DRUMMOND AREA SCHOOL DISTRICT

SCHOOL ENERGY AND DEMAND REDUCTION OPPORTUNITY ASSESSMENT

JULY 25, 2019

Mr. Robert Drevlow

FACILTIY: Drummond Area K-12 School

LOCATION: Drummond WI.

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Disclaimers

PURPOSE

Identify power and energy reductions that can reduce the school's utility bill and provide the basis for qualifying for a state sponsored" Energy Innovation Grant" that combines incentives for implementation of renewable energy sources with reductions in existing electricity use through improved equipment and operation.

PROCESS

A team representing the grant program consisting of Bill Bailey, Niels Wolter and myself met with Chris Vaillancourt, school facilities manager, toured the facility and discussed facility operations and observed existing spaces, equipment and significant energy using equipment and applications.

Bill Bailey provided general background of the solar component and background for the grant application, Niels Wolter explored and discussed potential mounting and interface opportunities for the solar application. I observed and commented on various energy application and energy reduction opportunities. Chris Vaillancourt provided information about the current facility conditions and current equipment and controls.

I reviewed the information acquired from the on-site assessment, made a preliminary assessment of items of interest and followed this with an additional meeting with Chris Vaillancourt to assess his and the perceived school district interests and limitations and to secure additional information needed to create useful decision-making models.

I prepared Xcel worksheet models to evaluate the energy and demand reduction potential, make recommendation for implementation and rudimentary simple payback period estimates.

Chris Vaillancourt provided a multiyear utility bill summary showing monthly and annual energy use, demand components and expenses. He also provided a total lamp count for several major areas in the school, as well as other valuable information relative to equipment and operating practices.

APPLICATIONS REVIEWED

Opportunities for power and energy reductions in the following areas were explored.

1. Lighting
2. Heating system circulation pumps
3. Air handlers
4. Univents

It is noted that only electric energy reduction opportunities were reviewed but that significant fuel reduction opportunities also exist.

It is also noted that air conditioning equipment electricity reduction opportunities have not been evaluated at this time.

GENERAL INFORMATION

The facility is a K-12 school building constructed over many years with the most recent construction occurring in 1986, 1992 and 2000.

The facility's total area is approximately 100,000 square feet, is totally utilized and include 2 gyms, a large commons/cafeteria. Classrooms, mechanical skills workshop area, food service area and equipment rooms, administration offices and board room areas and various storage and mechanical equipment areas.

The facility is light and airy in most areas. The facility does not appear overcrowded, and appears well maintained.

The annual electric energy expense for the facility was $47,343 for a 12-month period in 2018-2019 and the maximum peak monthly billing demand was 175kw. The annual energy consumption was 442,000 kwh. for the same period. The minimum monthly demand was 86 kW occurring in the summer, non-school session, period. The effective annual rate for all electric energy used is $0.107 per kWh. The facility is served by Xcel Energy on a time of use rate structure.

The boiler and circulation pump systems are high performance and were very recently replaced.

The lighting system is T-8 lamp based throughout. The existing lamps and ballasts are reported to have been installed in 2010 but the troffers appear to date to the building's original construction dates.

Control systems are limited. Direct Digital Control (DDC), i.e., Metasys control, is provided for the 2000 construction only and currently does not provide visual access to control graphics or control due to a software issue. This limitation is expected to be resolved by June 30, 2019. The older parts of the facility are served by pneumatic controlled air handlers and independently controlled univents.

Food service exhaust fans exist but are reported to be used minimally.

Computer and information technology exist but was not reviewed.

Exterior lighting was not reviewed.

SUMMARY OF ASESSMENTS

1. Lighting

Lighting is the facility's largest installed energy use application and therefore presents a significant energy and demand reduction opportunity if appropriate cost-effective measures can be identified and implemented.

Light energy reduction can be achieved in several ways.

- Light level reductions, including: delamping, low watt lamp and ballast replacement, and control
- Light hour use reductions
- More efficient lighting equipment, including lamp replacement and fixture replacement
- Combinations of the above

Light Level Reductions

It was noted in touring the facility that lighting levels (lumen values) varied significantly across the facility. Lighting levels appeared to vary for apparently similar applications at different locations in the school. This suggests that some of the areas are "over lit" and a reduction in light levels could be implemented to reduce energy, demand and expenses.

It was also observed that several instructors had taken steps to reduce the lighting levels in their classrooms by applying films over the lighting troffers to reduce the light levels to what they considered a more appropriate level.

It was also noted that various gym lighting levels were available through switching but hardly ever used by the staff. This suggests that light level reductions are desired and being achieved but the school is not gaining any corresponding reduction in energy use or cost.

It is also noted that current instructional processes utilize personal computer screens and smartboards more and pages and paper less. Higher lighting levels result in higher glare levels for personal screen use and less contrast for smart boards and other front screen applications. Light level reductions may result in light levels more compatible for current instructional methods.

The T-8 troffers used throughout the classrooms, halls and large space areas are all lensed troffers. The current troffers observed appear to be troffers from the original construction dates but have been upgraded to T-8 lamps and electronic ballasts reported to be 2010.

Lighting control is limited to manual wall switching. Two switches exist in many classrooms and can switch 2 independent circuits but it does not appear that these are being applied in any consistent way to reduce energy and demand. it is also not known how the circuits allocate the light in the classrooms.

Light level reductions should be based on an evaluation of current and proposed light level requirements for the activity and or instruction occurring in the lighting zone. The overall aesthetic impact of the light levels and the desires of the primary occupants of the space also need to be considered. The probability of the space light level requirements changing over time due to activity, instructional or personnel changes also needs to be considered.

The primary tool in this process is a "light meter ", which measures the lumen /lux values at any point the light meter is held. This measures the input of all light sources. Thus, the impact of a reduction of a single light source may only result in a fractional reduction of the light total light level.

Light level recommendations are available from many sources including Focus on Energy, lighting providers, engineers etc. The final decision however needs to be made by the school administration based on their needs and desired final out comes.

There are several means of reducing light levels:

Delamping

Delamping is a low cost but effective means of reducing light output from a troffer or fixture to reduce power and energy requirements. Light power reduction by removing a lamp from a fixture will be generally proportional but somewhat less than the number of lamps removed to the total lamps in the troffer. E.g., removing 1 lamp from a 4-lamp troffer may result in a 20 % power and lighting reduction.

Removing a lamp from a fixture reduces the heat generated in the troffer and marginally increases lamp life of the remaining lamps thereby reducing the cooling load for the space and allowing the heating load to be supplied by a lower cost heat source.

Delamping results in a change in the appearance of the troffer lens itself. The light intensity will be reduced in the area the lamps were removed.

