BEST MANAGEMENT PRACTICES

On-Farm Energy: A Primer

Canada

Ontario

OFA Ontario Federation of Agriculture

What is a Best Management Practice or "BMP"?

- a proven, practical and affordable approach to conserving soil, water and other natural resources in rural areas

What is the BMP Series?

- innovative, award-winning books presenting many options that can be tailored to meet your particular environmental concerns and circumstances
- current BMP titles are:

A Phosphorus Primer
Application of Municipal Sewage Biosolids to Cropland
Buffer Strips
Controlling Soil Erosion on the Farm
Cropland Drainage
Deadstock Disposal
Establishing Tree Cover
Farm Forestry and Habitat Management
Fish and Wildlife Habitat Management
Greenhouse Gas Reduction in Livestock Production Systems
Integrated Pest Management
Irrigation Management
Managing Crop Nutrients
Manure Management
Nutrient Management Planning
No-Till: Making It Work
On-Farm Energy: A Primer
Pesticide Storage, Handling and Application
Soil Management
Streamside Grazing
Water Management
Water Wells
Woodlot Management

For information on how to obtain your free copies of BMP books, please see back cover.

Best Management Practices for On-Farm Energy: A 3-Part Series

Energy efficiency, self-sufficiency, and on-farm energy production benefit both your business and the environment.

Three BMP booklets will address on-farm energy.

1. *On-Farm Energy: A Primer* – a basic overview of rural energy opportunities in conservation, efficiency, and production
2. *Green Energy: Comparing Options* – a reference guide to help farmers and rural landowners choose green energy options (alternative energy sources) for their property
3. *Saving Energy: BMPs for On-Farm Energy Conservation and Efficiency* – a more detailed explanation of how to save energy in livestock facilities and field operations

A Word about Watts

A watt is a unit of power that expresses electrical energy. It corresponds to the rate of energy consumption or generation in an electric circuit.

UNIT	SYMBOL	DEFINITION	EXAMPLE
Watt	W	one joule per second	lightbulbs, indicating power consumption
Kilowatt	kW	1,000 watts	heaters, electric motors, tools, machines
Megawatt	MW	1,000,000 watts	power plants
Watt-hour	Wh	energy used when 1 watt is applied for 1 hour	a 60 W bulb burning for 1 hour consumes 60 Wh
Kilowatt-hour	kWh	energy used when 1 kW is applied for 1 hour	utilities often bill us in kWh

CONTENTS

INTRODUCTION

Farming relies on energy to heat, light and ventilate barns and greenhouses, plant and harvest crops, power electric fencing, fuel equipment, pump and heat water, and much more.

In nearly every energy use are opportunities to improve efficiency and reduce costs. The key is to identify how much you're using in each facet of your operation, where efficiencies are possible, and the most appropriate solutions for your circumstances.

Farming also offers opportunities in renewable energy generation. Conserving or generating energy begins with familiarizing yourself with all the different approaches – what's involved and pros and cons – and which might be feasible in your operation.

This booklet begins where you should too: the farm auditing process. Working with a professional is the best way to map out what your operation uses now, and where you can save.

We also introduce different forms of on-farm generation: solar, wind, geothermal, micro hydropower, biomass, biofuels, and biogas. The focus is farm-scale generation for on-farm use.

Whether it's a large or small investment, always work with reliable industry professionals to ensure you're making the best choices for your circumstances.

This booklet introduces farm-scale projects for energy efficiency and generation.

Barn renovations provide a good opportunity for replacing older equipment, like this ventilation fan, with energy-efficient technology.

GETTING STARTED

One energy conservationist has advised: "Invest your first energy dollar in conservation and efficiency. Then invest the money you've saved in green energy alternatives."

Many energy-saving steps have very quick paybacks, making them the best place to start.

STEP 1
Conduct an energy assessment or audit.

STEP 2
Follow the energy audit: conserve energy and replace with energy-efficient technology where recommended.

STEP 3
Explore and integrate green energy technology where feasible.

In energy speak, *conservation* and *efficiency* are not interchangeable.

Conservation is wise use. For example, when using the clothes dryer, it's best to do a full load, not just a few small items.

To continue the dryer analogy, *efficiency* would mean drying similar fabrics together – using energy more efficiently. Or it could mean upgrading to a more efficient dryer that uses less energy.

FARM ENERGY AUDITS

An energy audit consists of a set of actions aimed at identifying and evaluating energy management opportunities within a farm operation, or a specified portion of a farm operation.

An audit should yield a good deal of information you can work with. It will identify:

- where energy improvements should be made
- potential cost-saving measures
- parts of the management system to monitor more closely
- maintenance and other preventative measures that will reduce downtime.

