Town of Hartford, Vermont

Five-Year Energy Action Plan

March, 2017

Authors: Juliette Juillerat, Damon Lane, Stephanie Morse,

Vermont Energy Investment Corporation

Table of Contents

Introduction

The Hartford Energy Commission (HEC), since its inception in 2007, has directed most of its efforts toward helping the Town of Hartford become more energy efficient in its municipal operations (mainly street lights and building operations). Collaboration among HEC and the select board, town manager, building supervisors and department heads, and Efficiency Vermont has effected many improvements.

Aware that most of the municipal energy efficiency measures that could be overseen by well-meaning non-professionals (HEC members) had been accomplished, the Commission reevaluated its priorities and activities. This process led to a restatement of the HEC mission:

> to help the Town *and its residents* achieve greater energy efficiency and move toward local renewable power generation, in keeping with Vermont state policy.

Since having professional guidance with establishing a plan to accomplish this goal was advisable, the Town authorized a short-term contract with the Vermont Energy Investment Corporation (VEIC) to:

1. Assist with implementation of the recommendations of previously performed energy audits of the Bugbee Senior Center and the Public Safety Building;
2. Draft and present a 5-year Energy Action Plan that would guide energy-related efforts of the Town and HEC in the medium term; and
3. Build on the efforts and direction outlined in (2) to provide an outline for the Town and HEC to use in mapping out the Town's comprehensive energy plan for the foreseeable future.

The document below is VEIC's recommendation for steps the Town of Hartford might follow in the next 5 years, to help the Town's municipal infrastructure achieve greater energy efficiency, help the Town and - by extension- its residents save on the cost of energy, and meet the goals of the Vermont Comprehensive Energy Plan.

To provide these recommendations VEIC followed the following steps:

- Described the municipal buildings and facilities' energy and water consumption over the past 3 to 5 calendar years;
- Reviewed prior energy efficiency work the Town has done with Efficiency Vermont;
- Estimated the magnitude of the energy savings that might result from specific actions or sets of actions, and the resulting cost savings where they could be estimated;
- Prioritized the recommendations by potential impact on total municipal energy consumption, confidence in achieving energy and/or cost savings, and ease of implementation; and
- Created a stepwise outline of specific actions for HEC and the Town to undertake, by year, to achieve the stated gains.

Executive Summary- Five Year Action Plan

The Town of Hartford (Town) hired VEIC to complete a 5-year Hartford Energy Action Plan (EAP) detailing strategic investment in the Town's energy future between now and FY 2022.

The Town of Hartford's Energy Action Plan (EAP) is written in the larger context of a Comprehensive Energy Plan that maps out the road leading to the energy goals set forth in the State Comprehensive Energy Plan and aligns with goals in the Regional Planning Commission Energy Plan. The EAP is a living document that serves as a resource for the Town for annual planning and budgeting.

Overall, the majority of the Town's energy costs are from electric use, followed by thermal fuels (building heating fuels: oil and propane), and transportation fuels (gasoline and diesel), as illustrated in Figure 2.

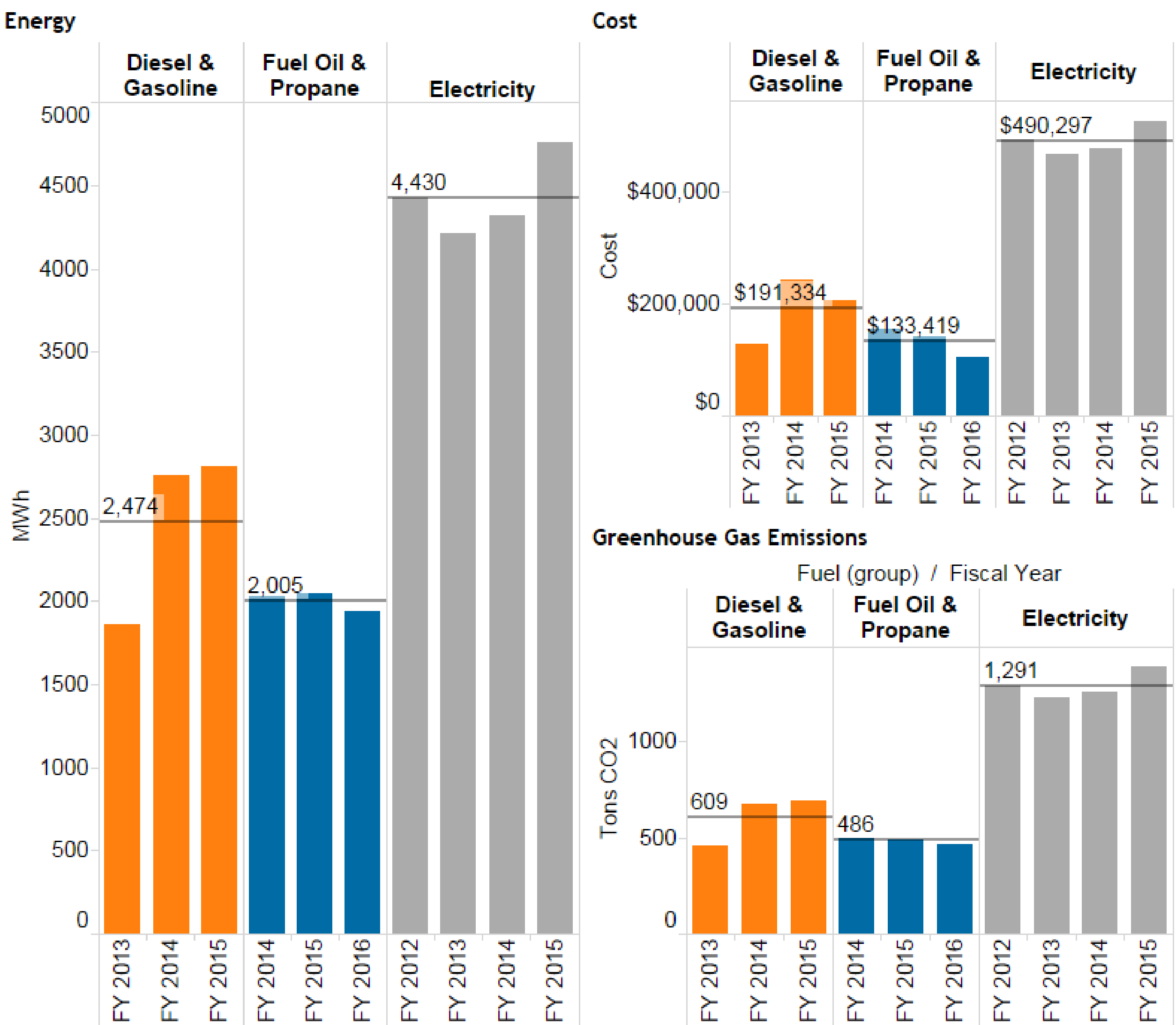


Figure 1. Total energy consumption, spending, and Greenhouse Gas emissions

Following a thorough review of energy consumption, municipal infrastructure, and municipal fleet data provided by the Town, VEIC recommends the following actions be taken by the Town between now and 2022, in order to achieve energy improvements that will benefit the Town and the community as a whole, have a clear return on investment, have high visibility, and provide opportunities for public engagement.

Details on the recommendations and supporting documentation for the recommendation can be found in the next section: Documentation Supporting the Five Year Energy Action Plan.

Any energy or water audits that the Town commissions (e.g. from Efficiency Vermont or a water auditor) typically include a list of prioritized next steps, often including simple payback of the investment, return on investment, energy saved, net present value of energy savings, etc., that will help the Town make decisions with good financial information in hand. The higher level information in this Energy Action Plan does not allow for this detailed financial review, but energy audits and quotes form technology providers will. The Energy Action Plan analysis does consider order of magnitude costs and returns in the selection and prioritization of actions.

The Energy Action Plan below is laid out as a list of prioritized recommendations, organized by topic, to allow the reader responsible for a subject area focus on the recommendations most relevant to them. Recommendations are also presented organized in a year by year basis, for capital planning purposes and to highlight the steps that are recommended to achieve these prioritized tasks. Estimated cost and potential savings that can be achieved are included in the tables, where they could be estimated. Suggestions on financing these steps are also provided for each step.

Completing the Energy Action Plan is not the end of the road, but rather the beginning, as the Comprehensive Energy Plan will then lay out the next steps for the Town as a whole on the way to meeting the goals of the 2050 State Energy Plan.

Recommendations

Energy consumption related to water and wastewater dominates town energy spending and should be considered first. While water savings can bring significant energy and cost savings, they are likely not to have an effect on tax rates because more than 90% of water delivery and treatment costs are supported by water rates (approximately 7% of the water enterprise fund revenues come from hydrant rental which is a general fund expense). So, while reducing water costs by reducing energy costs required to provide and treat the water will benefit water users on Town water, it will likely not greatly impact the Town's budget and tax rates.

The results of the water audits will guide the next steps. If leaks or efficiency opportunities are found in the water system, those should be addressed first. If the Water Department can absorb lower water revenue without affecting the water rates, Town and community water efficiency should be prioritized.

Below is a list of key opportunities and recommendations identified for Town owned facilities and fleet:

1. Water Use
    a Commission a water audit to identify leaks in the distribution system and potential lost revenue from non-revenue losses (i.e. water losses before the customer water meter).
    b Evaluate water department revenue and cost structure to determine if aggressive water savings would negatively affect revenue or services.
    c Determine how enterprise accounts, such as water and wastewater, can use solar generation while addressing recent concerns about mixing funding and benefits between the general fund and enterprise funds
    d Determine if any pressure reducing values (PRVs) are candidates for replacement with small generating turbines: Some water systems have hydropower potential. Where the pressure needs to be reduced, for example downstream of a high elevation reservoir, there may be locations that could generate power while reducing pressure. Determine if there are such locations in Hartford's water system.
    e Investigate water plants and pumps for savings opportunities (Pump House)
2. Town Buildings
    a. Implement efficiency improvement recommendations at Bugbee
    b. Implement efficiency improvement recommendations at the Public Safety Building
    c. Wood heat for Municipal arena/ ice rink, and/or highway garage
3. Town Vehicles
    a. Make fuel efficiency a required consideration when replacing fleet vehicles.
    b. Contact fuel efficiency improvement technology providers (e.g. idle-reduction technology) for cost estimates.
    c. Replace one to three cars with electric vehicles
    d. Re-evaluate the savings potential from alternative transportation fuels
4. Residents and Businesses
    a. Engage the Community in the Development of a Comprehensive Energy Plan
    b. Implement a Community Outreach Campaign to Reduce Water Consumption Town-wide (multi-year)
5. Cross-cutting
    a. Enter all Town and School District Infrastructure into Portfolio Manager
    b. Re-Evaluate the Potential for Solar PV at Wastewater and Highway Facilities
    c. Hire an energy coordinator who can work through these priorities and monitor energy costs to identify savings opportunities, and manage new projects that upcoming technologies will bring beyond 2022.

Year-by-Year Energy Action Plan

A detailed year-by-year overview of the high priority recommendations provided in the report are provided in a table format in Appendix I, p.62, and include cost and savings estimates (where available), financing options for each task, and reference to the section of the report where the task is described more thoroughly.

Documentation Supporting the Five Year Energy Action Plan

Summary of Findings

The Town has already completed many efficiency projects in municipally-owned facilities. Major efficiency upgrades can still be done for at least two of the Town's buildings (Bugbee Senior Center and the Public Safety building). While there are still opportunities available to improve the Town-owned building stock, focusing on water conservation and expanding energy savings to the whole community are likely to present the best ways for the Town to be more energy efficient, and for the Town to save energy and money on its water utility activities such as pumping, treatment, and wastewater treatment. The wastewater treatment plant has already incorporated many efficient features and the focus should be on water pumping and treatment, and community-wide water conservation and efficiency.

Introduction

The Town of Hartford (Town) hired VEIC to complete a 5-year Hartford Energy Action Plan (EAP) detailing strategic investment in the Town's energy future between now and FY 2022. Specifically, the Town was seeking to identify specific opportunities for ongoing Town investment, financially and non-financially, in energy improvements that will benefit the Town and the community as a whole, and have a clear return on investment (including rate of return and payback period), high visibility, and opportunities for public engagement.

Overall, the majority of the Town's energy costs are from electric use, followed by thermal fuels (oil and propane), and transportation fuels (gasoline and diesel), as illustrated in Figure 2.

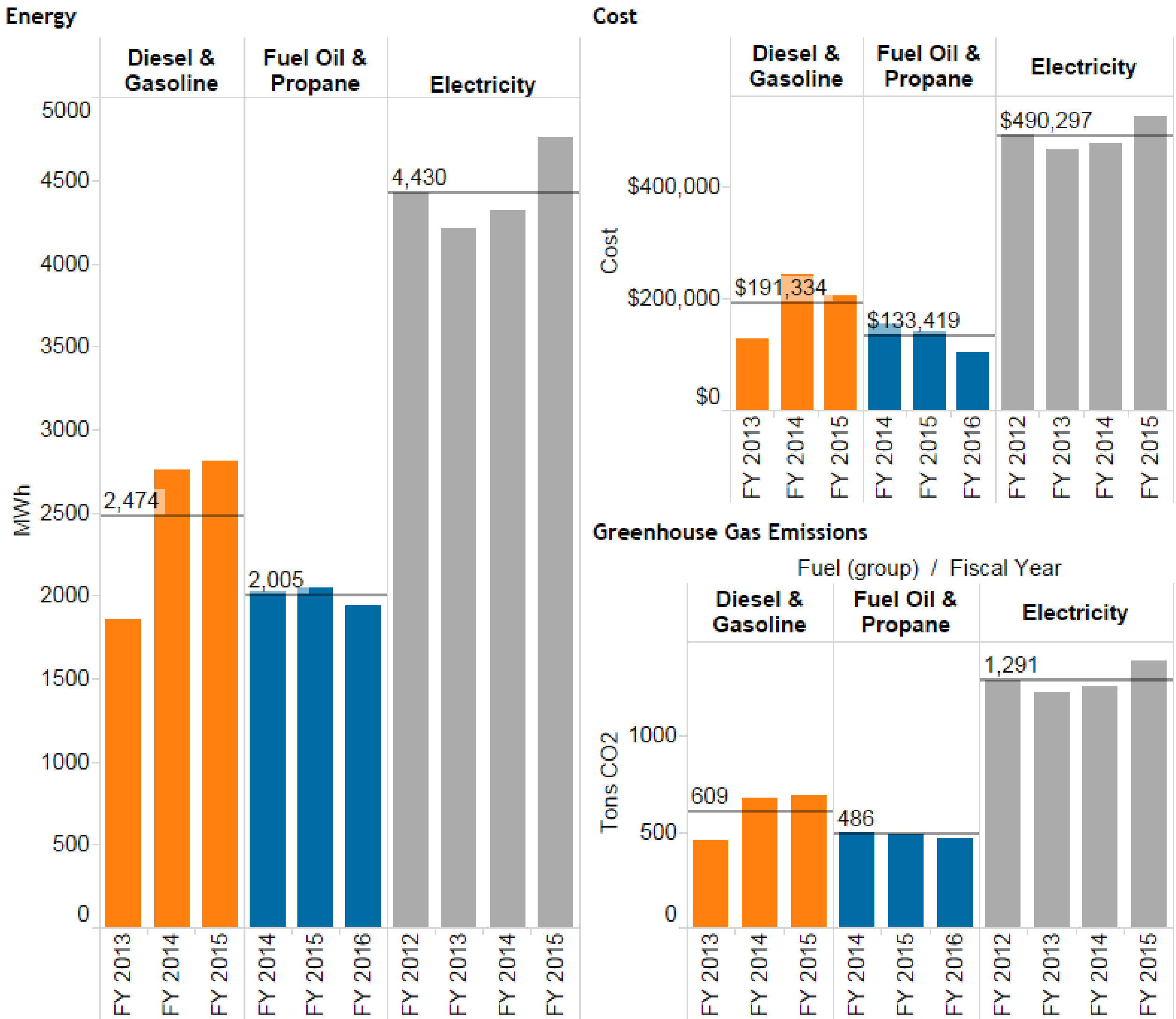


Figure 2. Total energy consumption, spending, and Greenhouse Gas emissions

Given the predominance of electricity in the Town's total energy costs, this report addresses the electric and thermal energy first, followed by a section on energy embedded in water, as this is a large proportion of the total electricity costs, and then a review of energy consumption in Town's transportation activities. In each section, we evaluate the best options for efficiency and renewable energy. Best in this case includes cost effectiveness and minimal interruption into ongoing town activities.

VEIC structured the analysis of data provided by the Town into four aspects of energy consumption:

- Town infrastructure (aside from buildings)
- Town buildings
- Water treatment and distribution
- Transportation

The Town of Hartford was also seeking recommendations on community engagement and the potential creation of an energy coordinator staff position with the Town. Recommendations on these two topics are provided in subsequent sections of the Action Plan.

Electricity Use for Public Infrastructure

Electricity Use for Public Infrastructure - Recommendations Summary

Public infrastructure in Hartford uses 90% of the electricity that the Town buys, but thorough efficiency efforts have already captured most of the potential savings in this area. In the buildings section, Bugbee Senior Center is recommended as a candidate for Efficiency Vermont's Deep Energy Retrofit incentive program. Other Town buildings may also qualify for the program that is limited to commercial, industrial, or mixed-use buildings over 5,000 square feet. Some savings potential may remain, but more may be found by reducing community-wide water consumption to lower water and wastewater energy.

While most of the electric efficiency opportunities in this sector have already been completed, there are a few small energy efficiency tasks the Town can pursue now, as well as considerable water efficiency work that should be considered.

Consider wastewater efficiency reports and whether anything has changed that may allow adoption of measures previously declined.

Investigate water plant and pumps for savings opportunities.

Determine how enterprise accounts, such as water and wastewater, can use solar generation while addressing recent concerns about mixing funding and benefits between the general fund and enterprise funds

Determine if any pressure reducing values (PRVs) are candidates for replacement with small generating turbines.

Investigate closing these two inactive electric accounts to save around $400 a year in monthly customer charges (there is zero kWh for either account in our data, which spans January 2011 to February 2016, including the deep freeze in Winter/Spring 2015):

- o Woodstock Rd Heat Tape For Water Line-Water

- o Rte 5 Pump/Super 8 Lot

Replace Christmas lights with LED if they are not already

- o Consumes over 3,000 kWh/yr costing $500-650/yr

Review of Current Usage

Public infrastructure, including parks, the ice rink, the landfill, the radio tower, water, wastewater, and streetlights account for the vast majority of the Town of Hartford's electricity consumption. The buildings associated with the landfill, waste water and water plants, and the ice rink are included in this data, but their high energy consumption may predominantly be due to their functions instead of building energy inefficiencies. Figure 3 shows Town electricity consumption, with accounts linked to public non-building infrastructure colored blue and building electricity use shown in orange. The Town's total electricity consumption is over 2 million kilowatt-hours a year; this costs around $500,000 annually. Public infrastructure accounts for 90% of this.

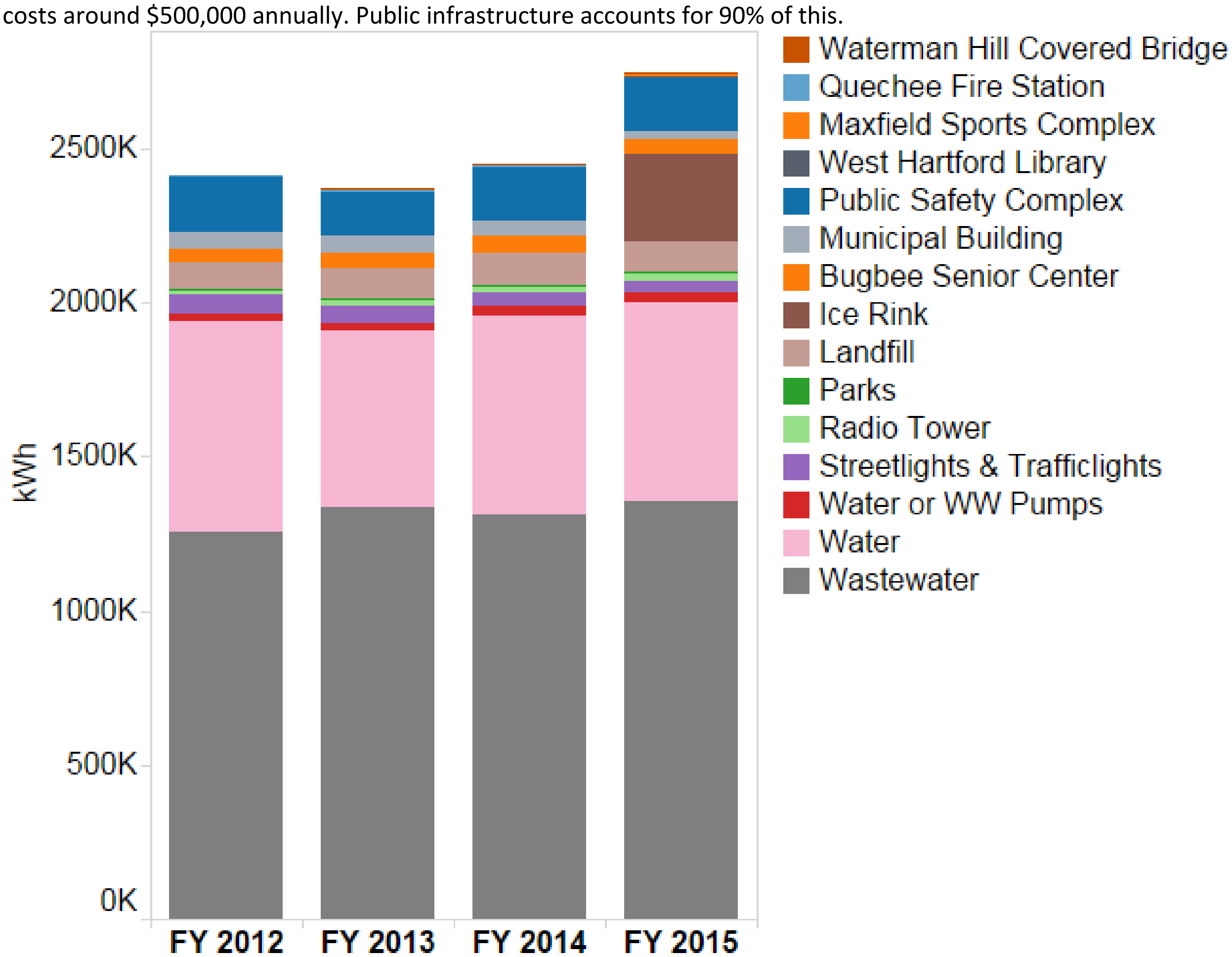


Figure 3. Electricity consumption by fiscal year showing the predominance of public infrastructure in the Town's electricity consumption[1]

DATA AND DATA COLLECTION ISSUES

[1] The Ice Rink changed electric account during the analysis period. The old account was not included in the data request, or this analysis but should be added to ongoing tracking efforts in Portfolio Manager or other.

VEIC obtained monthly electricity usage data from Efficiency Vermont for the Town's 66 electrical accounts for January of 2011 to February of 2016. This provided information from complete fiscal years from FY2011-2012 to FY2014-2015. For this report, VEIC found it useful to group the electrical accounts into categories that relate to responsibility and opportunity for improvements. At the highest level the groups were infrastructure and buildings. The infrastructure group was broken down further into categories, from largest consumption to smallest: wastewater, water, ice rink, landfill, streetlights and traffic lights, pumps,[2] radio tower, parks, and the Maxfield Sports Complex. There are 14 accounts associated with streetlights and 20 associated with wastewater. The Town may also benefit from aggregating and categorizing if it does not already do so. Also, the Town can work with Green Mountain Power[3] to analyze 15-minute data from smart meters for opportunities to reduce demand charges and other costs using peak reduction and load shifting or switching to different rates.

See tables and graphs in appendix for details such as consumption, by year, for each account, as well as spreadsheets provided. Electricity consumption data like this can be combined with operational data to find problems or efficiency opportunities. For example, from the electric use alone, a person cannot tell if any of the pumps are operating inefficiently because the high use ones may just be pumping more water. But if the consumption data is combined with flow data or run hours, ratios such as kWh per MG can be calculated for each location and for individual pumps that can be monitored to help operators use less energy. Data collected by Public Works department staff can be compiled as in Table 1 below. In this example from Vermont, it was determined that 30% of the station energy use was for the electric heater, which could be reduced by adjusting the thermostat setting.

