

SPECIAL BOARD MEETING

Monday, March 30, 2015 6:30 PM Central

HS CONFERENCE ROOM

705 N 9th Street
Arlington, NE 68002

1. Special Meeting Called to Order and Roll Call

1.1. Pledge of Allegiance

2. Approve Special Meeting Agenda

motion to approve the agenda as presented Passed with a motion by Greg Sampson and a second by Teri O'Flaherty.

Micheal Dwyer: Yea, Matt O'Daniel: Yea, Teri O'Flaherty: Yea, Greg Sampson: Yea, Bruce Scheer: Yea, Luanne Sundberg: Yea

3. Discuss and Consider information presented from the energy study and possible ways to address HVAC concerns.

Engineers from Advanced Engineering Services (AES) presented the summary information from the Energy Study to the board and identified three leading options for addressing HVAC concerns.

4. Discuss and Consider potential funding mechanisms for identified facility needs.

Tobin Buchanan, First National Bank, presented various funding mechanisms for potential HVAC project.

5. Public Comment

6. Adjourn



ADVANCED
ENGINEERING
SYSTEMS

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February 27, 2015

Lynn Johnson
Superintendent
Arlington Public Schools

RE: Arlington Public Schools Energy Study
AES Project #: 14178

Dear Ms. Johnson,

In response to your request, Advanced Engineering Systems, Inc. (AES) has performed the energy study for the Arlington Public School in Arlington, Nebraska, based on direction, information & documentation provided to us along with visits to the site we have completed the energy study for the facility. The attached report summarizes our efforts noting what was found, descriptions and estimated savings.

We would like to take this opportunity to recognize and thank you and your staff, without whose valuable input this energy study would not have been possible.

Feel free to contact our office if you need clarifications or further information. We would be glad to meet to further discuss our findings. We look forward to help direct and implement any further recommendations developed in the energy study.

Sincerely,

ADVANCED ENGINEERING SYSTEMS, INC. (AES)

Handwritten signature of Kyle Wilkinson in black ink.

Kyle Wilkinson, PE, LEED AP
Mechanical Engineer

Handwritten signature of Steve Jensen in black ink.

Steve Jensen
Electrical Engineer

Handwritten signature of Vishal G. Khanna in black ink.

Vishal G. Khanna, M.S., P.E., LEED AP
Principal

Attachment

Energy Study

Project:

Energy Study for Arlington Public Schools

Arlington, Nebraska



Updated:

February 27, 2015

Prepared by:

Advanced Engineering Systems, Inc./ABCx LLC

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Energy Study

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APPENDICES

1. Executive Summary

9 Different HVAC system options for the Arlington Public School were evaluated; brief descriptions of the options and tags are summarized in the table below. More details are provided in the body of the report about each item.

Option Brief Description		Option Brief Description	
Base Model	Repair existing system and replace some major equipment	Option 5	CentGeo CHs to FCU - Central Geothermal heat pump system with heat recovery chillers to create hot and chilled water for Fan Coil Units
Option 1	DX/Gas RTUs - Standard Roof Top Units with gas heat	Option 6	CentGeo CHs to FCU+DX/Gas DOAS - Central Geothermal heat pump system with heat recovery chillers to create hot and chilled water for Fan Coil Units; with DX and gas fired Dedicated Outdoor Air System units
Option 2	B/FC HP sys - Boiler and fluid cooler heat pump loop	Option 7	AC-VRF + DX/Gas DOAS - Air Cooled Condensers for Variable Refrigerant Flow with DX and gas fired Dedicated Outdoor Air System units
Option 3	B/ AC-CH FCU - Boiler and Air Cooled chiller 4-pipe system with chilled water and hot water to Fan Coil Units	Option 8	Geo WC VRF + DX/Gas DOAS - Geothermal Water Cooled Condensers for Variable Refrigerant Flow with DX and gas fired Dedicated Outdoor Air System units
Option 4	Geo VS-HPs - Geothermal heat pump system with Variable Speed Heat Pumps	Option 9	B/FC WC VRF + DX/Gas DOAS - Boiler and Fluid Cooler water cooled condensers for Variable Refrigerant Flow with DX and gas fired Dedicated Outdoor Air System units

Energy savings results and economic factors are summarized in the table below

Option #	System	Estimated Initial Cost	Estimated First Year Maintenance Cost	Estimated Energy Savings per year	Simple Payback	50 Year Life Cycle Payback	IRR	50 Year Life Cycle Cost
Base Model	Repair existing system	\$1,812,500	\$69,371	\$0	∞	No Payback	-	\$8,080,265
Option 1	DX/Gas RTUs	\$2,900,000	\$48,559	\$29,485	21.6	9.9	9.3	\$7,545,077
Option 2	B/FC HP sys	\$3,987,500	\$34,685	\$57,587	37.8	49.2	6.4	\$7,946,662
Option 3	B/ AC-CH FCU	\$4,205,000	\$34,685	\$41,779	57.3	No Payback	3.1	\$8,998,016
Option 4	Geo VS-HPs	\$4,422,500	\$13,874	\$96,308	27.1	29.7	8.3	\$7,200,594
Option 5	CentGeo CHs to FCU	\$4,712,500	\$27,748	\$47,906	60.5	No Payback	3.2	\$9,174,055
Option 6	CentGeo CHs to FCU+DX/Gas DOAS	\$4,567,500	\$41,622	\$41,449	66.5	No Payback	2.6	\$9,361,768
Option 7	AC-VRF + DX/Gas DOAS	\$3,335,000	\$34,685	\$15,558	30.3	29.1	8.6	\$7,446,224
Option 8	Geo WC VRF + DX/Gas DOAS	\$4,821,250	\$27,748	\$8,265	60.3	No Payback	4.1	\$9,017,017
Option 9	B/FC WC VRF + DX/Gas DOAS	\$4,458,750	\$34,685	\$17,569	52.6	No Payback	4.1	\$8,900,701

Further option descriptions and background about the analysis are given in the body of the report. Two secondary analyses were also completed; the first included potential OPPD rebates which ranged from an estimated low of \$17,600 to a high of just over \$53,000. This lowered the overall life cycle cost, increased the IRR and decreased the simple payback a little. It did not appear to change the order of results. The detailed results are in the body of the report.

The second additional analysis done included an economizer on all options (only included in Option 1 in base analysis). Typically economizers would not be provided on systems as modeled in Option 2-9; however, the State energy office has stated they are going to start enforcing that they be provided, but did single out a geothermal heat pump system (similar to Option 4) as not requiring them. An added cost of \$175,000 was added for this analysis along with including enthalpy based economizer. The economizers did not appear to save much energy compared to the initial cost and the economic factors got worse. The detailed results are in the body of the report.

Based on the analysis AES recommends the following:

- If upfront cost is the primary criteria then Option 1 should be pursued – This option will be the easiest to phase and least expensive upfront.

- If energy use and long term life cycle cost is of importance then Option 4 should be pursued – This option will save the most on energy though pose a few more challenges on phasing. The location of the heat pumps will have to be explored further, currently above the ceiling or small heat pump closets are figured in the cost. Other options include.

Option	Cost	Take from floor space	Maintenance accessibility
Units above ceiling	\$	No	Bad
Units in closets in or close to room	\$\$	Yes	Good but space taken from student areas
Units in mechanical rooms (existing building area)	\$\$	Yes	Good
Units in new pent house on roof	\$\$\$	No	Good

- For a compromise between upfront cost and energy use Option 7 could be pursued – This option will provide better life cycle cost over Option 1 and will be less expensive than Option 4. Phasing will be easier than Option 4 but harder than Option 1.

For all options the phasing and timing the amount of rooms turned over to the contractor at any one time will need to be analyzed further and would affect the overall price.

2. General Building Information

Project Name	Energy Study for Arlington Public Schools
Project Address	705 North 9 th Street, Arlington, NE, 68002
Building Type	k-12 School
Square Footage	138,741 Conditioned Square Feet (in energy model)
Building Description	General single story k-12 school
Project Execution Date	2015

3. Project Overview

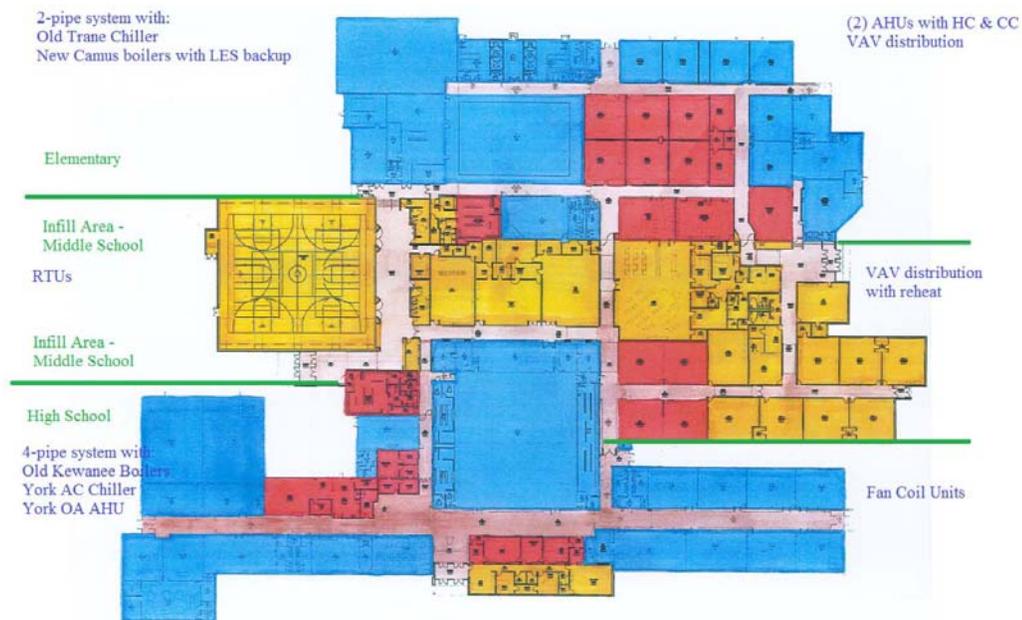
This project is intended to explore different HVAC system modification/ replacement options to save annual energy consumption, save summer electrical demand and provide a system that requires less maintenance and better reliability at the Arlington Public School in Arlington NE. A base model of the building using the latest version of Trane Trace software, was used to model different HVAC system options. The base model was based on existing floor plans and past utility history and information provided by the maintenance staff. The base model was then altered with the different HVAC system options and estimated energy and cost savings were calculated.

There are many potential HVAC system options to be considered, this report focuses on what AES considered the top 9 potential systems. Other systems can be considered if desired by the owner.

Costs were estimated based on 2014 RS Means, past experience as well as budget costs from equipment supplier representatives.

4. Brief HVAC System Overview

The Building was originally 2 separate buildings and was then in-filled to create 1 large encompassing building. Because of this there are multiple heating and cooling systems. A Trane building automation system controls the elementary portion along with much of the infill addition. An older Johnson Controls system is used in the high school portion of the school.



The cooling system for the high school portion is driven by an 80 ton air cooled chiller; the air cooled chiller operates as needed to provide chilled water through a 4-pipe (2 CW & 2 HW pipes) system for the comfort cooling of the high school portion. The chilled water is used by fan coil units (FCUs) and air handlers. The Elementary portion of the building is also served by an air cooled chiller; since there is only a 2-pipe (supply and return) system the chiller only operates once the heating hot water system has been turned off. The chilled water is utilized by air handling units with Variable Air Volume (VAV) downstream air distribution. Much of the infill portion is served by DX roof top units (RTUs) with VAV downstream air distribution. The RTUs and VAVs do not utilize chilled water.



The heating system is supported by two Kewanee 59 boiler horsepower (BHP) boilers serving the high school portion and two newer 24 BHP Camus condensing boilers serving the elementary and in-fill portion of the school. As of early February 2015 the Camus boilers were found to have cracked heat exchangers which are now in need of replacement. There is also an older LES boiler that is utilized for backup purposes on the 2-pipe system; it is currently being utilized as of early February 2015. The hot water produced is utilized in the same 4-pipe and 2-pipe systems mentioned above at the terminal equipment. Some of the infill portions of the building have roof top units with gas heating; the reheat coils downstream at the VAV boxes utilize the hot water produced at the elementary school system.



The base model is created based on the existing systems and utility bills, the first option that all other options are compared to is to repair the existing system. This would involve repairing and replacing much of the system initially and would include at a minimum:

- New air cooled chillers
- All new boilers to replace the existing Kewanee, Camus and LES
- All new control valves
- New pumps, valving and etc to support the new equipment
- New chemical feed equipment
- Updating controls to one control system

There would be negatives from simply repairing the existing system and would include:

- Needing to maintain 3 separate water loops
- Needing to maintain multiple chillers and boilers (could be fewer with a single system)

- Keeping multiple system and equipment types in the school leading to more expertise needed on different systems to maintain and trouble shoot.
- Not all RTUs, terminal equipment would need to be replaced initially but would need to be replaced in approximately 10 years, leading to another large capital project.
- All existing ducting and zoning would remain as is unless additional dollars spent to modify the systems.

The existing distribution piping was evaluated using an ultra sonic measuring device to measure pipe wall thickness and visual inspection of the piping exterior. The results of this are later in the body of the report.

5. Utility History

Energy intensity is the measure of annual energy used for a building per square foot, the lower the value, the more efficient the building is. The value is calculated based on the total amount of energy consumed by the building in a years' time. For this building it is comprised of the electricity and natural gas used. The energy intensity values for this facility are shown in the table below. For reference, typical school buildings are 76.8 kBtu/yr per square foot for this climate zone (according to EIA energy intensity data from CBECS, and MECS, EPRI and other third party energy use data sheets); others buildings can vary from 1.6 for parking garages to over 400 kBtu/yr per square foot for high energy use spaces like data centers and labs. The Average line is the average of each individual month over the past 2 years. The base model is the energy model created to match the existing building and utility usage as closely as possible.

Year	kBtu/sq ft / yr
2013	65
2014	63
Average	63
Base	61

These numbers appear better than the average but can be deceiving if the occupant load, occupied schedule are less than the average and/or fresh air quantities are not up to code mandated amounts.

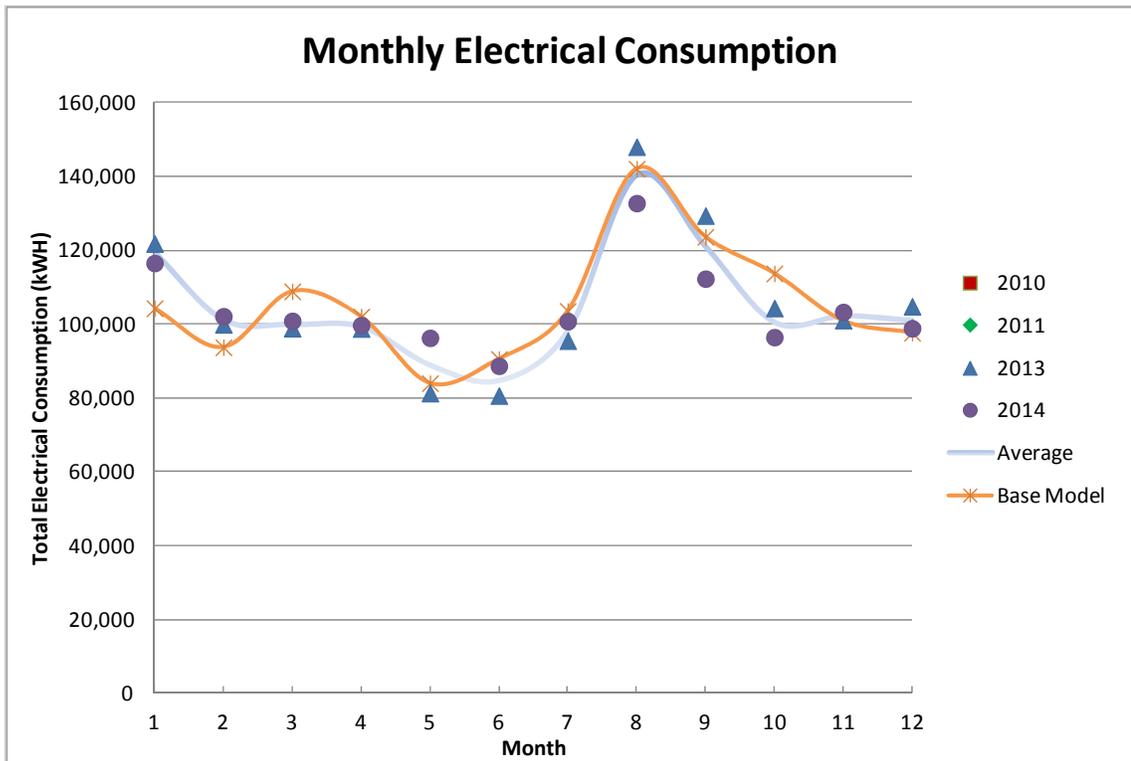
The Energy Star rating is a nationwide benchmark with a scale from 1-100, with 100 being the best. A rating of 75 or above is defined as Energy Star rated; while a score of 50 is considered average. Based on the average utility history from 2013 and 2014 and some reasonable assumptions the building would score approximately an Energy Star score of **53**. This is based on the Energy Star Target Finder design tool. Energy Star is a rating system that compares buildings based on actual energy used for any 1 year period. Various factors are taken into account depending on building type. For office type usage, the factors are:

