The Cold Hard Lessons of Winters Past.

Vermont Heating Seasons: Variability and Vulnerability

Prepared by the Vermont Sustainable Heating Initiative

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Abstract The winter heating season can be predicted within ranges of probability. Simple algorithms can be used to predict the ranges of fluctuations with in a given time period. It is ultimately the responsibility of the home or business owner to determine what level of certainty they want to have in being able to meet their heating needs with in a price target. If they allow short term market trends to determine the price they will pay for fuel, then they will have to pay much more. They can contract for, or purchase and store fuel when it is less expensive and have considerable savings. A failure to understand heating load fluctuations can result in running out of pellet fuel. The data for heating loads in Burlington Vermont is one of the most complete in the United States going back to 1884. This allows for use of mathematical models to help forecast heating needs. The mathematical models will be useful to all who heat in Vermont, and can be adapted for use in other regions. This analysis is being conducted specifically to help plan for the emerging pellet fuel industry in New England.

Definition of Climate and Weather:

Climate is a measure of the average weather patterns in a given region over a long period of time. Climate scientists agree that the Earth's climate is generally warming at the present, and that this trend will continue. The greatest warming is occurring at the highest northern latitudes.

Weather is the current state of the atmosphere in a given location at a given time.

Between climate and weather in temporal duration, there are fluctuations in a regions weather pattern that can be linked statistically to physical causes. Such variations can last from a few weeks to a few years in duration. The longer term drivers for these fluctuations include the following.

Short term changes in the sun's physical activity
The sun's energy output fluctuates with an average period of eleven years. When there are sun spot maxima, there are colder than average winters in New England. When there are sun spot minima the winters are generally milder. These trends last generally for one to two years. The physics of this is not well understood but the correlation is well established. The year 1917 was the coldest winter between (1884 and 2014) in Burlington and also had the most sun spots between (1881 and 1937). Other locations HDD maxima correlate with sun spot maxima.

For a more detailed statistical analysis of temperature and snow fall related to sun spot maxima in Boston, go to http://www.solarstorms.org/Boston.html and http://www.solarstorms.org/SClimate.html

Long term changes in the sun's physical activity.
Long term changes in solar activity that can last approximately a century. Only one such cycle has been recorded by scientist since sun spot data has been recorded. This period is known as the Maunder Minimum, or little ice age. The Maunder Minimum, also known as the "prolonged sunspot minimum," is the name used for the period starting in about 1645 and continuing to about 1715 when sunspots became exceedingly rare, as noted by solar observers of the time. The physics of this is not well understood but the correlation is well established.

Large Volcanic Events
Large volcanic events can alter the Earth's atmosphere for from one to many years. Particulate matter, aerosols and sulfur dioxide in the stratosphere tend to cool the Earth's surface. Such recent weather events include the following eruptions. The 1991 eruption of Mt. Pinatubo caused global cooling that lasted three years. The 1883 eruption of Krakatoa caused global cooling for four years. The 1815 eruption of Mt. Tambora caused mid-summer frosts and snows in Vermont in 1816, also known as "the tear without a summer." Such volcanic cooling events cannot be predicted at this time but have occurred regularly for all of recorded history.

Changes in Ocean Surface Temperature
Changes in the ocean's surface temperature in the Pacific and Atlantic that last from one to several years and can cause cooling or warming trends in North America.

Phase change in yearly HDD cycle
Changes can also occur in when in the yearly cycle the greatest cold or HDD occur. Recently in both the Eastern parts of North America and Asia the late spring has been unusually cold and wet. The March of 2014 weather data for New England show this trend. Similarly the 1884 through 1891 in Vermont there was period of unusually warm falls. The December average for this period was less than 7% of the 130 year average HDD for December. What drives these cycles of warm or cold falls and springs is not clearly understood, but may be linked to changes in the Arctic, Atlantic and Pacific oceans.

Even though the general trend is towards warmer winters, it would be foolish to assume that fluctuations will not occur and to plan for statistically colder winters.

