Building Load Analysis

In order to successfully design any mechanical system the building's load profiles must be accurately predicted. This is especially true for combined heat and power system due to the fact that the thermal capacity of the system is a function of the electrical capacity. If the prime mover were to be sized to meet the building's thermal loads, the thermal load profile would be calculated throughout the year, and the prime mover would be selected accordingly. Since the Xanadu Sports Complex mechanical system redesign's prime mover is designed to meet the building's electric demand, it is essential that the electrical profiles are accurately calculated for all days of the year. Using a combination of mechanical equipment technical data, building operation schedules, TRANE's TRACE 700 Energy Simulation Software, and the Oak Ridge National Laboratory's BCHP Screening Tool software the building's electrical profile for a typical year was calculated. Figure 15 below illustrates the average monthly electrical demand for both the existing conditions and the mechanical system redesign.

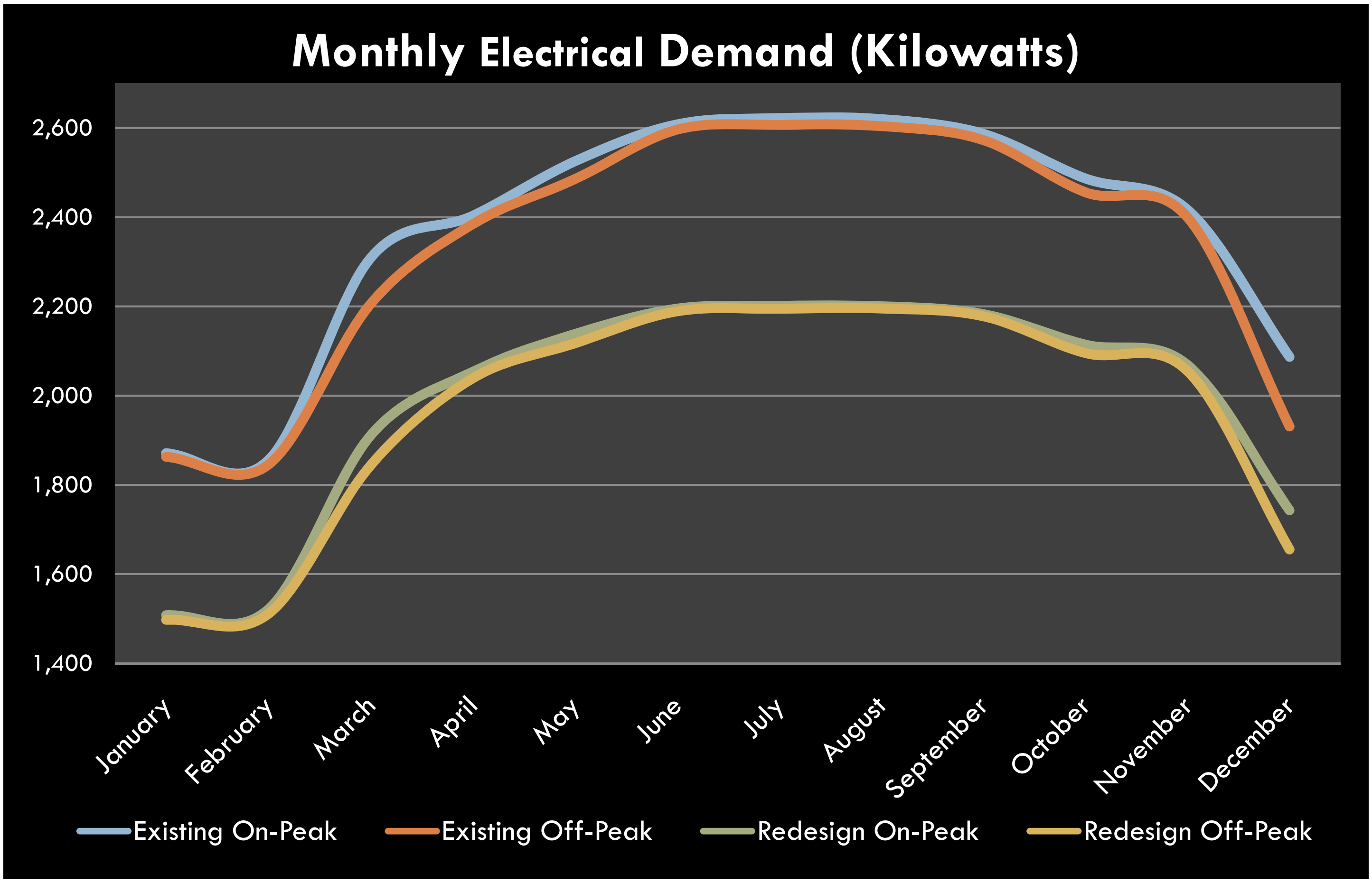

Figure 15: Existing and Redesign Monthly Electrical Demand

When the type schedule for Building A is considered it can be seen from the graph that the electrical demand is very accurate. As discussed in the Building Background Section of this report, due to the schedules of both the indoor ski resort and the retail section the electrical on-peak and off-peak demands stay very consistent throughout the year. This is due to the fact that the majority of the electrical demand required is drawn from the mechanical equipment in the Snowdome section of the building. To be able to maintain skiing conditions throughout the day the equipment must run nearly all hours of the day. However, as the snow making process begins at night and the ski resort temperature is driven to 28°F the electrical demand for that section of building increases. At the same time the snow making process is beginning, the retail section's mechanical system is beginning its nighttime setback cycle. The fact that when one section of the building is demanding more energy the other section requires less energy provides the fairly constant demand profile. This constant daily demand profile will greatly improve the overall efficiency of the system since the constant demand will more than likely eliminate the need for an electrical lag chiller and gas fired lag boiler.