[2] The following accounts are pumps, but VEIC does not know whether they are for water or waste water. They are shown in Figure 3 in one of the small, unlabeled blue areas:
ALDEN PARTRIDGE RD PUMP STATION, QUECHEE, 05059 (Service District: Woodstock)
ARBORETUM LN SPORTS PK PUMP, WHITE RIVER JCT, 05001 (Service District: White River Jct)
MAXFIELD PUMP STA, HARTFORD, 05047 (Service District: White River Jct)
RT 5 PUMP/SUPER 8 LOT, WHITE RIVER JCT, 05001 (Service District: White River Jct)

[3] Brenda Spafford (Brenda.Spafford@greenmountainpower.com), Dave Winslow, or Don Lorraine

Table 1: example of information that could be collected by staff on pump house energy use[4]

Month	Pump Hours #1	Pump Hours #2	Total Pump Hours	Pump Energy Use (kWh)	Station Energy Use (kWh)	Remaining Energy Use for Heat/ Misc. Equipment	Total Monthly Electric Energy Cost
Jan-12	20	24	44	519	1221	702	$143
Feb-12	18	20	38	448	1587	1139	$175
Mar-12	19	22	41	484	1553	1069	$167
Apr-12	17	21	38	448	992	544	$124
May-12	19	20	39	460	703	243	$99
Jun-12	15	16	31	366	660	294	$97
Jul-12	17	18	35	413	580	167	$89
Aug-12	16	17	33	389	613	224	$92
Sep-12	18	20	38	448	637	189	$96
Oct-12	17	18	35	413	463	50	$77
Nov-12	17	19	36	425	537	112	$86
Dec-12	18	20	38	448	879	431	$115
Total	**211**	**235**	**446**	**5,263**	**10,425**	**5,162**	**$1,359**

Continuous Energy Improvement (CEI) is the practice of choosing these metrics, monitoring, refining processes and upgrading equipment, and monitoring the change in the metrics.

The Town should organize, track, and store energy data in Portfolio Manager, which is a Department of Energy tool created for that purpose for businesses, campuses, and other large energy users. While inputting data takes an investment in time, some utility data can be automatically uploaded, and data stored and updated this way is always ready and available to assist in making decisions without the delay and cost of having a consultant or energy coordinator collect, clean, and analyze data.

The larger community can track the town's progress toward the 90% renewable energy target using the Community Energy Dashboard.[5] Finally, Efficiency Vermont is developing a tool for analyzing town electricity data that can help target efficiency efforts and quantify the results of community engagement efforts that were previously very difficult to evaluate.

Progress to Date

Efficiency Vermont data show 430,000 kWh of electrical saving related to these electric accounts since 2012. This includes the energy that is not being consumed (avoided electricity consumption) by the efficient new wastewater treatment plants, so the actual consumption has not fallen by this amount, rather it would have gone up if an inefficient wastewater treatment plants had been built.

[4] Source: Steve Bolles Presentation: Water/Wastewater Energy Evaluations Lessons Learned in the Field
[5] http://www.vtenergydashboard.org/my-community/hartford/progress

Streetlights

The Town has aggressively reduced electricity use in streetlights by reducing the number of lights and converting the remaining lights to LEDs. Figure 4 shows a 39% decrease in consumption between FY12 and FY2014-2015.

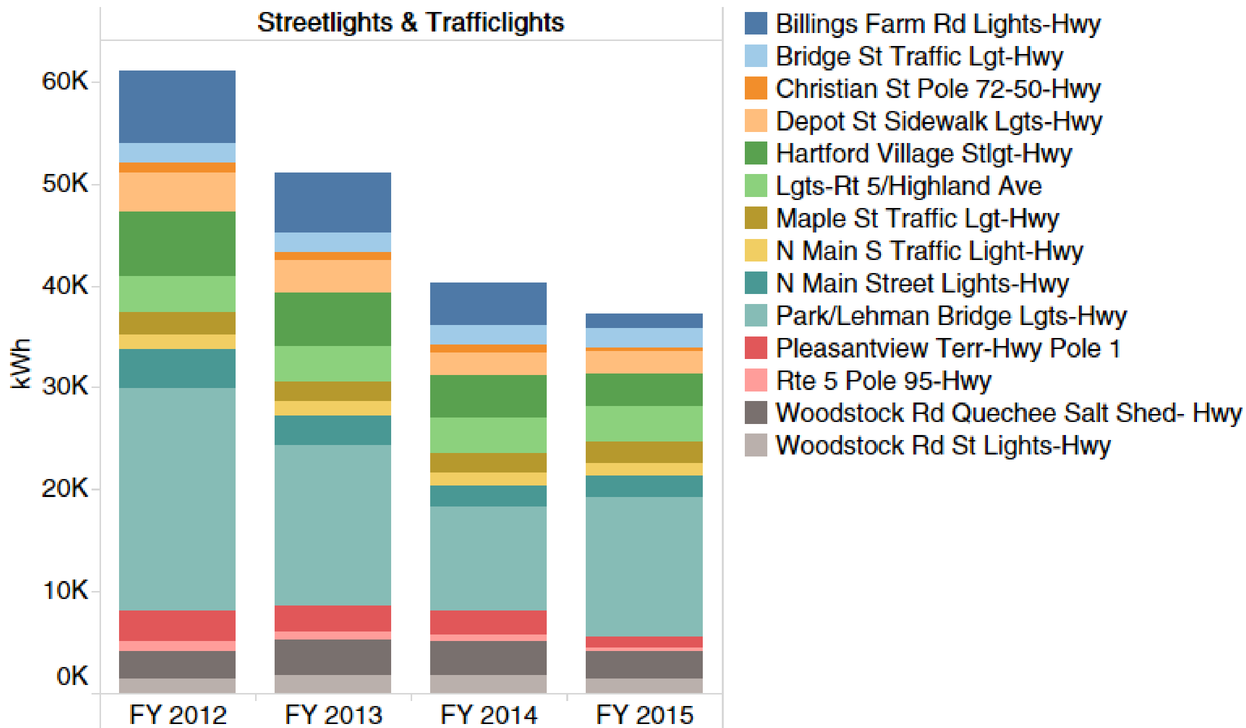


Figure 4. Electric use by streetlight and traffic lights declining over time

Landfill

Electricity use at the landfill dropped 42% between FY2012 and FY2013 and has been nearly steady since. The 2014 report "Upper Valley Solid Waste and Recycling Analysis"[6] explores options of consolidating municipal waste collection and processing at the regional level. The energy implications of any consolidation should be considered in the decision making process. The potential of solid waste digestion will be considered in the Comprehensive Energy Plan, as it was not considered a top priority for the next five years.

Wastewater and Water

Wastewater and water are the largest users of energy among the Town's electric accounts. The wastewater plants are new, efficient by design, and have incorporated additional efficiency measures. Figure 5 shows relatively constant electricity consumption at the wastewater and water accounts.

---

[6] DSM Environmental Services, Inc., "Upper Valley Solid Waste and Recycling Analysis," July 15, 2014. http://www.hartford-vt.org/DocumentCenter/View/246

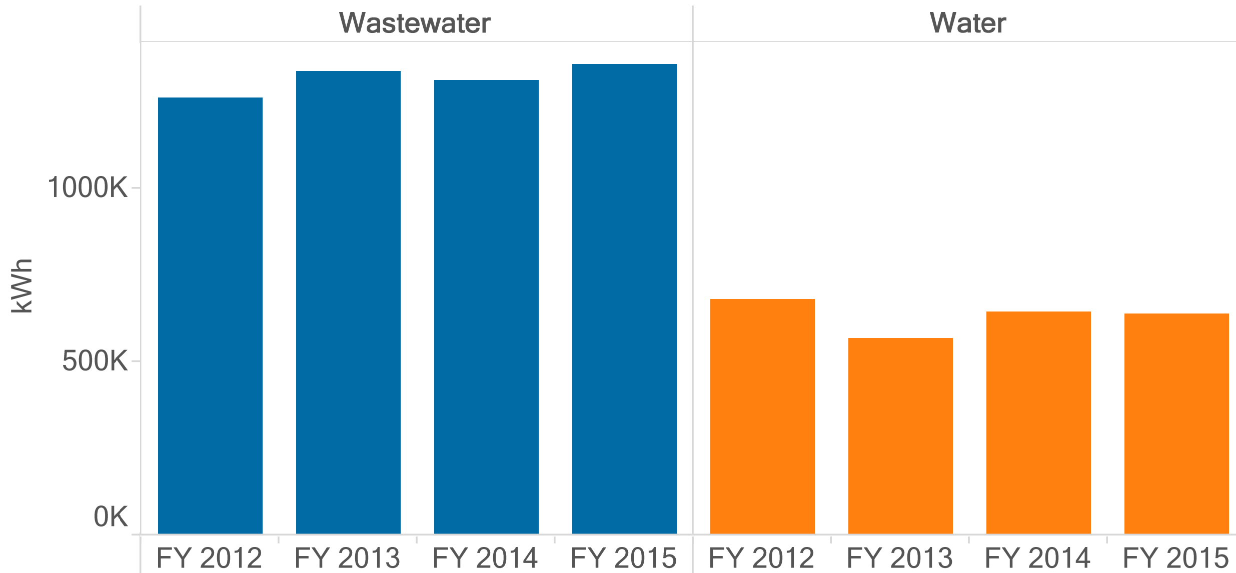


Figure 5. Wastewater and water electricity use by fiscal year remains relatively constant.

Given the large scale of wastewater energy use, which accounts for more than half the Town's total electricity consumption, the Town should again review previous energy audit reports and consider acting on any remaining recommendations. During an earlier building energy audit, one of the pump stations was including and $3,000 a year savings were found by shutting off one of the pumps. The remaining stations have not been audited and may hold large savings.

Table 2 shows electricity use per account within the water and wastewater systems, sorted by fiscal year 2015 consumption. As expected the wastewater plants and water wells are the highest users, but nearly all are worth investigating for savings potential.

Table 2. Electricity consumption at water and wastewater facilities (kWh)

Service Address	Premise Address (group)	FY 2012	FY 2013	FY 2014	FY 2015
N Elm Treatment Plnt-W/W	Wastewater	1,411,040	1,636,320	1,499,725	1,619,388
Woodstock Rd Treatment Pl W/W	Wastewater	943,926	967,866	1,000,695	997,311
Wilder Well-Water	Water	564,960	444,480	506,287	503,307
Lake Pinneo Water Well	Water	79,680	79,887	88,804	82,240
Depot S W/W	Wastewater	112,680	72,940	93,410	79,316
High St Main St Pumping Station - W/W	Wastewater	38,840	36,958	36,697	36,320
Noyes Ln Kingswood Resv Pole 19-2 Water	Water	8,720	13,600	15,420	18,880
Municipal Bldg Eastman Hill Pump-Water E..	Water	12,845	14,208	14,981	18,802
Municipal Bldg Whitman Brook Pump Stn-..	Wastewater	14,968	15,269	12,725	18,682
Maxfield Pump Sta	Water or WW Pumps	9,334	13,868	17,856	16,558
Sugar Hill Ln Water Pump	Water	11,910	12,334	14,579	15,738
Maple St Sewer Pump-W/W	Wastewater	12,941	12,899	14,102	13,672
Arboretum Ln Sports Pk Pump	Water or WW Pumps	11,234	12,028	13,582	11,450
Ferry Rd-Sewer Pump	Wastewater	6,710	9,809	10,217	10,966
78 Murphys Rd Murphy Rd Pump Stn-W/W	Wastewater	7,413	7,178	8,282	10,003
Bridge St Pump Station-W/W	Wastewater	4,797	6,399	8,065	8,443
Olcott Commerce Park-W/W	Wastewater	7,431	6,023	7,749	7,535
S Main St Pump Station-W/W	Wastewater	5,315	5,353	5,663	5,471
Elm/Gillette S Pump W/W	Wastewater	6,706	8,833	9,097	5,444
Bentley Rd Pump - W/W	Wastewater	3,493	2,885	4,224	4,444
Campbell S Pump Stn-Wtr	Water	2,552	3,692	4,383	4,365
Club House Rd Mill Run Pump Station - W/..	Wastewater	4,313	2,835	4,152	3,417
Quechee Hartland Rd Quech/Hrtlnd Sec7 P..	Wastewater	3,613	2,618	4,053	3,316
Dewey Family Rd Jay Hill Rd Pump Stn-W/..	Wastewater	4,521	2,972	3,173	2,469
A St Pump Station-W/W	Wastewater	1,598	1,535	1,531	1,738
Noyes Ln Pump Stn-W/W	Wastewater	2,066	2,135	2,145	1,675
Alden Partridge Rd Pump Station	Water or WW Pumps	851	967	960	882
Va Cutoff Wtr Stor Tank Alarm	Water	473	700	719	726
Lake Pinneo Wastewater Pump Station	Wastewater	693	670	673	705
Hemlock Ridge Vault-Water	Water	577	916	918	702
Hendee Wa W/W Hendee Way - W/W	Wastewater	669	866	979	333
Wheelock Rd Sec 2 - Water	Water	0	85	133	157
Rte 5 Pump/Super 8 Lot	Water or WW Pumps	0	0	0	0
Woodstock Rd Heat Tape For Water Line-..	Water	0	0	0	0

Efficiency Vermont show records of 86,000 kWh per year in avoided electricity use through efficient design and operation of the wastewater plants and Efficiency Vermont staff note that nearly all of the opportunities for savings were adopted.

The water accounts have fewer Efficiency Vermont project records and should also be examined for efficiency opportunities. These accounts are roughly one quarter of Town electricity consumption. The Wilder facility has relatively new (~2004) variable frequency drives (VFD) and premium efficiency well pumps on both wells. The Quechee system is an older facility and might benefit from an energy audit.

The main water account, Wilder Well Water, is on a time-of-use rate. Pumping water when electric rates are low is a good cost savings strategy. The White River Junction system strives to pump off peak. After construction of the new water tank in Quechee the Town hopes to have enough water storage capacity to pump off peak there as well. Management of pumping can help lower energy costs and avoid demand rates.

In the future, when renewable energy production affects energy prices, it may be beneficial to pump when excess renewable energy is available,[7] which at times can drive wholesale electricity prices near or below zero. Actions taken now should not preclude this future strategy.

The Department of Public Works supports investigation of solar for Town infrastructure. About 6 years ago several firms (e.g. Gro-Solar) looked at the Town's water, wastewater and highway facilities for solar photovoltaic opportunities. The payback was not beneficial to the Town at the time but should be re-evaluated as the solar market has greatly evolved in recent years. Figure 6 shows the national median installed price for solar has been cut in half over the past five years. Vermont prices are typically near the national average. Owning solar provides more economic benefit than leasing or power purchase agreements, but the Town cannot utilize the valuable Federal tax credits. Partnering with an investor with tax liability could be beneficial and earn the town 5-10% savings on electricity. If the Town has land that could host solar, the Town could also receive revenue for leasing it to a solar installation. Details of leases are usually kept private between the parties, but $500-$750/acre is not unreasonable. The simplest option is to buy solar credits from a community array. Offers vary widely and change over time, so it is hard to predict what quotes Hartford will receive. But given the low costs, expect at least 2% savings on electric bills. Know that community arrays need to sell all of their credits to get high net metering incentives. Like any product, the Town may be able to negotiate a volume discount because of the high usage of these accounts.

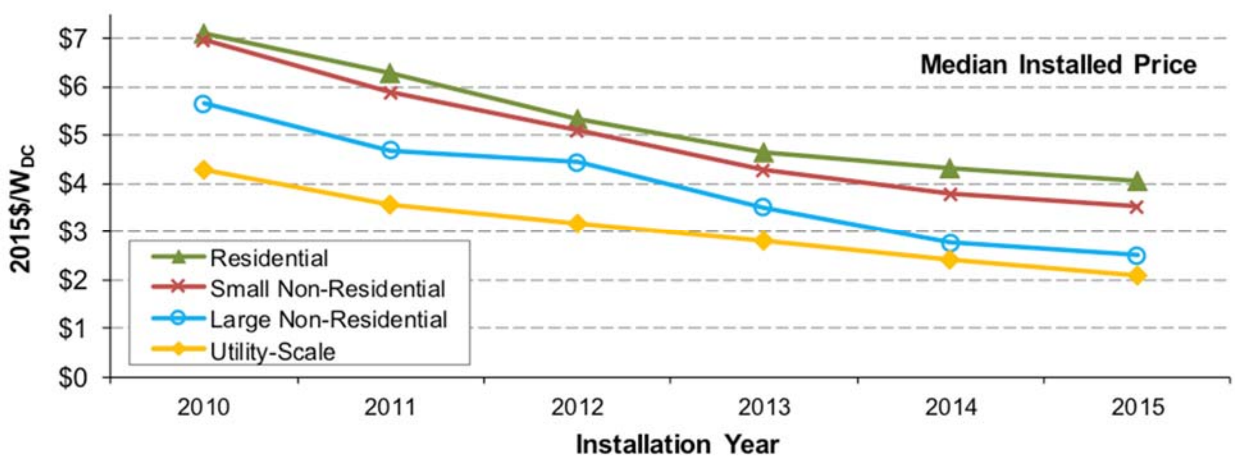


Figure 6: Median Installed Price for solar has dropped by more than half in the last five years[8]

Reducing water use can save energy in both the water and wastewater systems and should be thoroughly investigated by the Town as the best option to save energy and money town-wide (see Section on Energy Embedded in Water for a thorough discussion).

[7] Regulatory Assistance Project, "Teaching the Duck to Fly," 2016. http://www.raponline.org/knowledge-center/teaching-the-duck-to-fly-second-edition/

[8] Lawrence Berkely National Lab, "Tracking the Sun VIII," 2015. https://emp.lbl.gov/sites/all/files/lbnl-188238_2.pdf

Opportunities for Improvements and Upgrades and Next Steps

The largest opportunity to reduce the electricity used by public infrastructure is likely in reducing the amount of water used to reduce operations at the water and wastewater treatment plants.

Efficiency is the most effective strategy to reduce electricity costs. Hartford has achieved most of the potential at the infrastructure sites and for more savings can look to renewable energy. Hartford already gets credits on their electric bills from three solar arrays: one on the roof of the Public Safety Building, and two community arrays. Solar can be installed on the building it serves or somewhere else. When the solar panels are in a field or other remote location, the energy they produce can be allocated as credits on the accounts of people who either own, lease, or have another financial arrangement with them. Initially Hartford's solar credits were allocated to Town meters without consideration for which ones are enterprise funds and which are paid from the general fund. To remedy the situation, Hartford asked VEIC to evaluate which non-enterprise accounts would be best to get solar credits.

Under current net metering rules, the residential rates is always used to calculate the solar credit, so the rates of the various accounts do not matter today to the value of solar energy. However the solar adder ends 10 years after system installation and we cannot predict what types of incentives or rates will be available then. As a general rule, accounts with the highest per kWh rate are the best ones to offset. Table 3 shows non-enterprise accounts with their average monthly consumption and estimated average monthly bills. The rates shown in the table are the final 2020 rates GMP has proposed after transitions from legacy GMP and CVPS rates, so may not match current bills. The accounts in green are already receiving solar credit. Although two of these have the lower rate per kWh, they have higher customer charges that under the current net metering rule can also be offset with solar credit. Together, the accounts in the table below can absorb 62,200 kWh of solar credits per month plus about another 3,600 kWh to offset the customer fees. The Town is currently receiving over 50,000 kWh of solar credit in an average month, close to the consumption of the non-enterprise accounts. The Town should investigate regulations and strategies for acquiring solar credit for enterprise funded account as a way to increase the use of renewable energy and address the large share of Town energy consumption those accounts make up.

Hartford may also have hydropower potential within its water system. Generally, where there are pressure reducing values (PRVs) that have a pressure differential of 25 psi or greater, there is opportunity to replace them with a small turbine.[9] Bennington and Barre, Vermont and Keene, NH all use this type of system.[10] The detailed feasibility study[11] and a one-page case study[12] for Barre's project

[9] Community Hydro, http://www.communityhydro.biz/watersystems.html.

[10] EcoStrategies & Fuss & O'Neill, Inc., "Barre Micro-Hydro Project," Presented at Community Energy and Climate Change Conference, http://www.vecan.net/wp-content/uploads/jeff-McDonald_VECAN_Barre-Micro-Hydro-Project.pdf.

[11] Rentricity, "City of Barre Energy Recovery Study–Final Report," 2007, www.vtenergyatlas-info.com/wp-content/uploads/2010/02/Barre-hydro-final-study.pdf.

[12] Rentricity, Barre Case Study, 2014, http://rentricity.com/wp-content/uploads/2014/07/City-of-Barre-Case-Study-7-14.pdf

are available online. The applicability is highly site specific, so a preliminary assessment should be able to determine if/where there is reason for more detailed study.

Table 3. Non-enterprise Town electric accounts average usage per month, and estimated monthly costs and rates

Service Address	Premise Address	Account On Bill	Avg. Quantity	Avg. Cost	Customer charge ($/mo)	Peak/1st kWh ($/kWh)
Municipal Bldg-Bridge St	MUNICIPAL BLDG-BRIDGE ST, HARTFORD, 05047 (Service District: White River Jct)	53833000002	4,465	$689	16.14	0.15
	45 HIGHLAND AVE-HOCKEY RINK, Hartford, 05047 (Service District: White River Jct)	84964606663	28,369	$2,158	102.99	0.10
	120 LESLE DR PAVILLION A, White River JCT, 05001 (Service District: White River Jct)	13414587553	356	$70	16.14	0.15
	120 LESLE DR PAVILLION B, White River JCT, 05001 (Service District: White River Jct)	67399084366	252	$54	16.14	0.15
	120 LESLE DR PAVILLION C, White River JCT, 05001 (Service District: White River Jct)	39135140109	28	$20	16.14	0.15
Public Safety Bldg-Va Cutoff	PUBLIC SAFETY BLDG-VA CUTOFF, HARTFORD, 05047 (Service District: White River Jct)	39424000006	13,892	$1,109	102.99	0.10
Solid Waste Facility-Landfill	SOLID WASTE FACILITY-LANDFILL, WHITE RIVER JCT, 05001 (Service District: White Rive..)	02624000002	3,885	$602	16.14	0.15
262 N Main - Senior Ctr	262 N MAIN - SENIOR CTR, HARTFORD, 05047 (Service District: White River Jct)	27762000001	4,024	$623	16.14	0.15
Radio Tower	RADIO TOWER, HARTFORD, 05047 (Service District: White River Jct)	34591000004	928	$156	16.14	0.15
Park/Lehman Bridge Lgts-Hwy	PARK/LEHMAN BRIDGE LGTS-HWY, WHITE RIVER JCT, 05001 (Service District: White Ri...)	34926000000	639	$112	16.14	0.15
WoodstockRdQuecheeSaltShed- Hw	WOODSTOCK RD QUECHEE SALT SHED- HWY, QUECHEE, 05059 (Service District: Woo...)	62592200000	255	$55	16.14	0.15
Village Green Balloon Festival	VILLAGE GREEN BALLOON FESTIVAL, QUECHEE, 05059 (Service District: Woodstock)	48933200007	254	$54	16.14	0.15
Hartford Village Stlgt-Hwy	HARTFORD VILLAGE STLGT-HWY, HARTFORD, 05047 (Service District: White River Jct)	13611000004	394	$75	16.14	0.15
Billings Farm Rd Lights-Hwy	BILLINGS FARM RD LIGHTS-HWY, WILDER, 05088 (Service District: White River Jct)	44390000006	434	$82	16.14	0.15
Woodstock Rd St Lights-Hwy	WOODSTOCK RD ST LIGHTS-HWY, QUECHEE, 05059 (Service District: Woodstock)	74713200009	133	$36	16.14	0.15
Willard Rd Quechee Fire Station	WILLARD RD QUECHEE FIRE STATION, QUECHEE, 05059 (Service District: Woodstock)	67003200002	123	$35	16.14	0.15
Solid Waste Admin Bldg-Landfil	SOLID WASTE ADMIN BLDG-LANDFIL, HARTFORD, 05047 (Service District: White River Jct)	91624000005	344	$68	16.14	0.15
Lgts-Rt 5/Highland Ave	LGTS-RT 5/HIGHLAND AVE, WHITE RIVER JCT, 05001 (Service District: White River Jct)	23833000005	294	$60	16.14	0.15
Rte 14 W Hartford Library	ROUTE 14 W HARTFORD LIBRARY, WEST HARTFORD, 05084 (Service District: Woodstock)	68053200009	385	$74	16.14	0.15
Depot St Sidewalk Lgts-Hwy	DEPOT ST SIDEWALK LGTS-HWY, HARTFORD, 05047 (Service District: White River Jct)	33490000008	243	$53	16.14	0.15
N Main Street Lights-Hwy	N MAIN STREET LIGHTS-HWY, WHITE RIVER JCT, 05001 (Service District: White River Jct)	97762000004	223	$50	16.14	0.15
Pleasantview Terr-Hwy Pole 1	POLE 1 PLEASANTVIEW TERR-HWY, HARTFORD, 05047 (Service District: White River Jct)	77700100009	196	$46	16.14	0.15
Maple St Traffic Lgt-Hwy	MAPLE ST TRAFFIC LGT-HWY, HARTFORD, 05047 (Service District: White River Jct)	87833000000	166	$41	16.14	0.15
Bridge St Traffic Lgt-Hwy	BRIDGE ST TRAFFIC LGT-HWY, HARTFORD, 05047 (Service District: White River Jct)	43833000003	156	$40	16.14	0.15
Waterman Hl Covered Bridge Job	WATERMAN HL COVERED BRIDGE JOB, QUECHEE, 05059 (Service District: Woodstock)	84443200005	81	$28	16.14	0.15
N Main S Traffic Light-Hwy	N MAIN ST-TRAFFIC LIGHT-HWY, HARTFORD, 05047 (Service District: White River Jct)	37762000000	116	$34	16.14	0.15
Christian St Pole 72-50-Hwy	CHRISTIAN ST POLE 72-50-HWY, HARTFORD, 05047 (Service District: White River Jct)	87700100008	67	$26	16.14	0.15
Va Cutoff Wtr Stor Tank Alarm	VA CUTOFF WTR STOR TANK ALARM, HARTFORD, 05047 (Service District: White River Jct)	49424000005	55	$24	16.14	0.15
Rte 5 Pole 95-Hwy	RT 5 POLE 95-HWY, HARTFORD, 05047 (Service District: White River Jct)	67700100000	56	$25	16.14	0.15
Briggs Park-Main S Rec	BRIGGS PARK-MAIN ST-REC, WHITE RIVER JCT, 05001-0697 (Service District: White River...)	09832000005	47	$23	16.14	0.15
Frost Park-A Street	FROST PARK-A STREET, WILDER, 05088 (Service District: White River Jct)	36340000003	12	$18	16.14	0.15
Lyman Point Park-Rec	LYMAN POINT PARK-REC, HARTFORD, 05047 (Service District: White River Jct)	13833000006	1	$16	16.14	0.15
N Main S Christmas Tree	N MAIN ST-CHRISTMAS TREE, HARTFORD, 05047 (Service District: White River Jct)	26340000004	1,315	$214	16.14	0.15
		Total	62,183	$6,771	*	*

NEXT STEPS

While most of the electric efficiency opportunities in this sector have already been completed, there are a few small energy efficiency tasks the Town can pursue now, as well as considerable water efficiency work that should be considered.