An audit will also specify and compare capital improvements – including changing energy sources – to reduce energy use and/or cost.

Note that energy *audits* are conducted by engineers. Energy *assessments* are less detailed, and can be done by trained specialists.

An energy audit or assessment identifies energy savings and alternative opportunities.

The farm energy audit helps producers make informed decisions about farm energy use.

An audit conducted by a professional engineer will thoroughly examine all aspects of energy consumption, system improvements, costs, and management.

THE ENERGY AUDIT PROCESS

This 10-step process involves the auditor working closely with the farm manager to get a clear picture of energy use and opportunities.

1. Plan the audit

- discuss which parts of the farm operation and management systems are to be included

2. Organize records

- organize files for energy bills, maintenance and repair work

3. Perform an inventory

- look at the cost and consumption rate of electricity, natural gas, gasoline, diesel, and other energy sources
- determine amount of production for a given time interval, e.g. amount of grain dried, amount of milk produced, rate of gain of animals
- walk through operation looking at energy sources and technologies, insulation, ventilation, and energy-consuming devices and appliances – especially lighting, heating and motors

4. Make a preliminary analysis (benchmarking)

- develop a base-cost assessment and compare with industry standards as supplied by experienced professional auditors

A qualified auditor will look at all your energy sources and uses – especially for lighting, heating and motors.

5. Identify energy management opportunities

- look for quick wins – changes in practices, timing and scheduling, maintenance and repair
- identify high-cost areas requiring further auditing

6. Perform diagnostic audits

- measure efficiencies and effectiveness of current energy technologies and systems
- discuss next steps

7. Analyze energy management options

- identify management and technology options for energy areas
- analyze energy efficiency, potential cost-savings, suitability, costs, and return on investment

8. Make recommendations and decisions

- discuss recommendations – highlight where monitoring and control systems would help further energy savings
- make decisions

9. Implement plan

- select reputable service providers
- schedule projects and other improvements

10. Monitor and target activities

- track changes in energy consumption after implementation
- fine-tune operating systems to improve savings
- follow recommended equipment and system maintenance schedules to maintain savings

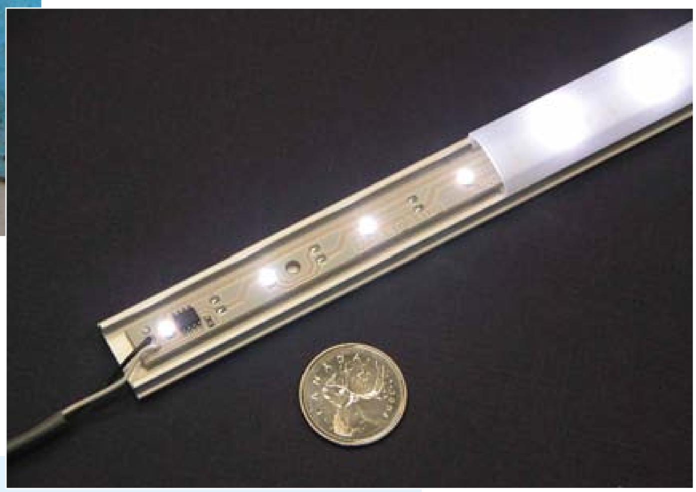
BMPs FOR ENERGY EFFICIENCY

AROUND THE HOME

Energy audits are a great way to start. There are always improvements – no matter how small – that can reduce your energy bills. Basic BMPs for energy conservation for the home are highlighted below.

Energy controls can be used for heating, lighting and appliances. Energy controls will help to use energy more efficiently and reduce energy needs.

Energy-efficient appliances like this water heater pay for themselves in energy savings.



Energy-efficient lighting such as light-emitting diode (LED) lights is a simple way to start saving energy around the home.

AROUND THE BARN

The best way to start is by comparing your energy use with similar operations – a process referred to as *benchmarking* (see Step 4, pg. 4). It will help pinpoint areas of your operation where you can make improvements in energy efficiency and conservation.

