CASE STUDY
OTHER WORLD COMPUTING—GALAXY WAY, WOODSTOCK , IL

ASHRAE ILLINOIS CHAPTER
EXELENCE IN ENGINEERING AWARD 2016

Energy Efficiency

In Spring 2010 Other World Computing Incorporated (OWC), a privately owned corporation, received their LEED Platinum certification (NC Version 2.2) for their new headquarters facility on Galaxy Way, Woodstock, IL. The LEED certification also included 3 credits for EAc2 resulting from an on-site wind turbine. In 2012 OWC received their Energy Star certification. The key energy efficiency and renewable energy features include:

a. Building envelope insulation values that exceed ASHRAE 90.1-2004. This includes: double-glazed, low-E, argon-filled, fixed-windows with thermally-broken aluminum framing; pre-insulated, high-thermal mass pre-cast concrete panel structure and finished exterior with additional interior insulation and finished gypsum walls. The high window and wall insulation levels allowed the design team to eliminate a separate perimeter heating system. The high wall and roof insulation levels allowed the design team to use a simple plenum return air system. The high insulation levels help simplify and reduce the cost of the HVAC systems.

b. Exterior and interior window shading elements. Fixed exterior horizontal window shading elements reduce solar gain and glare. Manually operable interior shades provide added adjustable thermal and glare control.

c. Heat pump geo-exchange heating and cooling system for all HVAC systems and for the IT server room. This includes a vertical well field rated for approximately 70 tons of cooling capacity. During the winter the heat pumps that serve the IT server room inject their heat of rejection into the condenser water loop, thereby virtually eliminating the need for any supplemental heating. Only two of the 11 heat pumps (that serve critical zones) have supplemental heating (electric resistance).

d. Distributed condenser water pumping. Instead of a central, or a primary/secondary, pumping system for the condenser water loop, each heat pump is equipped with its own pump(s) that operate as necessary and thus reduce total pumping energy.

e. Multi-zone, Variable Volume & Temperature (VVT) air distribution. About half of the heat pumps serve multi-zone air distribution systems for improved temperature control. They are controlled by a VVT-like sequence of control that enables temperature control in multiple spaces with varying loads and minimal use of electric reheat.

f. Evaporative cooling and heat recovery for the ventilation air. Outdoor air for ventilation is supplied by a roof-top unit that functions as a direct and indirect evaporative cooler to temper and dehumidify the outdoor air during the summer and to preheat the outdoor air with waste heat from the building exhaust during the winter.

g. Demand-control ventilation uses wall-mounted carbon dioxide (CO2) sensors in critical zones. The CO2 sensors control the amount of outdoor air delivered to a zone and to a heat pump in order to efficiently provide the amount of outdoor air needed for breathing.

h. Air Economizer for the IT server room. One of the outcomes of the SEDAC Level 3 Energy Assessment & Feasibility Report done in 2013 was to upgrade the HVAC system serving the IT server room so that outdoor air is used when appropriate for cooling.

i. High efficiency interior and exterior lighting. T-5 fluorescent lamp/ballast technology, along with highly reflective troffers, are the foundation of the highly efficient interior general lighting. The general lighting is designed to take into account task lighting where ever it is available—in the offices as well as at work stations in the warehouse, testing and picking and shipping areas. High efficiency exterior metal-halide fixtures illuminate the building exterior and parking lot. Daylight is directed from roof-mounted collectors through fiber optic conduits to the few interior spaces with no windows.

j. Occupancy-based and daylight harvesting lighting controls. Occupancy sensors activate lights when rooms and warehouse storage aisles are occupied. Daylight harvesting controls modulate the light levels through the ballasts or in steps depending on whether the lights being controlled are the perimeter office areas or in the skylight lit warehouse/storage areas.

k. Central Energy Management System (EMS). Enabled the design team and controls contractors to develop a customized sequence of control that will optimally control for the zone dampers, heat pumps, outdoor air dampers and the few supplemental electric reheats.

