Mechanical System Redesign Conclusions

The objective behind the redesign of the mechanical system was to take a negative situation and create a positive one, turning a liability into an asset. In order to meet this goal two key factors had to be met, substantially reducing the environmental impact the building produces while maintaining an economically feasible system. If, and only if, these two criteria are met can the system redesign be considered a success.

Economic Analysis

In order to maintain a retail building and indoor ski resort year round a large amount of energy is required. Due to this large amount of energy a large amount of money must be spent to run the building each year. Due to the location of the Xanadu Sports Complex the local utility provider of electricity and natural gas is PSEG Power. Table 4 below summarizes the electrical rates for PSEG. As an alternative, if the building were to use natural gas instead of landfill gas, the PSEG CS-CFG gas rate would be used. This gas rate is used for buildings that are going to use the gas to produce their own electricity. This rate also comes with a small fee to still remain connected to the electrical grid. The charge is applied to ensure the electrical capacity will be available to the building in the case of a engine failure. The natural gas rate averages around 99 cents per therm throughout the year and the monthly fee for the grid connections is approximately $4,200.

Table 4: PSEG Electricity Rates

Charge Type	Months	Rate
Electric Demand On Peak	October-May	$3.894 /kW
	June-September	$7.227 /kW
Electric Demand Off Peak	October-May	$2.923 /kW
	June-September	$5.420 /kW
Electric Consumption On Peak	October-May	$0.088 /kWh
	June-September	$0.097 /kWh
Electric Consumption Off Peak	October-May	$0.070 /kWh
	June-September	$0.071 /kWh

There is a large difference between typical utility rates and the rate structure of current landfill gas systems. Typical utility rates have a structure dictated by the utility company and are subject to increase. Current utility rate trends and predicted trends will be used in the overall economical evaluation. Figures 26 and 27 illustrate the trend of utility rates for the past years. This is not the case with landfill gas systems. The rate for landfill gas delivery is worked out between the landfill and the building owner in the form of a multiple year contract. This locks the price of landfill gas to a set value for years. Not only is the price set for years, the price per therm of LFG is much less than that of natural gas. Through research it was found that the average price of LFG per therm is around 30 cents,

