

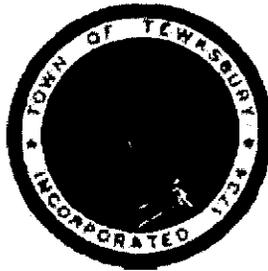
**Massachusetts Department
of Energy Resources**

**Energy Conservation
Improvement Program
Energy Audit**

The Town of Tewksbury Public Schools

**Tewksbury John Wynn Middle School
Tewksbury, MA**

May 15, 2008



Prepared by



**AMERICAN DEVELOPMENT
INSTITUTE**

2348 POST ROAD • WARWICK, RI 02886 • 401.524.5334 v • 206-309-0853 F

WWW.AD-INSTITUTE.COM

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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 John Wynn Middle 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 \$6,988, or 32,143 kWh and 179 MMBTU. These savings represent 4.3% of the present annual energy costs of \$160,846. With a total installed cost of approximately \$37,740, the overall project payback is 5.4 years. There may be utility incentives available from NGrid Electric Company, the electric utility company, for lighting occupancy sensors and efficient lighting retrofits, which will improve the retrofit payback to 4.3 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 \$0.1231 per kWh and \$16.90 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 John Quinn 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 | | 179 | \$ 3,032 | \$ 10,630 | 3.5 | \$ 10,630 | 3.5 | |
| ECM 87 | Use High-Efficiency Fluorescent Lighting | 25,415 | | \$ 3,128 | \$ 22,620 | 7.2 | \$ 17,100 | 5.5 | |
| ECM 91 | Install Occupancy Sensors | 6,728 | | \$ 828 | \$ 4,490 | 5.4 | \$ 2,190 | 2.6 | |
| Total | | 32,143 | 179 | \$ 6,988 | \$ 37,740 | 5.4 | \$ 29,920 | 4.3 | |

SECTION 2: FACILITY OVERVIEW

BUILDING DESCRIPTION

The Tewksbury John Wynn Middle School building was constructed in 1962 with additions/modifications made in 2003, comprising a total of 106,230 ft² of floor space. The building is of masonry construction with a brick exterior. The operating hours for the building are Monday through Friday from 7 am to 4 pm, with evening activities in the gym. The exterior windows double pane and are in very good condition. The primary lighting systems in the school are newer technology fluorescent T8 fixtures, except for the gymnasium, which is served by metal halide lighting systems. Exit signs are LED.

The building is heated by a central hot water system that is supplied by two gas-fired fire tube boilers. Terminal equipment consists primarily of unit ventilators in the individual classrooms, with associated cabinet unit heaters, fin tube convectors, and some heating and ventilating units. Administrative offices and the library are cooled by window air conditioning units. Domestic hot water is provided by gas fired water heater.

Temperature control systems are electric. A Honeywell Energy Management System (EMS) provides supervisory and scheduling control and monitoring of the boiler plant and the HVAC systems. ADI staff reviewed the operation of the EMS in the field including a review of the schedules implemented for unoccupied setback control. The building staff members are operating the EMS effectively with aggressive scheduling in place to maximize efficiency.

The Annual Energy Index (AEI) for the school, as shown in the Facility Energy Profile presented here, is 59,929 BTU/SF/Year. This value could be lower for a building of this type in the New England climate, reflecting a relatively lower level of energy efficiency.



Hot Water Boiler Plant



Energy Management System

ENERGY PROFILE

Based on the electric billing history for fiscal year 2006-2007, the total electrical consumption for the school was 814,184 kWh, with a total cost of \$100,201. Electricity is provided by NGrid Electric Company. ADI has utilized the average blended rate for the School of \$0.1231 per kWh for our electric energy saving calculations.

The facility utilizes natural gas for heating and domestic hot water, with an annual total of 34,830 ccf of natural gas annually for a total of \$60,645. ADI has used the average cost of \$16,90/MMBtu for our energy savings calculations.

Table 2.1: Profile of Annual Energy Use

| | Electric | Fuel | Total |
|---------------------|---------------------|-----------------------|-----------------------|
| Total Energy Usage | 814,184 kWh | 3,587 MMBtu | 6,366 MMBtu |
| Total Energy Cost | \$ 180,201 | \$ 60,645 | \$ 160,846 |
| Total Energy per sf | 7.664 kWh per sf | 0.034 MMBtu per sf | 0.060 MMBtu per sf |
| Total Cost per unit | \$ 0.12 \$/kWh | \$ 16.90 \$/MMBtu | \$ 23.27 \$/MMBtu |
| Total Cost per sf | \$ 0.94 | \$ 0.57 | \$ 1.51 |

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 periods*.
- 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/orders/frnElectricitySuppliers.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:

Section 3: Energy Conservation Measures

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 |
| | | 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 |
| | 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 |

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 |
| | | ECM 31 | Install Air Cleaners | NO |
| | | ECM 32 | Install Local Ventilation Systems | NO |
| | | ECM 33 | Clean Evaporator and Condenser Surfaces of Fouling | NO |
| | Improve Chiller Efficiency | 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 |
| | | ECM 37 | Clean Boiler Surfaces of Fouling | NO |
| | Improve Boiler or Furnace Efficiency | 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 |
| | Improve Air-Conditioner or Heat Pump Efficiency | 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 |
| | | ECM 52 | Install Variable Air Volume Systems | NO |
| | Reduce Energy Used for Tempering Supply Air | ECM 53 | Reset Supply Air Temperatures | NO |
| | | ECM 54 | Reset HotChilled 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 |