l. On-site Soar and Wind Renewable Energy Systems. This site has two renewable energy systems: a 500 kW wind-turbine and a 266kW DC rooftop solar photovoltaic (PV) system. The wind turbine has been operating since 2011 one year after the building was first occupied. Another outcome of the SEDAC Level 3 Assessment was to invest in a rooftop solar PV system to enable OWC-Galaxy Way to become a net-zero energy facility. The solar PV system was installed and commissioned in the Fall of 2015 with the first full month of energy production occurring in December 2015. Figure 1 includes the production data for both the wind and solar PV systems through August 31, 2016. The sum of all the bar components is the actual building energy use for the month. Note that wind energy production is greatest during colder weather when solar energy production is lowest and solar energy production is highest when wind energy production is lowest. The two renewable sources complement each other resulting in fairly consistent renewable energy production throughout the year.

Figure 2 shows the monthly cumulative net energy use for the building and the corresponding cumulative % of building energy generated by the wind and solar PV systems. By August 31, the renewable energy systems had generated renewable energy totaling 95% of the cumulative energy need of the facility. The table below shows that adding the solar PV system has increased the % building energy use provided by renewables from 64% in 2013 to 95% in 2016.

m. Energy Monitoring System. As part of the solar PV project, we upgraded accuracy of the energy monitoring system to enable it to measure real power use and power factor energy used by the facility, energy sold to the utility grid, energy produced by the wind turbine and energy produced by the solar PV system. The system is monitored through the BAS and allows us to periodically compare with the utility bill data that is based on the utility's net metering system.

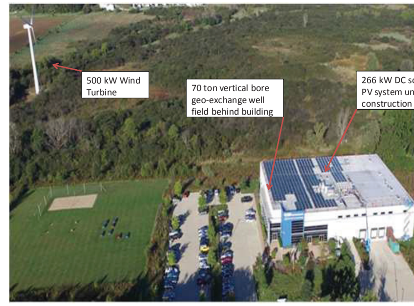


Figure 1. Energy Use and Renewable Energy Production—Jan to Aug 2016

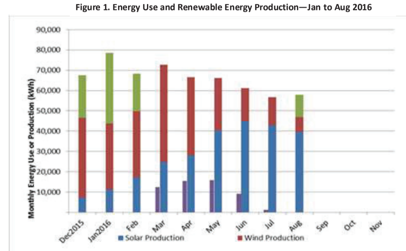
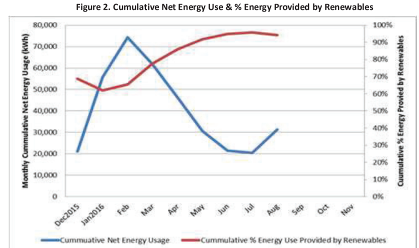


Figure 2. Cumulative Net Energy Use & % Energy Provided by Renewables



Building Energy Performance Summary

	Annual Building Energy Use (kWh/yr)			Renewable Energy Production (kWh/yr)			Net Utility Energy Required (kWh)	% Energy Provided By Renewables
	Total	% Process Energy	w/o Process Loads	Wind	Solar	Total		
Base Case (LEED Energy Model)	673,178	25	504,884	0	0	0	673,178	0
Actual (12mo. to Nov 2016)[1]	705,862	>35	458,810	323,548	353,004	676,552	23,310	**95.8%**
Annual Savings (using most recent Actual data period)			40,074	323,548	353,004	676,552		

Indoor Air Quality

The system is designed to provide 30% more than the recommended minimum outdoor air to the breathing zone of the building. The air distribution system was kept simple, overhead supply air registers and a plenum return system with a resulting average ventilation effectiveness of 0.70 during the heating season and 1.0 during the cooling season. The ventilation procedure method in ASHRAE Standard 62.1-2004 was used to determine the corresponding required outdoor air intake rate.

To efficiently condition the required large additional amount of outside air, a roof-top outdoor air handler was selected that uses evaporative cooling to pre-cool and dehumidify the outdoor air during the cooling season and pre-heat the outdoor air by recovering heat from the building exhaust air during the heating season. The carbon dioxide sensors are located in critical zones (those having the highest occupancy levels and corresponding highest outdoor air per sq. ft. (zone of maximum ventilation air demand) requirements in the area served by a given heat pump. This enables the HVAC system to vary the amount of delivered outdoor air based on occupancy.

