Coefficient of Performance (COP) evaluation of electric water-cooled chiller during partial/full load operation at PUTRAJAYA plant 1

By

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<u>CERTIFICATION OF ORIGINALITY</u>

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the reference and acknowledgements, and the original work contained herein have not been undertaken or done by unspecified sources or persons.

LUQMAN HAKIM BIN MAZLAN

ABSTRACT

Air-conditioning and refrigeration system are the most energy consuming as the energy are needed to cool the system. COP stands for Coefficient of Performance and it is indicating the efficiency of heating and cooling machines. This study presents an evaluation of the COP of the water-cooled chiller, partial load and cool thermal storage. The objective of this paper is to evaluate the COP of water-cooled chiller at Putrajaya Plant 1. There are two types of chillers that are existed, it is air-cooled chiller and water-cooled chiller. The thermal storage can be used to reduce the amount of usage of the energy during peak hour as the demand for the cooling at the highest. The data (parameters that are related to chiller) are taken from the Putrajaya Plant 1 by minutes. Using COP model that was made by using Microsoft Excel, the data was taken out at every 1 hour and arranged by week starting from week 1, 2019 to week 8, 2019. The analysis can be made by tabulating the data and plotting. From the plotting, we can see the behavior of the COP throughout the week. This study provides the analysis and reasoning for the COP behavior to reduce the loses of energy in the chiller system.

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1. <u>INTRODUCTION</u>

What is a Chiller? Chiller is a device that uses a compression or absorption cooling system to remove heat from a liquid. The fluid may then be circulated to cool machines or other systems, such as air or process water, through the heat exchanger. To make the room cool, heat from the cooler interior (heat sources) must be transferred from the air conditioner into the warmer exterior. The concept is to shift heat to a cooler ambient temperature air in your kitchen (the heat sink) from the heat inside the cold ice box (the hot source).

Energy in the worldwide used are high used in this age. According to [1], the requirement of fossil fuel resources is rising, and energy conservation measures are becoming necessity. The most important thing is the performance of some device or process to ensure that power utilization minimize. According to [2], the consumption of energy is increasingly at rapid pace. Air conditioning is the main energy user. This is also highlighted by [3], the effect of the use of air conditioning on worldwide energy consumption in hot humid climate between countries has been reported by many writers. As reported earlier [3], Cooling and air conditioning of non-residential buildings in South East Asia island nation of Singapore are roughly one in five of the overall primary electricity consumptions. Quanwen et al. [4] reported that the demand for energy is growing quickly, but there are limited fossil fuel resources.

As reported [5], the energy consumed by the water-cooled electric chillers is estimated to surpass 60% of the energy consumed by central air conditioning systems. It was also mentioned that electricity uses in chiller plants typically accounted for 35%-40% of total buildings' electricity consumption in commercial buildings. Commercial building refrigeration equipment in the United States used about 77.4 GWh of primary energy in 2010 [6]. Chillers alone accounted for about 35 percent of commercial building cooling energy consumption. Reducing energy usage and increasing energy efficiency of chillers will be a good way to reduce both the central and the building's energy consumption.

1.1 Background of Study

The chiller is a cooling system that removes heat from a load and transmits it to the air. This thermal transfer unit is the perfect refrigerator for power stations and other large-scale installations. Heat as a form of energy transmitted by temperature difference. To a greater or lesser degree, heat occurs everywhere. It cannot be created or destroyed as a form of energy; thus, heat can be transferred to other forms of energy and vice versa. Retrieve and transfer excessive heat from an object, substance or space to another body, substance or space is a refrigeration or cooling system. Heat reduction lowers heat and can be achieved using ice, snow, frozen air and mechanical cooling.

Coolants are chemicals that, when pumped to a mechanical refrigerant process, alternately are compressed and condensed into a liquid and can become a vapor or gas. Based on the *figure 1.1*, we can see the refrigerant cycle flow chart. The refrigeration cycle's task is to extract and discharge unnecessary heat from one location to another. The coolant is used to dissipate the coolant into the environment if the system was not closed. As the refrigerant is closed, it will be recycled throughout the cycle and removed and unloaded from the refrigerant. The 'low side' evaporation or low pressure and the' high side' condensation or high pressure are the different pressure levels in the process. All pressures are split between two points: one is the coolant flow measurement device and the other the compressor with the steam being compressed.
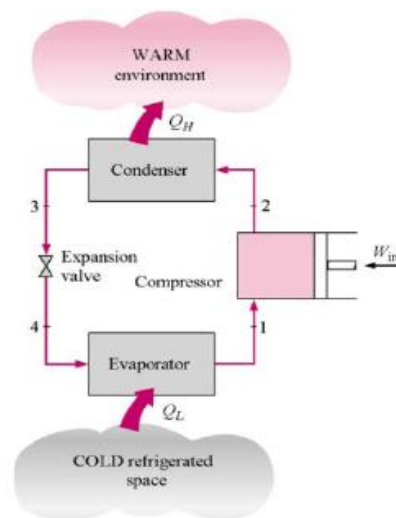
Figure 1.1: Refrigerant Cycle [7]
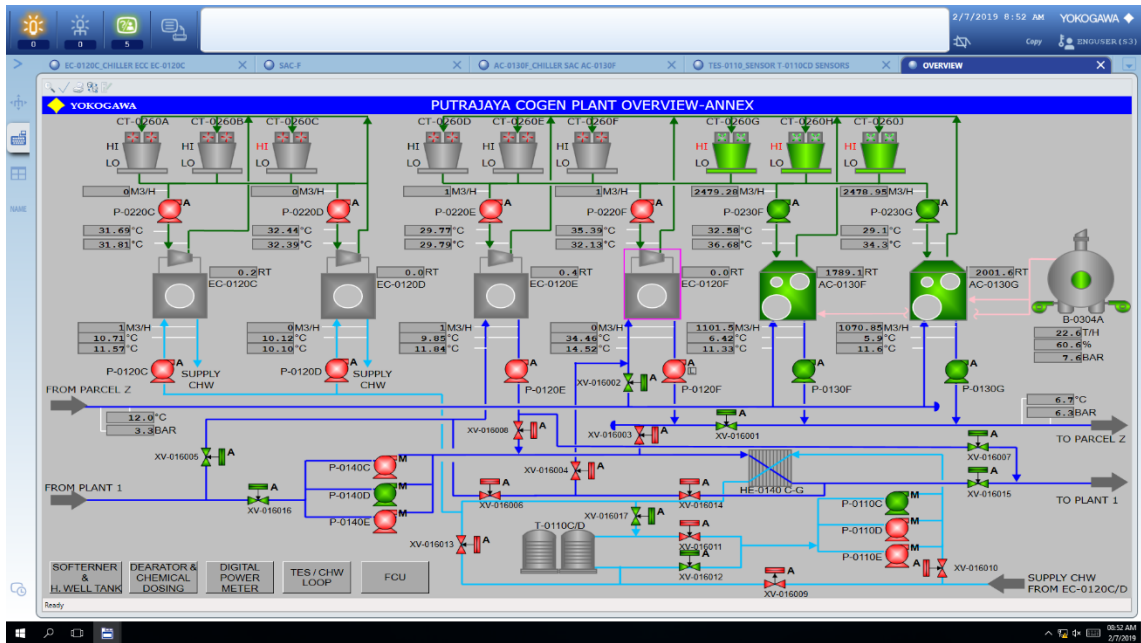
Figure 1.2: Schematic Diagram Putrajaya Plant 1
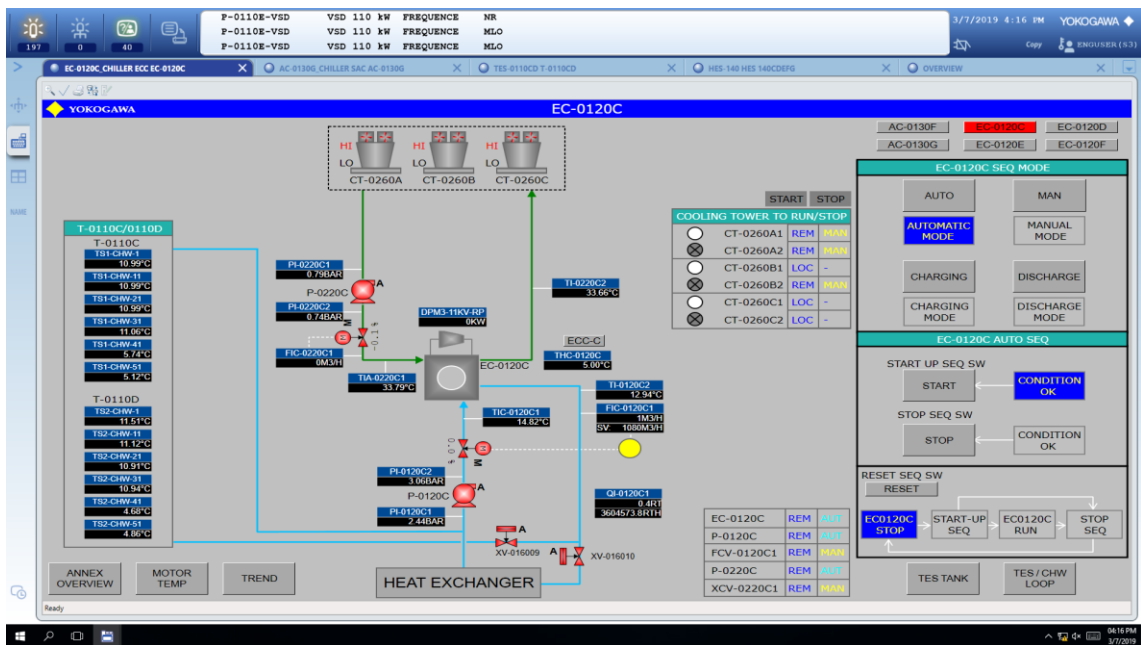
Figure 1.3: Schematic Diagram of Chiller EC-120C at Putrajaya Plant 1

Figure 1.2 shows the schematic diagram of the Putrajaya Plant 1. The Plant consists of 4 chillers. The plant consists of 9 cooling towers. Three cooling towers (CT-0260A, CT-0260B and CT-0260C) are connected to the pump (P-0220C) that connected to chiller (EC-0120C) and pump (P-0220D) that connected to the chiller (EC-0120D). The chiller (EC-120C and EC-0120D) supply the chill water. The other cooling towers (CT-0260D, CT-0260E, CT-0260F, CT-0260G, CT-0260H and CT-0260J) are connected to the pump (P-0220E, P0220F, P-0230F and P-0230G). These pumps are connected to the chillers (EC-0120E and EC-120F) and Air-conditioner (AC-0130F and AC-0130G).

The chiller (EC-120C and EC-120D) supply the chill water to the cool thermal storage. The function of this thermal storage is to store the cooling thermal at night (low ambient temperature) and use it during the daytime (high ambient temperature). The benefit of using the thermal storage is to increase the efficiency of the plant. As you can see in the *figure 1.3*, the schematic diagram shows the chiller are connected to the thermal storage tank. Each chiller (EC-120C and EC-120D) are connected to the six thermal storage tanks to increase the COP of the chiller.

1.2 Problem Statement

The energy consumption across the globe is on the increase. The air-conditioning and refrigerator or cooling system are the main consumers. These statements can be supported by [2], [3], [5] and [6]. They stated that, more than 55% of the energy are used in the air conditioning and cooling systems. 35%-40% of the energy drain of the building contributes by the chiller itself. Several researchers have been working to achieve optimal control of the plants to improve operational efficiency of the chiller plants. In order to utilize the system of the water-cooled chiller, we need to increase the machine performance. Based on the energy consuming, the analysis of the Coefficient of Performance (COP) of the electric water-cooled chiller are important to make sure that the efficiency and plant utilization always at the highest peak.

1.3 Objectives

The objectives of the research are:

1. To evaluate the COP of water-cooled electric chillers at Putrajaya Plant 1 during partial and full load operation.

1.4 Scope of Study

The scope of study of this project will focus on the water-cooled electric chiller. Temperature, pressures and mass flow rate of the entry and exit of the chiller are the parameters involved in this analysis. This study will analyze the behavior of the chiller by using the data and plotting. The duration of the data will be taken out for 8 weeks at the Putrajaya plant 1. Refrigerant cycle is the cycle are being used by the chiller. The location of this site has an average humidity of 93% and 33°C.

2. <u>LITERATURE REVIEW</u>

2.1 Types of Chillers

There are two kind of chiller that are famous across the globe, such as, air-cooled chiller and water-cooled chiller. However, the air-cooled chiller is quite low in efficiency. Ghassem et al. [2] It claimed that the air-cooled chiller's low output was due to Head Pressure Control (HPC). Nevertheless, air-cooled chiller tends to be necessary for use in the humid climate. As the cooling tower has a low efficiency, the water-cooled chiller cannot be used for hot and humid environments [2]. The quality of climate change unit, load control, the deflate aged wear heat exchanger, coolant leakage and oil reduction is influenced factor that affect the air-conditioning performance [8].

In countries with hot, humid and subtropical conditions, air-cooled chillers are generally considered to be energy-intensive devices. In [9], intensive energy users are air-cooled chillers, responsible for more than one-fourth of energy consumption to cool the buildings. The advantages of air-cooled chiller are lower installed cost rather than water cooled chiller. However, the water-cooled chiller has indoor chiller location and longer life. Based on the calculation of the water-cooled chiller operating conditions, [10] found that in most buildings, most of the chiller operates at low load levels and its low energy efficiency ratio has a serious impact on the building's energy consumption level.

While choosing between air-cooled and water-cooled chillers, operating costs are one of the primary factors. The costs of maintenance of air-cooled chillers are generally lower as they are not cooled by a cooling tower, condenser water pumps, or heat condenser chemical treatment. Nevertheless, operating expenditures generally favor water-cooled chillers. This is because water-cooled chillers will benefit from lower temperature condensation compared to air-cooled chillers. Even though the COP of air chillers is well known to be significantly lower than those of water-cooled chillers, they remain a popular choice because they are desirable in warm and arid regions with scarce water resources or in sub-tropical regions where water and cooling water are not available readily. [9]

Table 2.1: Refrigeration Cycle [7]

Process	Description
1-2	Isentropic Compression
2-3	Constant pressure heat rejection in the Condenser
3-4	Throttling in an Expansion valve (non-isentropic)
4-1	Constant pressure heat addition in the Evaporator

The **table 2.1** shows the description at each process in the refrigerant cycle. Process 1-2 is the isentropic compression. Process 2-3 and 4-1 is the constant pressure process and it added heat or reject heat through this process. As we can see on the **figure 2.1** and **table 2.2**, the expanding coolant evaporates (changes) through the evaporator, the heat is drained from the material or from the space in which the evaporation system is placed. Heat flows from the hotter material to the evaporator cooled by refrigerant evaporation inside the device, allowing the refrigerant to "boil" and evaporate, turning it into a vapor. At a much lower temperature the refrigerant boils a low-pressure steam compressor is powered by the pump into a high-temperature steam compressor. In order to discontinue the heat, it received in the evaporator, the compressor discharges it to the condenser. The vapor of the coolant is higher. Therefore, energy moves to colder air or water from hotter coolant vapor.

A change of state happens in this process when heat is drained from the vapor and the steam is returned to the liquid at high and high temperatures. The liquid refrigerant now flows to the metering device, through a small gap, where pressure and temperature decreases and then the evaporator or cooling coil is reached. As the coolant flows into the evaporator tube or belt, it vaporizes and is ready for a further cycle.
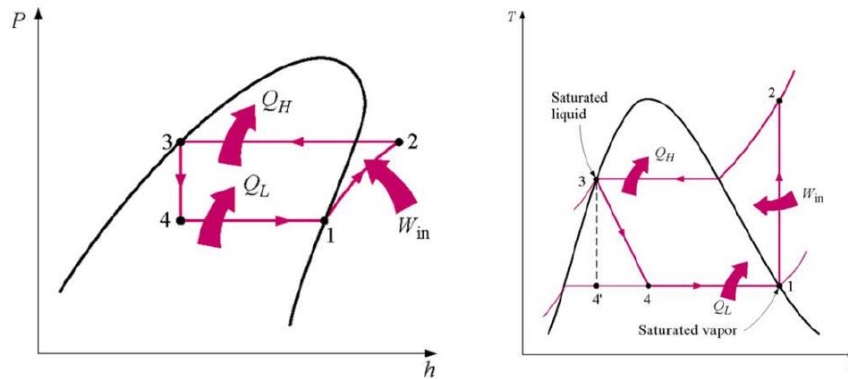
Figure 2.1: P-h diagram (left) and T-s diagram right of the ideal compression of vapor
[7]

Table 2.2: Summarize of Vapor-Compression Refrigeration Cycle [7]

Process 1-2	The W_{in} compressor begins with saturated vapor and compresses is entropically (P, T, and h significantly increase to a superheated condition).
Process 2-3	Rejects the heat Q_H (Enthalpy of evaporation) in a constantly high P condenser (h and s decrease; T decreases but is constant while the mixture is saturated.) No work is done.
Process 3-4	Throttling by means of the expansion valve at constant h (P and T decrease; this irreversible step increases) (alternatively, the use of a 4' isentropic turbine could lead to a COP_R improvement rather than 4)
Process 4-1	Heat Q_L in the evaporator is absorbed by the coolant at consistently low P and constant low T. The combination of water and vapor evaporates into a hot steam. The refrigerated space providing the Q_L is chilled. (h and s increase).

2.2 Air-Cooled Chiller- Subsection of the components

The heat from a fluid is absorbed by the chiller by a cooling process of steaming or absorption. Air cooled chillers can be used in different building areas in air-side systems as primary air fan coils, constant air volume systems, and varying air volume systems [9]. There are 5 main components of the air-cooled chiller and the description in the *table 2.3*.

In this unit, refrigeration cool process reject heat through the outdoor unit (condenser) to the environment. Outdoor unit have the coil evaporator to increase the rate of the heat rejection using cooling fin. Cooling fin increase the surface area between the machine and ambient air to increase the heat rejection rate. Outdoor unit consist of condenser fans to flow the air through the cooling fin as the heat rejection process.

Table 2.3: The Description of the main components [10]

The compressor	Typically screw, scroll or reciprocating. The coolant is left as a high pressure, high temperature, superheated vapor in the compressor and then enters the condenser.
The condenser	A bunch of horizontal tubes containing a hot refrigerant, these are surrounded in the vertical axis by a variety of thin sheets of metal. These help in spreading heat away from the tubes and into the air blown over the tubing and the thin metal plates.
Condenser Fans	Through the condenser coils, they stir air from the sides and then push it out into the environment from above the unit.
Expansion Valve	It extends the coolant before entering the evaporator.
Evaporator	This is where the chilled water is produced and the heat is removed, which will be sent to the condenser from the hot return "chilled water."

2.3 Water-Cooled: Subsection of the components

As already mentioned, water-cooled chillers are widely used due to their high performance. Chiller and cooling tower systems provide cooling power, but with significant electricity and water consumption, for commercial and industrial installations. [10]. It also has smaller size than air-cooled chillers and last longer. A humid air stream is used by the water-cooled chiller or cooling tower (air stream and spray water), while an air-cooled chiller uses an air stream. The cooling tower, condenser water pumps and water pumps, chillers and fans are the essential components of the water-cooled chiller.

The condenser will carry the indoor cooling load and the compressor energy to the compressed air. As we can see in the *figure 2.2*, the loop of the processes for the water-cooled chiller system. Pumps provide power to transfer the water between the condensers and the cooling towers. Heat is rejected to the ambient air, by heat transfer and evaporation, through the cooling tower. A typical HVAC system includes a water condenser and a chilled water circuit that integrated the chillers and indoor air loops to ensure a comfortable environment in the house, in *figure 2.3*. This system is fitted with a compact or air-conditioner [11].

Hot refrigerant is rejected through water medium that circulates on water-cooled condenser and then circulates back to the cooling tower for refrigerant process. Cooling power unit have a filler and a fan. The filler is used to increase the heat dissipation area and extending the heat exchange time between water and air. The function of the fan is to flow the cool air to cool water that flow through the filler as a heat rejection process.
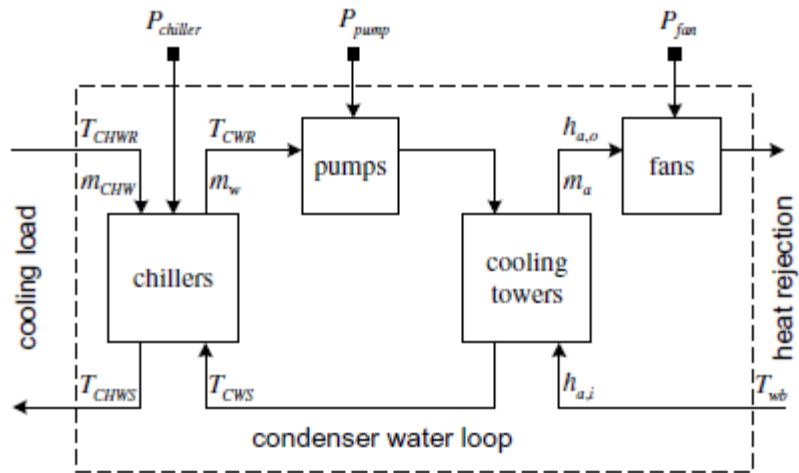
Figure 2.2: The block diagram of condenser water loop [11]
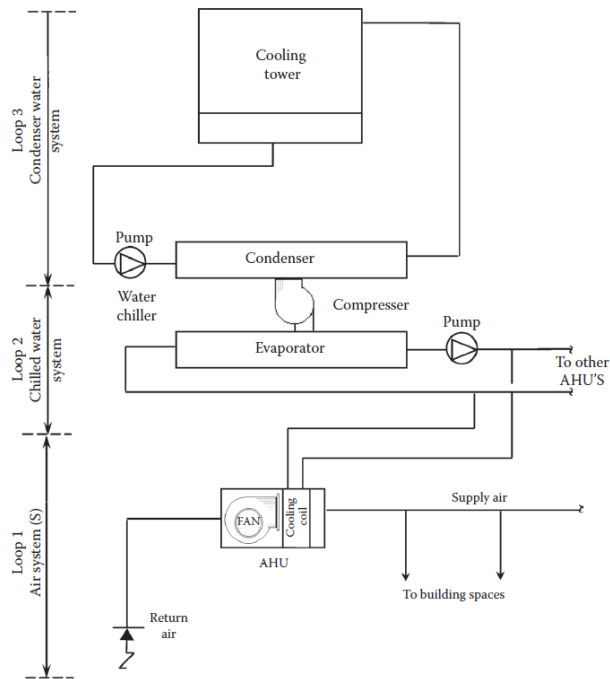
Figure 2.3: Water-Cooled HVAC system schematic [12]

2.4 Coefficient of Performance (COP)

According to [9], Typically, there are at least three chillers on the large-scale chiller network which can provide the same or different refrigeration power to central air conditioning. The Coefficient of Performance (COP) is theoretically defined as the evaporator cooling capacity ratio. The chillers rely on the heating medium, atmospheric conditions, compressor efficiency and chiller load, on their energy performance or COP [9]. The COP may be larger than unity, as opposed to the standard definitions of "efficiency". High values are good and therefore for a given amount of work a certain amount of heat was lost. COP usually is dependent on the operating conditions, including refrigerated storage temperatures and the warm space and type of refrigeration process [12]. *Figure 2.4* shows the example of the water-cooled chiller configuration system.
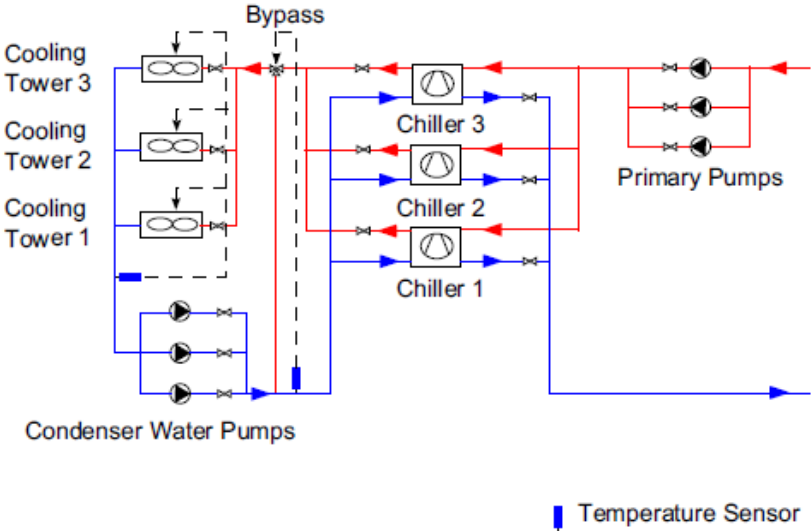
Figure 2.4: Example of the chiller plant system [6]
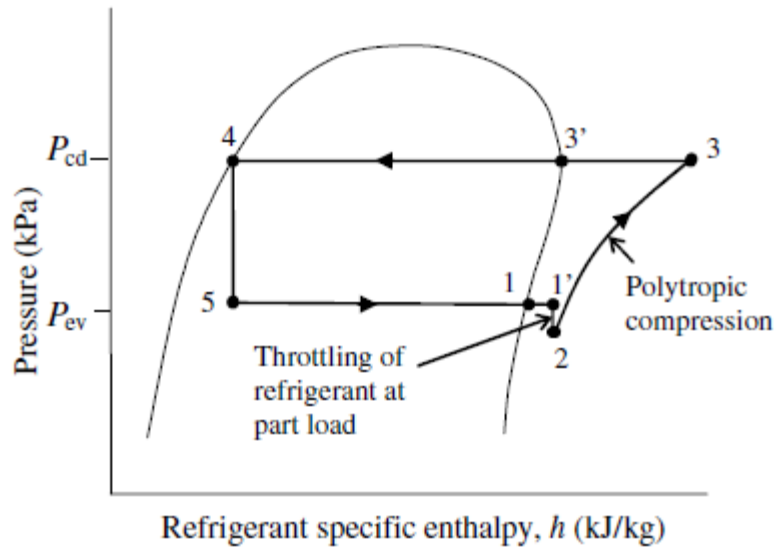
Figure 2.5: Vapor compression cycle of the chiller [10]

The performance of the household refrigerators has improved substantially in the last decades due to make motor and compressors more efficient, stronger insulation (Urethane foam expanded in place) and dyes, and wider spool surfaces. The *figure 2.5* above shown the refrigerant specific enthalpy versus the pressure throughout the refrigerant cycle. Thermal efficiency can never exceed 100 percent by common definitions. The performance of a refrigerator is expressed by [7]:

$$Coefficient\ of\ Performance, COP_R = \frac{Desired\ Output}{Required\ Input} \tag{1}$$

$$= \frac{Q_L}{W_{net,in}} = \frac{Q_L}{Q_H - Q_L} = \frac{1}{\frac{Q_H}{Q_L} - 1}$$

W_{in} : Compressor

$Q_{H,OUT}$: Condenser

$Q_{L,in}$: Evaporator

Throttle: Expansion

In *equation 1* above, we can calculate the COP of the cooling system. The performance coefficient for air-cooled chillers is between 2.40 and 3.06 and the coefficient for water-cooled chillers is 3.80 to 6.39 under standard load-full load conditions [13]. Many guidelines also suggest COP criteria for the running of integrated component loads or seasonal energy efficiency ratios. Chengcheng et al. [2] Noted that two key methods are available to obtain screw chiller COP. Second, by measuring the outcome or artificial intelligence model using the hypothetical physical formula, that predicts with the artificial intelligence model the value from past information. In [9], a two-stage reheat absorption chiller was designed with the Artificial Intelligence (AI) method. It is easier to express COP technological than coolant side data in terms of quickly measured waterside data. [2].

Due to low outside temperatures, Chillers in Dubai run at greater partial load ratios for about 4-5 months with a lower output coefficient (COP) [9]. The chiller works under partial load conditions based on cooling loads that vary in time and the consumption of power of the chiller has been significantly affected by the COP chiller (performance coefficient) under low part load conditions [14]. Lu et al., [11] have shown among many published researches results that due to partial loads, different fans of cooling towers can lower energy consumption.

To increase the efficiency of the chiller system, hence, increase the COP. We need to decrease the required input or reduce the work. The difference between indoor (heat) and outdoor (heat sink) room temperature represents the workload required for the building cooling system. The main components of chiller devices are compressors. The evaluation of the different types of compressors therefore is a possible design option. In order to reduce pump energy in chilled water, increasing variable flows of chilled water and condense water are used [10].

There are various kind of compressor that found by [15], stated the reciprocating compressors, screws, scrolls and rotary compressors provide positive displacement compressors, while compression is done by increasing compression chamber size. Transfer of kinetic energy is achieved by using the dynamic compression. The centrifugal compressor is the most common type of heat pump flexible with component-based sub

models designed to permit extensive inspection and comparison of various design configurations for certain boundary conditions [15].

As seen in [3], temperature gradients increase between subprocesses of the cooling system increase the work required by the cooling system. According to [16], Chillers, pumps and cooling towers are linked in parallel to common headers, in order to improve efficiency while increasing the need for standby components. If heat is efficient for refreshing low-temperature waste, it can significantly reduce energy consumption [4].

2.5 Partial Load Operation

What is partial load? The load quantity. The max capacity of a power source is provided. It is the full load operation. If the load is partial, the charge is less than the supply and delivery requirements. The single machine increases its operating power by adjusting the parallel host numbers under partial load conditions, which effectively improves system thermal efficiency [18]. If several coolers have different cooling capabilities, the function relationship to calculate the resistance to parallel chiller is as follows. [18]:

$$\Delta p = \Delta p \ (Z, L_o, D_i, v_o, n_o, G_o) \tag{2}$$

L_o: effective heat transfer tube length of evaporator

D_i: Inner diameter of the tube

Z: Form of frozen water stream

n_o: Number of pipes

v_o: flow rate of frozen water

ΔP: Total resistance of frozen water resistance through the evaporator

G_o: Flow of evaporator

In cooling and climate control, the enhancement of cooling systems performance, particularly in residential and commercial sectors, is an important issue. The most popular dynamical compressor in centrifugal chillers is centrifugal compressors, while the pressure increases over several speed measures. [19]. The dissipation of power in the compressors is only caused by fluid friction and turbulence as the moving components are less than other compressors. It results in higher efficiencies of centrifugal chillers and cools for various commercial and residential buildings. COP depends on chiller's cooling effect, loading, electricity consumption and outside air conditioning [19].
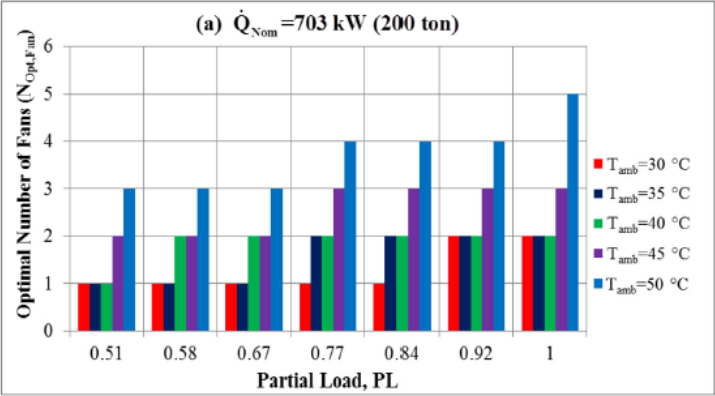
Figure 2.6: Optimal chiller capacity of capacitor fans with 703 kW cooling capacity [19]
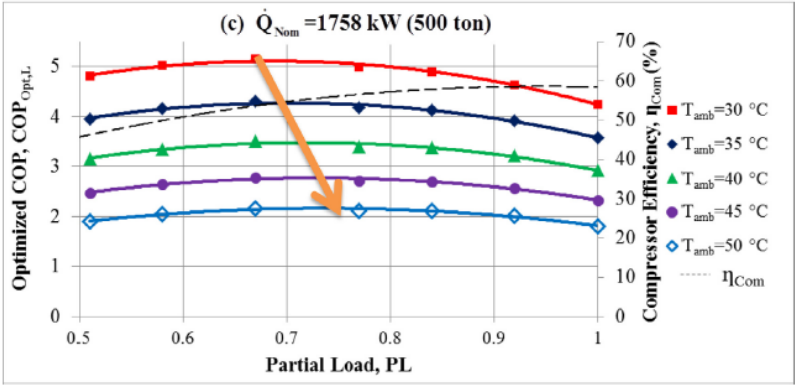
Figure 2.7: Optimized COP versus partial outdoor load for three chillers with a cooling capacity of 1758 kW at different ambient temperatures [19]

In the *figure 2.6*, when load increases, the optimal number of fans is increasing. The comparisons of optimized COPs and compressor efficiency with a partial charge in the chillers are shown in *figure 2.7*. The maximum value for the COP is decreased with a partial charge, which is proportional to the total COP, by increasing the chiller volume. Component loads for three sizes of chillers lead to peak COP ranges from 0.68 to 0.76.

2.6 Cooling Thermal Storage

Thermal energy storage has been used to reduce the use of chiller during the high hours in order to utilize the efficiency of the chiller system. In reference [17], During peak hours the additional chiller was switchover automatically to satisfy the increasing demand for refrigeration when the working chiller capacity was exceeded by 10 percent over more than 15 minutes. One of the chillers is witched off when the capacity of the unit fell by more than any chiller's rated capacity.

We can reduce the usage of the electricity usage in the peak hour by using the cool storage technology. Hasnain [1], reported that the most sophisticated and cost-efficient system in load management has been the resurgence of cool storage technology. As mentioned earlier [1], The cooling system can be operated during off-peak night-time hours at low cooling loads using cool ambient temperature. Instead of the compressor, cooling may be provided during the day and high peak by circulation of the coolant medium.