Lamp and troffers experience light depreciation with age i.e. light levels gradually decay. Lamp replacement of the remaining lamps and thorough cleaning of the troffer and lens will offset much of the light output reduction caused by the lamp removal.

Low Watt Lamp and Ballast Replacements

Reductions in power input and light output of a troffer can also be achieved by replacing the current lamps and or ballasts with available lower power and output replacements. 25-watt 4 ft florescent tubes are available to replacement existing 32- or 40-watt tubes. Low ballast factor ballasts are also available which cause a power and light reduction from the lamps served.

Although these opportunities exist for any area where light level reductions are considered appropriate, this measure has in general been superseded by conversion to L.E.D. lamps and or fixtures.

Controls

The time-honored method for light reduction has been and remains "turning some of the light sources off". The historic manual methods of achieving this, however, have proven ineffective in many applications due to a lack of motivation, understanding or discipline of the appropriate "switch person".

Dimming is an effective light and power reduction technique but not easily implemented or cost effectively applied to T-8 florescent lamps (the current lighting system in this facility). Dimming is however readily accomplished with many of the current L.E.D. (light emitting diode) lamps and troffers. Dimming can be implemented based on instructional needs, schedules, or total light levels in the space (e.g., responding to varying levels of window-sourced daylight).

Partial lamp shutdown techniques are available but relatively expensive to implement and require multiple circuits and switching or controls, which, as previously indicated, do not currently exist for the entire facility.

In general dimming is preferable to partial lamp switching as a light level reduction technique.

Light Hour Reductions

Light energy and expense are directly related to the operating time of the lamps. Occupancy controls can turn off lights in areas where no occupant need for light exists. Photo sensor controls allow entry ways, foyers and other areas experiencing significant daylight introduction through windows or skylights to turn off the interior lights at desired total light levels. Electronic time clocks or DDC system control can provide effective precise lighting applications and curtail light use when not required.

More Efficient Lighting Equipment

Recent technological improvements and manufacturing efficiencies have made L.E.D. lighting products cost effective upgrade opportunities for T-8 troffers. L.E.D. products have been used for many years for specialty applications including exit lighting, traffic lighting and signage.

More recently, however, the range of cost-effective applications for L.E.D. lighting products has expanded to include the general lighting applications for common school facility applications. The efficiency of the L.E.D. technology can be applied in several ways and provide some alternatives for reducing light power and energy.

Lamp Replacement

The current 4 ft T-8 lamps provide light output initially at approx. 90 lumens per watt. Over time this deteriorates by 20% to 30%. 4 ft. L.E.D. tubes are currently available that provide up to 2200 lumens at approximately 125 lumens per watt.

The light output of the L.E.D. tubes depreciates very little over the life of the tube and the tube life expectancy is much longer than a florescent lamp. This means that the light level remains more constant over the life of the lamp and less excess has to be applied initially to assure appropriate light levels at the end of lamp life.   Thus, a lower initial light level can be applied which reduces power and energy for the entire lamp life.

The maximum light output from the 4 ft. L.E.D. tubes however is less than the initial output of approximately 2900 lumens from a new T-8 lamp and represents a significant reduction depending on the existing and proposed equipment and needs to be considered in the application.

Where the reduced light level is acceptable, this measure results in significant energy and power reductions and typically can be installed by in house staff.

The reduced power input to the L.E.D lamp also reduces the heat generated in the troffer which results in reduced cooling load for the space and reduced heating energy cost.

The L.E.D. lamps are available as dimmable units if controls are applied. The L.E.D. tubes are available in "bypass units" which allow removal of the existing ballast if desired or" direct connect" which retain the existing ballast.

Fixture Replacement

It has been noted that the majority of the facility lighting is lensed troffers. Lensed troffers of the era of the existing lighting had efficiencies of approx. 70% this means that approximately 30 % of the light generated by the lamps doesn't make it out of the troffer. This light loss also increases with time due to dirt accumulation and deterioration of the lens material.

Current troffer design without lenses achieve higher efficiencies by design. Use of lamps in the existing troffers means that light is equally radiated from all portions of the circular tube and a reflector is required to redirect the light radiated from the upper portions of the tube down into the lighting zone. This results in light loss and eventual light level depreciation.   The L.E.D. tubes are directional and don't require reflectors to place the light output into the desired area. This allows a more efficient application than T-8 lamp type application. Reflectors are still provided however in many efficient fixtures to provide indirect lighting to reduce glare.

Fixture selection needs to consider the application. The L.E.D. fixtures are also dimmable and controllable but require additional sensors and or controls.

Combination of the Above

It should seem obvious that the maximum demand and energy reduction potential would lie in a careful light reduction effort followed by or incorporated with implementation of more efficient and effective lighting apparatus responding to effective control mechanisms.

To that end the L.E.D. fixture applications with associated controls and applied to the considered appropriate light levels represents the maximum reduction opportunity consistent with adequate, appropriate and aesthetic light application.

Lighting Evaluation

In consideration of the previous discussion I prepared excel worksheets modeling the estimated impact of several of the scenarios described. The models represent the energy, demand and expense reductions likely to occur based on the lamps estimated operating hours, number of lamps, utility rates and estimated implementation expenses. All of the variables are available for revision by the facility management and the revised work sheets will show the impact of the revision. The number of lamps involved in all models is based on the current total lamps by area as provided by Chris Vaillancourt.

The following lighting models were developed:

Delamping: Removing lamps from areas that have higher than required or desired lighting levels throughout the facility. The major delamping is anticipated to occur in classrooms where shading is currently applied, hallways where activity-based lighting requirements are low and the elementary gym. Effective delamping requires that a light level assessment be made prior to delamping. The only significant expense beyond in-house labor is lamp disposal for lamps physically removed from the troffers. Note: it is not necessary to remove either lamps from the troffers but is recommended.

Lamp replacement: Replacing current 32-watt t-8 lamps with L.E.D. tubes which fit easily into the existing troffers. Although this is expected to provide adequate and appropriate light levels throughout the premise in most applications, there may be some areas where the lighting targets are not met by the currently available L.E.D tubes and replacements will not be possible. The number of potential replacements will hinge on the light study. Thorough reflector and lens cleaning is recommended at this time.

Fixture replacement: Replacing existing troffers with high performance, dimmable L.E.D sourced indirect unlensed troffers. Again it is presumed that not all applications will allow simple replacement. Some applications may require higher output or additional troffers to achieve the lighting goals.

2. Heating System Circulation Pumps

The heating system hot water from the boilers is circulated throughout the facility by 2 ABB variable speed drive-controlled pumps. The pumps appear to be controlled by a differential pressure control at the system supply and return headers adjacent to the pumps. The pumps appear to be operating in a sequential scenario. As observed, the lead pump was running at a much higher speed than the secondary pump. I believe that the pumps were designed to provide redundant service which provides continuing operation upon failure of one of the pumps. This scenario however provides twice the design capacity required even during peak load periods.

