Energy Efficiency Opportunities
For
Town Facilities
Lyme, New Hampshire

Preliminary Assessment

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Provided by:
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1.0 Introduction and Executive Summary

Peregrine Energy Group, Inc. ("Peregrine") has prepared this preliminary energy efficiency and renewable energy investment assessment for the facilities we visited in Lyme, NH. We've prepared this report on behalf of the New Hampshire Office of Energy and Planning with support from the Energy Technical Assistance & Planning for New Hampshire Communities program ("ETAP"). Funding for this project comes from the American Recovery and Reinvestment Act Energy Efficiency and Conservation Block Grant program of the U.S. Department of Energy. Peregrine gratefully acknowledges the assistance that Dina Cutting, Charles Ragan, Michael Hinsley, Betsy Eaton, and Susan MacKenzie, who assisted us with utility data and building information.

The primary goal for this report is to identify cost-effective energy efficiency and renewable energy investments that Lyme may want to consider as part of its long term energy management plan. The report includes Peregrine's recommendations for energy cost reductions that Lyme may want to pursue and a summary of building energy use and cost information we were able to collect.

Findings and Recommendations

In order to generate our list of recommendations, Peregrine's site visit and staff interviews focused on:

- Observations of existing facility conditions
- Current operating practices and facility uses
- Short term and long term facility plans
- Potential building and mechanical equipment energy efficiency upgrades
- Potential renewable energy upgrades

After our site visit, Peregrine reviewed utility bill information for each facility to corroborate our site visit observations and ground our recommendations against actual energy consumption.

Drawing on our site visit observations and discussions with town staff, Peregrine has identified several energy saving opportunities in facilities we visited. Many of our recommendations focus on opportunities to improve energy management practices in day to day operations that the Town can implement within existing town budgets using existing staff resources. More capital intensive energy efficiency recommendations that Peregrine identified include:

- Install a waste oil furnace for the Fire Station
- Install high efficiency, high bay lighting in the Highway Garage
- Air seal and insulate the Center Academy and Fire Station

In addition, Peregrine considered potential renewable energy investment opportunities for facilities that include:

- Install solar make up air systems on the Fire Station and Highway Garage

Table 1. Energy Reduction Program Potential Results[1]

Facility	Approximate Installed Cost ($)	Utility Incentive Available[1]	Potential Utility Savings				Cost Avoidance ($)	Simple Payback Yr	Simple Payback Yr
			Other Benefits	Electric kWh/yr	Oil Gallons/ yr	Wood pellets Tons/ yr			
Highway Garage	8,000	-	A	7,728		1.0	1,527	5-6	5.2
Library	500	-	A,C,D	-	51		167	3	3.0
Center Academy	3,000	-	A	-	161		517	5-6	5.8
Fire Station	9,100	-	-	-	1,792		6,101	1-2	1.5
Total	$20,600		A,B,C	7,728	2,004	1.0	$8,312	2-3	2.5
Notes					*Current Utility Budget:*		*$38,727 /yr*		
(1) Subject to Utility Incentive Policy and Screening Analysis					*Percent Reduction:*		*21%*		
(2) A - Better Comfort; B - Improved Reliability; C - Reduced Maintenance; D - Enhanced Appearance									

Summarizing our Major Findings and Recommendations:

- A waste oil furnace installed in the Fire Station would reduce the fuel oil cost at this building and the amount of waste oil that the Town needs to pay to dispose of. Peregrine can help Lyme prepare a Request for Proposals for this work.
- Higher efficiency high bay lighting can reduce the electricity cost at the Highway Garage. Lyme can request assistance from Public Service of New Hampshire for this work.
- Air sealing and targeted insulation in the Center Academy and the Fire Station can reduce the fuel oil cost in these buildings. Peregrine can help Lyme prepare a Request for Proposals for this work.
- Solar Make up air collectors installed in the Highway Garage and the Fire Station can improve and or reduce fuel oil costs in these buildings. Peregrine can help Lyme plan for future renewable energy installations in these locations and review potential financing mechanisms to support these investments.

In general, we found that

Lyme has energy-related building structure challenges in the Fire Station, Highway Garage, and the Library that contribute to higher than average energy use in these buildings. Energy efficiency and renewable energy investments can help address these problems.

Suggested Next Steps

Within the context of the ETAP program, Peregrine can continue to support the Town to help plan and execute these recommendations. All projects identified in this report will require further development and analysis to obtain firm pricing and confirm energy savings estimates.

Immediate next steps include:

- Select which measures the Town would like to proceed with and establish an implementation schedule.

[1] This table does not include renewable energy or replacement window costs and savings

- Authorize further engineering activity, if necessary, to develop detailed specifications and/or generate more accurate savings projections.
- Develop request for proposal documents and/or select preferred mechanical, lighting and controls vendors. Your utility company may require use of specific vendors for work supported by their programs.
- Secure quotes for projects and select controls, insulation, air sealing, mechanical, and lighting contractors.

2.0 Utility Cost and Consumption

Energy Cost

The total energy cost for the buildings Peregrine visited is about $133,333. The cost per square foot varies from a high of $3.42 at the Fire Station down to $1.21 at the Center Academy.

Table 2. – Annual Utility Cost and Energy Cost Intensity

Facility	Square Feet	Electric Cost ($)	Oil Cost ($)	Propane Cost ($)	Corn & Wood Cost ($)	Total Cost ($)	Cost ($) per Square Foot
Highway Garage	9,507	4,266	-	-	7,929	12,195	1.28
Library	6,276	5,057	5,580	335	-	10,972	1.75
Center Academy	3,728	518	3,978	-	-	4,496	1.21
Fire Station	3,236	1,463	9,601	-	-	11,065	3.42
Total	22,747	$11,305	$19,159	$335	$7,929	$38,727	$1.70

Energy Use

Total energy use for the buildings Peregrine visited is about 63,230 kWh for Electricity, 5,767 gallons for oil, and 34 tons of corn and wood. The total energy intensity units are expressed in site[2] kBtu[3] per square foot.

