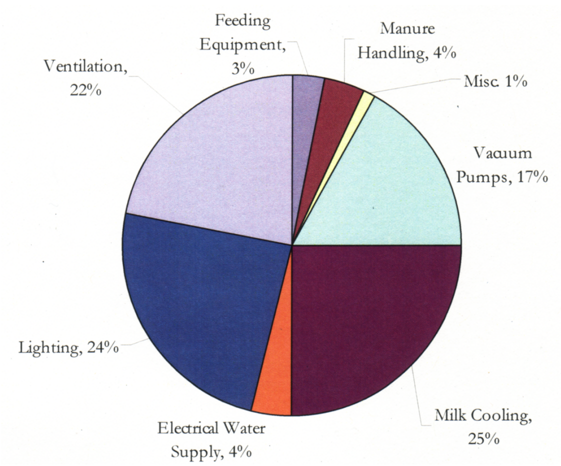
ENERGY

DESCRIPTION

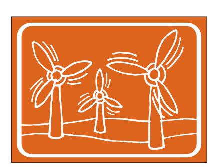
There are two main types of energy: renewable and non-renewable. As the name implies, a non-renewable energy source is an energy resource that is not replaced or is replaced only very slowly by natural processes. Primary examples of non-renewable energy resources are the fossil fuels—oil, natural gas, and coal. Fossil fuels are continually produced by the decay of plant and animal matter, but the rate of their production is extremely slow, very much slower than the rate at which we use them. Any non-renewable energy resources that we use are not replaced in a reasonable amount of time (a lifetime or that of the next generation) and are thus considered "used up", not available to us again.[63] This category can be further broken down into direct and indirect energy. Electricity is a major use of direct energy farms. Milk cooling, lighting, ventilation and vacuum pumps account for 88% of all direct energy used on dairy farms.[64] Typically, total annual energy used by dairy farms is equal to 3.4 million kWh/year divided into energy intensive components as described in Figure 1.

Figure 1: Typical Energy Use by Equipment on a Dairy Farm [65]



Indirect energy use is comprised of the following sources: fertilizer type or nutrient quantity; chemical pesticides, seeds, feed that was bought-in from outside or sold, and grazing-off farm recorded by number of animals and time away from the property.[66] The manufacturing of chemical fertilizers and pesticides makes up almost 40% of the energy allocated to agricultural production.

Renewable energy on the other hand, is "any energy resource that is naturally regenerated over a short time scale and derived directly from the sun (such as thermal, photochemical, and photoelectric), indirectly from the sun (such as wind, hydropower, and photosynthetic energy stored in biomass), or from other natural movements and mechanisms of the environment (such as geothermal and tidal energy)."[67] The most relevant form of renewable energy for dairy farmers is methane recovery. Methane is found in manure and can be converted to renewable energy through specific technologies, such as anaerobic digesters, resulting in cost savings to those farmers and a reduction in emissions of greenhouses gases to the environment. Biodiesel is another renewable energy source on the farm. It is a clean burning alternative fuel produced from domestic, renewable resources, contains no petroleum, but can be blended at any level with petroleum diesel to create a biodiesel blend. Biodegradable, nontoxic, and essentially free of sulfur and aromatic, over the course of its production and use, biodiesel produces 78% less carbon dioxide emissions and almost 100% less sulfur dioxide, according to joint study commissioned by the US Department of Energy and the US Department of Agriculture,[68] biodiesel already meets the new EPA standards for low-sulfur diesel fuel mandated for introduction in 2006.[69]



Current agricultural practices, including those on dairy farms, emit a large amount of greenhouse gases globally. Generated through the combustion of fossil fuels, electricity contributes to the emissions of greenhouse gases such as methane, nitrous oxide, and carbon monoxide. These gases, once emitted into the atmosphere, trap heat in the atmosphere, potentially causing global warming.[70]

INCENTIVES FOR CHANGE

In order to gain maximum farmer participation in adopting best management practices, it is necessary to outline how the dairy farmer benefits from managing their energy use.

- **Cost Savings.** Vermont's electricity rates are among the highest in the country.[71] Energy efficient lighting and equipment can make a substantial difference in reducing monthly energy bills. According to Efficiency Vermont, and as seen below, a farmer can reduce milk cooling costs by 50% with plate-type milk pre-cooler; reduce vacuum pump energy costs by up to 66% with a variable speed drive pump; and save as much as 65% on lighting costs by switching to energy saving lighting.[72]

ASSESSMENT QUESTIONS

For all questions, please choose the answer(s) that best identify your current management practices. Use the Summary sheet on the last page of this module to evaluate overall performance.

