



**MIDWEST
CHP
APPLICATION
CENTER**

Elgin Community College **Building Cooling, Heating, and Power (CHP) Plant**

Site Description

Elgin Community College (ECC), located in Elgin, Illinois, a northwestern suburb of Chicago, provides education to the residents of Cook and Kane Counties. The main campus of ECC consists of 11 buildings on over 145 acres, totaling 726,000 square feet of floor space. With a current student population of 25,000, which is expected to grow to 50,000 by 2020, ECC has been looking to efficient and energy saving technologies to serve their future needs utilizing the concepts of cogeneration.

In 1996, a 3.2 MW Buildings, a Cooling, Heating, and Power Plant (CHP) Plant was installed at the main campus of Elgin Community College to provide:

- 1) Energy Reliability
- 2) Energy Savings
- 3) On-Site Energy Control

The load following cogeneration system operates during ComEd (Commonwealth Edison's), the local electric utility's, on-peak energy period between 9 AM and 10 PM. This schedule enables ECC to avoid the high peak electric rates. The system is shut down in the evening taking advantage of the lower electric rates offered during the off-peak period.



Figure 1: Main campus of Elgin Community College located in Elgin, Illinois.

Cooling, Heating, and Power (CHP) Configuration

The CHP Plant at ECC includes the following equipment:

- ◆ Four (4) 800 kWe Waukesha (VHP2100GL) Lean Burn Natural Gas Engine Generators rated at 4,160 volts, 1200 rpm
- ◆ Four (4) Beard Heat Recovery Silencers, Maxim Model TRP-12" with level control package, feed water valve and safety pressure relief valve, which produce about 2800 lbs./hr of 15 psig steam (2,800 MBTU/hr) per engine generator from jacket water and exhaust gas,
- ◆ Four (4) Beard Exhaust Silencers, Maxim Model MT41-12",
- ◆ One (1) York, Single Stage 500 ton Absorption Chiller,
- ◆ Three (3) Kewaunee Hot Water Boilers totaling over 44 MMBTU

Supplemental Heating and Cooling

The supplemental heating and cooling at ECC includes the following equipment:

- ◆ One (1) Trane 550-ton, 3-stage centrifugal chiller
- ◆ Forty-Five (45) Various Size Trane Electrical Air-Conditioners - 850 ton total capacity
- ◆ Nine (9) Patterson-Kelly Hot Water Heaters totaling 15 MMBTU

Financial Statistics

The total cost of the ECC CHP Plant, including engineering, construction, Capital Development Board (CDB) fees, equipment, and change orders totaled near \$2.5 million.

Total CHP Cost:	\$2,500,000
Original Goal:	Payback in 6.5 years
Calculated Performance:	Payback in 5.7 years
Operating Savings:	Approximately \$440,000/yr
Internal Rate of Return:	17.0%

Energy/Financial Analysis Overview

Based on actual data from the local utilities and Elgin Community College, an analysis of the CHP utility operating costs was analyzed. Further, a Baseline Case was developed using the existing equipment at ECC minus the electric on-site generators and then compared to the CHP data. The assumption used in this analysis were:

Assumptions:

- ◆ Fuel Consumption: 26.0 MMBTU/hr (75% load)
- ◆ Recovered Heat (75% load)
 - Exhaust Heat: 3.2 MMBTU/hr
 - Jacket Water Heat Rejection: 6.1 MMBTU/hr
- ◆ Maintenance costs: 1.2 ¢/kWh generated
- ◆ Average price of natural gas: 52¢/therm
- ◆ The generators follow the college electric load during the ComEd peak period (M-F 9:00 AM to 10:00 PM)
- ◆ All hot water produced by heat recovery is sent to the boilers
- ◆ Baseline electric demand is equal to the CHP maximum generator kW output
- ◆ Supplemental electricity for the CHP Plant is provided by ComEd as per their Rate 6 when the generators cannot meet the total demand (CHP)
- ◆ When the thermal load is greater than the recovered heat provided from the engines, supplemental heat is provided by the natural gas boilers
- ◆ Supplemental cooling load is provided by the centrifugal chiller when cooling load is greater than capacity of absorption chiller
- ◆ The overall electric facility demand/load remains the same for both cases
- ◆ Taxes on electric charges incorporated
- ◆ Variable commodity and utility delivery charges included on natural gas charges



