Massachusetts Department of Energy Resources

Energy Conservation Improvement Program Energy Audit

The Town of Tewksbury Public Schools

Tewksbury Louise Davy Trahan School
Tewksbury, MA

May 15, 2008

Prepared by

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SECTION 1: EXECUTIVE SUMMARY

American Development Institute (ADI) has been retained by the Division of Energy Resources (MA – DOER) to prepare a scoping energy audit for a number of municipal buildings and school department buildings for the Town of Tewksbury, Massachusetts.

This energy study for the Tewksbury Louise Davy Trahan School was commissioned in order to identify cost-effective energy conservation measures (ECMs) that would qualify for funding under the Energy Conservation Improvement Program (ECIP). The ECIP may fund a portion of this project.

The ECMs recommended in this study, if implemented, will yield annual energy savings of approximately $15,852, or 35,073 kWh and 667 MMBTU. These savings represent 18.3% of the present annual energy costs of $86,593. With a total installed cost of approximately $35,500, the overall project payback is 2.2 years. There may be utility incentives available from NGrid Electric Company, the electric utility company, for the installation of variable speed drives and premium efficient motors, which will improve the retrofit payback to 2.1 years. In addition to the proposed measures, ADI recommends the facility implement retro-commissioning to optimize the operational efficiency of the building systems.

The costs, annual savings, and simple paybacks for the qualified ECMs are summarized in Table 1.1 below. Detailed descriptions of each ECM are presented in Section 3. To estimate cost savings, we have used the school's blended electric rate of $0.1287 per kWh and $16.99 per MMBtu for fuel. Savings calculations are estimates only, based on field observations, building plans, interviews with school employees, or assumptions based on ADI's experience on similar projects. Similarly, cost estimates were made using R.S. Means, vendor information, or ADI experience.

Acknowledgements

The cooperation and assistance of Scott Durkee of the Massachusetts DOER and James Sharkey of the Town of Tewksbury is greatly appreciated in making this study possible.

Table 1.1: Summary of Energy Efficiency Measures

ECM #	ECM Description	Annual Savings			Installed Cost ($)	Simple Payback (years)	Utility Funding ($)	Net Cost $	Net Payback yrs
		Electricity (kWh)	Fuel (MMBTU)	Total Savings ($)					
	Retro-commissioning	19,227	352	$ 8,455	$ 20,000	2.4		$ 20,000	2.4
ECM 65	Insulate Condensate Tank		34	$ 572	$ 1,500	2.6		$ 1,500	2.6
ECM 97/98A	Add VFD to Cafeteria AHU Fan	6,338	70	$ 2,013	$ 5,000	2.5	$ 800	$ 4,200	2.1
ECM 97/98B	Add VFD to Original Building AHU Fan	9,508	211	$ 4,812	$ 9,000	1.9	$ 800	$ 8,200	1.7
Totals		35,073	667	$ 15,852	$ 35,500	2.2	$ 1,600	$ 33,900	2.1