Calculate the amount you spend on energy and machinery as a percentage of gross income:

PART 1: From your Schedule F Income Tax Filing add items in the table below.

PART 2: Divide Part 1 by gross income.

Items	Dollar Amount ($)
Milk house cleaners	
Custom hire (machine work) - fertilizer, pesticides/herbicides and planting or harvesting	
Depreciation on buildings and equipment	
Own application of fertilizer, pesticides/herbicides	
Fuel	
Rent or lease of vehicles, machinery and equipment	
Repairs and maintenance	
Utilities	
Total Dollars Spent:	
Total Gross Income:	
Total Dollars Spent/Total Gross Income x 100 =	%

Percentage of Total Income

❑ 1. My total dollars spent per total gross income is greater than 50%.
❑ 2. My total dollars spent per total gross income is between 25% and 50%.
❑ 3. My total dollars spent per total gross income is between 10% and 25%.
❑ 4. My total dollars spent per total gross income is less than 10%.

Recording the amount of money spent on electricity and other energy sources can help homeowners and business managers understand just how much they spend on energy-related services, often prompting a move towards increasing energy efficiency to reduce costs.[73]

When it comes to lighting: [74]

❑ 1. I use only standard lighting in my barns and outbuildings (i.e. mercury vapor yard lights).
❑ 2. I have converted a portion of my lights to more energy efficient alternatives, such as high-pressure sodium yard lights. And I have worked with Efficiency Vermont for assistance.
❑ 3. I have converted all of my lights to energy efficient models (such as high pressure sodium yard lights).

When it comes to milking cows:

❑ 1. I use a traditional vacuum pump.
❑ 2. I am saving money to buy a variable speed drive controller.
❑ 3. I use a variable speed drive controller.

According to one farmer member in the St. Albans Coop, the use of a variable speed pump has reduced somatic cell count in his milk, upgraded the quality of milk and increased the dollar value he receives for the milk.[75]

When it comes to ventilation in the barn:

❑ 1. I use the standard (i.e. fans), mechanical equipment that is not energy efficient.
❑ 2. I am saving money to be able to convert to more energy efficient equipment.
❑ 3. I have converted a portion of my barn to be ventilated by more energy efficient equipment.
❑ 4. I have converted my barn(s) to be ventilated by more energy efficient equipment.

In recent years, mechanical ventilation in large freestall barns has become one of the largest peak energy users on dairy farms. Switching to efficient fans can produce savings of 12% to 15% in both smaller barns and large freestall barns.[76]

When it comes to milk cooling equipment:

❑ 1. I use the standard, milk cooling equipment.
❑ 2. I am saving money to use a 'plate milk pre-cooler'.
❑ 3. I have converted to using a plate milk pre-cooler to reduce my energy usage during milk cooling.

Energy conservation measures on farms include variable speed pumps, plate milk pre-coolers and energy efficient lighting technology. According to farm surveys conducted by EnSave, a Vermont based electric company, the two main areas of resistance to adopting these technologies include labor shortages and high upfront costs.[77] However, as indicated in the table below, the upfront costs of installing new technology can be offset over on the average of five years. For example, a variable speed pump drive will cost a farmer approximately $3401 to install. However, by installing this technology, the farmer will save almost 10,000 kWh, or $1061/year in energy bills. At this savings rate, the cost of installing the pump will be returned to the farmer within five years on average. Data detailing these savings is listed in Table 3.

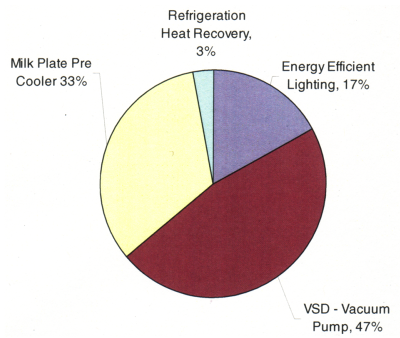
Table 3: Summary of Energy Savings for Energy Conservation Measures [78]

	Annual kWh	Estimated Annual Savings	Estimated Installed Cost	Average Payback Years (range)
Install VSD on Vacuum Pump	9,988	$1,061	$3,401	4.73 years
Add Refrigeration Heat Recovery	5,781	$579	$2,861	5.00 years
Install Plate Milk Pre-cooler	9,414	$948	$2472	4.22 years
Install Energy Efficient Lighting	3,491	$344	$1,473	4.50 years
Total Savings	**28,674**	**$2,931**	**$10,207**	**4.6 years**

*These numbers are based on the average costs in the northeast region in 2002.