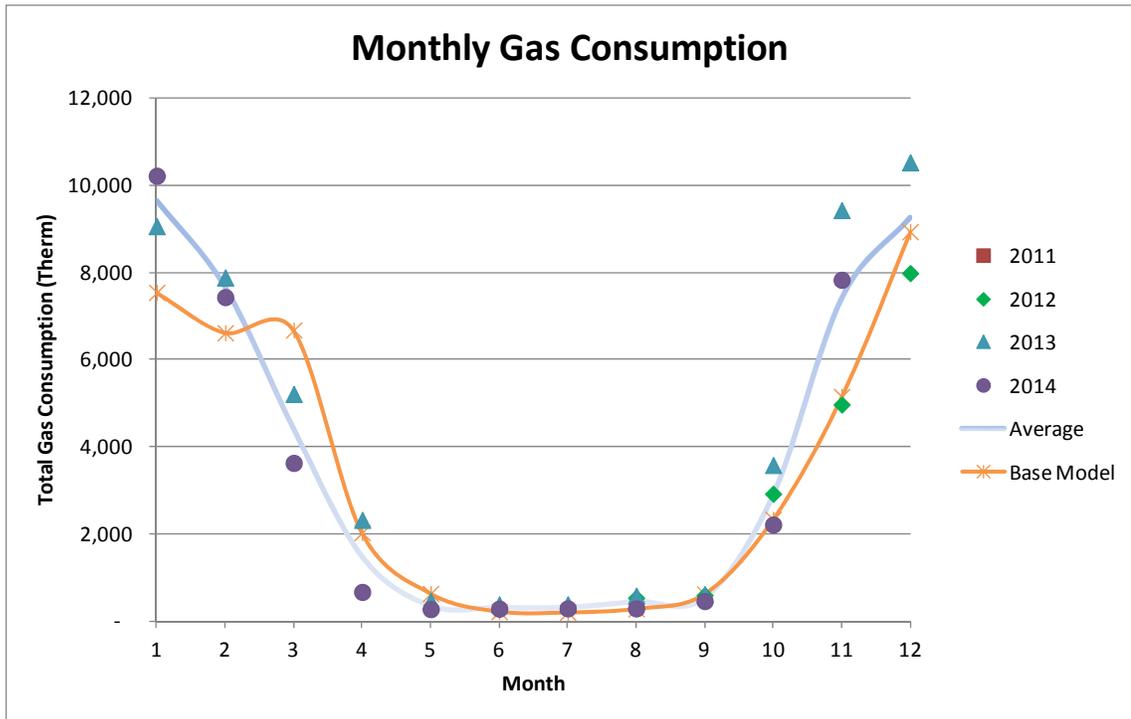
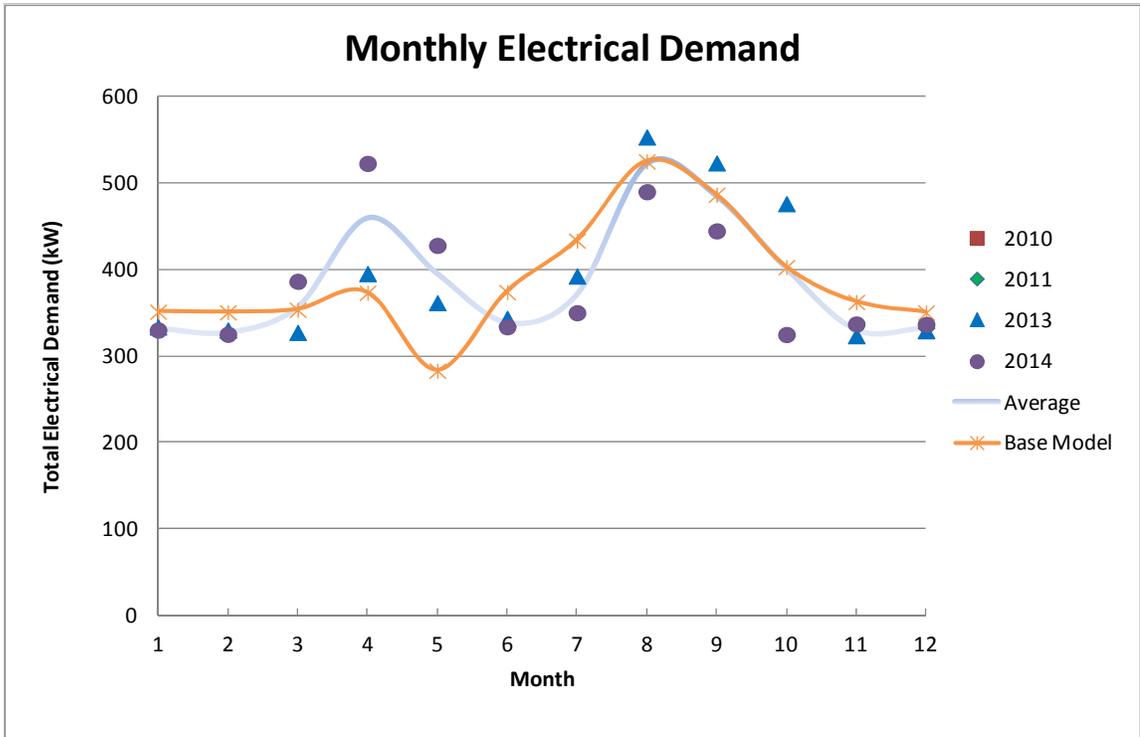
- Floor area
- Number of people

- Number of computers
- Percentage of floor area heated and cooled
- Location
- Weekly operating hours

The Energy Star software can be found online at www.energystar.gov/targetfinder and the online Portfolio Manager tool is found at www.energystar.gov/istar/pmpam/.

The following graphs show the electrical consumption & demand, and natural gas utility consumption history. The base energy model is also shown on the graphs, this will be the base line from which all the options are created.





6. HVAC System Options

General Background Information

A Base Model was created using Trane Trace 700 software relative to past energy bills. The Base Model was then modified for the different energy efficiency measures (EEMs). Factors that affect energy use but could be ambiguous include variations in weather from year to year, user habits, and unique operating characteristics of equipment.

All of the cost estimates are based on 2014 construction cost estimates, information from equipment suppliers, and past history; and do include miscellaneous and contingency factors, electrical, mechanical, and general construction costs. The utility costs presented include plug loads, lights and domestic water heaters. The life cycle costs and life cycle paybacks include inflation, maintenance cost, replacement cost, and value of money. Performance and required maintenance data for equipment is based on input from manufacturers' representatives. Equipment service life estimates are from ASHRAE 2007 HVAC Applications handbook.

All the utility rate information used was as follows:

- Blackhills natural gas rates are assumed to be as follows:
 - \$18.50 Black Hills Energy customer charge
 - \$0.70/Therm (Jan 1 – Dec 31) Actual rates vary month to month depending on the market; the rates above are average rates and generalized for the study.

- Electric rates are from Omaha Public Power District's electric rate schedule (231) for a Commercial General Service-Small Demand Customer for Three-Phase Power Service as of January 1, 2014 and is as follows:
 - \$94.5/ 18 kW (Jan 1 – Dec 31) for the first 18 kW and \$5.25/kW after
 - \$0.0720/kWh (June 1 – Sept 30) for the first 300 kWh and \$0.0488/kWh after
 - \$0.0595/kWh (Oct 1 – May 31) for the first 300 kWh and \$0.0366/kWh after
 - \$19.38 Customer Charge
 - \$113.88 Minimum monthly bill

The economic factors included in the analysis are as follows:

Economic Assumptions		
Study Life (Years used in determining Life Cycle Cost and IRR)	50	Years
Mortgage Life	15	Years
Depreciation Life	15	Years
Mortgage Interest Rate	6%	
Percent of Initial Cost Financed	80%	
Depreciation Taxes	None	
Income Tax Rate	0%	
Cost of Capital	6%	
Property Tax	0%	
Insurance Expenses	0.20%	
Maintenance Expense Inflation	3%	
Replacement Expense Inflation	3%	
Property Tax Inflation	0%	
Insurance Expenses Inflation	3%	
Utility Cost Inflation	3%	

When reviewing results, the following describes what they are based on:

- Estimated Energy Savings – This is the estimated amount saved in year one, the savings will go up each year with the inflation factor used.
- Simple Payback (years) – This is cost divided by yearly savings, not taking economic factors into account.
- Life Cycle Cost – This is the sum of all recurring and non-recurring costs over the full life span or specified period of a good, service, structure, or system. This includes purchase price, installation costs, operating costs, maintenance, and upgrade costs and any remaining salvageable costs at the end of ownership or its useful life. This calculation does take economic factors into account.
- Life Cycle Cost Savings – This is the difference between the life cycle costs for the base model and model with EEM's incorporated.
- Internal Rate of Return – This is the discount rate that makes the present value of all incremental cash flows equal to zero. This represents the discount rate for which the sum of the future incremental cash flows converted to today's dollars breaks even with the down payment difference. This calculation does take economic factors into account.

System Option Information

This study will look at what was determined to be the top 9 HVAC options. Each of the 9 options is described below:

	<u>Option Brief Description</u>	<u>Option would provide:</u>
Base Model	Repair existing system and replace some major equipment	Replacements / repairs to the existing system including: new air cooled chillers, control valve replacements, control system upgrades, new boilers to replace all boilers and misc other work. (No distribution piping is assumed to be replaced)
Option 1	DX/Gas RTUs - Standard Roof Top Units with gas heat	Standard DX Roof Top Units (RTUs) with gas heat to serve the entire school, each system would have 1 thermostat and be constant volume air flow.
Option 2	B/FC HP sys - Boiler and fluid cooler heat pump loop	A 2-pipe heat pump system utilizing boilers and fluid coolers for the heat source/sink. Heat pumps would be located in the building to serve each space. All outside air would be conditioned by the same system.
Option 3	B/ AC-CH FCU - Boiler and Air Cooled chiller 4-pipe system with chilled water and hot water to Fan Coil Units	A 4-pipe heating hot water and chilled water system utilizing boilers and air cooled chillers for the heat source/sink. Fan coil units would be located in the building to serve each space. All outside air would be conditioned by the same system.
Option 4	Geo VS-HPs - Geothermal heat pump system with Variable Speed Heat Pumps	A 2-pipe heat pump system utilizing a ground heat exchanger for the heat source/sink. Heat pumps would be located in the building to serve each space. All outside air would be conditioned by the same system.
Option 5	CentGeo CHs to FCU - Central Geothermal heat pump system with heat recovery chillers to create hot and chilled water for Fan Coil Units	A 4-pipe heating hot water and chilled water system utilizing a ground heat exchanger tied to heat recovery chiller for the heat source/sink. Fan coil units would be located in the building to serve each space. All outside air would be conditioned by the same system.
Option 6	CentGeo CHs to FCU+DX/Gas DOAS - Central Geothermal heat pump system with heat recovery chillers to create hot and chilled water for Fan Coil Units; with DX and gas fired Dedicated Outdoor Air System units	A 4-pipe heating hot water and chilled water system utilizing a ground heat exchanger tied to heat recovery chiller for the heat source/sink. Fan coil units would be located in the building to serve each space. All outside air would be conditioned by DX/gas outside air units on the roof not tied to the main system.

Option 7	AC-VRF + DX/Gas DOAS - Air Cooled Condensers for Variable Refrigerant Flow with DX and gas fired Dedicated Outdoor Air System units	A Variable Refrigerant Volume (VRF) system utilizing air cooled condensing units and back-up electric heat for the heat source/sink. Terminal units would be located in the building to serve each space. All outside air would be conditioned by DX/gas outside air units on the roof not tied to the main system.
Option 8	Geo WC VRF + DX/Gas DOAS - Geothermal Water Cooled Condensers for Variable Refrigerant Flow with DX and gas fired Dedicated Outdoor Air System units	A Variable Refrigerant Volume (VRF) system utilizing water cooled condensing units tied to a ground heat exchanger for the heat source/sink. Terminal units would be located in the building to serve each space. All outside air would be conditioned by DX/gas outside air units on the roof not tied to the main system.
Option 9	B/FC WC VRF + DX/Gas DOAS - Boiler and Fluid Cooler water cooled condensers for Variable Refrigerant Flow with DX and gas fired Dedicated Outdoor Air System units	A Variable Refrigerant Volume (VRF) system utilizing water cooled condensing units tied to boilers and a fluid cooler for the heat source/sink. Terminal units would be located in the building to serve each space. All outside air would be conditioned by DX/gas outside air units on the roof not tied to the main system.

Each of these systems was input into the modeling software to calculate estimated energy saving and life cycle costs. Only system information was changed between the options, all internal loads, scheduling and envelope load remain the same between all options. (Actual fresh air quantities may differ than current amounts and would affect energy usage but not system efficiency.) The following chart summarizes briefly some major system options that were included and cooling equipment efficiency.

		Economizer	Energy Recovery	Hot Gas Reheat HGRH	Energy Efficiency Ratio EER
Base Model	Repair existing system	Partial on AHUs/RTUs	No	No	~ 9.0
Option 1	DX/Gas RTUs	Yes	No	No	11.50
Option 2	B/FC HP sys	No	Yes	Yes	14.50
Option 3	B/ AC-CH FCU	No	Yes	No	10.40
Option 4	Geo VS-HPs	No	Yes	Yes	19.00
Option 5	CentGeo CHs to FCU	No	Yes	No	20.00
Option 6	CentGeo CHs to FCU+DX/Gas DOAS	No	Yes	No	20.00
Option 7	AC-VRF + DX/Gas DOAS	No	Yes	Yes	16.00
Option 8	Geo WC VRF + DX/Gas DOAS	No	Yes	Yes	18.00
Option 9	B/FC WC VRF + DX/Gas DOAS	No	Yes	Yes	18.00

The following chart summarizes the costs used to calculate paybacks and life cycle costing.

		Initial Cost		HVAC	Mech	Elec	Arch/Sturc	Geo	Fire
		Total Cost	\$/SF	\$/SF	\$/SF	\$/SF	\$/SF	\$/SF	\$/SF
Base Model	Repair existing system	\$1,812,500	\$12.50	\$3.00	\$8.00	\$1.50	\$0.00	\$0.00	\$0.00
Option 1	DX/Gas RTUs	\$2,900,000	\$20.00	\$11.75	\$1.50	\$4.00	\$2.50	\$0.00	\$0.25
Option 2	B/FC HP sys	\$3,987,500	\$27.50	\$15.00	\$4.50	\$4.00	\$3.75	\$0.00	\$0.25
Option 3	B/ AC-CH FCU	\$4,205,000	\$29.00	\$14.00	\$7.00	\$4.00	\$3.75	\$0.00	\$0.25
Option 4	Geo VS-HPs	\$4,422,500	\$30.50	\$15.00	\$3.00	\$4.00	\$3.75	\$4.50	\$0.25
Option 5	CentGeo CHs to FCU	\$4,712,500	\$32.50	\$13.00	\$7.00	\$4.00	\$3.75	\$4.50	\$0.25
Option 6	CentGeo CHs to FCU+DX/Gas DOAS	\$4,567,500	\$31.50	\$13.50	\$6.50	\$4.00	\$3.75	\$3.50	\$0.25
Option 7	AC-VRF + DX/Gas DOAS	\$3,335,000	\$23.00	\$15.00	\$1.25	\$4.00	\$2.50	\$0.00	\$0.25
Option 8	Geo WC VRF + DX/Gas DOAS	\$4,821,250	\$33.25	\$17.00	\$5.00	\$4.00	\$3.50	\$3.50	\$0.25
Option 9	B/FC WC VRF + DX/Gas DOAS	\$4,458,750	\$30.75	\$17.00	\$7.00	\$4.00	\$2.50	\$0.00	\$0.25

All prices are engineering estimates, actual bid prices may vary depending on a number of factors including market condition. Costs assume a continuous project over 1 to 1-1/2 years and not broke, into separate phases done independently over multiple years. The price for the options that include fan coil units (FCUs) and heat pumps (HPs) are to install the units above the ceiling by the zone or in a closet in the zone (condensate pumps would likely be needed). There are multiple options available for location of FCU and Heat pumps and includes the following. A combination of these may make the most sense.

Option	Cost	Take from floor space	Maintenance accessibility
Units above ceiling	\$	No	Bad
Units in closets in or close to room	\$\$	Yes	Good but space taken from student areas
Units in mechanical rooms (existing building area)	\$\$	Yes	Good
Units in new pent house on roof	\$\$\$	No	Good

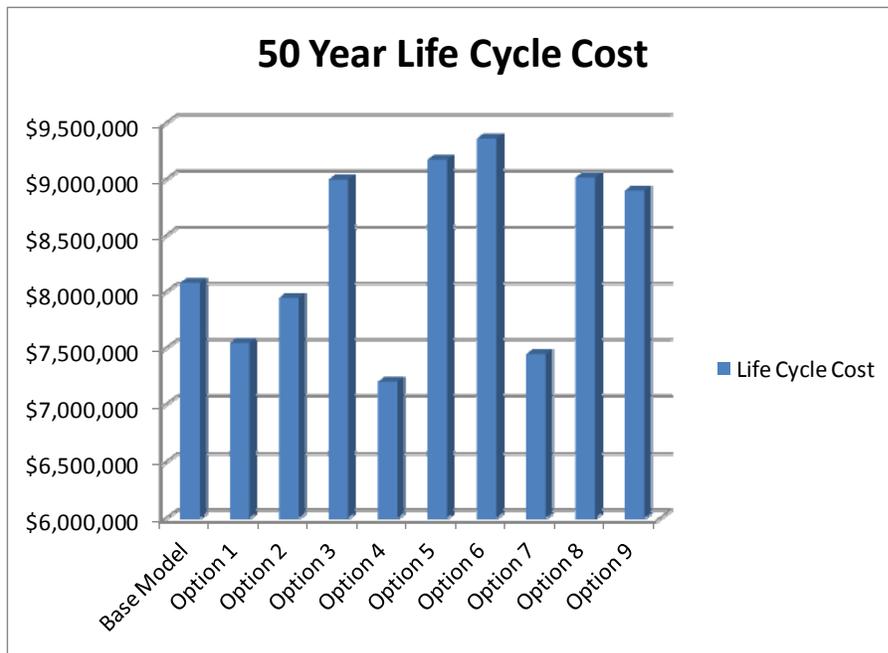
It should be noted, that AES is aware of a contractor out of Hastings NE that has said that they typically can install VRF systems for less than is estimated above. These lower figures are not included to be conservative. Therefore, if lower initial costs actually come to fruition then the economic results of Option 7 - 9 would get better.

Analysis Results

All options are compared to the base model – repair system option to calculate simple and life cycle paybacks. The following chart summarizes the estimated initial cost, annual maintenance cost, annual energy savings and economic results. The life cycle costs and payback take all economic factors into account as well as replacement costs. Replacement costs have been estimated and included based on ASHRAE median life expectancies for equipment.