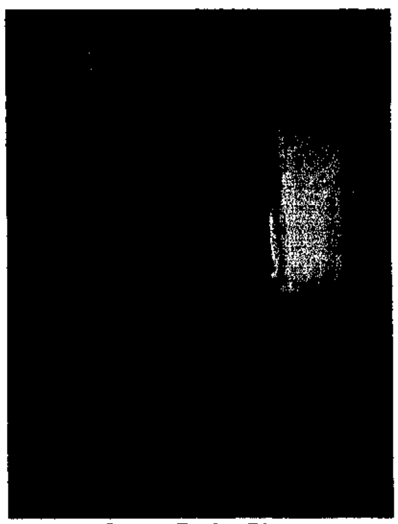
SECTION 2: FACILITY OVERVIEW

BUILDING DESCRIPTION

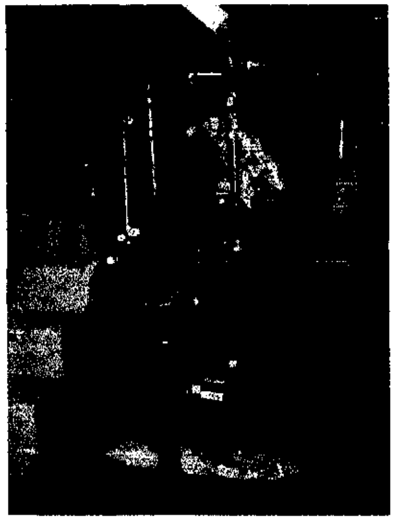
The Louise Davey Trahan School building was constructed in 1952 and comprises 40,350 ft^2 of floor space on one level. The facility has a partial basement which includes the boiler room and storage areas and part of the basement area is used as a fresh air plenum for class room ventilation. The building is of masonry construction with a brick exterior. According to school officials, the building operates approximately sixty-five (65) hours per week. The Elementary School and Kindergarten serve the educational needs of approximately 395 students. The building has undergone some changes through the years including an addition in 1957 and the Kindergarten addition in 1975. With the exception of the Cafeteria, which has thermo pane windows, all other windows are Plexiglas. The primary lighting systems have been upgraded to high-efficiency, fluorescent T8 lamps.

The building is heated by a central steam system that is supplied by two gas-fired steam boilers that are in good condition. Terminal equipment consists primarily of finned tube radiation in the original building, unit ventilators in the 1957 addition, and heating and ventilating units in the Kindergarten and Gymnasium addition.

Temperature control systems are pneumatic. The boiler plant and the HVAC systems are controlled by a Honeywell Control system that provides supervisory and scheduling control. The system does not provide easy access to changes in schedules and set points which is reflected in the Annual Energy Index (AEI) for the school. As shown in the Facility Energy Profile presented here, the AEI based on end-use energy is 104.6 kBTU/sf/year. This very high value reflects a low level of energy efficiency for a building of this type in the New England climate. A typical AEI for this type of building would be in the range of 60 – 80 kBTU/sf/year.



Steam Boiler Plant



Condensate Tank

ENERGY PROFILE

Based on the electric billing history for fiscal year 2006-2007, the total electrical consumption for the school was 208,120 kWh, with a total cost of $26,788. Electricity is provided by NGrid Electric Company. ADI has utilized the average blended rate for the School of $0.1287 per kWh for our electric energy saving calculations.

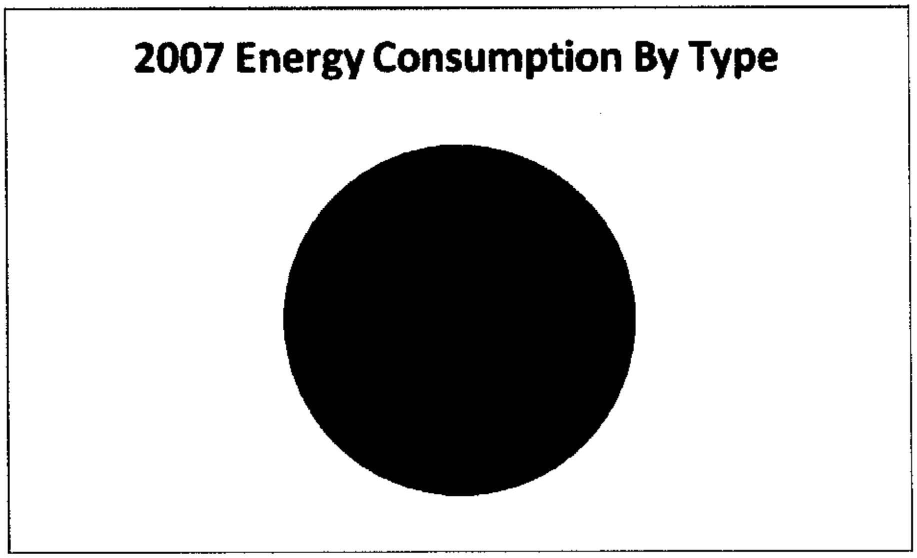
The facility utilizes natural gas for heating and domestic hot water, with an annual total of 34,180 ccf of natural gas annually for a total of $59,805. ADI has used the average cost of $16,99/MMBtu for our energy savings calculations.