These energy conservation measures result in the savings by percentage as shown in Figure 2.

Figure 2: Energy Savings per Area [79]



When it comes to renewable energy:

- ❑ 1. I do not use any renewable energy measures on my farm.
- ❑ 2. I plan to implement wind, solar, biodiesel or methane recovery as a renewable technology measures on my farm as soon as I save enough money or I have received funding.
- ❑ 3. I have already started using Biodiesel or Methane Recovery as a renewable energy technology because it makes sense for my size farm.

The use of methane recovery technology, such as anaerobic digesters, has significant improvements in cost efficiency, manure management efficiency, and a reduction in the need of direct energy. However, the practicality of it must be determined on an individual farm basis. The costs of an anaerobic digester to break methane down into energy depend on specific farm conditions. Moreover, the average pay back can range from a few years to more than ten years. According to the Wisconsin Public Service Commission, a minimum herd size of 300 dairy cows is needed to make such a system feasible,[80] while other estimates are in the range of 5000 cows. However, money isn't the only consideration. It takes approximately 45 minutes of daily maintenance, including inspection, mixing and pumping manure into a digester twice a day, and checking and recording gauges to measure biogas and electricity output, in order to keep an anaerobic digester working smoothly. Generator engines also require monthly maintenance including oil changes, valve adjustments and spark plug cleaning.[81] Currently, the Vermont Department of Public Service and the Vermont Department of Agriculture have received a total of $695,000 from the federal government to promote the use of methane recovery technology on Vermont dairy farms.[82] The project has been designed to consider methane recovery in a broad context, taking into account its potential benefits as a component of a comprehensive nutrient management system, as a renewable energy source and as a strategy for greenhouse gas reduction.

Biodiesel is a clean air, renewable energy source that is more expensive than petroleum diesel, however it is the least cost strategy when compared with other alternative fuel systems. Consumer benefits include the following: 1) because it is more lubricating than petroleum diesel fuel, biodiesel can extend the life of diesel engines; 2) it does not require any major engine modifications or special storage/handling procedures; 3) it can be made from domestically produced, renewable oilseed crops such as soybeans, as well as from recycled vegetable oil that has already used for frying; and 4) when burned in a diesel engine, biodiesel replaces the exhaust odor of petroleum diesel with the pleasant smell of popcorn, French fries, or donuts.[83]

LINKAGES TO OTHER MODULES

While the questions above cover some of the basics regarding energy management, other practices also impact energy use. Please review your practices regarding the following topics in the Educational Modules listed below.

ENERGY TOPIC	OTHER MODULE(S)
Energy	Farm Financials
Product Quality	Animal Husbandry
Manure Management	Nutrient Management

FURTHER INFORMATION

Additional details and information on the above can be obtained through the following sources:

- **EnSave Energy Performance Inc.** This energy calculator shows farmers all the aspects that can lead to energy savings on the farm.
  - Address: 65 Millet Street, Suite 105, Richmond, VT 05477
  - Tel: 800-732-1399; Fax: 802-434-7011
  - http://www.ensave.com/EnergyCalculators.htm/

- **Efficiency Vermont.** This is a source of quick information about lowering costs with energy efficiency in new equipment or in existing or new building designs. It recently began to provide 0% financing to supplement financial incentives and technical assistance for dairy farms.
  - Address: 255 S. Champlain Street, Suite 7, Burlington VT 05401
  - 1-888-921-5990
  - http://www.efficiencyvermont.com/

- **Consumer's Guide to Small Wind Electric Systems in Vermont**
  - http://www.eere.energy.gov/windpoweringamerica/pdfs/small_wind/small_wind_vt.pdf/

- **Renewable Energy Vermont**
  - P.O. Box 1036; Montpelier, VT 05601;
  - Phone/Fax (802) 229-0099
  - Andrew Perchlik: E-Mail perchlik@REVermont.org
  - http://www.REVermont.org

