

Assessment of Vermont Sheep Wool Insulation product

Suzy Hodgson and Kimberly Hagen



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Summary

The potential success of a new sheep wool insulation product in Vermont depends on a number of factors aligning:

Wool Supply: In order to sustain a sufficient wool supply for a wool insulation product in Vermont, substantial amounts of wool would need to be sourced from New York State. Existing wool pools coordinated by the respective sheep trade associations in New York State and Vermont could provide the initial volumes required to develop a Vermont branded product.

Wool Insulation demand: Product awareness is low and wool insulation product attributes and performance lack documentation so estimating potential demand is difficult. Architect and builder interest in the future potential of a “natural” and “high performing” insulation product in Vermont is relatively high.

Costs & Timing: Start-up and launch of a blown-wool insulation product using existing wool processing facilities in Vermont and New York would take at least seven years to break even, assuming R & D funds and working capital is available for the first seven years of management and operation. (See projections on page 7)

“Natural” Residential Insulation Demand – Demand for insulation and “natural” insulation products is estimated to be growing upwards of 7% per annum in the USA. However, the marketplace is crowded with many insulation products competing for attention so product positioning and pricing for sheep wool insulation with expert opinion formers is particularly important.

Measurable Product Attributes – While the “natural”, “local” “environmental” and intrinsic material properties of a wool insulation product are attractive to potential clients, more empirical data is needed on performance (R-value at specific densities in wall assemblies, hygroscopic properties in comparison to cellulose) to build confidence in a new product.

Project Aims

This report investigates the potential of using local sheep wool to develop a building insulation product. The potential for developing and marketing a sheep wool insulation product in Vermont and the surrounding region is assessed including economic, market, technical, and management aspects of product development in terms of the potential market and viability for Vermont sheep farmers. This first phase of the investigation is a preliminary feasibility assessment, which includes identifying, researching and evaluating:

- Raw materials, primarily the readily available supply of sheep wool,
- Potential for a regional supply network to provide suitable raw material,
- Current best practice methods for processing
- Market assessment
- Product requirements, attributes, and energy efficiency properties
- Potential market and marketing to end users including builders, DIY, Energy Efficiency technical advisors

This project has the potential to identify and potentially derive value from otherwise wasted sheep wool, by converting it to a useful building insulation material. Realizing the potential value from low-grade sheep wool could improve the economic profitability of small sheep farmers in Vermont and improve the viability of sheep farming in the region.

Methods

Phone interviews were conducted with shearers, sheep farm wool pool coordinators, wool processing facilities, green builders and architects. The literature search included Irish and UK websites and e-mail contact with manufacturers about product specifications, performance, and market demand. The range of interviews reflected the supply chain and its stakeholders from sheep farmers to shearers to wool processors to product development/distribution companies to builders and architects as the end customers. The aim of the phone interviews was to gather comparable product and market information in order to assess the feasibility of developing Vermont wool insulation and to map out a scenario. The scenario projections are based on current costs and potential sales estimates derived from market research on natural insulation trends

Background

Over the past five years, the available supply of wool appears to be increasing as the trend for having small herds of sheep grows in Vermont and surrounding states.¹ However, the market for mixed sheep wool is limited. While some purebreds can command reasonable wool prices, most sheep fleeces have limited uses and low or no value. The end result is that this raw commodity is often wasted, left in storage reaching a point where it is merely used as mulch or disposed as waste. Current estimates are that at least 50% of sheared sheep wool is likely wasted.²

History

Sheep wool has been recognized for its unique insulation properties since the first “sweater” was knitted in the British Isles in 15th century. Throughout the 19th century, sheep wool was a primary product for clothing and sometimes used as insulation material both in UK and USA. Over the past 15 years, there has been a revival in the use of “natural” materials for residential building materials recognized as renewable, naturally-grown fibers such as straw, hemp, cotton³, wool, hemp, flax, cork, or wood. Unlike petroleum-derived non-renewable plastic foams, these “natural” insulation products are based on renewable raw materials with low carbon footprints.