Table 2.1: Profile of Annual Energy Use

	Electric	Fuel	Total
Total Energy Usage	208,120 kWh	3,521 MMBtu	4,231 MMBtu
Total Energy Cost	$ 26,788	$ 59,805	$ 86,593
Total Energy per sf	5.145 kWh per sf	0.087 MMBtu per sf	0.105 MMBtu per sf
Total Cost per unit	$ 0.13 $/kWh	$ 16.99 $/MMBtu	$ 20.47 $/MMBtu
Total Cost per sf	$ 0.66	$ 1.48	$ 2.14

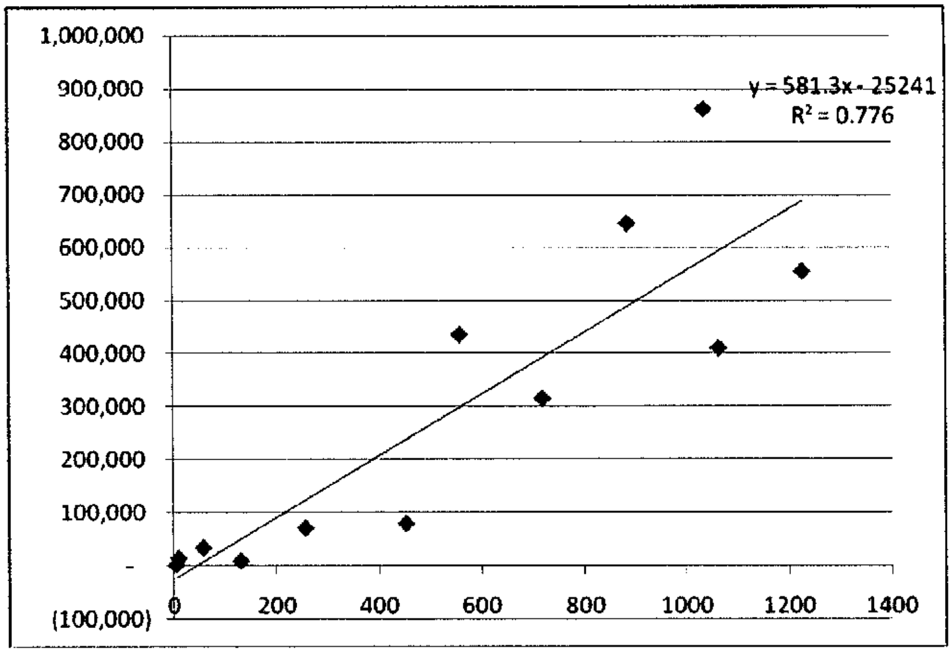
The Total AEI of 104.6 kBTU/Sf/Year is considered a high value for this type of building in New England.

The following Chart shows total annual energy consumption by type of energy.



The value of 86% of total energy consumption for Space Heating is a typical value for this type of facility. ADI has calculated the amount of heat lost due to low energy efficiency windows (shown below) and the amount of heat lost if the windows met the current minimum specification for windows in Massachusetts. This calculation indicates that the AEI for the School would be reduced by 15.39 kBTU/sf. In addition, the recommended ECM's in the next section would further reduce the AEI by 19.15 kBTU/sf giving a revised AEI of 70.1 kBTU/sf which would be considered a good AEI for this type and age of building in New England.

