## Life Cycle Cost Analysis

Previous analysis has successfully proven cogeneration can save City Hospital 17 – 27 % in energy cost annually. Besides energy and energy cost saving, the alternate building system should have a reasonable payback period to justify its application. To analysis economic viability of the cogeneration, life cycle cost (LCC) analysis is performed for both existing and alternate system with two (2) equipment staging scenarios.

A period of twenty (20) years is chosen for LCC analysis since most boilers has an average lifetime of twenty (20) years. Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis-2007 is used to obtain “Fuel Escalation Rates” and “Real Discount Rate” of 3% for investments with 11 – 30 years period.

Other perimeters for LCC analysis included equipment capital cost, annual energy cost, and operating and maintenance (O&M) cost in 2007 dollars. Annual energy cost, operating and maintenance cost for the alternate system has taken into considerations that the CHP will be taking off-line between 4 - 5 days semiannually for maintenance, and overhaul every 30,000 – 50,000 hours suggested by James Knight, Associate Director for Utilities and Co-generation at Bucknell University.

| Item | Installed Cost | O&M Cost |
|---|---|---|
| 800 bhp Boiler | $ 379,907 | $ 3,559 |
| 2000 bhp Boiler | $ 1,122,116 | $ 9,095 |
| 1.2 MW CHP | $ 2,067,032 | $ 94,044 |
| 3.5 MW CHP | $ 4,245,927 | $ 209,431 |

Another perimeter that is taken into consideration for LCC analysis is the effect of utility deregulation. Deregulation of electric utility should foster competition in the provision of electricity. However, Baltimore, Maryland where deregulation has already occurred, consumer experience a dramatic 75% increase in electricity costs, contrary to the intentions of deregulation. With Pennsylvania’ electric utilities fully deregulated by December 30, 2010, how electric rate change remained uncertain. As a result, four (4) LCC scenarios will be analysis for P 1&2, West Tower, and the completed campus.

(1) Normal Fuel Price escalation
(2) 75% increase in electricity cost by 2011, natural gas cost remain normal
(3) 15% increase in electricity cost by 2011, natural gas cost remain normal
(4) 15% increase in natural gas cost by 2009, electricity cost remain normal

| Scenario 1_Annual Saving and Payback Period for 20 Year LCC (2007 Dollars) | | | | | | |
|---|---|---|---|---|---|---|
| Construction Milestones | Phase 1 & 2 | | West Tower | | Completed Campus | |
| | Energy Cost Savings | Discounted Payback Period | Energy Cost Savings | Discounted Payback Period | Energy Cost Savings | Discounted Payback Period |
| **Scenarios** | ($ mil) | (Yr) | ($ mil) | (Yr) | ($ mil) | (Yr) |
| Normal Fuel Escalation | 0.01 | **155.1** | 1.20 | 0.8 | 2.86 | 1.6 |
| 75% Increase in Elec. (2011) | 0.34 | 6.1 | 2.35 | 0.4 | 5.42 | 0.8 |
| 15% Increase in Elec. (2011) | 0.09 | 23.1 | 1.46 | 0.6 | 4.16 | 1.1 |
| 15% Increase in NG (2009) | (0.04) | **(56.3)** | 1.12 | 0.8 | 2.32 | 2.0 |

| Scenario 3_Annual Saving and Payback Period for 20 Year LCC (2007 Dollars) | | | | | | |
|---|---|---|---|---|---|---|
| Construction Milestones | Phase 1 & 2 | | West Tower | | Completed Campus | |
| | Energy Cost Savings | Discounted Payback Period | Energy Cost Savings | Discounted Payback Period | Energy Cost Savings | Discounted Payback Period |
| **Scenarios** | ($ mil) | (Yr) | ($ mil) | (Yr) | ($ mil) | (Yr) |
| Normal Fuel Escalation | - | - | 1.68 | 1.9 | 3.42 | 1.3 |
| 75% Increase in Elec. (2011) | - | - | 3.38 | 0.9 | 6.80 | 0.7 |
| 15% Increase in Elec. (2011) | - | - | 2.07 | 1.5 | 4.20 | 1.1 |
| 15% Increase in NG (2009) | - | - | 1.56 | 2.0 | 3.18 | 1.4 |

The 20 Year LCC for the alternate system has shown that equipment staging Scenario 2 is superior to Scenario 1. Scenario 1 would have too long of a payback period to be economic viable for many owners. The alternate system may cost more if price of natural gas is higher than normal prediction. Other than minimized capital cost and “lost rentable space”, equipment staging Scenario 2 has larger annual saving and shorter payback period than Scenario 1 in all fuel price escalation scenarios (*Appendix vii – xix*).