Windham Public Library Energy Assessment Report

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2. Project Description

The building, originally built in 1981 at about half its present size, was a 3,392 square foot wood framed two story building. It was expanded and renovated in the mid 1993 to its present size of 7,000 SF. The ground level east wing rests on a poured concrete foundation that has a finished space for book stacks and reading, the west wing is above grade with public facilities and a meeting room. The upper level is offices, work rooms, book storage, computer facilities and reading space. The facade of the building is wood clapboards with wood trim and the roof is asphalt shingles. Some of the windows have been replaced with newer vinyl thermo-pane double hung windows. The interior has been renovated, is painted drywall with wood trim, the floors are mostly carpet with some tile and acoustical tile ceilings.

The front entrance of the building faces a north easterly direction. The building presently serves as the library for the town.

3. Executive Summary

3.1 Introduction:

This report details the recommendations and findings of the audit report conducted for the Windham Library, located at 217 Windham Center Road in Windham, Maine. The initial site visit was conducted on February 26, 2011 and completed on March 2, 2011. At the time John Monaghan met with Ben Smith, the Assistant Town Planner and David Dickerson, the Public Works Supervisor.

This assessment recommends nineteen (19) Energy Conservation Measures (ECMs) addressing the electric and # 2 fuel usage; increasing comfort and cost savings. Details of the findings and recommendations are contained in the assessment.

The priorities are to improve the building envelope, improve the lighting, improve the heating system controls and add a timer to hot water system.

3.2 Identified Energy Conservation Measures:

1. Energy Efficient Lighting

a. **Re-ballast &re-lamp the existing T12 fixtures to T8's**
b. **Install occupancy sensors**
c. **Install a switch for bi level lighting**
d. **Replace HPS exterior fixtures lamps with LED replacement lamps**
e. **Replace HPS exterior fixtures with LED's**

2. Building Envelope Improvements

a. **Provide general air sealing throughout the building**
b. **Apply 2" of spray foam insulation at the rim joist**
c. **Retrofit the insulation at the steel columns in the lower level walls**
d. **Replace four windows**
e. **Air seal around window frames**
f. **Replace the meeting room door**
g. **Retrofit the front entrance door**
h. **Provide insulated and weather stripped attic hatches**
i. **Retrofit and replace the attic insulation in the older section of the building**
j. **Retrofit and insulate the elevator shaft in the attic**
k. **Insulate the diffusers in the attic**

3. Heating System

a. **Install an outdoor reset**
b. **Install programmable thermostats**

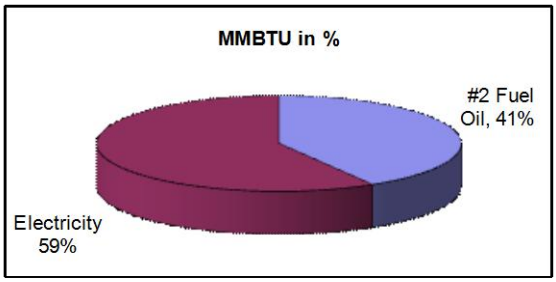
4. Domestic Hot water

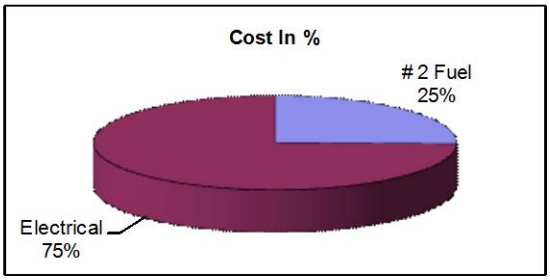
a. **Add a seven day timer**

4. Energy Usage

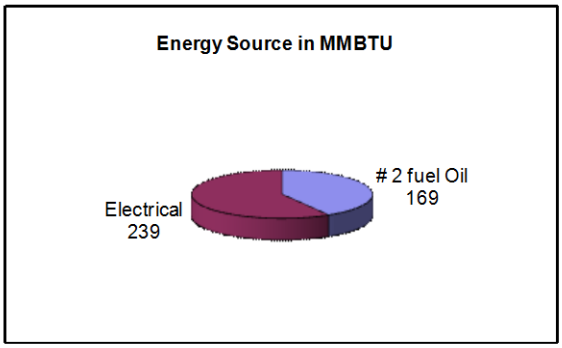
The energy usage of the building is from two sources: electricity for lighting, domestic hot water, air conditioning and power; and #2 fuel oil for heat.

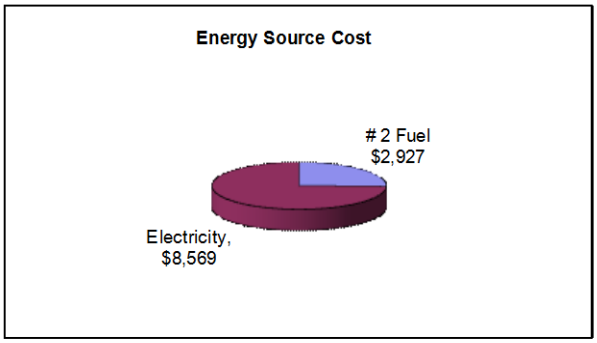
The first series of pie charts show the energy usage in percent for both BTU's, the common energy measurement unit and as the cost of energy.





The second series of pie charts shows the energy usage in millions of BTU's (MMBtu) and the cost in dollars.





As shown in the pie charts, electricity accounts for the greater portion of the energy usage in cost, $ 8,569 or 75% in dollars and is the greater in energy units, 239 MMBTU or 59 % of the BTU's. This illustrates the higher cost of producing electric energy.

4.1 Historic Energy Consumption

1. Electrical

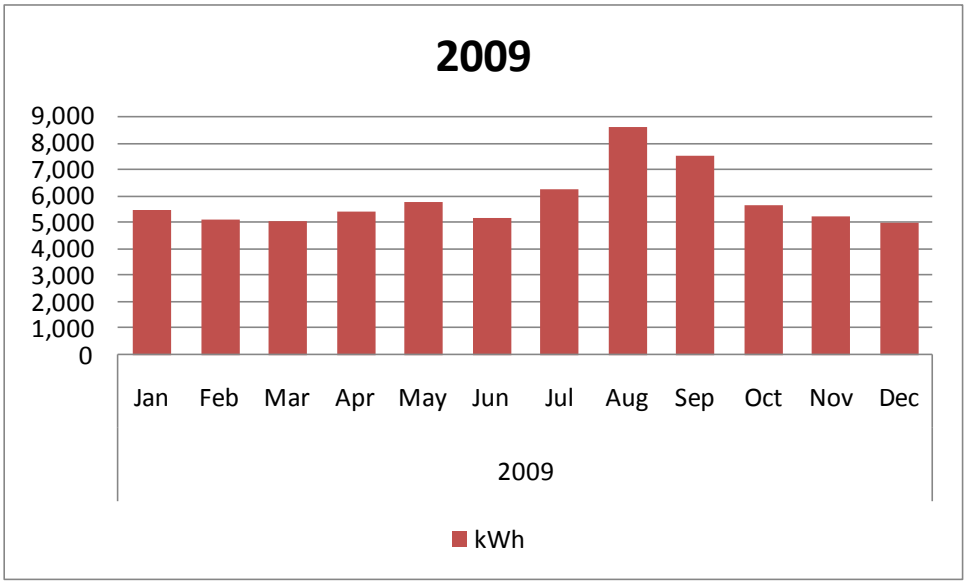
Usage is shown in the table and graph below for the year 2009. The baseline average monthly consumption is about 5,200 kWh/month based on June.

The monthly usage increased beginning in July reflecting the use of air conditioning, but did not return to the expected usage until November. This could have been caused by a longer meter reading cycle.

Electrical use per square foot is 10.01 kWh as compared to the New England average of 10.8 kWh which is 93% of the average for commercial buildings in New England. This is below the New England average but higher than other municipal buildings that have been assessed in Maine. Lighting is estimated to account for 63% of the electrical use, DOE data indicates the average commercial building uses about 38% of its electricity for lighting and the disparity helps explain the higher electrical use.

Lighting presents the greatest opportunities to improve the electrical usage.

Windham Library			
Electricity Usage-2009			
		kWh	Cost (incl demand)
2009	Jan	5,473	911
	Feb	5,110	903
	Mar	5,035	779
	Apr	5,409	564
	May	5,747	621
	Jun	5,190	592
	Jul	6,233	717
	Aug	8,551	960
	Sep	7,501	830
	Oct	5,643	616
	Nov	5,216	519
	Dec	4,959	556
	Total	70,067	$8,569
12 Mo	Avg	5,839	$714
Avg	$/kW		$0.12

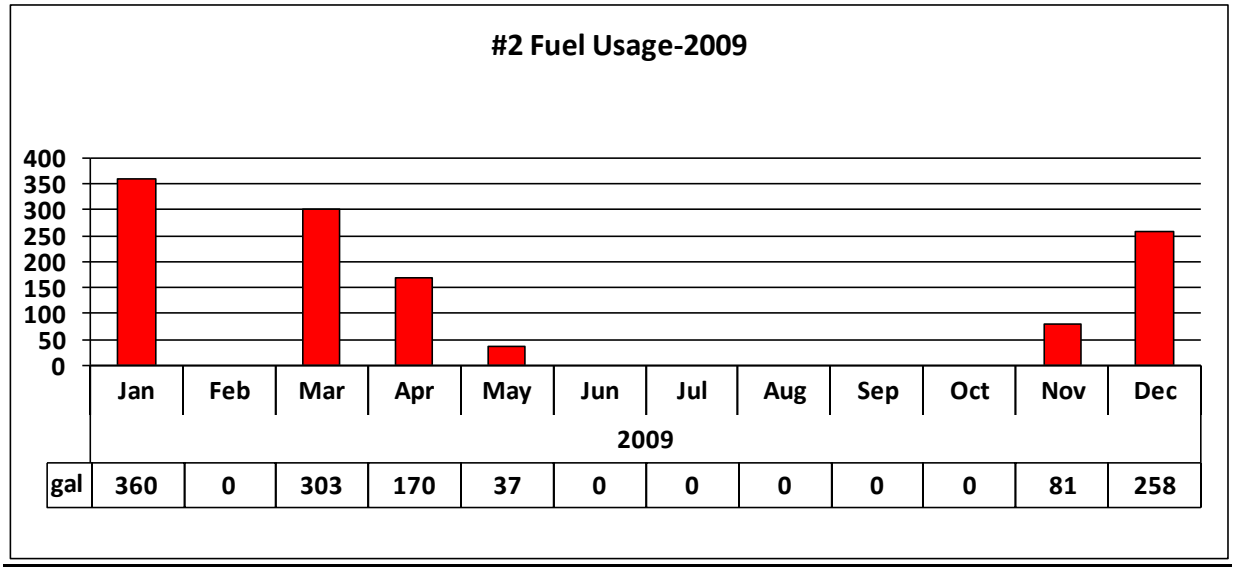


2. # 2 Fuel

The # 2 usage for the last year, beginning in January 2009 and ending in December of 2009 is shown below in the table and graph. The oil usage mostly coincides with the colder winter weather.