To further understand how Louise Davey Trahan School uses energy, ADI has carried out a weather sensitivity analysis on the natural gas consumption. The following chart shows the correlation between annual energy consumption for natural gas and weather, as represented as heating degree days (HDD). The chart shows a fairly good correlation between gas consumption and weather. The chart does, however, indicate some control issues in that that it appears as though the building is over and under responding to changes in temperature. This may result in less than optimum temperatures within the building and wasteful energy consumption. Better energy management controls can eliminate a significant portion of this problem.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UTILITY PURCHASING SAVINGS OPPORTUNITIES

There are a number of ways that the Town of Tewksbury can reduce their energy bills in addition to energy conservation. They are outlined below.

Energy Procurement

Municipalities can derive large savings by employing a number of energy procurement strategies:

1. Electricity: Municipalities should consider getting their electricity supply from a licensed electricity supplier.[1]
    a. *Real-time Pricing*: The savings from a variable priced offering can be great because the customer assumes the risk of price fluctuations. It is important for customers to understand the risk and potential savings of a real-time index product as compared to a fixed price contract by looking carefully at electricity usage during peak price periods and comparing those trends to the elements of the variable priced offerings. In the event that a customer's usage tends to be during off-peak periods, large savings can be derived. Suppliers should be asked if they have a real-time rate and be requested to give an estimate for what a customer would have paid in the last year using the customer's specific usage data, indicating the supplier's charge (in $/kWh) for such a product and other charges that may apply.
2. Aggregation: It is recommended for municipal offices to aggregate as many electric and gas accounts as possible when going out to bid for energy procurement contracts. In some cases, municipalities have benefited even more by aggregating with other bordering municipalities.

Demand Response

ADI has determined that the Town of Tewksbury may be a good candidate for enrolling in the ISO New England Demand Response Program. This program pays customers for reducing their demand by at least 100 kW *when called upon*. This location may not be individually eligible but could be included in an aggregation of all the Town of Tewksbury accounts, if acceptable to the ISO New England Demand Response Program.

- There are a number of ways that customers can reduce their load when called upon: onsite generation, shifting usage to *non event p*eriods.
- ISO-NE usually calls upon participants depending upon the system conditions.-reliability and or high prices. In 2007 there were three DR events and 10 in 2006.
- Response time depends on the program; either day ahead or within 30 minutes.
- Entities can enroll in demand response through their utility or a third party.

Forward Capacity Payments

ADI has determined that the Town of Tewksbury may be a good candidate for enrolling in the ISO New England Forward Capacity Market. This program pays customers for reducing their demand by at least 100 kW *during performance hours*

Things to consider:

[1] A list of licensed suppliers can be found at the Dept. of Public Utilities Commission website: http://db.state.ma.us/dpu/qorders/frmElectricitySuppliers.asp

- There are a number of things that customers can enroll: onsite generation, shifting usage to off peak periods.
- The measure (or project) enrolled must be metered or verified to demonstrate the customer's demand was reduced during the performance hours.
- Energy efficiency measures that received a rebate from the utility are NOT eligible.
- It is recommended for entities to enroll in FCM through their utility or a third party; this reduces the payment, but, requires less attention from facility managers.

It is recommended for the proper representative to contact the Division of Energy Resources to learn more about opportunities for the Energy Procurement, Forward Capacity Market, and Demand Response. These programs would apply to the aggregation of all buildings in the Town of Tewksbury.

SECTION 3: ENERGY CONSERVATION MEASURES

This section describes all the ECMs that are recommended for inclusion in the ECIP. The selected measures meet the cost-effectiveness criteria of the program, and are eligible for funding under the ECIP.