- Consider wastewater efficiency reports and whether anything has changed that may allow adoption of measures previously declined.
- Investigate water plants and pumps for savings opportunities.
- Determine how solar credit can be used for enterprise accounts.
- Determine if any pressure reducing values (PRVs) are candidates for replacement with small generating turbines.
- Investigate closing (although these may be needed to eliminate the potential for a freeze up of a water main and a sewer force main):
  - Woodstock Rd Heat Tape For Water Line-Water
  - Rte 5 Pump/Super 8 Lot
- Replace Christmas lights with LED if they are not already
  - Consumes over 3,000 kWh/yr costing $500-650

COST AND ESTIMATED SAVINGS

The remaining energy efficiency potential is small compared to what has been done to date and to the opportunity in other areas. Cost savings potential from water efficiency will be highly dependent on the impact of water efficiency on water rates (see Section Energy Embedded in Water for details). Solar credits can lower electricity costs by 2% of more.

Energy Use in Buildings

Energy Use in Buildings- Recommendations Summary

While significant energy efficiency was achieved at the municipal building, other buildings in Town have the potential to save energy and costs through a similar deep energy retrofit effort.

- Short term recommendations for building energy for the Bugbee Senior Center and the Public Safety building were provided under Task 2 of this project - Implementation Oversight.
- Evaluate each oil and propane end-use for efficiency and fuel switching opportunities.
- Apply for Efficiency Vermont's Deep Energy Retrofit incentive[13] for Bugbee. Accepted projects that save more than 50% of total energy will receive an incentive of $55/MMBtu saved, around $9,000 in Bugbee's case. Participation in the program could help raise the additional funds needed for the project; going to the voters to ask for funds to participate in a Deep Energy Retrofit program may be received better than asking for air sealing or weatherization of aging buildings.

Review of Current Usage

Hartford Town buildings account for about 10% of the Town electric consumption, and also accounts for all of the Town's thermal fossil fuel use. Together, the energy use in buildings is a little over 20% of the Town's total energy spending. As discussed above, for the purposes of this analysis the ice rink and solid waste administration buildings are including in the public infrastructure section.

Electricity consumption at seven Town buildings is shown in Figure 7. Over the four fiscal years shown, the Public Safety Complex has used over half of the total buildings' electricity, while the Municipal Building and Senior Center each used about 20% until the Municipal Building's consumption fell drastically between FY2013-2014 and FY2014-2015 following a deep energy retrofit. The other buildings use relatively minor amounts of electricity.

[13] https://www.efficiencyvermont.com/services/project-support/deep-retrofit

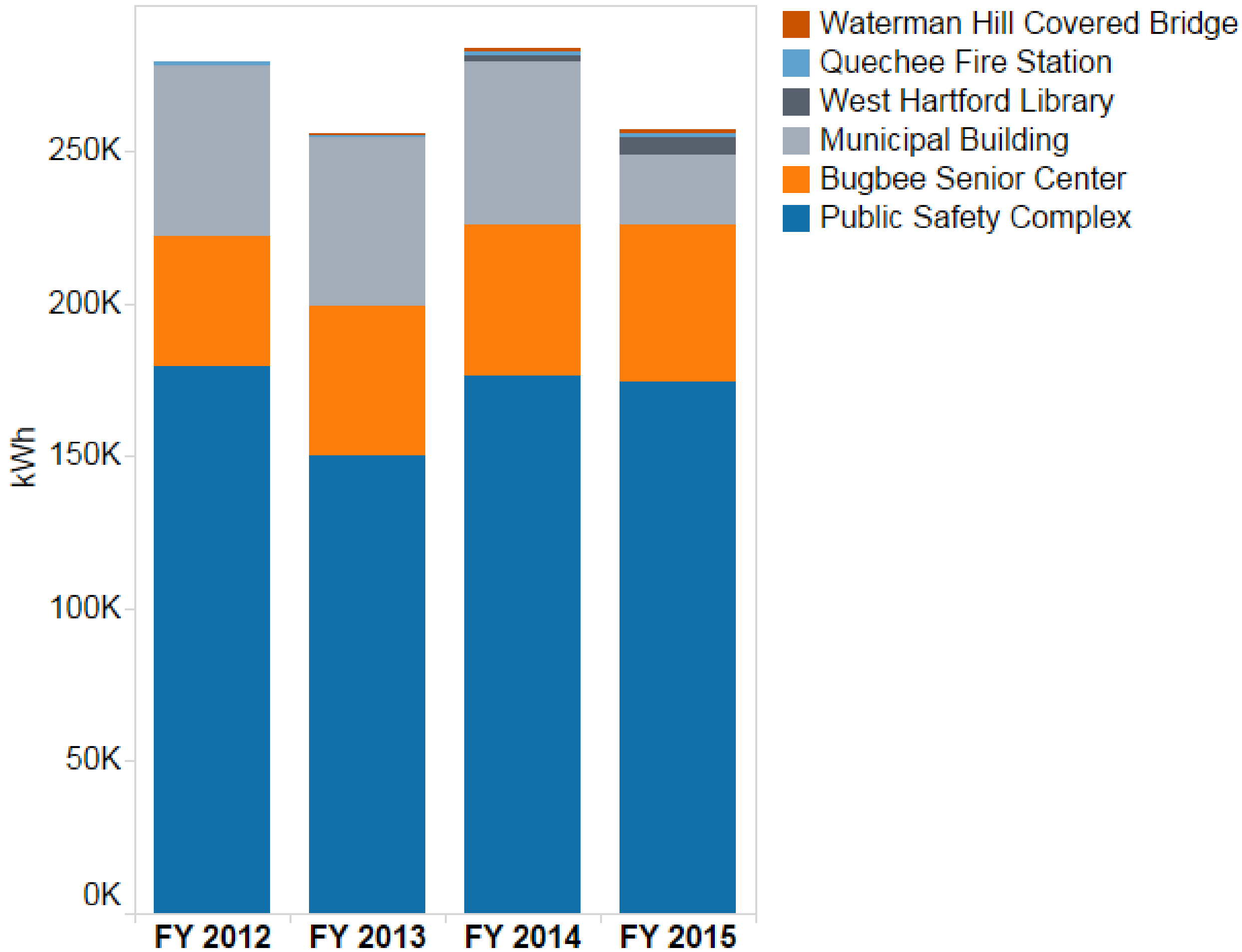


Figure 7. Seven town buildings use about 10% of the electricity the Town consumes, with three buildings using nearly all of that.

Name	FY 2012	FY 2013	FY 2014	FY 2015
Bugbee Senior Center	42,610	48,880	49,840	51,840
Municipal Building	56,113	55,160	53,360	22,880
Public Safety Complex	179,440	150,480	176,320	174,480
Quechee Fire Station	1,362	1,519	1,525	1,506
Waterman Hill Covered Bridge		306	1,013	1,026
West Hartford Library			1,831	5,489

Heating fuel consumption has remained steady, showing only the variation expected due to weather. Figure 8 shows gallons of fuel oil and propane purchased in the past three fiscal years.

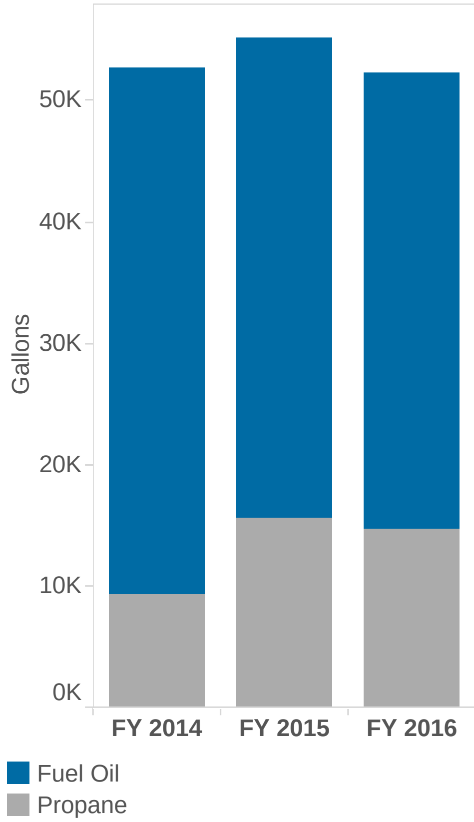


Figure 8. Consumption of thermal fuels was somewhat higher in FY2014-2015 reflecting a colder winter
Figure 9 shows that Town spending on thermal fuels fell by one third between FY2013-2014 and FY2015-2016, primarily due to falling prices. Monetary savings based on market conditions cannot be relied on for long term cost savings, but the annual savings that come from lower-than-expected fuel prices could be used to fund efficiency efforts that can lock in lower annual energy spending over the long range.

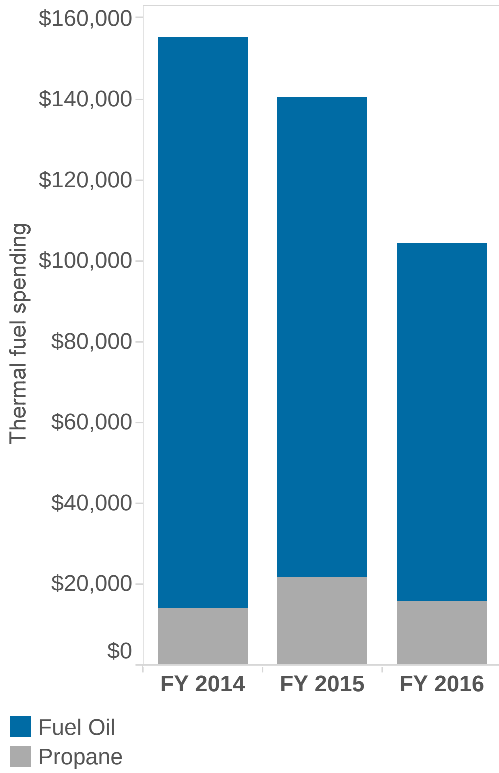


Figure 9. Despite steady consumption, fuel oil spending fell sharply because of falling prices

Data and Data Collection Issues

The three years of data provided by the fuel suppliers provide a good baseline for consumption but do not clearly show trends in use. Irving provided the easiest to use electronic data, rather than scanned paper documents. The tank numbers assigned to buildings help keep track of which locations use more fuel. Connecting these data to the electric and water data would give a more complete picture of the buildings or facilities to focus on for savings opportunities. This would require dealing with small issues such as consistency in account names. The planned process of entering the data into Portfolio Manager would accomplish this.

The electricity data used in this analysis was monthly. Monthly data show the result of larger efficiency projects and trends over long periods, but is not as effective as 15-minute increment smart meter data for spotting operational issues, and opportunities for energy and cost savings.

Progress to Date

Efficiency Vermont data shows 90,000 kWh of electrical savings related to these building accounts since 2009. In addition, Figure 10 shows the data in Figure 8 broken down by building instead of by fuel type. Although electricity consumption for public infrastructure was discussed separately, all thermal fuel use is included in this figure for two reasons: (1) no single end use dwarfs the others as waste water and water do for electricity, and (2) because all of this energy is thermal fossil fuel and can be evaluated for replacement with wood or heat pumps, depending on scale and temperature. For buildings that are physically close to each other, shared modern wood heating systems (district heat) may be a solution.

Three of the accounts in the figure show noticeable decreases: the Public Safety Building, the Bugbee Senior Center, and the Water facilities. These reductions are largely offset by increases at wastewater facilities, the highway garage, the ice rink, and the landfill.

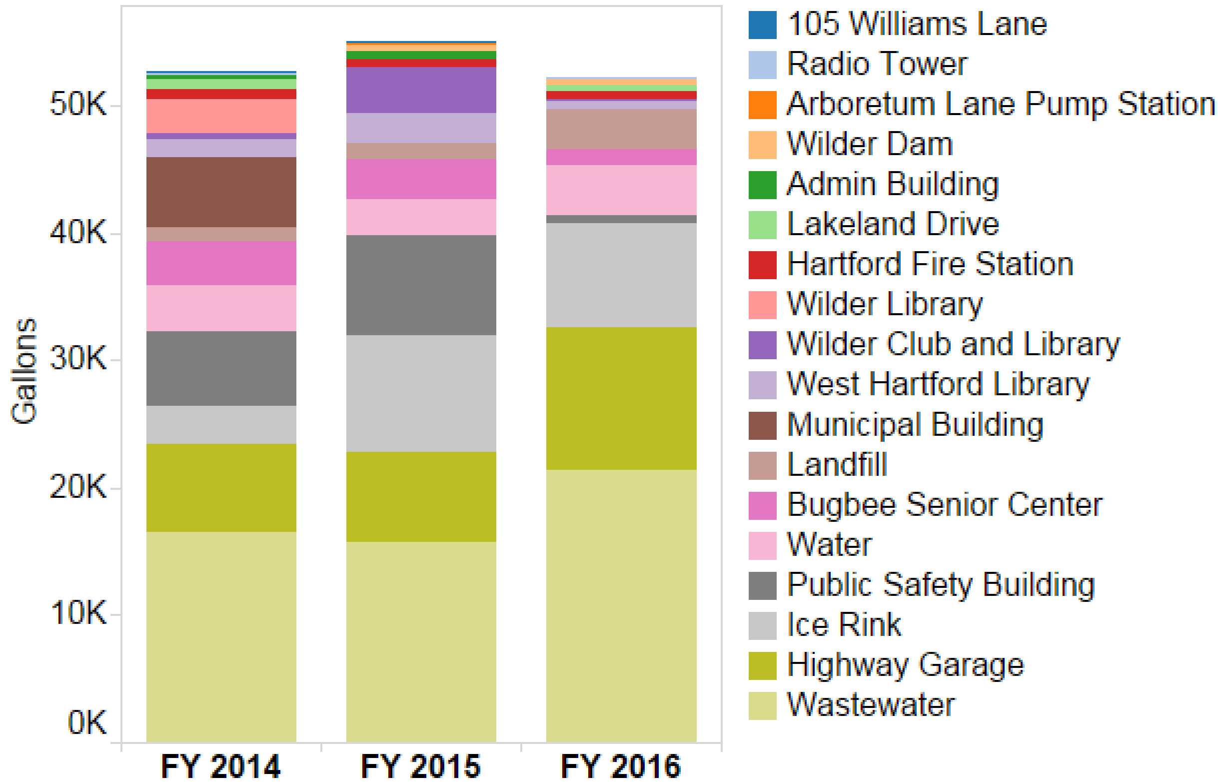


Figure 10. Thermal fuel consumption over time by building shows decreases at the Public Safety Building, Bugbee Senior Center, and at Water facilities

Opportunities for Improvements and Upgrades and Next Steps

Thermal fuels are a smaller component of total energy spending than electricity or transportation fuels (Figure 2), but there may be significant opportunity for further reductions or fuel switching to less price volatile fuels such as wood and electricity. Table 4 comes from the Vermont Fuel Price Report, produced monthly by the Department of Public Service.[14] The prices shown are for residential levels of consumption. The Town can expect the same comparisons between fuels to hold, but to be able to negotiate lower prices. The highlighted prices per million British thermal units are for heating systems the Town may already be using or could consider switching to. Propane in particular is a more expensive fuel and should be a focus for replacement.

Table 4. Cost per unit energy of residential heating fuels in Vermont

[14] Vermont Department of Public Service, "Vermont Fuel Price Report" June 2016, http://publicservice.vermont.gov/sites/dps/files/documents/Pubs_Plans_Reports/Fuel_Price_Report/2016/June%202016%20Fuel%20Price%20Report.pdf

Comparing the Cost of Heating Fuels							
Type of Energy	BTU/unit	Typical Efficiency	$/unit	$/MMBtu		High Efficiency	$/MMBtu
Fuel Oil, gallon	138,200	80%	$2.09	$18.88		95%	$15.90
Kerosene, gallon	136,600	80%	$2.68	$24.56			
Propane, gallon	91,600	80%	$2.24	$30.51		95%	$25.69
Natural Gas, Ccf	100,000	80%	$1.38	$17.23	*	95%	$14.51
Electricity, kWh (resistive heat)	3,412	100%	$0.15	$43.46			
Electricity, kWh (cold climate heat pump)	3,412		$0.15		#	240%	$18.32
Wood, cord (green)	22,000,000	60%	$227	$17.21	^		
Pellets, ton	16,400,000	80%	$275	$20.96	^		

Larger town facilities should consider wood pellets or woodchips as a historically lower cost heating fuel. Smaller facilities can switch to wood pellets or air source heat pumps. Despite the high efficiency and the fact that fuel oil is the lowest–priced heating energy shown in the table available in Hartford, it does not move the Town toward the renewable energy goals and is not recommended.

Modern Wood Heat

Hartford High School already uses woodchips, and wood pellet should be considered for other facilities in Town. Bugbee Senior center can currently until the end of the year access highly discounted pre-feasibility studies[15] that will inform the Town if the switch to wood heat is a good investment. Less detailed but free “desktop studies” calculating the current value of that investment are also currently available for a limited time from the Vermont State Wood Energy Team if the Town does not wish to commit funds to a detailed pre-feasibility study right away (see service announcement in Appendix). The Clean Energy Development Fund Small-Scale Renewable Energy Incentive Program (CEDF SSREIP) has just launched a commercial and institutional-scale rebate program that make switching at Town facilities an even better deal.[16]

VEIC estimated the financial benefits that would result from switching some of the Town’s facilities to wood heat. The Biomass Energy Resource Center (BERC) @VEIC life-cycle cost (LCC) analysis tool was

[15] see Appendix I, pre-feasibility studies include a site visit and analysis of fuel consumption data to complete a 30 year Life Cycle Cost Analysis of savings
[16] http://publicservice.vermont.gov/renewable_energy/cedf

used to assess the economic performance of an investment in modern wood heating systems for each building. The option to install wood pellet heating systems was explored for buildings that have not had an energy audit with targeted recommendations and that are some of the larger consumers of oil or propane.

These buildings are:

- The municipal arena/ice rink (replacing 8,500 gallon of propane, 26,056 sq ft)
- The highway garage (replacing 8,300 gallons of fuel oil, 16,126 sq ft)

The pellet systems would accompany the existing propane boilers, which would serve as a backup and cover periods of peak heating load. This option was compared against the status quo option of continuing to heat the apartments with propane with the existing boilers. The LCC analysis examined costs including debt service, fuel costs, and operation and maintenance (O&M) over time. A 30-year analysis period was used and the accumulative savings over heating with propane were presented in 2016 dollar values (NPV). The table below provides the key assumptions used in this analysis, followed by the results of the conceptual analysis.

Assumption	Value used in analysis
Annual consumption of propane or oil	Building specific
Year 1 price of propane	$2.32 per gallon[17]
Year 1 price of propane	$2.67 per gallon
Fossil fuel price escalation rate	1.5% over general inflation
Percent peak demand covered by pellet system	50%
Percent annual heating covered by wood heat system	90%
Year 1 price of bulk pellets	$260 per ton
Wood fuel price escalation rate	At general inflation
Percent of project cost financed	80%[18]
Term of financing	20 years
Interest rate	4.00%

[17] Ibid.

[18] Assumes 20% grant coverage through a source such as the Clean Energy Development Fund (CEDF).

Percentage of grants received	20%

Municipal Arena switched to wood heat to replace 8,000 gallon of oil for the 26,000 sq ft facility, the Town may see a 20 year payback for a $127,600 NPV of investment over 30 years, if switching to pellets.[19]

Results of the Conceptual Analysis

The following table illustrates the financial performance of installing bulk pellet fueled heating systems at the assumed project cost scenarios. The capital costs explored are conceptual estimates informed by professional experience. A pre-feasibility analysis or engineering design review would be needed to confirm these numbers.

- The municipal arena/ice rink:

Capital Costs Scenario	**$154,000**
First year fuel savings	$5,895
Simple payback (years)[20]	21
Annual debt service	$9,590
30YR NPV #2 propane heating[21]	$868,070
30YR NPV pellet heating[21]	$740,481
30YR NPV of savings[21]	$127,589
IRR[21]	4%

- The highway garage:

Capital Costs Scenario	**$154,000**
First year fuel savings	$5,786
Simple payback (years)[22]	23
Annual debt service	$10,573

[19] Assuming the project could be installed for $154,000, and assuming a $2.67/gallon price of heating oil.
[20] This calculation is based on the financed amount, and so is based on 80% of the capital cost scenario.
[21] This calculation is based on 100% of the capital cost.
[22] This calculation is based on the financed amount, and so is based on 80% of the capital cost scenario.

30YR NPV #2 propane heating[23]	$852,050
30YR NPV pellet heating[21]	$742,738
30YR NPV of savings[21]	$109,313
IRR[21]	3%

The table above indicates very favorable results for installing wood pellet heating systems, provided the project could be performed for the three capital cost scenarios. It is expected that pellet heating systems of the estimated output capacity and the associated pellet fuel storage, thermal buffer tank, system controls could be installed for the capital cost presented. Fossil fuel prices are very volatile and could change very quickly. The price of pellets, on the other hand has been very stable from year to year and is not subject to the high volatility of the propane market. If the cost of propane were to rise, a much faster payback and better return on investment for the pellet system would be expected.

Next steps

- Short term recommendations for building energy for Bugbee Senior Center and the Public Safety building were provided under Task 2 of this project- Implementation Oversight.
- Working down the list in following table of heating fuel gallons by location and fuel[24], evaluate each fuel use for efficiency and fuel switching opportunities (e.g. to wood heat as discussed in the previous section, or heat pumps).