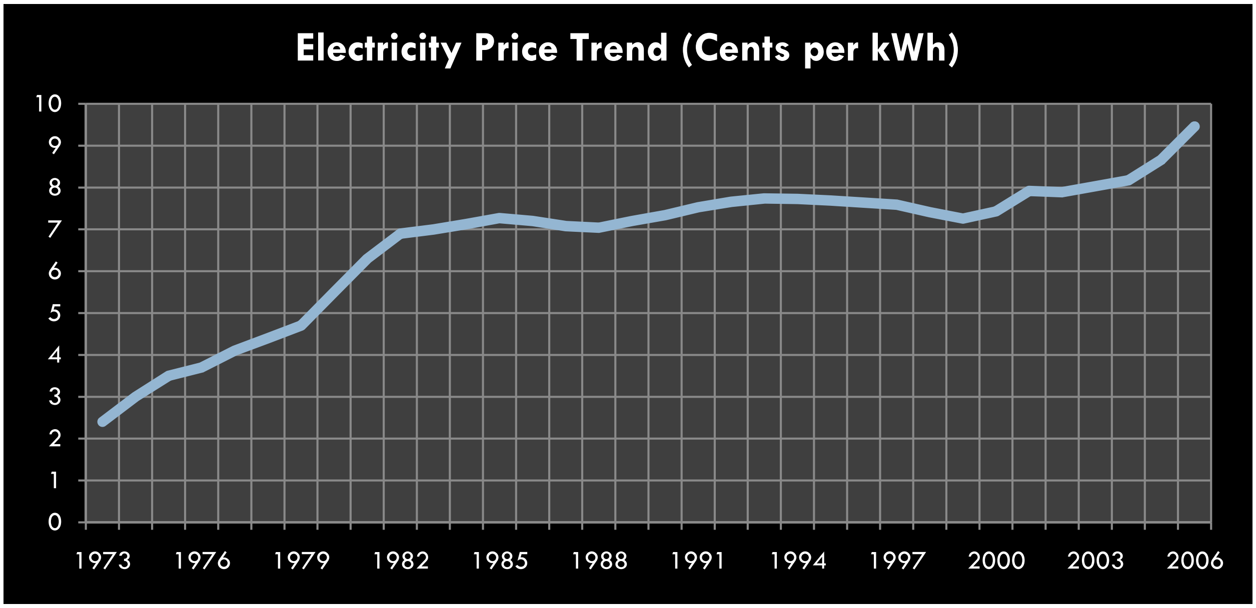


Figure 26: Electricity Price Trends

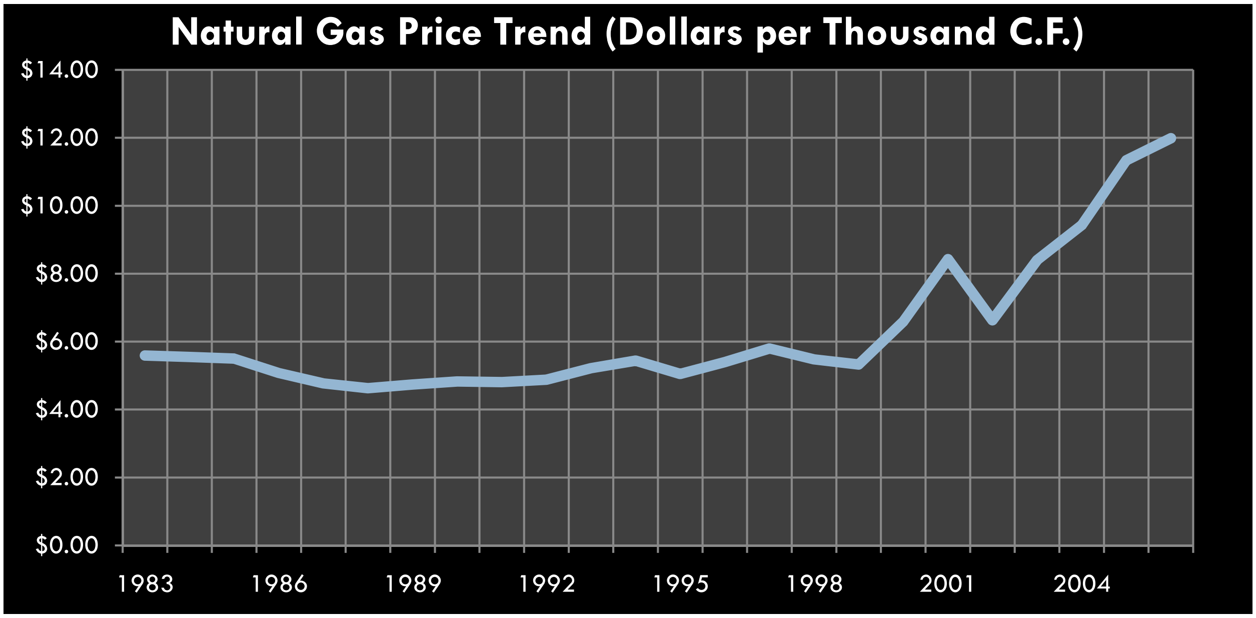


Figure 27: Natural Gas Price Trends

more than a third less than that of natural gas. As long as there is an abundance of landfill waste, the cost of LFG will be much lower than the cost of other typical utilities. In addition to the lower costs, there are multiple tax credits available to promote the use of renewable fuel. The biggest credit is the Environmental Protection Act of 2005 Section 45 Credit. This credit requires the use of renewable energy and that the building is in operation by December, 2008. The use of LFG is considered a renewable energy, and the Xanadu Sports Complex is scheduled to open in November of 2008, therefore this is a feasible tax credit. This credit provides 1 cent for each per kilowatt-hour used. This credit will be evaluated in the overall cost analysis.

Based on the different utility rates, the TRACE 700 energy model, and the results from the BCHP Screening Tool, the overall utility costs for the three alternatives can be determined. Figures 28 through 31 illustrates the findings.