“Fifty degrees below zero meant eighty-odd degrees of frost. Such fact impressed him as being cold and uncomfortable, and that was all. It did not lead him to meditate upon his frailty as a creature of temperature, and upon man's frailty in general, able only to live within certain narrow limits of heat and cold; and from there on it did not lead him to the conjectural field of immortality and man's place in the universe.”
Jack London, “To Build a Fire”

The heating season of 2013 - 2014 was a hard one for many Vermonters. The winter was one of the colder ones in the last ten years, and had what felt like a very cold March. Vermont ran out of wood pellets in February and March. Even suppliers such as Home Depot rationed them, and finally just had no more for sale. To make matters worse LP gas prices spiked. How does Vermont plan for heating seasons to come based on weather data? Was the winter of 2013 - 2014 really that cold?

Burlington Vermont has good heating degree data going back to 1884 with complete data going back to 1891. Other parts of Vermont are warmer or colder, but we can use the Burlington data to look at variations from year to year and trends. Other towns in Vermont can use the Burlington data and adjust for warmer or colder variations.

Calculations in this report are made using data from NOAA and the National Weather Service, Monthly Total Heating Degree Days for Burlington Vt.
Available at http://www.weather.gov/btv/climo_hdd

Similar data is available for Hanover New Hampshire going back to 1894. This data is at http://www.wrcc.dri.edu/cgi-bin/cliMONthdd.pl?nh3850 This data is used to compare heating needs in Burlington with Hanover, and show some range with in the state of Vermont. (Hanover is adjacent to the Vermont New Hampshire boarder.

What is a heating degree day? Every day that you need to heat your building to 65F. If the outside air temperature is 64F, this is one heating degree day. If the temperature outside is 55F, or ten degrees colder for one day then that is ten degree days. All of the heating degree days for each month are added up to calculate the heating needs for a year. Generally, it one season has 20% more HDD, then a building will need 20% more fuel to keep it at 65F. If the inside thermometer is set higher or lower than 65, then that will also change the amount of heat needed. Standard calculations are done based on keeping the inside of a building at 65F.

Yearly fluctuations in heating needs, 1892 and 2014 examples.

When I was a teenager growing up in Craftsbury, Vermont, the old timers liked to always be at least one winter ahead in fire wood. Come September, they liked to have twice the cord wood stacked and split that they thought they might need the next winter.

Why did they do this? They figured it was better than having money in the bank. If someone got sick, broke an arm and could not cut and split wood, they were ready. Also, they knew that old mother nature was fickle. You might get a real cold and snowy March. The old houses went through 10-12 cords of wood. Some of the rooms stayed below freezing most of the winter. But at least the kitchen was warm and cozy. Their Grandparents had lived through the winter on 1892. They did not mention that year in my childhood, but the cultural memory was alive in the community.

Heating in 1892.
Those who were not ready, froze. Those who heated with coal, had to get more coal from the mines down south. Those who heated with wood, and had not laid in a two year supply, probably spent much of January, February and March scrounging for standing dead wood to haul back home on horse drawn sleds. What happened in 1892? It was actually an average winter that followed several years of very warm winters. People got used to burning less wood to stay warm. Then they suffered the consequences of shortsightedness. (See data below on 1892.)

Heating in 2013
How has this changed today? Some Vermonters stocked up on wood pellets when the price was low 2013 summer. If they had burned four tons in 2012, year before, they figured four tons would get them through, but they were wrong. 2012 was the warmest winter in 123 years. The next heating season was 24% colder than the previous yearly HDD. When they went to purchase that fifth ton, it was not there.

Let's take a look at why Vermont ran out of pellets. Stores do not want to stock what they are not going to sell quickly. Pellet manufactures do not want inventory in storage. So the Vermont distributers stocked what they had sold the previous year. Home owners stocked what they thought they needed. There was no regional back up in supply.

Small stores based their inventory on what had sold the year before. But what about stores like Home Depot? Home Depot is not a small store. Home Depot in Williston ran out in February, but then were able to restock. The next week they started limiting the amount of pellets customers could purchase. Some customers became hostile and threatened violence. Finally Home Depot ran out. When Home Depot runs out of pellets it is a regional distribution run out.

This spring there were pellets in the Eastern US, but they were under contract to large consumers, and to be exported to Europe.