[23] This calculation is based on 100% of the capital cost.
[24] This table is also provided in an editable form in the data file.

Address (group)	Product (group)	FY 2014	FY 2015	FY 2016
Wastewater	Fuel Oil	16,590	15,795	21,406
Highway Garage	Fuel Oil	7,001	7,001	11,266
	Propane	-195		
Ice Rink	Propane	371	9,221	8,127
Public Safety Building	Fuel Oil	5,722	7,699	481
	Propane	102	121	126
Water	Propane	3,736	2,786	4,014
Bugbee Senior Center	Fuel Oil	2,737	2,511	693
	Propane	600	638	538
Landfill	Fuel Oil	1,148	1,279	3,118
Municipal Building	Fuel Oil	5,510		
West Hartford Library	Fuel Oil	1,031	1,085	
	Propane	418	1,382	743
Wilder Club and Library	Fuel Oil	491	3,541	32
Wilder Library	Fuel Oil	2,659		
Municipal Arena	Propane	2,648		
Hartford Fire Station	Propane	758	703	615
Lakeland Drive	Fuel Oil			438
	Propane	777		
Admin Building	Fuel Oil	520	579	
Wilder Dam	Propane		450	518
Arboretum Lane Pump Station	Fuel Oil			105
	Propane		367	10
Radio Tower	Propane	36	20	80
105 Williams Lane	Propane	91	14	

Apply for Efficiency Vermont's Deep Energy Retrofit incentive[25] for Bugbee. Accepted projects that save more than 50% of total energy will receive an incentive of $55/MMBtu saved, around $9,000 in Bugbee's case. Participation in the program could help raise the additional funds needed for the project; going to the voters to ask for funds to participate in a Deep Energy Retrofit program may be received better than asking for air sealing or weatherization of aging buildings.

Energy Embedded in Water

Energy Embedded in Water- Recommendations Summary

As detailed in the section Electricity Use for Public Infrastructure, the electricity consumption resulting from treating and pumping water is a significant energy user and cost for the Town. Reducing the water consumption of the Town would lower this energy use and may result in cost savings.

Assess the rate impact of water efficiency, in case water department savings are less than the reduced revenue from billing water usage. If usage is reduced, water rates are likely to increase because the revenue based on consumption is also likely to decrease. The Town should be aware of the potential impact on water rates prior to engaging in widespread water efficiency.

[25] https://www.efficiencyvermont.com/services/project-support/deep-retrofit

Explicitly make water efficiency a required consideration when purchasing or replacing any water-using product.

Inform Town personnel (and the whole community) that water has a hidden energy cost that the Town and everyone in Town is paying for.

Commission a water audit to identify leaks in the distribution system and potential lost revenue from non-revenue losses. Leak detection is available through the Vermont Rural Water Association (http://www.vtruralwater.org); audits are free for rural Towns of less than 10,000 residents. In the past Hartford's population was above 10,000 and the Town was technically not eligible for Rural Water assistance, but according to 2010 Census, Town population fell below 10,000.

Work with Efficiency Vermont to get the drinking water treatment plant and pumps audited and identify potential savings in pumping and cost savings in shifting pumping away from peak hours - if relevant. An energy audit of the water plant and pumping infrastructure can be obtained from Steve Bolles, who did the Hartford wastewater plant audit post construction (Steve Bolles, Process Energy Services, LLC, P.O. Box 615, Londonderry, NH 03053, (603) 537-1286)

Install low-cost, water efficient plumbing devices and appliances in all Town-owned facilities.

Engage the whole community in a water saving challenge. Savings of 10-25% of water consumption can be achieved.[26]

Review of Current Usage

While the focus of this report is on *energy* use in municipally-owned facilities, there is a large amount of energy embedded in water. Water requires energy to be heated for a range of applications using hot water. In addition, the pumping, treatment, distribution and wastewater treatment of water requires a large amount of energy. The Town's largest electricity users are the pumping, treatment and wastewater treatment facilities owned by the Town. Therefore, energy and cost savings can be achieved by reducing not only hot water use, but water use as a whole.

For municipally supplied water, the national averages in Table 5 can be used to estimate the amount of energy embedded in water. In addition it takes it takes 0.357 kWh to heat 1 gallon of water for indoor use (from the temperature at which it enters the facility).[27]

Table 5: Embedded energy in water, in kilowatt-hours per million gallons (kWh/MG), excluding Southern California, which has a much larger energy consumption

	Indoor	**Outdoor**
National (surface water)	3,300 kWh/MG	1,400 kWh/MG

[26] http://www.ecy.wa.gov/programs/wq/tmdl/spokaneriver/dissolved_oxygen/docs/utilityconservation.pdf

[27] Source: http://wecalc.org/calc/, based on Electric Power Research Institute (EPRI). (1996). Water and Wastewater Industries: Characteristics and Energy Management Opportunities. Electric Power Research Institute. CR-106941., and: California Energy Commission (CEC). (2006). California Energy Commission. Refining Estimates of Water-Related Energy Use in California. Prepared by Navigant Consulting, Inc. Sacramento, CA.

National (groundwater)	3,700 kWh/MG	1,800 kWh/MG

Water used indoors has more embedded energy than that used outdoors because it must be treated at a wastewater treatment plant after use, which requires energy. Water used outdoors is not generally treated after use. Waste-water typically averages 99.94% water by weight; only a small 0.06% is actually waste material[28]

For comparison with this national average, the Town of Hartford pumps and treats 311 MG[29] of water annually, for an annual electricity consumption of 1,979,166 kWh to treat, pump, and distribute that water, which is equivalent to 6,363 kWh/MG, which is in the same order of magnitude, but higher than the national average calculated by other entities.

Data and Data Collection Issues

The Town of Hartford provided water consumption for municipally owned facilities. Water consumption data was available on a quarterly basis, which allows for the identification of broad trends and allowed for comparisons among buildings and with national trends, but it did not allow VEIC to tease out the amount of water that may be used for any landscaping purposes.

The municipal facilities consuming the largest amount of water in Town are: municipal arena (ice rink, starting in FY 2015-2016, 28%), the swimming pool (27%), Latham treatment plant (24%), and public safety (9%). The remainder of the facilities consume 12% of the water used in municipally-owned facilities (Figure 11), indicating that focusing on the top four users will have the biggest impact on water usage in municipal facilities.

[28] http://www.burlingtonvt.gov/uploadedFiles/BurlingtonVTgov/Departments/Public_Works/Water_and_Wastewater/Following%20the%20Flow%20of%20Wastewater.pdf

[29] 258 million gallons pumped in Hartford in 2015, 53 million gallons pumped in Quechee in 2016

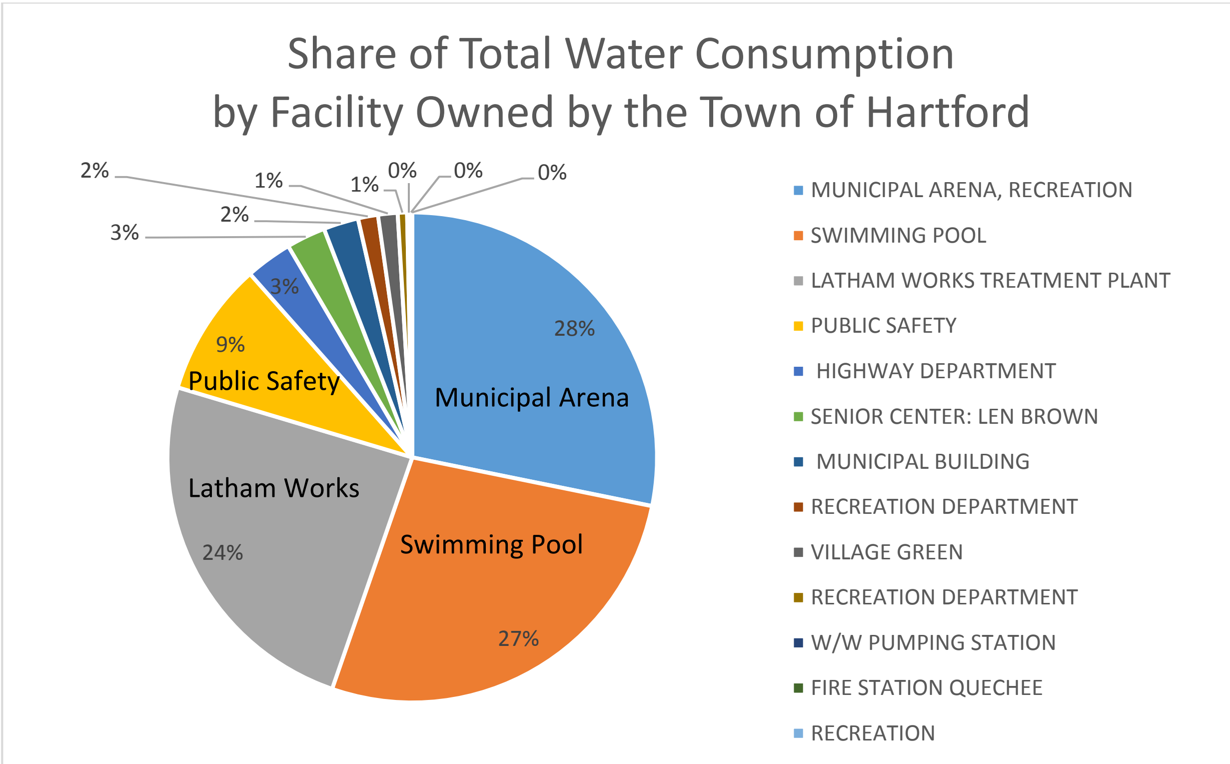


Figure 11: Water Consumption by Municipal Facility

Water consumption in municipal facilities is highly variable from year to year. Annual water consumption for the municipal facilities has historically largely be dictated by the swimming pool and Latham treatment plant. The municipal arena started showing water consumption in FY 2015-2016. Only one years of data is available but it appears that the ice rink is also going to be a significant user of water (Figure 12).

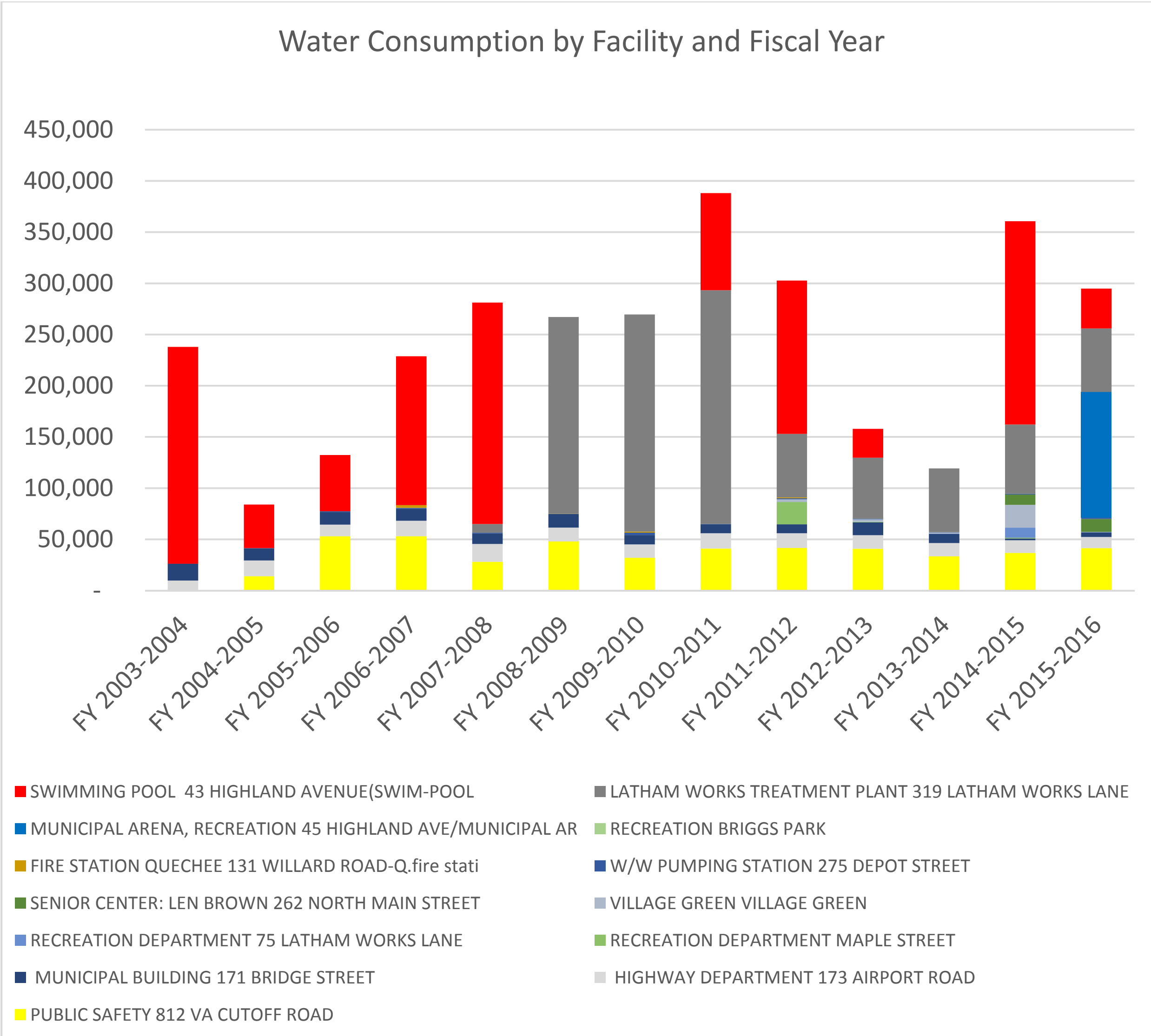


Figure 12: Water Consumption by Municipal Facility and Fiscal Year

The data available does not provide information on whether the water used at the Latham plant and safety buildings are used for cleaning purposes (facilities, tanks, or rinsing vehicles), and to what extent that water is used for other purposes (trainings, firefighting, etc.).

A water audit for those facilities would be required to identify opportunities for water savings. General low-cost recommendations that apply to this type of facilities are provided in the recommendation section below, but an audit would be required to know if these recommendations are directly applicable to the specific facility.

There are 2,513 residential and 352 commercial customers on Hartford and Quechee's water distribution system[30], and 2,711 residential and 313 commercial customers on Hartford and Quechee's

[30] In the Hartford System Water: residential:1,801 commercial: 288, Sewer: residential: 1,695 commercial: 262

municipal sewage system. Using the national average annual household water use (including outdoor) of 127,400 gallons, that's equal to about 320 million gallons,[31] close to the actual usage of 311 million gallons[32] annually, making it valid to use the national average to estimate residential water consumption and potential savings.

The municipal water usage is has been about 1.8 million gallons (240,000 cubic feet) per year on average over the last five years, 2.2 million gallons (295,000 cubic feet) in FY 2015-2016 when the ice rink was in use, this represents about 1 % of the Town's total water consumption (the Town of Hartford pumps and treats 311 million gallons[33] of water annually), on average depending on the year. The school district uses another 0.9 million gallons (125,000 cubic feet) a year. Saving 10% of the water consumed by the municipal and school facilities would not have a significant impact on the water treatment needs of the plants, but would nevertheless reduce the town water bill. If, however, the Hartford community as a whole reduced their water consumption by 10%, however, this would result about 10% less water needing to be treated by the treatment and waste water plant, and depending on how the water treatment and wastewater plant are operated, about 10% energy savings could be achieved.

Benchmark of Current Usage with National and/or Regional Trends

Data entered by facility managers nationwide has allowed the EPA to compile nationwide trends in water use intensity (gallon per square feet per year) by facility type (Figure 13).[34] Unfortunately these benchmark do not include buildings such as swimming pools, ice rinks, etc.

In the Quechee System Water: residential: 712   Commercial: 64, Sewer: residential: 1,016   Commercial: 51

[31] Source: Residential End Uses of Water (Denver, Colo.: Water Research Foundation, 1999).

[32] 258 million gallons pumped in Hartford in 2015, 53 million gallons pumped in Quechee in 2016

[33] 258 million gallons pumped in Hartford in 2015, 53 million gallons pumped in Quechee in 2016

[34] Portfolio Manager Data Trends, Water Use Tracking, 2012

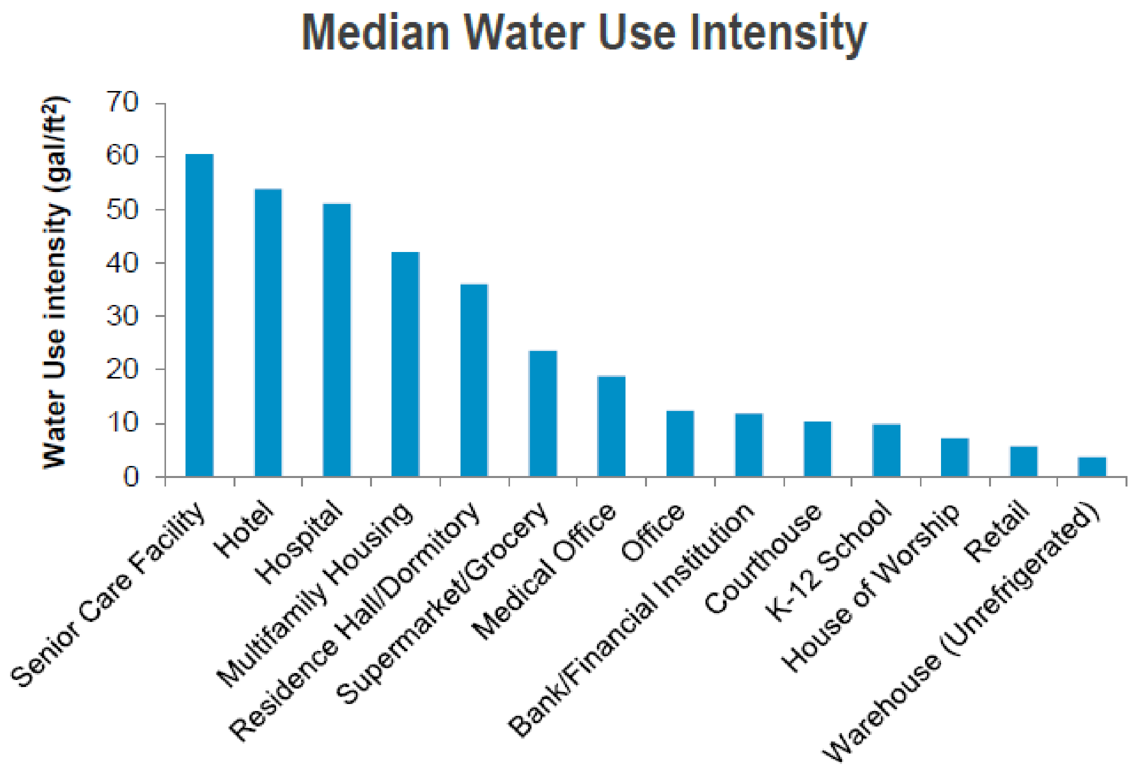


Figure 13: National averages for water use intensity by facility type.
By comparison, municipal facilities in Hartford use between 49 and 377 gal/sq.ft./year (Figure 14).

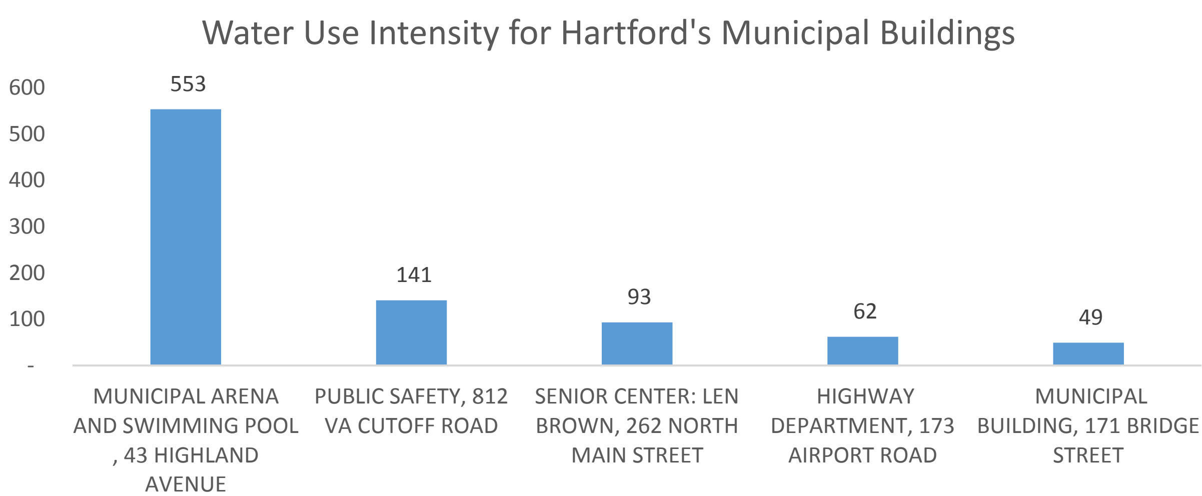


Figure 14: Water Use Intensity for some of the municipal buildings
By comparison, the City of Pittsburgh[35] has been tracking its water use and has found restaurants to be a large water consumer (Figure 15). The senior center provide dining services and it is therefore not

[35] http://www.2030districts.org/pittsburgh/news/pittsburgh-2030-district-releases-water-baseline-report

surprising that its water use intensity is relatively large. The water use intensity for the municipal building, was much higher than expected compared to national trends until the end of FY 2013-2014 (11,000 cf consumed annually on average, 54 gallon/sq ft/year), but water consumption has been greatly reduced since, with an average now of about 3,000 cf (15 gallon/sq ft/year) annually in FY 2014-2015 and FY 2015-2016, which is much more in line with the national average. This drop in water consumption was likely the result of the extensive renovations in the building in 2012.

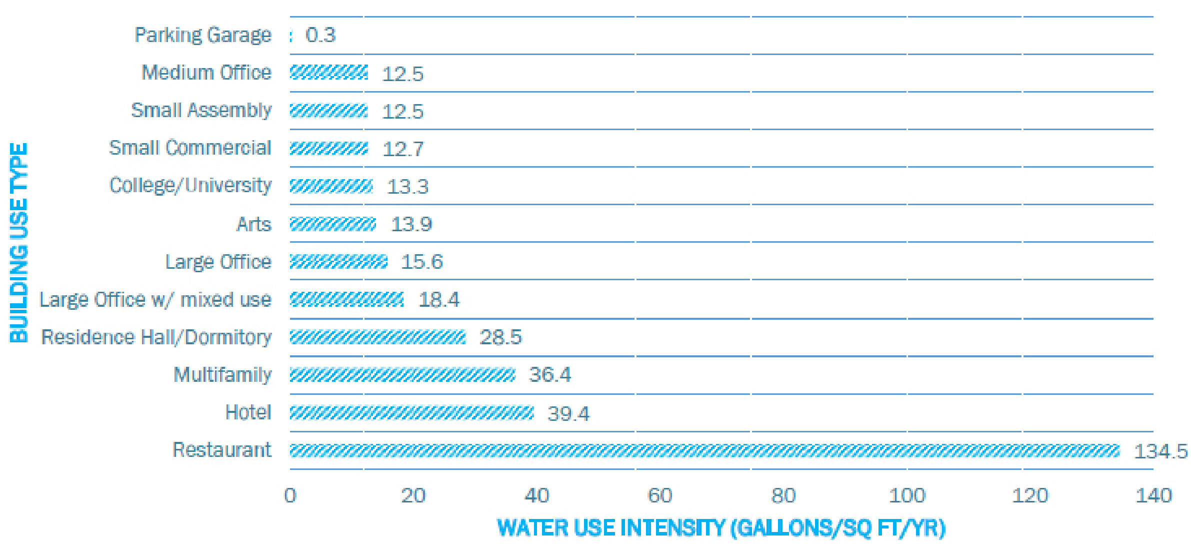


Figure 15: City of Pittsburgh baseline water use intensity data

Opportunities for Improvements and Upgrades and Next Steps

Next Steps for the Town

Education

A first and easy step to reduce water consumption at municipal facilities would be to remind all Town employees that while water in Vermont is abundant, water that comes out of the faucet is not free and comes with a significant energetic and monetary cost. An infographic at each municipal facility providing an estimate of how much the facility's water usage is costing the Town would be an easy first step toward water conservation.