The following measures were considered in our evaluation:

Table 3.1: Energy Conservation Measures Evaluated

Building System	Category	ECM#	ECM Name	Y/N
BUILDING EQUIPMENT OPERATION	*Reduce Operating Hours*	ECM 1	Reduce Operating Hours for Space Heating and Cooling Systems	NO
		ECM 2	Reduce Operating Hours for Ventilation Systems	NO
		ECM 3	Reduce Operating Hours for Water Heating Systems	NO
		ECM 4	Reduce Operating Hours for Lighting Systems	NO
		ECM 5	Reduce Operating Hours for Escalators and Elevators	NO
		ECM 6	Reduce Operating Hours for Equipment and Machines	NO
	Adjust Space Temperature and Humidity Setpoints	ECM 7	Maintain Heating and Coolers Cooling Temperature at recommended Setpoints	NO
		ECM 8	Maintain Humidification and Dehumidification at Setpoints	NO
		ECM 9	Adjust Heating and Cooling Setpoints When the Building Is Not Occupied	NO
BUILDING ENVELOPE	*Reduce Heat Conduction Through Ceilings and Roofs*	ECM 10	Insulate Ceilings and Roofs	NO
		ECM 11	Install Vapor Barriers in Ceilings and Roofs	NO
	Reduce Solar Heat Gain Through Roofs	ECM 12	Install Reflective Roof Services	NO
	Reduce Heat Conduction Through Walls	ECM 13	Insulate Walls	NO
		ECM 14	Install Vapor Barriers in Walls	NO
	Reduce Heat Conduction Through Floors	ECM 15	Insulate Floors	NO
	Reduce Heat Conduction and Long-Wave Radiation Through Glazing Areas	ECM 16	Install Storm Windows and Multiple-Glazed Windows	NO
		ECM 17	Insulate Movable Windows	NO
		ECM 18	Install Operable Windows	NO
	Control Solar Heat Gain Through Glazing Areas	ECM 19	Install Exterior Shading	NO
		ECM 20	Install Interior Shading	NO
		ECM 21	Use Tinted or Reflective Glazing or Films	NO
		ECM 22	Plant Shade Trees	NO
	Reduce Infiltration	ECM 23	Seal Vertical Shafts and Stairways	NO
		ECM 24	Caulk and Weatherstrip Doors and Windows	NO
		ECM 25	Install Revolving Doors or Construct Vestibules	NO

Building System	Category	ECM#	ECM Name	Y/N
HEATING, VENTILATION AND AIR-CONDITIONING (HVAC) SYSTEMS	***Electric to Fossil Fuel Conversions***	ECM 26	Convert Existing Electric Domestic Hot Water System to Fossil Fuel or Heat Pump	NO
		ECM 27	Convert Existing Heating System from Electric to Domestic Hot Water	NO
	Reduce Ventilation	ECM 28	Reduce Ventilation Rates Without Affecting Indoor Air Quality	NO
		ECM 29	Reduce the Generation of Indoor Pollutants	NO
		ECM 30	Install Air-to-Air Heat Exchangers	NO
		ECM 31	Install Air Cleaners	NO
		ECM 32	Install Local Ventilation Systems	NO
	Improve Chiller Efficiency	ECM 33	Clean Evaporator and Condenser Surfaces of Fouling	NO
		ECM 34	Raise Evaporator or Lower Condenser Water Temperature	NO
		ECM 35	Isolate Off-Line Chillers and Cooling Towers	NO
		ECM 36	Install Evaporation-Cooled or Water-Cooled Condensers	NO
	Improve Boiler or Furnace Efficiency	ECM 37	Clean Boiler Surfaces of Fouling	NO
		ECM 38	Check Flue for Improper Draft and repair if necessary	NO
		ECM 39	Check for Air Leaks and repair if necessary	NO
		ECM 40	Install Flue Gas Analyzers for Boilers	NO
		ECM 41	Preheat Combustion Air, Feed Water or Fuel Oil with Reclaimed Waste Heat	NO
		ECM 42	Isolate Off-Line Boilers	NO
		ECM 43	Install Automatic Vent Dampers	NO
		ECM 44	Install Automatic Boiler Blow-Down Control	NO
		ECM 45	Install Pulse or Condensing Boilers/Furnaces	NO
		ECM 46	Install Air-Atomizing Burners (for Oil-Fired Systems)	NO
		ECM 47	Install Low-Excess-Air Burners (for Oil-Fired Systems)	NO
		ECM 48	Install Modular Units	NO
	Improve Air-Conditioner or Heat Pump Efficiency	ECM 49	Clean Air Filters	NO
		ECM 50	Install Add-On Heat Pumps	NO
		ECM 51	Install Ground or Ground-Water Source Heat Pump	NO
	Reduce Energy Used for Tempering Supply Air	ECM 52	Install Variable Air Volume Systems	NO
		ECM 53	Reset Supply Air Temperatures	NO
		ECM 54	Reset Hot/Chilled Water Temperatures	NO
	Use Energy-Efficient Cooling Systems	ECM 55	Install Economizer Cooling Systems	NO
		ECM 56	Install Evaporative Cooling Systems	NO
		ECM 57	Install Desiccant Cooling Systems	NO
		ECM 58	Install Cooling Tower Cooling Systems	NO
		ECM 59	Install Roof-Spray Cooling Systems	NO
		ECM 60	Create Air Movement with Fans	NO
		ECM 61	Exhaust Hot Air From Attics	NO

