



CARPENTERS SHELTER

ENERGY SURVEY REPORT (ASHRAE LEVEL 1)

Prepared for:

*The City of Alexandria, T&ES Office of
Environmental Quality. Prepared with
funding from DOE's Energy Efficiency
& Conservation Block Grant.*

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Acronyms Defined

ASA - Alexandria Sanitation Authority
ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers
CBECS - Department of Energy's Commercial Building Energy Consumption Survey
CDD - Cooling Degree Days
CFL - Compact Fluorescent
DHW - Domestic Hot Water
DOE - Department of Energy
DX - Direct Expansion
ECM - Energy Conservation Measure
EPA - U.S. Environmental Protection Agency
EPR - Energy Performance Rating
F - Fahrenheit
gal - gallons
GPF - Gallons per Flush
GPM - Gallon per minute
HDD - Heating Degree Days
HID - High Intensity Discharge
HVAC - Heating Ventilation and Air Conditioning
kWh - Kilowatt-hour
T&ES - Transportation and Environmental Services
yr - year

1. Introduction

2rw Consultants, Inc. was contracted by the City of Alexandria's T&ES Office of Environmental Quality to conduct an energy survey of Carpenter's Shelter using funds provided by DOE's Energy Efficiency and Conservation Block Grant. The purpose of the survey was to identify potential low-cost, no-cost energy conservation measures that will result in a quick financial payback. This report presents the findings of the survey and includes a list of the measures identified along with typical savings ranges and payback periods. More capital-intensive energy conservation opportunities are also noted in the report; however, it is not within the scope of this survey to analyze these measures. It is recommended that a more comprehensive audit be completed to refine these opportunities and determine their financial and constructability feasibility.

2rw energy engineers were provided with some basic information about the building including utility usage and cost history. A utility analysis was conducted to gauge the potential opportunities that may exist in the building and refine the plan for the site visit. Next, a walk through of the facility was scheduled and completed to observe operations, verify equipment, and identify energy and water saving opportunities.

The survey resulted in the identification of several low-cost/no-cost conservation measures outlined in the table below. The particulars of these measures are outlined in Section 4.

Conservation Measure	Total Cost Savings [\$/yr]	Implementation Cost	Simple Payback [yr]
Programmable Thermostats	\$400-\$500	\$1,500	3-4
Washing Machines	\$2,000	\$12,000	6
Shower Heads	\$1,500-\$2,000	\$700	<1
Lighting Controls	\$500-\$1,500	\$6,500	4-13
Computer Power Management	up to \$75/computer	---	---
Vending Machine Controls	\$200	\$400-\$600	2-3
DHW Circulation Pump Control*	\$50-\$100	\$300-\$500	3-6

*May not be appropriate for Carpenter's Shelter

Section 5 presents a list of the more capital intensive energy and water conservation opportunities that require a more detailed analysis to refine into feasible energy and water conservation measures.

2. Existing Conditions

The Carpenter's Shelter is transitional housing located in Alexandria, Virginia. The building is two-stories and approximately 30,000 square feet.



Building Envelope

Carpenter's Shelter is constructed of walls with a brick façade on the exterior face. The roof is flat and likely consists of a rubber membrane over rigid insulation on top of a steel deck. The ground floor is a poured-in-place concrete slab. All glazing is double pane.

Building Occupancy and Usage

Carpenter's Shelter is generally at least partially occupied twenty-four hours per day. As transitional housing, individuals are required to have employment and children are required to attend school. As a result of these requirements, the staff indicated that during the hours of 9:00 AM to 5:00 PM on Monday through Friday the shelter is 60 to 70 percent unoccupied. All other times, the shelter is occupied by the residents.

The rear portion of the building is operated by David's Place, a member-based organization which provides meals, laundry, and shower facilities for homeless individuals. David's Place is generally open from 8:00 AM to 11:00 AM and again from 12:00 PM to 3:00 PM. During winter months, David's Place serves as an emergency shelter to provide sleeping accommodations for the homeless. When operating as an emergency shelter, David's place is open from 7:00 PM until 7:00 AM.

Heating Ventilation and Air Conditioning (HVAC)

Carpenter's Shelter is conditioned by three condensing gas-fired furnaces with direct expansion (DX) air conditioners and a gas-fired DX rooftop unit. All of the systems appeared to have been installed within the previous five years (some having been installed in 2011). The systems all were in good working condition. Each system is controlled by a non-programmable thermostat.