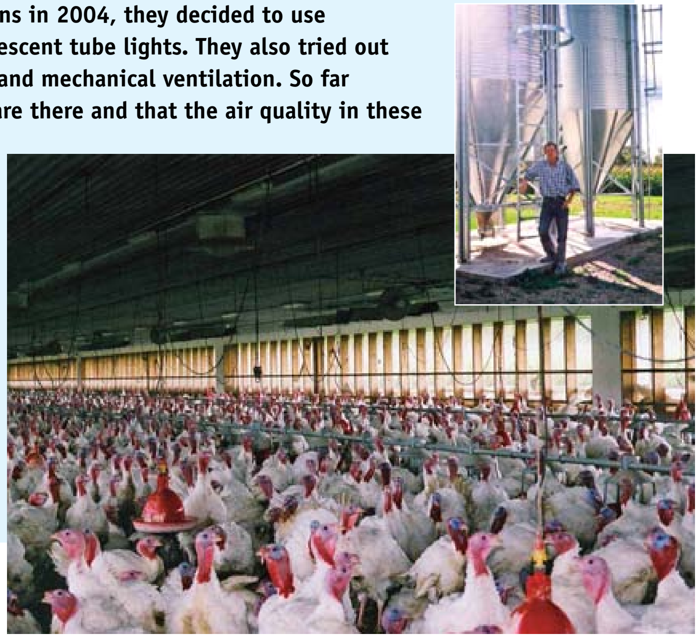
The biggest users of electrical energy in livestock operations are heat, lights and motors. Consider the technologies illustrated below when making improvements.

POULTRY

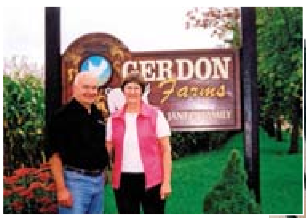
When Bill Revington and his company built two new barns in 2004, they decided to use two-stage infrared tube heaters and dimmable T-8 fluorescent tube lights. They also tried out curtain-sided dual ventilation, which uses both natural and mechanical ventilation. So far they have been impressed. They know that the savings are there and that the air quality in these new barns is significantly improved.

"We focused directly on the primary uses of energy in our operation – ventilation, lighting and heating – to decrease our energy cost," Bill says.

"We used to see significant condemnations due to airsacculitis, since birds are very susceptible to getting dust lodged in their lungs, which in turn causes infection. The respiratory system of a bird is not well-serviced by its immune system. This situation is greatly improved in the new barns with dual ventilation and improved air quality."



SWINE



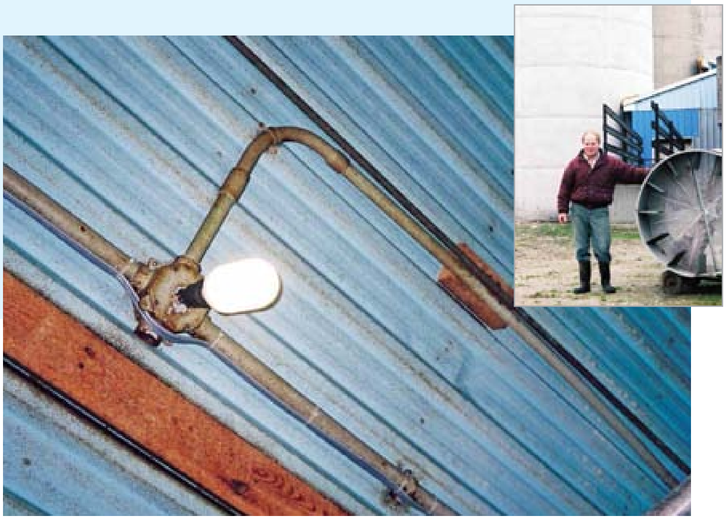
Climate is critical for farrowing operations: piglets require a nursery temperature of 36 °C (96.8 °F) and sows will be most comfortable and maximize their milk production at about 18 °C (64.4 °F).

"We are in the business of nurturing and producing animals," comments Gerald Jantzi, "so we want to keep them as comfortable as possible in a clean creep environment."

The Jantzis changed to electric creep heat mats and now use roughly half as much energy. Their energy bills are somewhere around $4,000 per month, and they have been able to take 10% off those costs – saving approximately $5,000 per year on their farm.

DAIRY

Steve Veldman is no stranger to saving energy, reducing costs and improving efficiency. Steve embraces the culture of energy conservation, and he is constantly changing the way he runs his 75-cow tie-stall dairy farm to gain benefits. One simple area of improvement was the conversion from fluorescent to compact fluorescent lighting. It provides superior lighting and an electric cost savings of roughly $1,500 per year.



There are many opportunities to improve energy efficiency in milking centres, such as variable-speed drive equipment, milking pre-coolers, heat reclaimers, and scroll compressors.

Henk and Ary Grootendorst have built an impressive dairy operation by paying careful attention to the barn environment for their cows and by purchasing energy-efficient equipment.

"We installed our variable-frequency drive vacuum pump 10 years ago when we built our first barn. Since we have to run it at only 30% of its full capacity, there are definite energy savings with the additional benefit of a longer operational life for the pump," comments Henk.

"The best part of all is that we have not had to fix the pump over the 10 years."