- **Appropriate Technology Transfer for Rural Areas**
  - ATTRA . www.attra.ncat.org

- **Vermont Alternative Energy Council**
  - 147 Allen Brook Lane, Suite 104, Williston, VT 05495
  - (P) 802.879.4896/ (F) 802.879.5486
  - http://www.vaec2000.com/

SUMMARY RESULTS FOR ENERGY

Instructions: In the table below, please record the score for the answer you selected for each question. For multiple-choice questions, the response number serves as your score for that category (i.e. choice # 2 is worth 2 points). For "check all that apply questions," please see scoring criteria for each question in the chart below. Once all responses have been completed, add up the answers and record the total.

QUESTION	ANSWER/SCORE
1. Percentage of Income	
2. Lighting	
3. Milking (Use of Variable Speed Driver)	
4. Ventilation	
5. Milk Cooling Equipment	
6. Renewable Energy	
Total Score (Out of Possible 20)	

Interpretation: The next step in understanding your farm's performance in the category of Energy Module is to compare your results to best practices. Below is a table that ranks your performance from best practice (green) to practices that require improvement (red). Compare the number of points you received for your practices compared to optimal practices.

	Point Range	Interpretation
Green	16 - 20	Best practices regarding Energy are currently being employed on this farm.
Yellow	14 - 15	Farm is using some good practices regarding Energy; however there are some key areas that should be improved on.
Red	6 - 13	Energy practices should be carefully evaluated and a strong effort should be made to adopt improved practices in several areas.

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Footnotes

63 http://www.cpast.org/Articles/fetch.adp?topicnum=12. Corporation for Public Access to Science and Technology. Non Profit based in St. Louis, MO that publishes scientific and technical information on the web for a general audience.

64 Ludington, David and Eric L. Johnson. Dairy Farm Energy Audit Summary Report. Prepared for New York State Energy Research and Development Authority. July 2003.

65 Ibid.

66 Heller, Martin and Gregory A. Keoleian. "Assessing the Sustainability of the U.S. Food System: A life Cycle Perspective. Center for Sustainable Systems, School of Natural Resources and Environment, University of Michigan. ScienceDirect. May 14, 2002

67 Texas Renewable Energy Industries Association; Definition of Renewable Energy. <http://www.treia.org/redefinition.htm>.

68 National Biodiesel Board; What is Biodiesel. December 2003. <www.biodiesel.org/resources/faqs/default.shtm>.

69 Ibid.

70 Australian Greenhouse Office; Greenhouse Emissions from Dairy Farms. 10 Oct. 2003. <http://www.greenhouse.gov.au/agriculture/factsheets/fs_dairy.html>.

71 Vermont Department of Energy, Vermont Electricity Rates, 2000. <http://www.eere.energy.gov/state_energy/states_currates.cfm?state=VT>.

72 Efficiency Vermont. Dairy Farms: Top Energy Saving Methods. <www.efficiencyvermont.com/index.cfm?L1=84&L2=165&L3=278&sub=bus>

73 Appropriate Technology Transfer of Rural Agriculture; Dairy Farm Sustainability Check List; www.attra.ncat.org. March 2001.

74 Ludington, David and Eric L. Johnson. Dairy Farm Energy Audit Summary Report. Prepared for New York State Energy Research and Development Authority. July 2003.

75 Visit to the St. Albans Cooperative Creamery; 8 Nov.. 2003.

76 EnSave Energy Performance; 10 Nov. 2003, <http://www.ensave.com>.

77 Ibid.

78 Ludington, David and Eric L. Johnson. Dairy Farm Energy Audit Summary Report. Prepared for New York State Energy Research and Development Authority. July 2003.

79 Ibid.

80 Wisconsin Public Service Corporation; Methane Gas Recovery: Is it Right for Your Farm? < http://www.wisconsinpublic-service.com/farm/gasrecovery.asp >

81 Ibid.

82 Forward, Jeffrey. Vermont Methane Project Quarterly Report. January 2001. <http://www.state.vt.us/psd/ee/4th2000.pdf>; January 2001

83 University of Vermont Environmental Council; "What is Biodiesel." <http://esf.uvm.edu/envcncl/referlibrary/biodiesel.html>; July 13 2001.