

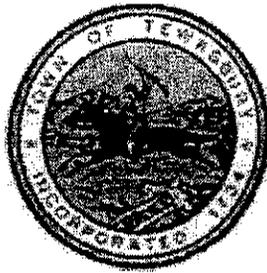
**Massachusetts Department
of Energy Resources**

**Energy Conservation
Improvement Program
Energy Audit**

The Town of Tewksbury

**South Fire Station
Tewksbury, MA**

March 17, 2009



Prepared by



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SECTION 1: EXECUTIVE SUMMARY

American Development Institute (ADI) has been retained by the Department 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 South Fire Station 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.



Based on our investigations, we do not recommend any energy conservation measures that involve replacement or installation of equipment or controls at the facility at this time. ADI does recommend, however, that the facility implement retro-commissioning of the building systems and controls in order to optimize the operation of the facility and document the control of the EMS. ADI estimates that this will lead to 883 kWh and 96 MBTU in savings, for a total of \$979.

Savings are summarized in Table 1.1 below.

Acknowledgements

The cooperation and assistance of Scott Durkee of the Massachusetts DOER and Ed Johnson 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	883	96	979	\$ 3,000	3.1	\$ -	\$ 3,000	3.1
Totals		883	96	979	\$ 3,000	3.1	\$ -	\$ 3,000	3.1

Introduction

Through the Energy Audit Program (EAP) offered by the Commonwealth of Massachusetts, Department of Energy Resources (DOER), technical assistance is provided for all buildings owned and operated by cities, towns, regional school districts and wastewater districts to identify capital improvements to reduce energy costs. The technical assistance provided by DOER includes an initial benchmarking of buildings and structures included in the application. Based on the results of the benchmarking, a detailed energy audit may be performed as well as a variety of feasibility studies to evaluate the potential to incorporate renewable energy sources. This comprehensive assistance provides communities with the knowledge needed to reduce energy consumption and associated financial resources.

The purpose of this audit report is to provide the program participant with a list of energy conservation projects, their costs and estimated energy savings. This information may be used to support a future application to DOER's Energy Conservation Improvement Program (ECIP), support performance contracting or justify a municipal bond funded improvement program. ECIP is a state funded grant program that provides funds for energy conserving capital improvements.

The approach taken in this audit included a thorough walk-through of the building(s) and associated systems and equipment, including both process systems and building systems. The major areas covered in the audit included the building envelope, process systems, electrical systems, HVAC systems, lighting systems and operational and maintenance procedures. A major element of the audit also included an initial interview and ongoing consultation with operational and maintenance personnel, as well as building occupants. This approach is critical to the quality of the audit process, since the input of building personnel is invaluable to the effort to obtain accurate information required for the audit.

The recommendations within this report are based on one year of submitted usage data, a site review and preliminary evaluation. The energy savings and energy production figures are projected estimates based on conceptual project upgrades, information gathered at the site, and from the historical utility information provided. The actual savings may vary from these estimates due to a variety of factors. The figures used for the cost of recommended upgrades are 'opinions of probable cost' and are intended to be used for feasibility purposes only. The recommended measures should proceed to detailed design and further re-evaluation followed by competitive bidding per the Massachusetts Procurement Guidelines. The resulting responses to the bid should be used for budget approval purposes. For more information see:

Office of the Inspector General, Municipal, County, District, and Local Authority Procurement of Supplies, Services, and Real Property, Publication No. CR-1520-170-200-09/06-IGO.

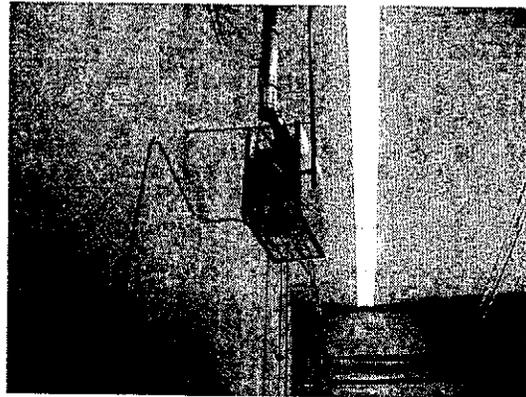
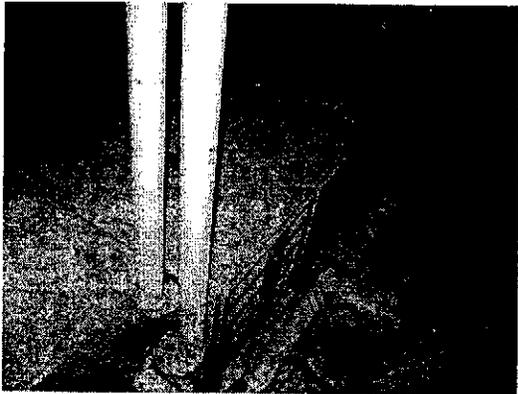
SECTION 2: FACILITY OVERVIEW