For their water system, they have installed a high-efficiency water heater. Warm water from the milk pre-cooler and milk heat reclaimer is stored in several water storage tanks, which feed preheated water to the water heater. The warm water also goes to the cattle for drinking water, preheats the milk parlour floor, and is used in the warm-water sanitation cycles and other cleaning activities.

IN THE GREENHOUSE

Research indicates that 80% of the energy to heat a single-glazed greenhouse is required at night, so reducing heat loss at night can pay dividends.

A movable insulated curtain can reduce the heat loss by up to 70% when the curtain is closed. There are several types of blanket materials, each with their own advantages and disadvantages. Non-porous aluminized materials provide the most savings – up to 70% when closed. Porous blankets save about 20% when closed, but can be used for shading in the summer and allow water to drain through them.

A double polyethylene-covered greenhouse reduces air infiltration losses. But unless it has an infrared-treated film, infrared radiation can be transmitted out of the greenhouse.

The infrared/anti-condensation-treated films are expensive but reduce energy use by up to 20%. The payback on the incremental cost of purchasing these treated films is often less than one heating season.

IN THE FIELD

Save energy during field operations by following the owner's manuals and keeping equipment properly maintained.

Reduce fossil fuel consumption with the following BMPs:

- ✔ **assess fuel efficiency performance**
- ✔ **match tractor capacity to task at hand**
- ✔ **follow recommendations for ballast distribution**
- ✔ **use timers for block heaters.**

Mulch tillage and no-till cropping systems reduce the number of passes in the field, which reduces fuel consumption by up to 70% when compared with conventional systems.

BMP OVERVIEW FOR ON-FARM ENERGY PRODUCTION

Green energy production uses on-farm renewable resources and production systems to generate energy.

Federal, provincial and municipal legislation may directly affect the design, construction and maintenance of green energy technologies or structures. Always consult reliable industry professionals to verify requirements for proposed projects.

Wind that blows across rural Ontario can be captured by turbines that convert it into electrical power.

Anaerobic digesters produce biogas by using manure and other organic inputs such as energy crops and food processing by-products. Biogas can be used as a replacement for natural gas to produce heat, electricity and/or transportation fuel.

On Ontario farms, solar panels (photovoltaic cells) can be used to produce electricity, and solar walls can capture heat.

Ontario farmers can grow new energy crops such as switchgrass for on-farm use in biomass combustion systems, or for further processing (e.g. pelletizing) for off-farm use.

SOLAR

Solar radiation is energy that can be harnessed to provide sources of heat, hot water and electricity. Solar heating systems for hot air or hot water are called *solar air* or *solar thermal* systems. Solar electric systems are called *photovoltaic* systems.

Solar air – refers to the solar heating of buildings, either passively (using air movement) or actively (using fans and a circulation system). Heat is absorbed from the sun. Air is passed over the heated surface and circulated around the space to be heated using convection or fans.

Poultry barns require carefully controlled temperatures and proper ventilation to maximize bird health and growth. Well-designed solar space-heating systems can help meet both of these needs.

Solar thermal – refers to solar heating systems that heat a liquid inside a closed-loop system of pipes. Pipes are arranged in boxes under glass. Solar heat is trapped in the box by a flat black plate (plate collector) or by tubes between layers of glass (evacuated tube collectors). Hot water heating systems use fluid that will not freeze in the winter, and pump that fluid to a heat exchanger to heat water for use inside a building.

One type of solar collector for a water-heating system is the glazed flat-plate collector. The water or heat transfer fluid circulates through a network of copper piping attached to a flat black plate inside a glass-covered frame.

BMP*i*

Solar panels should be cleaned regularly to avoid dirt buildup, especially in lower edges. Be careful not to cause damage. Use a low-pressure cleaning system and demineralized water.

Solar electric – refers to the conversion of solar radiation to electricity by photovoltaic cells and modules. The photovoltaic cell uses two semiconducting materials that create an electric current from solar-activated electrons. Electric currents are used as DC or inverted to AC for use as supplemental energy for lights and equipment in barns, workshops or farm homes.

Photovoltaics (PV) can be used to power lighting, electric fencing, small motors, aeration fans, gate-openers, irrigation valve switches, and automatic supplement feeders.

Solar electric energy can even be used to move some sprinkler irrigation systems.

On a larger scale, some or all of the energy produced can be delivered and sold to a local utility through a grid-tie system. This can involve net-metering, where the utility compensates the producer for the net outflow of power (i.e. minus producer use) or a feed-in tariff, where the producer is paid by the kilowatt hour for all the power produced and put onto the grid.

Land in areas with a high proportion of annual sunlight hours may be suitable as solar farms where arrays of photovoltaic modules capture solar radiation. Ideally these systems are located on marginal lands where crops for food are not displaced. Farmstead roofs are an ideal location for solar panels.