The increasing awareness of climate change and its severity, as well as other environmental issues such as resource depletion and health are factors in builders, architects, and homeowners’ decisions to choose “natural” materials. A number of DIY homeowners and builders have used such materials in their own homes in recent years.

¹ USDA Census data 2007 & 2012

² Conversations with New York state wool pool coordinator and UVM livestock specialist

³ Example of green supplier for recycled cotton denim insulation <http://www.greendepot.com/greendepot/>. This denim bat product for R21 is \$1/sq ft compared to estimated \$0.50/sq ft for blown in wool.

Market

US demand for insulation is projected to rise 7.6% annually to \$10.3 billion in 2017 of which about half is attributed to the residential market.⁴ The recent revival of the housing sector⁵ and the record number of housing starts in 2014 will trigger growth in the insulation market. In addition, the retrofit residential market and higher state insulation standards will be an impetus to more significant growth in the next decade.

The insulation market is dominated by fiberglass closely followed by plastic foams, together these product categories comprise about 93% of the insulation market value with multi-nationals such as Owens Corning with extensive R & D and building material distribution channels controlling this market place. These companies and their products have high brand recognition, high economies of scale, low prices, as well as deep business experience and market capitalization to develop new products.

Cellulose insulation is estimated to make up less than 10% of the marketplace but is forecast to see a faster growth rate (about 15% per year), than the overall insulation market so its market share will increase. While the other “natural” fibers market is a very small percentage of the insulation market, it is growing at a rate at least equal if not more than the overall insulation market.⁶ If it grew to 0.5% of the residential insulation market share, the size of the “natural” fibers insulation could be \$25.75 million. However, sheep wool insulation is only one product type among a large variety of competing “green” products, which have a natural fiber component (e.g., cellulose insulation, cotton fiber, recycled fibers, hemp). Moreover, wool insulation product awareness is low, empirical data on product performance is thin, and marketing channels are less developed. Only two small companies have a presence in the USA, Oregon Shepherd and Black Mountain, which rely solely on digital media for their sales.

Insulation costs as part of building costs

While sheep wool insulation is more costly to produce, some conversations with green builders indicate a willingness to pay a premium of 30% to 50% for a “natural” product such as sheep wool insulation. With premium insulation products increasing the cost of insulation by at least one third, on average, this would be about \$1140 for a residential house, which amounts to only 1/3% increase in overall sales price for the home.⁷ Other conversations point to the already significant costs for insulating higher performance homes and any increase in costs for

⁴ Insulation - Industry Market Research, Market Share, Market Size, Sales, Demand Forecast, Market Leaders, Company Profiles, Industry Trends, 11/2013

⁵ Residential insulation accounted for approximately half of the total U.S. insulation market in terms of volume for the year 2011.

⁶ One Northeast distributor is experiencing 20% per annum growth in natural insulation.

⁷ National Association of Home Builders

environmentally acceptable insulation choices such as cellulose could be difficult to justify. In these cases, in order to choose sheep wool over cellulose insulation, the client would need to be “passionate about the product.”

Builders and architects have indicated that priorities across residential clients do vary; some times recommendations for quality building materials which are “less visible” such as “natural” insulation can be a line item cost which clients cut as compared to more visible costs such as finishings, counters, and cabinets; other times, clients are committed to high performance homes and will wait on finishings, which can always be added more easily at a later date unlike deep wall assemblies.

Sheep wool insulation is one of many “natural” products in a crowded marketplace and at a higher price point of at least 30% more than cellulose insulation, its market potential is likely to be more limited. However, its product attributes are relatively unknown and its market potential has not yet been tapped.

