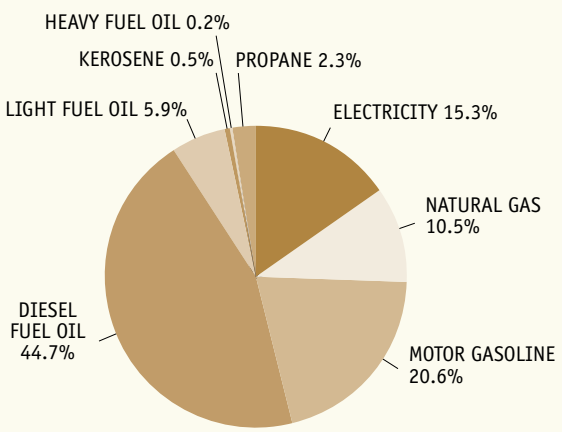
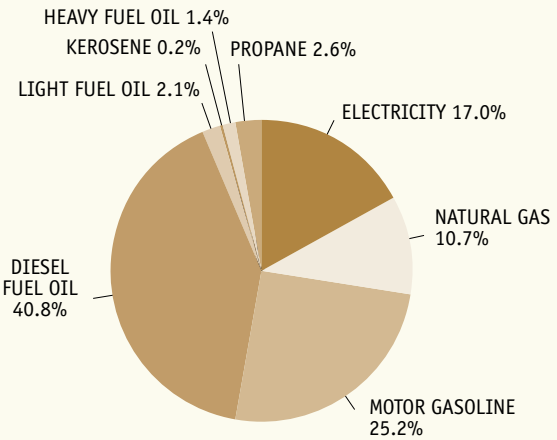
ENERGY CONSERVATION AND PRODUCTION

CONSERVATION

Agriculture is an energy-intensive industry. Crop production, livestock housing, transportation, and domestic life are just some of the vital activities that need reliable energy sources.



1999
ENERGY USE BY ENERGY SOURCE
229.9 (PJ)



2003
ENERGY USE BY ENERGY SOURCE
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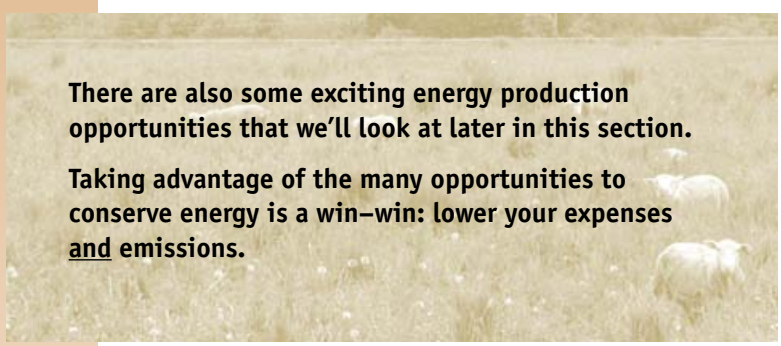
Agriculture is an energy-intensive industry. A high proportion of energy used is for farm vehicles and equipment.



There are also some exciting energy production opportunities that we'll look at later in this section.

Taking advantage of the many opportunities to conserve energy is a win–win: lower your expenses and emissions.