The fuel oil usage on a square foot basis is .17 gals/SF as opposed to .32 gals/SF and 24,180 BTU/SF as opposed to 44,480 BTU/SF, or 54% of the average for commercial buildings in New England.

Windham Library			
#2 Fuel Usage-2009			
		gal	cost
2009	Jan	360	942
	Feb	0	0
	Mar	303	794
	Apr	170	445
	May	37	71
	Jun	0	0
	Jul	0	0
	Aug	0	0
	Sep	0	0
	Oct	0	0
	Nov	81	0
	Dec	258	675
	Total	1,209	$2,927
Month	Average	101	$244
$/gal	Average		$2.42



The heating season for 2009 was about 13% warmer than the average heating season for the greater Portland area based on Heating Degree days which adjust the gals/ SF to almost .2 and the Btu's to 27,323. The amount of heat generated from lighting can also help explain the lower oil usage for heating.

4. Building Envelope

As stated the building, originally built in 1981, was expanded and renovated in 1993 to its present size of 7,000 SF. The older section of the building walls are 2x4 framing with 3.5" of batt insulation at the upper level and the newer section has 2x6 framing and 5.5" of batt insulation at both levels. At the ground level of the 1981 section of the building there is a combination of full height concrete walls that are built out with 1 1/2" of rigid insulation nested between the studs placed on the flat or wood framed walls with what appears to be 6" of batt insulation. The rim joist has poorly fitted batt insulation in a number of locations which does not provide much insulating or air sealing value. The newer section of the building at the lower level is better insulated, but the rim joist is also insulated with batt insulation. It is recommended that the batt insulation be removed where ever accessible, especially in the older section of the building, and replaced with 2" of closed cell spray foam insulation. This will more than double the present insulation value, provide air sealing and a moisture barrier

for rim joist which is a major source of heat loss for buildings. During the infrared scan of the lower section two areas of cold were noted. One was at the south wall in the story time room and the other in the west wall of the meeting room. Removal of the ceiling tiles revealed a steel beam supported by a steel column in the wall that is poorly insulated and shows a chimney affect within the wall cavity. It is recommended that the wall be opened at these locations and they be insulated with 3" of closed cell spray foam insulation. Not only is this a heat loss issue, but it is also a source of condensation within the wall cavity and potential mold growth.

The library staff expressed concerns about the windows being drafty. At the ground level of the older section of the building both of the windows were found to be in need of replacement, showing signs of moisture and air infiltration. These are older generation double paned windows. The sills of the windows were close to the ground level particularly on the east side. It is recommended that these windows be replaced and their height be reduced to raise the sills. An awning window should be considered. At the upper level of the older section of the building the windows are also older generation double paned windows, two are in poor condition. Replacing all the windows would improve the heat loss and air infiltration through the windows. Window replacement solely based on improved energy efficiency rarely has a good payback, but when coupled with maintenance and replacement costs energy efficient windows can become a worthwhile investment. It is recommended that the four windows in poor condition be replaced and the remainder of the older windows be considered for replacement.

An infrared scan of the newer windows revealed some air infiltration at the windows themselves but more infiltration at the perimeter. The perimeter infiltration is likely due to poor air sealing between the window frame and the rough opening. It is recommended that the trim be removed from the window to inspect the situation. If no insulation is found or if batt is stuffed into the gap between the frame and rough opening then foam insulation can be applied to the gap around the perimeter of the window and caulk be applied to the back of the trim when it is reinstalled. A skilled carpenter can usually perform this work without damaging the trim. It is recommended that this be done at the offices and locations where occupants sit next to the windows for extended periods of time. At the other windows the perimeters and joints between the trim and window to sash edge should be caulked to reduce air infiltration.

A visual inspection and infrared scan of the doors revealed considerable air infiltration at the side door to the meeting room. It is recommended that it be replaced with a commercial grade door with an R-12 value. Both interior and exterior doors at the vestibule show signs of considerable wear resulting in air infiltration. It is time consuming and costly, as doors such as these require considerable maintenance and adjustment to keep them tight. Replacing them with more efficient doors should be considered as part of an ongoing maintenance program. At the side panels and entrance perimeter the joints should be caulked, and installing an interior insulated panel at the side lights is recommended. The fact that the library has a vestibule, considering the foot traffic, is a major energy saver.

Inspection of the 1981 section attic area revealed the suspended acoustical tile ceiling to be about 1' below the ceiling joists, there was no pressure or moist barrier at the ceiling joist other than the foil face on the 6" batt insulation nested between the joist. The batt insulation is not well fitted, as revealed in the infrared scan and visual inspection. It is topped with blown in fiber glass, which appears to have been added during the addition to the Library and the depth ranges from 0" to 10", but averages 4" to 6". The effective R-value in the better locations is estimated to be R-18 and the poorer locations R-0. Several locations had the insulation pulled back; there is little or no insulation around the diffusers and no cover or insulation at the access hatch. These situations help create a stack effect in the building, drawing in cold air in the winter that has to be heated and warm air in the summer that has to be cooled.

The insulation at the older section of the building seems to taper at the wall eave intersection, there is no means to vent the air from the eave overhang to the attic and no air block. It is likely the batt insulation at the wall is not tightly fitted at the top of the wall. All of this causes heat loss, air infiltration and contributes to the ice dams that are occurring.

At the ceiling above the old section of the building a pressure and moisture barrier needs to be installed, the insulation improved, gaps filled in, the diffusers insulated and insulated hatches installed. The best measure would be to install a layer of drywall on the underside of the ceiling joists, fire tape it and apply a coat of moisture resistant latex paint, but this would be costly and interfere with the operation of the library. It is recommended that the existing insulation be removed, Dens-glass be cut and fitted between the ceiling joist, the edges sealed and 10" of blown in cellulose to achieve an R-38, the current energy code standard. Most of this can be done from above the ceiling. At the diffusers the perimeter will need to be wrapped, the top of the diffuser covered and the flexible duct protected before blowing in

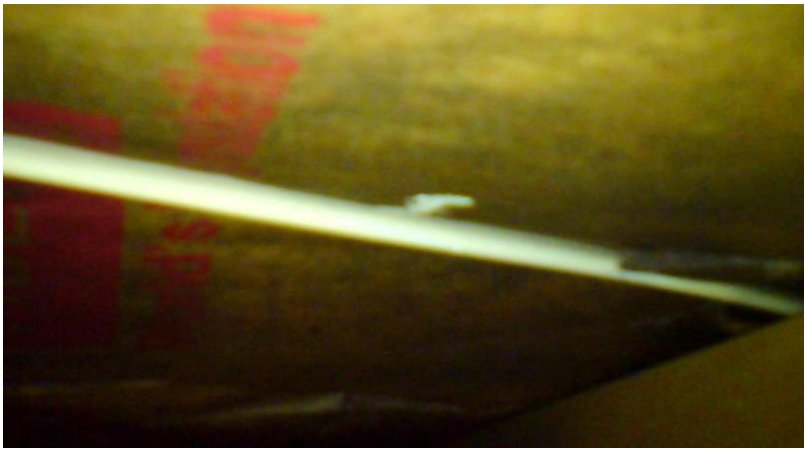
insulation. At the eave /wall intersection, proper vent and an air block should be installed to channel the air from the soffit and prevent the insulation from going into the overhang. Air sealing at all of the penetrations should occur before blowing in the cellulose. A code compliant air barrier around the chimney should be installed and the access to the attic should have an insulated and weather stripped hatch.

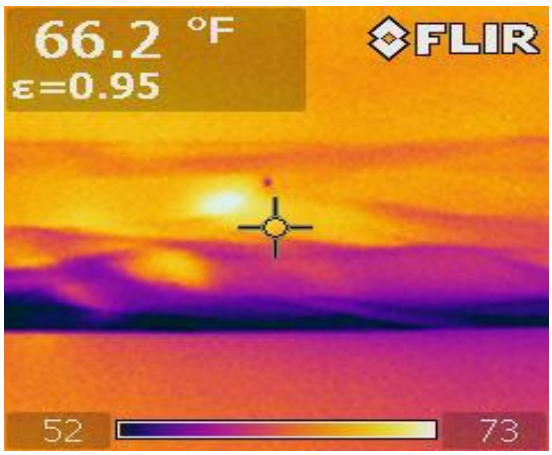
The ceiling above the new section ceiling has a layer of ploy, which acts as a pressure and moisture barrier except where it is penetrated, 6" of batt insulation and 6" to 8" of blown in fiber glass with an estimated effective R value of R-32. There are some areas where the insulation has been pushed back, which needs to be repaired. The upper portion of the elevator shaft is not insulated, the perimeter has no air barrier, and there is little or no insulation around the diffusers and no cover or insulation at the access hatch.

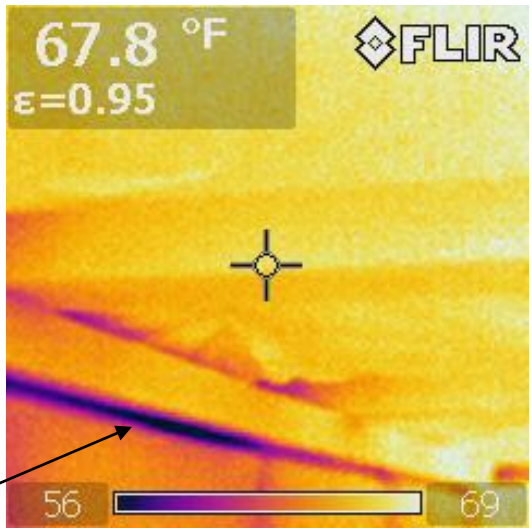
It is recommended that the penetrations to the moisture/pressure barrier be repaired, the areas where the blown in insulation has been disturbed be fixed, voids at the elevator shaft should be repaired, and the shaft should be covered with rigid insulation to a thickness that will result in an R- 20 on the sides and R-30 on the cap. In addition the diffusers will need to be protected before blowing in insulation. The access to the attic should have an insulated and weather stripped hatch.