Product Benefits

With unique physical and intrinsic chemical properties, sheep wool as insulation retains its volume and shape compared to conventional materials and does not lose its R-value over time due to settling or moisture. Moreover, it absorbs sound waves and thus has better acoustic properties than fiberglass or cellulose. It is generally considered healthier as wool insulation requires no special health and safety equipment compared to conventional fiberglass insulation which requires breathing, eye, and hand protection and unlike foam products, there is no off-gassing which affects indoor air quality.

While well-designed walls and assembly should include effective moisture barriers, in New England, moisture issues and high variations in humidity are quite common⁸. In these cases, wool can mitigate moisture problems, especially compared to fiberglass. Wool with high hygroscopic material property has the ability to absorb and release moisture as relative humidity rises and falls. Homes, which suffer from moisture problems or have high moisture and humidity variability, will find wool insulation a benefit.

Depending on residential design and wall systems, performance specifications, which take account of issues such as overheating, acoustics and breathability can make sheep wool insulation a comparable choice.

⁸ Wool can hold up to 30% of its weight in moisture.

Sheep wool, pool, value, and numbers

From a farmer perspective, it is important to recognize that sheep wool is a joint and secondary product to the value of sheep as a meat product. Moreover, sheep wool as an insulation product is on the low end of the value for other wool products. Therefore, the value of wool for insulation product should be assessed in relation to the core value of sheep as a meat product. Historically, wool receipts have been about one-quarter of the income from sheep production activities when a price supports program⁹ for wool was in place.

The 2012 US Census data show the majority of sheep (58%) are in New York State with Vermont (13%) and the remainder spread across the other New England states. In New England and New York, the five-year USDA figures show a downward trend from 1997 to 2007 in the number of sheep, but a turnaround from 2007 to 2012. It is too early to say whether this is an overall trend reversal from the 1990s decline. Demand for lamb meat has remained steady, but the competitive price of lamb imports meets much of this demand. There has been discussion in the industry about the potential of using different business model for the sheep industry. The experience of Australia and New Zealand shows that aggressive marketing and diversification of demand can be the cornerstone of an industry's recovery.¹⁰

With the majority of sheep in New York State and hence the bulk of the available wool in this state, it is clear that the market for a potential new product relying on local sheep wool as raw material would need the inclusion of wool from New York's sheep.

Both New York and Vermont run annual or seasonal wool pools where farmers bring their wool to a drop-off location where it is sorted, weighed and aggregated for sale. In recent years, Vermont had sold their wool to the Mid-State Wool Growers Cooperative Association based in Ohio. Prices determined by Mid-State range widely depending on fiber size, quality, and color of wool received.¹¹ For this project, a potential wool insulation product would use fibers, which are less than 3 inches in length and considered defective, hence at the lower end of the price scale, about \$0.50 per pound. The New York State wool pools collected about 92,000 pounds of wool, about 1/3 of total wool production. In Vermont, the annual wool pool collected about 20,000 pounds, about 1/5 of total wool production based on USDA survey data.

⁹ National Wool Act of 1954

¹⁰ <http://www.ers.usda.gov/amber-waves/2004-february/marketing-could-boost-the-us-sheep-industry.aspx#.U9FEVFbn2es>

¹¹ Mid-State Wool 2014 prices per lb for Vermont wool pool; Fine wool, \$0.75 & \$1.35; Med 48s, 54s, 58s \$0.50 to \$0.80; and Black, short, common, med defect \$0.07 - \$0.35, market values are minus handling charges (i.e. transportation, grading, etc.)

Production Process and Product

Starting with raw wool from sheep fleeces, wool are sorted according to grade, that is, by length, color, type of fiber and the degree of contamination with vegetative matter. The higher quality grades can be segregated for high value yarns and products. It is the lower quality grades, which can be captured as raw material for a potential insulation product. While the lower wool grades with shorter fibers and some vegetative matter can be used for an insulation product, a threshold would need to be established for acceptable wool, e.g., minimum length for fiber, maximum amount for vegetative material.