HOME ENERGY CONSERVATION

CATEGORY	BEST MANAGEMENT PRACTICES	IMPACT
SITING	✔ Site for east-west axis orientation ✔ Design roof overhangs to save energy	• Maximized solar energy capture in winter • Minimized solar energy effect in summer • Reduced heat loss • Reduced energy requirements
LANDSCAPING	✔ Use shade trees ✔ Site building for shelter ✔ Plant shelterbelts	• Maximized solar energy use • Protection from prevailing winds by using hills • Reduced heat loss/reduced energy needs
INSULATION	✔ Know where insulation is needed ✔ Choose suitable products ✔ Install insulation properly ✔ Install vapour barriers properly	• Insulated where heat loss is greatest • Reduced energy requirements • Ensured effectiveness of insulating materials • Reduced heat loss in winter • All key areas of heat loss are insulated
VENTILATION	✔ Follow building codes ✔ Use suitable technology	• Protected insulation and vapour barrier • Reduced energy requirements
HEATING	✔ Properly size system to meet needs ✔ Choose high efficiency furnace ✔ Use supplemental heating	• Improved energy efficiency/reduced energy requirements
HOME ENERGY AUDITS	✔ Perform an energy audit on your home	• Improved energy efficiency/reduced energy requirements
ENERGY EFFICIENCY	✔ Use natural lighting ✔ Use open floor plans ✔ Close off less-used spaces ✔ Choose energy-efficient flooring and décor ✔ Use energy-efficient doors and window ✔ Use energy controls – for heating, lighting, appliances ✔ Use energy-efficient appliances ✔ Use energy-efficient lighting	• More effective use of natural energy sources • Improved comfort • Reduced hydro needs and energy requirements
	✔ Try passive energy conservation: • day-lighting • natural ventilation • cooling towers	• Improved comfort • Reduced heat loss in winter • Increased heat loss in summer • Reduced energy requirements
	✔ Incorporate renewable energy whenever possible – photo-voltaics, solar, smallwind, geo-thermal, etc.	• Reduced hydro needs and energy requirements

LIVESTOCK FACILITIES

CATEGORY	BEST MANAGEMENT PRACTICES	IMPACT
SITE SELECTION	✔ Plan facilities for east-west axis orientation ✔ Place close to other buildings and hills ✔ Plant shelterbelts ✔ Design roof overhangs to save energy	• Maximized solar energy capture in winter • Minimized solar energy effect in summer • Reduced hydro needs and energy requirements geo-thermal, etc.
INSULATION	✔ Know where insulation is needed ✔ Choose suitable products ✔ Install insulation properly	• Reduced hydro needs and energy requirements
VENTILATION	✔ Select suitable technology ✔ Use energy-efficient systems (e.g., heat-recovery)	• Improved livestock comfort • Direct reduction of greenhouse gas • Reduced energy requirements
PASSIVE ENERGY SYSTEMS	✔ Use passive energy heat-recovery systems to release energy during cold nights	• Reduced heat loss • Reduced energy requirements
ELECTRICAL MOTORS	✔ Use energy-efficient motors ✔ Monitor energy use ✔ Properly size wire, and back-up electrical source	• Improved management of loads and peaks • Reduced demand-side electrical use
FARM ENERGY AUDITS	✔ Do an energy audit for your operation	• Improved energy efficiency • Cost savings

Use energy-efficient ventilation systems.

DAIRY		
CATEGORY	**BEST MANAGEMENT PRACTICES**	**IMPACT**
ENERGY-EFFICIENT SUPPLEMENTAL	✔ Install energy-efficient fluorescents in stanchion/ tie-stall barns ✔ Install high-intensity discharge (HID) lamps	• Increased production • Reduced hydro requirements and demands **Solar power can be used to provide drinking water to livestock.** 
COW COMFORT	✔ Install sprinklers ✔ Install evaporative cooling pads	• Increased cooling • Improved energy use
MILKING EQUIPMENT	✔ Use variable-speed drive equipment ✔ Use milking precoolers ✔ Install water heating and heat reclaimer ✔ Maintain vacuum systems ✔ Use scroll compressors	• Improved energy efficiency • Cost savings • Reduced energy requirements
NUTRIENT MANAGEMENT	✔ Complete and follow a nutrient management plan	• Reduced energy from reduced fertilizer use • More efficient use of manure application equipment

OTHER LIVESTOCK ENERGY SAVINGS		
CATEGORY	**BEST MANAGEMENT PRACTICES**	**IMPACT**
SAVE HEAT IN HOG OPERATIONS	✔ Use hovers (solid partition enclosures located in farrowing pen, accessible to piglets) ✔ Monitor and reduce energy use	• Reduced fossil fuel consumption • Increased electrical energy savings
OTHER ENERGY SAVINGS IN HOG BARNS	✔ Use energy-efficient lighting ✔ Improve ventilation ✔ Improve cooling ✔ Install heat exchangers ✔ Use evaporative pads for summer cooling	• Reduced electrical demand and energy consumption • Reduced heat-energy use • Increased comfort – less mortality
ENERGY EFFICIENCY FOR POULTRY	✔ Use energy-efficient lighting ✔ Improve ventilation ✔ Improve heating efficiency	• Reduced electrical demand and energy consumption • Reduced heat-energy use • Increased comfort – less mortality
GRAZING LIVESTOCK	✔ Alternate water sources using solar and wind power	• Reduced electrical energy use
GRAIN DRYING	✔ Use alternative energy sources ✔ Install heat reclamation systems ✔ Integrate natural drying ✔ Use aeration treatments to improve efficiency	• Reduced fossil fuel consumption and electrical energy savings

