Hartland, Vermont town building energy use April 30, 2009

The energy use of the town buildings has been entered into the EPA Portfolio Manager program to allow comparison between the buildings, and with similar buildings in the area. This program adjusts for yearly variations in weather, compares energy used on site (oil) to energy generated offsite (electricity) in terms of efficiency and pollution, and adjusts for regional power plant characteristics.

The data used in this report was taken from monthly billing records, except for 3 instances (such as oil delivery for Hartland Elementary School) where a yearly figure was divided by 12.

The baseline period was set to 2007-08, to allow comparison with 2008-09 and the energy upgrades that were done to Damon Hall, the Rec center, and Four Corners Activity Center.

Facility Name	Total Floor Space (Sq. Ft.)
Fire Station #2	1,440
Martin Memorial Library	2,460
Mill Rd. school	2,466
Town Garage	4,200
Fire Station #1	5,543
Library	6,882
Four Corners Activity Center	7,236
Damon Hall	7,378
Recreation center	7,544
Hartland Elementary School	54,000

Facility Name	Current Total Site Energy Use (kBtu)
Mill Rd. school	76,666.04
Fire Station #2	82,904.08
Martin Memorial Library	113,363.85
Town Garage	300,837.72
Library	305,455.68
Fire Station #1	329,109.27
Recreation center	376,115.59
Four Corners Activity Center	438,532.47
Damon Hall	522,169.15
Hartland Elementary School	3,980,302.41

Facility Name	Current Rating (1-100)
Damon Hall	N/A
Fire Station #1	N/A
Fire Station #2	N/A
Four Corners Activity Center	N/A
Library	N/A
Martin Memorial Library	N/A
Mill Rd. school	N/A
Town Garage	N/A
Hartland Elementary School	70
Recreation center	96

The first table lists the buildings by size, note that HES is about 10 times larger than the other buildings physically, it also has about 400 occupants, or 10-60 times more than the others, and that shows up in the energy amounts. (However, a 1% reduction, (which is easier) at HES is worth a 10% reduction (harder) at the other buildings.)

The second table lists total energy use for each building in thousands of Btus per year.

The third table shows that most of the buildings are ineligible for an Energy Star rating, (mostly because of the small size limit), but HES and the Rec Center are above average (which is a rating of 50) for buildings of their category, (this needs to be qualified).

Facility Name	Current Site Energy Intensity (kBtu/Sq. Ft.)
Mill Rd. school	31.1
Library	44.4
Martin Memorial Library	46.1
Recreation center	49.9
Fire Station #2	57.6
Fire Station #1	59.4
Four Corners Activity Center	60.6
Damon Hall	70.8
Town Garage	71.6
Hartland Elementary School	73.7

Facility Name	Current Source Energy Intensity (kBtu/Sq. Ft.)
Mill Rd. school	31.4
Martin Memorial Library	53.1
Recreation center	69.2
Fire Station #1	71.6
Fire Station #2	77.7
Library	84.3
Four Corners Activity Center	86.1
Damon Hall	91.2
Town Garage	92.5
Hartland Elementary School	125.6

Facility Name	Change from Baseline: Adjusted Energy Use (%)
Fire Station #2	-12.1
Damon Hall	-6.8
Library	-2.3
Recreation center	-1.7
Hartland Elementary School	0.4
Four Corners Activity Center	1.7
Martin Memorial Library	4.7
Fire Station #1	11.9
Town Garage	62.3
Mill Rd. school	161.7

For the first two tables; the site energy is the energy used at the site (oil), and the source energy is the energy produced offsite and delivered (electricity). For the source total (second list), the program factors in power plant efficiency and transmission line loss using the physical address of the building. At the bottom of these lists is HES, with many electrical devices (using source energy) in the classrooms. Note that the library amounts are much smaller than HES although they are somewhat similar building uses, this can be attributed to better insulation in the library walls for the site energy, and fewer devices for the source energy. The next larger consumers per square foot are the Town Garage and Damon Hall. The less used buildings have minimal consumption at the top of the lists.

The third table compares this winter (08/09) with the baseline previous winter (07/08), the figures are automatically adjusted for weather differences. After reviewing the data, Fire Station #2 must have had a change in use pattern, which shows up as a 12.1% drop in source (electricity) use. The weatherization improvements show up for Damon Hall (6.8% less energy use) and the Rec Center (1.7% less), but the Four Corners Activity Center had a gain of 1.7%. HES remained neutral despite it's new roof, which for most purposes was a weatherproofing upgrade and not an energy upgrade. (The white color would have helped if the building was air conditioned.) The Town Garage's large increase was from source (electricity) use that showed up on the summer month bills. The Mill Rd school had no energy use listed in the records for 07/08, but some oil was delivered in 08/09, so although the amount was small, it shows up as a huge increase.