Wool then needs to be baled and transported to a wool processing facility. At the processing plant, the bales are opened and the wool is mixed together to produce a blend, which meets the required specifications. This blend then undergoes a scouring process, where wool is washed in warm water through a series of baths until dirt, most vegetative matter, and lanolin are removed leaving primarily the raw fibers. The next stage will vary depending on whether the final product is an insulation bat or a blown-in product. The blown-in product is a much simpler and less costly process than forming bats. According to Black Mountain Wool, the processing/production line costs for bat assembly are about four times the upfront costs of the blown-in variety. The sheep wool bat product currently marketed and sold in the USA is labeled as an Oregon Shepherd or Black Mountain product but is imported from the UK as there is no manufacturing plant in the USA. Hence, the focus here is on the blown-in wool product. All sheep wool products are finally coated in a borate solution by spraying or soaking the fibers to increase the pest and fire resistance and meet ASTM insulation standards.

Potential Scenario

The potential of a producing a wool insulation product in Vermont depends on both the market demand for the product and the capacity, supply, inputs prices, and processing costs in the region. To assess the current prices of the wool supply, data was collected from wool pools (i.e., the aggregation of wool by the trade associations) in New York and Vermont, as these states are the largest producers of wool in the region. In addition, phone interviews were conducted with wool processing facilities in Vermont and New York about processing costs.

In Vermont and New York, washing and scouring processing varies widely from \$1.00 to \$9.50/ per lb. To a large extent, the costs per pound for processing vary in relation to the quality and quantity of the input material and the expected level of the output material.

Our current investigation of regional sheep wool processing facilities indicates that there is some capacity for taking on additional scouring contracts. Of the mills identified and interviewed, processing capacity in Vermont indicated a potential for 10,000 additional pounds of wool and in New York for about 50,000 pounds.

The costs of wool scouring and the costs of wool purchasing are the key inputs, which affect the final costs of the product. The price points of comparable sheep wool insulation product in the USA were used as baseline to compare the production costs.

The total costs can be divided into the total fixed costs of developing a sheep wool insulation business and the variable costs, which depend on the inputs and the outputs per pound of wool. It is estimated that fixed annual costs to run the business/organization would amount to \$60,000 annually including marketing, brand development, media, management, insurance, product testing, certification, and administration.

This scenario of fixed costs does not include any building or equipment costs as it is assumed that the wool could be cleaned, stored, and cut into an insulation product at an existing wool facility.

Based on market research and current wool pool data, the variable costs of wool processing per pound are estimated to be:

Raw materials - wool	\$0.50
Raw inputs - eg borate solution	\$0.01
Processing/Scouring costs	\$1.50
Packaging & labelling	\$0.01
Material, Shipping, Insurance Costs	\$0.03

Given the prevailing costs and potential revenues from the sheep wool insulation, it is unlikely a farmer could receive more than \$0.50 for raw wool and the processing and scouring costs would need to be on the lower end of the scale at \$1.50 per pound.

This scenario does not include initial product specification and development costs such as insulation product ratings for ASTM standards, technical design specifications, developing Material Safety Data Sheets, which cover product and company identification, hazards identification, and composition/information on ingredients.

A new business is likely to need to secure start-up funds to cover product development and the burn rate until break-even is reached. For example, Oregon Shepherd relied on USDA working capital grant of \$300,000 in 2009 to launch its company. According to our preliminary estimates based on market research to date, a new organization in Vermont would need at least \$230,000 to cover its initial running costs in the first six years not including the initial start up costs of developing its own product.

A Vermont start up with less risks would be to develop a partnership with an existing manufacturer before contracting with a wool processing facility to produce a pilot product.

Scenario for feasibility

With fixed product development and management costs, producing an insulation product requires a certain scale of operation. Assuming fixed management and marketing costs of close to \$60,000 each year, a sheep wool insulation business would break even in year 7 with the use about 114,000 lbs of wool to produce 81,600 lbs of sheep wool insulation. Sales projections start in year two of the business with 4000 pounds of wool processed for 2900 pounds of product. The projections assume a loss rate of 40% by weight after processing. Given the current size of the wool markets in New England, 20,000 pounds would need to be collected from the Vermont market (about 20% of total wool production in Vermont) and 94,000 from the New York market (about 30% of total wool production in New York state).