Water Audits

The town should consider conducting a water audit to identify any potential leaks in the water distribution system, as well as conducting water audits in the four largest water consumers to identify specific water saving measures specific to these measures.

An audit of the water distribution system will help establish if any water and revenue is lost through leaks and identify opportunities for improvements (Table 6).[36] More information on water audits can be

[36] http://www.allianceforwaterefficiency.org/Water_Audit_Process_Introduction.aspx

found on the Alliance for Water Efficiency website,[37] and in the articles listed under the Resource section.

While several Town have done energy retrofits on their pump houses and wastewater treatment plants, Efficiency Vermont is mandated to keep this information confidential unless the customer expressly signs a data release form. Therefore, only anecdotal anonymous information can be shared here. One such anecdote is of one water pumping station in northern Vermont has seen savings of more than 50% to the point where the electric utility changed the electric meter three times thinking it was malfunctioning.

Generally, pump station energy reviews can be done with a simple spreadsheet using monthly pump run time hours, a kWh measurement and monthly energy bills (see section 2.3.2. Data and Data Collections Issues for a more complete discussion).

Table 6: Water audits and loss of water

More information on leak detection is available from the Water Efficiency magazine (free magazine):
http://foresternetwork.com/water-efficiency-magazine/we-water/leaks-and-audits/leak-detection-is-not-wasted/
http://foresternetwork.com/water-efficiency-magazine/we-water/leaks-and-audits/leak-detection/
http://foresternetwork.com/water-efficiency-magazine/we-water/resource-management/non-revenue-water/
More information on Water Audits and Water Efficiency can be found on :
http://www.allianceforwaterefficiency.org/Water_Audit_Process_Introduction.aspx

[37] http://www.allianceforwaterefficiency.org/Water_Audit_Process_Introduction.aspx

<table>
<tr><td rowspan="10">Water Supplied</td><td rowspan="4">Authorized Consumption</td><td rowspan="2">Billed Authorized Consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption</td><td>Unbilled metered Consumption</td><td rowspan="8">Non-revenue Water</td></tr>
<tr><td>Unbilled unmetered consumption</td></tr>
<tr><td rowspan="6">Water Losses</td><td rowspan="3">Apparent Losses</td><td>Systematic Data Handling Errors</td></tr>
<tr><td>Customer Metering Inaccuracies</td></tr>
<tr><td>Unauthorized Consumption</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on Transmission and Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to the point of Customer Metering</td></tr>
</table>

Energy Audit

Work with Efficiency Vermont to get the water treatment plant audited and identify potential savings in pumping and cost savings in shifting pumping away from peak hours- if the audit finds that it is a relevant strategy.

Low-cost Measures

There are currently no water efficiency incentives program in Vermont, but low-cost measures can be installed for a small or no cost premium. Measures that see hot water savings may be eligible for an incentive through efficiency Vermont when done as part of a whole building retrofit (e.g. pre-rinse spray valve), or as a stand-alone incentive (e.g. energy and water efficient appliances). For any measure considered, the Town should check with Efficiency Vermont for the current incentive offering.

The Town could lead by example and start with low cost, short payback measures- if they have not already been installed- focusing the four largest users:

Swimming Pool:

Check local health regulations and pool chemistry, to assess if water can be changed less frequently.

Arena, Swimming Pool, Senior Center, and Other Municipal Buildings:

Replace all of the following that are not already water and energy efficient. WaterSense is a label maintained by the EPA that helps consumers identify water-saving products:

https://www3.epa.gov/watersense/products/index.html.

- Pre-rinse spray valve
- Toilet
- Dishwasher
- Clothes washers
- Faucet aerator
- Showerheads
- Toilets
- Bathroom sink faucets and accessories
- Landscape irrigation controls
- Urinals
- Flushometer-Valve Toilets

The Town should add water efficiency to Town purchasing requirements; require that any product shall be replaced with a water efficient product if available, require purchasing a product labeled WaterSense[38] if it is available.

The Town should act swiftly to fix any leaky faucet, showerhead and toilet, as water losses from leaks can be significant.

Community as a Whole:

Water conservation at the community level can generate significant water treatment and sewer cost savings, if widely adopted, with a payback of 3-7 years.[39] For the Town to save energy currently spent on water treatment and pumping, water consumption savings are necessary not only at the Town level but community-wide, because the share of municipal water consumption is only approximately 1%.

The energy embedded in water presents a unique challenge in that for the Town municipal water treatment and wastewater treatment plants to be able to save energy and water, the water consumption of the Town as a whole must be reduced. Therefore, the community should be engaged and enticed to make water saving choices that will help the town save energy and water.

Average daily indoor per capita water use nationally is 69.3 gallons.[40] Average daily household water use nationally (including outdoor) is 350 gallons.[41] By installing more efficient water fixtures and regularly checking for leaks (faucet, toilet), households can reduce daily indoor per capita water use by about 35% to about 45.2 gallons per day, as broken out in Table 7.[42]

[38] https://www3.epa.gov/watersense/
[39] http://cdmsmith.com/en-US/Shared-Items/Videos/Webinars/Water-Conservation.aspx
[40] Source: Handbook of Water Use and Conservation, http://www.awwa.org/store/productdetail.aspx?ProductId=6471 Amy Vickers
[41] Source: Residential End Uses of Water: http://www.waterrf.org/resources/Pages/reports.aspx (Denver, Colo.: Water Research Foundation, 1999).
[42] Source: Handbook of Water Use and Conservation, http://www.awwa.org/store/productdetail.aspx?ProductId=6471 Amy Vickers

Table 7: Breakout of residential water use

	Residential Water Use Breakdown		Water Efficient Fixtures and Regularly Checking for Leaks	
Use	**Gallons per Capita**	**Percentage of Total Daily Use**	**Gallons per Capita**	**Percentage of Total Daily Use**
Showers	11.6	16.8%	8.8	19.5%
Clothes Washers	15.0	21.7%	10.0	22.1%
Dishwashers	1.0	1.4%	0.7	1.5%
Toilets	18.5	26.7%	8.2	18%
Baths	1.2	1.7%	1.2	2.7%
Leaks	9.5	13.7%	4.0	8.8%
Faucets	10.9	15.7%	10.8	23.9%
Other Domestic Uses	1.6	2.2%	1.6	3.4%

Average household water use annually (including outdoor) is 127,400 gallons. [43] If for example all residential customers reduced their consumption by 10% on average, this would result in a decrease in water consumption of 10%, which may equate to a reduction in energy consumption of about 10%.[44]

There is also a large water savings potential in schools that could be achieved through a community-wide effort and applying the same recommendations provided for the municipal buildings to the school district facilities (education, water audit, low-cost measures).

Estimated Cost and Savings of Proposed Next Steps

Estimating the exact monetary savings that would result from water efficiency is not straightforward, and will depend on how the water utility is pumping water (continuously throughout the day, or so as to avoid peak electric rates for example). If pumping is continuous, the water utility could consider pumping primarily outside of peak utility rates (if the facility is on an account with peak rates), or using renewable energy systems such as solar for pumping during that time.

The water rate is currently set up as a mixed rate, it has a base rate and a consumption rate. The base rate comes with zero gallons of water included. All metered customers pay for every gallon of water used. The base rate also increases if an account consistently uses

[43] Source: Residential End Uses of Water: http://www.waterrf.org/resources/Pages/reports.aspx (Denver, Colo.: Water Research Foundation, 1999). This would be equivalent to a Water Use Intensity of 64 gallon/sq.ft. per year for an average 2,000 sq ft home.

[44] Note: water rates may need to be adjusted to reflect the lost revenue, but also the decreased operational costs.

more than 1 equivalent dwelling unit (which is 210 gpd). Approximately 60-70% of the fund expenses are fixed, which means that when sales (consumption) drops there will need to be a mechanism to recover the loss in revenue. Ideally, water rates should be set up that they not only cover water distribution costs, but also to save money for infrastructure updates and repairs in the long term.

In addition to water savings, water efficiency will lead in many cases to a reduction in hot water consumption, and water heating savings for the building owner.

Other utilities have seen dramatic water and cost savings, the case studies are presented in the Resource section but include an example from Massachussetts where a water authority reduced their consumption by 80 million gallon per day (mgd) from a more than 300 mgd total (about 24% reduction). Seattle achieved a 20% per capita reduction in water consumption. The case studies presented below are almost 20 years old now, but the magnitude of savings is expected to remain the same today, or maybe slightly less, in a location that has not done extensive water efficiency yet.[45]

Transportation Energy

Transportation Energy Recommendations Summary

Conversions to alternative fuels are gaining in popularity, and this transportation section of the Action Plan suggests which, if any, provide opportunities for Hartford. Specifically, propane and biodiesel present potential for slightly reducing costs, but electricity holds the most promise for overall efficiency improvements and emissions reduction. Additionally, electricity presents the best opportunities for renewably powered transportation. No one alternative fuel is appropriate for all vehicles though, and the best applications for each are discussed. Ultimately however, a complete fleet assessment, analyzing detailed data on fuel consumption and idling time for each vehicle is necessary to fully assess the savings potential and appropriateness of alternative fuels.

Fuel efficiency improvement technologies, on the other hand, present significant opportunities for fuel savings with little upfront analysis required, and many examples nationally are showing very promising returns on investments. These technologies allow vehicles to function more efficiently, primarily through reducing idling. These technologies are especially effective at reducing fuel use of any vehicle that idles for long periods of time in order to continue performing vital services, such as those required of police cruisers, fire trucks, and ambulances.

Hartford, like many cities and towns, is considering transportation fuel use and exploring opportunities to reduce emissions, use more efficient or lower cost fuels, reduce consumption, and ultimately, save money. Ideally, these factors would all occur simultaneously, but in many cases, choices must be made to prioritize one factor over another.

[45] http://www.ecy.wa.gov/programs/wq/tmdl/spokaneriver/dissolved_oxygen/docs/utilityconservation.pdf

Nationally, conversions to alternative fuels are gaining in popularity, and this transportation section of the Action Plan suggests which, if any, provide opportunities for Hartford. Specifically, propane and biodiesel present potential for reducing costs, but electricity holds the most promise for overall efficiency improvements and emissions reduction. Additionally, electricity presents the best opportunities for renewably powered transportation. No one alternative fuel is appropriate for all vehicles though, and the best applications for each are discussed. Ultimately however, a complete fleet assessment, analyzing detailed data on fuel consumption and idling time for each vehicle is necessary to fully assess the savings potential and appropriateness of alternative fuels.

Fuel efficiency improvement technologies, on the other hand, present significant opportunities for fuel savings with little upfront analysis required, and many examples nationally are showing very promising returns on investments. These technologies allow vehicles to function more efficiently, primarily through reducing idling. These technologies are especially effective at reducing fuel use of any vehicle that idles for long periods of time in order to continue performing vital services, such as those required of police cruisers, fire trucks, and ambulances.

Overall, this transportation section of the Action Plan suggests as next steps:

- Explicitly make fuel efficiency a required consideration when replacing fleet vehicles.
- Contact fuel efficiency improvement technology providers for estimates.
- Consider pursuing a pilot project as a lower cost and lower risk option for exploring alternative fuels, particularly with electric vehicles integrated with renewable resources.
- Collect detailed data on vehicle usage, miles traveled, and fuel consumption for a comprehensive fleet assessment if interested in pursuing a switch to alternative fuels.
- Approach propane and biodiesel suppliers for price quotes.

Estimating the savings potential from a switch to alternative fuels or through implementing vehicle efficiency improvement technologies is extremely dependent on negotiated fuel prices, maintenance costs, vehicle use, and price estimates for technology services. However, examples of experiences of other municipalities provides useful considerations and are presented here.

Review of Current Usage

Transportation fuel is a significant proportion of energy use and spending in Hartford. Transportation energy use represents the fuel needed to operate the town's fleet, including police vehicles, ambulances, fire trucks, dump trucks, snow plows, and all other vehicles and equipment owned and operated by the town. For the purposes of this Action Plan, we focus on any transportation energy used specifically for municipal operations. Therefore, no personal travel is factored. All personal travel, including town employees traveling to and from work, is therefore excluded from this Action Plan.

Overall, Figure 16 below shows that Hartford has spent between $164,657 in FY2012-2013 and $242,674 in FY2013-2014 on transportation fuel. In FY2014-2015, spending decreased from the previous year to $204,351. Consumption of gasoline and diesel remained relatively consistent between FY2013-2014 and FY2014-2015, with lower average costs per gallon accounting for the decreased spending.

Figure 16: Transportation Fuel Use and Spending

	Transportation Gas			Transportation Diesel			Total $
	Gallons	$	Avg. $/Gal	Gallons	$	Avg. $/Gal	
FY 2012-2013	18,721	$63,487.94	$3.39	28,824	$101,159.55	$3.51	$164,647.49
FY 2013-2014	30,195	$100,391.86	$3.32	40,550	$142,282.04	$3.51	$242,673.90
FY 2014-2015	32,020	$88,813.80	$2.77	40,226	$115,537.01	$2.87	$204,350.81

The chart below in Figure 17 shows how the total spending in FY2014-2015 was distributed between municipal departments. Here we can see that nearly half (48%) of the spending on transportation fuel is for the Highway Department and nearly a quarter (23%) is for the Police Department.

The Highway Department operates 23 vehicles, including dump trucks, plows, pickup trucks, and equipment (grader, excavator, cat loader, sidewalk tractor, etc.). The Police Department operates six police cruisers, three detective cars, one SUV, and one van.

All other departments combined make up just over one quarter (29%) of the town's spending on transportation fuel.

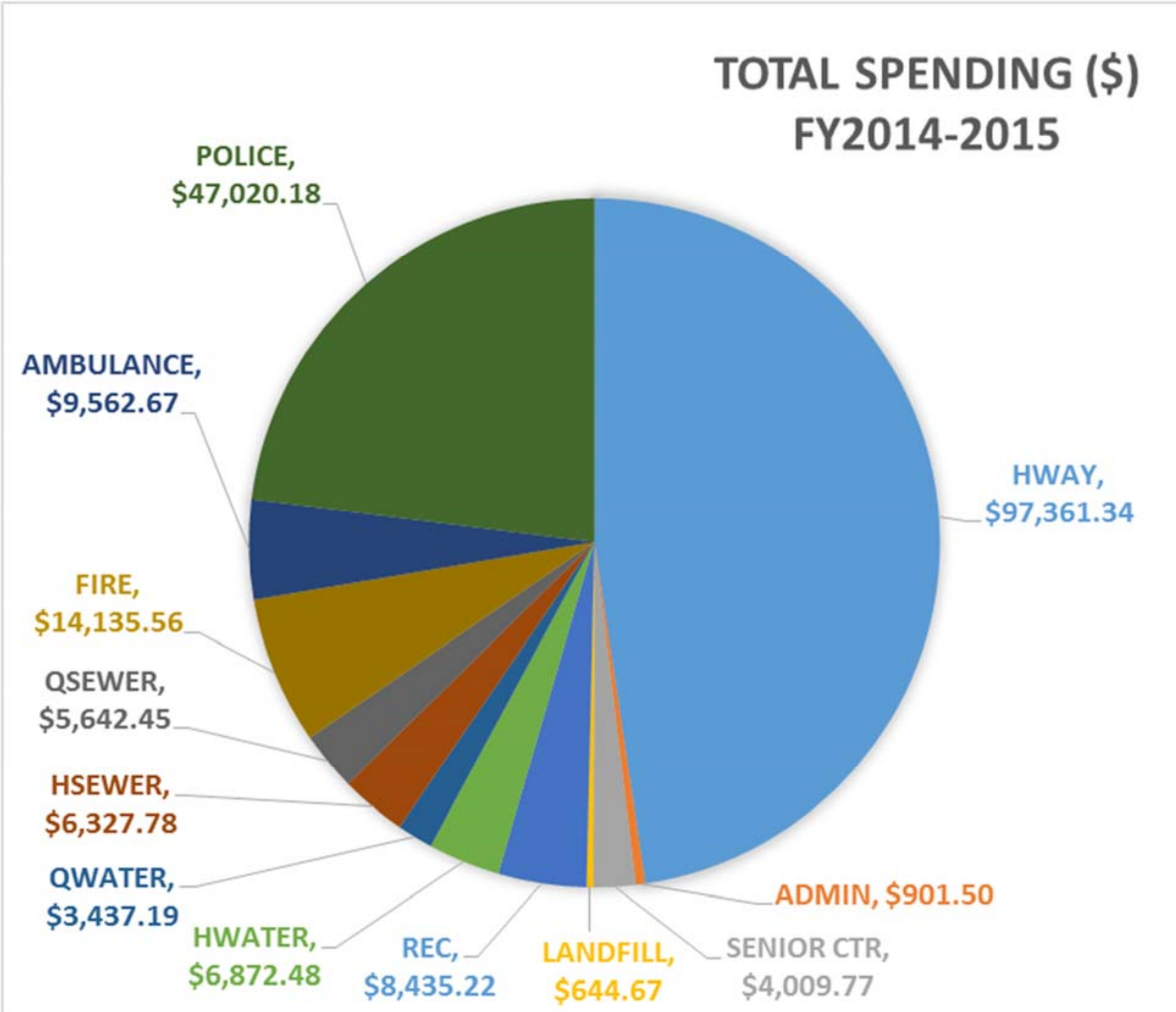


Figure 17.Total Transportation Spending by Department (FY 2014-2015)

To demonstrate how transportation fuel consumption is broken down between gas and diesel, Figure 18 shows the total fuel consumption for FY2014-2015 by fuel type and by department. As expected from the breakdown of spending, this chart shows that the majority of gas consumption is by the Police Department and the majority of diesel consumption is by the Highway Department. This indicates that focusing efficiency efforts on these two departments will likely have the most significant impact on overall transportation fuel consumption and spending by the town.

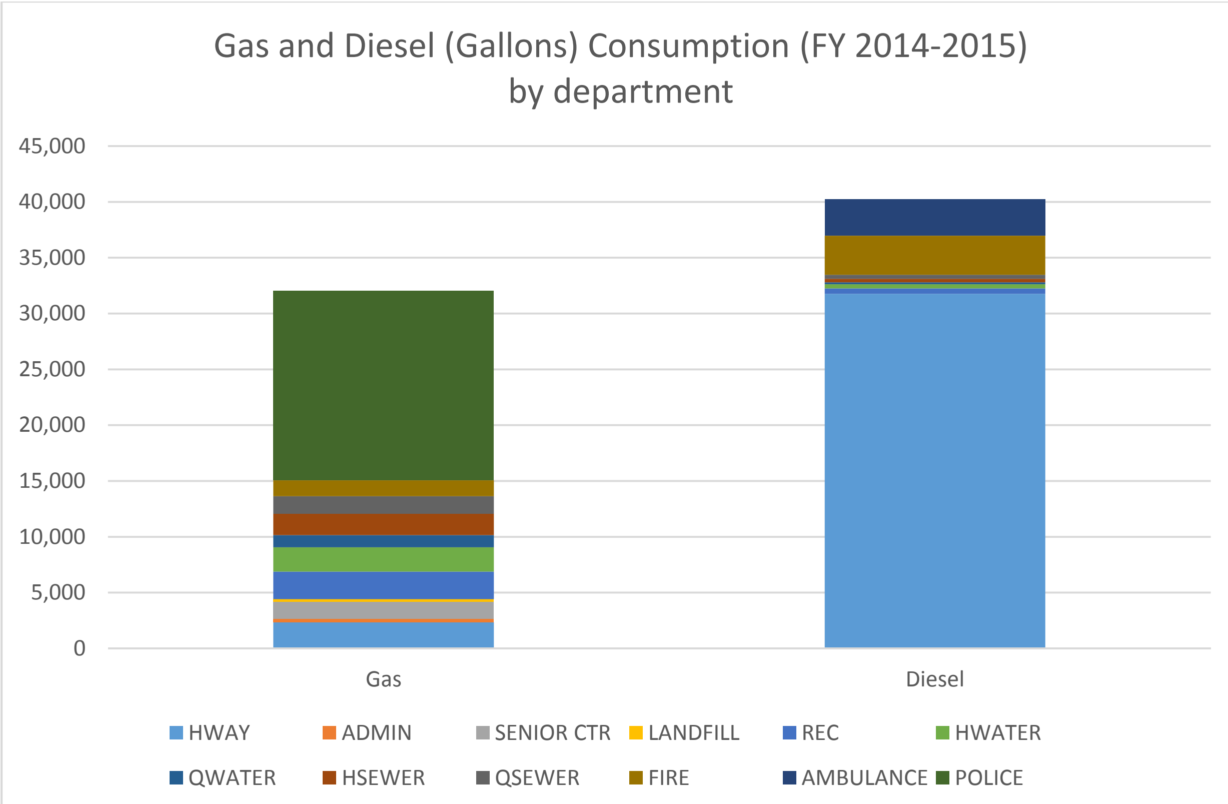


Figure 18. Fuel Consumption by Department

Data and Data Collection Issues

Two primary data sources were made available for the transportation component of this Action Plan. First, a fuel usage report was provided for FY2014-2015 and FY2015-2016 which included data for gallons of fuel used and miles or hours of usage for each individual vehicle. This data is generated from software on the town pumps, but it is dependent on information entered by the user and is therefore subject to error. Additionally, it was noted that at times, the pumps do not function properly and the user must bypass the computer system. Multiple data points are therefore missing for multiple vehicles, including critical information on odometer readings and gallons of fuel used. Given this lack of reliable data on the use of specific vehicles, it was determined that this data could not be used to assess the efficiency of specific vehicles, and rather, was used as a list of all vehicles and their make.

The second data source made available for this analysis is a set of fuel expense allocation reports for FY2012-2013, FY2013-2014, and FY2014-2015. These reports include spending on and gallons of both gas and diesel, as allocated to the town departments. This served as the primary data source with the fuel usage reports providing supplemental information on the vehicles owned and operated by each department.

As discussed later in Next Steps of this transportation section, a complete vehicle by vehicle fleet assessment estimating the efficiency gains potential requires data not available through the town pumps, but is also outside of the scope of this Action Plan. Such analysis requires detailed data on each vehicle, specifically on the use of vehicles, including trip distances and idle time, at a much more granular level than available through annual use data. This Action Plan, therefore, focuses on higher level opportunities, rather than a vehicle by vehicle replacement plan. It is noteworthy, however, that the software associated with the town fuel pumps does have the potential to provide powerful data. Efforts to continue to improve the functioning and accuracy of this data are well worthwhile.

National Trends in Transportation Efficiency

Nationally, many cities and towns are exploring opportunities to reduce emissions, use more efficient or lower cost fuels, reduce consumption, and ultimately, save money. Ideally, these factors would all occur simultaneously, but in many cases, choices must be made to prioritize one factor over another. For example, shifting from gasoline to electricity as the primary fuel in personal vehicles has significant potential to reduce emissions but may, at least in the short term, be more expensive. Alternatively, a conversion to propane fueled vehicles can provide a lower cost alternative to diesel, but with little to no benefit in terms of life-cycle emissions. The alternative fuels that are gaining in popularity for energy and emission reduction potential as well as cost savings are introduced below. Additionally, technologies to reduce fuel consumption are summarized. This section focuses on national trends, and subsequent sections discuss potential opportunities specific to Hartford.

Alternative Fuels

While efforts around alternative fuel adoption are expanding, diesel and gasoline have been and continue to be the primary transportation fuel used in the United States for light, medium, and heavy duty vehicles. This gives traditional fossil fuels an advantage in terms infrastructure, such as supply chains and storage resources, design of maintenance facilities, and maintenance technician training. At the time this Action Plan was written (July 2016), diesel and gasoline prices are near historic low prices (see Figure 19, note: Vermont average annual gasoline prices are very close to the national average and are not displayed to improved readability), increasing the attractiveness of the fuel. Therefore, for alternative fuels to be competitive with diesel, both the costs to develop a fuel supply and storage system, as well as the unit cost of the fuel need to be considered.