The area served by the rooftop unit was recently reconfigured to enclose a new conference room and new private offices. During this renovation, the HVAC system was not modified or rebalanced. As a result, the occupants of the private office reported to being consistently cold. This situation will require reconfiguration or renovation of the HVAC system to be alleviated.

Lighting & Electricity

Interior lighting is a combination of linear T8 fluorescent fixtures with electronic ballasts and compact fluorescent (CFL) fixtures. Most spaces are provided with manual switching; the newly renovated conference room and private offices are the exception and are provided with occupancy sensors.

Exterior lighting is high-intensity-discharge (HID) lighting, controlled by a combination of photocells and timers.



In the resident spaces, electronics are not allowed. There are two televisions in the children's playrooms; however, the devices are reported to be used sparingly. The offices occupied by case management and operations staff (director, deputy director, etc.) contain computers, printers, and other typical office equipment.

Each floor of the shelter is provided with three washing machines and three electric dryers. David's Place also has two washing machines and two electric dryers. There is a commercial kitchen in the building which is used to prepare at least two meals per day. Additionally, there are two refrigerated vending machines.

Water

Domestic hot water is supplied from two natural gas-fired, tank-type water heaters coupled with an additional storage tank. A circulating pump circulates domestic hot water through the building. Typical fixtures include 1.6 GPF toilets, 1.0 GPF urinals, 2.5 GPM shower heads, and 0.5 GPM sink aerators.



3. Utility Analysis

Energy Utilization Assessment

An assessment of energy efficiency has been determined based on the U.S. Environmental Protection Agency's (EPA) Energy Star Target Finder™ computer software. Target Finder™ uses information about a facility and its annual energy consumption to determine an Energy Performance Rating. The Energy Performance Rating (EPR) uses a scale from 1-100, with 100 being the most energy efficient. A building can receive an Energy Star ranking with an EPR of 75 or above. Target Finder™ is based on the US Department of Energy's Commercial Building Energy Consumption Survey (CBECS) data.

The EPA has defined three categories of EPR scores. The EPA recommends a different course of action for each category. The definitions of the three categories are quoted below from the EPA's website.

“Low ratings (1-49) - Greatest opportunities for investments

Buildings in this category have the most attractive returns for capital investments. Look for opportunities to upgrade lighting and other significant energy using systems, including system coordination. Renewing the commitment of senior executives to energy management will be an important component to your strategy.

Middle ratings (50-74) - Fine tune O&M

Buildings with mid-range benchmarks should consider low- or no-cost activities such as re-commissioning campus buildings, developing and implementing preventative maintenance plans, increasing employee training, or re-assessing incentive, recognition, and reward systems to ensure that they drive energy performance. Often, these relatively low-cost efforts can turn these facilities into "top performers".

High ratings (75-100) - Reward and Learn

Buildings within this range are among the highest energy performers compared to U.S. hospitals. Facility managers may consider sharing their energy management plans and operational strategies with other hospitals in their system. And they can continue to improve performance.”

SOURCE: EPA¹

Using the utility data provided by the building owner, a Target Finder™ EPR of 60 was calculated for the building. This indicates that Carpenter's Shelter is operating relatively efficiently but can still implement conservation measures which will help to further reduce energy consumption.