Estimated Costs and Revenues of Sheep Wool insulation

Years	1	2	3	4	5	6	7
Advertising & promotion	(\$30,000)	(\$21,000)	(\$21,000)	(\$21,000)	(\$21,000)	(\$21,000)	(\$21,000)
License Contract	(\$3,000)						
Management & Admin	(\$20,000)	(\$20,000)	(\$20,000)	(\$20,000)	(\$20,000)	(\$20,000)	(\$20,000)
Insurance		(\$4,000)	(\$4,000)	(\$4,000)	(\$4,000)	(\$4,000)	(\$4,000)
Testing & Certification	(\$4,000)	(\$2,000)	(\$2,000)	(\$2,000)	(\$2,000)	(\$2,000)	(\$2,000)
Fixed Costs Total	(\$57,000)	(\$47,000)	(\$47,000)	(\$47,000)	(\$47,000)	(\$47,000)	(\$47,000)
Variable Costs		(\$8,541)	(\$25,622)	(\$66,263)	(\$109,555)	(\$160,974)	(\$240,313)
Total Costs	(\$57,000)	(\$55,541)	(\$72,622)	(\$113,263)	(\$156,555)	(\$207,974)	(\$287,313)
Gross Sales Estimate		\$9,875	\$29,625	\$77,175	\$129,000	\$193,845	\$287,340
Cash Flow	(\$57,000)	(\$45,666)	(\$42,997)	(\$36,088)	(\$27,555)	(\$14,129)	\$28

Assumptions in variable costs per lb

Est. raw materials - wool	\$0.50
Est. raw inputs - eg borate solution	\$0.01
Est. processing costs	\$1.50
Packaging & labelling	\$0.01
Material, Shipping, Insurance Costs	\$0.03

Starting sales in year 2 with insulating one 2200 sqft house, two 50% house retrofits, and 10 wall assemblies 14 X 8.

* See Variable Costs on next tables

Excludes initial product and development costs

Assumes project sales:

	yr 2	yr3	yr 4	yr 5	yr 6	yr 7
2200 square foot house	1	3	6	12	16	28
50% house retrofit	2	6	18	23	30	39
1 walls at 14' X 8' insulated to R21	10	30	90	180	360	492

Positive cash flow in Yr 7 of operation and year 6 of sales

A working capital grant of estimated

\$223,500 would be needed to cover negative cash flow in first six years of operation

Product Performance

As a relatively new product without a well-recognized track record, product performance data in residential use appears to be lacking. While manufacturer's data is available, empirical data about how sheep wool insulation performs in actual residential wall assemblies across the seasons is needed to demonstrate product performance.

A recent application of sheep wool insulation at a Yestermorrow project showed a difference in recommended use and the actual use. In fact, the amount of sheep wool insulation needed to fill a wall cavity was significantly greater than the level recommended. (See table in Appendix). While density of the product may be a factor, it is still unclear what the ideal density of sheep wool insulation should be for peak performance.

Partners and strategic approach

In order for a new sheep wool insulation product to find a niche and grow in a crowded market with many insulation products, a prolonged market adoption and extensive marketing efforts and investments are likely to be required.

With an existing producer of sheep wool insulation in the current marketplace (Oregon Shepherd) and several importers (e.g, Black Wool, Good Shepherd), one strategic approach could be to enter into a mutually beneficial relationship or partnership with an established insulation provider or distributor. Working with another insulation producer/distributor would obviate the need and related upfront costs for product licensing, initial testing and certification, and upfront marketing. It could be possible for the product in Vermont to be its own brand "Vermont Shepherd" with its own unique selling proposition, that is, made locally with a reasonable proportion of Vermont wool.

