March 2017

Capitalaire

The National Capital Chapter of ASHRAE

Monthly Newsletter

Adapt Today to Shape Tomorrow

ASHRAE National Capital Chapter

ASHRAE Society Technology Awards

BUTCH & SALLY MICHEL CENTER FOR PARKS & PEOPLE

Institutional Building (Other) - New Construction

Mechanical Engineering: Patrick Murphy, Brandon Harwick, Malory Faust
Electrical Engineering: Brian Charles
Plumbing Engineering: John Rattenbury, John Schasny, Shawn Tyler
Principal-in-Charge: Sam Bohsali and Don Posson

From left to right: Patrick Murphy, Omar Hawit & Patti Gunderson

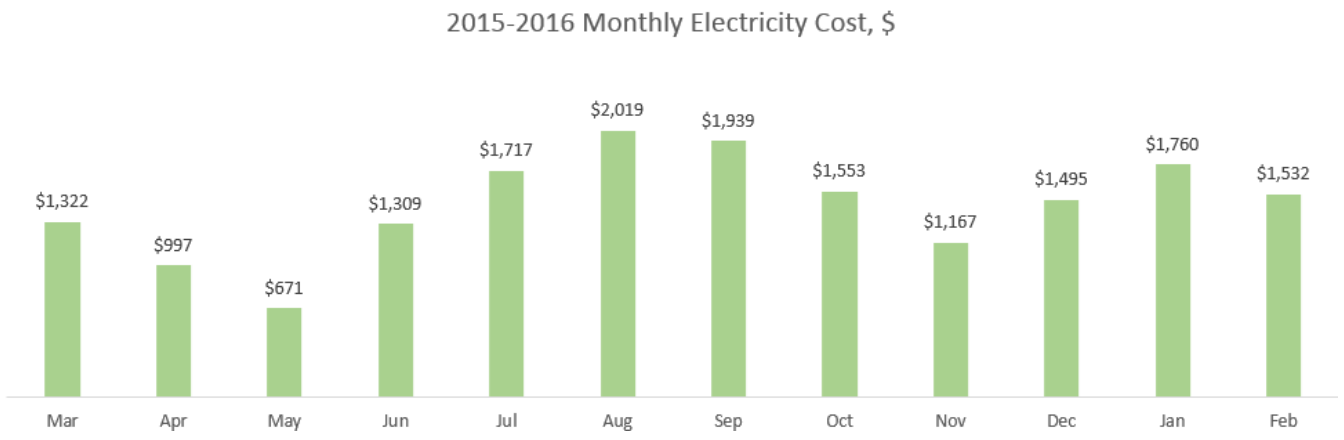
Project Summary

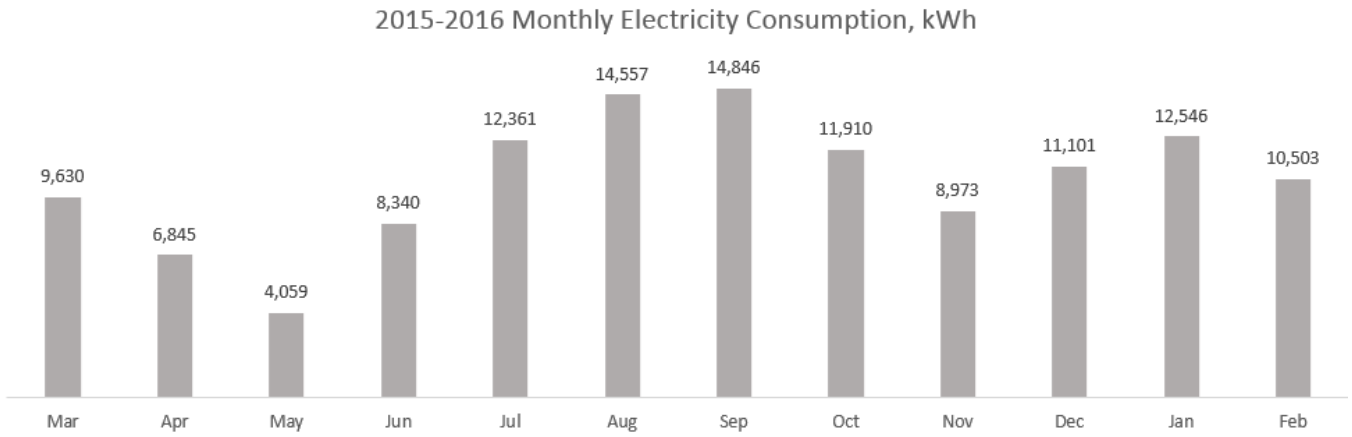
This LEED® v2.2 Platinum certified project has been occupied since the fall of 2014 and includes the new 10,000 GSF Butch and Sally Michel Center for Parks and People office building and the historic renovation of a 4,200 GSF Park Superintendent's House that was constructed in Baltimore, MD in 1872. The project includes offices, community event space, teaching labs, reading rooms, and seminar rooms. The facility accommodates space for Parks and People Foundation as well as the University of Maryland Urban Research Station. Site amenities include research fields for the University of Maryland Urban Research Station, demonstration gardens, a storm water demonstration area, parking and a transit center/park connection path.