As mentioned, Figure 15 illustrates both the existing and redesigned systems. Both systems follow the trend of less electrical demand in the winter months due to the fact that less cooling is needed to maintain skiing conditions. The obvious difference in the systems comes from the magnitude of the overall electrical demand. This difference is due to the fact that the four direct expansion rooftop units that serve the retail section have now been replaced with the steam fired absorption chiller/heater that will provide the thermal capacity to the new rooftop units serving the retail section. While the retail section equipment has changed, the Snowdome equipment will remain the same. The main reason for this decision is that to produce the temperatures needed for the indoor skiing conditions, an electrically driven chiller is the only option.

Beyond monthly electric demand profiles, daily profiles are also required to assure that based on the amount of electricity generated that the thermal demand can also be reached. Figure 16 and Figure 17 below illustrate a February day electrical demand and a July day electrical demand profile respectively. February and July were picked to be illustrated in this report due to the fact that the lowest demand and the highest demand come from days in these months. Both days follow somewhat similar trends. From 9:00 P.M. until approximately 5:00 A.M. the snow making process is running in the Snowdome. It can be seen that as the process progresses throughout the night and nears the end of the cycle less energy is needed. Shortly after, the load demand from the retail section quickly brings the demand to a higher level. Throughout the day the electrical demand fluctuates as electricity is needed. Towards the end of the day the occupancy begins to decrease, thus the electrical demand begins to decrease. However, throughout the day the overall demand only fluctuates by 25 kilowatts.