Table 3 – Annual Utility Consumption and Energy Use Intensity

Facility	Square Feet	Electric kWh	Oil Gallons	Propane Gallons	Corn & Wood (Tons)	Total kBTU	Site kBtu per Square Foot
Highway Garage	9,507	25,560	-	-	34	604,236	64
Library	6,276	27,090	1,712	140	-	344,906	55
Center Academy	3,728	2,210	1,235	-	-	180,443	48
Fire Station	3,236	8,370	2,820	-	-	423,367	131
Total	22,747	63,230	5,767	140	34	1,552,952	68

[2] Site energy = All fuel consumption in the building measured “after the meter.”

[3] kBtu = 1,000 British Thermal Units. 1 kilowatt hour of electricity = 3,413 Btus, 1 gallon of #2 oil = 140,000 Btus, 1 gallon of Propane = 92,000 Btus, 1 ton of corn = 14,000,000 Btus, and 1 ton of wood pellets = 16,400,000 Btus.

3.0 DPW Garage

Lyme's DPW garage is a slab-on-grade, structural steel building constructed in 2005 with about 9,507 square feet of heated space. The garage bay area includes seven insulated rollup doors and a very high ceiling. A separate entrance provides access to the superintendent's office and break room.

Figure 1. DPW Garage



The primary sources of energy use at the facility are a choice of either corn or wood pellets for heating and domestic hot water and electricity for interior and exterior lighting, compressed air, repair tools, kitchen appliances, and office equipment.

Building Envelope

The back of the building is set into the side of a hill. Extensive drainage swales draw ground water away from the building. The front of the building with the garage doors faces north. The roof and walls are insulated with vinyl- back fiberglass insulation pinned against the interior steel frame by the metal siding and roofing. Windows are aluminum frame sliders with insulated glass. Garage bay doors are high quality insulated steel with tight seals. There are a few lower seal gaps at the bottom of the garage doors where concrete has chipped away. Other towns have installed angle iron in the concrete floors below the doors to protect against this kind of damage.

Peregrine understands that Lyme had to remove the original insulation to remove and clean mold that had built up behind the insulation. The mold was treated and removed; however, the wet insulation has not been replaced. Peregrine's research and observation of similar buildings is that steel buildings are more susceptible to condensation due to air leakage and cold surface condensation[45]. Depending on the location of the mold buildup this could be a summer-driven problem. The back of the building that is built against the hillside and warm moist summer air in the building may condense against the colder

[4] Insulation website http://steelbuildingbulletin.com/category/metal-building-insulation/

[5] Condensation fact sheet http://www.naima.org/insulation-resources/metal-building-insulation/facts-26-facts-about-moisture-and-fiber-glass-metal-building-insulation-mb306.html

back wall. Peregrine has not seen mold problems like this in other DPW facilities that we've visited to date. None of the other facilities we've visited are built against a hillside.

Heating

Two "corn-fed" or "wood pellet-fed" HS Tarm boilers heat water for a closed-loop radiant floor heating system imbedded in the concrete slab. According to instructions posted near the boilers, one boiler is adequate for outdoor temperatures at night down to 15-30 Deg F. and two boilers are required to keep the building warm below this outdoor temperature range. One circulation system (set for a slightly warmer floor temperature) provides heated water to the office area and another circulation system provides heated water to the garage bay area.

Figure 2. Multifuel boilers



Two Wirsbo thermostats control the set point temperature for the two heated spaces. Two Modine-style space heaters have been installed in the equipment bays to help circulate heat and bring the temperature of the building up more quickly when equipment comes in during the winter. In addition, ceiling fans are that were set on low speed are set on high speed now.

Domestic Hot Water

A flat plate heat exchanger with a dedicated circulation loop off the boilers provides heat for domestic hot water.[6] In addition, there's an electric storage tank in the mezzanine that provides domestic hot water when the pellet boilers are off.

Ventilation

Ventilation in the garage is limited to exhaust only ventilation. Two exhaust fans with positive seal dampers are installed relatively low on the back wall. Another exhaust fan with positive seal dampers is installed at the peak of the roof on the back wall.

[6] Peregrine was not able to confirm if the heat exchanger loop system supplies water to a separate storage tank or simply preheats cold water directly.

Lighting

Energy efficiency fluorescent light fixtures provide lighting for the office and break room area. High bay metal halide light fixtures provide lighting for the garage bay area.

Figure 3. High bay metal halide lighting



Other Electric Loads

The highway department has 7.5 horsepower reciprocating air compressor for the facility's pneumatic power tools and related compressed air needs. Other electric loads are limited to power tools, circulation pumps, the exhaust ventilation fans, kitchen appliances, and office equipment.

Recommendations

Table 4. Summary of energy reduction opportunities for the DPW Garage

	Description	Approximate Installed Cost ($)	Utility Incentive Available[1]	Other Benefits[2]	Potential Utility Savings		Annual Cost Avoidance ($)	Simple Payback Yr
					Electric kWh/yr	Wood Pellets Tons/ yr		
1	Install T8 High Bay Lighting	$4,800		A	7,728	-	$1,290	3-4
3	Install Solar Make Up Air	$3,200				1	$237	10+
	Estimated Program	***$8,000***	***$0***	***A***	***7,728***	***1***	***$1,527***	***5.2***

Notes ***Current Utility Budget:*** ***$12,195 /yr***

(1) Subject to Utility Incentive Policy and Screening Analysis ***Percent Reduction:*** ***13%***

(2) A - Better Comfort; B - Improved Reliability; C - Reduced Maintenance; D - Enhanced Appearance

1. Install T8 High Bay Lighting

Replace existing metal halide high bay lighting with new high efficiency T8 fluorescent lighting fixtures. T8 technology offers a considerably more efficient light source that also improves lighting quality and has much longer and consistent lamp life. As Table 5 indicates T8 fluorescent lights are the most cost-effective upgrade, however, Lyme can consider other options listed in the table that are almost as cost effective and save more energy.

