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: 222 S. Riverside Plaza - Mechanical Upgrades

City/State: Chicago, IL

3. Project Description: MEP Upgrades and Energy Efficiency Improvements

Project Study/Design Period: 02/2016 (Begin date (mm/yyyy)) to 09/2016 (End date (mm/yyyy))

Percent Occupancy at time of submission: 100%

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

a. Name: Fiona Martin and Michael Murphy
(Last / First / Middle)

Membership Number: 8138567 (Martin) and 5165026 (Murphy)

Chapter: Illinois

Region: VI

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Evanston (City) IL (State) 60201 (Zip) USA (Country)

c. Telephone: (O) 847-328-3555 d. Email: fmartin@grummanbutkus.com; mn

e. Member's Role in Project: Engineers

f. Member's Signature: Fiona Martin

Digitally signed by Fiona Martin
DN: cn=Fiona Martin, o, ou, email=fmartin@grummanbutkus.com, c=US
Date: 2016.09.30 15:16:35 -05'00'

5. Engineer of Record: Michael Murphy, P.E.

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.

222 South Riverside Plaza – Mechanical Upgrades

222 S. Riverside Plaza is a 34-story office building in downtown Chicago. The building sits atop the terminal for Chicago Union Station. Originally constructed in 1971, the building has approximately 1,224,500 square feet of conditioned space. The first floor consists of the main building entry and retail space. The second floor is mechanical space for equipment serving floors 3 through 19, also known as the "low-rise." (No floor is designated as the 13th floor.) The "high-rise" consists of floors 20 through 34, which is served by mechanical equipment on the 35th floor.

The building was purchased by Deutsche Bank A.G. in December 2014. Through the purchasing process, a number of MEP upgrade projects were identified. The submitting firm was retained to perform an energy study, create a full building energy model, design the recommended improvements, and commission the new systems. These changes have resulted in major reductions in both resource usage and costs.

The following describes the base building systems before the project commenced.

Air-handling units (AHUs) serving the floors were operated as constant volume from 6 a.m. to 6 p.m., shutting off at night unless the tenants requested "overtime hours." For both the high and low rise, four air handling units serve a core quadrant (e.g. AHU S-10 serves the northeast core quadrant for the high-rise). Two additional AHUs serve perimeter induction units (e.g. AHU S-7 served the north and east perimeters of the high-rise). The induction unit AHUs share a return fan with the associated core AHU. Return fans were equipped with variable frequency drives (VFDs) that varied speeds to maintain a building static pressure setpoint. The remaining core AHUs, which were not coupled with induction unit AHUs, had dedicated constant volume return fans that tracked the supply fan. The lobby and retail spaces were served by two variable air volume AHUs.

There are four duct take-offs on each floor, each serving a quadrant of the core areas of the building and each equipped with a hot water reheat coil. The reheat coils were controlled to maintain return air temperature when hot water was available.

The second floor also contains the **chilled water plant.** The plant consisted of four constant-speed, 900-ton electric centrifugal chillers. (Two control panels were identified as out of date and could not be integrated to the BAS.) The chilled water distribution was of constant volume primary configuration, with five dedicated chilled water pumps (one as standby) headered so that any pump could serve any chiller. The primary chilled water pumps served the AHUs on the second floor and 35th floor. Heat rejection was via the Chicago River. Condenser water was pumped into a track-level pump house east of the building and filtered through a strainer. Five pumps ranging from 125 hp to 350 hp were staged to correspond to the condenser water flow demand of the operating chillers. Heat exchangers and secondary pumps supplied hot or cold water for the induction units.

Facility **renovation and upgrade projects** included the following:

1. Install VFDs on all supply and exhaust/return fans and integrate to BAS.
2. Install air flow measuring stations for all AHUs and integrate to BAS.
3. Install variable air volume terminal units including air flow measuring for floor-by-floor quadrant control, converting the total air distribution system to VAV. Future floor renovations will include VAV terminal units.
4. Seal supply air risers up to and around new terminal units and downstream reheat coils.
5. Replace control panels and motor starters and add VFDs to two chillers to convert to variable speed.
6. Add VFDs to the five 200-hp primary chilled water pumps
7. Install modulating control valves and magnetic flow meters on evaporator side of each chiller.
8. Install modulating control valves and differential pressure sensors on condenser side of each chiller.
9. Replace motors and install VFDs on high-rise tenant condenser water system cooling tower fans.
10. Replace fill on high-rise tenant condenser water system cooling towers.
11. Replace four elevator machine room HVAC systems.
12. Replace four river water pumps and add VFDs to four new river water pumps and integrate to BAS.
13. Replace river water piping from water inlet to strainers.