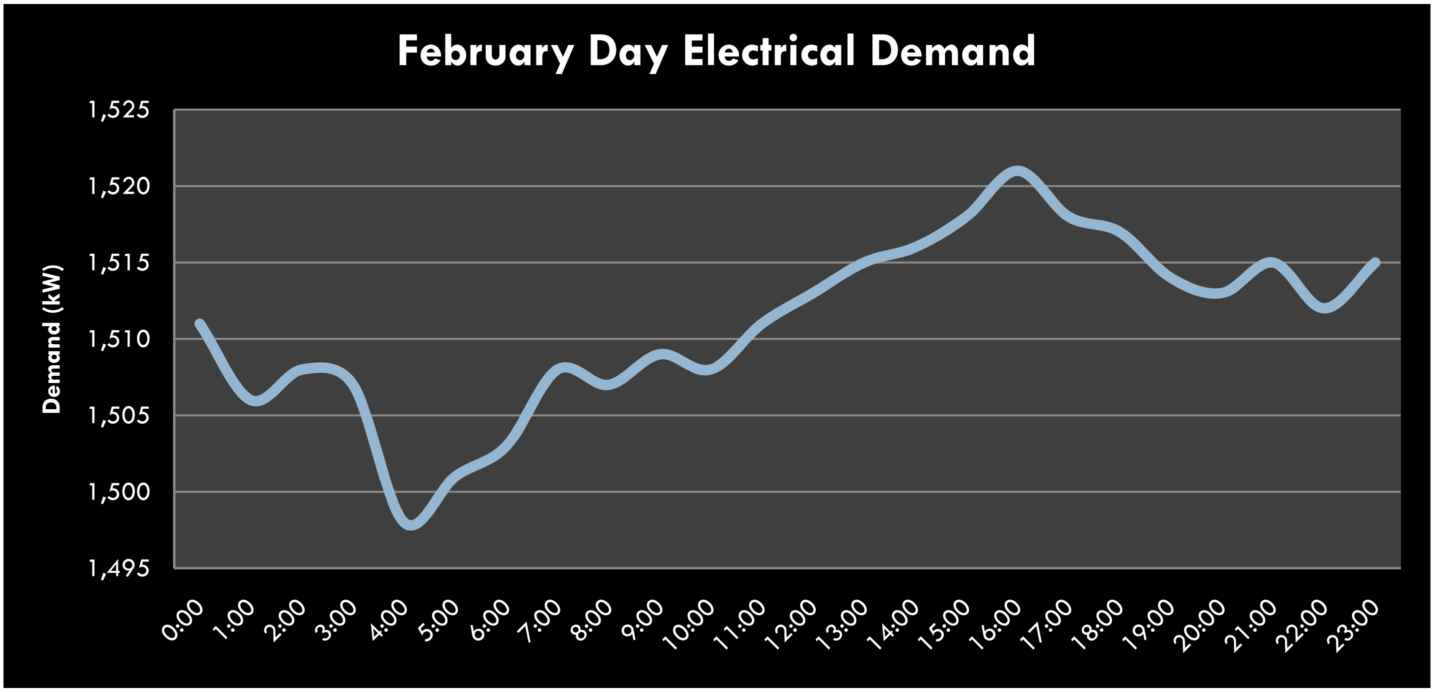

Figure 16: Typical Redesign February Day Electrical Demand

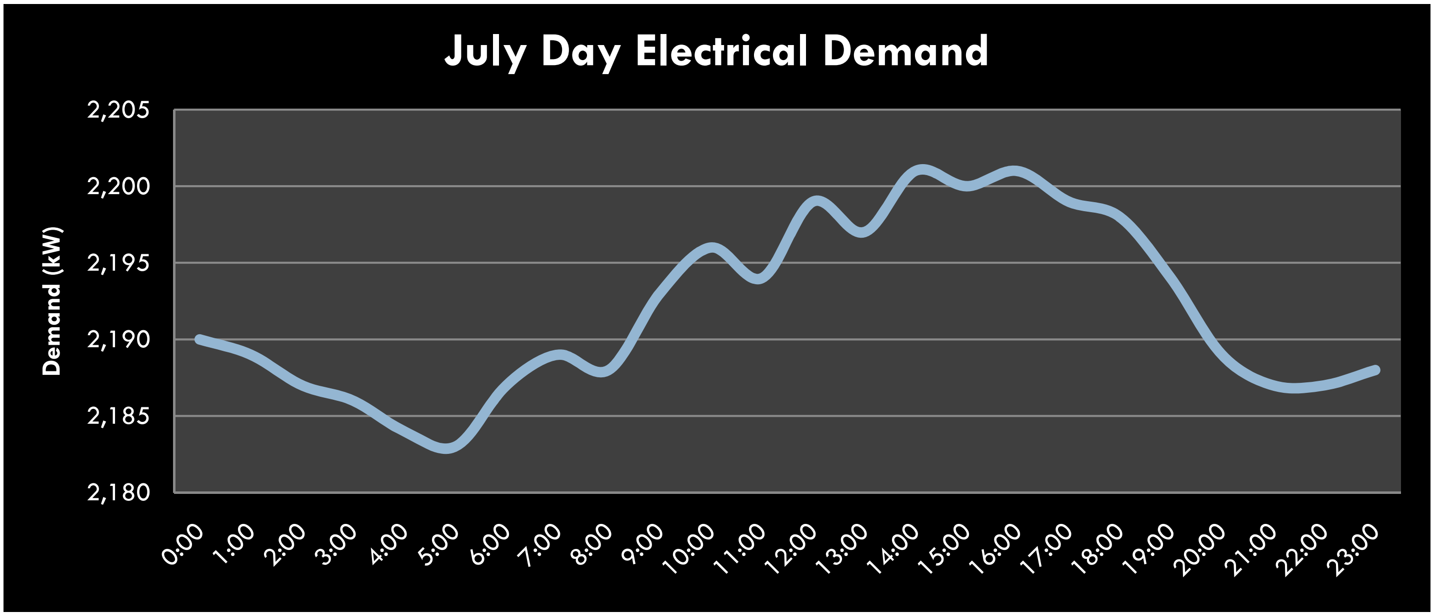

Figure 17: Typical Redesign July Day Electrical Demand

In addition to demand it is also to calculate the overall building electrical consumption. Figure 18 illustrates the consumption of both the existing and redesigned system.