The current operating scenario is expected to provide the pressure needed to supply any of the radiation devises on the system with adequate flow to achieve the rated heat output with essentially all of the radiation devises calling for rated heat output.

This control scenario provides more pressure and uses more power than required for most if not all of the operating hours due to the fact that the design loads typically are greater than any realized heating loads. A more effective control strategy would provide only the pressure required for the heating loads currently being experienced. There are several control options to consider. A frequently used option is to monitor and control the pressure required at the most remote radiation devise on the system. The laws of physics relating to pump operations (pump laws) indicate that operating 2 pumps in parallel results in lower total power requirements and less energy than a sequential operation as is currently in use. This scenario will be effective for the upper operating range of operations. An investigation is required to determine at which speed point the parallel operation should begin. At the lower load range, single pump operation at low speed will result in the lowest total power use

Additional pump power and reductions are available by adding an "unoccupied mode set back" control, and "warm weather shutdown "controls for both occupied and unoccupied mode operations. The "unoccupied mode setback" control recognizes that less pressure and flow are required for the reduced unoccupied period loads during, nights, weekends and holidays, and reduces the pressure setpoint and thereby the power and energy used.

The "warm weather shut down" control recognizes that at some temperature conditions, heating is no longer needed in the facility and shuts the pumps off. This control reduces the pumping requirements but also eliminates the flow of heated water throughout the system which provides inadvertent, and undesirable, heating of the facility. The Boiler system includes an option for warm weather shut down but is not currently operational. Boiler and pump system controls need to be coordinated but both can be effectively utilized.

Although providing the enhanced pump system controls may be accomplished independently at the VFD control. Providing the enhanced controls through the DDC control system will allow remote monitoring and a wider range of control operations and integrations with other operating systems. An Excel model was prepared for this opportunity.

3. Air Handlers

The largest air handler in the facility serves the auditorium. It is equipped with a cooling system.

The unit is reported to operate in a temperature maintenance mode for most of the year.   The auditorium space is sparsely occupied for all school session days and only sees occupancy levels requiring full capacity operation during performances. It also has a summer operating requirement that includes cooling but again the space has low occupancy levels except for performance periods. These conditions are in many respects, similar to gym operations and can be effectively served by a "large space" control configuration that utilizes variable speed fan control to reduce fan power and energy for the low occupancy time periods while maintaining set point temp and adequate ventilation. The system can be operated as a single zone variable flow application. Continuous operation at low speeds or at variable but low speeds requires less energy than intermittent operation, eliminates the whine and associated strain on belts and bearings associated with startups and operates at a much lower and less objectionable noise level than full speed intermittent operation. The low speed continuous operation also allows more effective operation of the associated cooling system. This unit is currently controlled by the DDC system and would allow the addition of additional control features at minimum expense. An Excel model was prepared to analyze this opportunity.

4 small air handlers exist in the facility. They service several areas in the facility and are controlled by a Metasys pneumatic control system.

These units are not variable speed control. The units serve music rooms and a gym which are both characterized as "large spaces" having predominantly low occupancies with intermittent periods of higher occupancies. These air handlers will respond to variable speed operation and reduced power and energy use when equipped with variable speed drives and DDC control. An excel model was prepared for this opportunity.

4. Univents

Many of the classrooms have the heating, ventilation and air circulation needs served by Trane Univents.

These units are reported to have variable speed motors and originally were able to modulate fan speed in response to heat requirements. Over time a significant share of these units have lost modulating capacity and operate as on or off units only. Their continuous modulating speed operations will use less power and energy than intermittent full speed operation.

It is noted, that the current intermittent operation of the failing units does not meet the state code and ASHRAE recommendations for continuous ventilation in classroom spaces.

Although power and energy reductions are anticipated, with the restoration of the variable speed operating capability of all of the classroom units, restorating the continuous ventilation capability appears to be the more compelling motivation for implementing variable speed operation restoration to these units. An Excel model of this opportunity was prepared.

Results

Table 1. Summary of the Energy Efficiency Opportunities to Reduce Energy Costs at the Drummond School. Note that payback periods do not include available incentives (such as from Focus on Energy).

	Energy Savings (kWh)	Energy Savings ($)	Demand Reduction (kW)	Monthly Demand Savings ($)	Distribution Demand Savings ($)	Annual Bill Savings ($)	Cost of Measure ($)	Payback Period (Years)
Lighting Options								
1. Delamping	38,468	$ 2,654	16	$ 1,925	$ 231	$ 4,810	$ 269	0.06
2. LED Relamping	64,895	$ 4,475	29	$ 3,332	$ 332	$ 8,139	$ 16,944	2.1
3. Troffer Replacement	94,282	$ 6,420	39	$ 4,572	$ 531	$ 11,523	$ 61,596	5.4
Other Measures								
Auditorium Overhead Can LEDs	2,906	$ 191	3	$ 76	$ 4	$ 273	$ 600	2.2
Auditorium Side Mount Flood LED Lamps	3,563	$ 235	2.4	$ 78	$ 4.00	$ 317	$ 75	0.24
Hot Water Ciculation Pump Controls	28,846	$ 2,012	4	$ 552	$ 89	$ 2,653	$ 5,000	1.9
Auditorium Air Handler	17,611	$ 1,189	7.5	223	45	$ 1,467	$ 7,000	4.8
Four Small Air Handler VFDS Control	4,197	$ 277	3	$ 155	$ 20	$ 452	$ 6,000	13
Maximum Opportunity	151,405	$ 10,324	59			$ 16,685	$ 80,271	5
Includes the Troffer Replacement								
Annual Energy, Demand and Bill Savings	34%		34%			35%		
Based on 2018-2019 Billing								

All of the lighting opportunities modeled and evaluated appear to be effective in reducing power and energy and result in simple payback periods well within the life expectancy of the application. The troffer replacement option provides the most power and energy reduction opportunity but does not yield as early a payback as the other options given that extended equipment life and improved lighting environments are not considered.

The small air handler VFD and control measure does not appear to be available without an expansion of the DDC controls to include these units. The addition of the DDC control upgrade to this measure results in a very long payback period.

All of the additional opportunities evaluated also appear to be effective in reducing power and energy use in the facility and simple paybacks are within the life of the application with the exception of the Uninvent repair. However, as previously noted power and energy reduction should not be the primary motivation for implementing this opportunity.

The simple payback assessments do not recognize the value of extended system life or improved instructional environments. They do however provide a key element for more sophisticated evaluations which include unique school administrative inputs and perspectives.

The estimated power and energy reduction values of each measure modeled as well as the totals and associated paybacks are shown on a summary worksheet. The individual opportunity worksheets are also available for revision and confirmation of input parameters and applications. It is noted that all cost information is based on estimates only and no "proposals" for any opportunity implementation were collected.