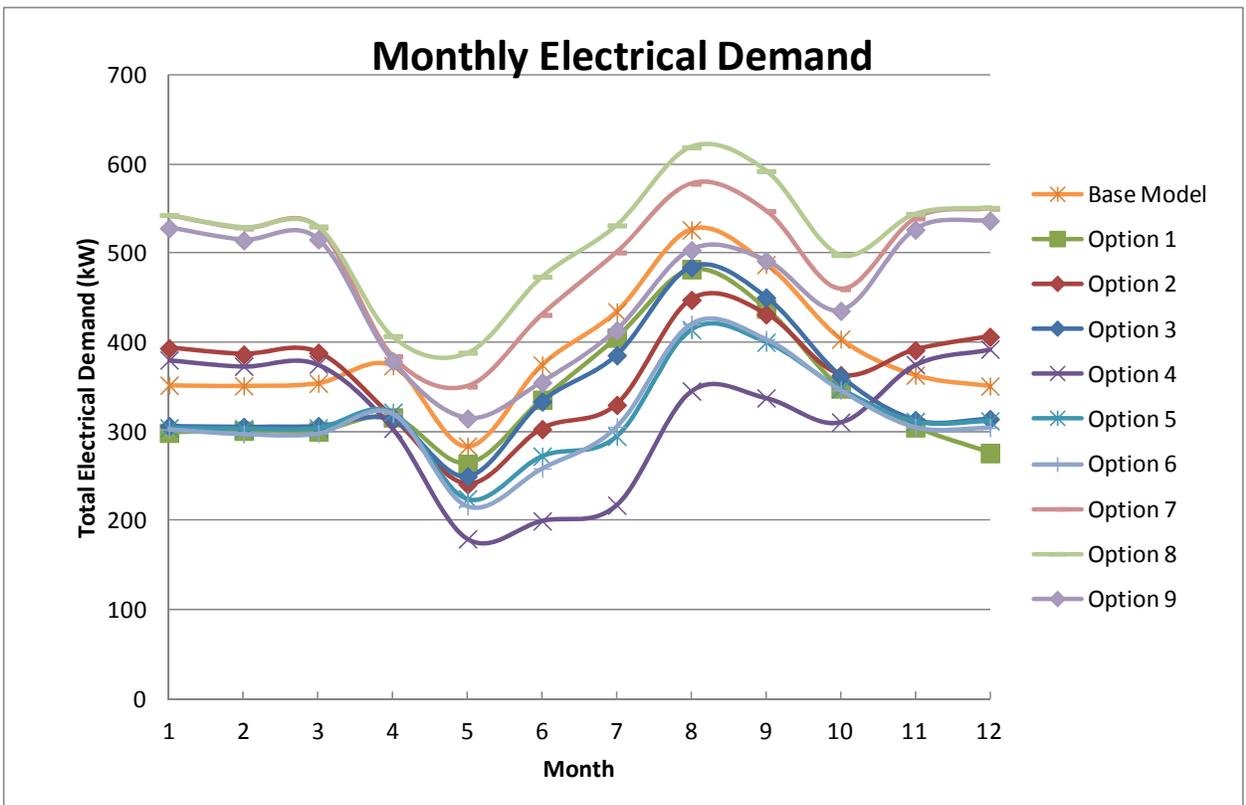
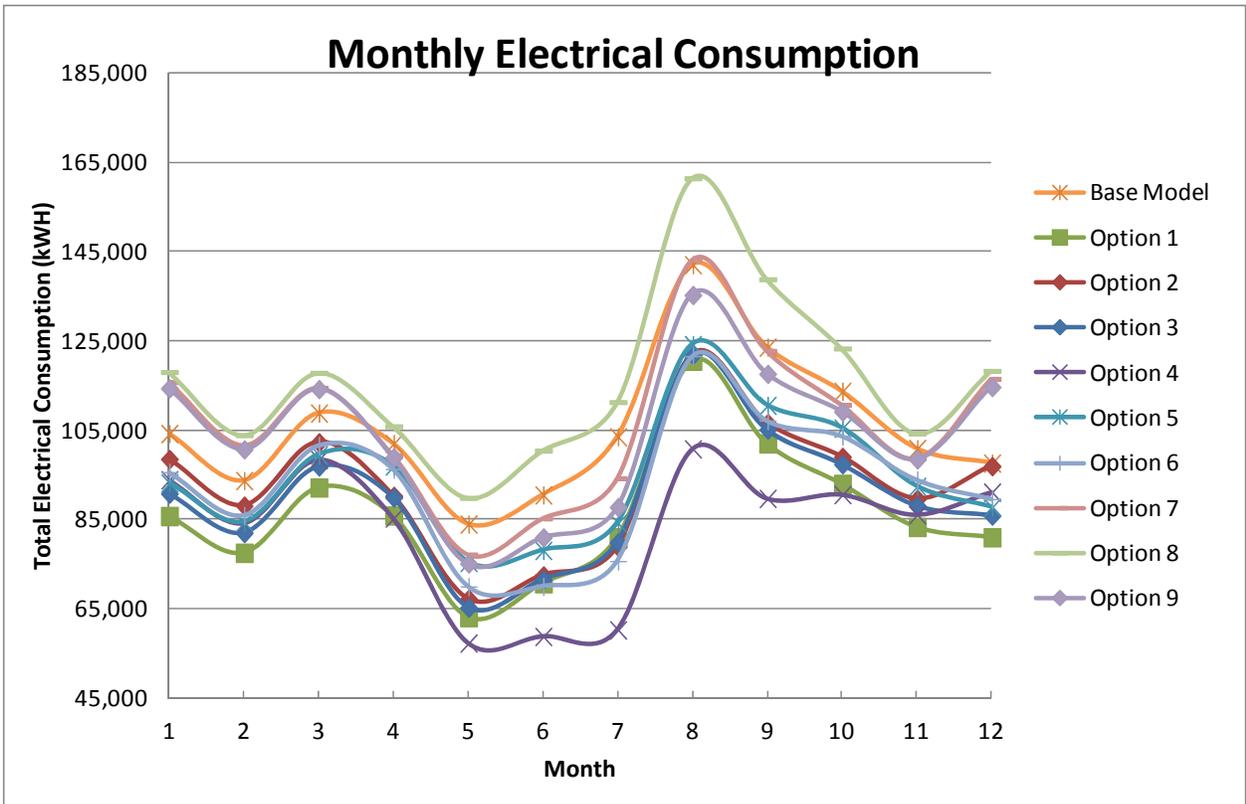
Option #	System	Estimated Initial Cost	Estimated First Year Maintenance Cost	Estimated Energy Savings per year	Simple Payback	50 Year Life Cycle Payback	IRR	50 Year Life Cycle Cost
Base Model	Repair existing system	\$1,812,500	\$69,371	\$0	∞	No Payback	-	\$8,080,265
Option 1	DX/Gas RTUs	\$2,900,000	\$48,559	\$29,485	21.6	9.9	9.3	\$7,545,077
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Option 6	CentGeo CHs to FCU+DX/Gas DOAS	\$4,567,500	\$41,622	\$41,449	66.5	No Payback	2.6	\$9,361,768
Option 7	AC-VRF + DX/Gas DOAS	\$3,335,000	\$34,685	\$15,558	30.3	29.1	8.6	\$7,446,224
Option 8	Geo WC VRF + DX/Gas DOAS	\$4,821,250	\$27,748	\$8,265	60.3	No Payback	4.1	\$9,017,017
Option 9	B/FC WC VRF + DX/Gas DOAS	\$4,458,750	\$34,685	\$17,569	52.6	No Payback	4.1	\$8,900,701

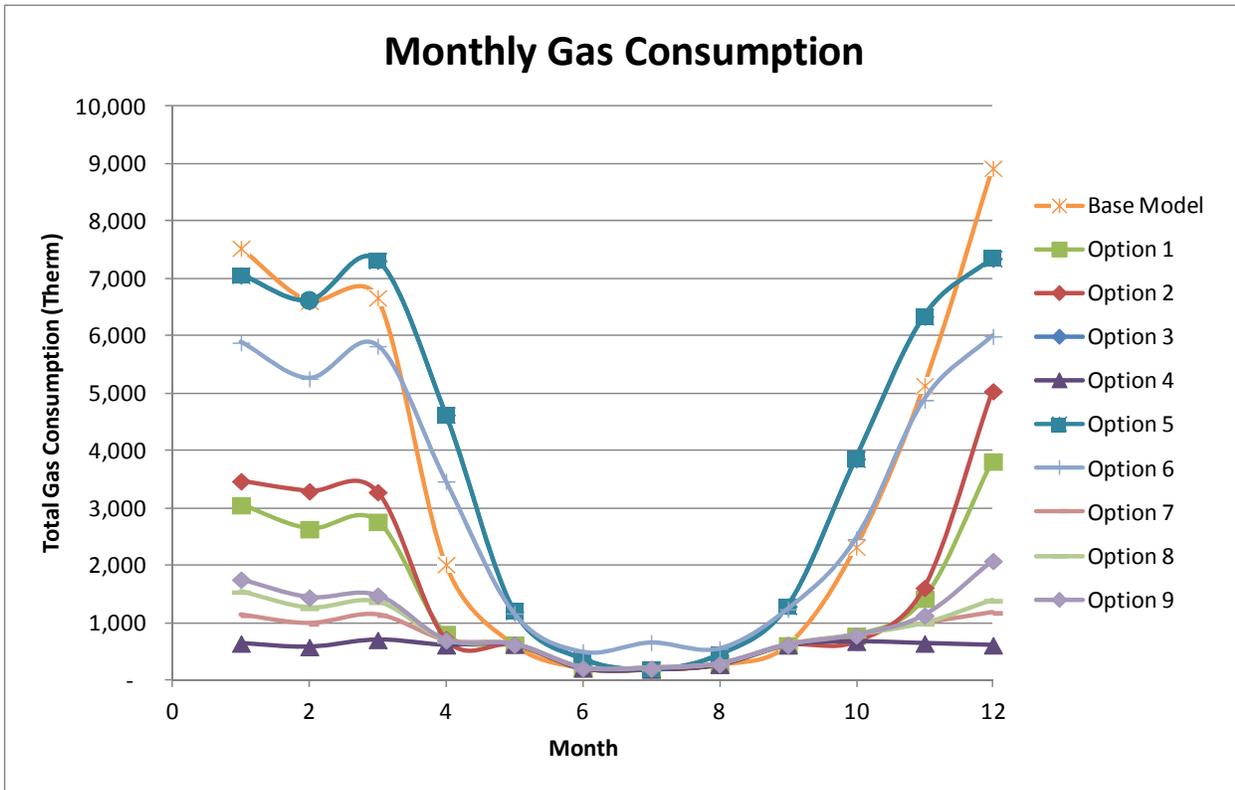
It should be noted that the Trace Trace analysis program is still working on its VRF data (as are most energy analysis programs), specifically its water cooled data. Therefore the analysis results should be looked at with a bit of caution when looking at the last two options (Option 8 and Option 9).



The life cycle cost is the amount of money spent over the life cycle period on all aspects including upfront cost, utilities, maintenance cost and replacement costs brought back into today's dollars. In order of low to high life cycle costs, Options 4, 7 and 1 appear good.

The following graphs show the estimated monthly electrical consumption and demand as well as gas consumption.





There are 3 options that appear to be the better options, some of the pros and cons of each are listed below.

- Option 1 – Utilizing DX/Gas roof top units
 - Pro – Lowest upfront cost by \$580,000 to the next lowest option
 - Pro – Best Simple payback, 50 year life cycle payback and IRR (compared to base)
 - Pro – No water loop piping / boilers / Chillers to maintain
 - Pro – Simple to do phased construction
 - Pro – Possible OPPD Rebate in \$15,000 - \$20,000 Range
 - Con – Higher anticipated annual maintenance cost
 - Con – Lowest estimated annual energy savings
 - Con – No practical way to reuse any existing piping or new condensing boilers
 - Con – All equipment on roof (more roof penetrations and maintenance performed on the roof)

- Option 4 – Closed loop geothermal heat pump system with variable speed heat pumps
 - Pro – Lowest 50 year life cycle cost (due to ground heat exchanger not needing replaced like mechanical equipment)
 - Pro – Highest estimated annual energy savings
 - Pro – Possibility of re-using existing condensing boilers as backup heat, and reusing existing piping mains to an extent.
 - Pro – Only outdoor air units on roof (unless space found indoors), therefore fewer roof penetrations and equipment to maintain on roof
 - Pro – State Energy Office as of 2/1/15 does not enforce the need for economizers on geothermal heat pump systems. (it is not included in base analysis)
 - Pro - Possible OPPD Rebate in \$50,000 - \$55,000 Range
 - Con – Highest up front cost.
 - Con – Closed loop water system to maintain (no piping exposed to freezing conditions so glycol is not needed).
 - Con – More difficult and expensive to install economizers

- Option 7 – Air cooled Variable Refrigerant Flow (VRF) system with DX/Gas outdoor air units
 - Pro – Second lowest upfront cost
 - Pro – Second best 50 year life cycle cost
 - Pro - Only outdoor air units and condensing units on roof (unless space found indoors), therefore fewer roof penetrations and equipment to maintain on roof.
 - Pro – No water loop to maintain (unless utilized for backup heat)
 - Con - State Energy Office as of 2/1/15 has said they will start to enforce the need for economizers on VRF systems. (it is not included in base analysis as it is not typically done and would add cost if included).
 - Con – Toward lower end of estimated annual energy savings
 - Con – Electric back up heat would be needed (possibly could utilize existing piping and condensing boilers)
 - Con – Calculated Demand will increase, therefore no OPPD rebate possible.

Additional Analysis Results with Economizer

As Discussed briefly above, the current base energy analysis does not include economizers because all the options but the roof top unit option (Option 1) do not typically have economizers installed because they utilize smaller terminal units closer to or in the spaces. If economizers were installed it would lead to many more roof penetration and/or larger outside air ducts. An addition cost of \$175,000 is included in the analysis to cover the cost of the additional control dampers, duct and roof penetrations. The table below summarizes the findings compared to the base analysis.

Option #	System	Previous Base Analysis (no Economizer and No Rebates)					With Economizers + \$175,000				
		Simple Payback	50 Year Life Cycle Payback	IRR	50 Year Life Cycle Cost	Estimated Annual Energy Savings	Simple Payback	50 Year Life Cycle Payback	IRR	50 Year Life Cycle Cost	Estimated Annual Energy Savings
Base Model	Repair existing system	∞				\$0	∞				\$0
Option 1	DX/Gas RTUs	21.6	9.9	9.3	\$7,545,077	\$29,485	20.3	9.9	9.9	\$7,556,708	\$53,512
Option 2	B/FC HP sys	37.8	49.2	6.4	\$7,946,662	\$57,587	43.4	No Payback	5.6	\$8,311,237	\$54,148
Option 3	B/ AC-CH FCU	57.3	No Payback	3.1	\$8,998,016	\$41,779	53.6	No Payback	3.2	\$9,119,119	\$47,925
Option 4	Geo VS-HPs	27.1	29.7	8.3	\$7,200,594	\$96,308	28.0	30.3	7.9	\$7,401,945	\$99,295
Option 5	CentGeo CHs to FCU	60.5	No Payback	3.2	\$9,174,055	\$47,906	55.6	No Payback	3.4	\$9,263,298	\$55,306
Option 6	CentGeo CHs to FCU+DX/Gas DOAS	66.5	No Payback	2.6	\$9,361,768	\$41,449	65.6	No Payback	2.5	\$9,558,016	\$44,637
Option 7	AC-VRF + DX/Gas DOAS	30.3	29.1	8.6	\$7,446,224	\$15,558	40.6	47.6	6.9	\$7,938,406	\$41,780
Option 8	Geo WC VRF + DX/Gas DOAS	60.3	No Payback	4.1	\$9,017,017	\$8,265	82.9	No Payback	3.2	\$9,585,728	\$38,411
Option 9	B/FC WC VRF + DX/Gas DOAS	52.6	No Payback	4.1	\$8,900,701	\$17,569	69.9	No Payback	3.1	\$9,443,970	\$41,780

Additional Analysis Results with Potential OPPD Rebates

Omaha Public Power District (OPPD) offers customers rebates for projects that reduce the peak summer demand. This is an effort to prolong the need to build a new power plant to meet the peak demand seen on the grid. The base analysis shows the following results for peak demand savings and the resulting OPPD incentive. The OPPD rebates are based on actual measured results, not theoretical calculations, so the actual incentives received could be larger or smaller due to actual weather conditions, set points, occupant load and many other things.

Option #	System	Potential OPPD	
		Estimated kW savings	Rebate at \$400/kW
Base Model	Repair existing system	-	
Option 1	DX/Gas RTUs	44	\$17,624
Option 2	B/FC HP sys	78	\$31,352
Option 3	B/ AC-CH FCU	42	\$16,760
Option 4	Geo VS-HPs	134	\$53,456
Option 5	CentGeo CHs to FCU	112	\$44,728
Option 6	CentGeo CHs to FCU+DX/Gas DOAS	105	\$42,180
Option 7	AC-VRF + DX/Gas DOAS	-52	\$0
Option 8	Geo WC VRF + DX/Gas DOAS	-93	\$0
Option 9	B/FC WC VRF + DX/Gas DOAS	-10	\$0

The following chart shows the updated economic results with these rebates included at the beginning of the project. In actuality they would not be received till after the new systems are fully operation and have a chance to operate for at least 4-6 weeks over the hottest part of the summer. The economic results did increase for the options that would receive an incentive. The following chart compares the base analysis with to the same analysis with OPPD rebates included.

Option #	System	Previous Base Analysis (no Economizer and No Rebates)				With Estimated OPPD Rebates			
		50 Year Life				50 Year Life			
		Simple Payback	Cycle Payback	IRR	50 Year Life Cycle Cost	Simple Payback	Cycle Payback	IRR	50 Year Life Cycle Cost
Base Model	Repair existing system	∞			\$8,080,265	∞			\$8,080,265
Option 1	DX/Gas RTUs	21.6	9.9	9.3	\$7,545,077	21.3	9.9	9.5	\$7,526,557
Option 2	B/FC HP sys	37.8	49.2	6.4	\$7,946,662	37.2	49.0	6.5	\$7,913,717
Option 3	B/ AC-CH FCU	57.3	No Payback	3.1	\$8,998,016	56.9	No Payback	3.1	\$8,980,404
Option 4	Geo VS-HPs	27.1	29.7	8.3	\$7,200,594	26.5	29.5	8.5	\$7,144,422
Option 5	CentGeo CHs to FCU	60.5	No Payback	3.2	\$9,174,055	59.6	No Payback	3.3	\$9,127,054
Option 6	CentGeo CHs to FCU+DX/Gas DOAS	66.5	No Payback	2.6	\$9,361,768	65.4	No Payback	2.6	\$9,317,444
Option 7	AC-VRF + DX/Gas DOAS	30.3	29.1	8.6	\$7,446,224	30.3	29.1	8.6	\$7,446,224
Option 8	Geo WC VRF + DX/Gas DOAS	60.3	No Payback	4.1	\$9,017,017	60.3	No Payback	4.1	\$9,017,016
Option 9	B/FC WC VRF + DX/Gas DOAS	52.6	No Payback	4.1	\$8,900,701	52.6	No Payback	4.1	\$8,900,700

7. Existing Piping Condition

Existing Piping Evaluation

The existing piping was evaluated in some representative spots throughout the school. The insulation condition and exterior surface of the piping condition under the insulation were observed. In all cases the insulation appeared to be in good condition. The surface of the hot water piping appeared to be good and rust free. The chilled water piping appeared to have slight surface rust, indicating condensation has been happening under the insulation and can result in damage to the insulation.