Facility Name	Current Direct GHG Emissions ($MtCO_2e$)
Fire Station #2	5.21
Mill Rd. school	6.15
Martin Memorial Library	7.83
Library	13.89
Town Garage	21.23
Fire Station #1	22.18
Recreation center	23.17
Four Corners Activity Center	26.58
Damon Hall	33.83
Hartland Elementary School	205.59

Facility Name	Current Indirect GHG Emissions ($MtCO_2e$)
Mill Rd. school	0.00
Martin Memorial Library	0.86
Fire Station #2	1.51
Fire Station #1	3.43
Town Garage	4.51
Recreation center	7.60
Damon Hall	7.75
Four Corners Activity Center	9.60
Library	14.50
Hartland Elementary School	147.36

Facility Name	Current Total GHG Emissions ($MtCO_2e$)
Mill Rd. school	6.15
Fire Station #2	6.71
Martin Memorial Library	8.69
Fire Station #1	25.61
Town Garage	25.74
Library	28.39
Recreation center	30.77
Four Corners Activity Center	36.18
Damon Hall	41.58
Hartland Elementary School	352.95

The first table “Direct Green House Gas Emissions” is similar to site energy and is a result of oil usage, and the second table “Indirect GHG Emissions” is from the electricity usage, they are in Metric tons of CO2 equivalent. The Green House Gas production is much larger from the furnaces in the buildings than the electrical use, by a factor of 3-6 times. This applies even for HES with many electrical devices. Because of this, an emphasis should be put on efficient heating systems, insulation and repairing air leak problems.

The third table is the total GHG emissions for the buildings, helping to prioritize the buildings. For example, although the Town Garage performs poorly and might be an easier building to upgrade, it is only a medium energy user, following 5 other buildings and should not automatically be given the first efforts.

In general, the buildings at the top of the lists either perform better or use a smaller amount of energy, and thus are not as important for upgrading. The buildings at the bottom of the lists perform worse, or use large amounts of energy, and are more important for working on.

Facility Name	Change from Baseline: GHG Emissions ($MtCO_2e$)
Damon Hall	-4.33
Fire Station #2	-1.29
Recreation center	-0.92
Martin Memorial Library	0.76
Four Corners Activity Center	0.82
Library	1.44
Hartland Elementary School	1.79
Fire Station #1	3.19
Mill Rd. school	3.82
Town Garage	11.62

Facility Name	Annual Energy Cost (US Dollars ($))
Mill Rd. school	$973.09
Fire Station #2	$1,583.29
Martin Memorial Library	$2,135.82
Fire Station #1	$5,938.86
Town Garage	$6,612.79
Recreation center	$7,057.04
Library	$7,984.56
Four Corners Activity Center	$9,989.95
Damon Hall	$10,236.83
Hartland Elementary School	$97,687.22

Facility Name	Total Energy Cost per Sq. Ft. (US Dollars ($))
Mill Rd. school	$0.39
Martin Memorial Library	$0.87
Recreation center	$0.94
Fire Station #1	$1.07
Fire Station #2	$1.10
Library	$1.16
Four Corners Activity Center	$1.38
Damon Hall	$1.39
Town Garage	$1.57
Hartland Elementary School	$1.81

The first table, "Change from baseline: GHG Emissions", again shows the improvements made to Damon Hall and the Rec Center reduced energy use. The Four Corners Activity Center increase is hard to pinpoint, because the amount is small enough to be within weather variations, which I cannot compensate for as Portfolio Manager does. As a rough estimate, it seems to be split between both site and source energy, which would mean that it is a change in usage pattern, perhaps more operating hours.

The last two tables again help to prioritize, especially the cost per square foot figures. Setting aside HES because of it's need for electrical devices in the classroom and the ongoing light fixture improvement, there are three buildings that have consistently been towards the bottom of all the tables: Four Corners Activity Center, Damon Hall, and the Town Garage, in a group at $1.38 to $1.57 per square foot on the last table.

The other large energy user, the Rec Center, has averaged towards the middle and is not quite as important, although it should continue to be improved, because it is a larger account. Also, according to the EPA database it is doing much better than other similar buildings.

Based on the site, source, and GHG tables, heating energy use is the main concern, and electricity (except for HES) a smaller goal. New more efficient heating systems can be compared to the total yearly cost table to estimate the payback period. Unfortunately both Damon Hall and HES have brick walls with relatively little insulation, but the basement at the Four Corners Activity Center could be insulated from the inside more easily. Walkthroughs by committee volunteers should be done on these buildings, and some thought should be given to pressure testing the buildings to find air leaks, considering the difficulty of insulating the two brick buildings.