RECOMMENDATIONS

- Recommended - Lighting Study: To achieve the maximum electric power and energy reduction possible, a lighting study is recommended to determine the desired but minimum acceptable light levels for all areas served by T-8 troffers followed by installation of high performance, indirect L.E.D. troffers with dimming control and associated controls appropriate for the application wherever possible.
- Recommended - DDC Control Hot Water System: Implementation of DDC control for the hot water heating circulation pumps with application of parallel pump control, load reset warm weather shutdown and occupied, and unoccupied setback is recommended.
- Recommended - DDC Control Auditorium: Installation of a variable speed drive and control for the auditorium and with DDC control application as a single zone variable air volume application.
- Recommended: Upgrading Pneumatic System Control for the 4 Small Air Handlers: Consider upgrading the pneumatic system control for the 4 small air handlers with the implementation of VFDs and associated large space management controls upon completion of the DDC improvements.
- Install a datalogger, like an eGauge, to monitor moment-by-moment electrical consumption. A basic unit would cost $700-$800 and a more detailed logger would add about $35/current transformer. This data would be useful for future energy efficiency analysis and could be coupled with solar generation analysis. They are easily ordered online and installed by any electrician.

Annex 1. Delamping and Conversion of t-8 lamps to LED, Data, Assumptions and Analysis.

SCHOOL LIGHTING ASSESSMENT			R.A.DREVLOW
OPTION A		DELAMPING	
	REMOVE ONE OR MORE T-8 4 FT LAMPS FROM EACH ELECTRONICALLY BALLASTED		
	2X2 TROFFER WHERE THE REDUCED LIGHT LEVEL IS DEEMED DESIREABLE OR ADEQUATE AND APPROPRIATE		
	FOR INSTRUCTIONAL, ACTIVITY AND AESTHETIC REQUIREMENTS.		
BENEFIT	A	POWER DEMAND AND ENERGY COST REDUCTION	
	B	ACHIEVE DESIRED LIGHT LEVELS CURRENTLY ACHIEVED BY SHADING OF TROFFERS	
	C	TRANSFER ASSOCIATED HEATING TO A LOWER COST FUEL	
	D	REDUCE COOLING LOAD WHEN COOLING IS DESIRED	
	E	ZERO INVESTMENT EXPENSE IF DONE IN BY IN HOUSE STAFF	
	F	MARGINALLY IMPROVES LUMINAIRE EFFICIENCY	
	G	PROCESS CAN BE REVERSED AT NO EXPENSE IF APPLICATIONS CHANGE	
		OR LIGHTING TARGET CHANGES	
DOWN SIDES			
	A	LESS POWER AND DEMAND REDUCTION POTENTIAL THAN	
		OTHER OPTIONS	
	B	REDUCTION IN UNIFORM LIGHT DISTRIBUTION FROM TROFFERS	
	C.	NOT COMPATIBLE WITH DIMMING OPTIONS	

SCHOOL WIDE LAMP TOTAL						
AREA	ELEMENTARY	LIBRARY CAFETERIA HALLWAYS ETC	MUSIC TECH MIDDLE SCH HALLWAYS	UPSTAIRS	H.S. GYM	TOTAL
LAMPS	597	959	844	634	146	**3180**
DELAMP POTENTIAL	20%	25%	10%	15%	0%	**17%**
LAMPS	119	240	84	95	0	**539**
LAMP WATTAGE	30	30	30	30	30	
TOTAL KW REDUCTION	3.6	7.2	2.5	2.9	0.0	16.2
AVE MO FACILITY DEMAND	135.0	135.0	135.0	135.0	135.0	135.0
% REDUCTION	3%	5%	2%	2%	0%	12%
EST. AVE ANNUAL	2200	2500	2500	2200	3000	
OPERATING HOURS						
ESTIMATED ANNUAL	7880.4	17981.25	6330	6276.6	0	38468.25
KWH REDUCTION						
TOTAL FACILITY KWH USE	450000	450000	450000	450000	450000	450000
REDUCTION %	1.8%	4.0%	1.4%	1.4%	0.0%	8.5%
CURRENT ON PEAK	$ 0.075	$ 0.075	$ 0.075	$ 0.075	$ 0.075	
KWH RATE						
CURRENT OFF PEAK	$ 0.045	$ 0.045	$ 0.045	$ 0.045	$ 0.045	
KWH RATE						
EST ON PEAK USE	0.8	0.8	0.8	0.8	0.8	
EFFECTIVE RATE	$ 0.07	$ 0.07	$ 0.07	$ 0.07	$ 0.07	
EST.ANNUAL ENERGY	$ 543.75	$ 1,240.71	$436.77	$433.09	$ -	$ 2,654.31
COST REDUCTION						
CURRENT MO DEMAND	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	
RATE ,PER KWPER MO						
EST AVE DEMAND	0.9	0.9	0.9	0.9	0.9	
COINCIDENCE FACTOR						
EST ANNUAL DEMAND	$ 428	$ 855	$ 297	$ 345	$ -	$ 1,925
CHARGE REDUCTION						
DIST DEMAND	0.95	0.95	0.95	0.95	0.95	
COINCIDENCE						
CURRENT DIST DEMAND	1.25	1.25	1.25	1.25	1.25	
RATE (PER KWPER MO)						
EST ANNUAL DIST	$ 51	$ 103	$ 36	$ 41	$ -	**$ 231**
DEMAND CHARGE REDUCTION						
EST TOTAL POWER AND	$ 1,023	$ 2,199	$ 769	$ 819	$ -	**$ 4,810**
ENERGY EXPENSE REDUCTION						
EST LAMP DISPOSAL	$ 0.50	$ 0.50	$ 0.50	$ 0.50	$ 0.50	
EXPENSE PER LAMP						
EST TOTAL DISP[OSAL	$ 59.50	$ 120.00	$ 42.00	$ 47.50	$ -	$ 269.00
EXPENSE						
EST SIMPLE PAYBACK	0.06	0.05	0.05	0.06	#DIV/0!	0.06
OF EXPENSE						

Annex 2. LED Relamping Data, Assumptions and Analysis.