In addition, the building made numerous improvements to its **control strategies**:

1. Implement a discharge air temperature reset controls strategy to all fan systems.
2. Implement a static pressure reset to all core fan systems to a minimum static pressure of 0.5-in. w.c.
3. Convert chilled water system to variable volume.
4. Implement a chilled water differential pressure setpoint reset strategy based on cooling coil valve position.
5. Complete conversion of existing Barber Colman BAS to new Niagara system.

6. Convert river water system to variable volume and optimize pump staging through enhanced controls.
7. Reduce over-pumping of river water system through flow-limiting devices and enhanced controls.
8. AHU control sequences were modified to optimize free cooling.
9. AHU sequences were modified to include a morning warm-up cycle to prevent excess humidity from entering the spaces.

Energy Efficiency

Since changes began to be implemented, the building's electricity use is down 12%. On a peak cooling day, the high-rise core AHUs operated at 85% speed and the low-rise core AHUs operated at 53% (compared with 100% speed and constant volume). Peak chiller operation has reduced from three chillers to two.

Not all of the savings have been achieved since a full year has not passed since implementation was completed. It is anticipated that the savings will reach 22% of total energy consumption. The following chart documents current performance, and additional tables and charts are attached that provide a detailed analysis of performance improvements.

Year	Annual Electricity Consumption (kWh/yr)	Energy Consumption (MMBtu/yr)	Energy Cost ($/year)	Cooling Degree Days
2014	12,171,592	41,542	$1,385,940	2,130
12 mo. ending 08/2016	10,651,681	36,354	$955,951	2,578
Total Annual Savings	**1,519,911**	**5,188**	**$136,792**	**--**

Indoor Air Quality

No system changers were made that would compromise the indoor air quality. Space temperature sensors were replaced to provide better temperature control, and CO_2 sensors were upgraded. The significant reductions in energy use improved the regional environment.

Innovation

The project was a collaborative effort that involved not only management and design engineers, but also significant input from the facilities staff and controls contractors. Weekly meetings were held as implementation progressed to stay on target and discuss any issues that arose and how to effectively resolve them while maintaining the integrity of the design and optimizing energy efficiency.

Operations & Maintenance

Operating and maintenance costs were reduced in several areas. Four elevator machine room HVAC units that were at their end of life were replaced with new, higher efficiency models. Adding VFDs on two of the chillers, the chilled water pumps, river water pumps, tenant condenser water pumps, cooling tower fans, and supply and exhaust/return fans result in increased operational efficiency. This upgrade will also prolong the life of the chillers, pumps, and fans.