Table 5. High bay lighting options

		400 Watt High Bay Metal Halide	200 Watt High Bay 6 bulb T8 Flourescent	200 Watt High Bay 4 bulb T5 Flourescent	150 watt High Bay LED	Solar Tube
	Watts/ Fixture	458	200	236	120	-
	Fixture Cost	$199	$200	$229	$680	$500
	Bulb replacement ($)	$30	$18	$36	$680	$0
	Bulb replacement (hrs)	30 minutes	2 minutes	30 minutes	30 minutes	2 hours
	Est. life (hours)	20,000	30,000	20,000	50,000	
	Est. life (years)	8.0	12.0	8.0	20.0	20.0
	Startup time	3-5 minutes	2 seconds	2 seconds	Instant	Automatic
	Restart delay	12 minutes	Instant	Instant	Instant	N/A
	Initial Lumens	40,000	30,000	20,000	11,000	11,000
	40% life Lumens	24,000	18,000	16,800	8,800	11,000
	Annual kWh	1,143	499	589	300	-
			644	554	844	
Annual Cost						
If $/kWh	**$0.10**	$114	$50	$59	$30	$35
If $/kWh	**$0.15**	$171	$75	$88	$45	$53
If $/kWh	**$0.20**	$229	$100	$118	$60	$70
Annual Savings						
If $/kWh	**$0.10**		$64	$55	$84	$79
If $/kWh	**$0.15**		$97	$83	$127	$119
If $/kWh	**$0.20**		$129	$111	$169	$158
New fixture cost (est)			$200	$229	$680	$500
Installation Cost (est)			$200	$229	$680	$500
Installed Cost (est)			$400	$458	$1,360	$1,000
New Fixture Simple Payback (Yrs)						
If $/kWh	**$0.10**		6.2	8.3	16.1	12.6
If $/kWh	**$0.15**		4.1	5.5	10.7	8.4
If $/kWh	**$0.20**		3.1	4.1	8.1	6.3

Next Step: Request a proposal from PSNH to upgrade the lighting in the service bays.

2. Install Solar Make Up Air

One of the best applications for solar energy is raw, low temperature heating. The back wall next to the hill provides an interesting opportunity for solar pre-heat panels to provide auxiliary heating and potentially help reduce humidity levels in the building. Peregrine recommends Conserval's Solarwall product[7] for this application.

If the Town decides it needs additional ventilation to address excessive moisture in the building, the Town can consider installing a high quality air to air heat exchanger ventilation system. Bradford, NH installed a heat exchanger ventilation system manufactured by Environmental Air Solutions, Inc (http://keeptheheat.com/). The design is very simple and from Bradford's DPW staff feedback, is very effective. A y-shaped assembly mounted on the outside of the building houses two fans, one

[7] Conserval website: http://solarwall.com/

for stale exhaust air and one for fresh intake air. The exhaust fan draws stale air from the building at the ceiling level into the metal ductwork. The warm stale air preheats cold outside air drawn into the building by the intake fan through corrugated PVC drain pipe in the metal ductwork. Schedule 20 PVC piping delivers warm air from the corrugated drain piping at about waist height next to each structural support. DPW staff turns the fans on and off as needed with manual switches located on the main wall near the office/ boiler room.

<u>Next Step</u>: We suggest that the town prepare a Request for Proposals to install solar make-up air collectors for the DPW Garage. The request should include a more detailed analysis of potential application. Peregrine can help prepare a technical specification for this measure if Lyme is interested.

4.0 Library

Existing Conditions

Lyme's library was originally constructed in 1938. A major addition constructed in 1980 brought the total building are up to about 6,276 square feet of heated space. Located across the street from the town's elementary school, the library serves as both the town library and the school library. The library is open 4 to10 hours daily. From 1980 to 2008, the building housed the Town's administration offices in the basement until the new town office and police department building was completed in 2008. The local school district maintains an office in the basement now and holds regular business hours during the week. The School district's basement office is accessible from a separate entrance in the back of the building.

Figure 4. Converse Free Library



The primary sources of energy use at the facility are oil for heating and electricity for interior and exterior lighting, office equipment, computers, and assorted plug loads.

Building Envelope

Lyme's public library is a structural brick building constructed on a full concrete foundation. Windows are single-pane wood frame with exterior storm windows in the original building and wood thermopane windows in the new addition. The new addition carries the "look and feel" of the original building with the same exterior building material selection; however, the roof has a shallower pitch. Roofing material is slate in front and asphalt or rubber membrane in back.

Peregrine was unable to confirm the level of attic and wall insulation in the building through our visual inspection. The basement walls are uninsulated. According to Library staff, moisture has been an issue in the basement. The Library trustees approved basement wall crack repairs and exterior drainage for the south side of the building. Moisture problems in the front of the building exist; however, they are not as severe as the problems on the south side so repairs have been deferred.

Heating

An oil-fired, cast-iron, forced hot water boiler provides heat to the building. Water heated by the boiler circulates through black iron and copper pipe distribution lines to commercial grade steel fin-tube radiators. Individual thermostats installed throughout the building control zone valves that open and close and allow water to circulate or not to circulate through the fin-tube radiators in single rooms in the basement and two heating zones for the larger open spaces on the main floor.

One of the challenges the Library has struggled with is inconsistent room temperature control. This includes overheating in downstairs rooms near the boiler room and insufficient heat in other rooms.

Figure5. HB Smith boiler



The Basement art gallery is one of the most problematic rooms to heat with significant undershoot and overshoot of room set point temperatures. Figure 6 highlights bookshelves installed in front of the baseboard radiators, essentially “insulating” the radiators. Another factor that affects room heat delivery in this room is the location of the 1-1/2” copper supply piping distribution directly over the radiator fins inside the radiator cover. The bookshelves and the large copper pipe both reduce radiator heat circulation significantly. In response to lower output of some radiators it appears that the boiler is set to provide higher than necessary water temperature through the piping which further exacerbates “too hot”, “too cold” balancing problems.

Figure 6. Basement Art gallery



Domestic Hot Water

It appears that the boiler provided domestic hot water (DHW) at one point with an internal boiler heat exchanger. The piping to the internal heat exchanged is currently capped (see figure 5), however, it's unclear if the aquastat installed on the boiler to maintain adequate boiler temperature for DHW has been disconnected as well[8]. Domestic hot water is currently supplied by a small electric storage tank located in the utility room.