BUILDING DESCRIPTION

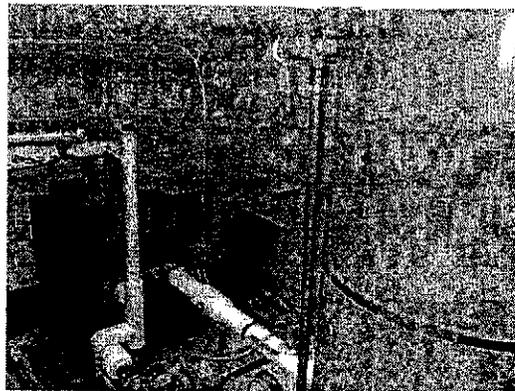
The South Fire Station building was constructed in 2001 with a total area of 7,480 ft². The facility is operated continuously. The exterior windows are double pane and are in good condition. The primary lighting systems in the facility are newer technology fluorescent T8 fluorescent fixtures.

The building is conditioned by a combination of gas-fired heating and ventilating units and split DX air conditioning units under the control of dedicated thermostats. Domestic hot water is provided by an gas-fired tank heater.

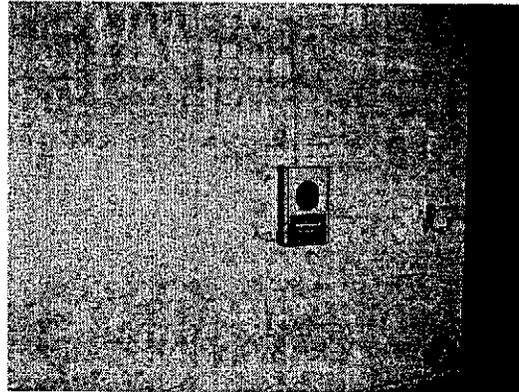
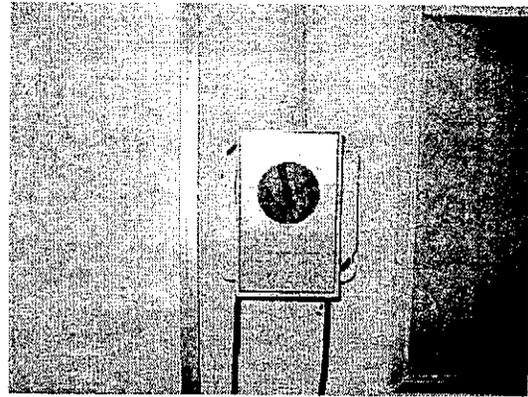
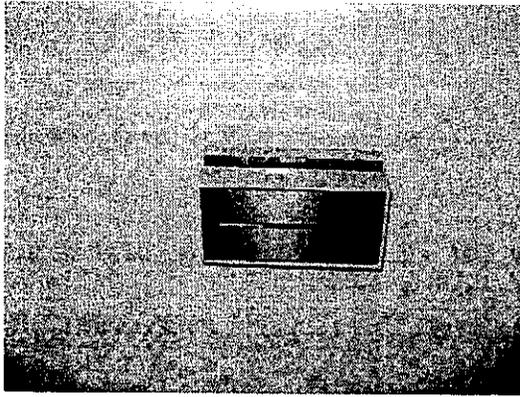
The Annual Energy Index (AEI) for the facility, as shown in the Facility Energy Profile, is 168,516 BTU/sf/year. This value is relatively high for a building in New England, but is most likely due to its hours of operation and the opening and closing of the fire truck bays, introducing unconditioned air into the facility each time.



Heating and Ventilating Units



Domestic Hot Water



Controls

ENERGY PROFILE

Based on the electric billing history for fiscal year 2007, the total electrical consumption for the facility was 88,290 kWh, with a total cost of \$12,122. Electricity is provided by NGrid Electric Company. ADI has utilized the average blended rate of \$0.1373 per kWh for our electric energy saving calculations.

The facility utilizes natural gas for heating, with an annual total of 959 MMBtu annually for a total of \$8,577. ADI has used the average cost of \$8.94/MMBtu for our energy savings calculations.

