CHAPTER/REGIONAL TECHNOLOGY AWARD - SHORT FORM

1. Category - Check one and indicate New, Existing, or Existing Building Commissioning (EBCx)

☐ Commercial Buildings	■ New	☐ Existing or	☐ EBCx	
Institutional Buildings:				
☐ Educational Facilities	☐ New	☐ Existing or	☐ EBCx	
☐ Other Institutional	☐ New	☐ Existing or	☐ EBCx	
☐ Health Care Facilities	☐ New	☐ Existing or	☐ EBCx	
☐ Industrial Facilities or Processes	☐ New	☐ Existing or	☐ EBCx	
☐ Public Assembly	☐ New	☐ Existing or	☐ EBCx	
☐ Residential (Single and Multi-Family)				

2. Name of building or project: McDonald's Global Flagship - Buena Vista

City/State: Buena Vista, FL

3. Project Description: New Net Zero McDonald's Quick Service Restaurant

Project Study/Design Period: 07/01/2020 (Begin date (mm/yyyy)) to 09/16/2021 (End date (mm/yyyy))

Percent Occupancy at time of submission: 100%

4. Entrant (ASHRAE member with significant role in project):

a. Name: Skelton (Last) Benjamin (First) A (Middle)

Membership Number: 05219191

Chapter: Illinois (049)

Region: Region VI

b. Address (including country): 815 S Wabash Ave

Chicago (City) IL (State) 60605 (Zip) USA (Country)

c. Telephone: (O) (312) 520-0025 d. Email: bskelton@cyclone.energy

e. Member's Role in Project: Engineer, Commissioning Agent, M&V

f. Member's Signature: Benjamin A Skelton

5. Engineer of Record: McDonald's, Cyclone Energy Group, WSP, CPH

By affixing my signature above, I certify that the information contained in this application is accurate to the best of my knowledge. In addition, I certify that I have discussed this entry with the owner and have received permission from the owner to submit this project to the ASHRAE Technology Awards Competition.

Project Overview

McDonald's designed and built what is believed to be the world's first net-zero energy quick service restaurants at the Walt Disney World campus outside of Orlando Florida. The new store replaces an existing store which was demolished. The all-electric design (no gas for cooking or heating) has a goal to be net-zero energy after twelve consecutive months in operation. Through 11 months of the initial zero-energy performance period, the store is less than 20,000 kWh from achieving the goal and is expected to easily be net-positive within the month.

Energy Efficiency

The original store used 1,079,114 kWh/yr and the new store was designed to be approximately 38% more energy efficient (666,000 kWh/yr) and generate 705,000 kWh through solar photovoltaics. A majority of the energy reduction was obtained using innovations in kitchen equipment control, which significantly reduced process loads (see Figure 1.) The store has 24-hour operations and three cooking lines are typically kept operational. Each line has an innovative stand-by mode of operation that significantly reduces the passive energy consumption and allows equipment to return to ready instantly to address consumer demand. Cooling is the second largest reduction using air-cooled heat recovery VRF units. Typically a store would use packaged rooftop equipment. Ventilation is provided to the dining room by a dedicated air system (DOAS) with demand control ventilation. A variable speed make-up air unit (MAU) with energy recovery provides ventilation to the kitchen and a demand controlled kitchen exhaust system adjusts the exhaust air based on actual cooking load. The restaurant features operable windows that are activated based on outdoor temperature, humidity, enthalpy and wind speed. When conditions are appropriate, the louvers actuate open and the ventilation and HVAC systems serving the dining area are shut down so the space becomes ventilated naturally. Indoor lighting is all-LED with daylight dimming zones, commissioned to minimum light levels. Outdoor lighting is on a daylight sensor and is all-LED as well. Parking lot LED lights are powered by photovoltaic panels on each light pole. The roof of the building has a 379 kW monocrystalline solar PV array. The outdoor dining areas is covered with a custom designed glass with amorphous silicone PV panels that can generate 51 kW.