Ventilation

In response to air quality concerns in the basement, the Library installed a LifeBreath heat recovery ventilation system. The heat exchanger is located in a closet in the school district office and the wall-mounted control is located in the conference room. According to library staff, noisy operation by the machine has been an issue in the adjoining office and the fan is turned off during the day and turned on at night to flush the air in the basement.

Figure 7. Basement heat recovery ventilation system



[8] The library's service company should be able to confirm that the aquastat has been disconnected. Peregrine did not see the existing DHW heating system and assumes that it is an electric storage tank.

Lighting and other electric loads

Lighting in the library has all been upgraded with energy efficient lighting except in the front reading room that has antique light fixtures.

Recommendations

Table 6. Summary of energy reduction opportunities for the Library

	Description	Approximate Installed Cost ($)	Utility Incentive Available[1]	Other Benefits[2]	Potential Utility Savings		Annual Cost Avoidance ($)	Simple Payback Yr
					Electric kWh/yr	Oil Gallons/ yr		
1	Install modulating aquastat	$500		A		51	$167	2-3
2	Review light levels	low cost		A, D				<1
3	Review LifeBreath operation	N/A		A,C				<1
	Estimated Program	***$500***	***$0***	***A,C,D***	***-***	***51***	***$167***	***3.0***

Notes ***Current Utility Budget:*** ***$10,972 /yr***

(1) Subject to Utility Incentive Policy and Screening Analysis ***Percent Reduction:*** ***2%***

(2) A - Better Comfort; B - Improved Reliability; C - Reduced Maintenance; D - Enhanced Appearance

1. **Install modulating aquastat**

   The least expensive investment the Library can make at this point is to install a modulating aquastat. Ideally this would be done in conjunction with reassessing the heating output of individual room radiators, particularly in the basement where shelves and distribution piping have reduced the potential heat output of radiators in these rooms.

   Next Step: The Library can contact its service contractor and review costs to install a modulating aquastat.

2. **Review light levels**

   Four rooms in the library[9] have light levels that are higher than necessary. Library staff should review light levels in these rooms, temporarily delamp fixtures, and assess if reduced lighting levels would be acceptable in these rooms. A permanent solution to provide light levels consistent with the recommended target levels could be as simple as removing light bulbs.

   Next Step: Remove sample light bulbs and determine if reduced light levels in four rooms is acceptable.

3. **Review LifeBreath ventilation system operation**

   Occupants in the SAU #76 office turn the LifeBreath ventilation system off during the day. Library staff should review what the ventilation system was designed to accomplish and determine if the ventilation system is needed still. The primary complaint Peregrine heard is that the ventilation system is noisy. The noise level could potentially be reduced if this is the only concern and the ventilation system is needed still.

[9] The four rooms include the SAU #76 Office, Program Room, Lyme Room, and the Children's book stacks.

Next Step: Review any documentation regarding the original purpose for the ventilation system. Library staff could turn the ventilation system off for a short period of time and monitor if any changes occur with the basements thermal comfort, moisture control, or air quality.

Capital Upgrade Measures

Peregrine discussed two capital upgrade measures with library staff that are beyond the scope of this assessment. The first capital upgrade measure we discussed was to insulate the library's basement walls. This measure would need to be performed as part of a comprehensive upgrade of the basement rooms and would not be cost effective as a stand-alone measure. Rigid insulation affixed to the basement walls would help improve thermal comfort in the winter and help control moisture condensation in the summer. The second capital upgrade was to review and potentially re-pipe portions of the radiator distribution system in the basement. From discussions with library staff and our observation of the distribution piping, the radiator output may be poorly matched to the heating needs of the room.

Next Step: Peregrine can review the capital upgrades with staff if requested.

5.0 Lyme Centre Academy

Existing Conditions

Constructed in 1839, the Lyme Centre Academy includes about 3,728 square feet of heated space. As explained in the National Register Lyme Centre Historic District documentation, the Lyme Center Academy was "financed by a private corporation formed in 1836. After about fifteen years, the building was transferred to Lyme School District #12 and it was used as a public school until 1885 when districts were abolished. At that time, it was reverted to the Academy Corporation. In 1909, the first floor was made into two rooms. Lighting and heating improvements were made in 1931 and in 1936 electric lights were added. Running water dates to 1939. In 1953, the Lyme School District purchased the building from the heirs of the Academy and it was transferred to the town in 1962." The most recent rehabilitation was completed in 2001. A small meeting room and the Lyme historic society occupy the first floor. A small auditorium occupies the second story. A hydraulic elevator installed in the new addition provides ADA accessibility service to the second floor auditorium.

Figure 8. Department of Public Works



The primary sources of energy use at the facility are #2 oil, for heating and domestic hot water, and electricity, for interior and exterior lighting, an elevator, and plug loads.

Building envelope

The Lyme Centre Academy is a two story wooden structure constructed on a granite foundation. Siding is wooden clapboards and the roof is both corrugated metal on the original part of the building and standing seam metal on the back addition. It's unclear from Peregrine's visual observations how much insulation exists in the walls and attic of the academy. We understand that some level of infrared analysis has been performed on the building and identified opportunities for minor air sealing and insulation upgrades. Windows are single-pane six over six double hung windows with well crafted interior storm windows. Three doors on the first floor are wooden in keeping with the building's historic designation. Peregrine and our tour guide were unable to locate access to the basement to inspect the condition of this area. The boiler room is located in a separate room with access on the side of the building.

Figure 9. Interior storm window detail



Heating, domestic hot water, and mechanical ventilation

A residential sized boiler provides heating and domestic hot water (DHW) to the building. Six individual zones circulate water to fin-tube baseboard radiators. A seventh zone circulates water to an indirect heat exchanger in the DHW storage tank to provide potable hot water. Individual digital thermostats control the set point temperature for each heating zone and turn the boiler and individual circulators, one per zone, on to maintain the thermostat set point temperature. A well-mounted thermocouple and mechanical set point control turns the boiler and DHW circulator zone on to maintain the DHW storage tank temperature.