Most wood pellets made in the US are, or are soon to be under contracted to be shipped overseas. There are huge pellet factories being built in southern states. 400,000 ton a year projects with rail heads to ship pellets to Germany where they will be burned to generate electricity. Regardless of what you think of this use of wood, it means that the United States Pellet market is connected to the global pellet market.

Pellets go to where the money is. Long term contracts are signed to direct the shipment of pellets.

Supply chain issues. Pellets have a lower energy density than most other globally traded fuels. This means that they need to be shipped by very energy efficient means. Large freight ships or modern rail are the only economically viable ways to move pellets large distances. Even if pellets could be purchased on the global market, the time and logistical challenges of rail freight mean they could not be delivered to Vermont in a timely fashion.

What does this mean for Vermont? We need to manufacture pellets here for local use to ensure a reliable and affordable supply. Regional and National weather trends overwhelmed the Vermont pellet market. If pellets are to become a more significant part of the local heating economy, a localized solution is essential.

Unless pellet manufacture is local, and controlled by the local community, it will feed into the regional or global supply chain. This means that in cold years Vermonters will go without.

Vermont's forest resources should be used for the benefit of Vermont's heating needs first. So how do we ensure that not only each building that is heated with pellets has an adequate supply, but that the state as a whole has an adequate supply?

How to ensure Vermont has the fuel to heat its buildings?

"Though you live near a forest, do not waste firewood." - Chinese Proverb

Let's take a look at some of the data and compare some heating seasons with the one hundred and thirty year average.

Heating Season Data for Burlington Vermont

Heating season	HDD	Deviation from 130 year average
2012 Warmest winter since 1891	6155	17.0% warmer than average
winter of 2013-14	7628	2.9% colder than average
Average (2004 to 2013) Worst year in this period 2004	7052 7768	4.9% warmer 4.8% colder

Heating season	HDD	Deviation from 130 year average
Average (1994 to 2003) Worst year in this period 2003	7295 7798	1.6% warmer 5.2% colder
Average (1884 to 2013)	7410	~
Max. year 1917 Coldest year	8941	21% colder
Min. year 1890 Warmest year	2763	63% warmer

Notice the general variation in the HDD in relation to the 130 year average above.

General warming trend over recent decades

If we look at the ten year average for the last 60 years we see a general warming trend. The averages are calculated backwards from 2013. This is the most recent full year that Burlington has full data for.

Decade	HDD Decade Average	Deviation from 130 year average
1954 to 1963	8009	8.1% colder
1964 to 1973	8210	10.8% colder
1974 to 1983	7735	4.4% colder
1984 to 1993	7517	1.4% colder
1994 to 2003	7295	1.6% warmer
2004 to 2013	7052	4.9% warmer

HDD Ten year averages from 1954 to 2013 as % deviation from 130 year average.

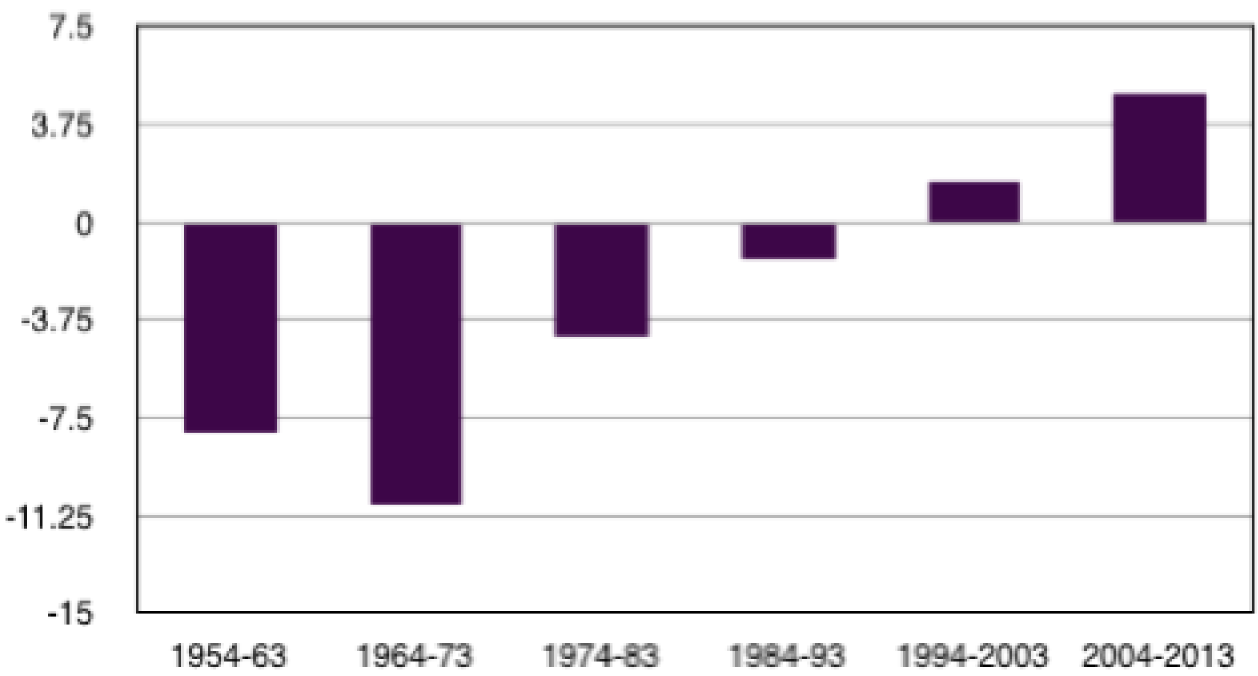
The above chart clearly shows the warming trend for the last 60 years. The trend in the HDD load is warming by about 3% per decade.