General air sealing of any penetrations, gaps and voids that are accessible is recommended for attic, walls and foundations.

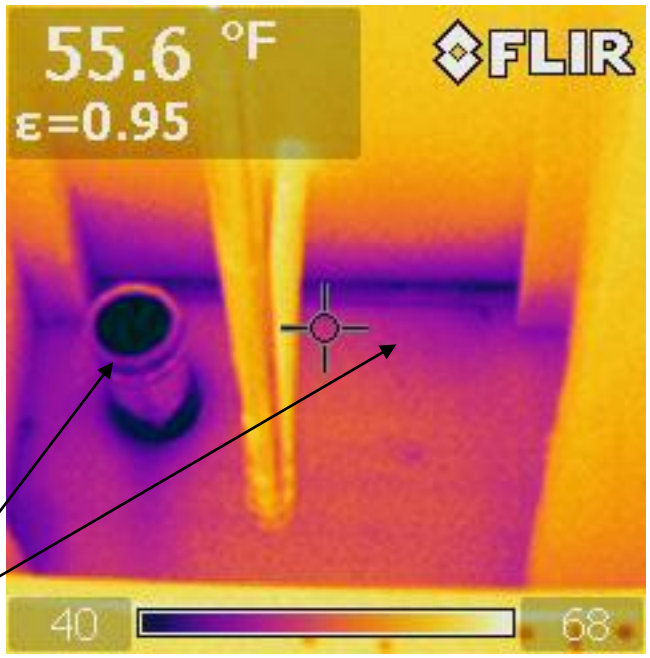
The purpose of including the following photos is to offer a visual representation of the present condition of the building envelope so the reader may have a better understanding of the situation and why the recommendations are being made.



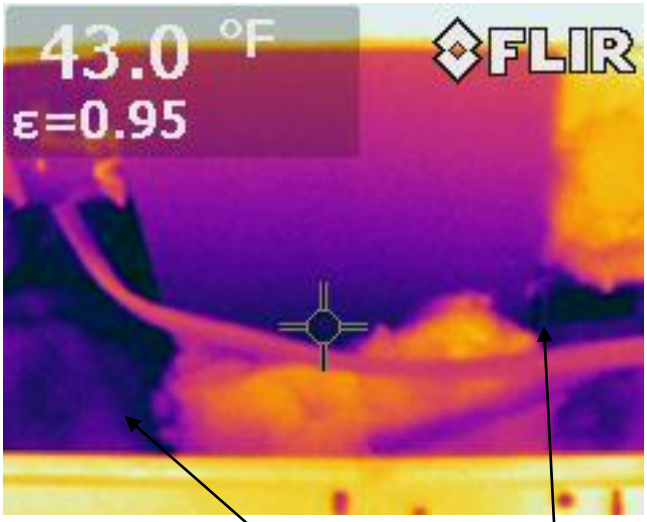


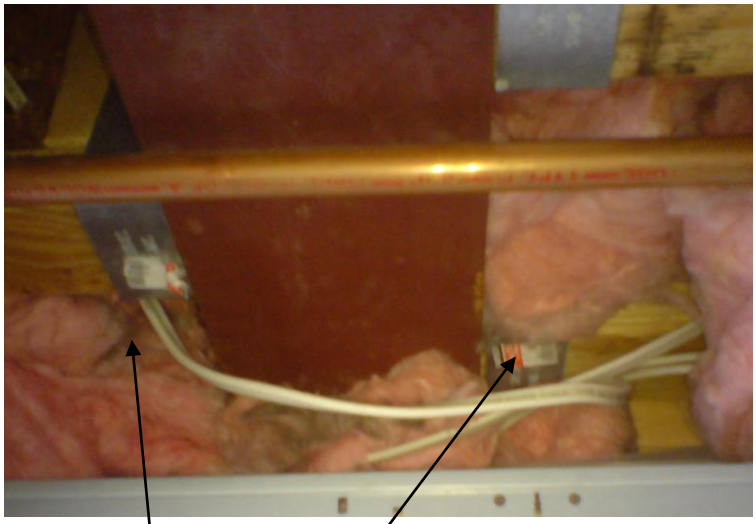


Rim joist at older section west side showing cold & air infiltration- spray foam recommended

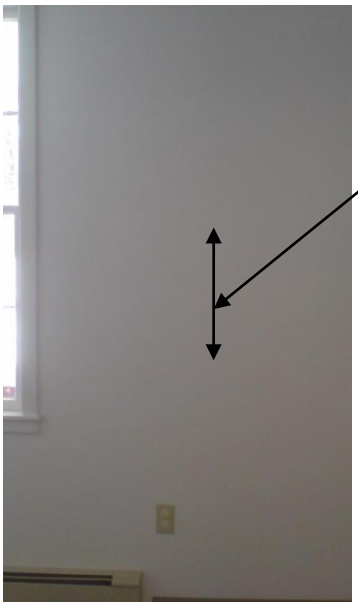


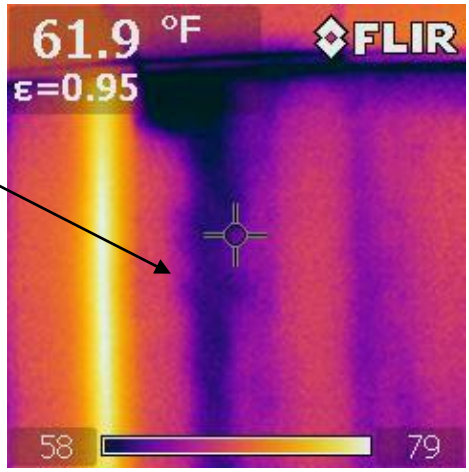
Rim joist at story time room showing lack of insulation & open pipe with cold air infiltration and heat loss

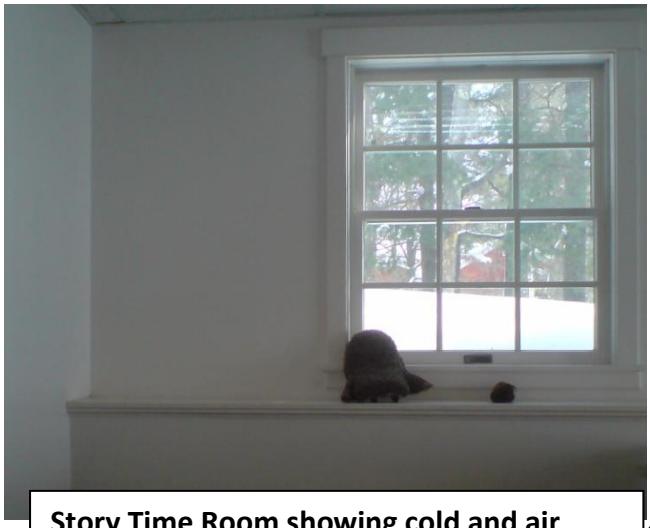


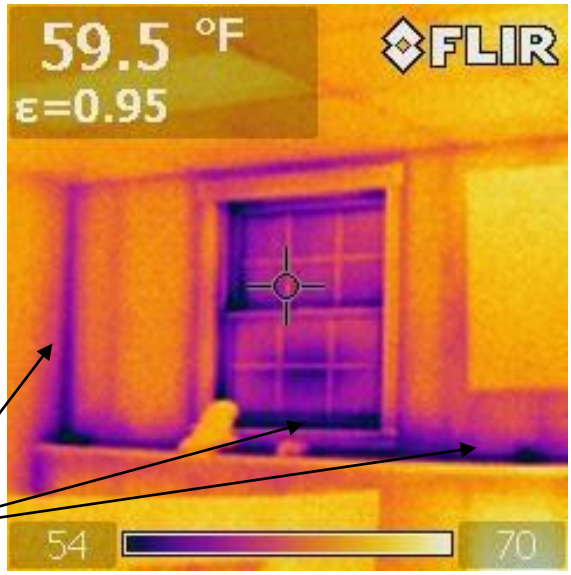


Steel beam and column in Story Time Room- note cold, air infiltration & moisture potential