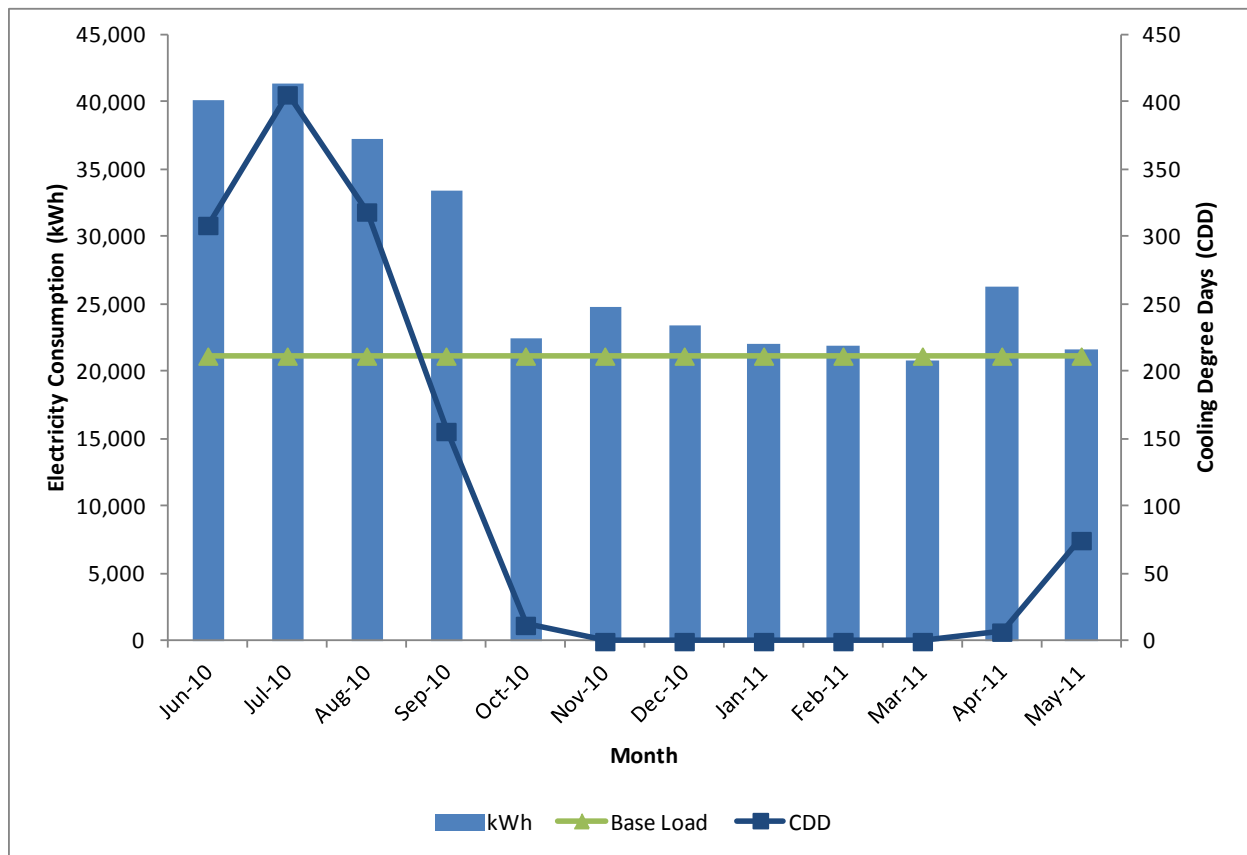
Electricity

Rates

The building receives electric service from Dominion Power. Over the past year, the average price of electricity was about \$0.08 per kWh. All electricity conservation calculations performed for this survey used a rate of \$0.08 per kWh.