Table 2.1: Profile of Annual Energy Use

	Electric	Fuel	Total
Total Energy Usage	88,290 kWh	959 MMBtu	1,261 MMBtu
Total Energy Cost	\$ 12,122	\$ 8,577	\$ 20,699
Total Energy per sf	11.803 kWh per sf	0.128 MMBtu per sf	0.169 MMBtu per sf
Total Cost per unit	\$ 0.14 \$/kWh	\$ 8.94 \$/MMBtu	\$ 16.42 \$/MMBtu
Total Cost per sf	\$ 1.62	\$ 1.15	\$ 2.77

CLEAN ENERGY OPPORTUNITIES

The Commonwealth of Massachusetts is dedicated to promoting clean energy as an alternative to traditional sources of energy. As such, the DOER and other agencies have developed a number of programs to promote the use of clean energy sources by potentially providing technical assistance and/or financial incentives based on project feasibility. A brief discussion of the various programs is provided below, along with specific projects that may be appropriate for the respective technologies.

Solar Energy

Through the Commonwealth Solar Program¹, rebates are offered to encourage the installation of solar photovoltaic (PV) power by homeowners, businesses and municipalities. The rebate program is designed to help defray the costs that are associated with the installation of eligible systems from 20% - 60%. Rebate applications have been available since January 23, 2008. Incentives are greater for projects on public buildings and those that incorporate products manufactured in Massachusetts. The rebates are available for systems that will be directly owned by the applicant, as well as those financed through a third-party ownership model that takes advantage of federal and state tax credits. A total of \$68 million is available over the next four years. The following table provides the initial rebate levels:

Non-Residential Rebates for Incremental Capacity (\$/Watt)				
Incremental Capacity	First: 1 to 25 kW	Next: > 25 to 100 kW	Next: > 100 kW to 200 kW	Next: > 200 kW to 500 kW
Base Incentive	\$3.25	\$2.50	\$2.00	\$1.50
<i>PLUS: Additions to Base Incentives</i>				
Massachusetts Manufactured System	\$0.25	\$0.25	\$0.25	\$0.25
Public Building	\$0.50	\$0.50	\$0.25	\$0.25

Wind and Hydroelectric

The Massachusetts Technology Collaborative² (MTC) is a quasi-public agency and is the state's development agency for renewable energy. MTC offers a number of programs, including those that provide funding for wind and hydroelectric projects. The two primary programs are the Small Renewables Initiative (SRI) and the Large Onsite Renewables Initiative (LORI). The SRI provides rebates for the installation of wind and small hydroelectric projects that are up to 10 kW. Annual funding is approximately \$3.6 million and is provided on a "first come - first served" basis.

The LORI awards grants for feasibility studies and design and construction projects for projects that are greater than 10 kW. Feasibility grants are capped at \$40,000 with an applicant cost share of 15%. Design grants are capped at the lesser of \$125,000 or 75% of actual cost and construction grants are capped at the lesser of \$275,000 or 75% of actual costs.

¹ Web site: www.commonwealthsolar.org

² Web site: www.masstech.org

Wood Pellet Fueled Heating

On a periodic basis, the DOER accepts grant applications for wood pellet fueled heating systems³, which burn pellets made from renewable sources of energy such as compacted sawdust, wood chips, bark and agricultural crop waste. Funding is available to cities, towns, regional school districts, as well as water and wastewater districts. A maximum of \$50,000 per project is available for installation; however, applicants may propose greater grant requests, which will be considered based on the merits of the project and available funding. A total of \$525,000 is available for this program. The grantee is responsible for repaying 30% of the funds granted within one year of the completed installation.

Clean Energy Projects for the Town of Tewksbury

Based on the walkthrough that was performed as part of this audit, the Town of Tewksbury does not have *Clean Energy* opportunities at South Fire Station facility that could be pursued further. If a decision is made in the future to move forward on any *Clean Energy* opportunities, then the granting authority should be contacted for the respective program, as previously described. The typical process requires the submittal of an initial application. Once a preliminary approval is obtained, a more detailed technical assessment is performed to determine the specific costs and potential payback of the project. Often times, the granting authority will provide some level of funding to support this phase of the project. If there are any questions or further guidance required, please contact Scott Durkee at DOER, phone number (617) 727-4732 ext. 40156.

³ http://www.mass.gov/Eoca/docs/doer/pub_info/doer_pellet_guidebook.pdf

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
	Adjust Space Temperature and Humidity Setpoints	ECM 6	Reduce Operating Hours for Equipment and Machines	NO
		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
		ECM 10	Insulate Ceilings and Roofs	NO
BUILDING ENVELOPE	Reduce Heat Conduction Through Ceilings and Roofs	ECM 11	Install Vapor Barriers in Ceilings and Roofs	NO
		ECM 12	Install Reflective Roof Services	NO
	Reduce Solar Heat Gain Through Roofs	ECM 13	Insulate Walls	NO
		ECM 14	Install Vapor Barriers in Walls	NO
	Reduce Heat Conduction Through Walls	ECM 15	Insulate Floors	NO
		ECM 16	Install Storm Windows and Multiple-Glazed Windows	NO
	Reduce Heat Conduction and Long-Wave Radiation Through Glazing Areas	ECM 17	Insulate Movable Windows	NO
		ECM 18	Install Operable Windows	NO
		ECM 19	Install Exterior Shading	NO
	Control Solar Heat Gain Through Glazing Areas	ECM 20	Install Interior Shading	NO
		ECM 21	Use Tinted or Reflective Glazing or Films	NO
		ECM 22	Plant Shade Trees	NO
		ECM 23	Seal Vertical Shafts and Stairways	NO
	Reduce Infiltration	ECM 24	Caulk and Weatherstrip Doors and Windows	NO
		ECM 25	Install Revolving Doors or Construct Vestibules	NO