There are three main storage systems, such as Chilled Water Storage (CWS), Ice Storage and Eutectic Salt Storage [1]. Chen [14] has used a basic concept of a heat storage air conditioning system in the storage tank capsules which release, or absorb, large latent thermal heat during changes to the cycle of phase characteristics of the Phase Change Material (PCM). Example of Thermal Energy Storage (TES) from [1], This reported that heat or coolness was electrically generated for use during peak hours and storage for space refreshment in the summer during subsequent high hours. How does the conservation of cool thermal energy work?
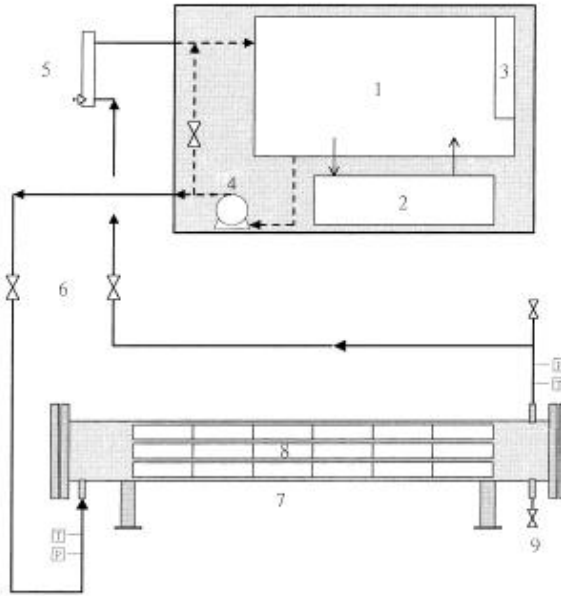
Figure 2.8: Schematic diagram of the thermal storage tank, a polyvinyl chloride (PVC) cylinder [17]
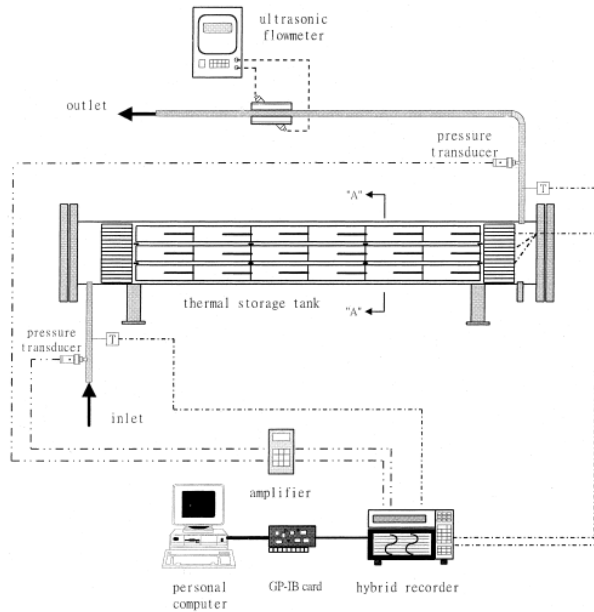
Figure 2.9: Schematic diagram of the thermal storage tank, a polyvinyl chloride (PVC) cylinder [17]

A chiller is refreshed with water containing 25% ethylene and propylene glycol during overnight, off-peak hours. *figure 2.8* and *2.9* above shows the example of the schematic diagram of the encapsulated thermal storage tank. The solution circulates within the tank and freezes 95 percent of the air within the heat exchanger. Ice is formed by counterflow heat exchanger in the tank uniformly. Ice forms but water keeps moving freely, preventing tank damage. The solution circulates through ice storage tanks during the daytime on peak hours, which supplies the stored energy to the building. In [1], full storage and load change strategy reduces building cooling costs through shift from low to off-time energy consumption. Different system part combinations are present to meet the demand for cooling and environmental conditions of a house [16].

There are two types of chiller with different COP. The COP of the chiller with water cooling is higher than that of the chiller with air. The main component common in both types of chiller is the compressor, expansion valve, condenser and evaporator. Due to the high temperature during the daytime, the work is needed to cool the fluid is high. We can reduce the cooling work by using the thermal storage. During the night, when the ambient heat is lower, the thermal storage works, thus reducing the work of cooling.

2.7 Summary

The refrigeration process consists of 4 simple processes: isentropic compression, constant pressure heat addition, throttling in expansion (non-isentropic) and constant pressure heat rejection. There are two types of chiller that are existed. The cooled water chiller uses a cooling tower and the cooled air chiller uses the air-cooled condenser. According to [9], the most energy users are air-cooled chillers, which account for more than one-fourth of building's energy consumption. The air-cooled chiller has a COP significantly lower than the water-cooled chiller but is still a good option as it can be cooled in hot and arid areas without readily available seal or cooling water with low water or sub-tropical areas [9]. Chiller and cooling systems for industrial and commercial systems are widely used for cooling energy, although they are used to consume significant electricity and water [10]. A bigger chiller system usually has at least 3 chillers that can supply cooling resources with the same or different power for a central air conditioner unit.

Usually efficiency is the crucial part in any type of systems but in the cooling system, many researchers using COP. COP is generally based on operating conditions like cooled space and rejectable warm space and the kind of refrigeration process used [12]. COP depends on the chiller cooling effect, loading, energy consumption and air conditioning outdoors [19]. The Coefficient of Performance (COP) for air-cooled chillers range from 2.40 to 3.06 and for water-cooled chillers, from 3.80 to 6.39 under normal rating conditions at full load operation [13]. Lastly, we can reduce the usage of the electricity usage in the peak hour by using the cool storage technology. Hasnain [1], reported that the newest advanced and most cost-effective load management system was the best storage technology.

3. **METHODOLOGY**

The flow of the methodology is shown in the figure 3.1. The project required to assess the Coefficient of Performance (COP) of the water-cooled electric chillers in which it focuses on data analysis. For this purpose, COP model developed to analysis the chiller behavior using Microsoft Excel. Why doing in Microsoft Excel? There are many parameters that needed to consider seeing the chiller behavior. So, Microsoft Excel are the easiest way to play with all these data. Literature review are used to gain some knowledge about the recent research and study. By doing the literature review, the important datum and parameters was found.

The procedure is started by the data are taken by minutes at the Putrajaya plant 1. The duration will be 8 weeks. Based on the *figure 1.2*, we will have 4 chillers in this plant. the data will be taken at the 4 chillers and the thermal storage tank. A sensor shall be mounted from the bottom up in the thermal storage tank. The chiller that are evaluated in this project was EC-120C. As we understand from the schematic diagram in the *figure 1.3*, the chiller is supplying the cool thermal to the thermal storage tank. Coefficient of Performance (COP) model is created using Microsoft Excel. The COP model are created based on the parameters such as chiller water suction pressure, chiller water discharge pressure, chiller temperature, chilled water flow, heat summation, power and COP. The parameter at the tank is the water temperature inside the tank. The parameter of the chillers is the power consumption, chiller pressure, chiller temperature and chiller water flow.

COP have been analyzed by plug in the data to the table including the heat summation and electricity (real power) for chiller ECC-120C. Next, the chiller temperature and the cooled water's mass flow rate plug in to the table as these data will be the reason how the COP will behave. Then, analysis of the COP by using the plotting COP versus time. Scatter graph was used to plot all this data. After that, the result was review by using the plot of the line graph and analyze how it should work in the working hour, holiday, weekend and weekday. Lastly, the data and the results was documented.

3.1 Flow Chart
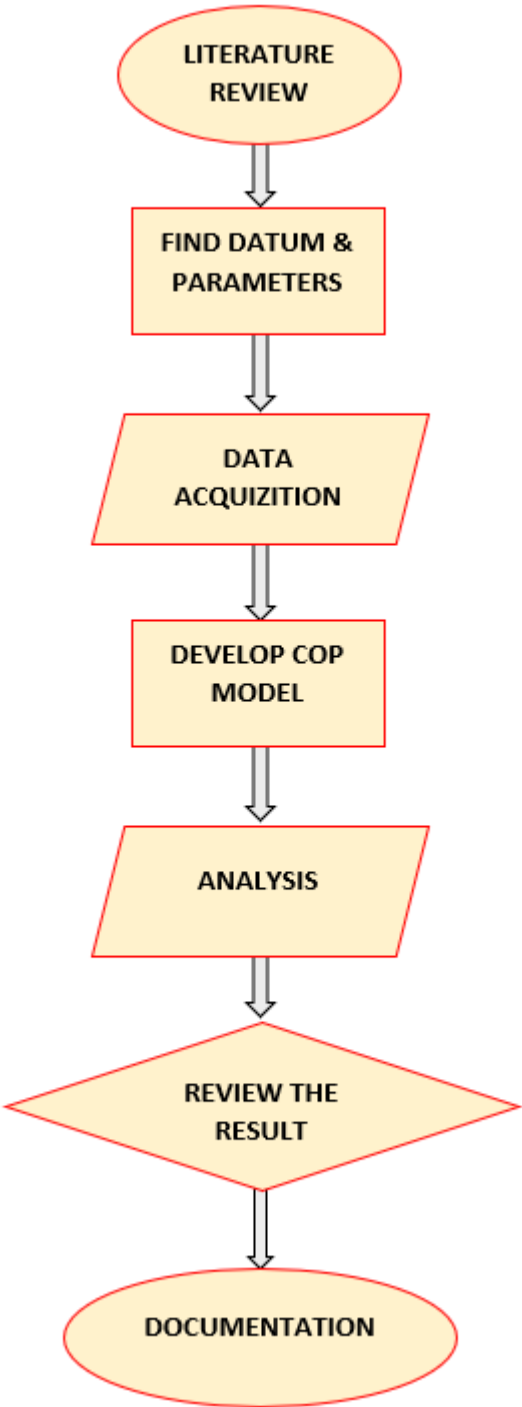
Figure 3.1: Methodology chart

3.2 Gantt Chart

Table 3.1: Gantt Chart

No	Tasks	Week													
		01	02	03	04	05	06	07	08	09	10	11	12	13	14
1	Collect Data from SV	▓	▓												
2	Project Discussion with SV	▓	▓	▓	▓	▓	▓	▓	▓	▓					
3	Checking Method and Results						▓	▓	▓						
4	Tabulate data							▓	▓	▓					
5	Progress assessment 1							▓							
6	Viva												▓		
7	Progress assessment 2														▓
8	Plotting Data and Analysis									▓	▓	▓	▓	▓	
9	Dissertation Submission														▓

4 RESULTS

4.1 Configuration of the Chiller at Putrajaya Plant 1

This project had analyzed the performance of the chiller (EC-120C) at Putrajaya Plant 1. The data are taken from chiller, thermal storage tank and power consumption. Based on the *figure 4.1 and 4.3*, these are the block diagram of the configuration at Putrajaya Plant 1 using Microsoft PowerPoint. The *figure 4.2* is the thermal storage tank schematic diagram.

Figure 4.1 shows the block diagram of the whole chiller plant. In the *figure 4.1*, there are 4 chillers and 3 cooling towers for each 2 chillers. The cooling tower are used to dispose heat from chiller. 2 chillers will be used to cool the thermal storage tank during the low load time. *Figure 4.3* shows, the block diagram of the one chiller (EC-120C) and be the reference to tabulate the data in the COP model. In the *figure 4.3*, there will be one pump between thermal storage tank and the chiller at the inlet of the chiller. A pump at the inlet of the chiller between the chiller and the cooling tower.

The data that are taken hourly at the Putrajaya Plant 1 starting from week 1 to week 8 of 2019. The data are used to evaluate the COP are, chiller pressure (before and after compressor), chiller temperature (in and out), chiller water flow and heat summation (in refrigeration ton, RT). RT is the refrigeration ton equal to 3.5 kW or 12000 BTU/h. Based on the *figure 4.2*, the temperature sensor is installed from top to bottom of the tank. The function of this thermal storage is to store the cooling capacity during low demands time (nights) and discharge it in peak hours to reduce the usage of the chiller during the high demand time.
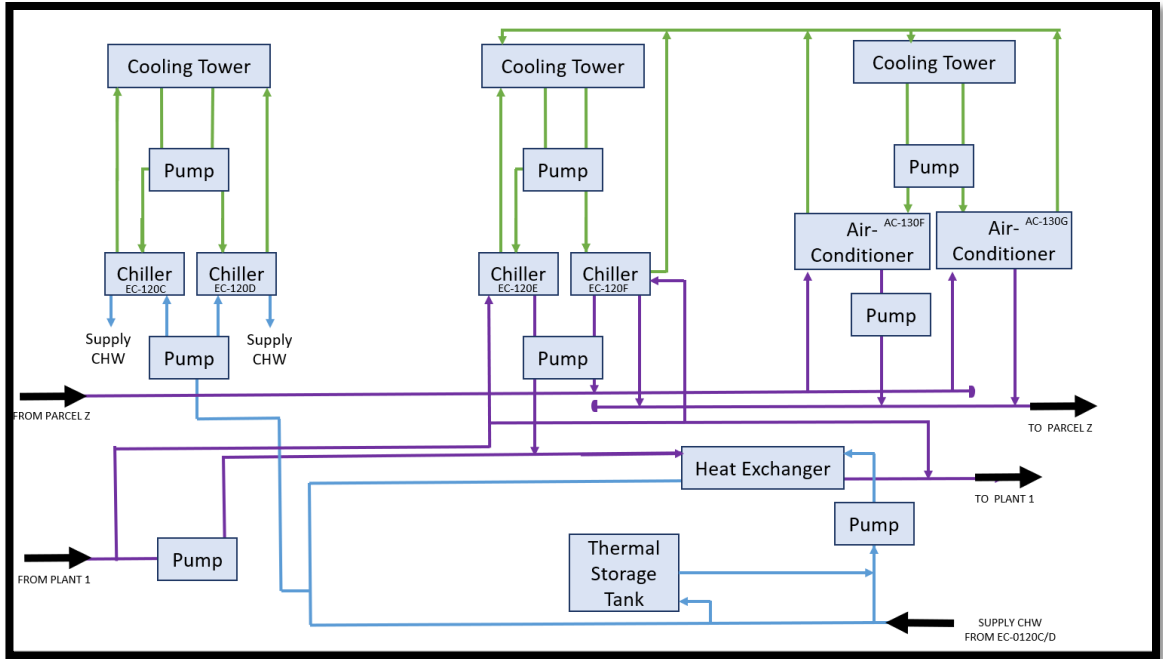
Figure 4.1: Configuration of the 4 chillers at Putrajaya Plant 1 using block diagram
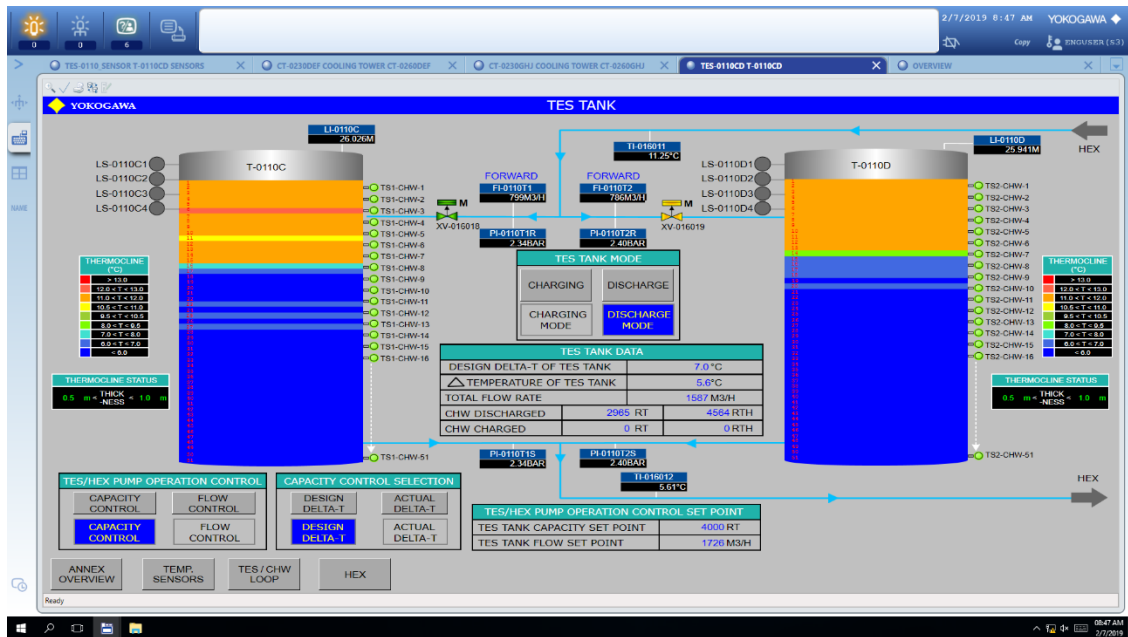
Figure 4.2: Thermal storage tank configuration with temperature sensor at Putrajaya Plant 1
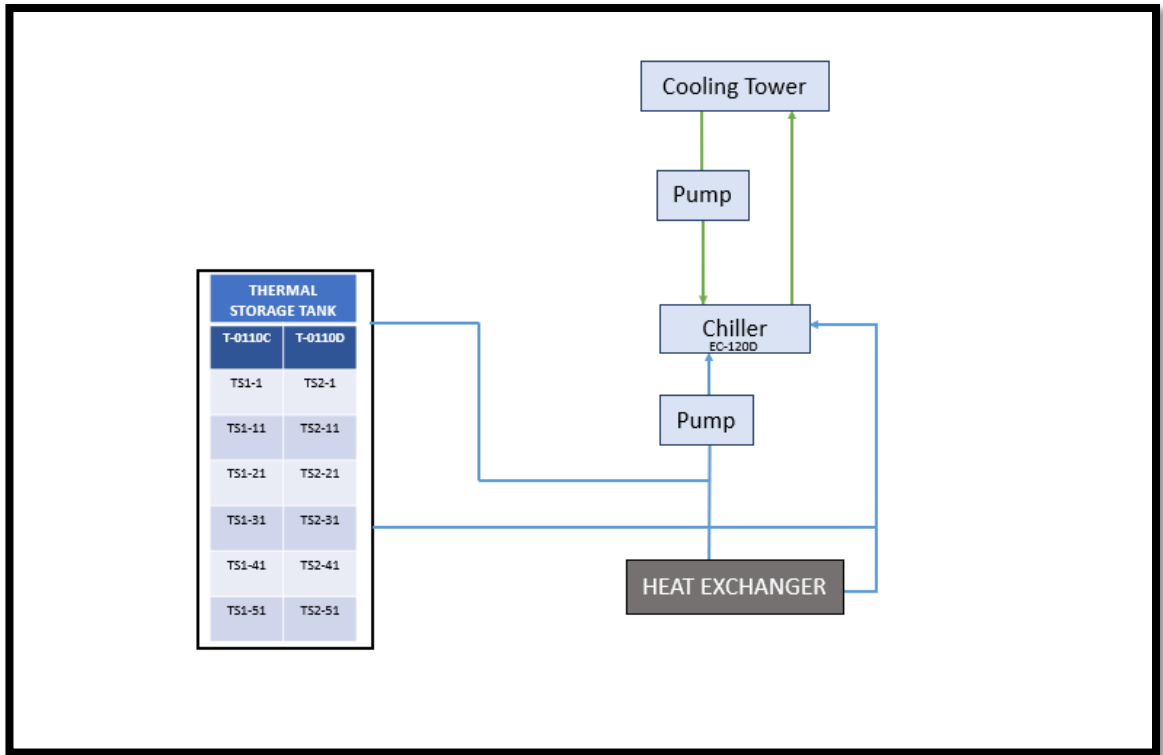
Figure 4.3: Configuration of 1 chiller (EC-120C) at Putrajaya Plant 1 using block diagram

4.2 Evaluation of the COP

4.2.1 Sample Calculation

Week 1, 1st April 2019 (Tuesday):

Table 4.1: Data for Sample Calculation

CHW SUCTION PRESSURE (BAR)	1.79	CHILL WATER FLOW (m³/h)	1200
CHW DISCHAGEPRESSURE (BAR)	3.80	HEAT SUMMATION (RT)	2332.9
CHR TEMPERATURE (°C)	10.74	MAX REAL POWER DEMAND (KW)	1510
CHS TEMPERATURE (°C)	4.86		

Change the heat summation from RT to KW= 2332.9 x 3.51685 = 8204.63 KW

$$COP = \frac{Desired\ Output}{Required\ Input} = \frac{8204.63}{1510} = 5.43$$

4.2.2 Week 1

On 1st January 2019 (Tuesday), the COP looks normal as it is in good performance. The COP are 0 during noon as the chiller not working as the cooling was taking from the thermal storage. The thermal storage will be load by cooling during night as the ambient temperature are lower at night. The chiller only working during the lowest ambient temperature. The COP behavior of the week 1 act normally (see *appendix A(a)* and *I(a)* for raw data of the 1st day on week 1)

On the second day, the COP gradually drop at 0600 from 5.4 to 4.6 at 0700 and drop to 0 for the rest of the day. The chiller works the same and normally on the next day until Friday (4th January 2019). On Saturday and Sunday, the chiller not operates as it is a weekend. There is no demand, so there is no supply.

4.2.3 Week 2

Proceed to the second week, the results are on the (*appendix B* and *J*). The COP behave the same with the week 1. On Monday (7th January 2019), COP constant at 0 until it operates on 2300. It continues to operate with COP of 5 and stop at 0800 on the next day. At 0900, the demand is increased as people are getting to work and open the air conditioning. The thermal storage tanks supply the cool thermal by using supply chill water. The chiller operates the same through the week except in weekend.

On Friday, the COP drop to 0 at 0800. Friday is the working day, but the thermal storage tanks have enough supply to satisfy the demand. The chiller stops for one day on Saturday (12th January 2019). On Sunday, the chiller started to operate at 2300 to reserve the cool thermal for the use on the first day of the week 3.

4.2.4 Week 3

Appendix K shows the COP during the third week. On Monday (14th January 2019), the COP operates normally and drop at 0800 on that day. On the next day, the chiller does not work. The chiller operates early on Wednesday (16th January 2019) at 2100. As we can see in the *appendix (d)*, the COP are ranging 4 to 6 throughout the day and drop to 0 at 21:00 and increase again. In that day, the chiller is working throughout the day, it supposed to work only during the low ambient temperature to reduce the energy consumption.

Based on the *appendix C(d)*, it shows that the chill water flow drops to 0.1-meter cube per second. It supposed to range between 1200 to 2500-meter cube per second. On Friday (18th January 2019), the chiller operates normally. The COP gradually drop at 0700 to 4.8 and at 0800 to 0. On weekend, the chiller does not operate throughout the day.

4.2.5   Week 4

On Monday (21st January 2019, the chillers not operate as it has no demand on that day because it is Thaipusam (Public holiday). The chiller supposed to operate on Monday at 2300 to reserve the thermal energy for tomorrow demand. *Appendix L(b), (c)* and *(e)* shows the bad COP trend. Based on the *appendix D (a),* on Monday morning, the chiller temperature increase and ranging between 16 to 18 degree Celsius. On Tuesday (22nd January 2019), the chiller operates at 3:00 and reduce the chiller temperature to 7.81 degree Celsius (see *appendix D(b)*). The chiller operates again at 11:00, it shows that the thermal storage did not have enough cooling capacity of the demand capacity. The trend of the COP was not good as the chiller need to operate during daytime and does not have reserve in the thermal storage tank.

On Wednesday (23rd January 2019), the chiller needs to operate at 0900 because the chiller did not operate during the night. The thermal storage did not reserve the cooling capacity during night. On the next day, the COP trends act normally and drop at 0700. On Friday (25th January 2019), the trends still scattered. Going up on 0800 and drop to 0 on 1200 and going up again until 2000 (see *appendix L(e)*). There was no operation of the chiller during the weekend.

4.2.6   Week 5

Appendix M (a) and *(b)* shows the COP trend up and down rapidly. We can assume the chiller and the thermal storage undergoing maintenance as the trend better than week 4. Based on the *appendix E*, the chiller temperature is ranging between 6 to 11 and it is a good data. The chiller suction pressure and the chiller discharge pressure also in good state. On Monday (28th January 2019) at 0900, the heat summation is 353 kw, then it is going up to 2400 kw.

The maintenance was going during the first and the second day on the week 5 (see *appendix E(a)* and *(b)*). On Wednesday (30th January 2019), the COP trends act normally throughout the week. The reservation of the thermal energy started on the Tuesday (29th January 2019) at 2100. The chiller was not operated throughout the weekend.

4.2.7   Week 6

On Monday (4th February 2019), the COP drop to 0 at 0700 and stays throughout the day (see ***appendix N(a)***). Tuesday and Wednesday are the Chinese New Year (public holiday). The COP stays 0 until Wednesday (6th February) at 2200. The chiller operates at Friday night and Saturday morning to reserve the cooling capacity when needed in demand. (see ***appendix F*** and ***N*** for raw data of week 6).

4.2.8   Week 7

On Monday (11th February 2019), there are demand throughout the day because during nighttime the chiller operates to supply the cooling capacity to thermal storage tank. The trend looks typical throughout the week. There was no demand during weekend as people are not working during the weekend. (see ***appendix G*** and ***O*** for raw data of the week 7).

4.2.9   Week 8

On Monday (18th February 2019), the COP drops at 0800 and going up early at 1800. Based on the ***appendix H(a)***, the data shows the chiller using the power but there are only 0.35 kW heat summation starting from 0800 until 1800. Because of the dropping of the chill water from 1074 m^3/h at 0700 to 1 m^3/h at 0800 and it stays until 1800. At 1900, the chill water flow going up to 1058 m^3/h. The trend is normalize again starting from Tuesday (19th January 2019) until Friday (22nd February 2019).

On Friday, the chiller operates at 2000 to reserve the cooling thermal energy to the thermal storage tank to be used on next week. During the weekend, there are no demands. So, the chiller does not operate as the thermal storage tank already reserve the full cooling capacity. (see ***appendix H*** and ***P*** for raw data of the week 8)

4.3 <u>Average COP by day and week</u>

Table 4.2: Average COP by week for 8 weeks

week 1	week 2	week 3	week 4	week 5	week 6	week 7	week 8
3.59	3.02	2.94	2.57	3.50	3.04	3.22	4.39
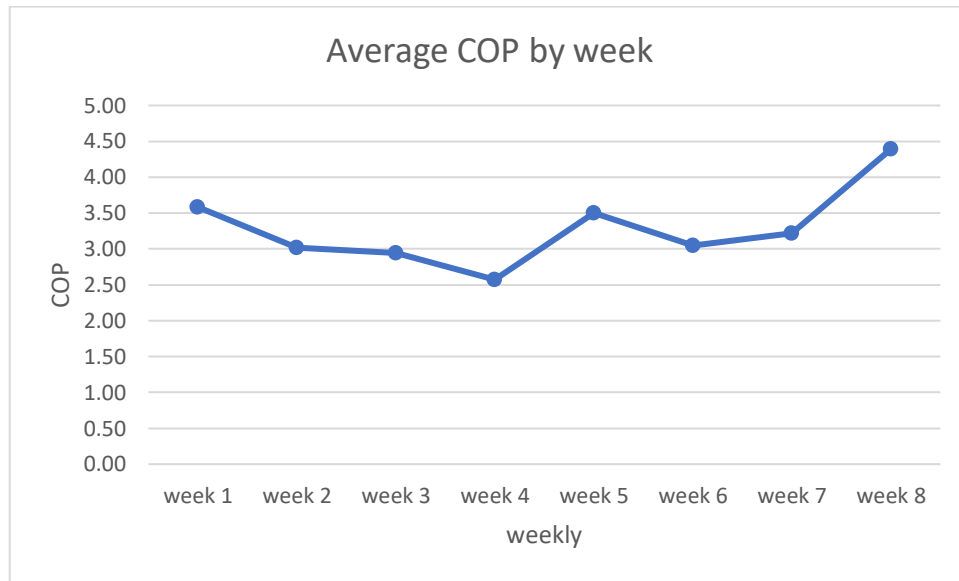
Figure 4.4: Average COP by week for 8 weeks

Table 4.1 shows the average COP by weeks in duration of 8 weeks. The average COP is 3.28. The *figure 4.4* shows the line graph of the COP average. **Appendix Q** and **R** shows the average COP by day. The average COP is quite low. It happens because the chiller not working the weekend. Most of the data shows the average COP is 0 during the weekend.

4.4 Partial Load and Full Load

Table 4.3: Max, Min and Average of the Important Parameters

COP (MIN)	COP (MAX)	COP (Average)	Heat Summation (Average)	Max Real Power (Average)	Power (Average)	kW/Ton (Average)	kW/Ton (Max)
0	9.35	5.23	579.01 RT	1330.44 kW	376.38 kW	40.86	12.14

Based on the *table 4.1* above, the minimum value of COP is 0 because the chiller is not operating. The maximum value of COP is 9.35, that means it has the highest efficiency throughout this project. The average of heat summation is 579.01 RT equal to 2036.3 kW. Heat summation is the amount of heat removed by chiller system. The max power of the chiller is 1330.4 kW and the average power is 375.38 kW.

kW/Ton is the ratio of energy consumption in kW to the rate of removal in tons at rated condition. The average of it is 40.86 and the maximum is 12.14. The lower the number of kW/Ton the more efficient the chiller. The chiller is working in the load of 60-70% because the average COP 5.23. The chiller only reaches full load for about 1-2%. Full load operation has the highest efficiency, but it is impossible to operate in full load operation for a long time.

4.5 <u>Summary</u>

The study on the chiller has bring us to a conclusion that chiller is not about the cooling, but it does involve in the refrigerant cycle. For the project, it needs to evaluate the COP of the water-cooled electric chiller through the data that have been taken at the Putrajaya Plant 1. The graph indicates the trend for each of the parameter. The table and the graph are in the *appendix*. As you can see in the *appendix J, K, L, M, N, O* and *P*, the chiller is working during the low ambient temperature to reduce the energy used during the cooling. Most of the behavior of the COP during the weekdays are same throughout the project the week.

The chiller is not working during the weekend and public holiday as there are no demand for the cooling. Week 6, 7 and 8 shows the good trend of COP. The chiller operates during the night to provide cooling capacity to the thermal storage. At night, the ambient temperature was lower than during the day. During the weekend, the chiller not operate as the thermal storage already full in capacity during the Friday night and can be used on Monday next week. In order to increase the efficiency of the chiller process, the chiller COP is required in its best performance. The difference between the temperature inside (heat resource) and outside (heat sink) is representative of the work the cooling system needed.

The chiller is not operating in the best efficiency as the operation are not fully load. Optimal control, with a variable water condenser flow, will reduce the annual power consumption by 5.3% and the running costs by 4.9 percent, with constant speed fans and pumps with a fixed setpoint compared to the comparable system [10]. The variable speed can increase efficiency because we can change speed of the fan based on the best requirement. Finally, the Coefficient of Performance evaluation using COP model is achievable.

5 DISCUSSION

Coefficient of Performance of the chiller is the ratio of the cooling capacity and work required. Efficiency of the refrigeration cycle are the most important as the energy consumption is high. Due to the increasing demand of the cooling, the chiller needs to operate in high COP to reserve the power to the other usage. Return chilled water temperature can vary depending upon the cooling load in the building [9]. The chiller is not operated at full load operation, so the efficiency of the chiller is lower. Several chillers are running at a low rate under partial load state [14].

The thermal storage was used to reduce the energy consumption of the chiller. The function of the thermal energy storage is to stock thermal energy by cooling and can be used in later time. In this plant, the thermal energy storage was used to save the thermal energy during the night and circulate it during noon. At night, the power was used by the chiller are lower than during the day as the ambient temperature are lower during night.

Sometimes, the COP does not behave as the plan because the plant needs to fulfill the demand. If the demand is higher than the thermal energy stored in the thermal energy storage, the chiller needs to operate to fulfill the demand. Proposed comprised of a conventional water-cooled screw chiller and a specific throttle mechanism can reduce the exegetic loss of the evaporator [14]. Maintenance often happen during office hour. As the maintenance are ongoing, the demand cannot be fulfilled. So, the backup chiller come in handy during this time.

The results in this paper shows that the efficiency of the chiller is influence by the load, ambient temperature and water flow. Based on [9], the cooling output increases as the ambient temperature increases. Thus, reducing the efficiency of the chiller. These finding indicates that the data from the chiller can be used to improve the operation and utilize the power consumption. The trend of the COP from the chiller can be used to review the chiller operation and reduce the time to find the error during failure or shutdown.

6   <u>CONCLUSION</u>

The objective of this study is to determine the to evaluate the COP of water-cooled chillers at Putrajaya Plant 1 during partial and full load operation in duration of 8 weeks. The methods are started with the literature review and remarks all the important parameters. The literature review function as the tool to study and research paper that related to it. The configuration of the chillers is taken from the Putrajaya Plant. Schematic diagram and block diagram were drawing by using Microsoft PowerPoint. The data was taken from Putrajaya Plant 1 starting from week 1 of 2019 until week 8 of 2019.

The COP model are created in the excel with the important parameter. The analysis was made based on the COP trend on the line graph. A high COP value represents a high efficiency [14]. COP value of 4 means a refrigeration system a COP of 4 indicates that 1 kW of electricity is needed for an evaporator to extract 4 kW of heat. Based on the results, the chiller is mostly running on partial load rather than full load operation. The full load operation only running about 0.74% throughout the duration. The chiller mostly operates at 60-70% of the load. Thermal storage is helping a lot during the operation. Without the thermal storage, the efficiency would drop more.

The COP of water-cooled chiller ranging between 4 to 6. If the COP is 0, that means the chiller did not operate during that time. Based on the result, we can see that the chiller operates mostly during night as the ambient temperature is lower than daytime. An increase is seen in COP as the ambient temperature increases, even though the cooling output varies irregularly [9]. The chiller did not operate during weekend and noon. During noon, the chiller stops operate, however, the thermal storage circulates the cool thermal energy that had been collected during nighttime (see *appendix* for raw data of the operation). Thus, this model can show the trend to manage and collect information regarding the chiller operation.