You need to ensure the roof is structurally adequate to withstand the panels and any changes to snow loading.

Photovoltaic systems are well-suited to pumping water for livestock in remote streamside pastures, where power lines are unavailable.

SOLAR	
BENEFITS	**CHALLENGES**
• a renewable resource • suitable for remote applications • reduced grid energy consumption • no moving parts unless trackers are used	• some solar systems, e.g. photovoltaic, are a substantial investment • applications limited by sunlight hours and energy generated • if not connected to the grid, energy must be stored for times when solar power is unavailable – batteries are expensive and relatively inefficient

WIND

Not only does the sun supply the earth with direct radiant energy, it also heats the earth and the atmosphere, producing temperature differentials that result in wind. Wind power uses energy from the moving air to turn blades on windmills.

In the past, the motion of the blades was used to grind flour or pump water. Now the blades turn turbines, which rotate generators in order to produce electricity.

Wide open windy spaces are needed in order for these systems to be efficient.

Small wind energy systems come in two sizes:

- micro-electrification or small-capacity wind turbines (100 W–1 kW) – limited on-site or domestic use
- auto production (1–50 kW) – suitable for farm operation needs.

There are several types of wind energy systems:

- **stand-alone –** provides power solely from the wind. In most cases, these systems are grid-connected. Some stand-alone systems may use batteries to store energy when wind conditions are not good.
- **hybrid –** combines wind and photovoltaic (PV) technologies, offering several advantages over just wind or PV. In most locations, wind speeds are low in the summer when the sun shines brightest and longest. The wind is strong in the winter when less sunlight is available.
- **mechanical –** used to aerate ponds or pump water for livestock, irrigation, or household water supplies. More than a million mechanical wind systems are said to be in use in the world today, most of them on farms.

Mini wind power systems are suitable for charging batteries for small electrical loads.

BMP*i*

Wind turbine tower foundations have special requirements depending on turbine type, tower design and size, and local soil conditions. A key BMP is to consult a local engineer or contractor – *before* you start – to determine whether the soil at the site requires special consideration for the foundation type proposed by the manufacturer.

WIND POWER: ON-FARM APPLICATIONS

Wind has been used as a reliable and inexpensive water-pumping power source for generations. Either a mechanical or electric water-pumping system could be ideal for rural and remote locations to supply livestock, a household, or even a small community.

Wind energy systems can do much more than pump water for a modern agricultural operation. Because they are ideal where remote, low voltage power is required, wind energy electrical generators are used for such farm components as electric fences and yard lights.

WIND

BENEFITS	CHALLENGES
• a renewable resource • suitable for remote applications • reduced grid energy consumption	• can be a substantial investment • not operational unless wind speeds are suitable (11–45 km/h or 7–28 mph) • can have high maintenance requirements • small systems may be noisy • some failed technology in recent years

GEOTHERMAL

Geothermal energy is evident on the earth's surface in the forms of volcanoes, geysers, and hot springs. Not far below the ground surface, the seasonal effects of ambient temperatures have little influence, and the internal heat of the earth provides consistent temperatures year-round. One way to tap geothermal energy is *geothermal heat pumps* that provide heat and cooling to buildings.

Also called *ground-source heat pumps,* they take advantage of the constant year-round temperature of about 10 °C (50 °F) that is just 3 to 5 metres (10–16.5 ft) underground.

In a conventional domestic geothermal system, heat transfer fluid is pumped through pipes that are buried underground, and recirculated into the building. The underground loops of piping act as a heat exchanger. When the heat transfer fluid passes through the loops, it absorbs heat from the ground, which causes it to be warmed.

The heat pump component upgrades this heat to a usable level. Typically for every 1 kWh of electrical power used by the heat pump, you get 4 kWh of usable heat.

This upgraded heat can be used directly in a hydronic or in-floor heating system, or it can be converted to a forced-air system through a heat exchanger.

In summer, the liquid moves heat from the building into the ground. In winter, it does the opposite, providing pre-warmed air and water to the heating system of the building.

Heat pumps can offset greenhouse heating costs.

GEOTHERMAL	
BENEFITS	**CHALLENGES**
• more energy-efficient than most other green energy sources • payback is 5–8 years • heating/cooling and hot water available for all types of farm buildings and homes, potential for hybrids • a heat pump can heat and cool different buildings at the same time, e.g. heating a farm shop and cooling potato storage sheds simultaneously	• initial capital cost • soil limitations – depth to bedrock, stoniness and dry conditions • compatibility with existing heat distribution or hot water systems can be a problem for upgrade projects

MICRO HYDROPOWER

Hydropower is the conversion of energy from flowing water to electrical energy through the use of a turbine.