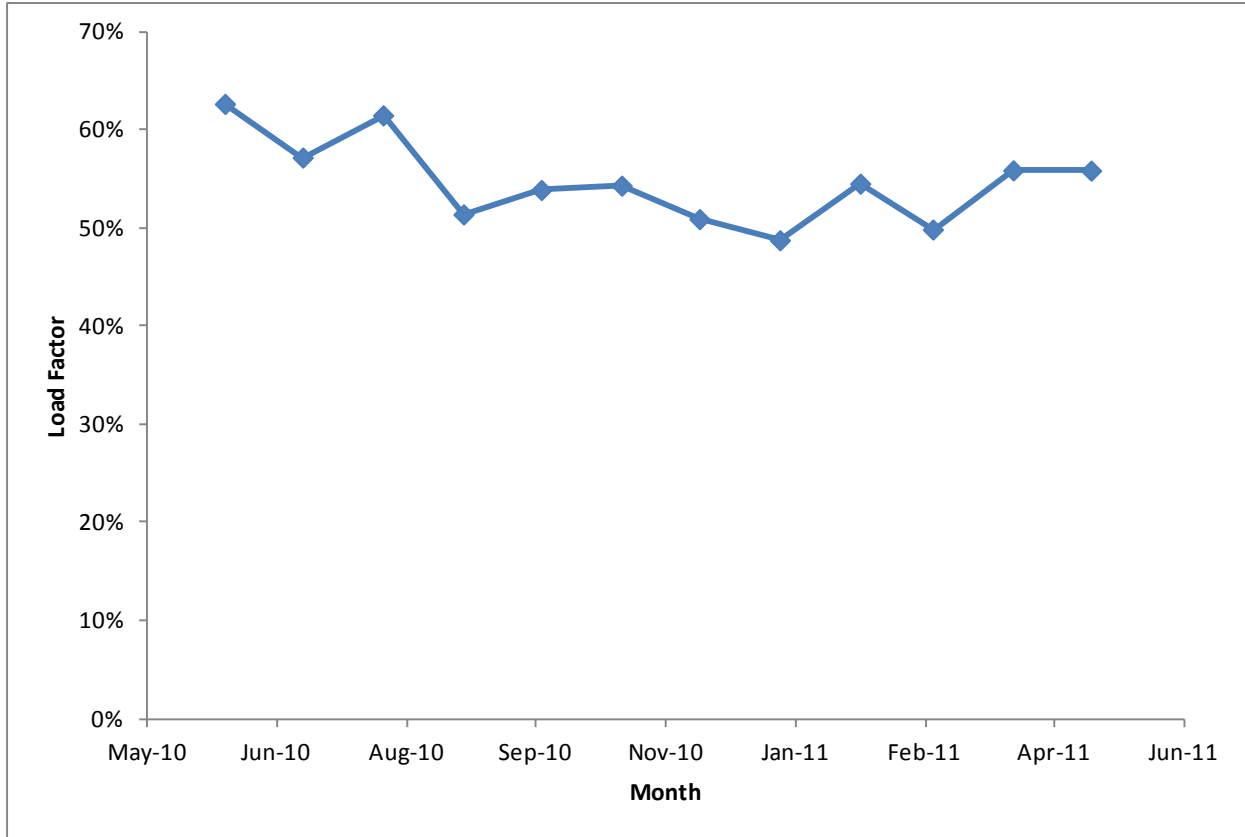
Trends in Electricity Use

The following chart plots the energy consumption for the most recent twelve months as provided by Carpenter's Shelter.



The chart of electricity consumption shows a weather-dependent peak during summer months due to the use of air conditioning. Additionally, it shows a constant base load of electricity use of 21,200 kWh. This consumption is attributable to lights, cooking, washing machines, clothes dryers, office equipment, and bed bug elimination cases.

The following figure presents the facility's load factor. Load factor is defined as the ratio of average electrical power usage within a system to its maximum or "peak power" usage. Plotting the load factor on a monthly basis creates a graphical representation of the electrical power usage in comparison to the peak electrical demand which can serve to help identify current usage profiles and building operation.



The load factor chart displays a slight seasonal variation is likely due to gas being used for heating while cooling is electric based. It may also indicate that cooling setpoints are not adjusted during unoccupied periods.