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APPENDIX

APPENDIX A

DATA TABLE OF WEEK 1, 2019 (IN HOUR)

		PI-0120C1.PV	PI-0120C2.PV	TIC-0120C1.PV	TI-0120C2.PV	FIC-0120C1.PV	QI-0120C1.PV	QI-0120C1.PV	DPM3-11KV-MRPD.PV	
		CHW SUCTION PRESSURE	CHW DISCHAGEPRESS	EC-0120C CHR TEMP.	EC-0120C CHS TEMP	CHILL WATER FLOW	HEAT SUMMATION	HEAT SUMMATION	MAX REAL POWER DEMA	COP
		BAR	BAR	°C	°C	M3/H	RT	KW	KW	KW/KW
WEEK 1										
01-01-19	00:00:00	1.79	3.8	10.74	4.86	1200	2332.9	8204.46	1510	5.43
01-01-19	01:00:00	1.79	3.79	10.73	4.84	1196	2328.4	8188.63	1510	5.42
01-01-19	02:00:00	1.79	3.8	10.73	4.84	1192	2322.1	8166.48	1510	5.41
01-01-19	03:00:00	1.79	3.8	10.72	4.83	1192	2324.1	8173.51	1513	5.40
01-01-19	04:00:00	1.79	3.8	10.72	4.84	1193	2316.4	8146.43	1513	5.38
01-01-19	05:00:00	1.79	3.79	10.7	4.84	1193	2311.3	8128.50	1513	5.37
01-01-19	06:00:00	1.79	3.8	10.67	4.84	1198	2307.7	8115.83	1513	5.36
01-01-19	07:00:00	1.79	3.79	10.53	4.84	1205	2269.8	7982.55	1513	5.28
01-01-19	08:00:00	2.23	2.35	8.97	9.01	1	0	0.00	1513	0.00
01-01-19	09:00:00	2.23	2.35	9.18	8.67	1	0.1	0.35	1513	0.00
01-01-19	10:00:00	2.23	2.35	9.34	8.9	1	0.1	0.35	1513	0.00
01-01-19	11:00:00	2.23	2.35	9.45	9.2	1	0	0.00	1513	0.00
01-01-19	12:00:00	2.23	2.35	9.56	9.26	1	0.1	0.35	1513	0.00
01-01-19	13:00:00	2.23	2.35	9.67	9.63	1	0	0.00	1513	0.00
01-01-19	14:00:00	2.39	2.5	9.79	9.75	1	0	0.00	1513	0.00
01-01-19	15:00:00	2.39	2.5	9.9	9.75	1	0	0.00	1513	0.00
01-01-19	16:00:00	2.39	2.5	10.01	9.72	1	0.1	0.35	1513	0.00
01-01-19	17:00:00	2.39	2.51	10.12	9.98	1	0	0.00	1513	0.00
01-01-19	18:00:00	2.38	2.5	10.24	10.26	1	0	0.00	1513	0.00
01-01-19	19:00:00	2.39	2.5	10.32	10.22	1	0	0.00	1513	0.00
01-01-19	20:00:00	2.39	2.5	10.42	10.62	1	0	0.00	1513	0.00
01-01-19	21:00:00	2.39	2.5	10.5	10.77	1	0	0.00	1513	0.00
01-01-19	22:00:00	2.39	2.5	10.59	11.02	1	0	0.00	1513	0.00
01-01-19	23:00:00	1.79	3.8	10.14	4.84	1201	2106.7	7408.95	1348	5.50

(a)

01-02-19	00:00:00	1.79	3.8	10.13	4.85	1200	2099.6	7383.98	1354	5.45
01-02-19	01:00:00	1.79	3.8	10.12	4.84	1190	2080.5	7316.81	1358	5.39
01-02-19	02:00:00	1.79	3.8	10.13	4.85	1202	2095.8	7370.61	1358	5.43
01-02-19	03:00:00	1.79	3.79	10.12	4.84	1196	2085.7	7335.09	1358	5.40
01-02-19	04:00:00	1.79	3.79	10.1	4.83	1198	2089.3	7347.75	1358	5.41
01-02-19	05:00:00	1.79	3.79	10.07	4.86	1193	2058.7	7240.14	1358	5.33
01-02-19	06:00:00	1.79	3.79	7.75	4.76	1192	1178.3	4143.90	996	4.16
01-02-19	07:00:00	2.31	2.43	5.54	5.57	1	0	0.00	0	0.00
01-02-19	08:00:00	2.3	2.41	5.79	5.7	1	0	0.00	0	0.00
01-02-19	09:00:00	2.3	2.41	5.96	5.97	1	0	0.00	0	0.00
01-02-19	10:00:00	2.3	2.41	6.1	6.25	1	0	0.00	0	0.00
01-02-19	11:00:00	2.43	2.54	6.21	6.33	1	0	0.00	0	0.00
01-02-19	12:00:00	2.41	2.52	6.32	6.58	1	0	0.00	0	0.00
01-02-19	13:00:00	2.4	2.52	6.45	6.6	1	0	0.00	0	0.00
01-02-19	14:00:00	2.41	2.52	6.57	6.77	1	0	0.00	0	0.00
01-02-19	15:00:00	2.4	2.52	6.7	6.87	1	0	0.00	0	0.00
01-02-19	16:00:00	2.4	2.52	6.82	7.19	1	0	0.00	0	0.00
01-02-19	17:00:00	2.4	2.52	6.94	7.33	1	0	0.00	0	0.00
01-02-19	18:00:00	2.4	2.51	7.06	7.62	1	0	0.00	0	0.00
01-02-19	19:00:00	2.29	2.4	7.18	7.74	1	0	0.00	0	0.00
01-02-19	20:00:00	2.29	2.4	7.29	7.8	1	0	0.00	0	0.00
01-02-19	21:00:00	2.23	2.35	7.39	8.05	1	0	0.00	0	0.00
01-02-19	22:00:00	2.23	2.35	7.51	8.35	1	0	0.00	0	0.00
01-02-19	23:00:00	1.89	4.41	11.13	11.33	970	0	0.00	0	0.00

(b)

01-03-19	00:00:00	1.79	3.79	11.1	5.01	1197	2410.5	8477.37	1542	5.50
01-03-19	01:00:00	1.79	3.79	11.09	5.06	1189	2371.6	8340.56	1564	5.33
01-03-19	02:00:00	1.79	3.8	11.09	5.03	1193	2392.3	8413.36	1581	5.32
01-03-19	03:00:00	1.79	3.79	11.09	5.01	1197	2407.5	8466.82	1581	5.36
01-03-19	04:00:00	1.79	3.79	11.08	5.02	1195	2395.4	8424.26	1581	5.33
01-03-19	05:00:00	1.79	3.79	11.08	5.03	1201	2401	8443.96	1581	5.34
01-03-19	06:00:00	1.79	3.79	11.06	5.01	1196	2395.9	8426.02	1584	5.32
01-03-19	07:00:00	2.3	2.41	11.11	11.09	1	0	0.00	1584	0.00
01-03-19	08:00:00	2.29	2.41	11.26	10.96	1	0.1	0.35	1584	0.00
01-03-19	09:00:00	2.29	2.41	11.39	11.11	1	0.1	0.35	1584	0.00
01-03-19	10:00:00	2.37	2.48	11.5	11.1	1	0.1	0.35	1584	0.00
01-03-19	11:00:00	2.38	2.49	11.6	11.19	1	0.1	0.35	1584	0.00
01-03-19	12:00:00	2.38	2.49	11.7	11.43	1	0.1	0.35	1584	0.00
01-03-19	13:00:00	2.37	2.48	11.8	11.45	1	0.1	0.35	1584	0.00
01-03-19	14:00:00	2.37	2.49	11.9	11.48	1	0.1	0.35	1584	0.00
01-03-19	15:00:00	2.37	2.48	12	11.67	1	0.1	0.35	1584	0.00
01-03-19	16:00:00	2.37	2.48	12.1	11.91	1	0.1	0.35	1584	0.00
01-03-19	17:00:00	2.38	2.5	12.21	12.04	1	0	0.00	1584	0.00
01-03-19	18:00:00	2.29	2.4	12.3	12.35	1	0	0.00	1584	0.00
01-03-19	19:00:00	2.23	2.35	12.41	12.48	1	0	0.00	1584	0.00
01-03-19	20:00:00	2.23	2.35	12.49	12.45	0	0	0.00	1584	0.00
01-03-19	21:00:00	2.23	2.35	12.59	12.89	1	0	0.00	1584	0.00
01-03-19	22:00:00	2.23	2.35	12.68	11.79	1	0.2	0.70	1584	0.00
01-03-19	23:00:00	1.79	3.79	11.66	5.5	1198	2442.4	8589.55	1559	5.51

(c)

01-04-19	00:00:00	1.79	3.79	11.66	5.49	1195	2440.2	8581.82	1560	5.50
01-04-19	01:00:00	1.79	3.79	11.66	5.48	1194	2439.9	8580.76	1561	5.50
01-04-19	02:00:00	1.79	3.79	11.65	5.46	1194	2442.7	8590.61	1561	5.50
01-04-19	03:00:00	1.79	3.78	11.64	5.44	1199	2462.3	8659.54	1561	5.55
01-04-19	04:00:00	1.79	3.79	11.63	5.41	1197	2463.7	8664.46	1568	5.53
01-04-19	05:00:00	1.79	3.79	11.6	5.33	1192	2467.5	8677.83	1574	5.51
01-04-19	06:00:00	1.79	3.79	11.22	5.02	1201	2463.9	8665.17	1575	5.50
01-04-19	07:00:00	2.3	2.42	11.02	11.01	1	0	0.00	1575	0.00
01-04-19	08:00:00	2.32	2.43	11.16	10.82	1	0.1	0.35	1575	0.00
01-04-19	09:00:00	2.31	2.43	11.29	10.92	1	0.1	0.35	1575	0.00
01-04-19	10:00:00	2.31	2.42	11.39	10.89	0	0.1	0.35	1575	0.00
01-04-19	11:00:00	2.31	2.43	11.51	11.21	1	0.1	0.35	1575	0.00
01-04-19	12:00:00	2.42	2.53	11.59	11.3	1	0.1	0.35	1575	0.00
01-04-19	13:00:00	2.42	2.53	11.7	11.36	1	0.1	0.35	1575	0.00
01-04-19	14:00:00	2.42	2.53	11.8	11.55	1	0.1	0.35	1575	0.00
01-04-19	15:00:00	2.42	2.53	11.91	11.62	1	0.1	0.35	1575	0.00
01-04-19	16:00:00	2.42	2.53	12.02	11.71	1	0.1	0.35	1575	0.00
01-04-19	17:00:00	2.42	2.53	12.13	11.98	1	0	0.00	1575	0.00
01-04-19	18:00:00	2.42	2.53	12.21	12.18	1	0	0.00	1575	0.00
01-04-19	19:00:00	2.42	2.54	12.31	12.33	1	0	0.00	1575	0.00
01-04-19	20:00:00	2.42	2.53	12.42	12.58	1	0	0.00	1575	0.00
01-04-19	21:00:00	2.23	2.35	12.5	12.69	1	0	0.00	1575	0.00
01-04-19	22:00:00	2.23	2.35	12.6	12.85	1	0	0.00	1575	0.00
01-04-19	23:00:00	1.98	2.09	12.69	13.18	1	0	0.00	1575	0.00

(d)

01-05-19	00:00:00	1.98	2.1	12.77	13.22	1	0	0.00	1575	0.00
01-05-19	01:00:00	1.98	2.1	12.85	13.22	1	0	0.00	1575	0.00
01-05-19	02:00:00	1.98	2.1	12.92	13.42	0	0	0.00	1575	0.00
01-05-19	03:00:00	1.98	2.09	13.01	13.42	1	0	0.00	1575	0.00
01-05-19	04:00:00	1.98	2.1	13.09	13.45	1	0	0.00	1575	0.00
01-05-19	05:00:00	1.99	2.1	13.16	13.7	1	0	0.00	1575	0.00
01-05-19	06:00:00	1.98	2.1	13.24	13.8	1	0	0.00	1575	0.00
01-05-19	07:00:00	1.98	2.1	13.3	13.88	1	0	0.00	1575	0.00
01-05-19	08:00:00	2.23	2.34	13.38	13.9	1	0	0.00	1575	0.00
01-05-19	09:00:00	2.23	2.34	13.45	14.16	1	0	0.00	1575	0.00
01-05-19	10:00:00	2.23	2.35	13.52	14.3	1	0	0.00	1575	0.00
01-05-19	11:00:00	2.23	2.35	13.6	14.43	1	0	0.00	1575	0.00
01-05-19	12:00:00	2.23	2.35	13.68	14.69	1	0	0.00	1575	0.00
01-05-19	13:00:00	2.23	2.35	13.77	14.83	1	0	0.00	1575	0.00
01-05-19	14:00:00	2.23	2.35	13.87	15	1	0	0.00	1575	0.00
01-05-19	15:00:00	2.23	2.35	13.96	15.07	1	0	0.00	1575	0.00
01-05-19	16:00:00	2.23	2.35	14.06	15.28	1	0	0.00	1575	0.00
01-05-19	17:00:00	2.23	2.35	14.16	15.33	1	0	0.00	1575	0.00
01-05-19	18:00:00	2.23	2.35	14.27	15.43	1	0	0.00	1575	0.00
01-05-19	19:00:00	2.23	2.35	14.36	15.53	1	0	0.00	1575	0.00
01-05-19	20:00:00	2.23	2.35	14.47	15.62	1	0	0.00	1575	0.00
01-05-19	21:00:00	2.23	2.35	14.56	15.84	1	0	0.00	1575	0.00
01-05-19	22:00:00	2.23	2.35	14.65	15.98	1	0	0.00	1575	0.00
01-05-19	23:00:00	2.23	2.35	14.74	15.92	1	0	0.00	1575	0.00

(e)

01-06-19	00:00:00	2.23	2.35	14.82	16.09	1	0	0.00	1575	0.00
01-06-19	01:00:00	2.23	2.35	14.89	16.17	1	0	0.00	1575	0.00
01-06-19	02:00:00	2.23	2.35	14.98	16.25	1	0	0.00	1575	0.00
01-06-19	03:00:00	2.23	2.35	15.05	16.42	1	0	0.00	1575	0.00
01-06-19	04:00:00	2.23	2.35	15.13	16.48	1	0	0.00	1575	0.00
01-06-19	05:00:00	2.23	2.35	15.21	16.56	1	0	0.00	1575	0.00
01-06-19	06:00:00	2.23	2.35	15.29	16.6	1	0	0.00	1575	0.00
01-06-19	07:00:00	2.23	2.35	15.36	16.63	1	0	0.00	1575	0.00
01-06-19	08:00:00	2.23	2.35	15.45	16.76	1	0	0.00	1575	0.00
01-06-19	09:00:00	2.23	2.35	15.52	16.83	1	0	0.00	1575	0.00
01-06-19	10:00:00	2.23	2.35	15.6	16.91	0	0	0.00	1575	0.00
01-06-19	11:00:00	2.23	2.35	15.68	17.08	1	0	0.00	1575	0.00
01-06-19	12:00:00	2.23	2.35	15.77	17.13	1	0	0.00	1575	0.00
01-06-19	13:00:00	2.23	2.35	15.87	17.19	1	0	0.00	1575	0.00
01-06-19	14:00:00	2.23	2.35	15.96	17.14	1	0	0.00	1575	0.00
01-06-19	15:00:00	2.23	2.35	16.05	17.41	1	0	0.00	1575	0.00
01-06-19	16:00:00	2.23	2.35	16.16	17.34	1	0	0.00	1575	0.00
01-06-19	17:00:00	2.23	2.35	16.25	17.45	1	0	0.00	1575	0.00
01-06-19	18:00:00	2.23	2.35	16.36	17.61	0	0	0.00	1575	0.00
01-06-19	19:00:00	2.23	2.35	16.45	17.6	1	0	0.00	1575	0.00
01-06-19	20:00:00	2.23	2.35	16.54	17.71	1	0	0.00	1575	0.00
01-06-19	21:00:00	2.23	2.35	16.63	17.69	1	0	0.00	1575	0.00
01-06-19	22:00:00	2.23	2.35	16.71	17.77	1	0	0.00	1575	0.00
01-06-19	23:00:00	2.23	2.35	16.79	17.93	1	0	0.00	1575	0.00

(f)

APPENDIX B

DATA TABLE OF WEEK 2, 2019 (IN HOUR)

		PI-0120C1.PV	PI-0120C2.PV	TIC-0120C1.PV	TI-0120C2.PV	FIC-0120C1.PV	QI-0120C1.P	QI-0120C1.P	DPM3-11KV-MR	PD.PV
		CHW SUCTION PRESSURE	CHW DISCHAGEPRESSURE	EC-0120C CHR TEMP.	EC-0120C CHS TEMP.	CHILL WATER	HEAT SUMM	HEAT SUMM	MAX REAL POW	COP
		BAR	BAR	°C	°C	M3/H	RT	KW	KW	KW/KW
01-07-19	00:00:00	2.23	2.35	16.87	17.93	1	0	0.00	1575	0.00
01-07-19	01:00:00	2.23	2.35	16.94	18.04	1	0	0.00	1575	0.00
01-07-19	02:00:00	2.23	2.35	17.03	18.13	1	0	0.00	1575	0.00
01-07-19	03:00:00	2.23	2.35	17.09	18.22	1	0	0.00	1575	0.00
01-07-19	04:00:00	2.23	2.35	17.15	18.18	1	0	0.00	1575	0.00
01-07-19	05:00:00	2.23	2.35	17.23	18.32	0	0	0.00	1575	0.00
01-07-19	06:00:00	2.23	2.35	17.3	18.37	1	0	0.00	1575	0.00
01-07-19	07:00:00	2.23	2.35	17.35	18.42	0	0	0.00	1575	0.00
01-07-19	08:00:00	2.3	2.41	17.43	18.39	1	0	0.00	1575	0.00
01-07-19	09:00:00	2.29	2.41	17.49	18.13	1	0	0.00	1575	0.00
01-07-19	10:00:00	2.38	2.49	17.56	18.07	1	0	0.00	1575	0.00
01-07-19	11:00:00	2.41	2.53	17.63	18.03	0	0	0.00	1575	0.00
01-07-19	12:00:00	2.43	2.55	17.72	17.88	1	0	0.00	1575	0.00
01-07-19	13:00:00	2.44	2.56	17.8	17.84	1	0	0.00	1575	0.00
01-07-19	14:00:00	2.45	2.56	17.89	17.9	1	0	0.00	1575	0.00
01-07-19	15:00:00	2.45	2.56	17.97	17.76	0	0	0.00	1575	0.00
01-07-19	16:00:00	2.45	2.56	18.06	17.77	1	0.1	0.35	1575	0.00
01-07-19	17:00:00	2.45	2.56	18.15	17.71	1	0.1	0.35	1575	0.00
01-07-19	18:00:00	2.23	2.35	18.22	17.88	1	0.1	0.35	1575	0.00
01-07-19	19:00:00	2.23	2.35	18.32	17.9	1	0.1	0.35	1575	0.00
01-07-19	20:00:00	2.23	2.35	18.39	17.93	1	0.1	0.35	1575	0.00
01-07-19	21:00:00	2.23	2.35	18.45	18.17	1	0.1	0.35	1575	0.00
01-07-19	22:00:00	2.23	2.35	18.53	18.15	1	0.1	0.35	1575	0.00
01-07-19	23:00:00	1.79	3.79	12.08	6.4	1204	2262.1	7955.47	1587	5.01

(a)

01-08-19	00:00:00	1.79	3.79	12.07	6.37	1201	2262.7	7957.58	1594	4.99
01-08-19	01:00:00	1.79	3.79	12.07	6.35	1203	2276.7	8006.81	1596	5.02
01-08-19	02:00:00	1.79	3.79	12.08	6.32	1191	2267	7972.70	1601	4.98
01-08-19	03:00:00	1.79	3.78	12.06	6.33	1194	2264.5	7963.91	1601	4.97
01-08-19	04:00:00	1.79	3.79	12.07	6.3	1196	2278.3	8012.44	1601	5.00
01-08-19	05:00:00	1.78	3.79	12.07	6.31	1198	2283.3	8030.02	1601	5.02
01-08-19	06:00:00	1.79	3.79	12.04	6.29	1191	2269.1	7980.08	1606	4.97
01-08-19	07:00:00	1.79	3.78	11.91	6.23	1188	2234.4	7858.05	1606	4.89
01-08-19	08:00:00	2.45	2.56	8.97	9	1	0	0.00	1606	0.00
01-08-19	09:00:00	2.45	2.56	9.17	9.01	1	0	0.00	1606	0.00
01-08-19	10:00:00	2.44	2.56	9.34	9.15	1	0	0.00	1606	0.00
01-08-19	11:00:00	2.43	2.54	9.46	9.32	1	0	0.00	1606	0.00
01-08-19	12:00:00	2.42	2.53	9.57	9.42	1	0	0.00	1606	0.00
01-08-19	13:00:00	2.41	2.52	9.7	9.66	0	0	0.00	1606	0.00
01-08-19	14:00:00	2.41	2.52	9.82	9.93	0	0	0.00	1606	0.00
01-08-19	15:00:00	2.41	2.52	9.94	10.15	1	0	0.00	1606	0.00
01-08-19	16:00:00	2.42	2.53	10.07	10.1	0	0	0.00	1606	0.00
01-08-19	17:00:00	2.41	2.53	10.19	10.5	1	0	0.00	1606	0.00
01-08-19	18:00:00	2.41	2.53	10.31	10.62	1	0	0.00	1606	0.00
01-08-19	19:00:00	2.23	2.35	10.42	10.76	1	0	0.00	1606	0.00
01-08-19	20:00:00	2.23	2.35	10.54	11.01	1	0	0.00	1606	0.00
01-08-19	21:00:00	2.23	2.35	10.65	11.25	1	0	0.00	1606	0.00
01-08-19	22:00:00	2.23	2.35	10.75	11.41	1	0	0.00	1606	0.00
01-08-19	23:00:00	1.78	3.79	11.99	5.88	1199	2421.4	8515.70	1564	5.44

(b)

01-09-19	00:00:00	1.79	3.79	11.99	5.87	1194	2416.9	8499.87	1590	5.35
01-09-19	01:00:00	1.79	3.79	11.98	5.82	1198	2442.9	8591.31	1590	5.40
01-09-19	02:00:00	1.79	3.79	11.96	5.78	1198	2447.2	8606.44	1590	5.41
01-09-19	03:00:00	1.79	3.79	11.9	5.74	1200	2444.4	8596.59	1590	5.41
01-09-19	04:00:00	1.79	3.79	11.68	5.52	1199	2444.9	8598.35	1590	5.41
01-09-19	05:00:00	1.79	3.79	11	4.9	1188	2396.5	8428.13	1590	5.30
01-09-19	06:00:00	1.79	3.79	10.63	4.84	1186	2274.5	7999.08	1590	5.03
01-09-19	07:00:00	2.3	2.41	10.56	10.55	1	0	0.00	1590	0.00
01-09-19	08:00:00	2.3	2.41	10.71	10.34	1	0.1	0.35	1590	0.00
01-09-19	09:00:00	2.29	2.41	10.86	10.47	1	0.1	0.35	1590	0.00
01-09-19	10:00:00	2.4	2.52	10.96	10.55	1	0.1	0.35	1590	0.00
01-09-19	11:00:00	2.4	2.52	11.09	10.78	0	0.1	0.35	1590	0.00
01-09-19	12:00:00	2.41	2.52	11.2	10.71	1	0.1	0.35	1590	0.00
01-09-19	13:00:00	2.4	2.52	11.32	11	1	0.1	0.35	1590	0.00
01-09-19	14:00:00	2.4	2.52	11.43	11.03	1	0.1	0.35	1590	0.00
01-09-19	15:00:00	2.37	2.49	11.55	11.29	1	0	0.00	1590	0.00
01-09-19	16:00:00	2.31	2.42	11.66	11.35	1	0.1	0.35	1590	0.00
01-09-19	17:00:00	2.4	2.51	11.77	11.7	1	0	0.00	1590	0.00
01-09-19	18:00:00	2.4	2.51	11.9	11.85	1	0	0.00	1590	0.00
01-09-19	19:00:00	2.23	2.35	12	12.1	1	0	0.00	1590	0.00
01-09-19	20:00:00	2.23	2.35	12.09	12.17	1	0	0.00	1590	0.00
01-09-19	21:00:00	2.23	2.35	12.19	12.36	1	0	0.00	1590	0.00
01-09-19	22:00:00	2.23	2.35	12.27	12.53	1	0	0.00	1590	0.00
01-09-19	23:00:00	1.79	3.79	11.89	5.77	1202	2434.6	8562.12	1562	5.48

(c)

01-10-19	00:00:00	1.79	3.8	11.89	5.73	1198	2438.6	8576.19	1568	5.47
01-10-19	01:00:00	1.79	3.79	11.88	5.77	1193	2414.1	8490.03	1568	5.41
01-10-19	02:00:00	1.79	3.79	11.88	5.75	1191	2416.7	8499.17	1568	5.42
01-10-19	03:00:00	1.79	3.79	11.87	5.76	1193	2409.1	8472.44	1580	5.36
01-10-19	04:00:00	1.79	3.79	11.86	5.74	1198	2427.2	8536.10	1580	5.40
01-10-19	05:00:00	1.79	3.79	11.86	5.71	1202	2445.8	8601.51	1580	5.44
01-10-19	06:00:00	1.79	3.79	11.83	5.69	1197	2429	8542.43	1580	5.41
01-10-19	07:00:00	2.29	2.41	11.39	11.39	1	0	0.00	1580	0.00
01-10-19	08:00:00	2.3	2.41	11.54	11.2	1	0.1	0.35	1580	0.00
01-10-19	09:00:00	2.3	2.41	11.66	11.39	1	0.1	0.35	1580	0.00
01-10-19	10:00:00	2.3	2.42	11.77	11.48	1	0.1	0.35	1580	0.00
01-10-19	11:00:00	2.3	2.41	11.88	11.52	1	0.1	0.35	1580	0.00
01-10-19	12:00:00	2.37	2.49	11.98	11.62	1	0.1	0.35	1580	0.00
01-10-19	13:00:00	2.38	2.49	12.09	11.9	1	0.1	0.35	1580	0.00
01-10-19	14:00:00	2.38	2.49	12.21	11.93	1	0.1	0.35	1580	0.00
01-10-19	15:00:00	2.39	2.5	12.31	11.91	1	0.1	0.35	1580	0.00
01-10-19	16:00:00	2.39	2.5	12.42	12.09	1	0.1	0.35	1580	0.00
01-10-19	17:00:00	2.39	2.5	12.53	12.52	1	0	0.00	1580	0.00
01-10-19	18:00:00	2.35	2.46	12.63	12.51	1	0	0.00	1580	0.00
01-10-19	19:00:00	2.3	2.41	12.73	12.58	1	0	0.00	1580	0.00
01-10-19	20:00:00	2.23	2.35	12.84	12.73	1	0	0.00	1580	0.00
01-10-19	21:00:00	2.23	2.35	12.94	12.95	1	0	0.00	1580	0.00
01-10-19	22:00:00	2.23	2.35	13.04	13.16	1	0	0.00	1580	0.00
01-10-19	23:00:00	1.79	3.79	11.83	5.87	1194	2350.6	8266.71	1593	5.19

(d)

01-11-19	00:00:00	1.79	3.79	11.82	5.78	1203	2404.2	8455.21	1606	5.26
01-11-19	01:00:00	1.8	3.79	11.83	5.79	1196	2387.5	8396.48	1606	5.23
01-11-19	02:00:00	1.79	3.78	11.81	5.73	1197	2406.6	8463.65	1614	5.24
01-11-19	03:00:00	1.79	3.8	11.82	5.84	1193	2356.1	8286.05	1616	5.13
01-11-19	04:00:00	1.79	3.79	11.82	5.79	1191	2377.1	8359.90	1616	5.17
01-11-19	05:00:00	1.79	3.78	11.81	5.77	1198	2395	8422.86	1616	5.21
01-11-19	06:00:00	1.79	3.79	11.79	5.75	1195	2385.9	8390.85	1616	5.19
01-11-19	07:00:00	1.79	3.8	11.34	5.44	1201	2345.8	8249.83	1616	5.11
01-11-19	08:00:00	2.23	2.35	9.03	9.05	1	0	0.00	1616	0.00
01-11-19	09:00:00	2.39	2.51	9.2	8.57	1	0.2	0.70	1616	0.00
01-11-19	10:00:00	2.39	2.5	9.36	8.87	1	0.1	0.35	1616	0.00
01-11-19	11:00:00	2.38	2.49	9.48	9.2	1	0.1	0.35	1616	0.00
01-11-19	12:00:00	2.39	2.5	9.6	9.09	1	0.1	0.35	1616	0.00
01-11-19	13:00:00	2.38	2.5	9.72	9.35	1	0.1	0.35	1616	0.00
01-11-19	14:00:00	2.38	2.5	9.85	9.66	1	0	0.00	1616	0.00
01-11-19	15:00:00	2.39	2.5	9.97	9.73	0	0	0.00	1616	0.00
01-11-19	16:00:00	2.46	2.57	10.09	10.01	1	0	0.00	1616	0.00
01-11-19	17:00:00	2.46	2.57	10.21	10.06	1	0	0.00	1616	0.00
01-11-19	18:00:00	2.3	2.41	10.32	10.3	1	0	0.00	1616	0.00
01-11-19	19:00:00	2.3	2.41	10.45	10.49	1	0	0.00	1616	0.00
01-11-19	20:00:00	2.3	2.42	10.56	10.66	1	0	0.00	1616	0.00
01-11-19	21:00:00	2.3	2.41	10.67	10.82	1	0	0.00	1616	0.00
01-11-19	22:00:00	2.23	2.35	10.78	11.04	1	0	0.00	1616	0.00
01-11-19	23:00:00	2.23	2.35	10.89	11.36	1	0	0.00	1616	0.00

(e)

01-12-19	00:00:00	2.23	2.35	10.99	11.47	1	0	0.00	1616	0.00
01-12-19	01:00:00	2.18	2.3	11.08	11.72	1	0	0.00	1616	0.00
01-12-19	02:00:00	2.18	2.3	11.17	11.66	1	0	0.00	1616	0.00
01-12-19	03:00:00	2.19	2.3	11.26	11.92	1	0	0.00	1616	0.00
01-12-19	04:00:00	2.19	2.3	11.34	12.15	1	0	0.00	1616	0.00
01-12-19	05:00:00	2.19	2.3	11.42	12.17	1	0	0.00	1616	0.00
01-12-19	06:00:00	2.19	2.3	11.5	12.3	1	0	0.00	1616	0.00
01-12-19	07:00:00	2.19	2.3	11.58	12.41	1	0	0.00	1616	0.00
01-12-19	08:00:00	2.23	2.35	11.67	12.68	1	0	0.00	1616	0.00
01-12-19	09:00:00	2.23	2.35	11.74	12.71	1	0	0.00	1616	0.00
01-12-19	10:00:00	2.23	2.34	11.82	13.02	0	0	0.00	1616	0.00
01-12-19	11:00:00	2.23	2.34	11.9	13.14	1	0	0.00	1616	0.00
01-12-19	12:00:00	2.23	2.35	11.99	13.28	1	0	0.00	1616	0.00
01-12-19	13:00:00	2.23	2.35	12.07	13.49	1	0	0.00	1616	0.00
01-12-19	14:00:00	2.23	2.35	12.17	13.63	1	0	0.00	1616	0.00
01-12-19	15:00:00	2.23	2.35	12.27	13.77	1	0	0.00	1616	0.00
01-12-19	16:00:00	2.23	2.35	12.36	13.92	1	0	0.00	1616	0.00
01-12-19	17:00:00	2.23	2.35	12.46	14.02	1	0	0.00	1616	0.00
01-12-19	18:00:00	2.23	2.35	12.56	14.05	1	0	0.00	1616	0.00
01-12-19	19:00:00	2.23	2.35	12.66	14.27	1	0	0.00	1616	0.00
01-12-19	20:00:00	2.23	2.35	12.76	14.39	1	0	0.00	1616	0.00
01-12-19	21:00:00	2.23	2.35	12.85	14.56	1	0	0.00	1616	0.00
01-12-19	22:00:00	2.23	2.35	12.95	14.76	1	0	0.00	1616	0.00
01-12-19	23:00:00	2.23	2.35	13.04	14.77	1	0	0.00	1616	0.00

(f)

1/13/2019	00:00:00	2.23	2.34	13.12	14.91	0	0	0.00	1616	0.00
1/13/2019	01:00:00	2.23	2.34	13.21	14.94	0	0	0.00	1616	0.00
1/13/2019	02:00:00	2.23	2.35	13.3	15.05	1	0	0.00	1616	0.00
1/13/2019	03:00:00	2.23	2.34	13.38	15.22	1	0	0.00	1616	0.00
1/13/2019	04:00:00	2.23	2.34	13.45	15.23	1	0	0.00	1616	0.00
1/13/2019	05:00:00	2.23	2.34	13.55	15.37	1	0	0.00	1616	0.00
1/13/2019	06:00:00	2.23	2.34	13.62	15.42	1	0	0.00	1616	0.00
1/13/2019	07:00:00	2.23	2.34	13.71	15.53	1	0	0.00	1616	0.00
1/13/2019	08:00:00	2.23	2.35	13.8	15.65	1	0	0.00	1616	0.00
1/13/2019	09:00:00	2.23	2.34	13.87	15.7	1	0	0.00	1616	0.00
1/13/2019	10:00:00	2.23	2.34	13.95	15.8	1	0	0.00	1616	0.00
1/13/2019	11:00:00	2.23	2.34	14.04	15.77	1	0	0.00	1616	0.00
1/13/2019	12:00:00	2.23	2.34	14.13	15.88	1	0	0.00	1616	0.00
1/13/2019	13:00:00	2.23	2.35	14.24	16.06	1	0	0.00	1616	0.00
1/13/2019	14:00:00	2.23	2.35	14.33	16.07	0	0	0.00	1616	0.00
1/13/2019	15:00:00	2.23	2.34	14.45	16.19	1	0	0.00	1616	0.00
1/13/2019	16:00:00	2.23	2.35	14.55	16.28	1	0	0.00	1616	0.00
1/13/2019	17:00:00	2.23	2.35	14.64	16.31	1	0	0.00	1616	0.00
1/13/2019	18:00:00	2.23	2.35	14.75	16.4	1	0	0.00	1616	0.00
1/13/2019	19:00:00	2.23	2.35	14.84	16.55	1	0	0.00	1616	0.00
1/13/2019	20:00:00	2.23	2.35	14.92	16.54	1	0	0.00	1616	0.00
1/13/2019	21:00:00	2.39	2.5	15.01	16.62	1	0	0.00	1616	0.00
1/13/2019	22:00:00	2.4	2.51	15.1	16.45	0	0	0.00	1616	0.00
1/13/2019	23:00:00	1.97	3.85	11.02	5.87	1257	2138.1	7519.38	1346	5.59

(g)

DATA TABLE OF WEEK 3, 2019 (IN HOUR)