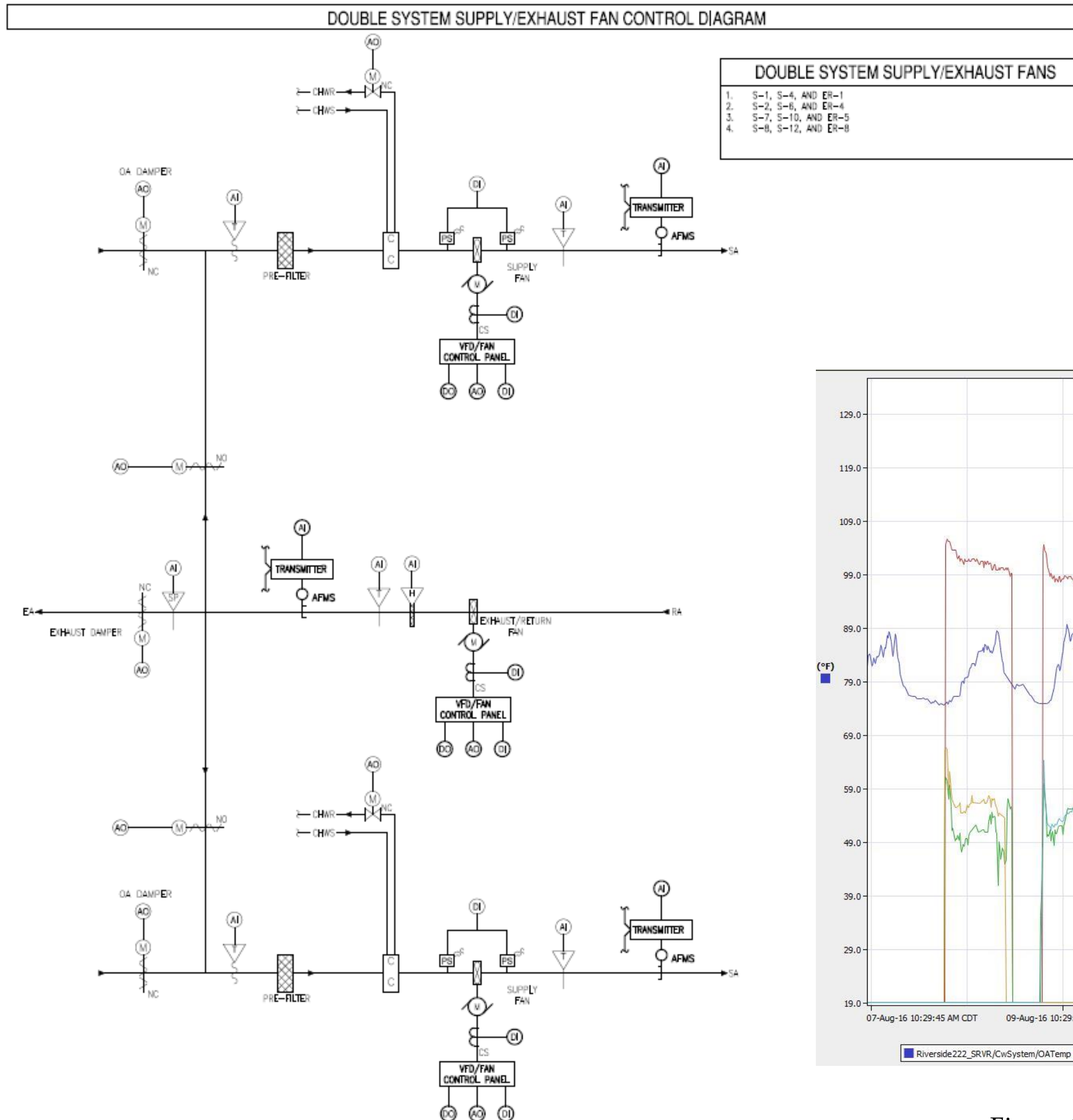
More equipment is now accessible via the building automation system, which also includes new alarms. An "override page" shows the building operators any setpoint changes or override commands that are preventing the BAS from operating in full automation per the design. Staff can assess, and quickly respond to, any system changes or issues detected.