Figure 10. Peerless boiler and Hotstow domestic hot water tank



Lighting and other electric loads

Lighting on the first floor is primarily compact fluorescent light (CFL) bulbs installed in standard incandescent fixtures. Lighting on the second floor is primarily incandescent light bulbs installed in period-style incandescent light fixtures (double check). High quality CFL bulbs could be installed on a test basis to see if the warm character of the existing lighting can be replicated with more efficient lighting.

Figure 11. Auditorium lighting



Recommendations

Table 7. Summary of energy reduction opportunities for the Lyme Centre Academy

	Description	Approximate Installed Cost ($)	Utility Incentive Available[1]	Other Benefits[2]	Potential Utility Savings		Annual Cost Avoidance ($)	Simple Payback Yr
					Electric kWh/yr	Oil Gallons/ yr		
1	Setback temperature	low cost				49	$159	<1
2	Air Seal and insulation	$3,000		A		86	$278	10
3	Review DHW operation	low cost				25	$80	<1
	Estimated Program	***$3,000***	***$0***	***A***	***-***	***161***	***$517***	***5.8***

Notes ***Current Utility Budget:*** ***$4,496 /yr***

(1) Subject to Utility Incentive Policy and Screening Analysis ***Percent Reduction:*** ***12%***

(2) A - Better Comfort; B - Improved Reliability; C - Reduced Maintenance; D - Enhanced Appearance

1. Monitor and control indoor temperature

Install a digital temperature recorder for one week to document the building temperature and confirm that the building temperature closely matches the building operating hours. One recorder can be moved about the building each week or multiple meters could be installed in different rooms. The goal for this measure would be to identify 1% to 5% energy savings from tighter scheduling of the programmable thermostat settings.

Next Step: Peregrine can help identify suitable data loggers that are available online to perform this work.

2. Air Seal and confirm insulation integrity

Based on what we heard about the attic during our site visit, it would be cost effective to hire a weatherization vendor to identify and seal air leaks in the attic and most likely the basement of the building. A trained crew would come equipped with insulation material and air leakage and thermal diagnostic equipment. The vendor would identify and address thermal bypass deficiencies during the visit and confirm and recommend additional insulation options for the attic, basement, and potentially the exterior walls.

Next Step: Peregrine can help Lyme prepare a Request for Proposals for pressure diagnostic technical services if the Town would like to pursue this measure.

3. Review Domestic Hot Water operation

Domestic hot water (DHW) use in the building is very limited. Currently the boiler maintains a steady DHW temperature in the DHW storage tank regardless of the need for DHW. Peregrine recommends that Lyme two action items for the DHW system. First, install a digital timer to turn off the boiler when DHW is not needed. Second, install a small electric point-of-use instantaneous water heater for the bathroom used most often during the day. This will allow the main DHW tank to remain off even longer.

Next Step: Request a proposal from the town's service contractor to install a digital timer and an instantaneous electric water heater in the first floor bathroom.

6.0 Fire House

Existing Conditions

Lyme purchased a slab-on-grade steel building constructed in 1973 to serve as the town's police station and volunteer fire station. The police department moved to the new town offices, however, the volunteer fire department continues to use the building. The total heated area of the building is about 3,236 square feet.

Figure 12. Fire House



The primary sources of energy use at the facility are #2 oil, for heating and domestic hot water and electricity, for interior and exterior lighting, compressed air, repair tools, kitchen appliances, and office and emergency communications equipment. The hours of operation for the fire station are limited to about 9 hours per month.

Building Envelope

The Fire Station includes a structural steel building with a small wood frame addition on the left side of the building that was added on in 1986. According to volunteer fire department staff, the steel building most likely is not designed for the winter snow loads in Lyme. From a structural perspective, the only saving grace for the building that protects it from collapsing from heavy snow loads is the lack of insulation in the roof and walls. Roof and wall insulation is loose fitting 1" Styrofoam board treated with a fire retardant. Heating the building provides enough warmth to melt snow from the roof before it builds up to dangerous levels. Condensation generated underneath the roof drips down on the board insulation and contributes to significant ice buildup in front of the garage doors and in back of the building from snow melting from the roof and the interior condensation. Numerous holes in the metal walls and exhaust vent louvers that open on windy days contribute to building air leakage. The outside surface of the concrete slab is insulated with 1" Styrofoam as well.

The addition is wood frame with batt insulation installed in the walls and the attic. Windows are insulated double pane and the entrance and roll-up garage doors are insulated steel doors.

Heating and Domestic Hot Water (DHW)

Twin 140 Kbtu/ hr Modine-style oil-fired furnaces provide heating in the garage. Nothing else worked to keep the space warm in the winter before these were installed. One furnace is adequate to heat the space until the outdoor weather gets extremely cold.

Figure 13. Twin oil-fired furnaces



A separate boiler provides heat and domestic hot water for the training room and kitchen.

Figure 14. Instruction Room heating and DHW system



Individual thermostats in the garage and the training room control the temperature settings in these rooms. The fire department staff set the temperature in both rooms to 52 when unoccupied (most of the time except for about 9 hours per month)

Mechanical ventilation and air conditioning

The Town added an exhaust fan on the north end of the building to address air quality concerns that came up when the building was occupied during the day. The exhaust fan is never on. Volunteer fire fighters are investigating ways to cover the fan in the winter to seal the opening more effectively and at the same time, allow the fan to function if the cover is opened.

The building currently does not have any air conditioning. The fire department will probably install a window air conditioner in the near future for the emergency support services located in the building.

Lighting and other electric loads

A combination of natural lighting and T8 or T12 fluorescent light fixtures provide light in the building. Fiberglass siding mounted high on the back wall provides daylight in the garage. A row of 8' fluorescent light bulbs runs down the center of the garage and provides supplemental light. Exterior windows and dropped ceiling fluorescent light fixtures provide natural and supplemental lighting in the training room. Other electric loads in the building include kitchen appliances, tools used for vehicle repairs, communication equipment and other temporary plug loads.