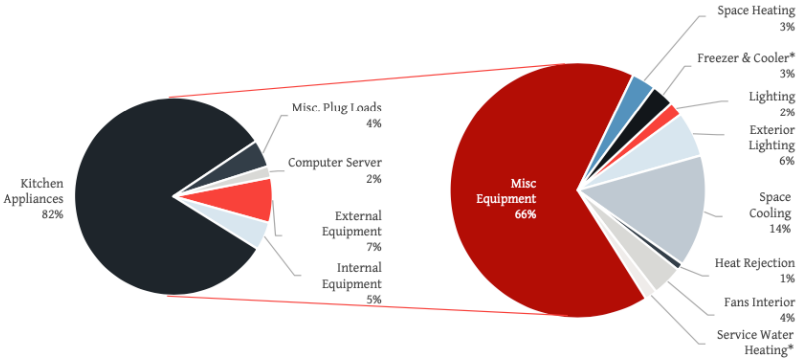


Figure 1 - Building Energy by End Use

Indoor Air Quality

The restaurant's HVAC design brings in outside air into both the dining and kitchen areas to provide replacement air for the toilet and cooking exhaust systems, as well as providing a slight overall positive building pressure. Within the restaurant the dining area is maintained slightly positive to the kitchen area so that air is transferred from the dining to the kitchen to ensure cooking odors and contaminants fully captured. Kitchen exhaust operates based on cooking demand and the dining room DOAS unit tracks CO_2 to maintain high-quality indoor air. All equipment has MERV-13 filtration.

The windows of the dining room are louvers that provide natural ventilation. The louvers line the full glass face of the dining area façade. When activated, the system shuts down the VRF system and small ventilation fans draw fresh air through the area. Despite the hot and humid weather in Orlando, the natural ventilation system operates nearly 65% of the year. The system provided a unique commissioning challenge as the window system actuates at the consumer level (Figure 2.) A specialized laser system that creates an invisible wall stops the actuators instantly when breached and an audible message is played explaining the safety feature. Further complicating the design, the local fire department required an additional override if the fire alarm is activated to ensure the windows all closed. A large lanai was created, covered by custom design solar glass and uses high volume low velocity (HVLS) fans that operate based on temperature and humidity conditions to maintain thermal comfort in the often tropical climate.

Figure 2 - Operable Windows

Innovation

Innovations unique to quick serve restaurants include: heat recovery VRF, covered outdoor dining with HVLS fans, dedicated outdoor air units with ERV, DCV kitchen exhaust, LED lighting with daylight dimming, parking lot lights off-the-grid, and a living wall covering the outdoor façade. Amorphous silicon PV panels are not as efficient as monocrystalline, but have outperformed predicted energy generation by nearly 200% thus far. Service water heating for kitchen and bathrooms is provide by an air-cooled heat pump water heater that rejects cool air, reducing HVAC loads in the stock room and kitchen. Freezers and coolers have new refrigeration control technology providing much higher efficiency. Permanent sub-metering on each breaker in the building serves as a monitoring-based commissioning tool, allowing for real-time control adjustments to be made based on actual energy performance data.

Cost Effectiveness

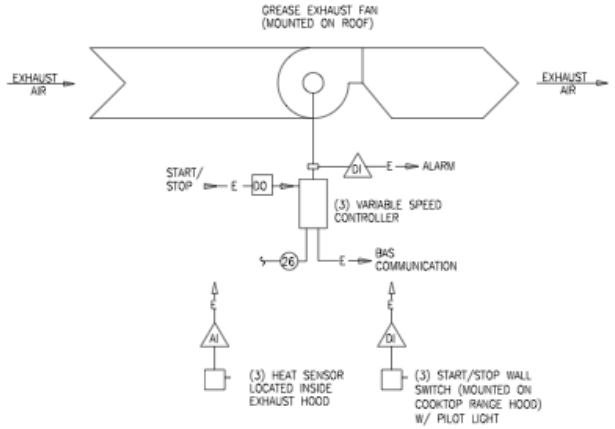
Flagship stores serve as an opportunity to evaluate emerging technologies that can be incorporated into prototypical designs. Demand-control kitchen exhaust, stand-by kitchen equipment, VRF and DOAS have proven value. The marketing of a zero-energy restaurant and the impact it will have on those who explore it is certainly the most cost effective strategy towards a reduced carbon future.

Operation and Maintenance

The store was largely commissioned virtually as substantial completion occurred at the start of COVID-19 travel restrictions in March of 2020. Using remote automation access as well as branch level metering systems, equipment was tested and systems were optimized based on real-time data. Given the uniqueness of systems and equipment, a customized systems manual was created and the store personnel was trained onsite by the Commissioning Authority.

Environmental Impact

In the 11-month zero-energy performance period, the store has consumed 694,750 kWh and generated 675,141 kWh resulting 19,609 kWh from being net-zero energy. Based on modeling, after September 2021 the store will be net-positive. As an all-electric building, it has a net-zero carbon energy impact. The living wall on the exterior and permeable pavers throughout the parking and drives also provide localized environmental benefits.