The facility was designed starting in 2006 and evolved over a five year design period, followed by a four year construction process. Occupancy began in the Fall of 2015. The final installed MEP systems include a 20-ton geothermal variable refrigerant flow (VRF) system; an 1800 CFM geothermal water-source heat pump total energy recovery unit for mechanical ventilation; natural ventilation controls during optimal outside temperature conditions; ceiling fans to expand the thermal comfort window; rooftop photovoltaic power; a green roof; daylighting optimization; and composting toilets.

Energy Efficiency

The overall site project design is projected to reduce energy cost relative to the ASHRAE Std. 90.1-2004 baseline by 49.3 percent, achieves an Energy Star Score of 100. The headquarters building has an energy use intensity of 43.1 kBTU/SF-year based on utility meter data from March 2015 to February 2016. The energy efficiency for the project is achieved through a number of complementary design features to reduce energy consumption and produce renewable energy on site. The building envelope is highly insulative with a green roof, R-25 structural insulated wall and roof panels, and 0.18 U-value/0.63 shading coefficient triple pane glazing. Natural ventilation eliminates fan and cooling energy consumption during prolonged periods in the Spring and Fall. Skylights, reflective surfaces, and daylighting control limits wasted lighting energy consumption. A geothermal heat pump system utilizes the thermal mass of the earth to store and reject heat throughout the year. Finally, an 18 kW photovoltaic panel array on the roof produces electricity to offset the electricity consumption of the facility from the grid. Energy modeling was done in eQuest 3.64 and DOE2.2 utilizing the ASHRAE Std. 90.1-2007 Appendix G Performance Rating Method.





Indoor Air Quality & Thermal Comfort

The headquarters building HVAC system is designed to maintain a healthy work environment for occupants and to comply with ASHRAE Std. 62.1 and ASHRAE Std. 55. The natural ventilation mode introduces abundant fresh air to flush the building. During active ventilation with the energy recovery unit, ventilation air is filtered through MERV-8 prefilters and MERV-13 final filters. All recirculating VRF units are also provided with MERV-8 filters. Materials and adhesives used during construction were selected for low VOC content. Spaces used for storage of chemicals such as janitor closets, as well as spaces used for copying and printing are exhausted and isolated from adjacent spaces. Entryways are provided with permanent walk-off mats to capture dirt brought in by occupants. All conference rooms and densely occupied spaces are provided with CO_2 sensors to monitor and control CO_2 levels in the breathing zone with a maximum CO_2 setpoint of 1000ppm. Finally, the HVAC system serving the classroom and meeting spaces in the Superintendent's House utilizes displacement ventilation for optimal ventilation effectiveness.

The ventilation system effectiveness was evaluated utilizing the Ventilation Rate Procedure described in Section 6 of ASHRAE Std. 62.1-2004 for LEED, and ASHRAE Std. 62.1-2007/IMC 2009 for code. Typical spaces included offices (5 CFM/person + 0.06 CFM/SF, 5 people/1000sf), main entry lobbies (5 CFM/person + 0.06 CFM/SF, 10 people/1000sf), conference rooms (5 CFM/person + 0.06 CFM/SF, 50 people/1000sf), corridors (0.06 CFM/SF), equipment rooms (0.06 CFM/SF), and storage rooms (0.12 CFM/SF). A ventilation effectiveness of 0.8 was assumed based on ceiling supply of warm air since outdoor air was ducted directly to VRF units that provided heating. No occupant diversity was taken. The ventilation rate procedure calculation resulted in a requirement of providing 1530 CFM, and the design sum of the supply outlets 1690 CFM to allow for building pressurization, future capacity, testing and balancing, and leakage. The testing and balancing contractor confirmed that all spaces and equipment were provided with their required outside air, and the ERU supplies 1769 CFM. The ERU was also balanced to maintain positive building pressurization of 193 CFM. Locker rooms, break rooms, and restrooms are exhausted per Table 6-4 in ASHRAE Std. 62.1-2007.

Occupant comfort is optimized through the installation of dedicated thermostats in all open office spaces, all conference rooms, and 50 percent of enclosed offices. Occupants in the open office may also control individual ceiling fans, operable windows, manual shades, and task lights for their comfort. More than 50 percent of all occupants are provided with temperature controls.