Figure 2: Four 800 kW Waukesha engines operating at ECC

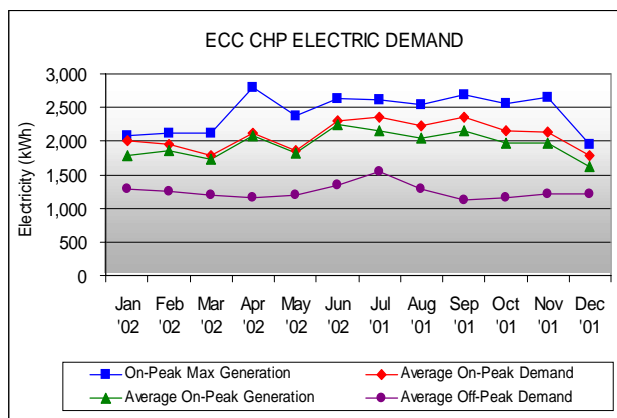


Figure 3: Average Hourly Electric Demand in kW

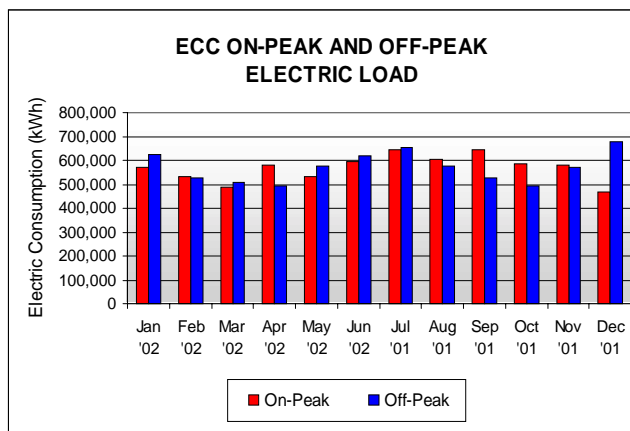


Figure 4: Elgin Community College On-Peak and Off-Peak Electric Loads

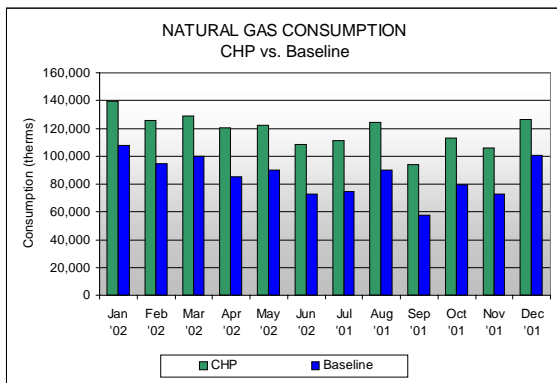


Figure 5: ECC Natural Gas Consumption – CHP vs. Baseline



Figure 6: York Absorption Chiller Controls

Results

The CHP Plant provided the following:

- ◆ CHP Annual Operating Savings of \$440,023 (Tables 2 and 3)
- ◆ CHP Plant generated 6,587,510 kWh
- ◆ Annual Heat Recovery savings of \$165,322
- ◆ CHP plant recovered 25,372 MMBTU of thermal energy from the engine generators (Figure 7)
- ◆ 94% of the yearly electric demand is met by the CHP Plant during on-peak hours (Figure 3)
- ◆ Average Cost of on-peak electricity (Table 1):
 - 12.09 ¢/kWh – Baseline
 - 7.45 ¢/kWh – CHP
- ◆ Average on-peak CHP savings on cost of electricity is 4.64 ¢/kWh when natural gas is 52¢ per therm
- ◆ Electric Facility Load - 13,678,806 kWh
- ◆ On-Peak Facility Load – 6,834,289 kWh
- ◆ Annual Natural Gas Consumption (Figure 5):
 - 1,066,824 therms – Baseline
 - 1,460,646 therms – CHP
- ◆ Actual CHP savings are greater than estimated in the project feasibility study, which resulted in a quicker payback than expected

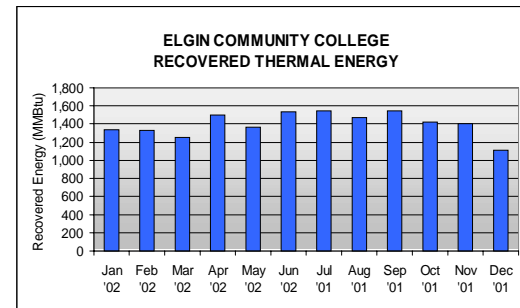


Figure 7: ECC Recovered Thermal Energy from Engines

ANNUAL OPERATING SAVINGS - GAS SENSITIVITY			
Natural Gas Average Price (¢/therm)		Annual Savings	Monthly Savings
30	40%	\$527,154	\$43,930
35	37%	\$507,488	\$42,291
40	34%	\$487,797	\$40,650
45	32%	\$468,106	\$39,009
50	29%	\$448,414	\$37,368
52	28%	\$440,023	\$36,669
55	27%	\$428,723	\$35,727
60	25%	\$409,032	\$34,086
65	23%	\$389,341	\$32,445
70	21%	\$369,650	\$30,804
80	18%	\$330,268	\$27,515