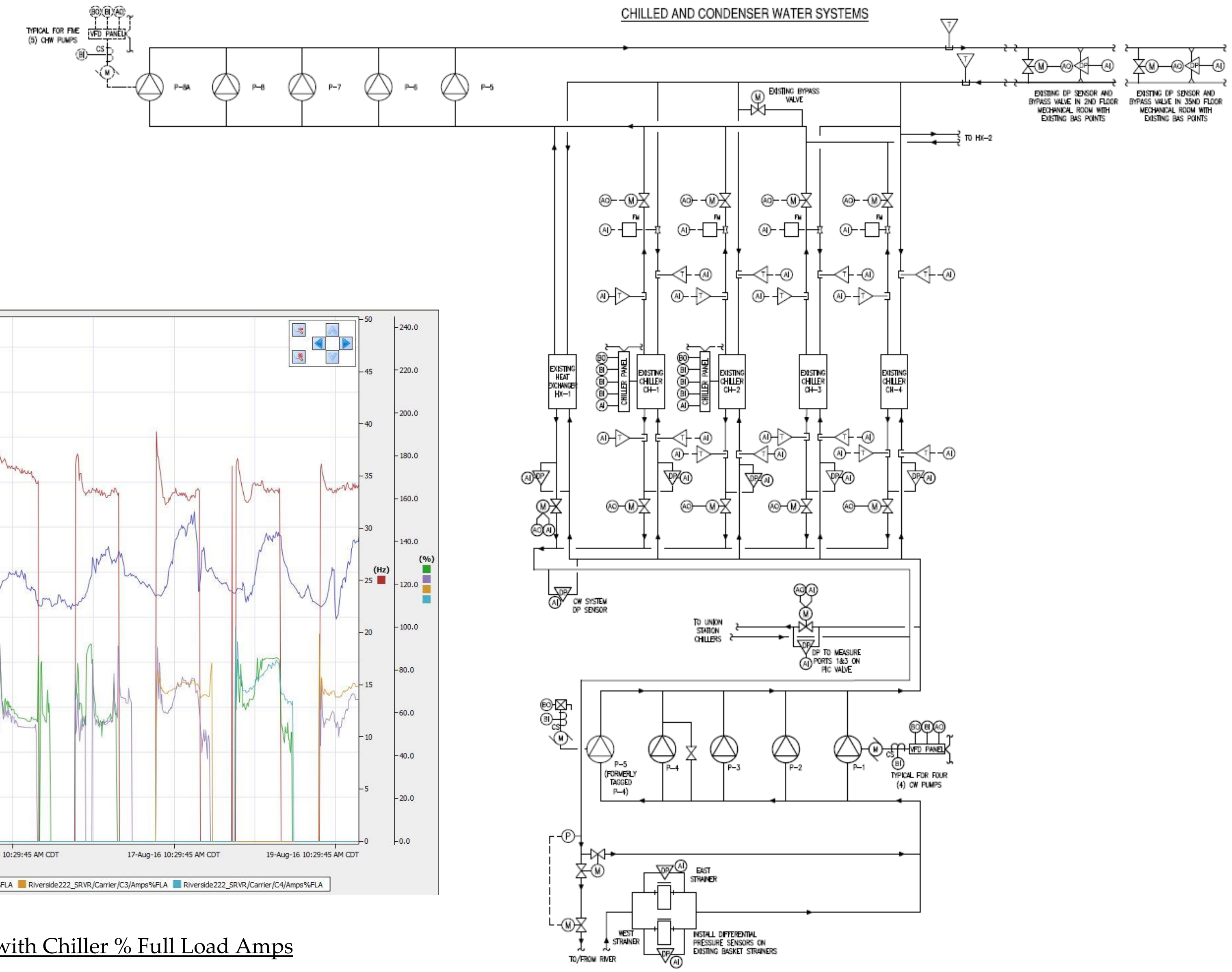
Cost Effectiveness

Projects were divided between operations and capital funds. Operations included upgrading equipment and replacing units that were at the end of their useful life. Capital projects included long- term energy savings measures, such as adding VFDs on the chillers. Through the building automation system upgrade, additional short-term energy saving measures were also implemented, such as discharge air temperature reset and static pressure reset.

Environmental Impact

The project's energy use reductions have obvious positive environmental effects. Fans operating at lower speeds result in reduced filter replacements and waste. Optimization of the discharge air temperature control results in less run time of the chillers and therefore less refrigerant use. Reduced chiller operation results in water-use reductions accompanied by reductions in condensate waste, sewer discharge, and related treatment.