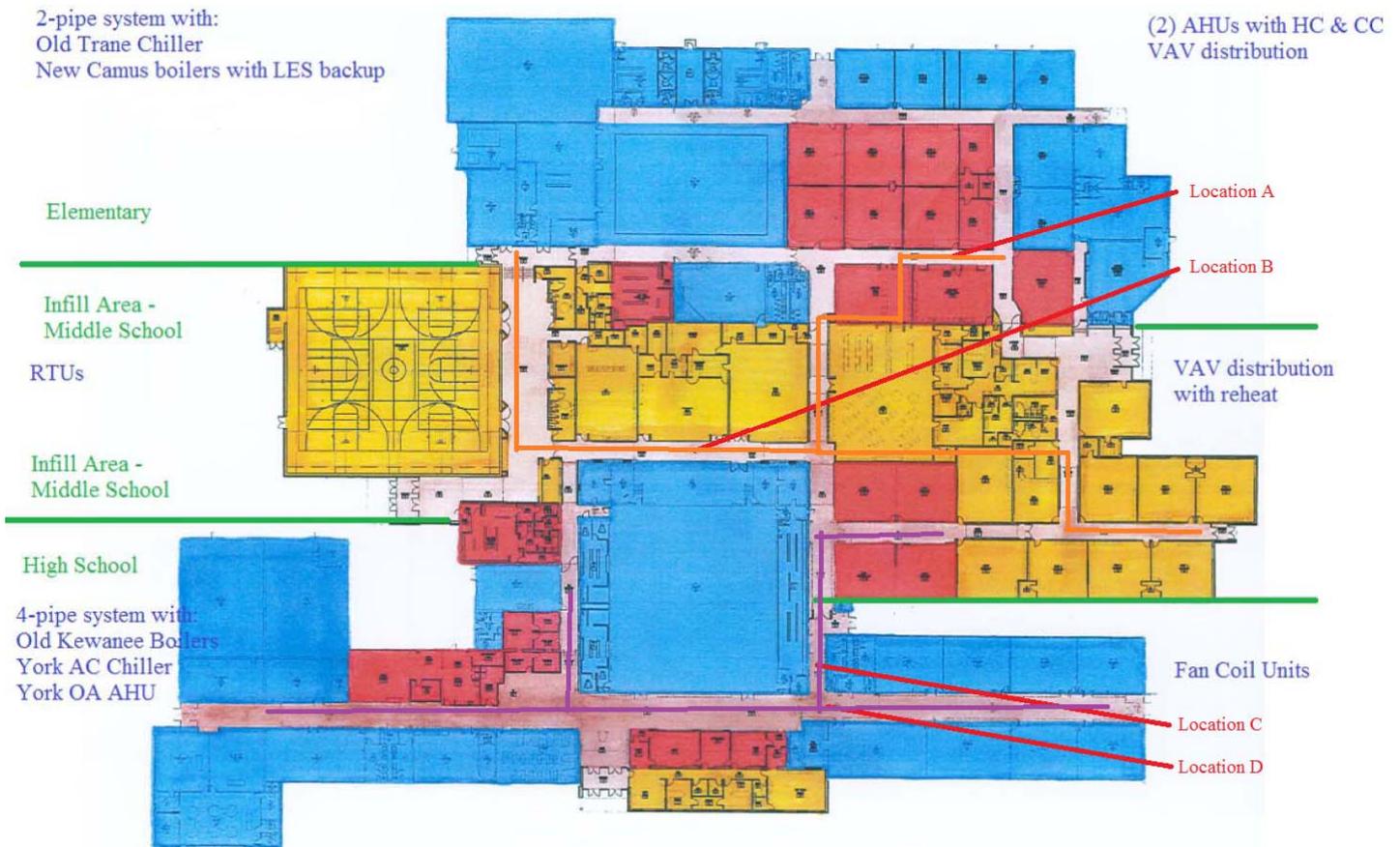
The pipe thickness was measured using an ultra sonic measuring device which is a non-destructive way to measure the pipe thickness (corrosion included). The results of these measurements are shown below. All piping appears to be within 5% of the nominal thickness for schedule 40 steel piping.

location	Pipe Type	Pipe size	Thickness readings [inches]			Average	% of nominal	Approx nominal thickness For Schedule 40 Steel [inches]
			bottom	side	side			
A	CW/HW	3"	0.207			0.207	-4.17%	0.216
B	CW/HW	4"	0.234	0.235		0.235	-1.05%	0.237
C	HWR	2"	0.150	0.152		0.151	-1.95%	0.154
C	CWS	2"	0.156	0.159		0.158	2.27%	0.154
D	HWR	2-1/2"	0.190	0.195	0.199	0.195	-4.15%	0.203
D	CWR	3"	0.213	0.205		0.209	-3.10%	0.216

It is recommended that the piping be destructively tested as well if the piping is planned to be reused. This is because the non-destructive testing done only give the thickness measured, this material thickness could be the piping or piping + corrosion. So it is possible that the piping walls are deteriorated but has a scale build up back to the original thickness.

The locations are shown on the following floor plan, they are identified by the red lines. The purple and orange lines show the approximate locations of the 4-pipe and 2-pipe systems respectively.

Being able to reuse the piping will depend on the system option chosen and phasing. The existing piping may be on the smaller side for a heat pump loop as they are normally operated at 3 GPM/ton which is more than chilled water and hot water system operates at. Reusing the piping could potentially save in the \$40,000 - \$70,000 range depending on exact scope.



8. Electrical Analysis

The existing Elementary School is served from an OPPD transformer located west of Mechanical/Equipment Room #466. It feeds a 1200 amp, 277/480 volt, 3-phase, 4-wire ITE switchboard with a main bolted-pressure switch. The date on the switchboard indicates that it was installed in 1973. There appears to be a roof drain pipe partially blocking the CT section. We spoke with Mark O'Connor with OPPD and the maximum demand on this service was 345 KW (approximately 519 amps) in May of 2014.



Existing OPPD Transformer serving the Elementary School



Roof drain pipe blocking CT section



1200 amp, 480 volt bolted-pressure switch



1200 amp, 480 volt, 3-phase switchboard serving Elementary School

The switchboard has reached its end of useful life (42 years).

Recommendation: AES recommends replacing the existing switchboard due to age and correct the code violation on the roof drain pipe location.

The existing High School is served from an OPPD Transformer west of Metal/Auto Room #128. It feeds a 600 amp, 277/480 volt, 3-phase, 4-wire Square D disconnect. The two (2) conduits from the transformer to the disconnect run up the exterior of the building, across the ceiling of Room #128 and down to the disconnect. It appears that these secondaries are not fused and not concrete encased. We spoke with Mike O'Connor with OPPD and the maximum demand on this service was 179 KW (approximately 270 amps) in May of 2014. The cost for this is included in the Mechanical Section, Page 15.



Existing OPPD Transformer serving the High School



Existing 600 amp, 480 volt service serving High School



Existing 600 amp, 480 volt service serving High School



Existing 600 amp, 480 volt service serving High School



Existing 600 amp, 480 volt service serving High School

The gear appears older (no visible date).

Recommendation: AES recommends replacing the existing switchboard due to age and correct code deficiency. We would place the new main breaker for this service on an exterior wall. The cost for this is included in the Mechanical Section, Page 16.

9. Football Field Lighting

Arlington Public Schools requested that AES provide a brief summary for relighting the football field. The existing football field is lit from eight (8) wood poles with three (3) fixtures each.



Recommendation: AES recommends relighting the field with four (4) 70' poles with eighteen (18) 1500 watt metal halide fixtures each. A preliminary cost estimate would be \$145,000 - \$185,000.

Appendix A

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Status: Analysis Program (Trane Trace) Outputs, other printouts / results available upon request.



YEARLY CASH FLOW

By AES

Alternative: 1
Life Cycle Cost: \$ 8,080,264.80

Year	Utility Cost (\$)	Maint. Cost (\$)	Interest Cost (\$)	Principal Cost (\$)	Property Taxes (\$)	Insurance Cost (\$)	Revenue Penalty (\$)	Replace. Expenses (\$)	Deprec. Tax (\$)	Cash Flow Effect (\$)	Present Value (\$)
0	0	0	0	362,500	0	0	0	0	0	362,500	362,500
1	106,498	69,371	87,000	62,296	0	3,625	0	0	0	328,790	310,179
2	109,693	71,452	83,262	66,034	0	3,734	0	0	0	334,175	297,414
3	112,984	73,595	79,300	69,996	0	3,846	0	0	0	339,721	285,236
4	116,373	75,803	75,100	74,196	0	3,961	0	0	0	345,434	273,616
5	119,865	78,077	70,649	78,647	0	4,080	0	0	0	351,318	262,525
6	123,460	80,420	65,930	83,366	0	4,202	0	0	0	357,379	251,938
7	127,164	82,832	60,928	88,368	0	4,328	0	0	0	363,621	241,829
8	130,979	85,317	55,626	93,670	0	4,458	0	0	0	370,051	232,175
9	134,909	87,877	50,006	99,291	0	4,592	0	0	0	376,673	222,953
10	138,956	90,513	44,048	105,248	0	4,730	0	913,341	0	1,296,836	724,147
11	143,125	93,228	37,733	111,563	0	4,872	0	0	0	390,521	205,722
12	147,418	96,025	31,040	118,257	0	5,018	0	0	0	397,757	197,673
13	151,841	98,906	23,944	125,352	0	5,168	0	0	0	405,211	189,979
14	156,396	101,873	16,423	132,873	0	5,323	0	0	0	412,889	182,621
15	161,088	104,929	8,451	140,845	0	5,483	0	0	0	420,797	175,584
16	165,921	108,077	0	0	0	5,648	0	0	0	279,645	110,081
17	170,898	111,320	0	0	0	5,817	0	0	0	288,035	106,966
18	176,025	114,659	0	0	0	5,992	0	206,606	0	503,282	176,322
19	181,306	118,099	0	0	0	6,171	0	0	0	305,576	100,997
20	186,745	121,642	0	0	0	6,356	0	0	0	314,743	98,139
21	192,347	125,291	0	0	0	6,547	0	0	0	324,186	95,361
22	198,118	129,050	0	0	0	6,744	0	0	0	333,911	92,662
23	204,061	132,921	0	0	0	6,946	0	0	0	343,929	90,040
24	210,183	136,909	0	0	0	7,154	0	1,825,567	0	2,179,814	538,368
25	216,489	141,016	0	0	0	7,369	0	0	0	364,874	85,015
26	222,983	145,247	0	0	0	7,590	0	0	0	375,820	82,609
27	229,673	149,604	0	0	0	7,818	0	0	0	387,095	80,271
28	236,563	154,092	0	0	0	8,052	0	0	0	398,708	77,999
29	243,660	158,715	0	0	0	8,294	0	0	0	410,669	75,792
30	250,970	163,477	0	0	0	8,543	0	1,649,596	0	2,072,584	360,859
31	258,499	168,381	0	0	0	8,799	0	0	0	435,678	71,562
32	266,254	173,432	0	0	0	9,063	0	0	0	448,749	69,537
33	274,241	178,635	0	0	0	9,335	0	0	0	462,211	67,569
34	282,469	183,994	0	0	0	9,615	0	0	0	476,078	65,657
35	290,943	189,514	0	0	0	9,903	0	0	0	490,360	63,799
36	299,671	195,200	0	0	0	10,200	0	0	0	505,071	61,993
37	308,661	201,056	0	0	0	10,506	0	0	0	520,223	60,238
38	317,921	207,087	0	0	0	10,821	0	0	0	535,830	58,534
39	327,459	213,300	0	0	0	11,146	0	0	0	551,904	56,877
40	337,282	219,699	0	0	0	11,480	0	0	0	568,462	55,267
41	347,401	226,290	0	0	0	11,825	0	0	0	585,515	53,703
42	357,823	233,078	0	0	0	12,180	0	0	0	603,081	52,183
43	368,557	240,071	0	0	0	12,545	0	0	0	621,173	50,706
44	379,614	247,273	0	0	0	12,921	0	0	0	639,808	49,271
45	391,003	254,691	0	0	0	13,309	0	0	0	659,003	47,877
46	402,733	262,332	0	0	0	13,708	0	0	0	678,773	46,522
47	414,815	270,202	0	0	0	14,120	0	0	0	699,136	45,205
48	427,259	278,308	0	0	0	14,543	0	3,711,002	0	4,431,112	270,291
49	440,077	286,657	0	0	0	14,979	0	0	0	741,713	42,683
50	453,279	295,257	0	0	0	15,429	0	2,979,353	0	3,743,317	203,219

YEARLY CASH FLOW

By AES

Alternative: 2
 Life Cycle Cost: \$ 7,545,076.57

Year	Utility Cost (\$)	Maint. Cost (\$)	Interest Cost (\$)	Principal Cost (\$)	Property Taxes (\$)	Insurance Cost (\$)	Revenue Penalty (\$)	Replace. Expenses (\$)	Deprec. Tax (\$)	Cash Flow Effect (\$)	Present Value (\$)
0	0	0	0	580,000	0	0	0	0	0	580,000	580,000
1	77,013	48,559	139,200	99,674	0	5,800	0	0	0	370,246	349,289
2	79,324	50,016	133,220	105,654	0	5,974	0	0	0	374,188	333,026
3	81,703	51,517	126,880	111,993	0	6,153	0	0	0	378,247	317,583
4	84,154	53,062	120,161	118,713	0	6,338	0	0	0	382,428	302,919
5	86,679	54,654	113,038	125,836	0	6,528	0	0	0	386,735	288,991
6	89,279	56,294	105,488	133,386	0	6,724	0	0	0	391,171	275,760
7	91,958	57,983	97,485	141,389	0	6,926	0	0	0	395,739	263,189
8	94,716	59,722	89,001	149,872	0	7,133	0	0	0	400,445	251,245
9	97,558	61,514	80,009	158,865	0	7,347	0	0	0	405,293	239,892
10	100,485	63,359	70,477	168,397	0	7,568	0	0	0	410,285	229,101
11	103,499	65,260	60,373	178,501	0	7,795	0	0	0	415,428	218,842
12	106,604	67,218	49,663	189,211	0	8,029	0	0	0	420,724	209,087
13	109,802	69,234	38,311	200,563	0	8,269	0	0	0	426,180	199,810
14	113,096	71,311	26,277	212,597	0	8,517	0	0	0	431,799	190,985
15	116,489	73,451	13,521	225,353	0	8,773	0	1,512,590	0	1,950,176	813,741
16	119,984	75,654	0	0	0	9,036	0	0	0	204,674	80,569
17	123,583	77,924	0	0	0	9,307	0	0	0	210,814	78,289
18	127,291	80,261	0	0	0	9,587	0	0	0	217,139	76,073
19	131,110	82,669	0	0	0	9,874	0	0	0	223,653	73,920
20	135,043	85,149	0	0	0	10,170	0	0	0	230,363	71,828
21	139,094	87,704	0	0	0	10,475	0	0	0	237,273	69,795
22	143,267	90,335	0	0	0	10,790	0	0	0	244,392	67,820
23	147,565	93,045	0	0	0	11,113	0	0	0	251,723	65,901
24	151,992	95,836	0	0	0	11,447	0	0	0	259,275	64,035
25	156,552	98,711	0	0	0	11,790	0	0	0	267,053	62,223
26	161,248	101,673	0	0	0	12,144	0	0	0	275,065	60,462
27	166,086	104,723	0	0	0	12,508	0	0	0	283,317	58,751
28	171,068	107,865	0	0	0	12,883	0	0	0	291,816	57,088
29	176,200	111,101	0	0	0	13,270	0	0	0	300,571	55,472
30	181,486	114,434	0	0	0	13,668	0	2,356,565	0	2,666,153	464,205
31	186,931	117,867	0	0	0	14,078	0	0	0	318,876	52,377
32	192,539	121,403	0	0	0	14,500	0	0	0	328,442	50,895
33	198,315	125,045	0	0	0	14,935	0	0	0	338,295	49,454
34	204,265	128,796	0	0	0	15,384	0	0	0	348,444	48,055
35	210,392	132,660	0	0	0	15,845	0	0	0	358,897	46,695
36	216,704	136,640	0	0	0	16,320	0	0	0	369,664	45,373
37	223,205	140,739	0	0	0	16,810	0	0	0	380,754	44,089
38	229,902	144,961	0	0	0	17,314	0	0	0	392,177	42,841
39	236,799	149,310	0	0	0	17,834	0	0	0	403,942	41,629
40	243,903	153,789	0	0	0	18,369	0	0	0	416,060	40,450
41	251,220	158,403	0	0	0	18,920	0	0	0	428,542	39,306
42	258,756	163,155	0	0	0	19,487	0	0	0	441,399	38,193
43	266,519	168,050	0	0	0	20,072	0	0	0	454,640	37,112
44	274,514	173,091	0	0	0	20,674	0	0	0	468,280	36,062
45	282,750	178,284	0	0	0	21,294	0	3,671,451	0	4,153,779	301,773
46	291,232	183,632	0	0	0	21,933	0	0	0	496,798	34,050
47	299,969	189,141	0	0	0	22,591	0	0	0	511,702	33,086
48	308,968	194,815	0	0	0	23,269	0	0	0	527,053	32,149
49	318,237	200,660	0	0	0	23,967	0	0	0	542,865	31,240

YEARLY CASH FLOW

By AES

50	327,785	206,680	0	0	0	24,686	0	0	0	559,150	30,355
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Alternative: 3
 Life Cycle Cost: \$ 7,946,661.89

Year	Utility Cost (\$)	Maint. Cost (\$)	Interest Cost (\$)	Principal Cost (\$)	Property Taxes (\$)	Insurance Cost (\$)	Revenue Penalty (\$)	Replace. Expenses (\$)	Deprec. Tax (\$)	Cash Flow Effect (\$)	Present Value (\$)
0	0	0	0	797,500	0	0	0	0	0	797,500	797,500
1	83,596	34,685	191,400	137,051	0	7,975	0	0	0	454,708	428,970
2	86,104	35,726	183,177	145,275	0	8,214	0	0	0	458,496	408,060
3	88,687	36,798	174,460	153,991	0	8,461	0	0	0	462,397	388,238
4	91,348	37,902	165,221	163,230	0	8,714	0	0	0	466,415	369,445
5	94,088	39,039	155,427	173,024	0	8,976	0	0	0	470,554	351,626
6	96,911	40,210	145,046	183,406	0	9,245	0	0	0	474,817	334,728
7	99,818	41,416	134,041	194,410	0	9,523	0	0	0	479,208	318,701
8	102,813	42,659	122,377	206,075	0	9,808	0	0	0	483,731	303,499
9	105,897	43,938	110,012	218,439	0	10,102	0	0	0	488,390	289,077
10	109,074	45,257	96,906	231,545	0	10,406	0	0	0	493,188	275,394
11	112,346	46,614	83,013	245,438	0	10,718	0	0	0	498,130	262,409
12	115,717	48,013	68,287	260,165	0	11,039	0	0	0	503,220	250,085
13	119,188	49,453	52,677	275,774	0	11,370	0	0	0	508,463	238,388
14	122,764	50,937	36,131	292,321	0	11,712	0	0	0	513,864	227,283
15	126,447	52,465	18,591	309,860	0	12,063	0	0	0	519,426	216,738
16	130,240	54,039	0	0	0	12,425	0	0	0	196,704	77,432
17	134,148	55,660	0	0	0	12,798	0	0	0	202,605	75,240
18	138,172	57,330	0	0	0	13,181	0	0	0	208,683	73,111
19	142,317	59,049	0	0	0	13,577	0	0	0	214,943	71,042
20	146,587	60,821	0	0	0	13,984	0	0	0	221,392	69,031
21	150,984	62,646	0	0	0	14,404	0	0	0	228,034	67,077
22	155,514	64,525	0	0	0	14,836	0	0	0	234,875	65,179
23	160,179	66,461	0	0	0	15,281	0	1,341,272	0	1,583,193	414,476
24	164,985	68,455	0	0	0	15,739	0	592,076	0	841,254	207,772
25	169,934	70,508	0	0	0	16,212	0	0	0	256,654	59,800
26	175,032	72,623	0	0	0	16,698	0	0	0	264,353	58,108
27	180,283	74,802	0	0	0	17,199	0	0	0	272,284	56,463
28	185,692	77,046	0	0	0	17,715	0	0	0	280,452	54,865
29	191,262	79,358	0	0	0	18,246	0	0	0	288,866	53,312
30	197,000	81,738	0	0	0	18,794	0	0	0	297,532	51,803
31	202,910	84,190	0	0	0	19,357	0	0	0	306,458	50,337
32	208,997	86,716	0	0	0	19,938	0	0	0	315,652	48,913
33	215,267	89,318	0	0	0	20,536	0	0	0	325,121	47,528
34	221,725	91,997	0	0	0	21,152	0	0	0	334,875	46,183
35	228,377	94,757	0	0	0	21,787	0	0	0	344,921	44,876
36	235,228	97,600	0	0	0	22,441	0	0	0	355,269	43,606
37	242,285	100,528	0	0	0	23,114	0	0	0	365,927	42,372
38	249,554	103,544	0	0	0	23,807	0	0	0	376,905	41,173
39	257,041	106,650	0	0	0	24,521	0	0	0	388,212	40,007
40	264,752	109,849	0	0	0	25,257	0	0	0	399,858	38,875
41	272,694	113,145	0	0	0	26,015	0	0	0	411,854	37,775
42	280,875	116,539	0	0	0	26,795	0	0	0	424,210	36,706
43	289,301	120,035	0	0	0	27,599	0	0	0	436,936	35,667
44	297,980	123,636	0	0	0	28,427	0	0	0	450,044	34,658
45	306,920	127,346	0	0	0	29,280	0	0	0	463,545	33,677
46	316,127	131,166	0	0	0	30,158	0	2,647,116	0	3,124,568	214,152
47	325,611	135,101	0	0	0	31,063	0	0	0	491,775	31,797
48	335,380	139,154	0	0	0	31,995	0	1,203,568	0	1,710,096	104,313