		PI-0120C1.PV	PI-0120C2.PV	TIC-0120C1.PV	TI-0120C2.PV	FIC-0120C1.	QI-0120C1.PV	QI-0120C1.PV	DPM3-11KV-MRPD.PV	
		CHW SUCTION	CHW DISCHAG	EC-0120C CHR T	EC-0120C CHS	CHILL WATE	HEAT SUMMA	HEAT SUMMAT	MAX REAL POWER DEMAND	COP
		BAR	BAR	°C	°C	M3/H	RT	KW	KW	KW/KW
1/14/2019	00:00:00	1.79	3.8	11	5.06	1200	2356.4	8287.11	1592	5.21
1/14/2019	01:00:00	1.78	3.79	11	4.99	1189	2362.9	8309.96	1592	5.22
1/14/2019	02:00:00	1.79	3.8	10.99	4.95	1196	2391.8	8411.60	1592	5.28
1/14/2019	03:00:00	1.79	3.79	10.98	4.96	1202	2394.9	8422.50	1592	5.29
1/14/2019	04:00:00	1.79	3.79	10.98	4.86	1202	2429.1	8542.78	1592	5.37
1/14/2019	05:00:00	1.79	3.8	10.97	4.89	1197	2406.4	8462.95	1599	5.29
1/14/2019	06:00:00	1.79	3.79	10.95	4.87	1192	2392.9	8415.47	1599	5.26
1/14/2019	07:00:00	1.79	3.79	10.81	4.82	1198	2373.5	8347.24	1599	5.22
1/14/2019	08:00:00	2.39	2.51	10.52	10.45	1	0	0.00	1599	0.00
1/14/2019	09:00:00	2.43	2.55	10.67	10.26	1	0.1	0.35	1599	0.00
1/14/2019	10:00:00	2.41	2.52	10.78	10.38	1	0.1	0.35	1599	0.00
1/14/2019	11:00:00	2.41	2.52	10.89	10.55	1	0.1	0.35	1599	0.00
1/14/2019	12:00:00	2.41	2.53	11	10.58	1	0.1	0.35	1599	0.00
1/14/2019	13:00:00	2.41	2.52	11.11	10.67	1	0.1	0.35	1599	0.00
1/14/2019	14:00:00	2.41	2.52	11.22	11.11	1	0	0.00	1599	0.00
1/14/2019	15:00:00	2.42	2.53	11.33	11.1	1	0.1	0.35	1599	0.00
1/14/2019	16:00:00	2.42	2.54	11.46	11.25	1	0	0.00	1599	0.00
1/14/2019	17:00:00	2.42	2.53	11.55	11.18	1	0.1	0.35	1599	0.00
1/14/2019	18:00:00	2.42	2.53	11.65	11.71	1	0	0.00	1599	0.00
1/14/2019	19:00:00	2.23	2.34	11.74	11.81	1	0	0.00	1599	0.00
1/14/2019	20:00:00	2.23	2.34	11.83	11.9	1	0	0.00	1599	0.00
1/14/2019	21:00:00	2.23	2.34	11.92	12.06	1	0	0.00	1599	0.00
1/14/2019	22:00:00	2.23	2.34	12.01	12.22	1	0	0.00	1599	0.00
1/14/2019	23:00:00	2.23	2.34	11.59	11.71	1	0	0.00	1599	0.00

(a)

1/15/2019	00:00:00	2.16	2.27	11.77	10.58	1	0.3	1.06	1599	0.00
1/15/2019	01:00:00	2.16	2.27	11.87	10.29	1	0.4	1.41	1599	0.00
1/15/2019	02:00:00	2.16	2.27	11.97	9.78	1	0.4	1.41	1599	0.00
1/15/2019	03:00:00	2.16	2.27	12.07	9.76	1	0.6	2.11	1599	0.00
1/15/2019	04:00:00	2.16	2.27	12.16	9.48	1	0.5	1.76	1599	0.00
1/15/2019	05:00:00	2.16	2.27	12.24	9.33	1	0.6	2.11	1599	0.00
1/15/2019	06:00:00	2.16	2.27	12.33	9.53	1	0.6	2.11	1599	0.00
1/15/2019	07:00:00	2.23	2.34	12.41	9.31	1	0.8	2.81	1599	0.00
1/15/2019	08:00:00	2.23	2.34	12.49	9.69	1	0.7	2.46	1599	0.00
1/15/2019	09:00:00	2.23	2.34	12.58	10.13	1	0.6	2.11	1599	0.00
1/15/2019	10:00:00	2.23	2.34	12.64	10.75	0	0.3	1.06	1599	0.00
1/15/2019	11:00:00	2.3	2.41	12.72	11.1	1	0.4	1.41	1599	0.00
1/15/2019	12:00:00	2.3	2.42	12.81	11.32	1	0.3	1.06	1599	0.00
1/15/2019	13:00:00	2.31	2.42	12.9	11.71	1	0.2	0.70	1599	0.00
1/15/2019	14:00:00	2.3	2.42	12.98	11.73	1	0.2	0.70	1599	0.00
1/15/2019	15:00:00	2.31	2.42	13.08	11.84	1	0.3	1.06	1599	0.00
1/15/2019	16:00:00	2.29	2.41	13.18	12.12	1	0.2	0.70	1599	0.00
1/15/2019	17:00:00	2.3	2.42	13.28	12.37	1	0.2	0.70	1599	0.00
1/15/2019	18:00:00	2.23	2.34	13.37	12.5	1	0.2	0.70	1599	0.00
1/15/2019	19:00:00	2.23	2.34	13.48	12.63	1	0.2	0.70	1599	0.00
1/15/2019	20:00:00	2.23	2.34	13.54	12.85	1	0.2	0.70	1599	0.00
1/15/2019	21:00:00	1.98	2.1	13.61	12.97	1	0.1	0.35	1599	0.00
1/15/2019	22:00:00	2.05	2.16	13.69	11.16	1	0.5	1.76	1599	0.00
1/15/2019	23:00:00	2.05	2.16	13.76	10.58	1	0.6	2.11	1599	0.00

(b)

1/16/2019	00:00:00	2.05	2.16	13.84	10.2	1	0.9	3.17	1599	0.00
1/16/2019	01:00:00	2.05	2.16	13.91	9.96	1	0.9	3.17	1599	0.00
1/16/2019	02:00:00	2.05	2.16	13.98	9.81	1	1	3.52	1599	0.00
1/16/2019	03:00:00	2.05	2.17	14.05	9.96	1	0.9	3.17	1599	0.00
1/16/2019	04:00:00	2.05	2.16	14.12	9.81	1	1.1	3.87	1599	0.00
1/16/2019	05:00:00	2.05	2.16	14.19	9.63	1	0.9	3.17	1599	0.00
1/16/2019	06:00:00	2.05	2.16	14.24	9.62	1	1	3.52	1599	0.00
1/16/2019	07:00:00	2.03	2.14	14.32	9.93	1	1	3.52	1599	0.00
1/16/2019	08:00:00	2.28	2.39	14.38	9.43	1	1.5	5.28	1599	0.00
1/16/2019	09:00:00	2.28	2.4	14.44	9.6	1	1.1	3.87	1599	0.00
1/16/2019	10:00:00	2.28	2.4	14.51	9.83	1	1	3.52	1599	0.00
1/16/2019	11:00:00	2.35	2.46	14.57	9.73	1	1.3	4.57	1599	0.00
1/16/2019	12:00:00	2.35	2.47	14.66	9.43	1	1	3.52	1599	0.00
1/16/2019	13:00:00	2.35	2.46	14.73	9.75	1	1.1	3.87	1599	0.00
1/16/2019	14:00:00	2.35	2.46	14.81	9.75	1	1	3.52	1599	0.00
1/16/2019	15:00:00	2.35	2.46	14.91	9.42	1	1.4	4.92	1599	0.00
1/16/2019	16:00:00	2.35	2.46	14.99	9.59	0	0.8	2.81	1599	0.00
1/16/2019	17:00:00	2.35	2.47	15.07	9.6	1	1.3	4.57	1599	0.00
1/16/2019	18:00:00	2.35	2.46	15.16	9.88	1	1.1	3.87	1599	0.00
1/16/2019	19:00:00	2.35	2.47	15.23	10.18	1	1	3.52	1599	0.00
1/16/2019	20:00:00	2.35	2.46	15.31	10.11	1	1.2	4.22	1599	0.00
1/16/2019	21:00:00	2.23	2.34	15.38	9.57	1	1.2	4.22	1599	0.00
1/16/2019	22:00:00	1.81	3.78	9.57	4.81	1210	1904.7	6698.54	1258	5.32
1/16/2019	23:00:00	1.81	3.78	9.56	4.83	1203	1879.5	6609.92	1258	5.25

(c)

1/17/2019	00:00:00	1.81	3.78	9.55	4.82	1203	1881.8	6618.01	1258	5.26
1/17/2019	01:00:00	1.81	3.78	9.56	4.84	1213	1892.5	6655.64	1258	5.29
1/17/2019	02:00:00	1.81	3.78	9.55	4.84	1207	1878.7	6607.11	1258	5.25
1/17/2019	03:00:00	1.81	3.78	9.55	4.83	1212	1891.1	6650.72	1258	5.29
1/17/2019	04:00:00	1.81	3.78	9.55	4.84	1219	1899	6678.50	1258	5.31
1/17/2019	05:00:00	1.81	3.78	9.55	4.84	1222	1902.7	6691.51	1258	5.32
1/17/2019	06:00:00	1.81	3.78	9.52	4.84	1221	1892	6653.88	1258	5.29
1/17/2019	07:00:00	1.81	3.78	8.3	4.78	1213	1412.7	4968.25	999	4.97
1/17/2019	08:00:00	2.23	4.44	11	5.06	1106	2170.6	7633.67	1567	4.87
1/17/2019	09:00:00	2.23	4.44	10.72	4.82	1101	2148.2	7554.90	1575	4.80
1/17/2019	10:00:00	2.23	4.45	10.91	4.85	1106	2213	7782.79	1575	4.94
1/17/2019	11:00:00	2.23	4.44	10.92	4.81	1104	2229.4	7840.47	1575	4.98
1/17/2019	12:00:00	2.23	4.44	10.7	4.8	1111	2167.1	7621.37	1575	4.84
1/17/2019	13:00:00	2.23	4.44	10.74	4.81	1114	2184.5	7682.56	1575	4.88
1/17/2019	14:00:00	2.23	4.44	10.77	4.84	1106	2169.8	7630.86	1575	4.84
1/17/2019	15:00:00	2.21	4.38	10.99	4.92	1122	2252.2	7920.65	1575	5.03
1/17/2019	16:00:00	2.21	4.39	10.92	4.99	1124	2205	7754.65	1575	4.92
1/17/2019	17:00:00	2.21	4.38	11.03	5.04	1127	2228.8	7838.36	1575	4.98
1/17/2019	18:00:00	2.21	4.39	9.58	4.78	1125	1786.2	6281.80	1575	3.99
1/17/2019	19:00:00	2.21	4.38	9.41	4.87	1126	1688.4	5937.85	1575	3.77
1/17/2019	20:00:00	2.21	4.38	9.55	4.86	1127	1749.2	6151.67	1575	3.91
1/17/2019	21:00:00	2.23	2.34	9.82	9.35	1	0.1	0.35	0	0.00
1/17/2019	22:00:00	1.81	3.79	10.59	4.85	1204	2283.5	8030.73	1482	5.42
1/17/2019	23:00:00	1.8	3.79	10.59	4.83	1207	2297.8	8081.02	1489	5.43

(d)

1/18/2019	00:00:00	1.79	3.79	10.59	4.82	1203	2293.9	8067.30	1489	5.42
1/18/2019	01:00:00	1.79	3.79	10.59	4.83	1194	2273.7	7996.26	1489	5.37
1/18/2019	02:00:00	1.79	3.79	10.58	4.83	1197	2278	8011.38	1489	5.38
1/18/2019	03:00:00	1.79	3.79	10.58	4.83	1189	2258.4	7942.45	1489	5.33
1/18/2019	04:00:00	1.79	3.79	10.57	4.84	1204	2278.4	8012.79	1489	5.38
1/18/2019	05:00:00	1.79	3.79	10.56	4.85	1199	2264.5	7963.91	1489	5.35
1/18/2019	06:00:00	1.79	3.79	10.52	4.84	1202	2257.9	7940.70	1489	5.33
1/18/2019	07:00:00	2.06	4.04	11.73	8.4	1199	1313	4617.62	958	4.82
1/18/2019	08:00:00	2.42	2.53	12.21	9.73	1	0.5	1.76	1545	0.00
1/18/2019	09:00:00	2.42	4.37	12.33	9.57	1	0.7	2.46	1545	0.00
1/18/2019	10:00:00	2.4	2.51	11.54	10.28	1	0.3	1.06	1545	0.00
1/18/2019	11:00:00	2.41	2.52	11.68	9.55	1	0.5	1.76	1545	0.00
1/18/2019	12:00:00	2.39	2.5	11.79	9.7	1	0.6	2.11	1545	0.00
1/18/2019	13:00:00	2.31	2.42	11.89	9.4	1	0.6	2.11	1545	0.00
1/18/2019	14:00:00	2.31	2.42	12.01	9.61	1	0.5	1.76	1545	0.00
1/18/2019	15:00:00	2.3	2.42	12.1	9.14	1	0.7	2.46	1545	0.00
1/18/2019	16:00:00	2.31	2.42	12.22	9.64	1	0.5	1.76	1545	0.00
1/18/2019	17:00:00	2.31	2.42	12.33	10.04	1	0.7	2.46	1545	0.00
1/18/2019	18:00:00	2.31	2.42	12.43	10.28	1	0.4	1.41	1545	0.00
1/18/2019	19:00:00	2.23	2.35	12.53	9.3	1	0.7	2.46	1545	0.00
1/18/2019	20:00:00	2.23	2.35	12.63	8.18	1	0.9	3.17	1545	0.00
1/18/2019	21:00:00	2.07	2.18	12.71	8.38	1	0.9	3.17	1545	0.00
1/18/2019	22:00:00	2.06	2.18	12.8	9.41	1	0.9	3.17	1545	0.00
1/18/2019	23:00:00	2.06	2.18	12.89	9.53	1	0.8	2.81	1545	0.00

(e)

1/19/2019	00:00:00	2.06	2.18	12.97	9.91	1	0.5	1.76	1545	0.00
1/19/2019	01:00:00	2.06	2.17	13.05	10.5	1	0.6	2.11	1545	0.00
1/19/2019	02:00:00	2.06	2.18	13.13	10.41	1	0.5	1.76	1545	0.00
1/19/2019	03:00:00	2.06	2.18	13.21	10.7	1	0.6	2.11	1545	0.00
1/19/2019	04:00:00	2.06	2.18	13.28	10.77	1	0.6	2.11	1545	0.00
1/19/2019	05:00:00	2.06	2.17	13.36	11.22	1	0.5	1.76	1545	0.00
1/19/2019	06:00:00	2.06	2.17	13.43	11.35	1	0.5	1.76	1545	0.00
1/19/2019	07:00:00	2.06	2.17	13.51	11.35	1	0.4	1.41	1545	0.00
1/19/2019	08:00:00	2.23	2.34	13.56	11.68	1	0.4	1.41	1545	0.00
1/19/2019	09:00:00	2.23	2.34	13.64	12.02	1	0.3	1.06	1545	0.00
1/19/2019	10:00:00	2.23	2.34	13.7	11.94	1	0.4	1.41	1545	0.00
1/19/2019	11:00:00	2.23	2.34	13.77	12.25	1	0.4	1.41	1545	0.00
1/19/2019	12:00:00	2.23	2.34	13.85	12.57	1	0.3	1.06	1545	0.00
1/19/2019	13:00:00	2.23	2.34	13.94	12.78	1	0.2	0.70	1545	0.00
1/19/2019	14:00:00	2.23	2.34	14.02	12.93	1	0.3	1.06	1545	0.00
1/19/2019	15:00:00	2.23	2.34	14.12	12.96	1	0.3	1.06	1545	0.00
1/19/2019	16:00:00	2.23	2.34	14.21	13.3	1	0.2	0.70	1545	0.00
1/19/2019	17:00:00	2.23	2.34	14.3	13.36	1	0.3	1.06	1545	0.00
1/19/2019	18:00:00	2.23	2.34	14.4	13.59	1	0.1	0.35	1545	0.00
1/19/2019	19:00:00	2.23	2.34	14.48	13.76	1	0.2	0.70	1545	0.00
1/19/2019	20:00:00	2.23	2.34	14.56	13.9	1	0.1	0.35	1545	0.00
1/19/2019	21:00:00	2.23	2.34	14.64	14.02	1	0.2	0.70	1545	0.00
1/19/2019	22:00:00	2.23	2.34	14.73	14.08	1	0.1	0.35	1545	0.00
1/19/2019	23:00:00	2.23	2.34	14.81	14.14	1	0.2	0.70	1545	0.00

(f)

1/20/2019	00:00:00	2.23	2.34	14.9	14.38	1	0.1	0.35	1545	0.00
1/20/2019	01:00:00	2.23	2.34	14.97	14.48	1	0.1	0.35	1545	0.00
1/20/2019	02:00:00	2.23	2.34	15.04	14.59	1	0.1	0.35	1545	0.00
1/20/2019	03:00:00	2.23	2.34	15.11	14.64	1	0.1	0.35	1545	0.00
1/20/2019	04:00:00	2.23	2.34	15.16	14.83	1	0.1	0.35	1545	0.00
1/20/2019	05:00:00	2.23	2.34	15.23	14.87	1	0.1	0.35	1545	0.00
1/20/2019	06:00:00	2.23	2.34	15.29	15.12	1	0	0.00	1545	0.00
1/20/2019	07:00:00	2.23	2.34	15.35	14.98	1	0.1	0.35	1545	0.00
1/20/2019	08:00:00	2.23	2.34	15.41	15.22	0	0	0.00	1545	0.00
1/20/2019	09:00:00	2.23	2.34	15.48	15.32	1	0	0.00	1545	0.00
1/20/2019	10:00:00	2.23	2.34	15.55	15.45	1	0	0.00	1545	0.00
1/20/2019	11:00:00	2.23	2.34	15.6	15.52	1	0	0.00	1545	0.00
1/20/2019	12:00:00	2.23	2.34	15.67	15.55	1	0	0.00	1545	0.00
1/20/2019	13:00:00	2.23	2.34	15.74	15.59	1	0	0.00	1545	0.00
1/20/2019	14:00:00	2.23	2.34	15.82	15.77	1	0	0.00	1545	0.00
1/20/2019	15:00:00	2.23	2.34	15.9	15.87	1	0	0.00	1545	0.00
1/20/2019	16:00:00	2.23	2.34	15.98	15.9	1	0	0.00	1545	0.00
1/20/2019	17:00:00	2.23	2.34	16.05	16.1	1	0	0.00	1545	0.00
1/20/2019	18:00:00	2.23	2.34	16.13	16.07	1	0	0.00	1545	0.00
1/20/2019	19:00:00	2.23	2.34	16.2	16.13	1	0	0.00	1545	0.00
1/20/2019	20:00:00	2.23	2.34	16.26	16.25	1	0	0.00	1545	0.00
1/20/2019	21:00:00	2.23	2.34	16.33	16.28	1	0	0.00	1545	0.00
1/20/2019	22:00:00	2.23	2.34	16.38	16.33	1	0	0.00	1545	0.00
1/20/2019	23:00:00	2.23	2.34	16.45	16.53	1	0	0.00	1545	0.00

(g)

APPENDIX D

DATA TABLE OF WEEK 4, 2019 (IN HOUR)

		PI-0120C1.PV	PI-0120C2.PV	TIC-0120C1.PV	TI-0120C2.PV	FIC-01	QI-0120C1.PV	QI-0120C1.PV	DPM3-11KV-MR	PD.PV
		CHW SUCTION PRES	CHW DISCHAGEPRE	EC-0120C CHR TE	EC-0120C CHS TE	CHILL V	HEAT SUMMATIO	HEAT SUMMAT	MAX REAL POW	COP
		BAR	BAR	°C	°C	M3/H	RT	KW	KW	KW/KW
1/21/2019	00:00:00	2.23	2.34	16.52	16.58	1	0	0.00	1545	0.00
1/21/2019	01:00:00	2.23	2.34	16.58	16.55	1	0	0.00	1545	0.00
1/21/2019	02:00:00	2.23	2.34	16.64	16.64	1	0	0.00	1545	0.00
1/21/2019	03:00:00	2.23	2.34	16.7	16.74	1	0	0.00	1545	0.00
1/21/2019	04:00:00	2.23	2.34	16.75	16.73	1	0	0.00	1545	0.00
1/21/2019	05:00:00	2.23	2.34	16.81	16.79	1	0	0.00	1545	0.00
1/21/2019	06:00:00	2.23	2.34	16.87	16.92	1	0	0.00	1545	0.00
1/21/2019	07:00:00	2.23	2.34	16.92	16.96	1	0	0.00	1545	0.00
1/21/2019	08:00:00	2.23	2.34	16.98	16.97	1	0	0.00	1545	0.00
1/21/2019	09:00:00	2.23	2.34	17.03	17.13	1	0	0.00	1545	0.00
1/21/2019	10:00:00	2.23	2.34	17.09	17.13	1	0	0.00	1545	0.00
1/21/2019	11:00:00	2.23	2.34	17.14	17.29	1	0	0.00	1545	0.00
1/21/2019	12:00:00	2.23	2.34	17.19	17.32	1	0	0.00	1545	0.00
1/21/2019	13:00:00	2.23	2.34	17.26	17.26	1	0	0.00	1545	0.00
1/21/2019	14:00:00	2.23	2.34	17.33	17.31	1	0	0.00	1545	0.00
1/21/2019	15:00:00	2.23	2.34	17.41	17.39	1	0	0.00	1545	0.00
1/21/2019	16:00:00	2.23	2.34	17.49	17.56	1	0	0.00	1545	0.00
1/21/2019	17:00:00	2.23	2.34	17.57	17.69	1	0	0.00	1545	0.00
1/21/2019	18:00:00	2.23	2.34	17.64	17.65	1	0	0.00	1545	0.00
1/21/2019	19:00:00	2.23	2.34	17.71	17.78	1	0	0.00	1545	0.00
1/21/2019	20:00:00	2.23	2.34	17.78	17.94	1	0	0.00	1545	0.00
1/21/2019	21:00:00	2.23	2.34	17.84	17.84	1	0	0.00	1545	0.00
1/21/2019	22:00:00	2.23	2.34	17.9	18.02	1	0	0.00	1545	0.00
1/21/2019	23:00:00	2.23	2.34	17.94	16.14	1	0.4	1.41	1545	0.00

(a)

1/22/2019	00:00:00	2.23	2.34	18	16.36	0	0.2	0.70	1545	0.00
1/22/2019	01:00:00	2.23	2.34	18.05	16.68	1	0.3	1.06	1545	0.00
1/22/2019	02:00:00	2.23	2.34	18.09	17.05	1	0.2	0.70	1545	0.00
1/22/2019	03:00:00	2.04	4.35	7.83	4.81	1077	1074.6	3779.21	955	3.96
1/22/2019	04:00:00	2.04	4.31	7.15	4.62	1098	920.2	3236.21	955	3.39
1/22/2019	05:00:00	2.23	2.34	5.99	6.07	1	0	0.00	0	0.00
1/22/2019	06:00:00	2.23	2.34	6.23	6.12	0	0	0.00	0	0.00
1/22/2019	07:00:00	2.32	2.43	11.42	11.39	1	0	0.00	0	0.00
1/22/2019	08:00:00	2.33	2.44	11.47	9.81	1	0.3	1.06	0	0.00
1/22/2019	09:00:00	2.33	2.44	11.58	8.48	1	0.6	2.11	0	0.00
1/22/2019	10:00:00	2.42	2.53	11.2	10.32	1	0.2	0.70	0	0.00
1/22/2019	11:00:00	2.26	4.54	11.51	5.01	1068	2295	8071.17	1511	5.34
1/22/2019	12:00:00	2.26	4.55	11.37	4.82	1073	2322.5	8167.88	1574	5.19
1/22/2019	13:00:00	2.26	4.54	11.23	4.82	1084	2300.3	8089.81	1574	5.14
1/22/2019	14:00:00	2.26	4.53	11.19	4.82	1077	2266.5	7970.94	1574	5.06
1/22/2019	15:00:00	2.26	4.53	11.16	4.8	1076	2263.8	7961.45	1574	5.06
1/22/2019	16:00:00	2.26	4.54	11.27	4.85	1080	2289	8050.07	1574	5.11
1/22/2019	17:00:00	2.26	4.54	11.27	4.87	1084	2294	8067.65	1587	5.08
1/22/2019	18:00:00	2.33	4.66	10.04	4.82	1049	1811.6	6371.13	1587	4.01
1/22/2019	19:00:00	2.07	4.2	10.54	5.13	1148	2056.2	7231.35	1587	4.56
1/22/2019	20:00:00	2.09	4.34	10.52	4.86	1097	2052.5	7218.33	1587	4.55
1/22/2019	21:00:00	2.05	2.17	10.44	10.29	1	0	0.00	1587	0.00
1/22/2019	22:00:00	2.05	2.16	10.63	10.1	1	0.1	0.35	1587	0.00
1/22/2019	23:00:00	2.03	2.15	10.78	10.22	1	0.1	0.35	1587	0.00

(b)

1/23/2019	00:00:00	2.04	2.15	10.89	10.61	1	0.1	0.35	1587	0.00
1/23/2019	01:00:00	2.03	2.15	11	10.74	1	0.1	0.35	1587	0.00
1/23/2019	02:00:00	2.04	2.15	11.11	10.92	1	0	0.00	1587	0.00
1/23/2019	03:00:00	2.04	2.15	11.2	11.1	1	0	0.00	1587	0.00
1/23/2019	04:00:00	2.03	2.15	11.3	11.33	1	0	0.00	1587	0.00
1/23/2019	05:00:00	2.03	2.15	11.4	11.6	1	0	0.00	1587	0.00
1/23/2019	06:00:00	2.04	2.15	11.48	11.81	1	0	0.00	1587	0.00
1/23/2019	07:00:00	2.03	2.15	11.56	11.88	1	0	0.00	1587	0.00
1/23/2019	08:00:00	2.47	2.58	11.65	11.98	1	0	0.00	1587	0.00
1/23/2019	09:00:00	2.33	4.53	11.16	5.3	1111	2151.9	7567.91	1322	5.72
1/23/2019	10:00:00	2.32	4.66	11.37	4.84	1052	2270.4	7984.66	1498	5.33
1/23/2019	11:00:00	2.32	4.65	11.28	4.85	1044	2219.2	7804.59	1533	5.09
1/23/2019	12:00:00	2.32	4.65	11.19	4.81	1061	2238.9	7873.88	1533	5.14
1/23/2019	13:00:00	2.32	4.65	11.11	4.81	1052	2190.5	7703.66	1533	5.03
1/23/2019	14:00:00	2.23	4.46	11.6	5.19	1104	2339.7	8228.37	1533	5.37
1/23/2019	15:00:00	2.24	4.51	11.76	5.27	1073	2303.8	8102.12	1577	5.14
1/23/2019	16:00:00	2.23	4.52	11.13	4.84	1070	2227.4	7833.43	1582	4.95
1/23/2019	17:00:00	2.23	4.55	11.12	4.39	1053	2346.9	8253.70	1582	5.22
1/23/2019	18:00:00	2.06	4.12	10.1	4.98	1169	1981.8	6969.69	1582	4.41
1/23/2019	19:00:00	2.09	4.36	9.59	4.82	1084	1709.7	6012.76	1582	3.80
1/23/2019	20:00:00	2.09	4.37	9.56	4.8	1068	1677.9	5900.92	1582	3.73
1/23/2019	21:00:00	2.16	2.28	6.6	8.15	1	0	0.00	1582	0.00
1/23/2019	22:00:00	1.79	3.79	11.3	5.11	1195	2443.2	8592.37	1550	5.54
1/23/2019	23:00:00	1.79	3.78	11.28	5.11	1196	2442	8588.15	1558	5.51

(c)

1/24/2019	00:00:00	1.79	3.79	11.29	5.07	1199	2465.3	8670.09	1567	5.53
1/24/2019	01:00:00	1.79	3.79	11.28	5.09	1192	2439.5	8579.36	1589	5.40
1/24/2019	02:00:00	1.79	3.79	11.28	5.12	1197	2440.8	8583.93	1589	5.40
1/24/2019	03:00:00	1.79	3.79	11.28	5.11	1200	2447.7	8608.19	1589	5.42
1/24/2019	04:00:00	1.79	3.79	11.28	5.08	1199	2461.3	8656.02	1589	5.45
1/24/2019	05:00:00	1.79	3.8	11.28	5.03	1199	2475.4	8705.61	1589	5.48
1/24/2019	06:00:00	1.79	3.79	11.25	5.02	1194	2461.7	8657.43	1589	5.45
1/24/2019	07:00:00	2.23	2.34	8.35	8.39	1	0	0.00	1589	0.00
1/24/2019	08:00:00	2.23	2.34	8.56	8.42	0	0	0.00	1589	0.00
1/24/2019	09:00:00	2.4	2.51	8.71	8.58	1	0	0.00	1589	0.00
1/24/2019	10:00:00	2.4	2.51	8.84	8.07	1	0.2	0.70	1589	0.00
1/24/2019	11:00:00	2.4	2.51	8.95	8.2	1	0.2	0.70	1589	0.00
1/24/2019	12:00:00	2.4	2.51	9.06	8.01	1	0.2	0.70	1589	0.00
1/24/2019	13:00:00	2.4	2.51	9.18	7.88	1	0.3	1.06	1589	0.00
1/24/2019	14:00:00	2.4	2.51	9.3	8.3	1	0.2	0.70	1589	0.00
1/24/2019	15:00:00	2.4	2.52	9.42	8.15	1	0.3	1.06	1589	0.00
1/24/2019	16:00:00	2.4	2.51	9.53	8.39	1	0.3	1.06	1589	0.00
1/24/2019	17:00:00	2.41	2.52	9.64	8.27	1	0.3	1.06	1589	0.00
1/24/2019	18:00:00	2.32	2.43	9.74	8.54	1	0.3	1.06	1589	0.00
1/24/2019	19:00:00	2.41	2.52	9.85	8.75	1	0.2	0.70	1589	0.00
1/24/2019	20:00:00	2.23	2.34	9.93	8.7	1	0.3	1.06	1589	0.00
1/24/2019	21:00:00	2.04	2.15	10.31	10.28	1	0	0.00	1589	0.00
1/24/2019	22:00:00	2.02	2.13	10.42	8.94	1	0.3	1.06	1589	0.00
1/24/2019	23:00:00	2.02	2.13	10.57	8.58	1	0.5	1.76	1589	0.00

(d)

1/25/2019	00:00:00	2.02	2.13	10.68	8.72	1	0.4	1.41	1589	0.00
1/25/2019	01:00:00	2.02	2.13	10.79	8.34	1	0.6	2.11	1589	0.00
1/25/2019	02:00:00	2.02	2.14	10.88	8.11	1	0.8	2.81	1589	0.00
1/25/2019	03:00:00	2.02	2.13	10.98	8.75	1	0.6	2.11	1589	0.00
1/25/2019	04:00:00	2.02	2.13	11.06	8.41	1	0.6	2.11	1589	0.00
1/25/2019	05:00:00	2.02	2.13	11.15	8.65	1	0.7	2.46	1589	0.00
1/25/2019	06:00:00	2.02	2.13	11.24	8.48	1	0.8	2.81	1589	0.00
1/25/2019	07:00:00	2.23	2.34	11.32	8.17	1	0.7	2.46	1589	0.00
1/25/2019	08:00:00	2.4	2.52	11.4	9.29	1	0.4	1.41	1589	0.00
1/25/2019	09:00:00	2.33	4.94	10.8	7.48	931	1017.6	3578.75	946	3.78
1/25/2019	10:00:00	2.27	4.6	10.92	4.83	1039	2091.9	7356.90	1347	5.46
1/25/2019	11:00:00	2.27	4.6	10.84	4.82	1049	2092	7357.25	1347	5.46
1/25/2019	12:00:00	2.41	2.52	10.96	10.91	1	0	0.00	1360	0.00
1/25/2019	13:00:00	2.27	4.62	11.06	4.78	1051	2183.4	7678.69	1409	5.45
1/25/2019	14:00:00	2.27	4.61	10.84	4.78	1046	2096.8	7374.13	1409	5.23
1/25/2019	15:00:00	2.27	4.61	10.66	4.81	1048	2027.5	7130.41	1409	5.06
1/25/2019	16:00:00	2.27	4.61	10.71	4.81	1050	2050.5	7211.30	1409	5.12
1/25/2019	17:00:00	2.27	4.61	10.79	4.83	1047	2063.2	7255.96	1409	5.15
1/25/2019	18:00:00	2.09	4.37	9.8	4.82	1075	1767	6214.27	1409	4.41
1/25/2019	19:00:00	2.23	2.34	7.67	7.85	1	0	0.00	1409	0.00
1/25/2019	20:00:00	2.02	2.14	7.98	7.9	1	0	0.00	1409	0.00
1/25/2019	21:00:00	2.03	2.14	8.16	8.25	1	0	0.00	1409	0.00
1/25/2019	22:00:00	2.03	2.14	8.29	8.55	1	0	0.00	1409	0.00
1/25/2019	23:00:00	2.02	2.14	8.41	8.83	1	0	0.00	1409	0.00

(e)

1/26/2019	00:00:00	2.02	2.14	8.53	8.95	1	0	0.00	1409	0.00
1/26/2019	01:00:00	2.02	2.14	8.65	9.1	1	0	0.00	1409	0.00
1/26/2019	02:00:00	2.03	2.14	8.73	9.51	1	0	0.00	1409	0.00
1/26/2019	03:00:00	2.02	2.14	8.84	9.63	1	0	0.00	1409	0.00
1/26/2019	04:00:00	2.02	2.13	8.94	9.93	1	0	0.00	1409	0.00
1/26/2019	05:00:00	2.02	2.13	9.03	9.92	1	0	0.00	1409	0.00
1/26/2019	06:00:00	2.02	2.13	9.12	10.04	1	0	0.00	1409	0.00
1/26/2019	07:00:00	2.02	2.13	9.21	10.31	1	0	0.00	1409	0.00
1/26/2019	08:00:00	2.23	2.34	9.3	10.63	1	0	0.00	1409	0.00
1/26/2019	09:00:00	2.23	2.34	9.4	10.55	1	0	0.00	1409	0.00
1/26/2019	10:00:00	2.23	2.34	9.47	10.84	1	0	0.00	1409	0.00
1/26/2019	11:00:00	2.23	2.34	9.56	10.94	1	0	0.00	1409	0.00
1/26/2019	12:00:00	2.23	2.34	9.64	11.19	1	0	0.00	1409	0.00
1/26/2019	13:00:00	2.23	2.34	9.74	11.18	1	0	0.00	1409	0.00
1/26/2019	14:00:00	2.23	2.34	9.85	11.52	1	0	0.00	1409	0.00
1/26/2019	15:00:00	2.23	2.34	9.95	11.58	1	0	0.00	1409	0.00
1/26/2019	16:00:00	2.23	2.34	6.39	6.52	1	0	0.00	1409	0.00
1/26/2019	17:00:00	2.23	2.34	6.75	7.1	1	0	0.00	1409	0.00
1/26/2019	18:00:00	2.23	2.34	6.9	7.09	1	0	0.00	1409	0.00
1/26/2019	19:00:00	2.23	2.34	7.05	7.49	1	0	0.00	1409	0.00
1/26/2019	20:00:00	2.23	2.34	7.18	7.7	1	0	0.00	1409	0.00
1/26/2019	21:00:00	2.23	2.34	7.3	7.79	1	0	0.00	1409	0.00
1/26/2019	22:00:00	2.23	2.34	7.42	8.05	1	0	0.00	1409	0.00
1/26/2019	23:00:00	2.23	2.34	7.53	8.33	1	0	0.00	1409	0.00