Product marketing including website development, product fact sheets and building instructions could be shared between the respective parties. The partner brand (e.g., Vermont Shepherd) could take ownership of championing the product in its regional sales and marketing channels. The parent could provide technical expertise and support to the Vermont locations on sourcing and production issues. Such a partnership could lead to a smooth progression through research and development, which would help ensure that the processing facility meets the relevant technical, ASTM standards, and customers' expectations.

With its strong green building network, Vermont is well positioned to develop demand in the New England market. Green building conferences in New England regularly attract 6000 to

7000 attendees who are on the look out for new “green” and “natural” building products.¹² Such a conference would be an ideal place to test the waters for a pilot product.”

In Vermont, home retrofit projects are driven in large part by Efficiency Vermont incentives and marketing offerings. If a new product such as sheep wool insulation, which meets energy efficiency standards, could be part of an incentive package, this would help establish product positioning. Moreover, energy efficiency campaigns, which include sheep wool insulation as a preferred “green” alternative, would be important in developing the brand.

Lastly, being proactive in working with builders, architects and consumers about the unique properties and benefits of a sheep wool insulation product and providing them with samples and test results and measurement over time will improve consumer confidence and buyer-seller relationships.

Next Steps

There are a couple of options for Vermont sheep farmers working with the Vermont Sheep & Goat Association to benefit from the interest in sheep wool insulation. The lowest level of involvement would be developing the contact at Oregon Shepherd and selling available low-grade wool from the wool pool, which could meet Oregon Shepherd’s specification for their existing Oregon Shepherd product.

More involved would be partnering with Oregon Shepherd to develop a Vermont-labeled product. A Vermont-based marketing channel and relevant sales literature could be developed while benefiting from the licensing and testing of an existing manufacturer. Regional sales and marketing could be handled and supported by a Vermont-based company or cooperative. Wholesale stocking of a regionally based product would alleviate some of the high customer shipping costs associated with distributing insulation, a low value to bulk product, where current shipping across the USA almost doubles the product cost. This product could also benefit from the Vermont brand for quality products and position in the green building network.

Yet more involved is developing a Vermont prototype product based on regionally sourced wool with local production at existing facilities in New York and Vermont. This route would require more extensive research, development, cost estimating, and prototype testing in partnership with New York’s sheep wool pool in coordination with, for example, the Empire Sheep Producers Association.

Overall, the potential development of a sheep wool insulation product would benefit from increasing the awareness and recognition of the unique attributes of sheep wool as insulation, which could be realized through a local demonstration project. Building a demonstration wall assembly with sheep wool insulation and comparing it to a wall cavity with cellulose insulation with the participation of “green” building stakeholders could accomplish this. Testing the

¹² Conversation with architect, David Pill, November 2014.

thermal properties of sheep wool, whether a Vermont prototype or an existing wool insulation product and documenting the performance in specific wall assemblies would lead to better understanding of the thermal and other material properties of this “new” product and the greater likelihood of a its potential success in Vermont.

Appendix

Lessons learned from cellulose insulation as new insulation product and comparison to sheep wool

Cellulose insulation is now a commonly used insulation product specified by builders for weatherizing buildings in Vermont. However, in the 1970s through 1990s, when cellulose insulation was in its infancy, there were a number of early problems, which could have killed this fledgling “green” product. Cellulose is generally made from waste paper, which is naturally flammable, and resulted in a number of house fires in the 1970s. As a result, Congress enacted an Emergency measure to require new federal standards for insulation, to mandate labeling of cellulose insulation as fire hazard and to prohibit installation near heat sources. In 1991, one of the drivers for cellulose insulation as an alternative product was the new supply of recycled paper which did not have sufficient end markets. Overcoming the public’s negative views concerning a paper product used as a fire retardant insulation material was no small feat.