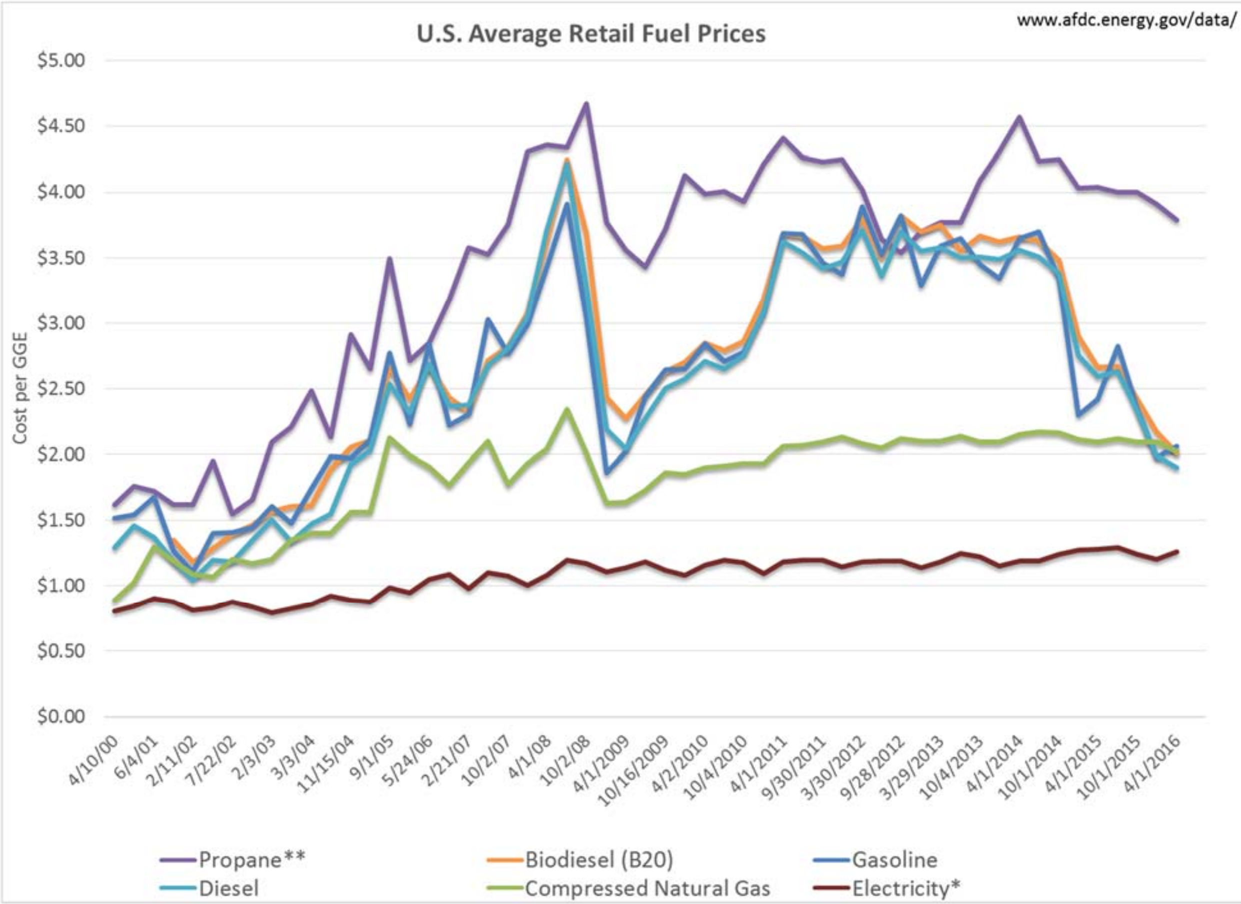


Figure 19. U.S. Average Fuel Prices, April 2000 – April 2016

Source: Alternative Fuel Data Center (U.S. Department Of Energy)
* Electric prices are reduced by a factor of 3.4 because electric motors are 3.4 times more efficient than internal combustion engines.
** Propane prices reflect the weighted average of "primary" and "secondary" stations.

Natural Gas

Natural gas is a mixture of gaseous hydrocarbons, primarily methane, which is odorless and colorless. It is used in the United States for home heating and cooking, electric power production, industrial uses, and as a vehicle fuel. The majority of natural gas produced is from fossil fuel sources but it can also be renewable (known as renewable natural gas, RNG) if it is from biogas or gases produced by decomposing organic matter.

There are currently two forms of natural gas that are used as transportation fuels, compressed natural gas (CNG) and liquefied natural gas (LNG). Both LNG and CNG can be utilized in any engine designed to burn natural gas, with the only difference being the state of the fuel stored on the vehicle and delivered to the engine. Historically, vehicle manufacturers have not produced many purpose built natural gas vehicles. Rather, vehicles were retrofitted to be fueled by either CNG or LNG. Today however, with growing popularity of the fuel, a number of manufactures are producing purpose built natural gas vehicles.

CNG and LNG are appealing alternative fuels because they typically burn more cleanly than diesel or gasoline, therefore contributing less greenhouse gas emissions and air pollution. However, while natural gas has historically been a relatively stable, low-cost fuel, Figure 19 shows a gradual increase in price and these prices are projected to continue increasing. Additionally, making cost-effective use of natural gas typically requires access to a natural gas pipeline. Without pipeline access, CNG and LNG must be delivered to stations, which can be prohibitively expensive. Maintenance facilities must also be upgraded to meet safety and regulatory requirements for servicing natural gas vehicles. Finally, the majority of natural gas vehicles have higher upfront costs.

PROPANE

Propane, also known as liquefied petroleum gas (LPG or LP-gas), is a byproduct of natural gas and petroleum refining. Propane has been used to power vehicles since the 1970s and is the third most popular vehicle fuel (among all vehicles), after gasoline and diesel. The benefits of propane as an alternative fuel stem mainly from its domestic availability, high energy density, clean-burning qualities, and relatively low cost for vehicles, fuel, and stations.

The recent introduction of liquid propane injection engine systems has significantly improved the fuel efficiency, performance (power, torque, etc.), and reliability of new propane vehicles. In addition, because propane is a simple fuel, it burns relatively cleanly in engines. Propane vehicles do not, therefore, require emission control systems similar to many diesel vehicles, and propane engines are simple and efficient, requiring less maintenance than modern diesel vehicles.

Propane vehicles can either be dedicated vehicles powered exclusively by propane, or they can be duel fuel, capable of being fueled by gasoline (or diesel) and propane. A handful of manufacturers make purpose built propane vehicles. However, more commonly, manufacturers partner with third party companies to conduct conversions. Conversions can be done prior to vehicle delivery or by a certified propane converter after purchase.

Propane fueling stations are relatively simple to install and maintain. Propane is delivered to stations via transport truck and is stored under pressure in carbon steel tanks, typically above ground. Fleets using propane often develop a propane station that consists of a fuel storage tank, fuel dispenser, pump and motor, and a fuel management system (see Figure 20). Propane stations can come either as skid-mounted or permanently installed systems, with skid-mounted stations often the more compact and less costly option. These systems typical come with 1,000- or 2,000-gallon storage tanks.

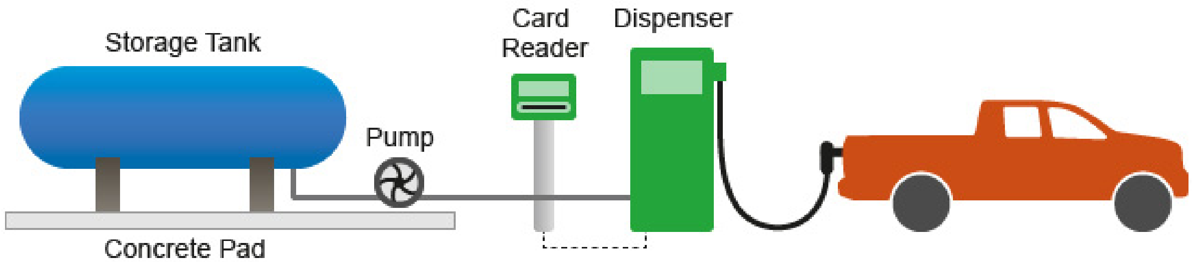


Figure 20. Illustrative Propane Station
Source: http://www.afdc.energy.gov/fuels/propane_infrastructure.html

Propane has been adopted by a number of municipalities looking to insulate themselves from fluctuating gas prices, reduce maintenance costs, and reduce tailpipe emissions. Propane is a popular fuel for school buses, police vehicles, and delivery vehicles. While the price of propane at the pump (see Figure 19) has historically been higher than the price of diesel, many fleets have reported negotiating a lower propane contract with fuel providers. Additionally, as discussed above, since propane is a cleaner burning fuel, vehicles require less maintenance resulting in savings over the vehicles life time.[46]

Biodiesel

Biodiesel is fuel manufactured from vegetable oils, animal fats, or recycled restaurant grease. Biodiesel is blended with petroleum diesel fuels to be used in diesel powered vehicles. Biodiesels may contain different concentrations of organic fuels ranging from two percent to levels approaching 100 percent by volume. It is regularly referenced by the portion of biodiesel to traditional diesel, i.e., B20 is a diesel blend with 20% biodiesel and 80% regular diesel. Most vehicles can use concentrations of up to 20% biodiesel (B20) without changes to the engine, and the U.S Environmental Protection Agency (EPA) considers existing diesel equipment and tanks to be compatible with biodiesel blends up to this level.[47] And while close to 80% of manufacturers have approved the use of biodiesel blends in all or most of their diesel vehicles[48], it is important to confirm with manufacturers that this application will not result in voiding the warrantee.

Biodiesel is not typically considered a strategy to reduce costs, as biodiesel is generally slightly more expensive than traditional diesel. While reduced maintenance costs are possible resulting from improved fuel lubricity and reduced wear on engine parts, this benefit does not always offset the higher fuel costs. Additionally, biodiesel has a lower energy content than traditional diesel, which can cause a decrease in torque, power, and fuel efficiency. However, this difference is small, often undetectable, and partially offset by improved combustion efficiency.[49] Biodiesel can also potentially gel in cold

[46] http://www.afdc.energy.gov/fuels/propane_benefits.html
[47] http://www.afdc.energy.gov/fuels/biodiesel_equip_options.html
[48] http://www.afdc.energy.gov/uploads/publication/biodiesel_basics.pdf
[49] The Citizen-Powered Energy Handbook: Community Solutions to a Global Crisis, Greg Pahl, Chelsea Green Publishing, 2007.

weather, but B20 can be treated for winter use, and a number of cold climate fleets have successfully operated the fuel year round, including Harvard University, the City of Denver, CO, and the City of Keene, NH.

Biodiesel is, however, safe, biodegradable, and produces less particulate matter and carbon dioxide emissions as compared to regular diesel fuel, and is therefore most commonly implemented to meet clean energy and emission reduction goals. For example, since 1992 the North Carolina Department of Transportation (NCDOT) has been utilizing biodiesel to meet state mandates and goals.[50] Important to note, however, is that the quality of biodiesel can vary by supplier, and NCDOT has found it vital to include specific requirements in their biodiesel contracts to ensure quality of the fuel will not cause issues in their engines.

In Vermont, the Agency of Transportation (VTrans) has had mixed experience with biodiesel.[51] Between 2008 and 2010, VTrans used biodiesel (B5 and B20) for a portion of its mid- and heavy-duty fleet. In 2010, VTrans was no longer able to purchase biodiesel from its supplier and therefore stopped its use. During these two years, technicians were resistant and reported issues with the fuel, but overtime, concerns decreased and the fuel's effectiveness was proven. VTrans currently has plans to reintroduce biodiesel in their fuel mix, and the Vermont Department of Buildings and General Services released its annual Request for Proposals for liquid fuels, which included specifications for biodiesel.

Electric

Plug-in electric vehicles (EVs) receive energy from the electric grid to recharge a battery used to power a motor. All Electric Vehicles (AEVs, also referred to as battery electric) are powered solely by energy stored in a battery; Plug-in Hybrid Vehicles (PHEV) can be powered by a battery for a distance, but also have a gasoline or diesel engine for extended range operation.

Over the past few years, EVs have grown in popularity because they produce no greenhouse gas or particulate emissions at the tailpipe, have quieter engines, and have lower operating costs and maintenance costs as compared with diesel or gasoline vehicles. Additionally, as renewable sources of electricity continue to make up a greater portion of the generation mix in the state, electric vehicles provide an opportunity for renewably powered transportation. While varying by model efficiency and electricity prices, driving in electric mode provides the equivalent to paying just over $1 per gallon for gasoline. Because electric rates tend to be relatively stable, EVs also help to guard against rising and volatile gasoline prices. Additionally, AEVs have a fraction of the moving parts of gasoline vehicles, making them very reliable and require no oil changes, spark plugs, catalytic converters or other emissions equipment. As a result, they generally only need servicing once or twice a year to check vehicle systems and rotate the tires.

However, there are tradeoffs. Three main challenges with municipal adoption of electric vehicles are: (1) the upfront cost of EVs can be higher than conventionally fueled vehicles, although these prices continue to decrease and competitive lease options exist; (2) AEVs have limited range before requiring

[50] http://altfueltoolkit.org/wp-content/uploads/2004/05/NCDOT_AFV_Activities.pdf
[51] http://altfueltoolkit.org/wp-content/uploads/2004/05/VTrans_AFV_Activities.pdf

charging; and (3) the vehicles' storage capacity is often reduced as a result of the battery taking up significant space.

Nationally, many police departments have been assessing these tradeoffs, experimenting with EVs with the goal of reducing operations costs. Specifically, EV pilot projects are being carried out in California, Michigan, and Massachusetts. Additionally, multiple agencies in California have begun using electric motorcycles.[52]

In Vermont, a number of municipalities, including Winooski, Burlington, Jericho, and Milton, have leased EVs for their administrative staff needs. In 2013, these four municipalities leased Mitsubishi i-MiEVs, small light duty vehicles that can seat 4 people. According to the U.S. FuelEconomy.gov, the i-MiEV has a range of 62 miles on a full charge and a 112 miles per gallon equivalent gasoline efficiency. Burlington, Jericho, and Milton leased one vehicle each; Winooski transitioned four vehicles to electric.

Nationally, many opportunities are being explored for integrating EVs with the grid and using their batteries as storage resources. One potential application being considered is to aid in the integration of renewable resources, as the battery capacity can help utilize and/or store intermittent renewable generation. The potential synergies between electrified transportation and renewable generation are an important consideration when assessing the value of electric vehicles in total energy planning.

Vehicle Efficiency Improvement Technologies

As introduced above, alternative fuels are being considered by many municipal fleets as a strategy to reduce transportation emissions and spending. However, there are also strategies to reduce fuel consumption that do not require a shift in fuel. These technologies include telematics, auxiliary power units, and more recently, vehicle calibration devices that can improve vehicle efficiency.

Telematics

Generally, telematics is any technology that remotely allows communication with and tracking of vehicles. Telematics allow fleet managers to track vehicles using global positioning systems (GPS) technology and the vehicles' diagnostics systems. These technologies are used by both private and public fleet managers to plan routes, monitor vehicle utilization, enhance vehicle and driver safety, and collect real-time data. Allowing fleet managers to have real-time monitoring of vehicles also enable fleets to save money and reduce fuel consumption by deploying vehicles more efficiently.

Additionally, telematics can monitor driver behaviors that increases fuel consumption such as idling, aggressive speeding, and harsh acceleration. Eco-driving, or driving in a manner to minimize fuel consumption, is one behavioral change being considered as a strategy to improve efficiency. Telematics technology enables the impact of these behavior changes to be measured.

[52] http://www.policemag.com/blog/vehicles/story/2013/06/calif-agency-converts-electric-motorcycle-for-patrol.aspx

In 2013, Baltimore County installed telematics devices on 651 of its vehicles.[53] This enabled the Baltimore Department of Public Works to better manage vehicle activities and automate its manual process for tracking snow removal. The County was able to realize a reduction in fuel consumption quickly as a result of optimizing routes and reducing inefficient driving.

Auxiliary Power Units

An auxiliary power unit (APU) is a device that can be installed on a vehicle to provide energy for functions other than propulsion. APUs allow systems on vehicles to operate without idling and can be powered by a number of different fuels including electric, diesel, gasoline, propane, and natural gas. APUs, therefore, can help reduce fuel use of any vehicle that idles for long periods of time in order to continue performing vital services, such as those required of police cruisers, fire trucks, and ambulances.

APUs are an integral part of the New York City Clean Fleet plan. After running a number of successful pilot programs, the city has decided to deploy battery powered APU systems throughout their fire department's fleet. Costs for these APUs are expected to be approximately $20,000, but the reported payback period is estimated at 18 months.[54]

Vehicle Calibration

Vehicle calibration units can make aftermarket alternations to vehicle settings to reduce fuel consumption and idling. They do this by turning off engines that are idling. Critical functions of the vehicle, such as radios, scanners, computers, and even heat and air conditioning, then function off of the battery. The vehicle calibration system is set to turn the car back on when the battery drops below a preset level. There are a number of companies that will work with fleet managers to calibrate vehicles tailoring them specifically to the fleet's needs. These systems can allow vehicles to operate more efficiently without making any major changes or investments.

A number of municipalities, including the City of Columbus, have found vehicle calibration to be helpful in reducing the fuel consumption, specifically of their police vehicles.[55] The City is installing calibration technology on 90 police vehicles at a total cost of $278,000, or just over $3,000 per vehicle. With an expected 34% reduction in idling, the units are estimated to pay for themselves in less than one year, generating fuel savings of over $3,500 in the first year.

Opportunities for Improvements and Upgrades

In considering which, if any, vehicle efficiency improvement technologies or alternative fuels provide Hartford with a cost-effective opportunity to reduce energy consumption, reduce emissions, and reduce spending, there is no one perfect fit. Different alternative fuels provide different benefits and are more or less appropriate in various applications. The pros and cons of each alternative fuel and efficiency improvement technology introduced above are summarized here with a specific focus on Hartford. The

[53] http://www.government-fleet.com/article/story/2013/12/telematics-case-study-managing-public-works-vehicles.aspx
[54] http://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/NYC%20Clean%20Fleet.pdf
[55] http://www.government-fleet.com/article/story/2014/11/anti-idling-technologies-do-they-work.aspx

departments identified as having the most potential for realizing savings, the Highway Department and the Police Department, receive particular focus.

Alternative Fuel Opportunities in Hartford

While some municipalities are seeing CNG and LNG as a cost saving alternative fuel, Hartford's lack of access to a natural gas pipeline and the need to ship the gas will likely make this alternative cost prohibitive. Additionally, the costs necessary to upgrade facilities would only be a worthwhile investment if a complete fleet overhaul were being considered. For Hartford, a conversion to a CNG fleet is not advised.

Propane, on the other hand, has the potential to provide an opportunity for Hartford to save on transportation fuel spending. Adding a propane fueling station can likely be done at little to no cost, making the largest determinant of cost savings the contract price negotiated with a propane provider relative to the price Hartford is currently paying for diesel. Because Hartford has an established contract with Irving, negotiating a fixed rate that would provide savings is a potential option. As noted above, propane is a common alternative fuel for police vehicles, as maintenance costs on police vehicles tend to be high, and propane helps to reduce these costs. Therefore, Hartford's current spending on maintenance for the police fleet will also be an important determinant of savings.

Biodiesel presents an interesting opportunity for Hartford in that vehicle conversion or replacement is not required. Because biodiesel (up to level B20) can be used in any diesel vehicle, it can easily be transitioned into the existing fleet. Therefore, as with propane, the biggest determinant of cost savings will be the fuel price negotiated. Additionally, biodiesel has been shown to reduce maintenance costs by reducing wear and tear on engines. These characteristics—requiring no investment in new vehicles and the potential to reduce maintenance costs—make biodiesel a good potential option for much of the Highway Department's vehicles and equipment. Again, the negotiated fuel price will be the key determinant, but given VTrans plans to reintroduce biodiesel, there is the potential for larger opportunities statewide.

While propane and biodiesel have the potential to reduce spending, they do not contribute to improved efficiency or reduced energy consumption. Electric is the only alternative fuel that accomplishes this, but with variable impacts on costs. Electric vehicles are most readily available for light duty vehicles and provide the best cost savings for vehicles that idle a lot, making them an interesting consideration for police vehicles. This also has the impact of being a highly visible commitment to energy efficiency on the part of the town. Nationwide, pilot projects integrating electric police vehicles are very new though, and data on the findings and results are limited. Another possibility for integrating an electric vehicle in Hartford is in replacing the Administration vehicle. This car is quite new though and would not likely be replaced in the next five years. However, installing a charging station at the town offices and having a town electric vehicle presents another very visible symbol of the town's commitment to clean energy and efficiency.

Ultimately however, to weigh these tradeoffs and assess the savings potential, detailed data is required for each vehicle in the town's fleet. While the fuel usage reports generated from the town's pumps provide a good start, more detailed usage data is required to understand vehicle usage, miles traveled, maintenance costs, and fuel consumption on a more granular level. For example, it is helpful to know the annual miles driven in the Administration Manager's vehicle, but to consider if an all-electric vehicle is an appropriate alternative and the savings potential, it is important to know *how* these miles are driven. In other words, are many short trips made around town, or is the Manager frequently traveling 100 miles round trip to Montpelier? Recommendations for collecting this data are included below.

Vehicle Efficiency Improvement Technologies

While a switch to an alternatively fueled fleet requires significant data collection and in many cases must be considered as part of the town's vehicle replacement plans, idle-reduction technology allows for a lower cost investment in reducing transportation fuel consumption that the town can undertake at any point in time. To fully assess the potential savings from idle reduction technology, data on idle time of vehicles is helpful but not necessary. Technology providers will often provide estimates of costs savings based on the number of vehicles and standard estimates of idle time. Therefore, while most examples nationally of municipalities making use of vehicle efficiency improvement technologies are for larger fleets, technology providers will be able to help determine the cost effectiveness for Hartford's relatively small fleet.

As introduced above and discussed in more detail below, vehicle efficiency improvement technologies are most effective at reducing fuel consumption in vehicles that idle as a means to maintain ancillary functions of the vehicle. This therefore makes them a great option for the Police Department's cruisers and also a consideration for ambulances, fire trucks, and the Highway Department's dump trucks.

Next Steps for the Town

First and foremost, Hartford will benefit from explicitly making fuel efficiency a required consideration when replacing fleet vehicles, and by prioritizing this. This perhaps seems like an obvious suggestion as an opportunity to reduce transportation fuel consumption, but without documenting this as a stated priority where buying requirements are detailed, it may be difficult to justify spending more upfront on a vehicle due to operational cost savings expected to accrue over time.

Next, because the vehicle efficiency improvement technologies described above do not require vehicle replacement or more thorough data on vehicle use, a great action item for Hartford will be to contact technology providers for estimates. Technology providers will inquire about the number and types of vehicles in the town's fleet and provide cost figures as well as estimates, and in some cases, guarantees, of fuel and cost savings. As noted above, these technologies will likely provide the best return on investment for vehicles that idle a lot, making this an appealing option for the Police Department's vehicles as well as for ambulances, fire trucks, and the Highway Department's vehicles, areas identified as ideal departments in which to realize savings.

Hartford may consider pursuing a pilot project as a lower cost and lower risk option for exploring alternative fuels, particularly with electric vehicles. The town could consider purchasing or leasing an electric vehicle, testing it for various purposes, and assess its viability. A single purchase of an electric vehicle would not require investment in fueling infrastructure. An electric vehicle could be plugged into a standard, 110 volt outlet at the town's maintenance facility and charged overnight. Purchasing an electric vehicle will require an upfront investment in the increased vehicle cost, but it would give the town an opportunity to test the new fuel in their operations. Alternatively, a leased vehicle could be returned to the manufacturer at the end of the lease term if it is not meeting the town's needs.

Next, if Hartford is interested in pursuing a more complete switch to alternative fuels, detailed data on vehicle usage, miles traveled, and fuel consumption will significantly help assess the savings potential. This data is required at the level of individual vehicle trips to assess factors such as idle time, trip distances, and usage patterns. Detailed data on maintenance costs will also contribute to a better understanding of the savings potential from various alternative fuels. This would enable a complete vehicle by vehicle fleet assessment of vehicle use patterns and enable recommendations specific to Hartford's fleet. As noted above, this is outside of the scope of this Action Plan, largely due to the time and cost needed to conduct this type of data collection and analysis. Companies, such as FleetCarma (http://www.fleetcarma.com/platform/conventional/), provide data collection solutions on fleet management and fuel efficiency through on-board diagnostics devices and user platforms. Pricing for these services is customized for each use-case, but if Hartford decides to move ahead with a more comprehensive alternative fuel assessment, this level of data collection would be advised.