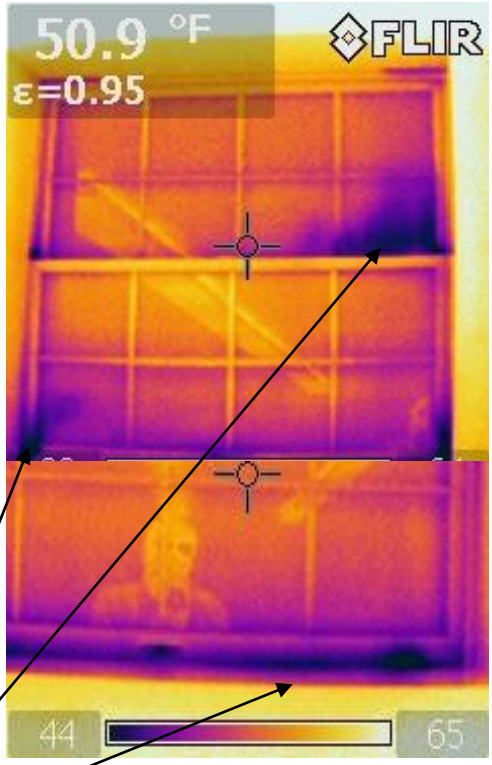




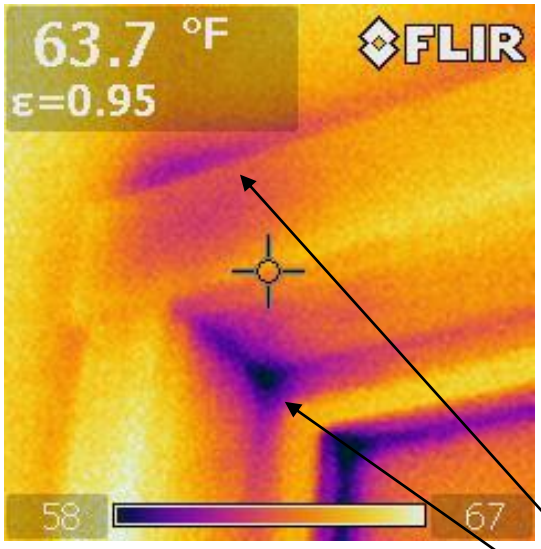


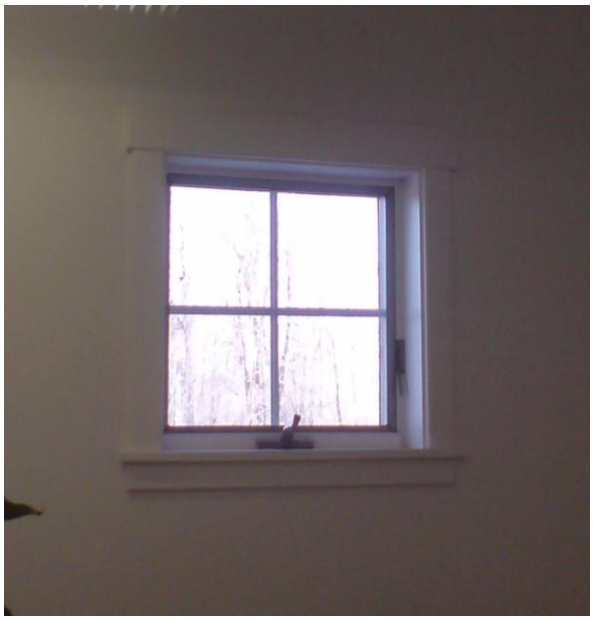


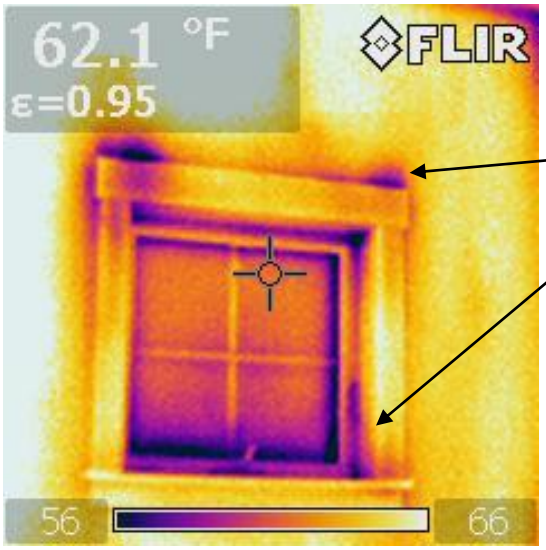
Story Time Room showing cold and air infiltration at window & foundation wall – air sealing & foam are recommended



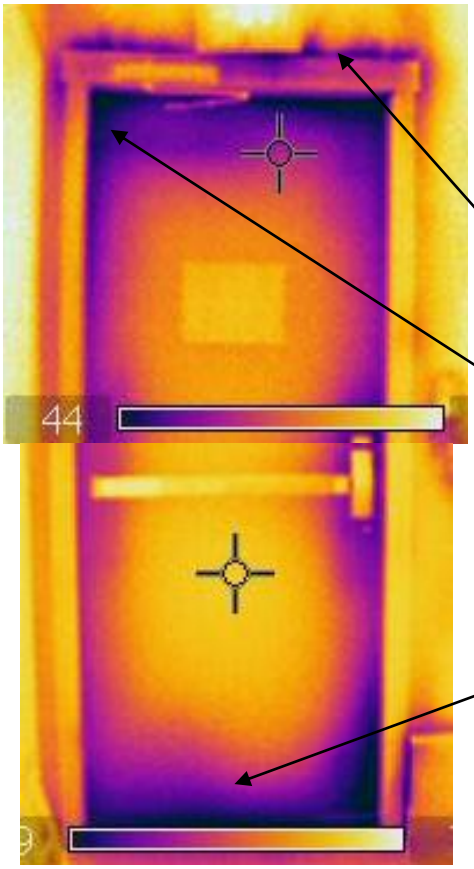
East window lower level showing low sill, cold & air infiltration- window replacement recommended



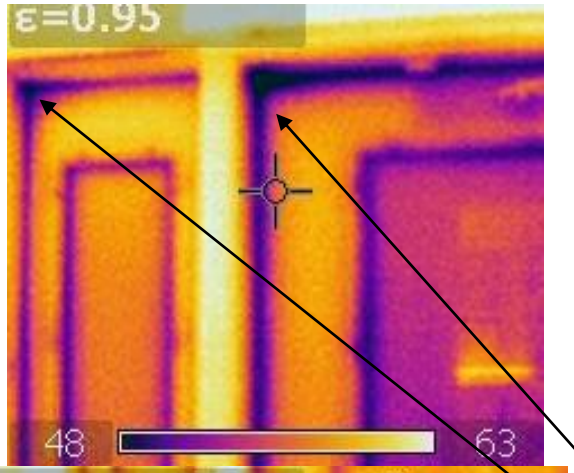


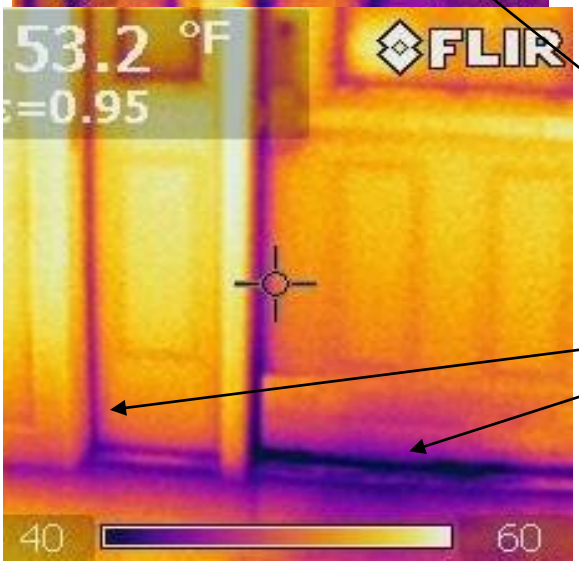


Air infiltration around window in west book stack area showing lack of or poor insulation & air sealing around rough opening

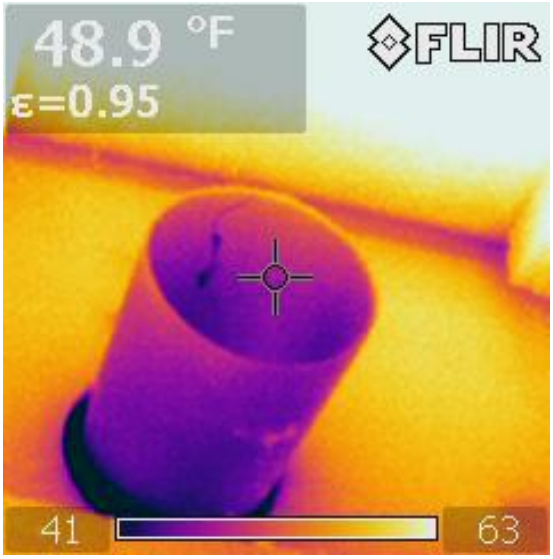


Meeting Room door showing air infiltration at frame & around trim

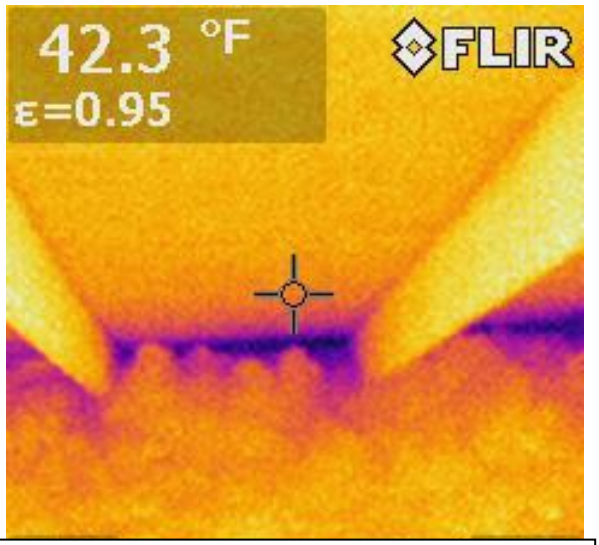




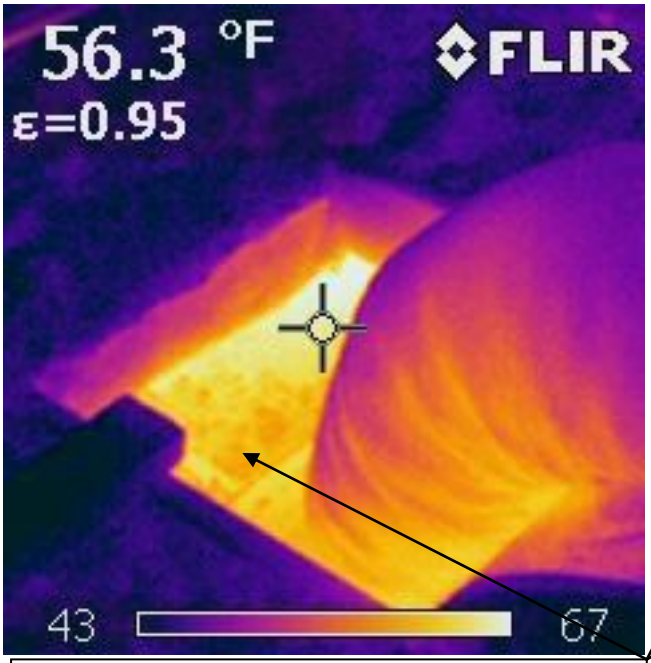
View of front door showing air infiltration at door & side panels



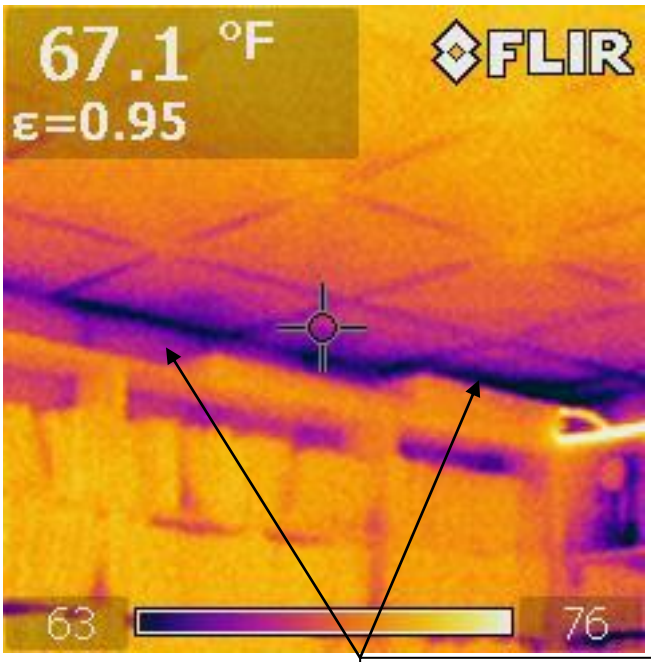
Exhaust vent & rim joist in men's room with no insulation or hose connected. Cold air is entering the building