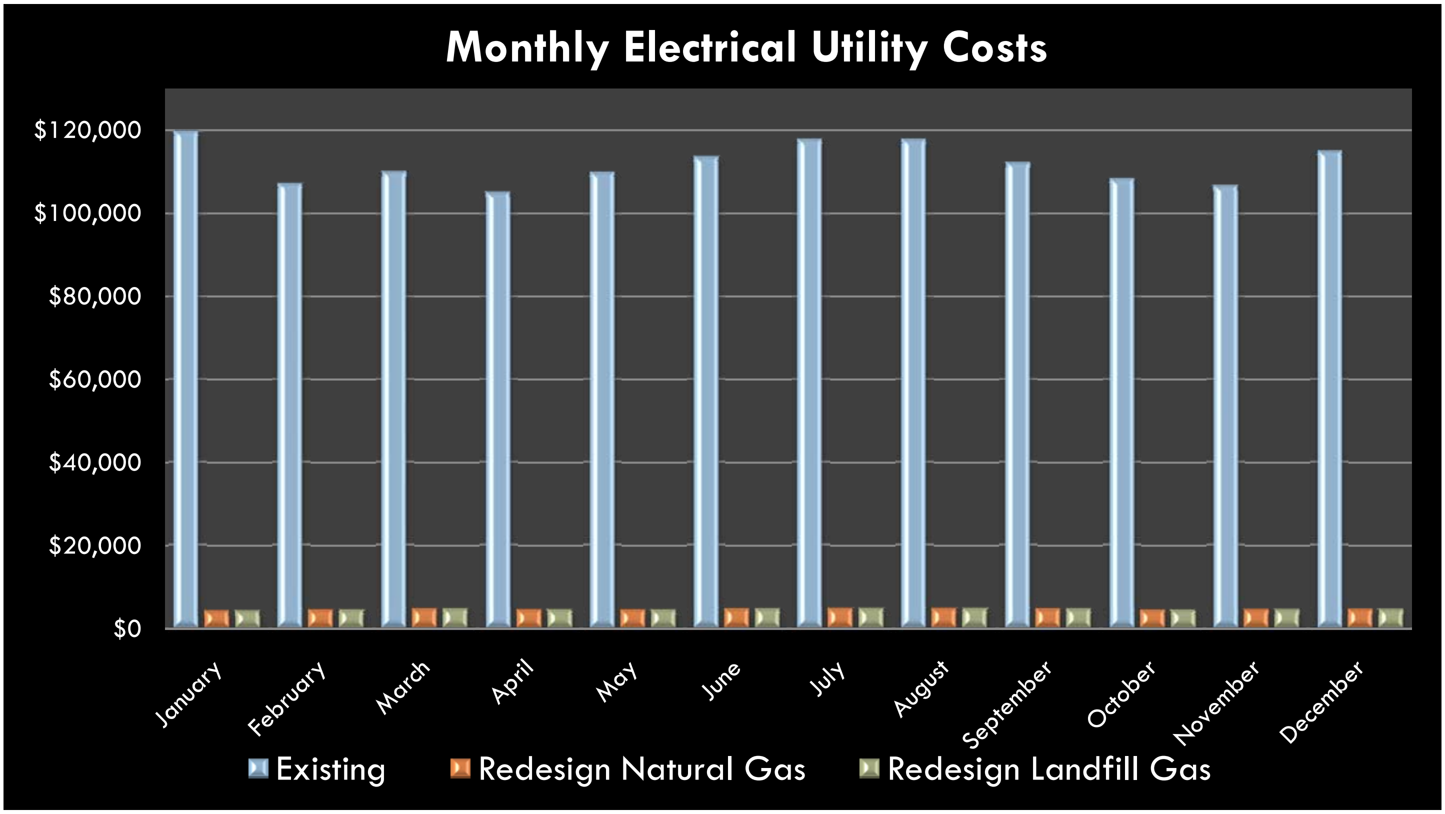


Figure 28: Monthly Electrical Utility Costs

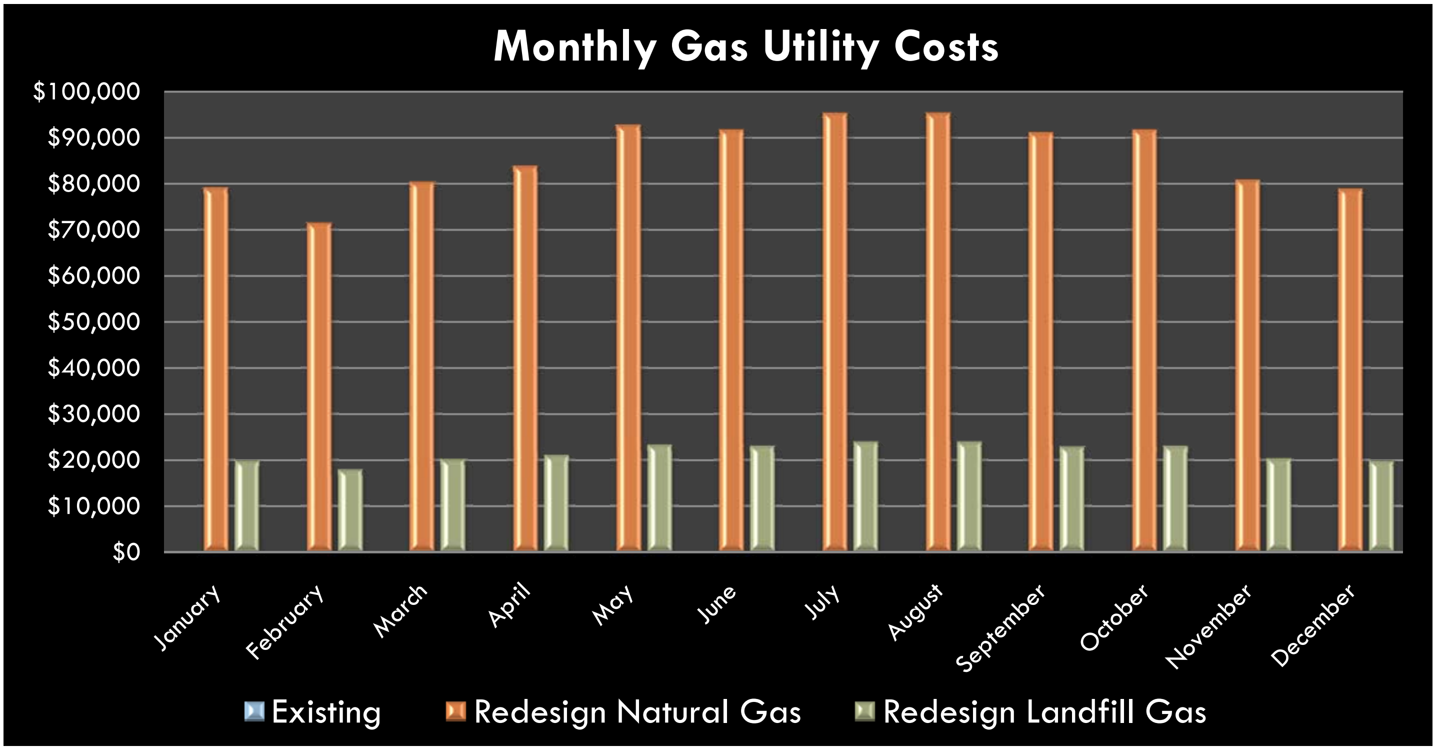


Figure 29: Monthly Gas Utility Costs

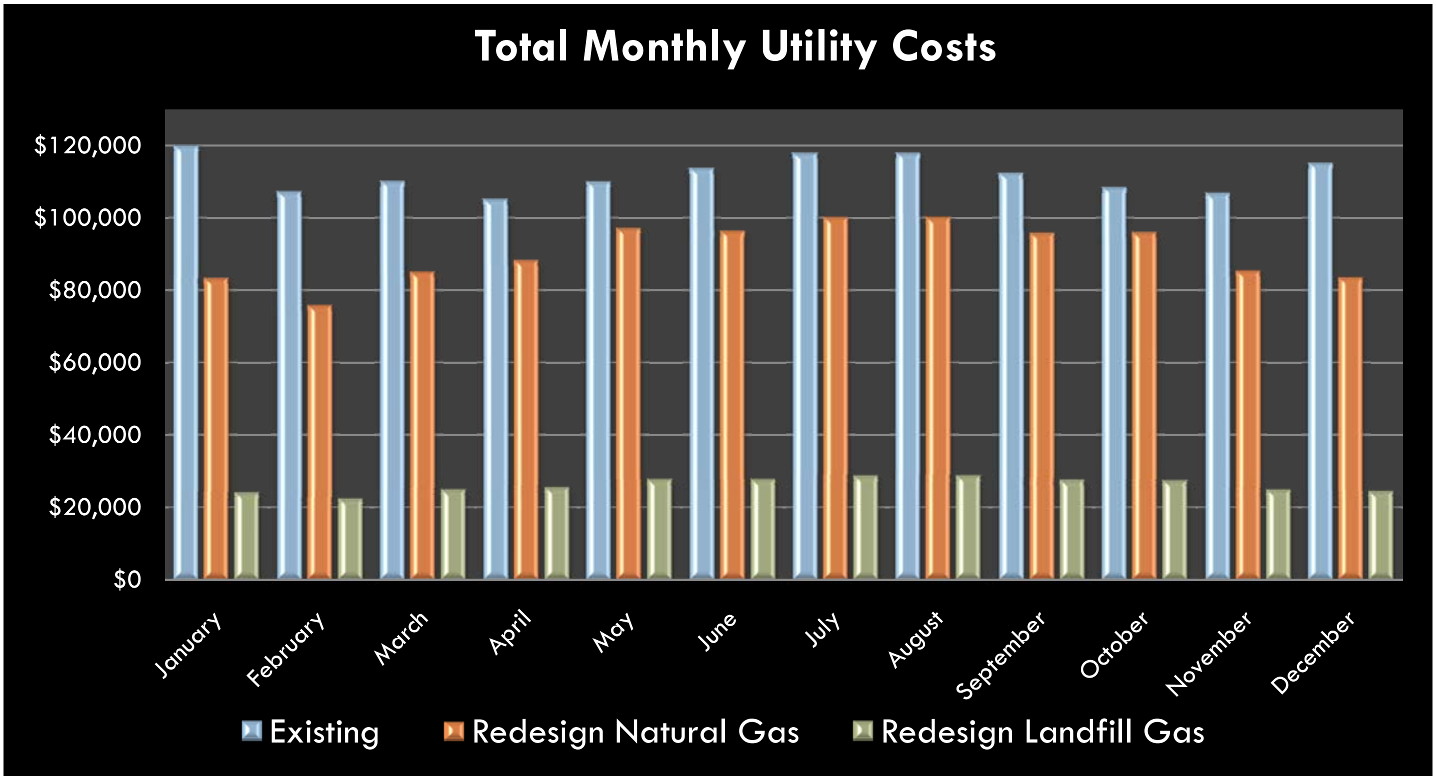


Figure 30: Total Monthly Utility Costs

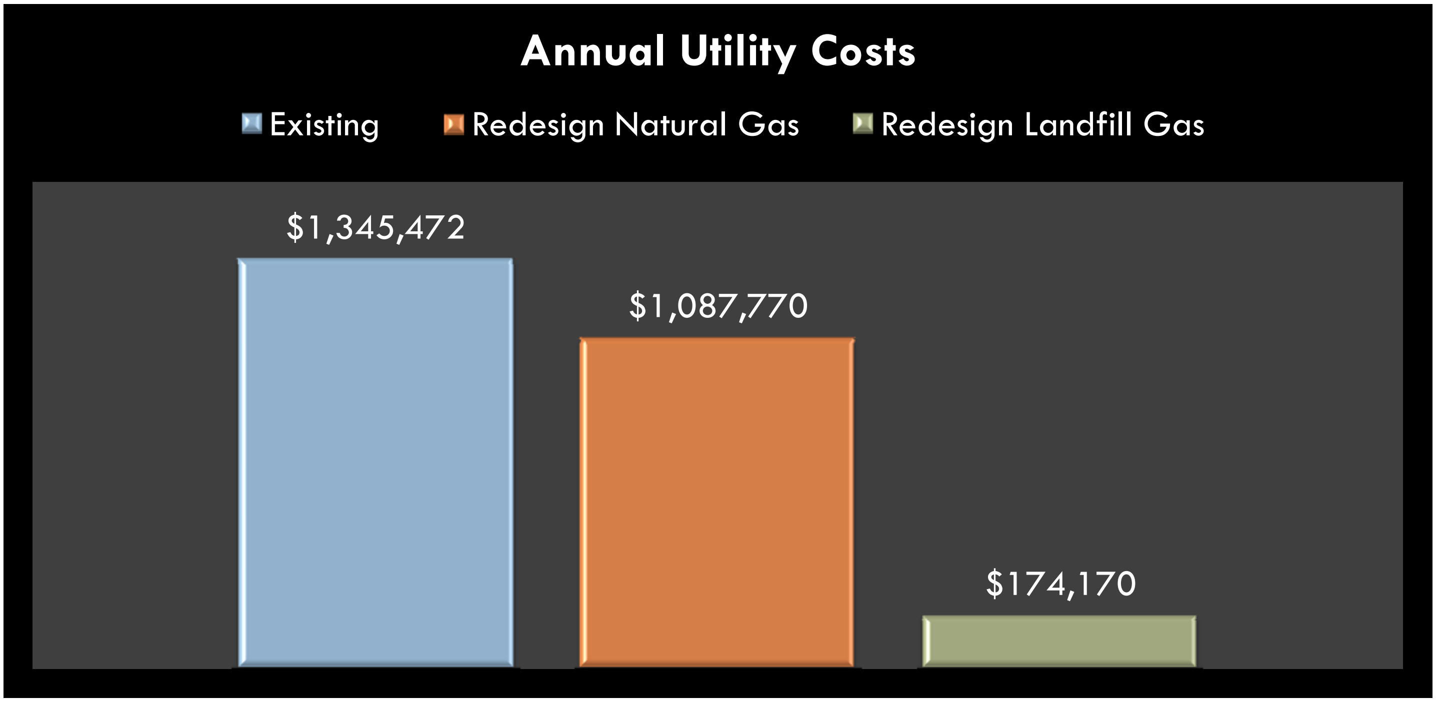


Figure 31: Total Annual Utility Costs

The above figures indicate that the most expensive annual operation rate is produced from the existing building conditions costing approximately $1.4 million a year. The second most expensive