With more detailed information about the fuel consumption and use patterns of the town's fleet, Hartford would then be in a good position to approach propane and biodiesel suppliers for price quotes. Because Hartford already purchases propane from Irving, it may be possible to negotiate a good price here. For biodiesel, because VTrans is planning to reintroduce the fuel, they have already developed the specifications to ensure the quality of biodiesel purchased; Hartford could use these specifications when approaching suppliers. The complete fleet assessment suggested above would help determine which vehicles would be best candidates for these alternative fuels, but propane is a common alternative for police vehicles, and biodiesel, given the fact that it requires no investment in new vehicles, could be a good option for many of the Highway Department's expensive vehicles and equipment. Alternatively, Hartford could approach fuel suppliers first as a way to gauge if conducting a complete fleet assessment is a worthwhile endeavor.

Estimated Cost and Savings of Proposed Next Steps

As noted throughout, estimating the savings potential from a switch to alternative fuels or through implementing vehicle efficiency improvement technologies is extremely dependent on negotiated fuel prices, maintenance costs, vehicle use, and price estimates for technology services. Detailed data on the use of vehicles (trip distances, idle time, etc.) is required for a full analysis of the savings potential of alternative fuels. Additionally, because with many alternative fuels, the saving are derived from lower cost fuels rather than improved efficiency, negotiated fuel prices are a key determinant. However, examples of experiences of other municipalities provides useful considerations.

For example, Chesterfield County, VA, reports saving more than $30,000 in three years (as well as gaining more than $35,000 in tax rebates) from a shift to propane.[56] The fleet manager began by up-fitting the police department vehicles, and after seeing fuel savings there, moved on to the school district. After working with the school district for one year, 22 buses were converted to propane. Important characteristics to note of Chesterfield County's experience include: the Fleet Services Department manages a large fleet of over 2,500 vehicles; an existing state propane contract was in place, so they had no additional infrastructure costs; and significant fleet assessments were conducted to assess if smaller vehicles were options.

An example perhaps more relevant for a small Vermont town can be seen in the City of Winooski's adoption of electric vehicles. In 2014, the City took advantage of a special lease deal for the Mitsubishi i-MiEV. This deal enabled the town to lease the electric vehicle for $110 a month, with no down payment. Looking to save money and demonstrate their commitment to the environment, the City decided to remove five outdated vehicles and replace them with i-MiEVs. The City was featured in a video for the U.S. Department of Energy Clean Cities program citing cost savings in fueling and maintenance costs.[57]

Vehicle efficiency improvement technologies likely present the most near term, cost-effective options for Hartford to reduce fuel consumption, and multiple examples exist of other municipalities pursuing these technologies. In Santa Barbara County, it was estimated that police vehicles were consuming approximately 51,000 gallons of gasoline a year by idling.[58] In order to reduce this, the County installed a system that monitors vehicle use and shuts off the engine when idling. This allows on-board electronics to run off the battery when the engine is off. The calibration system monitors the battery charge and automatically turns the vehicle back on when the battery drops below 12 volts. After a short pilot, these systems were installed in 42 of their 51 patrol units. At an average cost of $450 per vehicle, the payback period is expected to be less than six months.

National examples show vehicle efficiency technologies to be worth the investment. To assess if this is the case in Hartford, we consider the fuel spending by one department, the Police Department, and estimate very high level, gross savings potential. One efficiency improvement technology provider[59] reports a range of savings resulting from improved efficiency and reduced idling. Using their average savings reported at 12% and considering the approximately $47,000 that the Police Department spent on gasoline in FY 2014-2015, these technologies could save Hartford's Police Department approximately $5,600 per year in fuel spending. These savings do not, however, reflect the cost of the technology, and would therefore need to be compared to the costs if Hartford took the step of requesting a cost estimate.

Because the Highway Department has been identified as a key focus area in Hartford, attempts were made to find relevant pilot projects examining fuel savings in trucks, and heavy duty vehicles and equipment. In addition to exploring biodiesel, as discussed above, the North Carolina Department of

[56] http://www.government-fleet.com/news/story/2016/06/va-county-succeeding-with-propane-autogas.aspx
[57] https://www.youtube.com/watch?v=W_EKSRYsMVY&list=PLTTHf6mU88szn1VIqVo-H_KeSa9403CXU&index=19
[58] http://www.government-fleet.com/article/story/2014/11/anti-idling-technologies-do-they-work.aspx
[59] http://derivesystems.com/efficiency/solutions/

Transportation is also piloting vehicle calibration in 30 Class 1 pick-up trucks, focused on anti-idling but also calibration of the powertrain of the vehicles. The pilot has resulted in four percent savings in fuel consumption and they are now planning to expand to 150 vehicles.

Additionally, a U.S. Department of Energy, Energy Efficiency and Renewable Energy report[60] estimates the payback period of various idle-reduction technologies in various types of vehicles. They show payback periods of less than one year for APU systems in police cars, 2.9 years in fire trucks, and between 2-8 years in ambulances. This report is included here as Appendix A.

---

[60] http://www.afdc.energy.gov/uploads/publication/idling_emergency-service_vehicles.pdf

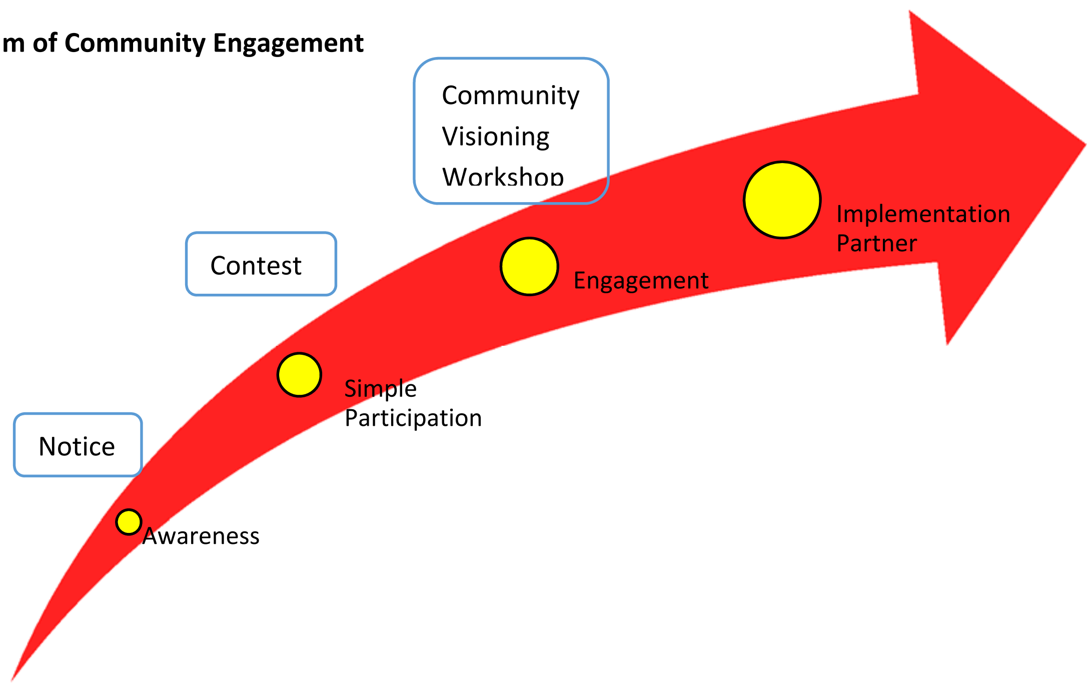
Community Engagement

The Town of Hartford hired VEIC to identify specific opportunities for ongoing Town investment, financially and non-financially, in energy improvements that will benefit the Town and the community as a whole, and have a clear return on investment, high visibility, and opportunities for public engagement. The section below offers suggestions to engage community members and key stakeholders in a comprehensive discussion with the end goal of developing new energy goals for the town, and strategies to achieve the goals, relying on Hartford Energy Committee to lead community engagement efforts.

Community Engagement Recommendations

Generally community engagement can range from a wide spectrum of engagement levels, from one-directional awareness (e.g. notice in a newsletter or newspaper), to simple participation (e.g. submit ideas in a contest), to engagement (e.g. "community visioning" workshop- details provided in the following sections), to being a full implementation partner. We strongly recommend encouraging the community to become involved to the fullest level possible, so that participants feel that they have some sense of ownership in the project. This helps ensure that when ideas come to a vote or the implementation phase, the community is already supportive of the project and there is broad support for moving it forward.

Spectrum of Community Engagement



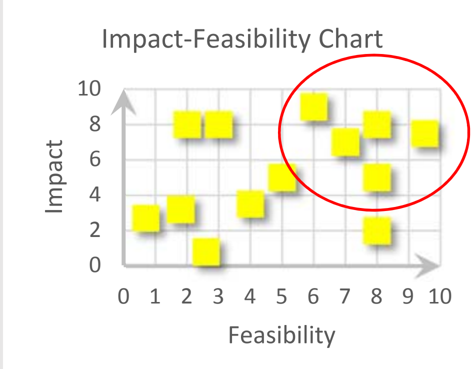
Community Visioning

VEIC recommends that the Town of Hartford engages the community through a community visioning workshop. In this type of workshop, community members are encouraged to share what they want the energy future to look like for the Town, what they would like to see in their Town as they walk through the Town's downtown(s) for example. Then the community is invited to reflect on what it would take to get there and what are the top priorities. The group is then split into sub-groups for each of the top priorities identified. Participants in the workshop then self-select into each group based on their interest and what they see as top priority.

A sample agenda for the community and moderator are included in Appendix. Local non-profit organizations may have resources available to help organize such a workshop (e.g. Vital Communities http://vitalcommunities.org/energy/municipal/). Efficiency Vermont may also have limited resources available to help structure the agenda for the workshop.

Impact-Feasibility Chart

In this helpful exercise community members and stakeholders rate all projects in terms of perceived impact and feasibility, to identify what should be top priorities. Participants write their ideas on post-it notes. The group then works collaboratively to post them on a chart as illustrated below. Ideas with the greatest impact and that are most likely to be feasible (red circle below) get selected for further discussion.



Contest

Not everyone in Town will have the desire or time to participate in a community visioning workshop. To capture input from people who will not or cannot come to that workshop, we recommend that the Town organizes a little contest.

In this contest, the Town would ask the community a challenging questions (e.g. How to eliminate energy bills for everyone in Town? How can the Town become Carbon Neutral? etc.). The Town offers a reward for the best answer(s), based on feasibility and impact. The questions can be posed online on the Town website, or on social media, but should also be made accessible to people who may not have easy access to the web. This could be done through a card placed in local, public places (e.g. plastic tree wherever people wait in line, such as grocery store, post office, etc.).

While a contest may generate some great ideas, VEIC still recommends to do a visioning workshop where the community engagement and sense of ownership is much greater than a simple participation in a contest.

Opportunities for Engagement

If the Town wants to maximize community participation, it is essential to take the message to people where they already convene, and get some time on the agenda of these meetings (e.g. rotary club, church, school, venues where landlords meet in Town, etc.). This will ensure that a diversity of opinion is captured.

Schools are also a great venue to engage the community, for example through an art contest, or by having 6-12 graders share their vision for the future, or by having a prize for the class that returns the most contest cards, etc.

Given that Hartford comprises five villages, the Town should strive to provide geographic outreach not only to all income levels, but also to each of the Towns.

We strongly encourage the Town to dovetail the community engagement efforts with the Downtown Initiative the Efficiency Vermont is piloting in Town in 2016. Between July and December, Efficiency Vermont will be in the Hartford community twice a month, hosting open “office hours” in a community setting in the mornings, and conducting walk-throughs in the afternoon at various businesses (hotel, convenience stores, etc.). Through these activities, Efficiency Vermont will inform the community in how Efficiency Vermont can help them save energy, what rebates and technical assistance is available, etc. They will also conduct presentations and workshops during lunch or in the evening at various civic groups. Efficiency Vermont will also host supplemental events where they will offer sponsorship, presentations, an informational table, etc., as well as supporting a school LED fundraiser.

Efficiency Vermont will rely on a range of means to advertise their effort: through Vital Communities, the Chamber of Commerce, email lists, phone calls, word of mouth, social media, print advertising, and possibly a media campaign with the local TV station.

The Town should take advantage of this effort and ensure that information about any community engagement activity (workshop and contest, as recommended above) is made available at all Efficiency Vermont events. Meghan Chambers, B.E.P. at Efficiency Vermont is the Account Manager for this effort and she can be reached at (802) 774-8233 (cell) or mchambers@veic.org. She is coordinating this event with Lori Hirshfield, Director, Department of Planning & Development Services for the Town.

MESSAGING

The most effective way to ensure participation is to speak to what people care about, to appeal to what people value and would fear losing. It helps to remind community members that something that they value is threatened (e.g. global warming will bring more floods and wash out roads, cause power outages, or Town energy bills are likely to go sky-rocketing when the price of oil sharply increases again, etc.). To engage the community and get a wide range of ideas, the Town needs to get community members to feel that their participation will make a difference for the future of the town. A sample agenda for the community and moderator, as well as an example of a flyer used in Waterbury for similar activities are included in Appendix.

Energy Coordinator

The Town of Hartford requested that VEIC develops and presents a recommended role for a new Town Energy Coordinator position, including a Scope of Work for a designated period of time to ensure implementation of the 5-year Energy Action Plan.

No towns in Vermont currently have a dedicated energy coordinator staff fully on the Town's payroll. Some Towns do have dedicated energy coordinator, but through the creation of non-profits and the heavy reliance on volunteers; examples include:

- The Brattleboro Climate Protection is a non-profit organization with 20 volunteers, led by Paul Cameron, Executive Director (pcameron@brattleboro.org). The group is funded by grants, and has also historically received funds from the town.
- Waterbury Local Energy Action Partnership (LEAP) is a town energy committee that has become a 501(c)(3) non-profit organization and as such is not a town organization. It was funded by Duncan McDougall in 2007 (http://www.waterburyleap.org). LEAP is funded by grants and run essentially on a volunteer basis.

Hosting an Energy Coordinator at the regional planning commission would see two major barriers. First, the Two Rivers-Ottauquechee Regional Commission (TRORC) provides support to towns for a range of services, however the TROC is unlikely to have funding available for the hire of an energy coordinator shared among towns. The TRORC will help with the master plan and energy plan component of the master plan, but is unlikely to be willing to raise their membership fees to fund such a position. Second, for the roles that an energy coordinator will play, the Town needs boots on the ground, someone close to the Town that can make things happen, either as a part-time employee or as someone contracted out.

If the Town of Hartford wants to lead the way in Vermont and hire a dedicated energy coordinator on the Town payroll, we suggest a part-time position (~50%) as detailed below.

Scope of Work:

The Energy Coordinator would be responsible for the following activities:

- Monitor and track municipality energy and water usage in buildings (incl. schools, if the school board is supportive) and energy usage in the Town's fleet Enter data in Portfolio Manager to track improvements in energy and water consumption
- Set priorities for energy improvements
- Manage contractors
- Manage the RFP process
- Research funding opportunities and apply for grants and incentives as they become available
- Monitor savings from improvements that have been made
- Document monetary savings resulting from energy and water savings
- Present improvements and savings to the community (Town newsletter, select board meetings, Town meetings)
- Engage the community in energy improvement efforts (if that role is supported by the select board, see below for details)
- Advise and participate with the Town Energy Commission

Future Town endeavors may make the role of an energy coordinator essential, and the scope of work would then be extended to additional activities such as: implementing and hosting community solar projects, managing the use of energy storage infrastructure (e.g. if the school bus fleet is upgraded to electric buses and the buses' batteries used for electricity storage for Green Mountain Power), or other future technologies. The need and scope of work of an energy coordinator should be revisited on a regular basis.

Skills and Compensation

Skills required for the position will depend on the focus of the Energy Coordinator. If the Energy Coordinator is to focus exclusively on the Town and School district facilities and implementing an action plan, then the skills required are those of a facilities manager with specific expertise on energy, contractor management, benchmarking, and reporting. If the scope of the work also includes encouraging energy improvements in the community, then the hire should also have strong community engagement skills.

Although no similar position in Vermont currently exists and to use as a reference, salary for an Energy Coordinator position is likely to be in the $40-$70,000 range (full time equivalent), depending on skills.

Another option that the Town could consider, if the select board is not supportive of hiring a new staff (the preferred option), is hiring an AmeriCorps volunteer, or an intern through a college or university. This option will however have two disadvantages: 1.) the hire is likely to have less professional experience than ideal, 2.) the hire may be seasonal in the case of interns, and may change annually in the case of AmeriCorps volunteers. However, this could be a good option if the select board does not support funding an energy coordinator through the use of municipal cost savings resulting from energy improvements.

Funding of the Position

If the energy coordinator position is paid out of a municipal budget, the Town will likely need a return on investment to justify the expense, for the select board to approve the position. For this reason, we recommend that the energy coordinator focusses essentially on municipal buildings (including water savings community-wide that will result in energy savings at the municipal water and sewage plants). Energy savings resulting from the energy improvements can then be used to pay for the energy coordinator position and justify the hire.

If there is support from the select board, the position could be expanded to engaging the community and achieving community-wide energy and cost savings, and while a very significant return on investment will still be present, it will be more difficult to demonstrate.

If the school board offers its support and there is funding available from the school district, the position should also focus on schools. We recommend starting with the Town facilities and then expanding the scope to schools once the concept has proved its value with municipal facilities, as it will then be easier to demonstrate the value to the school board, and the community as a whole if a community vote is required.

If the Town wishes to limit the financial burden placed on the Town, sharing an energy coordinator with a neighboring Town could be considered. The most likely candidate in the region is Lebanon, NH, but this will require the need to convince another public board.

Appendix I: Year-by-Year Energy Action Plan and Funding Mechanisms to Consider

FY 2016-2017					
Task	**Priority**	**Capital Costs and Resulting Savings if known or can be estimated**	**Financial Mechanism Options*, incl. Available Incentives**	**Rationale and Assumptions**	**Section of Report and Page Number**
Solar credits for Water & Wastewater Infrastructure	High (no upfront cost, ongoing savings).	2-5% savings on electricity. Requires some staff or volunteer time to get started.	Solar company will take Federal and State incentives, reflected in the bill savings for the Town.	The Town is moving credits away from these accounts. Need to address any issues applying credits to enterprise accounts.	Section 2.3.2, p. 16
Enter all Town and School District Infrastructure into Portfolio Manager	Medium (ease of implementation; can help prioritize future efforts).	No upfront capital cost. Volunteer hours from the Energy Committee and staff time.	N/A	Helps find savings opportunities and malfunctioning equipment and organizes data.	Section 2.3.2, p. 12
Determine Hydropower Potential for Water & Wastewater Pipes	Low (aquifer based system may not have	No upfront capital cost.	Town budget.	Where pressure in the system needs to be reduced more than 25 psi, energy can	Section 2.3.3,

	potential, but it can be rapidly assessed).	~1 day of Public Works staff time.		be generated while reducing the pressure.	p. 17
Implement Efficiency Improvement Recommendations at Bugbee	High (high degree of confidence in savings).	$100K gross project cost; energy savings = ~$7500/year (8% annual ROI after EVT incentives).	Town budget, heat pump lease program, and/or financing instrument.	To achieve energy and cost savings, and to improve comfort, the Town should move forward with: 1.) high-priority improvements outlined in O&M #1, ECMs #1, #2, #3, #4. 2.) installation of heat pumps for heating & cooling across site.	Bugbee Energy Action Plan
Implement Efficiency Improvement Recommendations at the Public Safety Building (First Year of a Two Year Project)	High (high degree of confidence in savings).	$20K energy project cost; ventilation project cost will likely be much more; energy savings = $3000/year (15% annual ROI) .	Town budget or to accelerate efforts, consider performance contracting services.	To achieve energy and cost savings, and to improve comfort, the Town should move forward with 1.) upgrades to ventilation systems required by health, safety, and building codes, 2.) with high-priority improvements in O&M #1, ECMs #1, #2, #6. 3.) Continue to upgrade interior lighting as staff electrician time allows.	Public Safety Energy Action Plan

Engage the Community in the Development of a Comprehensive Energy Plan	High (magnitude of impact is large).	No upfront capital cost. Volunteer hours from the Energy Committee.	Volunteer hours	1. Develop a long range plan to meet State goals and requirements 2. Engage the community in the process, to create a feeling of ownership of the Comprehensive Energy Plan.	Section 2.7., p.56
Make Fuel Efficiency a Required Consideration when Replacing Fleet Vehicles	High (ease of implementation, magnitude of savings).	No upfront capital cost.	N/A	With very minimal effort, this task could have a considerable impact on the efficiency of vehicles purchased. Without documenting fuel efficiency as a stated priority in purchasing requirements, it may be difficult to justify spending more upfront on vehicles when operational cost savings are expected to accrue over time.	Section 2.6.3, p. 49
Implement Transportation Fuel Efficiency Improvement	High (ease of implementation, low capital cost, high confidence in potential savings).	Savings may be achieved in the range of 10-15% of fuel costs, which would be	N/A	This is likely a low-cost, near term approach to begin generating fuel savings from transportation. As a first step, cost estimates should be obtained from fuel efficiency improvement technology providers (e.g.	Section 2.6.3, p. 51

		equivalent to about $5,600 in fuel savings annually.[61] A few hours of staff time will be required.		idle-reduction technology). A few technology providers were contacted, but estimates were not provided to us as consultants.	
FY 2017-2018					
Task	**Priority**	**Capital Costs and Resulting Savings if known or can be estimated**	**Financial Mechanism Options*, incl. Available Incentives**	**Rationale and Assumptions**	**Section of Report and Page Number**
Replace One to Three Cars with Electric Vehicles (EVs)	Medium (low-risk, ease of implementation, but low cost-savings)	The incremental cost of an EV is in the range of $6-10,000 on the purchase price, but with lease deals and rebates, costs can be comparable and even competitive.	Town budget	An electric vehicle pilot project will not likely generate immediate cost savings, but rather, provide a lower-cost, lower-risk opportunity to test the technology in meeting the Town's needs. Replacing the Administration vehicle with a	Section 2.6.3, p. 49

[61] Cost estimates will need to be obtained from technology providers. Data from comparably sized fleets is not available. Savings estimates will also be included in quotes. Rough estimates of savings (not specific to Hartford's fleet) are reported at 10-15% of fuel costs. Assuming 12% savings and considering the approximately $47,000 that the Police Department spent on gasoline in FY 2014-2015, applying vehicle efficiency improvement technologies to the full police fleet would result in $5,600 in fuel savings annually.

				leased EV would likely be the easiest test case. However, the Administration vehicle is quite new and not likely to be replaced soon. Cost estimates will therefore need to be re-evaluated because the technology and costs of EVs are changing so rapidly.	
Re-Evaluate the Potential for Solar PV at Wastewater and Highway Facilities	High (significant savings/income)	Details vary, but Town may get 5-10% savings on electricity OR $500-$750/acre for leasing land	N/A	Solar costs have dropped by half since the potential for solar PV was last evaluated.	Section 2.3.2., p.16
Commission an Energy audit of Water Distribution Infrastructure (Pump House)	High (potential magnitude of savings, ease of implementation)	Dependent on assistance that Efficiency Vermont or the Vermont Rural Water Association can provide that year**	Town Budget, with the assistance of Efficiency Vermont Programs		Section 2.3.2., p.15
Implement Efficiency Improvement Recommendations at the Public Safety Building (Second Year of a Two Year Project)	Medium (magnitude of savings, ease of implementation)	$70K gross project cost; energy savings = $5,500/year (8% annual ROI)	Town budget, heat pump lease program, and/or financing instrument	Move forward with medium-priority improvements outlined in ECMs #3, #6	Public Safety Energy Action Plan

Wood heat for Municipal arena/ ice rink, and/or highway garage	Medium (magnitude of savings can be high for the buildings, but confidence in savings is less certain without evaluation of building layout through a pre-feasibility assessment)	Pre-feasibility study: approximately $5,000-$10,000 Capital Cost: Conceptually ~$300,000-350,000 for each building. Savings potential if project moves forward: $109,000 thirty-year Net Present Value	Pre-feasibility: Town budget Project capital costs: Commons Energy, Efficiency Vermont Loan Program, or municipal bond. As of the writing of this report, incentives are available from the CEDF ($1.25 /heated sq ft)[62] and Efficiency Vermont ($2,000 per boiler)	Wood heat delivers central heat and domestic hot water at a lower fuel cost, and a much more stable and predictable fuel cost than oil or propane	Section 2.4.3., p. 24
Include Budget for an Energy Coordinator in the Town Budget	High (potential impact of total energy consumption for the Town *and its residents*)	$20,000-$35,000 for a part-time (50% FTE) staff	Energy Savings that the Town is expecting from energy improvement activities can contribute to	Implementation of this plan and the comprehensive energy plan, as well as tracking of energy data to prioritize improvements requires a dedicated person's time. The Town does not have a dedicated facilities manager, due to the size of	Section 2.8, p.59