(f)

1/27/2019	00:00:00	2.23	2.34	7.64	8.66	1	0	0.00	1409	0.00
1/27/2019	01:00:00	2.23	2.34	7.74	8.75	1	0	0.00	1409	0.00
1/27/2019	02:00:00	2.23	2.34	7.85	9.01	1	0	0.00	1409	0.00
1/27/2019	03:00:00	2.23	2.34	7.95	9.28	1	0	0.00	1409	0.00
1/27/2019	04:00:00	2.23	2.34	8.05	9.45	1	0	0.00	1409	0.00
1/27/2019	05:00:00	2.23	2.34	8.14	9.68	1	0	0.00	1409	0.00
1/27/2019	06:00:00	2.23	2.34	8.24	9.87	1	0	0.00	1409	0.00
1/27/2019	07:00:00	2.23	2.34	8.33	10.02	1	0	0.00	1409	0.00
1/27/2019	08:00:00	2.23	2.34	8.42	10.1	0	0	0.00	1409	0.00
1/27/2019	09:00:00	2.23	2.34	8.53	10.46	1	0	0.00	1409	0.00
1/27/2019	10:00:00	2.23	2.34	8.61	10.55	1	0	0.00	1409	0.00
1/27/2019	11:00:00	2.23	2.34	8.7	10.84	0	0	0.00	1409	0.00
1/27/2019	12:00:00	2.23	2.34	8.81	11	1	0	0.00	1409	0.00
1/27/2019	13:00:00	2.23	2.34	8.92	11.21	1	0	0.00	1409	0.00
1/27/2019	14:00:00	2.23	2.34	9.04	11.23	1	0	0.00	1409	0.00
1/27/2019	15:00:00	2.23	2.34	9.16	11.56	1	0	0.00	1409	0.00
1/27/2019	16:00:00	2.23	2.34	9.29	11.52	1	0	0.00	1409	0.00
1/27/2019	17:00:00	2.23	2.34	9.4	11.8	1	0	0.00	1409	0.00
1/27/2019	18:00:00	2.23	2.34	9.53	11.85	1	0	0.00	1409	0.00
1/27/2019	19:00:00	2.23	2.34	9.66	11.98	1	0	0.00	1409	0.00
1/27/2019	20:00:00	2.23	2.34	9.78	12.16	1	0	0.00	1409	0.00
1/27/2019	21:00:00	2.23	2.34	9.9	12.31	1	0	0.00	1409	0.00
1/27/2019	22:00:00	2.23	2.34	10.02	12.55	1	0	0.00	1409	0.00
1/27/2019	23:00:00	2.23	2.34	10.15	12.63	1	0	0.00	1409	0.00

(g)

APPENDIX E

DATA TABLE OF WEEK 5, 2019 (IN HOUR)

		PI-0120C1.PV	PI-0120C2.PV	TIC-0120C1.PV	TI-0120C2.PV	FIC-0120C1.PV	QI-0120C1.PV	QI-0120C1.PV	DPM3-11KV-M	RPD.PV
		CHW SUCTION P	CHW DISCHAGEP	EC-0120C CHR TEM	EC-0120C CHS TEM	CHILL WATER FLOW	HEAT SUMMATI	HEAT SUMMAT	MAX REAL PO	COP
		BAR	BAR	°C	°C	M3/H	RT	KW	KW	KW/KW
1/28/2019	00:00:00	2.23	2.34	10.27	12.67	1	0	0.00	1409	0.00
1/28/2019	01:00:00	2.23	2.34	10.39	12.88	1	0	0.00	1409	0.00
1/28/2019	02:00:00	2.23	2.34	10.5	13	1	0	0.00	1409	0.00
1/28/2019	03:00:00	2.23	2.34	10.63	13.03	1	0	0.00	1409	0.00
1/28/2019	04:00:00	2.23	2.34	10.74	13.28	1	0	0.00	1409	0.00
1/28/2019	05:00:00	2.23	2.34	10.84	13.3	1	0	0.00	1409	0.00
1/28/2019	06:00:00	2.23	2.34	10.96	13.4	1	0	0.00	1409	0.00
1/28/2019	07:00:00	2.23	2.34	11.07	13.41	0	0	0.00	1409	0.00
1/28/2019	08:00:00	2.23	2.34	11.19	10.05	1	0.3	1.06	1409	0.00
1/28/2019	09:00:00	2.24	5.09	11.9	11.53	821	100.2	352.39	1409	0.25
1/28/2019	10:00:00	2.47	2.58	11.85	9.42	1	0.4	1.41	1409	0.00
1/28/2019	11:00:00	2.47	2.58	11.98	9.2	1	0.6	2.11	1409	0.00
1/28/2019	12:00:00	2.32	4.6	11.49	4.84	1087	2391.2	8409.49	1495	5.63
1/28/2019	13:00:00	2.5	2.62	11.35	11.29	2	0	0.00	1495	0.00
1/28/2019	14:00:00	2.5	2.61	11.5	8.81	1	0.7	2.46	1495	0.00
1/28/2019	15:00:00	2.44	2.55	11.34	11.37	2	0	0.00	1495	0.00
1/28/2019	16:00:00	2.48	2.59	11.48	9.42	0	0.3	1.06	1495	0.00
1/28/2019	17:00:00	2.35	4.63	11.66	4.91	1077	2404.6	8456.62	1560	5.42
1/28/2019	18:00:00	2.49	2.6	11.33	9.64	1	0.5	1.76	1564	0.00
1/28/2019	19:00:00	1.88	4.14	11.7	6.5	1086	1866.1	6562.79	1243	5.28
1/28/2019	20:00:00	1.87	4.14	11.69	5.2	1087	2332	8201.29	1556	5.27
1/28/2019	21:00:00	1.88	4.15	11.69	5.02	1075	2371.3	8339.51	1556	5.36
1/28/2019	22:00:00	1.87	4.14	11.69	4.95	1089	2423.6	8523.44	1561	5.46
1/28/2019	23:00:00	1.87	4.15	11.68	4.83	1093	2475.8	8707.02	1578	5.52

(a)

1/29/2019	00:00:00	1.87	4.15	11.68	4.79	1081	2464.4	8666.93	1590	5.45
1/29/2019	01:00:00	1.88	4.15	11.68	4.79	1082	2465.2	8669.74	1590	5.45
1/29/2019	02:00:00	1.88	4.15	11.67	4.84	1079	2434.8	8562.83	1590	5.39
1/29/2019	03:00:00	1.88	4.15	11.65	4.83	1082	2441.3	8585.69	1590	5.40
1/29/2019	04:00:00	1.88	4.15	11.64	4.84	1080	2431	8549.46	1590	5.38
1/29/2019	05:00:00	1.87	4.09	11.57	4.88	1100	2432.8	8555.79	1590	5.38
1/29/2019	06:00:00	1.87	4.16	7.01	4.31	1076	962.6	3385.32	992	3.41
1/29/2019	07:00:00	2.29	2.41	6.08	6	1	0	0.00	0	0.00
1/29/2019	08:00:00	2.41	2.52	6.33	6.13	1	0	0.00	0	0.00
1/29/2019	09:00:00	2.46	2.57	6.46	6.22	1	0.1	0.35	0	0.00
1/29/2019	10:00:00	2.46	2.57	6.59	6.36	1	0	0.00	0	0.00
1/29/2019	11:00:00	2.25	4.53	11.3	4.84	1086	2316.7	8147.49	1396	5.84
1/29/2019	12:00:00	2.26	4.54	10.99	4.8	1085	2220.8	7810.22	1399	5.58
1/29/2019	13:00:00	2.25	4.53	10.94	4.82	1074	2172.3	7639.65	1399	5.46
1/29/2019	14:00:00	2.26	4.52	10.96	4.8	1085	2213.4	7784.20	1399	5.56
1/29/2019	15:00:00	2.26	4.53	10.99	4.82	1077	2197.4	7727.93	1399	5.52
1/29/2019	16:00:00	2.25	4.52	11.19	4.79	1083	2292.3	8061.68	1465	5.50
1/29/2019	17:00:00	2.25	4.53	11.15	4.78	1082	2279.1	8015.25	1473	5.44
1/29/2019	18:00:00	2.32	2.43	11.05	9.46	1	0.4	1.41	1473	0.00
1/29/2019	19:00:00	2.23	2.34	11.22	8.77	1	0.5	1.76	1473	0.00
1/29/2019	20:00:00	2.23	2.34	11.36	9.04	1	0.4	1.41	1473	0.00
1/29/2019	21:00:00	2.23	2.34	11.47	9.66	1	0.4	1.41	1473	0.00
1/29/2019	22:00:00	1.87	4.13	11.09	4.89	1091	2238.5	7872.47	1445	5.45
1/29/2019	23:00:00	1.87	4.12	11.07	4.86	1097	2253.7	7925.92	1445	5.49

(b)

1/30/2019	00:00:00	1.87	4.11	11.07	4.87	1092	2243.2	7889.00	1446	5.46
1/30/2019	01:00:00	1.88	4.17	11.07	4.8	1074	2229	7839.06	1446	5.42
1/30/2019	02:00:00	1.88	4.18	11.08	4.81	1068	2214.5	7788.06	1446	5.39
1/30/2019	03:00:00	1.88	4.16	11.07	4.78	1069	2223.8	7820.77	1446	5.41
1/30/2019	04:00:00	1.88	4.18	11.07	4.78	1079	2246.9	7902.01	1446	5.46
1/30/2019	05:00:00	1.88	4.14	11.07	4.79	1082	2247.7	7904.82	1448	5.46
1/30/2019	06:00:00	1.88	4.14	11.07	4.84	1085	2237.7	7869.66	1448	5.43
1/30/2019	07:00:00	1.85	4.04	11.06	4.8	1129	2337.8	8221.69	1485	5.54
1/30/2019	08:00:00	2.33	2.44	11.15	10.13	1	0.2	0.70	1488	0.00
1/30/2019	09:00:00	2.33	2.44	11.29	8.46	1	0.6	2.11	1488	0.00
1/30/2019	10:00:00	2.33	2.44	11.4	8.39	1	0.7	2.46	1488	0.00
1/30/2019	11:00:00	2.48	2.59	11.49	7.5	1	0.9	3.17	1488	0.00
1/30/2019	12:00:00	2.48	2.59	11.59	8.02	0	0.5	1.76	1488	0.00
1/30/2019	13:00:00	2.48	2.59	11.69	7.72	1	0.7	2.46	1488	0.00
1/30/2019	14:00:00	2.48	2.59	11.8	8.56	1	0.9	3.17	1488	0.00
1/30/2019	15:00:00	2.48	2.59	11.88	8.06	1	0.8	2.81	1488	0.00
1/30/2019	16:00:00	2.48	2.59	12	8.09	1	0.7	2.46	1488	0.00
1/30/2019	17:00:00	2.49	2.6	12.1	8.16	1	1	3.52	1488	0.00
1/30/2019	18:00:00	2.23	2.34	12.19	8.67	1	0.9	3.17	1488	0.00
1/30/2019	19:00:00	2.23	2.34	12.29	9.45	1	0.6	2.11	1488	0.00
1/30/2019	20:00:00	2.23	2.34	12.38	9.86	1	0.5	1.76	1488	0.00
1/30/2019	21:00:00	2.04	4.3	12.17	6.05	1087	2200.3	7738.13	1569	4.93
1/30/2019	22:00:00	2.03	4.27	12.12	6.25	1102	2139.9	7525.71	1573	4.78
1/30/2019	23:00:00	1.88	4.19	12.04	5.31	1070	2382.6	8379.25	1573	5.33

(c)

1/31/2019	00:00:00	1.87	4.13	12	5.28	1089	2421	8514.29	1573	5.41
1/31/2019	01:00:00	1.87	4.12	11.98	5.26	1083	2407.2	8465.76	1573	5.38
1/31/2019	02:00:00	1.87	4.13	11.94	5.14	1085	2441.4	8586.04	1573	5.46
1/31/2019	03:00:00	1.87	4.14	11.87	5.01	1093	2478.4	8716.16	1573	5.54
1/31/2019	04:00:00	1.87	4.15	11.82	4.93	1083	2467.5	8677.83	1573	5.52
1/31/2019	05:00:00	1.88	4.14	11.79	4.91	1086	2469.1	8683.45	1573	5.52
1/31/2019	06:00:00	1.87	4.1	11.64	4.79	1099	2491.1	8760.83	1573	5.57
1/31/2019	07:00:00	1.88	4.16	11.55	4.69	1070	2426.6	8533.99	1573	5.43
1/31/2019	08:00:00	2.32	2.43	11.67	10.59	1	0.3	1.06	1573	0.00
1/31/2019	09:00:00	2.32	2.44	11.79	10.92	1	0.2	0.70	1573	0.00
1/31/2019	10:00:00	2.32	2.43	11.91	11.02	1	0.2	0.70	1573	0.00
1/31/2019	11:00:00	2.48	2.59	12.01	11.2	1	0.2	0.70	1573	0.00
1/31/2019	12:00:00	2.48	2.59	12.12	11.34	1	0.2	0.70	1573	0.00
1/31/2019	13:00:00	2.48	2.59	12.24	11.67	1	0.1	0.35	1573	0.00
1/31/2019	14:00:00	2.49	2.61	12.33	11.77	0	0.1	0.35	1573	0.00
1/31/2019	15:00:00	2.39	2.5	12.44	11.65	1	0.2	0.70	1573	0.00
1/31/2019	16:00:00	2.39	2.5	12.55	12	1	0.1	0.35	1573	0.00
1/31/2019	17:00:00	2.48	2.59	12.65	12.13	1	0.1	0.35	1573	0.00
1/31/2019	18:00:00	2.23	2.34	12.75	12.28	1	0.1	0.35	1573	0.00
1/31/2019	19:00:00	2.23	2.34	12.85	12.52	1	0.1	0.35	1573	0.00
1/31/2019	20:00:00	2.23	2.34	12.95	12.79	1	0	0.00	1573	0.00
1/31/2019	21:00:00	2.23	2.34	13.05	13.06	1	0	0.00	1573	0.00
1/31/2019	22:00:00	2.23	2.34	13.14	13.24	1	0	0.00	1573	0.00
1/31/2019	23:00:00	1.88	4.14	11.74	5.12	1084	2376	8356.04	1558	5.36

(d)

02-01-19	00:00:00	1.88	4.14	11.73	5.08	1091	2399.9	8440.09	1570	5.38
02-01-19	01:00:00	1.87	4.14	11.71	5.02	1076	2379.8	8369.40	1570	5.33
02-01-19	02:00:00	1.88	4.17	11.55	4.76	1074	2409.9	8475.26	1570	5.40
02-01-19	03:00:00	1.89	4.19	11.53	4.68	1069	2421.3	8515.35	1570	5.42
02-01-19	04:00:00	1.87	4.13	11.52	4.85	1087	2400.3	8441.50	1570	5.38
02-01-19	05:00:00	1.88	4.17	11.51	4.78	1069	2382.7	8379.60	1570	5.34
02-01-19	06:00:00	1.87	4.13	11.51	4.74	1085	2430.6	8548.06	1570	5.44
02-01-19	07:00:00	1.87	4.12	11.51	4.86	1087	2390.4	8406.68	1570	5.35
02-01-19	08:00:00	2.23	2.34	11.54	11.54	1	0	0.00	1570	0.00
02-01-19	09:00:00	2.23	2.34	11.69	10.34	1	0.3	1.06	1570	0.00
02-01-19	10:00:00	2.23	2.34	11.81	10.86	1	0.2	0.70	1570	0.00
02-01-19	11:00:00	2.23	2.34	11.92	11.2	1	0.1	0.35	1570	0.00
02-01-19	12:00:00	2.23	2.34	12.02	11.3	1	0.1	0.35	1570	0.00
02-01-19	13:00:00	2.23	2.34	12.12	11.57	1	0.1	0.35	1570	0.00
02-01-19	14:00:00	2.23	2.34	12.23	11.92	1	0.1	0.35	1570	0.00
02-01-19	15:00:00	2.23	2.34	12.34	12.03	1	0.1	0.35	1570	0.00
02-01-19	16:00:00	2.47	2.58	12.44	12.37	1	0	0.00	1570	0.00
02-01-19	17:00:00	2.47	2.59	12.55	12.28	1	0.1	0.35	1570	0.00
02-01-19	18:00:00	2.29	2.4	12.66	12.35	1	0.1	0.35	1570	0.00
02-01-19	19:00:00	2.23	2.34	12.75	12.59	1	0	0.00	1570	0.00
02-01-19	20:00:00	2.23	2.34	12.85	12.74	1	0	0.00	1570	0.00
02-01-19	21:00:00	2.23	2.34	12.94	12.95	1	0	0.00	1570	0.00
02-01-19	22:00:00	2.23	2.34	13.04	12.94	1	0	0.00	1570	0.00
02-01-19	23:00:00	2.23	2.34	13.12	13.16	1	0	0.00	1570	0.00

(e)

02-02-19	00:00:00	2.23	2.34	13.2	13.23	1	0	0.00	1570	0.00
02-02-19	01:00:00	2.23	2.34	13.28	13.32	1	0	0.00	1570	0.00
02-02-19	02:00:00	2.23	2.34	13.35	13.71	1	0	0.00	1570	0.00
02-02-19	03:00:00	2.23	2.34	13.44	13.63	1	0	0.00	1570	0.00
02-02-19	04:00:00	2.23	2.34	13.52	13.77	1	0	0.00	1570	0.00
02-02-19	05:00:00	2.23	2.34	13.59	13.97	1	0	0.00	1570	0.00
02-02-19	06:00:00	2.23	2.34	13.65	14.03	1	0	0.00	1570	0.00
02-02-19	07:00:00	2.23	2.34	13.73	14.27	1	0	0.00	1570	0.00
02-02-19	08:00:00	2.23	2.34	13.79	14.34	1	0	0.00	1570	0.00
02-02-19	09:00:00	2.23	2.34	13.86	14.42	1	0	0.00	1570	0.00
02-02-19	10:00:00	2.23	2.34	13.93	14.44	1	0	0.00	1570	0.00
02-02-19	11:00:00	2.23	2.34	14.01	14.67	1	0	0.00	1570	0.00
02-02-19	12:00:00	2.23	2.34	14.09	14.74	1	0	0.00	1570	0.00
02-02-19	13:00:00	2.23	2.34	14.17	14.97	1	0	0.00	1570	0.00
02-02-19	14:00:00	2.23	2.34	14.25	14.94	1	0	0.00	1570	0.00
02-02-19	15:00:00	2.23	2.34	14.33	15.13	1	0	0.00	1570	0.00
02-02-19	16:00:00	2.23	2.34	14.43	15.16	1	0	0.00	1570	0.00
02-02-19	17:00:00	2.23	2.34	14.53	15.4	0	0	0.00	1570	0.00
02-02-19	18:00:00	2.23	2.34	14.6	15.33	1	0	0.00	1570	0.00
02-02-19	19:00:00	2.23	2.34	14.68	15.54	1	0	0.00	1570	0.00
02-02-19	20:00:00	2.23	2.34	14.75	15.62	1	0	0.00	1570	0.00
02-02-19	21:00:00	2.23	2.34	14.84	15.67	1	0	0.00	1570	0.00
02-02-19	22:00:00	2.23	2.34	14.92	15.59	1	0	0.00	1570	0.00
02-02-19	23:00:00	2.23	2.34	14.99	15.79	1	0	0.00	1570	0.00

(f)

02-03-19	00:00:00	2.23	2.34	15.08	15.85	1	0	0.00	1570	0.00
02-03-19	01:00:00	2.23	2.34	15.15	16.1	1	0	0.00	1570	0.00
02-03-19	02:00:00	2.23	2.34	15.23	16.08	1	0	0.00	1570	0.00
02-03-19	03:00:00	2.23	2.34	15.3	16.1	1	0	0.00	1570	0.00
02-03-19	04:00:00	2.23	2.34	15.37	16.24	1	0	0.00	1570	0.00
02-03-19	05:00:00	2.23	2.34	15.45	16.19	1	0	0.00	1570	0.00
02-03-19	06:00:00	2.23	2.34	15.52	16.23	1	0	0.00	1570	0.00
02-03-19	07:00:00	2.23	2.34	15.59	16.37	1	0	0.00	1570	0.00
02-03-19	08:00:00	2.23	2.34	15.66	16.44	1	0	0.00	1570	0.00
02-03-19	09:00:00	2.23	2.34	15.73	16.41	1	0	0.00	1570	0.00
02-03-19	10:00:00	2.23	2.34	15.82	16.6	1	0	0.00	1570	0.00
02-03-19	11:00:00	2.23	2.34	15.89	16.58	1	0	0.00	1570	0.00
02-03-19	12:00:00	2.23	2.34	15.97	16.82	1	0	0.00	1570	0.00
02-03-19	13:00:00	2.23	2.34	16.06	16.71	1	0	0.00	1570	0.00
02-03-19	14:00:00	2.23	2.34	16.14	16.72	1	0	0.00	1570	0.00
02-03-19	15:00:00	2.23	2.34	16.24	16.8	1	0	0.00	1570	0.00
02-03-19	16:00:00	2.23	2.34	16.33	16.97	0	0	0.00	1570	0.00
02-03-19	17:00:00	2.23	2.34	16.43	17.01	1	0	0.00	1570	0.00
02-03-19	18:00:00	2.23	2.34	16.51	17.05	1	0	0.00	1570	0.00
02-03-19	19:00:00	2.23	2.34	16.6	17.2	1	0	0.00	1570	0.00
02-03-19	20:00:00	2.23	2.34	16.69	17.26	1	0	0.00	1570	0.00
02-03-19	21:00:00	2.23	2.34	16.75	17.2	1	0	0.00	1570	0.00
02-03-19	22:00:00	2.23	2.34	16.83	17.37	0	0	0.00	1570	0.00
02-03-19	23:00:00	2.23	2.34	16.91	13.83	1	0.7	2.46	1570	0.00

(g)

APPENDIX F

DATA TABLE OF WEEK 6, 2019 (IN HOUR)

		PI-0120C1.PV	PI-0120C2.PV	TIC-0120C1.PV	TI-0120C2.PV	FIC-0120C1.PV	QI-0120C1.PV	QI-0120C1.PV	DPM3-11KV-	MRPD.PV
		CHW SUCTION	CHW DISCHAC	EC-0120C CHR T	EC-0120C CHS	CHILL WATER FL	HEAT SUMMAT	HEAT SUMMAT	MAX REAL PC	COP
		BAR	BAR	°C	°C	M3/H	RT	KW	KW	KW/KW
02-04-19	00:00:00	2.03	4.29	11.36	6.13	1087	1875.8	6596.91	1297	5.09
02-04-19	01:00:00	2.03	4.29	11.08	4.86	1086	2233.8	7855.94	1453	5.41
02-04-19	02:00:00	2.04	4.36	11.04	4.81	1060	2182.3	7674.82	1453	5.28
02-04-19	03:00:00	1.99	4.34	11.03	4.69	1035	2169.9	7631.21	1453	5.25
02-04-19	04:00:00	1.87	4.14	11.01	4.83	1081	2212	7779.27	1456	5.34
02-04-19	05:00:00	1.87	4.14	10.99	4.81	1080	2209.3	7769.78	1458	5.33
02-04-19	06:00:00	1.87	4.12	10.78	4.82	1091	2151.2	7565.45	1458	5.19
02-04-19	07:00:00	2.23	2.34	5.82	5.85	1	0	0.00	0	0.00
02-04-19	08:00:00	2.4	2.52	6.04	5.9	1	0	0.00	0	0.00
02-04-19	09:00:00	2.41	2.52	6.25	6.12	1	0	0.00	0	0.00
02-04-19	10:00:00	2.4	2.52	6.39	6.42	1	0	0.00	0	0.00
02-04-19	11:00:00	2.42	2.53	6.51	6.61	1	0	0.00	0	0.00
02-04-19	12:00:00	2.43	2.54	6.64	6.71	1	0	0.00	0	0.00
02-04-19	13:00:00	2.43	2.54	6.76	6.84	1	0	0.00	0	0.00
02-04-19	14:00:00	2.42	2.53	6.89	7.14	1	0	0.00	0	0.00
02-04-19	15:00:00	2.42	2.53	7.01	7.47	1	0	0.00	0	0.00
02-04-19	16:00:00	2.51	2.63	7.14	7.58	1	0	0.00	0	0.00
02-04-19	17:00:00	2.51	2.62	7.25	7.61	1	0	0.00	0	0.00
02-04-19	18:00:00	2.23	2.34	7.37	8.07	1	0	0.00	0	0.00
02-04-19	19:00:00	2.23	2.34	7.47	8.02	1	0	0.00	0	0.00
02-04-19	20:00:00	2.23	2.34	7.58	8.43	1	0	0.00	0	0.00
02-04-19	21:00:00	2.23	2.34	7.69	8.64	1	0	0.00	0	0.00
02-04-19	22:00:00	2.23	2.34	7.79	8.84	1	0	0.00	0	0.00
02-04-19	23:00:00	2.02	2.14	7.89	9.03	1	0	0.00	0	0.00

(a)

02-05-19	00:00:00	2.02	2.14	7.98	9.07	1	0	0.00	0	0.00
02-05-19	01:00:00	2.02	2.14	8.09	9.33	1	0	0.00	0	0.00
02-05-19	02:00:00	2.02	2.14	8.19	9.66	1	0	0.00	0	0.00
02-05-19	03:00:00	2.02	2.14	8.29	9.66	1	0	0.00	0	0.00
02-05-19	04:00:00	2.02	2.13	8.38	9.86	1	0	0.00	0	0.00
02-05-19	05:00:00	2.02	2.13	8.48	9.99	1	0	0.00	0	0.00
02-05-19	06:00:00	2.02	2.13	8.58	10.26	1	0	0.00	0	0.00
02-05-19	07:00:00	2.02	2.14	8.69	10.38	1	0	0.00	0	0.00
02-05-19	08:00:00	2.23	2.34	8.78	10.42	1	0	0.00	0	0.00
02-05-19	09:00:00	2.32	2.43	8.86	10.71	1	0	0.00	0	0.00
02-05-19	10:00:00	2.29	2.4	8.97	10.77	1	0	0.00	0	0.00
02-05-19	11:00:00	2.29	2.4	9.07	10.86	1	0	0.00	0	0.00
02-05-19	12:00:00	2.29	2.41	9.16	11.08	1	0	0.00	0	0.00
02-05-19	13:00:00	2.29	2.41	9.27	11.24	1	0	0.00	0	0.00
02-05-19	14:00:00	2.29	2.4	9.39	11.15	1	0	0.00	0	0.00
02-05-19	15:00:00	2.29	2.4	9.51	11.44	1	0	0.00	0	0.00
02-05-19	16:00:00	2.31	2.42	9.63	11.64	1	0	0.00	0	0.00
02-05-19	17:00:00	2.31	2.43	9.75	11.55	1	0	0.00	0	0.00
02-05-19	18:00:00	2.31	2.42	9.89	11.72	1	0	0.00	0	0.00
02-05-19	19:00:00	2.23	2.34	10.02	11.82	1	0	0.00	0	0.00
02-05-19	20:00:00	2.23	2.34	10.15	12.09	1	0	0.00	0	0.00
02-05-19	21:00:00	2.23	2.34	10.26	12.16	1	0	0.00	0	0.00
02-05-19	22:00:00	2.23	2.34	10.36	12.21	1	0	0.00	0	0.00
02-05-19	23:00:00	2.23	2.34	10.46	12.37	1	0	0.00	0	0.00

(b)

02-06-19	00:00:00	2.23	2.34	10.57	12.67	1	0	0.00	0	0.00
02-06-19	01:00:00	2.23	2.34	10.67	12.7	0	0	0.00	0	0.00
02-06-19	02:00:00	2.23	2.34	10.76	12.69	0	0	0.00	0	0.00
02-06-19	03:00:00	2.23	2.34	10.88	12.83	1	0	0.00	0	0.00
02-06-19	04:00:00	2.23	2.34	10.99	12.98	1	0	0.00	0	0.00
02-06-19	05:00:00	2.23	2.34	11.09	13.03	1	0	0.00	0	0.00
02-06-19	06:00:00	2.23	2.34	11.2	13.12	1	0	0.00	0	0.00
02-06-19	07:00:00	2.23	2.34	11.31	13.12	1	0	0.00	0	0.00
02-06-19	08:00:00	2.23	2.34	11.41	13.23	1	0	0.00	0	0.00
02-06-19	09:00:00	2.23	2.34	11.5	13.26	1	0	0.00	0	0.00
02-06-19	10:00:00	2.23	2.34	11.6	13.44	1	0	0.00	0	0.00
02-06-19	11:00:00	2.23	2.34	11.71	13.51	1	0	0.00	0	0.00
02-06-19	12:00:00	2.23	2.34	11.82	13.63	1	0	0.00	0	0.00
02-06-19	13:00:00	2.23	2.34	11.93	13.66	1	0	0.00	0	0.00
02-06-19	14:00:00	2.23	2.34	12.05	13.75	1	0	0.00	0	0.00
02-06-19	15:00:00	2.3	2.42	12.17	13.88	1	0	0.00	0	0.00
02-06-19	16:00:00	2.31	2.42	12.29	13.92	1	0	0.00	0	0.00
02-06-19	17:00:00	2.3	2.42	12.42	13.93	1	0	0.00	0	0.00
02-06-19	18:00:00	2.3	2.42	12.54	14.02	1	0	0.00	0	0.00
02-06-19	19:00:00	2.23	2.34	12.64	14	1	0	0.00	0	0.00
02-06-19	20:00:00	2.23	2.34	12.77	14.03	0	0	0.00	0	0.00
02-06-19	21:00:00	2.23	2.34	12.87	14.2	1	0	0.00	0	0.00
02-06-19	22:00:00	2.23	2.34	12.96	14.25	1	0	0.00	0	0.00
02-06-19	23:00:00	2.04	4.3	11.15	4.89	1089	2257	7937.53	1497	5.30

(c)

02-07-19	00:00:00	2.03	4.3	11.14	4.99	1090	2217.9	7800.02	1588	4.91
02-07-19	01:00:00	2.04	4.31	11.14	4.69	1084	2316	8145.02	1588	5.13
02-07-19	02:00:00	1.87	4.13	11.14	4.85	1084	2254.4	7928.39	1588	4.99
02-07-19	03:00:00	1.88	4.15	11.15	4.83	1088	2272.3	7991.34	1588	5.03
02-07-19	04:00:00	1.88	4.15	11.14	4.83	1070	2234.2	7857.35	1588	4.95
02-07-19	05:00:00	1.87	4.14	11.14	4.82	1081	2260.1	7948.43	1588	5.01
02-07-19	06:00:00	1.88	4.14	11.14	4.83	1075	2242.2	7885.48	1588	4.97
02-07-19	07:00:00	1.88	4.14	11.13	4.83	1077	2241.1	7881.61	1588	4.96
02-07-19	08:00:00	2.48	2.6	11.25	10.92	1	0.1	0.35	1588	0.00
02-07-19	09:00:00	2.48	2.59	11.39	10.92	1	0.1	0.35	1588	0.00
02-07-19	10:00:00	2.48	2.59	11.51	10.96	1	0.1	0.35	1588	0.00
02-07-19	11:00:00	2.48	2.59	11.6	11.2	1	0.1	0.35	1588	0.00
02-07-19	12:00:00	2.4	2.51	11.69	11.19	1	0.1	0.35	1588	0.00
02-07-19	13:00:00	2.4	2.51	11.8	11.33	1	0.1	0.35	1588	0.00
02-07-19	14:00:00	2.4	2.51	11.89	11.29	1	0.1	0.35	1588	0.00
02-07-19	15:00:00	2.4	2.51	12	11.47	1	0.1	0.35	1588	0.00
02-07-19	16:00:00	2.23	2.34	12.1	11.83	1	0.1	0.35	1588	0.00
02-07-19	17:00:00	2.23	2.34	12.2	11.85	1	0.1	0.35	1588	0.00
02-07-19	18:00:00	2.23	2.34	12.3	12.2	1	0	0.00	1588	0.00
02-07-19	19:00:00	2.23	2.34	12.41	12.29	1	0	0.00	1588	0.00
02-07-19	20:00:00	2.23	2.34	12.5	12.46	1	0	0.00	1588	0.00
02-07-19	21:00:00	2.23	2.34	12.6	12.71	1	0	0.00	1588	0.00
02-07-19	22:00:00	2.13	5.01	11.81	12.74	803	0	0.00	1588	0.00
02-07-19	23:00:00	1.87	4.15	11.21	4.8	1083	2294.5	8069.41	1478	5.46

(d)

02-08-19	00:00:00	1.87	4.15	11.2	4.83	1081	2278.8	8014.20	1478	5.42
02-08-19	01:00:00	1.88	4.15	11.2	4.82	1071	2259.1	7944.92	1480	5.37
02-08-19	02:00:00	1.88	4.14	11.2	4.79	1080	2292	8060.62	1480	5.45
02-08-19	03:00:00	1.88	4.15	11.2	4.81	1091	2304.6	8104.93	1480	5.48
02-08-19	04:00:00	1.88	4.14	11.2	4.84	1083	2276.9	8007.52	1480	5.41
02-08-19	05:00:00	1.87	4.14	11.19	4.82	1068	2252.2	7920.65	1480	5.35
02-08-19	06:00:00	1.88	4.15	11.19	4.81	1082	2283.8	8031.78	1480	5.43
02-08-19	07:00:00	1.88	4.15	11.18	4.84	1080	2266.5	7970.94	1480	5.39
02-08-19	08:00:00	2.3	2.41	11.22	11.21	1	0	0.00	1480	0.00
02-08-19	09:00:00	2.31	2.42	11.37	10.97	1	0.1	0.35	1480	0.00
02-08-19	10:00:00	2.48	2.6	11.49	11.03	1	0.1	0.35	1480	0.00
02-08-19	11:00:00	2.48	2.59	11.59	11.11	1	0.1	0.35	1480	0.00
02-08-19	12:00:00	2.48	2.59	11.69	11.18	1	0.1	0.35	1480	0.00
02-08-19	13:00:00	2.48	2.59	11.8	11.31	1	0.1	0.35	1480	0.00
02-08-19	14:00:00	2.47	2.59	11.91	11.55	1	0.1	0.35	1480	0.00
02-08-19	15:00:00	2.48	2.59	12.03	11.61	1	0.1	0.35	1480	0.00
02-08-19	16:00:00	2.42	2.53	12.13	11.89	1	0.1	0.35	1480	0.00
02-08-19	17:00:00	2.42	2.54	12.25	11.78	1	0.1	0.35	1480	0.00
02-08-19	18:00:00	2.23	2.34	12.36	12.17	1	0	0.00	1480	0.00
02-08-19	19:00:00	2.23	2.34	12.47	12.41	1	0	0.00	1480	0.00
02-08-19	20:00:00	2.23	2.34	12.57	12.61	1	0	0.00	1480	0.00
02-08-19	21:00:00	2.23	2.34	12.65	12.71	1	0	0.00	1480	0.00
02-08-19	22:00:00	2.23	2.34	12.74	13.06	1	0	0.00	1480	0.00
02-08-19	23:00:00	1.88	4.13	12.11	5.33	1091	2449.5	8614.52	1574	5.47