Warm Period Fluctuations

There have been some real warm spells like the one from 1889 to 1891. Followed by a more normal winter in 1892.

YEAR	HDD	Deviation from 130 year average
1889	3970	- 56.4% warmer
1890	2763*	- 62.7% warmer
1891	4076	- 45.0% warmer
1892	7429	+ .3% colder

* Some data is missing from the record for April through October in 1890. However the heating load that year was probably not much greater than the 2763 HDD recorded.



If you were heating with cord wood, and had a two year supply split and stacked, then 1892 was not a hard ship for you. If you were basing your heating needs on the average of the last three years, or even the average of the previous decade, and were only preparing for a 4000 HDD heating need, then you froze in 1892.

Cold Period Fluctuations
There have been some real cold snaps like the one from 1958 to 1963.

YEAR	HDD	Deviation from 130 year average
1957	7422	.2% colder
1958	8193	10.5% colder
1959	7814	5.5% colder
1960	7828	5.6%colder
1961	8307	12.1% colder
1962	8530	15.1% colder
1963	8651	16.7% colder
1964	7888	6.5% colder
Average since 1884	7410	~

The period from 1954 to 1957 indicates that any surplus from one year, will not be helpful over such a cold period lasting years. The pellet industry and the consumer will need to plan for such events.

Reliability of distribution and supply by fuel type.

"Chop your own wood. It will warm you twice."
Henry Ford

	Local	Regional	Global
Fuel Oil	Very limited state storage. Efficient local delivery infrastructure in place. No local refineries or wells	Regional Storage Reserve in Conn and New Jersey. Two Week Supply for New England. No regional wells. Prices spike during regional shortages	US Heavily dependent on foreign supply. Historic embargoes and price fluctuations.
LP Gas	Limited State Storage. Efficient local delivery infrastructure in place. No local refineries or wells.	Recent price surge due to large agricultural demand and limited supply. No regional wells.	Global Market from LPGN tankers.
Natural Gas	Availability limited to Chittenden and adjacent Counties. No local wells.	Current stable supply. Historic shortages and price spikes during cold snaps. Distribution limited to pipe line locations except for large customers use.	Global Market LGN tankers and pipe lines deliver to global markets. Russia is using delivery to Europe as threat.
Cord Wood	Vermont has local supply. If you have access to a wood lot, the most reliable of any fuel.	Some New England States have limited supply. Regional shortages during oil embargos. Regional bans on shipment due to invasive species threats.	There is a global fire wood shortage for cooking and heating. Limited international trade.