Occupant comfort was evaluated compared to ASHRAE Standard 55-2004. Activity levels were assumed to equal a metabolic rate of 1.0-1.2 met (office activities seated, reading, or writing; typing, or filing seated), and a clothing insulation of 0.54-0.96 clo (knee-length skirt, short-sleeve shirt, sandals on the low end; trousers, long-sleeve shirt, and suit jacket on the high end), both similar to most office spaces per ASHRAE Standard 55-2004, Section 5.2.1.1. Space temperature setpoints are 75 deg F (+/- 2 deg F) in the cooling season and 72F (+/- 2F) in the heating season. Relative humidity for all occupied spaces is designed to a maximum of 60% based on a supply air temperature reset schedule with a temperature range of 49F to 58F. Mean radiant temperature asymmetry is within the allowable tolerance for a warm and cool wall per ASHRAE Standard 55-2004 Table 5.2.4.1. A walkway separates occupants from being seated in direct sunlight.

Innovation

The facility was designed starting in 2006 and was a pioneer of geothermal-cooled variable refrigerant flow (VRF) systems. The primary means of mechanical heating and cooling for the headquarters facility is a 20-ton water-to-refrigerant heat pump system tied to fifteen (15) indoor VRF fan coils. The water side of the VRF

system includes a geothermal well field consisting of twenty-two (22) 200 foot deep wells and two (2) 10 hp circulating pumps.

The geothermal system also supports the heating and cooling load from a 1,800 CFM ventilation unit with a total energy recovery wheel. The controls for this energy recovery unit (ERU) are set up to alert occupants of optimal outdoor air temperature conditions for natural ventilation. In these conditions, the ERU and VRF units shut down, indicator lights in the occupied space turn on, and occupants open an operable wall and four clerestories. Additionally, occupants are provided with control of twelve (12) ceiling fans which operate at multiple speeds and widen the range of comfortable temperatures in the space to as high as 78 deg F. This allows for a reduction in energy consumption for cooling.

During design, an innovative earth tube system was included to precondition outside air through a series of concrete tubes buried below the frost line. Ultimately these earth tubes were not included in the final design due to budget constraints.

Finally, the project included innovative sustainable strategies such as preparing the site using goats to clear the site of invasive growth in an environmentally sustainable way; more than a 56 percent reduction in potable water use; and the use of reclaimed, recycled, and rapidly renewable finish materials.

Operation & Maintenance

The system was designed to maintain occupant comfort, health, and safety without a full time facility engineer on site. A geothermal system was deliberately selected for the headquarters building over air-cooled VRF or air-cooled DX systems to eliminate outdoor equipment to allow for a tranquil park environment around the facility, and to keep all mechanical equipment maintenance indoors. Runtime of equipment is reduced through the use of natural ventilation, providing opportunities for maintenance of equipment without disruption to ventilation and conditioning of occupied spaces. The water-cooled VRF system centralizes the compressors and most maintenance to the mechanical room, which was designed to provide adequate clearance for safe maintenance of all equipment. Maintenance tasks are limited to routine inspections of the ERU, pumps, and VRF equipment; annual tune ups; and regular filter replacements. The BMS controls automatically operate the building, and are set up to alert the owner of any alarms from the HVAC systems. The systems were also commissioned by a third party through the LEED v2.2 Enhanced Commissioning process.

In June 2016, Vanderweil conducted a post-occupancy evaluation inspecting the operation of the systems, reviewing utility bills, and interviewing key staff to evaluate the real world operation of the facility and develop lessons learned for future projects. This post-occupancy evaluation indicated that the Parks and People Foundation leadership and staff are pleased with the facility, and operational issues are limited to minor items common to new buildings (e.g. leaky faucets). A lesson learned is to establish new language in the controls and commissioning specifications to require additional training for staff recorded on video for new future staff.

Cost Effectiveness

Both achieving LEED Platinum certification and designing to a tight budget were high priorities for the owner. A value engineering exercise optimized the location and quantity of the geothermal wells. A test well was installed to determine the site-specific performance of each well, and this data was used to determine the minimum quantity of wells needed to meet the building loads. This test well was reused as one of the permanent wells. Also, the selection of a VRF system required less ductwork, floor-to-floor height, central equipment, and

labor costs than a traditional VAV air handling system. The campus is expected to realize approximately $20,000 in energy cost savings per year relative to the energy model baseline, based on an aggregate electricity rate of $0.1558/kWh.

Environmental Impact

The owner and design team shared a project vision for an innovative sustainable facility that minimized its impact on the environment. This resulted in the project earning LEED NC v2.2 Platinum certification.

The energy efficiency of the HVAC, lighting, and building envelope systems results in a projected reduction of CO_2 emissions of 75 metric tons of CO_2, a savings of nearly 80 percent compared to the median property in the Energy Star Target Finder. In addition, the project uses only R-410A refrigerant in order to prevent ozone depletion and limit global warming potential.

Limiting water use was also a major focus of the design team. The project reduces overall water consumption for water closets, urinals, lavatories, and sinks by 56 percent. Potable water use for toilet flushing is reduced by over 50 percent. This is achieved through a combination of low-flow water closets and lavatories, waterless urinals, and composting toilets. Additionally, the closed loop geothermal system eliminates the need for makeup condenser water consumption.