ENERGY CONSERVATION IN FIELD OPERATIONS		
CATEGORY	**BEST MANAGEMENT PRACTICES**	**IMPACT**
FUEL CONSUMPTION	✔ Assess fuel use ratings of new farm equipment ✔ Use fuel alternatives, e.g., propane, biofuels	• Reduced fossil fuel consumption • Reduced direct GHG emissions
TRACTOR TIRES	✔ Match tire type and size to unit ✔ Inflate to correct pressures ✔ Ballast to improve traction	• Reduced slippage and wear and improved efficiency from properly sized and functioning tires
TRACTORS	✔ Assess fuel efficiency performance ✔ Use timers for heater	• Reduced fossil fuel consumption • Reduced direct GHG emissions • Reduced electrical energy consumption
MACHINERY MAINTENANCE	✔ Regular tune-ups for fuel savings ✔ Match load with tractor ✔ Plan loads and trips with conservation in mind	• Extended life, improved efficiency and reduced waste • Reduced fossil fuel consumption
TILLAGE	✔ Reduce tillage ✔ Assess operations for one-pass opportunities	• Reduced fossil fuel consumption • Reduced direct GHG emissions • Reduced soil carbon loss

PRODUCTION

While agriculture is heavily energy-dependent, it's foreseeable that agriculture will become a generator of energy. For example, prime, marginal and fragile croplands could be growing woody energy crops. Small waterfalls and windy fields could be supplying on-farm electricity needs and feeding the grid with any surplus generated.

Follow maintenance schedules for machinery and equipment.

No-till greatly reduces the number of field passes, thus reducing both fuel use and labour.

FIELD CROPS FOR ETHANOL, BIODIESEL AND BIOMASS

For years, field corn and other grains have been grown as an energy crop. Ethanol is blended with gasoline as E10 (10% ethanol) and E85 (85%). The estimated net emission reduction for each is 4% and 37% respectively. By 2010, these reductions are expected to increase to 5% and 45% respectively.

Greater reductions are predicted when stover can be converted to ethanol. Soybean oil can be converted to biodiesel (about 1.5 gallons per bushel of beans). It has similar power and combustion qualities to diesel – without the emissions and particulate matter.

Perennial crops like switchgrass can also be converted to ethanol. The advantages of a crop like switchgrass are that it:

- ▶ is a perennial
- ▶ can be grown on fragile, marginal and degraded lands
- ▶ provides excellent wildlife habitat.

Field crop feedstocks can be used to produce ethanol fuels. Ethanol fuels help to reduce greenhouse gas emissions.

SHORT-ROTATION WOODY PRODUCTS FOR ENERGY

Woody plants can be grown on cropland for energy. Trees such as hybrid poplars, silver maple, willows, ash and cottonwood can be planted in plantation spacing (2 metres between trees and 3 metres between rows), grown for five to 20 years, then harvested. The sprouts or coppice growth can be re-harvested in five to 10 years on a sustainable basis from that point onwards.

Another variation for wood-crop energy combines fast-growing hardwoods with more valuable hardwoods in perimeter plantings such as buffer strips, wildlife corridors, field windbreaks and farmstead shelterbelts. The fast-growing hardwoods can serve as a nurse crop and provide an early harvest of biomass.

Woody plants can be grown on marginal and fragile farmlands for ethanol production or for biomass energy systems.

Biomass is made up of biological organisms. It can be considered a form of stored solar energy, captured through photosynthesis in growing plants.

SMALL HYDRO, WIND AND SOLAR POWER

The presence of a large wind energy installation at Pincher Creek, Alberta does not impede livestock grazing.