Recommendations

Table 8. Summary of energy reduction opportunities for the Fire House

	Description	Approximate Installed Cost ($)	Utility Incentive Available[1]	Other Benefits[2]	Potential Utility Savings		Annual Cost Avoidance ($)	Simple Payback Yr
					Electric kWh/yr	Oil Gallons/ yr		
1	Install Waste Oil Furnace	$7,500				1,692	$5,761	1-3
2	Install Solar Make Up Air	$1,600				100	$340	4-5
	Estimated Program	***$9,100***	***$0***		***-***	***1,792***	***$6,101***	***1.5***

Notes ***Current Utility Budget:*** ***$11,065 /yr***

(1) Subject to Utility Incentive Policy and Screening Analysis ***Percent Reduction:*** ***55%***

(2) A - Better Comfort; B - Improved Reliability; C - Reduced Maintenance; D - Enhanced Appearance

1. Install waste oil furnace

Most DPW facilities heat the Town Garage with waste oil. In this case, Lyme's Highway Department heats the Town Garage with corn or wood pellets. The fire station would be the next most appropriate location to install a waste oil furnace. The Town of Deerfield installed a waste oil furnace recently for its Town Garage that is about the same size as Lyme's Fire Station and is very pleased with it[10].

Next Step: We suggest that the town prepare a Request for Proposals to install a waste oil furnace. Peregrine can help review a technical specification for this measure if Lyme is interested.

3. Install Solar Make Up Air

As mentioned for the DPW Garage, one of the best applications for solar energy is raw, low temperature heating. The south side wall of the fire station provides an interesting opportunity for solar pre-heat panels to provide auxiliary heating. Peregrine recommends Conserval's Solarwall product[11] for this application.

[10] For more information about used oil furnaces and used oil management, call the DES Used Oil Program at (603) 271-6424 or 1-888-TAKEOIL

[11] Conserval website: http://solarwall.com/

<u>Next Step</u>: We suggest that the town prepare a Request for Proposals to install solar make-up air collectors for the Fire Station. The request should include a more detailed analysis of potential application. Peregrine can help prepare a technical specification for this measure if Lyme is interested.

Capital Upgrade Measures

Depending on the Town's Long term plans for the volunteer fire department's facility needs, it would be prudent to identify a solution to add insulation to the garage roof and walls. It's unclear from Peregrine's initial discussions with volunteer fire staff if the roof's questionable snow load capacity is driven by the main steel support structures, the thin metal purlins, or both roof support members. Peregrine understands that an engineering study would cost on the order of $5K - $7K to determine the structural integrity of the building and whether or not it could handle the full design snow load for Lyme if the building is insulated. Voluntary fire staff has already discussing framing options to build another roof over the existing roof, however, this would be very expensive in its own right.

Rather than heat the building continuously, the Town can consider insulating the roof and install electric heat tape, solar hot air panels, or a similar mechanism to warm up the snow on the roof so it slides off the roof after each snowfall. The fire department could insulate a small portion of the roof and test this approach as an inexpensive alternative to more rigorous analysis.

<u>Next Step</u>: Continue to review snow removal options from metal roofs.

7.0 Town Offices/ Police Department

Lyme's new Town Office and Police Department building was constructed in 2008 and has about 4,811 square feet of heated space. The building is one story, wood frame construction built on a concrete slab. Town services provided in the building include management offices for the town Selectmen and staff, building-related departments, financial departments, and the police department.

Figure 15. Town offices and police department



The primary sources of energy use at the facility are propane for heating and electricity for air conditioning, domestic hot water, interior and exterior lighting, kitchen appliances, office equipment, and police communications and emergency support equipment.

Heating, Domestic Hot Water, and Ventilation

A high efficiency modulating output Triangle Tube condensing boiler provides heat to the building. Heated water from the boiler circulates through PEX tubing imbedded in the concrete slab as called for by five programmable thermostats. A small electric storage tank provides heated water for the building's domestic hot water needs.

Figure 16. High efficiency heating system



Two LifeBreath heat recovery ventilation systems provide preheated fresh air for the building.

Lighting and other electric loads

Lighting in the offices is provided by T5 fluorescent light bulbs. Other electric loads include standard office equipment, and the police department's communication and emergency response equipment.

Recommendations

Peregrine's recommendation for this new building is to confirm that the building operates as originally designed and monitor the utility bills quarterly.

1. **Confirm building operates as designed**

   It's been a couple years since the Town office building was completed. This is a good time for the town to step back and review the original target performance standards set by the design team and compare the design standards to actual building performance. It's a rare construction project that translates the original design intent and performance assumptions into the final day to day operations. Specific questions the town can review include the target lighting, temperature, and humidity levels, ventilation rates, hours of operation, mechanical equipment efficiency.

   Next Step: Peregrine can work with the Town to review the original design assumptions and report back to the Town how the current building performance matches the original design intent.

2. **Monitor utility bills**

   New Hampshire's ETAP program offers an on-line utility bill monitoring tool to each City and Town free of charge. The tool requires Cities and Towns to identify each utility account, match them to specific end uses such as street lighting and individual buildings, and enter utility data that isn't metered by the State's investor-owned utility companies. The State's vendor for this service will access and update utility company information directly. Peregrine recommends that the Town monitor utility consumption for each account the Town elects to set up on the Energy Inventory Tool quarterly to identify energy consumption variations that should be investigated more closely.

Next Step: Identify a point person to take the web-based training for NH ETAP's Energy Inventory Tool and enter fossil fuel and wood pellet energy information and monitor the Town's utility bills quarterly.

8.0 Light Level Readings

Following are light level readings recorded during the site visit by Peregrine and Town Staff. The measured light levels correlate reasonably well with target light levels suggested by the Illuminating Engineering Society of North America. The one exception is a few rooms in the library that may have light levels that are higher than necessary[12].