In the past, water-powered mills played essential roles in rural Ontario – for milling flour, grist and feed, and for saw mills.

Hydropower systems are classified as large, medium, small, mini and micro, according to their installed power generation capacity. (The smaller systems are within the scope of this booklet.)

A **micro hydro** system typically has a generating capacity of less than 100 kW.

A **mini hydro** system has an installation capacity of 100–1000 kW (1 MW).

A **small hydro** system is defined as having a capacity of 1–10 MW.

BMPi

Micro hydro systems are not maintenance-free. Owners should clean out blockages (silt, branches and weeds) from intakes and pipes once a year.

Flowing water can turn a turbine. The turbine then drives a generator to produce electricity.

Existing rural dams can be converted to capture micro hydropower.

MICRO HYDROPOWER	
BENEFITS	**CHALLENGES**
• reduced dependency on grid • accessible in remote areas • less pollution	• suitable site conditions required • cannot be expanded • low power during low-water conditions • some environmental impact – fish and wildlife migration • creating or modifying dams will require permits since this may affect upstream or downstream users

BIOMASS

Biomass materials such as wood, field crops, livestock manure, and other dry organic materials can be used as renewable sources of energy to heat homes and generate electricity.

Biomass is wood or energy crops (e.g. native grass varieties) that can be combusted in high-efficiency systems to produce heat or power, or be converted to bio-oils.

Biomass such as fuelwood has been used for millennia. When burned, biomass converts to carbon dioxide and water, and releases the sun's energy.

Many types of plants can be used for biomass energy production. There are two main approaches: growing plants specifically for energy use, or using the residues from plants that are grown for other purposes.

Grasses – cool-season and warm-season native and introduced grasses can be suitable biomass energy crops.

Grain crops – many farmers have discovered that grain corn may be burned economically in purpose-built burners for affordable domestic heating.

Oilseeds – crops such as soybeans and canola can be processed for oil (biodiesel), and the meal by-products can be used as livestock feed.

Switchgrass, big bluestem, and other native varieties can be harvested for up to 10 years or longer before replanting.

BMPi

Harvest less than 30% of crop residue to leave some biomass for soil organic matter.

Biomass wood – on-farm wood materials can be used for biomass too. Sources of on-farm woody biomass include:

- fuelwood – harvested and processed for space heating
- short-rotation woody biomass crops (e.g. willow) – harvested, chipped and burned for heat energy
- waste products from farm woodlot or plantation forest harvest (e.g. limbs, treetops and inferior woody debris) – chipped as woody biomass.

Short-rotation biomass can be harvested for energy production.

APPLICATIONS

- wood heat for farm buildings and greenhouses to replace high-cost fossil fuels
- combustion of low-quality grains for heat
- combustion of sustainable biomass for large electrical power plant

Biomass can be used by large biomass combustion-based electrical power plants.

BIOMASS	
BENEFITS	**CHALLENGES**
• cleaner fuels – fewer greenhouse gas emissions than fossil fuels • renewable resource • alternative land use • opportunities for rural economic diversification • farmers across Ontario can participate by growing biomass crops	• cost–benefit for intensive management • opportunity costs – land for food and feed vs. land for energy • environmental impact of conventional crop systems for growing energy crops • removal of nutrients and organic matter from the farm • increased market for crop products may impact other users (e.g. livestock, food) • some biomass has high mineral (nutrient) concentrations, which can cause challenges such as clinker formation during burning • some outside wood-burning furnaces can cause air pollution (smoke), especially when operating at low capacity • getting paid for the biomass baled and stored on-farm

BIOFUELS

After space heating, transportation and tractor fuels are among the biggest energy needs. Biomass can be converted to transportation fuel. Ethanol and biodiesel are forms of biofuels. Ethanol can be mixed with gasoline and used in gasoline-burning engines. Biodiesel, from the treated oils of oilseed crops, can be mixed with diesel fuel.

ETHANOL

Ontario currently has a 5% ethanol mandate for commercial vehicle fuels. Blending ethanol results in a cleaner-burning fuel that emits an average of 20% less carbon monoxide than unblended gasoline.

Ethanol is currently made from corn or wheat. Research continues on producing ethanol from non-crop biomass to produce what is known as cellulosic ethanol.

Ethanol-gas mixtures can be used for any gas-fuelled farm vehicles such as trucks, ATVs, and small engines.