operation cost comes from the use of natural gas with the redesigned system costing approximately $1.2 million a year. It should be noted that the natural gas cogeneration system does not produce a significant savings. This is due to the electricity and natural gas utility rates. While energy from natural gas is cheaper than the grid electricity during on-peak conditions, it is more expensive to use natural gas during off-peak conditions. For this reason, if natural gas is to be used it would be much more beneficial to install an electrically driven lag boiler and lag chiller to operate during off-peak conditions. Finally, the lowest operating cost comes from the redesigned CHP system using the landfill gas, costing only $405,249 a year to operate. The redesigned system produces operational savings nearly 3.5 times less than the existing system.

Beyond the annual costs, the initial capital costs of the systems needs to be evaluated. While the annual savings are significant, a higher initial cost is to be expected. Table 5 on the next page summarizes the total costs of each system. The evaluation indicated that the redesigned landfill gas and CHP system will increase the initial system cost by 1.5 times. This increased initial cost and the annual savings works out to produce a payback period of just under 7 years. While 7 years is higher than originally desired, the 13 year span after the payback period will produce savings of $15,042,055.

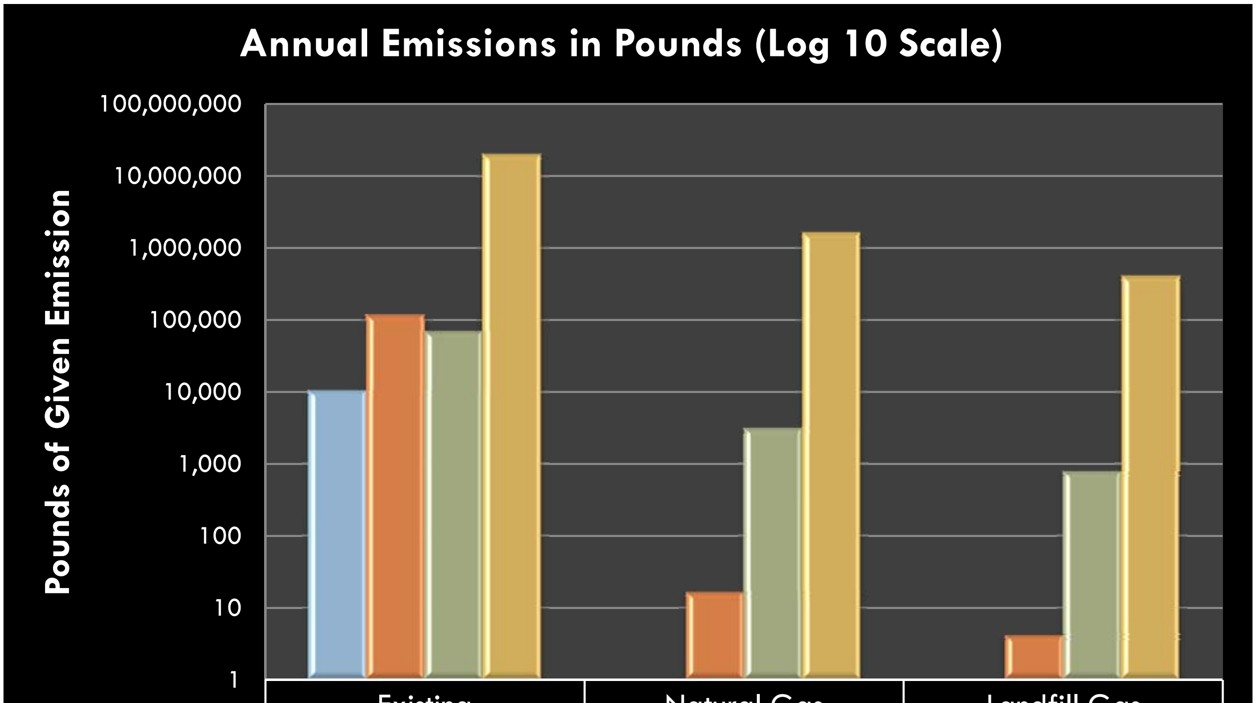
Table 5: Mechanical System Redesign Economic Evaluation