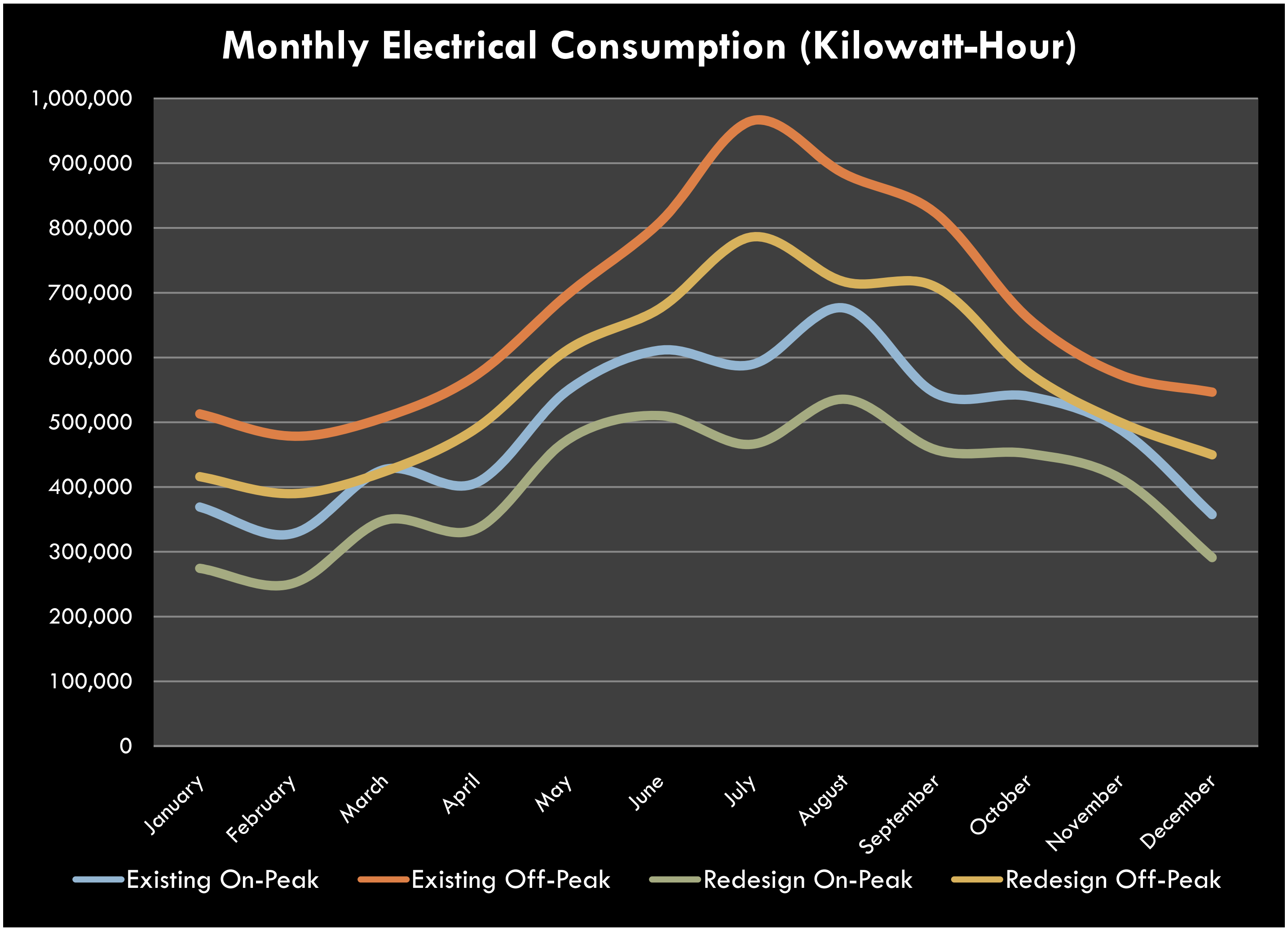

Figure 18: Existing and Redesign Monthly Electrical Consumption

Based on all the data calculated regarding building loads, the overall steam production can be calculated. With the steam production capacity calculated it can be determined if the steam alone can meet the thermal demand for the building year round. Figure 19 below illustrates the overall steam production. The steam produced by the prime mover meets the thermal demand throughout the whole year. This confirms that a single absorption chiller/heater will be able to meet the thermal loads for the entire building. The excess steam created presents another opportunity that will be utilized by heating the domestic hot water for the entire complex. This will lower the sizing of the domestic hot water heater for the complex. Since the domestic hot water encompasses the entire complex and just not Building A, the resizing of the domestic hot water boiler is beyond the scope of this redesign. It should also be noted that in order to calculate the steam production the redesigned system's equipment technical data was used. At this point in the report the equipment technical data has not been discussed and will be discussed in detail in the next sections.