(e)

02-09-19	00:00:00	1.88	4.14	11.95	5.29	1083	2388.5	8400.00	1574	5.34
02-09-19	01:00:00	1.88	4.14	11.93	5.24	1085	2397.2	8430.59	1574	5.36
02-09-19	02:00:00	1.88	4.2	11.92	5.09	1066	2408.2	8469.28	1574	5.38
02-09-19	03:00:00	1.87	4.13	11.92	5.19	1089	2423.8	8524.14	1574	5.42
02-09-19	04:00:00	1.87	4.13	11.91	5.15	1092	2439.6	8579.71	1574	5.45
02-09-19	05:00:00	1.88	4.18	11.91	5.01	1068	2437.6	8572.67	1574	5.45
02-09-19	06:00:00	1.87	4.12	11.9	5.12	1089	2443.6	8593.77	1574	5.46
02-09-19	07:00:00	1.88	4.14	11.91	5.07	1090	2464	8665.52	1574	5.51
02-09-19	08:00:00	2.23	2.34	11.94	11.92	1	0	0.00	1578	0.00
02-09-19	09:00:00	2.23	2.34	12.05	11.77	1	0.1	0.35	1578	0.00
02-09-19	10:00:00	2.23	2.34	12.17	11.89	1	0.1	0.35	1578	0.00
02-09-19	11:00:00	2.23	2.34	12.27	12.09	1	0	0.00	1578	0.00
02-09-19	12:00:00	2.23	2.34	12.38	12.2	0	0	0.00	1578	0.00
02-09-19	13:00:00	2.23	2.34	12.48	12.46	1	0	0.00	1578	0.00
02-09-19	14:00:00	2.23	2.34	12.59	12.56	1	0	0.00	1578	0.00
02-09-19	15:00:00	2.23	2.34	12.7	12.83	1	0	0.00	1578	0.00
02-09-19	16:00:00	2.23	2.34	12.8	12.86	0	0	0.00	1578	0.00
02-09-19	17:00:00	2.23	2.34	12.92	13.1	1	0	0.00	1578	0.00
02-09-19	18:00:00	2.23	2.34	13.03	13.24	1	0	0.00	1578	0.00
02-09-19	19:00:00	2.23	2.34	13.12	13.47	1	0	0.00	1578	0.00
02-09-19	20:00:00	2.23	2.34	13.22	13.66	1	0	0.00	1578	0.00
02-09-19	21:00:00	2.23	2.34	13.3	13.85	0	0	0.00	1578	0.00
02-09-19	22:00:00	2.23	2.34	13.38	13.96	1	0	0.00	1578	0.00
02-09-19	23:00:00	2.23	2.34	13.46	14	1	0	0.00	1578	0.00

(f)

02-10-19	00:00:00	2.23	2.34	13.55	14.15	1	0	0.00	1578	0.00
02-10-19	01:00:00	2.23	2.34	13.62	14.36	1	0	0.00	1578	0.00
02-10-19	02:00:00	2.23	2.34	13.69	14.58	1	0	0.00	1578	0.00
02-10-19	03:00:00	2.23	2.34	13.77	14.79	1	0	0.00	1578	0.00
02-10-19	04:00:00	2.23	2.34	13.85	14.81	1	0	0.00	1578	0.00
02-10-19	05:00:00	2.23	2.34	13.92	14.83	0	0	0.00	1578	0.00
02-10-19	06:00:00	2.23	2.34	14	14.96	1	0	0.00	1578	0.00
02-10-19	07:00:00	2.23	2.34	14.06	15.24	1	0	0.00	1578	0.00
02-10-19	08:00:00	2.23	2.34	14.14	15.49	1	0	0.00	1578	0.00
02-10-19	09:00:00	2.23	2.34	14.21	15.34	1	0	0.00	1578	0.00
02-10-19	10:00:00	2.23	2.34	14.28	15.54	1	0	0.00	1578	0.00
02-10-19	11:00:00	2.23	2.34	14.35	15.64	0	0	0.00	1578	0.00
02-10-19	12:00:00	2.23	2.34	14.43	15.73	1	0	0.00	1578	0.00
02-10-19	13:00:00	2.23	2.34	14.51	15.85	1	0	0.00	1578	0.00
02-10-19	14:00:00	2.23	2.34	14.59	15.93	1	0	0.00	1578	0.00
02-10-19	15:00:00	2.23	2.34	14.69	16.12	1	0	0.00	1578	0.00
02-10-19	16:00:00	2.23	2.34	14.79	16.22	1	0	0.00	1578	0.00
02-10-19	17:00:00	2.23	2.34	14.85	16.28	1	0	0.00	1578	0.00
02-10-19	18:00:00	2.23	2.34	14.93	16.39	1	0	0.00	1578	0.00
02-10-19	19:00:00	2.23	2.34	15	16.48	1	0	0.00	1578	0.00
02-10-19	20:00:00	2.23	2.34	15.09	16.7	1	0	0.00	1578	0.00
02-10-19	21:00:00	2.23	2.34	15.17	16.7	1	0	0.00	1578	0.00
02-10-19	22:00:00	2.23	2.34	15.24	16.85	0	0	0.00	1578	0.00
02-10-19	23:00:00	2.23	2.34	15.31	16.83	0	0	0.00	1578	0.00

(g)

APPRNDIX G

DATA TABLE OF WEEK 7, 2019 (IN HOUR)

		PI-0120C1.PV	PI-0120C2.PV	TIC-0120C1.PV	TI-0120C2.PV	FIC-0120C1.PV	QI-0120C1.PV	QI-0120C1.PV	DPM3-11KV-MRPD.PV
		CHW SUCTION	CHW DISCHA	EC-0120C CHR	EC-0120C CHS	CHILL WATER F	HEAT SUMMA	HEAT SUMMA	MAX REAL P COP
		BAR	BAR	°C	°C	M3/H	RT	KW	KW KW/KW
02-11-19	00:00:00	2.23	2.34	15.4	16.86	1	0	0.00	1578	0.00
02-11-19	01:00:00	2.23	2.34	15.47	17.03	1	0	0.00	1578	0.00
02-11-19	02:00:00	2.23	2.34	15.55	17	0	0	0.00	1578	0.00
02-11-19	03:00:00	2.23	2.34	15.64	17.16	0	0	0.00	1578	0.00
02-11-19	04:00:00	2.23	2.34	15.71	17.25	1	0	0.00	1578	0.00
02-11-19	05:00:00	2.23	2.34	15.78	17.24	1	0	0.00	1578	0.00
02-11-19	06:00:00	2.23	2.34	15.85	17.4	1	0	0.00	1578	0.00
02-11-19	07:00:00	2.3	2.42	15.92	13.55	1	0.6	2.11	1578	0.00
02-11-19	08:00:00	2.28	2.4	15.99	12.59	1	0.8	2.81	1578	0.00
02-11-19	09:00:00	2.28	2.39	16.05	12.07	1	0.7	2.46	1578	0.00
02-11-19	10:00:00	2.41	2.52	16.13	12.02	1	0.8	2.81	1578	0.00
02-11-19	11:00:00	2.41	2.52	16.19	11.08	1	1.2	4.22	1578	0.00
02-11-19	12:00:00	2.4	2.52	16.27	11.65	0	0.6	2.11	1578	0.00
02-11-19	13:00:00	2.4	2.52	16.35	11.86	1	1	3.52	1578	0.00
02-11-19	14:00:00	2.4	2.52	16.42	11.31	1	1.2	4.22	1578	0.00
02-11-19	15:00:00	2.4	2.51	16.5	10.91	1	1.3	4.57	1578	0.00
02-11-19	16:00:00	2.41	2.52	16.59	10.6	1	1.1	3.87	1578	0.00
02-11-19	17:00:00	2.47	2.58	16.67	11.35	1	1.2	4.22	1578	0.00
02-11-19	18:00:00	2.23	2.34	16.76	10.58	1	1.2	4.22	1578	0.00
02-11-19	19:00:00	2.23	2.34	16.84	11.74	1	1.2	4.22	1578	0.00
02-11-19	20:00:00	2.04	4.31	11.77	6.47	1085	1899.5	6680.26	1256	5.32
02-11-19	21:00:00	2.04	4.32	11.74	4.94	1086	2446.6	8604.33	1574	5.47
02-11-19	22:00:00	2.04	4.35	11.74	4.74	1077	2494	8771.02	1574	5.57
02-11-19	23:00:00	1.87	4.12	11.73	4.9	1092	2468.9	8682.75	1574	5.52

(a)

02-12-19	00:00:00	1.88	4.17	11.73	4.75	1073	2480.5	8723.55	1574	5.54
02-12-19	01:00:00	1.87	4.14	11.73	4.82	1080	2467.6	8678.18	1574	5.51
02-12-19	02:00:00	1.88	4.14	11.73	4.81	1082	2478.8	8717.57	1574	5.54
02-12-19	03:00:00	1.87	4.14	11.74	4.82	1081	2472.7	8696.11	1574	5.52
02-12-19	04:00:00	1.87	4.15	11.73	4.87	1078	2445.8	8601.51	1574	5.46
02-12-19	05:00:00	1.87	4.12	11.73	4.88	1099	2490.4	8758.36	1574	5.56
02-12-19	06:00:00	1.87	4.13	11.72	4.86	1090	2471.3	8691.19	1574	5.52
02-12-19	07:00:00	1.87	4.14	11.64	4.8	1079	2442.1	8588.50	1574	5.46
02-12-19	08:00:00	2.4	2.52	10.02	10	1	0	0.00	1574	0.00
02-12-19	09:00:00	2.51	2.62	10.25	9.79	1	0.1	0.35	1574	0.00
02-12-19	10:00:00	2.51	2.62	10.36	9.83	1	0.1	0.35	1574	0.00
02-12-19	11:00:00	2.47	2.58	10.47	9.96	1	0.1	0.35	1574	0.00
02-12-19	12:00:00	2.48	2.6	10.59	10.14	1	0.1	0.35	1574	0.00
02-12-19	13:00:00	2.49	2.6	10.7	10.26	1	0.1	0.35	1574	0.00
02-12-19	14:00:00	2.49	2.6	10.81	10.43	1	0.1	0.35	1574	0.00
02-12-19	15:00:00	2.67	2.78	10.92	10.61	1	0.1	0.35	1574	0.00
02-12-19	16:00:00	2.41	2.52	11.04	10.67	1	0.1	0.35	1574	0.00
02-12-19	17:00:00	2.3	2.41	11.16	10.81	1	0.1	0.35	1574	0.00
02-12-19	18:00:00	2.23	2.34	11.27	11.01	1	0	0.00	1574	0.00
02-12-19	19:00:00	2.23	2.34	11.39	11.16	1	0	0.00	1574	0.00
02-12-19	20:00:00	2.23	2.34	11.5	11.64	1	0	0.00	1574	0.00
02-12-19	21:00:00	2.23	2.34	11.61	11.81	1	0	0.00	1574	0.00
02-12-19	22:00:00	2.14	4.21	12.23	12.34	560	0	0.00	1574	0.00
02-12-19	23:00:00	1.88	4.15	12.01	5.25	1080	2417.4	8501.63	1569	5.42

(b)

2/13/2019	00:00:00	1.88	4.14	11.99	5.22	1084	2424.2	8525.55	1569	5.43
2/13/2019	01:00:00	1.88	4.14	11.98	5.27	1075	2384.2	8384.87	1579	5.31
2/13/2019	02:00:00	1.87	4.14	11.98	5.22	1071	2393.1	8416.17	1579	5.33
2/13/2019	03:00:00	1.88	4.19	11.97	5.15	1067	2408.4	8469.98	1579	5.36
2/13/2019	04:00:00	1.87	4.14	11.97	5.17	1091	2454.8	8633.16	1580	5.46
2/13/2019	05:00:00	1.87	4.15	11.97	5.1	1084	2463.1	8662.35	1590	5.45
2/13/2019	06:00:00	1.88	4.14	11.94	5.15	1076	2414.8	8492.49	1590	5.34
2/13/2019	07:00:00	1.87	4.14	11.52	4.82	1091	2418.2	8504.45	1590	5.35
2/13/2019	08:00:00	2.4	2.52	11.49	11.08	1	0.1	0.35	1590	0.00
2/13/2019	09:00:00	2.41	2.52	11.64	11.13	1	0.1	0.35	1590	0.00
2/13/2019	10:00:00	2.41	2.52	11.75	11.32	1	0.1	0.35	1590	0.00
2/13/2019	11:00:00	2.41	2.52	11.86	11.25	1	0.2	0.70	1590	0.00
2/13/2019	12:00:00	2.41	2.52	11.96	11.59	1	0.1	0.35	1590	0.00
2/13/2019	13:00:00	2.41	2.52	12.07	11.56	1	0.2	0.70	1590	0.00
2/13/2019	14:00:00	2.4	2.52	12.17	11.64	0	0.1	0.35	1590	0.00
2/13/2019	15:00:00	2.41	2.52	12.29	11.81	0	0.1	0.35	1590	0.00
2/13/2019	16:00:00	2.42	2.53	12.4	12.02	1	0.1	0.35	1590	0.00
2/13/2019	17:00:00	2.42	2.53	12.5	12.04	1	0.1	0.35	1590	0.00
2/13/2019	18:00:00	2.23	2.34	12.61	12.49	1	0	0.00	1590	0.00
2/13/2019	19:00:00	2.23	2.34	12.72	12.65	1	0	0.00	1590	0.00
2/13/2019	20:00:00	2.23	2.34	12.84	12.92	1	0	0.00	1590	0.00
2/13/2019	21:00:00	2.23	2.34	12.94	13.14	1	0	0.00	1590	0.00
2/13/2019	22:00:00	2.23	2.34	13.03	13.28	1	0	0.00	1590	0.00
2/13/2019	23:00:00	1.88	4.18	12.27	5.64	1073	2353.1	8275.50	1568	5.28

(c)

2/14/2019	00:00:00	1.87	4.14	11.99	5.49	1073	2308.7	8119.35	1572	5.16
2/14/2019	01:00:00	1.87	4.11	11.76	5.2	1092	2367.8	8327.20	1572	5.30
2/14/2019	02:00:00	1.88	4.18	11.73	5.06	1060	2338.4	8223.80	1572	5.23
2/14/2019	03:00:00	1.88	4.19	11.71	4.99	1068	2374.7	8351.46	1572	5.31
2/14/2019	04:00:00	1.88	4.14	11.69	5.07	1083	2367.8	8327.20	1582	5.26
2/14/2019	05:00:00	1.87	4.14	11.53	4.9	1076	2360.2	8300.47	1582	5.25
2/14/2019	06:00:00	1.87	4.09	11.34	4.81	1104	2387.2	8395.42	1582	5.31
2/14/2019	07:00:00	1.87	4.14	11.28	4.68	1079	2354.9	8281.83	1582	5.24
2/14/2019	08:00:00	2.32	2.43	11.38	11.33	1	0	0.00	1582	0.00
2/14/2019	09:00:00	2.29	2.4	11.53	11.1	1	0.1	0.35	1582	0.00
2/14/2019	10:00:00	2.31	2.42	11.66	11.19	1	0.1	0.35	1582	0.00
2/14/2019	11:00:00	2.31	2.42	11.78	11.41	1	0.1	0.35	1582	0.00
2/14/2019	12:00:00	2.32	2.43	11.89	11.41	1	0.1	0.35	1582	0.00
2/14/2019	13:00:00	2.32	2.43	11.99	11.41	1	0.1	0.35	1582	0.00
2/14/2019	14:00:00	2.32	2.43	12.11	11.74	1	0.1	0.35	1582	0.00
2/14/2019	15:00:00	2.32	2.43	12.22	11.78	1	0.1	0.35	1582	0.00
2/14/2019	16:00:00	2.44	2.55	12.34	11.87	1	0.1	0.35	1582	0.00
2/14/2019	17:00:00	2.44	2.56	12.43	11.99	1	0.1	0.35	1582	0.00
2/14/2019	18:00:00	2.28	2.39	12.54	12.23	1	0.1	0.35	1582	0.00
2/14/2019	19:00:00	2.3	2.42	12.64	12.57	0	0	0.00	1582	0.00
2/14/2019	20:00:00	2.3	2.42	12.75	12.65	1	0	0.00	1582	0.00
2/14/2019	21:00:00	2.3	2.42	12.85	12.64	1	0	0.00	1582	0.00
2/14/2019	22:00:00	2.23	2.34	12.94	11.4	1	0.3	1.06	1582	0.00
2/14/2019	23:00:00	1.88	4.17	11.87	5.13	1076	2397.3	8430.94	1543	5.46

(d)

2/15/2019	00:00:00	1.87	4.12	11.86	5.16	1090	2413.8	8488.97	1552	5.47
2/15/2019	01:00:00	1.87	4.14	11.86	5.12	1080	2406.1	8461.89	1558	5.43
2/15/2019	02:00:00	1.88	4.19	11.86	5.07	1074	2411.2	8479.83	1558	5.44
2/15/2019	03:00:00	1.87	4.14	11.85	5.04	1086	2442.5	8589.91	1562	5.50
2/15/2019	04:00:00	1.88	4.15	11.85	5.03	1076	2427.2	8536.10	1572	5.43
2/15/2019	05:00:00	1.88	4.15	11.85	4.99	1086	2462.1	8658.84	1572	5.51
2/15/2019	06:00:00	1.87	4.14	11.83	5.01	1083	2444.9	8598.35	1572	5.47
2/15/2019	07:00:00	1.87	4.15	11.82	4.99	1069	2415	8493.19	1572	5.40
2/15/2019	08:00:00	2.33	2.44	11.84	11.83	1	0	0.00	1572	0.00
2/15/2019	09:00:00	2.33	2.44	11.99	11.57	1	0.1	0.35	1572	0.00
2/15/2019	10:00:00	-0.12	-0.02	12.12	11.63	1	0.1	0.35	1572	0.00
2/15/2019	11:00:00	2.35	2.44	12.23	11.71	1	0.1	0.35	1572	0.00
2/15/2019	12:00:00	2.43	2.52	12.33	11.79	1	0.1	0.35	1572	0.00
2/15/2019	13:00:00	2.43	2.52	12.45	11.81	1	0.1	0.35	1572	0.00
2/15/2019	14:00:00	2.43	2.52	12.56	12.09	1	0.1	0.35	1572	0.00
2/15/2019	15:00:00	2.43	2.52	12.67	12.24	1	0.1	0.35	1572	0.00
2/15/2019	16:00:00	2.43	2.52	12.78	12.36	1	0.1	0.35	1572	0.00
2/15/2019	17:00:00	2.42	2.52	12.89	12.44	1	0.1	0.35	1572	0.00
2/15/2019	18:00:00	2.43	2.52	13	12.74	1	0.1	0.35	1572	0.00
2/15/2019	19:00:00	2.25	2.34	13.1	12.82	1	0.1	0.35	1572	0.00
2/15/2019	20:00:00	2.25	2.34	13.21	13.17	1	0	0.00	1572	0.00
2/15/2019	21:00:00	2.25	2.34	13.31	13.05	1	0.1	0.35	1572	0.00
2/15/2019	22:00:00	2.25	2.34	13.41	13.3	1	0	0.00	1572	0.00
2/15/2019	23:00:00	2.25	2.34	13.51	13.72	1	0	0.00	1572	0.00

(e)

2/16/2019	00:00:00	2.25	2.34	13.59	13.72	1	0	0.00	1572	0.00
2/16/2019	01:00:00	2.25	2.34	13.68	13.72	1	0	0.00	1572	0.00
2/16/2019	02:00:00	2.25	2.34	13.74	13.97	1	0	0.00	1572	0.00
2/16/2019	03:00:00	2.25	2.34	13.81	14.05	1	0	0.00	1572	0.00
2/16/2019	04:00:00	2.25	2.34	13.88	14.31	1	0	0.00	1572	0.00
2/16/2019	05:00:00	2.25	2.34	13.95	14.46	1	0	0.00	1572	0.00
2/16/2019	06:00:00	2.25	2.34	14.03	14.46	1	0	0.00	1572	0.00
2/16/2019	07:00:00	2.25	2.34	14.08	14.54	1	0	0.00	1572	0.00
2/16/2019	08:00:00	2.25	2.34	14.15	14.68	1	0	0.00	1572	0.00
2/16/2019	09:00:00	2.25	2.34	14.21	14.66	1	0	0.00	1572	0.00
2/16/2019	10:00:00	2.25	2.34	14.27	14.88	1	0	0.00	1572	0.00
2/16/2019	11:00:00	2.25	2.34	14.34	14.91	1	0	0.00	1572	0.00
2/16/2019	12:00:00	2.25	2.34	14.42	15.13	1	0	0.00	1572	0.00
2/16/2019	13:00:00	2.25	2.34	14.5	15.24	1	0	0.00	1572	0.00
2/16/2019	14:00:00	2.25	2.34	14.58	15.33	1	0	0.00	1572	0.00
2/16/2019	15:00:00	2.25	2.34	14.66	15.46	1	0	0.00	1572	0.00
2/16/2019	16:00:00	2.25	2.34	14.75	15.52	1	0	0.00	1572	0.00
2/16/2019	17:00:00	2.25	2.34	14.84	15.53	1	0	0.00	1572	0.00
2/16/2019	18:00:00	2.25	2.34	14.93	15.72	1	0	0.00	1572	0.00
2/16/2019	19:00:00	2.25	2.34	15.01	15.76	1	0	0.00	1572	0.00
2/16/2019	20:00:00	2.25	2.34	15.1	15.96	1	0	0.00	1572	0.00
2/16/2019	21:00:00	2.25	2.34	15.18	15.94	1	0	0.00	1572	0.00
2/16/2019	22:00:00	2.25	2.34	15.23	15.98	1	0	0.00	1572	0.00
2/16/2019	23:00:00	2.25	2.34	15.28	16.27	1	0	0.00	1572	0.00

(f)

2/17/2019	00:00:00	2.25	2.34	15.35	16.15	1	0	0.00	1572	0.00
2/17/2019	01:00:00	2.25	2.34	15.4	16.39	1	0	0.00	1572	0.00
2/17/2019	02:00:00	2.25	2.34	15.47	16.35	1	0	0.00	1572	0.00
2/17/2019	03:00:00	2.25	2.34	15.53	16.47	1	0	0.00	1572	0.00
2/17/2019	04:00:00	2.25	2.34	15.59	16.59	1	0	0.00	1572	0.00
2/17/2019	05:00:00	2.25	2.34	15.66	16.58	1	0	0.00	1572	0.00
2/17/2019	06:00:00	2.25	2.34	15.73	16.62	1	0	0.00	1572	0.00
2/17/2019	07:00:00	2.25	2.34	15.8	16.64	1	0	0.00	1572	0.00
2/17/2019	08:00:00	2.25	2.34	15.86	16.88	1	0	0.00	1572	0.00
2/17/2019	09:00:00	2.25	2.34	15.92	16.79	1	0	0.00	1572	0.00
2/17/2019	10:00:00	2.25	2.34	15.99	16.75	1	0	0.00	1572	0.00
2/17/2019	11:00:00	2.25	2.34	16.06	16.85	1	0	0.00	1572	0.00
2/17/2019	12:00:00	2.25	2.34	16.14	16.92	1	0	0.00	1572	0.00
2/17/2019	13:00:00	2.25	2.34	16.21	17.06	1	0	0.00	1572	0.00
2/17/2019	14:00:00	2.25	2.34	16.3	17.05	1	0	0.00	1572	0.00
2/17/2019	15:00:00	2.25	2.34	16.37	17.06	1	0	0.00	1572	0.00
2/17/2019	16:00:00	2.25	2.34	16.47	17.08	1	0	0.00	1572	0.00
2/17/2019	17:00:00	2.25	2.34	16.55	17.24	1	0	0.00	1572	0.00
2/17/2019	18:00:00	2.25	2.34	16.63	17.25	1	0	0.00	1572	0.00
2/17/2019	19:00:00	2.25	2.34	16.72	17.26	1	0	0.00	1572	0.00
2/17/2019	20:00:00	2.25	2.34	16.8	17.45	1	0	0.00	1572	0.00
2/17/2019	21:00:00	2.25	2.34	16.88	17.44	1	0	0.00	1572	0.00
2/17/2019	22:00:00	2.25	2.34	16.95	17.27	1	0	0.00	1572	0.00
2/17/2019	23:00:00	1.91	4.19	11.8	5.28	1068	2301.2	8092.98	1561	5.18

(g)

APPENDIX H

DATA TABLE OF WEEK 8, 2019 (IN HOUR)

		PI-0120C1.PV	PI-0120C2.PV	TIC-0120C1.PV	TI-0120C2.PV	FIC-0120C1.PV	QI-0120C1.PV	QI-0120C1.PV	DPM3-11KV-M	RPD.PV
		CHW SUCTION P	CHW DISCHAGER	EC-0120C CHR TE	EC-0120C CHS TE	CHILL WATER FLO	HEAT SUMMATIO	HEAT SUMMATIO	MAX REAL PO	COP
		BAR	BAR	°C	°C	M3/H	RT	KW	KW	KW/KW
2/18/2019	00:00:00	1.9	4.13	11.78	5.25	1086	2342.5	8238.22	1578	5.22
2/18/2019	01:00:00	1.89	4.13	11.76	5.18	1087	2368.1	8328.25	1588	5.24
2/18/2019	02:00:00	1.89	4.13	11.77	5.13	1077	2360.2	8300.47	1595	5.20
2/18/2019	03:00:00	1.89	4.13	11.76	5.19	1077	2340.9	8232.59	1606	5.13
2/18/2019	04:00:00	1.89	4.13	11.75	5.17	1076	2342.7	8238.92	1606	5.13
2/18/2019	05:00:00	1.89	4.15	11.76	4.94	1082	2442.2	8588.85	1606	5.35
2/18/2019	06:00:00	1.89	4.11	11.74	5	1080	2407	8465.06	1606	5.27
2/18/2019	07:00:00	1.89	4.14	11.73	5	1074	2390.2	8405.97	1606	5.23
2/18/2019	08:00:00	2.42	2.53	11.85	11.03	1	0.2	0.70	1606	0.00
2/18/2019	09:00:00	2.42	2.52	11.97	11.3	1	0.1	0.35	1606	0.00
2/18/2019	10:00:00	2.41	2.52	12.08	11.33	0	0.1	0.35	1606	0.00
2/18/2019	11:00:00	2.42	2.52	12.19	11.65	0	0.1	0.35	1606	0.00
2/18/2019	12:00:00	2.41	2.52	12.28	11.47	1	0.2	0.70	1606	0.00
2/18/2019	13:00:00	2.42	2.52	12.38	11.88	1	0.1	0.35	1606	0.00
2/18/2019	14:00:00	2.42	2.52	12.48	11.98	1	0.1	0.35	1606	0.00
2/18/2019	15:00:00	2.42	2.53	12.57	11.96	0	0.1	0.35	1606	0.00
2/18/2019	16:00:00	2.42	2.52	12.67	12.14	1	0.1	0.35	1606	0.00
2/18/2019	17:00:00	2.42	2.52	12.77	12.36	0	0.1	0.35	1606	0.00
2/18/2019	18:00:00	2.24	2.34	12.86	12.57	1	0.1	0.35	1606	0.00
2/18/2019	19:00:00	1.9	4.18	11.66	6.19	1058	1916.3	6739.34	1299	5.19
2/18/2019	20:00:00	1.89	4.13	11.55	5.04	1086	2336.4	8216.77	1576	5.21
2/18/2019	21:00:00	1.89	4.13	11.51	4.97	1081	2338.9	8225.56	1578	5.21
2/18/2019	22:00:00	1.88	4.15	11.5	4.85	1067	2347.9	8257.21	1578	5.23
2/18/2019	23:00:00	1.88	4.09	11.5	4.96	1091	2360	8299.77	1604	5.17

(a)

2/19/2019	00:00:00	1.88	4.11	11.5	4.99	1096	2359.9	8299.41	1608	5.16
2/19/2019	01:00:00	1.88	4.12	11.5	4.95	1086	2348.5	8259.32	1608	5.14
2/19/2019	02:00:00	1.88	4.12	11.49	4.98	1075	2314.1	8138.34	1608	5.06
2/19/2019	03:00:00	1.88	4.12	11.47	4.97	1075	2312.3	8132.01	1608	5.06
2/19/2019	04:00:00	1.88	4.11	11.45	4.99	1089	2325.2	8177.38	1609	5.08
2/19/2019	05:00:00	1.88	4.11	11.44	4.99	1091	2324.9	8176.32	1609	5.08
2/19/2019	06:00:00	1.88	4.1	7.07	4.66	1086	864.7	3041.02	999	3.04
2/19/2019	07:00:00	2.24	2.34	5.48	5.53	1	0	0.00	0	0.00
2/19/2019	08:00:00	2.41	2.52	5.79	5.71	0	0	0.00	0	0.00
2/19/2019	09:00:00	2.41	2.52	5.96	6	1	0	0.00	0	0.00
2/19/2019	10:00:00	2.41	2.52	6.11	6.28	0	0	0.00	0	0.00
2/19/2019	11:00:00	2.42	2.52	6.24	6.39	1	0	0.00	0	0.00
2/19/2019	12:00:00	2.42	2.52	6.37	6.55	1	0	0.00	0	0.00
2/19/2019	13:00:00	2.4	2.51	6.49	6.67	1	0	0.00	0	0.00
2/19/2019	14:00:00	2.41	2.52	6.63	7.05	1	0	0.00	0	0.00
2/19/2019	15:00:00	2.41	2.52	6.75	7.04	1	0	0.00	0	0.00
2/19/2019	16:00:00	2.41	2.52	6.88	7.42	1	0	0.00	0	0.00
2/19/2019	17:00:00	2.42	2.52	7	7.41	1	0	0.00	0	0.00
2/19/2019	18:00:00	2.41	2.51	7.11	7.71	1	0	0.00	0	0.00
2/19/2019	19:00:00	2.08	4.56	10.92	10.54	981	127.7	449.10	0	0.00
2/19/2019	20:00:00	1.88	4.13	11.49	4.83	1088	2396.6	8428.48	1557	5.41
2/19/2019	21:00:00	1.89	4.16	11.49	4.74	1065	2375.1	8352.87	1559	5.36
2/19/2019	22:00:00	1.89	4.17	11.48	4.73	1067	2383.2	8381.36	1559	5.38
2/19/2019	23:00:00	1.89	4.16	11.47	4.76	1068	2367.8	8327.20	1559	5.34

(b)

2/20/2019	00:00:00	1.88	4.11	11.47	4.86	1085	2373	8345.49	1559	5.35
2/20/2019	01:00:00	1.88	4.12	11.47	4.86	1079	2359.1	8296.60	1559	5.32
2/20/2019	02:00:00	1.88	4.11	11.46	4.84	1092	2390.8	8408.08	1559	5.39
2/20/2019	03:00:00	1.89	4.18	11.46	4.79	1062	2343	8239.98	1559	5.29
2/20/2019	04:00:00	1.88	4.13	11.45	4.83	1091	2388.4	8399.64	1559	5.39
2/20/2019	05:00:00	1.88	4.13	11.38	4.78	1073	2342.8	8239.28	1559	5.28
2/20/2019	06:00:00	1.89	4.15	8.05	4.68	1069	1194.1	4199.47	998	4.21
2/20/2019	07:00:00	2.24	2.34	6	5.98	1	0	0.00	0	0.00
2/20/2019	08:00:00	2.41	2.52	6.3	6.14	1	0	0.00	0	0.00
2/20/2019	09:00:00	2.41	2.52	6.46	6.43	1	0	0.00	0	0.00
2/20/2019	10:00:00	2.41	2.52	6.59	6.6	1	0	0.00	0	0.00
2/20/2019	11:00:00	2.41	2.52	6.7	6.67	1	0	0.00	0	0.00
2/20/2019	12:00:00	2.41	2.52	6.83	6.83	1	0	0.00	0	0.00
2/20/2019	13:00:00	2.41	2.51	6.95	7.25	1	0	0.00	0	0.00
2/20/2019	14:00:00	2.41	2.52	7.08	7.28	1	0	0.00	0	0.00
2/20/2019	15:00:00	2.41	2.52	7.21	7.62	1	0	0.00	0	0.00
2/20/2019	16:00:00	2.42	2.52	7.32	7.85	0	0	0.00	0	0.00
2/20/2019	17:00:00	2.41	2.52	7.46	7.99	1	0	0.00	0	0.00
2/20/2019	18:00:00	2.41	2.52	7.58	8.15	1	0	0.00	0	0.00
2/20/2019	19:00:00	2.24	2.34	7.7	8.43	1	0	0.00	0	0.00
2/20/2019	20:00:00	1.87	4.11	11.26	4.85	1080	2288.6	8048.66	1582	5.09
2/20/2019	21:00:00	1.88	4.12	11.25	4.85	1087	2301.1	8092.62	1582	5.12
2/20/2019	22:00:00	1.88	4.13	11.25	4.82	1078	2293.9	8067.30	1582	5.10
2/20/2019	23:00:00	1.88	4.13	11.26	4.83	1084	2304.6	8104.93	1582	5.12

(c)