A US consumer product analysis found that cellulose insulation products must be applied with fire retardants at 20-23% by weight. In contrast, sheep wool as a safe insulation product does not require such a high fraction of fire retardant additives because of the intrinsic fire resistance properties of wool.

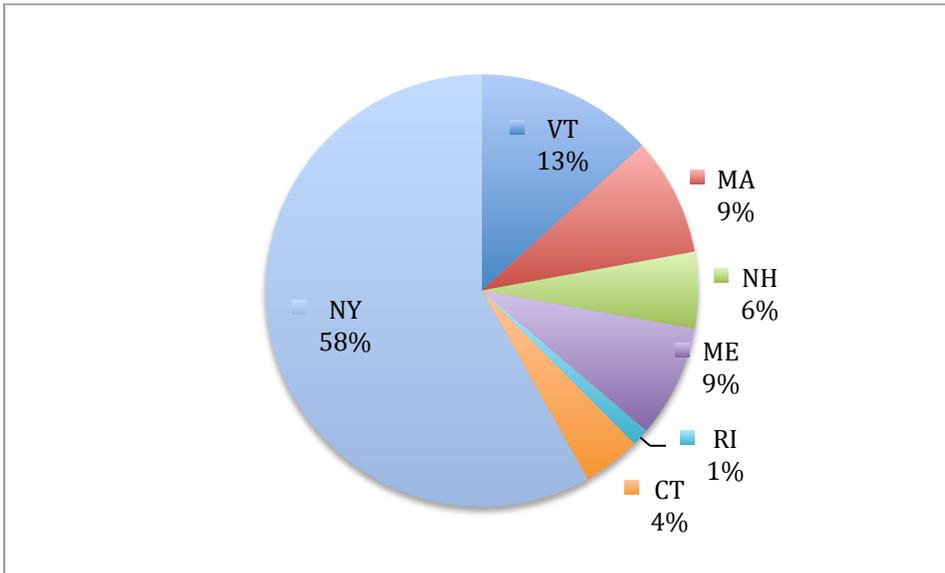
Over the past 25 years, new processing technologies and advanced materials have improved cellulose-based insulation products as well as foam materials as well as creating many high-performance novel insulation products with organic and inorganic materials. The viability of a new natural wool insulation product needs to compete in this sphere.

Residential Insulation R-value and prices

Material	R/Inch	R-Value (3.5")	Price: \$/ft2	Density: lb./ft3
Cellulose (dense pack)	3.65	13	0.5	1.02
Wool as manuf. tested	3.5	13		
Wool – as instructions	4	14	1.12	0.27
Wool – as installed	?	?	2.4	0.47
Rock Wool Batts (Roxul)	4.15	15	0.75	0.58
Fiberglass Batts	3.65	13	0.47	0.3
Fiberglass Loose Fill	4.15	15	0.46	0.44
Open Cell Spray Foam	3.7	13	1.9	0.5
Closed Cell Spray Foam	7	24.5	3	2.4

Reference: Brian Thompson, UVM and YesterMorrow Design/Build School Note: In a 6 ft. wall assembly, Black Mountain sheep wool insulation has been tested to achieve R-Value of 19 to 21 at a depth of 5.1 to 5.25 inches with a density of 0.39 lbs./sq. ft. Conversation with manufacturer, 1/22/201

