Mechanical System Redesign

The second, larger, section of the mechanical redesign will use current technologies that have been proven to work, however, are still considered to be on the cutting edge in heating, ventilation, and air condition field. The redesign will analyze an existing building that uses a large amount of energy from the electrical grid throughout all hours of the day and convert it to a new building that still requires a large amount of energy; however, the building will now obtain the needed energy while: lowering the environmental impact, receiving the energy at a lower cost to the owner, and changing a negative situation in the community into a positive one that educates everyone. In short, the mechanical redesign will take a building that is currently a liability and turn it into an asset.

Redesign Objectives

Since the development of the Xanadu Sports Complex began the project has seen multiple lawsuits filed that delayed the construction. One of these lawsuits was filed by four environmental advocacy groups on October 13, 2004 in the New Jersey Appellate Court. The lawsuit requested the halt of construction of the complex due to the fact that state officials and the developers had not fully assessed the environmental affects that such a complex will have on the area. The delays produced from this lawsuit and the others have raised the estimated cost of the Xanadu Sports Complex from $1.3 billion to the current amount of $2 billion. This lawsuit sparked the debate of whether or not an indoor ski resort is worth the environmental impact that such a space will produce. Considering that the existing building obtains all its energy through an electrical grid that receives 70% of its power through coal plants, the environmental impact produced will be a large one. Therefore, the overall objective of the mechanical system redesign is to reduce that environmental impact produced while still providing an economically feasible system.

Redesign Summary

To achieve these goals a combine heat and power (CHP) system will be implemented in the Xanadu Sports Complex. The CHP system will use a source of fuel to power a combustion process on the site of the building. This combustion process will take place in the building's prime mover. A prime mover for use in a CHP system can come in the form of an engine, turbine, or microturbine. The combustion process in the prime mover will be used to create the electricity needed to power the sports complex. The combustion process produces a large amount of excess heat that can be used through the use of heat exchanger to produce medium pressure steam. The combination of the electrical production and steam produced creates a fairly high efficient process that utilizes a cleaner burning fuel than coal.

The medium pressure steamed produced can be used for multiple uses throughout the building; however, for this report the steam will be used to run a steam fired heating and cooling absorption chiller. The absorption chiller can use the available steam to heat or cool the building. When a CHP system is designed, the prime mover can be designed to either meet the electrical demand or the thermal demand based on the steam output and the absorption chiller efficiency. In this report the prime mover will be designed to meet the electrical load and the resulting steam capacity will either meet all of the thermal demand or partially meet the thermal demand. Depending on the steam output a lag chiller and a lag boiler may need to be implemented to meet thermal demand loads during times of off-peak electrical demand. During times of off peak electrical demand when the building does not require as much electricity, the steam production will also decrease as the prime mover throttles down to meet the current electrical demand. At these times a centrifugal chiller or a gas fired boiler will be used in conjunction with the heating or cooling cycle of the absorption chiller to meet the current thermal load. Due to the large amount of energy needed to power the building, it is also possible that the electrical load will far outweigh the thermal demand. In this case there is no need for the lag chiller and boiler, and the excess steam produced will be used to heat the domestic water in the building.

One of the biggest impacts on the environmental impact is the type of fuel used to power the building. In many cases natural gas is used for CHP systems; however, a growing number of systems are using reclaimed landfill gas to power the prime mover's combustion process. Landfill gas can be collected by drilling large well systems deep into the piles of garbage at a local landfill. The well system collects the mixture of methane gas which is then sent through a treatment cycle to clean the gas of all impurities. The cleaned gas is then piped to the site to be used. Any excess gas collected can be flared off or sold to other local buildings in need of a fuel source.