Table 2: ECC Annual and Monthly Savings with varied costs of natural gas prices – CHP

AVERAGE COST OF ELECTRICITY (¢/kWh)			
	Yearly	Summer	Winter
Baseline	7.22	7.81	6.91
On-Peak	12.09	13.05	11.61
Off-Peak	2.33	2.33	2.34
CHP	5.19	5.10	5.24
On-Peak	7.45	7.16	7.59
Off-Peak	2.95	2.94	2.96

Table 1: ECC Average Cost of Electricity at 40 cents per therm of natural gas – CCHP vs. Baseline

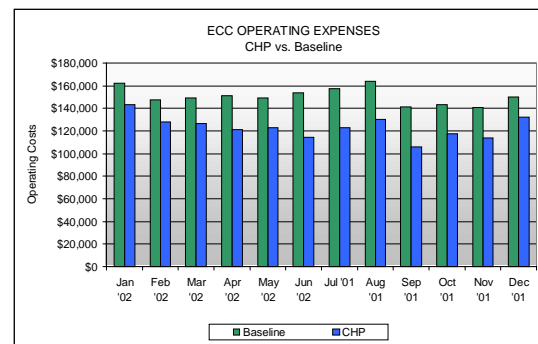


Figure 8: ECC Operating Expenses at 40 cents per therm – CHP vs. Baseline

ANNUAL OPERATING EXPENSES		
	Baseline	BCHP
Electricity	\$989,285	\$264,910
Natural Gas		
Boilers	\$561,512	\$394,527
Engines	\$0	\$374,269
Maintenance		
(1.2¢/kWh)	\$0	\$79,050
Total Expenses	\$1,552,778	\$1,112,756
Annual Savings		\$440,023
Monthly Savings		\$36,669

Table 3: ECC Operating Expenses at 40¢ per therm for natural gas

Lessons Learned

- (1) ECC is required to be a Federal Emergency Management Agency (FEMA) shelter in times of emergency. The CHP Plant insures that the ECC shelter will be fully functional with electricity should an emergency occur.
- (2) The Elgin Community College campus is shut down 10 Fridays during the summer beginning 11 PM on Thursdays. This provides an optimum time for maintenance and repairs of the CHP equipment when activity is at a minimum on the campus.
- (3) Facilities within certain zoning areas are allowed to sell emission credits to neighboring facilities if they are below the regulated emission standards. ECC does not sell their emission credits to other facilities although the ECC emission levels are well below its requirement. (Table 4)
- (4) ECC decided not to purchase their own transformer. Rather, ECC rents the transformer monthly from the local electric utility ComEd. This decision was made so that if the transformer were to fail or malfunction, ECC would not be responsible for replacing the equipment.
- (5) Funding by the Illinois Community College Board (ICCB), credits from previous projects, and the CHP Plant being incorporated into a larger building project brought the actual cost to ECC for the CHP to under \$1.5 million.

Environmental Considerations

The CHP plant at ECC produces low overall emissions of 4.106 tons per year, which is a mere 11% of the allowable amount of 35.93 tons. Table 4 shows the composition of the emissions from the college:

EMISSIONS	
Pollutant	tons/yr
NO _x	2.0
SO _x	0.012
CO ₂	0.0
CO	1.68
Misc.	0.414
Total	4.106

Table 4: ECC CHP Emissions

Future Considerations

Elgin Community College has been very satisfied with the CHP system installed at the campus. Because of its reliability, ECC plans to convert their entire campus to CHP within the next few years. The CHP system will cover over 50% of the cooling load with steam absorption. Within the next few years, the college plans to install an additional:

- 805 kW Waukesha engine (space already allocated)
- 800-ton York absorption chiller

Involved CHP Organizations:

Feasibility Study: KJWW Engineering, Co.
Equipment Supplier: Charles Equipment, Co.
General Contractor: Morse Electric, Co.
Local Gas Utility: NICOR
Local Electric Utility: ComEd

For further information contact:



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