Fast-flowing water, wind and sun can also be harnessed to generate energy for domestic use and grid-supply. As the cost of hydro increases, as we better understand all the costs (including environmental) associated with it, and as we learn more about alternatives, the alternatives are becoming more attractive. The once-prohibitive capital investment of small generators, windmills and solar energy cells may be quickly outweighed by the revenue generated from feeding the grid.

WIND ENERGY

Wind energy is a fast-growing, green energy option for livestock producers.

Wind energy systems can be small or large. Small systems are designed to meet some or all of the operation's energy needs. Large systems – like the ones at Pincher Creek, Alberta and Shelburne, Ontario – are intended to supply the grid.

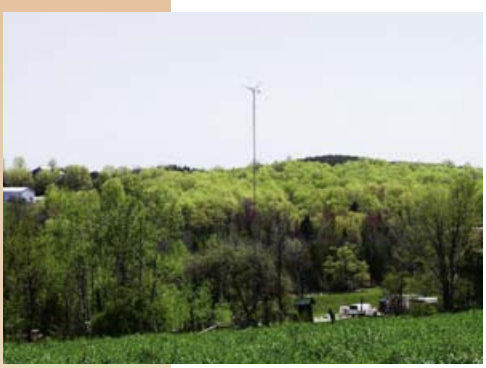
Small systems

There are three types:

- ▶ micro < 100W – suitable for electric fences, safety lighting
- ▶ mini 100W–10kW – generator backup; pumping for irrigation
- ▶ small 10–50kW – suitable for farm operation needs.

Wind turbines are of horizontal or vertical design and are set on towers 30 metres high.

The wind turns rotor blades on the turbine, which turns a gearbox or generator to produce an electrical current. Average wind speeds need to be greater than 13–15 km/hr. Stronger winds will generate more electrical power, reaching maximum power at 55 km/hr. Turbines shut down when wind speeds exceed 90 km/hr.



With a 10kW turbine and conversion of major appliances to gas, a small farm is off the grid. All electrical needs are met from turbine and battery storage. Installed cost: $60,000.

Large systems

Large wind systems are usually operated by power generators or by private companies contracted to supply energy to provincial girds. These systems come in sizes ranging from 300kW to 1.5mW. Each platform, tower and turbine covers up to 10 acres of land.

These systems are located in areas of strong, consistent winds that are located near transmission lines. The best locations so far are coastal areas, the prairies and the tundra.

These wind turbines at Shelburne, Ontario present no restrictions to activities on cropland, forages and pasture.

There are opportunities for land lease and royalty income. However, livestock producers should be well-organized and seek professional advice when approached by promoters of large wind-energy projects.

SOLAR ENERGY

Solar energy is being used on farms to heat homes, barns and water, run pumps and electrify remote fencing systems.

Passive solar techniques use dark-colour, heat-absorbing materials, and location of windows and roof overhang to attract heat for gradual release in colder conditions.

Active solar is deployed with solar water-heating systems that offset water-heating costs by using roof panels, antifreeze, pumps and a heat exchanger plumbed into the water heating system.

Photovoltaics, such as photovoltaic cells, are small, semiconductor devices that convert up to 15% of the sun's energy to DC currents. This form of solar energy is suitable for lighting, electronic equipment and electric fences. It's ideally suited to remote areas where grid connections are not economical.

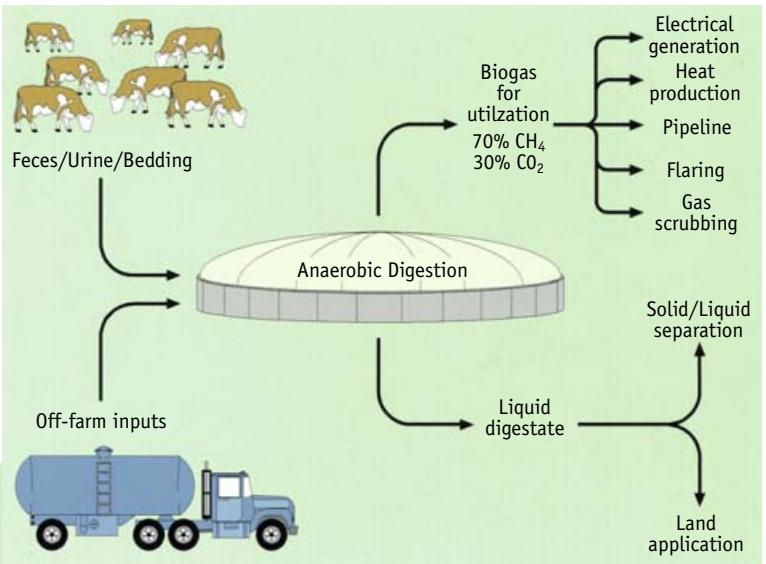
John Hill of Wentworth County relies on a hybrid system using solar and wind energy to service the electrical needs of his horticultural operation.