SCHOOL LIGHTING ASSESSMENT		R.A.DREVLOW
OPTION A		RELAMP WITH 4 FT HIGH PERFORMANCE,HIGH OUTPUT LED LAMPS
	REPLACE EXISTING T-8 LAMPS ADEQUATE FOR THE LIGHTING REQUIREMENTS OF THE	
	AREA WITH 4 FT LED TUBES.	
BENEFIT	A	ACHIEVES POWER AND ENERGY REDUCTION FOR THE ENTIRE FIXTURE LOAD
	B	ACHIEVE DESIRED LIGHT LEVELS CURRENTLY ACHIEVED BY SHADING OF TROFFERS
	C	TRANSFER ASSOCIATED HEATING TO A LOWER COST FUEL
	D	REDUCE COOLING LOAD WHEN COOLING I: ,MORE THAN DELAMPING
	E	MODEST INVESTMENT EXPENSE IF DONE BY IN HOUSE STAFF
	F	MARGINALLY IMPROVES LUMINAIRE EFFICIENCY
	G	ADDITIONAL LAMPS CAN BE ADDED IF FULL COMPLEMENT WAS NOT
		INITIALLY APPLIED OR ZONE USE CHANGES .
	H	LAMPS CAN BE REMOVED IF LIGHT LEVEL IS DEEMED EXCESSIVE
	I	LED TUBES MAY BE DIMMABLE FOR ADDITIONAL CONTROL
	J.	VERY LONG LAMP AND TROFFER LIFE EXTENSION.
DOWN SIDES		
	A	LUMEN DEPRECIATION OF AGED REFLECTORS AND LENSES REMAIN
	B	REDUCTION IN UNIFORM LIGHT DISTRIBUTION FROM TROFFERS
		WILL BE INCURRED IF LESS THAN FULL COMPLEMENT OF LAMPS IS USED

		LIBRARY	MUSIC	UPSTAIRS	H.S. GYM	
SCHOOL WIDE LAMP TOTAL		CAFETERIA	TECH			
		HALLWAYS	MIDDLE SCH			
AREA	ELEMENTARY	ETC	HALLWAYS			TOTAL
LAMPS	597	959	844	634	146	**3180**
LAMP CONVERSION	80%	75%	80%	75%	50%	**17%**
LAMPS	478	719	675	476	73	
EXISTING LAMP WATTS	30	30	30	30	30	
PROPOSED LAMP WATTS	18	18	18	18	18	
REDUCTION (KWPERLAMP)	0.012	0.012	0.012	0.012	0.012	
TOTAL KW REDUCTION	5.7	8.6	8.1	5.7	0.876	29
AVE MO FACILITY DEMAND	135.0	135.0	135.0	135.0	135.0	135.0
% REDUCTION	4%	6%	6%	4%	1%	22%
EST. AVE ANNUAL	2200	2500	2500	2200	3000	
OPERATING HOURS						
ESTIMATED ANNUAL	7880	21578	20256	12553	2628	64895
KWH REDUCTION						
TOTAL FACILITY KWH USE	450000	450000	450000	450000	450000	450000
REDUCTION %	1.8%	4.8%	4.5%	2.8%	0.6%	**14.4%**
CURRENT ONPEAK KWH RATE	$ 0.075	$ 0.075	$ 0.075	$ 0.075	$ 0.075	
CURRENT OFFPEAK KWH RATE	$ 0.045	$ 0.045	$ 0.045	$ 0.045	$ 0.045	
EST % ON PEAK	80%	75%	75%	80%	80%	
EST AVE EFFECTIVE RATE	$ 0.069	$ 0.068	$ 0.068	$ 0.069	$ 0.069	
EST. ANNUAL ENERGY COST	$ 544	$ 1,456	$ 1,367	$ 866	$ 181	**$ 4,415**
MO DEMAND RATE	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	
PER KWPER MO						
MONTHLY COINCIDINCE	0.9	0.9	0.8	0.9	0.8	
FACTOR						
MO DIST RATE	$ 1.25	$ 1.25	$ 1.25	$ 1.25	$ 1.25	
PER KWPER MO						
MO COINCIDENCE	0.9	0.9	0.9	0.9	0.9	
FACTOR						
EST.ANNUAL MO. DEMAND	$ 681	$ 1,025	$ 856	$ 678	$ 93	$ 3,332
EST.ANNUAL DIST DEMAND	$ 77.37	$ 116.52	$109.38	$ 77.03	$ 11.83	$ 392.13
EST TOTAL POWER AND	$ 1,302	$ 2,598	$ 2,332	$ 1,621	$ 286	**$ 8,139**
ENERGY COST						
EST. PER LAMP COST	$ 6.00	$ 6.00	$ 6.00	$ 6.00	$ 6.00	
EST TOTAL LAMP EXPENSE	$ 2,866	$ 4,316	$ 4,051	$ 2,853	$ 438	$ 14,523
EST. LAMP AND BALLAST	$ 1.00	$ 1.00	$ 1.00	$ 1.00	$ 1.00	
DISPOSAL EXP.PER LAMP						
EST.TOTAL DISPOSAL	$ 478	$ 719	$ 675	$ 476	$ 73	$ 2,421
EXPENSE						
EST. TOTAL EXPENSE	$ 3,343	$ 5,035	$ 4,726	$ 3,329	$ 511	**$ 16,944**
ESTIMATE SIMPLE PAYBACK	2.6	1.9	2.0	2.1	1.8	**2.1**
EXPENSE ONLY (YEARS)						

Annex 3. Troffer Replacement Data, Assumptions and Analysis.

SCHOOL LIGHTING ASSESSMENT		R.A.DREVLOW
OPTION A		REPLACE EXISTING TROFFERS WITH HI PERFORMANCE INDIRECT HIGH OUTPUT TROFFERS.
BENEFIT	A	ACHIEVES POWER AND ENERGY REDUCTION FOR THE ENTIRE FIXTURE LOAD
	B	ACHIEVE DESIRED LIGHT LEVELS CURRENTLY ACHIEVED BY SHADING OF TROFFERS
	C	TRANSFER ASSOCIATED HEATING TO A LOWER COST FUEL
	D	REDUCE COOLING LOAD WHEN COOLING I ,MORE THAN DELAMPING
	E	MODEST INVESTMENT EXPENSE IF DONE BY IN HOUSE STAFF
	F	MARGINALLY IMPROVES LUMINAIRE EFFICIENCY
	G	ADDITIONAL LAMPS CAN BE ADDED IF FULL COMPLEMENT WAS NOT
		INITIALLY APPLIED OR ZONE USE CHANGES .
	H	LAMPS CAN BE REMOVED IF LIGHT LEVEL IS DEEMED EXCESSIVE
	I	LED TUBES MAY BE DIMMABLE FOR ADDITIONAL CONTROL
	J.	VERY LONG LAMP AND TROFFER LIFE EXTENSION.
DOWN SIDES		
	A	LUMEN DEPRECIATION OF AGED REFLECTORS AND LENSES REMAIN
	B	REDUCTION IN UNIFORM LIGHT DISTRIBUTION FROM TROFFERS
		WILL BE INCURRED IF LESS THAN FULL COMPLEMENT OF LAMPS IS USED