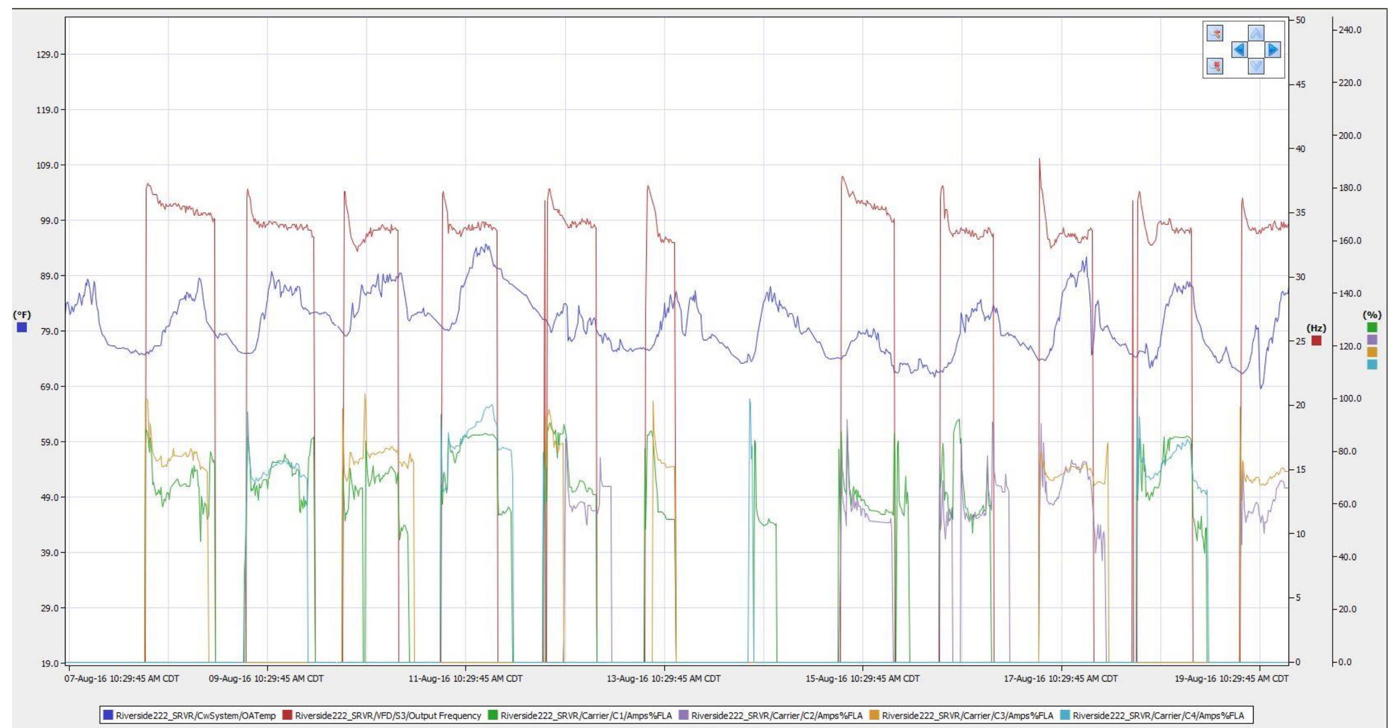


Figure 1: Supply Fan Speed (Hz) During Peak Cooling with Chiller % Full Load Amps

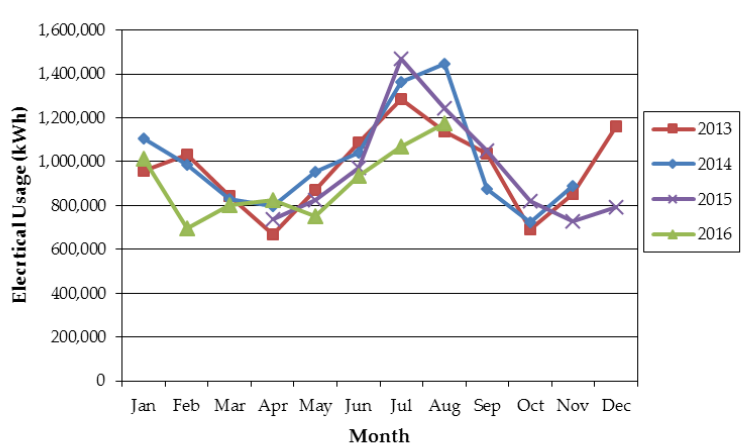


Figure 2: Annual Electricity Consumption

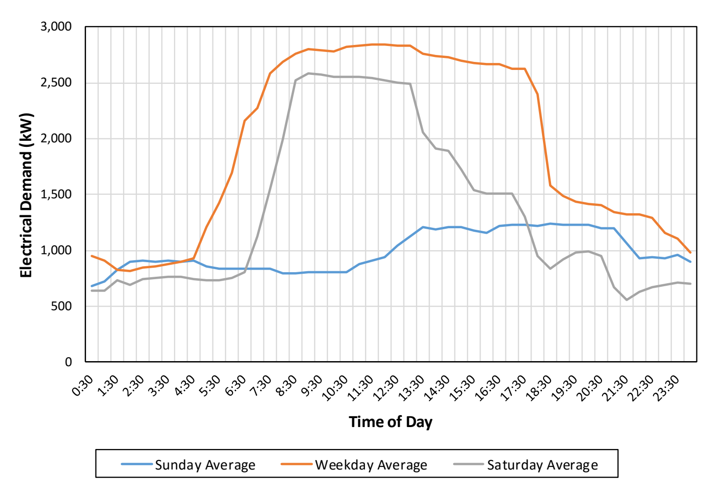


Figure 3: July 2013 Electrical Demand

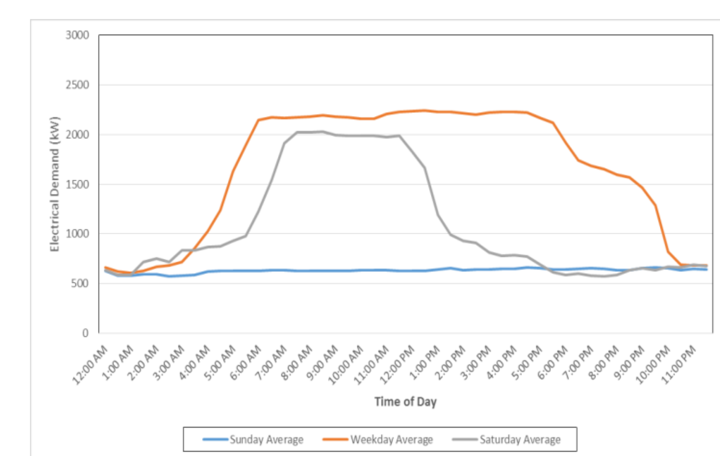


Figure 4: July 2016 Electrical Demand