Section 3: Energy Conservation Measures

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	
	Improve Chiller Efficiency	ECM 31	Install Air Cleaners	NO	
		ECM 32	Install Local Ventilation Systems	NO	
		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 45A	Replace Boiler/Furnace	NO	
		ECM 45B	Install Pulse or Condensing Boilers/Furnaces	NO	
	Improve Air-Conditioner or Heat Pump Efficiency	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	
		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
			ECM 55	Install Economizer Cooling Systems	NO
	Use Energy-Efficient Cooling Systems	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	

Section 3: Energy Conservation Measures

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
	Reduce System Flow Rates	ECM 65	Insulate HVAC System Pipes	NO
		ECM 66	Reduce System Air Flow Rates	NO
		ECM 67	Reduce Heating/Cooling Water or Steam Flow Rates	NO
		ECM 68	Clean Air Filters in Ducts	NO
	Reduce Steam Resistance	ECM 69	Remove Scale from Water and Steam Pipes	NO
		ECM 70	Rebalance Piping Systems	NO
		ECM 71	Rebalance Ducting Systems	NO
Reduce Hot Water Loads	ECM 72	Design Ducting Systems to Reduce Flow Resistance	NO	
	ECM 73	Install Booster Pumps	NO	
	ECM 74	Reduce Hot Water Consumption	NO	
WATER HEATING SYSTEMS	Reduce Hot Water Heating System Losses	ECM 75	Lower Hot Water Temperatures	NO
		ECM 76	Preheat Feedwater With Reclaimed Waste Heat	NO
	Use Energy-Efficient Water Heating Systems	ECM 77	Insulate Hot Water Pipes	NO
		ECM 78	Insulate Water Storage Tanks	NO
		ECM 79	Install Decentralized Water Heaters	NO
LIGHTING	Reduce Illumination Requirements	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
	Install Energy-Efficient Lighting Systems	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
	Use Daylight	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
POWER SYSTEMS	Reduce Power System Losses	ECM 90	Install High-Efficiency Ballasts	NO
		ECM 91	Install Occupancy Sensors	NO
	Install Energy-Efficient Motors	ECM 92	Install Dimming Controls with Windows	NO
		ECM 93	Install Dimming Controls with Skylights	NO
		ECM 94	Correct Power Factors	NO
	Reduce Peak Power Demand	ECM 95	Install Energy-Efficient Transformers	NO
		ECM 96	Replace Oversized Motors	NO
	Reduce Peak Power Demand	ECM 97	Use High-Efficiency Motors	NO
		ECM 98	Use Variable Speed Motors	NO
		ECM 99	Use Load-Shedding	NO
ECM 100		Install a Cogeneration System	NO	
ECM 101		Install a Cool Storage System	NO	

Section 3. Energy Conservation Measures

Building System	Category	ECM#	ECM Name	Y/N
ENERGY MANAGEMENT SYSTEMS	Use Energy Management and Control Systems	ECM 102	Install Temperature Setup/Seiback 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
		ECM 110	Install Double-Bundle Chillers	NO
		ECM 111	Reclaim Heat from Boiler Blowdown	NO
MISC.	Heat Reclaim Systems	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
		ECM 121	Install Energy-Efficient Appliances	NO
	Appliances	ECM 122	Convert Electric Drivers to Natural Gas	NO
		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
	Domestic Water Conservation	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 building systems 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 option.

ECM #	Savings		Total Cost	Payback	Utility Funding (\$)	Net Cost	Net Payback	
	Electricity kWh	Fuel MMBTU						\$
	883	96	\$ 979	\$ 3,000	3.1	\$ -	\$ 3,000	3.1

MEASURES CONSIDERED BUT NOT RECOMMENDED

ADI reviewed the systems in the facility 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:

Lighting Fixture Retrofits

The existing T8 fluorescent lighting fixtures are now considered standard efficiency compared to today's technology. While newer high performance T8 systems would use somewhat less electricity, the small annual energy cost savings would not justify the retrofit costs. Care would have to be taken to ensure that light levels would be maintained. ADI recommends that new higher efficiency T8 systems be considered when the existing lamps and ballasts have reached end of life and require replacement.