		LIBRARY	MUSIC	UPSTAIRS	H.S. GYM	
SCHOOL WIDE LAMP TOTAL		CAFETERIA	TECH			
		HALLWAYS	MIDDLE SCH			
AREA	ELEMENTARY	ETC	HALLWAYS			TOTAL
LAMPS	597	959	844	634	146	**3180**
LAMP CONVERSION	80%	75%	80%	75%	50%	**17%**
TROFFERS	119	180	169	119	18	
EXISTING TROFFER WATTS	120	120	120	120	120	
PROPOSED TROFFER WATTS	55	55	55	55	55	
REDUCTION (KWPERLAMP)	0.065	0.065	0.065	0.065	0.065	
TOTAL KW REDUCTION	7.8	11.7	11.0	7.7	1.2	39
AVE MO FACILITY DEMAND	135.0	135.0	135.0	135.0	135.0	135.0
% REDUCTION	6%	9%	8%	6%	1%	29%
EST. AVE ANNUAL	2200	2500	2500	2200	3000	
OPERATING HOURS						
ESTIMATED ANNUAL	17074	29220	27430	16999	3559	94282
KWH REDUCTION						
TOTAL FACILITY KWH USE	450000	450000	450000	450000	450000	450000
REDUCTION %	3.8%	6.5%	6.1%	3.8%	0.8%	**21.0%**
CURRENT ONPEAK KWH RATE	$ 0.075	$ 0.075	$ 0.075	$ 0.075	$ 0.075	
CURRENT OFFPEAK KWH RATE	$ 0.045	$ 0.045	$ 0.045	$ 0.045	$ 0.045	
EST % ON PEAK	80%	75%	75%	80%	80%	
EST AVE EFFECTIVE RATE	$ 0.069	$ 0.068	$ 0.068	$ 0.069	$ 0.069	
EST. ANNUAL ENERGY COST	$ 1,178	$ 1,972	$ 1,852	$ 1,173	$ 246	**$ 6,420**
MO DEMAND RATE	$ 11.00	$ 11.00	$ 11.00	$ 11.00	$ 11.00	
PER KWPER MO						
MONTHLY COINCIDINCE	0.9	0.9	0.8	0.9	0.8	
FACTOR						
MO DIST RATE	$ 1.25	$ 1.25	$ 1.25	$ 1.25	$ 1.25	
PER KWPER MO						
MO COINCIDENCE	0.9	0.9	0.9	0.9	0.9	
FACTOR						
EST.ANNUAL MO. DEMAND	$ 922	$ 1,389	$ 1,159	$ 918	$ 125	$ 4,512
EST.ANNUAL DIST DEMAND	$ 104.77	$ 157.79	$ 148.12	$ 104.31	$ 16.01	$ 531
EST TOTAL POWER AND	$ 2,205	$ 3,519	$ 3,158	$ 2,195	$ 387	**$ 11,464**
ENERGY COST						
EST. PER TROFFER COST	$ 100.00	$ 100.00	$ 100.00	$ 100.00	$ 100.00	
EST TOTAL TROFFER EXPENSE	$ 11,940	$ 17,981	$ 16,880	$ 11,888	$ 1,825	$ 60,514
EST. LAMP AND BALLAST	$ 5.00	$ 1.00	$ 1.00	$ 1.00	$ 1.00	
DISPOSAL EXP.PER LAMP						
EST.TOTAL DISPOSAL	$ 597	$ 180	$ 169	$ 119	$ 18	$ 1,083
EXPENSE						
EST. TOTAL EXPENSE	$ 12,537	$ 18,161	$ 17,049	$ 12,006	$ 1,843	**$ 61,596**
ESTIMATE SIMPLE PAYBACK	5.7	5.2	5.4	5.5	4.8	**5.4**
EXPENSE ONLY (YEARS)						

Annex 4. Auditorium Overhead Can LED Lamps Data, Assumptions and Analysis.

SCHOOL LIGHT REDUCTION

DRUMMOND K-12

APPLICATION

REPLACE 200 WATT INCANDESCENT DIMMABLE CAN LIGHTS WITH EQUIVALENT OUTPUT

LED REFLECTOR FLOODS

	EXISTING	LED	REDUCTION
LAMP WATTAGE	200	45	155
# LAMPS	25	25	
TYPE	INC	LED	
EST ANNUA LHRS	1000	1000	0
EST AVE USAGE	0.75	0.75	
EST AVE DEMAND	3.75	0.84	3
EST ANNUAL KWH	3750	843.75	2906
ON PEAK RATE	$ 0.075	$ 0.075	
OFF PEAK RATE	$ 0.045	$ 0.045	
ON PEAK %	70%	70%	
EFFECTIVE RATE	$ 0.066	$ 0.066	
EST ANNUAL ENERGY EXP	$247.50	$ 55.69	$191.81
MO DEMAND RATE	$ 11.00	$ 11.00	
EST MO DEMAND COINCIDENCE	0.2	0.2	
EST ANNUAL MO DEMAND CH.	$ 99.00	$ 22.28	$ 76.73
DIST DEMAND RATE	$ 1.25	$ 1.25	
ANNUAL DIST DEMAND COIN.	0.1	0.1	
EST ANNUAL DIST DEMAND EXPENSE	$ 5.63	$ 1.27	$ 4.36
EST TOTAL POWER AND ENERGY EXPENSE	$352.13	$ 79.23	$ 273
INVESTMENT PER LAMP		$ 24.00	
TOTAL INVESTMENT		$ 600.00	
SIMPLE PAYBACK	(YEARS)	**2.2**	

Annex 5. Auditorium Side Mount Flood LED Lamps Data, Assumptions and Analysis.

SCHOOL LIGHT REDUCTION				
	DRUMMOND K-12			
APPLICATION				
REPLACE 200 WATT 100WATT WATT FLOOD LAMPS(SIDE MOUNT) WITH EQUIVALENT OUTPUT LED				
FLOODS				
		EXISTING	LED	REDUCTION
	LAMP WATTAGE	100	15	85
	# LAMPS	26	15	
	TYPE	INC	LED	
	EST ANNUA LHRS	1500	1500	0
	EST AVE USAGE	100%	100%	
	EST AVE DEMAND	2.6	0.23	2.38
	(KW			
	EST ANNUAL KWH	3900	338	3563
	ON PEAK RATE	$ 0.075	$ 0.075	
	OFF PEAK RATE	$ 0.045	$ 0.045	
	ON PEAK %	70%	70%	
	EFFECTIVE RATE	$ 0.066	$ 0.066	
	EST ANNUAL	$257.40	$ 22.28	$ 235.13
	ENERGY EXP			
	MO DEMAND RATE	$ 11.00	$ 11.00	
	EST MO DEMAND	0.25	0.25	
	COINCIDENCE			
	EST ANNUAL	$ 85.80	$ 7.43	$ 78.38
	MO DEMAND CH.			
	DIST DEMAND RATE	$ 1.25	$ 1.25	
	ANNUAL DIST	0.1	0.1	
	DEMAND COIN.			
	EST ANNUAL	$ 3.90	$ 0.34	$ 3.56
	DIST DEMAND			
	EXPENSE			
	EST TOTAL POWER			
	AND ENERGY	$347.10	$ 30.04	$ 317.06
	EXPENSE			
	INVESTMENT PER LAMP		$ 5.00	
	TOTAL INVESTMENT		$ 75.00	
	SIMPLE PAYBACK	(YEARS)	**0.2**	

Annex 6. Hot Water Circulation Pump Controls, Data, Assumptions and Analysis.