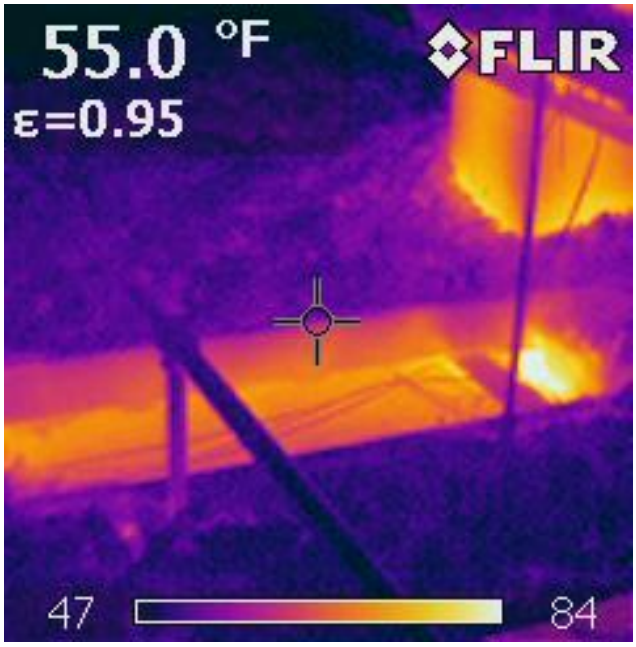
Older section attic showing how insulation tapers, no proper vent or air block & cold air infiltration contributing to ice dams



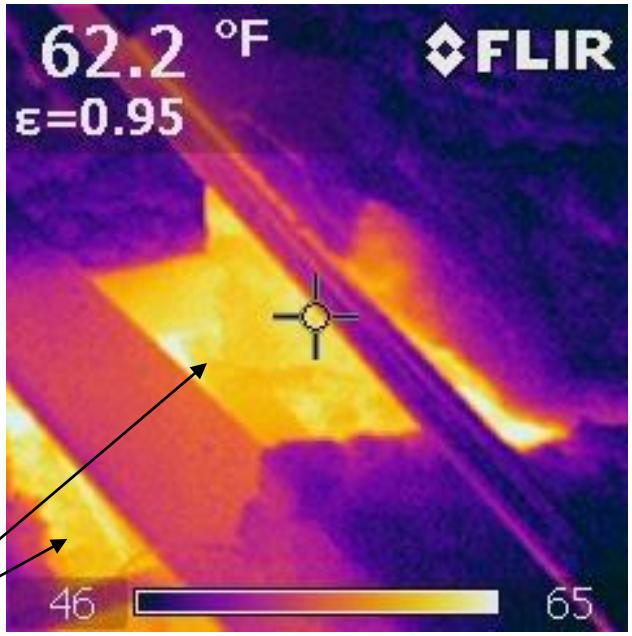
View of typical diffuser from attic, heat loss due to lack of insulation. Notice variation in insulation in digital photo



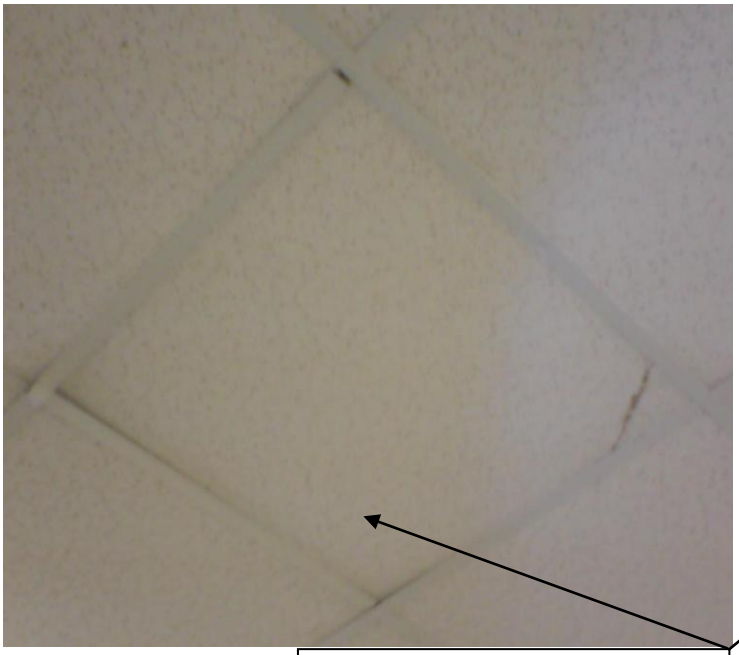
View of ice dam on west wall & ceiling line on the inside of wall indicating cold & air infiltration at ice dam

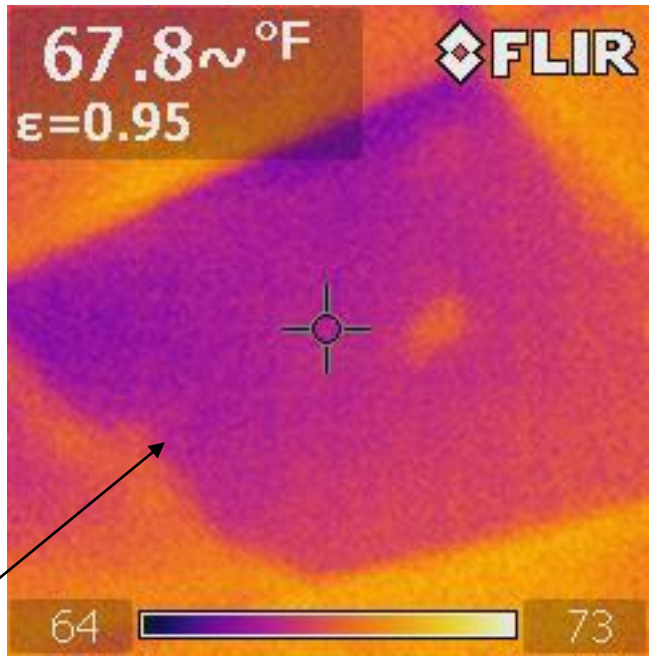


View of areas where insulation has been rolled back & view of chimney showing heat loss through ceiling