[62] See full program details at http://www.rerc-vt.org/incentives-program/eligibility

			funding of the position	the Town, making implementation of energy improvement projects challenging. Many of the tasks that an energy coordinator would do are not easily done by the HEC or any current staff position.	
FY 2018-2019					
Task	**Priority**	**Capital Costs and Resulting Savings if known or can be estimated**	**Financial Mechanism Options*, incl. Available Incentives**	**Rationale and Assumptions**	**Section of Report and Page Number**
Implement a Community Outreach Campaign to Reduce Water Consumption Town-wide (multi-year)	Medium (high potential savings, but not easy to implement)	No upfront capital cost. Primarily Volunteer labor, Energy Committee to lead the effort; hours from an Energy Coordinator if one if hired. 10% savings or more are achievable through leak repairs and switching to more water efficient appliances. The full savings	Town Budget with the potential assistance of Vermont Rural Water Association	Less water consumed will result in less water needing to be pumped for delivery and wastewater treatment. This will lead to a decrease in revenue for the water utility, and may require adjusting the water rate.	Section 2.7., p.56

		would likely not occur before 2020, depending on the level of the community outreach campaign. 10% savings would be equivalent to roughly a $16,800 reduction in water and wastewater pumping costs annually.[63]		This will not result in savings to taxpayers but to savings to municipal water customers.	
Re-evaluate the savings potential from alternative transportation fuels	Low (lower potential savings)	No upfront capital cost. A few hours of staff time will be required	N/A	At current fuel prices (gas and diesel low; propane high), a switch to propane or biodiesel is not recommended. However, if Hartford would like to pursue this further, collecting detailed data on vehicle usage, miles traveled, and fuel consumption for a comprehensive fleet assessment is recommended. This could become more viable if propane prices drop, at which point, suppliers should be contacted for price quotes. Additionally, more will be learned about the	Section 2.6.2, pp. 42 - 46

[63] A 10% savings would be equivalent to roughly a ~70,000 kWh reduction for water pumping and 140,000kWh reduction in wastewater pumping, or $5,600 per year in water pumping costs and $11,200 reduction in wastewater pumping cost. Lost revenue for the water department would be roughly 10% of revenue.

				savings potential from biodiesel as VTrans reintroduces it.	
FY 2020-2021 and **FY 2021-2022**					
Task	**Priority**	**Capital Costs and Resulting Savings if known or can be estimated**	**Financial Mechanism Options*, incl. Available Incentives**	**Rationale and Assumptions**	**Section of Report and Page Number**
Implement a Community Outreach Campaign to Reduce Water Consumption Town-wide (multi-year)	See above				

* Financial mechanisms options include:

- **Municipal Bonds** for projects that are bundled; the administrative costs are not justified for small projects
- Upcoming **Efficiency Vermont Loan Program**[64]
- **Tax exempt municipal leasing**
- **Commons Energy** is a comprehensive total-energy solution for owners of small to mid-size multifamily affordable housing, education, health care, and community and municipal facilities who may have difficulty accessing capital, technical skills, and implementation services. Established as a low-profit, limited liability company (L3C), a form of LLC that balances social and financial returns, Commons

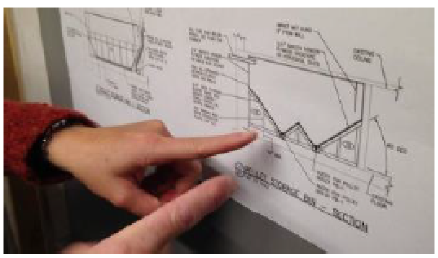
[64] Energy Efficiency Conservation Loan Program sponsored by the United States Department of Agriculture Rural Utilities Service ("RUS") in order to raise low cost funding for consumer loans to be issued to help implement efficiency and conservation measures whose costs are normally out of reach.

Energy is a subsidiary of Vermont Energy Investment Corporation that offers energy performance contracting services to public-serving institutions.

** We recommend that you engage with your Efficiency Vermont Account Manager to take advantage of programs and initiatives that Efficiency Vermont offers. They have offered support for energy audits in your Town buildings and facilities in the past and may be able to support you in the future. Efficiency Vermont can be a good partner to the Town in working towards energy goals. Efficiency Vermont can offer support for efficiency upgrades that occur when you are doing a renovation or new construction (as they have in the West Hartford Library, the Municipal Building, the ice rink and new recreation field development). Efficiency Vermont can also help you identify opportunities in the remaining buildings (including schools) as they have in the past with the many lighting upgrades that have happened around town. For in-depth analysis like what you have procured for Bugbee and Public Safety, an outside resource will need to be hired as this is beyond the scope of Efficiency Vermont services. Your account manager is a great resource and can assist the Town with Energy Projects as you move forward.

Appendix II: Wood Heat Service Announcement

We can Help You
Assess the Opportunity to Switch to
MODERN WOOD HEATING!



STAY WARM.

Woodchip and pellet heating systems are proven technologies used in hundreds of Vermont buildings for the past 20+ years.

SAVE MONEY.

Woodchips and pellets commonly cost considerably less than heating oil and propane.

HEAT LOCAL.

Heating with wood avoids exporting fuel dollars out of the local economy and supports local forest management.

Vermont State Wood Energy Team

Advancing the Use of Modern Wood Heating in Schools and Affordable Housing Across Vermont

The Vermont State Wood Energy Team is a public-private partnership of experts providing outreach and technical assessment services to public schools and affordable housing providers to evaluate installing modern wood heating systems.

- **Offering no-charge initial assessments** - Just send us 3 years of heating fuel records and we will provide a "first look" assessment of the savings opportunity.
- **Providing 80% of costs for in-depth "prefeasibility" studies** – We will conduct a site visit and a prepare more in depth report detailing the costs, savings, and specific design considerations.

To request these assessment services, please contact Paul Frederick, VT State Wood Energy Team Manager, at: paul.frederick@vermont.gov or (802) 777-5247.

We gratefully acknowledge the financial support provided by the Wildland Fire Hazardous Fuels, SWET Program of the U.S. Forest Service, Department of Agriculture. This institution is an equal opportunity provider.

Appendix III: Additional Transportation Efficiency Resources:

Idling Reduction for Emergency and Other Service Vehicles, U.S. DOE[65]

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Idling Reduction for Emergency and Other Service Vehicles

Emergency vehicles, such as police cars, ambulances, and fire trucks, along with other service vehicles such as armored cars, are often exempt from laws that limit engine idling. However, these vehicles can save fuel and reduce emissions with technologies that allow them to perform vital services without idling.

Police Vehicles

Police cruisers spend much of their time parked and running while officers monitor traffic, help at accident scenes, write reports, and wait to be called. Officers commonly require lights, radios, computers, radar, and video cameras.

In one recent report about police vehicle fuel consumption, the cruiser studied was found to idle 60% of the time during normal operation and used 21% of its total fuel while parked.[1] While the engine provided 250 horsepower (hp), together all of the accessories needed less than 2 hp. (Air conditioning consumed the most power, followed by external lighting.)

Several idling-reduction systems, with varying capabilities and costs, are available for police vehicles. Power-management systems may significantly reduce (but not eliminate) idling. They allow the vehicle's battery to power auxiliaries in engine-off mode and monitor the battery's state-of-charge. When the battery charge falls below a preset threshold, the system restarts the vehicle's engine to recharge the battery.

Another option is a heat-recovery device, which uses a small pump to circulate coolant from the warmed engine, providing heat to the passenger compartment after the engine has been turned off.

Battery auxiliary power units (APUs) are another option for police vehicles. These units store power when the engine is running and supply it to the vehicle's electrical devices for 4 hours or more when the engine is off.

Police vehicle auxiliaries can be powered by a battery pack that fits in the trunk. *Used with permission of ZeroRPM, Inc.*

Ambulances

Ambulance engines are idled to maintain lighting, communications equipment, computers, refrigeration for medication, and life-support equipment, as well as the vehicle's heating and cooling systems. Idling these diesel engines outside hospital emergency rooms while the drivers complete paperwork and await their next call not only wastes fuel but produces significant air pollution that can exacerbate respiratory or cardiovascular problems in sensitive populations.

On-board battery-powered APUs that can supply power for all needed functions are available for ambulances. Drivers can plug in the APU to charge at the hospital, or the vehicle engine can charge it while the ambulance is being driven. Solar panels can be installed on the roof to provide additional power. Stationary systems can be installed near the emergency room to enable ambulances to plug in for power and receive conditioned air through a window duct.

Ambulance hooked up to a MediDock, which provides power and conditioned air. *Used with permission of American Idle Reduction, LLC.*

Clean Cities
U.S. Department of Energy

VEHICLE TECHNOLOGIES OFFICE

Idling Reduction for Emergency and Other Service Vehicles, U.S. DOE, cont.

Fire Engines and Trucks

Only about 20% of fire dispatch calls are for fires; most are for medical emergencies or accidents. For any call, the vehicle is often idled to provide power for emergency lights and other accessories. Both battery-powered and diesel APUs can reduce fuel use, emissions, and noise for nonfire calls. These APUs, which can be factory-installed or installed as a retrofit, can supply power for all services, except for water pumping, which requires additional power.

Armored Cars

Armored cars make frequent stops for pickups and deliveries. Because the vehicles cannot be left unattended and the windows do not open, drivers generally leave the engine idling at stops to provide climate control. Battery-powered air-conditioning systems are available as an alternative to idling.

Power Sources Available for Stationary Emergency and Other Service Vehicles

Vehicle	Power Source	Services	Fuel Use* gal/h	Typical Equipment Cost ($)	Added Maintenance ($/yr)	Payback (yr)
Police Car	Idling[1]	All	0.5–1.0	0	350	
	Power Management System[1]	Restarts engine if battery low	0.02–0.38	1,200	0	0.2
	Heat Recovery System[2]	Heat	0	700	0	0.1
	Battery APU[3]	Power	0.6	3,300–4,300	0	0.6
Fire Truck/ Engine	Idling[4,5]	All	1.25–1.5	0	600	
	Diesel APU[4,5]	All but pumping	0.25	14,000	200	2.9
Ambulance	Idling[6]	All	1.5	0	1,000+	
	Battery Power Pack[7]	All	0.9	16,000	0	2–8
	Electrified Parking Space[8]**	All	0	0	30	2.5
Armored Car	Idling[9]	All	0.5–1.5	0	200	
	Battery APU[9]	All	0.4	15,000	0	3.8

APU = auxiliary power unit; gal = gallon(s); h = hour(s); IR = idle reduction; yr = year(s).

** Fuel use is lowest for low idle with no accessories on and rises with RPM and load.*

*** Infrastructure cost per space is ~$17,500.*

1. Eric Rask, et al., Argonne National Laboratory, *Final Report: Police Cruiser Fuel Consumption Characterization*, for the Illinois State Toll Highway Authority (February 2013).
2. Mike Trickey, Autotherm, personal communication with L. Gaines (5/6/2014).
3. Bastien Buchaca, Stealth Power, LLC, personal communication with P. Weikersheimer (11/25/2014).
4. GreenStar, *http://www.rosenbaueramerica.com/green_star* (accessed 11/6/2014).
5. Neil Chaney, Rosenbauer America, personal communication with L. Gaines (6/10/2014).
6. Power Pack Aims to Reduce Engine Idling, *American City & County*, October 19, 2012, *http://americancityandcounty.com/fleets-content/power-pack-aims-reduce-engine-idling-related-video* (accessed 1/05/2015).
7. Bastien Buchaca, Stealth Power, LLC, personal communication with L. Gaines (11/20/2014).
8. Medic Aire, LLC, letter to Community Hospital, Munster, Indiana, quote no. 313113 (10/31/2013).
9. Garet Ford, Griffin, Inc., personal communication with L. Gaines (5/15/2014).

U.S. DEPARTMENT OF ENERGY
Energy Efficiency & Renewable Energy

For more information, visit: cleancities.energy.gov

Prepared by Argonne National Laboratory,
a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC.

DOE/CHO-AC02-06CH11357-1501 • May 2015

Appendix IV: Templates for Use in Community Engagement Workshops:

VISIONING THE FUTURE OF THE TOWN OF HARTFORD

September xx, 2016 - 6:00-9:00 pm

Location

Sponsored by the Town of Hartford Energy Commission

6:30 Desserts and Socialize

Enjoy desserts

Socialize with your neighbors

7:00 Welcome and Introductions

Agenda review and purpose of tonight's forum

Breaking the ice -- "Who's here?"

7:15 The Town of Hartford Comprehensive Energy Plan: Purpose and Goals

Who we are and what we are trying to accomplish

Comprehensive Energy Plan: what is involved

Questions, answers, and discussion

7:45 Develop a Vision for The Town of Hartford *(Small groups)*

Develop a vision for The Town of Hartford, with a focus on each villages

Answer the question: "What would you like downtown The Town of Hartford to look and be like in 20 years?"

8:25 Develop a Collective Vision

Based upon the small group work, collectively develop a vision for the community.

Form subcommittees to further pursue priorities that emerged from small group discussions

8:50 Wrap-Up

Opportunities to help strengthen the Town of Hartford

Next steps

9:00 Adjourn

Small Group Discussion Ground Rules

Participant Handout

Please remember to:

Be respectful and courteous. Use good manners.

Speak one at a time. Allow others to talk without interruptions (except the facilitator who may interrupt to keep the conversation on track.)

Don't put down others' contributions.

Focus on the issues, don't personalize the discussions.

It's okay to say "pass" if you're not ready to speak.

It's fine to "piggyback" on someone else's idea – you are collaborating.

Be concise. Try to edit and limit your comments so that all will have a chance to speak.

Check to be sure that the recorder has written your ideas accurately.

INSTRUCTIONS FOR SMALL GROUP SESSION

Taking the Next Steps to Strengthen the Town of Hartford

Objectives of Small Group Session:

Review results of all ongoing activites, with emphasis on proposed Comprehensive Energy Plan activities;

Provide opportunity for participants to offer comments and suggestions on proposed activities; and,

Identify projects and activities that residents and businesses can work on right now to strengthen Hartford.

Time Allocation: 50 minutes

Instructions:

Lead your group from the main room to the small group session rooms.

Introductions: Facilitators introduce themselves, reviews purpose of small group session ; have each group member briefly introduce themselves -- giving their name and something about their relationship to the town. Pass around sign-in sheet with name, email, address, phone number. **(5 minutes)**

Review Action Plan and Comprehensive Energy Plan activities: Subcommittee chairpersons will provide a overview of the work, with an emphasis on proposed activities. Allow time for questions and answers. **(10 minutes)**

Provide opportunity for comments and suggestions: Provide opportunity for participants to share their reactions, suggestions, criticisms, and comments on the proposed list of activities identified in the plans. Record on flipcharts. Consider using one or more of the following questions to stimulate discussion. **(20 minutes)**

Do you have any:

Questions about what the proposed activities are or what they entail?

Thoughts or comments on the proposed list of activities or goals of the plan(s)?

Suggestions or recommendations on how to effectively implement any of the proposed activities or goals of the plan(s)?

Suggestions on additional activities that could be implemented to achieve the goals of the subcommittee?

Concerns about the proposed list of activities or goals of the plan(s)??

Identify projects and activities for action: Summarize results of the discussion. Identify 2-3 specific projects and activities that residents and businesses can work on right now to strengthen the Town of Hartford, or can include in the Comprehensive Energy Plan for future consideration. **(15 minutes)**

Use consensus to the greatest degree possible. Encourage participants to think about projects they should tackle first based upon a number of possible criteria, including among others:

doable - -within their means and wherewithal

effective – toward achieving their goals

highly visible

timely – can be done in the near future,

foundational – need to be done before other projects can be done

To begin the process, ask any of the participants to suggest a specific project that emerged during the previous discussion that they would propose moving ahead with in the near future. Ask them to summarize points from the previous discussion related to the specific project or activity. Ask for comments/reactions from other participants. Strive to reach consensus. If consensus can't be reached, use a simple voting approach where each individual votes for their top two activities or projects. As another alternative, bring back a full list of all activities that the group would like to move forward on.

7) Prepare list and bring back to full group: Re-write the top 2-3 projects and activities on a clean sheet of flipchart paper. Bring sheet and easel back to full group.

THE TOWN OF HARTFORD: PURSUING THE VISION

A Community Summit

September xx, 2016 - 6:00-9:00 pm

Location

Sponsored by the Town of Hartford Energy Commission

Annotated Agenda

Goals:

Provide opportunity for residents and businesses to provide input into the Town Long Comprehensive Energy Plan

Provide opportunity for residents and businesses to provide feedback on proposed activities identified by subcommittees created during community visioning workshop.

Encourage new individuals to get involved in specific projects to strengthen the Town of Hartford.

Provide social time for “community building” and strengthening internal ties in the community.

6:00 Dinner and Socializing

Enjoy dinner with your neighbors

Enjoy local entertainment by area youth

6:45 Youth presentation

7:00 Welcome and Introductions

Introductory remarks

Agenda review and purpose of tonight’s forum

Breaking the ice – "Who's here?"

7:15 Revitalizing The Town of Hartford: Status Report and Future Plans

What is the Energy Commission and what are we trying to accomplish

Comprehensive Energy Plan: status report and timeline

Brief progress report on subcommittee work (short, clearly point out integration of subcommittee work, representative of the each subcommittees)

Notes for presenters:

Recognize people involved in subcommittees

Reference Community Visions developed at community visioning workshop and subcommittees that resulted from the workshop

Reference hand-out materials summarizing the subcommittee reports

Allow time for questions, answers, and discussion

7:30 Taking the Next Steps to Strengthen The Town of Hartford *(Small groups) (Participants break into groups according to interest area; facilitated by individuals with facilitation skills – not chair people of working groups)*

Review results to date of subcommittees with focus on proposed activities; *(Chairs of subcommittees)*

Comments and suggestions on subcommittee working group proposed activities (facilitators).

Identify projects and activities that residents and businesses can work on right now to strengthen the Town of Hartford

8:30 Review Proposed List of Projects and Activities

Review projects and activities identified during small group sessions *(3-5 minutes for each group depending on number of small groups)*

8:55 Wrap-Up

Times, places, and dates for next subcommittee meetings

Reflections on the evening: what worked and what didn't?

9:00 Adjourn

EXAMPLE OF A FLYER USED BY AN ENERGY COMMITTEE:

DOWNTOWN WATERBURY: PURSUING THE VISION

A COMMUNITY SUMMIT

Come hear our ideas and share yours about the revitalization of downtown Waterbury.

Let's work together to pursue our vision of a vibrant downtown.

Tuesday, Sept. 19 • 6 to 9pm
St. Leo's Hall, 109 South Main St.

FREE community supper 6 to 6:45pm. Musical entertainment from area youth.
If you would like to contribute a food item to the supper you are welcome to do so.

MIRACLES HAPPEN
REVITALIZING WATERBURY

Sponsored by
the Waterbury Downtown Partnership (WDP)

Category	Name	Service Address	Average Annual kWh (FY14&FY15)
Building	Bugbee Senior Center	262 N Main - Senior Ctr	4,237
Building	Municipal Building	Municipal Bldg-Bridge St	4,236
Building	Public Safety Complex	Public Safety Bldg-Va Cutoff	14,617
Building	Quechee Fire Station	Willard Rd Quechee Fire Station	126
Building	Waterman Hill Covered Bridge	Waterman Hl Covered Bridge Job	85
Building	West Hartford Library	Rte 14 W Hartford Library	385
Infrastructure	Ice Rink		28,369
Infrastructure	Landfill	Solid Waste Admin Bldg-Landfil	340
Infrastructure	Landfill	Solid Waste Facility-Landfill	4,058
Infrastructure	Maxfield Sports Complex		356
Infrastructure	Maxfield Sports Complex		252
Infrastructure	Maxfield Sports Complex		28
Infrastructure	Parks	Briggs Park-Main S Rec	59
Infrastructure	Parks	Frost Park-A Street	0
Infrastructure	Parks	Lyman Point Park-Rec	1
Infrastructure	Parks	N Main S Christmas Tree	1,315
Infrastructure	Parks	Village Green Balloon Festival	231
Infrastructure	Radio Tower	Radio Tower	1,044
Infrastructure	Streetlights & Trafficlights	Billings Farm Rd Lights-Hwy	284
Infrastructure	Streetlights & Trafficlights	Bridge St Traffic Lgt-Hwy	155
Infrastructure	Streetlights & Trafficlights	Christian St Pole 72-50-Hwy	50
Infrastructure	Streetlights & Trafficlights	Depot St Sidewalk Lgts-Hwy	185
Infrastructure	Streetlights & Trafficlights	Hartford Village Stlgt-Hwy	307
Infrastructure	Streetlights & Trafficlights	Lgts-Rt 5/Highland Ave	292
Infrastructure	Streetlights & Trafficlights	Maple St Traffic Lgt-Hwy	157
Infrastructure	Streetlights & Trafficlights	N Main S Traffic Light-Hwy	114
Infrastructure	Streetlights & Trafficlights	N Main Street Lights-Hwy	169
Infrastructure	Streetlights & Trafficlights	Park/Lehman Bridge Lgts-Hwy	498
Infrastructure	Streetlights & Trafficlights	Pleasantview Terr-Hwy Pole 1	146
Infrastructure	Streetlights & Trafficlights	Rte 5 Pole 95-Hwy	41
Infrastructure	Streetlights & Trafficlights	Woodstock Rd Quechee Salt Shed- Hwy	250
Infrastructure	Streetlights & Trafficlights	Woodstock Rd St Lights-Hwy	133
Infrastructure	Wastewater	78 Murphys Rd Murphy Rd Pump Stn-W/W	762
Infrastructure	Wastewater	A St Pump Station-W/W	136
Infrastructure	Wastewater	Bentley Rd Pump - W/W	361
Infrastructure	Wastewater	Bridge St Pump Station-W/W	688
Infrastructure	Wastewater	Club House Rd Mill Run Pump Station - W/W Sewer Pu	315
Infrastructure	Wastewater	Depot S W/W	7,197
Infrastructure	Wastewater	Dewey Family Rd Jay Hill Rd Pump Stn-W/W	235
Infrastructure	Wastewater	Elm/Gillette S Pump W/W	606

Infrastructure	Wastewater	Ferry Rd-Sewer Pump	883
Infrastructure	Wastewater	Hendee Wa W/W Hendee Way - W/W	55
Infrastructure	Wastewater	High St Main St Pumping Station - W/W	3,042
Infrastructure	Wastewater	Lake Pinneo Wastewater Pump Station	57
Infrastructure	Wastewater	Maple St Sewer Pump-W/W	1,157
Infrastructure	Wastewater	Municipal Bldg Whitman Brook Pump Stn-W/W	1,309
Infrastructure	Wastewater	N Elm Treatment Plnt-W/W	64,982
Infrastructure	Wastewater	Noyes Ln Pump Stn-W/W	159
Infrastructure	Wastewater	Olcott Commerce Park-W/W	637
Infrastructure	Wastewater	Quechee Hartland Rd Quech/Hrtlnd Sec7 Pump Stn-W/W	307
Infrastructure	Wastewater	S Main St Pump Station-W/W	464
Infrastructure	Wastewater	Woodstock Rd Treatment Pl W/W	27,750
Infrastructure	Water	Campbell S Pump Stn-Wtr	365
Infrastructure	Water	Hemlock Ridge Vault-Water	68
Infrastructure	Water	Lake Pinneo Water Well	7,127
Infrastructure	Water	Municipal Bldg Eastman Hill Pump-Water Eastman Hill Pump	1,408
Infrastructure	Water	Noyes Ln Kingswood Resv Pole 19-2 Water	1,429
Infrastructure	Water	Sugar Hill Ln Water Pump	1,263
Infrastructure	Water	Va Cutoff Wtr Stor Tank Alarm	60
Infrastructure	Water	Wheelock Rd Sec 2 - Water	12
Infrastructure	Water	Wilder Well-Water	42,066
Infrastructure	Water	Woodstock Rd Heat Tape For Water Line-Water	0
Infrastructure	Water or WW Pumps	Alden Partridge Rd Pump Station	77
Infrastructure	Water or WW Pumps	Arboretum Ln Sports Pk Pump	522
Infrastructure	Water or WW Pumps	Maxfield Pump Sta	717
Infrastructure	Water or WW Pumps	Rte 5 Pump/Super 8 Lot	0