Introduction

Problem Description

The University of California at El Cajon (UCEC) is anticipating an increase in their energy demands over the next decade. This will require the University to upgrade their current power system in order to meet these demands.

One of the primary sources of energy required by UCEC is thermal power to produce both heating and cooling via a space heater and absorption chiller, respectively. The University currently has a cooling load requirement of 2,370 tons. Their combined heating and power system (CHP) system is also comprised of an absorption chiller cable of producing 120 tons of cooling. The remaining thermal load of 2,250 tons required for UCEC is then purchased from SDG&E.

Another primary source of energy required by UCEC is electrical power to produce lighting, cooling, and powering laboratory equipment. The University currently has a peak electrical load of about 8MW as well as a cooling load of 2,370 tons. Their combined heating and power (CHP) system is able to produce 2.59 MW total from two reciprocating engines. The remaining electrical load of 5.41 MW required for UCEC is then purchased from SDG&E.

The thermal requirement of the system is not expected to change over the next 10 years; however UCEC is expecting an increase of demand for electrical power of 19 MW. This will require a new power system to be implemented into the University in order to reach their new power demands. It is also important to mention that the peak electrical requirements during their summer sessions will drop to approximately 5 MW and will be considered in this report.

Control Systems

The final design will need to dynamically adjust to the thermal and electrical requirements of UCEC. Implementing an electromechanical control system will allow the power plant to vary its loading requirements based on the desires of the University. Through feedback control theory, several thermocouples will be placed strategically within the power system to monitor any varying temperatures. Actuated control valves will be placed strategically throughout the system to communicate with these sensors to maintain the both electrical and thermal loading requirements.

Control of Electrical Loading

The ambient temperature of the inlet air flow of the compressor has an effect on the work of the compressor and thus an effect of the power output of the system. Temperature sensors will be placed at both the inlet and outlet of the compressor as well as pre-combustion. There will also be a wattage sensor placed for the electrical generator to read the power output of the turbine. This will allow for electronic monitoring of state values that will correlate to both the amount of energy the system is producing and the amount of air flow to maintain 19 MW in real time.

Initially, temperature readings will be collected from both the inlet and outlet of the compressor. This will allow our control system to calculate the amount of work that the compressor must generate and will be compared to the amount of electrical power output of the turbine. The difference of the two will be the actual net power output of the system. If this value does not match the desired output of 19 MW an error signal is produced and to separate actuations occur. First, the flow rate of air will be adjusted as necessary through a variable frequency drive (FVD). Second, the flow rate of fuel into the combustion chamber will vary to maintain a desirable fuel-to-air ratio. This will provide the system with a method for achieving approximately 19 MW of power in the event of varying environmental condition such as the changing ambient air temperature.

Control of Thermal Loading

The need for heating and cooling will be varied throughout the day as well as over the entire year. A control system should be implanted to better generate the amount of water that is being heated and cooled for the thermal loading power system. The desired amount of energy from space heating or the absorption chiller will be monitored via thermostats placed throughout the campus. As the need for more heat is required a valve will be adjusted to allow more water flow to enter the space heater, allowing more energy to be used for heating the campus. As the need for more cooling is required the same valve will be adjusted to allow more water flow to enter the absorption chiller, allowing more energy to be used for cooling the campus.