Table 9. – Light levels measured by Peregrine and Town Staff

Building	Room	Measured	Target
Highway	kitchen	36-90	35-75
Highway	shed	13-20	15-30
Town Offices	select	44-52	35-50
Library	SAU #76 Office	62-92	35-50
Library	Program Room	54-119	35-50
Library	Lyme Room	68-125	35-50
Library	Basement Hall	5-50	20
Library	Friends Room	23-80	35-50
Library	Main Stack - Kids	60-98	35-50
Library	Main Stack - Adults	35-70	35-50
Library	Ralph Balch	2-4	35-50

[12] **Clarification of Lighting Recommendations**

"The recommended lighting levels stated above are maintained levels. This represents lighting levels after the fluorescent lamps have depreciated and the fixtures become dirty. Retrofitted or new fixtures initially will have light levels approximately 25 percent higher than those listed. This assumes existing fixtures are cleaned when retrofitted.

Light levels can be achieved with the associated lighting power densities (installed lighting wattage divided by space square footage) when fixtures are equipped with T-8 lamps and electronic ballasts. Areas that have dark colored ceilings, walls or floors may require higher lighting power densities to obtain the indicated light levels. Dark colors absorb light reducing the lighting system efficiency. As an alternative to adding more light in dark areas, consider painting the ceilings and walls with a light reflective color. "

Pasted from <http://www.puc.state.or.us/DAS/FAC/docs/Lighting_Level_Recommendati.doc?ga=t>

9.0 Waste Oil

DES has conducted a study of typical recycled oil burner emissions in order to simplify the compliance determination process. The study examined RTAP emissions from typical recycled oil burners using a variety of recycled oil characteristics, fuel use rates, and installation configurations. The results of this study show that recycled oil burners are in compliance with the provisions of Air Toxic Rule Env-A 1400 provided they meet all of the following criteria.

- Unit is rated at 500,000 BTUs/hour or less heat input.
- Unit is rated at 3.6 gallons/hour or less of fuel use.
- Unit burns 8,640 gallons or less per year of used oil.
- Exhaust stack is 8 inches or less in diameter.
- Exhaust stack outlet is 20 feet or more above the ground.
- The exhaust stack is vertical.
- The unit is operated and maintained in accordance with manufacturer's specifications.

If your facility operates a recycled oil burner meeting all of the above criteria, DES has determined that its emissions are in compliance with Env-A 1400 and the unit does not require a permit. However, records such as annual fuel use, number of days of operations, and maintenance records must be kept on-site to document that the above criteria are being met. Owners/operators of recycled oil burners that do not meet all of the criteria listed above should contact DES and conduct a source specific compliance determination as soon as possible in order to verify the compliance status of the installation.

All used oil burners, regardless of their compliance status with the NH Air Toxics Control Program, are required to submit a Notification Form to the DES Waste Management Division, (603) 271-2921. For more information also go to Reporting and Information Management Section.

Suggested Strategies for Reducing Energy Use and Increasing Energy Efficiency in Local Operations

Prepared by

Energy Technical Assistance & Planning For New Hampshire Communities
Funded by the ARRA Energy Efficiency Conservation Block Grant

Introduction

Whether you represent a City, Town, or County that is trying to reduce its energy use and expenses, adhering to the simple principles and processes described here will greatly increase the likelihood of both near term and long term success. Sections 2-4 give you specific steps you should take to move the process forward in your community. Section 5 outlines the broad steps for putting together a comprehensive Energy Management Plan.

Getting Organized for Energy Efficiency

The goal of the ETAP program is to assist communities take action to reduce their energy usage. Like any other project you might undertake at work or at home, knowing where you are and where you hope to get to and agreeing on the roles and responsibilities of the members of your team will make your efforts more fruitful.

Decide who is in charge: Designate an Energy Lead

Your community should have a single person responsible for monitoring energy use, tracking your progress in increasing energy efficiency, and measuring progress against goals. Ideally this should be an individual who has both the responsibility and the authority to affect policy and move your goals forward. This will help guarantee that energy efficiency initiatives stay on track and are an integral part of all policy and decision making.

Establish an Energy Committee and Share Information about Energy Use and Cost

A successful energy cost reduction strategy requires the involvement and commitment of elected officials, local government managers and departments, building users, and maintenance staff. Bringing them together to confirm policies, goals, and strategies, to determine resources needed, to establish timelines and responsibilities, and to measure and communicate progress is critical to your success.

You can't manage what you don't measure: Monitor Monthly Energy Use

Track energy use and cost for each building both month to month and year to year. Using the Inventory Tool offered by ETAP is an easy way to get an overview of this use and cost and to measure your progress toward reaching the energy efficiency goals you set.

Inform town employees that energy reduction is a priority and solicit suggestions

Town employees often have good ideas for how to reduce energy use. But no one ever asks them for their opinion. Get employees involved in energy efficiency discussions and ask for their ideas on how improvements can be made in your programs and policies.

Finding Resources to Implement Energy Projects

While many energy use reduction opportunities are low cost or even no cost, others will require the investment of funds for major capital projects.

Look for and secure utility rebates and incentives

New Hampshire's utility companies often offer incentives to encourage their customers to adopt and install energy efficiency technologies. Even when you purchase electricity or natural gas from a competitive supplier, you still qualify for incentives offered by the distribution company that delivers your supply to you. Before proceeding with any upgrades or renovations, contact your utility to see what is being offered and how you can qualify. If you've taken advantage of lighting upgrade programs in the past, you may qualify for additional incentives to upgrade lighting again with more efficient fixtures.

Plan for the inevitable replacement of older equipment: Include funding in CIP or in reserve funds for energy systems replacement when equipment is 50% of useful life

It is a typical for a municipality or county to use a piece of equipment, vehicle, or building energy system until it fails and needs to be replaced. But the time to think about improving the energy efficiency of equipment is not that January day when the heating system in the Town Building stops functioning. Bring in contractors to review the condition of your system and research what alternatives might be available. You might find out that it will pay to replace a system sooner with new efficient equipment and avoid the costly repairs that aging systems can require. Consider putting funds away yearly beginning when equipment gets to its half-life to minimize the budget impacts of its replacement.