Building System	Category	ECM#	ECM Name	Y/N
HVAC DISTRIBUTION SYSTEMS	***Reduce Distribution System Energy Losses***	ECM 62	Repair Ducting and Piping Leaks	NO
		ECM 63	Maintain Steam Traps	NO
		ECM 64	Insulate Ducts	NO
		ECM 65	Insulate HVAC System Pipes	YES
	Reduce System Flow Rates	ECM 66	Reduce System Air Flow Rates	NO
		ECM 67	Reduce Heating/Cooling Water or Steam Flow Rates	NO
	Reduce Steam Resistance	ECM 68	Clean Air Filters in Ducts	NO
		ECM 69	Remove Scale from Water and Steam Pipes	NO
		ECM 70	Rebalance Piping Systems	NO
		ECM 71	Rebalance Ducting Systems	NO
		ECM 72	Design Ducting Systems to Reduce Flow Resistance	NO
		ECM 73	Install Booster Pumps	NO
WATER HEATING SYSTEMS	***Reduce Hot Water Loads***	ECM 74	Reduce Hot Water Consumption	NO
		ECM 75	Lower Hot Water Temperatures	NO
		ECM 76	Preheat Feedwater With Reclaimed Waste Heat	NO
	Reduce Hot Water Heating System Losses	ECM 77	Insulate Hot Water Pipes	NO
		ECM 78	Insulate Water Storage Tanks	NO
	Use Energy-Efficient Water Heating Systems	ECM 79	Install Decentralized Water Heaters	NO
		ECM 80	Use Smaller Water Heaters for Seasonal Requirements	NO
		ECM 81	Use Heat Pump Water Heaters	NO
		ECM 82	Heat Water with Solar Energy	NO
LIGHTING	***Reduce Illumination Requirements***	ECM 83	Clean and Maintain Systems	NO
		ECM 84	Reduce Illumination to recommended levels	NO
		ECM 85	Reduce Time of Operations	NO
		ECM 86	Use Task Lighting	NO
	Install Energy-Efficient Lighting Systems	ECM 87	Use High-Efficiency Fluorescent Lighting	NO
		ECM 88	Use High-Pressure Sodium Lighting in Selected Areas	NO
		ECM 89	Install Pulse Start Metal Halide Lighting in Selected Areas	NO
		ECM 90	Install High-Efficiency Ballasts	NO
		ECM 91	Install Occupancy Sensors	NO
	Use Daylight	ECM 92	Install Dimming Controls with Windows	NO
		ECM 93	Install Dimming Controls with Skylights	NO
POWER SYSTEMS	***Reduce Power System Losses***	ECM 94	Correct Power Factors	NO
		ECM 95	Install Energy-Efficient Transformers	NO
	Install Energy Efficient Motors	ECM 96	Replace Oversized Motors	NO
		ECM 97	Use High-Efficiency Motors	YES
		ECM 98	Use Variable Speed Motors	YES
	Reduce Peak Power Demand	ECM 99	Use Load-Shedding	NO
		ECM 100	Install a Cogeneration System	NO
		ECM 101	Install a Cool Storage System	NO