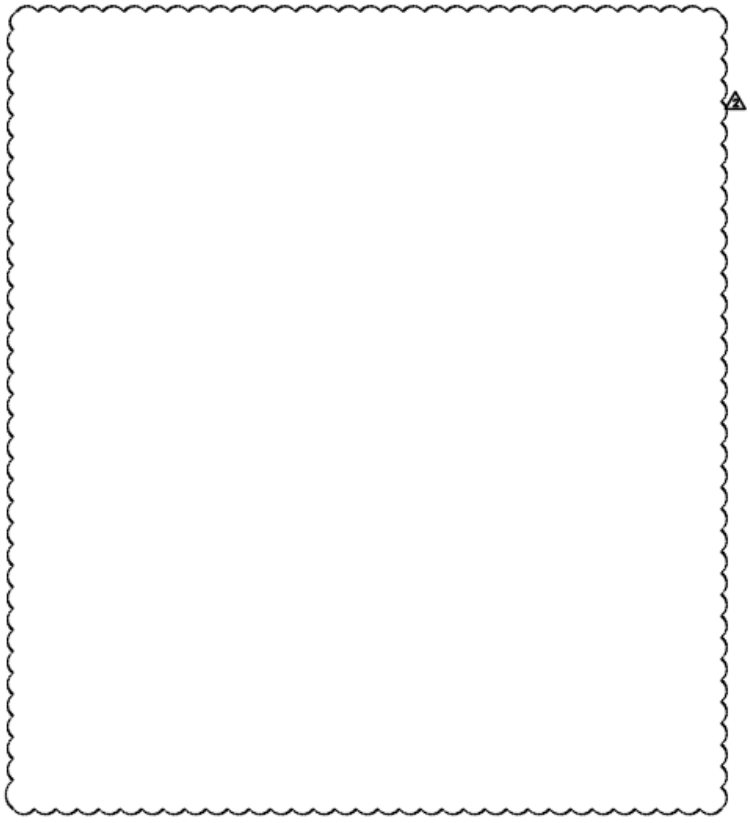
SEQUENCE OF OPERATION (TYPE I COOKING HOOD EXHAUST FANS)

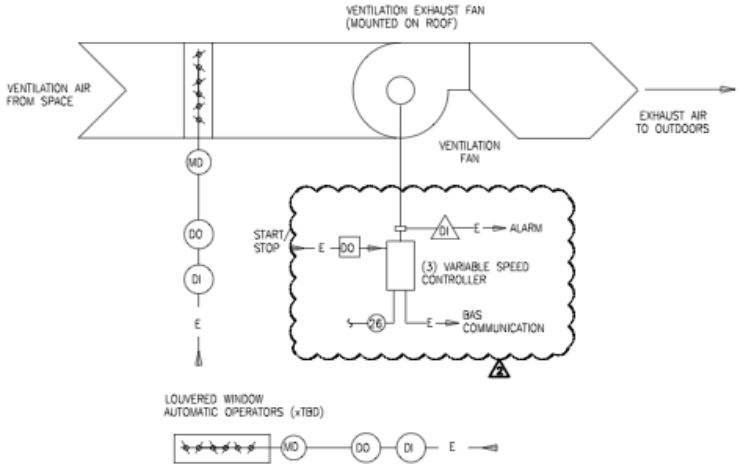
1. EACH HOOD EXHAUST FAN SHALL BE INITIATED BY EITHER A MANUAL WALL-MOUNTED SWITCH OR WHEN ANY COOKING EQUIPMENT UNDER THE ASSOCIATED HOOD IS ENERGIZED.
2. ONCE ENERGIZED THE FAN SPEED SHALL BE CONTROLLED BY A HEAT SENSOR MOUNTED IN OUTLET COLLAR OF EACH GREASE HOOD.
3. WHEN ALL COOKING EQUIPMENT UNDER THE ASSOCIATE HOOD IS DE-ENERGIZED AND WHEN THE HEAT SENSOR HAS REACHED IT'S LOWEST SETTING THE EXHAUST FAN SHALL DE-ENERGIZE.
4. COMBINED MINIMUM CFM ON ANY COMBINATION OF GREASE EXHAUST FANS SHALL EQUAL 1,600 CFM.

NOTES

1. THE EXHAUST FAN STARTER IS TO BE PROVIDED WITH A CURRENT SENSOR TO REPORT A GENERAL ALARM AT THE BAS WHEN THE FAN STATUS DOES NOT MATCH COMMAND.
2. REFER TO FIRE ALARM SEQUENCE OF OPERATION FOR ADDITIONAL INFORMATION.