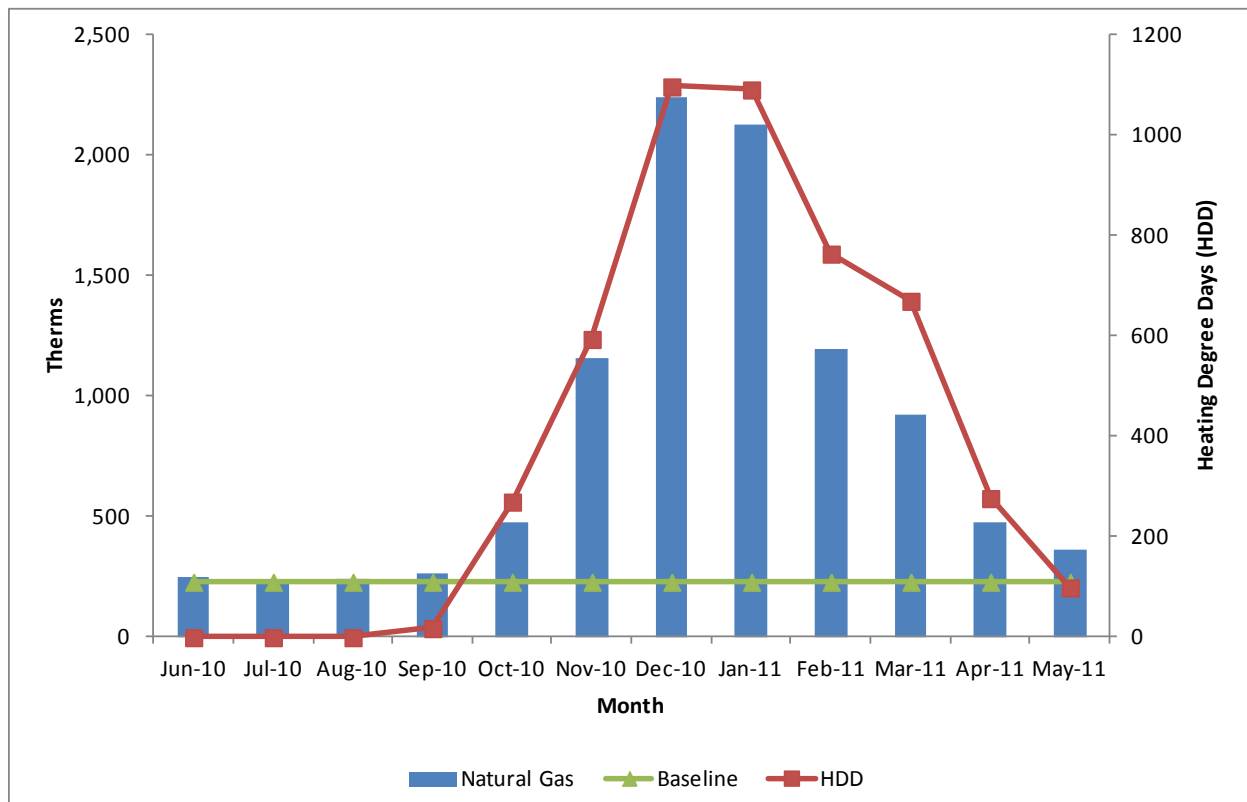
Natural Gas

Rates

The building receives natural gas from Washington Gas. Over the past year, the average price of natural gas for the building was about \$1.02 per therm (1 therm = 100,000 Btu). All natural gas conservation calculations performed for this survey used a rate of \$1.02 per kWh.

Trends in Gas Use

The following chart plots the natural gas consumption for the most recent twelve months as provided by Carpenter's Shelter.



A review of the chart reveals a significant seasonal component due to the use of natural gas for space heating. The base load of 230 therms is primarily due to domestic hot water production and some cooking energy.