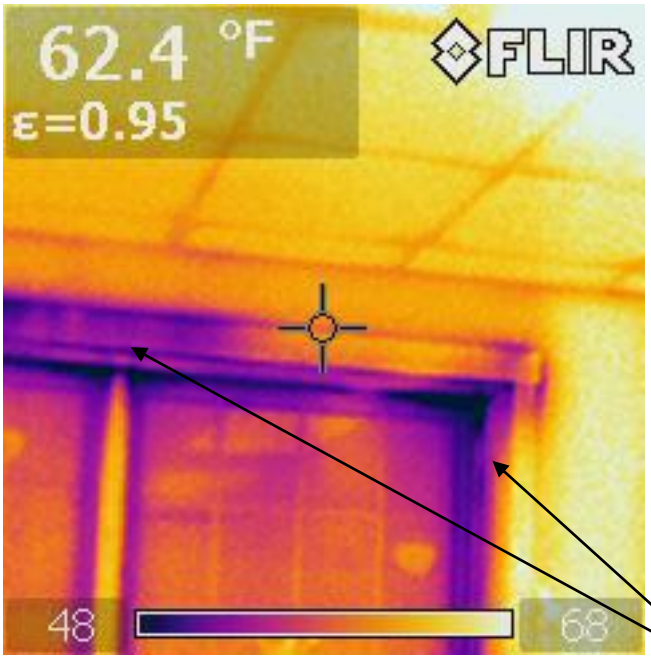


View of rolled back insulation showing heat loss

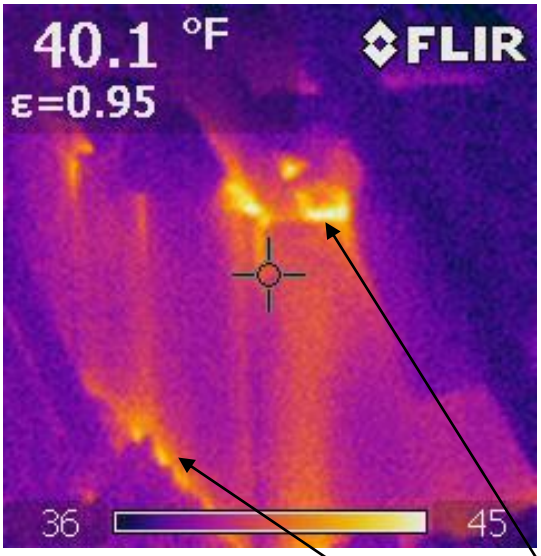


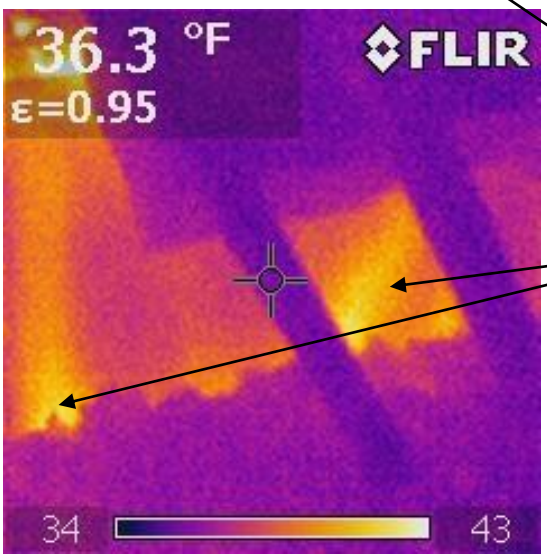


Access point into attic lack of insulation shows as cold

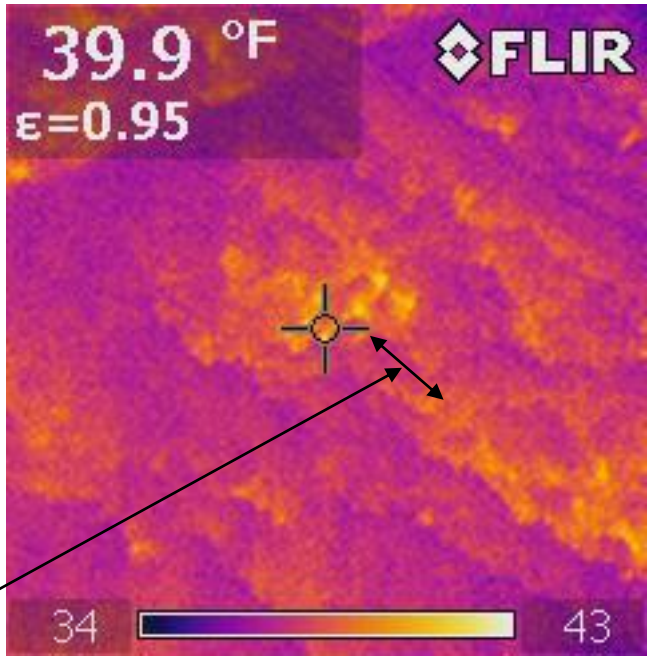


Cold air infiltration at double window

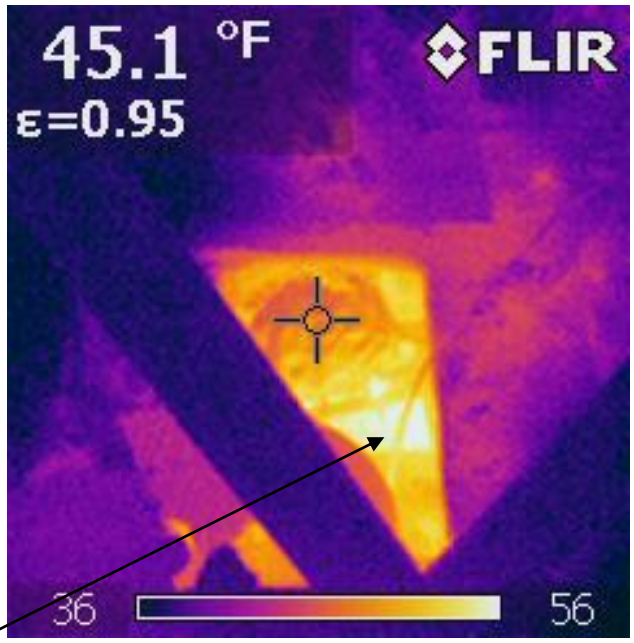




Elevator shaft showing heat loss & chimney affect due to lack of insulation & gaps in drywall



View of attic insulation showing variation in depth & heat loss in yellow



Sprinkler riser in attic showing heat loss due to insulation being rolled back

6. Lighting

The predominant lighting fixture is an older T12 linear fluorescent. There are also some interior incandescent and exterior high pressure sodium fixtures. The primary measures are to re-lamp and re-ballast the existing fixtures with high performance T8's and replace incandescent lamps with LED's. In the lower use areas replacing the incandescent with CFL's is recommended. Adding sensors in rooms to turn off lights when not occupied and installing sensors on alternating rows of linear fluorescent at some of the book stacks is recommended. This will allow the book stacks to remain lighted but reduce the number of fixtures when no one is in the area.

The exterior fixtures are high pressure sodium that appears to operate on photo cells. It is recommended that these be retrofitted with LED replacement lamps and, in some cases, the fixtures upgraded to an LED.

These recommendations should result in better lighting control, more comfortable lighting and save lighting expense. Many of the recommended improvements have the potential for Efficiency Maine incentives.

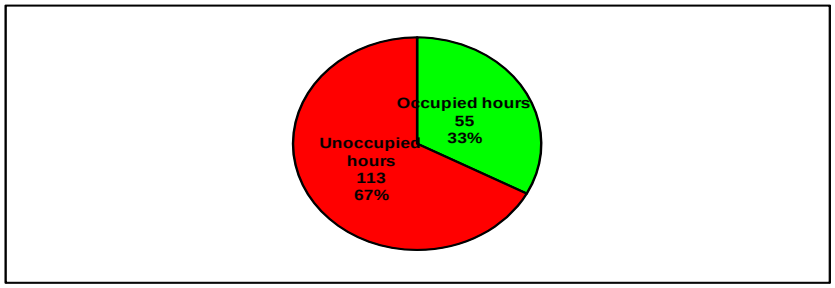
The table below provides an approximate potential for energy savings opportunities to reduce electrical lighting consumption throughout the facility by upgrading some of your lighting.

Summary Lighting Table												
	Location	Fixture type	# of units	Watts per Unit	Max Total kW	Hrs/ Day	# of Days	Annual Operating Hours	Annual Total kWh	Annual kWh Cost	Potential Annual Savings	Annual kWh Saved
										$0.12		
Estimated Annual Lighting Usage and Cost									44,171	$5,301		
TOTAL Estimated Annual Lighting Savings											$2,787	23,225
Estimated Carbon Dioxide (CO2) Savings Tons Per Year												18.2

Windham Public Library Energy Assessment Report

Based on 168 hours in a week

Occupied hours	Unoccupied hours
55	113



Windham Library Lighting Table												
1	Location	Fixture type	# of units	Watts per Unit	Max Total kW	Hrs/ Day	# of Days	Annual Operating Hours	Annual Total kWh	Annual kWh Cost	Potential Annual Savings	Annual kWh Saved
	Ground Level									$0.12		
Existing	Utility Rm	2L 1x4 T12	2	84	0.168	3	160	480	81	$10		
Retrofit		2L 1x4 HPT8	2	53	0.106	3	160	480	51	$6	$4	30
Existing	Book Stg	2L 1x4 T12	2	84	0.168	2	160	320	54	$6		
Retrofit		2L 1x4 HPT8	2	53	0.106	2	160	320	34	$4	$2	20
Existing	Mech Rm	1L Inc	1	65	0.065	2	52	104	7	$1		
Retrofit		1L CFL	1	15	0.015	2	52	104	2	$0	$1	5
Existing	Book Stacks	2L 1x4 T12	8	84	0.672	9.2	305	2806	1,886	$226		
Retrofit	add sensor	2L 1x4 HPT8	8	53	0.424	7	305	2135	905	$109	$118	980
Existing		2L 1x4 T12	15	84	1.26	9.2	305	2806	3,536	$424		
Retrofit		2L 1x4 HPT8	15	53	0.795	9.2	305	2806	2,231	$268	$157	1,305
Existing		2L 1x4 T12	8	84	0.672	9.2	305	2806	1,886	$226		
Retrofit	add sensor	2L 1x4 HPT8	8	53	0.424	7	305	2135	905	$109	$118	980
Existing		2L 1x4 T12	8	84	0.672	9.2	305	2806	1,886	$226		
Retrofit		2L 1x4 HPT8	8	53	0.424	9.2	305	2806	1,190	$143	$84	696
Existing	Corridor/ chk out	1L INC	5	75	0.375	9.2	305	2806	1,052	$126		
Retrofit		1L LED	5	12	0.06	9.2	305	2806	168	$20	$106	884
Existing	Story time Rm	2L 2x4 T12	3	84	0.252	3	305	915	231	$28		
Retrofit		2L 2x4 HPT8	3	53	0.159	3	305	915	145	$17	$10	85
Existing	Circulation Desk	4L 2x4 T12	5	156	0.78	9.2	305	2806	2,189	$263		
Retrofit	Bi-lvl switch	2/4L 2x4 HPT8	5	77	0.385	9.2	305	2806	1,080	$130	$133	1,108
Existing	Staff Rm	4L 2x4 T12	2	156	0.312	3	305	915	285	$34		
Retrofit	Bi-lvl switch	2/4L 2x4 HPT8	2	77	0.154	3	305	915	141	$17	$17	145
Existing	Elev Mach Rm	2L 1x4 T12	1	84	0.084	2	4	8	1	$0		
Retrofit		2L 1x4 HPT8	1	53	0.053	2	4	8	0	$0	$0	0
Existing	Rest Rm Hall	4L 2x4 T12	2	156	0.312	9.2	305	2806	875	$105		
Retrofit		2L 2x4 HPT8	2	53	0.106	9.2	305	2806	297	$36	$69	578
Existing	Mens Rest Rm	2L 1x4 T12	1	84	0.084	7	305	2135	179	$22		
Retrofit	add sensor	2L 1x4 HPT8	1	53	0.053	6	305	1830	97	$12	$10	82
Existing	W/mens Rest Rm	2L 1x4 T12	1	84	0.084	7	305	2135	179	$22		
Retrofit	add sensor	2L 1x4 HPT8	1	53	0.053	6	305	1830	97	$12	$10	82
Red indicates estimate									Annual Total kWh	Annual kWh Cost	Potential Annual Savings	Annual kWh Saved
										$0.12		
Estimated Annual Lighting Usage and Cost									14,325	$1,719		
Table 1 Estimated Annual Lighting Savings											$838	6,981

