented into the microgrid to displace imports of grid electricity, resulting in emission reductions. The battery storage project was installed for demand limiting purposes.

## Equipment and Operation

The gas turbine generates 10 MW of power at full capacity. Exhaust from the turbine is routed to the HRSG capable of producing 37,000 pounds per hour (pph) of steam at 600 psi without any additional firing, and up to 100,000 pph with additional duct burners. The steam enters the 2 MW high-pressure steam turbine, is expanded to 200 psi, and is then routed to the high-pressure campus steam line and to the 4 MW low-pressure steam turbine. Steam exits the low-pressure turbine at about 17 psi and is routed to the low-pressure campus steam line. Single-effect absorption chillers, which run off of the low-pressure steam line, produce up to 5,730 tons of cooling. There are three additional boilers on-site, each capable of producing 125,000 pph of steam. One of these boilers is designed to run at 600 psi, and the other two at 200 psi.

The plant draws approximately 200,000 gallons per day of treated wastewater from the Town of Amherst's nearby wastewater treatment plant to replace water lost in steam distribution and use rather than using clean drinking water.

The central heating plant uses the latest pollution control technologies. These controls, combined with the switch to natural gas, reduced annual emissions by approximately 97%. The UMass microgrid is configured to operate in parallel with the electric grid. In case of a grid failure it can seamlessly transition to operate in "island" mode.

> ***"CHP has proven to be an exceptional investment for the University. Notably reducing energy costs and greenhouse gas emissions while greatly improving the electrical supply reliability for the campus."***
>
> ***- Ray Jackson***
> ***Plant Director***

## Achievements and Awards

The solar canopies are the first of their kind in the Amherst area and were supported by a $146,000 *Leading by Example* Clean Energy grant from the Massachusetts Department of Energy Resources (DOER). In addition to providing shade for vehicles parked at the visitor center, the canopies also provide two "Level 2" and one "fast" vehicle charging stations. The solar canopies will reduce emissions in the regional grid by the equivalent of 31,000 tons of carbon dioxide and cut the university's electric bills by $6.2 million over 20 years. UMass continues to improve system efficiency and resiliency while maintaining a strong relationship with the New England CHP Technical Assistance Partnership.

**Solar canopy project at the central heating plant**
Photo courtesy of UMass Amherst

The plant has received several awards, including:

- In 2008, the Combined Cycle Journal Pacesetter Award for the best combined heat and power plant project in the U.S.;
- In 2009, the Sustainable Campus Leadership Award from the District Energy Association; and
- In 2011, the Combined Heat and Power ENERGY STAR Award from the U.S. Environmental Protection Agency.

## For More Information

**U.S. DOE New England CHP**
**Technical Assistance Partnership**
Dr. David Dvorak, Ph.D., P.E., Director
207-581-2338
dvorak@maine.edu

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Date updated: July 2020