Building System	Category	ECM#	ECM Name	Y/N
ENERGY MANAGEMENT SYSTEMS	*Use Energy Management and Control Systems*	ECM 102	Install Temperature Setup/Setback Control System	NO
		ECM 103	Install Time-of-Day Control System	NO
		ECM 104	Install Duty-Cycling Control System	NO
		ECM 105	Install Supply Air Temperature Reset Control System	NO
		ECM 106	Install Hot/Chilled Water Supply Temperature Reset Control System	NO
		ECM 107	Install Ventilation Purging Control System	NO
		ECM 108	Install Economizer Cooling Control System	NO
		ECM 109	Install Demand Limiting Control System	NO
MISC.	*Heat Reclaim Systems*	ECM 110	Install Double-Bundle Chillers	NO
		ECM 111	Reclaim Heat from Boiler Blowdown	NO
		ECM 112	Reclaim Incinerator Heat	NO
		ECM 113	Reclaim Heat from Composition System Flue	NO
		ECM 114	Install Water-Loop Heat Pump System	NO
		ECM 115	Reclaim Heat from Prime Movers	NO
		ECM 116	Install Piggyback Absorption Systems	NO
		ECM 117	Recover Heat from Light Systems	NO
		ECM 118	Reclaim Heat from Refrigerator Hot Gas	NO
		ECM 119	Reclaim Heat from Steam Condensate	NO
		ECM 120	Reclaim Heat from Waste Water	NO
	Appliances	ECM 121	Install Energy-Efficient Appliances	NO
		ECM 122	Convert Electric Dryers to Natural Gas	NO
	Domestic Water Conservation	WCM 1	Install Low Flow Aerators on Sinks	NO
		WCM 2	Install Low Flow Toilets, Urinals	NO
		WCM 3	Install Low Flow Shower Heads	NO
		WCM 4	Install Reverse Osmosis Water Demineralizing Systems	NO
		WCM 5	Install Cooling Towers Where Once Through Cooling is Prevalent	NO

RECOMMENDED MEASURES

Based on the scoping audit and analysis, ADI recommends that the following Energy Conservation Measures be further evaluated with a detailed study. ADI believes that the implementation of these ECM's will provide a relatively short simple payback period.

Retro-Commissioning

Measure Description

ADI proposes that facility personnel enhance the operation of the HVAC and lighting systems in the buildings by providing complete Retro-Commissioning of the existing control and operation of the systems in the building. While the systems that serve the building were most likely commissioned at startup, it is our experience that regular post-commissioning or Retro-Commissioning is required in order to ensure that the HVAC systems are properly optimized and adapt to changing building requirements.

Commissioning is a systematic process to ensure that all building systems and controls perform interactively according to the current operational needs of the building occupants/users while operating at peak energy efficiency. Commissioning activities involve actual performance review and testing with upgrades and changes to building control strategies as necessary to meet the building performance requirements.

When commissioning of existing building control systems is properly executed, substantial operational cost savings opportunities can be identified. Effective commissioning has been proven to increase the energy efficiency of buildings with more complex HVAC systems and controls by as much as 5% to 10%, with lower savings resulting from less complex systems. Improved integration and optimization of the building systems will also result in improved comfort and operation of the buildings in addition to increases in energy efficiency.

Implementation of Retro-Commissioning will involve the following scope of work:

1. Gathering all available existing information on the existing systems and controls, including drawings, specifications, control point listings, control sequences, schedules, and control hardware specifications.
2. Interviewing building operating staff and building users regarding the current operation of the buildings, noting any potential problems with temperature, humidity, indoor air quality, and areas where improvement is required.
3. Reviewing existing operating control sequences and observe the operation of HVAC system components, including fans, pumps, chillers, heat exchangers, and cooling towers, and comparing existing operating schedules, ventilation rates, pressures, temperatures, etc to specifications and plans.
4. Using portable data loggers and the data logging capabilities of the existing systems to gather operating data to analyze the operation of the existing systems.
5. Based on the above steps, developing a list of recommended improvements to each system or subsystem to improve overall performance and efficiency. Improvements may include control sequence changes and/or additions of control and monitoring points.
6. Revisiting the above Retro-Commissioning process seasonally to cover the heating season, the cooling season, and in-between seasons.