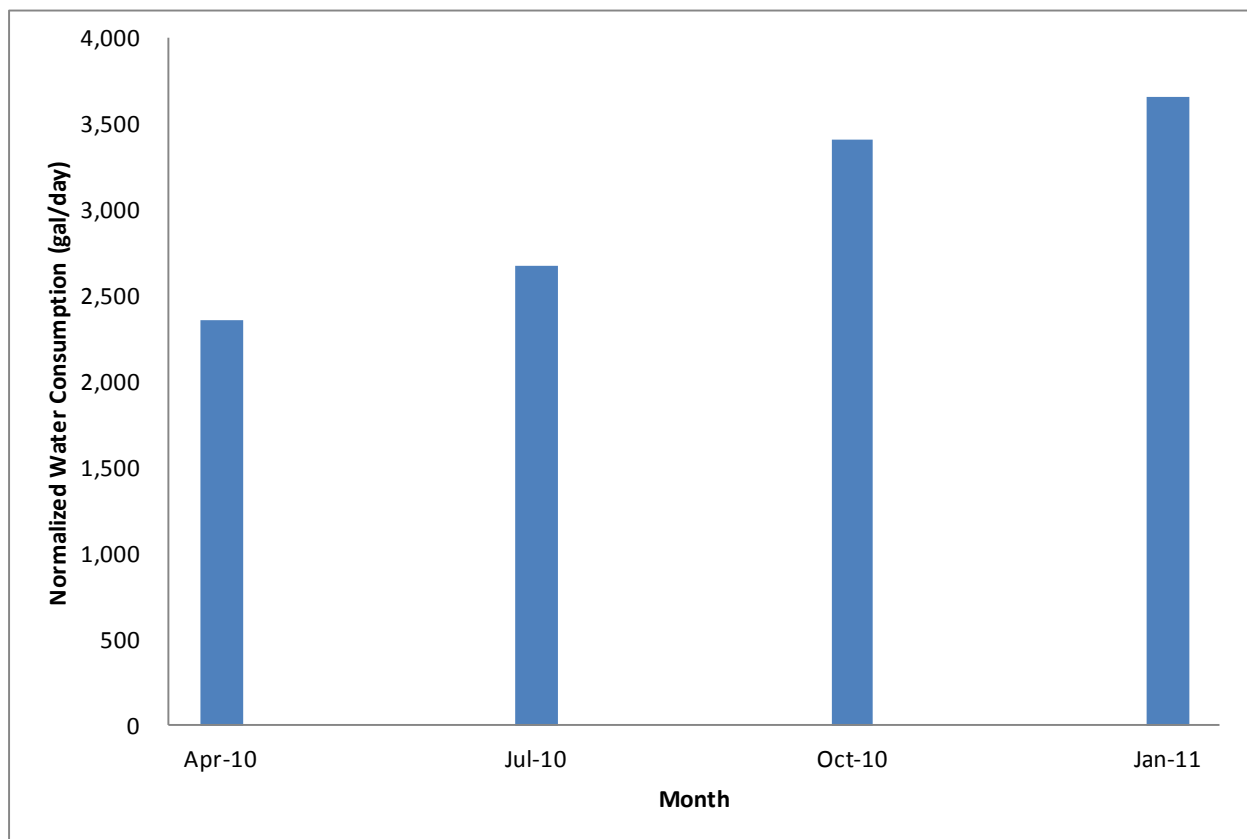
Water & Sewer

Rate Schedule

Water is provided to Carpenter's Shelter by the Virginia American Water Company and the sewer utility is the Alexandria Sanitation Authority (ASA). The average combined cost of water and sewer utilities is \$8.16 per thousand gallons. The ASA bill is calculated based on the total gallons purchased for consumption from VA American Water. All water conservation calculations performed for this survey used a rate of \$8.16 per thousand gallons.

Trends in Water Use

The following chart presents the most recent four quarters of water consumption as provided by Carpenter's Shelter.



The history of water use reveals the following trends:

- Water consumption has steadily increased over the past four quarters. This may be attributable to increased occupancy and operation or could indicate a more serious problem such as a leak.
- Average daily water consumption through the past year is approximately 3,000 gallons.

4. Low-cost/No-cost Energy Conservation Measures

During the walk through survey, 2rw's energy engineers identified the following low-cost/no-cost conservation measures. These measures should be implemented as soon as possible to achieve energy cost reductions.

Conservation Measure	Total Cost Savings [\$/yr]	Implementation Cost	Simple Payback [yr]
Programmable Thermostats	\$400-\$500	\$1,500	3-4
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Programmable Thermostats

Currently the HVAC equipment is controlled by standard thermostats (a combination of digital and bi-metallic). These thermostats are set once and maintain a single temperature regardless of how the space is occupied. By installing programmable thermostats, the temperatures can be automatically adjusted to a customized schedule as programmed by the user. Many current thermostats will allow for unique schedules on each of the seven days of a week. By installing a programmable thermostat to control each of the five heating systems, Carpenter's Shelter would be able to save an estimated \$400-\$500 per year. This analysis was based upon Carpenter's Shelter setting all units back between the hours of 10:00 PM and 9:00 AM, every day. The temperatures used in the analysis were as follows

Occupancy \ Mode	Heating	Cooling
Occupied (9:00 AM – 10:00 PM)	70°F	74°F
Unoccupied (10:00 PM – 9:00AM)	66°F	78°F

Based upon an estimated installation and programming cost of \$1,500 for all five programmable thermostats, this ECM would result in a three to four year simple payback.

Replace Washing Machines

The current top-loading washing machines are commercial units manufactured by Speed Queen. According to the manufacturer, each load consumes 36.7 gallons of water. Newer front-loading commercial washing machines, such as a Maytag MHN30PRAWW, consume only 12.4 gallons of water per load; or about one third as much. The current washing machines are used considerably as evidenced by high water bills. Based upon an estimated 30 loads of laundry per day, Carpenter's Shelter could stand to save as much as 700 gallons of water per day. Because some of the water used for laundry is hot water, natural gas savings are expected as well. Throughout a year, savings could amount to nearly \$2,000. Each new washing machine would cost approximately \$1,500 (\$12,000 to replace all eight) and the new washing machines would pay for themselves in approximately six years.