	Local	Regional	Global
Wood Chips	Minimal processing required. Local sourcing with plentiful supply. Very reliable and stable price.	Regional market is established but delivery of more than 40 miles becomes expensive because chips are ~50% water by weight.	There is no global market as shipping wood chips is to expensive.
Wood Pellets	Only small scale pellet production in Vermont currently. Small Scale decentralized production in Vermont will minimize transportation distances and ensure local supply Production can be established to have very high price stability and reliability. Pellet stoves can be run on battery power during blackouts.	Regional market is being established. Main, New York, New Hampshire, and Massachusetts all have large scale pellet manufacturing facilities in operation. The market is driven by supply and demand. The large operations sell to the highest bidder. During periods of shortages, small consumers have to go without. Regional shortages cause price fluctuations.	Global market is established and growing. Most wood pellets to be produced in the United States in the next decade will be sold to Europe. Global shortage of feed stock to make pellets.
Electric Heat Pump	Can be very cost effective down to 30F. Efficiency decreases below that temperature. At -10F becomes resistance heater.	Potential for regional electricity brownouts or blackouts during periods of peak demand in cold winters.	No global electric grid.

The most reliable heating fuel for Vermont is one that can be produced and stored locally in the state.

Local HDD versus regional HDD

By comparing the HDD records from Burlington Vermont and Hanover New Hampshire several patterns emerge in relation to state wide regional variations in HDD needs.

Max HDD in Hanover   The coldest year on record is 1904

Hanover New Hampshire	1904	9128 HDD
Same year in Burlington Vt.	1904	8119 HDD

9128 / 7771 = 17.5% over 130 year average in Hanover
8119 / 7410 = 9.6% over 130 year average in Burlington

Max HDD in Burlington Vt. The coldest year on record is 1917

Burlington Vt.	1917	8941 HDD
Hanover NH.	1917	8970 HDD

8941 / 7410 = 20.7% over 130 year average in Burlington
8970 / 7771 = 15.4% over 130 year average in Hanover

Conclusion for annual regional HDD variations.

Really cold winters tend to impact the entire region. Thus a cold winter in Burlington Vermont is also going to be a cold winter in the rest of the state, and region. 1904 was a more significantly deviation for Hanover than it was for Burlington. Similarly 1917 was a much colder than normal winter for Burlington than it was for Hanover. However, this does not mean that regional differences can make up for local pellet shortages in cold winters. Bulk pellets can be shipped thousands of miles by rail and still be cost competitive. However trucking pellets more than 80 to 100 miles is generally cost prohibitive. These factors mean that if Vermont has a pellet shortage, the region will also be experiencing a pellet shortage with no surplus available for Vermont. If there are pellets available in North America during local shortages, there are very limited transportation options that make economic sense.

Thus the best option for Vermonters is to have a contingency reserve available going into the heating season. (See calculations below)

Calculation of average Ten year consumption from yearly data.

This calculation can be for wood pellets or any heating fuel. If you know the consumption in any year, you can calculate the ten, twenty or thirty year average using the following method.

Consumption in year (Z) x (HDD average for period / HDD in year (Z)) = calculated average consumption for average period.

You know that you used 550 gallons of fuel oil in all of 2012, and that in 2012 you had a HDD of 6155. HDD data available at http://www.weather.gov/btv/climo_hdd
The ten year average from 2002 through 2013 is 7052 HDD.
For the ten year calculation, 550 gal x (7052 HDD / 6155 HDD) = 630 gal.

This is a good estimate of what you would have used during the last ten years as a yearly average, even if you only know one year's data.