TABLE 1 2003 CBECS[1] National Average Source Energy Use and Performance Comparisons by Building Type			
Building Use Description[2]	Average Source EUI[3] (Kbtu/Sqft)	Average Percent Electric	Average Site EUI (Kbtu/SqFt)
Education	170	63%	76
K-12 School	*See Target Finder / Portfolio Manager*		
College/University (Campus-level)	280	63%	120
Food Sales	681	86%	225
Grocery Store/Food Market	*See Target Finder / Portfolio Manager*		
Convenience store (with or without Gas Station)	753	90%	241
Food Service	786	59%	351
Restaurant/Cafeteria	612	53%	302
Fast Food	1306	64%	534
Health Care: Inpatient (Specialty Hospitals, Excluding Children's)	468	47%	227
Hospital (Acute Care, Children's)	*See Target Finder / Portfolio Manager*		
Health Care: Long Term Care (Nursing Home, Assisted Living)	255	54%	124
Health Care: Outpatient	183	72%	73
Clinic/Other Outpatient Health	219	76%	84
Medical Office	*See Target Finder / Portfolio Manager*		
Lodging	194	61%	87
Dormitory/Fraternity/Sorority	*See Target Finder / Portfolio Manager*		
Hotel, Motel or inn	*See Target Finder / Portfolio Manager*		
Mall (Strip Mall and Enclosed)	271	71%	107
Office	See Target Finder / Portfolio Manager		
Bank / Financial Institution	*See Target Finder / Portfolio Manager*		
Public Assembly	143	57%	66
Entertainment/Culture	265	63%	95
Library	246	59%	104
Recreation	136	55%	65
Social/Meeting	102	57%	52
Public Order and Safety	189	57%	90
Fire Station/Police Station	157	56%	78
Courthouse	*See Target Finder / Portfolio Manager*		
Service (Vehicle Repair/Service, Postal Service)	150	63%	77
Storage/Shipping/Nonrefrigerated Warehouse	56	56%	25
Self-storage	12	44%	4
Non-Refrigerated Warehouse	*See Target Finder / Portfolio Manager*		
Distribution/Shipping Center	90	61%	44
Refrigerated Warehouse	*See Target Finder / Portfolio Manager*		
Religious Worship	83	52%	46
Retail (Non-mall Stores, Vehicle Dealerships)	191	67%	82
Retail Stores	*See Target Finder / Portfolio Manager*		
Other[4]	213	56%	104

2003 CBECS National Average Source and Site Energy Use and Performance Comparisons by Building Type

Notes:

[1] **Commercial Building Energy Consumption Survey (CBECS)**, conducted in 2003, was used to calculate values presented in this table. The data is gathered from the Dept. of Energy's – Energy Information Administration (EIA). These are building types that are not currently available in EPA's Portfolio Manager or Target Finder tools. Please note all source and site EUI values displayed are annual figures.

[2] **Buildings Use Descriptions** are taken from valid building activities as defined by EIA in the 2003 CBECS data. The average Source EUI and Site EUI are calculated in kBtu/sqft as weighted averages across all buildings of a given type in the 2003 CBECS data set. The building type listed in blue is defined according to the CBECS variable for "Principal Building Activity" (PBA8) which is a broader defined category. The subset of building types listed below those broader categories are defined according to the CBECS variable for PBAPLUS8. These are defined as a more specific building activity within the broader PBA8 category. Note all building type definitions can be found at: http://www.eia.doe.gov/emeu/cbecs/building_types.html

[3] **Source Energy** is a measure that accounts for the energy consumed on site in addition to energy consumed during generation and transmission in supplying energy to the site.
Converting site to source energy:
Source energy value are calculated using a conversion factor for electricity of 1 kBtu site energy = 3.34 kBtu source energy; a conversion factor for natural gas of 1 kBtu site energy = 1.047 kBtu source energy; a conversion factor for district heat of 1 kbtu site energy = 1.40 source energy; and a conversion factor for fuel oil of 1 kbtu site energy = 1.01.

Explanation of Source Energy: The source energy intensity target cannot simply be converted into an equivalent site energy value because different design strategies may yield different fuel mixes. Thus the different fuel mixes translate into the corresponding site to source ratios for a specific building. It is important to note that reducing source energy by 50% is not always mathematically equivalent to reducing site energy by 50%. For the most equitable peer comparison, the associated fuel mix should be used to convert the modeled site energy into the total source energy. The source energy use can then be compared to the values in this table.