Engage citizens in energy efficiency planning and policy making

Where there may not be needed expertise within the town, city or county government to address energy efficiency issues, there may be concerned or interest citizens willing to help and lend their expertise. If your town does not have an Local Energy Committee, reach out to interested citizens to form one. This not only will help you optimize how local government uses energy, but will give you a conduit to citizens when you need to secure their support for capital projects and procurements.

Establishing Policies that Encourage Energy Efficiency

Use building renovations as an opportunity to improve energy efficiency

Every building upgrade should be viewed as a chance to improve how the building operates, including how it uses energy. Consider adding insulation when wall are being opened. Be sure that new doors or windows are purchased with efficiency in mind.

Consider life cycle energy costs when purchasing any new equipment

When purchasing any new system that uses energy to operate (such as boilers, ventilation, air conditioning units, street lights, or vehicles) don't only consider the "first cost" or sticker price of the equipment or system, but compare and consider the "total cost" of different equipment, including it operation and maintenance over its expected life. It may be that the least expensive system will have a far greater impact on annual operating budgets than a more expensive, but energy efficiency alternative. This should be a standard principal in budgeting for any item with uses energy.

Creating an Energy Management Plan

The goal of the ETAP program is to not only to help communities identify specific actions it can take to reduce energy waste, but also to support ongoing energy management and planning to make buildings, systems and processes more energy efficient.

There are general principles and methods that are pertinent to any community to move them along the path towards energy efficiency. These are set forth in *New Hampshire Handbook on Energy Efficiency & Climate Change, Volume II* (2009), developed by the NH Carbon Coalition, Clean Air-Cool Planet, and Sustainable Development & Energy Systems (SDES) along with the Local Energy Committee Working Group of the NH Energy Efficiency and Sustainable Energy (ESSE) Board. These documents lay out an energy efficiency planning "roadmap" that municipalities can follow to understand their energy usage, plan for increased energy efficiency and work with their community to educate and implement effective energy efficiency solutions.

The aspects of this Roadmap are illustrated in Figure 1 briefly described in the following sections. You may already be following some or all of these steps in your community, if so congratulations! If not these steps are a strong foundation to use for thinking and acting on energy efficiency objectives.

Figure 1 Energy Efficiency Roadmap



Energy Baseline and Benchmarking

An inventory process can help establish a baseline of energy data describing the current performance of each building, as well as other areas needing attention, such as transportation and street lighting. For buildings, this involves collecting and organizing energy use information over a number of years to be able to look at annual, monthly, and seasonal patterns of energy consumption. The ETAP program provides assistance in collecting, maintaining and utilizing

this information. If you have not taken advantage of this free ETAP service, contact your Regional Planning Commission for more information.

Establishing Priorities

Reviewing the baseline and benchmarking information can help a community target its energy efficiency initiative. One approach to setting priorities is to focus on buildings that are larger energy users or that have the higher energy use per square foot of floor area. Another approach focuses on buildings that are older or are known to have older systems or systems that have required frequent or costly repairs or have a record of occupant comfort complaints. We recommend a combination of approaches that looks at each building individually, recognizes that different types of building uses result in different energy profiles, and that high energy use can reflect envelope and equipment inefficiencies, poor maintenance practices, conscious choices by building occupants, opportunities for behavior modification, or the inherent energy requirements of the use to which a building is put.

Buildings Assessments/Audits

Once buildings are identified as being the high priority targets, a building assessment by a qualified specialist should be arranged to determine what steps could be taken to reduce energy use without conflicting with the business for which a building is used.

For buildings with systems which perform like residential buildings (such as former homes converted to office space), there are standards from the Building Performance Institute (BPI) for conducting audits. Commercial buildings have different systems and The American Society of Heating Air Conditioning and Refrigeration Engineers (ASHRAE) has developed standard energy audit levels for these types of buildings. For all such assessments, regardless of building type, the cost will vary with the level of detail and type of information sought. This can range from relatively inexpensive high level “scoping audits” which identify opportunities with ranges of costs and savings to help screen investment alternatives to extensive and expensive “investment grade audits” which provide exact costs and savings estimates and identify replacement equipment to be installed with design requirements.

Prioritizing and Implementing Recommendations

Building assessments will usually generate a range of recommendations that include relatively quick and easy changes or improvements as well as capital intensive projects. Some measures will have relatively quick paybacks on investment, while others will have long paybacks and may be best implemented as part of long term equipment replacement process.

Regardless, it is important to review all the recommendations and understand the implications of acting now or later on each one in terms of cost and savings; and further, to develop a formal plan, with responsibilities assigned and actions identified for proceeding with each recommendation of interest.

In many cases, the limiting factor in proceeding will be securing funding. While it is tempting to look for grant sources and wait until grant money is secured for projects, it may make more sense to commit and invest local funds now to gain efficiencies and savings as well as the peace of mind and greater comfort that new systems will create. If a significant energy cost savings can be documented, consider finding the funding for the work through loans programs such as the Municipal Energy Reduction Fund offered by the Community Development Finance Authority, or bonding. If the audits include lighting, HVAC or motor and drive upgrades, utilities may offer incentives that help pay for improvements.

Measurement/Assessment

Continue to monitor energy usage and savings achieved. If you've spent hard-won taxpayers dollars on these energy saving measures, you want to document how this work made a difference, and if not, determine why expected benefits are not being realized.

Reprioritize and Continue Improvements

Very seldom will one round of energy efficiency upgrades cover all the work that could be done to maximize energy savings. Establish the next set of priorities and begin the process of implementing these changes as well.

References

- New Hampshire Handbook on Energy Efficiency & Climate Change, Volume II (2009), developed by the NH Carbon Coalition, Clean Air-Cool Planet, and Sustainable Development & Energy Systems (SDES) along with the Local Energy Committee Working Group of the NH Energy Efficiency and Sustainable Energy (ESSE) Board. Copies of this document can found at http://www.nhenergy.org
- Information on building audits can be found at http://www.bpi.org and http://www.ashrae.org/
- Information on the Municipal Energy Reduction Fund can be found at http://www.nhcdfa.org/web/erp/merf/merf_overview.html .