YEARLY CASH FLOW

By AES

49	345,441	143,329	0	0	0	32,955	0	0	0	521,724	30,023
50	355,804	147,628	0	0	0	33,943	0	0	0	537,376	29,173

Alternative: 4
Life Cycle Cost: \$ 8,998,015.89

Year	Utility Cost (\$)	Maint. Cost (\$)	Interest Cost (\$)	Principal Cost (\$)	Property Taxes (\$)	Insurance Cost (\$)	Revenue Penalty (\$)	Replace. Expenses (\$)	Deprec. Tax (\$)	Cash Flow Effect (\$)	Present Value (\$)
0	0	0	0	841,000	0	0	0	0	0	841,000	841,000
1	99,404	34,685	201,840	144,527	0	8,410	0	0	0	488,867	461,195
2	102,387	35,726	193,168	153,199	0	8,662	0	0	0	493,142	438,894
3	105,458	36,798	183,976	162,390	0	8,922	0	0	0	497,545	417,748
4	108,622	37,902	174,233	172,134	0	9,190	0	0	0	502,080	397,695
5	111,881	39,039	163,905	182,462	0	9,466	0	0	0	506,752	378,674
6	115,237	40,210	152,957	193,410	0	9,749	0	0	0	511,563	360,632
7	118,694	41,416	141,353	205,014	0	10,042	0	0	0	516,519	343,515
8	122,255	42,659	129,052	217,315	0	10,343	0	0	0	521,624	327,273
9	125,923	43,938	116,013	230,354	0	10,654	0	0	0	526,881	311,860
10	129,700	45,257	102,192	244,175	0	10,973	0	0	0	532,297	297,232
11	133,591	46,614	87,541	258,826	0	11,302	0	0	0	537,875	283,346
12	137,599	48,013	72,012	274,355	0	11,641	0	0	0	543,620	270,163
13	141,727	49,453	55,550	290,817	0	11,991	0	0	0	549,538	257,645
14	145,979	50,937	38,101	308,266	0	12,350	0	0	0	555,633	245,757
15	150,358	52,465	19,605	326,762	0	12,721	0	0	0	561,911	234,466
16	154,869	54,039	0	0	0	13,103	0	0	0	222,010	87,393
17	159,515	55,660	0	0	0	13,496	0	0	0	228,670	84,920
18	164,300	57,330	0	0	0	13,900	0	0	0	235,530	82,517
19	169,229	59,049	0	0	0	14,317	0	0	0	242,596	80,181
20	174,306	60,821	0	0	0	14,747	0	1,052,104	0	1,301,978	405,963
21	179,535	62,646	0	0	0	15,189	0	0	0	257,370	75,707
22	184,921	64,525	0	0	0	15,645	0	0	0	265,092	73,564
23	190,469	66,461	0	0	0	16,114	0	1,341,272	0	1,614,316	422,624
24	196,183	68,455	0	0	0	16,598	0	345,378	0	626,613	154,760
25	202,069	70,508	0	0	0	17,096	0	0	0	289,673	67,493
26	208,131	72,623	0	0	0	17,609	0	0	0	298,363	65,583
27	214,375	74,802	0	0	0	18,137	0	0	0	307,314	63,727
28	220,806	77,046	0	0	0	18,681	0	0	0	316,533	61,924
29	227,430	79,358	0	0	0	19,241	0	0	0	326,029	60,171
30	234,253	81,738	0	0	0	19,819	0	0	0	335,810	58,468
31	241,281	84,190	0	0	0	20,413	0	0	0	345,884	56,813
32	248,519	86,716	0	0	0	21,026	0	0	0	356,261	55,205
33	255,975	89,318	0	0	0	21,656	0	0	0	366,949	53,643
34	263,654	91,997	0	0	0	22,306	0	0	0	377,957	52,125
35	271,563	94,757	0	0	0	22,975	0	0	0	389,296	50,650
36	279,710	97,600	0	0	0	23,665	0	0	0	400,975	49,216
37	288,102	100,528	0	0	0	24,375	0	0	0	413,004	47,823
38	296,745	103,544	0	0	0	25,106	0	0	0	425,394	46,470
39	305,647	106,650	0	0	0	25,859	0	0	0	438,156	45,154
40	314,816	109,849	0	0	0	26,635	0	1,900,216	0	2,351,516	228,620
41	324,261	113,145	0	0	0	27,434	0	0	0	464,840	42,635
42	333,989	116,539	0	0	0	28,257	0	0	0	478,785	41,428
43	344,008	120,035	0	0	0	29,104	0	0	0	493,148	40,256
44	354,329	123,636	0	0	0	29,978	0	0	0	507,943	39,116
45	364,959	127,346	0	0	0	30,877	0	0	0	523,181	38,009
46	375,907	131,166	0	0	0	31,803	0	2,647,116	0	3,185,993	218,362
47	387,185	135,101	0	0	0	32,757	0	0	0	555,043	35,888

YEARLY CASH FLOW

By AES

48	398,800	139,154	0	0	0	33,740	0	702,081	0	1,273,775	77,698
49	410,764	143,329	0	0	0	34,752	0	0	0	588,845	33,886
50	423,087	147,628	0	0	0	35,795	0	0	0	606,510	32,927

Economic Summary

Project Information

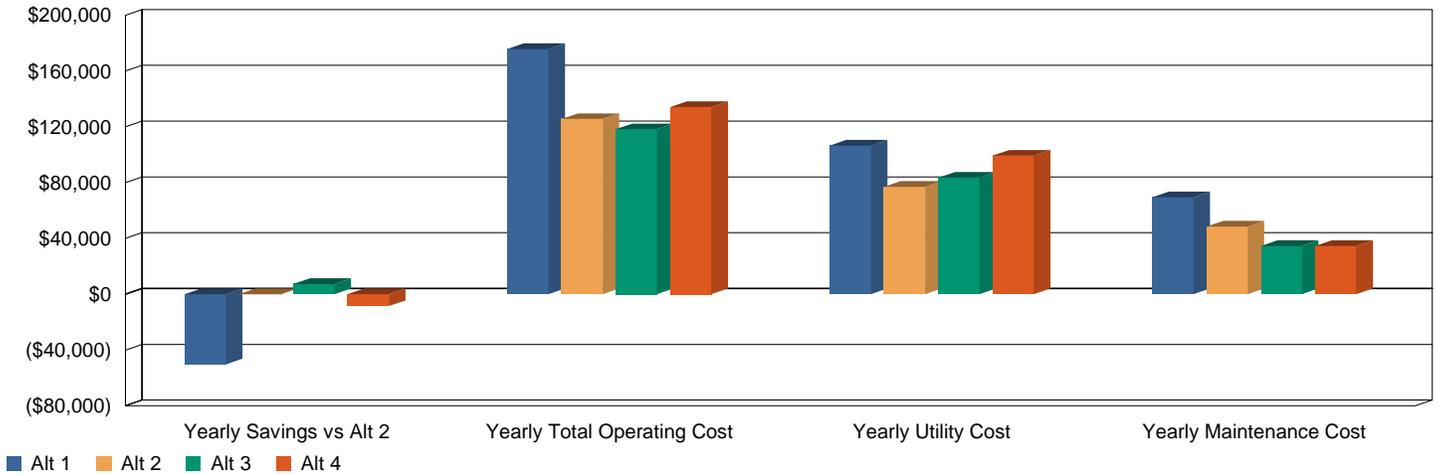
Location: Arlington, NE
 Project Name: APS - K-12 Facility Study
 User:
 Company:
 Comments:

Study Life: 50 years
 Cost of Capital: 6 %
 Alternative 1: APS - K-12 Facility Study
 Alternative 2: DX/Gas RTUs
 Alternative 3: Boiler / FC HP system
 Alternative 4: Boiler AC Chiller FCU system

Economic Comparison of Alternatives

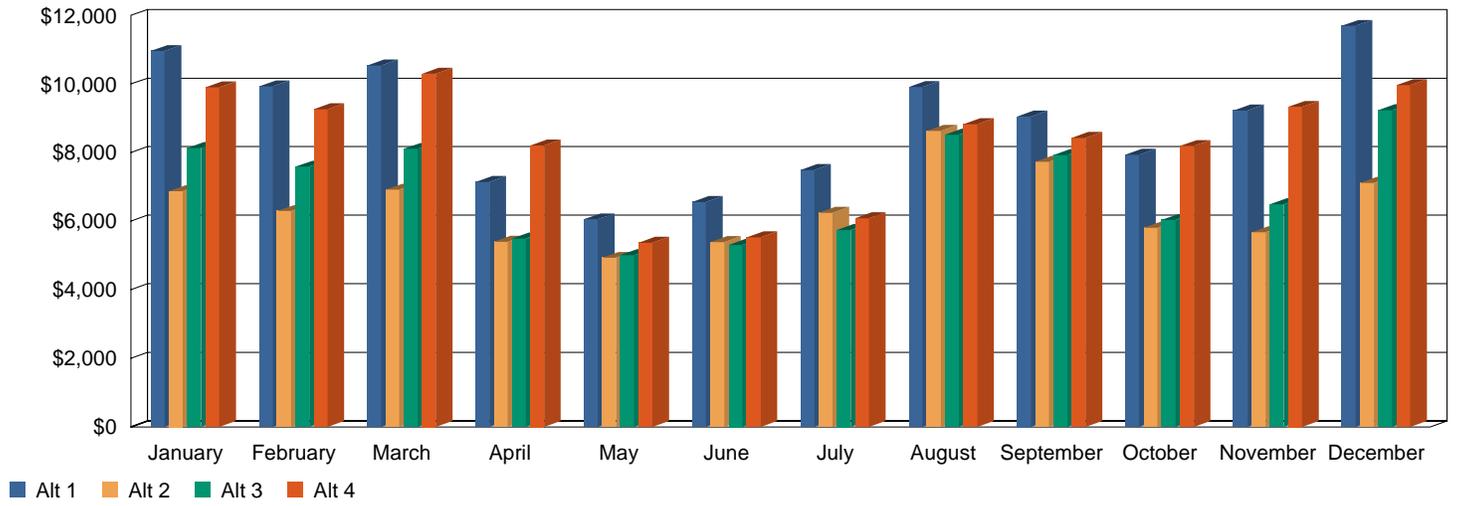
	Yearly Savings (\$)	First Cost Difference (\$)	Cumulative Cash Flow Difference (\$)	Simple Payback (yrs.)	Net Present Value (\$)	Life Cycle Payback (yrs.)	Internal Rate of Return (%)	Life Cycle Cost
Alt 2 vs Alt 1	50,296	1,087,500	7,611,614	21.6	535,188	9.9	9.3	535,188.30
Alt 3 vs Alt 1	57,587	2,175,000	8,384,084	37.8	133,603	49.2	6.4	133,602.90
Alt 4 vs Alt 1	41,779	2,392,500	4,035,544	57.3	-917,751	No Payback	3.1	-917,751.10
Alt 3 vs Alt 2	7,291	1,087,500	772,470	149.2	-401,585	No Payback	2.6	-401,585.30
Alt 4 vs Alt 2	-8,517	1,305,000	-3,576,070	No Payback	-1,452,939	No Payback	Does Not Payback	-1,452,939.00
Alt 4 vs Alt 3	-15,808	217,500	-4,348,540	No Payback	-1,051,354	No Payback	Does Not Payback	-1,051,354.00

Annual Operating Costs



	Yearly Savings vs Alt 2	Yearly Total Operating Cost (\$)	Yearly Utility Cost (\$)	Yearly Maintenance Cost (\$)	Plant kWh/ton-hr
Alt 1	-50,296	175,869	106,498	69,371	2.163
Alt 2	0	125,573	77,013	48,559	0.937
Alt 3	7,291	118,282	83,596	34,685	0.812
Alt 4	-8,517	134,090	99,404	34,685	0.960

Monthly Utility Costs



MONTHLY ENERGY CONSUMPTION

By AES

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 1 APS - K-12 Facility Study													
Electric													
On-Pk Cons. (kWh)	104,280	93,757	108,850	102,062	84,023	90,553	103,548	142,075	123,638	113,735	100,928	97,684	1,265,134
On-Pk Demand (kW)	352	351	354	374	284	375	434	526	487	404	363	351	526
Gas													
On-Pk Cons. (therms)	7,533	6,606	6,669	2,020	625	211	192	275	615	2,326	5,141	8,926	41,141
On-Pk Demand (therms/hr)	36	37	37	23	4	1	1	2	4	20	31	31	37

Energy Consumption

Building 60,775 Btu/(ft2-year)
 Source 124,589 Btu/(ft2-year)

Floor Area 138,741 ft2

Environmental Impact Analysis

CO2 1,806,497 lbm/year
 SO2 5,308 gm/year
 NOX 3,192 gm/year

MONTHLY ENERGY CONSUMPTION

By AES

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 2 DX/Gas RTUs													
Electric													
On-Pk Cons. (kWh)	85,814	77,588	92,196	85,943	63,189	70,772	81,034	120,597	102,062	93,006	83,371	81,061	1,036,633
On-Pk Demand (kW)	299	301	300	316	264	336	405	482	438	348	305	276	482
Gas													
On-Pk Cons. (therms)	3,055	2,639	2,767	811	625	211	192	275	615	782	1,425	3,816	17,214
On-Pk Demand (therms/hr)	46	47	47	27	4	1	1	2	4	13	45	48	48

Energy Consumption

Building 37,908 Btu/(ft2-year)
 Source 89,571 Btu/(ft2-year)

Floor Area 138,741 ft2

Environmental Impact Analysis

CO2 1,480,218 lbm/year
 SO2 4,350 gm/year
 NOX 2,616 gm/year

MONTHLY ENERGY CONSUMPTION

By AES

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 3 Boiler / FC HP system													
Electric													
On-Pk Cons. (kWh)	98,571	88,146	102,322	90,344	67,289	72,545	78,918	121,963	106,653	99,076	89,667	96,982	1,112,476
On-Pk Demand (kW)	393	386	389	316	241	303	330	448	431	363	391	406	448
Gas													
On-Pk Cons. (therms)	3,473	3,299	3,283	721	625	211	192	275	615	677	1,614	5,040	20,025
On-Pk Demand (therms/hr)	22	21	21	13	4	1	1	2	4	4	21	22	22
Water													
Cons. (1000gal)	0	0	0	22	48	72	106	128	99	39	8	0	523

Energy Consumption

Building 41,800 Btu/(ft2-year)
 Source 97,301 Btu/(ft2-year)

Floor Area 138,741 ft2

Environmental Impact Analysis

CO2 1,588,515 lbm/year
 SO2 4,668 gm/year
 NOX 2,807 gm/year

MONTHLY ENERGY CONSUMPTION

By AES

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 4 Boiler AC Chiller FCU system													
Electric													
On-Pk Cons. (kWh)	90,845	82,025	96,920	89,961	65,324	71,579	79,946	121,944	105,178	97,398	88,090	85,920	1,075,129
On-Pk Demand (kW)	306	305	306	313	250	334	386	484	450	362	313	314	484
Gas													
On-Pk Cons. (therms)	7,061	6,613	7,316	4,629	1,205	370	192	442	1,293	3,861	6,342	7,353	46,676
On-Pk Demand (therms/hr)	27	27	27	14	13	10	1	10	13	13	27	27	27

Energy Consumption

Building 60,090 Btu/(ft2-year)
 Source 114,765 Btu/(ft2-year)