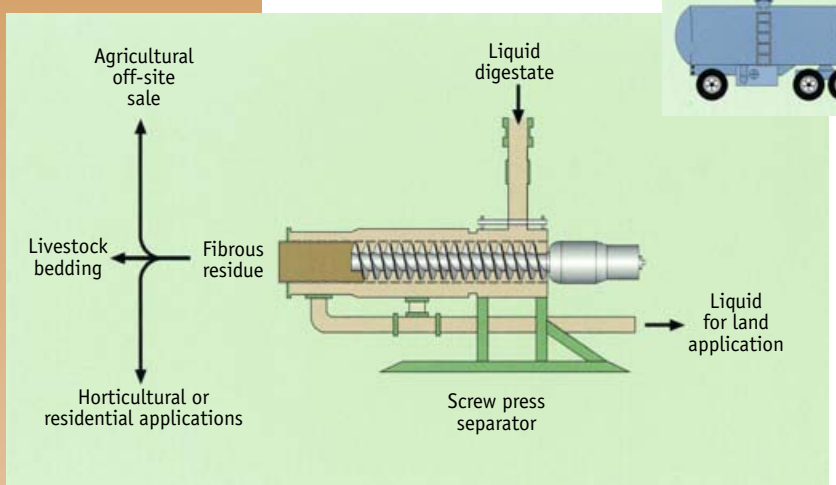
Liquid manure high in organic material is transformed by anaerobic bacteria into several end products, including "biogas" (carbon dioxide and methane). Biogas can be burned for heat or used to generate electricity.

ENERGY FROM MANURE – ANAEROBIC DIGESTION

Deriving energy from manure is obviously a win–win for livestock producers. The methane from biogas is 65% methane and 35% CO_2.

An anaerobic sequencing batch reactor or ASBR is a methane bio-digester that takes manure and creates electricity, organic fertilizer and water. The goal of this system is to transform methane into carbon dioxide and create usable energy (17–25 MJ/m^3).





Anaerobic digestion (AD) can perform most of the following functions:

- ▶ reduce manure volume for land application
- ▶ reduce or increase nutrient content of manure for land application
- ▶ recycle a product for reuse (e.g., water for flushing systems)
- ▶ reduce environmental impact (e.g., surface and ground water contamination)

- ▸ reduce odours and other nuisances
- ▸ reduce pathogens
- ▸ produce useful by-products for on-farm use or off-farm sales
- ▸ produce clean discharge
- ▸ reduce emissions of greenhouse gases
- ▸ produce renewable energy.

The biogas produced by anaerobic digestion units can be burned for heat or used to generate electricity.

How it works

Digesters function over a range of temperatures. Most work best at temperatures between 35 and 40°C (95–104°F).

Components include storage tanks, manure-handling equipment, digester tank, gas-handling equipment and electrical generation equipment.

Remaining outputs often require further processing prior to disposal or application.

Types of AD systems

Generally speaking, there are two AD system configurations suitable for Canada.

Completely mixed systems, as the name implies, consist of a large tank in which new and old materials are mixed. These systems are suitable for manure with lower dry matter content of 4–12%.

Plug-flow systems typically consist of long channels in which the manure moves along as a plug. These systems are suitable for thicker liquid manure (11–13% dry matter).

ADVANTAGES	DISADVANTAGES
• odour reduction • pathogen reduction • energy production	• increased capital cost, labour and maintenance • most suitable for very large operations • utility connections may be difficult