ETHANOL	
BENEFITS	**CHALLENGES**
• renewable energy from grain crops • ethanol can easily be blended with gasoline, allowing use in conventional engines • domestic energy source • less carbon dioxide emitted (than from fossil fuel combustion) • less MTBE used (this fuel additive is a known carcinogen and water contaminant)	• acreage required to produce ethanol • opportunity costs of growing feed and food • soil degradation from grain-centred cropping systems • risk of increased feed cost for livestock due to global corn ethanol market • loosens “gunk” in the fuel system, which can clog filters

BIODIESEL

Biodiesel is typically made by chemically reacting lipids, such as vegetable oil or animal fat, with an alcohol to create a product with characteristics similar to petroleum-based diesel fuel.

Biodiesel is meant to be used in standard diesel engines, and is thus different from the vegetable and waste oils used to fuel converted diesel engines.

Biodiesel can be used:

- as fuel in diesel engines – trucks, combines, swathers
- in boilers or furnaces designed to use heating oils or in oil-fuelled lighting equipment
- "straight" (100% biodiesel), or blended with petroleum diesel.

Tractors fuelled by biodiesel have lower emissions than tractors using petroleum diesel.

Using waste oil from food processing can result in a biodiesel that is cheaper than conventional diesel. However, competition is developing for the used oil product.

Biodiesel can be used in most on-farm diesel engines, and will usually be blended with diesel.

Oilseed field crops can be processed to produce biodiesel.

BIODIESEL	
BENEFITS	**CHALLENGES**
• safe and easy to handle • no sulphur • odour-free • operates in any kind of basic diesel engine (up to 20% biodiesel) • less air pollution • enhanced lubrication quality of the fuel • blends well with conventional diesel	• backyard brewing is unsafe without proper chemical-handling techniques • low energy content compared to petroleum-based fuels – 11% less energy, which can lead to power loss in engines • long-term storage can result in oxidation and fuel spoilage • hard to use under colder conditions • finding markets or uses for the co-products (e.g. meal and glycerine), which is critical to the economics of on-farm production

ANAEROBIC DIGESTION FOR BIOGAS PRODUCTION

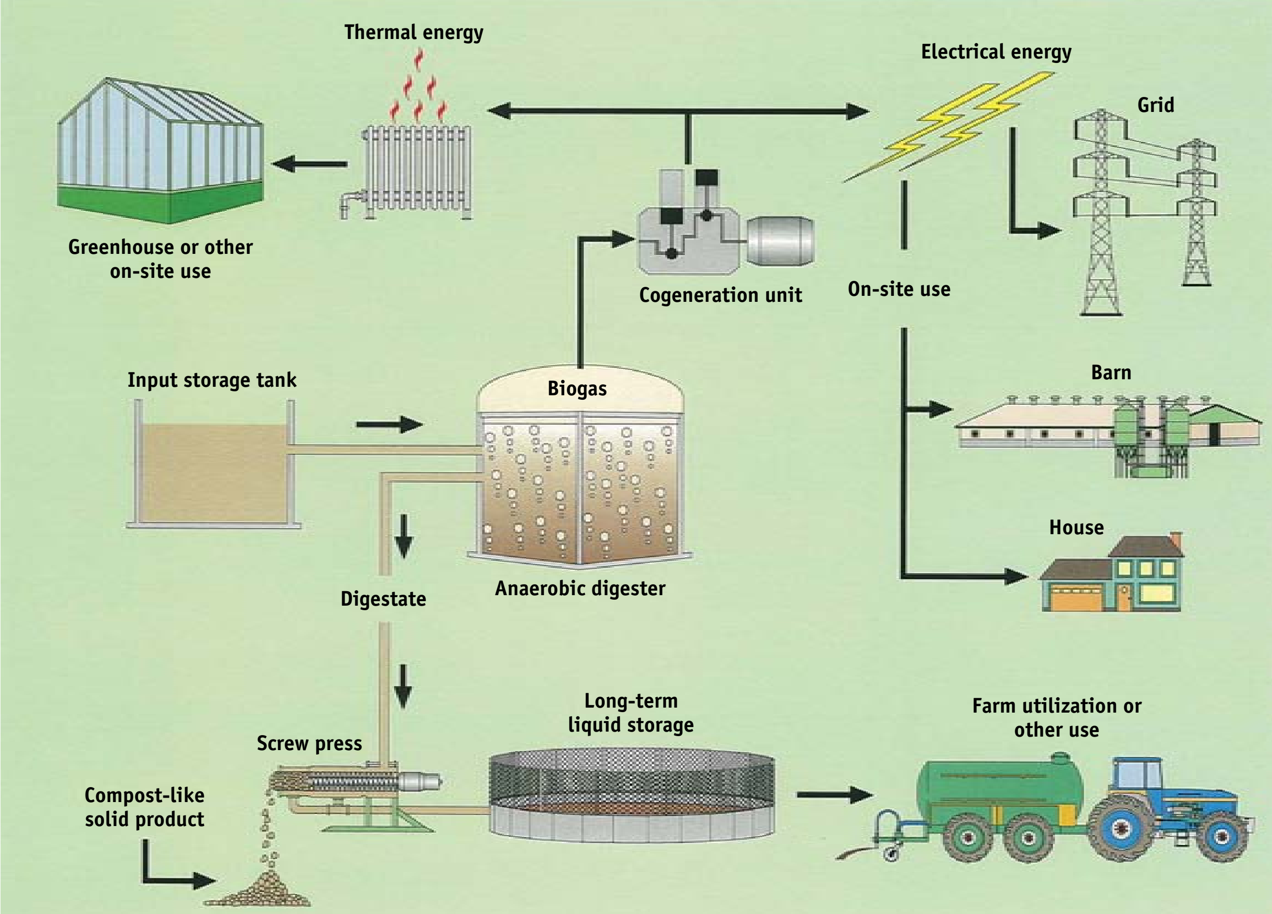
Anaerobic digestion (AD) is the process of micro-organisms breaking down organic materials in the absence of oxygen. Biogas is produced and used as a fuel for generators that produce electricity and for heat. Input material for digesters include manure, energy crops, and food and feed processing by-products.