2/21/2019	00:00:00	1.88	4.14	11.25	4.82	1079	2293	8064.14	1582	5.10
2/21/2019	01:00:00	1.88	4.15	11.25	4.79	1088	2323.8	8172.46	1582	5.17
2/21/2019	02:00:00	1.88	4.1	11.24	4.86	1104	2326.3	8181.25	1582	5.17
2/21/2019	03:00:00	1.88	4.13	11.23	4.83	1080	2286.5	8041.28	1582	5.08
2/21/2019	04:00:00	1.88	4.13	11.2	4.84	1076	2264.6	7964.26	1582	5.03
2/21/2019	05:00:00	1.89	4.14	11.13	4.85	1071	2225.4	7826.40	1582	4.95
2/21/2019	06:00:00	1.88	4.14	8.6	4.69	1074	1390	4888.42	997	4.90
2/21/2019	07:00:00	2.24	2.34	5.96	6.03	1	0	0.00	0	0.00
2/21/2019	08:00:00	2.41	2.51	6.29	6.15	1	0	0.00	0	0.00
2/21/2019	09:00:00	2.4	2.51	6.46	6.47	1	0	0.00	0	0.00
2/21/2019	10:00:00	2.41	2.52	6.59	6.67	1	0	0.00	0	0.00
2/21/2019	11:00:00	2.42	2.52	6.7	6.78	1	0	0.00	0	0.00
2/21/2019	12:00:00	2.41	2.52	6.83	6.89	1	0	0.00	0	0.00
2/21/2019	13:00:00	2.41	2.52	6.96	7.16	1	0	0.00	0	0.00
2/21/2019	14:00:00	2.41	2.52	7.08	7.37	1	0	0.00	0	0.00
2/21/2019	15:00:00	2.41	2.52	7.21	7.62	1	0	0.00	0	0.00
2/21/2019	16:00:00	2.41	2.52	7.33	7.74	1	0	0.00	0	0.00
2/21/2019	17:00:00	2.42	2.53	7.46	7.98	1	0	0.00	0	0.00
2/21/2019	18:00:00	2.41	2.52	7.59	8.32	0	0	0.00	0	0.00
2/21/2019	19:00:00	2.1	4.75	10.79	9.45	898	411	1445.43	0	0.00
2/21/2019	20:00:00	1.89	4.17	11.36	4.86	1057	2271.2	7987.47	1573	5.08
2/21/2019	21:00:00	1.88	4.12	11.36	4.91	1076	2296.4	8076.09	1574	5.13
2/21/2019	22:00:00	1.89	4.17	11.36	4.87	1061	2277.5	8009.63	1591	5.03
2/21/2019	23:00:00	1.88	4.1	11.36	4.96	1091	2306.1	8110.21	1605	5.05

(d)

2/22/2019	00:00:00	1.88	4.11	11.36	4.9	1084	2313.2	8135.18	1605	5.07
2/22/2019	01:00:00	1.89	4.15	11.35	4.94	1083	2292.5	8062.38	1608	5.01
2/22/2019	02:00:00	1.88	4.12	11.35	4.87	1077	2308.3	8117.94	1608	5.05
2/22/2019	03:00:00	1.88	4.11	11.31	4.69	1086	2375.9	8355.68	1608	5.20
2/22/2019	04:00:00	1.88	4.11	11.16	4.86	1083	2258.4	7942.45	1608	4.94
2/22/2019	05:00:00	1.88	4.16	11.04	4.75	1066	2213.5	7784.55	1608	4.84
2/22/2019	06:00:00	2.05	4.36	8.15	4.72	1071	1215.7	4275.43	998	4.28
2/22/2019	07:00:00	2.29	2.4	6.85	6.84	1	0	0.00	0	0.00
2/22/2019	08:00:00	2.41	2.52	7.1	7	1	0	0.00	0	0.00
2/22/2019	09:00:00	2.41	2.52	7.24	7.28	1	0	0.00	0	0.00
2/22/2019	10:00:00	2.41	2.52	7.37	7.47	1	0	0.00	0	0.00
2/22/2019	11:00:00	2.41	2.52	7.49	7.69	1	0	0.00	0	0.00
2/22/2019	12:00:00	2.41	2.52	7.61	7.86	1	0	0.00	0	0.00
2/22/2019	13:00:00	2.41	2.52	7.73	7.99	1	0	0.00	0	0.00
2/22/2019	14:00:00	2.42	2.52	7.86	8.23	1	0	0.00	0	0.00
2/22/2019	15:00:00	2.38	2.49	7.98	8.45	1	0	0.00	0	0.00
2/22/2019	16:00:00	2.41	2.52	8.12	8.75	1	0	0.00	0	0.00
2/22/2019	17:00:00	2.41	2.52	8.24	8.94	1	0	0.00	0	0.00
2/22/2019	18:00:00	2.41	2.52	8.37	9.15	2	0	0.00	0	0.00
2/22/2019	19:00:00	2.23	2.34	8.49	9.37	1	0	0.00	0	0.00
2/22/2019	20:00:00	1.88	4.14	11.22	4.81	1070	2267.1	7973.05	1521	5.24
2/22/2019	21:00:00	1.88	4.13	11.22	4.83	1086	2293.9	8067.30	1524	5.29
2/22/2019	22:00:00	1.88	4.13	11.22	4.8	1075	2285.2	8036.71	1525	5.27
2/22/2019	23:00:00	1.88	4.13	11.22	4.8	1079	2288	8046.55	1525	5.28

(e)

2/23/2019	00:00:00	1.88	4.13	11.21	4.8	1082	2296.8	8077.50	1525	5.30
2/23/2019	01:00:00	1.88	4.13	11.21	4.81	1067	2261.2	7952.30	1525	5.21
2/23/2019	02:00:00	1.88	4.13	11.2	4.8	1086	2299.4	8086.64	1525	5.30
2/23/2019	03:00:00	1.88	4.14	11.21	4.79	1076	2284.3	8033.54	1525	5.27
2/23/2019	04:00:00	1.88	4.13	11.2	4.82	1081	2277.5	8009.63	1525	5.25
2/23/2019	05:00:00	1.88	4.13	11.18	4.82	1082	2277.3	8008.92	1525	5.25
2/23/2019	06:00:00	1.88	4.13	8.68	4.67	1077	1431.6	5034.72	995	5.06
2/23/2019	07:00:00	2.23	2.34	5.97	6.02	1	0	0.00	0	0.00
2/23/2019	08:00:00	2.23	2.34	6.34	6.1	1	0	0.00	0	0.00
2/23/2019	09:00:00	2.23	2.34	6.49	6.32	1	0	0.00	0	0.00
2/23/2019	10:00:00	2.23	2.34	6.61	6.57	1	0	0.00	0	0.00
2/23/2019	11:00:00	2.23	2.34	6.72	6.67	1	0	0.00	0	0.00
2/23/2019	12:00:00	2.23	2.34	6.85	6.98	1	0	0.00	0	0.00
2/23/2019	13:00:00	2.23	2.34	6.97	7.28	1	0	0.00	0	0.00
2/23/2019	14:00:00	2.23	2.34	7.1	7.51	1	0	0.00	0	0.00
2/23/2019	15:00:00	2.23	2.34	7.22	7.69	1	0	0.00	0	0.00
2/23/2019	16:00:00	2.23	2.34	7.36	8.05	1	0	0.00	0	0.00
2/23/2019	17:00:00	2.23	2.34	7.49	8.32	1	0	0.00	0	0.00
2/23/2019	18:00:00	2.23	2.34	7.63	8.37	1	0	0.00	0	0.00
2/23/2019	19:00:00	2.23	2.34	7.76	8.84	1	0	0.00	0	0.00
2/23/2019	20:00:00	2.23	2.34	7.88	8.83	1	0	0.00	0	0.00
2/23/2019	21:00:00	2.23	2.34	7.99	9.09	1	0	0.00	0	0.00
2/23/2019	22:00:00	2.23	2.34	8.1	9.36	1	0	0.00	0	0.00
2/23/2019	23:00:00	2.23	2.34	8.22	9.7	1	0	0.00	0	0.00

(f)

|									
2/24/2019	00:00:00	2.23	2.34	8.32	9.69	1	0	0.00	0	0.00
2/24/2019	01:00:00	2.23	2.34	8.43	10.02	1	0	0.00	0	0.00
2/24/2019	02:00:00	2.23	2.34	8.53	10.17	1	0	0.00	0	0.00
2/24/2019	03:00:00	2.23	2.34	8.64	10.35	1	0	0.00	0	0.00
2/24/2019	04:00:00	2.23	2.34	8.73	10.49	1	0	0.00	0	0.00
2/24/2019	05:00:00	2.23	2.34	8.82	10.82	1	0	0.00	0	0.00
2/24/2019	06:00:00	2.23	2.34	8.92	10.77	0	0	0.00	0	0.00
2/24/2019	07:00:00	2.23	2.34	9	11.12	1	0	0.00	0	0.00
2/24/2019	08:00:00	2.23	2.34	9.09	11.12	1	0	0.00	0	0.00
2/24/2019	09:00:00	2.23	2.34	9.18	11.2	1	0	0.00	0	0.00
2/24/2019	10:00:00	2.23	2.34	9.27	11.51	1	0	0.00	0	0.00
2/24/2019	11:00:00	2.23	2.34	9.36	11.64	1	0	0.00	0	0.00
2/24/2019	12:00:00	2.23	2.34	9.47	11.67	1	0	0.00	0	0.00
2/24/2019	13:00:00	2.23	2.34	9.58	11.87	1	0	0.00	0	0.00
2/24/2019	14:00:00	2.23	2.34	9.7	11.99	1	0	0.00	0	0.00
2/24/2019	15:00:00	2.23	2.34	9.83	12.02	1	0	0.00	0	0.00
2/24/2019	16:00:00	2.23	2.34	9.97	12.33	1	0	0.00	0	0.00
2/24/2019	17:00:00	2.23	2.34	10.09	12.46	1	0	0.00	0	0.00
2/24/2019	18:00:00	2.23	2.34	10.23	12.51	0	0	0.00	0	0.00
2/24/2019	19:00:00	2.23	2.34	10.35	12.74	1	0	0.00	0	0.00
2/24/2019	20:00:00	2.23	2.34	10.48	12.86	1	0	0.00	0	0.00
2/24/2019	21:00:00	2.23	2.34	10.58	12.92	1	0	0.00	0	0.00
2/24/2019	22:00:00	2.23	2.34	10.69	13.08	1	0	0.00	0	0.00
2/24/2019	23:00:00	2.23	2.34	10.78	13.15	1	0	0.00	0	0.00

(g)

APPENDIX I

COP VS TIME (IN HOUR) ON WEEK 1
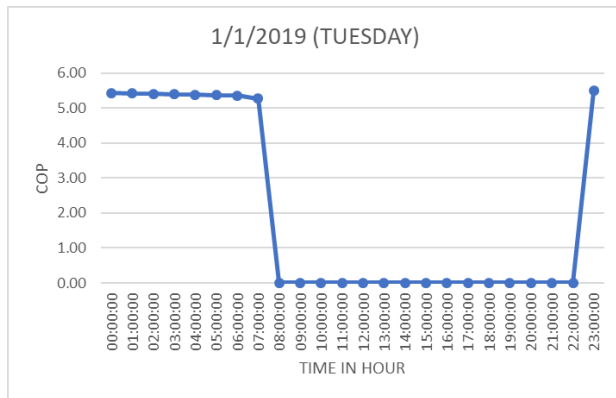
(a)
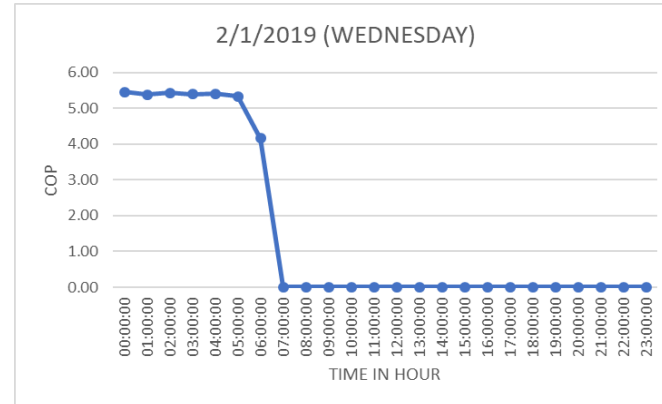
(b)
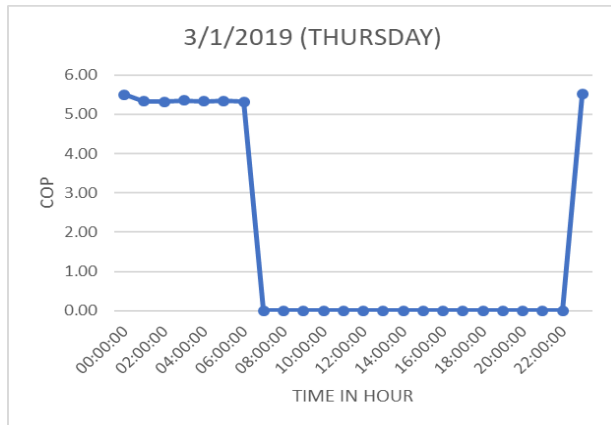
(c)
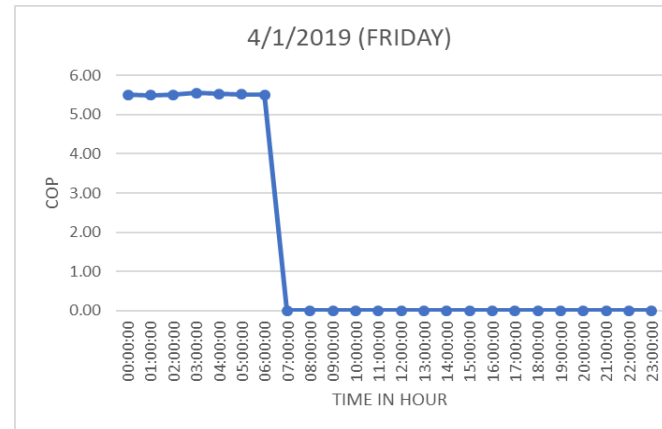
(d)
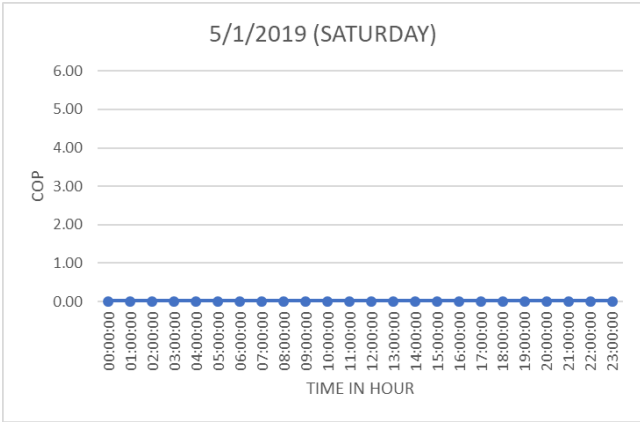
(e)
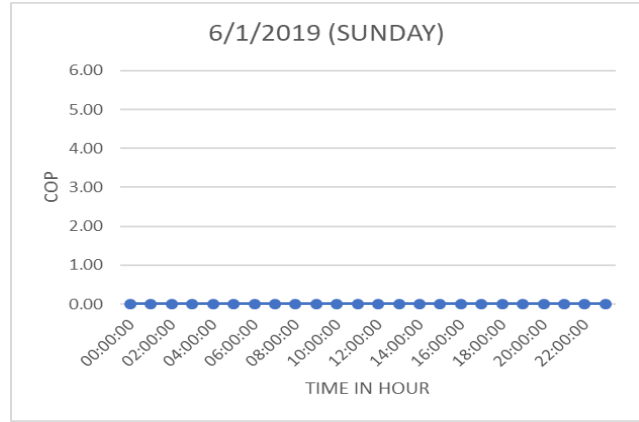
(f)

APPENDIX J

COP VS TIME (IN HOUR) ON WEEK 2

(a) 7/1/2019 (MONDAY)

(b) 8/1/2019 (TUESDAY)

(c) 9/1/2019 (WEDNESDAY)

(d) 10/1/2019 (THURSDAY)
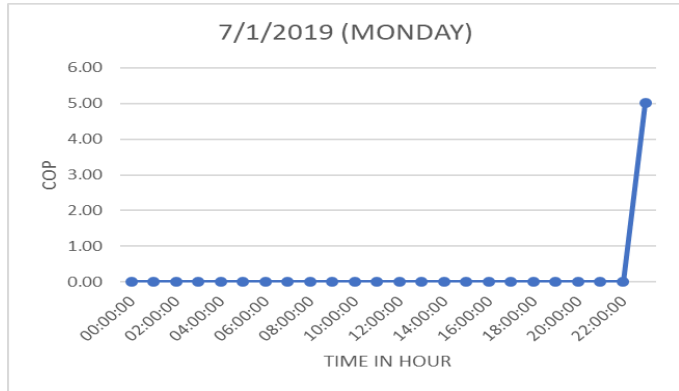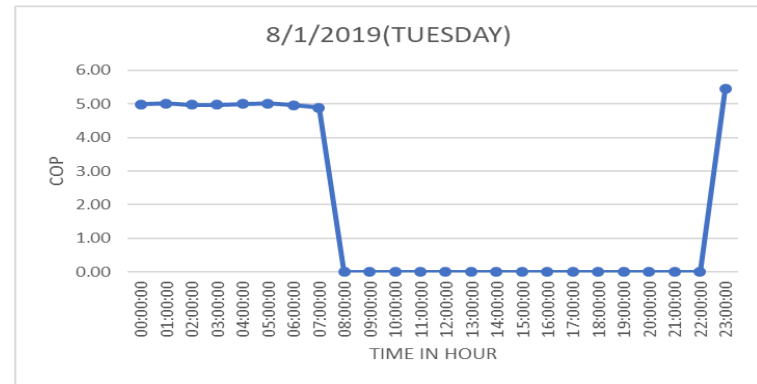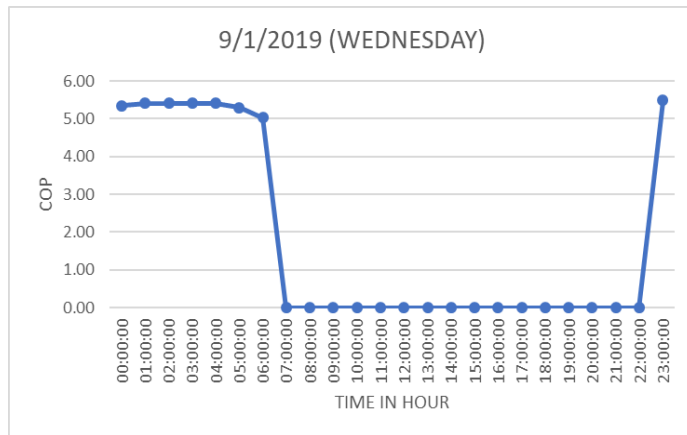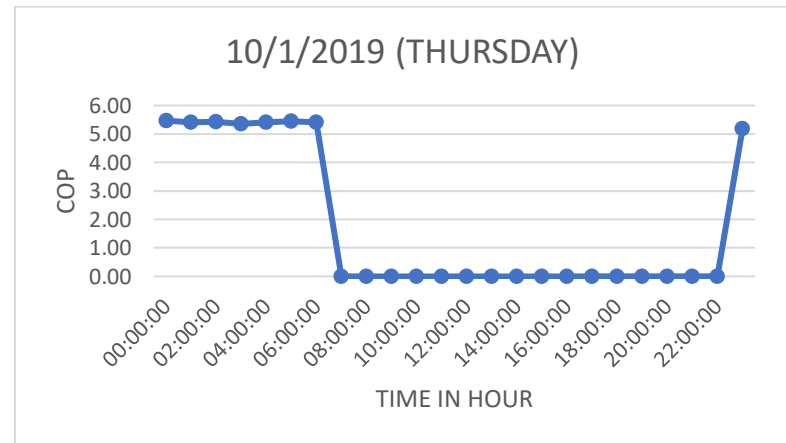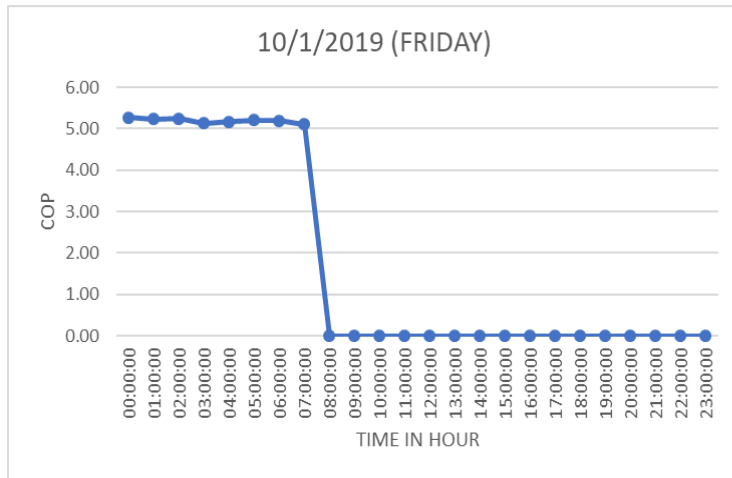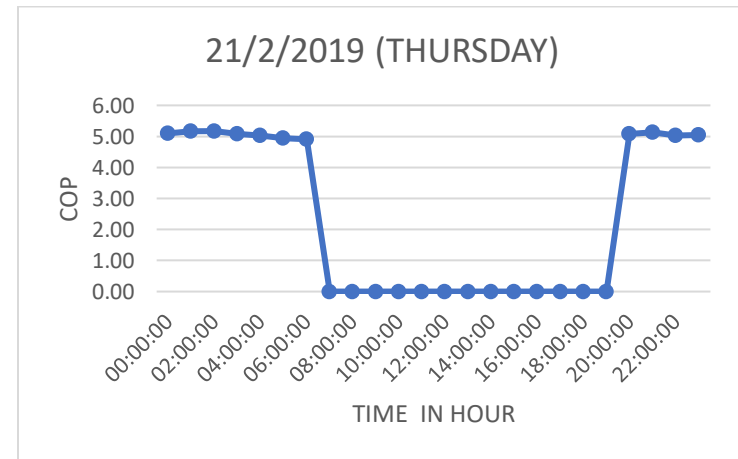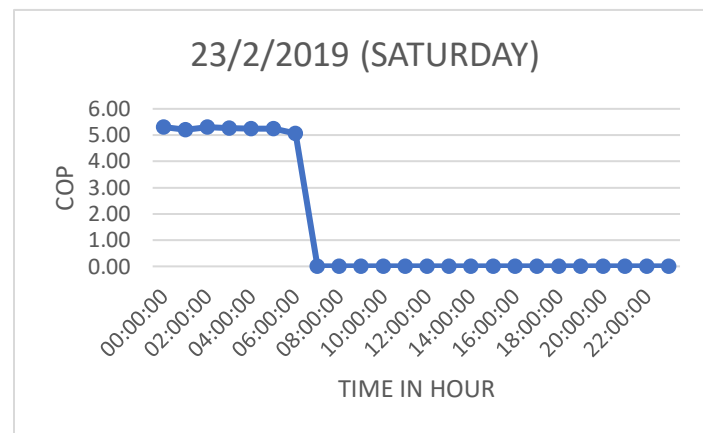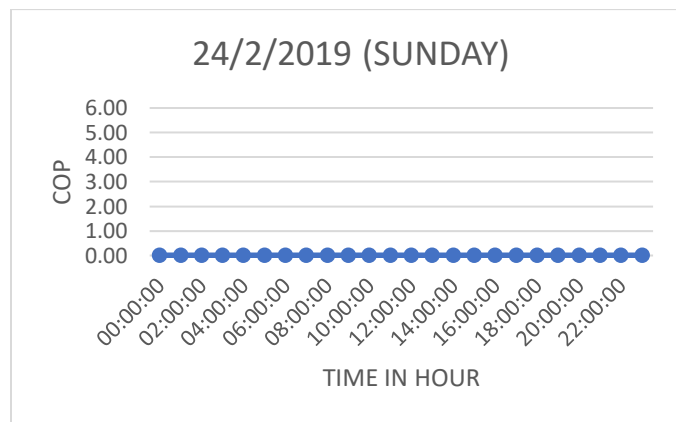
(e)
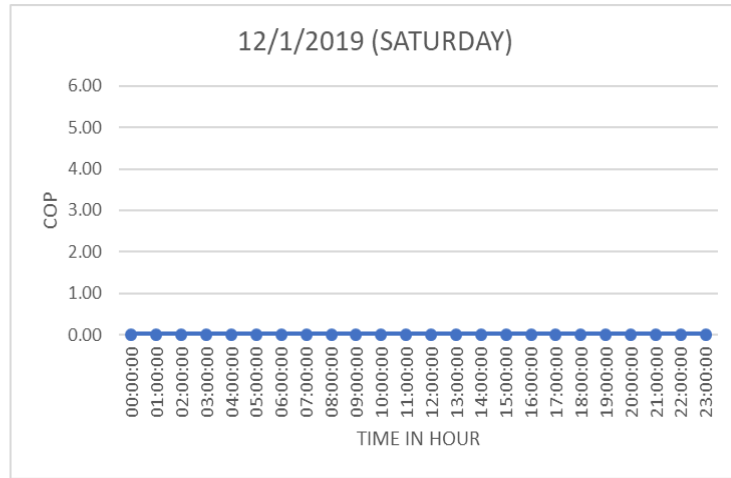
(f)
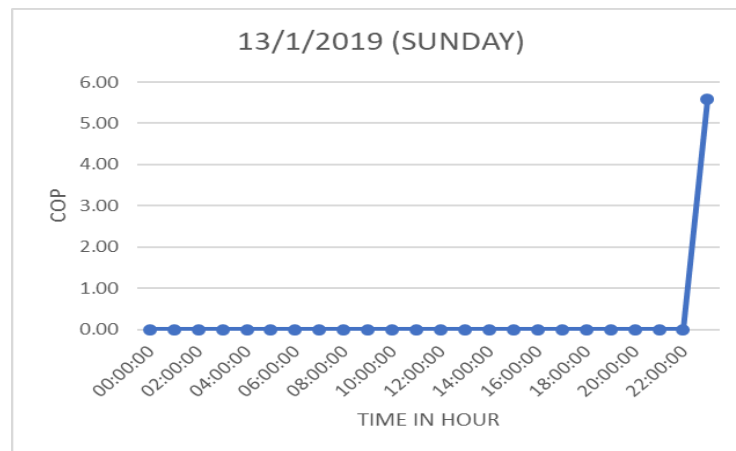
(g)

APPENDIX K

COP VS TIME (IN HOUR) ON WEEK 3
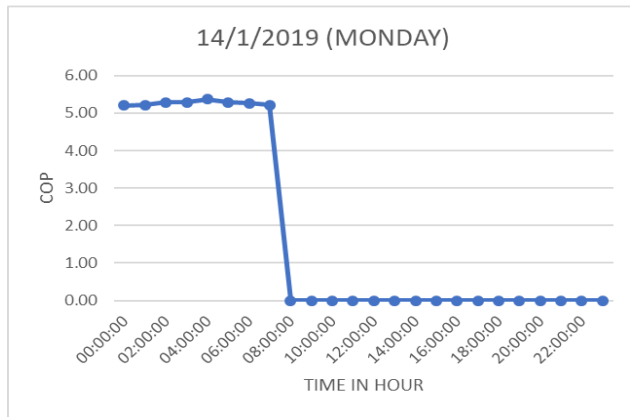
(a)
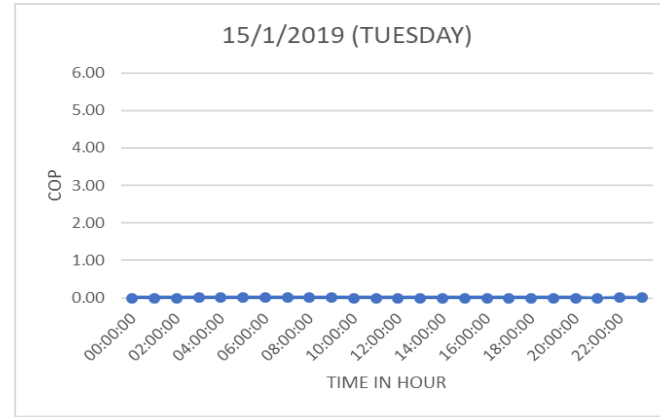
(b)
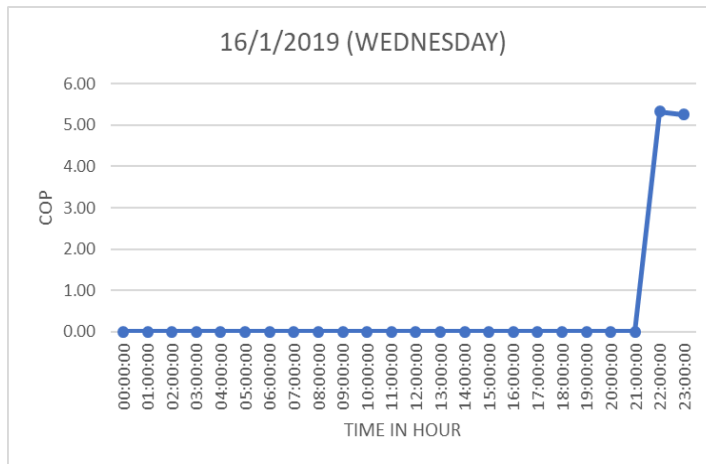
(c)
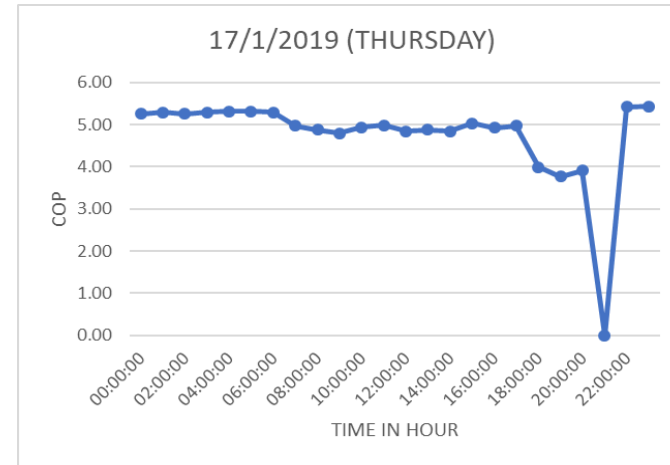
(d)
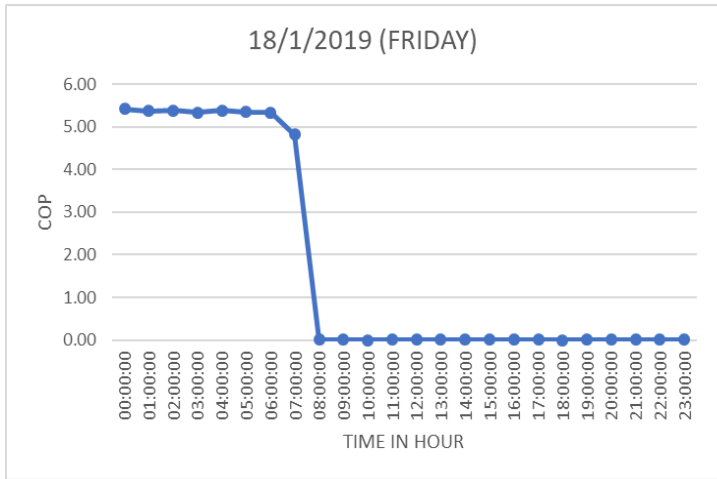
(e)
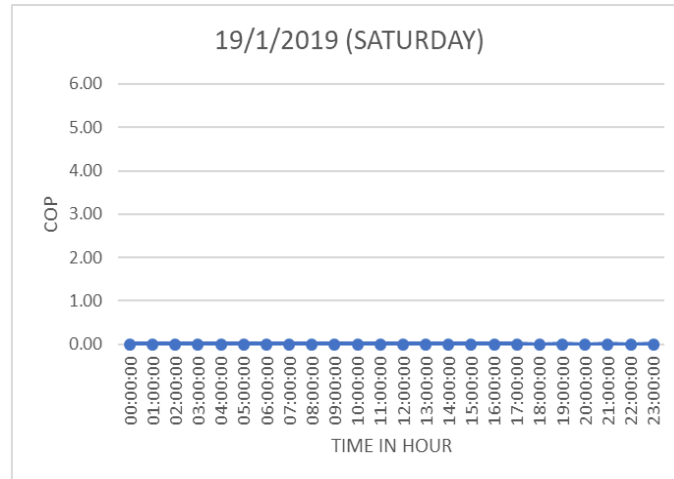
(f)
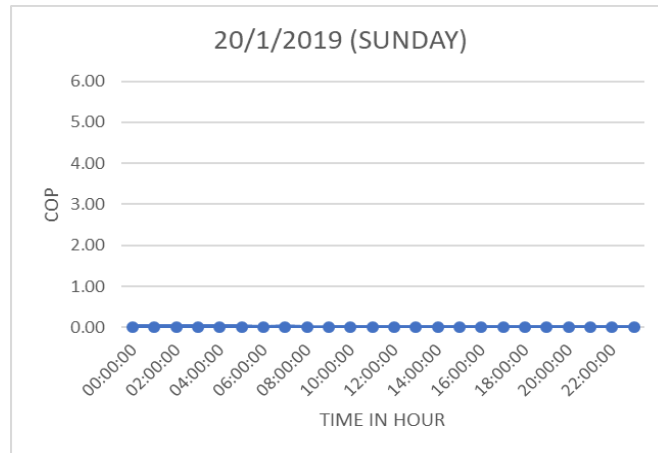
(g)

APPENDIX L

COP VS TIME (IN HOUR) ON WEEK 4

(a)

(b)

(c)

(d)

25/1/2019 (FRIDAY)

(e)

26/1/2019 (SATURDAY)

(f)

27/1/2019 (SUNDAY)