Windham Public Library Energy Assessment Report

2	Location	Fixture type	# of units	Watts per Unit	Max Total kW	Hrs/ Day	# of Days	Annual Operating Hours	Annual Total kWh	Annual kWh Cost	Potential Annual Savings	Annual kWh Saved
	Ground Level									$0.12		
Existing	Vestibule	1L INC	1	75	0.075	9.2	305	2806	210	$25		
Retrofit		1L LED	1	12	0.012	9.2	305	2806	34	$4	$21	177
Existing	Ent Hallway	1L INC	2	75	0.15	9.2	305	2806	421	$51		
Retrofit		1L LED	2	12	0.024	9.2	305	2806	67	$8	$42	354
Existing	Meeting Room	4L 2x4 T12	8	156	1.248	3	155	465	580	$70		
Retrofit		4L 2x4 HPT8	8	101	0.808	3	155	465	376	$45	$25	205
Existing		1L INC	2	75	0.15	3	155	465	70	$8		
Retrofit		1L LED	2	12	0.024	3	155	465	11	$1	$7	59
Existing		1L Halogon	2	50	0.1	1	50	50	5	$1		
Retrofit		1L Halogon	2	50	0.1	1	50	50	5	$1	$0	0
Existing	Stairwell	1L CFL	2	15	0.03	9.2	305	2806	84	$10		
Retrofit		1L CFL	2	15	0.03	9.2	305	2806	84	$10	$0	0
Existing	Chandelier	3L INC	1	40	0.04	9.2	305	2806	112	$13		
Retrofit		3L LED	1	5	0.005	9.2	305	2806	14	$2	$12	98
	First Level											
Existing	Sp Request Off	4L 2x4 T12	2	156	0.312	10	255	2550	796	$95		
Retrofit	add sensor	4L 2x4 HPT8	2	77	0.154	10	255	2550	393	$47	$48	403
Existing	W/Book Stacks	1L 1x4 T12	9	42	0.378	9.2	305	2806	1,061	$127		
Retrofit		1L 1x4 HPT8	9	28	0.252	9.2	305	2806	707	$85	$42	354
Existing		4L 2x4 T12	4	156	0.624	9.2	305	2806	1,751	$210		
Retrofit		4L 2x4 HPT8	4	101	0.404	9.2	305	2806	1,134	$136	$74	617
Existing		1L INC	5	75	0.375	9.2	305	2806	1,052	$126		
Retrofit		1L LED	5	12	0.06	9.2	305	2806	168	$20	$106	884
Existing	Computer Area	1L 1x4 T12	9	42	0.378	9.2	305	2806	1,061	$127		
Retrofit		1L 1x4 HPT8	9	28	0.252	9.2	305	2806	707	$85	$42	354
Existing	Perodicals	2L 1x4 T12	1	84	0.084	2	305	610	51	$6		
Retrofit		2L 1x4 HPT8	1	53	0.053	2	305	610	32	$4	$2	19
Existing	Hall	4L 2x4 T12	1	156	0.156	2	305	610	95	$11		
Retrofit		2L 2x4 HPT8	1	53	0.053	2	305	610	32	$4	$8	63
Existing	Break Rm	4L 2x4 T12	4	156	0.624	2	305	610	381	$46		
Retrofit		4L 2x4 HPT8	4	101	0.404	2	305	610	246	$30	$16	134
Existing	Rest Rm	4L 2x4 T12	4	156	0.624	2	305	610	381	$46		
Retrofit	add sensor	2L 2x4 HPT8	4	53	0.212	2	305	610	129	$16	$30	251
Existing	Staff Work Rm	4L 2x4 T12	3	156	0.468	4	305	1220	571	$69		
Retrofit		4L 2x4 HPT8	3	101	0.303	4	305	1220	370	$44	$24	201
Existing	Directors Office	4L 2x4 T12	2	156	0.312	9.5	305	2897.5	904	$108		
Retrofit	add sensor	4L 2x4 HPT8	1	101	0.101	9.5	305	2897.5	293	$35	$73	611
Red indicates estimate									Annual Total kWh	Annual kWh Cost	Potential Annual Savings	Annual kWh Saved
										$0.12		
Estimated Annual Lighting Usage and Cost									9,586	1,150		
Table 2 Estimated Annual Lighting Savings											$574	4,783

3	Location	Fixture type	# of units	Watts per Unit	Max Total kW	Hrs/ Day	# of Days	Annual Operating Hours	Annual Total kWh	Annual kWh Cost	Potential Annual Savings	Annual kWh Saved
	First Level									$0.12		
Existing	Study Rm	4L 2x4 T12	1	156	0.156	3	305	915	143	$17		
Retrofit		4L 2x4 HPT8	1	101	0.101	3	305	915	92	$11	$6	50
Existing	Circulation Desk	4L 2x4 T12	3	156	0.468	9.5	305	2897.5	1,356	$163		
Retrofit		4L 2x4 HPT8	3	101	0.303	9.5	305	2897.5	878	$105	$57	478
Existing		1L INC	3	75	0.225	9.2	305	2806	631	$76		
Retrofit		1L LED	3	12	0.036	9.2	305	2806	101	$12	$64	530
Existing	Main Book Stacks	4L 2x4 T12	4	156	0.624	9.5	305	2897.5	1,808	$217		
Retrofit		4L 2x4 HPT8	4	101	0.404	9.5	305	2897.5	1,171	$140	$76	637
Existing		1L 1x4 T12	21	42	0.882	9.2	305	2806	2,475	$297		
Retrofit	add sensor	1L 1x4 HPT8	21	28	0.588	7	305	2135	1,255	$151	$146	1,220
Existing		4L 2x4 T12	2	156	0.312	9.5	305	2897.5	904	$108		
Retrofit		4L 2x4 HPT8	2	101	0.202	9.5	305	2897.5	585	$70	$38	319
Existing		1L 1x4 T12	3	42	0.126	9.2	305	2806	354	$42		
Retrofit		1L 1x4 HPT8	3	28	0.084	9.2	305	2806	236	$28	$14	118
Existing		4L 2x4 T12	14	156	2.184	9.5	305	2897.5	6,328	$759		
Retrofit	add sensor	4L 2x4 HPT8	14	101	1.414	7	305	2135	3,019	$362	$397	3,309
Existing	Vestibule	1L INC	3	75	0.225	3	155	465	105	$13		
Retrofit		1L LED	3	12	0.036	3	155	465	17	$2	$11	88
Existing	Exit lights	1L LED	9	5	0.045	24	365	8760	394	$47		
Retrofit		1L LED	9	5	0.045	24	365	8760	394	$47	$0	0
	Exterior Lights											
Existing	Front Ent	1L HPS	1	65	0.065	12	365	4380	285	$34		
Retrofit	New Fixt	1L LED	1	10	0.01	12	365	4380	44	$5	$29	241
Existing	Front Wall Pk	1L HPS	1	465	0.465	12	365	4380	2,037	$244		
Retrofit	New Fixt	1L LED	1	50	0.05	12	365	4380	219	$26	$218	1,818
Existing	West Wall Pack	1L HPS	1	195	0.195	12	365	4380	854	$102		
Retrofit	re-lamp	1L LED	1	33	0.033	12	365	4380	145	$17	$85	710
Existing	Side Wall Pk	1L HPS	1	195	0.195	12	365	4380	854	$102		
Retrofit	New Fixt	1L LED	1	33	0.033	12	365	4380	145	$17	$85	710
Existing	Back Wall Pk	1L HPS	1	65	0.065	12	365	4380	285	$34		
Retrofit	re-lamp	1L LED	1	10	0.01	12	365	4380	44	$5	$29	241
										$0.12		
Estimated Annual Lighting Usage and Cost									18,812	$2,257		
Table 2 Estimated Annual Lighting Savings											$1,256	10,468

This table is for informational purposes only. Always consult your lighting professional before specifying a new technology for your facility.
The estimated annual savings are based on a general walk through of the building and the reported operating hours.
Detailed energy savings should be determined by your electrician, supplier or manufacturer before a purchase is completed.
Your electrician, supplier or manufacturer must confirm that the proposed lighting meets the Efficiency Maine prescriptive cash incentives.
You can find Efficiency Maine incentives at www.efficiencymaine.com/pdfs/Prescriptive-Cash-Incentives.pdf.

7. Mechanical Systems

The mechanical systems are comprised of the heating, air conditioning, controls and domestic hot water systems.

7.1 Heating System & Controls:

The heating system is hot water with a 275,000 BTU gross, 239,000 BTU I=B=R Burnham KV88 single pass boiler that was installed in the fall of 2005. The hot water is distributed to fin tube radiation; it is controlled by manual thermostats and has four zones. The steady state efficiency was measured at 84% which provides a measure of part of the systems efficiency at a point in time. Seasonal efficiency is a more accurate measure of efficiency of the system that occurs during the season at various loads and reflects partial load efficiency.

Natural gas is relatively close to the building and if available a natural gas modulating boiler would improve the efficiency of the system by 15% to 25% with proper controls. Because the boiler was replaced a few years ago it not cost effective at this time but should be kept in mind for the future.

Adding programmable thermostats and an outdoor reset is recommended and it is estimated to improve the system efficiency by 10% to 20% and increase the seasonal efficiency.

Below is a table showing the dollar reduction in fuel costs based up on a percentage improvement in fuel use, based on the usage by the old system. The library should expect a minimum 10% improvement with the new thermostasts and an out door reset. In addition using some industry parameters, if the recommended improvements to the building envelope and the heating system are made a savings of 10% to 25% could be realized.

Estimated Fuel Oil Savings for Your Building Based on Cost Per Gallon						
Gallons of fuel oil used in 2009/2010	864					
Fuel oil cost per gallon	$2.50	$2.75	$3.00	$3.50	$4.00	$4.00
10 percent savings	$216	$238	$259	$302	$346	$346
15 percent savings	$287	$315	$344	$401	$458	$458
20 percent savings	$382	$420	$458	$535	$611	$611
25 percent savings	$478	$525	$573	$669	$764	$764
30 percent savings	$573	$630	$688	$802	$917	$917
35 percent savings	$669	$735	$802	$936	$1,070	$1,070
40 percent savings	$764	$840	$917	$1,070	$1,222	$1,222

7.2 Domestic Hot Water:

Hot water is provided by an A.O. Smith 40 gallon electric hot water heater which is a typical way to provide hot water for the building. Based upon the scheduled use of the building it is recommended that a seven day timer be added to reduce the electric demand. This will allow the hot water heater to be shut off at night and on the weekends and turned on early in the morning and during the day when needed. The current electric hot water heater was installed in 1993 and is approaching the end of its useful life. An alternate approach would be to replace the 40 gallon tank with a newer efficient electric 20 gallon tank with a 24 hour timer. The table below indicates this should supply the library's needs. The first 8' of the supply and feed lines for the hot water tank should be insulated.

View of hot water tank showing its age

Below is a table showing the estimated hot water use for the building.

Estimated Hot Water Peak Demand and Yearly Use						
Fixture	**Units**	**Gals per minute**	**mins / day**	**gals / day**	**days / year**	**Gal Year**
Restroom Sink	3	0.5	8	12	300	3600
Kitchen Sink Small	2	1	10	20	305	6100
Peak use in gallons per minute (all fixtures on simultaneously)						3.5
Estimated total gallons of hot water per year						**9,700**
Days per year hot water is used						**300**
Estimated gallons of hot water used per day						**32**
These are estimates based on the number of fixtures and estimated use.						

The table below shows the estimated savings that can be realized by adding a 24 hour timer. Based on the projected savings the payback is estimated to be about 1.1 years.