Retro-Commissioning guidelines, published by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), The United States Green Buildings Council (USGBC) and Portland

Energy Conservation, inc. (PECI), can be utilized in the performance of the Retro-Commissioning process.

Economic Summary

The following table provides an economic summary of this ECM.

ECM #	Savings Electricity kWh	Savings Fuel MMBTU	Savings $	Total Cost $	Payback yrs	Utility Funding ($)	Net Cost $	Net Payback yrs
	19,227	352	$ 8,455	$ 20,000	2.4	$ -	$ 20,000	2.4

ECM 65: Insulate HVAC Distribution System Piping

Measure Description

ADI noticed that the condensate return tank and other small pieces of piping within the boiler room are uninsulated. ADI recommends that these items be insulated and that any other heating system piping that is not currently insulated be insulated.

Economic Summary

The following table provides an economic summary of this ECM.

ECM #	Savings Electricity kWh	Savings Fuel MMBTU	Savings $	Total Cost $	Payback yrs	Utility Funding ($)	Net Cost $	Net Payback yrs
ECM 65	0	34	$ 572	$ 1,500	2.6	$ -	$ 1,500	2.6

ECM 97/98A,B: Add VFD to Cafeteria and Original Building AHU Fans

Measure Description

In some facilities, the installation of premium efficiency motors and variable frequency drives (VFD's) can reduce energy costs. VSD's ADI is recommending the installation of VFD's on the air handling units for the Cafeteria and the Original Building. The VSD's will control the fan speed in accordance with space temperature requirements. part of the retrofit will include the installtion of new premium efficiency motors that are compatible with the variable speed drives installations.

Economic Summary

The following table provides an economic summary of this ECM.

ECM #	Savings Electricity kWh	Savings Fuel MMBTU	Savings $	Total Cost $	Payback yrs	Utility Funding ($)	Net Cost $	Net Payback yrs
ECM 97/98A	6,338	70	$ 2,013	$ 5,000	2.5	$ 800	$ 4,200	2.1
ECM 97/98B	9,508	211	$ 4,812	$ 9,000	1.9	$ -	$ 9,000	1.9

MEASURES CONSIDERED BUT NOT RECOMMENDED

ADI reviewed the systems in the school and considered a number of potential Energy Conservation Measures (ECM's). Based on a preliminary review, most of the possible ECM's were deemed to be not applicable for implementation due to long payback periods:

Boiler Replacement

The existing space heating boiler and domestic water heater could be replaced with higher efficiency equipment to reduce fuel usage. However, due to the relatively low energy usage for the building and to the high capital costs involved in replacing boilers, the simple payback period would likely be in the range of 20 years.

Destratification Fans for Gymnasium and Cafeteria

In facilities with high ceilings, the air temperature becomes stratified. Building heat loss from the roof and the upper walls is significantly reduced by the installation of destratification fans. In addition, temperatures at the floor level can be maintained at comfortable levels while reducing the annual energy required for heating. Although heating energy savings can be achieved through destratification fans, the electrical energy required to operate the fans makes the payback for this measure greater than 10 years.

Window Replacement

As mentioned above, all windows except the Cafeteria are Plexiglas. Although Plexiglas has many good qualities, is it not a energy efficient material for use a exterior grade windows. Based upon published data, the U value for Plexiglas is only about one-third the current energy code minimum value for windows. Although significant energy savings would accrue through a window retrofit program, the cost would likely be prohibitive with paybacks in the 15 to 20 year range.