SCHOOL ENERGY ASSESSMENT R DREVLOW

DRUMMOND K12 MAY 2019

ADJUST HOT WATER HEATING CIRC PUMP CONTROL

EXISTING CONTROL: APPEARS TO BE DIFFERENTIAL PRESSURE AT HEAD END SEQUENTIALLY

PROPOSED CONTROL: REMOTE PRES: PLUS ON OCC AND UNOCC WWSD AND UNOCC SETBACK

SYSTEM	EXISTING			PROPOSED				
	PUMPS		TOTAL					
NUMBER	1	2	2	1	2	2		
AMPS	28	12	40	15	15	30		
VOLTS	208	208		208	208			
POWER	10.1	4.3	14.4	5403.84	5403.84	10807.68		
ANNUAL OPERATING HOURS	5000	5000	5000	4000	4000	4000		
ANNUAL EFFECTIVE LOAD FACTOR			0.9			0.6		
ANNUAL EFFECTIVE LOAD KW			13.0			9		4.0
ANNUAL KWH			64846			36000		
ON PEAK ENERGY RATE			0.075				0.075	
OFF PEAK ENERGY RATE			0.045				0.045	
ON PEAK %			70%				$ 0.60	
EEFFECTIVE RATE			$ 0.066				$ 0.063	
EST ANNUAL ENERGY EXPENSE			$ 4,280			$ 2,268.0		$ 2,012
MO DEMAND CH			$ 11.00			11		
ANNUAL MO DEMAND								
COINCIDENCE FACTOR			0.6			0.4		
ESTIMATED ANNUAL DEMAND CH			$ 1,027			$ 475.20		$ 552
MO. DIST . DEMAND CH.			$ 1.25			$ 1.25		
EST. DIST CHARGE								
COINCIDENCE FACTOR			150%			150%		
EST ANNUAL DIST DEMAND CH			$ 291.81			$ 202.50		$ 89
TOTAL POWER AND ENERGY REDUCTION								**$ 2,653**
COST TO IMPLEMENT				$ 5,000				
SIMPLE PAYBACK(YEARS)				**1.9**				

NOTES

SYSTEM CURRENTLY IS REPORTED TO SERVE BOTH 2 WAY AND 3 WAY VALVES.

THESE VALVES RESPOND DIFFERENTLY TO CONTROL STRATEGY .

A- 3 WAY VALVES BYPASS FLOW I.E CAUSE UNNECESSARY FLOW AND REQUIRED POWER AT LOW LOAD PERIODS.

2 WAY VALVES LIMIT FLOW WHICH RAISES RESISTANCE AND ELEVATES PRESSURE AND POWER REQUIREMENTS IN LOW LOAD PERIODS.

FINDING A COMPROMISE THAT IS EFFECTIVE OVER THE FULL RANGE OF OPERATING I REQUIERES SOME OPBERVATIONS AND EXPERIMENTATIONS.

ALTERNATIVES

ALTERNATIVE SELECTION REQUIRES ASSESSMENT OF TYPES AND NUMBERS OF CONTROL VALVES OF EACH TYPE.

1. IMPLEMENT AND TUNE A COMPROMISE REMOTE PRESSURE BASED CONTROL UNOCCUPIED RESET AND OCC AND UNOCC WWSD.
2. CONVERT EXISTING 3 WAY TO 2 WAY VALVES
3. LOCK 3 WAY VALVE BYPASSES CLOSED TO CREATE 2 WAY VALVES AND REGULATE REMOTE END PRESSURE.

Annex 7. Auditorium Air Handler, Data, Assumptions and Analysis.

SCHOOL ENERGY ASSESSMENT				R DREVLOW	
DRUMOND K-12			13-May	2019	

SCENARIO

THE SCHOOL AUDITORIUM IS SERVED BY A 15 000 CFM AIR HANDLER

THE UNIT IS REPORTED AS CURRENTLY OPERATING IN A AN UNOCCUPIED TEMP MAINTENANCE MODE.

THE LARGE FAN OPERATING INTERMITTENTLY CREATES LARGE LOAD SURGES TO THE BOILER AND PUMPING SYSTEMS.

THESE CREATE EXCESSIVE BOILER PUMP LOADS AND BOILER LOAD SWINGS WHICH COMPROMISE OPTIMUM OPERATION.

STEADY STATE LOW FLOW /SPEED/POWER WOULD REDUCE POWER AND ENERGY BILLS AND IMPROVE ENERGY PERFORMANCE OF BOILER AND CIRC PUMP SYSTEMS .

A VFD AND APPROPRIATE CONTROL WILL BE REQUIRED TO ACCOMPLISH THE REDUCTION POTENTIAL .

THE CURRENT FAN CAPACITY IS LIKELY BASED ON SYSTEM COOLING REQUIREMENT AND LIKELY TWICE THE PEAK REQUIREMENT. HEATING REQUIREMENT AND LIKELY 3-4 TIMES AVERAGE HEATING LOAD

THIS SUGGESTS A SIGNIFICANT POWER AND ENERGY REDUCTION POTENTIAL FOR ALL HEATING CONDITIONS

GIVEN THE COOLING LOAD COINCIDENCE A SIGNIFICANT COOLING LOAD REDUCTION IS ALSO ANTICIPATED .

COOLING LOAD FAN REDUCTIONS WOULD NEED TO BE COMPATIBLE TO COOLING SOURCE APPLICATIONS.