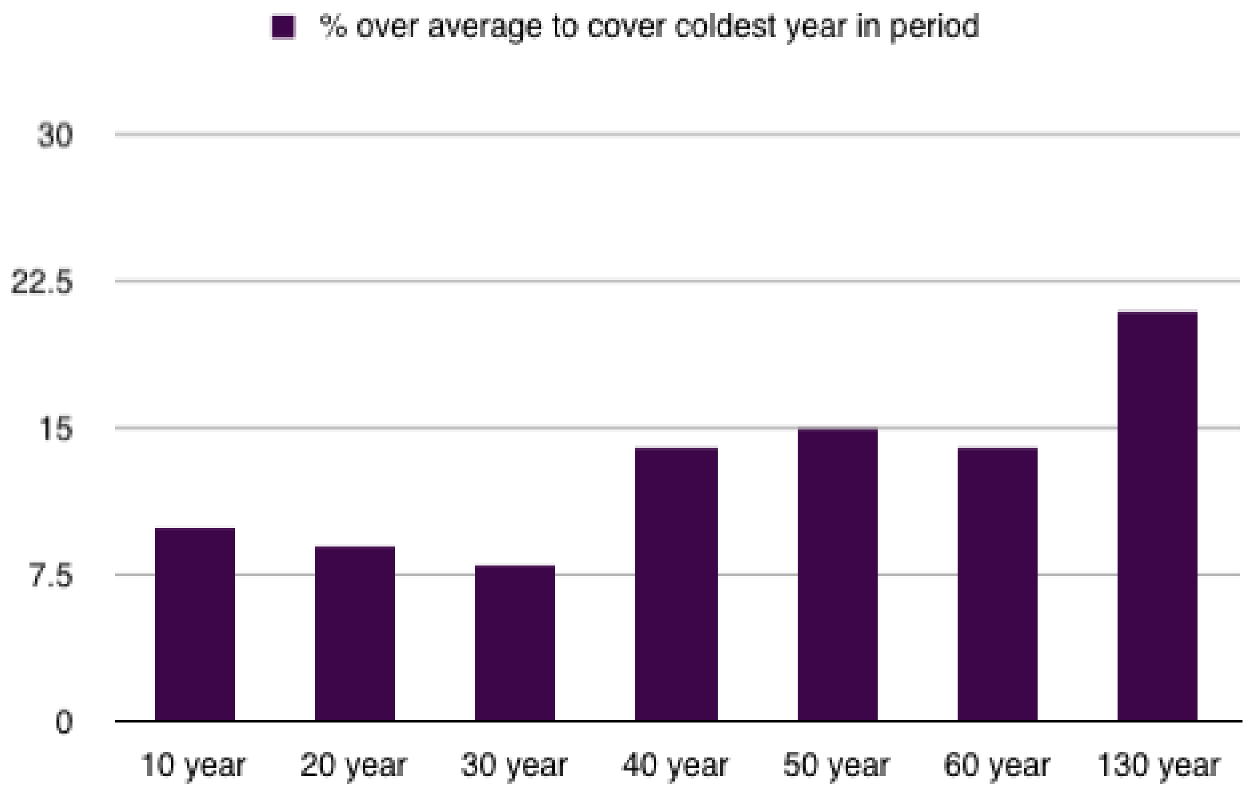
If you want to plan ahead, and be ready for a once in a ten year winter, have a 10% surplus available.

For ten year coldest event preparedness, take the 630 gallons and multiply by 1.10
630 gal x 1.10 = 693 gal This will probably get you through each winter in the next ten years with out going short in supply.

Note that the average HDD can be calculated over the the previous 10, 20 or more years. A more conservative approach is to use a longer time period average HDD in calculating worst case winters.

Annual Maximum heating needs in relation to "decade" averages

Time period before 2014	average HDD in that period	Multiplier of period average to include extreme maximum in period.
10 year **	7052	x 1.10 Worst year 2004 7768 HDD
20 year	7175	x 1.09 Worst year 1993 7818HDD
30 year	7288	x 1.08 Worst year 1989 7872 HDD



Time period before 2014	average HDD in that period	Multiplier of period average to include extreme maximum in period.
40 year	7400	x 1.14 Worst year 1978 8459 HDD
50 year	7562	x 1.15 Worst year 1968 8667 HDD
60 year	7636	x 1.14 Worst year 1968 8667 HDD
130 year	7410	x 1.21 Worst year 1917 8941 HDD

**The data used is calculated for yearly totals, not heating seasons. The 2014 heating year is not yet completed, so the data is calculated from the years 2004 through 2013, 1994 through 2013, etc.

From the above chart several trends can be seen. Decade by decade the HDD average is declining as Vermont gets warmer. The HDD load is decreasing on average 117 HDD each decade. If this continues the average ten years from now will be 6935 HDD. The multiplier to go from the average HDD to the extreme in that period goes from a high of 1.21 for the 130 year period to 1.1 for the last ten year period. Thus the percentage fluctuations of the HDD extremes are becoming less with each passing decade. The multiplier has been holding at about 1.1 for the last 30 years.