Floor Area 138,741 ft2

Environmental Impact Analysis

CO2 1,535,188 lbm/year
 SO2 4,511 gm/year
 NOX 2,713 gm/year

YEARLY CASH FLOW

By AES

Alternative: 1
Life Cycle Cost: \$ 8,116,605.28

Year	Utility Cost (\$)	Maint. Cost (\$)	Interest Cost (\$)	Principal Cost (\$)	Property Taxes (\$)	Insurance Cost (\$)	Revenue Penalty (\$)	Replace. Expenses (\$)	Deprec. Tax (\$)	Cash Flow Effect (\$)	Present Value (\$)
0	0	0	0	362,500	0	0	0	0	0	362,500	362,500
1	106,498	69,371	87,000	62,296	0	3,625	0	0	0	328,790	310,179
2	109,693	71,452	83,262	66,034	0	3,734	0	0	0	334,175	297,414
3	112,984	73,595	79,300	69,996	0	3,846	0	0	0	339,721	285,236
4	116,373	75,803	75,100	74,196	0	3,961	0	0	0	345,434	273,616
5	119,865	78,077	70,649	78,647	0	4,080	0	0	0	351,318	262,525
6	123,460	80,420	65,930	83,366	0	4,202	0	0	0	357,379	251,938
7	127,164	82,832	60,928	88,368	0	4,328	0	0	0	363,621	241,829
8	130,979	85,317	55,626	93,670	0	4,458	0	0	0	370,051	232,175
9	134,909	87,877	50,006	99,291	0	4,592	0	0	0	376,673	222,953
10	138,956	90,513	44,048	105,248	0	4,730	0	913,341	0	1,296,836	724,147
11	143,125	93,228	37,733	111,563	0	4,872	0	0	0	390,521	205,722
12	147,418	96,025	31,040	118,257	0	5,018	0	0	0	397,757	197,673
13	151,841	98,906	23,944	125,352	0	5,168	0	0	0	405,211	189,979
14	156,396	101,873	16,423	132,873	0	5,323	0	0	0	412,889	182,621
15	161,088	104,929	8,451	140,845	0	5,483	0	0	0	420,797	175,584
16	165,921	108,077	0	0	0	5,648	0	0	0	279,645	110,081
17	170,898	111,320	0	0	0	5,817	0	0	0	288,035	106,966
18	176,025	114,659	0	0	0	5,992	0	206,606	0	503,282	176,322
19	181,306	118,099	0	0	0	6,171	0	0	0	305,576	100,997
20	186,745	121,642	0	0	0	6,356	0	0	0	314,743	98,139
21	192,347	125,291	0	0	0	6,547	0	0	0	324,186	95,361
22	198,118	129,050	0	0	0	6,744	0	0	0	333,911	92,662
23	204,061	132,921	0	0	0	6,946	0	0	0	343,929	90,040
24	210,183	136,909	0	0	0	7,154	0	1,825,567	0	2,179,814	538,368
25	216,489	141,016	0	0	0	7,369	0	0	0	364,874	85,015
26	222,983	145,247	0	0	0	7,590	0	0	0	375,820	82,609
27	229,673	149,604	0	0	0	7,818	0	0	0	387,095	80,271
28	236,563	154,092	0	0	0	8,052	0	0	0	398,708	77,999
29	243,660	158,715	0	0	0	8,294	0	0	0	410,669	75,792
30	250,970	163,477	0	0	0	8,543	0	1,649,596	0	2,072,584	360,859
31	258,499	168,381	0	0	0	8,799	0	0	0	435,678	71,562
32	266,254	173,432	0	0	0	9,063	0	0	0	448,749	69,537
33	274,241	178,635	0	0	0	9,335	0	0	0	462,211	67,569
34	282,469	183,994	0	0	0	9,615	0	0	0	476,078	65,657
35	290,943	189,514	0	0	0	9,903	0	0	0	490,360	63,799
36	299,671	195,200	0	0	0	10,200	0	0	0	505,071	61,993
37	308,661	201,056	0	0	0	10,506	0	0	0	520,223	60,238
38	317,921	207,087	0	0	0	10,821	0	0	0	535,830	58,534
39	327,459	213,300	0	0	0	11,146	0	0	0	551,904	56,877
40	337,282	219,699	0	0	0	11,480	0	0	0	568,462	55,267
41	347,401	226,290	0	0	0	11,825	0	0	0	585,515	53,703
42	357,823	233,078	0	0	0	12,180	0	419,987	0	1,023,068	88,524
43	368,557	240,071	0	0	0	12,545	0	0	0	621,173	50,706
44	379,614	247,273	0	0	0	12,921	0	0	0	639,808	49,271
45	391,003	254,691	0	0	0	13,309	0	0	0	659,003	47,877
46	402,733	262,332	0	0	0	13,708	0	0	0	678,773	46,522
47	414,815	270,202	0	0	0	14,120	0	0	0	699,136	45,205
48	427,259	278,308	0	0	0	14,543	0	3,711,002	0	4,431,112	270,291
49	440,077	286,657	0	0	0	14,979	0	0	0	741,713	42,683
50	453,279	295,257	0	0	0	15,429	0	2,979,353	0	3,743,317	203,219

YEARLY CASH FLOW

By AES

Alternative: 2
 Life Cycle Cost: \$ 7,200,593.96

Year	Utility Cost (\$)	Maint. Cost (\$)	Interest Cost (\$)	Principal Cost (\$)	Property Taxes (\$)	Insurance Cost (\$)	Revenue Penalty (\$)	Replace. Expenses (\$)	Deprec. Tax (\$)	Cash Flow Effect (\$)	Present Value (\$)
0	0	0	0	884,500	0	0	0	0	0	884,500	884,500
1	65,687	13,874	212,280	152,002	0	8,845	0	0	0	452,688	427,064
2	67,657	14,290	203,160	161,123	0	9,110	0	0	0	455,340	405,251
3	69,687	14,719	193,492	170,790	0	9,384	0	0	0	458,072	384,606
4	71,777	15,161	183,245	181,037	0	9,665	0	0	0	460,886	365,065
5	73,931	15,615	172,383	191,900	0	9,955	0	0	0	463,784	346,566
6	76,149	16,084	160,869	203,414	0	10,254	0	0	0	466,769	329,054
7	78,433	16,566	148,664	215,618	0	10,561	0	0	0	469,843	312,473
8	80,786	17,063	135,727	228,556	0	10,878	0	0	0	473,010	296,773
9	83,210	17,575	122,014	242,269	0	11,205	0	0	0	476,272	281,905
10	85,706	18,103	107,477	256,805	0	11,541	0	0	0	479,632	267,824
11	88,277	18,646	92,069	272,213	0	11,887	0	0	0	483,092	254,487
12	90,926	19,205	75,736	288,546	0	12,244	0	0	0	486,657	241,854
13	93,653	19,781	58,424	305,859	0	12,611	0	0	0	490,328	229,885
14	96,463	20,375	40,072	324,210	0	12,989	0	0	0	494,109	218,545
15	99,357	20,986	20,619	343,663	0	13,379	0	0	0	498,004	207,800
16	102,337	21,615	0	0	0	13,780	0	0	0	137,733	54,218
17	105,408	22,264	0	0	0	14,194	0	0	0	141,865	52,684
18	108,570	22,932	0	0	0	14,619	0	0	0	146,121	51,193
19	111,827	23,620	0	0	0	15,058	0	0	0	150,505	49,744
20	115,182	24,328	0	0	0	15,510	0	0	0	155,020	48,336
21	118,637	25,058	0	0	0	15,975	0	0	0	159,670	46,968
22	122,196	25,810	0	0	0	16,454	0	0	0	164,461	45,639
23	125,862	26,584	0	0	0	16,948	0	1,341,272	0	1,510,667	395,489
24	129,638	27,382	0	0	0	17,456	0	0	0	174,476	43,092
25	133,527	28,203	0	0	0	17,980	0	0	0	179,711	41,872
26	137,533	29,049	0	0	0	18,519	0	0	0	185,102	40,687
27	141,659	29,921	0	0	0	19,075	0	0	0	190,655	39,536
28	145,909	30,818	0	0	0	19,647	0	0	0	196,375	38,417
29	150,286	31,743	0	0	0	20,237	0	0	0	202,266	37,330
30	154,795	32,695	0	0	0	20,844	0	0	0	208,334	36,273
31	159,438	33,676	0	0	0	21,469	0	0	0	214,584	35,246
32	164,222	34,686	0	0	0	22,113	0	0	0	221,021	34,249
33	169,148	35,727	0	0	0	22,777	0	0	0	227,652	33,280
34	174,223	36,799	0	0	0	23,460	0	0	0	234,481	32,338
35	179,449	37,903	0	0	0	24,164	0	0	0	241,516	31,423
36	184,833	39,040	0	0	0	24,889	0	0	0	248,761	30,533
37	190,378	40,211	0	0	0	25,635	0	0	0	256,224	29,669
38	196,089	41,417	0	0	0	26,404	0	0	0	263,911	28,829
39	201,972	42,660	0	0	0	27,196	0	0	0	271,828	28,013
40	208,031	43,940	0	0	0	28,012	0	0	0	279,983	27,221
41	214,272	45,258	0	0	0	28,853	0	0	0	288,383	26,450
42	220,700	46,616	0	0	0	29,718	0	0	0	297,034	25,702
43	227,321	48,014	0	0	0	30,610	0	0	0	305,945	24,974
44	234,141	49,455	0	0	0	31,528	0	0	0	315,123	24,267
45	241,165	50,938	0	0	0	32,474	0	0	0	324,577	23,581
46	248,400	52,466	0	0	0	33,448	0	2,647,116	0	2,981,431	204,341
47	255,852	54,040	0	0	0	34,452	0	0	0	344,344	22,265
48	263,527	55,662	0	0	0	35,485	0	0	0	354,674	21,635
49	271,433	57,331	0	0	0	36,550	0	0	0	365,314	21,022

YEARLY CASH FLOW

By AES

50	279,576	59,051	0	0	0	37,646	0	0	0	376,274	20,427
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Alternative: 3
 Life Cycle Cost: \$ 9,174,054.53

Year	Utility Cost (\$)	Maint. Cost (\$)	Interest Cost (\$)	Principal Cost (\$)	Property Taxes (\$)	Insurance Cost (\$)	Revenue Penalty (\$)	Replace. Expenses (\$)	Deprec. Tax (\$)	Cash Flow Effect (\$)	Present Value (\$)
0	0	0	0	942,500	0	0	0	0	0	942,500	942,500
1	100,215	27,748	226,200	161,970	0	9,425	0	0	0	525,558	495,810
2	103,221	28,581	216,482	171,688	0	9,708	0	0	0	529,680	471,413
3	106,318	29,438	206,181	181,989	0	9,999	0	0	0	533,925	448,294
4	109,508	30,321	195,261	192,909	0	10,299	0	0	0	538,298	426,382
5	112,793	31,231	183,687	204,483	0	10,608	0	0	0	542,802	405,613
6	116,177	32,168	171,418	216,752	0	10,926	0	0	0	547,441	385,924
7	119,662	33,133	158,413	229,757	0	11,254	0	0	0	552,219	367,257
8	123,252	34,127	144,627	243,543	0	11,592	0	0	0	557,140	349,557
9	126,949	35,151	130,015	258,155	0	11,939	0	0	0	562,209	332,771
10	130,758	36,205	114,525	273,645	0	12,297	0	0	0	567,430	316,850
11	134,681	37,291	98,107	290,063	0	12,666	0	0	0	572,808	301,748
12	138,721	38,410	80,703	307,467	0	13,046	0	0	0	578,347	287,421
13	142,883	39,562	62,255	325,915	0	13,438	0	0	0	584,053	273,827
14	147,169	40,749	42,700	345,470	0	13,841	0	0	0	589,929	260,926
15	151,584	41,972	21,972	366,198	0	14,256	0	0	0	595,982	248,683
16	156,132	43,231	0	0	0	14,684	0	0	0	214,046	84,259
17	160,816	44,528	0	0	0	15,124	0	0	0	220,468	81,874
18	165,640	45,864	0	0	0	15,578	0	0	0	227,082	79,557
19	170,609	47,240	0	0	0	16,045	0	0	0	233,894	77,305
20	175,728	48,657	0	0	0	16,527	0	0	0	240,911	75,117
21	180,999	50,116	0	0	0	17,023	0	0	0	248,139	72,991
22	186,429	51,620	0	0	0	17,533	0	0	0	255,583	70,926
23	192,022	53,169	0	0	0	18,059	0	1,341,272	0	1,604,522	420,060
24	197,783	54,764	0	0	0	18,601	0	1,184,152	0	1,455,299	359,428
25	203,716	56,407	0	0	0	19,159	0	0	0	279,282	65,072
26	209,828	58,099	0	0	0	19,734	0	0	0	287,661	63,231
27	216,123	59,842	0	0	0	20,326	0	0	0	296,290	61,441
28	222,606	61,637	0	0	0	20,936	0	0	0	305,179	59,702
29	229,285	63,486	0	0	0	21,564	0	0	0	314,334	58,013
30	236,163	65,391	0	0	0	22,211	0	0	0	323,764	56,371
31	243,248	67,352	0	0	0	22,877	0	0	0	333,477	54,775
32	250,546	69,373	0	0	0	23,563	0	0	0	343,482	53,225
33	258,062	71,454	0	0	0	24,270	0	0	0	353,786	51,719
34	265,804	73,598	0	0	0	24,998	0	0	0	364,400	50,255
35	273,778	75,806	0	0	0	25,748	0	0	0	375,332	48,833
36	281,991	78,080	0	0	0	26,521	0	0	0	386,592	47,451
37	290,451	80,422	0	0	0	27,316	0	0	0	398,189	46,108
38	299,164	82,835	0	0	0	28,136	0	0	0	410,135	44,803
39	308,139	85,320	0	0	0	28,980	0	0	0	422,439	43,535
40	317,384	87,880	0	0	0	29,849	0	0	0	435,112	42,303
41	326,905	90,516	0	0	0	30,745	0	0	0	448,166	41,105
42	336,712	93,231	0	0	0	31,667	0	0	0	461,611	39,942
43	346,814	96,028	0	0	0	32,617	0	0	0	475,459	38,812
44	357,218	98,909	0	0	0	33,596	0	0	0	489,723	37,713
45	367,935	101,876	0	0	0	34,603	0	0	0	504,414	36,646
46	378,973	104,933	0	0	0	35,642	0	2,647,116	0	3,166,663	217,037
47	390,342	108,081	0	0	0	36,711	0	0	0	535,133	34,601
48	402,052	111,323	0	0	0	37,812	0	2,407,136	0	2,958,324	180,453

YEARLY CASH FLOW

By AES

49	414,114	114,663	0	0	0	38,946	0	0	0	567,723	32,670
50	426,537	118,103	0	0	0	40,115	0	0	0	584,755	31,745

Alternative: 4
Life Cycle Cost: \$ 9,361,767.72

Year	Utility Cost (\$)	Maint. Cost (\$)	Interest Cost (\$)	Principal Cost (\$)	Property Taxes (\$)	Insurance Cost (\$)	Revenue Penalty (\$)	Replace. Expenses (\$)	Deprec. Tax (\$)	Cash Flow Effect (\$)	Present Value (\$)
0	0	0	0	913,500	0	0	0	0	0	913,500	913,500
1	92,797	41,622	219,240	156,986	0	9,135	0	0	0	519,781	490,359
2	95,581	42,871	209,821	166,405	0	9,409	0	0	0	524,087	466,436
3	98,449	44,157	199,837	176,390	0	9,691	0	0	0	528,523	443,758
4	101,402	45,482	189,253	186,973	0	9,982	0	0	0	533,092	422,259
5	104,444	46,846	178,035	198,191	0	10,282	0	0	0	537,798	401,874
6	107,577	48,252	166,143	210,083	0	10,590	0	0	0	542,645	382,544
7	110,805	49,699	153,538	222,688	0	10,908	0	0	0	547,638	364,211
8	114,129	51,190	140,177	236,049	0	11,235	0	0	0	552,780	346,821
9	117,553	52,726	126,014	250,212	0	11,572	0	0	0	558,077	330,325
10	121,079	54,308	111,001	265,225	0	11,919	0	0	0	563,532	314,674
11	124,712	55,937	95,088	281,138	0	12,277	0	0	0	569,152	299,822
12	128,453	57,615	78,220	298,007	0	12,645	0	0	0	574,939	285,727
13	132,307	59,344	60,339	315,887	0	13,024	0	0	0	580,901	272,349
14	136,276	61,124	41,386	334,840	0	13,415	0	0	0	587,041	259,649
15	140,364	62,958	21,296	354,931	0	13,818	0	423,525	0	1,016,890	424,313
16	144,575	64,846	0	0	0	14,232	0	0	0	223,653	88,040
17	148,912	66,792	0	0	0	14,659	0	0	0	230,363	85,549
18	153,380	68,795	0	0	0	15,099	0	0	0	237,274	83,127
19	157,981	70,859	0	0	0	15,552	0	0	0	244,392	80,775
20	162,720	72,985	0	0	0	16,018	0	0	0	251,724	78,489
21	167,602	75,175	0	0	0	16,499	0	0	0	259,276	76,267
22	172,630	77,430	0	0	0	16,994	0	0	0	267,054	74,109
23	177,809	79,753	0	0	0	17,504	0	862,246	0	1,137,312	297,745
24	183,143	82,145	0	0	0	18,029	0	1,184,152	0	1,467,469	362,434
25	188,638	84,610	0	0	0	18,570	0	0	0	291,817	67,993
26	194,297	87,148	0	0	0	19,127	0	0	0	300,571	66,069
27	200,126	89,763	0	0	0	19,700	0	0	0	309,589	64,199
28	206,129	92,455	0	0	0	20,291	0	0	0	318,876	62,382
29	212,313	95,229	0	0	0	20,900	0	0	0	328,442	60,616
30	218,683	98,086	0	0	0	21,527	0	659,838	0	998,134	173,786
31	225,243	101,029	0	0	0	22,173	0	0	0	348,445	57,234
32	232,000	104,059	0	0	0	22,838	0	0	0	358,898	55,614
33	238,960	107,181	0	0	0	23,523	0	0	0	369,665	54,040
34	246,129	110,397	0	0	0	24,229	0	0	0	380,755	52,511
35	253,513	113,708	0	0	0	24,956	0	0	0	392,177	51,024
36	261,118	117,120	0	0	0	25,705	0	0	0	403,943	49,580
37	268,952	120,633	0	0	0	26,476	0	0	0	416,061	48,177
38	277,021	124,252	0	0	0	27,270	0	0	0	428,543	46,814
39	285,331	127,980	0	0	0	28,088	0	0	0	441,399	45,489
40	293,891	131,819	0	0	0	28,931	0	0	0	454,641	44,201
41	302,708	135,774	0	0	0	29,799	0	0	0	468,280	42,950
42	311,789	139,847	0	0	0	30,693	0	0	0	482,329	41,735
43	321,143	144,042	0	0	0	31,613	0	0	0	496,799	40,554
44	330,777	148,364	0	0	0	32,562	0	0	0	511,703	39,406
45	340,700	152,815	0	0	0	33,539	0	1,028,006	0	1,555,060	112,976
46	350,921	157,399	0	0	0	34,545	0	1,701,718	0	2,244,583	153,839
47	361,449	162,121	0	0	0	35,581	0	0	0	559,151	36,154

YEARLY CASH FLOW

By AES

48	372,292	166,985	0	0	0	36,649	0	2,407,136	0	2,983,062	181,962
49	383,461	171,994	0	0	0	37,748	0	0	0	593,204	34,136
50	394,965	177,154	0	0	0	38,881	0	0	0	611,000	33,170

Economic Summary

Project Information

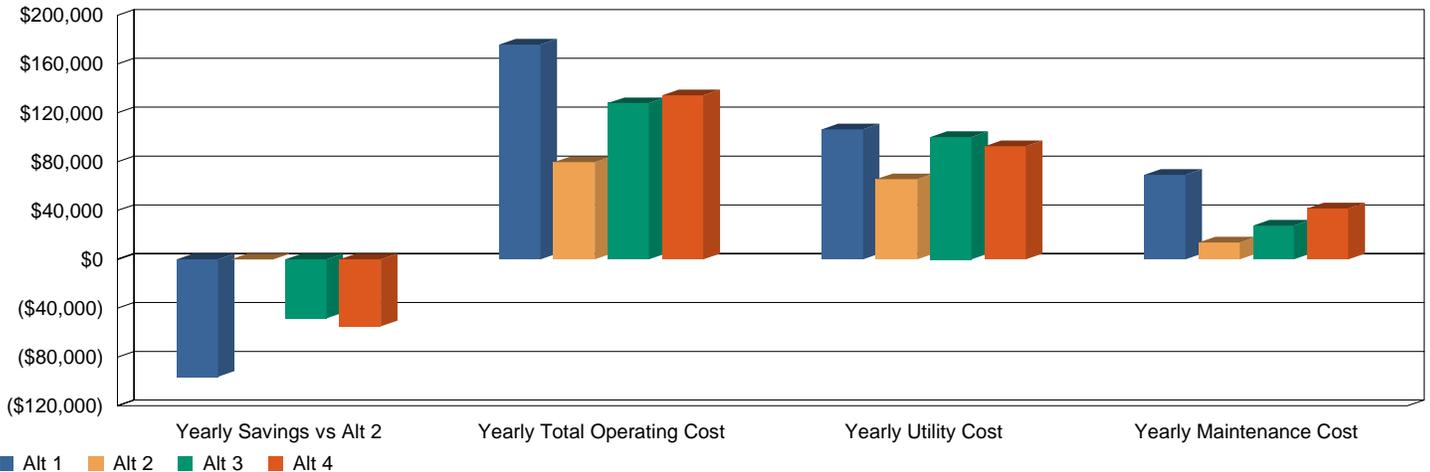
Location: Arlington, NE
 Project Name: APS - K-12 Facility Study
 User:
 Company:
 Comments:

Study Life: 50 years
 Cost of Capital: 6 %
 Alternative 1: APS - K-12 Facility Study
 Alternative 2: Geo HPs
 Alternative 3: CentGeo CHs to FCU
 Alternative 4: Cent Geo CH FCU with DXgas DOAS

Economic Comparison of Alternatives

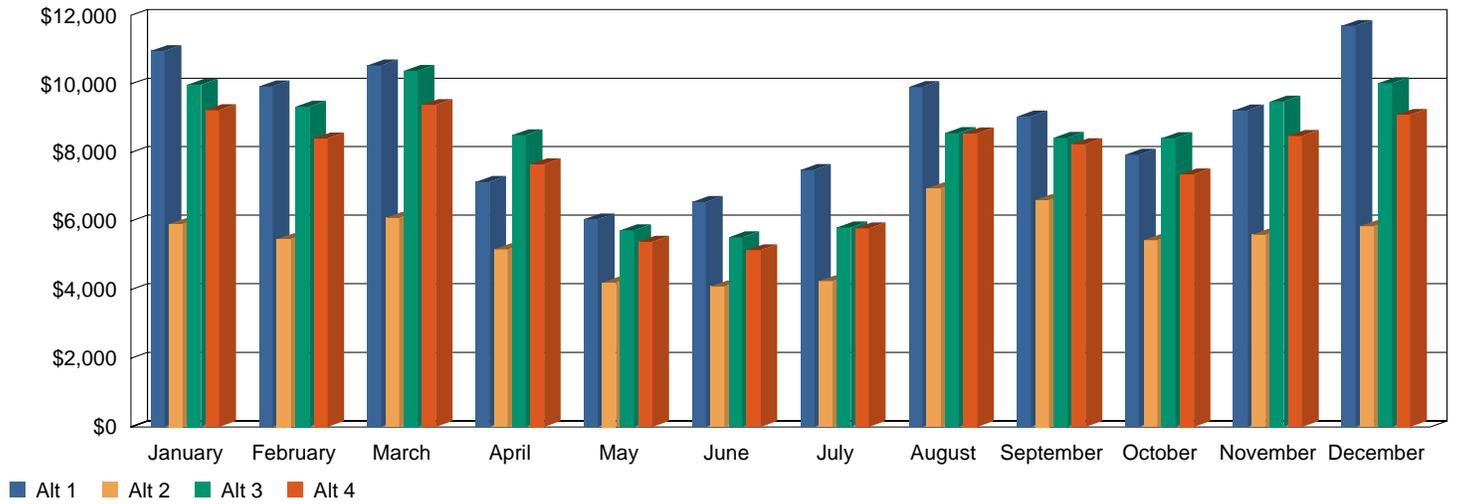
	Yearly Savings (\$)	First Cost Difference (\$)	Cumulative Cash Flow Difference (\$)	Simple Payback (yrs.)	Net Present Value (\$)	Life Cycle Payback (yrs.)	Internal Rate of Return (%)	Life Cycle Cost
Alt 2 vs Alt 1	96,308	2,610,000	14,244,720	27.1	916,011	29.7	8.3	916,011.30
Alt 3 vs Alt 1	47,905	2,900,000	4,712,036	60.5	-1,057,449	No Payback	3.2	-1,057,449.00
Alt 4 vs Alt 1	41,449	2,755,000	3,537,709	66.5	-1,245,163	No Payback	2.6	-1,245,163.00
Alt 3 vs Alt 2	-48,403	290,000	-9,532,685	No Payback	-1,973,461	No Payback	Does Not Payback	-1,973,461.00
Alt 4 vs Alt 2	-54,859	145,000	-10,707,010	No Payback	-2,161,174	No Payback	Does Not Payback	-2,161,174.00
Alt 3 vs Alt 4	6,456	145,000	1,174,328	22.5	187,713	14.4	14.3	187,713.20

Annual Operating Costs



	Yearly Savings vs Alt 2	Yearly Total Operating Cost (\$)	Yearly Utility Cost (\$)	Yearly Maintenance Cost (\$)	Plant kWh/ton-hr
Alt 1	-96,308	175,869	106,498	69,371	2.163
Alt 2	0	79,561	65,687	13,874	0.245
Alt 3	-48,403	127,963	100,215	27,748	1.371
Alt 4	-54,859	134,420	92,797	41,622	1.127

Monthly Utility Costs



MONTHLY ENERGY CONSUMPTION

By AES

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 1 APS - K-12 Facility Study													
Electric													
On-Pk Cons. (kWh)	104,280	93,757	108,850	102,062	84,023	90,553	103,548	142,075	123,638	113,735	100,928	97,684	1,265,134
On-Pk Demand (kW)	352	351	354	374	284	375	434	526	487	404	363	351	526
Gas													
On-Pk Cons. (therms)	7,533	6,606	6,669	2,020	625	211	192	275	615	2,326	5,141	8,926	41,141
On-Pk Demand (therms/hr)	36	37	37	23	4	1	1	2	4	20	31	31	37

Energy Consumption

Building 60,775 Btu/(ft2-year)
 Source 124,589 Btu/(ft2-year)

Environmental Impact Analysis

CO2 1,806,497 lbm/year
 SO2 5,308 gm/year
 NOX 3,192 gm/year

Floor Area 138,741 ft2

MONTHLY ENERGY CONSUMPTION

By AES

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 2 Geo HPs													
Electric													
On-Pk Cons. (kWh)	93,941	84,223	98,471	85,377	57,390	58,869	60,338	100,835	89,775	90,631	86,127	91,175	997,152
On-Pk Demand (kW)	380	373	376	304	180	200	218	346	338	311	375	392	392
Gas													
On-Pk Cons. (therms)	646	584	707	615	625	211	192	275	615	677	646	615	6,409
On-Pk Demand (therms/hr)	4	4	4	4	4	1	1	2	4	4	4	4	4

Energy Consumption

Building 29,149 Btu/(ft2-year)
 Source 78,459 Btu/(ft2-year)

Floor Area 138,741 ft2

Environmental Impact Analysis

CO2 1,423,843 lbm/year
 SO2 4,184 gm/year
 NOX 2,516 gm/year

MONTHLY ENERGY CONSUMPTION

By AES

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 3 CentGeo CHs to FCU													
Electric													
On-Pk Cons. (kWh)	93,240	84,446	99,483	97,043	75,453	78,115	84,259	124,181	110,609	105,497	92,467	87,782	1,132,576
On-Pk Demand (kW)	304	303	304	322	225	272	295	414	400	348	311	312	414
Gas													
On-Pk Cons. (therms)	7,061	6,613	7,316	4,629	1,205	370	192	442	1,293	3,861	6,342	7,353	46,676
On-Pk Demand (therms/hr)	27	27	27	14	13	10	1	10	13	13	27	27	27
Water													
Cons. (1000gal)	6	5	6	24	46	69	102	121	94	40	13	5	532

Energy Consumption

Building 61,504 Btu/(ft2-year)
 Source 119,005 Btu/(ft2-year)

Floor Area 138,741 ft2

Environmental Impact Analysis

CO2 1,617,216 lbm/year
 SO2 4,752 gm/year
 NOX 2,858 gm/year

MONTHLY ENERGY CONSUMPTION

By AES

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 4 Cent Geo CH FCU with DXgas DOAS													
Electric													
On-Pk Cons. (kWh)	95,629	85,941	101,586	96,333	70,050	70,092	75,744	121,614	107,176	103,739	93,917	89,608	1,111,429
On-Pk Demand (kW)	303	297	298	320	217	259	305	421	403	346	305	304	421
Gas													
On-Pk Cons. (therms)	5,888	5,259	5,827	3,470	1,167	500	660	556	1,243	2,465	4,887	5,996	37,917
On-Pk Demand (therms/hr)	22	22	22	12	10	8	8	8	11	12	21	22	22
Water													
Cons. (1000gal)	0	0	0	0	0	0	0	0	0	0	0	0	1

Energy Consumption

Building 54,670 Btu/(ft2-year)
Source 110,798 Btu/(ft2-year)

Floor Area 138,741 ft2

Environmental Impact Analysis

CO2 1,587,020 lbm/year
SO2 4,663 gm/year
NOX 2,804 gm/year

YEARLY CASH FLOW

By AES

Alternative: 1
Life Cycle Cost: \$ 8,116,605.28

Year	Utility Cost (\$)	Maint. Cost (\$)	Interest Cost (\$)	Principal Cost (\$)	Property Taxes (\$)	Insurance Cost (\$)	Revenue Penalty (\$)	Replace. Expenses (\$)	Deprec. Tax (\$)	Cash Flow Effect (\$)	Present Value (\$)
0	0	0	0	362,500	0	0	0	0	0	362,500	362,500
1	106,498	69,371	87,000	62,296	0	3,625	0	0	0	328,790	310,179
2	109,693	71,452	83,262	66,034	0	3,734	0	0	0	334,175	297,414
3	112,984	73,595	79,300	69,996	0	3,846	0	0	0	339,721	285,236
4	116,373	75,803	75,100	74,196	0	3,961	0	0	0	345,434	273,616
5	119,865	78,077	70,649	78,647	0	4,080	0	0	0	351,318	262,525
6	123,460	80,420	65,930	83,366	0	4,202	0	0	0	357,379	251,938
7	127,164	82,832	60,928	88,368	0	4,328	0	0	0	363,621	241,829
8	130,979	85,317	55,626	93,670	0	4,458	0	0	0	370,051	232,175
9	134,909	87,877	50,006	99,291	0	4,592	0	0	0	376,673	222,953
10	138,956	90,513	44,048	105,248	0	4,730	0	913,341	0	1,296,836	724,147
11	143,125	93,228	37,733	111,563	0	4,872	0	0	0	390,521	205,722
12	147,418	96,025	31,040	118,257	0	5,018	0	0	0	397,757	197,673
13	151,841	98,906	23,944	125,352	0	5,168	0	0	0	405,211	189,979
14	156,396	101,873	16,423	132,873	0	5,323	0	0	0	412,889	182,621
15	161,088	104,929	8,451	140,845	0	5,483	0	0	0	420,797	175,584
16	165,921	108,077	0	0	0	5,648	0	0	0	279,645	110,081
17	170,898	111,320	0	0	0	5,817	0	0	0	288,035	106,966
18	176,025	114,659	0	0	0	5,992	0	206,606	0	503,282	176,322
19	181,306	118,099	0	0	0	6,171	0	0	0	305,576	100,997
20	186,745	121,642	0	0	0	6,356	0	0	0	314,743	98,139
21	192,347	125,291	0	0	0	6,547	0	0	0	324,186	95,361
22	198,118	129,050	0	0	0	6,744	0	0	0	333,911	92,662
23	204,061	132,921	0	0	0	6,946	0	0	0	343,929	90,040
24	210,183	136,909	0	0	0	7,154	0	1,825,567	0	2,179,814	538,368
25	216,489	141,016	0	0	0	7,369	0	0	0	364,874	85,015
26	222,983	145,247	0	0	0	7,590	0	0	0	375,820	82,609
27	229,673	149,604	0	0	0	7,818	0	0	0	387,095	80,271
28	236,563	154,092	0	0	0	8,052	0	0	0	398,708	77,999
29	243,660	158,715	0	0	0	8,294	0	0	0	410,669	75,792
30	250,970	163,477	0	0	0	8,543	0	1,649,596	0	2,072,584	360,859
31	258,499	168,381	0	0	0	8,799	0	0	0	435,678	71,562
32	266,254	173,432	0	0	0	9,063	0	0	0	448,749	69,537
33	274,241	178,635	0	0	0	9,335	0	0	0	462,211	67,569
34	282,469	183,994	0	0	0	9,615	0	0	0	476,078	65,657
35	290,943	189,514	0	0	0	9,903	0	0	0	490,360	63,799
36	299,671	195,200	0	0	0	10,200	0	0	0	505,071	61,993
37	308,661	201,056	0	0	0	10,506	0	0	0	520,223	60,238
38	317,921	207,087	0	0	0	10,821	0	0	0	535,830	58,534
39	327,459	213,300	0	0	0	11,146	0	0	0	551,904	56,877
40	337,282	219,699	0	0	0	11,480	0	0	0	568,462	55,267
41	347,401	226,290	0	0	0	11,825	0	0	0	585,515	53,703
42	357,823	233,078	0	0	0	12,180	0	419,987	0	1,023,068	88,524
43	368,557	240,071	0	0	0	12,545	0	0	0	621,173	50,706
44	379,614	247,273	0	0	0	12,921	0	0	0	639,808	49,271
45	391,003	254,691	0	0	0	13,309	0	0	0	659,003	47,877
46	402,733	262,332	0	0	0	13,708	0	0	0	678,773	46,522
47	414,815	270,202	0	0	0	14,120	0	0	0	699,136	45,205
48	427,259	278,308	0	0	0	14,543	0	3,711,002	0	4,431,112	270,291
49	440,077	286,657	0	0	0	14,979	0	0	0	741,713	42,683
50	453,279	295,257	0	0	0	15,429	0	2,979,353	0	3,743,317	203,219

YEARLY CASH FLOW

By AES

Alternative: 2
 Life Cycle Cost: \$ 7,446,224.24

Year	Utility Cost (\$)	Maint. Cost (\$)	Interest Cost (\$)	Principal Cost (\$)	Property Taxes (\$)	Insurance Cost (\$)	Revenue Penalty (\$)	Replace. Expenses (\$)	Deprec. Tax (\$)	Cash Flow Effect (\$)	Present Value (\$)
0	0	0	0	667,000	0	0	0	0	0	667,000	667,000
1	90,940	34,685	160,080	114,625	0	6,670	0	0	0	407,000	383,963
2	93,668	35,726	153,203	121,502	0	6,870	0	0	0	410,969	365,761
3	96,479	36,798	145,912	128,792	0	7,076	0	0	0	415,057	348,490
4	99,373	37,902	138,185	136,520	0	7,288	0	0	0	419,268	332,099
5	102,354	39,039	129,994	144,711	0	7,507	0	0	0	423,605	316,542
6	105,425	40,210	121,311	153,394	0	7,732	0	0	0	428,072	301,774
7	108,587	41,416	112,107	162,597	0	7,964	0	0	0	432,673	287,752
8	111,845	42,659	102,351	172,353	0	8,203	0	0	0	437,412	274,438
9	115,200	43,938	92,010	182,695	0	8,449	0	0	0	442,293	261,793
10	118,656	45,257	81,049	193,656	0	8,703	0	0	0	447,321	249,782
11	122,216	46,614	69,429	205,276	0	8,964	0	0	0	452,499	238,371
12	125,883	48,013	57,113	217,592	0	9,233	0	0	0	457,833	227,529
13	129,659	49,453	44,057	230,648	0	9,510	0	0	0	463,327	217,226
14	133,549	50,937	30,218	244,487	0	9,795	0	0	0	468,985	207,433
15	137,555	52,465	15,549	259,156	0	10,089	0	423,525	0	898,339	374,846
16	141,682	54,039	0	0	0	10,392	0	0	0	206,112	81,135
17	145,932	55,660	0	0	0	10,703	0	0	0	212,296	78,839
18	150,310	57,330	0	0	0	11,024	0	0	0	218,664	76,608
19	154,820	59,049	0	0	0	11,355	0	0	0	225,224	74,440
20	159,464	60,821	0	0	0	11,696	0	789,078	0	1,021,059	318,371
21	164,248	62,646	0	0	0	12,047	0	0	0	238,941	70,286
22	169,176	64,525	0	0	0	12,408	0	0	0	246,109	68,297
23	174,251	66,461	0	0	0	12,780	0	0	0	253,492	66,364
24	179,478	68,455	0	0	0	13,164	0	0	0	261,097	64,485
25	184,863	70,508	0	0	0	13,559	0	0	0	268,930	62,660
26	190,409	72,623	0	0	0	13,965	0	0	0	276,998	60,887
27	196,121	74,802	0	0	0	14,384	0	0	0	285,308	59,164
28	202,005	77,046	0	0	0	14,816	0	0	0	293,867	57,489
29	208,065	79,358	0	0	0	15,260	0	0	0	302,683	55,862
30	214,307	81,738	0	0	0	15,718	0	659,838	0	971,601	169,166
31	220,736	84,190	0	0	0	16,190	0	0	0	321,116	52,745
32	227,358	86,716	0	0	0	16,676	0	0	0	330,750	51,252
33	234,179	89,318	0	0	0	17,176	0	0	0	340,672	49,802
34	241,204	91,997	0	0	0	17,691	0	0	0	350,892	48,392
35	248,440	94,757	0	0	0	18,222	0	0	0	361,419	47,023
36	255,893	97,600	0	0	0	18,768	0	0	0	372,262	45,692
37	263,570	100,528	0	0	0	19,332	0	0	0	383,429	44,399
38	271,477	103,544	0	0	0	19,911	0	0	0	394,932	43,142
39	279,622	106,650	0	0	0	20,509	0	0	0	406,780	41,921
40	288,010	109,849	0	0	0	21,124	0	1,425,162	0	1,844,146	179,292
41	296,651	113,145	0	0	0	21,758	0	0	0	431,553	39,582
42	305,550	116,539	0	0	0	22,411	0	0	0	444,500	38,462
43	314,717	120,035	0	0	0	23,083	0	0	0	457,835	37,373
44	324,158	123,636	0	0	0	23,775	0	0	0	471,570	36,315
45	333,883	127,346	0	0	0	24,489	0	1,028,006	0	1,513,723	109,972
46	343,899	131,166	0	0	0	25,223	0	0	0	500,288	34,289
47	354,216	135,101	0	0	0	25,980	0	0	0	515,297	33,318
48	364,843	139,154	0	0	0	26,759	0	0	0	530,756	32,375
49	375,788	143,329	0	0	0	27,562	0	0	0	546,679	31,459

YEARLY CASH FLOW

By AES

50	387,062	147,628	0	0	0	28,389	0	0	0	563,079	30,569
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Alternative: 3
 Life Cycle Cost: \$ 9,017,016.86