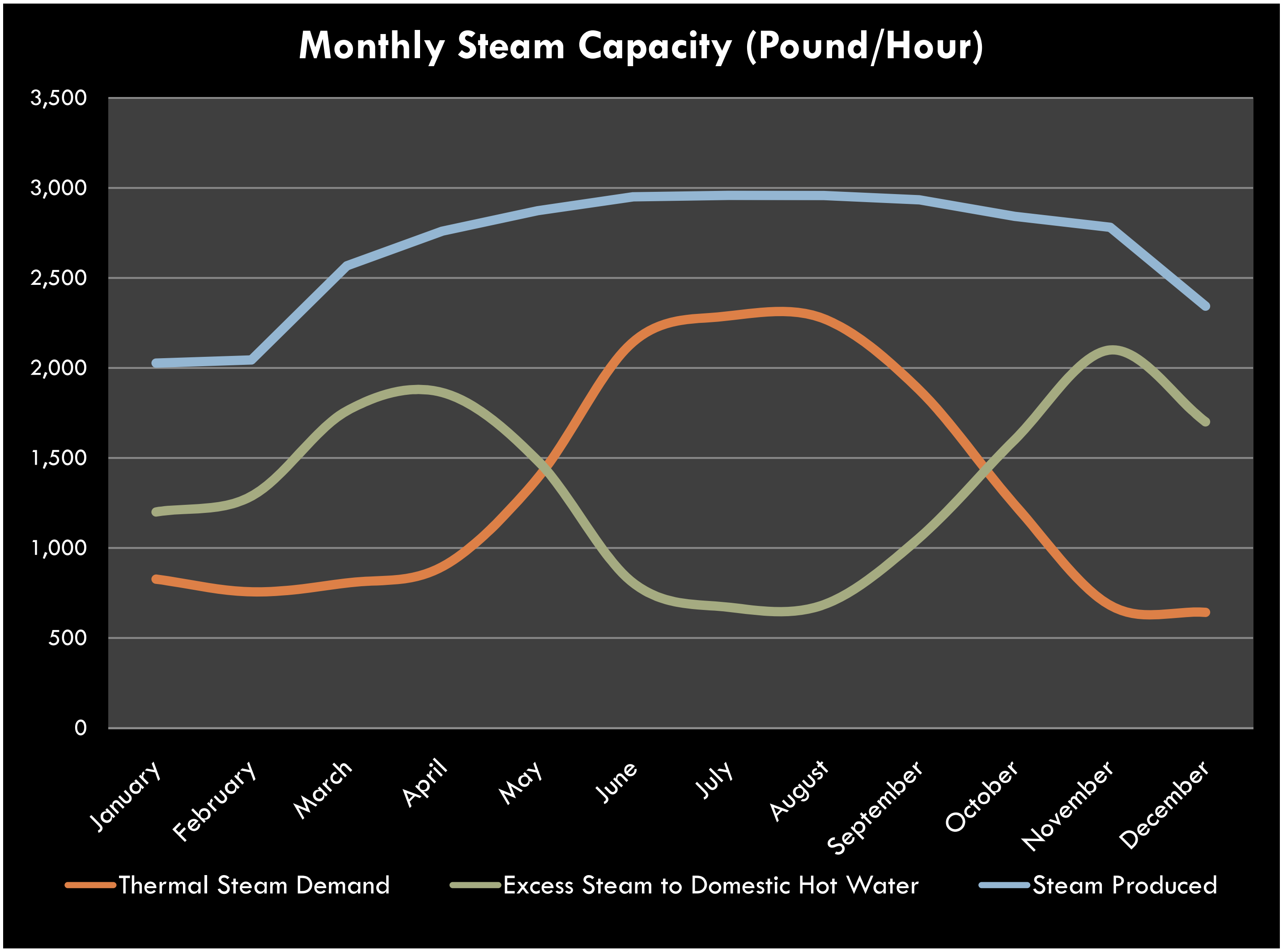

Figure 19: Redesign Prime Mover Steam Production