Electric Water Heater--Add 24 HourTimer												
	Location	Fixture type	# of units	Watts per unit	Max Total kW	Hrs/ Day	# of Days	Annual Operating Hours	Yearly Total kWh	Annual kWh Cost @	Potential Annual Savings	Annual kWh Saved
										$0.12		
Existing	Wrk Room	40 Gal electric water heater	1	3375	3.375	3	365	1095	3696	$443		
Retrofit		Add 7 day timer	1	3375	3.375	1.5	305	457.5	1544	185	$258	2152
									Yearly Total kWh	Annual kWh Cost	Potential Annual Savings	Annual kWh Saved
									3696	$443	$258	2,152
Estimated Carbon Dioxide (CO2) Savings Tons Per Year												1.7
Installing a timer will allow for the hot water heater to operate outside of normal business hours to help reduce electric demand.												
A seven day timer turns the water on and off during the week. For a typical application with the normal water demand less than the tank's capacity, you can run the heater twice a day (early morning and late evening) for an hour outside of the business peak demand.												

The table below shows the estimated savings that can be realized by changing to a 20 gallon electric tank with a 24 hour timer. Based on the projected savings the estimated payback is about 3.3 years.

Electric Water Heater--Change to a 20 gallon tank With a 7-day Timer												
	Location	Fixture type	# of units	Watts per unit	Max Total kW	Hrs/ Day	# of Days	Annual Operating Hours	Annual Total kWh	Annual kWh Cost @	Potential Annual Savings	Annual kWh Saved
										$0.12		
Existing	Wrk Room	40 Gal electric water heater	1	3375	3.375	3	365	1095	3696	$443		
Retrofit		20 gallon electric tank with a 7 day timer	1	1500	1.5	1.75	305	533.75	800.625	$96	$347	2895
									Annual Total kWh	Annual kWh Cost	Potential Annual Savings	Annual kWh Saved
									3696	$443	$347	2,895
Estimated Carbon Dioxide (CO2) Savings Tons Per Year												2.3
Installing a timer will allow for the hot water heater to operate outside of normal business hours to help reduce electric demand.												
A 7- day timer turns the water on and off during the week. For a typical application with the normal water demand less than the tank's capacity, you can run the heater twice a day (early morning and late evening) for an hour outside of the business peak demand.												

The seven day timer will allow you to program the hot water heater to be on early in the morning. The hour of 8 am is suggested since your daily usage is ~ 32 gallons and the tank is

rated at heating up to capacity in about an hour. The water heater will energize and heat up before your other equipment such as lights; computers, etc. are turned on.

7.3 Air Conditioning:

The building has a combination of five air conditioning units, it is estimated that the units used about 7,100 kWh in electricity and costs about $872 for the 2009 cooling season. The lower level of the older section of the building has two 30,000 Btu mini split units made by Tardian Applications Limited. The meeting room has one 17,000 Btu mini split unit made by Tardian Applications Limited. These units appear to have been installed in 1993 when the building was expanded. There is no information available about the units, but it was said they were early versions of split minis. It is estimated they have SEER of 10 or less, the current minimum is SEER 13, and Efficiency Maine requires a SEER of 15 for incentives. The units are approaching 20 years old, the typical life span is about 15 years, but because they are not used extensively it has likely been extended. Mini split systems have changed dramatically since 1993, compressors, motors, refrigerants and controls have all changed. It is likely the compressor or fan motor will go, replacing parts piecemeal can be expensive and just prolongs replacing the unit. It is recommended that a replacement plan be developed and replacing the units gradually should be considered. The newer units are 30% to 50% more efficient.

The upper floor is serviced by two split unit air conditioners with an outdoor condenser and a DX coil in the evaporator of the air handler which are located in the attic space. Even though the duct work is insulated, the efficiency of the units is reduced because they are located in the unconditioned attic. The insulation on the duct work was viewed as fair to good. These were manufactured by Advanced Distributer Products, a 30,000 Btu unit serves the newer section, and a 24,000 Btu unit serves the older section, both were installed in 1993. These units have similar efficiencies, expected useful life and replacement issues as the mini split units serving the ground floor do. When considering replacing these units a mini split system with multiple outlets, rather than a split system should be considered. The access to the attic would make replacing the existing units with standard split units costly.

Replacing the units is estimated to save between 30% to 50% depending upon the units selected and their usage application. This would be 2,130 to 3,550 kWh or $262 to $436 based on current electrical costs. The total tonnage of air conditioning is about 11 tons, using

$2,000 to $2,500 per ton for replacement cost; the replacement cost is estimated to be between $22,000 and $27,500 for the entire building. The simple payback based solely on energy savings is 60 to 80 years which is not cost effective. However, when maintenance cost, the fact that the units will need to be replaced and that Efficiency Maine incentives are available replacement does make more sense.

Note: none of the air conditioning systems were operated due to the time of the year and the fact the condensers were covered with snow.

7.4 Ventilation:

The building has two sources of ventilation, one is for the rest rooms and the other is for the building via an EZ Vent system.

View of the bath room exhaust vent and disconnected hose

The hose for both of men's and women's rest rooms was disconnected, not matched to the diameter of the vent, too long and of an inappropriate material. It is recommended that the hose be replaced with one that fits the vent, be shorter and of smoother appropriate material and properly connected to the vent. When it comes time to replace the exhaust fan, one that runs continuously at low speed when the building is occupied and boosts to a higher speed

when the rest room is occupied is recommended. These are efficient and low cost fans to operate.

The EZ Vent system appears to have been installed prior to the 1993 addition in the older section of the building. It operates on a timer, was originally used outside air and had humidification. The outside air and humidification appear not to be used any longer and the air that is circulated is interior air with some air infiltration. The system appears to be providing some ventilation but it is limited. Information on the system was not available and fan motors could not be accessed to assess energy use but it appeared to be minimal. Considerable natural ventilation occurs in the building by virtue of foot traffic, air infiltration and the use of windows.

Many of the newer split and mini split air conditioning units have ventilation option with heat or energy recovery capabilities and when these units are being replaced the ventilation option should be considered.

8. Electronic Equipment

The office and computer area has 20 computers and monitors which can account of 50% to 60 % of the power used for office equipment. The settings and hours of use for the computers were not determined during the audit, but can take place as part of a follow up to the audit. However, listed below is some information regarding procedures for savings and some examples of the type of savings that can be realized by following the recommended procedures.

The DOE through Energy Star has a Computer Power Management program for businesses both large and small, which can be accessed through www.energystar.gov/powermangement.

By setting your equipment to the standby or hibernate mode it is reported, based on historical data, that $25 to $75 per station can be saved.

Most new office equipment is Energy Star compliant and has energy saving software installed. Consult your manual for activating this feature.

In addition Smart Strips can shut off your equipment when not being used. These strips can operate manually, by motion or timer and can be purchased on the internet. They also can provide surge protection

Simply shutting off the computer monitor when not in use saves the equivalent of turning off a 60 to 100 watt light bulb. "Screen Savers" require as much energy as leaving your monitor on. "Sleep" mode lowers energy consumption to about 25 watts or less. Establish an office policy to shut down all non-essential computers nightly (i.e., servers and computers that are not externally accessed after office hours). See table below for a typical desktop computer savings.

You can expect potential annual savings from $23-150 a year per computer by simply shutting the computer off at the end of the work day and programming the sleep mode during the work day. Examples below:

The first example is a computer left on 24/7. The retrofit illustrates potential savings by turning the computer off at the end of each work day of 8 hours and on the weekends.

	Location	Unit Type	Number of Units	Watts per Unit	Total kW	Hours/ day	Number of Days	Annual Operating Hours	Total kWh	Annual Cost @ $.15/kWh	Potential Annual Savings	Annual kWh Saved
Existing	Office	Computer on 24 hrs/day/7 days	1	150	0.15	24	365	8760	1314	$197		
Retrofit	Office	Computer on 8 hrs/day/5 days	1	150	0.15	8	260	2080	312	$47	$150	1002
										SAVINGS	$150	1002
The energy consumption is an estimate: computer towers at 75 watts and monitors at 75 watts based on average published energy usage.												
The assumption is that the screen saver is not selected and is on the same amount of time the computer is on.												
There were no actual energy measurements taken on any of the electronic equipment.												

The second example shows a computer left on for the duration of the work week but shut off for the weekend. The retrofit illustrates potential savings by turning the computer off at the end of each work day and on the weekends.

The last example shows a computer on 8 hours a day for a 5 day work week versus a computer programmed for sleep mode with an average on-time of 4 hours a day for a typical 5 day work week.

	Location	Unit Type	Number of Units	Watts per Unit	Total kW	Hours/ day	Number of Days	Annual Operating Hours	Total kWh	Annual Cost @ $.15/kWh	Potential Annual Savings	Annual kWh Saved
Existing	Office	Computer on 8 hrs/day/5 days	1	150	0.15	8	260	2080	312	$47		
Retrofit	Office	Computer sleep mode on 4 hrs/day/5 days	1	150	0.15	4	260	1040	156	$23	$23	156
										SAVINGS	$23	156
The energy consumption is an estimate: computer towers at 75 watts and monitors at 75 watts based on average published energy usage.												
The assumption is that the screen saver is not selected and is on the same amount of time the computer is on.												
There were no actual energy measurements taken on any of the electronic equipment.												

As you can see, it is important to have an office policy regarding computers. Education is a key component in achieving savings with computers such as publishing the potential savings on the employee bulletin board. In a typical office, people attend meetings, take coffee and lunch breaks, etc. which are all opportunities for computer energy savings.

	Location	Unit Type	Number of Units	Watts per Unit	Total kW	Hours/ day	Number of Days	Annual Operating Hours	Total kWh	Annual Cost @ $.15/kWh	Potential Annual Savings	Annual kWh Saved
Existing	Office	Computer on 24 hrs/day/5 days	1	150	0.15	24	260	6240	936	$140		
Retrofit	Office	Computer on 8 hrs/day/5 days	1	150	0.15	8	260	2080	312	$47	$94	624
										SAVINGS	$94	624
The energy consumption is an estimate: computer towers at 75 watts and monitors at 75 watts based on average published energy usage.												
The assumption is that the screen saver is not selected and is on the same amount of time the computer is on.												
There were no actual energy measurements taken on any of the electronic equipment.												

There are a number of measures that may be applicable to help you generate and sustain energy savings such as ensuring copy machines and other equipment are programmed for sleep modes. Therefore, standing by the copier waiting for the 30 second warm up period can result in energy savings. Ensuring the copier machine is off or programmed for sleep mode after hours and weekends will result in significant savings.