Year	Utility Cost (\$)	Maint. Cost (\$)	Interest Cost (\$)	Principal Cost (\$)	Property Taxes (\$)	Insurance Cost (\$)	Revenue Penalty (\$)	Replace. Expenses (\$)	Deprec. Tax (\$)	Cash Flow Effect (\$)	Present Value (\$)
0	0	0	0	964,250	0	0	0	0	0	964,250	964,250
1	98,233	27,748	231,420	165,708	0	9,643	0	0	0	532,752	502,596
2	101,180	28,581	221,478	175,650	0	9,932	0	0	0	536,820	477,768
3	104,216	29,438	210,939	186,189	0	10,230	0	0	0	541,011	454,243
4	107,342	30,321	199,767	197,360	0	10,537	0	0	0	545,328	431,951
5	110,562	31,231	187,926	209,202	0	10,853	0	0	0	549,774	410,823
6	113,879	32,168	175,373	221,754	0	11,178	0	0	0	554,353	390,797
7	117,296	33,133	162,068	235,059	0	11,514	0	0	0	559,070	371,813
8	120,814	34,127	147,965	249,163	0	11,859	0	0	0	563,928	353,816
9	124,439	35,151	133,015	264,113	0	12,215	0	0	0	568,932	336,750
10	128,172	36,205	117,168	279,960	0	12,581	0	0	0	574,086	320,567
11	132,017	37,291	100,371	296,757	0	12,959	0	0	0	579,395	305,218
12	135,978	38,410	82,565	314,563	0	13,347	0	0	0	584,863	290,659
13	140,057	39,562	63,691	333,436	0	13,748	0	0	0	590,495	276,847
14	144,259	40,749	43,685	353,442	0	14,160	0	0	0	596,296	263,743
15	148,587	41,972	22,479	374,649	0	14,585	0	423,525	0	1,025,796	428,029
16	153,044	43,231	0	0	0	15,023	0	0	0	211,298	83,177
17	157,635	44,528	0	0	0	15,473	0	0	0	217,637	80,823
18	162,365	45,864	0	0	0	15,938	0	0	0	224,166	78,535
19	167,235	47,240	0	0	0	16,416	0	0	0	230,891	76,312
20	172,253	48,657	0	0	0	16,908	0	789,078	0	1,026,895	320,191
21	177,420	50,116	0	0	0	17,415	0	0	0	244,952	72,054
22	182,743	51,620	0	0	0	17,938	0	0	0	252,301	70,015
23	188,225	53,169	0	0	0	18,476	0	0	0	259,870	68,033
24	193,872	54,764	0	0	0	19,030	0	0	0	267,666	66,108
25	199,688	56,407	0	0	0	19,601	0	0	0	275,696	64,237
26	205,679	58,099	0	0	0	20,189	0	0	0	283,966	62,419
27	211,849	59,842	0	0	0	20,795	0	0	0	292,485	60,652
28	218,204	61,637	0	0	0	21,419	0	0	0	301,260	58,936
29	224,750	63,486	0	0	0	22,061	0	0	0	310,298	57,268
30	231,493	65,391	0	0	0	22,723	0	659,838	0	979,445	170,532
31	238,438	67,352	0	0	0	23,405	0	0	0	329,195	54,072
32	245,591	69,373	0	0	0	24,107	0	0	0	339,071	52,542
33	252,959	71,454	0	0	0	24,830	0	0	0	349,243	51,055
34	260,547	73,598	0	0	0	25,575	0	0	0	359,720	49,610
35	268,364	75,806	0	0	0	26,342	0	0	0	370,512	48,206
36	276,415	78,080	0	0	0	27,133	0	0	0	381,627	46,841
37	284,707	80,422	0	0	0	27,947	0	0	0	393,076	45,516
38	293,248	82,835	0	0	0	28,785	0	0	0	404,868	44,227
39	302,046	85,320	0	0	0	29,649	0	0	0	417,014	42,976
40	311,107	87,880	0	0	0	30,538	0	1,425,162	0	1,854,687	180,317
41	320,440	90,516	0	0	0	31,454	0	0	0	442,411	40,578
42	330,054	93,231	0	0	0	32,398	0	0	0	455,683	39,429
43	339,955	96,028	0	0	0	33,370	0	0	0	469,353	38,313
44	350,154	98,909	0	0	0	34,371	0	0	0	483,434	37,229
45	360,658	101,876	0	0	0	35,402	0	1,028,006	0	1,525,943	110,860
46	371,478	104,933	0	0	0	36,464	0	0	0	512,875	35,151
47	382,623	108,081	0	0	0	37,558	0	0	0	528,261	34,157
48	394,101	111,323	0	0	0	38,685	0	0	0	544,109	33,190

YEARLY CASH FLOW

By AES

49	405,924	114,663	0	0	0	39,845	0	0	0	560,432	32,251
50	418,102	118,103	0	0	0	41,041	0	0	0	577,245	31,338

Alternative: 4
Life Cycle Cost: \$ 8,900,700.57

Year	Utility Cost (\$)	Maint. Cost (\$)	Interest Cost (\$)	Principal Cost (\$)	Property Taxes (\$)	Insurance Cost (\$)	Revenue Penalty (\$)	Replace. Expenses (\$)	Deprec. Tax (\$)	Cash Flow Effect (\$)	Present Value (\$)
0	0	0	0	911,750	0	0	0	0	0	911,750	911,750
1	88,929	34,685	218,820	156,685	0	9,118	0	0	0	508,237	479,469
2	91,597	35,726	209,419	166,087	0	9,391	0	0	0	512,219	455,873
3	94,345	36,798	199,454	176,052	0	9,673	0	0	0	516,321	433,513
4	97,175	37,902	188,891	186,615	0	9,963	0	0	0	520,545	412,321
5	100,090	39,039	177,694	197,812	0	10,262	0	0	0	524,896	392,233
6	103,093	40,210	165,825	209,680	0	10,570	0	0	0	529,378	373,191
7	106,186	41,416	153,244	222,261	0	10,887	0	0	0	533,994	355,137
8	109,371	42,659	139,908	235,597	0	11,213	0	0	0	538,749	338,018
9	112,653	43,938	125,773	249,733	0	11,550	0	0	0	543,646	321,783
10	116,032	45,257	110,789	264,717	0	11,896	0	0	0	548,690	306,386
11	119,513	46,614	94,906	280,600	0	12,253	0	0	0	553,886	291,780
12	123,098	48,013	78,070	297,436	0	12,621	0	0	0	559,237	277,924
13	126,791	49,453	60,224	315,282	0	12,999	0	0	0	564,749	264,777
14	130,595	50,937	41,307	334,199	0	13,389	0	0	0	570,427	252,300
15	134,513	52,465	21,255	354,251	0	13,791	0	423,525	0	999,799	417,182
16	138,548	54,039	0	0	0	14,205	0	0	0	206,792	81,403
17	142,705	55,660	0	0	0	14,631	0	0	0	212,996	79,099
18	146,986	57,330	0	0	0	15,070	0	0	0	219,385	76,860
19	151,396	59,049	0	0	0	15,522	0	0	0	225,967	74,685
20	155,937	60,821	0	0	0	15,988	0	789,078	0	1,021,824	318,610
21	160,616	62,646	0	0	0	16,467	0	0	0	239,728	70,517
22	165,434	64,525	0	0	0	16,961	0	0	0	246,920	68,522
23	170,397	66,461	0	0	0	17,470	0	0	0	254,328	66,582
24	175,509	68,455	0	0	0	17,994	0	592,076	0	854,034	210,928
25	180,774	70,508	0	0	0	18,534	0	0	0	269,816	62,867
26	186,197	72,623	0	0	0	19,090	0	0	0	277,911	61,088
27	191,783	74,802	0	0	0	19,663	0	0	0	286,248	59,359
28	197,537	77,046	0	0	0	20,253	0	0	0	294,836	57,679
29	203,463	79,358	0	0	0	20,860	0	0	0	303,681	56,046
30	209,567	81,738	0	0	0	21,486	0	659,838	0	972,629	169,345
31	215,854	84,190	0	0	0	22,131	0	0	0	322,175	52,919
32	222,329	86,716	0	0	0	22,794	0	0	0	331,840	51,421
33	228,999	89,318	0	0	0	23,478	0	0	0	341,795	49,966
34	235,869	91,997	0	0	0	24,183	0	0	0	352,049	48,552
35	242,945	94,757	0	0	0	24,908	0	0	0	362,611	47,178
36	250,234	97,600	0	0	0	25,655	0	0	0	373,489	45,842
37	257,741	100,528	0	0	0	26,425	0	0	0	384,694	44,545
38	265,473	103,544	0	0	0	27,218	0	0	0	396,234	43,284
39	273,437	106,650	0	0	0	28,034	0	0	0	408,121	42,059
40	281,640	109,849	0	0	0	28,875	0	1,425,162	0	1,845,527	179,427
41	290,090	113,145	0	0	0	29,742	0	0	0	432,976	39,712
42	298,792	116,539	0	0	0	30,634	0	0	0	445,965	38,588
43	307,756	120,035	0	0	0	31,553	0	0	0	459,344	37,496
44	316,989	123,636	0	0	0	32,499	0	0	0	473,125	36,435
45	326,498	127,346	0	0	0	33,474	0	1,028,006	0	1,515,325	110,089
46	336,293	131,166	0	0	0	34,479	0	0	0	501,938	34,402
47	346,382	135,101	0	0	0	35,513	0	0	0	516,996	33,428

YEARLY CASH FLOW

By AES

48	356,774	139,154	0	0	0	36,578	0	1,203,568	0	1,736,074	105,898
49	367,477	143,329	0	0	0	37,676	0	0	0	548,481	31,563
50	378,501	147,628	0	0	0	38,806	0	0	0	564,936	30,670

Economic Summary

Project Information

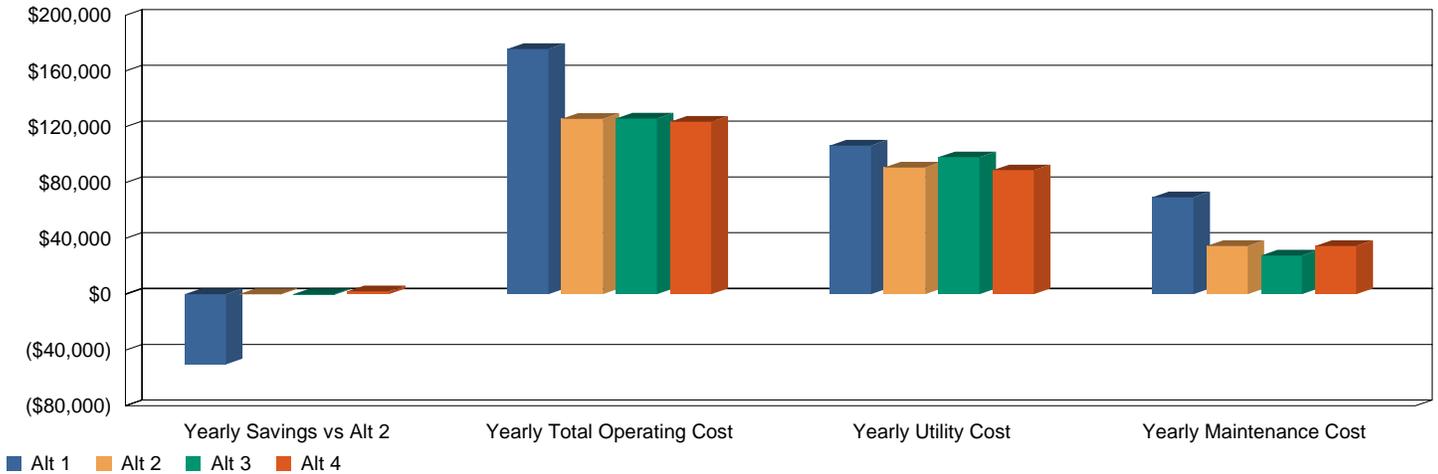
Location: Arlington, NE
 Project Name: APS - K-12 Facility Study
 User:
 Company:
 Comments:

Study Life: 50 years
 Cost of Capital: 6 %
 Alternative 1: APS - K-12 Facility Study
 Alternative 2: AC VRF with DX Gas DOAS

Economic Comparison of Alternatives

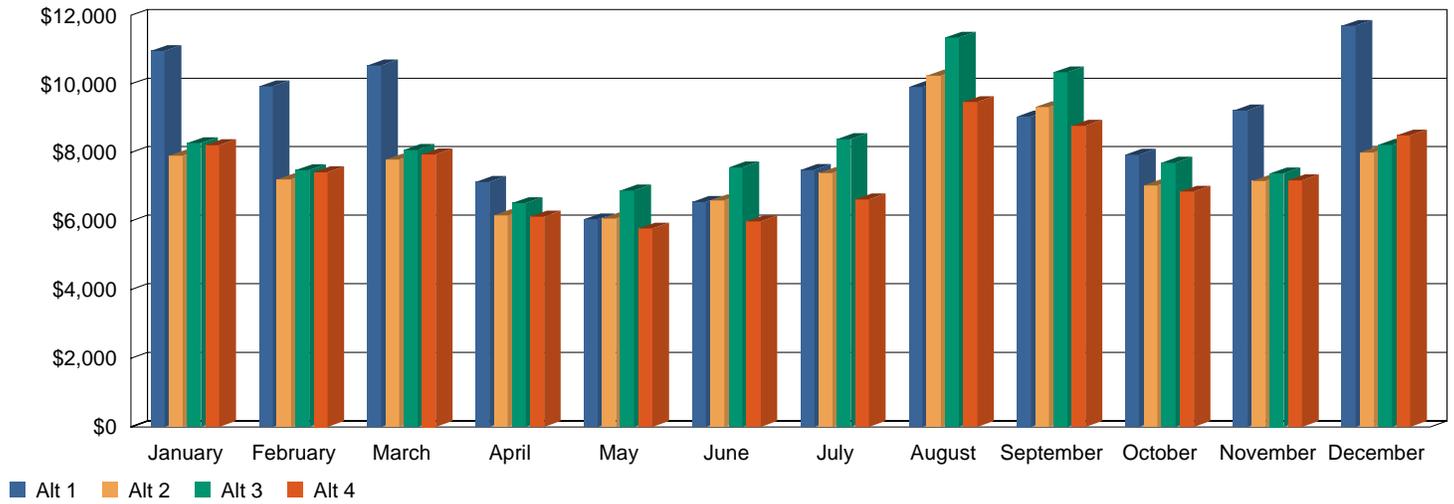
	Yearly Savings (\$)	First Cost Difference (\$)	Cumulative Cash Flow Difference (\$)	Simple Payback (yrs.)	Net Present Value (\$)	Life Cycle Payback (yrs.)	Internal Rate of Return (%)	Life Cycle Cost
Alt 2 vs Alt 1	50,243	1,522,500	10,518,020	30.3	670,381	29.1	8.6	670,381.10
Alt 3 vs Alt 1	49,887	3,008,750	8,008,995	60.3	-900,412	No Payback	4.1	-900,411.60
Alt 4 vs Alt 1	52,254	2,746,250	6,916,414	52.6	-784,095	No Payback	4.1	-784,095.30
Alt 3 vs Alt 2	-356	1,486,250	-2,509,023	No Payback	-1,570,793	No Payback	Does Not Payback	-1,570,793.00
Alt 4 vs Alt 2	2,011	1,223,750	-3,601,604	608.4	-1,454,476	No Payback	Does Not Payback	-1,454,476.00
Alt 3 vs Alt 4	-2,367	262,500	1,092,581	No Payback	-116,316	No Payback	4.1	-116,316.30

Annual Operating Costs



	Yearly Savings vs Alt 2	Yearly Total Operating Cost (\$)	Yearly Utility Cost (\$)	Yearly Maintenance Cost (\$)	Plant kWh/ton-hr
Alt 1	-50,243	175,869	106,498	69,371	2.163
Alt 2	0	125,626	90,940	34,685	0.370
Alt 3	-356	125,982	98,233	27,748	0.956
Alt 4	2,011	123,614	88,929	34,685	0.138

Monthly Utility Costs



MONTHLY ENERGY CONSUMPTION

By AES

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 1 APS - K-12 Facility Study													
Electric													
On-Pk Cons. (kWh)	104,280	93,757	108,850	102,062	84,023	90,553	103,548	142,075	123,638	113,735	100,928	97,684	1,265,134
On-Pk Demand (kW)	352	351	354	374	284	375	434	526	487	404	363	351	526
Gas													
On-Pk Cons. (therms)	7,533	6,606	6,669	2,020	625	211	192	275	615	2,326	5,141	8,926	41,141
On-Pk Demand (therms/hr)	36	37	37	23	4	1	1	2	4	20	31	31	37

Energy Consumption

Building	60,775 Btu/(ft2-year)
Source	124,589 Btu/(ft2-year)

Environmental Impact Analysis

CO2	1,806,497 lbm/year
SO2	5,308 gm/year
NOX	3,192 gm/year

Floor Area 138,741 ft2

MONTHLY ENERGY CONSUMPTION

By AES

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 2 AC VRF with DX Gas DOAS													
Electric													
On-Pk Cons. (kWh)	115,798	101,687	114,546	99,397	77,234	85,293	94,275	143,151	122,782	110,706	98,768	116,540	1,280,176
On-Pk Demand (kW)	542	528	529	385	351	431	501	578	547	460	539	550	578
Gas													
On-Pk Cons. (therms)	1,137	989	1,140	693	625	215	208	283	616	786	990	1,181	8,865
On-Pk Demand (therms/hr)	7	7	7	5	4	1	1	2	4	6	7	9	9

Energy Consumption

Building 37,881 Btu/(ft2-year)
 Source 101,211 Btu/(ft2-year)

Environmental Impact Analysis

CO2 1,827,976 lbm/year
 SO2 5,371 gm/year
 NOX 3,230 gm/year

Floor Area 138,741 ft2

MONTHLY ENERGY CONSUMPTION

By AES

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 3													
Electric													
On-Pk Cons. (kWh)	118,075	103,931	117,868	105,917	89,904	100,486	111,318	161,418	138,828	123,314	104,298	118,309	1,393,666
On-Pk Demand (kW)	543	529	530	407	388	474	531	619	592	498	544	551	619
Gas													
On-Pk Cons. (therms)	1,542	1,261	1,364	693	625	215	208	283	616	786	990	1,391	9,976
On-Pk Demand (therms/hr)	20	20	20	6	4	1	1	2	4	6	7	20	20
Water													
Cons. (1000gal)	0	0	0	7	50	69	94	113	91	46	15	0	485

Energy Consumption

Building 41,474 Btu/(ft2-year)
 Source 110,430 Btu/(ft2-year)

Floor Area 138,741 ft2

Environmental Impact Analysis

CO2 1,990,030 lbm/year
 SO2 5,848 gm/year
 NOX 3,516 gm/year

MONTHLY ENERGY CONSUMPTION

By AES

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 4													
Electric													
On-Pk Cons. (kWh)	114,413	100,732	114,230	98,980	75,202	81,044	87,829	135,291	117,644	109,204	98,510	114,689	1,247,769
On-Pk Demand (kW)	528	515	516	379	315	355	414	503	491	435	526	537	537
Gas													
On-Pk Cons. (therms)	1,758	1,447	1,481	701	625	215	208	283	616	786	1,131	2,084	11,335
On-Pk Demand (therms/hr)	20	19	19	7	4	1	1	2	4	6	18	19	20
Water													
Cons. (1000gal)	3	2	2	21	38	54	76	92	74	35	12	1	410

Energy Consumption

Building 38,865 Btu/(ft2-year)
 Source 100,693 Btu/(ft2-year)

Floor Area 138,741 ft2

Environmental Impact Analysis

CO2 1,781,702 lbm/year
 SO2 5,236 gm/year
 NOX 3,148 gm/year