The total outdoor air input rate is monitored by the air flow station located at the roof-top outdoor air handler. This provides an added check to ensure the appropriate total amount of outdoor air is entering the building. Air-borne particulates are captured by the MERV-13 filters at each heat pump and by floor mats at each building entry.

The building was designed to enable maintaining indoor temperatures that meet the guidelines of ASHRAE Standard 55-2004 for mechanically ventilated spaces. During the cooling season relative humidity is controlled through the regular dx cooling process which also dehumidifies. During the heating season, the IT room is humidified in order to avoid static discharge. The rest of the building does not require any special dehumidification according to ASHRAE Std 55-2004 or by the nature of the activities in the building.

Innovation

The innovative features in this design include :

a. eliminating a separate perimeter heating system and most reheats by taking advantage of the high insulation level in the building envelope;

b. using the waste heat generated by cooling the IT room to heat the other parts of the building and to avoid over-sizing the geothermal system. This enabled sizing the geothermal field to handle the required cooling load ;

c. using evaporative cooling and heat recovery to reduce the cooling and heating loads resulting from introducing large amounts of outdoor air ;

d. using a re-built wind turbine on-site to cost-effectively displace utility-purchased electricity. The rebult 500 kW wind-turbine enabled installing a sizable wind turbine at about half the cost of installing a new wind turbine.

e. occupancy sensors in the warehouse storage aisles

f. various daylight harvesting controls and conduits to direct sunlight to interior spaces.

Maintenance & Operation

a. There are no air-cooled condensers to clean and maintain. The heat exchange surfaces are all located underground and are not subject to fouling or damage.

b. All the heat pump/ventilation systems are inside the building instead of on the roof. Therefore the equipment is protected from weather, it is more accessible for maintenance & operation, it results in fewer penetrations through the roof membrane and less wear and tear on the roof membrane.

c. Central Energy Management System (EMS) makes it easier for staff to monitor key system parameters such as indoor temperature, carbon dioxide levels, discharge air temperatures, compressor and fan status, etc. It also makes it convenient to adjust setpoints, schedules and sequence of control programming to optimize equipment performance.

d. Written Sequences of Control and Operation & Maintenance procedures are customized for this building and help make it easier to keep the systems operating optimally. The commissioning process helped to optimize system operations and establish the O&M procedures.

e. Service contracts are in place for routine periodic maintenance of the HVAC systems.

f. Web-based building tour and description of features provides staff with an introduction to the builidng's energy saving, indoor air quality and other green features. See www.macsales.com and click on Environmental at the bottom of the Home page, or go directly to https://eshop.macsales.com/thinkgreen/

g. Designated Corporate-Exectuve level building systems manager, Lawrence O'Connor Sr. is responsible and has the authority to address and resolve building operation & maintenance issues.

Environmental Impact

a. Reduced amount of waste heat. Waste heat is reduced by: i) using the geo-exchange heat pump system to transfer waste heat into the ground during the cooling season instead of dumping it into the air the stored waste heat is then available to heat the facility during the heating season eliminates burning fossil fuels and using utility electric power produced and delivered at about 30% efficiency that requires cooling towers to dump central plant waste heat and water vapor into the atmosphere; ii) the on-site wind and solar PV generated electricity and air-side economizer for the IT server room eliminate the waste heat that would otherwise be produced at the: on-site cooling compressor serving the IT server room; central utility plants generate and deliver the electricity to OWC; iii) the air-economizer systems, heat recovery and evaporative cooling reduces the mechanical cooling energy required for the ventilation air

Reduced amount of greenhouse gas emissions. Greenhouse gases are reduced by: i) the geo-exchange heat pump system avoids on-site fossil fuel burning (expect for one small gas-fired domestic water heater for the washrooms) and reduces on-site carbon dioxide production; ii) the on-site renewable energy production displaces use of utility generated electricity; iii) the air-economizer systems, heat recovery and evaporative cooling reduces the mechanical cooling energy required for the ventilation air

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