(g)
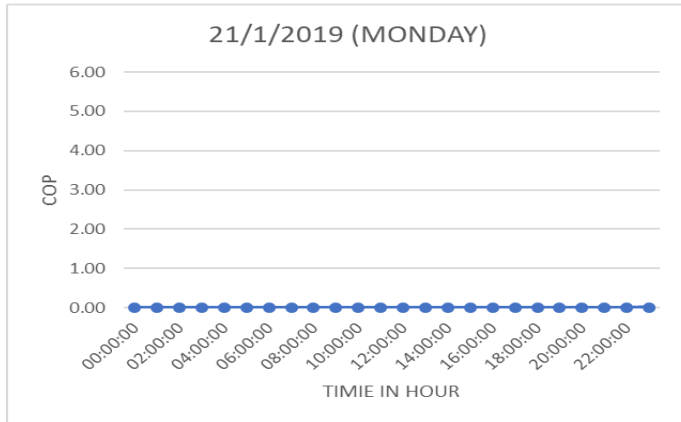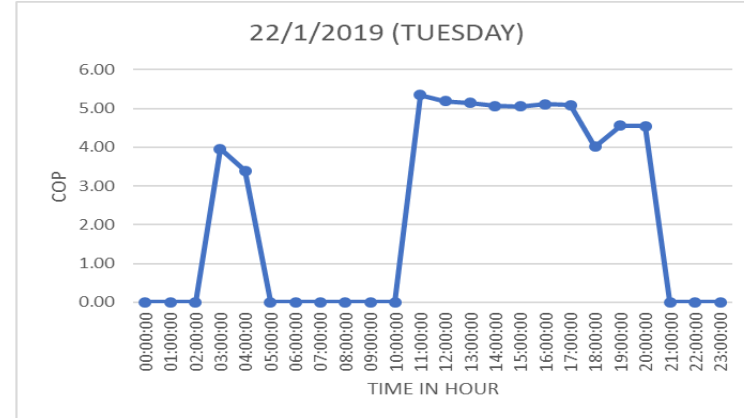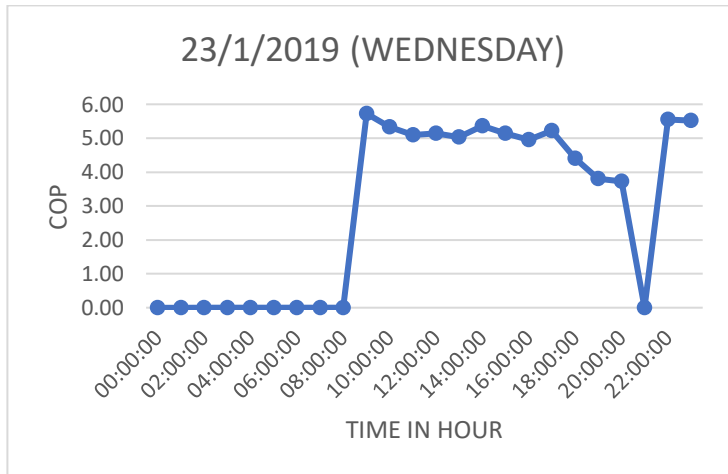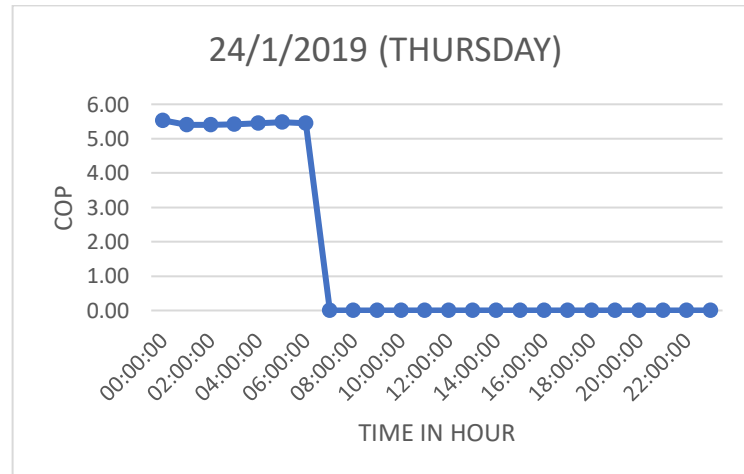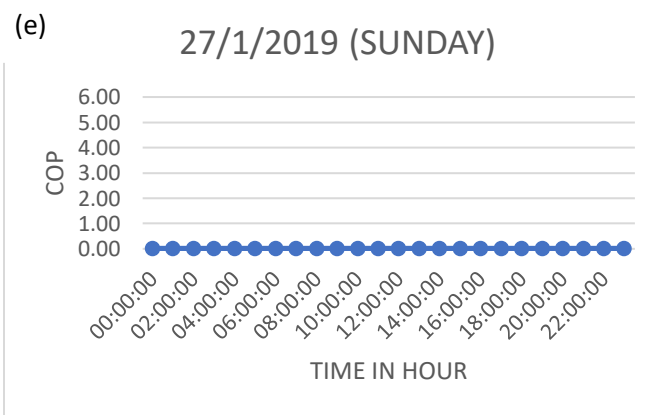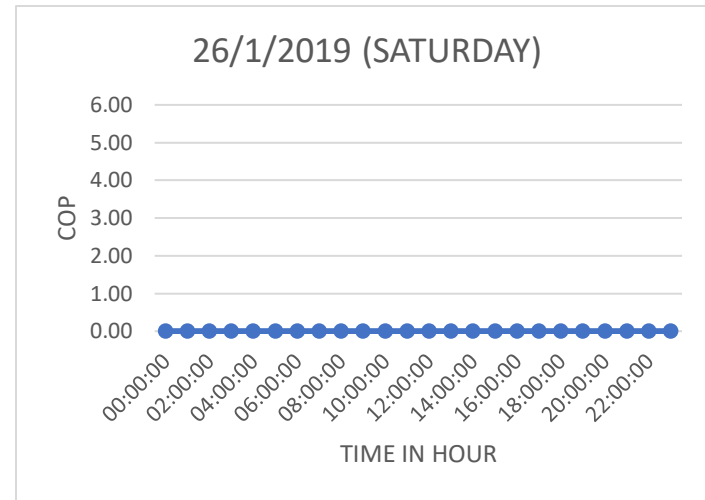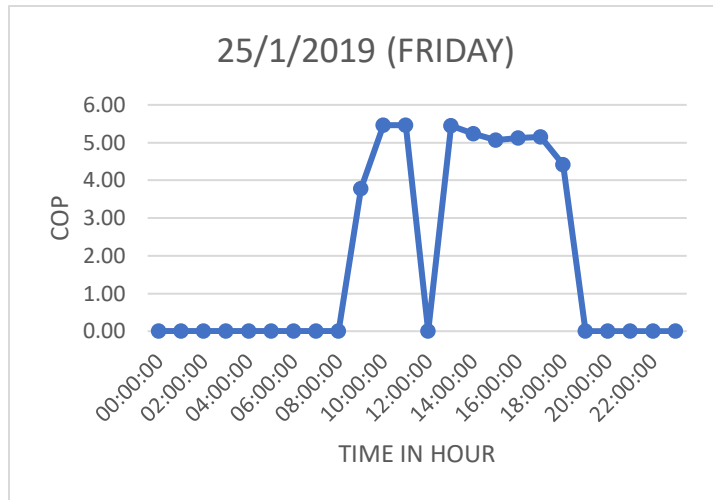
COP VS TIME (IN HOUR) ON WEEK 5

(a)

(b)

(c)

(d)

(e)

(f)

(g)
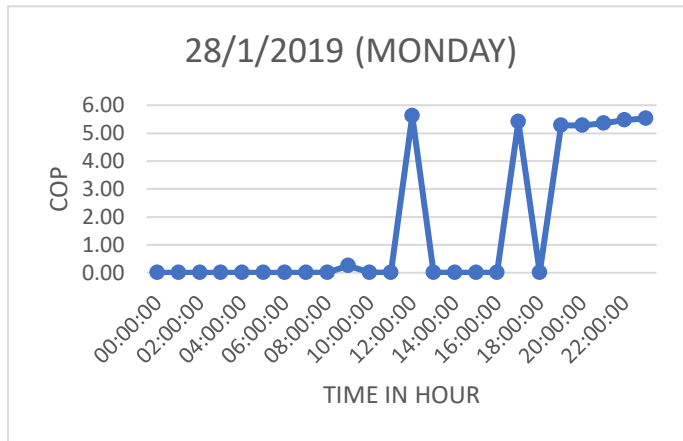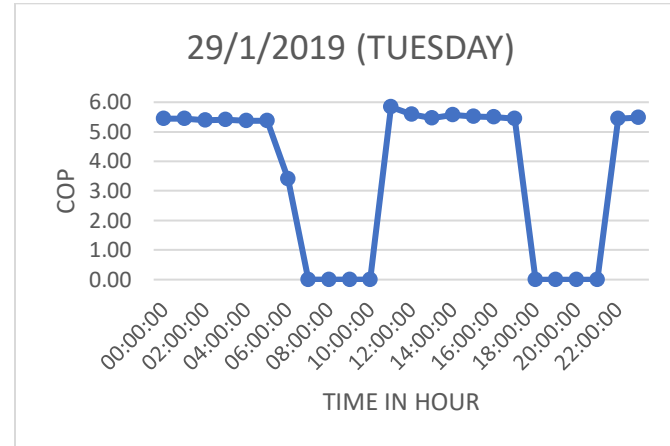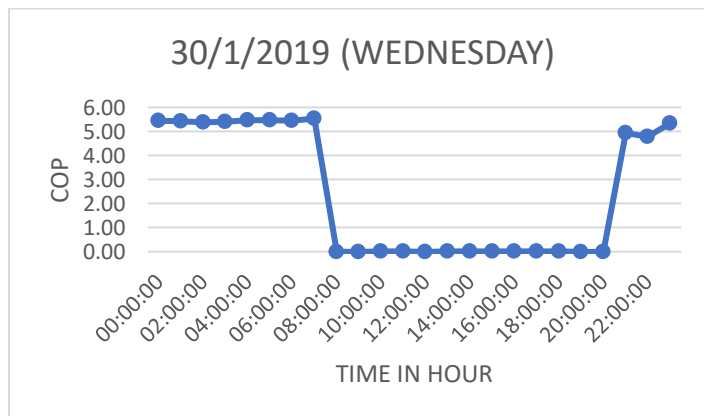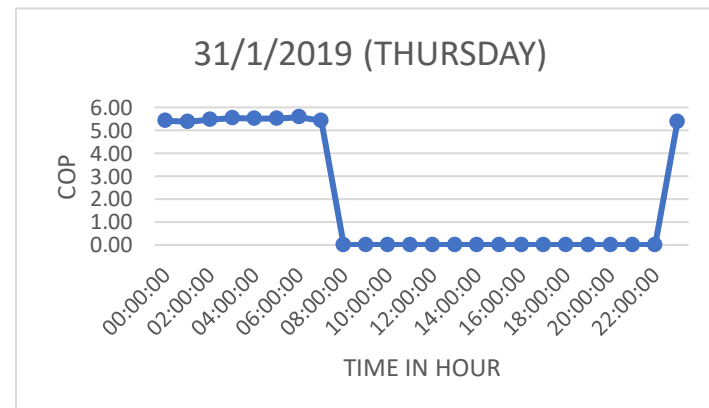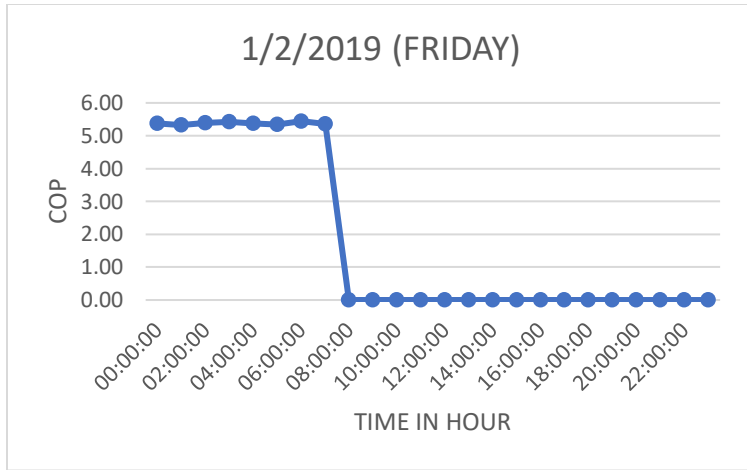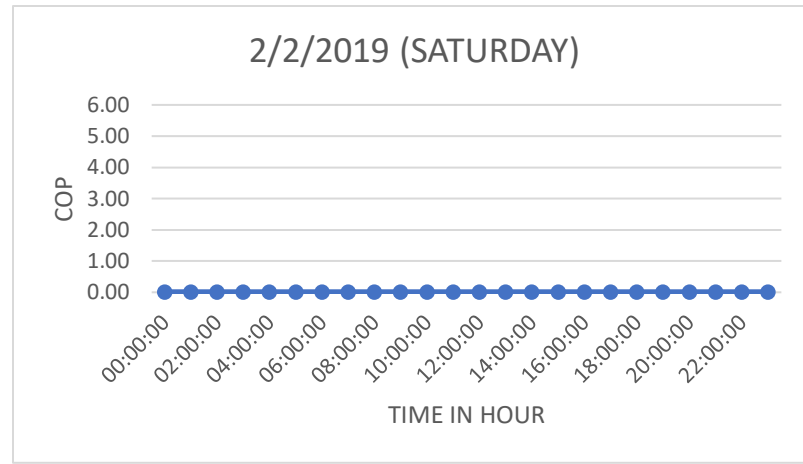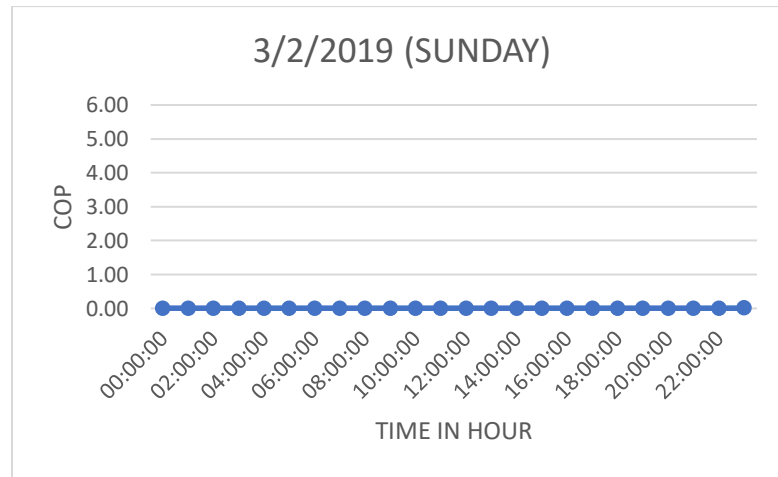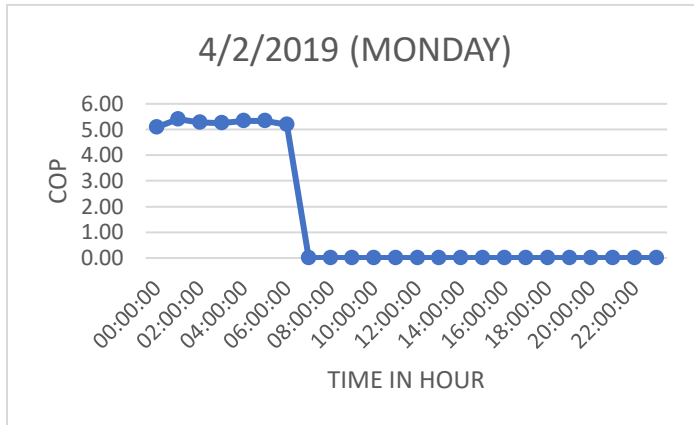
(a)
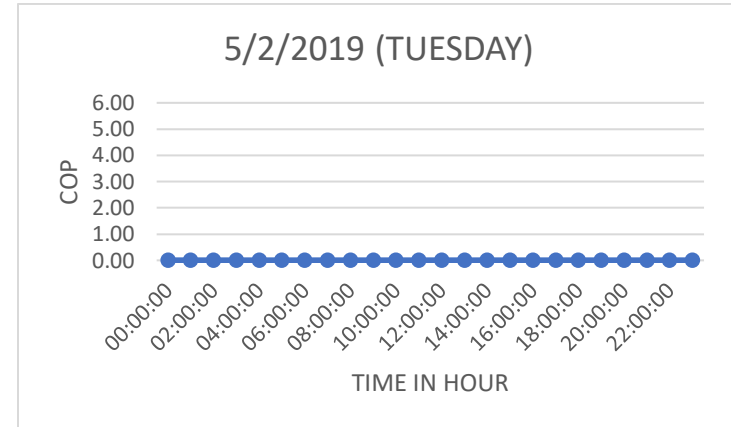
(b)
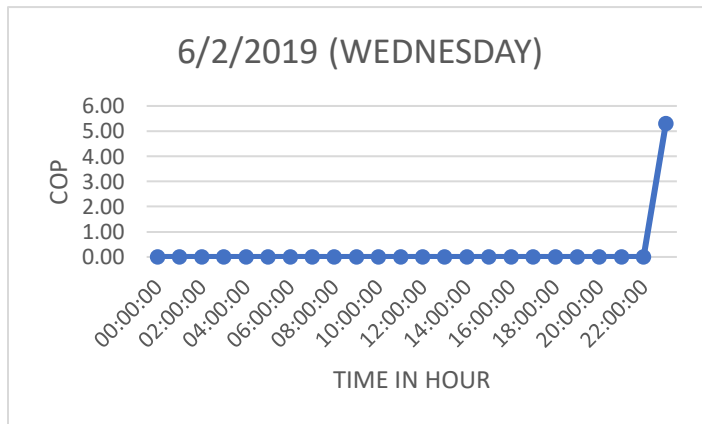
(c)
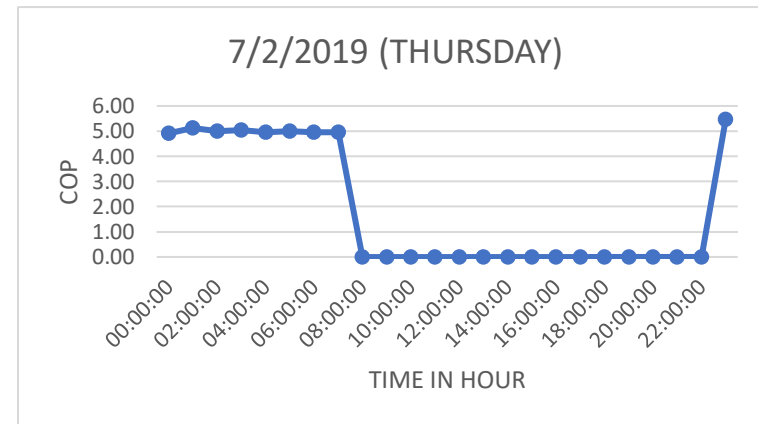
(d)
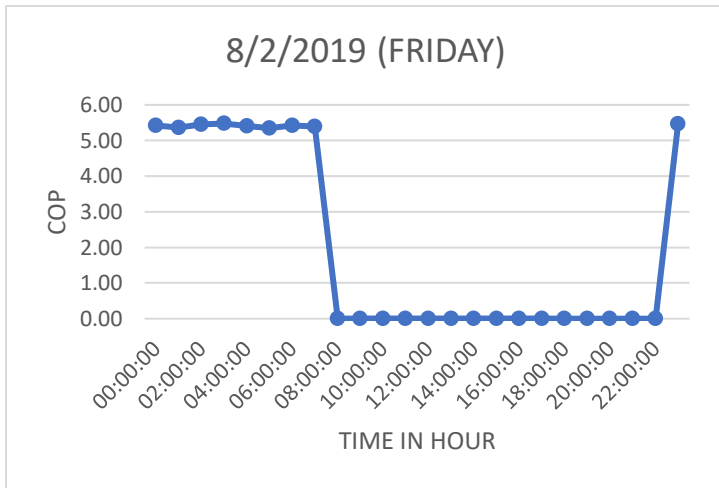
(e)
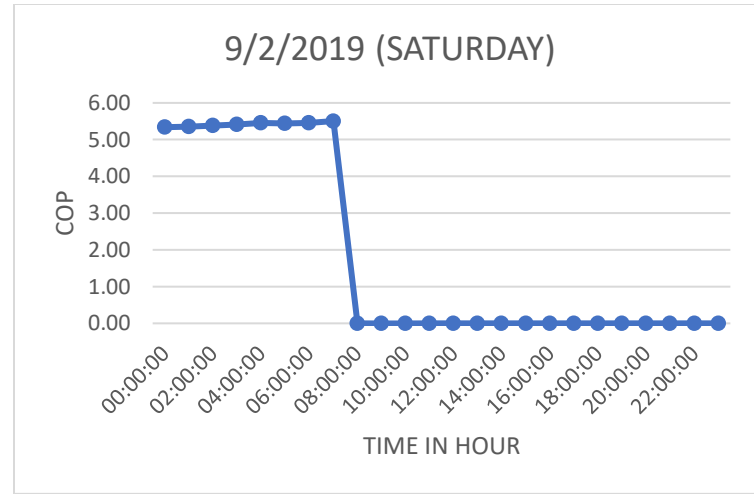
(f)
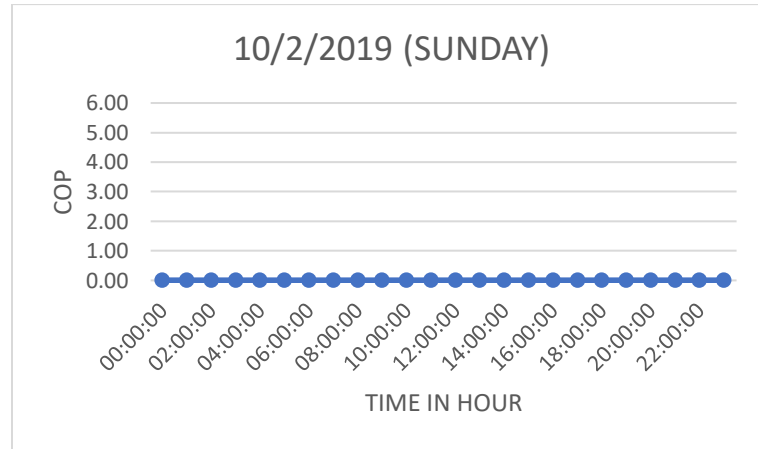
(g)

APPENDIX O

COP VS TIME (IN HOUR) ON WEEK 7
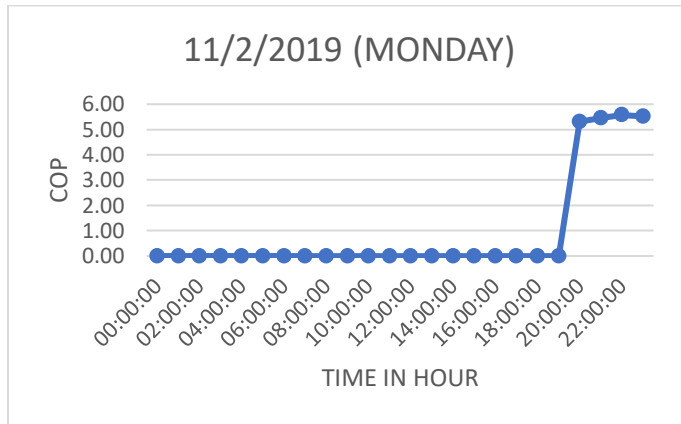
(a)
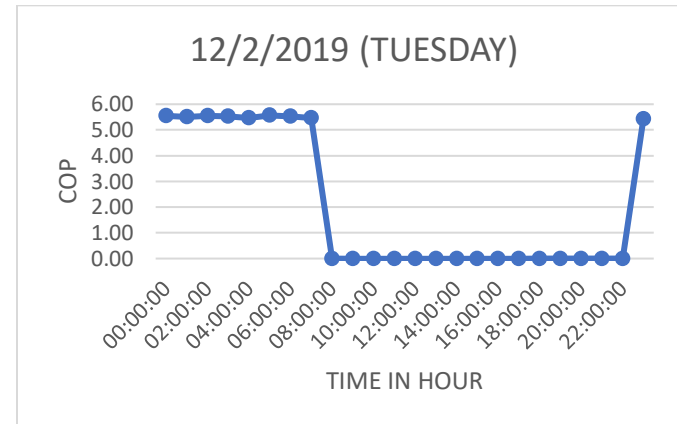
(b)
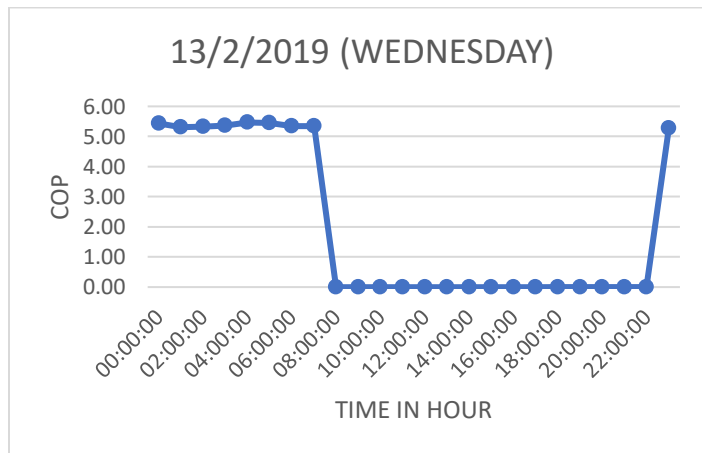
(c)
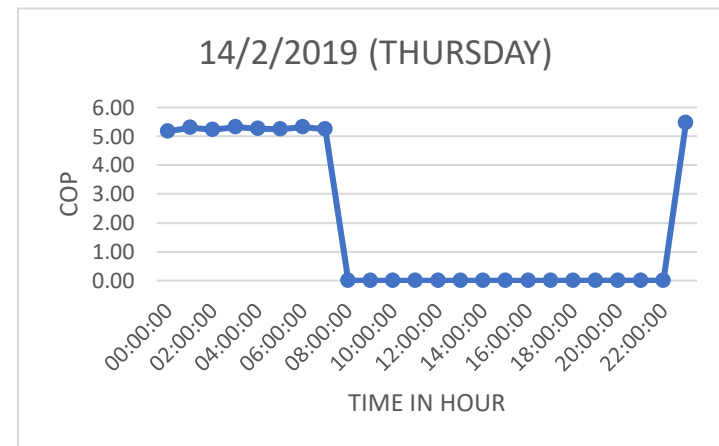
(d)
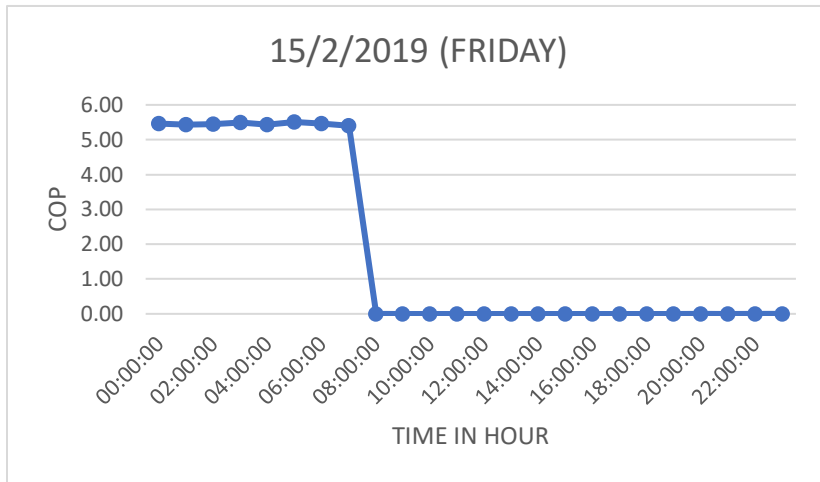
(e)
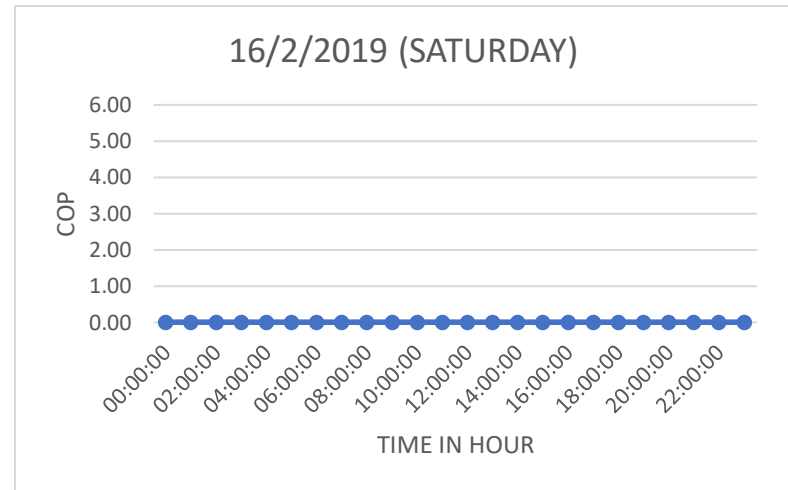
(f)
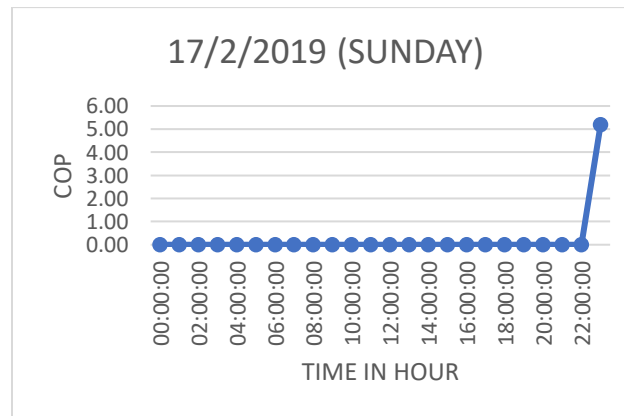
(g)

APPENDIX P

COP VS TIME (IN HOUR) ON WEEK 8
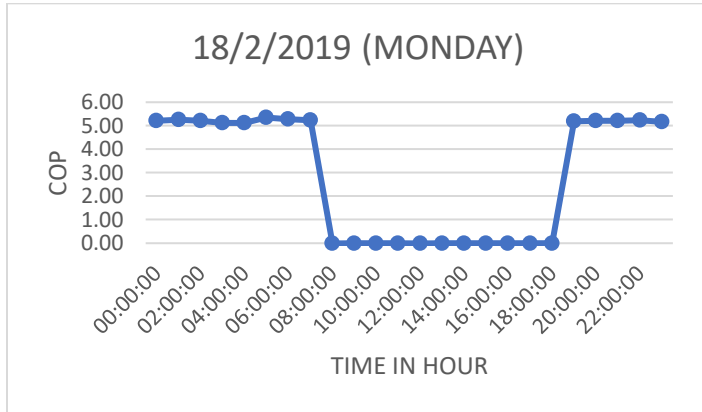
(a)
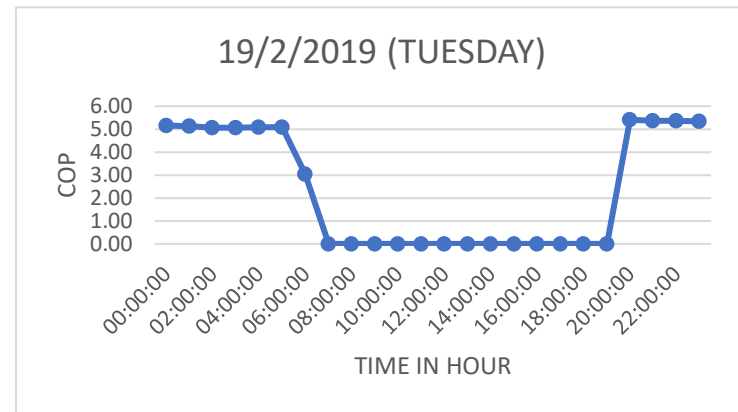
(b)
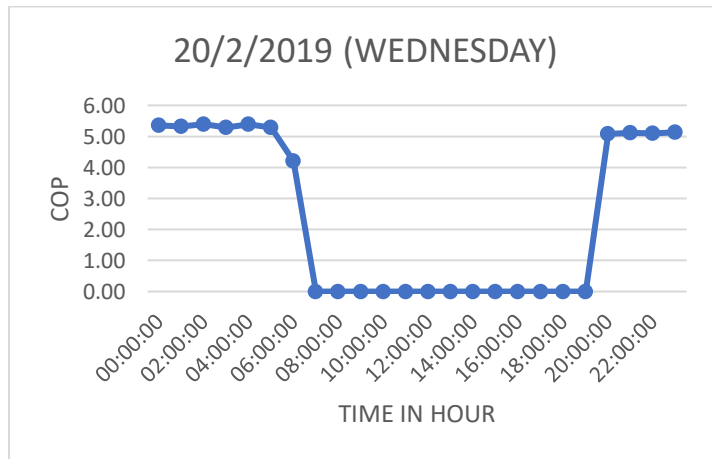
(c)

(d)
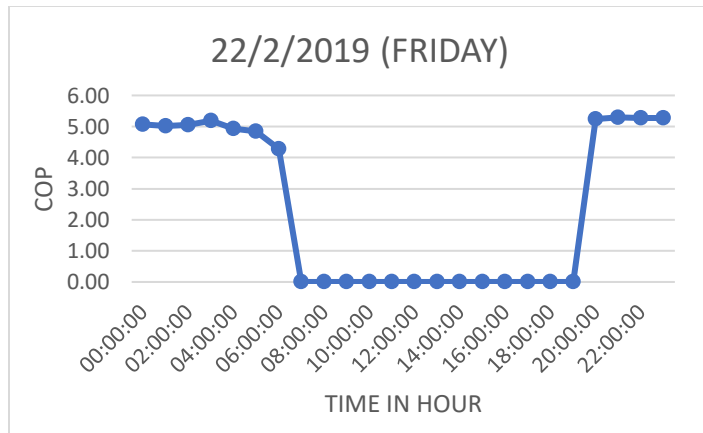
(e)

(f)

(g)

APPENDIX Q

Table of COP Average by day

a) Week 1:

day 1	day 2	day 3	day 4	day 5	day 6
5.38	5.26	5.36	5.51	0	0

b) Week 2:

day 1	day 2	day 3	day 4	day 5	day 6	day 7
0.21	4.98	5.33	5.42	5.19	0.00	0

c) Week 3:

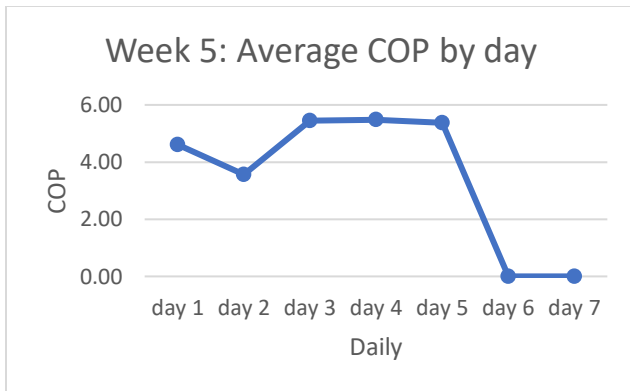| day 1	day 2	day 3	day 4	day 5	day 6	day 7
5.27	0.00	5.29	4.73	5.30	0.00	0

d) Week 4:

day 1	day 2	day 3	day 4	day 5	day 6	day 7
0.00	3.14	4.91	5.45	4.51	0.00	0

e) Week 5:

day 1	day 2	day 3	day 4	day 5	day 6	day 7
4.62	3.57	5.45	5.48	5.38	0.00	0

f) Week 6:

day 1	day 2	day 3	day 4	day 5	day 6	day 7
5.27	0.00	0.22	4.99	5.41	5.42	0

g) Week 7:

day 1	day 2	day 3	day 4	day 5	day 6	day 7
0.91	5.52	5.38	5.26	5.46	0.00	0

h) Week 8:

day 1	day 2	day 3	day 4	day 5	day 6	day 7
5.22	4.97	5.25	5.08	4.97	5.25	0

Graph of COP by day

(a)

(b)

(c)

(d)

(e)

(f)

(g)

(h)