	CURRENT		PROPOSED		
FAN RATING (CFM)	15000		15000		
MOTOR H.P	20				
EFF	0.9				
POWER FACTOR	0.87				
LOAD AT RATED CONDITION	14.4	KW			
CURRENT MOTOR	40				
AMPS					
OPERATING MOTOR P.F.	0.87				
EFFECTIVE MOTOR POWER	12.5	KW	5	KW	7.5
CURRENT OP CONDITION	87%		35%		
ANNUAL OPERATING HRS	3000		4000		
ESTIMATED ANNUAL	**37611**	KWH	20000		17611
ENERGY USE					
ON PEAK ENERGY	0.075				
OFF PEAK ENERGY	0.045				
% ON PEAK	75%		75%		
EFFECTIVE ENERGY RATE	$ 0.068		$ 0.068		
EST ANNUAL ENERGY EXPEN	$ 2,539		$ 1,350		$ 1,189
MO DEMAND RATE	11		11		
MO COINCIDENCE FACTOR	0.5		0.9		
ESTIMATED ANNUAL	$ 827		594		$ 233
MO DEMAND CHARGES					
DIST DEMAND RATE	$ 1.25		1.25		
ANNUAL DIST. DEMAND					
COINCIDENCE FACTOR	0.6		0.9		
EST. ANN. DIST DEMAND	$ 113		$ 68		$ 45
EXPENSE					
TOTAL EST ANN.POWE AND ENERGY					
EXPENSE	$ 3,479		$ 2,012		**$ 1,467**
ESTIMATED VFD AND CONTROL		$ 7,000			
IMPLEMENTATION EXPENSE					
ESTIMATED SIMPLE PAYBACK		4.8	YEARS		

Annex 8. Four Small Air Handler VFDS Control, Data, Assumptions and Analysis.

SCHOOL ENERGY ASSESSMENT					R DREVLOW					
	FACILITY		DRUMMOND K12			13-May				
ENERGY REDUCTION OPPORTUNITY										
	THE FACILITY HAS 4 SMALL PNEUMATICALLY CONTROLLED AIR HANDLERS.									
	THE PNEUMATIC CONTROL PROVIDES A CONSTANT VOLUME AIR SUPPLY FOR THE ROOMS/ZONES									
	BASED ON THE MAXIMUM COOLING LOAD LIKELY TO BE 6 ACH OR MORE.									
	CONTINOUS OPERATION IS REQUIRED FOR ALL OPERATING HOURS TO PROVIDE VENTILATION.									
	TYPICAL HEATING LOADS CAN NORMALLY BE ACCOMPLISHED WITH 2 TO 3 ACH .									
	THE SIGNIFICANT FAN SPEED /AIR FLOW REDUCTION WILL ALLOW SIGNIFICANT FAN POWER REDUCTIONS									
	FOR ALL HEATING AND MOST COOLING LOAD PERIODS.									
	VFDS AND DIGITAL CONTROL WILL BE REQUIRED TO ACCOMPLISH THE DESIRED POWER AND ENERGY REDUCTIONS.									
	CURRENTLY THE FACILITY DOES NOT HAVE MATASYS CONTROL CAPABILITY FOR THE AIR HANDLERS REFERENCED.									
	REDUCTION OF THE TOTAL FAN FLOW ALSO REQUIRED ADJUSTMENT OF THE OUTSIDE AIR FLOW DAMPER SYSTEM									
		TO MAINTAIN ADEQUATE OUTSIDE AIR WITH A VARIABLE SUPPLY FLOW. THIS IS POSSIBLE WITH DDC								
		CONTROL BUT DIFFICULT IF PROBLEMATIC TO ACCOMPLISH WITH PNEUMATIC CONTROL.								
		EXISTING				PROPOSED				
AIR HANDLERS		4				4				
MOTOR H.P		7.5				7.5				
MNOR EFF		0.85				0.85				
POWER FACTOR		8				0.8				
RATED POWER		6.58235								
		EXISTING								
EFFECTIVE /EQUIVALENT										
OPERATING LOAD		90%				0.6				
						0.3				
EST OPERATING LO,		5.92	KW							
EST OPERATING LOAD OUTPU			5.0	KW		1.97	KW		3.1	KW
EST ANNUAL OPERATING			3500							
HOURS										
EST ANNUAL ENERGY INPUT			82938			27646			55292	
EST EFFECTIVE ENERGY COST			0.065							
			$ 5,391			$ 1,797			$ 3,594	
MO DEMAND RATE			$ 11.00			$ 11.00				
MO COINCIDENCE			0.75			0.85				
ESTIMATED ANN. DEMAND			$ 586.49			$221.56			$ 365	
DIST DEMAND			1.25			1.25				
EST ANN DIST. DEMAND			$ 320			$ 178			$ 142	
EST COINC			0.9			1.5				
TOTAL POWER AND									$ 4,101	
ENERGY REDUCTION										
COST TO IMPLEMENT VFS AND CONTROLS ONTO A FUNCTIONING DDC SYSTEM FOR THE AIR HANDLERS										
					$ 12,000.00					
	SIMPLE PAYBACK				2.9	YEARS				

Annex 9. Repairing Trane UniVents, Data, Assumptions and Analysis.

SCHOOL ENERGY ASSESSMENT					R DREVLOW			
	FACILITY		DRUMMOND K12			13-May		
ENERGY REDUCTION OPPORTUNITY								
MULTIPLE CLASSROOMS ARE SERVED BY TRANE UNIVENTS .								
THE UNIVENTS ARE DESCRIBED AS HAVING VARIABLE SPEED FAN MOTORS.								
IT IS ALSO REPORTED THAT A NUMBER OF THE UNITS NO LONGER OPERATE AS								
VARIABLE SPEED UNITS AND ARE EITHER FULL SPEED ON OR OFF. OPERATING								
AT FULL SPEED AND CYCLING IS LESS EFFICIENT THAN OPERATING IN A								
MODULATING FASHION.								
FULL SPEED OPERATION WILL ONLY BE REQUIRED IN WARMUP MODE AND								
MAX COOLING PERIODS.								
	MOTORS							
	TYPE		VARIABLE SPEED					
	NUMBER		12					
	HP.		0.5					
	EFF		0.8					
	FULL SPD		0.46625	KW				
	POWER IN							
	COINCIDENCE		0.6					
	FACTOR							
	EST COINCIDENT		3.357	KW				
	LOAD							
	ANNUAL OPERATING			2500				
	HOURS							
	EST ANNUAL ENERGY			8393	KWH			
	EFF ENERGY RATE			$ 0.066				
	EST ANNUAL ENERGY EXPENSE				$ 554			
	MO DEMAND RATE			$ 11.00				
	DEMAND COINCIDENCE			0.7				
	EST ANNUAL DEMAND			$310.19				
	DIST DEMAND RATE			$ 1.25				
	COINCIDENCE			0.8				
	EST ANNUAL DIST DEMAND				$ 40			
	EST TOTAL POWER AND ENERGY EXPENSE					**$ 904**		
	ESTIMATED POWER AND ENERGY REDUCTION POTENTIAL OF							
	EFFECTIVE MODULATING FAN OPERATION					50%		
						$ 452.19		
	EST EXPENSE TO REPAIR					$ 500.00	PER UNIT	
	EST TOTAL REPAIE COST					$ 6,000.00		
	SIMPLE PAYBACK					**13.3**		YEARS