How should you prepare?

Should you plan to have available heating fuel for an average year, the coldest winter in the last 10 years, the coldest winter in the last 20 years, or the coldest winter on record?

If buildings in Vermont such as schools, offices, courts, and homes are to be heated using wood pellets as the primary fuel, what are the consequences of running out of fuel in the middle of winter? What are the consequences of running out of any fuel in winter? Or even in late March or April? The goal should not be to create a local pellet industry that can heat Vermont on the average winter, but an industry that will have 100% ability to deliver fuel when Vermonters need it. Thus we need to plan for those 100 year events.

Warm Year Heating Year Minimums

Annual minimum heating needs in relation to "decade" averages

Time period before 2014	average HDD in that period	Multiplier of period average to include extreme maximum in period.
10 year **	7052	x .873 Warmest year 2012 6155 HDD
20 year	7175	x .858 Warmest year 2012 6155 HDD
30 year	7288	x .845 Warmest year 2012 6155 HDD
40 year	7400	x .832 Warmest year 2012 6155 HDD
50 year	7562	x .814 Warmest year 2012 6155HDD
60 year	7636	x .806 Warmest year 2012 6155 HDD

Time period before 2014	average HDD in that period	Multiplier of period average to include extreme maximum in period.
130 year	7410	x .373 Warmest year 1890 2763? HDD

**The data used is calculated for yearly totals, not heating seasons. The 2014 heating year is not yet completed, so the data is calculated from the years 2004 through 2013, 1994 through 2013, etc.

What this means for the Vermont Heating industry.

The trend over the last 100 years has been towards warmer winters. Thus the warmest year in the last 60 years was in 2012. However the warmest year in the last 130 years was in 1890. If the pellet industry plans for a year's production at 110 % of the decade average to ensure a supply for customers if there is a cold winter, but the heating load that year is similar to the warmest in the last decade at 87.3% of the decade average, then the industry will have a surplus. The surplus of the difference, 110% - 87.3% = 22.7% of decade average yearly production. This amount of surplus can bankrupt a for profit corporation. Such surpluses will be regional, which means the short term whole sale market price of pellets will likely drop to below production costs.

Using the 60 year data, a HDD of 80.6% of average and a production of 114% to be ready for a cold winter could result in 33.4% surplus production.

Monthly and Quarterly adjustments to local pellet production.

A locally run pellet mill can keep track of HDD loads and know the inventory not only in its facility, but also in its customers storage. This will allow a pellet manufacture to adjust production upwards or downwards so that a large surplus does not occur. Production rates can be easily lowered, however it is much more difficult to adjust production upwards. (See appendix A)

Consumption occurs seasonally with the mean total HDD of 4959 occurring in the coldest 4 months from December through March out of a 130 year mean of 7410 HDD. Thus 66.9% of the demand occurs in only 33.3% of the year.

Because production is proportional to time this means that short term corrections to meet changes in demand are very difficult to accomplish.

The coldest three months are usually December through February with a total of 3882 HDD out of mean of 7410 HDD. Thus 52.4% of the demand occurs in only 25% of the year.

The coldest two months are usually January and February with a total 130 year mean of 2694 HDD. Thus 36.4% of the demand occurs in only 16.7% of the year.

Production capacity for a facility if set at the number of tons that can be produced in an hour. If a facility is planned to only operate two shifts, they can add an extra shift and go to three shifts a day increasing operation by 50%. An alternative is to go from 5 to 6 days a week operation, or from 6 to 7 day a week, or 5 to 7 days a week operation.

operation schedule change	2 to 3 shifts a day	5 to 6 days a week	6 to 7 days a week	5 to 7 days a week
Production change	50% increase	20% increase	16.7 % increase	40% increase
% of yearly total production	4.15%	1.66%	1.39%	3.3% increase

Running a facility for one month at an increased production rate will only increase the yearly production for 8.3 % of the year. Thus even the most drastic increase of 40% for one month will only increase the yearly total by 8.3% of 40% or 3.3% of yearly production.