3 HOOD EXHAUST SYSTEM CONTROL SCHEMATIC (KEF-1,-2,-3)





SEQUENCE OF OPERATION FOR ECONOMIZER VENTILATION FANS (VF-1, VF-2 AND VF-3)

1. WHEN OUTDOOR AIR / HUMIDITY LEVELS FALL INTO APPROPRIATE RANGE (SEE TABLE FOR CONDITIONS) FOR 7 MINUTES (ADJ) AND PRIOR TO ENERGIZING THE VENTILATION FANS, THE VRF INDOOR UNITS SERVING THE DINING AREA (IDU-01, -02, -03, -04) ARE TO SHUT OFF.
2. THEN THE AUTOMATIC WINDOW OPERATORS ON SOUTH- AND WEST-SIDE LOUVERED WINDOWS ARE TO OPEN.
3. ON PROVING ALL WINDOWS ARE OPEN, THE MOTORIZED DAMPER IN THE VENTILATION DUCTWORK OF EACH FAN WILL OPEN.
4. THE 100% OUTSIDE AIR UNIT DOAS-1 WILL BE DE-ENERGIZED.
5. ON PROVING THE MOTORIZED DAMPER IS OPEN, ENERGIZE THE FIRST OF THREE FANS, BASED ON EQUIPMENT RUNTIME. IF AFTER 5-MINUTES THE SPACE TEMPERATURE IS NOT MET ENERGIZED THE SECOND VENTILATION FAN AT MINIMUM SPEED, THEN IF CONDITIONS ARE ARE NOT MET AFTER AN ADDITIONAL 5-MINUTES ENERGIZE THE THIRD VENTILATION FAN AT MINIMUM SPEED.
6. IF AFTER ALL FANS ARE ENERGIZED AT MINIMUM SPEED AND SPACE CONDITIONS ARE STILL NOT MEET RAMP ALL THREE FANS TOGETHER TO MEET SPACE TEMPERATURE SETPOINT.
7. THE VENTILATION FANS SHALL OPERATE CONTINUOUSLY UNTIL ONE OF THE FOLLOWING OCCURS:
   A. OUTDOOR AIR CONDITIONS LEAVE SCHEDULED RANGE FOR 5 MINUTES (ADJ);
   B. INDOOR SPACE TEMPERATURES MOVE OUTSIDE OF +/-4 DEG (ADJ) OF OCCUPIED SETPOINTS FOR MORE THE 10-MINUTES (ADJ) OR
   C. OPERATIONS STAFF OVERRIDE THE NATURAL VENTILATION OPERATION.
8. SHUTDOWN SEQUENCE IS THE REVERSE OF THE STARTUP SEQUENCE (VENTILATION FANS DE-ENERGIZE, MOTORIZED DAMPERS CLOSE, THEN LOUVERED WINDOW AUTOMATIC OPERATORS TO CLOSE. ONCE WINDOW AND DAMPERS CLOSE, THE DOAS UNIT SHALL ENERGIZE AND THE INDOOR VRF UNITS SERVING DINING AREA ARE STAGED ON PER THEIR SEQUENCE OF OPERATION.
9. THE NATURAL VENTILATION SEQUENCE SHALL RUN FOR AT LEAST 5 MINUTES (ADJ) AT A TIME, AND BE LIMITED TO TWO START-STOP SEQUENCES WITHIN ANY GIVEN HOUR.

NOTES:

1. IF ANY OF AUTOMATIC WINDOW OPERATORS FAIL TO OPEN A GENERAL AN ALARM WILL BE SENT TO THE BAS OPERATOR STATION AND THE ASSOCIATED FANS WILL NOT ENERGIZE AND THE SYSTEM WILL REVERT TO OCCUPIED MODE.
2. IF A ANY OF THE MOTORIZED DAMPERS ASSOCIATED WITH THE VENTILATION FANS FAIL TO OPEN A GENERAL AN ALARM WILL BE SENT TO THE BAS OPERATOR STATION. THE REMAINING FANS WILL ENERGIZE AND OPERATE PER SEQUENCE.
3. IF A ANY OF THE VENTILATION FANS FAIL TO ENERGIZE A GENERAL AN ALARM WILL BE SENT TO THE BAS OPERATOR STATION. THE REMAINING FANS WILL ENERGIZE AND OPERATE PER SEQUENCE.
4. REFER TO FIRE ALARM SEQUENCE OF OPERATION FOR ADDITIONAL INFORMATION.

ECONOMIZER VENTILATION OUTDOOR AIR AND HUMIDITY LEVEL RANGES		
	LOW LIMIT	HIGH LIMIT
DRY BULB TEMP [DEG F]	45	72
ENTHALPY [BTU/LBda]	–	–
RELATIVE HUMIDITY [%]	–	60
WIND SPEED [MPH]	–	20
ALL SETPOINTS SHALL BE ADJUSTABLE		

1 ECONOMIZE VENTILATION FAN CONTROL SCHEMATIC (VF-1,-2,-3)