	Existing	Redesign Natural Gas	Redesign Landfill Gas
Capital Costs			
Unchanged Costs	$3,809,428	$3,809,428	$3,809,428
Snowdome	$9,493,073	$9,493,073	$9,493,073
Rooftop Units	$426,155	$462,393	$462,393
Retail UPS System	$9,000	$0	$0
Snowdome Emergency Generator	$19,000	$0	$0
GE Jenbacher Engine	$0	$1,703,100	$1,703,100
Absorption Chiller	$0	$471,600	$471,600
Cooling Tower	$0	$37,900	$37,900
Landfill Well System	$0	$0	$4,866,000
LFG Transportation	$0	$0	$104,412
LFG Excavation	$0	$0	$242,088
Totals	**$13,756,656**	**$15,977,494**	**$21,189,994**
Yearly Costs			
Grid Electricity	$1,345,472	$54,641	$54,641
Natural Gas	$0	$1,032,963	$0
Landfill Gas	$0	$0	$258,725
EPA 2005 Section 45 Credit	$0	$0	-$139,196
Maintenance	$83,517	$138,648	$231,079
Totals	**$1,428,990**	**$1,226,252**	**$405,249**
Economic Evaluation			
Payback Period	-	**8.4 Years**	**6.6 Years**
Total Utilities After 20 Years	$30,580,382	$25,260,787	$8,104,989
Total Savings After 20 Years	-	**$3,098,757**	**$15,042,055**

Environmental Analysis

While the economic analysis produced favorable results, the true goal of the system redesign was to turn a system that was a large liability and produce an asset not only to the owner but also to the local community. The existing system runs entirely on the PSEG electricity grid. This electrical grid produces nearly 70% of its electricity through coal-burning plants. The use of coal-burning plants is considered a highly dirty energy source due to the composition of coal. The exact chemical composition of coal is based largely on many variables. However, all coal shares the same attribute of being mainly comprised of carbon atoms and few hydrogen atoms. During the combustion process the small amount of hydrogen is used to create energy while the remaining products, largely carbon, are released into the atmosphere, thus creating large amounts of pollutants. The other 30% of the grid produces its electricity through the use of nuclear power plants. While coal is largely dirty, nuclear power is an extremely clean power and creates zero impact on the environment.

There are substantial environmental benefits through the use of natural gas and landfill gas. The chemical composition of natural gas is comprised of a single carbon atom and four hydrogen atoms. This fact makes the use of natural gas much cleaner due to the fact that for every carbon released into the atmosphere four hydrogen atoms have been utilized. The largest benefit is produced though the use of landfill gas. Under normal circumstances a landfill will produce large amounts of methane that will be directly introduced to the environment. However, when the landfill gas is collected for the use of a CHP system, the methane is used to offset the use of nonrenewable resources, such as coal, that will produce more pollutants. The total environmental impact is quantified in Figure 32 below.



	Existing	Natural Gas	Landfill Gas
Particulates	10,326	0	0
SO2	119,959	17	4
Nox	69,533	3,136	784
CO2	20,182,243	1,656,998	414,217

Figure 32: Annual Emission in Pounds

Figure 32 shows the large difference in emission between the three alternatives. The use of landfill gas for the use of a CHP system reduces the total carbon dioxide emissions by 19,768,026 pounds, nearly 50 times less. This value can be used to estimate the annual environmental impact into comparative terms. The use of the redesigned system can be estimated to be equivalent to planting 26,000 acres of forest or preventing the use of 221,000 barrels of oil or removing emissions equivalent to 18,200 vehicles annually.

Therefore, the use of landfill gas and a combined heat and power system truly is turning a liability into an asset by greatly reducing local air pollution while creating jobs, revenue, and cost savings.