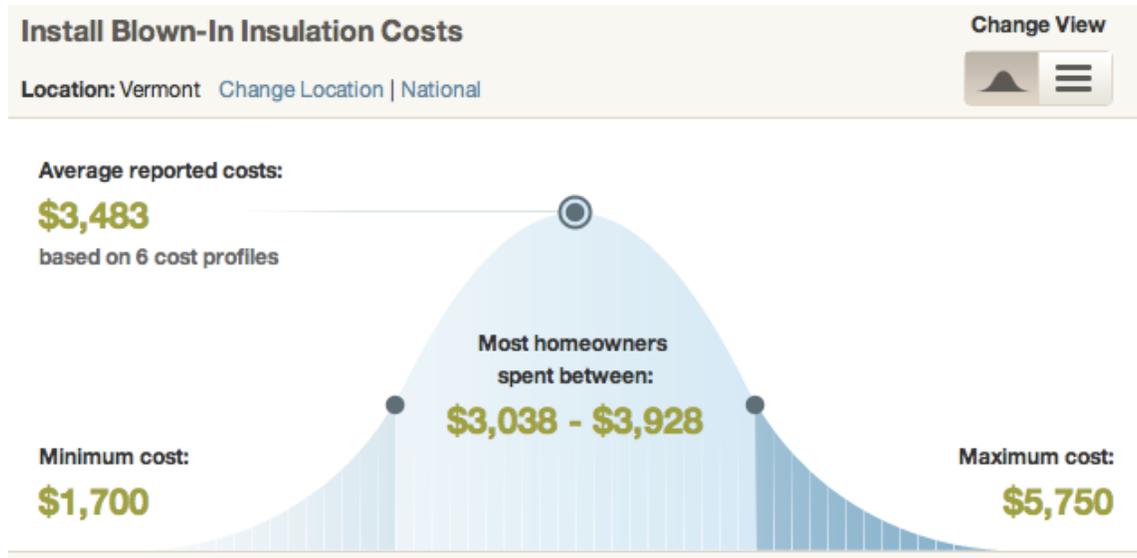
Number of Sheep and Proportion of Sheep in each State



USDA Agricultural Census for Sheep New England states + New York state

	Number of Sheep				Growth	No. of	Farms	Growth
	1997	2002	2007	2012	%			%
VT	16,589	14,743	13,925	18,803	35%	626	793	27%
MA	9,881	9,592	11,787	12,504	6%	734	776	6%
NH	8,237	7,423	7,671	8,079	5%	531	618	16%
ME	11,888	9,353	10,918	11,925	9%	647	759	17%
RI	1,331	1,422	1,459	1,823	25%	107	122	14%
CT	5,938	5,581	5,767	6,093	6%	399	498	25%
NY	69,248	83,630	63,182	82,286	30%	1,799	2,017	12%
Total	125,109	131,744	114,709	141,513	23%	4,843	5,583	15%

	Wool Production lbs.			Wool Value \$1,000		6 lbs./wool on avg	Estimated Capture rate	Wastage
	2007	2012	Growth %	2012	Avg \$/lb			
VT	81,167	101,330	25%	66,000	\$0.65	112,818	89.8%	10.2%
MA	63,971	70,127	10%	49,000	\$0.70	75,024	93.5%	6.5%
NH	42,351	40,465	-4%	27,000	\$0.67	48,474	83.5%	16.5%
ME	66,838	62,856	-6%	44,000	\$0.70	71,550	87.8%	12.2%
RI	5,797	7,699	33%	4,000	\$0.52	10,938	70.4%	29.6%
CT	28,972	26,864	-7%	19,000	\$0.71	36,558	73.5%	26.5%
NY	319,144	303,277	-5%	197,000	\$0.65	493,716	61.4%	38.6%
Total	608,240	612,618	1%	\$406,000	\$0.66			



Note: Sheep wool insulation as a blown-in product will be at the high end of the curve (i.e., dark blue). This cost profile does not appear to include high performance homes which can have three times the insulation thickness (i.e., 1 foot thick walls) bringing insulation costs to about \$12,000 per home.

Oregon Shepherd Sheep wool insulation delivered by box



Wool insulation in cellulose blower machine, Yestermorrow video clip, January 2015



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Vermont Green Building Network

Acorn Energy Co-op – Peter Carothers

Wool processing mills: Green Mountain Spinnery, Putney; Hampton Fiber Mill, Richmond, VT; Vermont Fiber Mill, Brandon, VT; Battenkill Fiber, Greenwich, NY; Barlett Yarns, Harmony, ME; Jagger Bros, ME, and Empire Sheep Growers, NY.

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