Completely mixed digester – a completely mixed system, as the name implies, consists of a large tank in which new and old materials are mixed. These systems are suitable for manure with lower dry matter content of 4–20%.

Generally speaking, the completely mixed system has proven to be the most reliable AD technology for Canadian farm conditions.

When manure and other organic materials such as food processing by-products or crop materials are heated and mixed, they can produce biogas, which is mostly made up of methane. The methane can be collected and burned to produce electricity and heat, or used as a fuel replacement.

ANAEROBIC DIGESTION PROCESS



In Ontario, biogas systems are usually built to produce renewable energy. There are also environmental improvements such as eliminating pathogens (e.g. E.coli) and reducing odour from manure.

The biogas is burned in a cogeneration unit that produces electricity and heat. The "digestate" is the nutrient-rich end product that can be used as a crop nutrient.

Some farmers extract a peat-like fibre out of the digestate that they use as livestock bedding to replace straw, shavings or sand.

ON-FARM APPLICATIONS

Biogas can be burned for heat or used to generate electricity. The biogas can also be processed to produce almost pure methane that is equivalent to natural gas. This material, called *renewable natural gas,* could be injected into a natural gas pipeline. As well, cleaned biogas (called *biomethane*) could be used as a fuel source for vehicles.

Most on-farm biogas systems receive off-farm materials like food processing by-products to boost biogas production.

Manure alone has relatively low energy, but has a good range of bacteria that can produce biogas.

Mixing fats, oils and greases, or vegetative materials not only produces lots of gas, but also returns the nutrients in these food by-products back to the cropland.

BMP*i*

Manage off-farm materials in a manner that reduces odour emissions.

ANAEROBIC DIGESTION	
BENEFITS	**CHALLENGES**
• odour reduction • pathogen reduction • energy production • nutrient retention for fertilizer use • reduction in greenhouse gas emissions • effective co-treatment of food processing wastes that may be expensive to manage using other methods	• high capital cost, labour and maintenance • most suitable for large operations • utility connections may be difficult • no decrease in the nutrient content of manure, so the same land base is required for spreading unless further treatment is done • can be difficulties with startup

For More Information

ONTARIO MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS

OMAFRA offers many helpful resources on energy issues in barns, yards, and in the field.

For information on energy efficiency, conservation and management, see **http://omafra.gov.on.ca/english/engineer/con_energy.htm**

For information on green energy generation, see **http://omafra.gov.on.ca/english/engineer/energy.html**

Get acquainted with the Green Energy Business Information Bundle for Farmers at **http://omafra.gov.on.ca/english/engineer/ge_bib/welcome.htm**

If you have a question regarding farming, agribusiness or rural business, call the Agricultural Information Contact Centre at 1-877-424-1300 or email **ag.info.omafra@ontario.ca**

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OTHER RESOURCES

Biogas Association
http://www.apao.ca

HydroOne
(energy efficiency around the home)
http://www.hydroone.com/MyHome/SaveEnergy

Natural Resources Canada –
Office of Energy Efficiency
(EnerGuide, Energy Star)
http://oee.nrcan.gc.ca/home

Ontario Ministry of Energy –
Renewable Energy Facilitation Office
(new renewable energy projects)
http://www.energy.gov.on.ca/en/renewable-energy-facilitation-office

Ontario Power Authority
(microFIT Program)
http://microfit.powerauthority.on.ca

Ontario Sustainable Energy Association
(community power projects)
http://www.ontario-sea.org

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