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 |
| | Reduce System Flow Rates | ECM 64 | Insulate Ducts | NO |
| | | 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 |
| | 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 |
| WATER HEATING SYSTEMS | Reduce Hot Water Loads | ECM 72 | Design Ducting Systems to Reduce Flow Resistance | NO |
| | | ECM 73 | Install Booster Pumps | NO |
| | Reduce Hot Water Heating System Losses | ECM 74 | Reduce Hot Water Consumption | NO |
| | | ECM 75 | Lower Hot Water Temperatures | NO |
| | Use Energy-Efficient Water Heating Systems | ECM 76 | Preheat Feedwater With Reclaimed Waste Heat | NO |
| | | ECM 77 | Insulate Hot Water Pipes | NO |
| | | ECM 78 | Insulate Water Storage Tanks | NO |
| | | ECM 79 | Install Decentralized Water Heaters | NO |
| | 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 | |
| ECM 83 | | Clean and Maintain Systems | NO | |
| ECM 84 | | Reduce Illumination to recommended levels | NO | |
| Install Energy-Efficient Lighting Systems | ECM 85 | Reduce Time of Operations | NO | |
| | ECM 86 | Use Task Lighting | NO | |
| | ECM 87 | Use High-Efficiency Fluorescent Lighting | YES | |
| | ECM 88 | Use High-Pressure Sodium Lighting in Selected Areas | NO | |
| | ECM 89 | Install Pulse Start Metal Halide Lighting in Selected Areas | NO | |
| Reduce Power System Losses | ECM 90 | Install High-Efficiency Ballasts | NO | |
| | ECM 91 | Install Occupancy Sensors | YES | |
| | ECM 92 | Install Dimming Controls with Windows | NO | |
| | ECM 93 | Install Dimming Controls with Skylights | NO | |
| | ECM 94 | Correct Power Factors | NO | |
| Install Energy Efficient Motors | ECM 95 | Install Energy-Efficient Transformers | NO | |
| | ECM 96 | Replace Oversized Motors | NO | |
| | ECM 97 | Use High-Efficiency Motors | NO | |
| | ECM 98 | Use Variable Speed Motors | NO | |
| 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 | |

Section 3: Energy Conservation Measures

| Building System | Category | ECMs | 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 |
| | | 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 Dryers 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 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 | | | Total Cost \$ | Payback yrs | Utility Funding (\$) | Net Cost \$ | Net Payback yrs |
|-------|--------------------|---------------|----------|------------------|----------------|-------------------------|-------------------|-----------------------|
| | Electricity kWh | Fuel MMBTU | \$ | | | | | |
| | 0 | 179 | \$ 3,032 | \$ 10,630 | 3.5 | \$ - | \$ 10,630 | 3.5 |

ECM 87: Use High-Efficiency Fluorescent Lighting

Measure Description

The existing lighting system in the gymnasium consists of 400 Watt metal halide fixtures. The replacement of these existing fixtures with new T5 HO systems would provide significant annual energy savings in addition to improvements in light levels and will also offer instant start to 100% light level, which is currently not available with the existing metal halide fixtures.

With an investment of \$22,620 and estimated annual energy cost savings of \$3,128, the payback for this retrofit will be 7.2 years. Incentives of approximately \$7,820 may be available from National Grid USA to improve the simple payback period for the retrofit to 5.5 years.

Economic Summary

The following table provides an economic summary of this ECM.

| ECM # | Savings | | | Total Cost \$ | Payback yrs | Utility Funding (\$) | Net Cost \$ | Net Payback yrs |
|--------|--------------------|---------------|----------|---------------------|----------------|-------------------------|-------------------|-----------------------|
| | Electricity kWh | Fuel MMBTU | \$ | | | | | |
| ECM 87 | 25,415 | 0 | \$ 3,128 | \$ 22,620 | 7.2 | \$ 5,520 | \$ 17,100 | 5.5 |

ECM 91: Lighting Control—Install Occupancy Sensors

Measure Description

The existing metal halide fixtures in the gymnasium require a warm up period before the lights operate at full lighting levels, requiring the fixtures to be operated for more hours than the gym is actually operated. Typically, the lights are turned on in the mornings and left on all day, regardless of the space usage. Retrofitting the gym lights to T5 technology will allow the lights to be controlled by occupancy sensors, which will greatly reduce the hours of operation. Incentives may be available from National Grid USA to improve simple payback periods. Costs and incentive calculations are based on fixture mounted sensors.

Economic Summary

The following table provides an economic summary of this ECM.

| ECM # | Savings | | | Total Cost \$ | Payback yrs | Utility Funding (\$) | Net Cost \$ | Net Payback yrs |
|--------|--------------------|---------------|--------|---------------------|----------------|-------------------------|-------------------|-----------------------|
| | Electricity kWh | Fuel MMBTU | \$ | | | | | |
| ECM 91 | 6,728 | 0 | \$ 828 | \$ 4,490 | 5.4 | \$ 2,300 | \$ 2,190 | 2.6 |

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 boilers and domestic water heater are only 5 years old and fairly efficient. They could be replaced with higher efficiency equipment to reduce fuel usage, however, due to the high capital costs involved in replacing boilers, the simple payback period would likely be in the range of 20 years.

Motor and Variable Frequency Drive Installations

In some facilities, the installation of premium efficiency motors and variable frequency drives (VFD's) can reduce energy costs. In the case of the High School, the existing electric motors that drive the HVAC systems are of relatively small HP. Generally, smaller HP motors do not lend themselves to cost-effective motor and VFD retrofit opportunities.

Lighting Fixture Retrofits

Classrooms, Corridors, and Office Areas – The existing lighting systems in these areas consist primarily of fluorescent lighting fixtures with T8 lamps and electronic ballasts. 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.