Replace Shower Heads

With approximately 80 residents and 40 daily visitors to David's place, showers are used frequently. Currently installed shower heads consume 2.5 gallons of water per minute. New shower heads have been developed to consume 1.5 gallons per minute while providing a similar shower experience. With an estimated 90 showers taken per day, Carpenter's Shelter could stand to save over 600 gallons per day by replacing the shower heads. Additionally, natural gas would be saved because showers consume hot water. Annual savings for replacing the shower heads would approach \$1,500 to \$2,000. With an estimated installed cost of \$50 per shower head (\$700 to replace all 14) the simple payback would be under one year.

Occupancy-based Lighting Controls

Vacancy sensors automatically turn lights off in an unoccupied room and require manual input to turn the lights back on. This improves energy savings over occupancy sensors which automatically turn lights on and off based on occupancy. Vacancy controls should be installed in all break rooms, conference rooms, private offices, sleeping quarters, play rooms, and the library. Additionally, occupancy sensors should be installed in all open offices, mechanical/equipment rooms, restrooms, and laundry rooms. This typically reduces the energy consumption of the controlled light fixtures by 10-25 percent or an estimated \$500 - \$1,500 per year at Carpenter's Shelter. The cost of vacancy and occupancy sensors varies from \$150 - \$400+ depending on whether they are infrared (requires a line of sight), ultrasonic (better for areas with partitions in the space such as a bathroom or sleeping quarters), switch-mounted (suitable for smaller spaces such as private offices, equipment rooms, and laundry rooms) or ceiling mounted (better for larger spaces such as bathrooms, sleeping quarters, and the library). Occupancy and vacancy sensors will generally result in simple paybacks ranging from 4 to 13 years depending on the type of room, type of sensors required, and number of sensors required to cover the room. Wireless technologies such as those manufactured by Leviton may simplify the installation process.

Computer Power Management

Implementing automatic computer power management can produce significant savings. Most operating systems (e.g. Microsoft Windows) have customizable power settings to allow for the computer to enter a reduced power state after a defined period of idling without input. These settings can result in \$15-\$75 of savings per computer per year depending on how aggressive the settings are and the current operation.

Automatic Vending Machine Controls

Vending machines constantly consume power, even when people are not around to purchase their goods. VendingMiser is a product which can be installed on existing vending machines to significantly reduce power consumption by turning off lights and controlling temperatures to modified levels when no motion is sensed. These devices can save as much as \$100 per year per vending machine and result in a simple payback ranging from 2-3 years.

Domestic Hot Water Circulation Pump Control

When domestic hot water is constantly circulated throughout a building, the hot water is always losing heat. This requires the water heaters to work harder and consume additional energy. Time clocks can be installed to automatically turn off the circulation pumps in domestic hot water systems during unoccupied or sleeping hours. By shutting down these pumps, water is not constantly circulated throughout the building losing heat at night. The installation of these time clocks typically results in a simple payback ranging from 3 years to 6 years. While this measure may result in savings, it may not be appropriate for Carpenter's Shelter which always has people in the building.

5. Further Energy Conservation Opportunities

Based upon the walk through survey, 2rw identified the following additional opportunities which may result in additional energy savings, but require a much more significant capital expenditure. It is beyond the scope of this survey to analyze the potential costs and savings associated with these opportunities. Should Carpenter's Shelter desire to further enhance the energy efficiency of the building, a more detailed ASHRAE Level 2 or 3-type energy audit should be completed to better develop these opportunities.

- Implementation of variable air volume system to serve the cafeteria, new conference room, and new private offices
- Instantaneous/distributed DHW generation
- Demand control ventilation to automatically adjust fresh air intake to match space occupancy
- Day light harvesting (dim electrical lighting in concert with natural day light provided to the space to maintain constant illumination levels)
- Toilet and urinal replacements
- Building envelope improvements
 - Roof insulation
 - Window replacements
 - Wall insulation
- Assessment for heat recovery opportunities
 - Air-to-air enthalpy wheels
- Renewable energy technologies
 - Photovoltaic panels
 - Solar thermal water heating
 - Solar thermal air preheating
 - Micro-wind turbines