A production facility to be economically feasible should probably be operating on a 6 day a week schedule with three shifts of production. Thus the amount of reserve production capacity is only 16.7% by transitioning from a 6 to a 7 days a week operation schedule. The ability to expand operations on very short notice is going to be dependent on having the trained employees available to take on the extra shifts.

The Hanover data indicates that the standard deviation for January is 151.84 HDD with a maximum deviation of 331 HDD. As a percentage of yearly mean of 7772 HDD, this is 2% and 4.3% Thus in a worst case scenario a facility operating at full capacity and increasing production by 3.3 % of the yearly total could not make up the difference in demand from an average January to the works recorded January.

Variability of Monthly HDD for Hanover New Hampshire

Month	December	January	February	March
Mean HDD	1297 HDD	1442 HDD	1256	1050 HDD
Standard deviation	145 HDD	152 HDD	125 HDD	130 HDD
Maximum Deviation from Mean HDD	1786 HDD 489 HDD	1772 HDD 330 HDD	1594 HDD 338 HDD	1296 HDD 246 HDD

Month	December	January	February	March
Max deviation as % of yearly average	6.3%	4.2%	4.3%	3.2%

7772 HDD is yearly average for Hanover

Conclusions from Variability of monthly HDD data from Hanover

December on average is not the coldest month, however it has had the record greatest HHD demand and also has the highest HDD deviation over the monthly mean.
Given that most business plans will not have over two or three percent of yearly production capacity available in any month, the expectation that the facility can make up production needs during a very cold December and January which can combined exceed 10.% of the average HDD is unrealistic.

A better pellet business model could include the following practices:

Give prices based on customers taking delivery of 1/4 of yearly pellets needs each quarter of the year. If pellets must be stored at the production facility, a small storage fee will be added.

Have customers contract for their needs based on at least 110% of the thirty year average.

Those who wish, may increase their ton capacity over the 110% of the thirty year average as a form of insurance.

Conclusion for Vermont Pellet fuel industry

Given HDD variability

The home owner who has storage space in a garage or silo, should purchase pellets when the price is lowest in the early summer and start the heating season with 110% of the thirty year average annual consumption at the home. This will statistically mean they should not run out of pellets when a thirty year event occurs. The pellets should be consumed on a first in, first used basis. Pellets properly stored should last two years.

Large consumers

Consumers such as schools or commercial buildings may not want to store 110% of the ten year average on site. If this is the case a pellet facility needs to charge a fee for storage and availability guarantee. The consequences of a fuel shortage for a commercial building or school are significant. Thus businesses should consider what their level of risk is. Should they use the ten, twenty, thirty, fifty, sixty or hundred year HDD average. Remember that the year 1917 was 21 % colder than the 130 year average. Just because the last 50 years have had a steady warming trend, does not mean that occasional statistical cold winters will not occur in the near future.

Multiple fuel options.
If you are a home owner, you may wish to have a wood stove as a backup. If all else fails, you can keep part of your house warm and cozy.

For large scale consumers of pellets, electric heat is very low cost to install, but very expensive to operate. Similarly an oil system can be added to a pellet boiler at minimal cost. A facility may with to only contract for !00% of the ten year average, and in the event of a really cold winter, use electric heat or fuel oil to get through the last part of the heating season. This may make cost effective sense, but has a degree of risk. Will the oil be available in the event of a regional shortage?

A for profit pellet business cannot produce and store 110% of the ten year average and expect to compete with other businesses that produce and store only 80% of the ten year average that they know they can sell.

Vermont is at the end of the supply chain for all heating fuels except for wood based chips, pellets and cord wood. The New England heating fuel emergency storage is hundreds of miles away, and only stocks a ten day supply if a crisis occurs in January. If a disruption occurs to the single natural gas pipe line from Canada, Vermont could be without gas for quite a while.

We have the ability to heat Vermont with locally sources fire wood, wood chips and wood pellets. The pellet industry can be established to ensure that the wood pellets are available when the customer needs them. The decision to have what degree of fuel reliability needs to be made by the consumer who is aware of the costs associated with that decision. For a consumer co-op member, the cost is a onetime $200 per ton production capacity, and some increased storage costs. For the typical home that burns three to five tons of pellets in an average year, contracting for an extra 10% capacity at $200 per ton is a cost effective form of insurance.